October 11, 2018

Electronically Submitted

Utah Coal Program
Utah Division of Oil, Gas, and Mining
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Subject: **Task #5690, Amendment to Volume 9, Appendix A-1 to Reduce the Hydrologic Monitoring Program for Sites Within and Outside Mine Permit Boundaries, PacifiCorp, Deer Creek Mine C/015/0018, Emery County, Utah.**

Amendment to Volume 1, R645-301-720 Hydrologic Resources and Monitoring Requirements (Including map HM-1A), to Reduce the Hydrologic Monitoring Program for Sites Within and Outside Mine Permit Boundaries, PacifiCorp, Deer Creek Mine C/015/0018, Emery County, Utah.

PacifiCorp, by and through its wholly-owned subsidiary, Interwest Mining Company "Interwest", submitted an amendment to amend Volume 9, Hydrologic Volume, Appendix A, to reduce the water monitoring responsibilities as outlined in the hydrologic monitoring program, on June 6, 2018. PacifiCorp sent a follow-up letter to the Division on June 25, following discussions at the Collaborative Meeting, suspending the monitoring program indefinitely due to hazardous conditions and Forest Service closures caused by the Trail Mountain Fire.

Since the June 25 letter, the Trail Mountain wildfire that began as a prescribed burn and that jumped out of control on June 5, 2018, eventually spread across the top of East Mountain, burning over 18,000 acres of lands above and around the PacifiCorp Deer Creek mine properties and permit area, devastating the vegetation and landscape. Nearly all of the surface springs that are in the PacifiCorp monitoring program that overlie the underground mining area are within the burned area. Nearly all of the few springs that remain outside the fire area are outside of the mining area as well. The destruction of the vegetation within the fire area has the potential to significantly alter the hydrologic characteristics of the springs and their recharge on East Mountain and mask any effects that could possibly be caused by mining. In addition, the surface hydrologic monitoring sites established and monitored for nearly thirty years are now completely impacted by the Trail Mountain fire. More than three years have elapsed since the cessation of mining activities at Deer Creek. Data presented in the above amendments shows that there has been no effect on the hydrologic balance from mining at Deer Creek.

On July 18, 2018, PacifiCorp received response from the Division identifying deficiencies to Task #5690. Specifically, two deficiencies were listed:

- Groundwater Water Monitoring

- The permittee must conduct a field inspection in conjunction with the Division and USDS Forest Service in order to ascertain the extent of monitoring that is required to assess potential impacts/material damage to the hydrologic balance within and adjacent to the permit area.

- Surface Water Monitoring
  - The permittee must conduct a field inspection in conjunction with the Division and USDS Forest Service in order to ascertain the extent of monitoring that is required to assess potential impacts/material damage to the hydrologic balance within and adjacent to the permit area.

The Division noted that the Trail Mountain fire affected the area of hydrologic monitoring and inspection of the monitoring sites would have to be delayed until it was safe to conduct a field reconnaissance.

On September 11, 2018, at the request of PacifiCorp, the Division representative Keenan Storrar and USFS representative Jeff Salow attended a meeting in Huntington to discuss the deficiencies outlined in the July 18, 2018 letter from the Division. To assist the Division and Forest Service with PacifiCorp's proposal to amend the hydrologic monitoring, transitioning from operational to reclamation status, PacifiCorp presented the following information:

- Historic perspective of Federal Lease Relinquishment
  - Case studies of PacifiCorp's previous applications (Phases I through III)
    - Environmental data submittal for a minimum of three years after the last date of mining (protocol for lease relinquishment developed in conjunction with BLM/USFS/DOGM and PacifiCorp. MOU agreement signed on 09/12/96, by BLM/USFS/DOGM)
      - Mining history
      - Subsidence analysis
      - Vegetation analysis
      - Hydrologic analysis (surface and groundwater)
      - CERCLA data
- Mill Fork Lease Extension
  - Permitting history of the Mill Fork Lease
  - Hydrologic baseline extension
  - Mine closure
- Cottonwood Mine
  - Hydrologic monitoring reduction amendment
  - Reclamation sequencing
  - Post reclamation hydrologic monitoring
- Final reclamation of the Deer Creek Mine
  - Status of current and future reclamation plans
  - Deer Creek Mine will be fully reclaimed by year end 2019

Based on all of the data presented, PacifiCorp reiterated the need to transition hydrologic monitoring from operational to reclamation status, especially in light of the devastating effects of the Trail Mountain Fire and the fact that the last effective date of production for the Deer Creek Mine was in December 2014. Discussions related to the hydrologic monitoring were separated into Groundwater and Surface monitoring.

Groundwater Monitoring

The Division expressed concern about the time frame of the mine closure (December 2014) and the period of post-mining hydrologic monitoring, through 2017 – three years of post-mining monitoring. PacifiCorp pointed out that even though the last effective date of production was December 2014, the actual date of second mining (full extraction) related to monitored groundwater sources was mid-2012. In addition, to fully evaluate potential mining impacts to groundwater resources, several factors have to be taken into account:

- Mine layout
  - Single or multiple seam mining
  - Mine layout and configuration dictates the amount of measured subsidence
- Mine timing
- Measured subsidence in reference to the location of groundwater resources

To provide better resolution of the mining timeline and the period of groundwater monitoring, PacifiCorp has revised the table entitled "Removed Sites" to include an additional column "Elapsed Time from Last Date of Mining" (see Electronic Transfer File 001 revised table "Removed Sites"). During the meeting, DOGM and USFS representatives recommended that PacifiCorp select a series of springs undermined by the Deer Creek Mine with measured subsidence and a groundwater source located along the Joes Valley Fault. A field visit will be scheduled to review the sites. PacifiCorp recommended the following series of springs for the field reconnaissance field trip (see attached map Mill Fork Subsidence with Springs):

Table 1

Spring ID	Spring Selection Requirement	Water Right	Years of Post Mine monitoring
MF-10	Near maximum measured subsidence	Yes	7 + years
MF-219	Near maximum measured subsidence	No	7 + years
SPI-26	Near measured subsidence boundary	Yes	Not undermined
UJV-101	Located along Joes Valley Fault	No	7 + years

Surface Water Monitoring

PacifiCorp discussed surface hydrologic monitoring sites associated with the Deer Creek Mine. As with the case of the Cottonwood Mine, PacifiCorp recommended retaining surface monitoring sites above and below reclaimed or scheduled reclamation sites. Those sites retained are the following:

Table 2

Surface Monitoring Site	Site Location	Projected Reclaimed Site (year)
RCF1	Rilda Canyon – Right Fork Above	Rilda Canyon 1st Right (2018)
RCF2*	Rilda Canyon – Above NEUWSSD Springs	Rilda Canyon 1st Right (2018)
RCF3	Rilda Canyon – Below NEWUSSD Springs	Rilda Canyon 1st Right (2018)
RCW4	Rilda Canyon – near Hwy 31	Rilda Canyon 1st Right (2018)
DCR01	Deer Creek Above Mine	Deer Creek Mine (2019)
DCR04	Deer Creek Below Mine	Deer Creek Mine (2019)
DCR06	Deer Creek near Hwy 31	Deer Creek Mine (2019)

*RCF2 flume site was removed by the USFS due to concerns with restricted flow from runoff as a result of the Trail Mountain fire

The devastating effects of the Trail Mountain Wildfire on vegetation resources and resulting runoff will make it difficult to assess reclamation related impacts to the drainage systems, especially in Rilda Canyon. All of the surface monitoring sites established to monitoring activities associated with the Deer Creek Mine have been impacted by the Trail Mountain Wildfire. The Division and USFS agreed with PacifiCorp's recommendation for the retained surface water monitoring program to assess reclamation activities.

Deficiency Response Groundwater Field Reconnaissance

To fulfill the amendment deficiency requiring a field inspection in conjunction with the Division and USDS Forest Service, DOGM scheduled a field inspection of the groundwater sites listed in Table 1 for October 10, 2018. PacifiCorp conducted a field reconnaissance evaluation of the groundwater sites listed in Table 1 on September 26, 2018 due to concerns with safety in accessing the groundwater sites within the boundary of the Trail Mountain Wildfire. PacifiCorp was able to access all of the selected sites listed in Table 1, see attached Mill Fork Spring Review – Photo Essay Sept. – Oct 2018 essay documenting the sites. In addition to those selected, PacifiCorp documented groundwater sites adjacent to the selected sites that were not included in the Hydrologic Monitoring Program. The following table documents results of the September 26, 2018 field visit:

Table 3

Spring ID	Base Spring Flow (gpm)	Calculated Peak Flow Based on Recession Factor	Peak to Base Flow Recession %[2]
MF-219	0.5	4.5	90
MF-218[1]	0.5	NA	
MF-217[1]	0.5	NA	
SPI-42[1]	1.0	NA	
SPI-26	2.9	19.5	85
MF-10	4.0	20.0	80
MF-12[1]	1.0	NA	
MF-13[1]	1.0	NA	
UJV-101	0.5	1.25	60

[1] Springs not included in Hydrologic Monitoring Program, baseline data collected during permitting survey

[2] Average recession from peak to base flow of monitored springs from 2000 - 2017

Spring hydrographs have been updated for the selected springs listed in Table 1 to include flow values collected during September 26, 2018 field visit (Electronic Transfer File 007). Spring discharge values are consistent with hydrologic trends and clearly demonstrates that yearly discharge fluctuations are a function of hydrologic trends and are not related to mining activities.

On October 10, 2018, PacifiCorp accompanied DOGM and USFS representatives on a field reconnaissance visit to the selected springs listed in Table 1. However, the pleasant fall weather Central Utah had been experiencing changed dramatically in the last week with the influence of hurricane Rosa. The East Mountain area received approximately three inches of precipitation, including at least twelve inches of snow at the higher elevations. The upper elevation spring sites were deemed inaccessible. The group was able to visit groundwater site UJV-101 in Upper Joes Valley (photo included in the attachment Mill Fork Spring Review – Photo Essay Sept. – Oct 2018).

PacifiCorp is confident that the data submitted in the Hydrologic Reduction Amendment clearly demonstrates that the protocols established by the mining industry and the Division to monitor potential impacts associated by mining have been achieved.

Sincerely,

Kenneth S. Fleck

Ken Fleck
Geology and Environmental Affairs Manager
Interwest Mining Company
P.O. Box 310
Huntington, Utah 84528

Attachments:

Mill Fork Spring Review – Photo Essay Sept. – Oct. 2018
Mill Fork Subsidence with Springs

Cc: file

PacifiCorp – Interwest Mining Company

Task #5690, Amendment to Volume 9, Appendix A-1 to Reduce the Hydrologic Monitoring Program for Sites Within and Outside Mine Permit Boundaries, PacifiCorp, Deer Creek Mine C/015/0018, Emery County, Utah

Mill Fork Springs
Field Reconnaissance Evaluation
September 2018
October 2018

Flow: <0.5 gpm
September 26, 2018
MF-219

Flow: <0.5 gpm
September 26, 2018
MF-219

Flow: <0.5 gpm
September 26, 2018
MF-219

Flow: <0.5 gpm
September 26, 2018
MF-218

Flow: <0.5 gpm
September 26, 2018
MF-217

MF-217 & 218
Combined Flow
Flow: <1.0 gpm
September 26, 2018

Flow: 1.0 gpm
September 26, 2018
SPI-42

Flow: 2.9 gpm
September 26, 2018
SPI-26

October 9, 2000

SPI-26

Flow: 2.9 gpm
September 26, 2018
SPI-26

Flow: 2.9 gpm
September 26, 2018
SPI-26

October 9, 2000

MF-10

Flow: 4.0 gpm
September 26, 2018
MF-10

Flow: 4.0 gpm
September 26, 2018
MF-10

Flow: 4.0 gpm
September 26, 2018
MF-10

Flow: 1.0 gpm
September 26, 2018
MF-12

Flow: 1.0 gpm
September 26, 2018
MF-12

Flow: 1.0 gpm
September 26, 2018
MF-13

Flow: 1.0 gpm
September 26, 2018
MF-13

Flow: <0.5 gpm
September 26, 2018

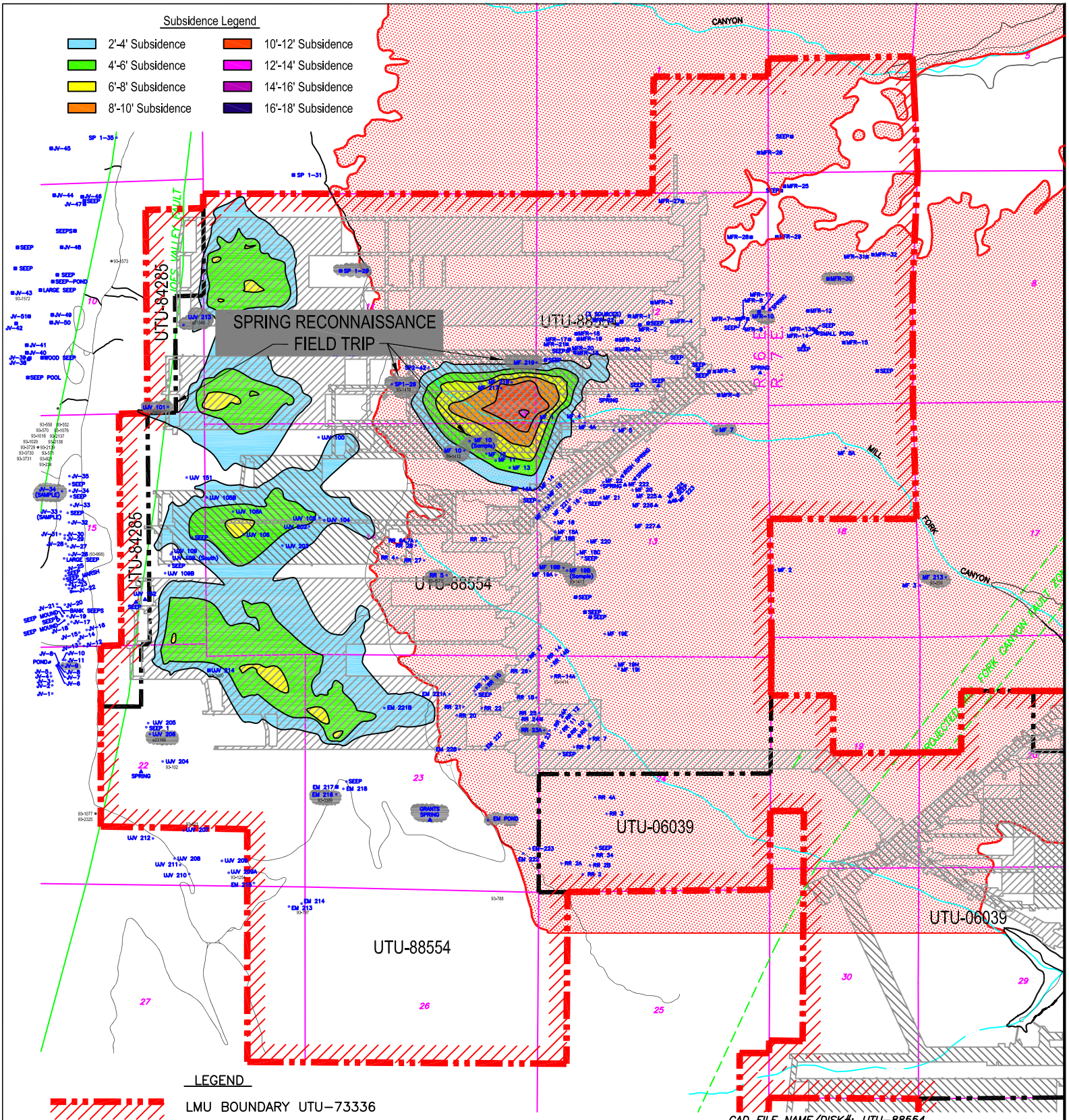
UJV-101

Flow: <0.5 gpm
September 26, 2018

UJV-101

DOGM & USFS
Field Visit
October 10, 2018
Flow: <0.5 gpm
October 10, 2018
UJV-101

DOGM & USFS
Field Visit
Access Limited to the
Northern Area of East Mountain
October 10, 2018



LEGEND

- LMU BOUNDARY UTU–73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-88554 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE
- MF 219 MILL FORK SPRING MONITORING PROGRAM
- 2018 TRAIL MOUNTAIN FIRE BOUNDARY

N

CAD FILE NAME/DISK#: UTU–88554

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
MILL FORK AREA
HYDROLOGIC MONITORING REDUCTION

DRAWN BY:	K. LARSEN	FIELD TRIP	
SCALE:	1" =3000'	DRAWING #:	
DATE:	APRIL 16, 2018	SHEET 1 OF 1	REV. ___

APPLICATION FOR COAL PERMIT PROCESSING

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

Permittee: PacifiCorp

Mine: Deer Creek Mine **Permit Number:** C/015/0018

Title: Amendment to Volume 1, R645-301-720 Hydrologic Resources and Monitoring Requirements and Volume 9, Appendix A-1 to Reduce the Hydrologic Monitoring Program for Sites Within and Outside Mine Permit Boundaries, PacifiCorp, Deer Creek Mine C/015/0018, Emery County, Utah - Response to Deficiencies

Description, Include reason for application and timing required to implement:
Hydrologic monitoring transitioning from operational to reclamation

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

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

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

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.

Kenneth Fleck — Kenneth S. Fleck — Manager of Environmental Affairs — OCTOBER 11, 2018
Print Name — Sign Name, Position, Date

Subscribed and sworn to before me this 11th day of October, 2018

Miranda Lofley
Notary Public

My commission Expires: 03-26, 2022

Attest: State of Utah } ss:
County of Emery

MIRANDA LOFLEY
NOTARY PUBLIC
STATE OF UTAH
COMMISSION # 699728
COMM. EXP. 03/26/2022

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

Form DOGM- C1 (Revised March 12, 2002)

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

Permittee: PacifiCorp

Mine: Deer Creek Mine **Permit Number:** C/015/0018

Title: Amendment to Volume 1, R645-301-720 Hydrologic Resources and Monitoring Requirements and Volume 9, Appendix A-1 to Reduce the Hydrologic Monitoring Program for Sites Within and Outside Mine Permit Boundaries, PacifiCorp, Deer Creek Mine C/015/0018, Emery County, Utah - Response to Deficiencies

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	Deer Creek Mine Permit Volume 1, R645-301-720 Hydrologic Resources and Monitoring Requirements, pages 2-220 - 225
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine Permit Volume 1, Hydrologic Resources and Monitoring Requirements, Hydrologic Data Map HM-1A
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine Permit Volume 9, Appendix A-1, Hydrologic Monitoring Program
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine Permit Volume 9, Appendix A-1, Hydrologic Monitoring Schedule
☐ Add	☒ Replace	☐ Remove	Deer Creek Mine Permit Volume 9, Appendix A-1, Hydrologic Data Map HM-1A
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan. This is a new volume of information related to relinquishments of Federal Leases UTU-88554 and UTU-84285 for reference purposes.	**Received by Oil, Gas & Mining**

Form DOGM - C2 (Revised March 12, 2002)

OPB = Outside Permit Boundaries
CCC = Cottonwood Canyon Creek
DC = Deer Creek
MF = Mill Fork
RC = Rilda Creek/Rilda Canyon
HC = Huntington Creek
MHC = Meetinghouse Creek
GW = Grimes Wash
ST = Straight Canyon
IC = Indian Creek

Recommended Field Reconnassiance Sites

REMOVED SITES

DOGM Database #	Monitoring Site	Mine	Location (Section)	Location (Twnshp/Rng)	Within Relinquished Area? (Y/N)	Lease #	Relinquishment Date	Date Mined Blind Canyon	Date Mined Hiawatha	Elapsed Time From Last Date Of Mining	Type	Stratigraphic Structure	Water Rights ID	Water Rights Owner	Remarks
12	Sheba Spring	DC	7	T17S, R7E	N	UTU-084923	Scheduled for relinquishment in 2018	No Mining	No Mining	NA	Spring	Flagstaff Form.			Spring developed for livestock. Water flows through an underground pipe to a trough
152	80-50	DC	29	T16S, R7E	N	UTU-06039	Retained for Reclamation	No Mining	No Mining	Na	Spring	Blackhawk Form.			Spring located near base of ridge separating the Right and Left forks of Rilda Canyon
369	SPI-29	DC	11	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining	NA	Spring	North Horn Form.			SPI-29 is a low volume spring/seep located below trail in a small clearing on a west facing slope surrounded with conifers and aspens. The spring drains to a small shallow basin adjacent to source. Crandall Canyon Mine developed the nearby trail into an access road during the 2007 mine collapse. Roadway reclaimed in 2013. Flow from spring SPI-29 generally ranges from 0.0/seep to a maximum of <3.0 gpm. Area near and the spring site disturbed/re-developed post Crandall Canyon mine collapse. Wet area developed on nearby access road, flow from original source dissipated (see Spring Justification document – photos). Post disturbance flow rate from spring source sufficient to maintain level in small basin, difficult to establish consistent measuring point. Flow rate estimated at 0.5 gpm on May 23, 2018.
281	UJV-213	DC	10	T16S, R6E	Y	UTU-88554	May-18		First Mining Hiawatha 25th West Bleeder Feb. 2012	6 Years +	Spring	Castle Gate Sandstone	a21560	USFS	UJV-213 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west. Flow from spring UJV-213 generally ranges from 0.0/seep to a maximum of 3.0 gpm. Spring flow dissipates rapidly below spring source. Change application is to allow the applicant the right to develop the 3 unnamed springs to draw a portion of the stock away from the Spoon Creek riparian area
259	UJV-101	DC	10	T16S, R6E	Y	UTU-84285	May-18		First Mining Hiawatha 22nd West Bleeder Mar. 2011	7 Years +	Spring	Castle Gate Sandstone			UJV101 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Flow from spring UJV-101 generally ranges from 0.0/seep to a maximum of < 4.0 gpm. Spring flow dissipates rapidly below spring source.
315	JV-34	OPB	15	T16S, R6E	N	Within 1/2 mile offset of UTU-84285	May-18				Spring	Joes Valley Alluvium			JV-34 spring located in Joes Valley alluvial basin near the 345 kV powerline. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-34 varies dramatically based on winter pack on spring runoff, generally ranges from 0.0/seep to a maximum of 80.0 gpm.
290	JV-9	OPB	22	T16S, R6E	N	Within 1/2 mile offset of UTU-84285	May-18				Spring	Joes Valley Alluvium			JV-9 spring is located in Joes Valley alluvial basin south of the Joes Valley cutoff road. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-9 varies dramatically based on winter pack on spring runoff, and generally ranges from 0.0/seep to a maximum of 3.0 gpm.
273	UJV-206	DC	22	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	Upper Price River	93-3400 a23166	USFS	UJV-206 is located along power line corridor on a west facing slope overlooking Joes Valley surrounded by aspens and conifers. Spring drains to a trough adjacent to the spring. Change application filed to allow Mr. Johansen the right to develop East Mountain Springs for use in a recreational cabin, and stock watering from a trough in the vicinity of the cabin, approved 6/16/2011.
200	MF-219	DC	11	T16S, R6E	Y	UTU-88554	May-18	First Mining Blind Canyon 7th Left Sep. 2009 Second Mining Blind Canyon 7th Left Apr. 2010	Second Mining Hiawatha: 23rd West Feb. 2011	BC 8 Years + Hia. 7 Years +	Spring	North Horn Form.			MF-219 is a spring/seep located along the reclaimed access road to Mill Fork Ridge originally developed as a fire access road and later used to access coal exploration sites for ARCO Coal. Access road reclaimed in the 1980's. MF-219 is located on a south facing slope surrounded with conifers. Flow from spring MF-219 generally ranges from 0.0/seep to a maximum of <15.0 gpm.
235	SPI-26	DC	11	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.			SPI-26 is a spring located near the main Mill Fork ridge road. SPI-26 is located on east facing slope surrounded with conifers. Site crudely developed with 1" PVC diverting flow to old steel bath tub. Flow from spring SPI-26 generally ranges from ~ 2 gpm to a maximum of 55.0 gpm.
173	MF-10	DC	14	T16S, R6E	Y	UTU-88554	May-18	Second Mining Blind Canyon 5th Left Jul. 2009	Second Mining Hiawatha 21st West Jan. 2011	BC 9 Years + Hia. 7 Years +	Spring	North Horn Form.	93-1412	USFS	aka Edmonds Bear Hole Spring MF-10 is a spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers. Flow from spring MF-10 generally ranges from ~ 5 gpm to a maximum of 60 gpm.
187	MF-19B	DC	13	T16S, R6E	Y	UTU-88554	May-18		First Mining Hiawatha 7th North Sump Feb. 2006	12 Years +	Spring	North Horn Form.	93-1413	USFS	aka Tuttle Ridge Spring MF-19B is located along natural bench directly below a massive sandstone channel on an east facing slope covered with conifers. Sampled approximately 100' below spring source. Flow from spring MF-19B generally ranges from 0 gpm to a maximum of 2.5 gpm.
209	RR-5	DC	14	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.	93-1571	USFS	RR-5 is located in a clearing on an east facing slope surrounded by conifers. Flow from spring RR-5 generally ranges from 0/seep to a maximum of 34 gpm.
156	EM-216	DC	23	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.	93-3399	USFS	EM-216 is a low volume spring/seep located along the Mill Fork access road. Flow from spring EM-216 generally ranges from 0.0 gpm to a maximum of 1.3 gpm. Flow from EM-216 normally occurs early in the year and dissipates rapidly with recordable flow rarely existing after the month of July.
377	Grants Spring	DC	23	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.			Grants Spring is a low volume spring/seep located below ridge on west facing slope above main Mill Fork access road vegetated with conifers and aspens. Flow from spring Grants Spring generally ranges from 0.5 gpm to a maximum of <3 gpm. Developed With Steel Pipe Diverted to Trough (not functioning).
219	RR-15	DC	23	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.			RR-15 located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District). Per request from Emery Conservancy District, PacifiCorp removed the weir and recorder in August 2002. Flow from spring RR-15 generally ranges from 10 gpm to a maximum of 55 gpm.
227	RR-23A	DC	24	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.			RR-23A is located in a clearing on an east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms a small drainage. Flow from spring RR-23A generally ranges from 10 gpm to a maximum of 50 gpm.
164	EMPOND	DC	23	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.			EMPOND is a located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring is dominated by conifers. Flow from spring EMPOND generally ranges from 1 gpm to a maximum of <10 gpm.

OPB = Outside Permit Boundaries
CCC = Cottonwood Canyon Creek
DC = Deer Creek
MF = Mill Fork
RC = Rilda Creek/Rilda Canyon
HC = Huntington Creek
MHC = Meetinghouse Creek
GW = Grimes Wash
ST = Straight Canyon
IC = Indian Creek

Recommended Field Reconnassiance Sites

REMOVED SITES

DOGM Database #	Monitoring Site	Mine	Location (Section)	Location (Twnshp/Rng)	Within Relinquished Area? (Y/N)	Lease #	Relinquishment Date	Date Mined Blind Canyon	Date Mined Hiawatha	Elapsed Time From Last Date Of Mining	Type	Stratigraphic Structure	Water Rights ID	Water Rights Owner	Remarks
366	MRF-30	DC	7	T16S, R7E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	Upper Price River			MFR-30 is located in small clearing on a north facing slope. Area surrounding the spring source is vegetated with mountain brush, aspens and conifers. Flow from spring MFR-30 generally ranges from 0/seep to a maximum of <3 gpm.
374	MFR-10	DC	12	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	North Horn Form.			MFR-10 is located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source is vegetated with conifers and aspens. Flow from spring MFR-10 generally ranges from 10 gpm to a maximum of 45 gpm (recorded flow of 2001 was 0.0 gpm).
171	MF-7	DC	12	T16S, R6E	Y	UTU-88554	May-18	No Mining	No Mining		Spring	Blackhawk Form.			MF-7 is located on hillside near Mill Fork drainage on a north facing slope covered with spruce trees. Flow from spring MF-7 generally ranges from 10 gpm to a maximum of 65 gpm.
197	MF-213	OPB	17	T16S, R7E	N	Within 1/2 mile offset of UTU-88554	May-18	No Mining	No Mining		Spring	Blackhawk Form.	93-259	USFS	aka Spring #3 MF-213 is located near drainage bottom (Mill Fork - Right Fork) on an east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits. Flow from spring MF-213 generally ranges from 15 gpm to a maximum of 70 gpm.
378	LITTLE BEAR	OPB	9	T16S, R7E	N	2.5 miles east of UTU-88554	May-18	No Mining	No Mining		Spring	Star Point Sandstone	93-1411	USFS	Little Bear Spring is located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo). Flow from spring Little Bear Spring generally ranges from 225 gpm to a maximum of 475 gpm.
319	ICA	OPB IC - Indian Creek	3	T16S, R6E	N	Within 1/2 mile offset of UTU-84285	May-18	No Mining	No Mining		Surface Water	NA	NA	NA	Surface monitoring site established as part of the Mill Fork Lease expansion in 2003.
373	ICF	OPB IC - Indian Creek	10	T16S, R6E	N	Within 1/2 mile offset of UTU-84285	May-18	No Mining	No Mining		Surface Water	NA	NA	NA	Surface monitoring site established as part of the Mill Fork Lease expansion in 2003.
317	ICD	OPB IC - Indian Creek	15	T16S, R6E	N	Within 1/2 mile offset of UTU-84285	May-18	No Mining	No Mining		Surface Water	NA	NA	NA	Surface monitoring site established as part of the Mill Fork Lease expansion in 2003.
318	ICB	OPB IC - Indian Creek	15	T16S, R6E	N	Within 1/2 mile offset of UTU-84285	May-18	No Mining	No Mining		Surface Water	NA	NA	NA	Surface monitoring site established as part of the Mill Fork Lease expansion in 2003.
376	MFU-03	OPB MF - Mill Fork	17	T16S, R7E	N	Within 1/2 mile offset of UTU-88554	May-18	No Mining	No Mining		Surface Water	NA	NA	NA	Mill Fork Canyon is a tributary of Huntington Creek and was included in PacifiCorp's monitoring program starting in 1997.
150	MFA01	OPB MF - Mill Fork	20	T16S, R7E	N	Within 1/2 mile offset of UTU-024317	May-18	No Mining	No Mining		Surface Water	NA	NA	NA	Mill Fork Canyon is a tributary of Huntington Creek and was included in PacifiCorp's monitoring program starting in 1997.
151	MFB02	OPB MF - Mill Fork	22	T16S, R7E	N	Within 1/2 mile offset of PC Fee	NA	No Mining	No Mining		Surface Water	NA	NA	NA	Mill Fork Canyon is a tributary of Huntington Creek and was included in PacifiCorp's monitoring program starting in 1997.
9	MHC01	OPB MHC - Meetinghouse Creek	35	T16S, R7E	N	Within 1/2 mile offset of UTU-47979	Scheduled for relinquishment in 2018	No Mining	No Mining		Surface Water	NA	NA	NA	Meetinghouse Canyon is a tributary of Huntington Creek and was included in PacifiCorp's monitoring program starting in 1984.
54	HCC01	OPB HC - Huntington Creek	36	T16S, R7E	N	NA	NA	No Mining	No Mining		Surface Water	NA	NA	NA	Monitoring of Huntington Creek was initiated in March 1988.
55	HCC02	OPB HC - Huntington Creek	31	T16S, R8E	N	NA	NA	No Mining	No Mining		Surface Water	NA	NA	NA	Monitoring of Huntington Creek was initiated in March 1988.
56	HCC04	OPB HC - Huntington Creek	6	T17S, R8E	N	NA	NA	No Mining	No Mining		Surface Water	NA	NA	NA	Monitoring of Huntington Creek was initiated in March 1988.
68	P1	DC RC - Rilda Canyon	28	T16S, R7E	N	UTU-2810	NA	No Mining	No Mining		Well	Alluvium	NA	NA	A series of alluvial wells (P1 - P7) established by West Appa Coal Company to monitor Rilda Canyon alluvial system adjacent to NEWUSSD springs.
72	P5	DC RC - Rilda Canyon	28	T16S, R7E	N	SL-051221	NA	No Mining	No Mining		Well	Alluvium	NA	NA	A series of alluvial wells (P1 - P7) established by West Appa Coal Company to monitor Rilda Canyon alluvial system adjacent to NEWUSSD springs.
73	P6	DC RC - Rilda Canyon	29	T16S, R7E	N	UTU-06039	NA	No Mining	No Mining		Well	Alluvium	NA	NA	A series of alluvial wells (P1 - P7) established by West Appa Coal Company to monitor Rilda Canyon alluvial system adjacent to NEWUSSD springs.
74	P7	DC RC - Rilda Canyon	29	T16S, R7E	N	UTU-06039	NA	No Mining	No Mining		Well	Alluvium	NA	NA	A series of alluvial wells (P1 - P7) established by West Appa Coal Company to monitor Rilda Canyon alluvial system adjacent to NEWUSSD springs.
67	EM-47	DC RC - Rilda Canyon	29	T16S, R7E	Y	UTU-06039	NA	No Mining	No Mining		Well	Blackhawk Star Point Sandstone	NA	NA	Monitoring well located in the Right Fork of Rilda Canyon established in 1980.

R645-301-720: HYDROLOGIC RESOURCES AND MONITORING REQUIREMENTS

Hydrology

The Deer Creek Mine is part of the East Mountain property in which PacifiCorp holds coal mining interests. The East Mountain property encompasses multiple adjacent mining operations including; Cottonwood/Wilberg Mine (completely reclaimed March 22, 2018), Deer Creek Mine, and the reclaimed Des Bee Dove Mine (Phase III Bond Release~~d~~ approved August 2014). PacifiCorp has collected comprehensive baseline information on the hydrologic resources of the East Mountain property that consists of ground and surface water investigations, climatological information, baseline cumulative impact area information, and probable hydrologic consequence determination to ensure the protection of the hydrologic balance of the Deer Creek Mine permit area and East Mountain property. This information is found in Volume 9, Volume 9A, and/or Volume 9B.

As part of the requirements of the Utah Coal Regulations R645-301-731.221 through R645-301-731.225, a hydrologic monitoring program has been established in cooperation with Utah Division of Oil, Gas, and Mining. The hydrologic monitoring program involves collecting water quality and quantity samples of ground and surface water for specific sites pertinent the Deer Creek Mine permit area.

PacifiCorp is reducing the extent of the mine's hydrologic monitoring to coincide with the final closure of the Deer Creek Mine. With the closure of the Deer Creek Mine, PacifiCorp has sealed all of the associated portals at Deer Creek Mine, including Deer Creek Canyon, Meetinghouse Canyon, Rilda Canyon Left Fork and Rilda Canyon 1st Right. Final coal production from PacifiCorp's mining operations was from the Deer Creek Mine on January 7, 2015. PacifiCorp maintained monitoring sites listed in the approved

hydrologic monitoring plan for a minimum of three years after the last date of coal production (2015, 2016 and 2017) as outlined in the Memorandum of Understanding (USDI Bureau of Land Management, USDA Forest Service, State of Utah, Division of Oil, Gas and Mining "Processing of Requests to Relinquish Federal Coal Leases," 1996). PacifiCorp proposes to eliminate both surface and groundwater sites established to monitor active mining operations and transition to reclamation monitoring. Surface monitoring sites will be retained above and below completed and on-going reclamation activities.

The following details the hydrologic monitoring program for the Deer Creek Mine permit for surface and UPDES~~ground water~~ monitoring sites for Reclamation Monitoring, required sampling parameter list, and map showing site locations.

Surface Water Hydrology (for detailed information for the Deer Creek Mine see Volumes 9, 9A, and 9B)

~~Cottonwood Creek Drainage System~~

~~Indian Creek (refer to Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)~~

~~1) ICA~~
~~2) ICF~~
~~3) ICD~~
~~4) ICB~~

Huntington Creek Drainage System

~~Huntington Creek (refer to Volume 9, Hydrologic Section, Cottonwood/Wilberg and Deer Creek Mines, Map HM-1A)~~

~~1) HCC01~~
~~2) HCC02~~
~~3) HCC04~~

Deer Creek Canyon (refer to Volume 9, Hydrologic Section, Cottonwood/Wilberg and Deer Creek Mines, Map HM-1A)

1) DCR01
2) DCR04
3) DCR06

~~Meetinghouse Canyon South Fork (refer to Volume 9, Hydrologic Section, Cottonwood/Wilberg and Deer Creek Mines, Map HM-1A)~~

~~1) MHC01~~

Rilda Canyon (refer to Volume 9, Hydrologic Section, Cottonwood/Wilberg and Deer Creek Mines, Map HM-1A)

1) RCF1
2) RCLF1
3) RCLF2
4) RCF2
5) RCF3
6) RCW4

~~Mill Fork Canyon (refer to Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)~~

~~1) MFA01~~
~~2) MFB02~~
~~3) MFU03~~

~~**Ground Water Hydrology** (for detailed information for the Deer Creek Mine see Volumes 9 and 9A: Hydrologic Section, Cottonwood/Wilberg and Deer Creek Mines)~~

~~East Mountain Springs (refer to Volume 9, Hydrologic Section, Cottonwood/Wilberg and Deer Creek Mines, Map HM-4)~~

~~1) Sheba Springs~~
~~2) 80-50~~
~~3) Rilda Canyon Meter 3*~~

~~* NEWUSSD controls Rilda Canyon meters. Monitoring will be conducted when meters are functioning.~~

~~East Mountain Springs - Mill Fork Area (refer to Deer Creek Permit Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)~~

~~1) EM-216~~
~~2) MFR-30~~
~~3) JV-9~~
~~4) JV-34~~
~~5) RR-5~~
~~6) RR-15~~
~~7) RR-23A~~
~~8) MF-7~~
~~9) MF-10~~
~~10) MF-19B~~
~~11) MF-213~~
~~12) MF-219~~
~~13) SP1-26~~
~~14) SP1-29~~
~~15) MFR-10~~
~~16) UJV 101~~
~~17) UJV-206~~
~~18) UJV-213~~
~~19) EM Pond~~
~~20) Little Bear Spring~~
~~21) Grants Spring~~

~~Piezometric Data – Surface~~

~~Rilda Canyon~~

~~1) P1~~
~~2) P5~~
~~3) P6~~
~~4) P7~~
~~5) EM-47~~

UPDES Monitoring Locations – UPDES Permit #UT0023604

1) 001 – Sediment Pond – Deer Creek Canyon
2) 002 – Mine Discharge - Deer Creek Canyon
3) 003 – Mine Discharge – Huntington Creek

Post Mine Closure Monitoring Locations – Deer Creek Mine

1. Deer Creek Mine
   Rilda Canyon Pipeline – terminus of pipeline DCRCP (refer to HM-1A)
2. Deer Creek Mine
   Rilda Canyon Pipeline – integrity evaluation meters (refer to Volume 11, R645-3-1-500 Engineering Section, Appendix I, Design Drawings Deer Creek Mine Water Relief Pipeline 2016 Rilda Canyon for location of upper and lower vaults – meter locations)

Required Monitoring Parameters

Field Measurements shall be collected during monitoring of surface and ground water sites. Field measurements include:

-Date and Time

-Flow

-pH

-Temperature

-Conductivity

-Dissolved Oxygen (perennial streams only)

Surface and mine discharge ~~ground~~ water samples shall be analyzed for quality utilizing the following parameters (in mg/L). Baseline parameters shall be collected every 5 years. Operational samples

shall be collected at all other times and as dictated by the monitoring schedule.

Laboratory Measurements:

#	*	-	Total Settleable Solids (UPDES Only)
#	*	-	Total Suspended Solids (Surface Only)
	*	-	Total Dissolved Solids
	*	-	Total Hardness ($CaCO_3$)
		-	Acidity ($CaCO_3$)
		-	Aluminum (Al) - Dissolved
		-	Arsenic (As) - Dissolved
		-	~~Boron (B) - Dissolved (Waste Rock Sites Only)~~
	*	-	Carbonate (CO_3^{-2})
	*	-	Total Alkalinity/Bicarbonate ($CaCO_3$)
		-	Cadmium (Cd) - Dissolved
	*	-	Calcium (Ca) - Dissolved
	*	-	Chloride (Cl-)
		-	Copper (Cu) - Dissolved
	*	-	Iron (Fe) - Total & Dissolved
		-	Lead (Pb) – Dissolved
	*	-	Magnesium (Mg) - Dissolved
	*	-	Manganese (Mn) - Total & Dissolved
		-	Molybdenum (Mo) - Dissolved
		-	Nitrogen: Ammonia (NH3) - reported as N
		-	Nitrite (NO_2) - reported as N
		-	Nitrate (NO_3^-) - reported as N
	*	-	Potassium (K) - Dissolved
	*	-	Oil & Grease*
		-	Ortho Phosphate (PO_4^{-3}) - reported as P
		-	~~Selenium (Se) - Dissolved (Waste Rock Sites Only)~~
	*	-	Sodium (Na) - Dissolved
	*	-	Sulfate (SO_4^{-2})
		-	Zinc (Zn) - Dissolved
	*	-	Cation-Anion Balance

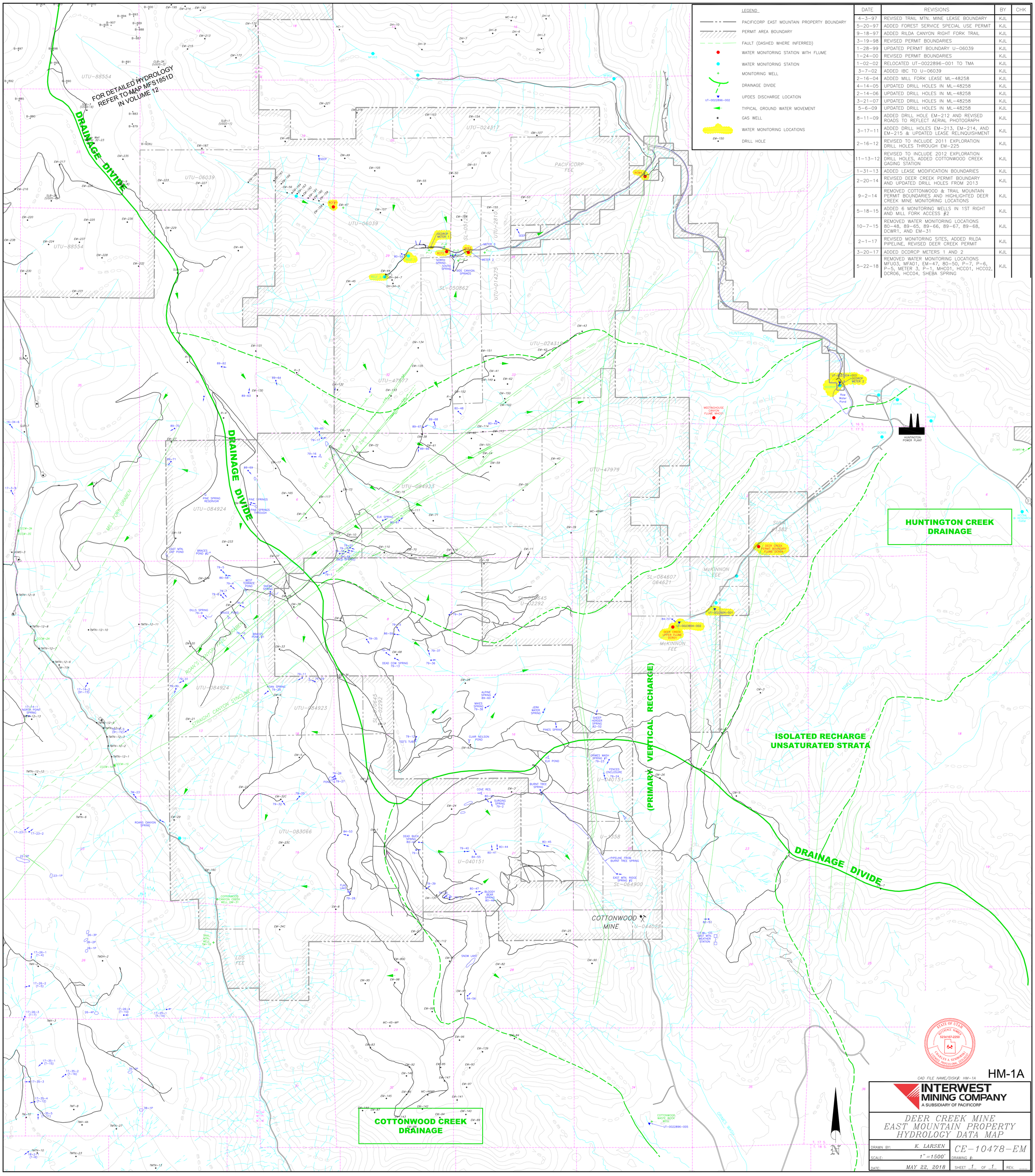
~~# Construction~~ * Operational - Baseline

*UPDES & surface waters above & below mine sites

Monitoring Schedule

Reclamation surface monitoring sites shall be field monitored quarterly for all field parameters ~~except for Indian Creek Sites – monitoring to be conducted during base flow only~~. Surface and UPDES sites shall also be analyzed for quality for all quality parameters listed ~~except for Indian Creek sites – monitoring to be conducted during base flow only~~.

~~East Mountain Springs (including the Mill Fork Area) shall be field monitored during the months of July and October. Rilda Canyon Springs – NEWUSSD: Meter 3 shall be field monitored monthly depending on access. East Mountain Springs (including the Mill Fork Area) shall also be analyzed for quality during the months of July and October. Rilda Canyon Springs – NEWUSSD: Meter 3 shall be monitored for quality monthly depending on access. All surface and ground water monitoring requirements for the Mill Fork Area are found in Volume 12, Deer Creek Mine, Mill Fork Lease, Section R645-301-700~~.



LEGEND

- PACIFICORP EAST MOUNTAIN PROPERTY BOUNDARY
- PERMIT AREA BOUNDARY
- FAULT (DASHED WHERE INFERRED)
- WATER MONITORING STATION WITH FLUME
- WATER MONITORING STATION
- MONITORING WELL
- DRAINAGE DIVIDE
- UT-0022896-002 — UPDES DISCHARGE LOCATION
- TYPICAL GROUND WATER MOVEMENT
- GAS WELL
- WATER MONITORING LOCATIONS
- EM-150 — DRILL HOLE

DATE	REVISIONS	BY	CHK
4-3-97	REVISED TRAIL MTN. MINE LEASE BOUNDARY	KJL	
5-20-97	ADDED FOREST SERVICE SPECIAL USE PERMIT	KJL	
9-18-97	ADDED RILDA CANYON RIGHT FORK TRAIL	KJL	
3-19-98	REVISED PERMIT BOUNDARIES	KJL	
1-28-99	UPDATED PERMIT BOUNDARY U-06039	KJL	
1-24-00	REVISED PERMIT BOUNDARIES	KJL	
1-02-02	RELOCATED UT-0022896-001 TO TMA	KJL	
3-7-02	ADDED IBC TO U-06039	KJL	
2-16-04	ADDED MILL FORK LEASE ML-48258	KJL	
4-14-05	UPDATED DRILL HOLES IN ML-48258	KJL	
2-14-06	UPDATED DRILL HOLES IN ML-48258	KJL	
3-21-07	UPDATED DRILL HOLES IN ML-48258	KJL	
5-6-09	UPDATED DRILL HOLES IN ML-48258	KJL	
8-11-09	ADDED DRILL HOLE EM-212 AND REVISED ROADS TO REFLECT AERIAL PHOTOGRAPH	KJL	
3-17-11	ADDED DRILL HOLES EM-213, EM-214, AND EM-215 & UPDATED LEASE RELINQUISHMENT	KJL	
2-16-12	REVISED TO INCLUDE 2011 EXPLORATION DRILL HOLES THROUGH EM-225	KJL	
11-13-12	REVISED TO INCLUDE 2012 EXPLORATION DRILL HOLES, ADDED COTTONWOOD CREEK GAGING STATION	KJL	
1-31-13	ADDED LEASE MODIFICATION BOUNDARIES	KJL	
2-20-14	REVISED DEER CREEK PERMIT BOUNDARY AND UPDATED DRILL HOLES FROM 2013	KJL	
9-2-14	REMOVED COTTONWOOD & TRAIL MOUNTAIN PERMIT BOUNDARIES AND HIGHLIGHTED DEER CREEK MINE MONITORING LOCATIONS	KJL	
5-18-15	ADDED 6 MONITORING WELLS IN 1ST RIGHT AND MILL FORK ACCESS #2	KJL	
10-7-15	REMOVED WATER MONITORING LOCATIONS 80-48, 89-65, 89-66, 89-67, 89-68, DCWR1, AND EM-31	KJL	
2-1-17	REVISED MONITORING SITES, ADDED RILDA PIPELINE, REVISED DEER CREEK PERMIT	KJL	
3-20-17	ADDED DCDRCP METERS 1 AND 2	KJL	
5-22-18	REMOVED WATER MONITORING LOCATIONS MFU03, MFA01, EM-47, 80-50, P-7, P-6, P-5, METER 3, P-1, MHC01, HCC01, HCC02, DCR06, HCC04, SHEBA SPRING	KJL	

STATE OF UTAH
LICENSE NUMBER
5234167-2250
CHARLES A. SEMBROWICZ
REGISTERED PROFESSIONAL ENGINEER

HM-1A

CAD FILE NAME/DISK#: HM-1A

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

DEER CREEK MINE
EAST MOUNTAIN PROPERTY
HYDROLOGY DATA MAP

DRAWN BY:	K. LARSEN	CE-10478-EM	
SCALE:	1"=1500'	DRAWING #:	
DATE:	MAY 22, 2018	SHEET 1 OF 1	REV. ___

PACIFICORP
~~ENERGY WEST~~
HYDROLOGIC MONITORING PROGRAM
DEER CREEK MINE

I. MONITORING LOCATIONS – DEER CREEK MINE

A. Surface Water Hydrology (for maps refer to Deer Creek and Wilberg/Cottonwood Mine: Volume 9 Map HM-1A, Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D Mill Fork Lease for East Mountain locations listed below)

~~**1. Cottonwood Creek Drainage System**~~

a. ~~***Indian Creek*** (refer to Deer Creek Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)~~

~~(1) ICA - Indian Creek Above~~
~~(Approximately 2500 feet northwest of the Mill Fork permit boundary) 400 feet North, 2350 feet West of the Southwest corner of Section 3, Township 16 South, Range 6 East.~~

~~(2) ICF - Indian Creek Flume~~
~~(Approximately 2100 feet west of the Mill Fork permit boundary) 300 feet North, 3400 feet West of the Southwest corner of Section 10, Township 16 South, Range 6 East.~~

~~(3) ICD - Indian Creek Ditch~~
~~(Approximately 1600 feet west of the Mill Fork permit boundary, irrigation ditch for Upper Joes Valley) 240 feet North, 2850 feet West of the Southwest corner of Section 15, Township 16 South, Range 6 East.~~

~~(4) ICB - Indian Creek Below~~
~~(Approximately 3700 feet west of the Mill Fork permit boundary, junction of Indian Creek and FDR040) 70 feet North, 120 feet West of the Southwest corner of Section 16, Township 16 South, Range 6 East.~~

2. Huntington Creek Drainage System

~~a. ***Huntington Creek*** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1A)~~

~~(1) HCC01 - Above Deer Creek Confluence:~~
~~1400 feet north, 2200 feet west of the southeast corner of Section 36, Township 16 South, Range 7 East.~~

~~(2) HCC02 - Below Deer Creek Confluence:~~
~~300 feet north, 300 feet west of the southwest corner of Section 31, Township 16 South, Range 8 East.~~

~~(3) HCC04 - @ Research Farm*~~
~~800 feet north, 200 feet east of the southwest corner of Section 5, Township 17 South, Range 8 East.~~
~~*Not listed on map due to scale.~~

b. ***Deer Creek*** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1A)

(1) DCR01 - Above the mine:
(Approximately 600 feet upstream from the mine facility.) 200 feet North, 800 feet West of the Southeast corner of Section 10, Township 17 South, Range 7 East.

(2) DCR04 - Near C1/C2 Belt Intersection:
(Approximately 5,000 feet downstream from the mine facility.) 300 feet North, 2000 feet East of the Southeast corner of Section 2, Township 17 South, Range 7 East.

(3) DCR06 - @ Huntington Creek Confluence:
(Approximately 15,000 feet downstream from the facility) 1400 feet north, 1100 feet east of the southeast corner of Section 6, Township 16 South, Range 7 East.

~~c. ***Meetinghouse Canyon - South Fork*** (refer to Deer Creek, Wilberg/Cottonwood, Des-Bee-Dove Mine: Volume 9 Map HM-1)~~

~~(1) MHC01 - Meetinghouse Canyon South Fork (Approximately 200 feet upstream from the north and south convergence.) 800 feet North, 1500 feet East of the Southwest corner of Section 35, Township 16 South, Range 7 East.~~

d. ***Rilda Canyon*** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1A)

(1) RCF-1 - Rilda Canyon - Right Fork: (Approximately 4000 feet upstream from the Right and Left fork convergence.) 400 feet South, 200 feet West of the Northeast corner of Section 30, Township 16 South, Range 7 East.

(2) RCLF1 - Rilda Canyon - Left Fork, below Rilda Canyon Portals: (Approximately 200 feet upstream from the Right and Left fork convergence.) 2400 feet North, 2100 feet West of the Southeast corner of Section 29, Township 16 South, Range 7 East.

(3) RCLF2 - Rilda Canyon - Left Fork, above Rilda Canyon Portals: (Approximately 1600 feet upstream from the Right and Left fork convergence.) 1600 feet North, 2300 feet West of the Southwest corner of Section 29, Township 16 South, Range 7 East.

(4) RCF2 - Rilda Canyon - Above NEWUSSD springs: 2500 feet South, 400 feet West of the Northeast corner of Section 29, Township 16 South, Range 7 East.

(5) RCF3 - Rilda Canyon - Below NEWUSSD springs: 2550 feet South, 1000 feet East of the Northeast corner of Section 28, Township 16 South, Range 7 East.

(6) RCW4 - Rilda Canyon: (Approximately 1000 feet upstream from the confluence with Huntington Creek.) 850 feet North, 1900 feet West of the Southeast corner of Section 26, Township 16 South, Range 7 East.

~~e. ***Mill Fork Canyon*** (refer to Deer Creek Volume 12 - R645-301-700: Hydrologic Monitoring Map MFS1851D)~~

~~(1) MFA01 - Mill Fork Canyon - Above Old Mine: (Approximately 2000 feet above old mine portals @ end of USFS development road.) 100 feet North, 1500 feet West of the Southeast corner of Section 17, Township 16 South, Range 7 East.~~

~~(2) MFB02 - Mill Fork Canyon - Above Huntington Creek Confluence: (Approximately 200 feet above confluence with Huntington Creek @ culvert outfall.) 100 feet South, 1900 feet East of the Northwest corner of Section 22, Township 16 South, Range 7 East.~~

~~(3) MFU03 - Mill Fork Canyon - Above Mill Fork Fault Crossing: (Approximately 700 feet upstream of projected Mill Fork Fault crossing) 1150 feet North, 1700 feet East of the Southwest corner of Section 17, Township 16 South, Range 7 East.~~

3. Reclamation Monitoring: Following final reclamation, backfilling and grading, hydrologic monitoring will be conducted at points immediately above and below the reclaimed sites.

B. Groundwater Hydrology – Deer Creek Mine

~~**1. East Mountain Springs** (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 maps HM-4)~~

~~Sheba Springs~~
~~80-50~~
~~Rilda Canyon (Meters 2&3)~~[1]

~~[1]NEWUSSD controls Rilda Canyon meters. Monitoring will be conducted when meters are functioning.~~

~~**2. East Mountain Springs – Mill Fork Area** (refer to Deer Creek Permit Volume 12 R645-301-700: Hydrologic Monitoring Map MFS1851D)~~

~~EM-216~~	~~MFR-30~~
~~JV-9~~	~~RR-5~~
~~JV-34~~	~~RR-15~~
~~MF-7~~	~~RR-23A~~
~~MF-10~~	~~SP1-26~~
~~MF-19B~~	~~SP1-29~~
~~MF-213~~	~~UJV-101~~
~~MF-219~~	~~UJV-206~~
~~MFR-10~~	~~UJV-213~~
~~EMPOND~~	~~Grants Spring~~
~~Little Bear Spring~~	

~~**3. Piezometric Data**~~

~~a. Surface~~

~~(1) Rilda Canyon (refer to Deer Creek and Wilberg/Cottonwood Mines: Volume 9 Map HM-1a)~~

~~P1~~
~~P5~~
~~P6~~
~~P7~~
~~EM-47~~

C. UPDES Monitoring Locations – Deer Creek Mine (refer to HM-1A)

a. ***Deer Creek Mine***
UPDES UT0023604
001- Sediment Pond – Deer Creek Canyon
002- Mine Discharge – Deer Creek Canyon
003- Mine Discharge – Huntington Creek

D. Post Mine Closure Monitoring Locations – Deer Creek Mine

a. **Deer Creek Mine**
Rilda Canyon Pipeline – terminus of pipeline DCDRCP (refer to HM-1A)

b. **Deer Creek Mine**
Rilda Canyon Pipeline – integrity evaluation meters (refer to Volume 11, R645-301-500 Engineering Section, Appendix I, Design Drawings Deer Creek Mine Water Relief Pipeline 2016 Rilda Canyon for location of upper and lower vaults – meter locations)

1. DCDRCP – Meter 1: located near the Rilda Canyon Portals
2. DCDRCP – Meter 2: located near the Huntington Power Plant Raw Water Pond

II. MONITORING SCHEDULE – DEER CREEK MINE
(See enclosed monitoring schedules for operational, baseline, and reclamation monitoring)

A. Field Measurements

Field Measurements collected during quality sampling: Listed below are the sites which will be monitored by PacifiCorp ~~- Energy West~~ in accordance with the guidelines established by DOGM; i.e.

- Date and Time
- Flow
- pH
- Temperature
- Conductivity
- Dissolved oxygen (perennial streams only)

Surface Monitoring

Surface monitoring locations will be field monitored quarterly for all field parameters, except Indian Creek - monitoring to be conducted during base flow only.

~~**1. Cottonwood Canyon Creek**~~

~~a. Indian Creek~~

~~(1) ICA~~
~~(2) ICF~~
~~(3) ICD~~
~~(4) ICB~~

2. Huntington Canyon Drainage

a. Deer Creek

(1) DCR01
(2) DCR04
(3) DCR06

~~b. Huntington Creek~~

~~(1) HCC01~~
~~(2) HCC02~~
~~(3) HCC04~~

~~Flow in Huntington Creek is measured only at HCC01 by Utah Power, and will be reported in the Annual Hydrologic Report.~~

~~c. Meetinghouse Canyon - South Fork:~~

~~(1) MCH01~~

d. Rilda Canyon

(1) RCF1~~*~~
(2) RCLF 1
(3) RCLF 2
(4) RCF2
(5) RCF3
(6) RCW4

~~* Baseline flow will be measured adjacent to EM-163~~

~~e. Mill Fork Canyon~~

~~(1) MFA01~~
~~(2) MFB02~~
~~a. MFU03~~

Groundwater Monitoring

~~1. East Mountain Springs (see monitoring location list I.B.1)~~

~~2. East Mountain Springs - Mill Fork Area (see monitoring location list I.B.3)~~

~~East Mountain Springs will be field monitored during the months of July and October. Rilda Canyon Springs - (NEWUSSD: Meter 3; when functioning) will be field monitored monthly depending upon access.~~

3. Post Mine Closure – Deer Creek Mine Drainage
   a. Rilda Canyon Pipeline – terminus of pipeline DCDRCP
   b. Rilda Canyon Pipeline – integrity evaluation meters – flow only (refer to Volume 11, R645-301-500 Engineering Section, Appendix I, Design Drawings, Water Relief Pipeline 2016 Rilda Canyon for location of upper and lower vaults – meter locations)
      1. DCDRCP – Meter 1: located near the Rilda Canyon Portals
      2. DCDRCP – Meter 2: located near the Huntington Power Plant Raw Water Pond

~~4. Piezometric Wells~~

~~a. Surface~~

~~Piezometric surface wells will be field monitored for level only on a monthly basis depending upon access.~~

~~(1) Rilda Canyon (see Map HM-1 for locations)~~

~~P1~~	~~P7~~
~~P5~~	~~EM-47~~
~~P6~~	

UPDES Monitoring

1. Deer Creek

UPDES sites 001, 002 and 003 will be monitored as specified in the individual permits.

Reclamation Monitoring

Surface Water Resources: (see enclosed summary of operational, baseline, and reclamation monitoring schedules)
Surface monitoring locations will be field monitored monthly for flow and all field parameters quarterly until bond release.

~~Ground Water Resources: (see enclosed summary of operational, baseline, and reclamation monitoring schedules)~~

~~Springs East Mountain Springs will be field monitored during the months of July and October.~~

~~Rilda Canyon Springs (NEWUSSD: Meter 3; when functioning) will be field monitored monthly for flow depending upon access. East Mountain Springs (including Rilda Springs) monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.~~

~~Wells: Piezometric surface wells (Rilda Canyon Canyon): will be field monitored for level only on a monthly basis depending upon access. Piezometric surface well monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.~~

Post Mine Closure:
Post Mine Closure monitoring locations will be field monitored monthly for flow including all field parameters until bond release.

UPDES: Sites will be monitored as specified in the individual permits.

B. Quality Sampling (Laboratory Measurements)

1. Surface Water Hydrology: Water samples will be collected and analyzed quarterly (one sample at low flow and high flow) during the first or second week of the quarter~~, except for Indian Creek - quality samples will be collected during baseflow only~~. Parameters analyzed are those listed in the DOGM Guidelines for Surface Water Quality (see Table 1-Surface Water Quality Parameter List). Quarterly sampling was initiated during March 1988 and will continue throughout the year; i.e., June, September, and December. Baseline analysis was performed in 2016 and will be repeated every five years there-after.

~~**a. Cottonwood Creek Drainage**~~

~~(1) Indian Creek~~

~~(a) ICA~~
~~(b) ICD~~
~~(c) ICB~~

b. Huntington Creek Drainage

(1) Deer Creek

(a) DCR01
(b) DCR04
(c) DCR06

~~(2) Huntington Creek~~

~~(a) HCC01~~
~~(b) HCC02~~
~~(c) HCC04~~

~~(3) Meetinghouse Canyon - South Fork:~~

~~(a) MCH01~~

(5) Rilda Canyon

(a) RCF1
(b) RCF3
(c) RCW4

~~(6) Mill Fork Canyon~~

~~(a) MFA01~~
~~(b) MFB02~~
~~(c) MFU03~~

Reclamation Monitoring - Surface Water Hydrology: Water samples will be collected and analyzed quarterly (one sample at low flow and high flow) during the first or second week of the quarter. Parameters analyzed are those listed in the DOGM Guidelines for Surface Water Quality (see Table 1-Surface Water Quality Parameter List). Sampling will be conducted on a quarterly basis until bond release. Baseline analysis will be performed on the 5th and 9th years following reclamation. In no case will baseline sampling time frame exceed 5 years converting from operational to reclamation monitoring.

~~**2. Groundwater Hydrology**~~

~~a. East Mountain Springs: Water samples will be collected and analyzed during the months of July and October. Rilda Canyon Springs (NEWUSSD: Meter 3; when functioning) will be monitored for quarterly for quality. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).~~

~~b. Wells: No analysis required~~

c. Post Mine Closure Rilda Canyon Pipeline – terminus of pipeline DCDRCP: One water sample will be collected and analyzed per location monthly. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).

Baseline analysis was performed in 2016 and will be repeated every five years thereafter.

Reclamation Monitoring - Groundwater Hydrology:

~~a. East Mountain Springs: Water samples will be collected and analyzed during the months of July and October. Rilda Canyon Springs (NEWUSSD: Meter 3; when functioning) will be monitored quarterly for quality. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List). East Mountain Springs (including Rilda Springs) monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.~~

~~b. Wells: Rilda Canyon wells will be sealed during final reclamation. Quarterly sampling will continue until sealing. Parameters analyzed are those listed in the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List).~~

c. Post Reclamation Monitoring: PacifiCorp commits to conduct annual surveys to identify new discharge locations within and below sealed portals. If discharge occurs, one water sample will be collected and analyzed per location quarterly. Parameters analyzed are those listed in

the DOGM Guidelines for Groundwater Water Quality (see Table 2-Ground Water Quality Parameter List). Baseline analysis will be performed on the 5th and 9th year.

3. UPDES Monitoring Sites

a. Deer Creek Mine

UPDES sites will be monitored as specified in the individual permits.

III. ANNUAL REPORTS

All data collected regarding the hydrology of East Mountain will be summarized by the applicant in an annual Hydrologic Monitoring Report. Copies of the report will be submitted to the Utah State Division of Oil, Gas and Mining. In addition, any raw data collected will be submitted to the Utah State Division of Oil, Gas and Mining on a quarterly basis.

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HYDROLOGIC MONITORING SCHEDULE

DEER CREEK MINE

SURFACE HYDROLOGY - OPERATIONAL SAMPLING (Table 1)

Drainage System	Drainage	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
~~*Cottonwood Creek Drainage System*~~	~~*Joes Valley*~~	~~ICA~~	~~Based Flow Monitoring Only (October or November)~~									~~Operational~~		
	~~*Indian Creek*~~	~~ICD~~	~~Based Flow Monitoring Only (October or November)~~									~~Operational~~		
		~~ICB~~	~~Based Flow Monitoring Only (October or November)~~									~~Operational~~		
Huntington Drainage System	*Deer Creek*	DCR01	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational
		DCR04	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational
		DCR06	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational
	~~*Huntington Creek*~~	~~HCC01~~	~~Flow *~~	~~Flow *~~	~~Operational*~~	~~Flow *~~	~~Flow *~~	~~Operational*~~	~~Flow *~~	~~Flow *~~	~~Operational*~~	~~Flow *~~	~~Flow *~~	~~Operational*~~
		~~HCC02~~			~~Operational*~~			~~Operational*~~			~~Operational*~~			~~Operational*~~
		~~HCC04~~			~~Operational*~~			~~Operational*~~			~~Operational*~~			~~Operational*~~
			~~* Flow in Huntington Creek is measured @ HCC01 by Utah Power, and will be reported in the Annual Hydrologic Report~~											
	~~*Meetinghouse Canyon*~~	~~MCH01~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
	Rilda Canyon	RCF1~~*~~	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational
		RCLF1	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field
		RCLF2	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field
		RCF2	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field
		RCF3	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational
		RCW4	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational	Flow	Flow	Operational
			~~* Baseline flow will be measured adjacent to EM-163~~											
	~~*Mill Fork Canyon*~~	~~MFA01~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
		~~MFB02~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
		~~MFU03~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~

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HYDROLOGIC MONITORING SCHEDULE

DEER CREEK MINE

SURFACE HYDROLOGY - BASELINE SAMPLING (Table 1) - 2021

Drainage System	Drainage	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
~~*Cottonwood Creek Drainage System*~~	~~*Joes Valley*~~	~~ICA~~	~~Based Flow Monitoring Only (October or November)~~									~~Baseline~~		
	~~*Indian Creek*~~	~~ICD~~	~~Based Flow Monitoring Only (October or November)~~									~~Baseline~~		
		~~ICB~~	~~Based Flow Monitoring Only (October or November)~~									~~Baseline~~		
Huntington Drainage System	*Deer Creek*	DCR01	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline
		DCR04	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline
		DCR06	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline
	~~*Huntington Creek*~~	~~HCC01~~	~~Flow *~~	~~Flow *~~	~~Baseline*~~	~~Flow *~~	~~Flow *~~	~~Baseline*~~	~~Flow *~~	~~Flow *~~	~~Baseline*~~	~~Flow *~~	~~Flow *~~	~~Baseline*~~
		~~HCC02~~			~~Baseline*~~			~~Baseline*~~			~~Baseline*~~			~~Baseline*~~
		~~HCC04~~			~~Baseline*~~			~~Baseline*~~			~~Baseline*~~			~~Baseline*~~
			~~* Flow in Huntington Creek is measured @ HCC01 by Utah Power, and will be reported in the Annual Hydrologic Report~~											
	~~*Meetinghouse Canyon*~~	~~MCH01~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~
	Rilda Canyon	RCF1~~*~~	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline
		RCLF1	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field
		RCLF2	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field
		RCF2	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field	Flow	Flow	Field
		RCF3	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline
		RCW4	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline	Flow	Flow	Baseline
			~~* Baseline flow will be measured adjacent to EM-163~~											
	~~*Mill Fork Canyon*~~	~~MFA01~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~
		~~MFB02~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~
		~~MFU03~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~

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HYDROLOGIC MONITORING SCHEDULE

DEER CREEK MINE

SURFACE HYDROLOGY - RECLAMATION SAMPLING (Table 1)

Drainage System	Drainage	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
~~*Cottonwood Creek Drainage System**~~	~~*Joes Valley*~~	~~ICA~~	~~Based Flow Monitoring Only (October or November)~~									~~Operational~~		
	~~*Indian Creek*~~	~~ICD~~	~~Based Flow Monitoring Only (October or November)~~									~~Operational~~		
		~~ICB~~	~~Based Flow Monitoring Only (October or November)~~									~~Operational~~		
*Huntington Drainage System**	*Deer Creek*	DCR01			Operational			Operational			Operational			Operational
		DCR04			Operational			Operational			Operational			Operational
		DCR06			Operational			Operational			Operational			Operational
	~~*Huntington Creek*~~	~~HCC01~~			~~Operational**~~			~~Operational**~~			~~Operational**~~			~~Operational**~~
		~~HCC02~~			~~Operational**~~			~~Operational**~~			~~Operational**~~			~~Operational**~~
		~~HCC04~~			~~Operational**~~			~~Operational**~~			~~Operational**~~			~~Operational**~~
			~~*** Flow in Huntington Creek is measured @ HCC01 by Utah Power, and will be reported in the Annual Hydrologic Report~~											
	~~*Meetinghouse Canyon*~~	~~MCH01~~			~~Operational~~			~~Operational~~			~~Operational~~			~~Operational~~
	Rilda Canyon	RCF1~~***~~			Operational			Operational			Operational			Operational
		RCLF1			Field			Field			Field			Field
		RCLF2			Field			Field			Field			Field
		RCF2			Field			Field			Field			Field
		RCF3			Operational			Operational			Operational			Operational
		RCW4			Operational			Operational			Operational			Operational
			~~*** Baseline flow will be measured adjacent to EM-163~~											
	~~*Mill Fork Canyon*~~	~~MFA01~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
		~~MFB02~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
		~~MFU03~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~

** Analyzed for Baseline Parameters During the Fifth (5) and Ninth (9) Year After Final Reclamation*

In no case will baseline sampling time frame exceed 5 years converting from operational to reclamation monitoring.

~~GROUNDWATER HYDROLOGY - RECLAMATION SAMPLING (Table 2)~~

~~Groundwater Type~~

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HYDROLOGIC MONITORING SCHEDULE
DEER CREEK MINE

~~*Springs*~~		~~Jan~~	~~Feb~~	~~Mar~~	~~Apr~~	~~May~~	~~Jun~~	~~Jul~~	~~Aug~~	~~Sep~~	~~Oct~~	~~Nov~~	~~Dec~~
	~~**East Mountain (Includes Mill Fork Springs)**~~							~~Operational~~			~~Operational~~		
	~~*Spring monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.*~~												
	~~**East Mountain-Rilda Canyon Meter**~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
	~~*Rilda Spring monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.*~~												
	~~*Spring monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.*~~												
~~*Wells*~~	~~**Rilda Canyon Wells***~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~
	~~*Rilda Canyon well monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.*~~												
	~~** Monitored monthly subject ot access*~~												

UPDES SAMPLING - (Table 1)

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Water Discharge**	***Deer Creek***	**DCD**	As Needed Basis According to UPDES Permit Stipulations											
	***** After Portal Sealing (Deer Creek Canyon and Rilda Canyon), PacifiCorp Will Monitor Down Dip For Development Of Groundwater Seeps/Springs Until Bond Release***													
		002 and 003												
Sediment Pond Discharge	***Deer Creek***	**1 Outfall**	As Needed Basis According to UPDES Permit Stipulations											

POST MINE CLOSURE SAMPLING - (Table 2)

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Water	***Deer Creek***	**DCDRCP**	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational
Rilda Canyon Pipeline	***Deer Creek***	**Meters** See Note	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow

Note:
DCDRCP - Meter 1: located near Rilda Canyon Portals
DCDRCP - Meter 2: located near Huntington Plant Raw Water Pond

Rilda Canyon Pipeline and Meter (s) monitoring will be conducted until permit area reduction approval or unless otherwise approved by the Division.

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HYDROLOGIC MONITORING SCHEDULE

DEER CREEK MINE

~~GROUNDWATER HYDROLOGY - BASELINE SAMPLING (Table 2) - 2016, 2021~~

~~Groundwater Type~~			~~Jan~~	~~Feb~~	~~Mar~~	~~Apr~~	~~May~~	~~Jun~~	~~Jul~~	~~Aug~~	~~Sep~~	~~Oct~~	~~Nov~~	~~Dec~~
~~*Springs*~~	~~*East Mountain*~~	~~*(Includes Mill Fork Springs)*~~							~~Baseline~~	~~Flow *~~	~~Flow *~~	~~Baseline~~		
									~~* Recession Springs~~					
	~~*East Mountain-Rilda Canyon Meter*~~		~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~	~~Flow~~	~~Flow~~	~~Baseline~~
~~*Wells*~~	~~*Rilda Canyon Wells*~~		~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~

UPDES SAMPLING - (Table 1)

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Water Discharge	*Deer Creek*	**DCD** 002 and 003	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational
Sediment Pond Discharge	*Deer Creek*	**1 Outfall**	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational

POST MINE CLOSURE SAMPLING - (Table 2)

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Water	*Deer Creek*	**DCDRCP**	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Rilda Canyon Pipeline	*Deer Creek*	**Meters** See Note	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow

Note:
DCDRCP - Meter 1: located near Rilda Canyon Portals
DCDRCP - Meter 2: located near Huntington Plant Raw Water Pond

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HYDROLOGIC MONITORING SCHEDULE

DEER CREEK MINE

~~GROUNDWATER HYDROLOGY - OPERATIONAL SAMPLING (Table 2)~~

~~Groundwater Type~~			~~Jan~~	~~Feb~~	~~Mar~~	~~Apr~~	~~May~~	~~Jun~~	~~Jul~~	~~Aug~~	~~Sep~~	~~Oct~~	~~Nov~~	~~Dec~~
~~*Springs*~~	~~*East Mountain*~~	~~*(Includes Mill Fork Springs)*~~							~~Operational~~	~~Flow *~~	~~Flow *~~	~~Operational~~		
									~~* Recession Springs~~					
	~~*East Mountain-Rilda Canyon Meter*~~		~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~	~~Flow~~	~~Flow~~	~~Operational~~
~~*Wells*~~	~~*Rilda Canyon Wells*~~		~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~	~~Level~~

UPDES SAMPLING - (Table 1)

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Water Discharge	*Deer Creek*	**DCD**	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational
		002 and 003												
Sediment Pond Discharge	*Deer Creek*	**1 Outfall**	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational

POST MINE CLOSURE SAMPLING - (Table 2)

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Water	*Deer Creek*	**DCDRCP**	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational
Rilda Canyon Pipeline	*Deer Creek*	**Meters** See Note	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow

Note:
DCDRCP - Meter 1: located near Rilda Canyon Portals
DCDRCP - Meter 2: located near Huntington Plant Raw Water Pond

DISCUSSION OF THE GEOLOGY AND THE GROUNDWATER HYDROLOGY OF EAST MOUNTAIN INCLUDING THE MILL FORK AREA

Introduction

PacifiCorp has conducted extensive research into interrelationships between the surface and groundwater hydrologic systems and the potential impacts associated with underground mining. The analysis has included seep and spring surveys, drainage surveys, baseline data collection, in-house and consultant hydrologic studies and government and non-government research projects. PacifiCorp initiated hydrologic monitoring related to mines of the East Mountain and Trail Mountain properties, including; Deer Creek, Des-Bee-Dove, and Wilberg/Cottonwood mines in 1977, Trail Mountain mine in 1993, and expanded into the Mill Fork Area in 2000. Monitoring of surface, intercepted, and discharged water conducted by PacifiCorp has been utilized to document quality and quantity characteristics of the hydrologic regime and was not conducted specifically for each coal lease (i.e. Federal/State/Fee).

Research by government and non-government agencies has been extended to evaluate the effects of subsidence due to underground mining operations to the surface and ground water systems. Subsidence of overburden in the Wasatch Plateau has often been cited for disrupting the local ground and surface water resources overlying underground coal mining operations. However, the data presented from these investigations have failed to find a relationship between the quality and quantity of spring discharge and mining operations. Research also includes age dating of groundwater and the presence of active and inactive groundwater systems.

This document presents a brief discussion of the investigations performed as well as their findings. The complete documents for the studies are attached herein (Appendix A: Response of Springs to Longwall Mining, Bureau of Mines, Appendix B: Surface and Groundwater Investigations, Mayo & Assoc., 1997, Appendix C: Surface and Groundwater Investigations, Mayo & Assoc., 2001).

PacifiCorp is reducing the extent of the mines hydrologic monitoring to coincide with the final closure of the Deer Creek Mine. With the closure of the Deer Creek Mine, PacifiCorp has sealed all of the associated portals at Deer Creek Mine, including Deer Creek Canyon, Meetinghouse Canyon, Rilda Canyon Left Fork and Rilda Canyon 1st Right. Final coal production from PacifiCorp's mining operations was from the Deer Creek Mine on January 7, 2015. PacifiCorp maintained monitoring sites listed in the approved hydrologic monitoring plan for a minimum of three years after the last date of coal production (2015, 2016 and 2017) as outlined in the MOU (see appendix D). PacifiCorp proposes to eliminate both surface and groundwater sites that were established to monitor active mining operations and now transition to reclamation monitoring. Surface monitoring sites will be retained above and below completed and on-going reclamation activities.

All of the springs proposed for elimination are in areas which PacifiCorp has applied for relinquishment of the federal coal leases and/or is outside its mining permit boundary. PacifiCorp has gathered quantity and quality data for each of the proposed springs. The flow data is compared to precipitation data as well

as the Palmer Hydrologic Drought Index. The PDHI is based on moisture inflow (precipitation), outflow, and storage, and does not take into account the long-term trend.

Justification statements for the springs proposed for elimination have been prepared to: outline the status of the lease where the spring is located, give a brief description of the subsidence (if any), and summarize the water quality and quantity data. There are 23 springs proposed for elimination (two in the greater East Mountain area and 21 in the Mill Fork area). Those sites that are being removed are outlined in the attached summary sheet. These springs are located in areas where: 1) the area has been mined out and no further mining is planned, 2) the areas are no longer included as part of PacifiCorp's mining permit, or 3) subsidence has been determined substantially complete and the area has been relinquished.

This information is included as part of the amendment package submitted to the Division of Oil, Gas, and Mining.

Research Conducted

The U.S. Bureau of Mines (USBM) completed an independent study (1994) of the mining impacts on the hydrology of East Mountain (Document entitled "Response of Springs to Longwall Coal Mining at Deer Creek and Cottonwood Mines, Wasatch Plateau, UT, Information Circular 9405, U.S. Bureau of Mines"). The data in this study was collected by PacifiCorp from springs determined to accurately represent hydrologic conditions on East Mountain. This determination was made by an ad hoc committee including representatives from DOGM and the U.S. Forest Service. This document is cited as support in the environmental assessment for Coal Lease Application UTU-67939, Winter Quarters Tract (July 1995).

The USBM used spring data available from the Deer Creek and Cottonwood mines. The expected response of springs to undermining would be dramatic alterations in flow. The lack of observed flow responses, however, was attributed to geologically driven site-specific conditions that buffered the effects of mining. These conditions included the thickness of overburden between the mine level and the springs (1,320 – 1800 feet). Additionally, the presence of hydrophilic clays and mudstones in the overburden, which act as aquatards, retarding the migration of water, likely lessened the vertical extent of strata dewatering. The locations of the springs above the estimated elevations of fracturing and caving in the overburden due to subsidence also contributed to the limited effects. The study failed to find any springs in the study area that were impacted by mining. This report is included in Appendix A.

In 1997, PacifiCorp contracted Mayo & Associates to conduct a comprehensive study of surface water and groundwater systems of East Mountain & Trail Mountain. The hydrology and hydrogeology of the PacifiCorp central Utah coal leases were evaluated by analyzing: 1) solute and isotopic compositions of surface waters and groundwaters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information. A copy of the 1997 report is also included herein in Appendix B.

In 2001, PacifiCorp contracted Mayo & Associates to conduct a comprehensive study of surface water and groundwater systems of East Mountain – Mill Fork Area. As with the 1997 research, hydrology and hydrogeology of the PacifiCorp central Utah Mill fork coal lease was evaluated by analyzing: 1) solute and isotopic compositions of surface waters and groundwaters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information. The result of the East Mountain and Mill Fork study combine with research on surrounding coal properties (Mayo & Associates and Brigham Young University) was the development of a comprehensive understanding of the interrelationship between surface and groundwater systems of the Central Utah Coal Field. A copy of the 2001 report is also included herein in Appendix C.

The following is a brief description of a groundwater model that was developed as part of this investigation:

Groundwater Model

The overall pattern of groundwater flow and surface water-groundwater interactions in the East Mountain including the Mill Fork Area can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes. Active regime groundwater flow systems contain abundant tritium (^3H), have excellent hydraulic communication with the surface and thus are dependent on annual recharge events and are affected by short term climatic variability. Groundwater in these systems circulates shallowly and has short flow paths. The active regime includes alluvial groundwater, all of the Flagstaff Limestone, near-surface exposures of all other bedrock formations except, perhaps, the Mancos Shale. The near surface active regime extends about 500 to 1,000 feet into cliff faces and is controlled by fracturing, weathering, and the surface exposures of fluvial channel sandstones. Further into the cliff faces the discontinuous character of the channel sands prevents active groundwater flow.

Inactive groundwater flow regimes contain old groundwater (i.e. 2,000 to 12,000 years), have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability. Groundwater in these systems tends to occur in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). These sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. The blanket sands of the Star Point Sandstone are also largely in the inactive zone. For the most part, faults encountered in mine workings are part of the inactive regime.

Relinquishment

In the years 1992, 1995, 1997, 2006, 2009 and 2018, PacifiCorp submitted acreage relinquishment applications to the Bureau of Land Management (BLM) for various federal leases that are directly leased or sublease by PacifiCorp. Applications have sought to relinquish federal lease acreage which has either been (1) mined out, (2) considered sub-economic (unmineable) due to limited mining access because of inherent faulting and adverse geologic conditions, and/or (3) the remaining unmined areas are burned, and no recoverable reserves remain. Applications for relinquishment have been sought for acreage in the East Mountain Logical Mining Unit (LMU).

These applications have been reviewed by the BLM, with regulatory input from the Manti LaSal National Forest (USFS) and the Utah Division of Oil, Gas, and Mining (DOGM). PacifiCorp participated with a governmental agency task force which included representatives from BLM, USFS, and DOGM to develop a "Memorandum of Understanding for Processing of Requests to Relinquish Federal Coal Leases (10-MOU-97-001). This document establishes "Standards for Relinquishment Consideration" including the amount of accepted variation in annual subsidence data (refer to Appendix D). As stated in the MOU, the area will

be considered stable, if the cumulative subsidence during the pre-relinquishment period (3 years) has been 1 foot or less under normal circumstances. PacifiCorp's experience on East and Trail Mountain has shown that the areas of minimum detectable subsidence, i.e. one foot or more, very rarely extend outside of the outline of the total mine workings, even in areas where more than one seam has been mined.

Field inspections and helicopter surveys conducted annually have not identified any visible evidence of subsidence within the relinquishment areas. In addition to the surveys, PacifiCorp hosted field reviews with regulatory agencies; including BLM, USFS, and DOGM. During the field reviews, PacifiCorp discussed both the East and Trail Mountain subsidence monitoring program and inspected the ground surface for evidence for subsidence. Based on the meetings and supporting data, subsidence was substantially complete, and the areas proposed for lease relinquishment were declared stable.

Hydrology

Since 1979 detailed data on the hydrology of the East Mountain area (and the Mill Fork Area since 2000) have been collected, compiled, and analyzed by PacifiCorp and several government agencies. Information collected by PacifiCorp is the result of exploratory drilling, field investigations, geologic mapping, aerial photography, spring surveys, groundwater tests, monitoring of numerous wells and stream stations, climatological monitoring, and investigations by independent consultants. The data collection program is part of a complete Hydrologic Monitoring Program which has been approved by the Utah Division of Oil, Gas and Mining (DOGM) and the Office of Surface Mining (OSM). All data collected have been and will continue to be submitted to OSM, DOGM, United States Forest Service (USFS), and the Bureau of Land Management (BLM) each year in the annual Hydrologic Monitoring reports submitted by PacifiCorp.

Hydrologic monitoring plan for the East Mountain mine properties is specified in Volume 9 Hydrologic Section: Appendix A in the approved Mining and Reclamation Plan (MRP).

As outlined by the BLM, the interested parties have agreed that under normal circumstances, the minimum time period for continued monitoring after cessation of mining activities will be three years. During this time period the operator/lessee will establish that the surface has substantially stabilized according to Appendix "A".

The following sections will describe and provide detail concerning the groundwater and surface water resources within and adjacent to the East Mountain including Mill Fork mine properties.

Groundwater

Groundwater resources of the East Mountain, including Mill Fork, are limited and are controlled by the terrain, slope aspect and geologic structures. Terrain of these properties range from flat to narrow ridge tops with gentle slopes in the upland part of the area to very steep side slope conditions along the areas borders. The topography and slope aspect limit the amount of recharge to these areas.

Strata in the East Mountain properties are gently down-folded in the area of the Straight Canyon Syncline which is present in the central portion of East Mountain and northeast of the northern boundary of Trail Mountain. The bearing of the Straight Canyon Syncline is approximately N30°E and the structure plunges to the southwest. Dips in the syncline range from two to six degrees with the north limb dipping the steepest.

In the area south of the Straight Canyon Syncline the coal seam dips gently in a northwest direction toward the syncline; however, to the northwest of the Straight Canyon Syncline the Hiawatha seam dips in a southeast direction at three to five degrees.

The strata within the East Mountain property have been offset by a series of north-south trending normal fault zones. Generally, the faults are nearly vertical and do not have significant amounts of fault gouge or drag associated with them. One of the major faults present in the region, the Pleasant Valley Fault, has been intersected in both the Deer Creek and Wilberg mines.

The Pleasant Valley Fault consists of two parallel fractures about 150 feet apart. The fault's total displacement (where it was intersected in the Deer Creek Mine) to the north is 150 feet with its downthrown side on the east. The displacement diminishes to less than one foot where it was intersected in the Wilberg Mine near the south end of the East Mountain property.

Another north-south trending fault, the Deer Creek Fault, is present to the east of the Pleasant Valley Fault. It limits the eastward development of the Wilberg/Cottonwood and Deer Creek mines. The displacement of the Deer Creek Fault ranges from 100 to 170 feet with the east block being downthrown.

A northeast-southwest trending fault system, the Roans Canyon Graben, is present along the axis of the Straight Canyon Syncline. In the central portion of East Mountain the fault system contains up to six normal faults having displacements ranging from a few feet to over 150 feet. Coal deposits present to the north of the fault have been accessed through rock tunnels driven from the 3rd North section of the Deer Creek Mine.

In the Mill Fork Area the only known fault is the Joes Valley Fault, which forms the western limit of the coal reserves in this area. The Joes Valley Fault is the largest and most prominent of several north south trending fault zones within the Wasatch Plateau coal field. Displacement of the fault is approximately 1,500 feet, downthrown on the western side. The fault creates a continuous north-south escarpment on the east side of Joes Valley. Several side canyons are cut into this escarpment on the western side of the lease area, all of which drain into Joes Valley. The fault zone itself is not visible along this escarpment, but the fault has been intercepted underground in the Genwal Mine to the north. Where the fault has been intercepted in the Genwal mine workings, a drag fold is present, indicated by a gentle downward folding of the strata along the fault zone, extending for a few hundred feet to the east of the fault.

The rock formations exposed in the East Mountain area range from Upper Cretaceous to Tertiary in age (see Figure HF-2, Volume 9, Hydrologic Volume). The formations, in ascending order, are the Masuk Shale member of the Mancos Shale, Star Point Sandstone, Blackhawk, Castlegate Sandstone Sandstone, Upper

Price River, North Horn, and Flagstaff Limestone. The coal deposits are restricted to the lower portion of the Blackhawk Formation.

The Masuk Shale is the upper member of the Mancos Shale and consists of light to medium gray marine mudstones. Usually this formation weathers readily, forming slopes which are often covered by debris. It is generally devoid of water.

Overlying and intertonguing with the Masuk Shale is the Star Point Sandstone. In the East Mountain area the Star Point consists of three or more cliff-forming massive sandstones totaling about 400 feet in thickness. Generally, the sandstones are fine to medium-grained and moderately well-sorted. The upper contact of the Star Point Sandstone is usually quite abrupt and readily identifiable on the outcrop. Even though the Star Point Formation exists throughout the entire East Mountain properties, the low permeability and lack of recharge limit its usefulness as a water producing aquifer. Permeability are the limiting factors of recharge, i.e., very little outcrop exposure and limited vertical groundwater migration caused by the mudstone layers of the North Horn and Blackhawk formations. Locally, the Star Point Sandstone exhibits aquifer characteristics.

The Blackhawk Formation consists of alternating mudstones, siltstones, sandstones, and coal. Although coal is generally found throughout the Blackhawk Formation, the economic seams are restricted to the lower 150 feet of the formation. The sandstones contained within the Blackhawk Formation are fluvial and increase in number in the upper portions of the formation. Many of the tabular sandstone channels form local perched water tables. The total thickness of the Blackhawk Formation in the mining areas is about 750 feet.

The Castlegate Sandstone, the lower member of the Price River Formation, generally caps the escarpment which surrounds the eastern limits of the East Mountain properties. The Castlegate Sandstone consists of about 250 feet of coarse-grained, light gray, fluvial sandstones; pebble conglomerates; and subordinate zones of mudstones.

The Upper Price River Formation, which overlies the Castlegate Sandstone, is about 350 feet thick and forms slopes which extend upward from the Castlegate Sandstone escarpment. Although some mudstones are present, fine-grained, poorly sorted sandstones dominate the Upper Price River Formation.

The North Horn Formation is about 850 to 900 feet thick in the regional area. Mudstones dominate the rock types present and are generally gray to light brown in color. Localized, lenticular sandstone channels are present throughout the formation. The sandstone beds are more common near the upper and lower contacts of the formation.

The Flagstaff Formation is the youngest formation and only exposed in East Mountain area. The formation consists of white to light gray lacustrine limestone. An erosional remnant of 100 to 150 feet of this formation remains, forming a cap on the highest plateaus.

Waters entering the groundwater system are mostly from snow melt. The amount of water which enters the groundwater system is highly variable from one site to another. The low surface relief on the tops of East Mountain encourage the infiltration of melting snow. Conversely, the many areas with steep slopes have a much more limited infiltration opportunity. All of the geologic formations which surface in the area have relatively low permeability which further reduces the amount of water entering the groundwater system. Probably less than five percent of the annual precipitation recharges the groundwater supply (Price and Arnow, 1974; U. S. Geological Survey, 1979 – PacifiCorp has referenced this report in Volume 9 Hydrologic Volume and has transmitted a copy of this report to the Division for reference).

Geology controls the movement of groundwater. Because of the low permeability of the consolidated sedimentary rocks in the East Mountain and surrounding areas, groundwater movement is primarily "through fractures, through openings between beds, and, in the case of the Flagstaff Limestone, through solution openings" (Danielson et.al., 1981, p. 25 - PacifiCorp has referenced this report in Volume 9 Hydrologic Volume and has transmitted a copy of this report to the Division for reference).

The majority of the groundwater which infiltrates the Flagstaff Limestone flows down vertical fractures which intersect sandstone channel systems in the North Horn Formation. The majority of the groundwater reaching this point intersects the surface in springs located in the North Horn Formation. Very little recharge intersects the Price River Formation and Castlegate Sandstone; consequently, they are not water saturated where intersected in the numerous drill holes penetrating those units. The remaining water then flows downdip (to the southwest) from the northern reaches of East Mountain until it intersects the trace of the northeast trending Roans Canyon Fault Graben. The system acts as an aquiclude because swelling bentonitic clays along the fault prohibit most of the water from penetrating across the fault. Most of the recharge south of the Roans Canyon Fault System comes from the snow melt directly above. The same mode of water migration occurs there as to the north; but, when the water intersects the sandstone channels, it migrates toward the canyons which surround and dissects the mining properties.

Data have been collected from numerous coal exploration drill holes, from within the mine workings, from surface drainages, and from the springs in the area. The data have identified two separate isolated aquifer systems on the East Mountain properties (including Mill Fork Area); the first is localized perched water tables in the North Horn Formation, and the second is a combination of localized perched water tables in the Blackhawk Formation and the Star Point Sandstone which exhibits some limited potential as a regional aquifer. Stratigraphy is the main controlling factor restricting groundwater movement and development of regional and perched aquifer systems within the area of the mining properties. The following is a description of the various formations and how they influence the groundwater systems. The description is in descending order, which parallels the general groundwater flow.

Stratigraphy Description in Detail

Flagstaff Limestone

This formation displays a strong joint pattern which permits good groundwater movement both vertically and horizontally through the formation.

North Horn Formation

This formation is comprised of a variety of rock types which range from highly calcareous sandstone to mudstone. Its permeability is variable.

Lenticular sandstone channels are oftentimes present in the upper and lower portions of the formation. Water which percolates down fractures from the overlying Flagstaff Limestone works its way into the sandstones, forming the perched water tables. The actual lateral extent, or correlation, between the perched water tables has not been identified; and it is not practical to do so because the tables are limited in extent and variable in stratigraphic location. Many springs have been identified where the sandstone channels intersect the land surface.

The lower two-thirds (upper Cretaceous in age) of the formation is generally highly bentonitic mudstone which is impermeable. It is likely that this material is acting as an aquiclude, preventing adequate recharge from reaching the Upper Price River Formation or Castlegate Sandstone below. The mudstones present swell when they come in contact with water. Therefore, vertical migration of water along fractures through this material is limited because the fractures are sealed by the swelling clays.

The depth of the aquifers in the North Horn Formation is variable due to the rugged topography. The localized perched water tables may either intersect the surface of the ground or be covered by as much as 1,000 feet of overburden. They are located at least 1,400 feet above the coal seam to be mined. Communication of water between the perched aquifers in the North Horn Formation and the water flowing into the mine is limited in quantity and occurs very slowly. The monitoring of the numerous springs located in the Mill Fork Area gives PacifiCorp the ability to assess any effects that mining might have on the North Horn Formation perched aquifers.

With the data available it is not possible to compile a piezometric map of the water-bearing strata in the North Horn Formation because the channels are discontinuous and not interconnected.

Upper Price River Formation

The Upper Price River Formation is comprised predominantly of sandstone but commonly contains mudstone beds between the point bar deposits. It is generally void of water because it lacks adequate recharge.

Castlegate Sandstone

The formation is thought to be fairly permeable but, where it has been intersected by drill holes, has never been found to be water-saturated. It is oftentimes dry or slightly damp in some zones. It is void of significant water because it lacks adequate recharge.

Blackhawk Formation

The Blackhawk Formation contains only perched or limited aquifers which exist within the strata overlying the coal seams and the upper portion of the Star Point Sandstone Formation. The perched aquifers exist as fluvial channels (ancient river systems) which overlie and scour into the underlying strata. These channel systems were part of a deltaic depositional setting active during and after the coal-forming peat accumulation. The largest influx of water encountered during the mining process occurs beneath the fluvial channels. The sandstone channels are mainly composed of a fine-to medium-grained sand with similar characteristics to the Star Point Sandstone Formation. The semi-permeable and porous nature of the channels allows an effective route for water transport. Other constituents of the Blackhawk Formation (i.e., mudstone, carbonaceous mudstone, coal seams, and interbedded mudstones/siltstone and sandstones) generally act as aquicludes which impede vertical groundwater flow to the lower stratigraphic units. In areas other than where faulting and fracturing have created secondary permeability, the migration of water from the perched aquifers-sandstone channel systems of the Blackhawk Formation to the Star Point Sandstone Formation is limited. Extensive mining in the Deer Creek and Cottonwood/Wilberg mines, which produces coal from the Hiawatha seam, is stratigraphically located on top of the upper member of the Star Point Formation Sandstone. Only minor quantities of groundwater have been produced from the Star Point Sandstone Formation. The coal seams of the Blackhawk Formation are effective in impeding vertical groundwater movement. In many areas in the mine where roof coal was left in place because of abundant thickness or as an additional effort to support the immediate roof, production of groundwater occurred only when roof support was installed or when a roof failure occurred exposing the overlying sandstone channel systems. The table below lists the hydrologic characteristics of individual rock types reported by the USGS, Open File Report 84-067.

Lithology: Sh, shale; Slt, siltstone; Ss, sandstone; f, fine grained; m, medium grained. Hydraulic conductivity: I, impermeable to water even at a pressure of 5,000 psi.					
Geologic Unit	**Lithology**	**Depth below the land surface (ft)**	**Porosity (%)**	**Hydraulic Conductivity (feet per day)**	
				Horizontal	**Vertical**
Blackhawk Formation	Ss, f	1,521	14	$1.5x10^{-2}$	$3.7x10^{-3}$
	Slt	1,545	3	$9.3x10^{-8}$	$1.2x10^{-7}$
	Sh	1,786	2	I	I
	Ss, f	1,792	14	$1.1x10^{-2}$	$3.9x10^{-3}$
	Sh	2,170	4	$1.1x10^{-8}$	
	Slt	2,265	2	$2.0x10^{-7}$	$2.2x10^{-6}$
Star Point Sandstone	Ss, m	2,466	17	$3.1x10^{-2}$	$1.1x10^{-2}$
	Ss, m	2,493	11	$1.5x10^{-2}$	$6.6x10^{-3}$

The majority of the water flowing into the mines comes from within the limited fluvial channel aquifers; however, water is also transmitted into the mine workings by way of faults, joints or fractures, and in-mine drill holes (see Figure HF - 4, Volume 9 - Hydrologic Volume). The Des-Bee-Dove permit area was an exception. The Deer Creek Fault, which separates Deer Creek and Wilberg/Cottonwood mines from Des-Bee-Dove, forms an aquiclude to the water migration to the east. Since 1978 the water flowing into the mine workings has been measured. The measurement locations in the Deer Creek Mine are shown on Map HM-2, Volume 9 Hydrologic Volume, in the Wilberg/Cottonwood Mine on HM-3, Volume 9 Hydrologic Volume. Many locations within the mines have been monitored in the past, but a limited number of accessible long-term water monitoring locations now exists because most water-producing areas of the mines are dewatered and stop flowing shortly after initial mining in the area.

In several locations in the Deer Creek and Wilberg/Cottonwood mines, such as retreated longwall panels, water is being produced but cannot be measured because the workings are inaccessible. The water entering these areas flows into numerous low areas in the mine which act as temporary sumps. The water is then pumped to the main sump located near the mine portal. Because the pumping system in the mine is ever changing (i.e., portable pumps being moved to various locations within the mine as the need arises), it is not possible to collect meaningful data from specific areas of the mine that can be compared with data collected from years or even months past.

The most accurate measurement of water flowing into the mine workings is achieved by measuring the total water leaving the mine, which is done and reported annually in the Hydrologic Monitoring Report. The total amount of water leaving the mine includes metered discharge water as well as estimated water which evaporates from the mine workings.

Based on current data, several observations have been made concerning the Blackhawk water-bearing strata. The sandstone, which is semi-permeable and porous, affords an effective route of water transport; while relatively impervious shale in the Blackhawk Formation prevents significant downward movement of the percolating water. Of the water-producing areas, those closest to the active mining face exhibit the greatest flows. As mining advances the area adjacent to the active face continues to be excessively wet, and previously mined wet areas experience a decrease in flow. It appears that the water source is being dewatered since mined out areas of the mine do not continue to produce water indefinitely. The water source must be either of limited extent, e.g., a perched aquifer, or have a limited recharge capacity.

Star Point Sandstone

The Star Point Sandstone Formation overlies and intertongues with the Masuk Shale. The formation is approximately 150 to 200 feet in thickness and consists of at least three upward coarsening sandstone units. Mudstone units of the Masuk Shale are present above the lower two sandstone members of the Star Point Sandstone Formation due to the intertonguing nature of the contact between the two units.

The Star Point Sandstone Formation, which immediately underlies the Hiawatha Coal Seam, exhibits some characteristics of an aquifer but experiences little recharge. Studies conducted by the USGS indicate that the Star Point Sandstone Formation is of low permeability, thus limiting its usefulness as a water-producing aquifer. Most of the water discharge from the Star Point Formation is where it has been intersected by the major canyons in the plateau or where faulting has caused secondary permeability. Drill holes completed in the Deer Creek and Wilberg/Cottonwood mines defined the piezometric gradient in the lower Blackhawk/Star Point Formation System and confirmed the groundwater flow to conform with the topographic relief and structural features, i.e., regional dip, Straight Canyon Syncline, and regional faulting (see Figure HF-5, Volume 9, Hydrologic Volume). This, plus the fact that the Star Point Formation is only slightly to moderately permeable, allows only limited flow of groundwater through the formation.

Water in most of the Blackhawk/Star Point aquifer is confined under pressure between shale and siltstone beds within the aquifer (USGS Lines, Open File Report 84-067). Water is released from storage from confined aquifers mainly by compression of the sandstones and less permeable, confining beds as pressure in the aquifer declines. The quantity of water that can be released from storage is dependent on the storage coefficient, which is about $1x10^{-6}$ per foot of thickness for most confined aquifers (Lohman, 1971, p. 8). Data collected by PacifiCorp on the Roans

Canyon Fault System in 1988, 3rd North fault crossing, confirmed the USGS storage coefficient estimations, with values ranging from $1.6x10^{-4}$ to $7.0x10^{-6}$. Transmissivity values computed for pump tests conducted by the USGS on Trail Mountain on non-fully penetrating wells in the Blackhawk/Star Point aquifer ranged from 0.7 to 100 ft^2 /day with a majority of the two results ranging from 1 to 10 ft^2 /day. The computed transmissivity of 100 ft^2 /day was greater than the laboratory data (listed early in this section) and was believed to be due to secondary permeability in the form of fractures. Transmissivity results ranging from 0.7 to 10 ft^2/day are indicative of the low permeability rock in most of the cretaceous and tertiary strata within the Wasatch Plateau.

Groundwater Occurrence

Groundwater naturally discharges, in greatly varying quantities, from most formations exposed in East Mountain. Approximately 75% of the identified springs issue from the North Horn Formation, which comprises nearly the entire plateau surface of these areas. Little Bear Spring, east of the Mill Fork Area discharges from fractures in the Star Point Sandstone. No springs have been identified discharging from the Mancos Shale.

Within the mines, groundwater issues from short-lived roof drips, the mine floors in some locations in the Deer Creek, Cottonwood, and Wilberg mines, and from the mine roof and mine floor after encountering some faults. Confined groundwater occurs in monitoring wells in the Star Point Sandstone that have been installed in the mines and elsewhere. Groundwater discharge is generally not associated with the Mancos Shale.

Springs and Seeps

The most frequent occurrences of springs are those located about 150 to 350 feet below the top of the North Horn Formation (see Figure HF-6, Volume 9 - Hydrologic Volume, Figure MFHF4, Volume 12 - Mill Fork Hydrologic Section). The drill hole data show a predominance of fluvial siltstone and sandstone at that stratigraphic interval. These sedimentary rocks represent many isolated fluvial systems which are water-bearing. The springs are formed where the fluvial channels intersect the land surface. Because the fluvial channels within this zone are generally not interconnected, the springs are not interrelated but share the same mode of occurrence.

Numerous springs located in the lower portion of the North Horn Formation occur when water flowing through fluvial sandstones which are underlain by a thin zone of impervious mudstone at the base of the North Horn Formation intersect the land surface. The surface drill hole data indicate that impervious mudstone units occur at the upper and lower portion of the North Horn Formation. Even though these individual mudstone layers are discontinuous, the occurrence of this type of strata exists throughout the East Mountain Property. As part of Volume 9 - Hydrologic Support Information, logs of representative holes from the East Mountain exploration programs are included to document the occurrence of this type of strata (additional drill hole data are located at PacifiCorp's Salt Lake or Huntington offices). The springs related to this mode of occurrence are not generally interrelated because they are fed by waters flowing through isolated fluvial channel sandstones and siltstones.

Several springs are located along the Roans Canyon Fault Graben. Generally, the springs are located within the North Horn Formation along the fault zone. Few springs are located in the area below the base of the North Horn Formation below where the impervious mudstone is located, supporting the fact that water percolating down a fracture or fault is stopped from further downward travel when it reaches the impervious clay zone which forms a seal along the fracture. Many of the largest springs on East Mountain are located along this fault system. Because the fault system is located along the trough of the Straight Canyon Syncline, water from both the north and the south flows toward the fault where it is allowed to migrate to the land surface. The springs located along this fault zone are generally interrelated.

A few springs are located within both the Flagstaff and Price River formations; however, their occurrence is insignificant in comparison to springs located in the North Horn Formation.

Generally springs with discharges exceeding 50 gpm are associated with faulting where permeability has been increased by fracturing. The discharge of the springs varies directly with the amount of precipitation and also varies seasonally. Discharge is greatest during the snow melt period, normally from late April through the month of June. Following periods of groundwater recharge the discharge recedes fairly rapidly at first, then gradually, indicating a double porosity effect. At the end of the water year the remaining discharge is only twenty to thirty percent (20-30%) of the peak discharge. Annual variations and historical comparisons are depicted in the annual Hydrologic Monitoring reports.

Spring Discharge Characteristics

More than 100 spring hydrographs have been created from water monitoring data and analyzed. Approximately 75% of the springs discharge from the North Horn Formation. The remainder discharge from creek bottom alluvial systems, the Flagstaff Limestone, the Price River Formation, the Castlegate Sandstone, and the Blackhawk Formation. No springs have been identified which discharge from the Star Point Sandstone or Mancos Shale.

Groundwater hydrology of East Mountain is a dynamic and complex process. Simply comparing yearly precipitation values to discharge rates does not accurately reflect the complete hydrologic situation. PacifiCorp has been comparing spring discharge rates to yearly precipitation as a simple trend indicator since the inception of the spring monitoring program. However, thorough analysis of yearly spring discharge data must take in account a multitude of hydrologic and climatic factors including;

- slope aspect of the recharge area (south facing versus north facing slope),
- type of vegetative cover,
- timing, type, and areal distribution of precipitation (snow or rain),
- timing of data collection versus precipitation,
- geologic occurrence of the spring (whether joint/fracture/fault controlled, outcrop of near surface fluvial sandstone channel systems or down gradient drainage flow systems),
- change in head differential, migration of source or source measuring point
- alteration of the recharge area: example - timbering practices, fires

- change/disruption of the discharge area: examples – grazing, wildlife, attempts to replace or enhance the discharge location and piping structures.

PacifiCorp recognized this dynamic hydrogeologic system and designed the groundwater/spring monitoring program based on the following criteria:

- Stratigraphic position (geologic formations ranging from the Flagstaff Limestone to the coal bearing Blackhawk Formation, structural control aspects – faulting)
- Area of potential influence from subsidence (springs monitored within and outside the area of potential impact)
- Representative areal distribution of springs (takes into account the variable aspect of precipitation)
- Established water rights
- Measurable flow based on historical surveys
- Reliable measuring point(s)

In addition to the site selection process, PacifiCorp established the spring monitoring program sampling schedule (July – peak flow and October – base flow) to conform to normal early and late season access to the mountainous terrain allowing for a consistent yearly comparison. However, during periods of below normal precipitation, especially prolonged periods of drought, timing of data collection can skew or miss the peak flow volumes. This is particularly evident in areas of limited recharge due to topographic considerations. Each of the variables listed above is taken into account to assess potential interruptions to the groundwater systems by underground mining.

Over the last forty years, Central Utah has experienced extreme climatic cycles, including an unprecedented record setting wet cycle in the late seventies and early eighties followed by several prolonged drought cycles. Development of PacifiCorp's spring monitoring program coincided with the record setting wet period elevating recharge and discharge rates to levels not achieved since this period. Monitoring data reveals that the unprecedented record setting wet cycle resulted in elevated flows for several years after even though the hydrologic cycle was returning to a normal pattern. However, instead of returning to a long term normal cyclic pattern, the intermountain west experienced several periods prolonged extreme drought. Episodic cycles of normal precipitation following these periods of extreme drought have ultimately affected the recharge and discharge of the near surface shallow spring systems. This is evident in reviewing similar declining discharge recession curves of springs that are outside the influence of mining. Surface runoff data from drainages of East Mountain confirms the trends of the groundwater system monitoring.

Summary

PacifiCorp proposes to eliminate spring monitoring of certain springs on both the East Mountain and Mill Fork mining properties. Many of these springs on East Mountain have been monitored as early as 1977 for both quantity and quality of each springs discharge. Monitoring of Mill Fork Area hydrology was instituted in 2000 three years prior to mining. PacifiCorp instituted a Hydrologic Monitoring Program in

1979 which has been approved by the Utah Division of Oil, Gas and Mining (DOGM) and the Office of Surface Mining (OSM). All data collected have been and will continue to be submitted to OSM, DOGM, United States Forest Service (USFS), and the Bureau of Land Management (BLM) each year in the annual Hydrologic Monitoring reports.

In-house research has been conducted on the collected data to analyze the interrelationships between the surface and groundwater hydrologic systems and the potential impacts associated with underground mining. Analysis has included; seep and spring surveys, drainage surveys, baseline data collection, and other hydrologic studies.

The Bureau of Mines conducted a study looking at mining induced subsidence and its potential disruption to the hydrologic systems of the Wasatch Plateau. The study hypothesized that springs are expected to show a greater response to underground mining where they are located over panels than those located over mains or barrier pillars since overburden deformation occurs over longwall panels as the roof caves and fractures form in the overburden. The springs in this study did not show a dramatic decrease in flow as was expected.

The study concluded that the limited response observed for the springs was thought to be influenced by site-specific conditions that buffered the effects of mining. These conditions include the thick overburden present and the presence of formations in the overburden that contain hydrophilic clays and mudstones. These clays were described to act as aquatards retarding the migration of water, lessening the vertical extent of strata dewatering.

This discussion also has included a presentation of the geology the East Mountain mining properties and its association to the surface and ground water systems. It has been shown that geology controls the movement of groundwater. Waters entering the groundwater system occur mostly from snow melt. The amount of water which enters the groundwater system, however, is highly variable because the terrain and slope aspect of the area is highly variable. On steeper and/or south facing slopes, water has less chance to infiltrate into the groundwater system.

Stratigraphy has been noted as the main controlling factor restricting groundwater movement. All of the geologic formations which surface in the area have a relatively low permeability which further reduces the amount of water entering the groundwater system. Data collected from holes drilled through the strata have identified two separate isolated aquifer systems on the East Mountain properties; the first is localized perched water tables in the North Horn Formation, and the second is a combination of localized perched water tables in the Blackhawk Formation and the Star Point Sandstone which exhibits some limited potential as a regional aquifer. These systems have been identified as part of Mayo & Associates "Investigation of Surface-Water and Groundwater Systems in the PacifiCorp Lease Area, East and Trail Mountains", as active and inactive groundwater systems.

Active groundwater flow systems have excellent hydraulic communication with the surface and thus are dependent on annual recharge events and are affected by short term climatic variability. Inactive

groundwater flow regimes contain old groundwater (i.e. 2,000 to 12,000 years), have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability.

Finally, justification statements have been prepared by PacifiCorp to justify the elimination of certain spring monitoring responsibilities by the company. As quality and quantity parameters have been monitored, there has been no data collected that shows any diminution or impacts to the quality of the surface or groundwater systems associated to PacifiCorp's mining operations within the East Mountain mining properties.

Flow data for springs has been presented comparing Julys peak flow to the collected precipitation data from PacifiCorps East Mountain weather station as well as the Palmer Hydrologic Drought Index. The data shows a very prominent correlation and trends suggest that spring flow is most likely regulated by climate rather than being impacted by underground mining operations. There has been no evidence in the 33 years of monitoring by PacifiCorp and others that suggest underground mining operations have impacted any spring discharges within the East Mountain mining areas.

This discussion report concludes that for all the investigations, research, analysis of the data, and information collected of the geologic and hydrologic systems within the East Mountain mining properties, there has not been any relationship found between the quality and quantity of spring discharge and PacifiCorp's underground mining operations.

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
UJV-213	First Mining	Hiawatha: 25th West Bleeder Feb. 2012	Within Relinquishment	10	16S	6E	NA
UJV-101	First Mining	Hiawatha: 22nd West Bleeder Mar. 2011	Within ½ mile Offset Within Lease UTU-84285	10	16S	6E	NA
JV-34	Not Undermined	NA Nearest second mining: 2670' Aug. 2008	Within ½ mile Offset	15	16S	6E	NA
JV-9	Not Undermined	NA Nearest second mining: 1940' Jun. 2005	Within ½ mile Offset	22	16S	6E	NA
UJV-206	Not Undermined	NA Nearest second mining: 1825' Dec. 2005	Within Relinquishment	22	16S	6E	NA
MF-219	First Mining - BC Longwall – BC First Mining – Hia.	Blind Canyon: First Mining 7th Left Sep. 2009 Second Mining 7th Left Apr. 2010 Hiawatha: 23rd West Feb. 2011	Within Relinquishment	11	16S	6E	1

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
SPI-26	Not Undermined	NA Nearest second mining: 460' Feb. 2010	Within Relinquishment	11	16S	6E	NA
MF-10	Longwall Panels	Blind Canyon: 5th Left Jul. 2009 Hiawatha: 21st West Jan. 2011	Within Relinquishment	14	16S	6E	7
MF-19B	First Mining	Hiawatha: 7th North Sump Feb. 2006	Within Relinquishment	13	16S	6E	0
RR-5	Not Undermined	NA Nearest second mining: 1000' Feb. 2009	Within Relinquishment	14	16S	6E	NA
EM-216	Not Undermined	NA Nearest second mining: 975' Sep. 2005	Within Relinquishment	23	16S	6E	NA
GRANTS SPRING	Not Undermined	NA Nearest second mining: 1560' Nov. 2005	Within Relinquishment	23	16S	6E	NA
RR-15	Not Undermined	NA Nearest second mining: 55' Mar. 2006	Within Relinquishment	14	16S	6E	NA

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
EMPOND	Not Undermined	NA Nearest second mining: 1620' Dec. 2005	Within Relinquishment	23	16S	6E	NA
MFR-30	Not Undermined	NA Nearest second mining: 4000' Mar. 2014	Within Relinquishment	7	16S	7E	NA
MFR-10	Not Undermined	NA Nearest second mining: 2380' Mar. 2014	Within Relinquishment	12	16S	6E	NA
MF-7	Not Undermined	NA Nearest second mining: 1707' Jul. 2010	Within Relinquishment	12	16S	6E	NA
MF-213	Not Undermined	NA Nearest second mining: 7915' Jul. 2010	Within ½ mile Offset	17	16S	7E	NA
LB10/ LB-11 Little Bear	Not Undermined	NA Nearest second mining: 13050' Mar. 2014	Adjacent to Lease	9	16S	7E	NA

SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 1 OF 10	REV. ___

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring SPI-29 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat on February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of SPI-26 in the Hiawatha Seam, 26th West gateroad, on October 2012. Spring SPI-29 is located in barrier pillar south of 26th West. Nearest seconding mining is approximately 295' north, 27th West longwall panel.

Subsidence: No subsidence has been detected near SPI-29. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. SPI-29 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring SPI-29. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - SPI-29 is a low volume spring/seep located below trail in a small clearing on west facing slope surrounded with conifers and aspens. Spring drains to small shallow basin adjacent to source. Crandall Canyon Mine developed the trail into an access road during the 2007 mine collapse. Roadway reclaimed in 2013. Flow from spring SPI-29 generally ranges from 0.0/seep to a maximum of <3.0 gpm. Area near and spring site disturbed/re-developed post Crandall Canyon mine collapse. Wet area developed on nearby access road, flow from original source dissipated (see following Geologic Occurrence – photos).

Geologic Mode of Occurrence for spring SPI-29:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 150' below top.

Justification for removal from monitoring: SPI-29 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site SPI-29 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **SP1-29**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1630' S.	3070' E.	NW	11	16S	6E	10360

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	1 ½ " Steel Pipe Non-functioning post Crandall Canyon drill hole disturbance	None	150' below top

Location Comments: Spring located below trail in a small clearing on west facing slope surrounded with conifers and aspens.

Probable Recharge Area: Areas of higher elevation located to the east (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as SP1-31.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

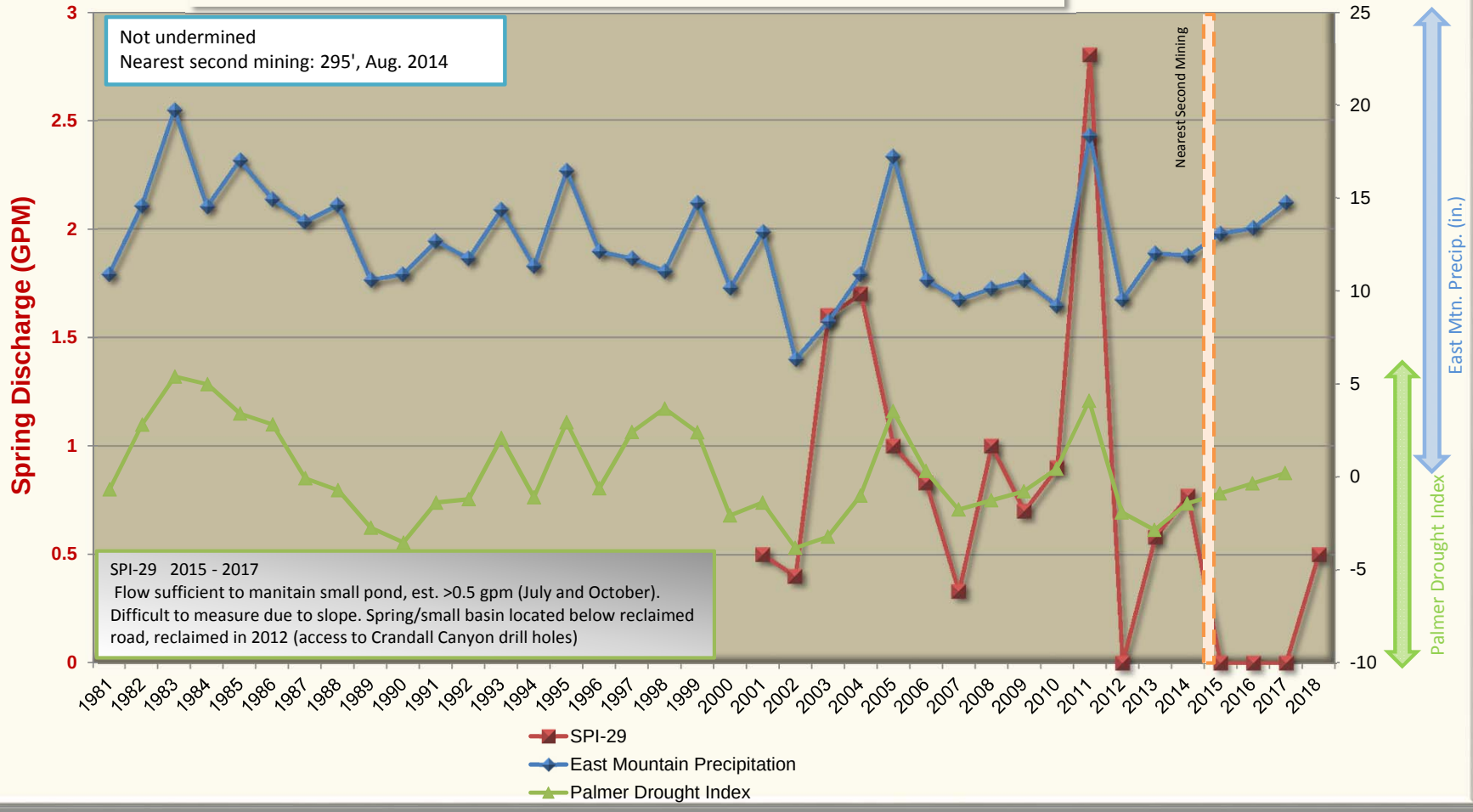
SPI-29 spring source, August 9, 2001

Small basin below SPI-29 post Crandall Canyon drill hole disturbance. View from reclaimed road, May 23, 2018

SPI-29 Spring source, May 23, 2018 (same view as August 9, 2001 photo)

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: SPI-29 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: SP1-29
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 295'
Date of Nearest Mining: Aug. 2014

	Pre-Mining Data: 20000101 THROUGH 20140701				Post-Mining Data: 20140701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	322	238	271	18	- No Sample Data -				BICARBONATE
CALCIUM	76.6	64	69.1122	18					CALCIUM
CARBONATE	0	0	0	8					CARBONATE
CHLORIDE	3	2	2.17222	18					CHLORIDE
CONDUCTIVITY	555	457	501.777	18					CONDUCTIVITY
DISSOLVED OXYGEN	0								DISSOLVED OXYGEN
FLOW	2.8	0.09	0.89444	18					FLOW
HARDNESS	288	246	266.277	18					HARDNESS
TOTAL IRON	0.06	0	0.0075	8					TOTAL IRON
DISSOLVED IRON	0	0	0	8					DISSOLVED IRON
MAGNESIUM	24.78	20.7	22.7277	18					MAGNESIUM
DISSOLVED MANGANESE	0.015	0	0.00225	8					DISSOLVED MANGANESE
MANGANESE	0.012	0	0.0015	8					MANGANESE
OIL AND GREASE	0								OIL AND GREASE
PH	7.96	7.24	7.64611	18					PH
POTASSIUM	2	0.98	1.35277	18					POTASSIUM
SET SOLIDS	0								SET SOLIDS
SODIUM	7.41	2.57	3.34333	18					SODIUM
SULFATE	9	5	6.74444	18					SULFATE
SUSPENDED SOLIDS	255	255	255	1					SUSPENDED SOLIDS
TEMPERATURE	8.8	3.6	5.04444	18					TEMPERATURE
TOTAL DISSOLVED SOLIDS	315	249	269.555	18					TOTAL DISSOLVED SOLIDS

Location: Section 10, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring UJV-213 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat on February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of UJV-213 in the Hiawatha Seam, 25th West Bleeder, in February 2012.

Subsidence: No subsidence has been detected near UJV-213. Maximum subsidence in area 400' east of UJV-213 has stabilized at approximately 2 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2012. UJV-213 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-213. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 – 2001 and 2007 – 2017 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV-213 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west. Flow from spring UJV-213 generally ranges from 0.0/seep to a maximum of 3.0 gpm. Spring flow dissipates rapidly below spring source.

Geologic Mode of Occurrence for spring UJV-213:

- Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Castle Gate (refer to Geologic Occurrence sheet).

- Stratigraphic Position: Mid-formation.

Justification for removal from monitoring: UJV-213 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-213 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-213**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
261' N.	889' W.	SW	10	16S	6E	8960

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Castle Gate	None	a21560 Change application is to allow the applicant the right to develop the 3 unnamed springs to draw a portion of the stock away from the Spoon Creek riparian area.	Middle

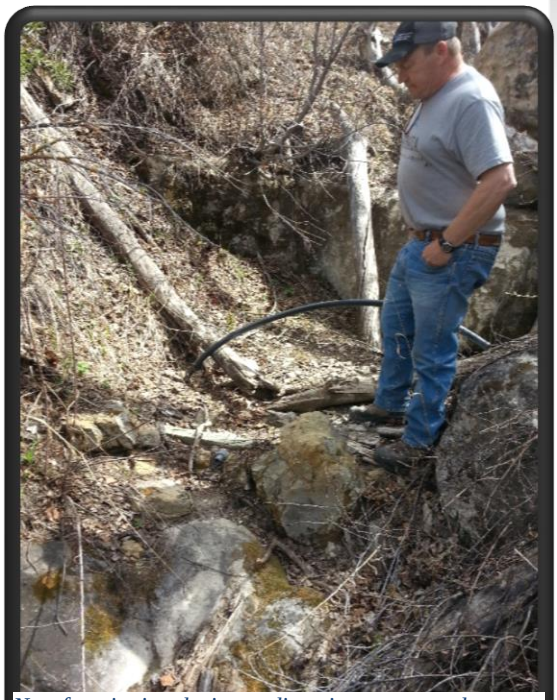
Location Comments: Spring located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area

Geologic Occurrence of Spring:

Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

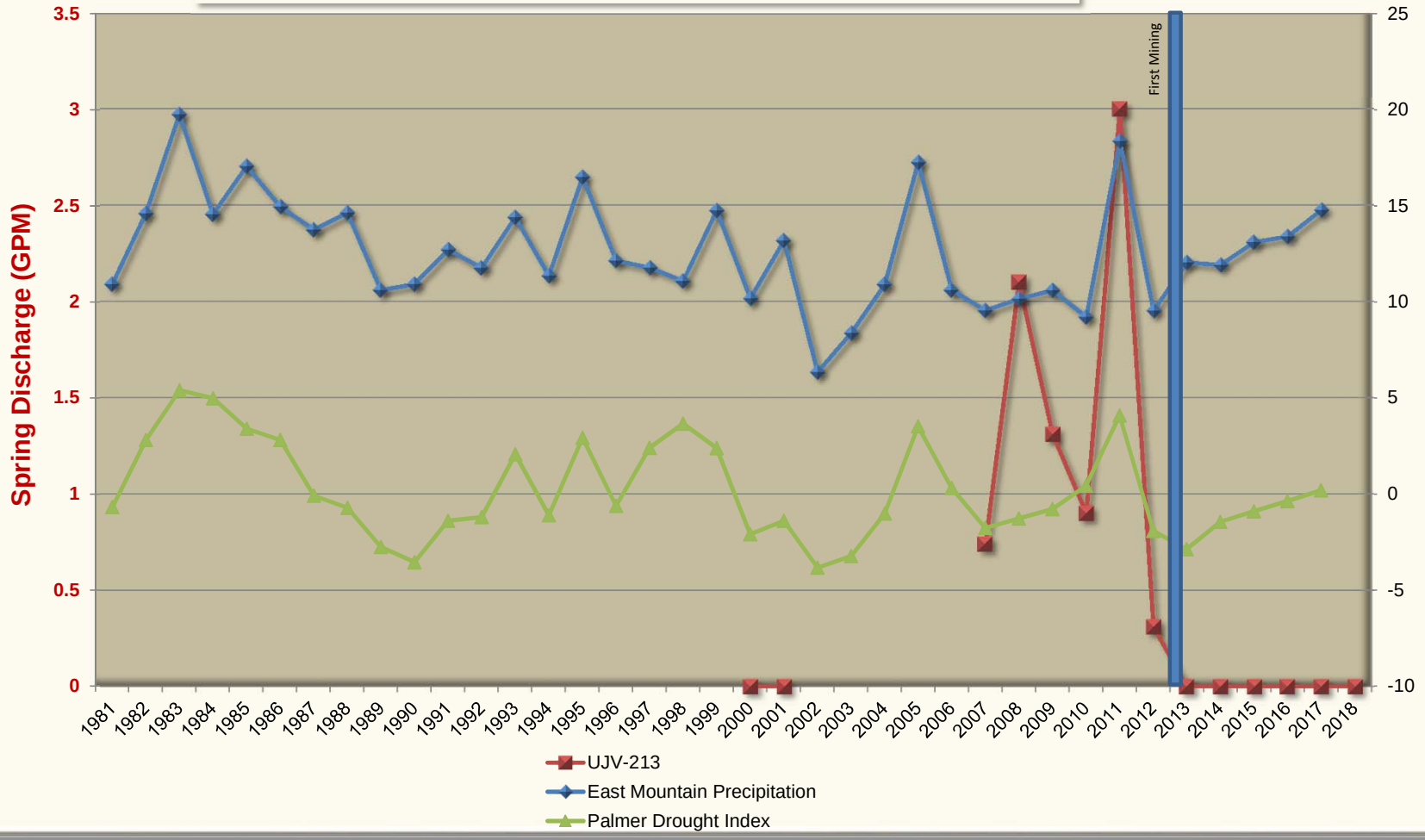


Non-functioning drainage diversion, un-named drainage near UJV-213

Non-functioning trough below UJV-213, source from un-named drainage

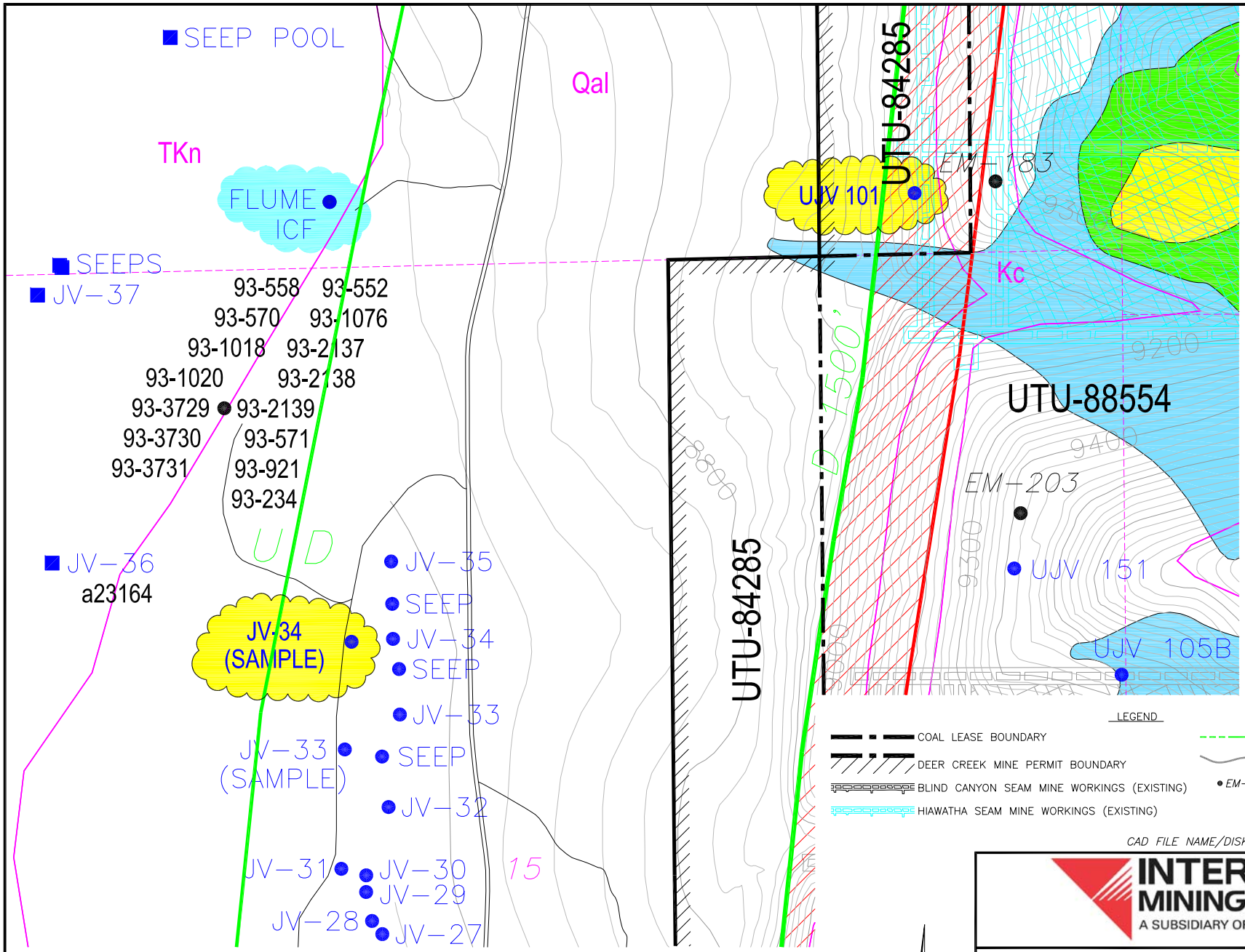
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-213 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-213
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb. 2012
Date of Second Mining: Not undermined
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20120131				Post-Mining Data: 20120201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	241	220	227.888	9	220	217	218.5	2	BICARBONATE
CALCIUM	71.32	62.92	68.4644	9	67.09	62.63	64.86	2	CALCIUM
CARBONATE	0	0	0	7	0	0	0	2	CARBONATE
CHLORIDE	4	3	3.66666	9	4	4	4	2	CHLORIDE
CONDUCTIVITY	583	478	511.222	9	489	467	478	2	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	3	0.21	1.12777	9	0.31	0.16	0.235	2	FLOW
HARDNESS	275	240	263.777	9	262	241	251.5	2	HARDNESS
TOTAL IRON	0.44	0	0.19333	9	0.97	0.15	0.56	2	TOTAL IRON
DISSOLVED IRON	0	0	0	7	0	0	0	2	DISSOLVED IRON
MAGNESIUM	23.81	20.15	22.5577	9	23.01	20.47	21.74	2	MAGNESIUM
DISSOLVED MANGANESE	0.011	0	3.44444	9	0.031	0.019	0.025	2	DISSOLVED MANGANESE
MANGANESE	0	0	0	7	0.003	0	0.0015	2	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.17	7.68	7.90888	9	8.18	7.64	7.91	2	PH
POTASSIUM	1.52	0.97	1.15555	9	1.3	1.11	1.205	2	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8.94	5.78	7.00222	9	5.85	5.77	5.81	2	SODIUM
SULFATE	40	33	36.5555	9	33	31	32	2	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	9.9	6.5	7.94444	9	10.3	9.5	9.9	2	TEMPERATURE
TOTAL DISSOLVED SOLIDS	320	284	298.222	9	277	273	275	2	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 2	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 2 OF 10	REV. ___

Location: Section 10, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-84285.

Lease Association: Spring UJV-101 is located within Federal Coal lease UTU-84285 adjacent to UTU-88554. The lease was originally acquired from Bureau of Land Management on November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. First mining occurred in vicinity of UJV-101 in the Hiawatha Seam, 23rd West Bleeder, in March 2011.

Subsidence: An area of minor subsidence occurs adjacent to spring UJV-101. Maximum subsidence in area 200' south of UJV-101 has stabilized at approximately 2 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2013. UJV-101 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-101. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1993 through 1995 by Genwal Resources and 2000 through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV101 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Flow from spring UJV-101 generally ranges from 0.0/seep to a maximum of < 4.0 gpm. Spring flow dissipates rapidly below spring source.

Geologic Mode of Occurrence for spring UJV-101:

- Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Castle Gate (refer to Geologic Occurrence sheet).
- Stratigraphic Position: Mid-formation.

Justification for removal from monitoring: UJV-101 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-101 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-101**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
261' N.	889' W.	SW	10	16S	6E	8960

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Castle Gate	None	None	Middle

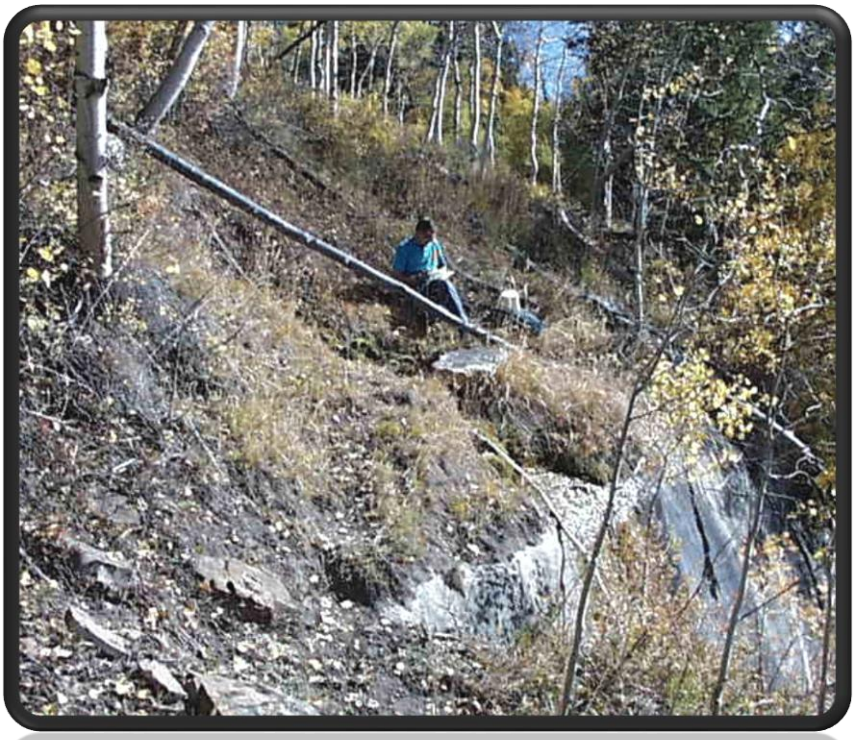
Location Comments: Spring located above small cliff (Joes Valley Fault) overlooking Joes Valley on west facing slope covered with aspens and mountain brush.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area

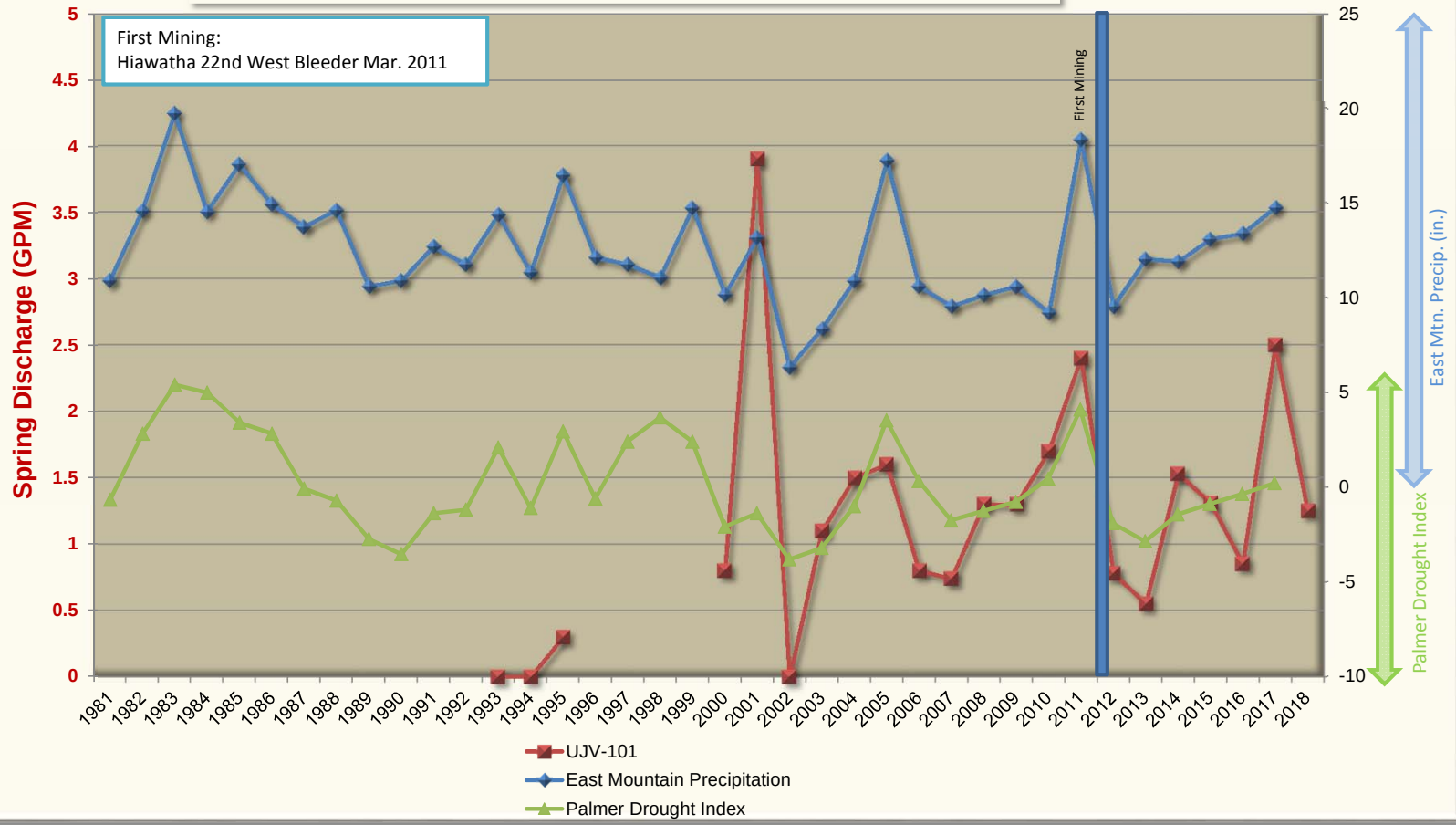
Geologic Occurrence of Spring:

Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.



EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-101 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-101
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Mar-11
Date of Second Mining: Not undermined
Location of Nearest Mining: NA
Date of Nearest Mining: NA

	Pre-Mining Data: 20000101 THROUGH 20110228				Post-Mining Data: 20110228 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	295	212	239.5625	16	249	216	230.428	14	BICARBONATE
CALCIUM	74.22	64.9	70.0531	16	81.82	66.61	72.7107	14	CALCIUM
CARBONATE	0	0	0	6	0	0	0	14	CARBONATE
CHLORIDE	6	4	4.525	16	4	3	3.92857	14	CHLORIDE
CONDUCTIVITY	690	475	533.0625	16	570	494	537.571	14	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	1.69	0.2	1.049375	16	2.5	0.38	1.04285	14	FLOW
HARDNESS	286	253	269.9375	16	317	257	285.571	14	HARDNESS
TOTAL IRON	0.88	0	0.28788	9	1.98	0	0.3	14	TOTAL IRON
DISSOLVED IRON	0	0	0	6	0	0	0	14	DISSOLVED IRON
MAGNESIUM	24.68	21.8	23.0556	16	27.32	22.04	25.2585	14	MAGNESIUM
DISSOLVED MANGANESE	0.019	0	6.11111	9	0.088	0	1.25714	14	DISSOLVED MANGANESE
MANGANESE	0.002	0	2.85714	7	0	0	0	14	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.38	7.5	7.9275	16	8.41	8.12	8.25142	14	PH
POTASSIUM	2	0.92	1.24875	16	1.82	1.17	1.37571	14	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	6.45	5.22	5.73625	16	6.66	5	6.085	14	SODIUM
SULFATE	51	27	39.34375	16	65	39	52.4285	14	SULFATE
SUSPENDED SOLIDS	293	293	293	1	0				SUSPENDED SOLIDS
TEMPERATURE	9.6	5.2	6.9125	16	10.6	4.1	7.38571	14	TEMPERATURE
TOTAL DISSOLVED SOLIDS	330	259	303.0625	16	365	289	325.142	14	TOTAL DISSOLVED SOLIDS

Location: Section 15, Township 16 South, Range 6 East, SLB&M. This site is located within the ½ mile offset of the Deer Creek mine permit boundary adjacent to Federal Coal leases UTU-84285 and UTU-88554.

Lease Association: Spring JV-34 is located adjacent to Federal Coal leases UTU-84285 and UTU-88554. The lease UTU-88554 was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Lease UTU-84285 was originally acquired from Bureau of Land Management on November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. No mining occurred in the vicinity of JV-34.

Subsidence: No subsidence has been detected near JV-34. For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring JV-34. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - JV-34 spring located in Joes Valley alluvial basin near the 345 kV powerline. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-34 varies dramatically based on winter pack on spring runoff, generally ranges from 0.0/seep to a maximum of 80.0 gpm.

Geologic Mode of Occurrence for spring JV-34:

- Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.
- Geologic Formation: Joes Valley Alluvium (refer to Geologic Occurrence sheet).

- Stratigraphic Position: NA.

Justification for removal from monitoring: UJV-34 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-34 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **JV-34**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1565' S.	1860' E	NW	15	16S	6E	8692

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Joes Valley Alluvium	None	None	NA

Location Comments: Spring with multiple sources located near power line. Measured flow at confluence of several sources near road. Brass tag attached to brush.

Probable Recharge Area: Areas of higher elevation located to the north and east.

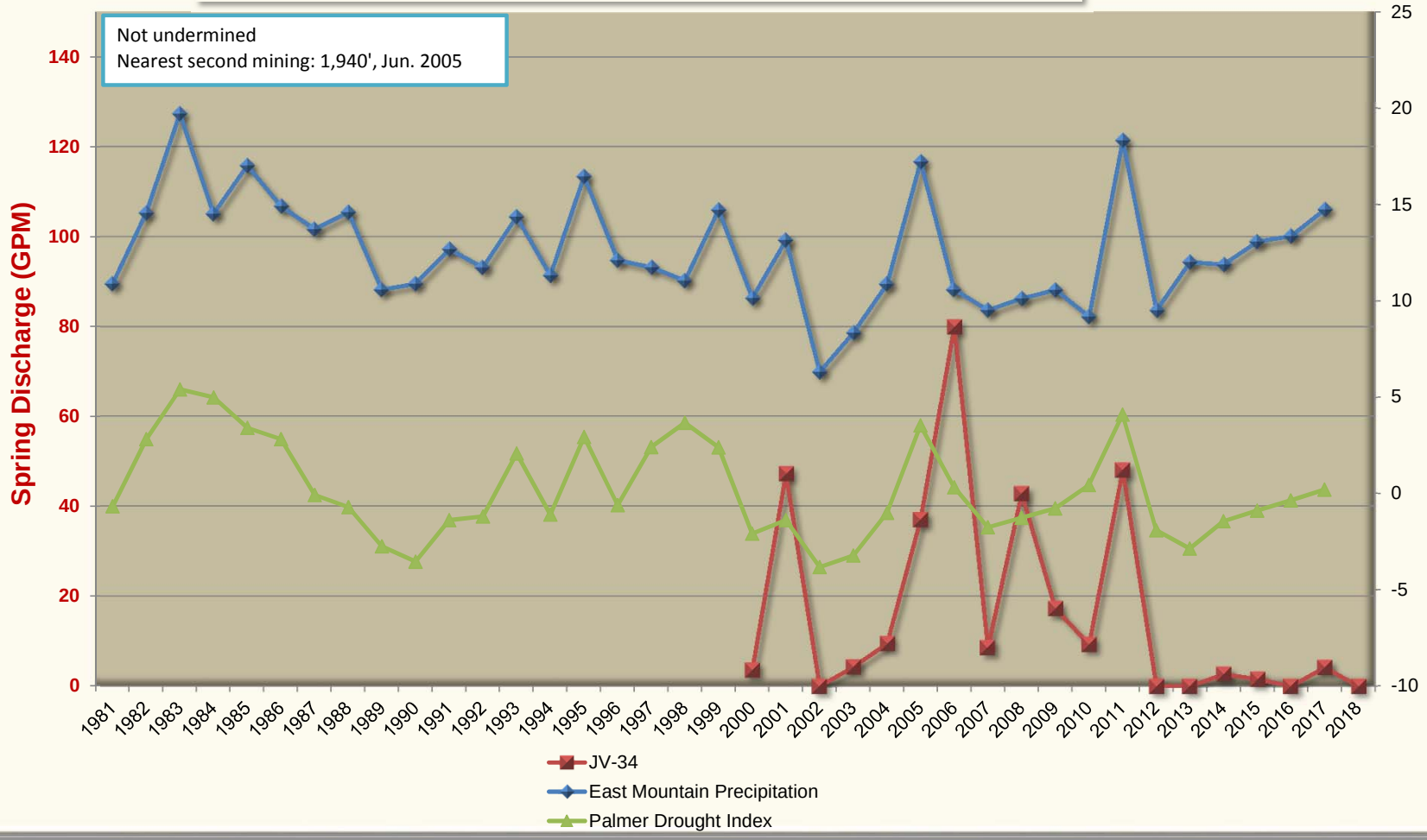
Relationship to Adjacent Springs: This spring occurs in the same manner as numerous springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

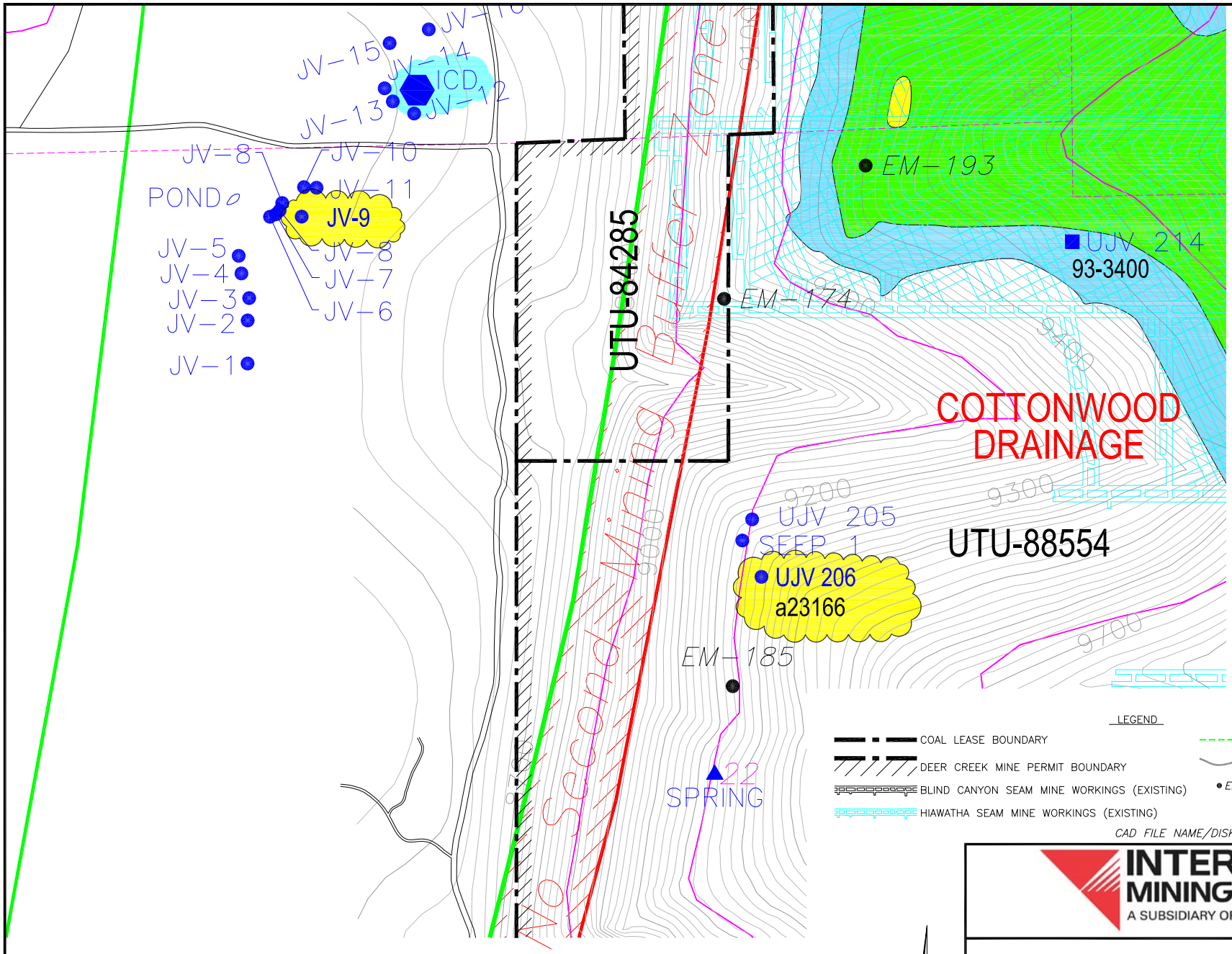
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: JV-34 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: JV-34
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 2670'
Date of Nearest Mining: Aug-08

	Pre-Mining Data: 20000101 THROUGH 20080801				Post-Mining Data: 20080831 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	400	282	323.285	14	351	278	310.538	13	BICARBONATE
CALCIUM	96.8	77	83.2414	14	101.05	73.39	87.3284	13	CALCIUM
CARBONATE	0	0	0	1	0	0	0	13	CARBONATE
CHLORIDE	5	1	3.02142	14	6	2	2.92307	13	CHLORIDE
CONDUCTIVITY	706	539	602.5	14	708	533	608.769	13	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	80	2.3	19.5071	14	48	0.23	8.82461	13	FLOW
HARDNESS	350	281	308.928	14	366	276	324.307	13	HARDNESS
TOTAL IRON	2.45	0.2	0.59161	13	1.36	0	0.23384	13	TOTAL IRON
DISSOLVED IRON	0.008	0	0.004	2	0	0	0	13	DISSOLVED IRON
MAGNESIUM	28.6	21	24.5685	14	28.54	22.51	25.83	13	MAGNESIUM
DISSOLVED MANGANESE	0.131	0.005	0.0495	10	0.074	0.004	2.56923	13	DISSOLVED MANGANESE
MANGANESE	0.052	0.003	0.0128	10	0.038	0	9.30769	13	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.26	7.84	8.06428	14	8.36	7.9	8.11615	13	PH
POTASSIUM	3.5	0.26	1.38615	13	2.1	0.4	1.13384	13	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8.75	6	7.41	14	8.78	6.65	7.88461	13	SODIUM
SULFATE	30	8	17.15	14	51	10	21.3846	13	SULFATE
SUSPENDED SOLIDS	304	304	304	1	0				SUSPENDED SOLIDS
TEMPERATURE	20.3	5	8.68571	14	20	3.8	11.3153	13	TEMPERATURE
TOTAL DISSOLVED SOLIDS	377	255	325.071	14	403	310	354.846	13	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED
- OUTCROP
- EM-169 DRILL HOLE

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 3	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 3 OF 10	REV. ___

Location: Section 22, Township 16 South, Range 6 East, SLB&M. This site is located within the ½ mile offset of the Deer Creek mine permit boundary adjacent to Federal Coal leases UTU-84285 and UTU-88554.

Lease Association: Spring JV-9 is located adjacent to Federal Coal leases UTU-84285 and UTU-88554. Lease UTU-88554 was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Lease UTU-84285 was originally acquired from Bureau of Land Management in November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. No mining occurred in the vicinity of JV-9.

Subsidence: No subsidence has been detected near JV-9. For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring JV-9. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - JV-9 spring is located in Joes Valley alluvial basin south of the Joes Valley cutoff road. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-9 varies dramatically based on winter pack on spring runoff, and generally ranges from 0.0/seep to a maximum of 3.0 gpm.

Geologic Mode of Occurrence for spring JV-9:

- Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

- Geologic Formation: Joes Valley Alluvium (refer to Geologic Occurrence sheet).
- Stratigraphic Position: NA.

Justification for removal from monitoring: JV-9 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-9 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **JV-9**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
299' S.	1836' E	NW	22	16S	6E	8618

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Joes Valley Alluvium	None	None	NA

Location Comments: Spring (boiling up from small hole) located in Joes Valley south of FDR 040.

Probable Recharge Area: Areas of higher elevation located to the north and east.

Relationship to Adjacent Springs: This spring occurs in the same manner as numerous springs in the immediate vicinity.

Geologic Occurrence of Spring:

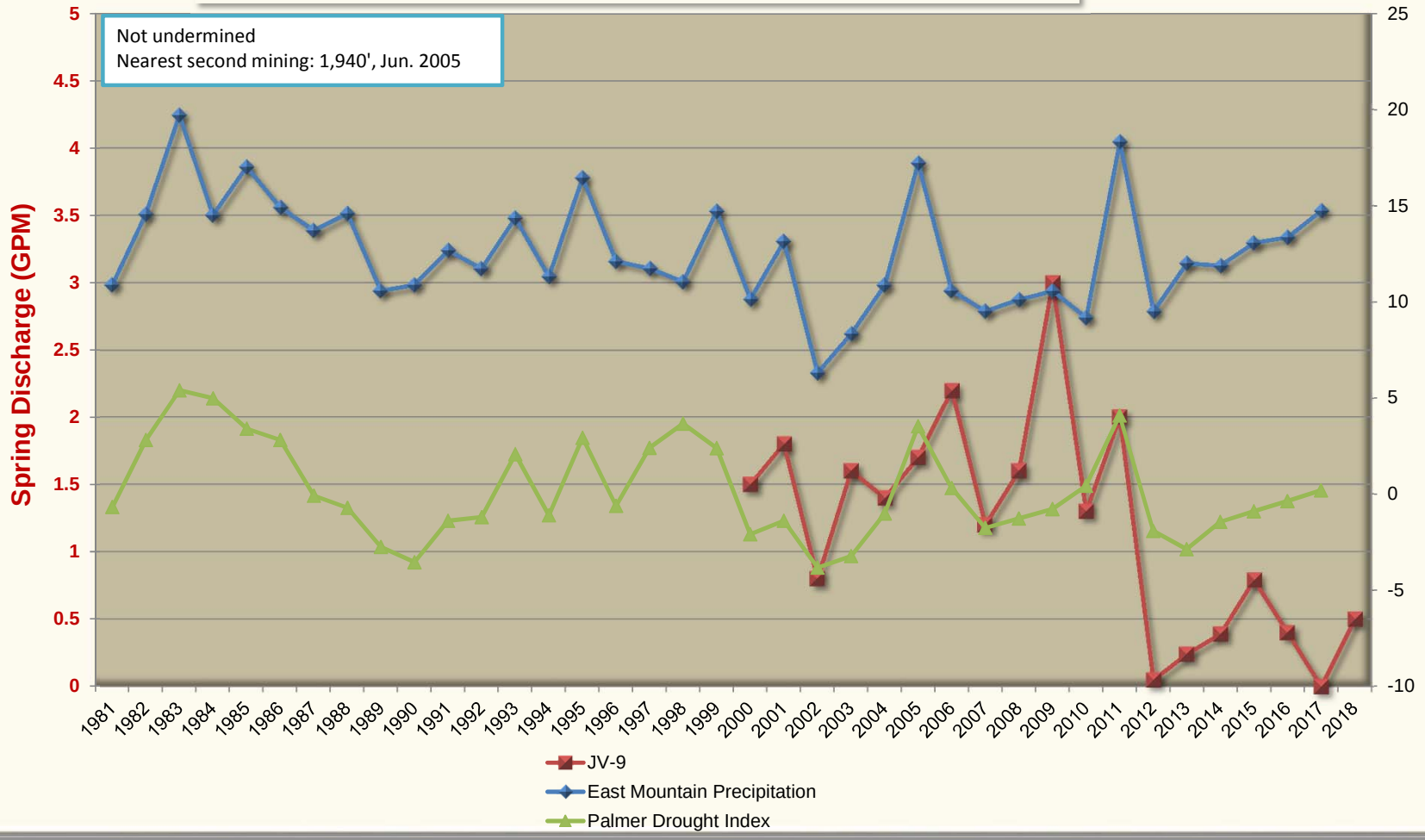
Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

Field reconnaissance October 19, 2000

Field reconnaissance May 9, 2018

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: JV-9 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: JV-9
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1940'
Date of Nearest Mining: Jun-05

	Pre-Mining Data: 20000101 THROUGH 20050601				Post-Mining Data: 20050630 THROUGH 201712311				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	395	318	371.444	9	330	293	310.3	20	BICARBONATE
CALCIUM	89.7	80	86.0333	9	91.7	81.62	87.961	20	CALCIUM
CARBONATE	0				0	0	0	14	CARBONATE
CHLORIDE	5	4	4.36666	9	9	4	4.85	20	CHLORIDE
CONDUCTIVITY	750	639	676.333	9	762	516	677.95	20	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	1.8	0.8	1.29222	9	3	0.24	1.206	20	FLOW
HARDNESS	371	262	345.888	9	377	344	362.45	20	HARDNESS
TOTAL IRON	0.298	0.298	0.298	1	0.51	0	9.88235	17	TOTAL IRON
DISSOLVED IRON	0				0	0	0	14	DISSOLVED IRON
MAGNESIUM	35.8	33	34.5111	9	36.7	31.88	34.671	20	MAGNESIUM
DISSOLVED MANGANESE	0.014	0.002	0.008	2	0.054	0	0.01	18	DISSOLVED MANGANESE
MANGANESE	0.005	0.005	0.005	1	0.02	0	4.61111	18	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	7.64	7.22	7.35888	9	8.06	6.88	7.4085	20	PH
POTASSIUM	1.5	1	1.17888	9	2.66	1.22	1.4335	20	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8	6.83	7.14222	9	8.42	6.71	7.4375	20	SODIUM
SULFATE	59	48	52.0888	9	58	38	50.05	20	SULFATE
SUSPENDED SOLIDS	387	387	387	1	0				SUSPENDED SOLIDS
TEMPERATURE	6.9	4.9	6.13333	9	12.3	5.6	8.095	20	TEMPERATURE
TOTAL DISSOLVED SOLIDS	404	357	380	9	411	241	378	20	TOTAL DISSOLVED SOLIDS

Location: Section 22, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring UJV-206 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred near spring UJV-206.

Subsidence: No subsidence has been detected near UJV-206. The 2017 Annual Subsidence Report reported that the subsidence north of the spring has been stable since at least 2009. UJV-206 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-206. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1993 through 1995 by Genwal Resources and by PacifiCorp from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV-206 is located along power line corridor on a west facing slope overlooking Joes Valley surrounded by aspens and conifers. Spring drains to a trough adjacent to the spring. In 2003, Division of Water Rights approved a Change Application (a23166) was approved allowing the right to develop UJV-206 for use in recreational cabin and stock watering from a trough in the vicinity of the cabin.

Geologic Mode of Occurrence for spring UJV-206:

- Water flowing down through fractures in the lower section of the Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Upper Price River (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 80' above base.

Justification for removal from monitoring: UJV-206 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-206 be removed from the monitoring program.

EAST MOUNTAIN
MILL FORK SPRING & SEEP SURVEY
GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-206**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
3567' N.	3604' W	SE	22	16S	6E	9200

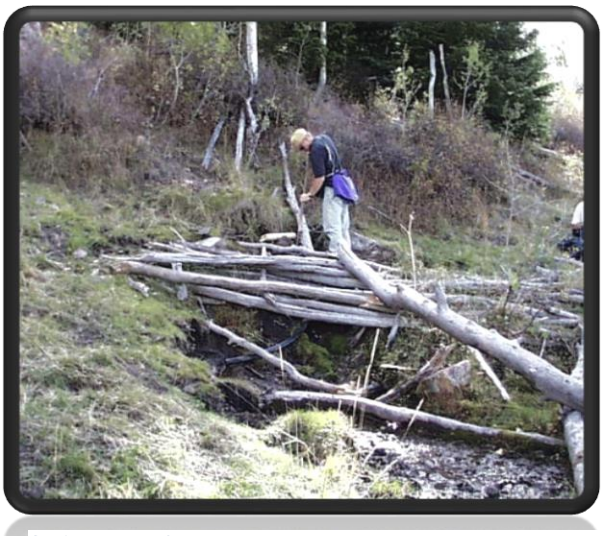
Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Upper Price River	Developed With Vertical CMP, Diverted To Trough (not functioning)	93-3400 A23166	80' above base

Location Comments: Spring located along power line corridor on west facing slope overlooking Joes Valley surrounded with aspens and conifers.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring occurs in the same manner as UJV-204 and UJV-205.

Geologic Occurrence of Spring: Water flowing down through fractures in the lower section of the Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

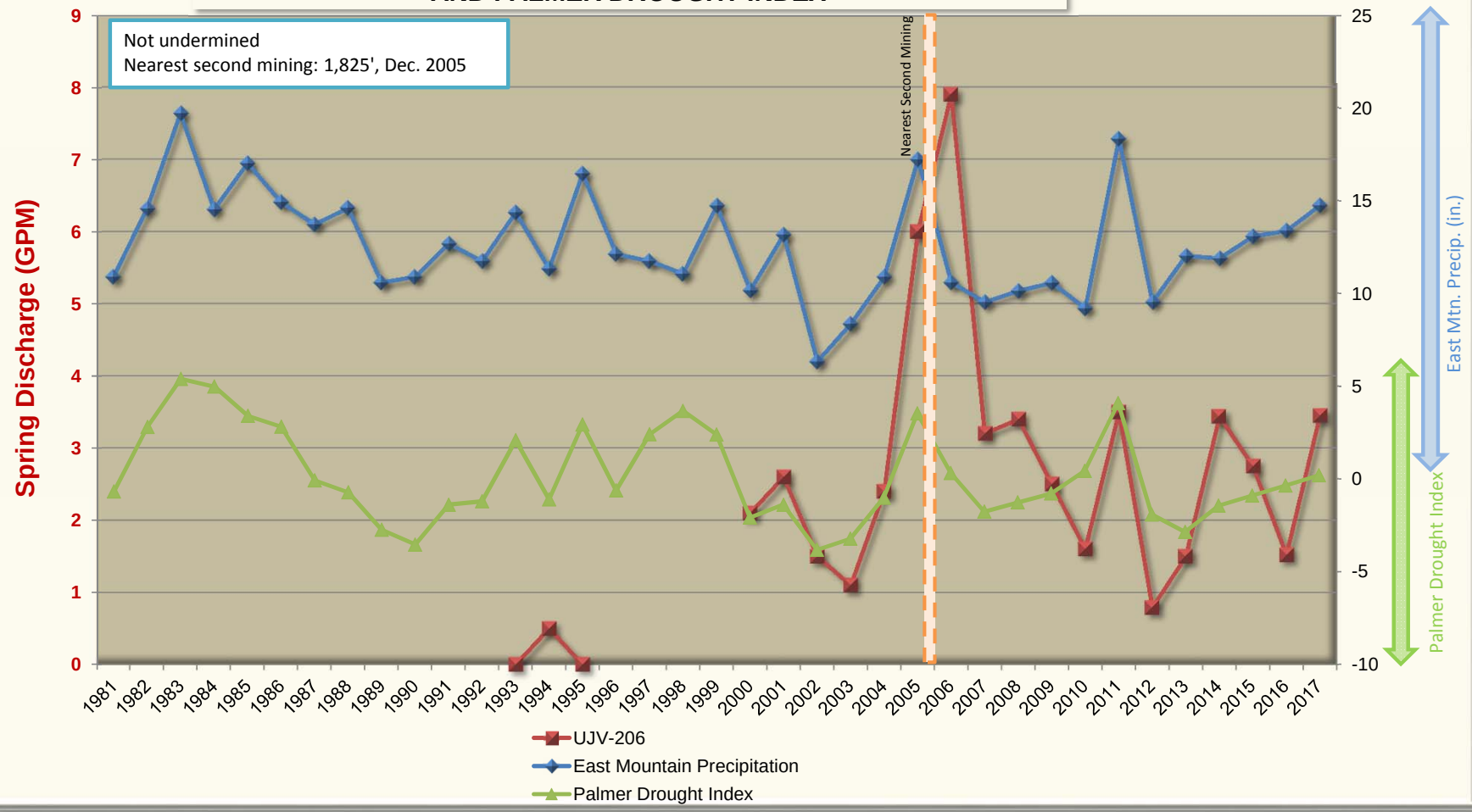


Spring UJV-206

UJV-206 Trough

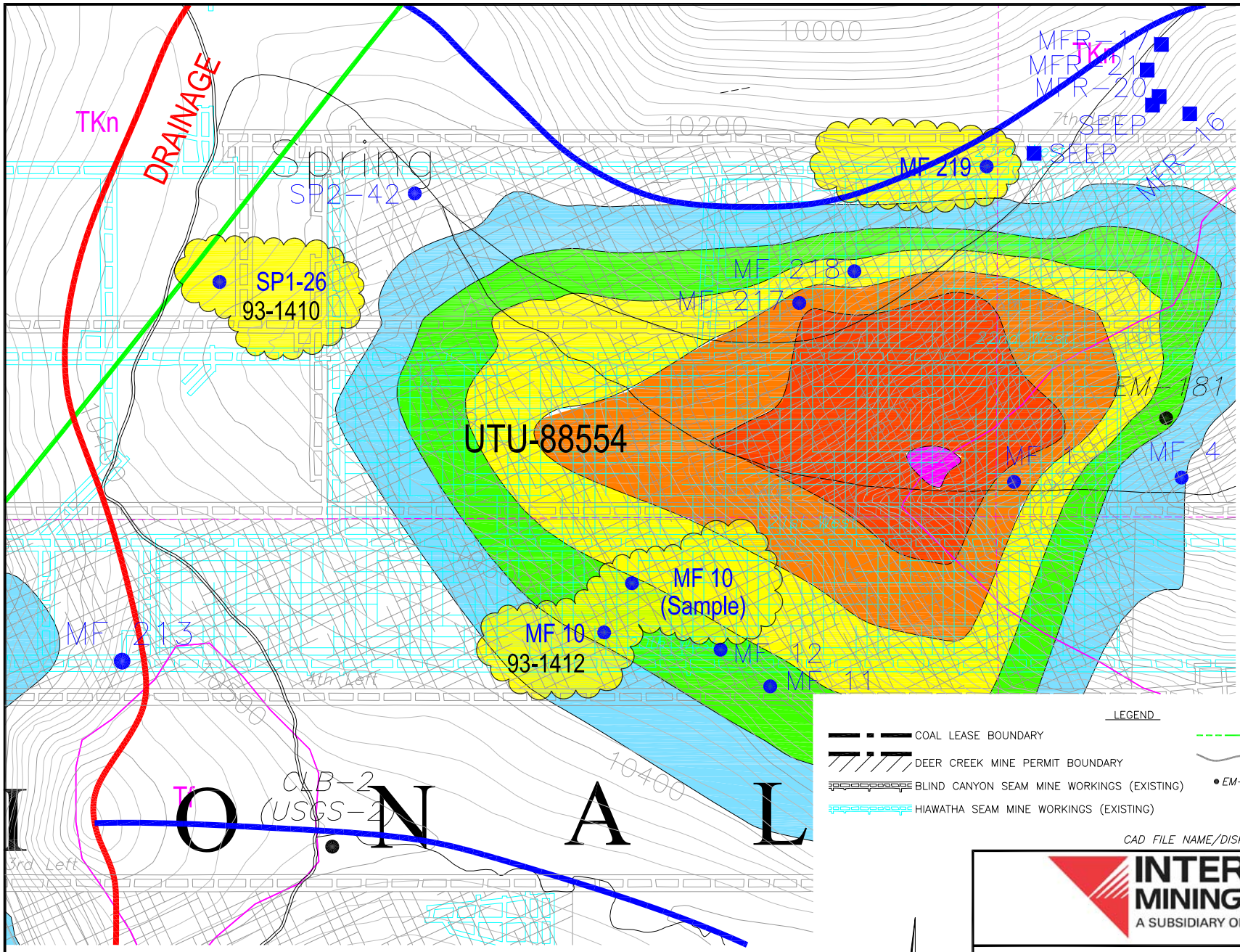
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-206 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-206
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1825'
Date of Nearest Mining: Dec. 2005

	Pre-Mining Data: 20000101 THROUGH 20051130				Post-Mining Data: 20051201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	294	239	270.545	11	259	221	235.086	23	BICARBONATE
CALCIUM	69.7	61	66.5727	11	76.27	61.98	67.7221	23	CALCIUM
CARBONATE	0				0	0	0	20	CARBONATE
CHLORIDE	6	4	4.5	11	6	4	4.7826	23	CHLORIDE
CONDUCTIVITY	615	490	521.727	11	672	438	521.26	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	6	0.5	2.33181	11	8.5	0.38	2.58608	23	FLOW
HARDNESS	271	243	262	11	303	243	267.086	23	HARDNESS
TOTAL IRON	0.11	0.1	0.105	2	0.06	0	2.85714	21	TOTAL IRON
DISSOLVED IRON	0				0	0	0	20	DISSOLVED IRON
MAGNESIUM	24.9	22	23.2636	11	27.45	21.31	23.796	23	MAGNESIUM
DISSOLVED MANGANESE	0				0.006	0	0.0003	20	DISSOLVED MANGANESE
MANGANESE	0				0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.33	7.79	8.04363	11	8.1	7.35	7.88956	23	PH
POTASSIUM	2	1	1.49	11	2.03	1.42	1.68434	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8	5.83	6.37909	11	6.73	5.16	6.29652	23	SODIUM
SULFATE	42	23	31.809	11	46	21	33.6956	23	SULFATE
SUSPENDED SOLIDS	290	290	290	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.4	4.7	5	11	8.2	4.6	6.26956	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	309	257	288	11	328	246	297.217	23	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 4	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 4 OF 10	REV. ___

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-219 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First and second mining occurred in vicinity of MF-219 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, second mining 7th Left longwall panel April 2010 and Hiawatha, first mining 23rd West gateroad, on February 2011).

Subsidence: No subsidence has been detected near MF-219. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MF-219 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-219. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-219 is a spring/seep located along the reclaimed access road to Mill Fork Ridge originally developed as a fire access road and later used to access coal exploration sites for ARCO Coal. Access road reclaimed in the 1980's. MF-219 is located on a south facing slope surrounded with conifers. Flow from spring MF-219 generally ranges from 0.0/seep to a maximum of <15.0 gpm.

Geologic Mode of Occurrence for spring MF-219:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 260' below top.

Justification for removal from monitoring: MF-219 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-219 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-219**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1508' N.	47' W.	SE	11	16S	6E	10220

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	260' below top

Location Comments: Spring located above reclaimed road on south facing slope covered with conifers. Seep located between MF-218 and MF-219.

Probable Recharge Area: Areas of higher elevation located to the northwest.

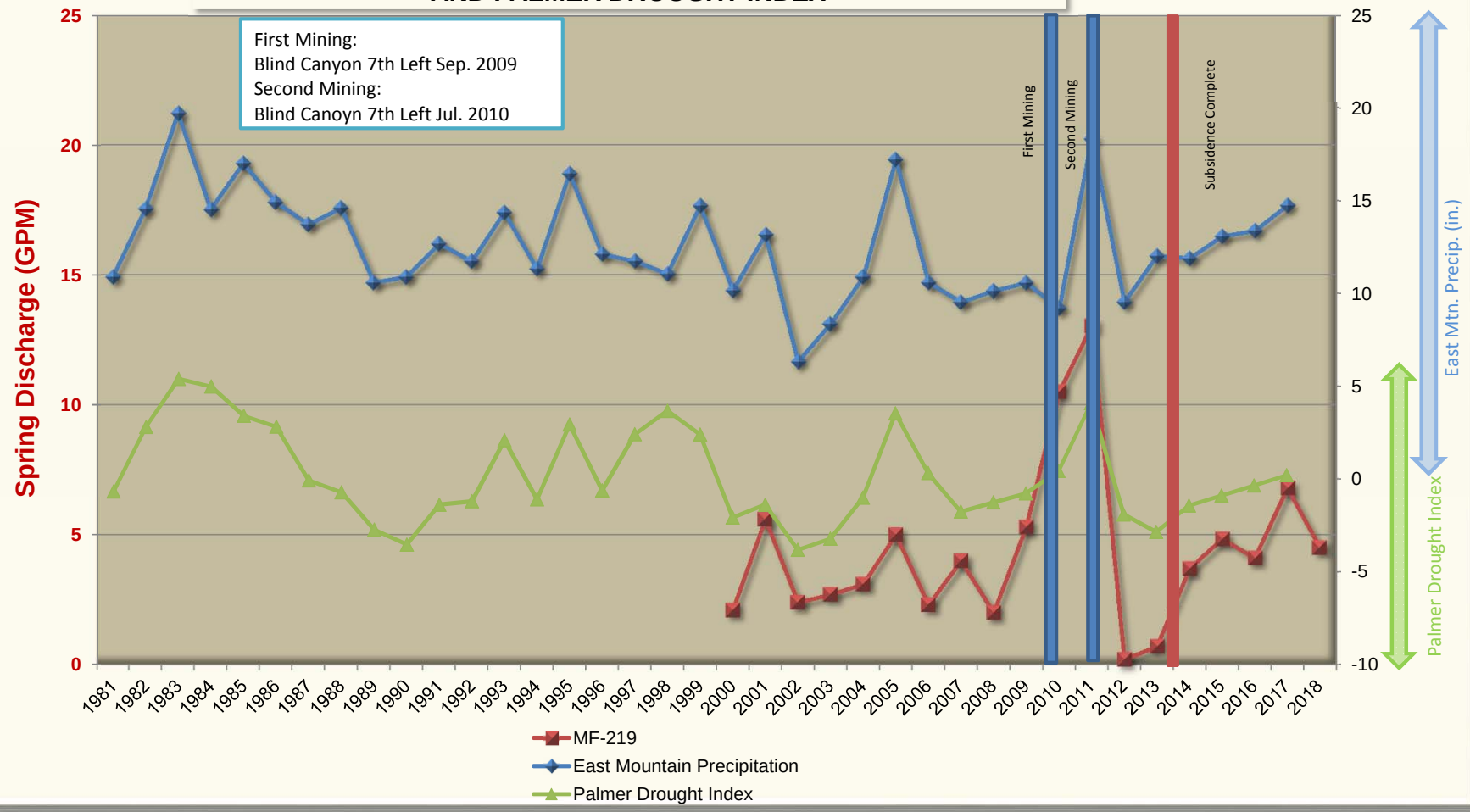
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-217 and MF-218.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-219 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-219
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb-11 Hiawatha 23rd West
Date of Second Mining: Apr-10 Blind Canyon 7th Left
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20110201 THROUGH 201712311				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	292	210	240.833	18	258	207	225.357	14	BICARBONATE
CALCIUM	70.7	59	66.1916	18	75.08	55.59	63.0285	14	CALCIUM
CARBONATE	0	0	0	4	0	0	0	14	CARBONATE
CHLORIDE	3	1	1.98333	18	3	1	1.85714	14	CHLORIDE
CONDUCTIVITY	557	417	500.611	18	574	410	479.714	14	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	5.5	2	3.24277	18	13.04	0.09	4.04	14	FLOW
HARDNESS	285	224	261.666	18	320	239	262.571	14	HARDNESS
TOTAL IRON	1.04	0.06	0.285	12	0.09	0	0.01	14	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	14	DISSOLVED IRON
MAGNESIUM	26.4	16.4	23.4016	18	32.29	22.14	25.5328	14	MAGNESIUM
DISSOLVED MANGANESE	0.134	0.002	1.94166	12	0.009	0	2.64285	14	DISSOLVED MANGANESE
MANGANESE	0.04	0	8.22222	9	0.004	0	5.71428	14	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.15	7.45	7.83888	18	8.52	7.82	8.11	14	PH
POTASSIUM	1.6	1	1.17352	17	2.52	1.34	1.69357	14	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.7	2.40333	18	3.01	1.99	2.44071	14	SODIUM
SULFATE	36	8	27.65	18	65	19	32.5	14	SULFATE
SUSPENDED SOLIDS	268	268	268	1	0				SUSPENDED SOLIDS
TEMPERATURE	8.7	2	5.41666	18	48.4	2.9	11.9928	14	TEMPERATURE
TOTAL DISSOLVED SOLIDS	331	205	272.555	18	322	204	273.714	14	TOTAL DISSOLVED SOLIDS

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring SPI-26 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of SPI-26 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, 7th Left longwall panel bleeder June 2009 and Hiawatha, 23rd West inter-panel barrier, in November 2010).

Subsidence: No subsidence has been detected near SPI-26. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. SPI-26 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring SPI-26. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - SPI-26 is a spring located near the main Mill Fork ridge road. SPI-26 is located on east facing slope surrounded with conifers. Site crudely developed with 1" PVC diverting flow to old steel bath tub. Flow from spring SPI-26 generally ranges from ~ 2 gpm to a maximum of 55.0 gpm.

Geologic Mode of Occurrence for spring SPI-26:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 260' below top.

Justification for removal from monitoring: SPI-26 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site SPI-26 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **SP1-26**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1041' N.	3349' W.	SE	11	16S	6E	10340

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	1" PVC Pipe Feeds Old Bath Tub	93-1410	170' below top

Location Comments: Spring near main reclaimed road on east facing slope covered with conifers. Flow measured below multiple sources.

Probable Recharge Area: Areas of higher elevation located to the west (recharge limited).

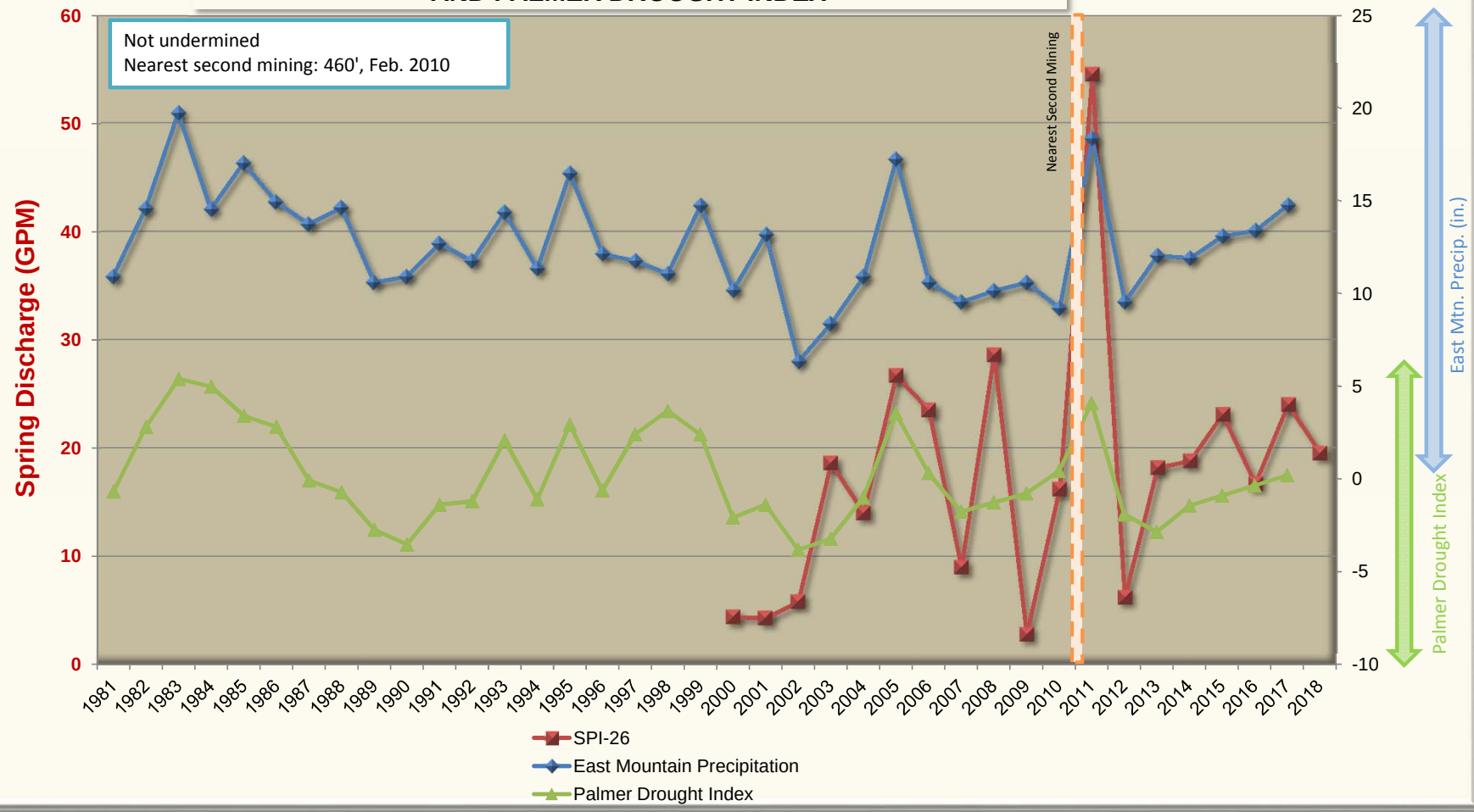
Relationship to Adjacent Springs: This spring occurs in the same manner as SP2-42.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: SPI-26 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: SP1-26
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 460'
Date of Nearest Mining: Feb. 2010

	Pre-Mining Data: 20000101 THROUGH 20100131				Post-Mining Data: 20100201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	253	185	213.21	19	226	184	203.588	17	BICARBONATE
CALCIUM	66	55	60.2105	19	72.65	49.56	59.9947	17	CALCIUM
CARBONATE	0	0	0	4	0	0	0	17	CARBONATE
CHLORIDE	4	1	2.57368	19	3	1	2.17647	17	CHLORIDE
CONDUCTIVITY	525	391	431.157	19	530	378	419.176	17	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	28.6	2.5	9.41666	18	54.5	0.7	12.85875	16	FLOW
HARDNESS	238	199	213.789	19	282	204	217.058	17	HARDNESS
TOTAL IRON	1.63	0	0.44571	7	0.31	0	0.11058	17	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0.04	0	2.35294	17	DISSOLVED IRON
MAGNESIUM	17.8	14	15.4068	19	24.68	14.09	16.3558	17	MAGNESIUM
DISSOLVED MANGANESE	0.07	0	1.95714	7	0.047	0	9.7647	17	DISSOLVED MANGANESE
MANGANESE	0.003	0	0.0018	5	0	0	0	17	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.4	7.44	7.79526	19	8.57	7.69	8.04117	17	PH
POTASSIUM	1.06	0.566	0.71464	14	1.51	0.51	0.79823	17	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.79	2.22	19	6.43	1.61	2.47235	17	SODIUM
SULFATE	10	5	7.06842	19	58	5	9.11764	17	SULFATE
SUSPENDED SOLIDS	214	214	214	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.5	3.8	4.67894	19	12.6	4.1	5.85882	17	TEMPERATURE
TOTAL DISSOLVED SOLIDS	273	206	233.052	19	336	217	239	17	TOTAL DISSOLVED SOLIDS

Location: Section 14, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-10 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred in vicinity of MF-10 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, 5th Left longwall panel, July 2009 and Hiawatha, 21st West panel, January 2011).

Subsidence: Approximately 4' of subsidence has been detected near MF-10. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2013.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-10. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-10 is a spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers. Flow from spring MF-10 generally ranges from ~ 5 gpm to a maximum of 60 gpm.

Geologic Mode of Occurrence for spring MF-10:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 200' below top.

Justification for removal from monitoring: MF-10 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-10 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-10**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
282' S.	1572' W.	NE	14	16S	6E	10250

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1412	200' below top

Location Comments: Spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers.

Probable Recharge Area: Areas of higher elevation located to the southwest.

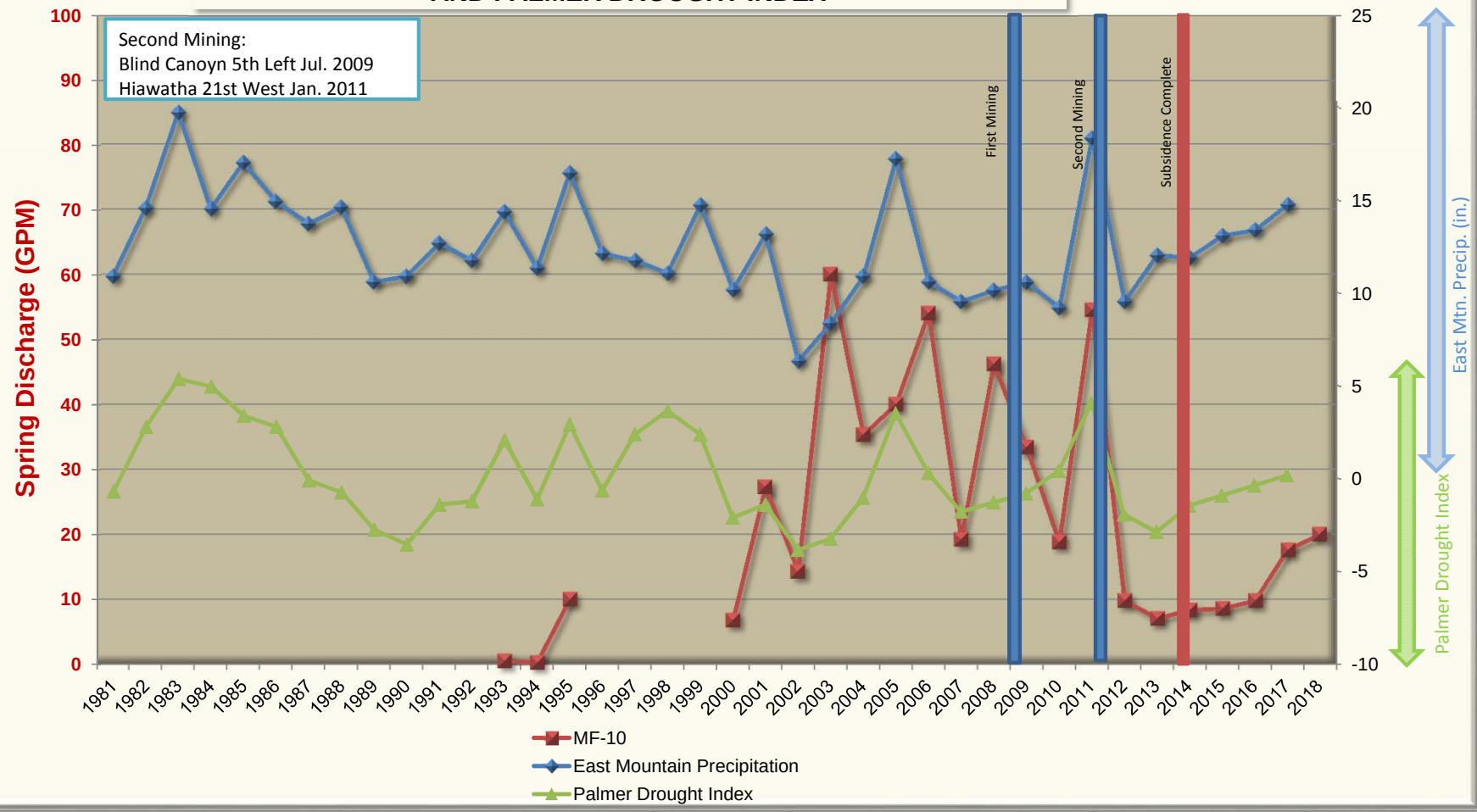
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

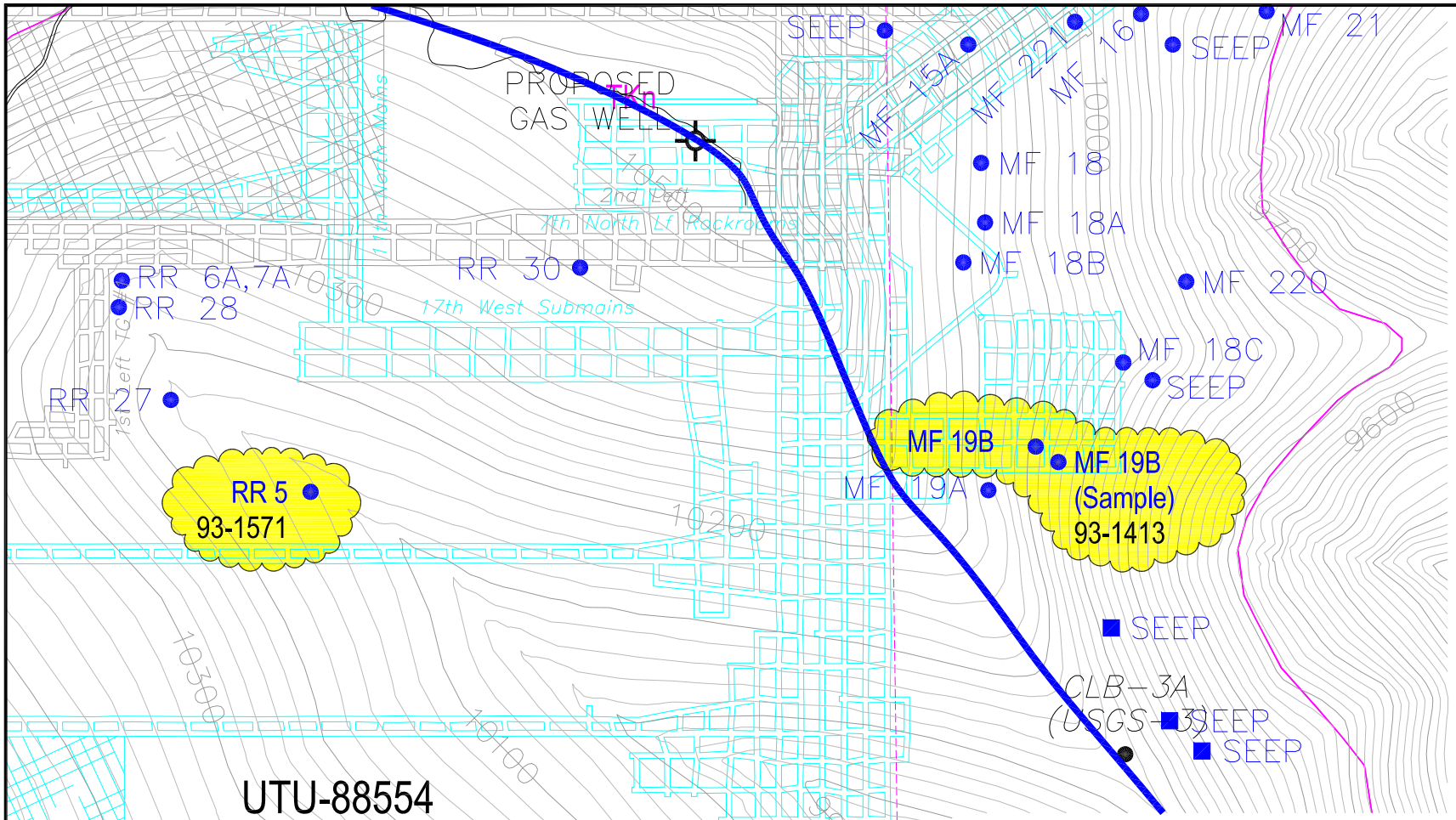
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-10 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-10
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Na
Date of Second Mining: Jul-09 Blind Canyon 5th Left
Jan-11 Hiawatha 21st West
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20090630				Post-Mining Data: 20090701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	256	181	217.882	17	228	178	193.941	17	BICARBONATE
CALCIUM	61.3	50	55.6664	17	60.36	46.7	51.0194	17	CALCIUM
CARBONATE	5	0	1.66666	3	10	0	0.58823	17	CARBONATE
CHLORIDE	4	1	1.7125	16	2	0	0.7647	17	CHLORIDE
CONDUCTIVITY	464	394	423.882	17	412	352	388.882	17	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	60	6.8	21.8647	17	54.5	0.41	10.6233	15	FLOW
HARDNESS	234	206	218.411	17	221	193	207.705	17	HARDNESS
TOTAL IRON	0	0	0	2	0	0	0	17	TOTAL IRON
DISSOLVED IRON	0	0	0	2	0	0	0	17	DISSOLVED IRON
MAGNESIUM	21	16.9	19.2717	17	22.17	16.43	19.5064	17	MAGNESIUM
DISSOLVED MANGANESE	0.006	0	0.002	3	0.01	0	8.23529	17	DISSOLVED MANGANESE
MANGANESE	0.006	0	0.002	3	0.01	0	5.88235	17	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.46	7.41	8.09764	17	8.46	7.76	8.18823	17	PH
POTASSIUM	2.18	0.49	0.9065	12	1.89	0.49	0.91	17	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.57	2.23235	17	2.66	1.64	2.13176	17	SODIUM
SULFATE	9	5	7.45294	17	11	4	6.94117	17	SULFATE
SUSPENDED SOLIDS	216	216	216	1	0				SUSPENDED SOLIDS
TEMPERATURE	23	1.6	4.15294	17	6.4	0.2	3.3	17	TEMPERATURE
TOTAL DISSOLVED SOLIDS	254	199	229.764	17	241	193	221.47	17	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 5	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 5 OF 10	REV. ___

Location: Section 13, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-19B is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of MF-19B in the Hiawatha seam, (7th North Sump, January 2006).

Subsidence: No subsidence has been detected near MF-19B. The 2017 Annual Subsidence Report reported that the subsidence north of the spring has been stable since at least 2013. MF-19B is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-19B. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-19B is located along natural bench directly below a massive sandstone channel on an east facing slope covered with conifers. Sampled approximately 100' below spring source. Flow from spring MF-19B generally ranges from 0 gpm to a maximum of 2.5 gpm.

Geologic Mode of Occurrence for spring MF-19B:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 400' below top.

Justification for removal from monitoring: MF-19B has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-19B be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-19B**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2136' N.	529' E.	SW	13	16S	6E	10111

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1413	400' below top

Location Comments: Spring located along natural bench directly below massive sandstone channel on east facing slope covered with conifers. Sampled approximately 100' below spring source.

Probable Recharge Area: Areas of higher elevation located to the west.

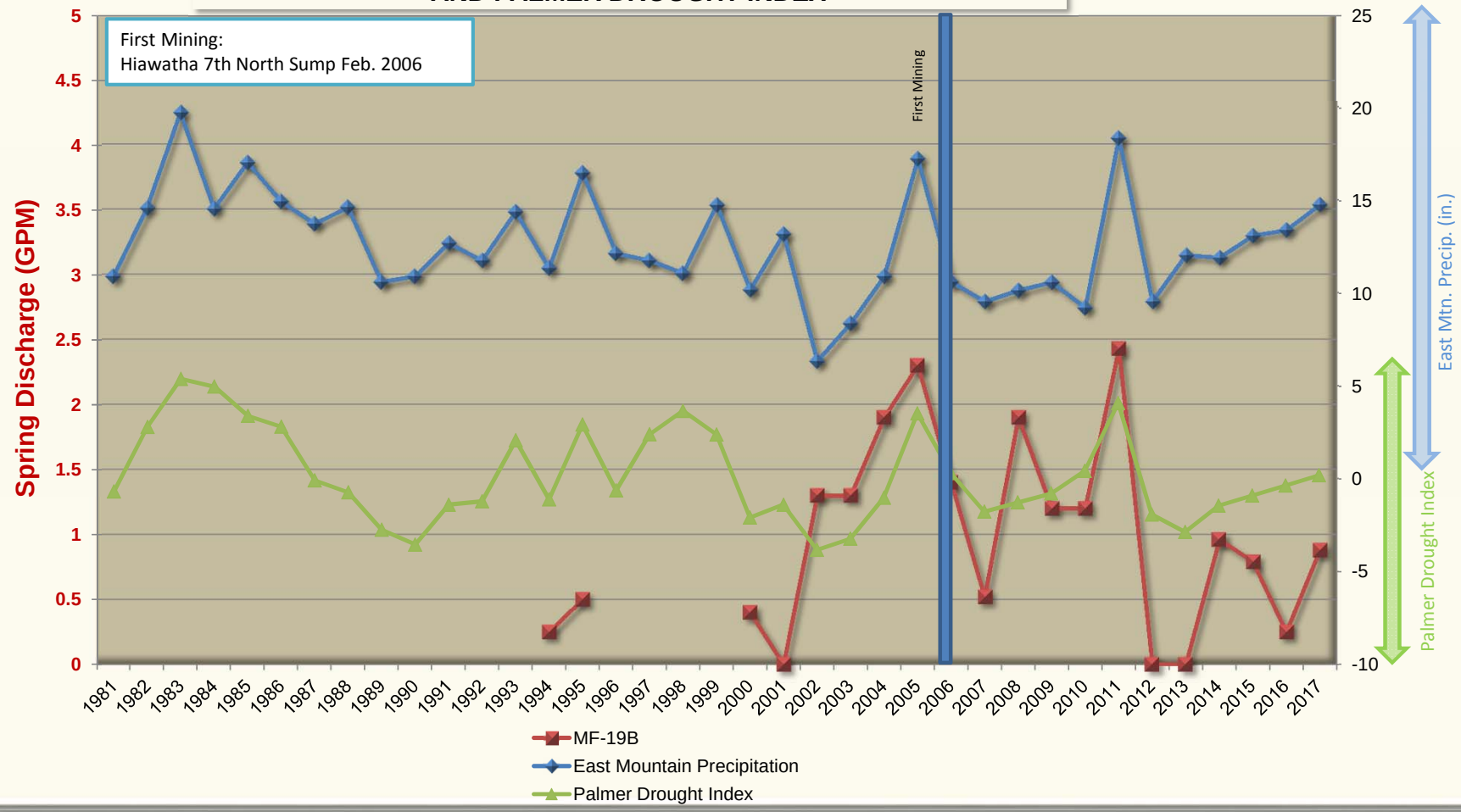
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-19B vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-19B
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb-10 Hiawatha 7th North Sump
Date of Second Mining: Not undermined
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20060131				Post-Mining Data: 20060201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	286	215	245.857	7	246	209	226.944	18	BICARBONATE
CALCIUM	67.3	58	64.7285	7	78.71	62.6	66.6505	18	CALCIUM
CARBONATE	0				19	0	2.86666	15	CARBONATE
CHLORIDE	2	1	1.16666	6	6	0	2	18	CHLORIDE
CONDUCTIVITY	462	420	431.428	7	551	430	460.944	18	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	2.3	0.52	1.26142	7	2.48	0.22	0.92588	17	FLOW
HARDNESS	245	231	238.428	7	287	232	246.055	18	HARDNESS
TOTAL IRON	4.59	0.18	1.1488	5	0.31	0	0.088125	16	TOTAL IRON
DISSOLVED IRON	0				0	0	0	14	DISSOLVED IRON
MAGNESIUM	21	17.5	18.6428	7	21.99	17.2	19.325	18	MAGNESIUM
DISSOLVED MANGANESE	0.055	0.005	0.02275	4	0.02	0	7.26666	15	DISSOLVED MANGANESE
MANGANESE	0.293	0.002	0.10366	3	0.003	0	3.33333	15	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.39	8.06	8.27857	7	8.52	8	8.29611	18	PH
POTASSIUM	1.28	0.32	0.6372	5	2.1	0.31	0.97222	18	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.53	1.83571	7	4.44	1.09	1.95888	18	SODIUM
SULFATE	7	4	6.14285	7	12	4	6.38888	18	SULFATE
SUSPENDED SOLIDS	237	237	237	1	0				SUSPENDED SOLIDS
TEMPERATURE	9.6	3.9	6.18571	7	12.8	3.7	8.16666	18	TEMPERATURE
TOTAL DISSOLVED SOLIDS	252	211	235.571	7	287	222	258.444	18	TOTAL DISSOLVED SOLIDS

Location: Section 14, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-5 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-5 in the Hiawatha seam, (17th West gateroad development, December 2006).

Subsidence: No subsidence has been detected near RR-5. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2011. RR-5 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-5. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-5 is located in a clearing on an east facing slope surrounded by conifers. Flow from spring RR-5 generally ranges from 0/seep to a maximum of 34 gpm.

Geologic Mode of Occurrence for spring RR-5:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 360' below top.

Justification for removal from monitoring: RR-5 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-5 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-5**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1952' N.	2140' W.	SE	14	16S	6E	10160

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1571	360' below top

Location Comments: Spring located in clearing on east facing slope surrounded with conifers.

Probable Recharge Area: Areas of higher elevation located to the west (recharge limited).

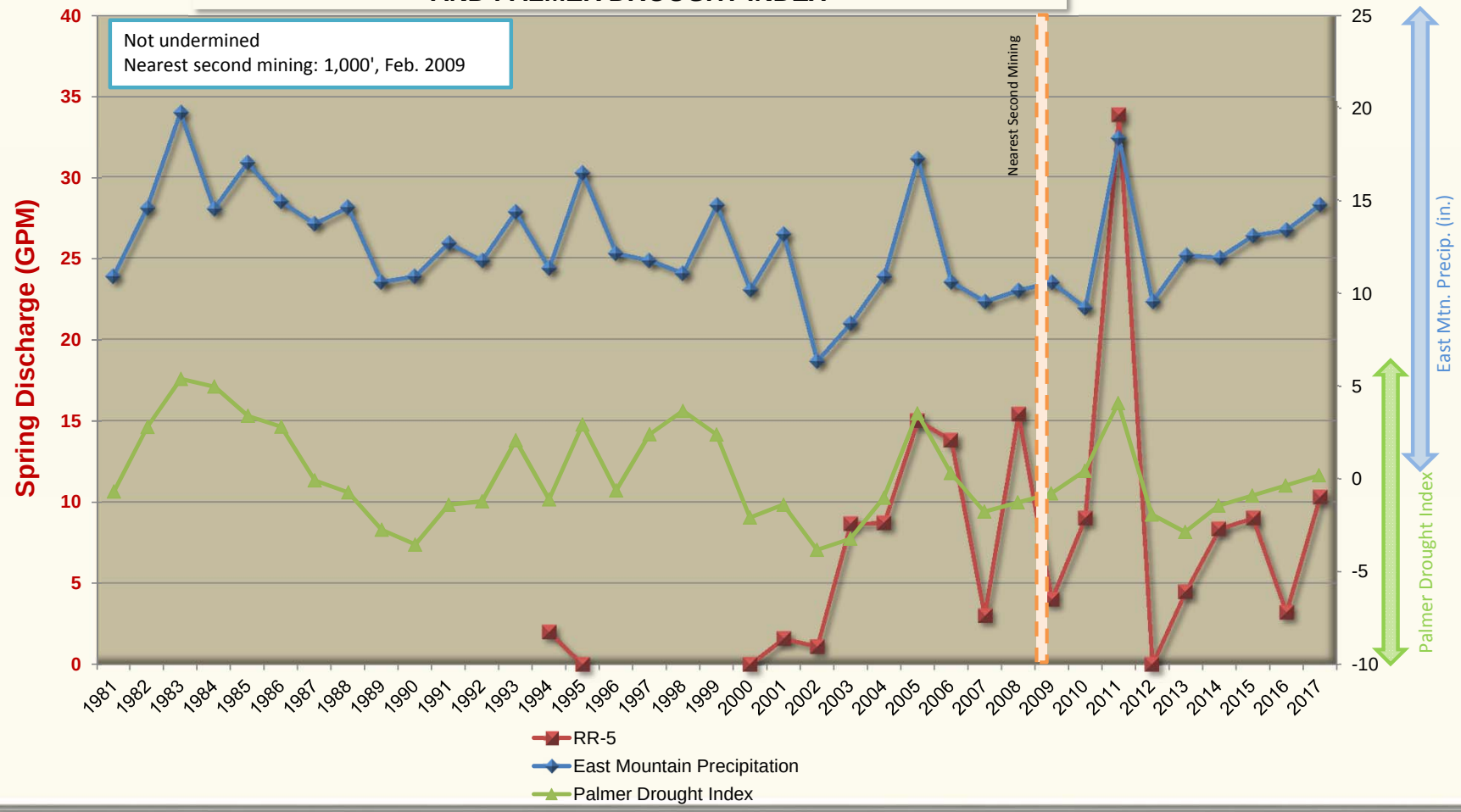
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity (RR-28, RR-6, RR-7A, RR-27, RR-4).

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

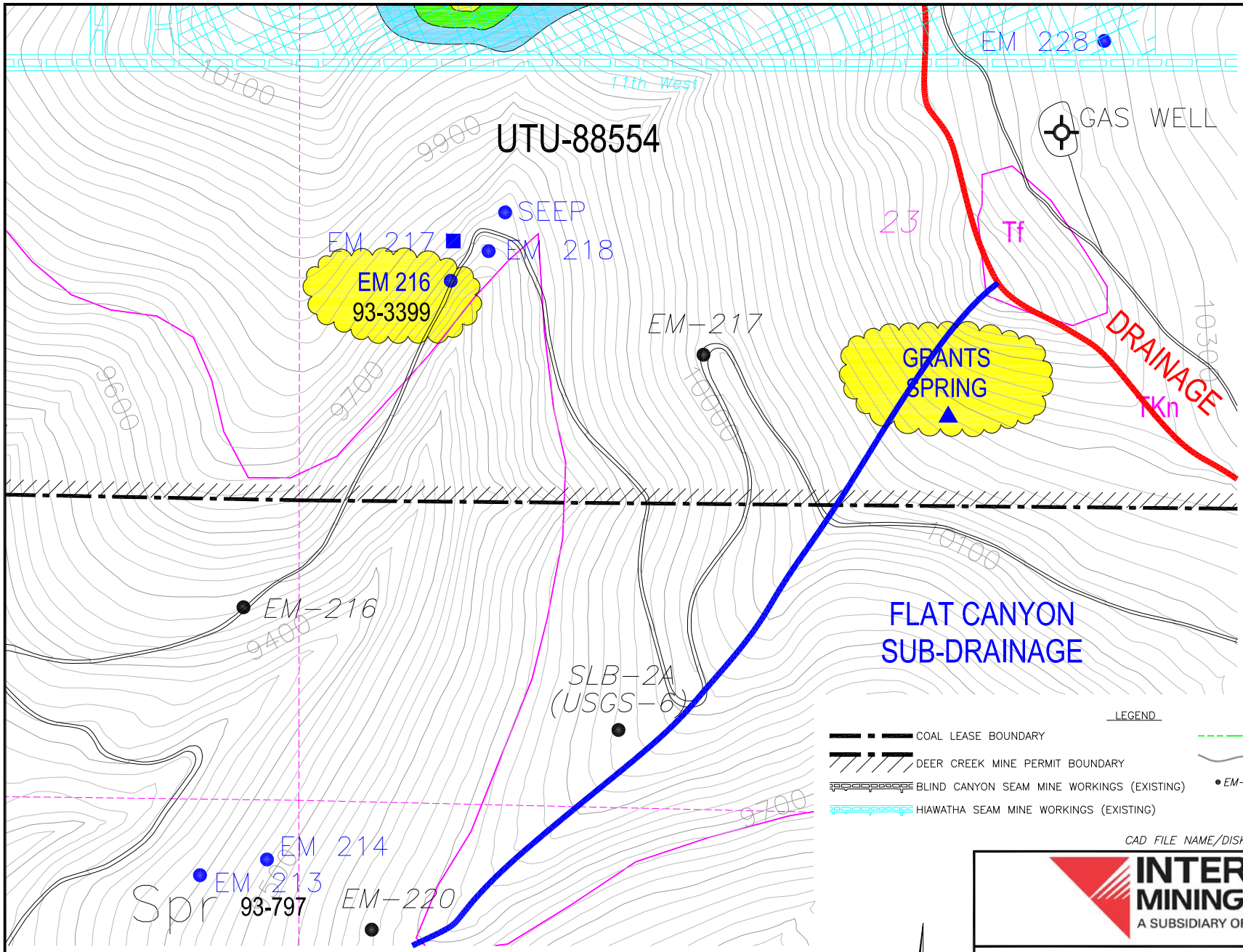
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-5 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-5
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1000'
Date of Nearest Mining: Feb-09

	Pre-Mining Data: 20000101 THROUGH 20090131				Post-Mining Data: 20090228 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	286	192	216.181	11	221	192	205.25	12	BICARBONATE
CALCIUM	74.39	61.7	64.5018	11	66.55	52.85	60.9233	12	CALCIUM
CARBONATE	0	0	0	2	0	0	0	12	CARBONATE
CHLORIDE	2	1	1.72727	11	2	0	0.75	12	CHLORIDE
CONDUCTIVITY	504	407	442.818	11	432	386	409.833	12	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	15.4	0.5	7.22909	11	33.8	0.42	7.58083	12	FLOW
HARDNESS	249	220	229.454	11	235	205	220.333	12	HARDNESS
TOTAL IRON	0.78	0.1	0.300125	8	1.65	0	0.24166	12	TOTAL IRON
DISSOLVED IRON	0	0	0	2	0	0	0	12	DISSOLVED IRON
MAGNESIUM	17.3	15.44	16.6318	11	17.89	14.53	16.62	12	MAGNESIUM
DISSOLVED MANGANESE	0.045	0.002	1.27142	7	0.055	0	1.20833	12	DISSOLVED MANGANESE
MANGANESE	0.013	0	0.0034	5	0.012	0	0.001	12	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.23	7.33	7.8009	11	8.4	7.55	7.96583	12	PH
POTASSIUM	0.99	0.31	0.50444	9	0.99	0.35	0.5675	12	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.52	1.81	11	2.16	1.52	1.8325	12	SODIUM
SULFATE	10	7	8.72727	11	10	6	8.08333	12	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	5.6	3	4.17272	11	10.4	3.7	5.425	12	TEMPERATURE
TOTAL DISSOLVED SOLIDS	274	209	243.363	11	255	223	238	12	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 6	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 6 OF 10	REV. ___

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring EM-216 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 975' north of EM-216 in the Hiawatha Seam on September 2005.

Subsidence: Maximum subsidence in area 975' north of EM-216 has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. EM-216 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring EM-216. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. EM-216 is a low volume spring/seep located along the Mill Fork access road. Flow from spring EM-216 generally ranges from 0.0 gpm to a maximum of 1.3 gpm. Flow from EM-216 normally occurs early in the year and dissipates rapidly with recordable flow rarely existing after the month of July.

Geologic Mode of Occurrence for spring EM-216:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 75' above base.

Justification for removal from monitoring: EM-216 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site EM-216 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **EM-216**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2250' N.	651' E.	SW	23	16S	6E	9740

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-3399	75' above base

Location Comments: Spring located on south facing slope adjacent to East Mountain Access Road.

Probable Recharge Area: Highlands area to the north.

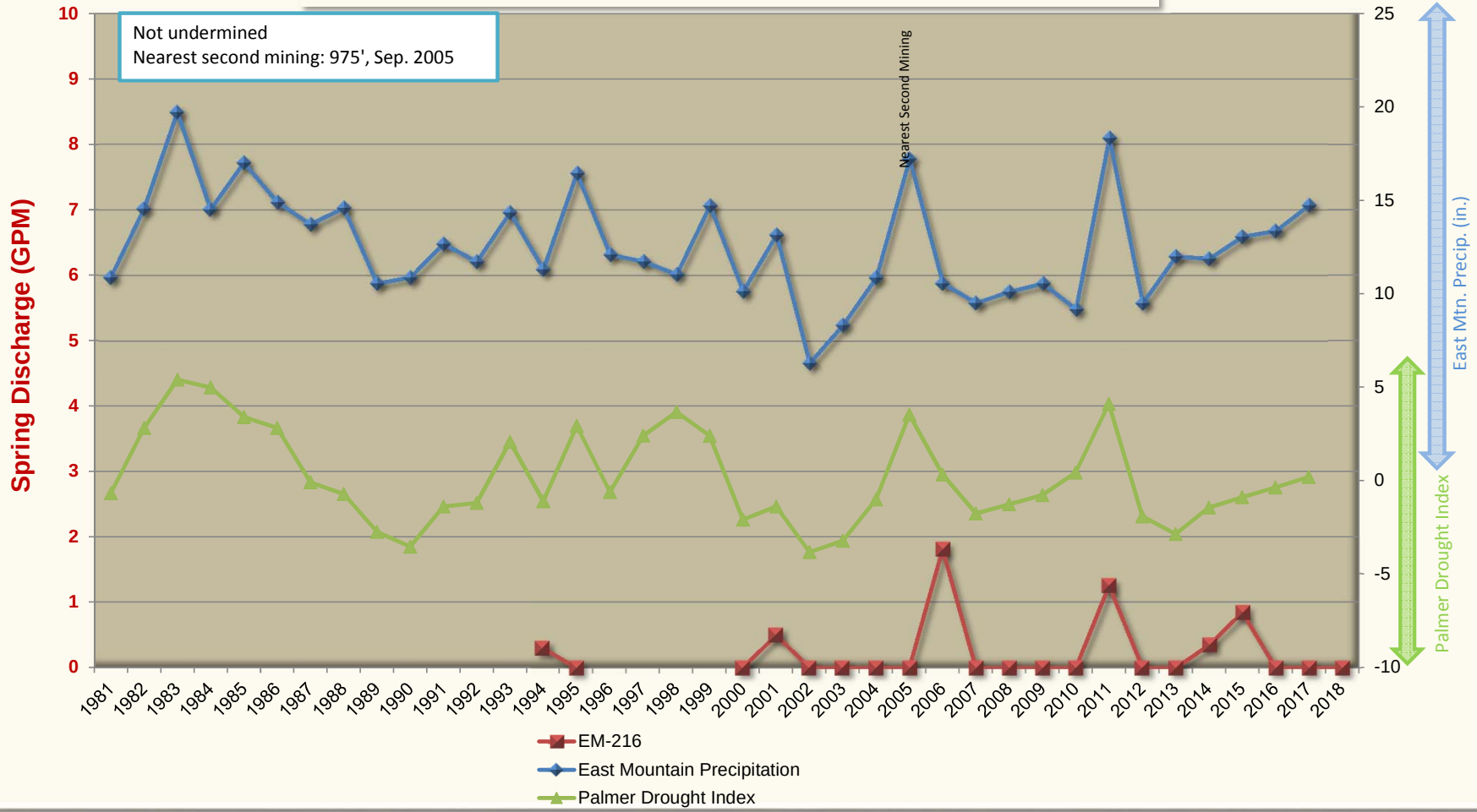
Relationship to Adjacent Springs: This spring occurs in the same manner as EM-218.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: EM-216 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: EM-216
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 975'
Date of Nearest Mining: Sep-05

	Pre-Mining Data: 2000101 THROUGH 20050801				Post-Mining Data: 20050831 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	- No Sample Data -				298	240	272.75	4	BICARBONATE
CALCIUM					94.6	70.16	81.235	4	CALCIUM
CARBONATE					0	0	0	3	CARBONATE
CHLORIDE					3	2	2.5	4	CHLORIDE
CONDUCTIVITY					663	502	579.25	4	CONDUCTIVITY
DISSOLVED OXYGEN					0				DISSOLVED OXYGEN
FLOW					1.8	0.35	1.06	4	FLOW
HARDNESS					344	273	304.25	4	HARDNESS
TOTAL IRON					0.19	0	8.66666	3	TOTAL IRON
DISSOLVED IRON					0	0	0	3	DISSOLVED IRON
MAGNESIUM					26.2	22.52	24.6675	4	MAGNESIUM
DISSOLVED MANGANESE					0.022	0	0.00825	4	DISSOLVED MANGANESE
MANGANESE					0.012	0	0.0055	4	MANGANESE
OIL AND GREASE					0				OIL AND GREASE
PH					8.36	7.66	7.965	4	PH
POTASSIUM					0.89	0.57	0.75	4	POTASSIUM
SET SOLIDS					0				SET SOLIDS
SODIUM					4.31	3.76	4.025	4	SODIUM
SULFATE					31	13	22.75	4	SULFATE
SUSPENDED SOLIDS					0				SUSPENDED SOLIDS
TEMPERATURE					17.7	9.3	13.575	4	TEMPERATURE
TOTAL DISSOLVED SOLIDS					319	278	304	4	TOTAL DISSOLVED SOLIDS

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Grants Spring is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 1,560' north of Grants Spring in the Hiawatha Seam in November 2005.

Subsidence: Maximum subsidence in area 1,560' north of Grants Spring has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. Grants Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Grants Spring Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 2002 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. Grants Spring is a low volume spring/seep located below ridge on west facing slope above main Mill Fork access road vegetated with conifers and aspens. Flow from spring Grants Spring generally ranges from 0.5 gpm to a maximum of <3 gpm.

Geologic Mode of Occurrence for spring Grants Spring:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 160' below top.

Justification for removal from monitoring: Grants Spring has been monitored by PacifiCorp since 2002. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Grants Spring be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **GRANTS SPRING**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1692' N.	2542' W.	SE	23	16S	6E	10280

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Developed With Steel Pipe Diverted to Trough (not functioning)	None	160' below top

Location Comments: Spring located below ridge on west facing slope above main access road. Area surrounding the spring source vegetated with conifers and aspens.

Probable Recharge Area: Highlands area to the northeast (recharge limited).

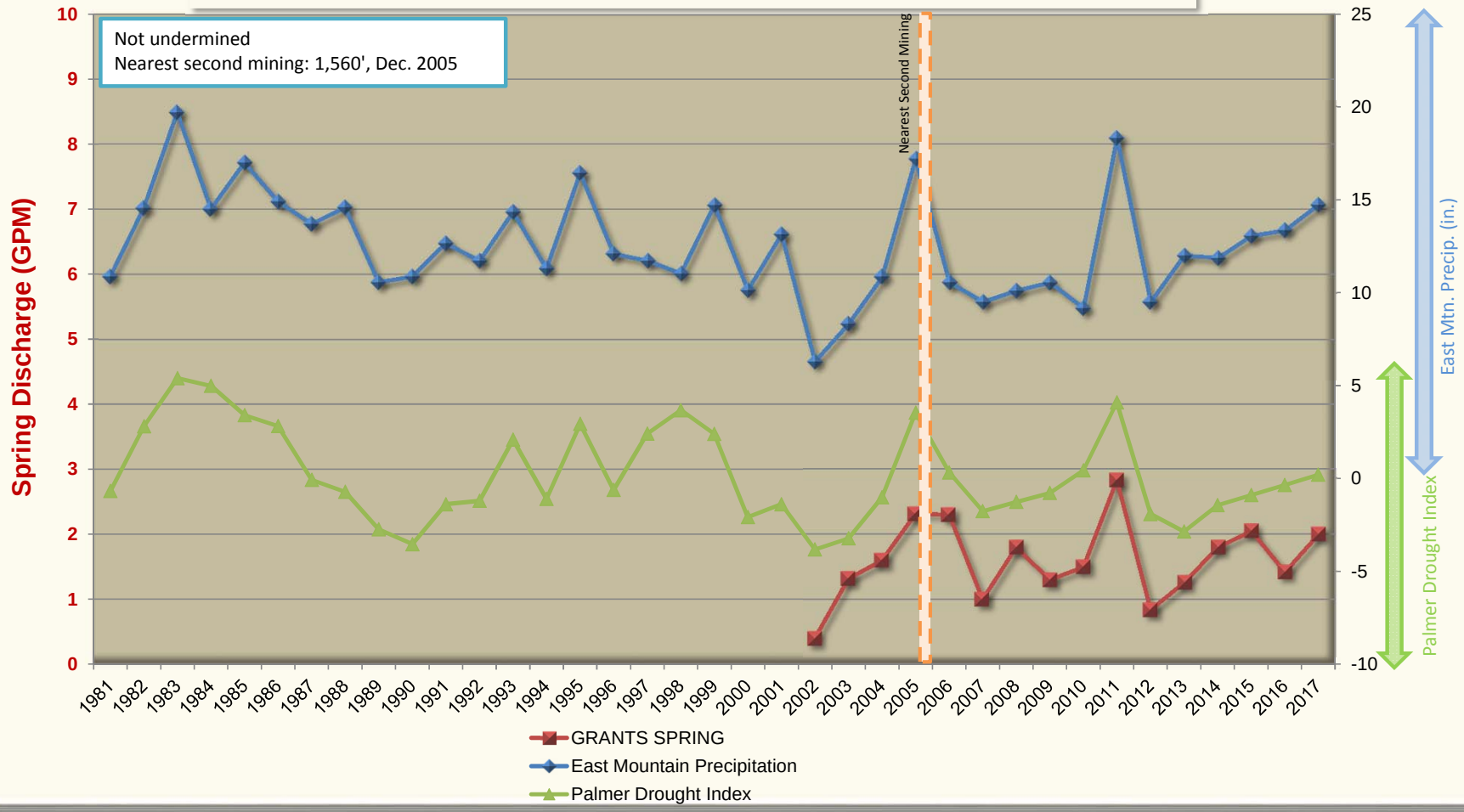
Relationship to Adjacent Springs: This spring occurs in the same manner as EMPOND.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

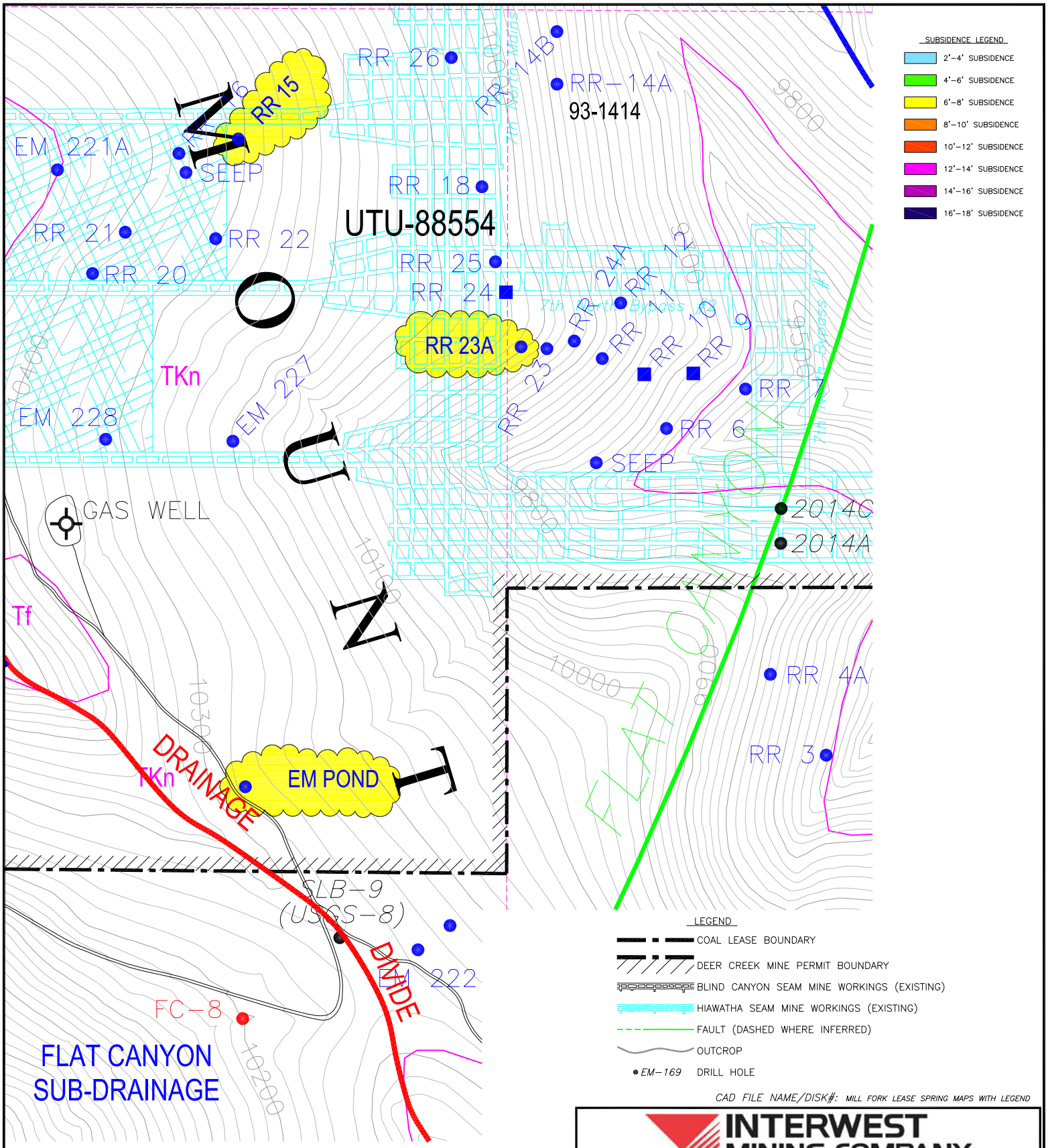
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: GRANTS SPRING vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: GRANTS SPRING
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1560'
Date of Nearest Mining: Nov-05

	Pre-Mining Data: 20000101 THROUGH 20051101				Post-Mining Data: 20051201 THROUGH 201712313				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	290	221	253.428	7	235	205	221.916	24	BICARBONATE
CALCIUM	56.7	54.1	55.7571	7	58.97	48.46	52.7758	24	CALCIUM
CARBONATE	0				8	0	0.4	20	CARBONATE
CHLORIDE	4	3	3.57142	7	7	2	3.20833	24	CHLORIDE
CONDUCTIVITY	491	457	473.285	7	508	422	454.791	24	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	2.31	0.3	1.11285	7	2.83	0.58	1.25541	24	FLOW
HARDNESS	256	241	248.857	7	255	211	235.708	24	HARDNESS
TOTAL IRON	0				0	0	0	20	TOTAL IRON
DISSOLVED IRON	0				0	0	0	20	DISSOLVED IRON
MAGNESIUM	27.7	25.4	26.6	7	28.1	15.59	25.2425	24	MAGNESIUM
DISSOLVED MANGANESE	0				0.002	0	0.0001	20	DISSOLVED MANGANESE
MANGANESE	0				0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.01	7.51	7.74428	7	7.94	7.47	7.77041	24	PH
POTASSIUM	1.34	1.11	1.24857	7	5.36	0.65	1.5	24	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3.62	3.41	3.48857	7	3.85	1.45	3.49416	24	SODIUM
SULFATE	15	11	13	7	12	6	10.2083	24	SULFATE
SUSPENDED SOLIDS	258	258	258	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.4	4.3	4.81428	7	8.3	4.7	6.3625	24	TEMPERATURE
TOTAL DISSOLVED SOLIDS	272	226	248.714	7	377	217	251.583	24	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 7	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 7 OF 10	REV. ___

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-15 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-15 in the Hiawatha seam, (14th West, June 2005). Extraction face of the 14th West longwall panel is 55' west of RR-15.

Subsidence: No subsidence has been detected near RR-15. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2008. RR-15 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-15. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1994 through 1995 by Genwal Resources and 2000 through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-15 located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District). Per request from Emery Conservancy District, PacifiCorp removed the weir and recorder in August 2002. Flow from spring RR-15 generally ranges from 10 gpm to a maximum of 55 gpm.

Geologic Mode of Occurrence for spring RR-15:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 170' below top.

Justification for removal from monitoring: RR-15 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-15 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-15**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
610' S.	1257'W.	NE	23	16S	6E	10350

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Diverted To Weir (not functioning)	None	170' below top

Location Comments: Spring located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District).

Probable Recharge Area: Areas of higher elevation located to the west.

Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area.

Geologic Occurrence of Spring:

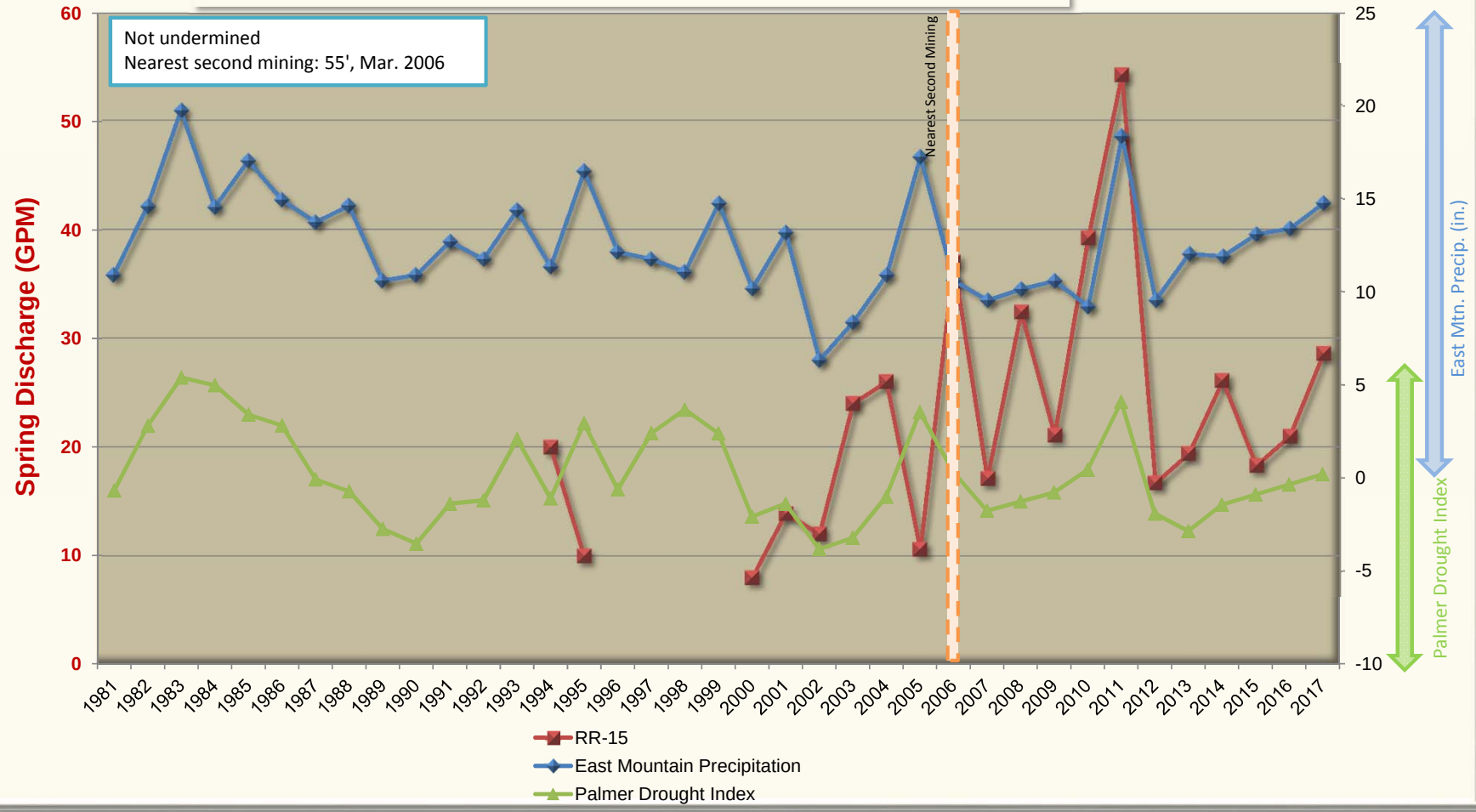
Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

RR-15 spring source

RR-15 Weir and recorder (removed August 22, 2002)

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-15 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-15
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 55'
Date of Nearest Mining: May-06

	Pre-Mining Data: 20000101 THROUGH 20060430				Post-Mining Data: 20060501 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	285	207	253.727	11	233	204	216.608	23	BICARBONATE
CALCIUM	65.8	55	59.3181	11	60.9	54	57.4321	23	CALCIUM
CARBONATE	0				0	0	0	20	CARBONATE
CHLORIDE	2	1	1.12	10	2	0	0.91304	23	CHLORIDE
CONDUCTIVITY	498	419	440	11	479	356	430.956	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	26	6	12.2363	11	54.2	0.52	19.3426	23	FLOW
HARDNESS	241	218	229.636	11	243	210	226.739	23	HARDNESS
TOTAL IRON	0.832	0.121	0.3106	5	0	0	0	20	TOTAL IRON
DISSOLVED IRON	0.084	0.084	0.084	1	0	0	0	20	DISSOLVED IRON
MAGNESIUM	21.4	16.6	19.809	11	23.2	17.12	20.23	23	MAGNESIUM
DISSOLVED MANGANESE	0.159	0.003	0.058	3	0	0	0	20	DISSOLVED MANGANESE
MANGANESE	0.012	0.003	0.0075	2	0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.43	7.53	8.04181	11	8.03	7.37	7.80695	23	PH
POTASSIUM	0.73	0.34	0.5978	5	1.32	0.59	0.8	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.96	2.77181	11	6.5	2.23	3.21565	23	SODIUM
SULFATE	11	4	6.04545	11	10	5	6.95652	23	SULFATE
SUSPENDED SOLIDS	214	214	214	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.8	3	4.01818	11	8.5	3.4	4.36086	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	259	213	237.727	11	272	215	243.086	23	TOTAL DISSOLVED SOLIDS

Location: Section 24, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-23A is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-23A in the Hiawatha seam, (7th North Mains, August 2004).

Subsidence: No subsidence has been detected near RR-23A. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2009. RR-23A is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-23A. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-23A is located in a clearing on an east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms a small drainage. Flow from spring RR-23A generally ranges from 10 gpm to a maximum of 50 gpm.

Geologic Mode of Occurrence for spring RR-23A:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 360' above base.

Justification for removal from monitoring: RR-23A has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-23A be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-23A**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1571' S.	64' E.	NW	24	16S	6E	10023

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	360' above base

Location Comments: Spring located in clearing on east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms small drainage.

Probable Recharge Area: Areas of higher elevation located to the west.

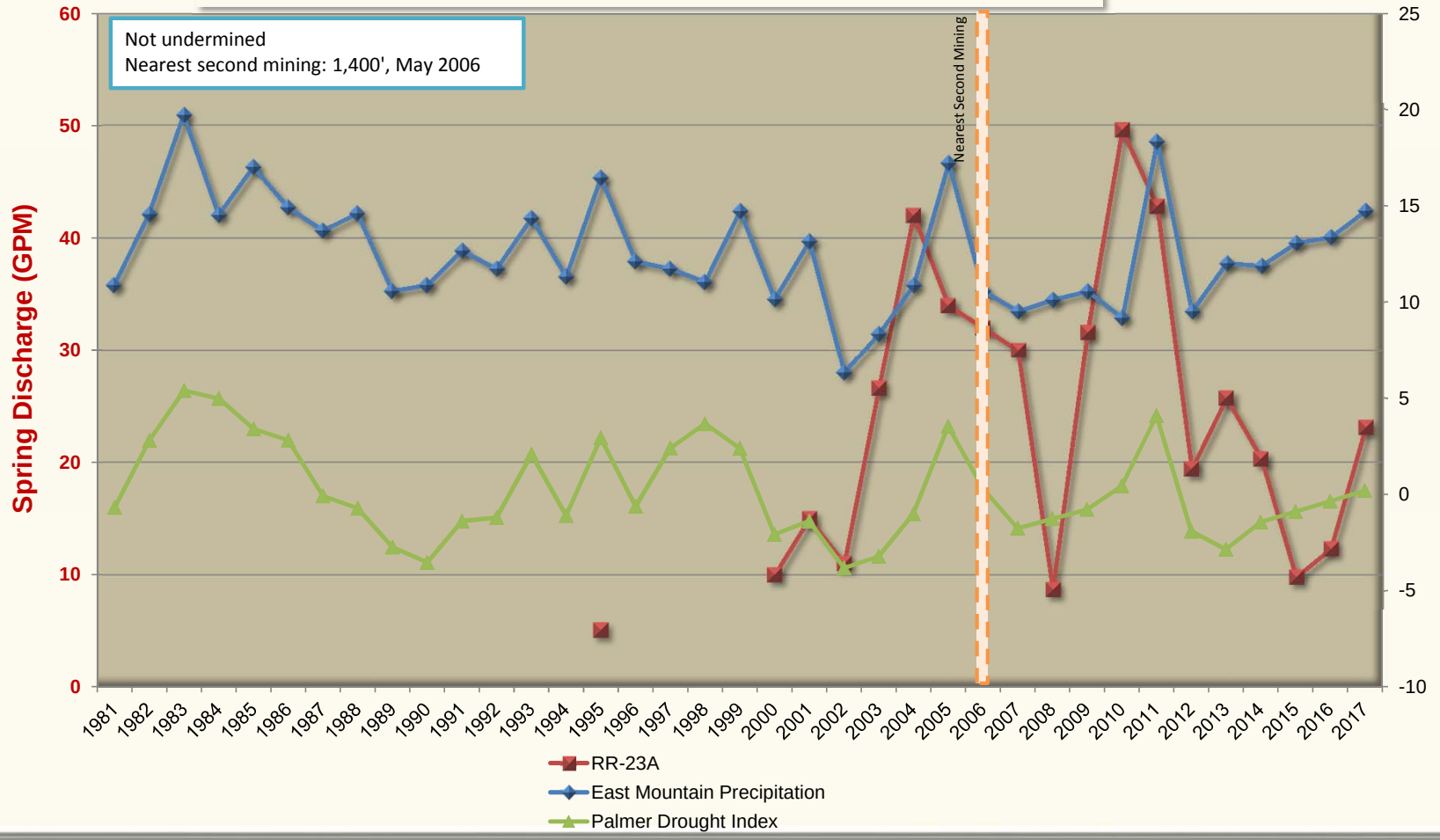
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-23A vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-23A
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1400'
Date of Nearest Mining: May-06

	Pre-Mining Data: 20000101 THROUGH 20060430				Post-Mining Data: 20060501 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	309	237	276.181	11	258	217	240.304	23	BICARBONATE
CALCIUM	73.1	65	68.8454	11	75.2	63.42	69.6313	23	CALCIUM
CARBONATE	0				0	0	0	19	CARBONATE
CHLORIDE	2	1	1.59	10	3	0	1.47826	23	CHLORIDE
CONDUCTIVITY	566	461	493.272	11	560	411	489.173	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	42	8.32	17.5381	11	49.6	5.7	18.6495	23	FLOW
HARDNESS	272	245	255.636	11	282	232	258.086	23	HARDNESS
TOTAL IRON	1.12	0.3	0.54725	4	1.19	0	0.12238	21	TOTAL IRON
DISSOLVED IRON	0.008	0.008	0.008	1	0	0	0	19	DISSOLVED IRON
MAGNESIUM	21.7	19.5	20.3181	11	22.8	17.95	20.4526	23	MAGNESIUM
DISSOLVED MANGANESE	0.265	0.012	0.1385	2	0.066	0	4.38095	21	DISSOLVED MANGANESE
MANGANESE	0.011	0.011	0.011	1	0	0	0	19	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.28	7.21	7.69818	11	8.3	7.15	7.53913	23	PH
POTASSIUM	0.714	0.51	0.60866	6	1.1	0.56	0.72043	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	2.22	2.89545	11	3.78	1.97	2.78608	23	SODIUM
SULFATE	14	10	11.9181	11	15	8	12.2173	23	SULFATE
SUSPENDED SOLIDS	280	280	280	1	0				SUSPENDED SOLIDS
TEMPERATURE	8.2	4	5.21818	11	8.6	3.9	5.1	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	304	226	271.545	11	312	249	277.043	23	TOTAL DISSOLVED SOLIDS

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: EMPOND Spring is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat on August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 1,620' north of EMPOND in the Hiawatha Seam in December 2005.

Subsidence: Maximum subsidence in area 1,560' north of Grants Spring has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. EMPOND is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Grants Spring Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 1993 through 1995 by Genwal Resources and 2000 and through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. EMPOND is a located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring is dominated by conifers. Flow from spring EMPOND generally ranges from 1 gpm to a maximum of <10 gpm.

Geologic Mode of Occurrence for spring EMPOND:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 160' below top.

Justification for removal from monitoring: EMPOND has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site EMPOND be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **EMPOND**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1744' N.	1223' W.	SE	23	16S	6E	10280

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	160' below top

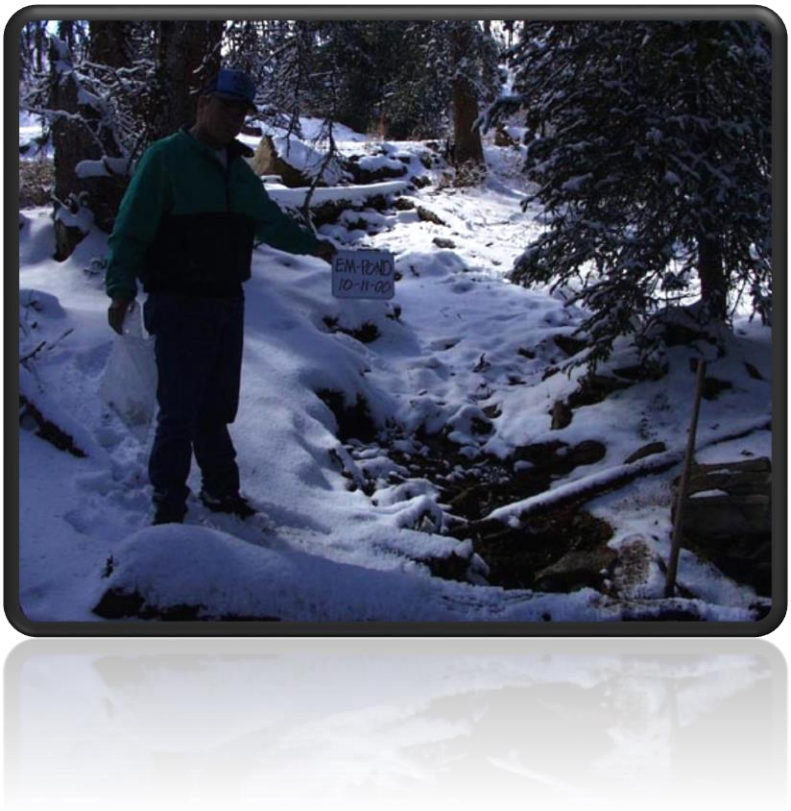
Location Comments: Spring located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring dominated by conifers.

Probable Recharge Area: Highlands area to the northwest (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as EM-222 and EM-223.

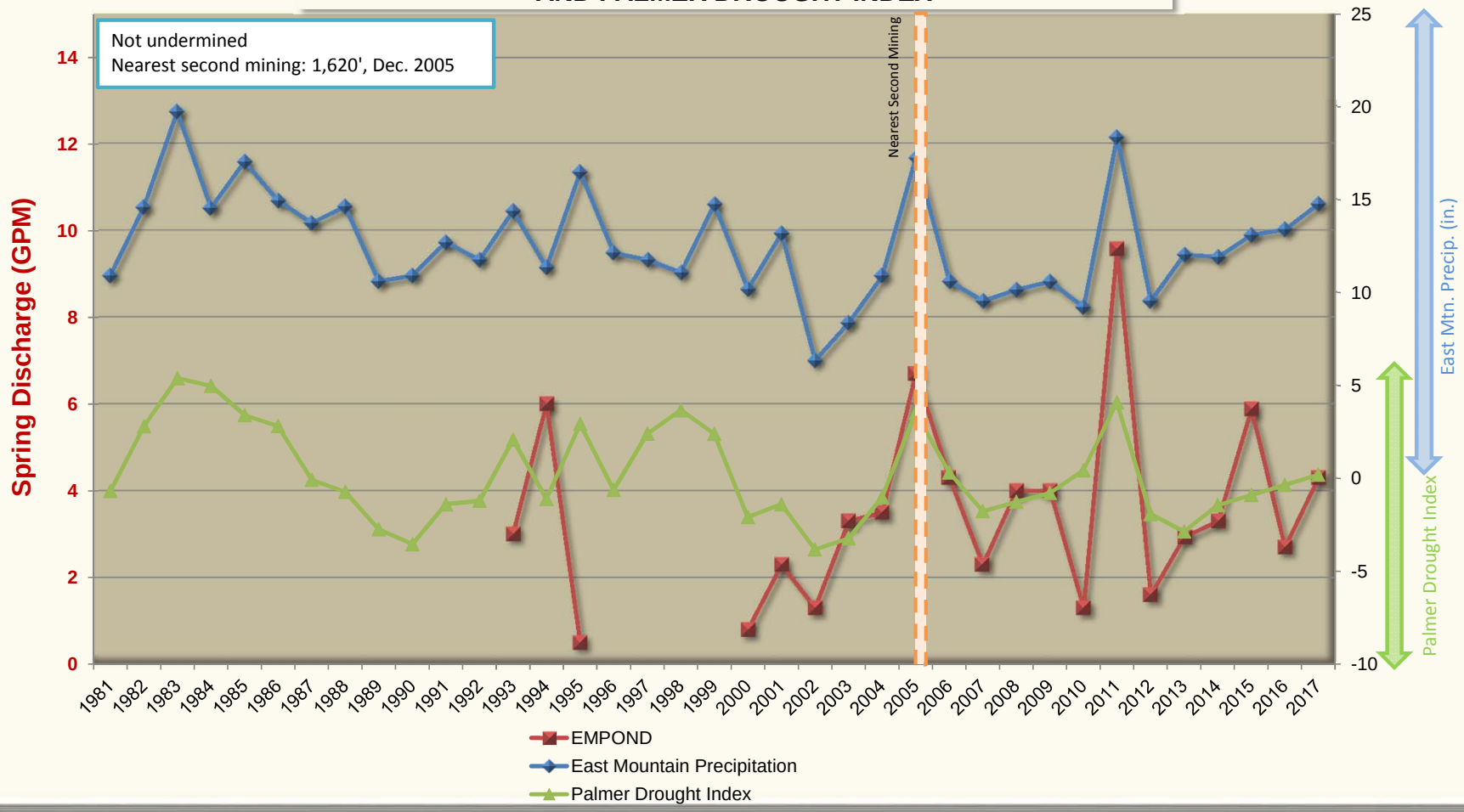
Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.



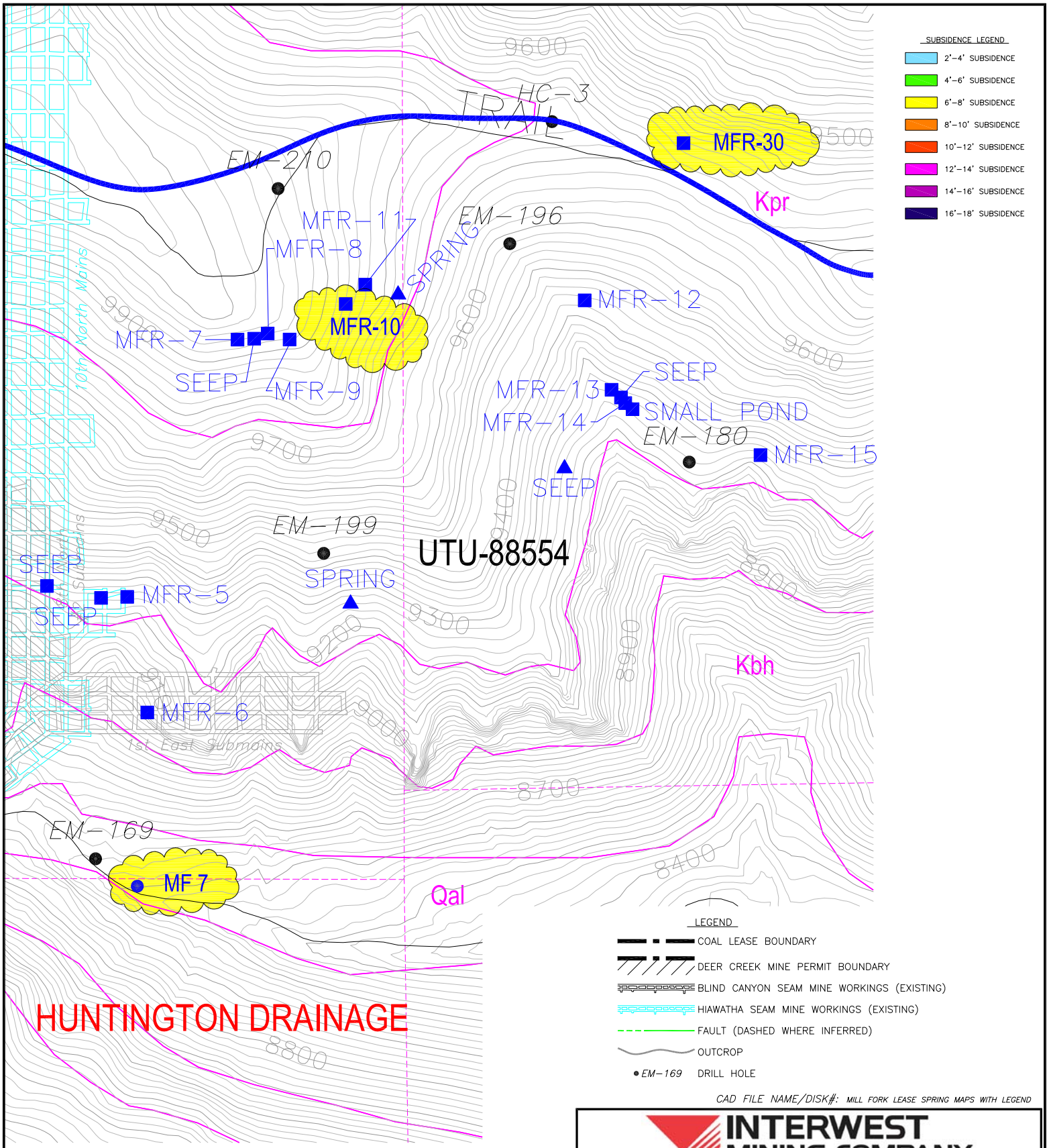
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: EMPOND vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: EMPOND
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1620'
Date of Nearest Mining: Dec-05

	Pre-Mining Data: 20000101 THROUGH 20051130				Post-Mining Data: 20051201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	296	228	269.1	10	239	213	225.875	24	BICARBONATE
CALCIUM	62	57.4	60	10	62.74	54.49	58.16125	24	CALCIUM
CARBONATE	0				12	0	0.6	20	CARBONATE
CHLORIDE	2	1	1.13	10	3	0	1.33333	24	CHLORIDE
CONDUCTIVITY	525	446	468.7	10	491	371	445.125	24	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	6.7	0.5	2.175	10	9.57	0.37	2.78333	24	FLOW
HARDNESS	249	231	242.7	10	254	221	236.375	24	HARDNESS
TOTAL IRON	1.5	0.088	0.4452	5	1.4	0	0.20695	23	TOTAL IRON
DISSOLVED IRON	0.056	0.056	0.056	1	0	0	0	20	DISSOLVED IRON
MAGNESIUM	23.7	21.3	22.57	10	24.1	20.45	22.137	24	MAGNESIUM
DISSOLVED MANGANESE	0.07	0.002	0.02	5	0.063	0	8.29166	24	DISSOLVED MANGANESE
MANGANESE	0.008	0.007	0.0075	2	0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.21	7.84	7.983	10	8.15	7.67	7.91791	24	PH
POTASSIUM	0.697	0.539	0.60433	6	0.92	0.53	0.65375	24	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	2	2.385	10	2.56	1.35	2.06583	24	SODIUM
SULFATE	7	4.8	5.38	10	6	3	3.79166	24	SULFATE
SUSPENDED SOLIDS	239	239	239	1	0				SUSPENDED SOLIDS
TEMPERATURE	6	3.8	5.24	10	10.6	4.9	6.9	24	TEMPERATURE
TOTAL DISSOLVED SOLIDS	280	231	251.6	10	287	204	245.333	24	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY: K. LARSEN	MAP 8	
SCALE: 1" =600'	DRAWING #:	
DATE: MAY 7, 2018	SHEET 8 OF 10	REV. ___

Location: Section 7, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MFR-30 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MFR-30.

Subsidence: No subsidence has been detected near MFR-30. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MFR-30 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MFR-30. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MFR-30 is located in small clearing on a north facing slope. Area surrounding the spring source is vegetated with mountain brush, aspens and conifers. Flow from spring MFR-30 generally ranges from 0/seep to a maximum of <3 gpm.

Geologic Mode of Occurrence for spring MFR-30:

- Water flowing down through fractures in the Upper Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Upper Price River (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 80' below top.

Justification for removal from monitoring: MFR-30 has been monitored by PacifiCorp since 2001. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MFR-30 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MFR-30**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2298' S.	1304' E.	NW	7	16S	7E	9680

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Upper Price River	None	None	80' below top

Location Comments: Spring located in small clearing on north facing slope. Area surrounding the spring source vegetated with mountain brush, aspens and conifers.

Probable Recharge Area: Areas of higher elevation located to the west.

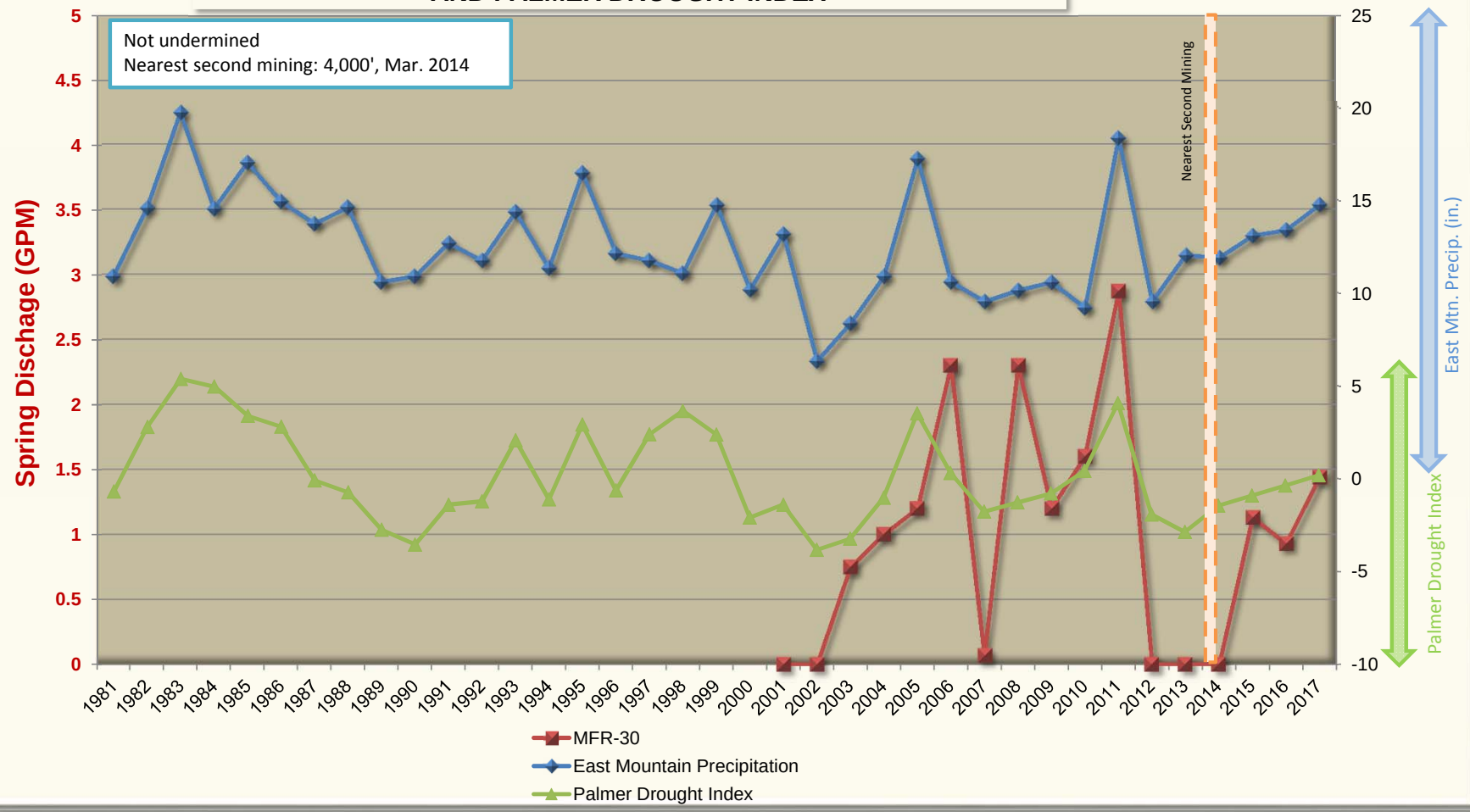
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area (MFR-28, MFR-29).

Geologic Occurrence of Spring:

Water flowing down through fractures in the Upper Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MFR-30 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MFR-30
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 4000'
Date of Nearest Mining: Mar-14

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	383	258	305.166	12	316	252	278.666	3	BICARBONATE
CALCIUM	89.22	77	84.275	12	83.94	63.67	71.8366	3	CALCIUM
CARBONATE	0	0	0	5	0	0	0	3	CARBONATE
CHLORIDE	3	1	2.25	12	3	2	2.33333	3	CHLORIDE
CONDUCTIVITY	698	593	624.833	12	633	552	587.333	3	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	26.6	0.22	3.41833	12	1.44	0.93	1.16666	3	FLOW
HARDNESS	327	287	311	12	318	266	283.666	3	HARDNESS
TOTAL IRON	1.23	0	0.4207	10	2.62	0	0.93	3	TOTAL IRON
DISSOLVED IRON	0	0	0	5	0	0	0	3	DISSOLVED IRON
MAGNESIUM	26.11	21	24.4258	12	26.24	23.72	25.33	3	MAGNESIUM
DISSOLVED MANGANESE	0.012	0	0.0036	5	0.061	0	2.13333	3	DISSOLVED MANGANESE
MANGANESE	0.026	0	0.00625	8	0	0	0	3	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.27	7.56	7.95416	12	8.55	7.89	8.19333	3	PH
POTASSIUM	1.04	0.73	0.81072	11	1.35	0.83	1.12	3	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	16.5	8	12.96	12	14.42	12.69	13.4433	3	SODIUM
SULFATE	39	22	32.25	12	36	31	33.6666	3	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.2	3	6.28333	12	61.3	6.2	25.6666	3	TEMPERATURE
TOTAL DISSOLVED SOLIDS	400	308	351.083	12	338	283	313	3	TOTAL DISSOLVED SOLIDS

Location: Section 12, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MFR-10 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MFR-10.

Subsidence: No subsidence has been detected near MFR-10. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MFR-10 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MFR-10. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2001 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MFR-10 is located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source is vegetated with conifers and aspens. Flow from spring MFR-10 generally ranges from 10 gpm to a maximum of 45 gpm (recorded flow of 2001 was 0.0 gpm).

Geologic Mode of Occurrence for spring MFR-10:

- Water flowing down through fractures in the lower section of the North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel.
- Geologic Formation: North Horn Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 140' above base.

Justification for removal from monitoring: MFR-10 has been monitored by PacifiCorp since 2001. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MFR-10 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MFR-10**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2680' N.	270' W	SE	12	16S	6E	9900

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Developed With Steel Pipe, Diverted To Trough (not functioning)	None	140' above base

Location Comments: Spring located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source vegetated with conifers and aspens.

Probable Recharge Area: Areas of higher elevation located to the west.

Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area.

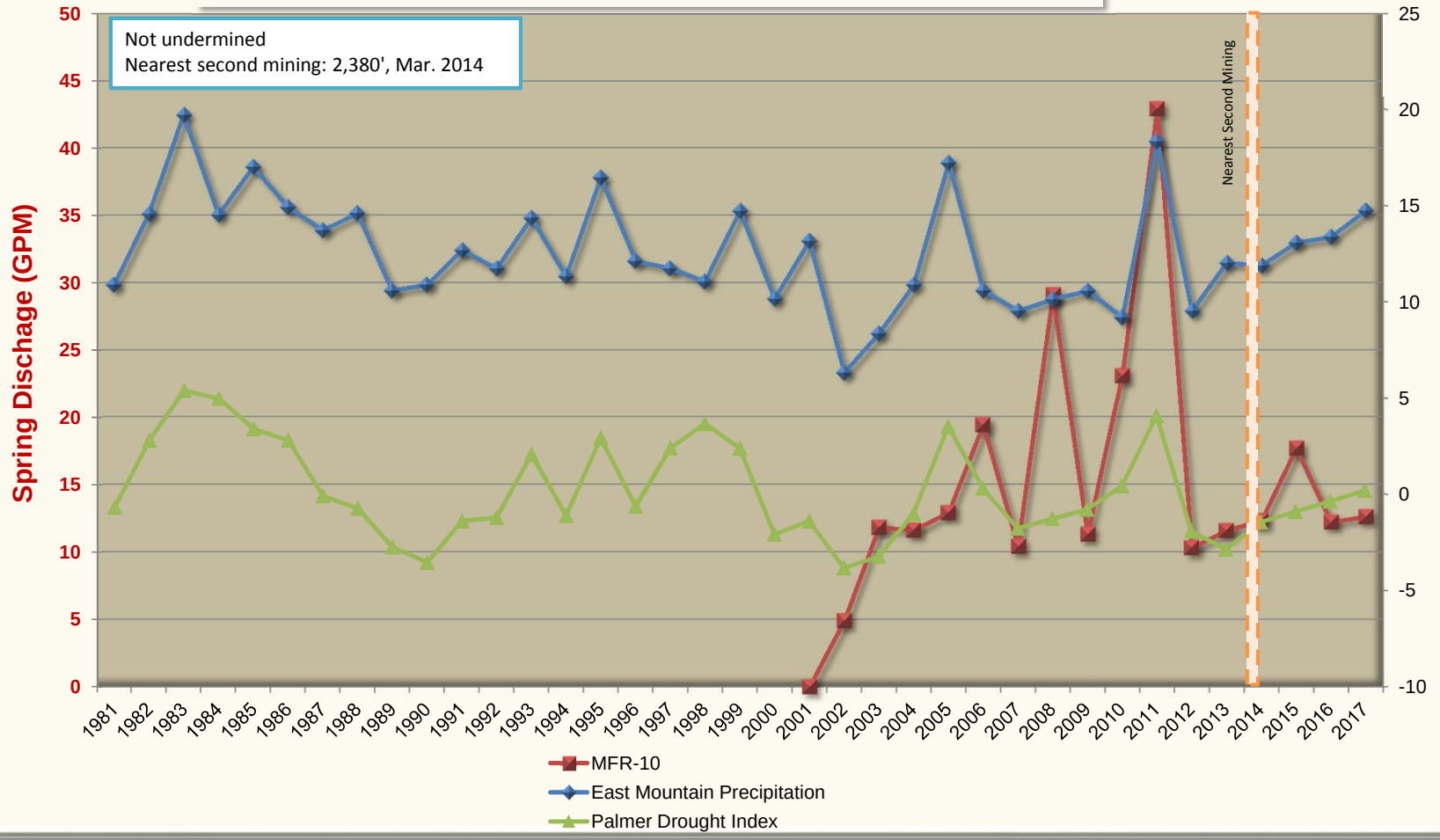
Geologic Occurrence of Spring: Water flowing down through fractures in the lower section of the North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel.

MFR-10 Spring Source

MFR-10 Trough

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MFR-10 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MFR-10
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 2380'
Date of Nearest Mining: Mar-14

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	326	228	263.73	26	260	229	244.75	8	BICARBONATE
CALCIUM	82.6	65	73.1584	26	74.25	58.28	65.83	8	CALCIUM
CARBONATE	6	0	0.46153	13	0	0	0	8	CARBONATE
CHLORIDE	4	2	2.38846	26	2	2	2	8	CHLORIDE
CONDUCTIVITY	618	380	525.5	26	545	497	517.25	8	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	151	2.4	15.4926	26	17.65	1.7	8.1375	8	FLOW
HARDNESS	305	253	279.653	26	288	236	261.75	8	HARDNESS
TOTAL IRON	1.34	0	0.19225	20	0	0	0	8	TOTAL IRON
DISSOLVED IRON	0	0	0	12	0	0	0	8	DISSOLVED IRON
MAGNESIUM	25.8	22	23.563	26	25.76	20.57	23.7175	8	MAGNESIUM
DISSOLVED MANGANESE	0.04	0	0.00431	16	0	0	0	8	DISSOLVED MANGANESE
MANGANESE	0	0	0	12	0	0	0	8	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.41	7.31	8.07038	26	8.54	8.16	8.2625	8	PH
POTASSIUM	1.15	0.48	0.82054	22	1.2	0.64	0.82875	8	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	6	2	4.04692	26	5.86	2.81	4.30125	8	SODIUM
SULFATE	29	11	23.073	26	31	19	25.375	8	SULFATE
SUSPENDED SOLIDS	267	267	267	1	0				SUSPENDED SOLIDS
TEMPERATURE	44.9	3.9	7.99615	26	50.1	2.4	11.675	8	TEMPERATURE
TOTAL DISSOLVED SOLIDS	341	262	295.346	26	314	269	291.75	8	TOTAL DISSOLVED SOLIDS

Location: Section 13, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

Lease Association: Spring MF-7 is located in Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MF-7.

Subsidence: No subsidence has been detected near MF-7. Nearest second mining is 1,707' west of MF-7. MF-7 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-7. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-7 is located on hillside near Mill Fork drainage on a north facing slope covered with spruce trees. Flow from spring MF-7 generally ranges from 10 gpm to a maximum of 65 gpm.

Geologic Mode of Occurrence for spring MF-7:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: MF-7 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-7 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-7**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
34' S.	1244' W.	NE	13	16S	6E	8580

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	None	320' below top

Location Comments: Spring located on hillside near Mill Fork drainage on north facing slope covered with spruce trees.

Probable Recharge Area: Areas of higher elevation located to the southwest.

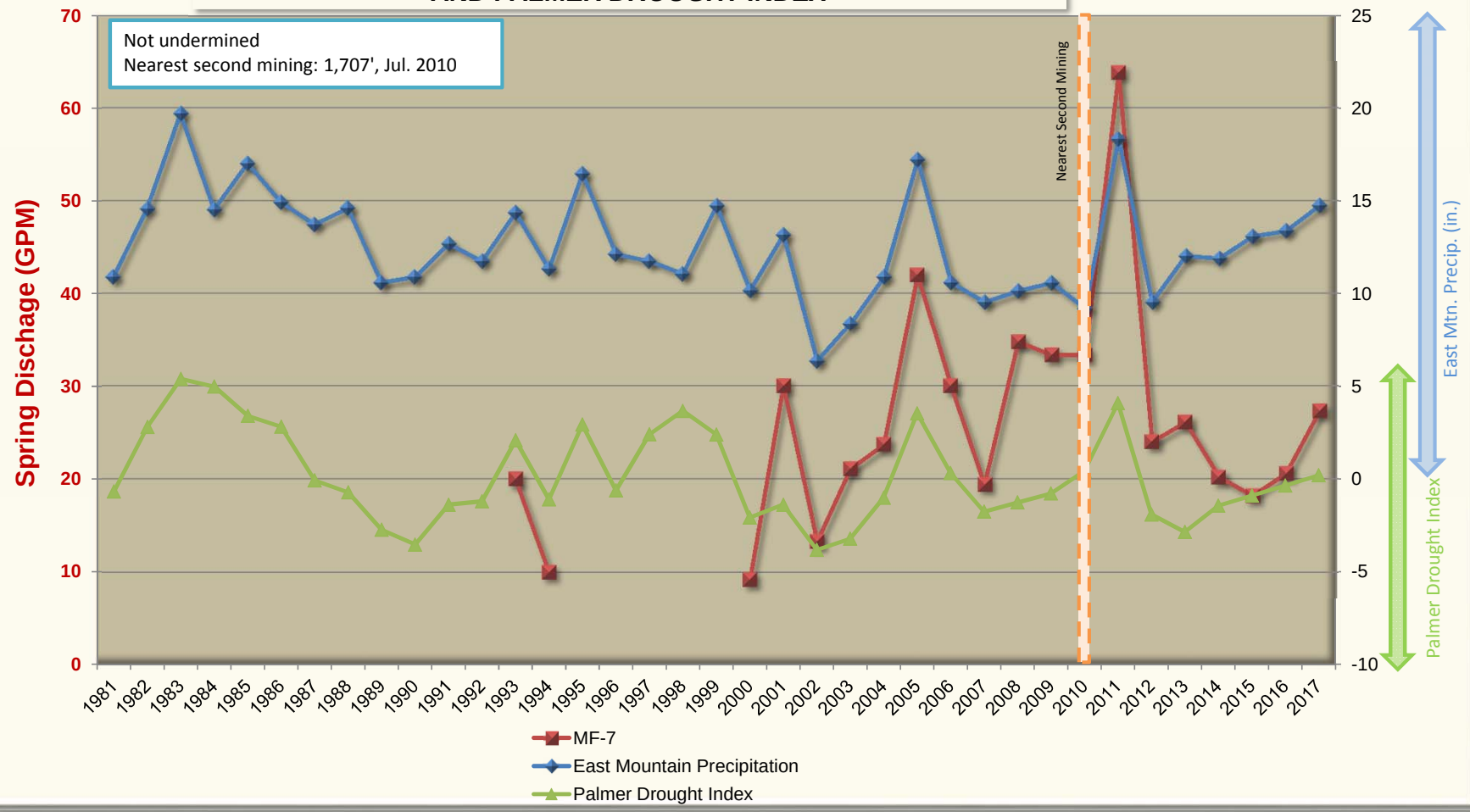
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-8A.

Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

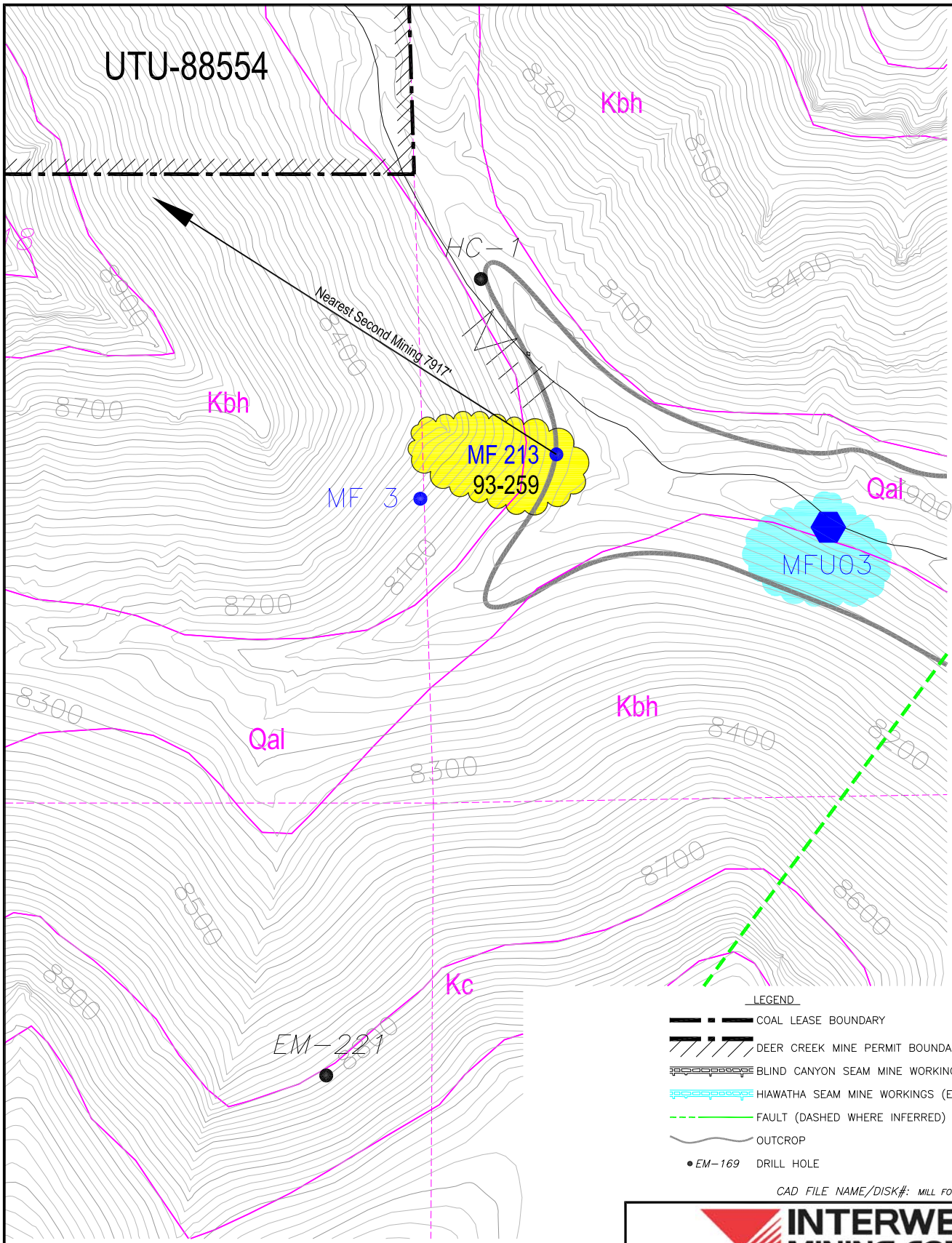
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-7 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-7
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1707'
Date of Nearest Mining: Jul-10

	Pre-Mining Data: 20000101 THROUGH 20100630				Post-Mining Data: 20100701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	335	242	279.21	19	277	250	262.9375	16	BICARBONATE
CALCIUM	77.1	65	72.901	19	77.13	36.37	70.0975	16	CALCIUM
CARBONATE	0	0	0	4	12	0	0.75	16	CARBONATE
CHLORIDE	4	2	2.71052	19	3	2	2.5	16	CHLORIDE
CONDUCTIVITY	681	512	583.263	19	670	532	593.4375	16	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	42	9.3	21.5315	19	63.8	12.8	24.5931	16	FLOW
HARDNESS	325	269	303.105	19	325	160	293.0625	16	HARDNESS
TOTAL IRON	0.1	0	0.02	5	1.18	0	0.101875	16	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	16	DISSOLVED IRON
MAGNESIUM	32.3	26	29.4015	19	32.32	16.75	28.665	16	MAGNESIUM
DISSOLVED MANGANESE	0	0	0	4	0.139	0	0.010125	16	DISSOLVED MANGANESE
MANGANESE	0	0	0	4	0	0	0	16	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8	7.45	7.80842	19	8.5	7.7	7.875625	16	PH
POTASSIUM	1.46	1	1.15833	18	1.84	1.04	1.34625	16	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	7	4	6.07789	19	68.11	6.87	13.59375	16	SODIUM
SULFATE	55	39	45.8315	19	74	29	51.8125	16	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	18.8	3.5	5.38333	18	40.5	4.4	7.25625	16	TEMPERATURE
TOTAL DISSOLVED SOLIDS	360	298	326.947	19	415	298	345.0625	16	TOTAL DISSOLVED SOLIDS



SUBSIDENCE LEGEND

- 2'-4' SUBSIDENCE
- 4'-6' SUBSIDENCE
- 6'-8' SUBSIDENCE
- 8'-10' SUBSIDENCE
- 10'-12' SUBSIDENCE
- 12'-14' SUBSIDENCE
- 14'-16' SUBSIDENCE
- 16'-18' SUBSIDENCE

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 DRILL HOLE

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

SPRING LEGEND

- MFB02 SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994-1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010-2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 GROUND WATER RIGHTS
- 93-198 SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989-1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY - DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 9	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 9 OF 10	REV. ___

Location: Section 17, Township 16 South, Range 7 East, SLB&M. This site is located within ½ mile offset of the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

Lease Association: Spring MF-213 is located within ½ mile offset of Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MF-213.

Subsidence: No subsidence has been detected near MF-213. Nearest second mining is 7,915' west of MF-213. MF-213 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-213. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-213 is located near drainage bottom (Mill Fork - Right Fork) on an east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits. Flow from spring MF-213 generally ranges from 15 gpm to a maximum of 70 gpm.

Geologic Mode of Occurrence for spring MF-213:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: MF-213 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-213 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-213**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1489' N.	584' E.	SW	17	16S	R7E	8030

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	93-259	At base

Location Comments: Spring located near drainage bottom (Mill Fork - Right Fork) on east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits.

Probable Recharge Area: Areas of higher elevation located to the west.

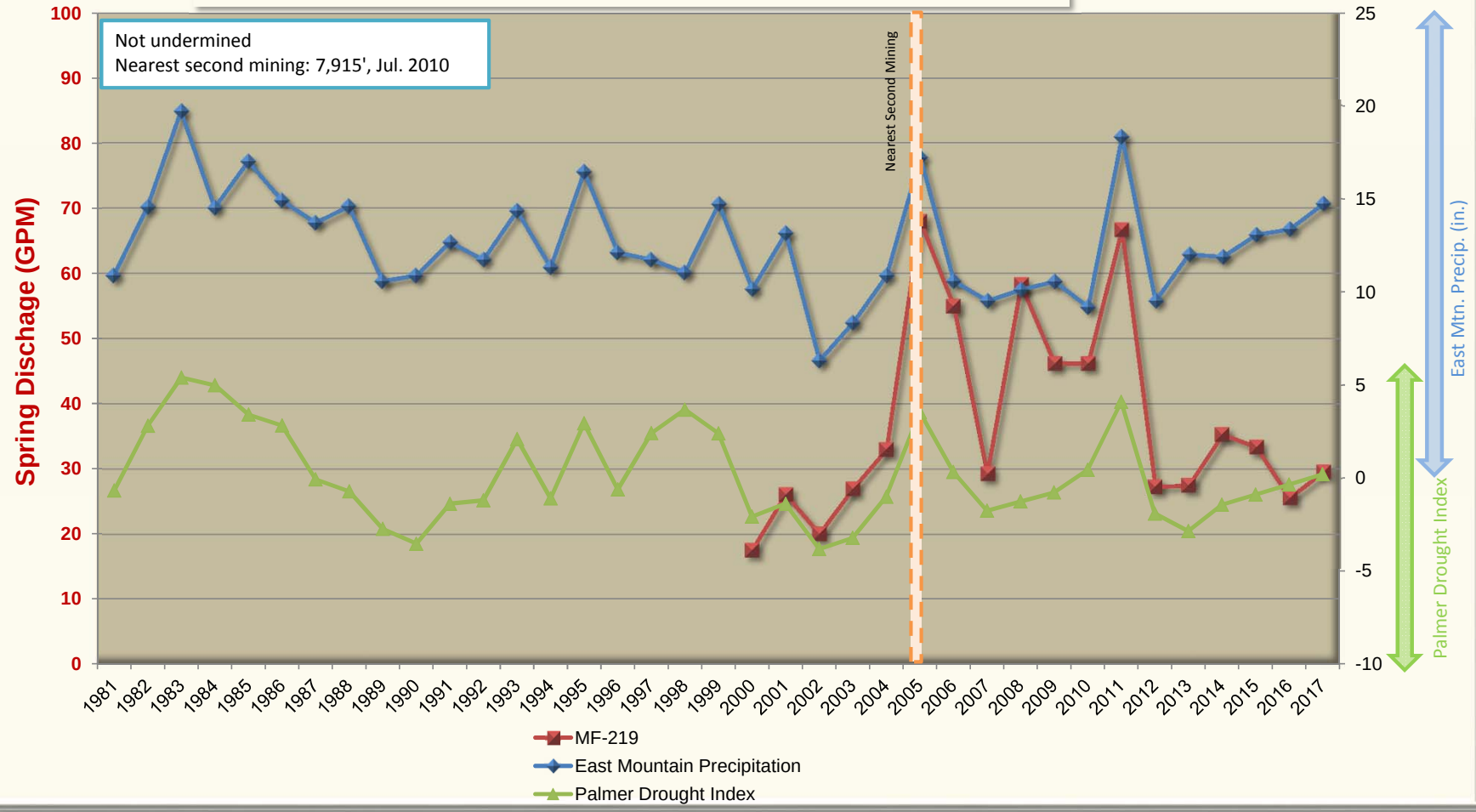
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-3.

Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-213 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-213
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 7915'
Date of Nearest Mining: Jul-10

	Pre-Mining Data: 20000101 THROUGH 20100630				Post-Mining Data: 20100630 THROUGH 20172131				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	332	241	279.842	19	261	226	252.25	16	BICARBONATE
CALCIUM	69.1	61	65.341	19	68.57	52.08	63.3456	16	CALCIUM
CARBONATE	9	0	1.8	5	5	0	0.3125	16	CARBONATE
CHLORIDE	4	2	2.66315	19	3	2	2.4375	16	CHLORIDE
CONDUCTIVITY	752	435	551.105	19	551	497	525.8125	16	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	68	10	28.2315	19	66.7	14.3	28.2075	16	FLOW
HARDNESS	294	272	283.157	19	290	227	273.75	16	HARDNESS
TOTAL IRON	0.313	0	6.88333	6	1.16	0	0.0725	16	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	16	DISSOLVED IRON
MAGNESIUM	31	27.4	29.1584	19	29.96	23.53	28.0681	16	MAGNESIUM
DISSOLVED MANGANESE	0.004	0	0.0008	5	0.067	0	0.00418	16	DISSOLVED MANGANESE
MANGANESE	0.004	0	0.0008	5	0	0	0	16	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.22	7.21	7.95105	19	8.45	8.03	8.138125	16	PH
POTASSIUM	1.2	0.93	1.02982	17	1.39	0.95	1.085	16	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	7	4.61	5.55	19	8.86	5.08	6.72375	16	SODIUM
SULFATE	29	23	25.4526	19	52	23	28.375	16	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.6	5.6	7.85789	19	50.8	6.1	11.4125	16	TEMPERATURE
TOTAL DISSOLVED SOLIDS	324	264	294.473	19	352	280	299.5	16	TOTAL DISSOLVED SOLIDS

Location: Section 9, Township 16 South, Range 7 East, SLB&M. This site is located 1 ½ mile east of the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

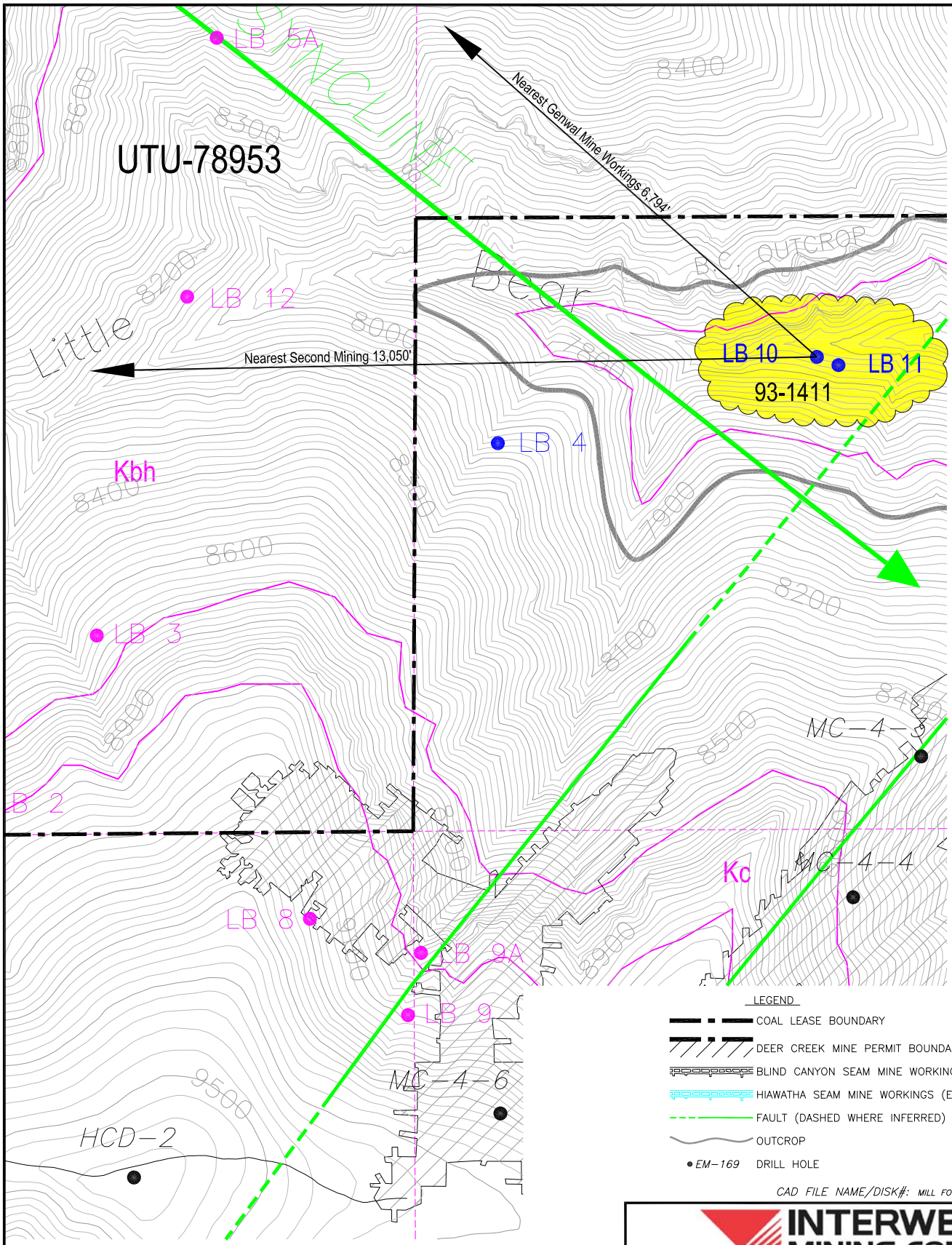
Lease Association: Little Bear Spring is located 1 ½ mile east of Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of Little Bear Spring.

Subsidence: No subsidence has been detected near Little Bear Spring. Nearest second mining is 13,050' west of Little Bear Spring. Little Bear Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Little Bear Spring. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1982 and has continued through 2017 by Castle Valley Special Service District. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - Little Bear Spring is located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo). Flow from spring Little Bear Spring generally ranges from 225 gpm to a maximum of 475 gpm.



SUBSIDENCE LEGEND

- 2'-4' SUBSIDENCE
- 4'-6' SUBSIDENCE
- 6'-8' SUBSIDENCE
- 8'-10' SUBSIDENCE
- 10'-12' SUBSIDENCE
- 12'-14' SUBSIDENCE
- 14'-16' SUBSIDENCE
- 16'-18' SUBSIDENCE

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 DRILL HOLE

SPRING LEGEND

- MFB02 SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994-1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010-2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 GROUND WATER RIGHTS
- 93-198 SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989-1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY - DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 10	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 10 OF 10	REV. ___

Geologic Mode of Occurrence for spring Little Bear Spring:

- Multiple potential recharge sources have been identified; south: fracturing related to the Mill Fork Graben, west: fractures - Little Bear Canyon, north: fractures - Huntington Creek Drainage.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: Little Bear Spring has been monitored by Castle Valley Special Service District since 1982 and by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Little Bear Spring be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **Little Bear Spring**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2028' N.	1726' E	SW	9	16S	6E	7540

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Star Point Sandstone Panther Member	Developed With Collection Boxes & Pipeline	93-1411	near base

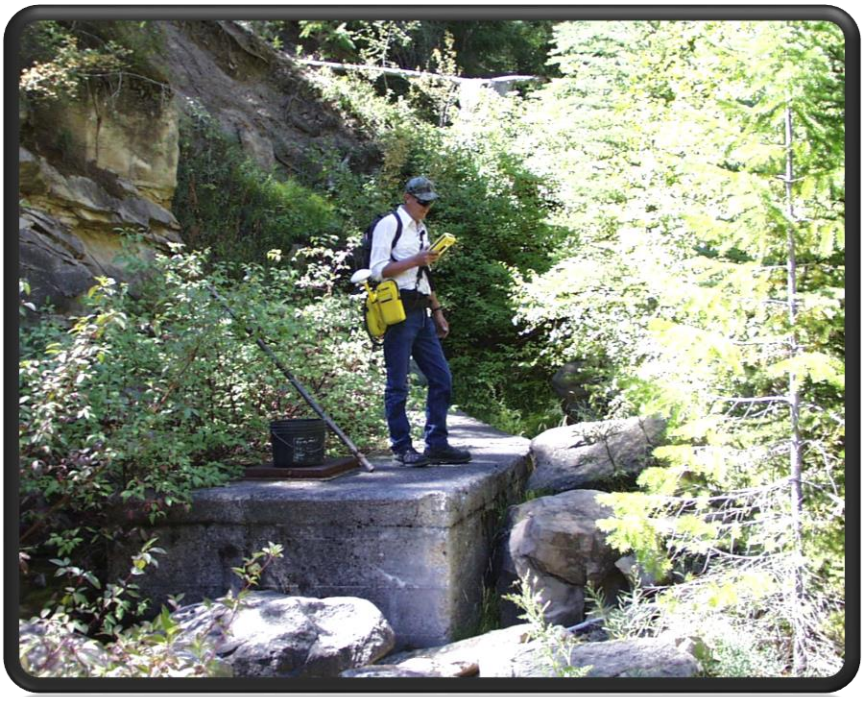
Location Comments: Spring located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo).

Probable Recharge Area: Multiple potential recharge sources have been identified; south: fracturing related to the Mill Fork Graben, west: fractures - Little Bear Canyon, north: fractures - Huntington Creek Drainage

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area.

Geologic Occurrence of Spring:

Water flowing through fractures in the lower section of the Star Point Sandstone (Panther Member) intersects the surface.

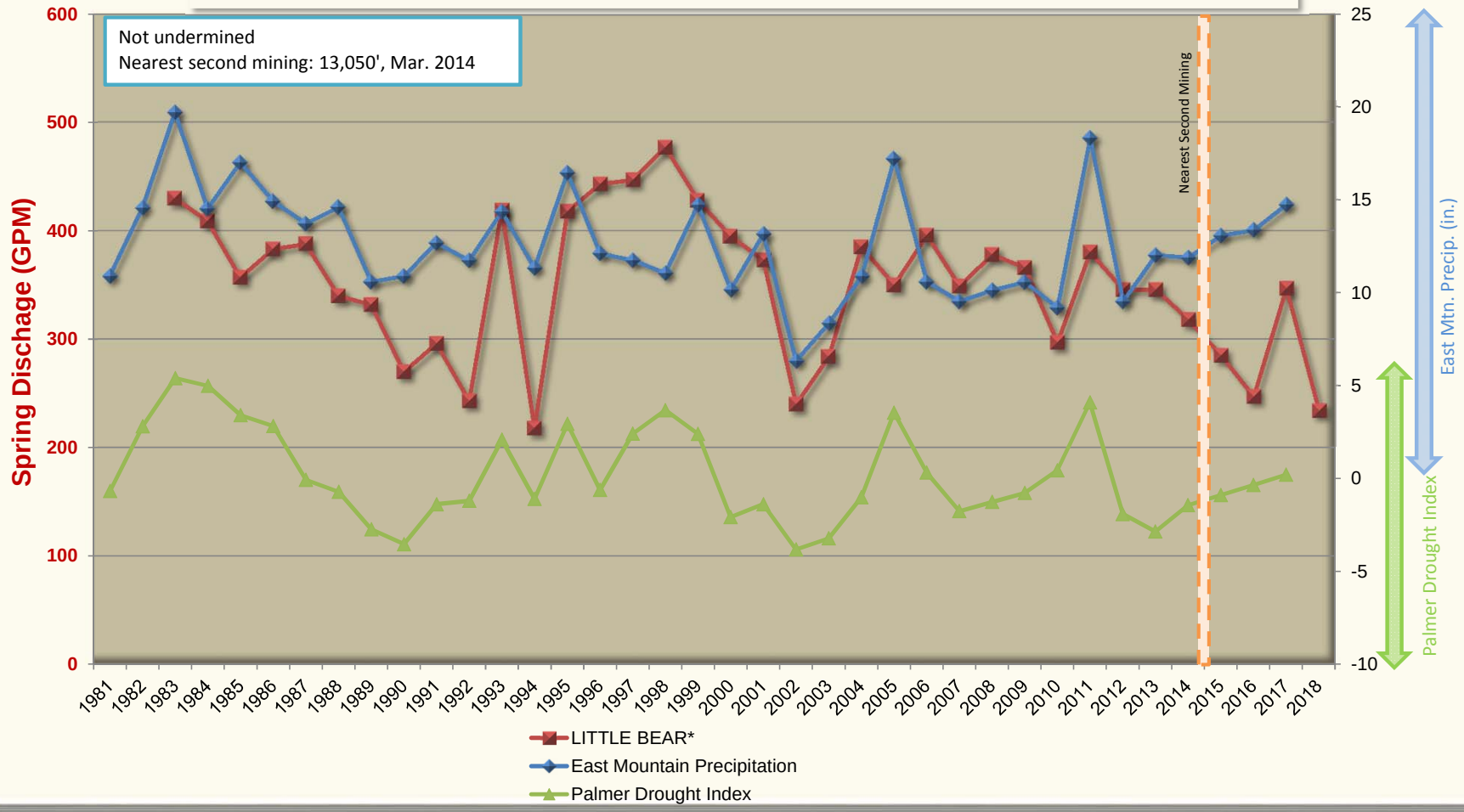


Little Bear Collection System

Little Bear Collection System

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: LITTLE BEAR SPRING vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX

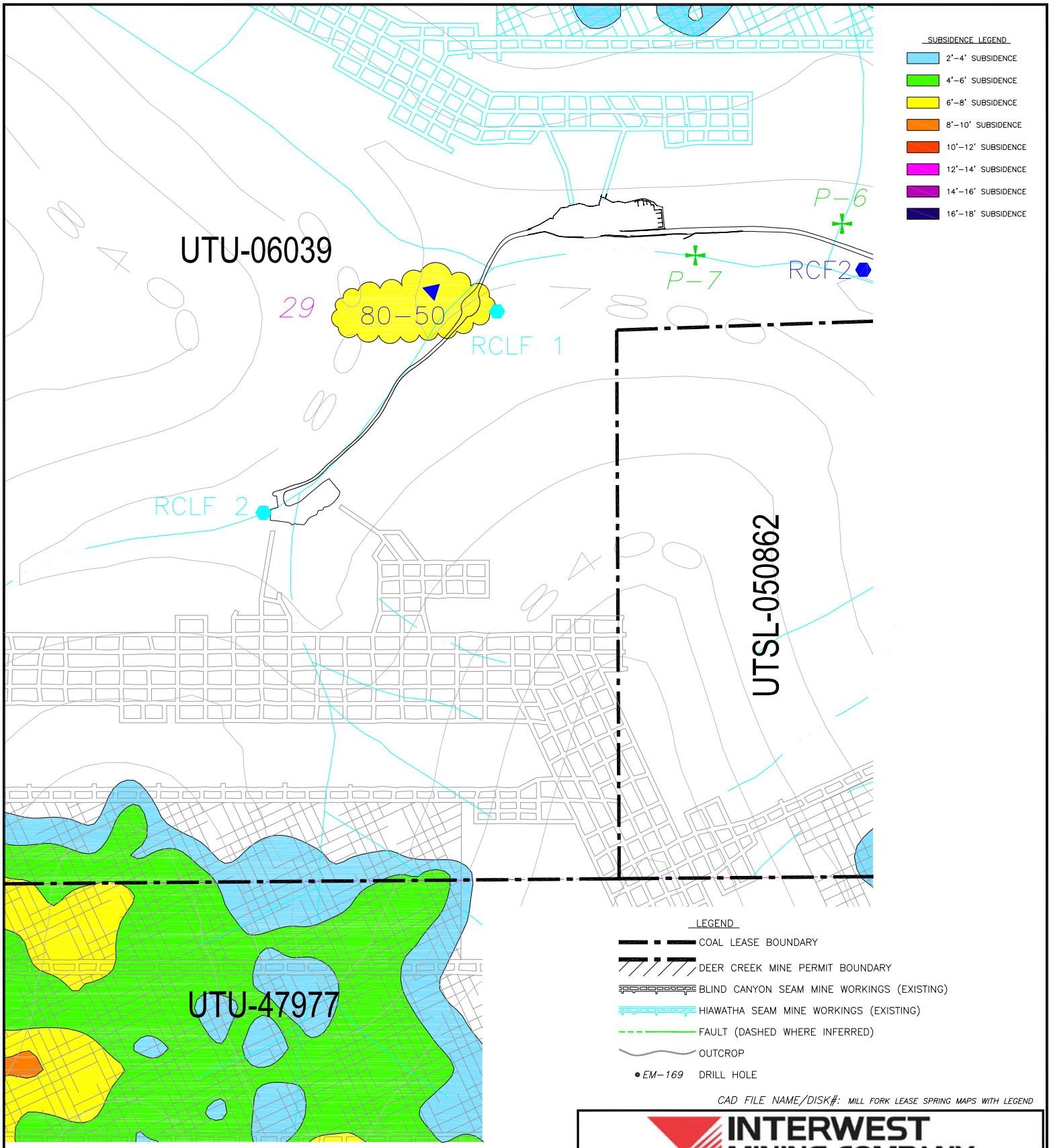


East Mountain Spring: Little Bear
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 13,050'
Date of Nearest Mining: Mar. 2014

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	354	265	284.523	21	290	265	277.25	8	BICARBONATE
CALCIUM	68.85	63.45	66.4838	21	67.46	60.63	63.78	8	CALCIUM
CARBONATE	0	0	0	10	0	0	0	8	CARBONATE
CHLORIDE	6	3	3.95238	21	9	3	4.25	8	CHLORIDE
CONDUCTIVITY	650	559	592.142	21	596	526	576.625	8	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	387	270	338.1	14	347	247	294.625	8	FLOW
HARDNESS	330	294	315.571	21	321	293	306.5	8	HARDNESS
TOTAL IRON	0.21	0	2.66153	13	0.27	0	0.04625	8	TOTAL IRON
DISSOLVED IRON	0.006	0	5.45454	11	0	0	0	8	DISSOLVED IRON
MAGNESIUM	38.5	32.91	36.2995	21	38.17	33.28	35.75	8	MAGNESIUM
DISSOLVED MANGANESE	0.003	0	0.0003	10	0.008	0	0.00225	8	DISSOLVED MANGANESE
MANGANESE	0.007	0	6.36363	11	0	0	0	8	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	7.68	7.04	7.4138	21	7.67	7.39	7.50375	8	PH
POTASSIUM	3.4	1.36	1.65619	21	2.1	1.37	1.58125	8	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	11.2	6.41	7.29238	21	9.91	7.57	8.83875	8	SODIUM
SULFATE	41	31	36.9047	21	44	38	41.625	8	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.6	5.4	9.07	20	10.1	8.3	9.2125	8	TEMPERATURE
TOTAL DISSOLVED SOLIDS	356	298	324.523	21	383	311	335.625	8	TOTAL DISSOLVED SOLIDS

EAST MOUNTAIN SPRING DATA
East Mountain Area

Federal Lease UTU-06039 and UTU-084923							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
80-50	Not Undermined	NA Nearest second mining: 1225' Oct. 2003	Within Relinquishment	29	16S	7E	NA
SHEBA SPRING	Not Undermined	NA Nearest second mining: 1890' Mar. 1991	Within Relinquishment	7	17S	7E	NA



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-06039
EAST MOUNTAIN SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 25, 2018	SHEET 1 OF 1	REV. ___

Location: Section 29, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-06039.

Lease Association: Spring 80-50 is located within Federal Coal lease UTU-06039. The lease was originally issued effective May 1, 1953. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Blind Canyon Seam in November 1993 with the first longwall retreat in August 1999. Hiawatha seam development began in October 2000 with the first longwall retreat in April 2002. . No mining occurred in vicinity of 80-50.

Subsidence: No subsidence has been detected near 80-50. The 2008 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2005. 80-50 is outside of the subsided area.

For additional data related to subsidence refer to the 2008 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring 80-50. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2001 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - 80-50 is located on east facing hillside which is densely populated with spruce trees above the Rilda Canyon road (Emery County Road #306) turn around. Flow from spring 80-50 generally ranges from 0gpm/seep to a maximum of 3.5 gpm.

Geologic Mode of Occurrence for spring 80-50:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 100' above base.

Justification for removal from monitoring: 80-50 has been monitored by PacifiCorp from 1980 through 1986 and from 1996 through 2018. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 (west and north of UTU-06039) ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site 80-50 be removed from the monitoring program.

EAST MOUNTAIN

EAST MOUNTAIN & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **80-50**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2850’ S.	2230' W.	NW	29	16S	7E	7810

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	None	100' above bottom

Location Comments: Spring located on east facing hillside which is densely populated with spruce trees.

Probable Recharge Area: Areas of higher elevations which are located to the west.

Relationship to Adjacent Springs: Spring not associated with any other springs.

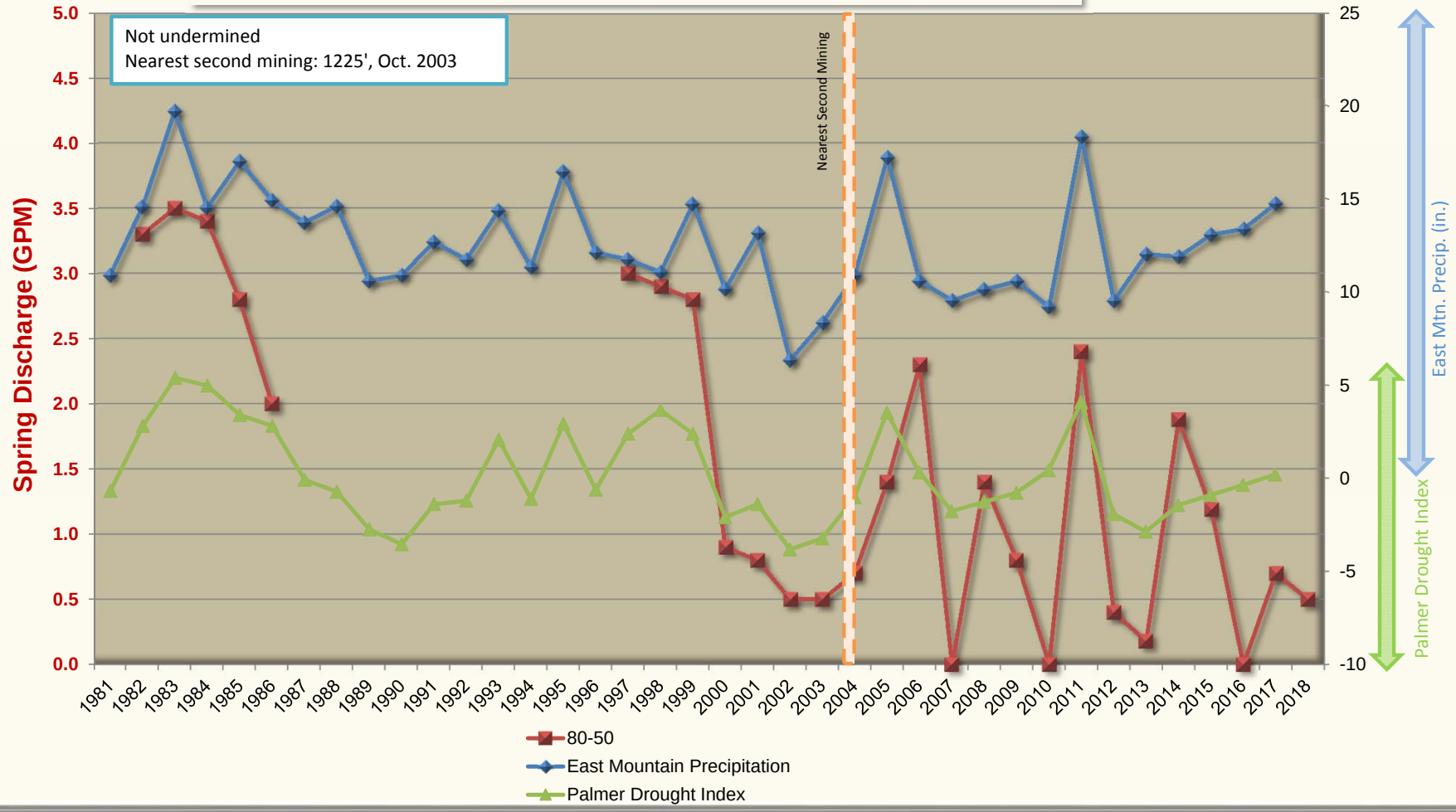
Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

Spring 80-50, May 22, 2018

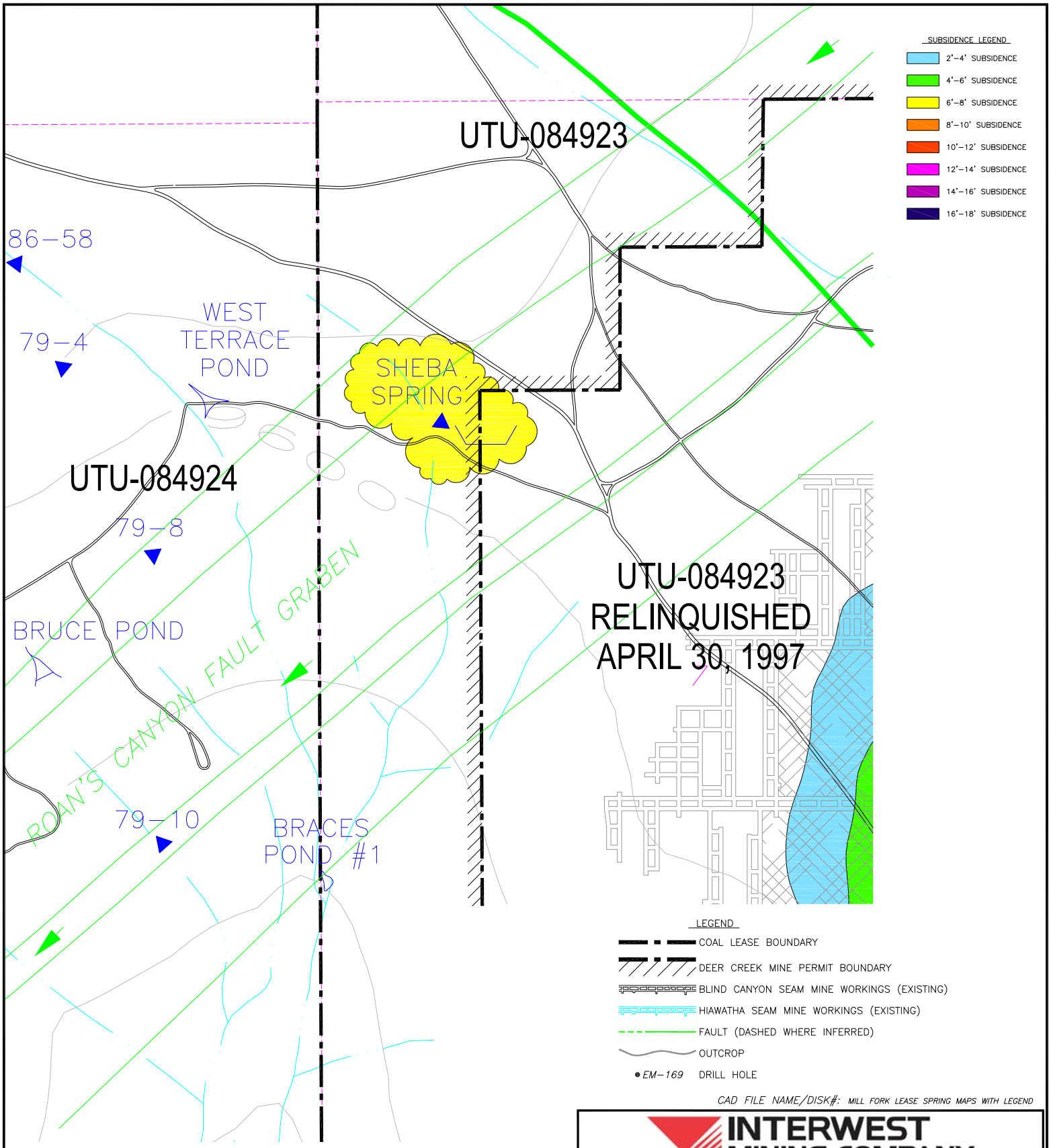
EAST MOUNTAIN SPRINGS - EAST MTN. SPRING: 80-50 Spring vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: 80-50
Water Quality Data: Operational
Mine Association: Deer Creek Mine - East Mountain
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1890'
Date of Nearest Mining: Oct-03

	Pre-Mining Data: 19770101 THROUGH 20031001				Post-Mining Data: 20031030 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	574	456	504.375	16	421	343	387.23	13	BICARBONATE
CALCIUM	150	44	59.8625	16	70.84	48.5	57.9692	13	CALCIUM
CARBONATE	0				0	0	0	9	CARBONATE
CHLORIDE	28	9	18.025	16	24	8	14.4615	13	CHLORIDE
CONDUCTIVITY	1298	872	1073.06	16	1249	800	991.538	13	CONDUCTIVITY
DISSOLVED OXYGEN	10.2	6.3	8.25	2	0				DISSOLVED OXYGEN
FLOW	3	0.38	1.436875	16	2.36	0.18	1.11538	13	FLOW
HARDNESS	670	452	566.214	14	679	420	525.384	13	HARDNESS
TOTAL IRON	0.8	0.063	0.4315	2	3.06	0	0.37363	11	TOTAL IRON
DISSOLVED IRON	0.4	0.33	0.365	2	0	0	0	9	DISSOLVED IRON
MAGNESIUM	133	27	98.63125	16	132	65.31	92.4038	13	MAGNESIUM
DISSOLVED MANGANESE	0				0.141	0	1.82222	9	DISSOLVED MANGANESE
MANGANESE	0				0.009	0	0.0009	10	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.14	7.04	7.748125	16	8.23	7.12	7.97692	13	PH
POTASSIUM	12	3	4.3125	16	3.58	2.53	3.03461	13	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	46	18	26.3125	16	25.5	19.18	21.943	13	SODIUM
SULFATE	252	114	184.525	16	256	89	154	13	SULFATE
SUSPENDED SOLIDS	79	1.5	40.25	2	0				SUSPENDED SOLIDS
TEMPERATURE	8.3	6.3	7.51875	16	11.4	7.6	9.15384	13	TEMPERATURE
TOTAL DISSOLVED SOLIDS	810	494	651.625	16	721	470	588.153	13	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

WATER MONITORING STATION WITH FLUME
WATER MONITORING STATION
MONITORING WELL
DRAINAGE DIVIDE
UPDES DISCHARGE LOCATION
UT-0022896-002
TYPICAL GROUND WATER MOVEMENT
WATER MONITORING LOCATIONS

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-084923
EAST MOUNTAIN SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 25, 2018	SHEET 1 OF 1	REV. ___

Location: Section 7, Township 17 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-084923.

Lease Association: Sheba Spring is located within Federal Coal lease UTU-084923. The lease was originally issued effective August 1, 1964. Room and pillar mining began in the Blind Canyon Seam in July 1983 with final production from the lease in June 2005. No mining occurred in vicinity of Sheba Spring.

Subsidence: No subsidence has been detected near Sheba Spring. The 2008 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2005. Sheba Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2008 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Sheba Spring. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1981 and has continued through 2018. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - Sheba Spring is located on south facing hillside vegetated with mountain brush and grass. Spring collection box and trough located adjacent to USFS Forest Development Road #303. Flow from spring 80-50 generally ranges from 0 gpm/seep to a maximum of ~25 gpm.

Geologic Mode of Occurrence for spring Sheba Spring:

- Spring located along the northern fault of the Roan's Canyon fault graben. Water percolating down fractures along the fault within the Flagstaff Formation intersect the North Horn Formation and flows laterally to the surface.
- Geologic Formation: Flagstaff Limestone (refer to Geologic Occurrence sheet).
- Stratigraphic Position: at base.

Justification for removal from monitoring: Sheba Spring has been monitored by PacifiCorp from 1981 through 2018. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in the Deer Creek Mine (federal leases UTU-88554 and adjacent Federal Lease UTU-84285 [Mill Fork area]) ceased as of January 7, 2015 Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Sheba Spring be removed from the monitoring program.

EAST MOUNTAIN

EAST MOUNTAIN & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **Sheba Spring**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1540' S.	500' E.	NW	7	17S	7E	9740

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Flagstaff	Spring box and trough	None	0' above bottom

Location Comments: Spring developed for livestock. Water flows through an underground pipe to a trough.

Probable Recharge Area: Areas of higher elevations to the northwest.

Relationship to Adjacent Springs: Located along the same fault as spring 79-10.

Geologic Occurrence of Spring:

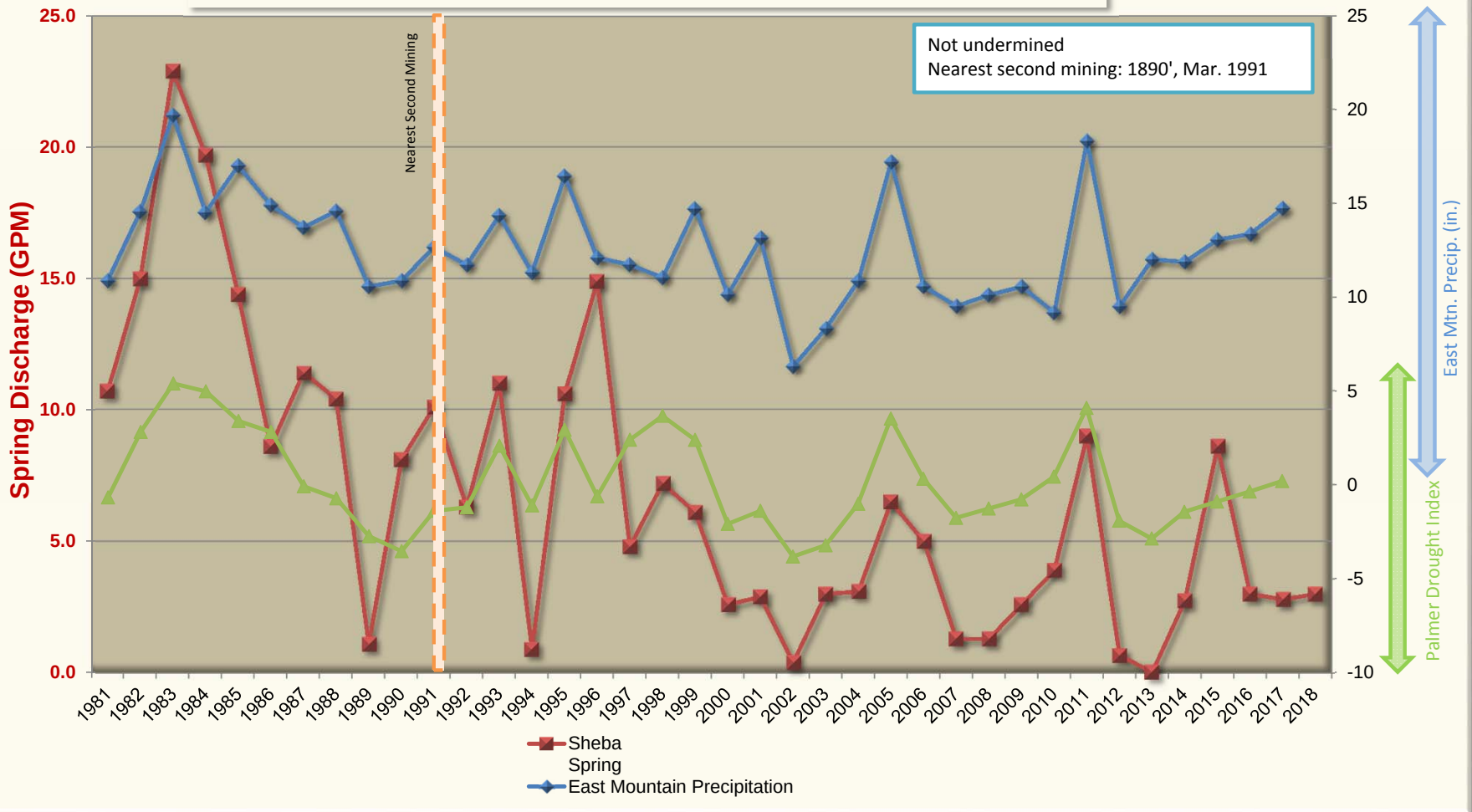
Spring located along the northern fault of the Roan's Canyon fault graben. Water percolating down fractures along the fault within the Flagstaff Formation intersect the North Horn Formation and flows laterally to the surface.

Sheba Spring, May 23, 2018

Sheba Spring Trough, May 23, 2018. Flow rate 3.0 gpm.

EAST MOUNTAIN SPRINGS - EAST MTN. SPRING: Sheba Spring vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



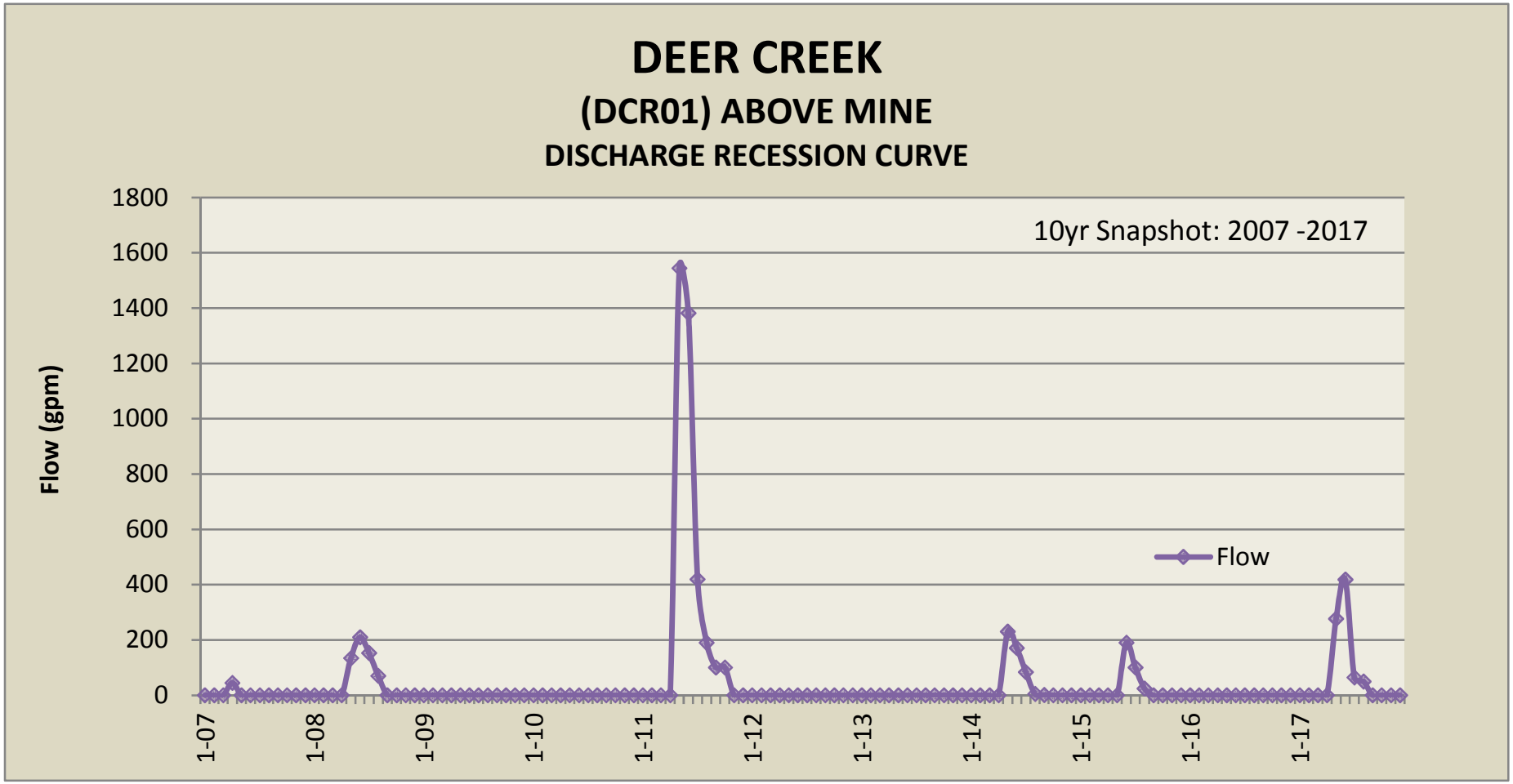
East Mountain Spring: Sheba Springs
Water Quality Data: Operational
Mine Association: Deer Creek Mine - East Mountain
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1890'
Date of Nearest Mining: Mar-91

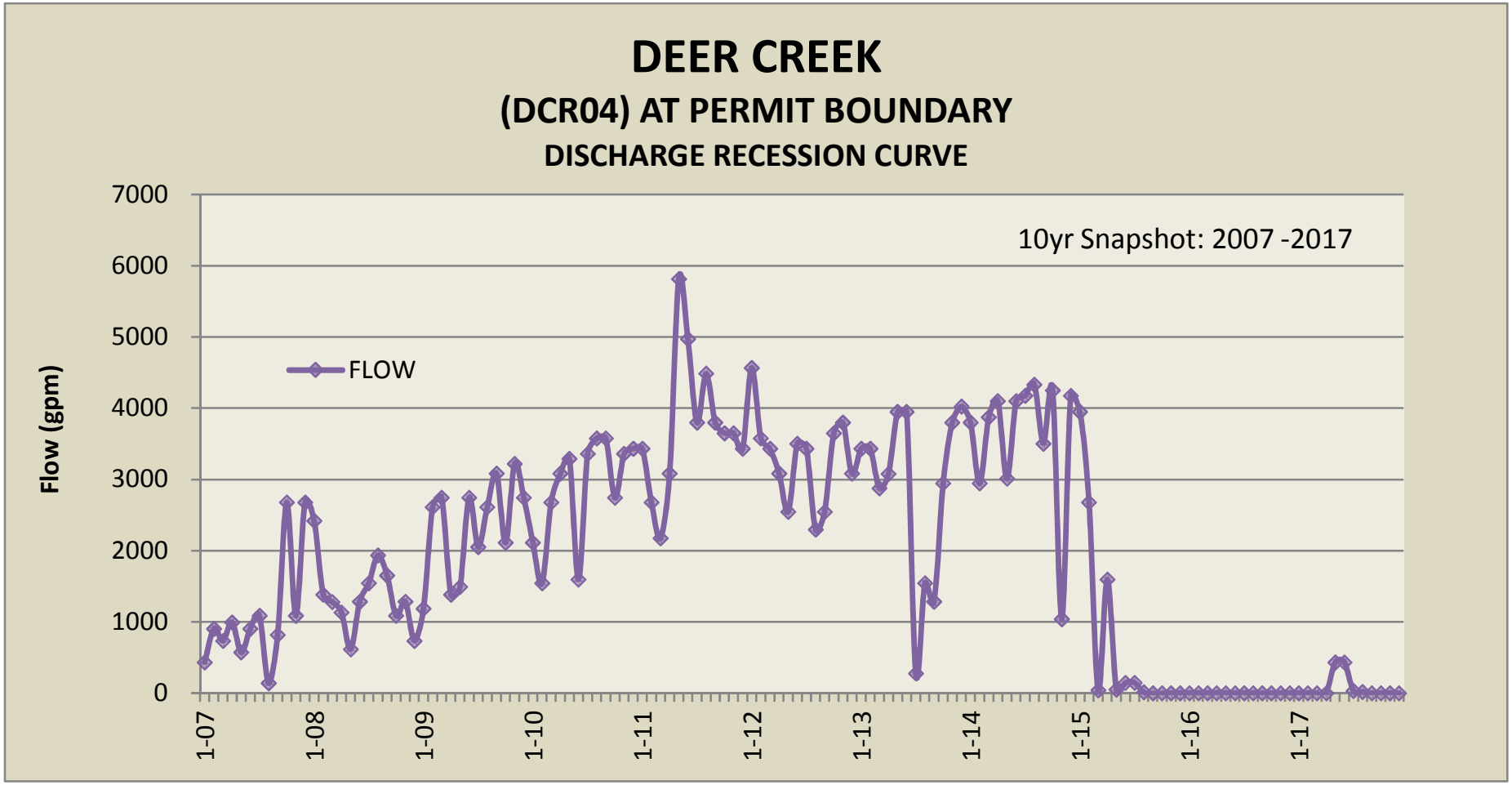
	Pre-Mining Data: 19770101 THROUGH 19910301				Post-Mining Data: 19910331 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	493	234	289.954	22	336	225	278.48	52	BICARBONATE
CALCIUM	137	64.3	89.8037	27	98.4	53.7	81.7456	57	CALCIUM
CARBONATE	1	1	1	18	5	0	0.81481	27	CARBONATE
CHLORIDE	15	2.1	5.15	20	25	0	3.56041	48	CHLORIDE
CONDUCTIVITY	700	230	434.518	27	556	304	467.771	57	CONDUCTIVITY
DISSOLVED OXYGEN	8.6	6.6	7.6625	8	11.6	5.6	8.25555	18	DISSOLVED OXYGEN
FLOW	19.8	0.09	5.23787	33	14.9	0.08	3.15927	55	FLOW
HARDNESS	314	191	250.944	18	296	198	251.803	56	HARDNESS
TOTAL IRON	0				0.36	0	7.7826	23	TOTAL IRON
DISSOLVED IRON	0.8	0.02	0.12454	22	0.2	0	4.23076	26	DISSOLVED IRON
MAGNESIUM	13.2	5.5	9.92074	27	23.16	7.5	11.2368	57	MAGNESIUM
DISSOLVED MANGANESE	0				0.025	0	3.7647	17	DISSOLVED MANGANESE
MANGANESE	0.02	0.01	1.17647	17	0.2	0	4.41612	31	MANGANESE
OIL AND GREASE	1	0.1	0.55	2	0				OIL AND GREASE
PH	8.4	6.95	7.58906	32	8.2	6.8	7.47267	56	PH
POTASSIUM	9	0.01	1.606	20	18	0	1.39296	27	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	14	1.61	5.562	20	5	0.64	3.25803	51	SODIUM
SULFATE	181	1	32.85	22	14	3	5.11176	51	SULFATE
SUSPENDED SOLIDS	15	0.1	4.36956	23	13	1	5.5	8	SUSPENDED SOLIDS
TEMPERATURE	49	3.3	24.3037	27	53.6	5.1	18.6762	54	TEMPERATURE
TOTAL DISSOLVED SOLIDS	392	212	265.217	23	320	204	264.647	51	TOTAL DISSOLVED SOLIDS

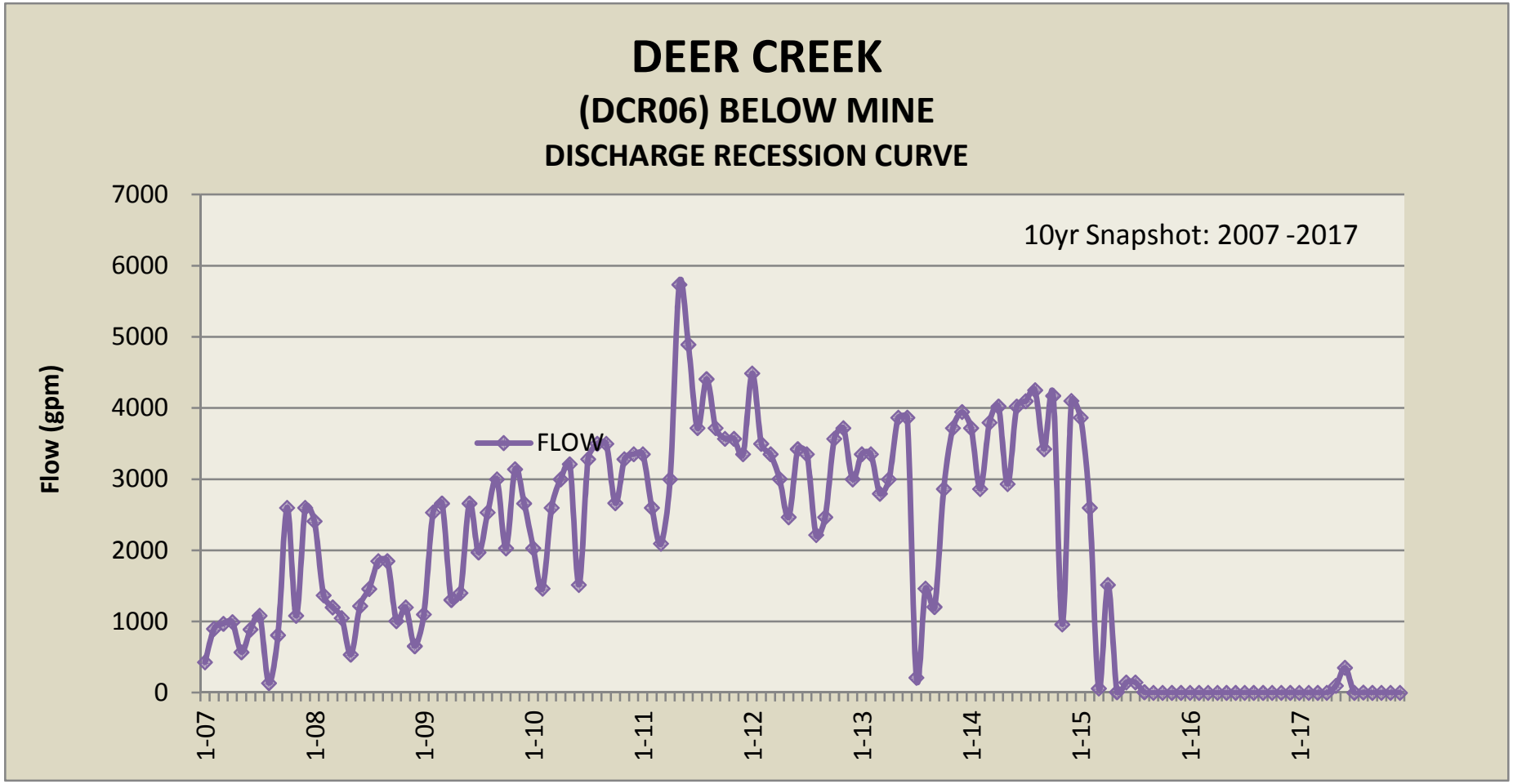
Volume 9
Deer Creek Mine C/015/0018
Amendment to Reduce Hydrologic Monitoring Program

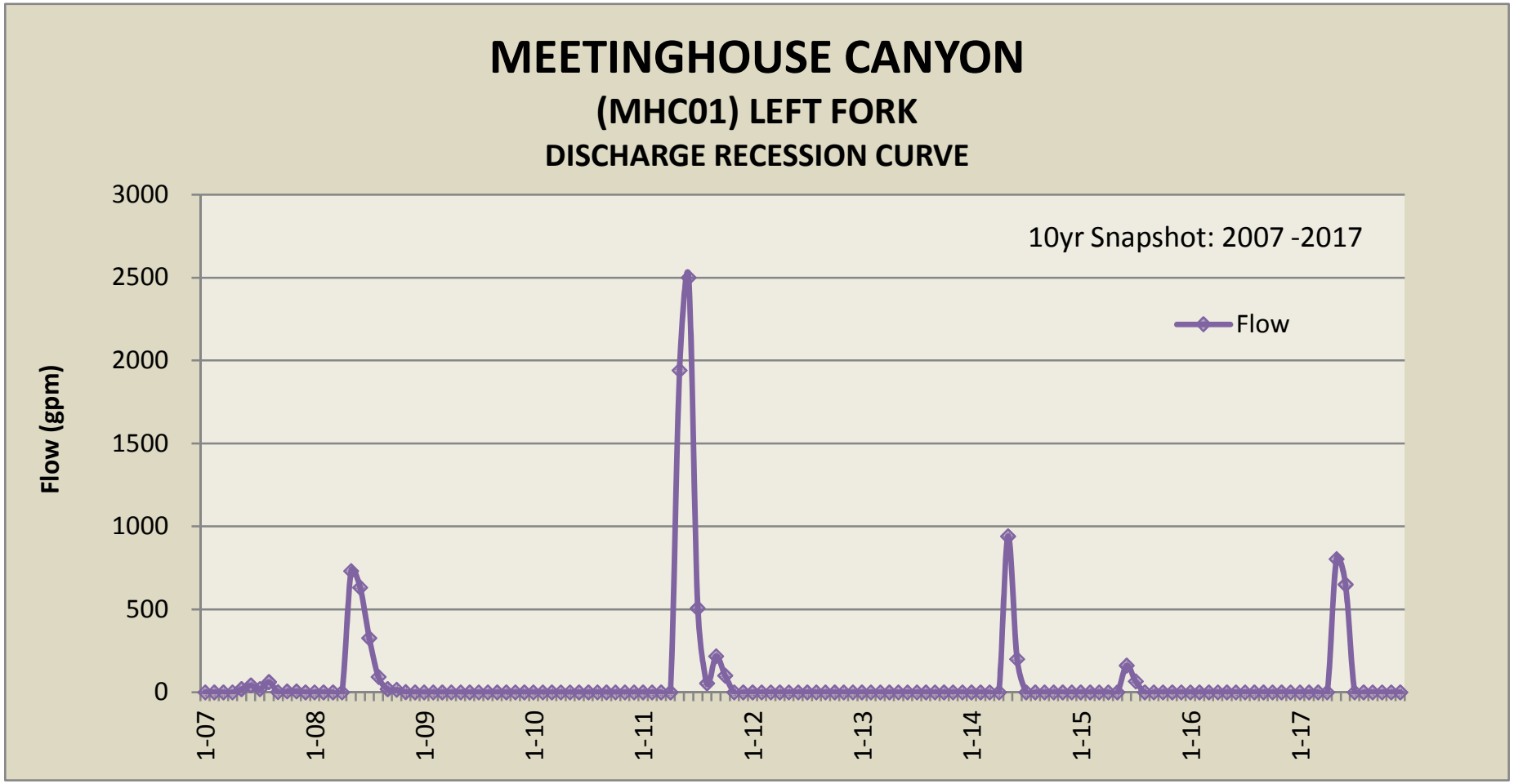
<u>Surface Water Assessment:</u>
Federal Lease UTU-88554 Surface Water Monitoring Sites

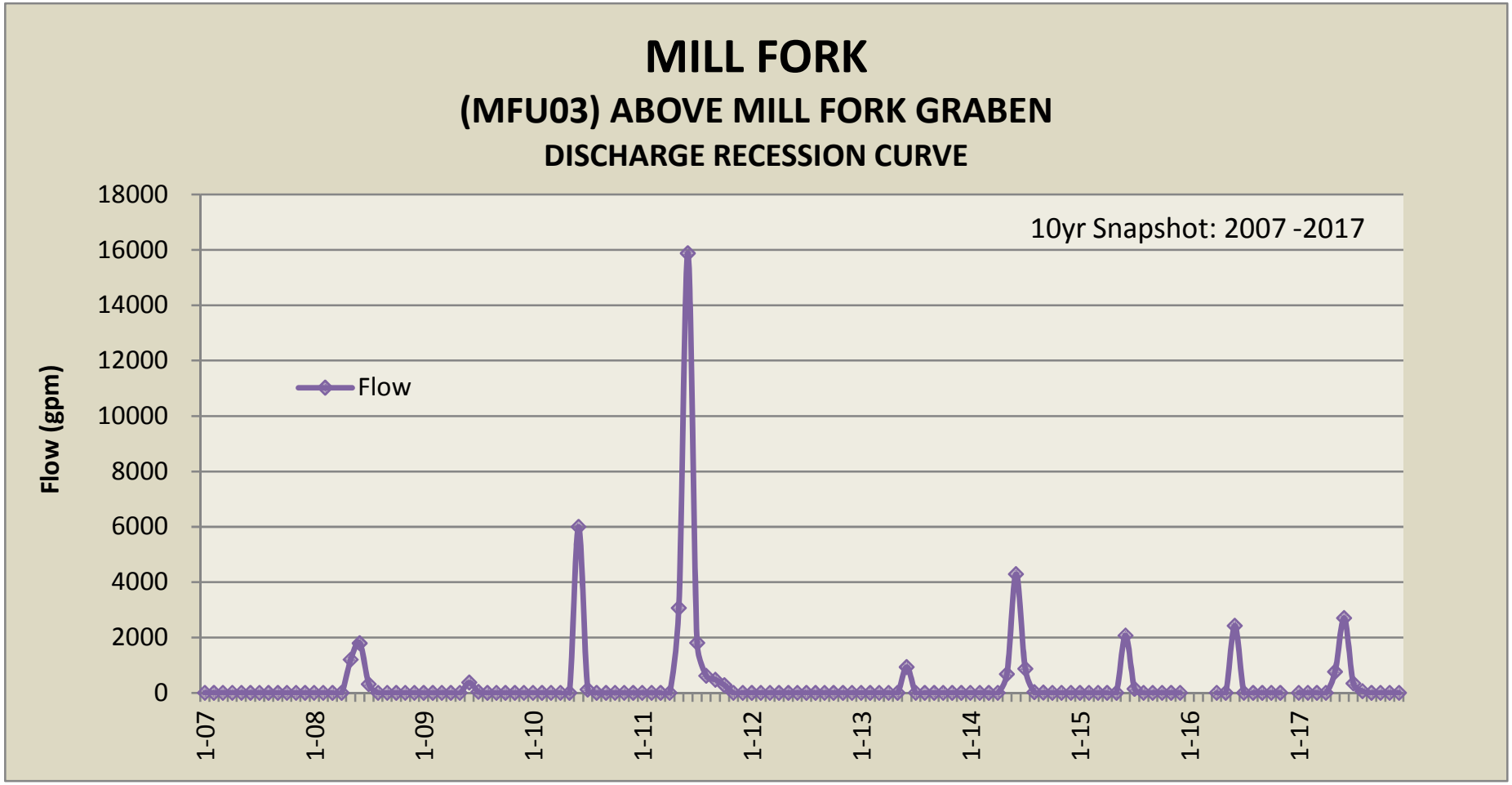
- Surface Monitoring Site Flow
- Surface Monitoring Site Quality

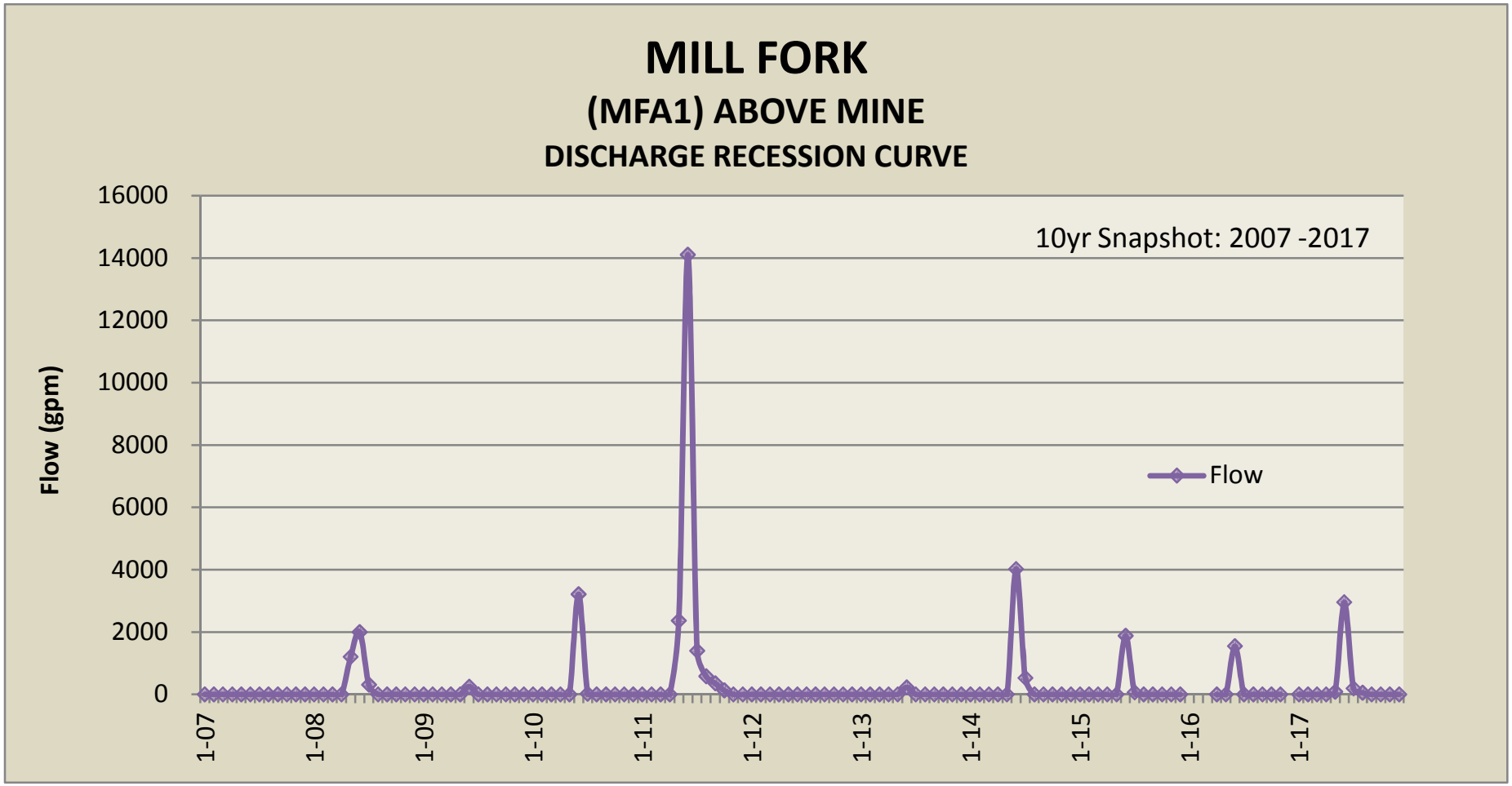

DEER CREEK
(DCR01) ABOVE MINE
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow (gpm)
1800
1600
1400
1200
1000
800
600
400
200
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17
Flow

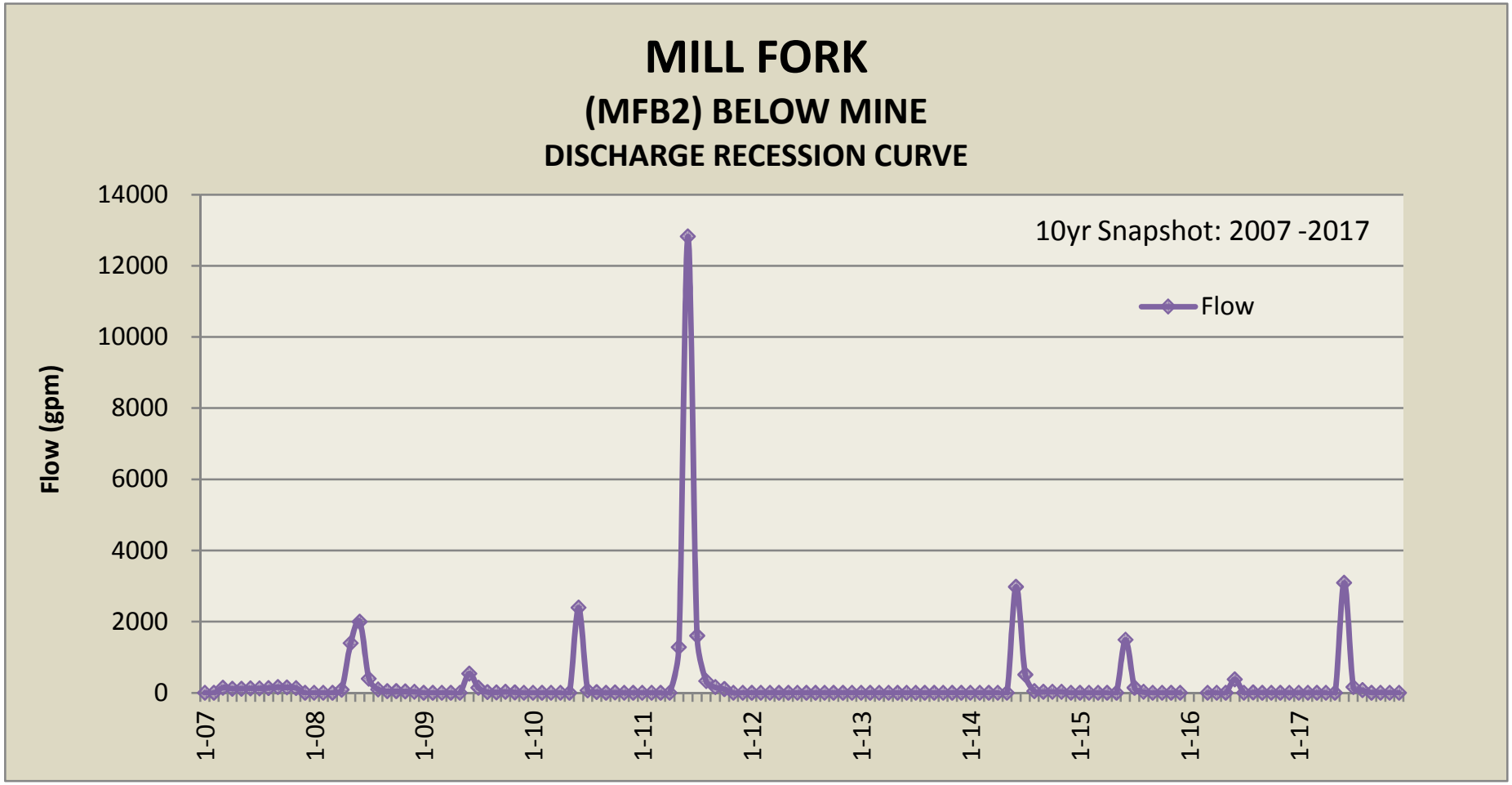

DEER CREEK
(DCR04) AT PERMIT BOUNDARY
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
FLOW
Flow (gpm)
7000
6000
5000
4000
3000
2000
1000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

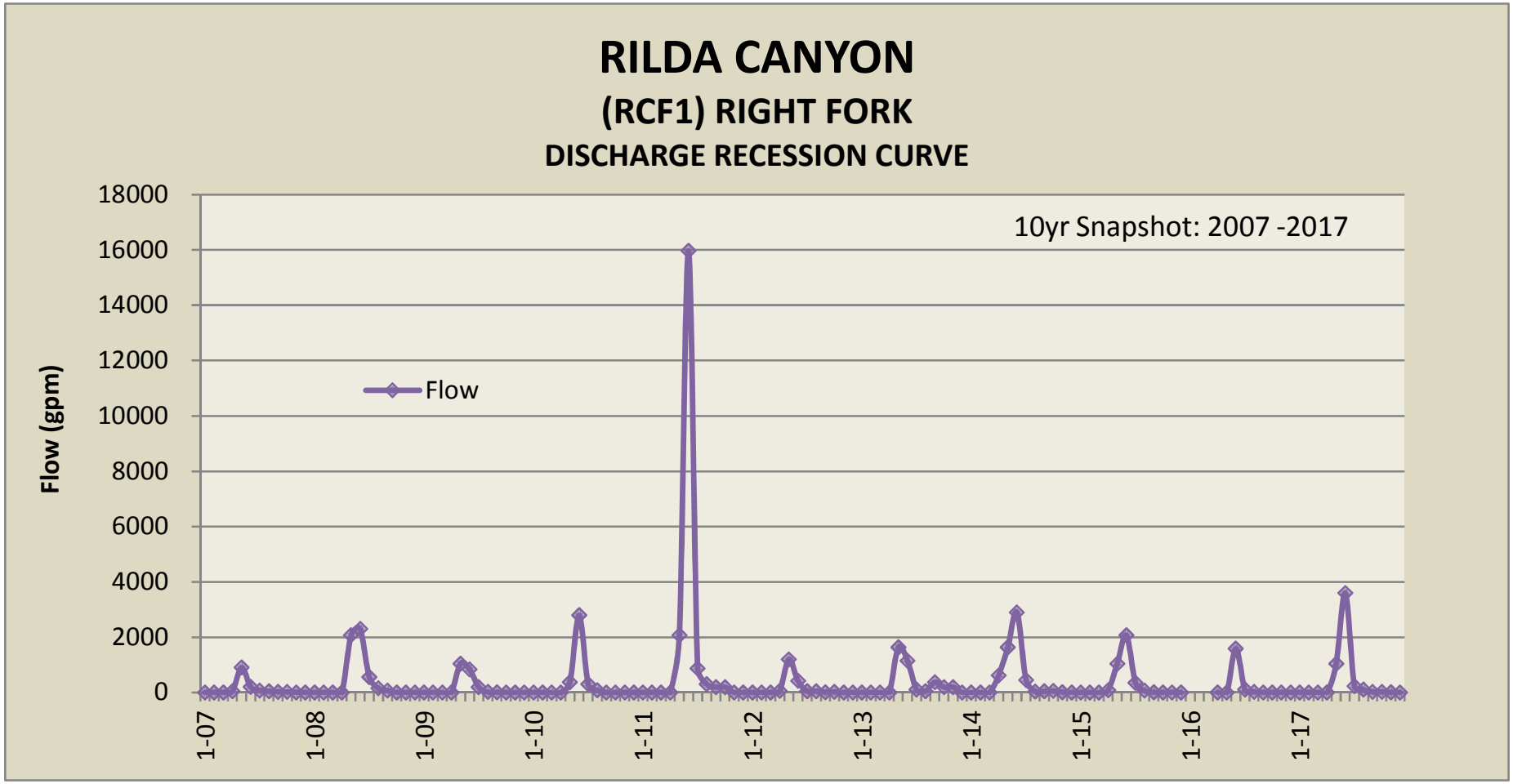

DEER CREEK
(DCR06) BELOW MINE
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow (gpm)
7000
6000
5000
4000
3000
2000
1000
0
FLOW
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

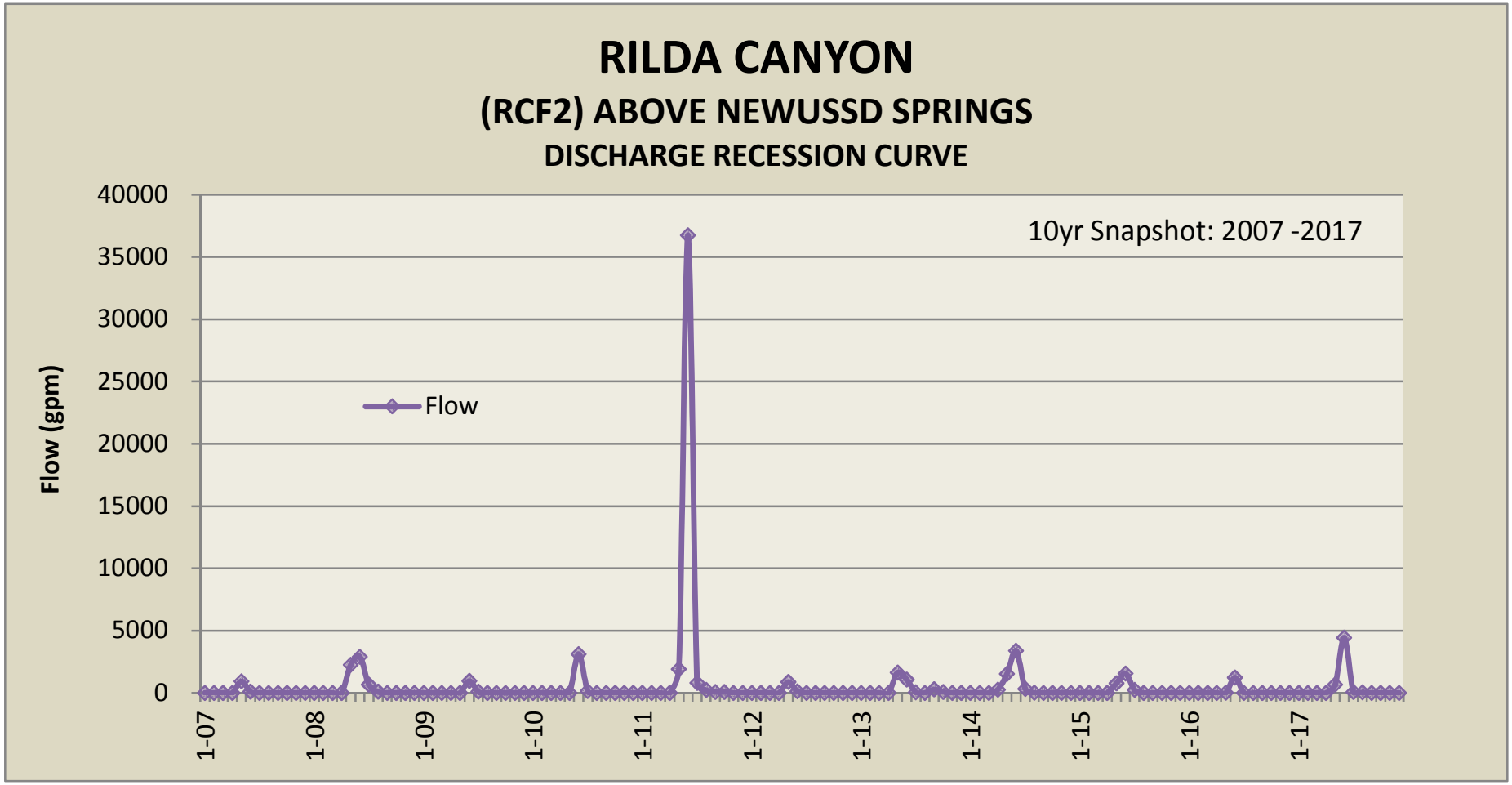

MEETINGHOUSE CANYON
(MHC01) LEFT FORK
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
3000
2500
2000
1500
1000
500
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

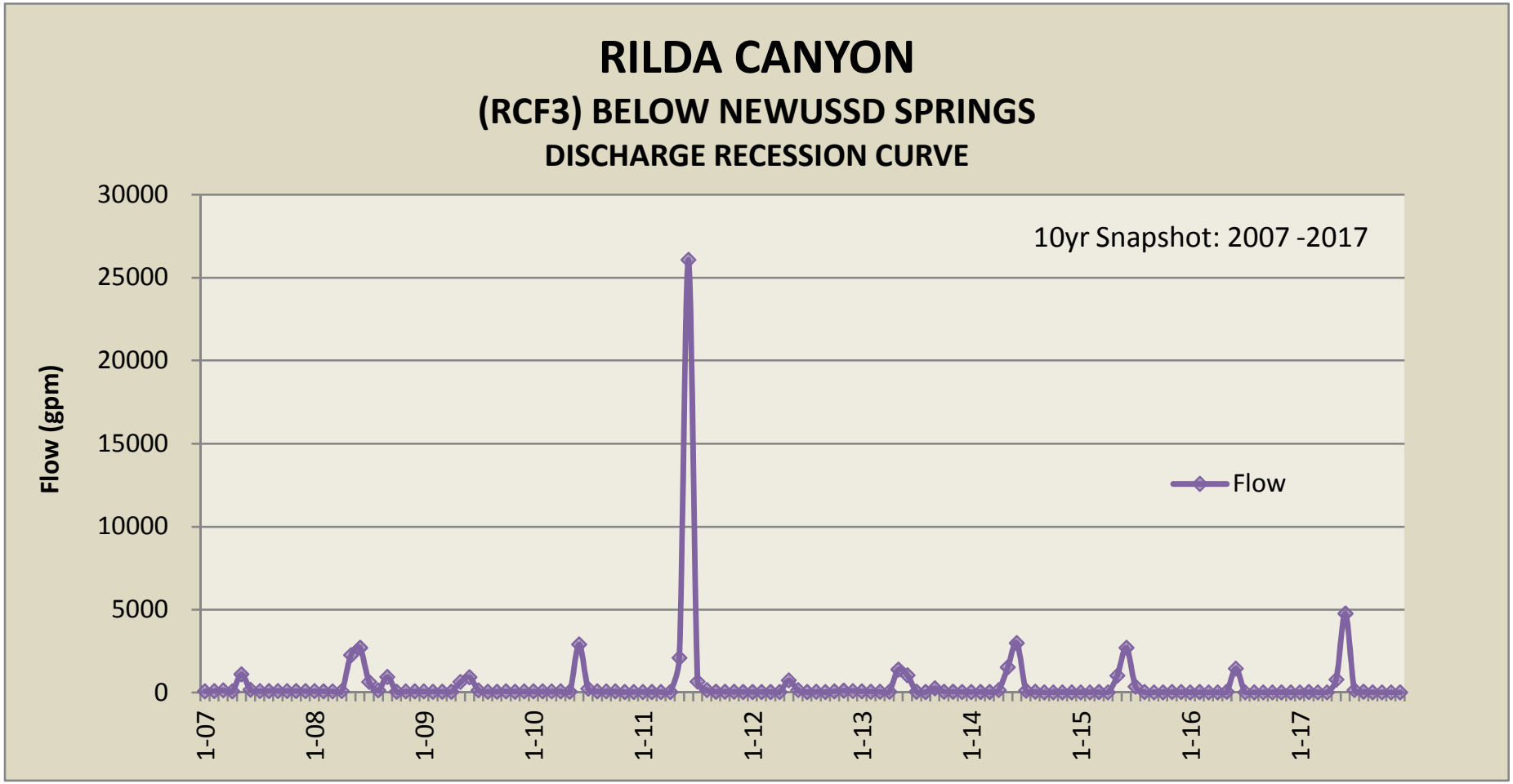

MILL FORK
(MFU03) ABOVE MILL FORK GRABEN
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

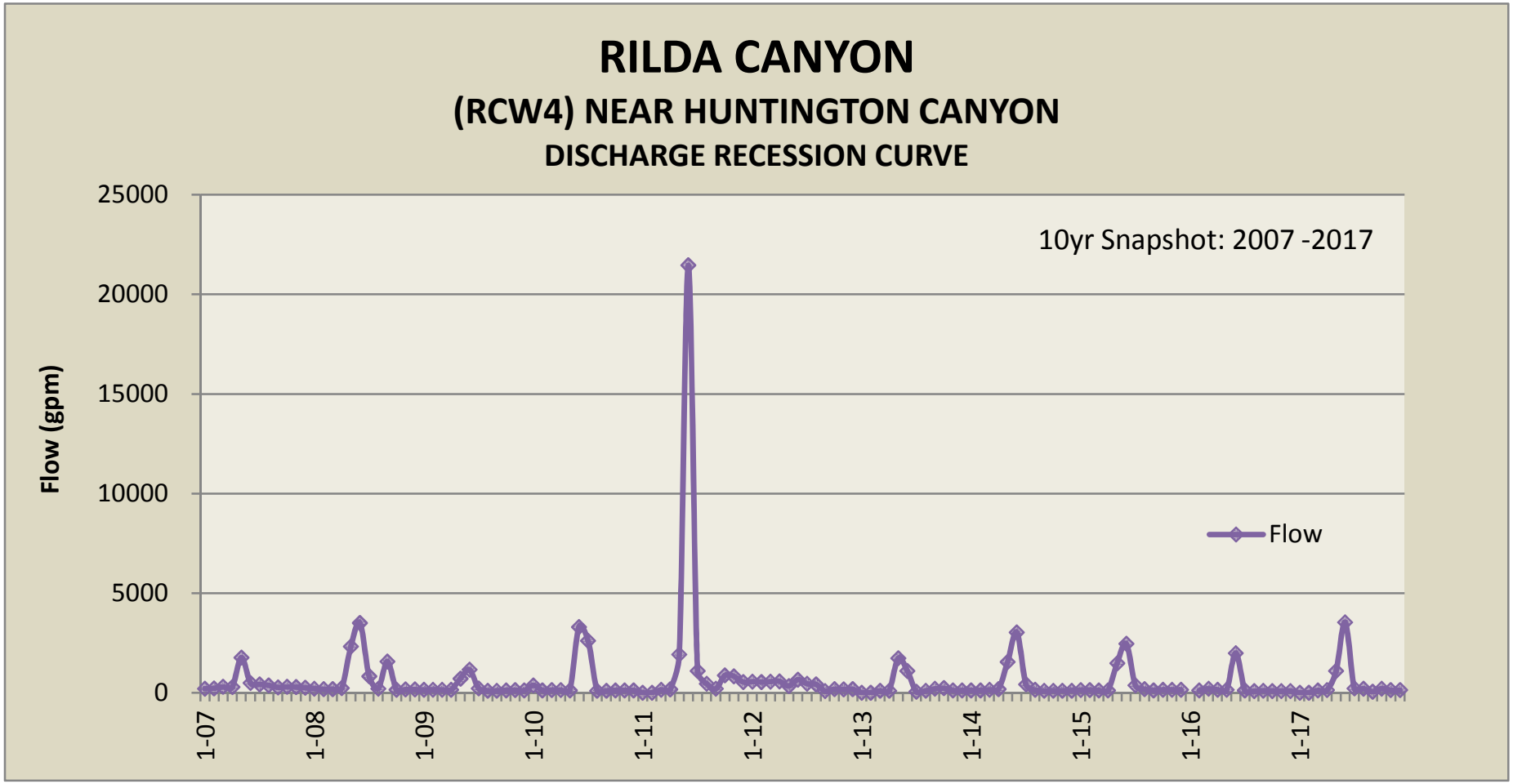

MILL FORK
(MFA1) ABOVE MINE
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
16000
14000
12000
10000
8000
6000
4000
2000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

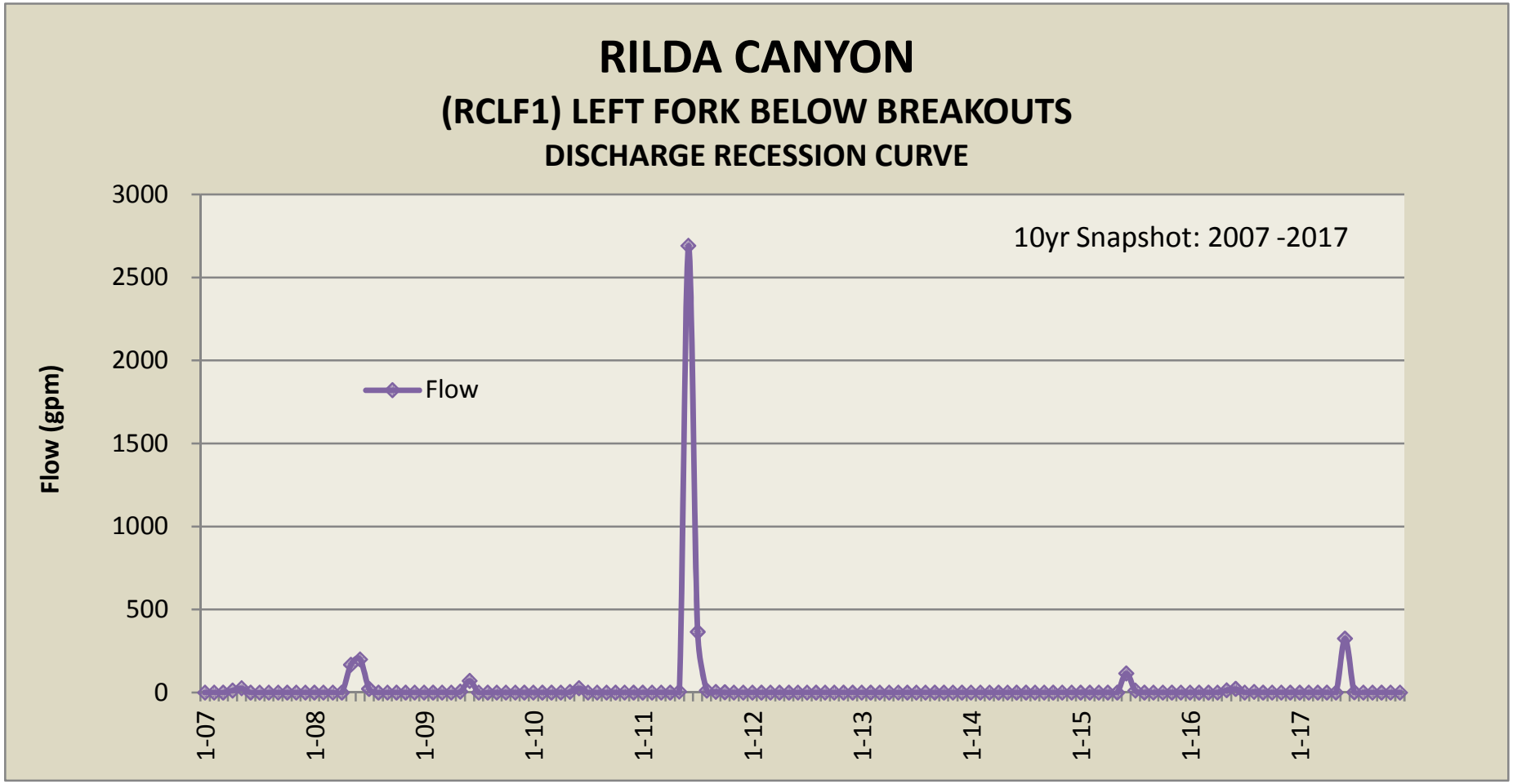

MILL FORK
(MFB2) BELOW MINE
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
14000
12000
10000
8000
6000
4000
2000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

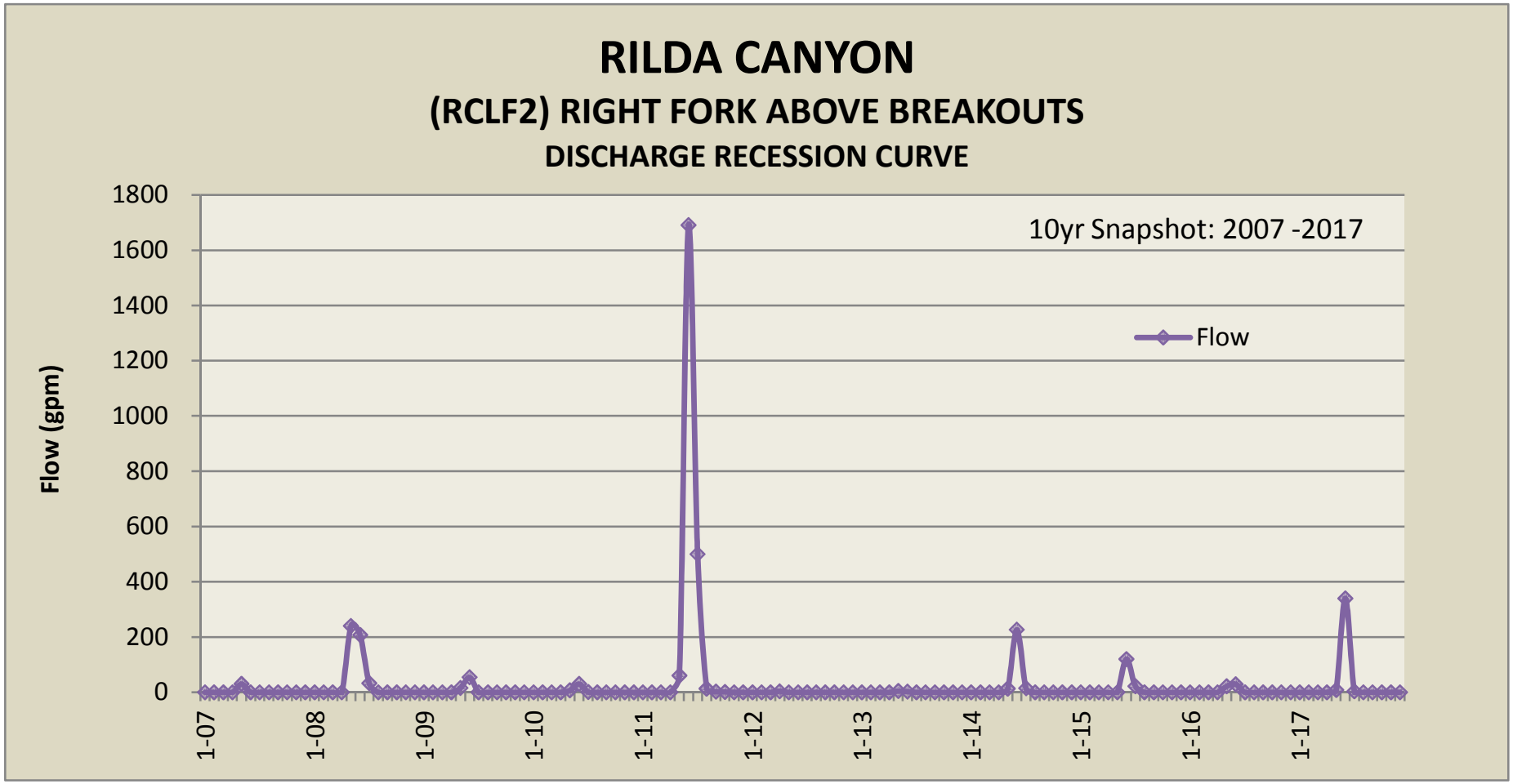

RILDA CANYON
(RCF1) RIGHT FORK
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

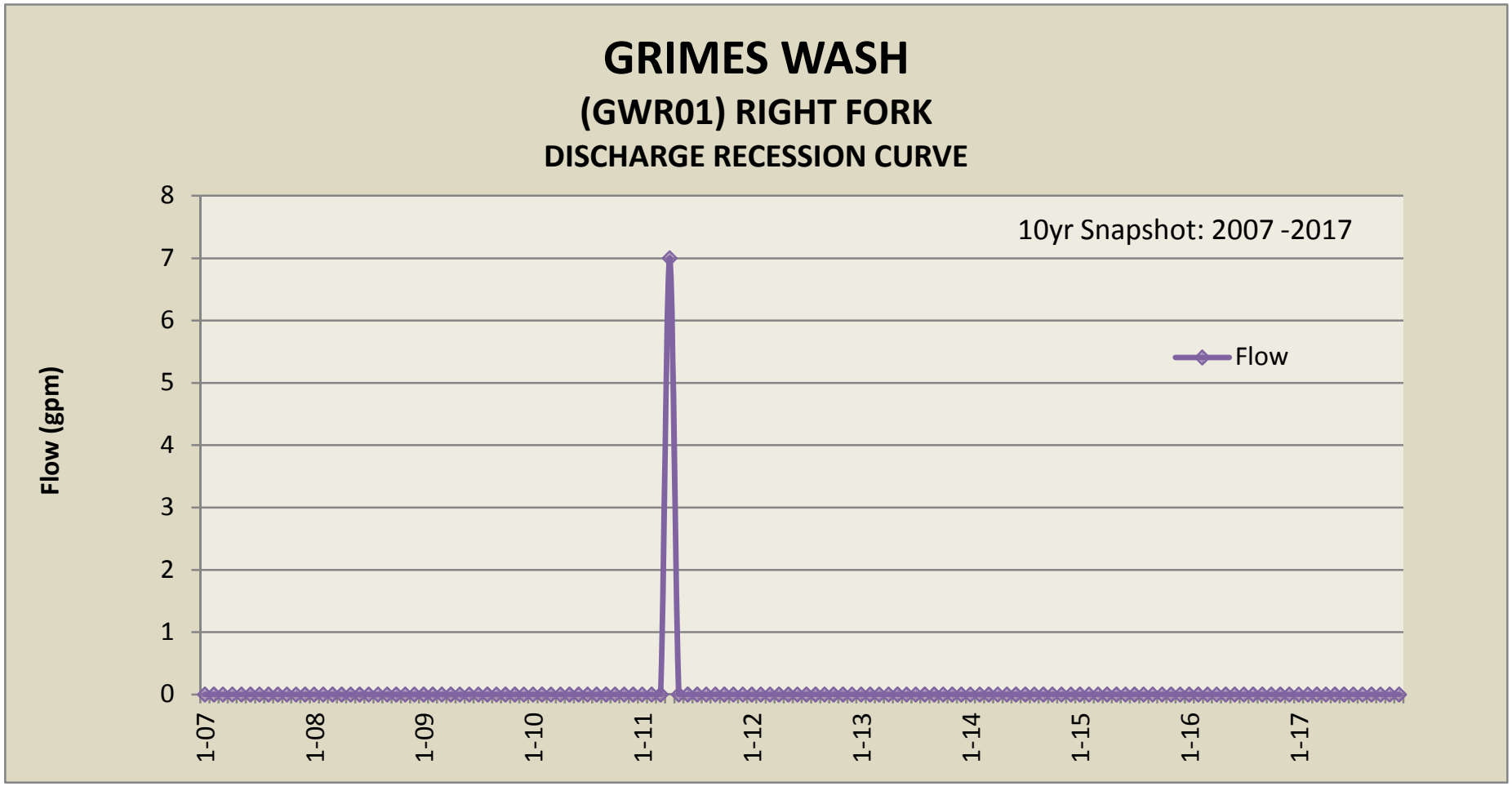

RILDA CANYON
(RCF2) ABOVE NEWUSSD SPRINGS
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
40000
35000
30000
25000
20000
15000
10000
5000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17

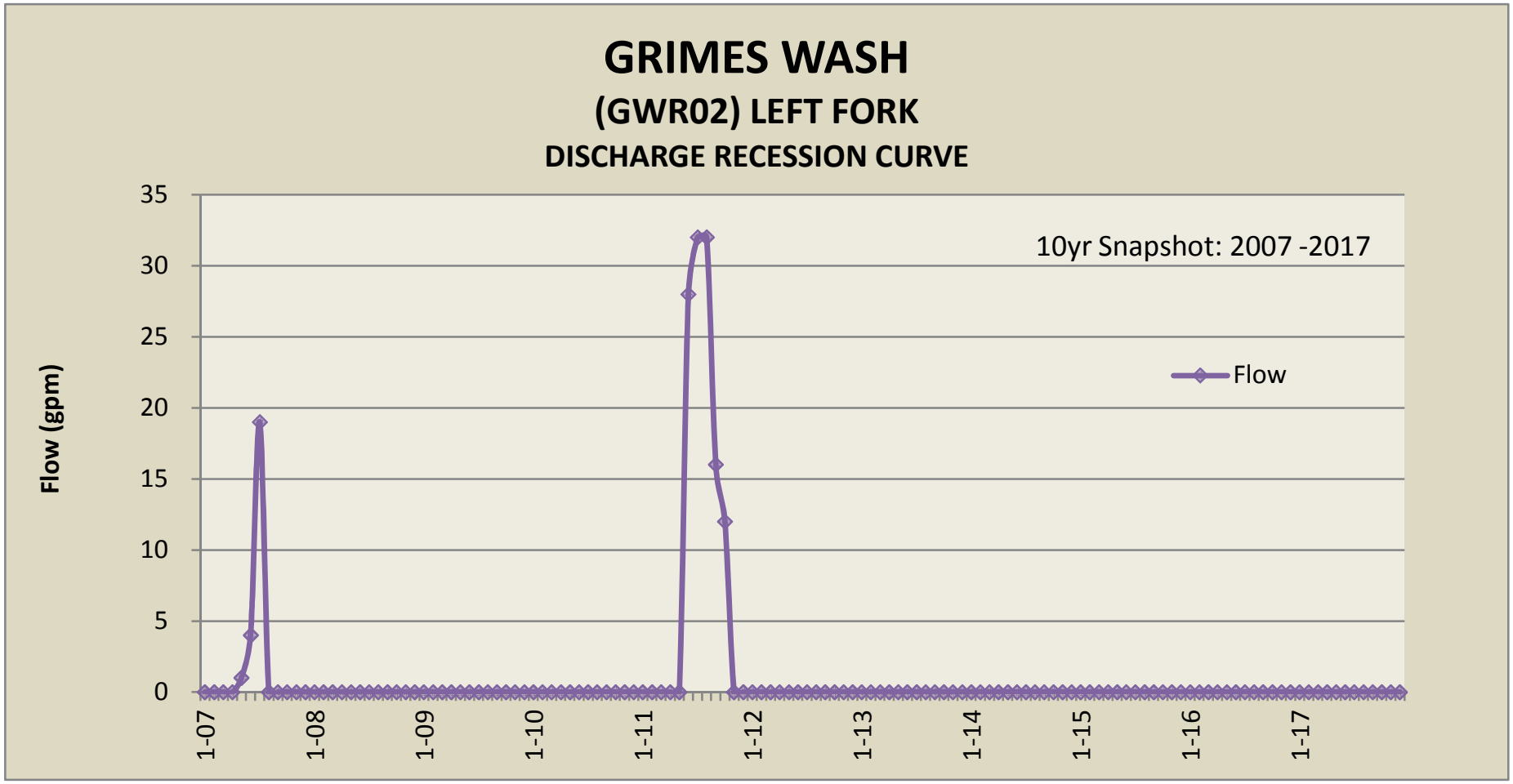

RILDA CANYON
(RCF3) BELOW NEWUSSD SPRINGS
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow (gpm)
30000
25000
20000
15000
10000
5000
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17
Flow

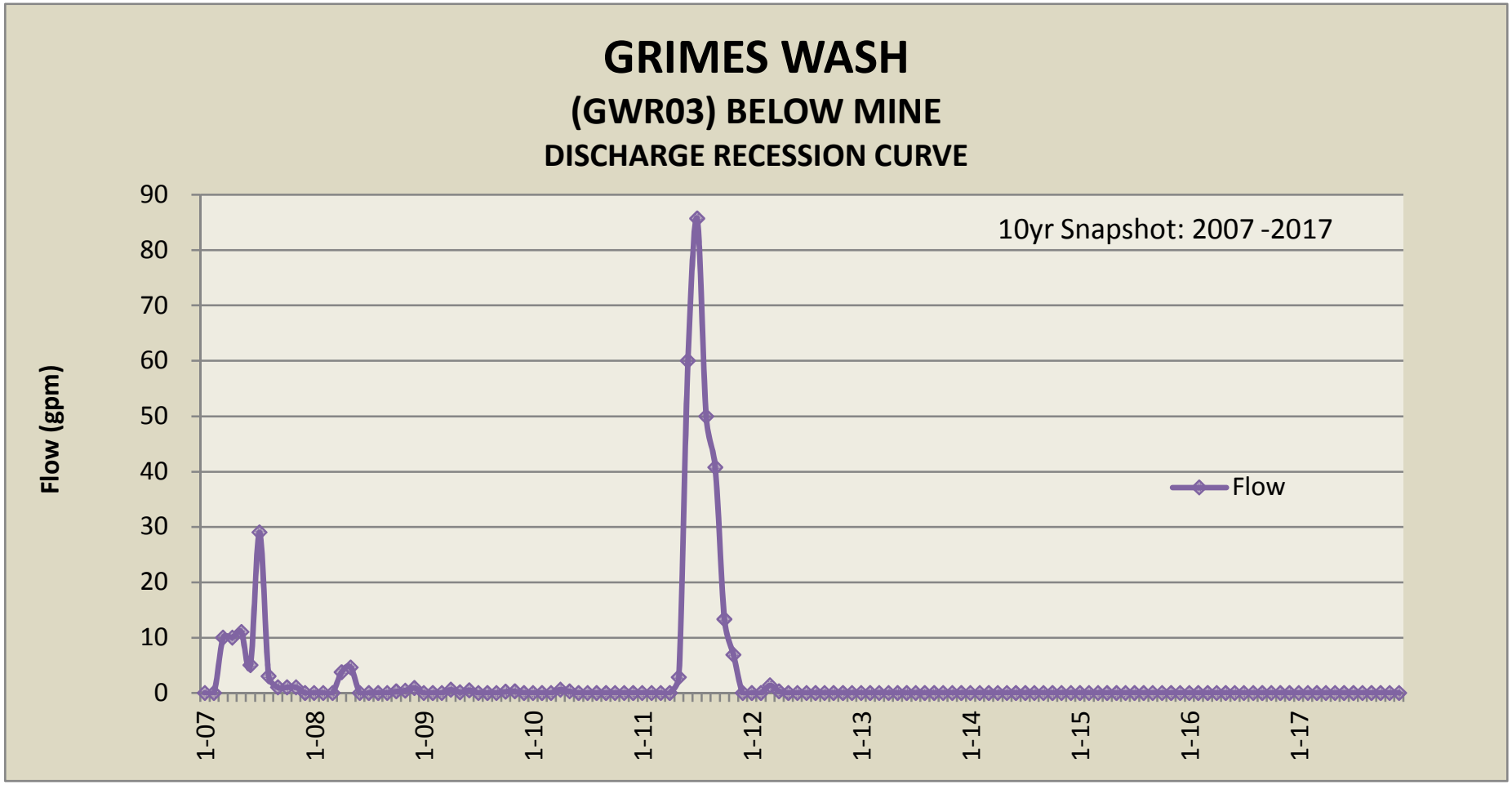

RILDA CANYON
(RCW4) NEAR HUNTINGTON CANYON
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow (gpm)
25000
20000
15000
10000
5000
0
Flow
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17


RILDA CANYON
(RCLF1) LEFT FORK BELOW BREAKOUTS
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
3000
2500
2000
1500
1000
500
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17


RILDA CANYON
(RCLF2) RIGHT FORK ABOVE BREAKOUTS
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
1800
1600
1400
1200
1000
800
600
400
200
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17


GRIMES WASH
(GWR01) RIGHT FORK
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
0
1
2
3
4
5
6
7
8
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17


GRIMES WASH
(GWR02) LEFT FORK
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow
Flow (gpm)
35
30
25
20
15
10
5
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17


GRIMES WASH
(GWR03) BELOW MINE
DISCHARGE RECESSION CURVE
10yr Snapshot: 2007 -2017
Flow (gpm)
90
80
70
60
50
40
30
20
10
0
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17
Flow

HUNTINGTON CREEK WATER QUALITY *

HCC01 - ABOVE POWER PLANT

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	DISSOLVED OXYGEN	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170314	0.0	221	64.7	9.0	38.0	646	7.60	285.00	0.6	0.00	29.99	0.01	0.0	8.4	2.34	19.64	71	82	352
20170608	0.0	161	48.7	0.0	6.0	342	9.80	173.00	0.6	0.00	12.41	0.00	0.0	8.5	0.9	4.18	13	106	193
20170907	0.0	162	43.6	8.0	8.0	384	10.60	165.00	0.21	0.00	13.7	0.00	0.00	8.59	1.3	6.4	25	13	231
20171206	0.0	238	66.2	0.0	15.0	591	15.90	295.00	0.15	0.00	31.6	0.01	0.00	8.36	2.4	12.6	56	0	370
No. of Analysis	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2017**																			
MIN	0	161	44	0	6	342	8	165	0	0	12	0	0	8	1	4	13	0	193
MAX	0	238	66	9	38	646	16	295	1	0	32	0	0	9	2	20	71	106	370
MEAN	0	196	56	4	17	491	11	230	0	0	22	0	0	8	2	11	41	50	287
2016**																			
MIN	0	156	44	0	5	338	8	175	0	0	13	0	0	8	0	3	16	8	213
MAX	0	233	60	10	17	557	11	264	1	0	28	0	0	9	2	12	59	88	317
MEAN	0	189	55	3	11	440	9	226	0	0	21	0	0	8	1	8	36	40	261
MIN	0	155	45	0	5	358	9	174	0	0	15	0	0	8	1	4	18	0	200
MAX	0	220	55	0	15	521	9	246	1	0	26	0	0	9	2	12	51	323	327
MEAN	0	193	51	0	10	435	9	211	1	0	20	0	0	8	1	9	35	101	274
2014**																			
MIN	0	186	52	0	4	386	0	190	0	0	14	0	0	8	1	4	18	23	223
MAX	0	233	65	0	19	662	0	289	1	0	31	0	0	9	2	20	85	108	365
MEAN	0	204	58	0	12	504	0	238	0	0	23	0	0	8	2	11	46	62	289
2013**																			
MIN	0	162	51	0	5	384	0	191	0	0	15	0	0	8	1	5	20	13	203
MAX	0	208	62	9	13	546	0	272	2	0	29	0	0	9	2	13	51	161	307
MEAN	0	186	58	2	10	455	0	232	1	0	21	0	0	9	1	9	35	70	253
2012**																			
MIN	0	143	48	0	5	327	0	167	0	0	11	0	0	8	1	5	12	8	183
MAX	0	251	73	10	16	602	0	320	1	0	34	0	0	9	2	13	61	85	329
MEAN	0	183	58	3	10	435	0	230	0	0	21	0	0	9	1	8	33	29	243
2011**																			
MIN	0	143	48	0	5	327	0	167	0	0	11	0	0	8	1	5	12	8	183
MAX	0	251	73	10	16	602	0	320	1	0	34	0	0	9	2	13	61	85	329
MEAN	0	183	58	3	10	435	0	230	0	0	21	0	0	9	1	8	33	29	243
2010**																			
MIN	0	155	45	0	3	321	8.80	164	0.09		11.55	0.00		8.47	0.73	4	13	9	188
MAX	0	211	62	15	15	539	11.00	272	1.43		28.86	0.00		8.61	1.70	14	58	128	322
MEAN	0	181	54	4	9	431	9.63	219	0.48		20.27	0.00		8.53	1.25	8	35	50	257
2009**																			
MIN	0	154	47	0	5	358	8	189	0		14	0		8	1	4	19	5	219
MAX	0	218	65	7	16	563	9	289	0		31	0		9	2	13	59	13	341
MEAN	0	184	56	3	10	454	9	235	0		23	0		9	1	9	40	10	278
2008**																			
MIN		144	52.7	0.0	4.0	361	7.80	185	0.12		12.94	0.01		8.34	0.78	3.89	15.0	0.0	229
MAX		216	65.8	15.0	20.0	630	15.10	306	1.05		34.36	0.07		8.60	2.08	15.49	83.0	11.0	399
MEAN		181	58.5	7.7	11.0	498	10.73	243	0.39		23.53	0.03		8.51	1.52	9.11	45.8	5.7	296
2007**																			
MIN		152	49	8	5	401	10.89	188	0.13		16	0.01		8.23	0.70	4	18	13	193
MAX		207	61	8	12	599	13.12	260	0.30		27	0.03		8.51	1.68	11	54	19	301
MEAN		181	56	8	9	486	11.80	226	0.23		21	0.02		8.40	1.39	7	36	15	250
2006**																			
MIN		157	47		5	387	11.61	177	0.12		14	0.00		7.99	0.75	4	19	8	209
MAX		233	73		20	701	14.32	324	8.77		35	0.02		8.43	1.93	18	85	969	467
MEAN		198	61		11	531	13.17	252	2.34		24	0.01		8.19	1.32	10	47	251	306
HISTORICAL 1990-2016																			
MIN	0.0	126.0	32.7	0.0	1.0	210.0	3.8	118.0	0.0	0.0	9.0	0.0	0.0	7.1	0.0	1.0	2.0	0.0	134.0
MAX	25.0	400.0	102.6	38.0	45.0	701.0	15.1	392.0	13.3	0.3	44.7	0.3	7.0	8.9	5.0	55.0	130.0	969.0	467.0
MEAN	3.5	210.5	56.4	4.2	11.7	418.5	8.7	222.4	0.5	0.1	19.8	0.0	1.6	8.4	1.4	8.3	32.9	35.7	243.7
COUNT	96	143	143	104	142	153	129	143	132	93	143	107	89	153	125	142	143	145	153

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

HUNTINGTON CREEK WATER QUALITY *

HCC02 - @ POWER PLANT (BELOW DEER CREEK CONFLUENCE)

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	DISSOLVED OXYGEN	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170314	0.0	222	65.8	9.0	35.0	641	7.90	288.00	0.7	0.00	30.12	0.01	0.0	8.3	2.37	20	62	76	357
20170608	0.0	161	45.1	0.0	6.0	346	9.90	160.00	0.6	0.00	11.59	0.00	0.0	8.5	0.88	4.14	13	133	192
20170907	0.0	159	47.8	9.0	9.0	383	10.70	181.00	0.22	0.00	15.0	0.00	0.00	8.62	1.4	6.8	25	13	223
20171206	0.0	235	64.8	0.0	16.0	590	15.70	282.00	0.13	0.00	29.1	0.01	0.00	8.31	2.5	13.5	56	6	381
No. of Analysis	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
2017																			
MIN	0	159	45	0	6	346	8	160	0	0	12	0	0	8	1	4	13	6	192
MAX	0	235	66	9	35	641	16	288	1	0	30	0	0	9	2	20	62	133	381
MEAN	0.00	194.25	55.84	4.50	16.50	490.00	11.05	227.75	0.41	0.00	21.45	0.00	0.00	8.45	1.79	11.12	39.00	57.00	288.25
2016																			
MIN	0	148	46	0	5	341	8	170	0	0	14	0	0	8	0	4	17	0	206
MAX	0	229	62	7	17	566	11	263	1	38	28	0	0	9	2	14	67	82	330
MEAN	0	188	55	2	11	445	9	223	0	9	21	0	0	8	1	9	39	39	259
2015																			
MIN	0	156	44	0	5	349	9	163	0	0	13	0	0	8	1	5	17	0	206
MAX	0	218	59	0	17	525	9	255	3	0	27	0	0	10	2	13	56	295	356
MEAN	0	192	52	0	10	436	9	215	1	0	20	0	0	9	1	9	35	95	283
2014																			
MIN	0	181	52	0	5	402	0	196	0	0	15	0	0	8	1	5	21	14	236
MAX	0	243	61	0	31	757	0	296	1	0	35	0	0	9	3	32	101	138	426
MEAN	0	206	57	0	18	553	0	246	0	0	25	0	0	9	2	17	56	71	321
2013**																			
MIN	0	160	51	0	6	391	0	192	0	0	16	0	0	8	1	6	23	12	209
MAX	0	207	62	0	27	597	0	274	2	0	29	0	0	9	3	23	64	156	348
MEAN	0	186	57	0	17	494	0	236	1	0	23	0	0	9	2	14	41	68	273
2012**																			
MIN	0	171	54	0	7	388	0	203	0	0	17	0	0	8	1	8	24	0	226
MAX	0	209	62	31	29	711	0	303	1	0	39	0	0	9	4	37	96	119	399
MEAN	0	192	57	11	17	524	0	247	0	0	25	0	0	9	2	18	50	46	301
2011**																			
MIN	0.0	148.0	49.3	0.0	6.0	332.0	0.0	172.0	0.2	0.0	11.9	0.0	0.0	8.5	0.8	5.3	13.0	0.0	191.0
MAX	0.0	251.0	70.6	19.0	18.0	660.0	0.0	331.0	1.3	0.0	37.6	0.0	0.0	8.6	2.9	21.7	82.0	98.0	382.0
MEAN	0.0	184.5	58.1	4.8	11.8	464.5	0.0	237.0	0.4	0.0	22.3	0.0	0.0	8.5	1.7	11.9	41.0	33.0	265.8
2010**																			
MIN	0	150	47	0	4	326	8.70	170	0.09		12	0.00		8.48	0.80	4	14	6	194
MAX	0	221	59	21	36	687	10.90	291	1.62		35	0.00		8.62	3.54	36	85	134	414
MEAN	0	185	53	5	17	496.5	9.65	226	0.52		23	0.00		8.55	2.11	18	48	45	293
2009**																			
MIN	0	155	47	0	7	370	8	194	0		15	0		8	1	6	22	10	229
MAX	0	227	64	9	33	686	9	306	0		35	0		9	3	28	78	17	422
MEAN	0	189	56	2	17	516	8	246	0		26	0		9	2	16	53	14	319
2008**																			
MIN									0.12			0.00			0.92				
MAX		227	64	9	33	686	9.20	306	4.00		35			8.61	4.00	28	78	17	422
MEAN		144	43	4	15	393.875	7.42	187.4375	1.14		20	1.00		7.39	2.50	13	39	11	243
2007**																			
MIN		158	48	10	5	412	10.15	185	0.14		16	0.01		8.27	1	4	19	8	192
MAX		215	61	10	22	681	14.04	270	0.24		29	0.03		8.56	2	19	66	15	330
MEAN		187	55	10	12	514.75	11.83	228.5	0.19		22	0.02		8.41	2	10	40	11	261
2006**																			
MIN		157	47		6	400	11.50	179	0.10		15	0.00		8.07	1	5	20	8	215
MAX		235	73		76	899	14.31	332	11.93		36	0.01		8.48	2	51	86	1420	498
MEAN		200	61		27	596.5	13.31	258.25	3.10		25	0.01		8.31	1	20	48	363	318
HISTORICAL 1990-2016																			
MIN	0.0	148.0	32.0	0.0	1.0	210.0	3.8	129.0	0.0	0.0	8.0	0.0	0.0	7.1	0.0	1.0	4.0	0.0	161.0
MAX	33.0	310.0	91.7	37.0	76.0	899.0	15.0	448.0	11.9	37.8	39.9	1.0	5.1	9.5	5.0	51.2	150.0	1420.0	498.0
MEAN	3.53	213.72	57.54	4.10	15.21	457.13	8.65	233.56	0.51	0.47	21.46	0.05	1.49	8.43	1.70	11.51	40.96	40.35	268.28
COUNT	94	141	141	109	140	151	128	141	133	93	141	105	90	151	123	141	141	145	151

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

HUNTINGTON CREEK WATER QUALITY *

HCC04 - @ RESEARCH FARM

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	DISSOLVED OXYGEN	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170314	0.0	222	65.8	9.0	35.0	641	7.90	288.00	0.7	0.00	30.12	0.01	0.0	8.3	2.37	20	62	76	357
20170608	0.0	161	45.1	0.0	6.0	346	9.90	160.00	0.6	0.00	11.59	0.00	0.0	8.5	0.88	4.14	13	133	192
20170907	0.0	159	47.8	9.0	9.0	383	10.70	181.00	0.22	0.00	15.0	0.00	0.00	8.62	1.4	6.8	25	13	223
20171206	0.0	235	64.8	0.0	16.0	590	15.70	282.00	0.13	0.00	29.1	0.01	0.00	8.31	2.5	13.5	56	6	381
No. of Analysis	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2017**																			
MIN	0	159	45	0	6	346	8	160	0	0	12	0	0	8	1	4	13	6	192
MAX	0	235	66	9	35	641	16	288	1	0	30	0	0	9	2	20	62	133	381
MEAN	0.00	194.25	55.84	4.50	16.50	490.00	11.05	227.75	0.41	0.00	21.45	0.00	0.00	8.45	1.79	11.12	39.00	57.00	288.25
2016**																			
MIN	0	160	46	0	5	353	6	173	0	0	14	0	0	8	0	5	20	7	208
MAX	0	228	61	0	20	564	11	271	1	0	30	0	0	9	2	17	68	84	315
MEAN	0	191	54	0	12	453	8	225	0	0	22	0	0	8	1	10	41	46	265
2015**																			
MIN	0	158	45	0	6	363	9	174	0	0	15	0	0	8	1	5	19	28	216
MAX	0	216	59	0	20	543	9	273	2	0	30	0	0	10	2	19	80	302	379
MEAN	0	192	54	0	13	462	9	226	1	0	22	0	0	9	1	11	43	123	293
2014**																			
MIN	0	180	54	0	6	397	0	198	0	0	15	0	0	8	1	6	22	11	235
MAX	0	220	61	0	31	692	0	286	1	0	33	0	0	9	3	27	84	148	398
MEAN	0	198	57	0	19	537		246	0	0	25	0	0	9	2	16	53	81	317
2013**																			
MIN	0	159	51	0	7	408	0	194	0	0	16	0	0	8	1	7	26	23	219
MAX	0	215	63	0	35	638	0	285	2	0	31	0	0	9	3	29	71	233	362
MEAN	0	188	56	0	21	518		238	1	0	24	0	0	9	2	18	47	88	290
2012**																			
MIN	0	172	53	0	8	392	0	200	0	0	17	0	0	8	1	8	26	0	229
MAX	0	212	63	26	36	745	0	321	1	0	41	0	0	9	4	39	108	136	409
MEAN	0	193	58	9	19	539	0	253	0	0	26	0	0	9	2	19	55	45	301
2011**																			
MIN	0.0	150.0	49.6	0.0	6.0	335.0	0.0	174.0	0.1	0.0	12.1	0.0	0.0	8.4	0.8	5.6	14.0	7.0	198.0
MAX	0.0	257.0	74.1	0.0	27.0	685.0	0.0	339.0	1.2	0.0	37.5	0.0	0.0	8.6	2.6	24.1	83.0	98.0	415.0
MEAN	0.0	192.3	59.0	0.0	15.8	482.5	0.0	241.0	0.5	0.0	22.8	0.0	0.0	8.5	1.6	13.4	43.8	42.5	284.5
2010**																			
MIN		159	48	0	4	327	8.70	167	0.08	0.00	12	0.00	0.00	8.45	0.82	5	15	7	188
MAX		235	59	26	37	690	10.80	291	1.78	0.00	35	0.00	0.00	8.61	3.36	36	88	142	411
MEAN		194	52	7	18	501.25	9.63	223.75	0.55	0.00	23	0.00	0.00	8.54	2.00	18	51	48	297
2009**																			
MIN		149	47	0	7	376	8	197	0	0	16	0	0	8	1	6	23	5	234
MAX		226	67	13	45	737	9	325	0	0	38	0	0	9	3	34	95	21	450
MEAN		187	57	7	24	556	9	258	0	0	28	0	0	9	2	21	61	13	341
2008**																			
MIN									0.00			0.00			0.92				
MAX		226	67		45	737	9.20	325	4.00		38	4.00		8.60	4.00	34	95	21	450
MEAN		142	44		20	418.1875	7.47	195.875	1.10		21	1.00		7.38	2.48	16	46	11	257
2007**																			
MIN		161	49		7	428	10.18	189	0.15		16	0.01		8.31	1	6	23	8	208
MAX		212	62		25	700	13.79	279	0.26		31	0.03		8.59	3	22	73	38	370
MEAN		187	56.5		15.0	536.25	11.99	235.75	0.20		22.99	0.02		8.44	1.60	12.36	45.8	19.0	283.25
2006**																			
MIN		159	48		8	420	11.58	184	0.12		16	0.01		8.02	1	7	25	6	215
MAX		235	78		104	1036	14.59	366	16.43		42	0.01		8.50	3	70	109	1370	589
MEAN		199	63		38	663	13.52	274	4.46		28	0.01		8.33	2	27	61	358	351
HISTORICAL 1991-2016																			
MIN	0.0	148	32.0	0.0	1.0	210	3.8	129	0.01	0.00	8.00	0.000	0.0	7.14	0.01	1.00	4.0	0.00	161
MAX	33.0	310	91.7	37.0	76.0	899	15.0	448	11.93	37.82	39.90	1.00	5.1	9.52	5.00	51.20	150.0	1420.00	498
MEAN	3.53	213.72	57.54	4.10	15.21	457.13	8.65	233.56	0.51	0.47	21.46	0.05	1.49	8.43	1.70	11.51	40.96	40.35	268.28
COUNT	94	141	141	109	140	151	128	141	133	93	141	105	90	151	123	141	141	145	151

*** Quality parameters are reported as mg/l unless otherwise noted.**

****Data: Database input restricted to values greater then laboratory minimum detection limit.**

INDIAN CREEK WATER QUALITY *

ICA

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	DISSOLVED OXYGEN	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20171016.0	0.0	258.0	77.7	0.0	2.0	497.0		285.0	0.0	0.0	22.2	0.0	0.0	8.2	0.9	3.2	12.0	0.0	269.0
2016**	0.0	234.0	70.4	0.0	2.0	444.0	9.0	267.0	0.0	0.0	22.1	0.0	0.0	8.4	0.8	3.3	15.0	0.0	243.0
2015**	0.0	257	72	0.0	2	493	9.5	273	0	0.0	23	0	0.0	8	1	3.5	13	0	300.0
2014**	0.0	267	69.2	0.0	2.0	509		259	0.13	0.00	20.83	0.00	0.0	8.28	0.75	2.51	11.0	0.0	295
2013**																			
MEAN	0.0	246	73.9	0.0	2.0	501		278	0.06	0.00	22.70	0.00	0.0	8.36	0.76	2.99	10.0	8.0	267
2012**																			
MEAN	0.0	253	73.5	0.0	2.0	490		281	0.00	0.00	23.68	0.00	0.0	8.26	0.70	3.16	9.0	0.0	273
2011**																			
MEAN	0	274	77	0	2	507		277	0	0	21	0		8	1	3	6	7	295
2010**																			
MEAN	0	264	72.59	0	3	512		270	0.21	0	21.56	0		8.19	1.05	3.26	12	0	313
2009**																			
MEAN	5	262	72.65		2	511		278	0.09		23.39			8.22	1.05	3.32	11	0	277
2008**																			
MEAN		257	74.26		2	499		280	0.12		22.97	0.002		8.3	0.89	3.27	10	0	286
2007**																			
MEAN		251	72.0		2	496		274	0.30		22.8	0.02		8.02	1.07	3.01	14	26	294
2006**																			
MEAN		297	77.5		3	554		282	0.06		21.5	0.01		7.96	0.64	2.71	8		282
2005**																			
MEAN		265	80.8		3	571		294	0.07		23	0		8.30	1.56	3.27	8	5	291
HISTORICAL 2000-2016																			
MIN	0	234.0	67.0	0.0	2	444	9	255.00	0.00	0.0	20.00	0.0	0.00	7.96	0.64	2.5	6.0	0	243
MAX	5	327.0	80.8	0.0	3	633	9.5	294.00	0.30	0.0	23.68	0.0	0.00	8.40	1.56	4.0	23.0	43	313
MEAN	0.56	272.18	73.04	0.00	2.21	510.35	9.25	273.06	0.11	0.00	22.00	0.00	0.00	8.21	0.93	3.14	11.79	7.38	285.12

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

INDIAN CREEK WATER QUALITY *

ICB

SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	DISSOLVED OXYGEN	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
2017**																			
20171016	0.0	232.0	52.8	0.0	2.0	487.0		210.0	0.0	0.0	18.9	0.0	0.0	8.3	1.0	4.1	14.0	0.0	246.0
2016**	0	218	57	0	2	404	9	231	0	0	21	0	0	8	1	4	14	0	240
2015**	0	234	**60**	0	2	**453**	10	245	**0**	0	23	**0**	0	8	**1**	4	13	**0**	267
2014**	0	241	61	0	2	475		239	0	0	21	0	0	8	1	3	12	20	272
2013**																			
MEAN	0	217	57	0	2	438		233	0	0	22	0	0	8	1	4	10	0	232
2012**																			
MEAN	0	226	60	0	2	436		247	0	0	24	0	0	8	1	4	10	11	207
2011**																			
MEAN	0	251	68	0	2	484		259	0	0	21	0		8	1	5	11	9	271
2010**																			
MEAN	0	240	63.17	0	3	457		246	0.32	0	21.48	0	0	8.32	1.08	4.37	13	25	288
2009**																			
MEAN	0	246	68		2	480		267	0.41		24	0.000		8.35	1.1	4.34	13	14	261
2008**																			
MEAN	7	236	66	0	2	465		259	0.25		23	0.006		8.27	0.9	3.99	11	0	276
2007**																			
MEAN		237	64.9		2.0	466		258	1.43		23	0.046		8.09	1.01	3.73	14.0	37	286
2006**																			
MEAN		239	72.0		3.0	527		268	0.24		22	0.005		8.25	0.61	3.62	9.0		278
2005**																			
MEAN		238	68.2	5	2.0	534		258	0.20		21	0.013		8.41	1.00	4.29	10.0	9	268
HISTORICAL 2000-2016																			
MIN	0.00	217.0	57.0	0.0	2.0	404.0	9.0	231.0	0.1	0.0	20.0	0.0	0.0	7.9	0.6	3.0	7.7	0.0	207.0
MAX	12.00	301.0	73.4	5.0	3.0	559.0	9.6	271.0	1.4	0.0	23.9	0.0	0.0	8.4	1.1	5.4	14.0	37.0	288.0
MEAN	1.90	249.00	63.49	0.50	2.14	470.29	9.30	248.76	0.36	0.00	21.91	0.01	0.00	8.27	0.88	3.83	11.04	11.40	258.82

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

INDIAN CREEK WATER QUALITY *

ICD

SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	DISSOLVED OXYGEN	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
2017**																			
20171016	0	290	123.8	0	3	829		471	0.06	0	39.29	0.015	0	8.05	1.33	11.25	178	0	541
2016**	0	226	130.48	0	4	914	9.4	506	0.15	0	43.81	0	0	8.36	1.13	10.91	298	25	668
2015**	0	275	97.62	0	4	696	9.4	384	0.1	0	34.14	0.023	0	8.1	1.01	10.58	115	0	477
2014**	0	256	81.19	0	4	653		333	0.06	0	31.56	0.004	0	8.35	1.04	9.23	98	6	413
2013**																			
MEAN	0	276	98.76	0	4	727		391	0.17	0	35.14	0.006	0	8.34	0.96	10.68	119	0	460
2012**																			
MEAN																			
2011**																			
MEAN	0	324	95.37	0	5	670		370	0.06	0	31.99	0.005		8.33	1.58	11.38	47	0	414
2010**																			
MEAN	0	273	93.72	0	5	671		365	0.28	0	31.72	0	0	8.3	1.11	10.72	108	10	456
2009**																			
MEAN	9	269	89.02	0	4	662		363	0.21	0	34.29	0.007	0	8.19	1.51	10.11	87	8	407
2008**																			
MEAN		279	85.77		4	628		350	0.06		33.04	0.005	0	9.43	1.19	10.15	66	0	395
2007**																			
MEAN		256	96.8	6.0	4.0	717		388	0.12		35.60	0.02		8.17	1.39	10.30	130.0		484
2006**																			
MEAN		361	108.0		7	813	9	413	0.14		35	0.06	4.00	8.04	2.45	11.20	47	7	450
2005**																			
MEAN		361	108.0		7	813	9	413	0.14		35	0.06	4.00	8.04	2.45	11.20	47	7	450
HISTORICAL 2000-2016																			
MIN	0	226.0	80.0	0.0	3	624	9.4	323.00	0.06	0	30.00	0.000	0.00	8.00	0.96	8.86	23.0	0	367
MAX	9	379.0	130.5	6.0	7	914	9.4	506.00	0.38	0.0	43.81	0.054	4.00	9.43	2.45	11.4	298.0	25	668
MEAN	1	293.56	94.48	0.6	4.32	710	9	375.00	0.16	0.0	33.80	0.015	0.44	8.29	1.26	10.26	104.63	6.00	444.63

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

MEETINGHOUSE CANYON WATER QUALITY *

MHC01 - LEFT FORK

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170606		209	50.3	0.0	3.0	437	218.00	0.6	0.00	22.57	0.00	0.0	8.4	1.12	6.47	28	73	239
Analysis	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
2017																		
MIN	0	209	50	0	3	437	218	1	0	23	0	0	8	1	6	28	73	239
MAX	0	209	50	0	3	437	218	1	0	23	0	0	8	1	6	28	73	239
MEAN	0.00	209.00	50.25	0.00	3.00	437.00	218.00	0.62	0.00	22.57	0.00	0.00	8.40	1.12	6.47	28.00	73.00	239.00
2016**	NO FLOW DURING 2016																	
2015**	0	196	46.7	0.0	3.0	426	214	0.16	0.00	23.77	0.00	0.0	8.50	0.89	6.09	24.0	43.0	261
2014**	NO FLOW DURING 2014																	
2013**	NO FLOW DURING 2013																	
2012**	NO FLOW DURING 2012																	
2011**																		
MIN	0	207	43	0	4	487	250	0	0	24	0	0	9	1	8	33	17	266
MAX	0	225	60	0	4	502	253	1	0	35	0	0	9	1	11	42	72	281
MEAN	0	216	52	0	4	495	252	0	0	29	0	0	9	1	10	38	45	274
2010**	NO FLOW DURING 2010																	
2009**	NO FLOW DURING 2009																	
2008**		183	36.18		3.0	451	208	0.72		28.53			8.62	1.13	9.8	22	25	249
2007**		191	37		4.0	485	221	0.33		31.60			8.39	0.90	10.0	28	31	223
2006**																		
MIN		199	42		5.0	437	219	0.07		27.40			8.37	0.93	8.2	26	22	222
MAX		207	43		5.0	498	229	0.14		29.41			8.59	1.05	10.5	30	22	262
MEAN		203	43		5.0	468	224	0.11		28.41			8.48	0.99	9.4	28	22	242
HISTORICAL 1986-2016																		
MIN	0.0	183.0	2.2	0.0	1.0	300.0	175.0	0.0	0.0	17.2	0.0	0.0	7.0	0.0	3.8	8.0	0.1	183
MAX	49.0	307.0	80.4	34.0	47.5	557.0	350.0	1.2	0.3	36.5	0.1	10.9	8.8	1.6	14.0	100.0	175.0	304
MEAN	5.55	232.80	45.14	5.38	6.50	428.04	229.74	0.28	0.07	27.23	0.02	1.34	8.29	0.94	8.57	30.98	31.64	247.39
COUNT	26	46	46	38	46	46	46	43	27	46	28	26	46	37	46	46	43	46

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

MILL FORK CANYON WATER QUALITY *

MFU3 - ABOVE MILL FORK FAULT

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170607	-274.0	221	57.1	0.0	2.0	453	222.00	0.4	0.00	19.19	0.00	0.0	8.6	1.32	16.8	23	74	260
No. of Analysis	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
2016**	0	225	51	0	2	415	188	1	0	15	0	0	8	1	26	30	55	315
2015**	0	215	50	12	2	470	201	2	0	18	0	0	9	1	25	29	211	312
2014**																		
MIN	0	223	49	0	2	484	221	0	0	19	0	0	8	1	20	29	8	261
MAX	0	250	57	8	4	503	237	0	0	28	0	0	9	1	20	41	67	294
MEAN	0	237	53	4	3	494	229	0	0	24	0	0	9	1	20	35	38	278
2013**	0	245	60	0	2	535	232	10	0	20	0	0	9	1	34	44	1096	310
2012**	No Flow During 2012																	
2011**																		
MIN	0	207	63	0	5	427	235	4	0	19	0	0	8	1	6	16	1804	258
MAX	0	219	63	0	5	482	259	4	0	27	0	0	8	1	8	32	1804	259
MEAN	0	213	61	0	4	455	247	2	0	23	0	0	8	1	7	24	902	259
2010**	0	191	54.75	0	2	393	206.00	4	0.00	16.90	0	0.00	8.53	0.86	6	15	409	221
2009**	0	209	62.60	9	2	453	251.00	0	0.00	23.11	0	0.00	8.49	0.98	6	23	0	261
2008**	0.0	162	60.72	37	2	428	233	0.37	0	19.69	0.01	0	8.50	0.78	4.11	15	53	234
2007**	No Flow During 2007																	
2006**		221	61.80		3	468	246	0.08		22.30			8.33	1	4.72	20	9	275
HISTORICAL 1986-2016																		
MIN	0.0	162.0	49.0	0.0	2.0	393.0	188.0	0.0	0.0	14.5	0.0	0.0	8.2	0.7	4.1	15.0	0.0	221
MAX	0.0	251.0	64.2	37.0	5.0	535.0	259.0	9.8	0.0	27.9	0.0	0.0	8.6	1.4	34.3	44.0	1804.0	315
MEAN	0.0	216.2	57.7	7.8	2.5	455.7	229.6	1.5	0.0	20.8	0.0	0.0	8.4	0.9	12.4	25.4	313.5	267.5714
COUNT	10	14	14	12	14	14	14	14	10	14	11	10	14.00	14	14	14	12	14

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

MILL FORK CANYON WATER QUALITY *

MFA1 - ABOVE MINE

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170607.0	-214	225.0	56.3	0.0	2	449	220.00	0.38	0.00	19.3	0.0	0	8.53	1.29	16.58	23	72.0	258.0
No. of Analysis	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
2016**	0	228	50	0	2	438	198	1	0	18	0	0	9	1	27	30	55	313
2015**	0	214	50	11	2	471	200	2	0	19	0	0	9	1	25	29	244	356
2014**	0	252	57	0	2	483	220	0	0	19	0	0	9	1	20	29	85	285
2013**	0	230	59	0	2	550	230	5	0	20	0	0	9	1	33	44	546	290
2012**	No Flow During 2012																	
2011**																		
MIN	0	206	54.73	0	2	427	231	0	0	18.49	0	0	8.42	0.73	6.17	16	0	253
MAX	0	210	61.86	0	2	468	247	13.41	0	26.71	0	0	8.5	0.99	7.4	32	1426	256
MEAN	0	208	58.295	0	2	447.5	239	6.705	0	22.6	0	0	8.46	0.86	6.785	24	713	254.5
2010**	0	191	54.76	0	2	387	206	3.29	0	16.82	0	0	8.56	0.85	5.89	15	379	226
2009**	0.0	206	61.23	10	2	443	246.00	0	0.00	23	0	0.00	8.61	0.96	6	23	8	264
2008**		162	60.59	36	2	433	233	0.40		19.78			8.52	0.78	4.20	15	26	227
2007**	No Flow During 2007																	
2006**		220	63		3	463	251	0.08		23			8.47	1	4.84	20	12	265
HISTORICAL 1986-2016																		
MIN	0.0	153.0	32.0	0.0	2.0	180.0	198.0	0.0	0.0	13.0	0.0	0.0	8.0	0.7	1.0	12.0	0.0	176
MAX	0.0	400.0	82.0	36.0	24.0	813.0	462.0	13.4	0.5	73.0	0.0	0.0	8.6	3.0	33.3	223.0	1426.0	710
MEAN	0.0	260.8	57.2	7.2	7.8	502.9	281.3	1.3	0.1	33.7	0.0	0.0	8.3	1.5	11.4	54.4	122.7	323.8485
COUNT	9	32	33	13	32	33	33	27	11	33	9	9	34	30	33	33	31	33

*** Quality parameters are reported as mg/l unless otherwise noted.**

**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

MILL FORK CANYON WATER QUALITY *

MFB2 - BELOW MINE

2017** SAMPLE DATES	ACIDITY	ALKALINITY BICARBONATE	CALCIUM	CARBONATE	CHLORIDE	CONDUCTIVITY (umhos/cm)	HARDNESS	IRON TOTAL	IRON DISSOLVED	MAGNESIUM	MANGANESE	OIL & GREASE	PH (units)	POTASSIUM	SODIUM	SULFATE	TSS	TDS
20170607	0.0	231	58.4	0.0	2.0	475	234.0	0.52	0.00	21.51	0.0	0.0	8.53	1.41	16.88	28	135	285.0
20170907	0	269	45.38	8	7	682	286	0	0	42.01	0	0	8.57	2.61	16.22	94	0	392.0
No. of Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016**	0	243	56	0	6	500	296	1	0	38	0	0	8	1	26	97	21	346
2015**	0	232	49	6	2	493	211	4	0	21	0	0	9	1	23	37	95	656
2014**																		
MIN	0	240	52	0	2	496	240	0	0	22	0	0	8	1	17	36	0	276
MAX	0	278	60	0	7	695	342	0	0	52	0	0	9	2	19	105	117	428
MEAN	0	259	56	0	5	596	291	0	0	37	0	0	9	2	18	71	59	352
2013**	NO FLOW DURING 2013																	
2012**	NO FLOW DURING 2012																	
2011**	0	217	63	0	2	441	239	18	0	20	0	0	8	1	6	19	1872	266
2010**																		
MIN		203	55	0	2	414	219	0	0	20	0	0	9	1	7	22	0	258
MAX		272	64	22	9	732	399	4	0	58	0	0	9	3	15	104	416	432
MEAN		238	60	11	6	573	309	2	0	39	0	0	9	2	11	63	208	345
2009**																		
MIN		267	59	0	6	628	347	0	0	43	0	0	9	2	12	70	0	357
MAX		269	67	0	10	759	408	0	0	63	0	0	9	3	15	117	18	473
MEAN		268	63	0	8	694	378	0	0	53	0	0	9	2	13	94	9	415
2008**																		
MIN		283	67	0	10	810	441			66	0		8	3	16	132	0	504
MAX		293	75	18	11	918	474			70	0		9	3	17	148	0	546
MEAN		288	71	9	11	864	458			68	0		8	3	17	140	0	525
2007**																		
MIN		315	70		11	956	438			64	0.003		8.13	2.32	17.40	124	7	561
MAX		351	82		14	1040	519			77	0.003		8.33	3.60	20.40	177	7	579
MEAN		336	77		12	984	487			71	0.003		8.23	2.94	19.23	154	7	571
2006**																		
MIN		251	66		5	564	296	0		32	0.002		8.41	1.29	7.06	39	17	324
MAX		332	77		12	924	447	0		62	0.002		8.43	2.58	16.98	132	17	497
MEAN		292	71		9	744	372	0		47	0.002		8.42	1.94	12.02	86	17	411
HISTORICAL 1986-2016																		
MIN	0.0	183.0	1.0	0.0	2.0	240.0	211.0	0.0	0.0	14.0	0.0	0.0	7.3	0.7	5.0	16.0	0.0	204
MAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
MEAN	0.0	296.4	58.6	9.2	8.3	588.7	327.9	1.1	0.9	44.7	0.0	0.0	8.3	2.0	11.8	70.1	83.3	377.5
COUNT	13	50	50	25	51	52	51	31	18	51	16	12	52	50	51	51	36	50

*** Quality parameters are reported as mg/l unless otherwise noted.**

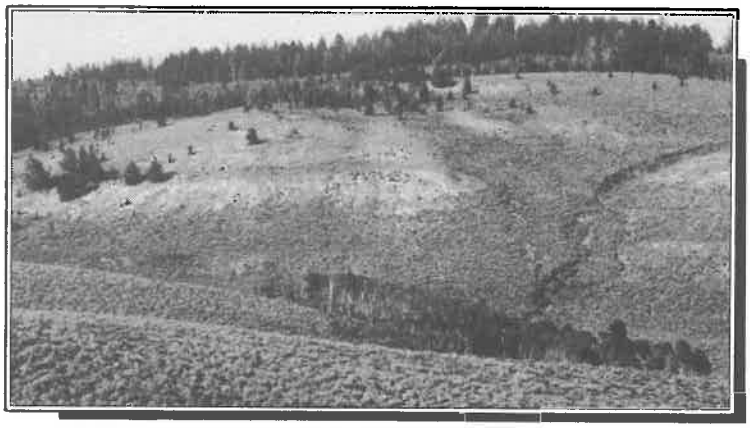
**** Data: Database input restricted to values greater then laboratory minimum detection limit.**

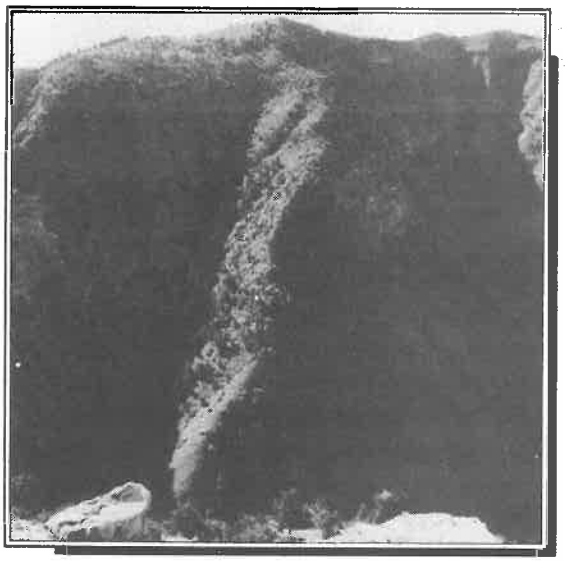
IC 9405

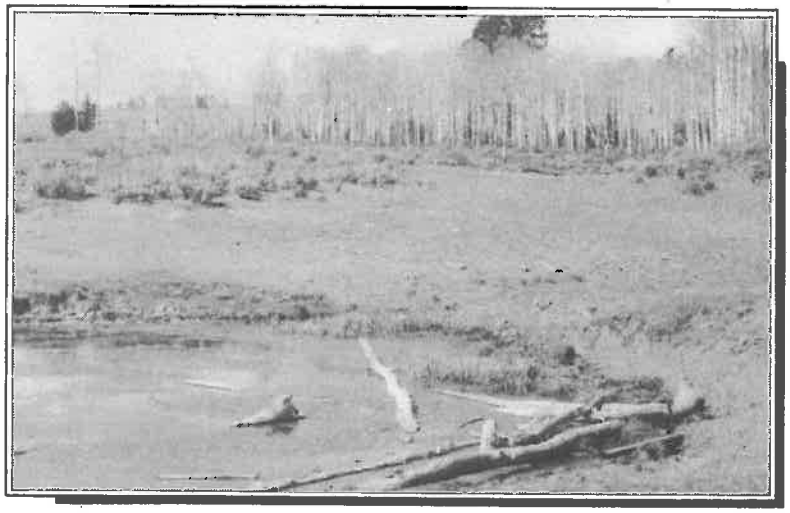
INFORMATION CIRCULAR/1994

Response of Springs to Longwall Coal Mining at the Deer Creek and Cottonwood Mines, Wasatch Plateau, UT

By Liane L. M. Kadnuck







United States Department of the Interior

Bureau of Mines

U.S. Department of the Interior Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally–owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

Cover: Clockwise from top left: topography of East Mouintain Summit; typical topography of Wasatch Plateau; surveying instrument in winter snowpack, soure of recharge for local springs; spring I and the stock watering pond it creates.

Information Circular 9405

Response of Springs to Longwall Coal Mining at the Deer Creek and Cottonwood Mines, Wasatch Plateau, UT

By Liane L. M. Kadnuck

UNITED STATES DEPARTMENT OF THE INTERIOR
Bruce Babbitt, Secretary

BUREAU OF MINES

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

cm	centimeter	m	meter
km	kilometer	pct	percent
L/s	liter per second		

RESPONSE OF SPRINGS TO LONGWALL COAL MINING AT THE DEER CREEK AND COTTONWOOD MINES, WASATCH PLATEAU, UT

By Liane L. M. Kadnuck[1]

ABSTRACT

This report summarizes the results of a hydrologic research study conducted by the U.S. Bureau of Mines (USBM) in cooperation with Energy West Mining Co. at the Deer Creek and Cottonwood Mines, near Orangeville, UT. The USBM evaluated hydrologic and overburden failure data to assess the response of local ground water to underground coal mining in single- and multiple-seam conditions. Fourteen springs located over the two mines were investigated in the study along with overburden failure response caused by longwall panel extraction. Spring discharge was compared to climatic variation and time of undermining to quantify response to undermining. Spring discharge had been reduced owing to below-normal precipitation during the period evaluated. The response of springs to mining in the vicinity was influenced in part by the thick overburden present at the study site, the presence of hydrophilic clays and mudstones in the overburden stratigraphy, and elevation of the springs above the mine level, which buffered the effects of undermining.

[1]Environmental engineer, Denver Research Center, U.S. Bureau of Mines, Denver, CO.

INTRODUCTION

To quantify the response of overburden stratigraphy to high-extraction coal mining, the U.S. Bureau of Mines (USBM) initiated a research program to evaluate the effects of mining and associated subsidence in varying geologic conditions. The primary objective of this program is to understand the mechanics of subsidence and overburden failure response resulting from underground mining in Western U.S. coalfields. Previous USBM studies have focused on surface effects of underground coal mining *(1-5)*.[2] Recognizing that subsidence produces alterations in overburden characteristics which in turn produce associated changes in the hydrologic system, the program was expanded to include characterization of the response of hydrologic systems contained in the overburden. This study addresses the effects of overburden failure on hydrologic resources in proximity to a mined area.

This report describes the response of ground water contained in the overburden to underground mining in the Wasatch Plateau Coalfield. The study involved evaluating the response of local ground water resources overlying the Deer Creek and Cottonwood coal mines in Emery County, UT. The goals of this study were to (1) quantify fluctuations in spring discharge associated with undermining, (2) assess longevity of discharge fluctuations, and (3) correlate the stratigraphic locations and elevations of springs in the overburden stratigraphic column with zones of overburden failure.

ACKNOWLEDGMENTS

PacifiCorp's Fuel Resources Division provided valuable assistance in performing this research. Specifically, Chuck Semborski of the Energy West Mining Co. and Rodger Fry of InterWest Mining contributed much of the data and information contained in this report. Without their assistance, this study could not have been undertaken.

DEER CREEK AND COTTONWOOD MINES STUDY SITE

The Deer Creek and Cottonwood Mines are located in the Wasatch Plateau Coalfield in south-central Utah (figure 1). Two major coal seams are mined in the area by Energy West Mining Co., a subsidiary of PacifiCorp.; the Deer Creek Mine operates in the Blind Canyon Seam, and the Cottonwood Mine produces coal from the Hiawatha Seam approximately 26 m below. The Deer Creek Mine overlies and partly overlaps the Cottonwood Mine; hence the study area contains areas of both single- and multiple-seam mining. The mines are located on East Mountain (elevation 2,942 m). The local topography is typified by rugged mountains dissected by stream-incised canyons. The overburden thickness averages 518 m but ranges from 260 to over 700 m, depending on local topography.

Both mines currently extract coal using longwall retreat methods, and each contains areas of past room-and-pillar extraction. The coal is hard, dense, and ranked B to C bituminous. The Deer Creek Mine operates at an average extraction height of 3.3 m, and the Cottonwood Mine has an average extraction height of 2.6 m.

[2]Italic numbers in parentheses refer to items in the list of references preceding the appendix.

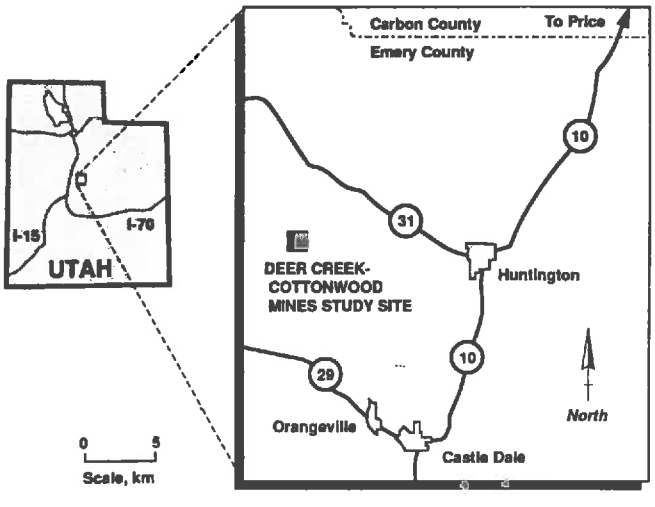

Figure 1.—Project location map.

GEOLOGY

Regional Geology

The mines are located on the Wasatch Plateau, a broad, north-south-trending, flat-topped mesa. The eastern edge of the plateau lies on the western flank of the San Rafael Swell and is typified by gently westward-dipping strata. The western edge of the plateau is complexly faulted and represents the transition between the Colorado plateau

region and the Great Basin. Geologic units outcropping in the area range in age from Cretaceous to Tertiary, with some thin, unconsolidated Quaternary deposits present in stream valleys.

Local Geology

Exposed strata in the mine area are of sedimentary origin. The economic coal deposits are found in the lower part of the stratigraphic section. Generalized lithologies and thicknesses of each geologic unit are summarized in figure 2 *(6)*.

The youngest geologic unit in the area, the Flagstaff Limestone, is a freshwater limestone that caps portions of the top of East Mountain. The Flagstaff is underlain by the North Horn Formation, a variegated shale and mudstone sequence derived from fluvial and lacustrine origins. The Price River Formation forms a steep, receding slope under the North Horn and consists of a conglomeratic fluvial sandstone with shale layers. The North Horn and Price River Formations each contain claystones and mudstones that are rich in hydrophilic clays. The fluvial Castlegate Sandstone forms a cliff between the Price River and Blackhawk Formations. The Blackhawk Formation is a marginal marine sequence of lenticular sandstone beds and carbonaceous shales with economic coal deposits. The Blackhawk is typified as having fluvial channels scoured into the top of the coal deposits. Underlying the Blackhawk is the Star Point Sandstone, a thinly bedded marine sandstone with shale interbeds at the base where it intertongues with the older Masuk Shale Member of the Mancos Formation.

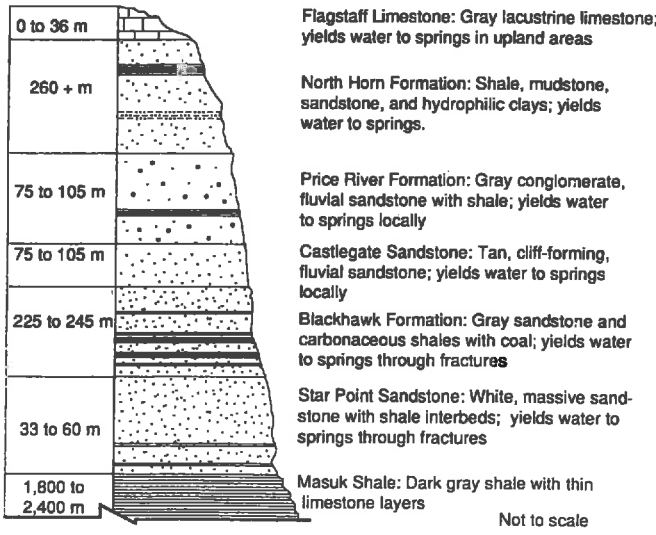

Figure 2.—Generalized overburden stratigraphy (modified from Danielson and others (7)).

The regional dip of the strata is broken by the northeast-trending axis of the Straight Canyon syncline, located on the western end of East Mountain. Faulting is common on the Wasatch Plateau, and three faults, the Deer Creek, Pleasant Valley, and Roan's Canyon, crosscut the permit area *(6)*. Jointing is also prevalent in the area, and joint sets trending northeast-southwest and northwest-southeast crosscut the study area. Figure 3 shows the locations and trends of the major structural features.

HYDROLOGIC SYSTEM

Ground Water Hydrology

Ground water occurs in all exposed geologic units discussed in the previous section in continuous or discontinuous water-bearing zones. The formations yield ground water from perched zones[3] to springs[4] where the hydraulic conductivity of the water-bearing zone is higher than that of the surrounding rock, and where the formations are fractured or faulted. The lateral continuity of these perched water tables is not known, though there is some evidence for limited lateral extent based on springs located at the same elevation *(6)*. The lateral extent of water-bearing zones is limited based on the discontinuous nature of the local topography. A continuous water-bearing unit was found to be present in the Star Point sandstone through drillers' logs and regional ground water studies.

Ground water in the area is recharged largely from precipitation, most of it from snowmelt, which percolates into the subsurface through fractures or matrix flow *(9)*. The flat top of East Mountain allows water to infiltrate to the subsurface through fractures exposed at the surface. Some recharge also infiltrates to the subsurface on the mountain flanks. Older units are recharged mainly from water that migrates through fractures. Impermeable lenses of shale and mudstone in the North Horn and Price River Formations retard downward migration of water, although some water is transmitted to the lower geologic units through continuous fractures. Geotechnical tests performed on the North Horn Formation indicated hydrophilic or swelling materials were present in the clays and mudstones that swelled 40 pct in the first hour of testing *(10)*. As a result, a large number of springs issue from the North Horn and Price River Formations. The Star Point Sandstone and the Blackhawk Formation are recharged from overlying units, mainly through faults and fractures *(6)*.

[3]By definition, perched water is "unconfined ground water separated from an underlying main body of ground water by an unsaturated zone" *(7)*.

[4]By definition, springs are a place where ground water flows naturally from a rock or the soil onto the land surface or into a body of water, and the occurrence depends upon the nature and relationship of rocks, especially permeable and impermeable strata *(8)*.

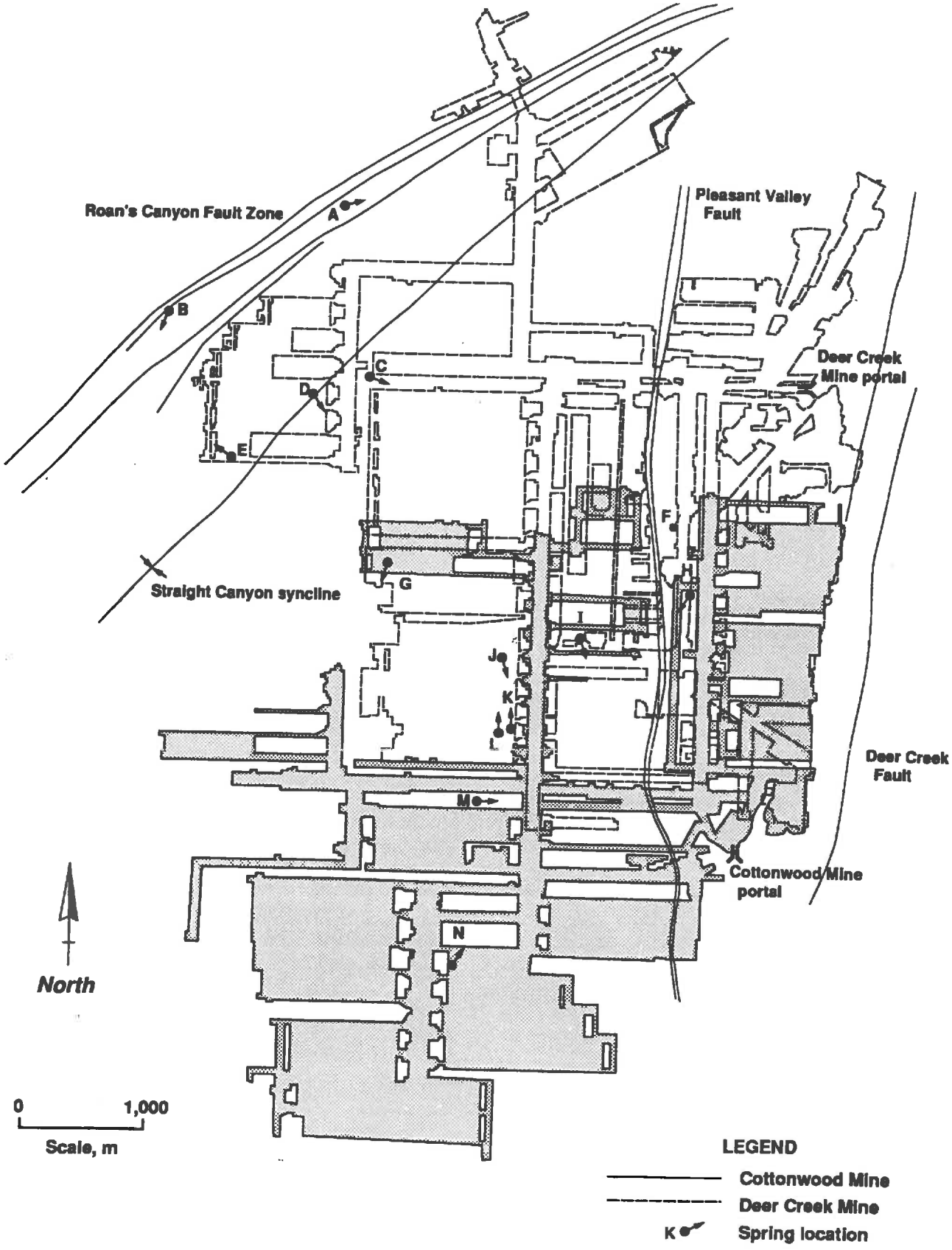

Figure 3.—Mine map showing spring locations.

Water movement is controlled by dip of bedding, primary hydraulic conductivity, and fractures. Regional ground water flow in the immediate area is affected by the Joes Valley and Pleasant Valley fault zones, which are thought to be major conduits of interbasin flow. Water-bearing fractures encountered in the mines further indicate that ground water is transported along faults and fractures *(10)*.

Surface Water Hydrology

As shown on figure 4, East Mountain forms a drainage divide between Huntington Creek to the north and Cottonwood Creek on the south. The north fork of Cottonwood Creek drains the area between Trail and East Mountains, while Huntington Creek drains the area between East Mountain and Gentry Mountain to the north. There are numerous tributaries to these creeks, most of which are ephemeral, flowing only during precipitation events, or intermittent, flowing during wet seasons of the year.

Most of the overland drainage is derived from snowmelt, and most baseflow in the streams originates as ground water discharged from perched aquifers issuing water to springs *(6, 11)*. Large fracture systems associated with the fault zones in the area are thought to control the surface drainage and may intercept creek flow and divert it into other basins. A lineament analysis *(12)* coupled with a drainage trace analysis indicated that the major trunk streams follow a regional northwest-southeast trend and that tributary drainages follow either a north-south, east-west, or northeast-southwest trend. The linearity of the drainage traces suggests that the surface drainage is following fracture or joint systems.

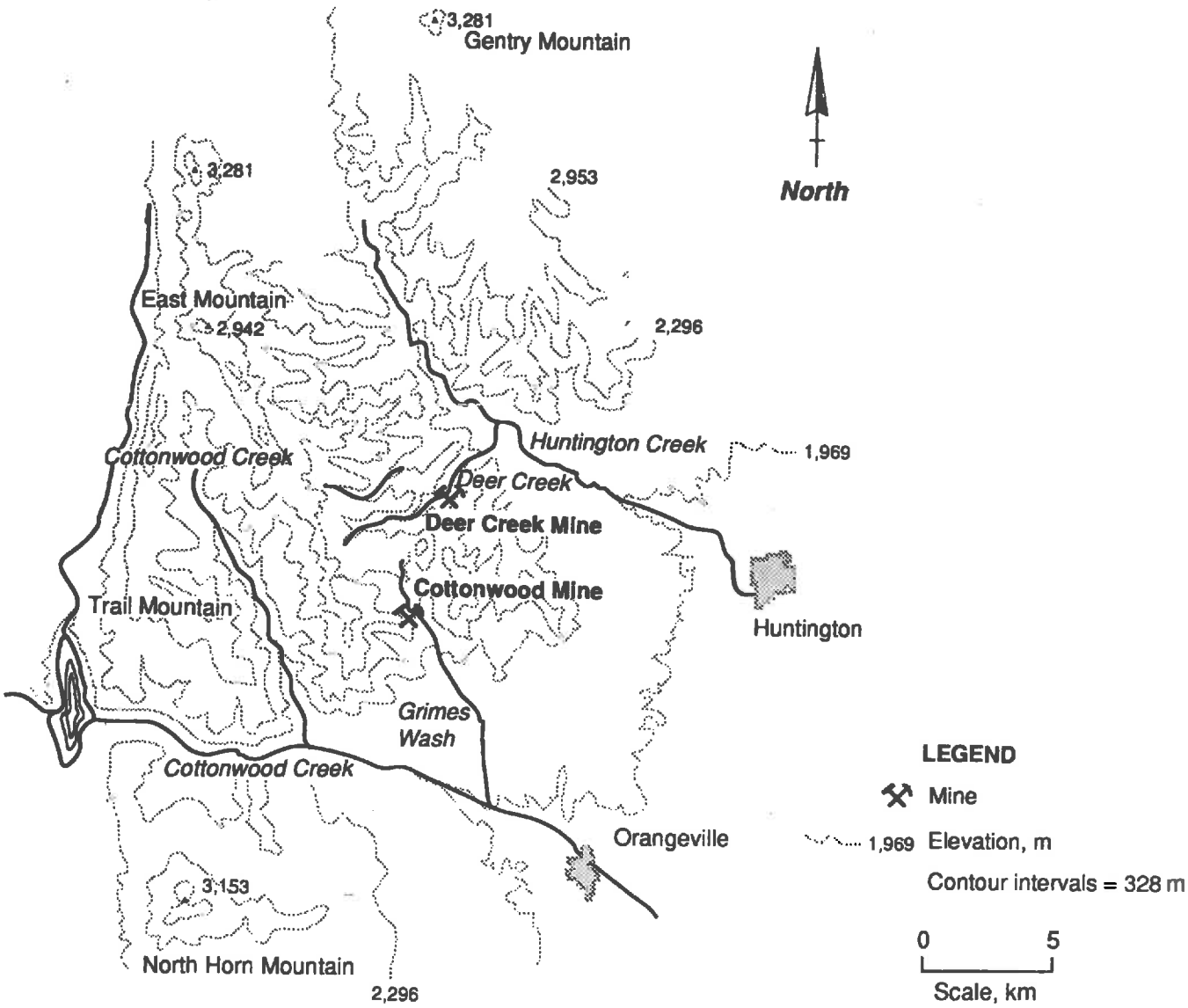

Figure 4.—Topography of East Mountain showing surface drainage.

HYDROLOGIC DATA COLLECTION

The mining company is required by law to monitor quantity of water resources within the permit area. Monitoring includes spring and stream discharge, piezometric levels in the mine floor, and mine discharge from both the Deer Creek and Cottonwood Mines. This study focused on ground water resources located above the mine level, namely springs, that could potentially be affected by mining. Springs issuing from East Mountain within the Deer Creek and Cottonwood Mines permit area were chosen by PacifiCorp and the Utah Division of Oil, Gas and Mining to be monitored for discharge and water quality. Thirty springs within the permit area are monitored, some on a semiannual basis and some on a monthly basis. Discharge monitoring was started in 1979, and additional springs have been added each year since that time; thus records vary for all the springs monitored. Discharge is measured by weirs, flumes, or manually. The 14 springs selected for use in this study were those with the longest available monitoring records. The springs monitored on a monthly basis are measured from July through October, since they are inaccessible during winter months. Discharge is reported from annual runoff through baseflow in the fall.

The monitoring is performed to allow comparison and assessment of the effects that mining has on the springs. The springs were characterized by mine personnel for issuing mechanism (for example, a fracture or a perched zone), issuing formation, and elevation measurements taken. This information is provided in table 1.

Water enters the mines through faults, fractures, and drill holes, and where localized saturated zones (fluvial sandstone channels) are intercepted by mine workings. Water discharged from the mines is measured at the discharge point on a daily basis and reported as a monthly total. Mine water from the Cottonwood Mine is discharged into Grimes Wash, and water from the Deer Creek Mine is discharged into Huntington Creek (figure 4).

Table 1.—Spring characteristics

Spring	Geologic unit	Issuing mechanism	Elevation, m	Location	Date undermined
A	North Horn	Fracture	2,850	Not in mined area	Not applicable.
B	Flagstaff	..do.	2,969	..do.	Do.
C	North Horn	..do.	2,831	Deer Creek barrier pillar	Do.
D	Flagstaff	Formation contact	2,921	Deer Creek panel	Oct. 1991.
E	North Horn	Perched zone	2,868	..do.	Feb. 1992.
F	Price River	..do.	2,743	Deer Creek barrier pillar	Not applicable.
G	North Horn	Fracture	2,831	Deer Creek panel	Apr. 1988.
H	..do.	Formation contact	2,754	Deer Creek mains, Cottonwood pillar	May 1976.
I	..do.	Perched zone	2,822	Deer Creek submains, Cottonwood panel	Aug. 1993.
J	..do.	..do.	2,831	Deer Creek panel	Aug. 1986.
K	Price River	Fracture	2,737	..do.	Dec. 1982.
L	..do.	Perched zone	2,743	..do.	Aug. 1982.
M	North Horn	..do.	2,850	Cottonwood barrier pillar	Not applicable.
N	..do.	Fracture	2,845	Cottonwood panel	Aug. 1989.

ANALYSIS OF SPRING RESPONSE TO MINING

This study concentrates on characterizing the impacts mining has on perched water-bearing zones in the overburden. In the study area, water-bearing zones above the mine level issue water to springs, representing an important part of water supply in the region for stream baseflow, agricultural, irrigation, and wildlife habitat purposes. Fourteen springs located on East Mountain were targeted for study based on availability of monitoring records and proximity to the mines and were designated with a letter identifier of A to N. Analysis of spring response followed a method used by Coe and Stowe (*13*), which is one of the few published studies that have examined responses of springs to undermining. This methodology required use of information sets including precipitation, spring discharge, and time of undermining.

This method involved comparing spring discharge hydrographs to precipitation for the period of monitoring. Monthly and total annual precipitation data for water years[5] 1981 to 1993 were utilized and are shown on figure A-1 in the appendix. Precipitation data are collected at a weather station on East Mountain on a daily basis. The availability of seasonal, monthly discharge data dictated using seasonal recession curves to assess mining impacts by determining if the springs departed from normal response. Patterns or trends in the spring discharge recession curves were sought to assess if the springs showed similar responses each year to precipitation, runoff, and baseflow conditions. Curves were compared to one another to discern if springs in the area responded differently based on issuing mechanism (fracture versus perched zone). There did not appear to be large differences in response as a result of issuing mechanism. Several years of data prior to mining were incorporated to establish baseline conditions. Spring discharges, shown as seasonal recession curves, are given on figure A-2.

Initial comparison of spring discharge to precipitation indicated that discharge did not immediately follow precipitation. Therefore, a statistical analysis that cross-correlated precipitation data with spring discharge was performed for two of the springs. This analysis showed that the springs in the study area respond to precipitation events within 6 months to 1 year (*14*). Discharge data for springs I and M were correlated with precipitation; this indicated that there is an approximate 6-month to 1-year lag time between precipitation events and discharge. The lag information was used to better assess variations due to climatic events without confusing them with response that may have been a result of mining. Results of the statistical analysis are given graphically on figure A-3. The graphs show the calculated lag time by offsetting the spring flow hydrograph by 1 year on the precipitation curve; for example, spring flow for 1982 is placed over precipitation for 1981. Local variation of lag time is expected based on differences in elevation, recharge source, and issuing mechanism for each of the springs studied. The statistical correlation gives an indication of the approximate lag time for the area. Figure A-4 gives the statistical results showing match position and correlation coefficient to demonstrate the validity of the correlation of the two data sets.

Spring discharge variation of both preundermining and postundermining was evaluated to identify if the spring discharge changed as the spring was undermined, or as mining progressed close by. Each spring location was compared with a map of mine workings and located with regard to placement over a mine structure such as a panel or a barrier pillar, as shown on figure 3. This information is also listed on table 1. Springs D, E, G, I, J, K, L, and N are located over longwall panels. Springs C, F, H, and M are located over other mine structures such as barrier pillars or mains. Springs A and B are located in an area that has not been undermined and were thus used as controls to identify discharge fluctuations due to climatic events. Spring discharge was carefully compared with precipitation, location of the spring over the extracted area, and time of undermining to assess response.

[5]The water year runs from October 1 to September 30.

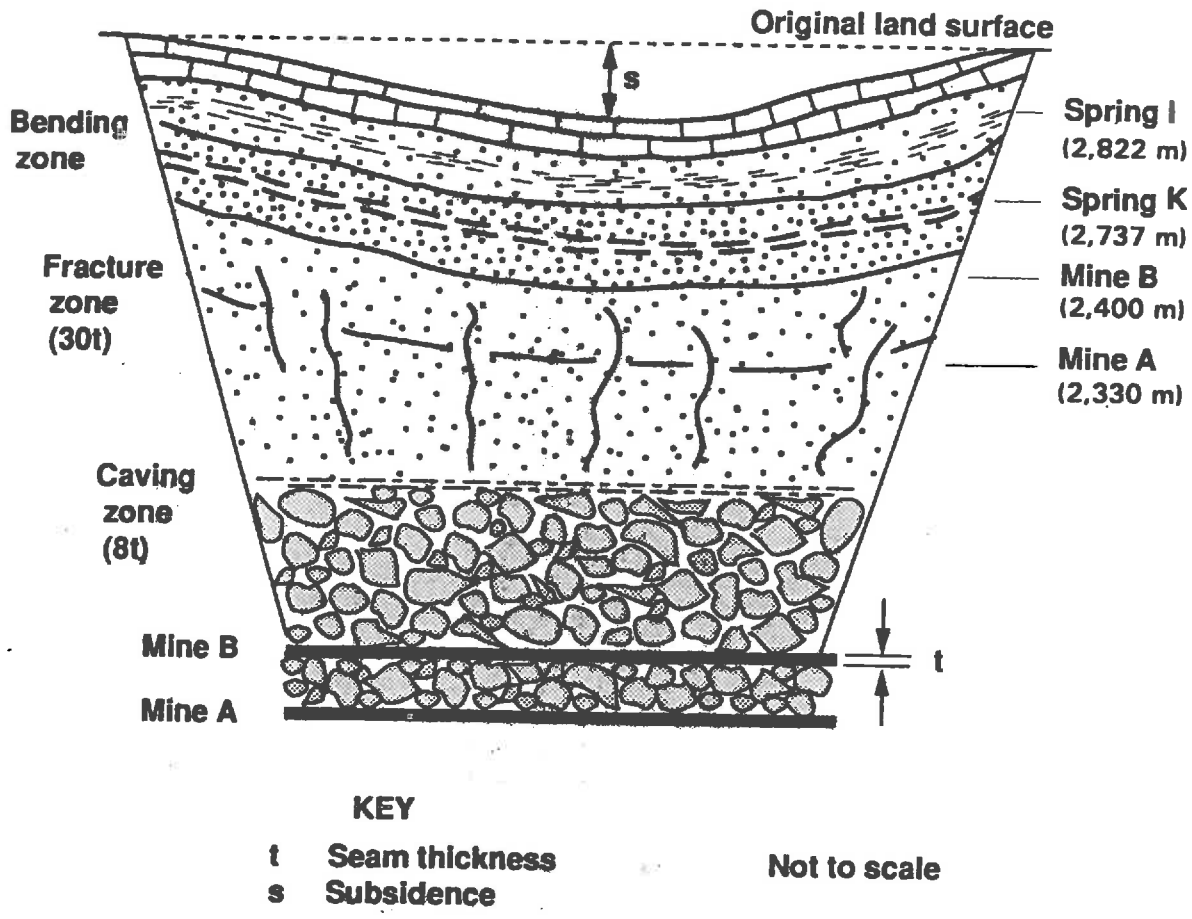

Figure 5.—Conceptual overburden failure schematic.

SUMMARY

The USBM used data available from the Deer Creek and Cottonwood Mines to perform a study of underground coal mining effects on local overburden hydrology. Data used in the study included seasonal and annual spring discharge, precipitation, surface subsidence, and overburden failure mechanics information. These data sets were used to quantify the response of 14 springs to underground mining.

Eight springs occurred over longwall panels. One of the eight, spring I, exhibited a departure from a normal recession curve coincident with the time of mining activity underneath it. Adjustments to valves and blockage of a pipe installed at the spring also occurred in the same time period and contributed to the variations in curve shape. The spring exhibited a constant discharge rate in the weeks after being undermined by a longwall panel, indicating that little variation occurred as a result of mining. The eight springs over panels all occurred at locations where the ratio of panel width to overburden thickness was greater than 1.0, thus limiting dewatering effects, as was observed in previous studies in Eastern U.S. coalfields. Surface subsidence did not appear to play a major role in the response of springs at this site.

Four springs experienced no discharge conditions during the period of study that were attributed to effects of regional decreased precipitation. Springs located over mine structures such as pillars or mains did not exhibit discernible effects from mining. For this study, the long-term availability of water resources was important and therefore dictated examining the seasonal response of springs in relation to mining.

The expected response of springs to undermining would be dramatic alterations in flow, as previously documented in other studies. The lack of observed responses was attributed to geologically driven site-specific conditions that buffered the effects of mining. These conditions included the thickness of overburden between the mine level and the springs, which ranged from 440 to over 600 m. Studies performed in the Appalachian coalfields noted dramatic decreases in spring discharge and water levels in wells

where thinner (70 to 245 m) overburden was present *(13, 15, 17)*. Additionally, the presence of hydrophilic clays and mudstones in the overburden, which act as aquitards retarding the migration of water, likely lessened the vertical extent of strata dewatering, as has been observed in other studies *(17)*. The location of the springs above the estimated elevations of fracturing and caving in the overburden due to subsidence also contributed to the limited effects.

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APPENDIX.—HYDROLOGIC DATA GRAPHS

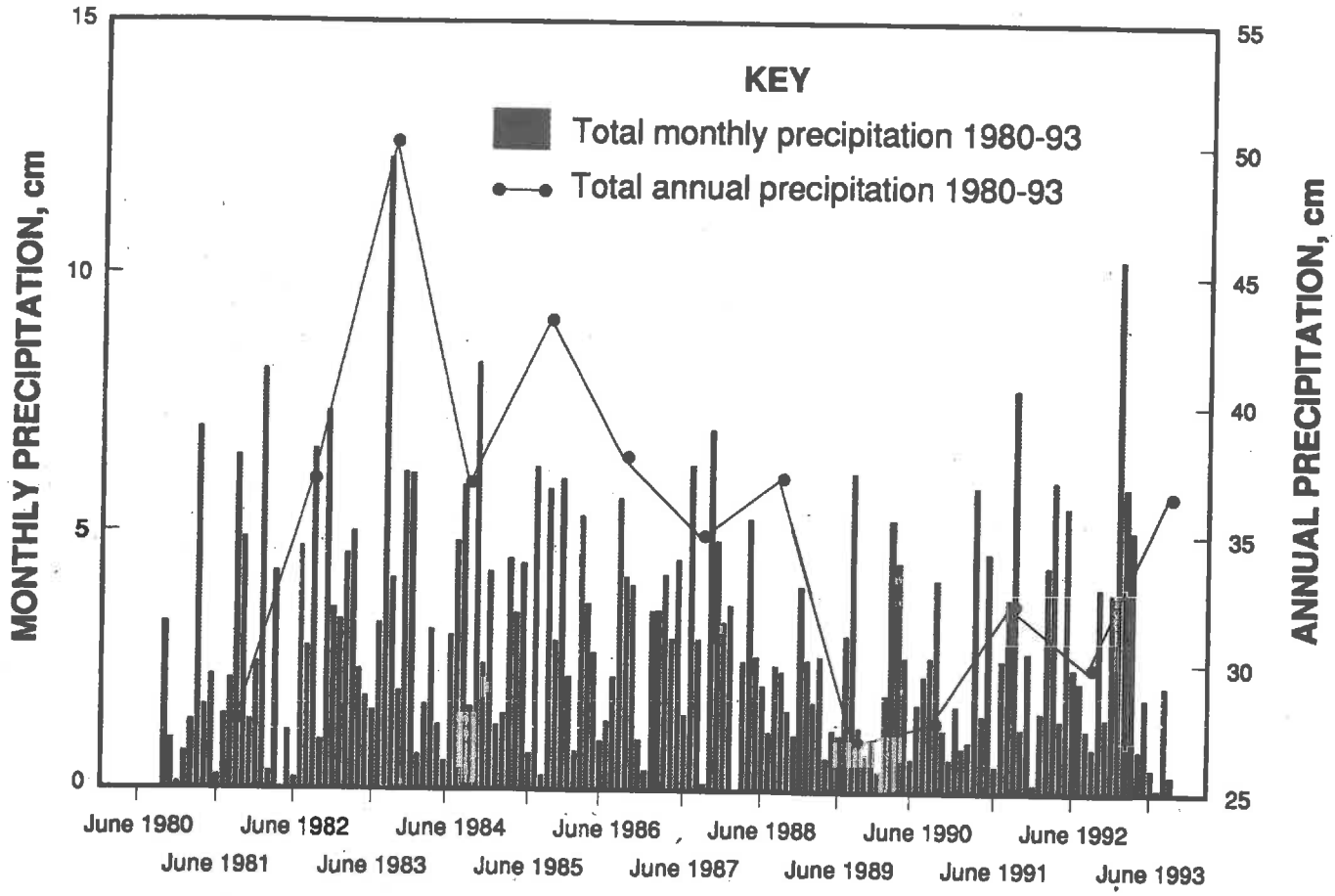


Figure A-1.—East Mountain precipitation for water years 1981-93.

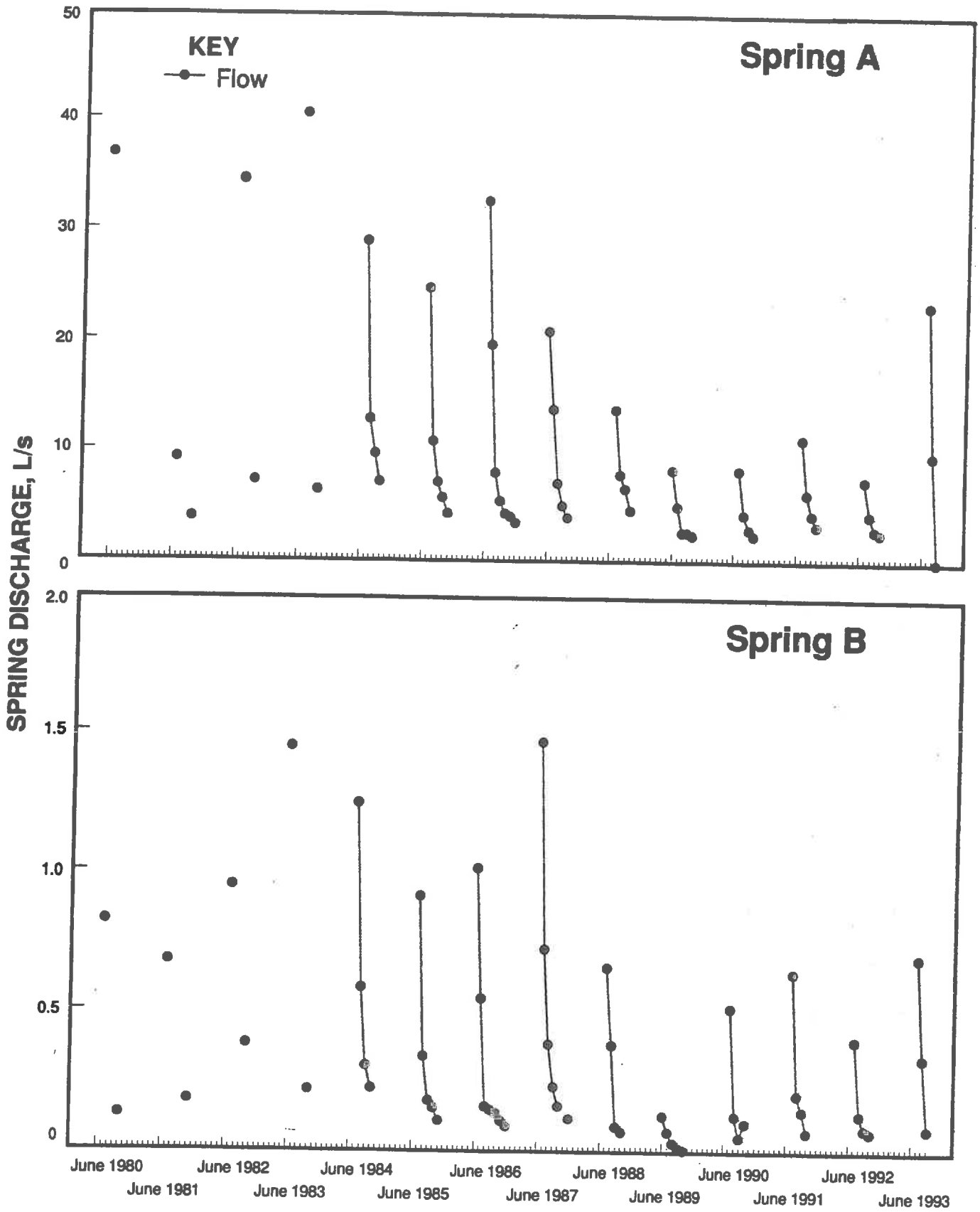


Figure A-2.—Spring discharge hydrographs for water years 1981-93.

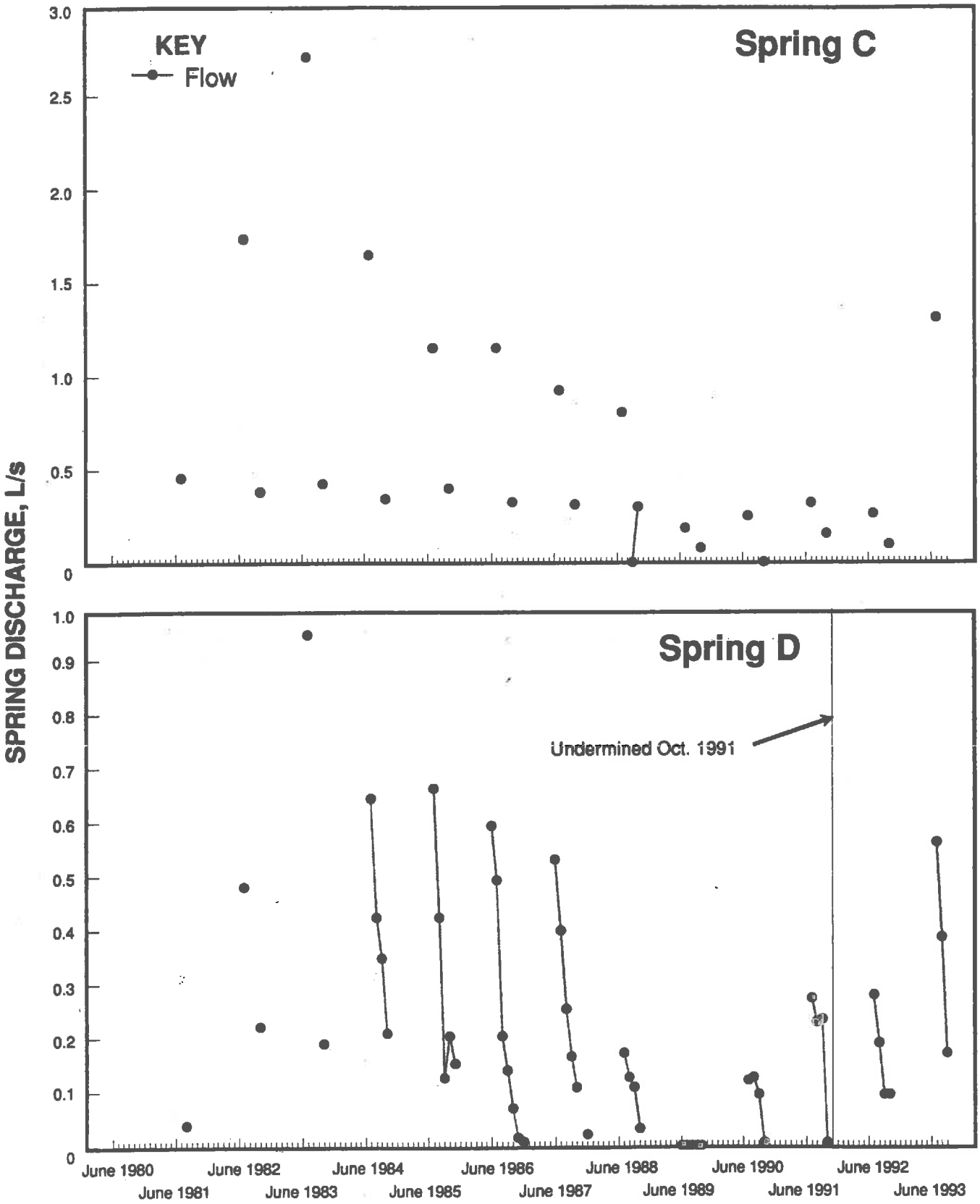
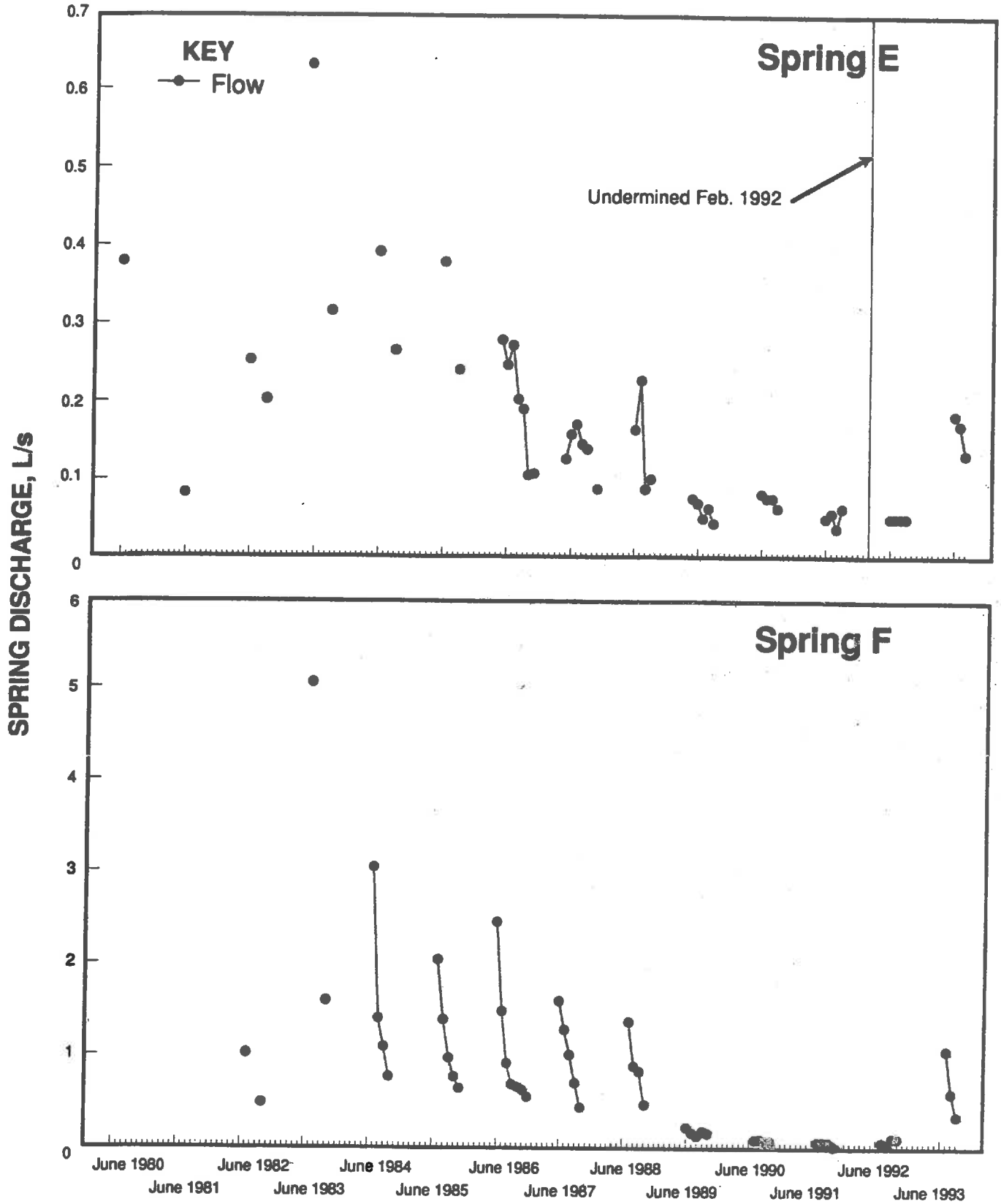


Figure A-2.—Continued.



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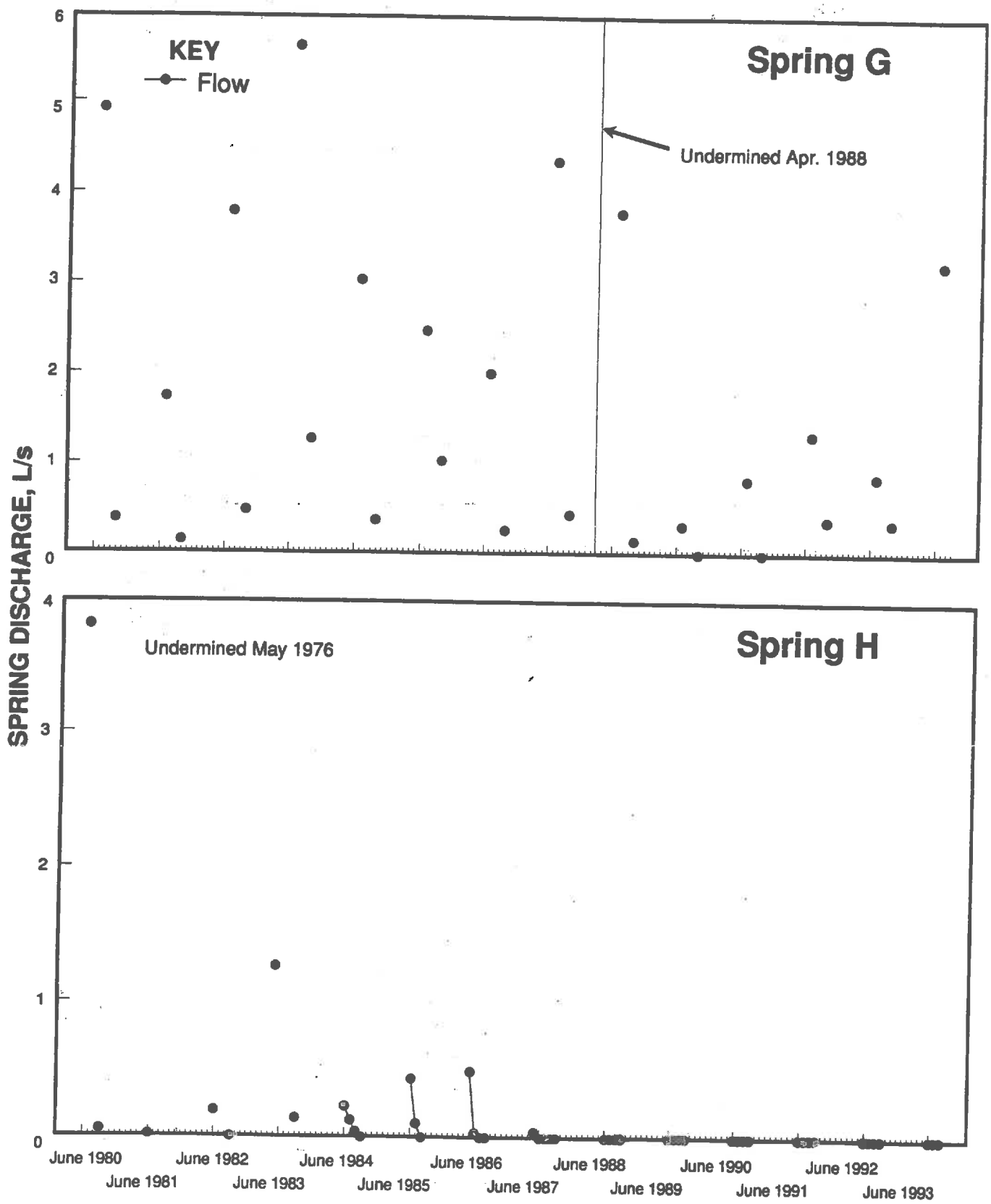

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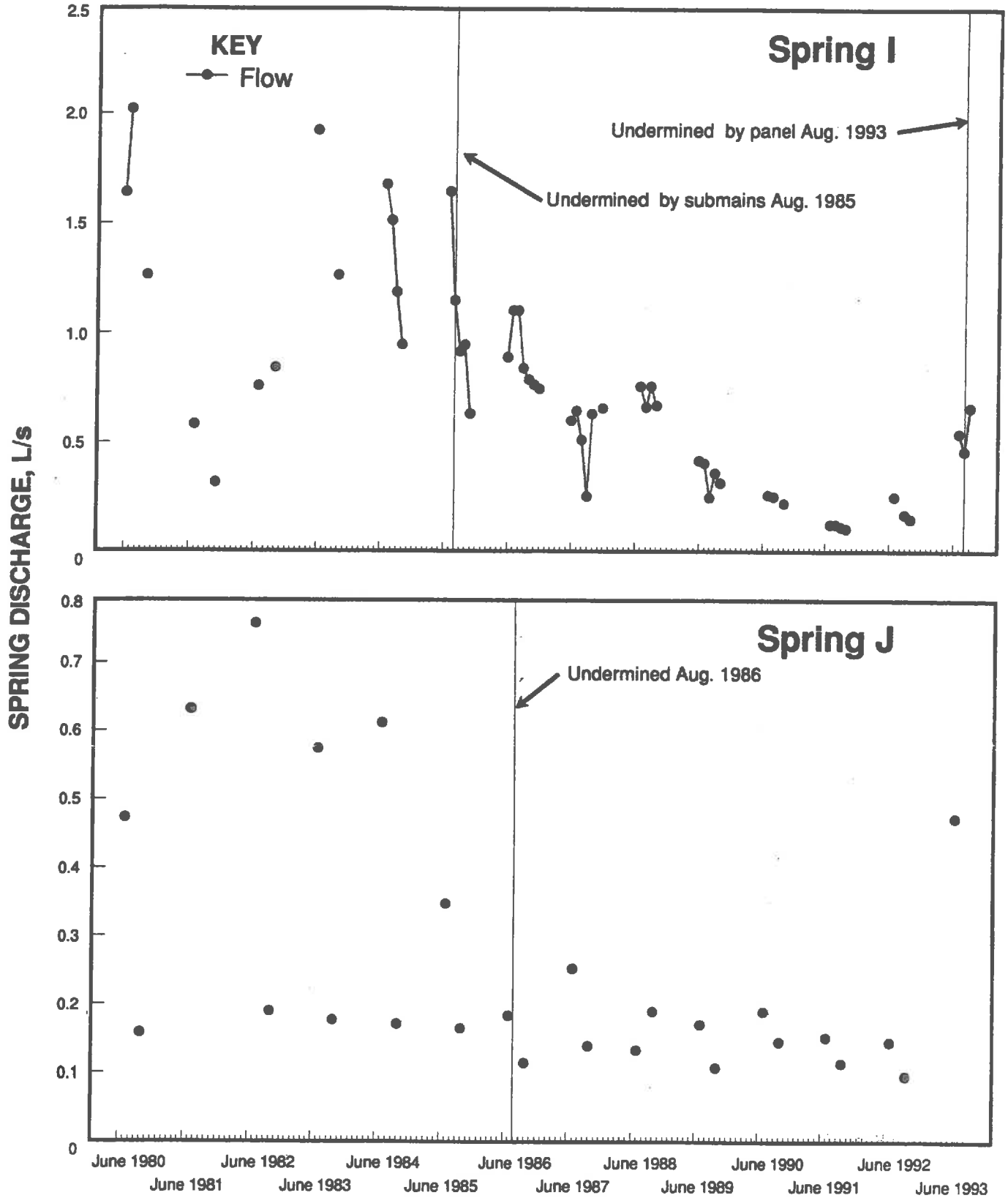

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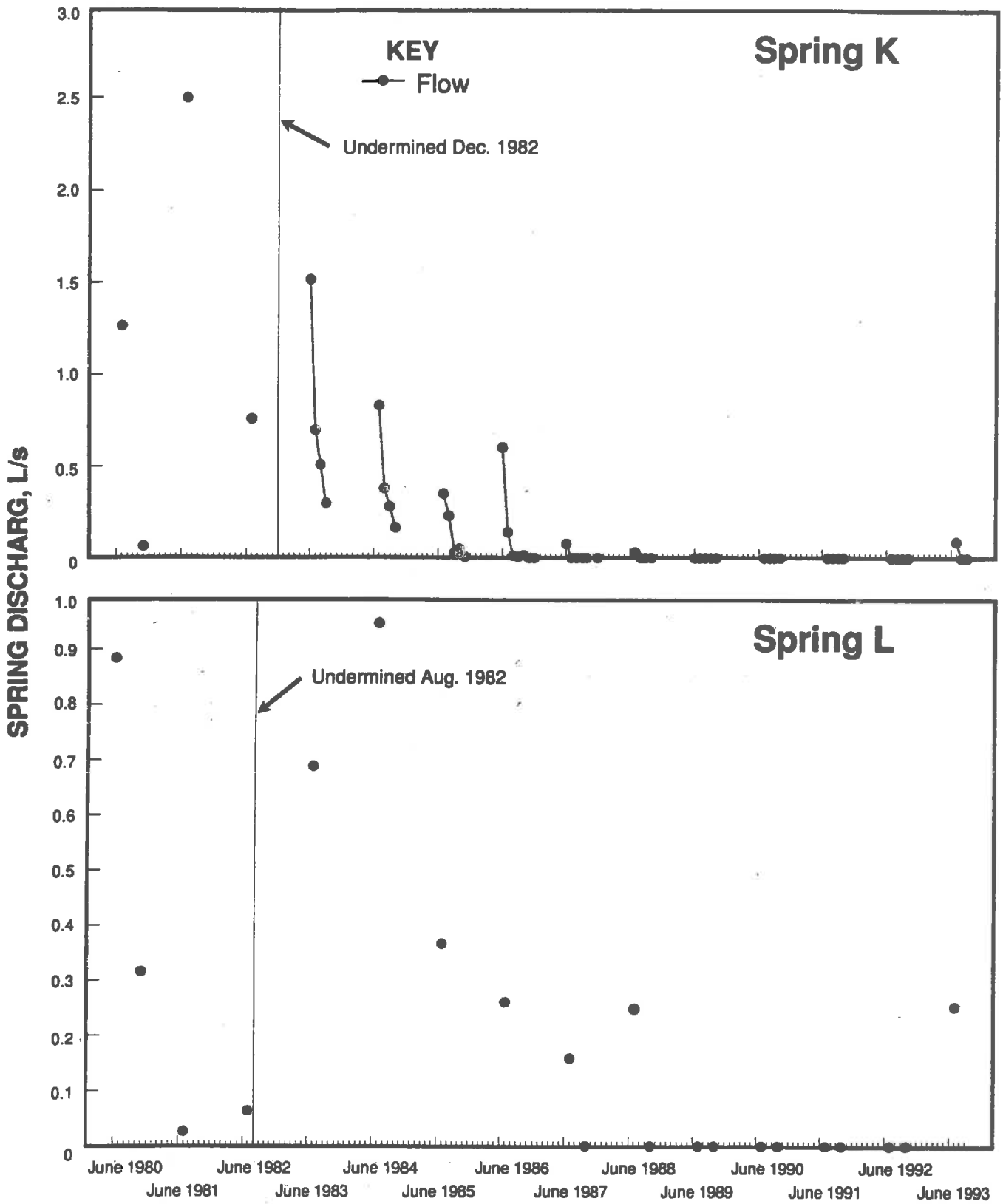

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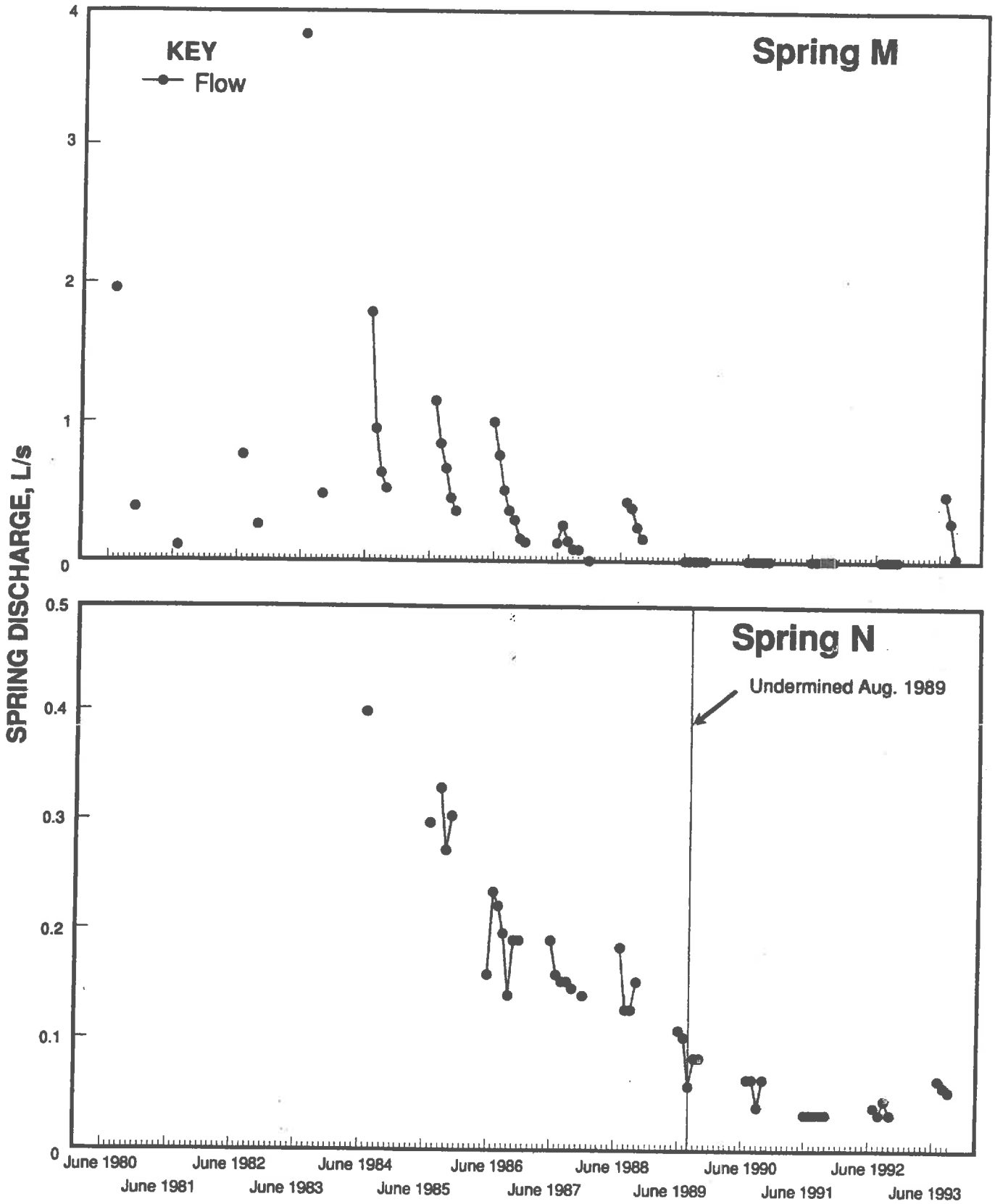

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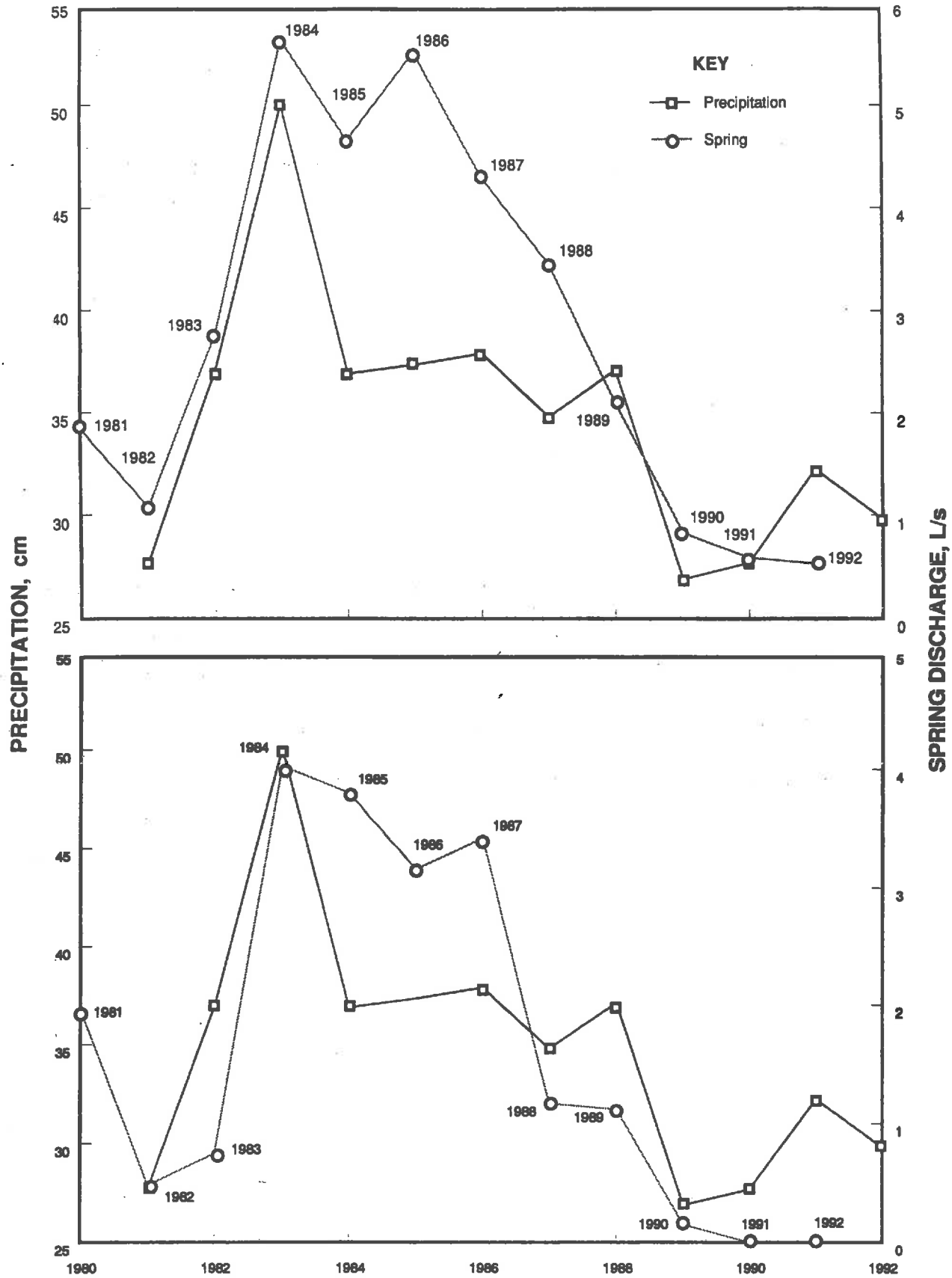

Figure A-3.—Cross-correlated spring and precipitation data. Top, spring I; bottom, spring M.

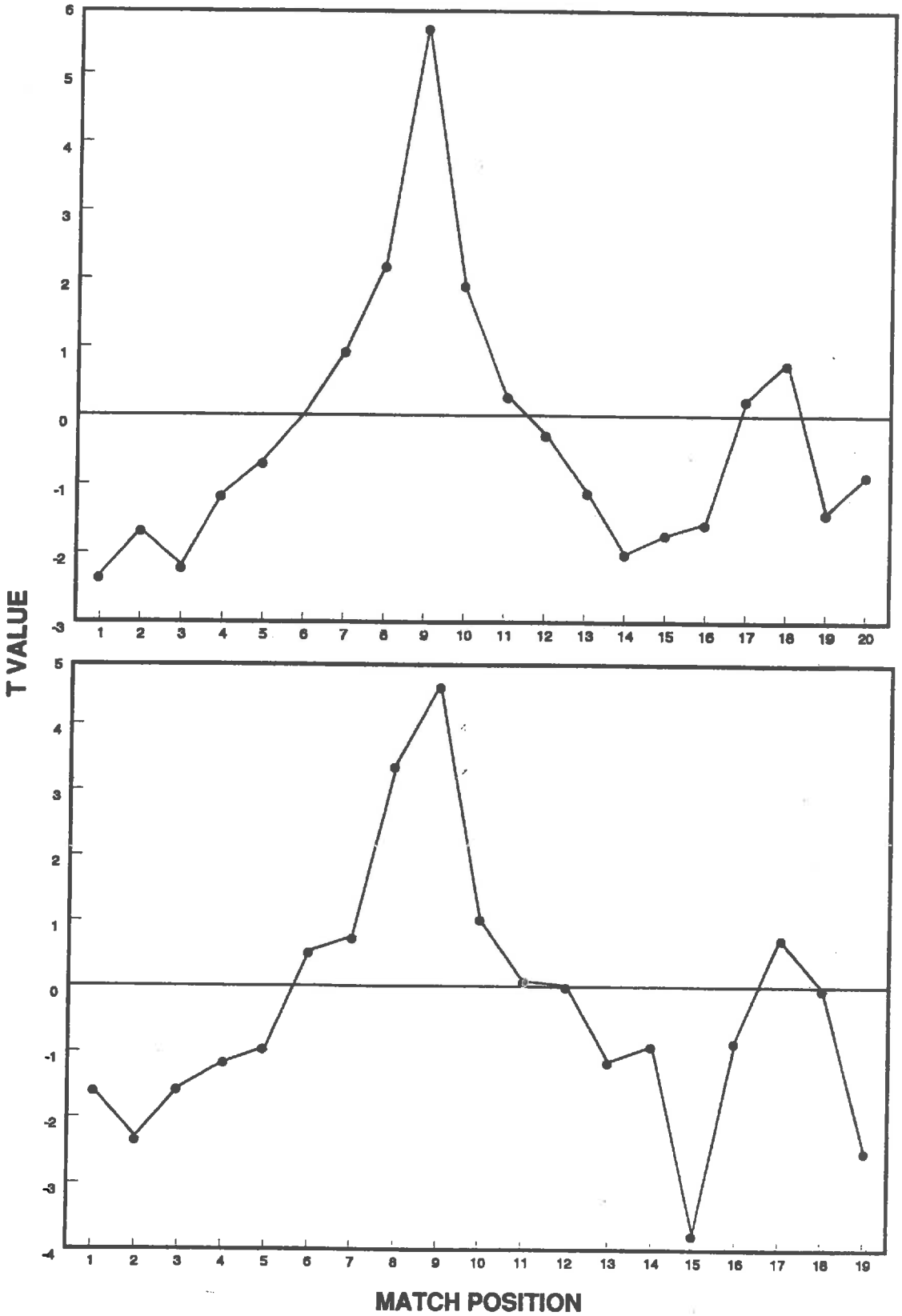

Figure A-4.—Match position versus T value. Top, spring I; bottom, spring M.

Investigation of Surface-Water and Groundwater Systems in the PacifiCorp Lease Area, East and Trail Mountains, Emery County, Utah:

Probable Hydrologic Consequences of Coal Mining in the Trail Mountain LBA and Recommendations for Surface-Water and Groundwater Monitoring

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PacifiCorp, Huntington, Utah

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Prepared by:

Alan L. Mayo, Ph.D.
California Registered Geologist #3265

Erik C. Petersen
Senior Hydrogeologist

Kelly L. Payne
Hydrogeologist

Mayo and Associates, LC
710 East 100 North
Lindon, Utah 84042

Mayo and Associates, LC
Consultants in Hydrogeology

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1. INTRODUCTION

PacifiCorp has operated the Cottonwood, Wilberg, Deer Creek, Des-Bee-Dove, and Trail Mountain mines since 1979. The mines are located in the central Wasatch Plateau west of Huntington, Utah. PacifiCorp is currently planning to expand their Trail Mountain mine north and west to include the Trail Mountain Lease-By-Application (Trail Mountain LBA; Figure 1). This report discusses the hydrology and hydrogeology of the PacifiCorp lease area and the probable hydrological consequences of underground coal mining in the Trail Mountain LBA. This report is divided into 11 sections including this introduction. These sections include:

Section 1	Introduction
Section 2	Project Overview
Section 3	Description of the PacifiCorp Mines
Section 4	Climatic, Physiographic, and Geologic Setting
Section 5	Solute and Isotopic Chemistry
Section 6	Groundwater
Section 7	Surface Water Hydrology
Section 8	Conclusions
Section 9	Probable Hydrologic Consequences
Section 10	Recommended Monitoring Plan
Section 11	References Cited

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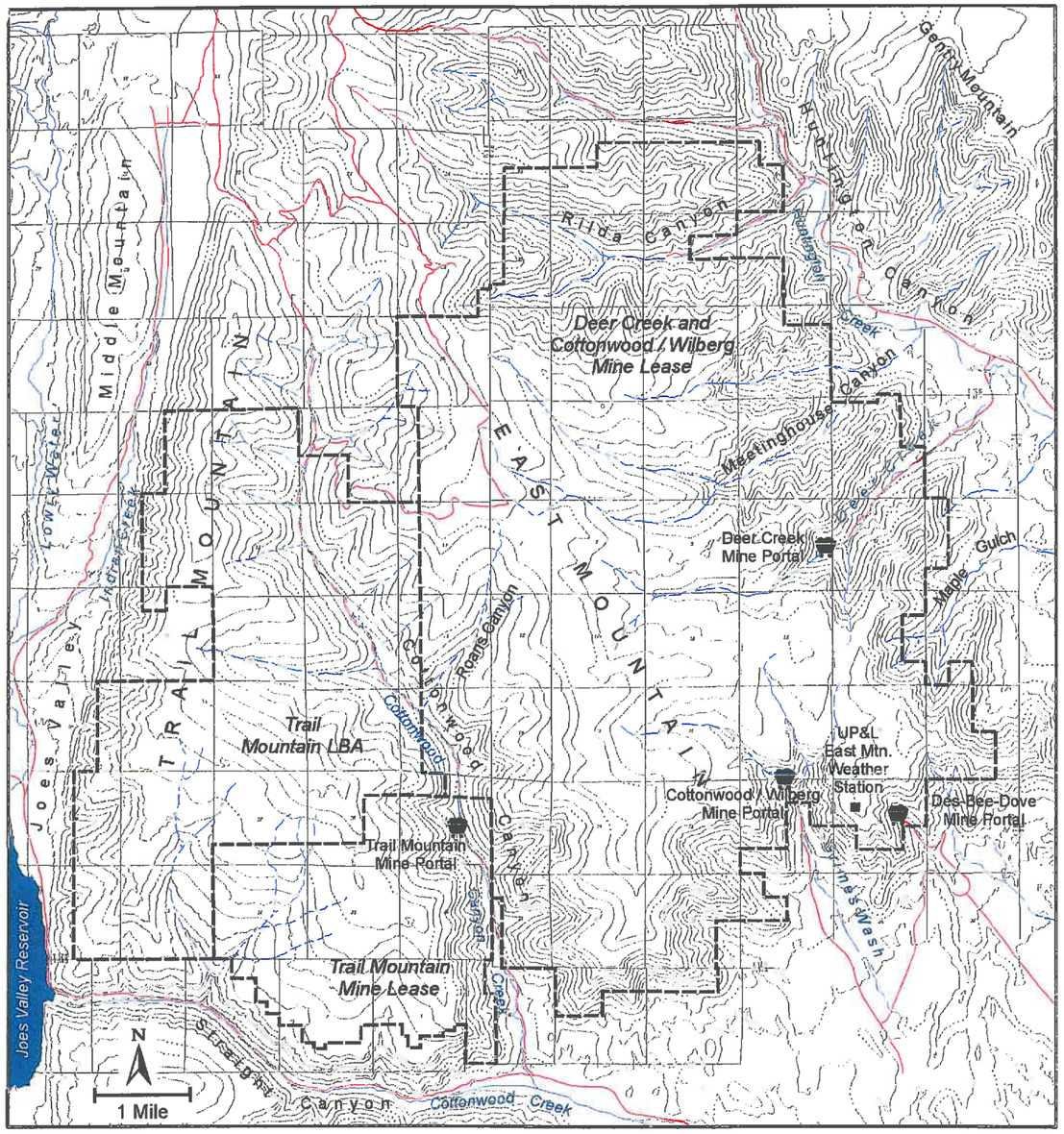


Lease Boundary

Contour interval 200 feet

Figure 1 Map showing the principal geographic features, locations of the mine lease areas, and mine portals.

2. PROJECT OVERVIEW

2.1 Purpose of investigation

The purpose of this investigation is to: 1) characterize the hydrology and hydrogeology of the PacifiCorp lease area on East Mountain and Trail Mountain, 2) describe the probable hydrologic consequences of underground coal mining to surface waters and groundwaters within the Trail Mountain LBA, and 3) recommend locations and protocols for surface water and groundwater monitoring for the Trail Mountain LBA.

2.2 Methods of investigation

The hydrology and hydrogeology of the PacifiCorp lease area have been evaluated by analyzing: 1) solute and isotopic compositions of surface waters and groundwaters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information. Specific methods of investigation are described below.

2.2.1 Maps and reports

Existing published and unpublished hydrologic, hydrogeologic, and geologic reports and maps were obtained and reviewed.

2.2.2 Compilation of historic water quality, piezometric and stream flow data

PacifiCorp and its predecessors have monitored springs on East and Trail Mountains since 1979. Both baseline and periodic water quality data have been collected from springs, groundwater monitoring wells, streams, in-mine roof drips and wells, and mine-water discharge points. Solute and discharge data have been collected at 14 stream sites, 96 springs,

4 french drains, mine discharge points, and 47 groundwater inflow sites within the mines. In addition to the quarterly monitoring conducted by PacifiCorp, flow, solute, and isotopic data have been collected at various times by government agencies, PacifiCorp personnel, and consultants. Solute and piezometric data are also available for 16 groundwater monitoring wells.

Historical solute, discharge, and water level data were obtained from PacifiCorp in electronic format for use in this investigation. Only those samples for which the complete suite of major ion analyses was available were used for analytical purposes in this investigation. The complete suite of major ions include Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^-, CO_3^{2-}, SO_4^{2-}, and Cl^-.

Mayo and Associates and mine personnel compiled site location data from information and digital drawings provided by the PacifiCorp. These data include state plane coordinates, elevation, geology, occurrence, and height above base of geologic formation.

2.2.3 Collection and analysis of additional solute and isotopic data

As a part of this investigation water samples from 13 springs, 2 wells, 9 in-mine groundwater discharge locations, the portal of the abandoned Oliphant Mine, and 6 snow sites were collected and analyzed for solute and isotopic composition during 1996 and 1997.

Isotopic samples for δ^2H, $\delta^{18}O$, and ^3H analyses were collected, sealed, and preserved in appropriate glass or HDPE plastic bottles. Dissolved inorganic carbon and SO_4^{2-} for $\delta^{13}C$, $\delta^{34}S$, and ^{14}C analysis were precipitated with $BaCl_2 \cdot 2H_2O$.

Stable isotopic analyses for δ^2H, $\delta^{18}O$, $\delta^{13}C$, and $\delta^{34}S$ compositions and unstable ^{14}C contents were performed by Geochron Laboratories, Cambridge, Massachusetts. The ^3H analyses were performed by the Tritium Laboratory, University of Miami, Florida using electrolytic enrichment and low level counting methods. Laboratory reporting sheets for isotopic analyses are included as Appendix A

2.2.4 Stream gauging

On August 22, 1996, Mayo and Associates and PacifiCorp personnel performed gain-loss measurements on Indian Creek and Cottonwood Creek between Joes Valley Reservoir and the confluence of Cottonwood Creek and Cottonwood Canyon Creek. Measurements were made using a Marsh-McBurney automated pressure transducer flow meter.

2.2.5 Data analysis

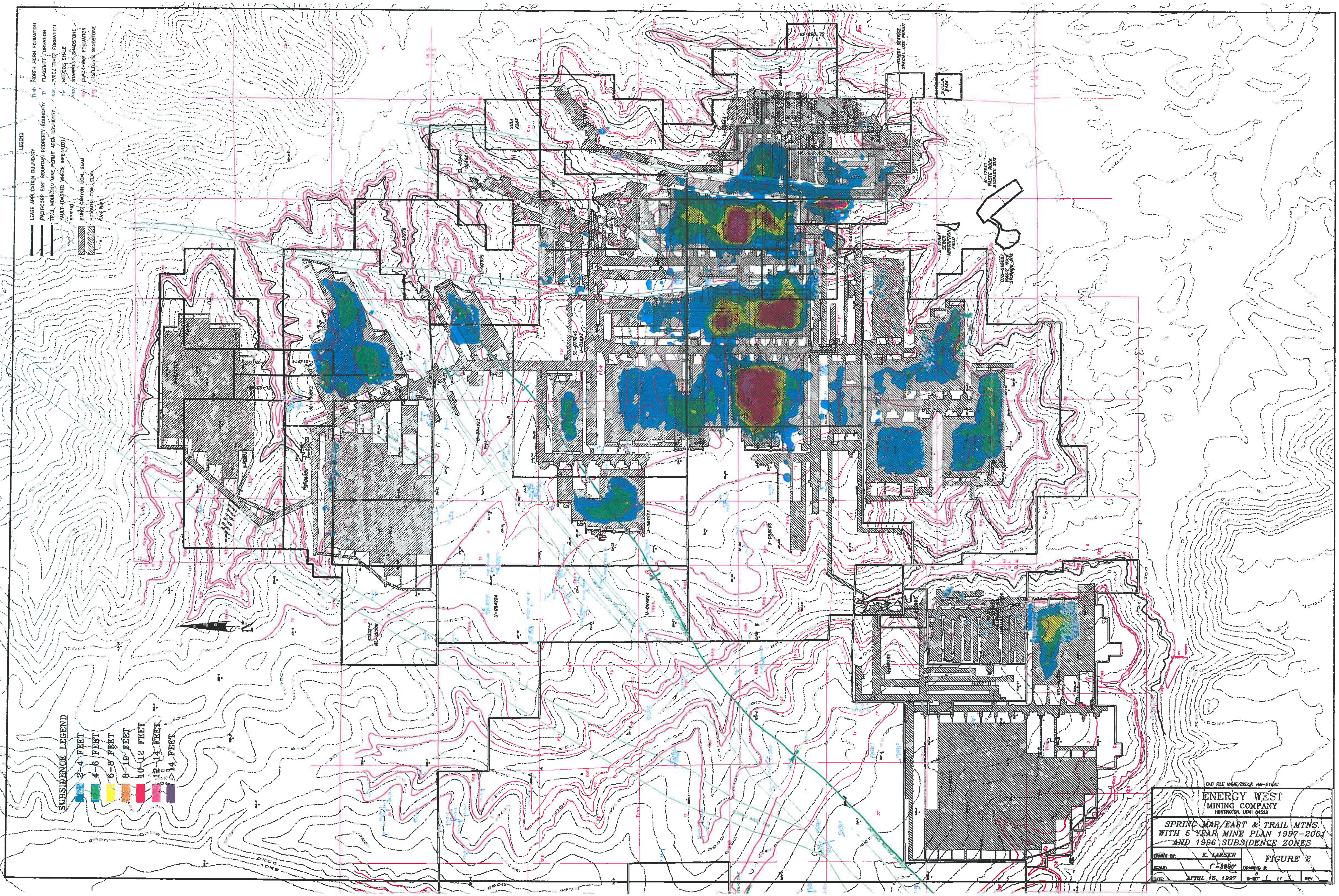
Geochemical, isotopic, discharge, and other data were compiled into electronic format and were analyzed by graphical, statistical, and computer methods. Solute compositions were graphically analyzed using Stiff (1951) and Piper (1944) diagrams. Solute data were analyzed using the computer code WATEQF (Plummer and others, 1976). Groundwater ^{14}C residence times were calculated using methods described by Fontes (1980), Mooke (1980), and Pearson (1970).

3. DESCRIPTION OF THE PACIFICORP MINES

Coal produced from the PacifiCorp mines is used to fire electrical power plants in Carbon and Emery Counties. Presently, PacifiCorp is actively mining in the Trail Mountain and Deer Creek mines. The Wilberg and Cottonwood mines are not currently mined, but are kept open to allow for the operation of a coal haulage beltway through the old mine workings. The Des-Bee-Dove Mine is no longer active and is planned for reclamation in the near future. Currently, all mining at the PacifiCorp mines is carried out using longwall mining techniques. Continuous miners are used only for driving gateroads for longwall panels.

PacifiCorp currently mines approximately 7.5 to 8.0 million tons of coal per year. This production rate has remained relatively constant over the past several years.

Subsidence above mined areas is closely monitored. Previously, surface subsidence monitoring was carried out using traditional survey methods. Currently, subsidence is monitored primarily using photogrammetric techniques. Ground subsidence measured in the lease areas is shown in Figure 2. Subsidence in excess of 15 feet has been measured. The greatest subsidence effects occur in steep cliff areas where the brittle Castlegate Sandstone is exposed and in areas where mining has occurred next to burned coal and less competent clinker beds which readily collapse under mining-induced compression (PacifiCorp, 1996a). To minimize any potential impacts to the steep sandstone cliffs where the Castlegate Sandstone crops out along the edge of the plateau, longwall mining is generally not carried out near cliff areas. Surface fractures are associated with subsidence in steep cliff areas and along the margins of longwall panels.


LEGEND
LEASE APPLICATION BOUNDARY
PACIFICORP EAST MOUNTAIN PROPERTY BOUNDARY
TRAIL MOUNTAIN MINE PERMIT AREA BOUNDARY
FAULT (DASHED WHERE INFERRED)
SPRING
BLIND CANYON COAL SEAM
HIAWATHA COAL SEAM
GAS WELL
Tknh NORTH HORN FORMATION
Tf FLAGSTAFF FORMATION
Kpr PRICE RIVER FORMATION
Km MANCOS SHALE
Ksp STARPOINT SANDSTONE
Kbh BLACKHAWK FORMATION
CASTLEGATE SANDSTONE
SUBSIDENCE LEGEND
2–4 FEET
4–6 FEET
6–8 FEET
8–10 FEET
10–12 FEET
12–14 FEET
>14 FEET
FOREST SERVICE SPECIAL USE PERMIT
U-57642 WASTE ROCK STORAGE SITE
SEWER ABSORPTION FIELD
UTU-085027 WASTE ROCK STORAGE SITE
U-47979
U-084923
U-084924
U-083066
U-02664
CAD FILE NAME/DISK#: HM-61835
ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528
SPRING MAP/EAST & TRAIL MTNS.
WITH 5 YEAR MINE PLAN 1997–2001
AND 1996 SUBSIDENCE ZONES
DRAWN BY: K. LARSEN
SCALE: 1" = 2000'
DATE: APRIL 18, 1997
FIGURE 2
DRAWING #:
SHEET 1 OF 1
REV.

4. CLIMATIC, PHYSIOGRAPHIC, AND GEOLOGIC SETTING

4.1 Climate

Maximum summertime temperatures in the lowest areas of the lease area commonly exceed 100°F (38°C), while midwinter minimum temperatures well below 0°F (-18°C) are common at higher elevations. Precipitation in the region varies greatly with elevation. Within the permit area mean annual precipitation ranges from about 10 inches in the low elevations to more than 25 inches in the highest elevations (PacifiCorp, 1996b).

Since 1981, PacifiCorp has operated a weather station on East Mountain (Figure 1) at an altitude of 8,985 feet. Long term precipitation data are shown in Figures 3a and 3b. Data from this station indicate that, of the total annual precipitation, about 50% occurs as summer rains, and about 50% as winter snowfall (Figure 3a). Although no measurements of sublimation have been made, it is believed that a significant portion of the winter snowpack is lost to sublimation, particularly on the high plateaus, which are subject to dry winds common to the region. The effects of climatic variability are shown in Figure 3b. Wetter years in the mid-1980s were followed by drier years in the late 1980s and early 1990s.

4.2 Physiography

The PacifiCorp mines are located in the central Wasatch Plateau. The topography of the area consists of narrow, flat-topped mesas surrounded by heavily vegetated slopes that extend to the precipitous cliffs of the eastern escarpment of the plateau. At the base of the plateau lies Castle Valley, which is developed on the Mancos Shale, and is naturally nearly devoid of vegetation. Cottonwood Canyon dissects the study area dividing East Mountain from Trail

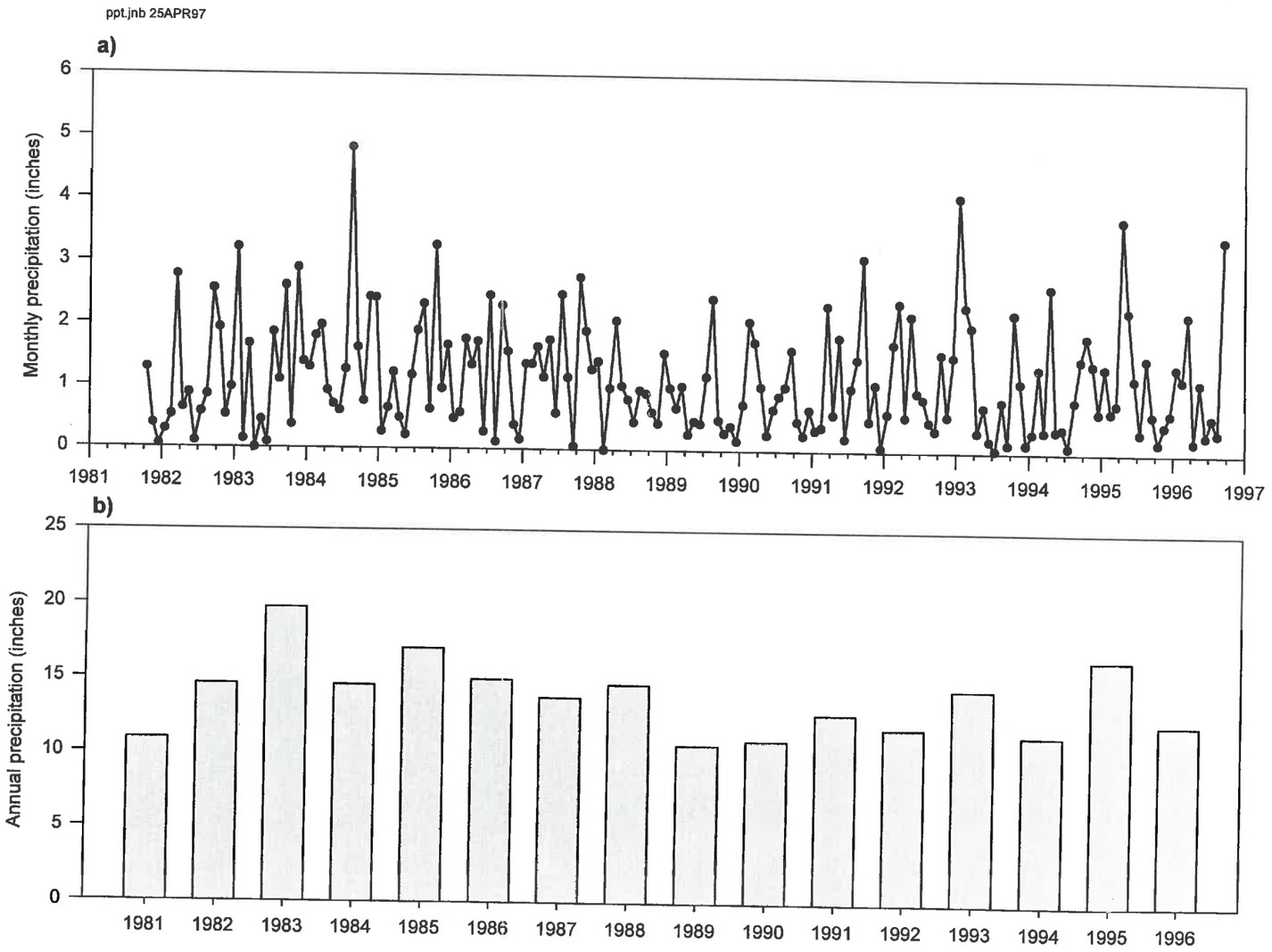


Figure 3 Precipitation at the UP&L East Mountain weather station: a) monthly total and b) annual totals by water year (October-September).

Mountain (Figures 1 and 4). Joes Valley defines the western margin of the study area. Ground elevations in the study area range from approximately 6,800 feet near the base of the plateau in Castle Valley to over 10,600 feet immediately north of Trail Mountain.

4.3 Geology

4.3.1 Stratigraphy

In the mine lease area, seven bedrock formations crop out (Figure 5). In descending order these formations are the: Flagstaff Limestone, North Horn Formation, Price River Formation, Castlegate Sandstone, Blackhawk Formation, Star Point Sandstone, and Mancos Shale (Figure 6). The upland plateau of the lease area is developed on the Flagstaff Limestone, the North Horn Formation, and the Price River Formation. The steep-walled canyons are cut into the Castlegate Sandstone, Blackhawk Formation, and Star Point Sandstone, and the broad expanse of lowland plateau is formed on the Mancos Shale (Figure 5). Geologic cross-sections through the mine lease area are shown in Figures 7a and 7b.

The bedrock formations were deposited during transgressions and regressions of the shoreline of the Western Cretaceous Interior Seaway during the Late Cretaceous and Early Tertiary. This ancient shoreline was located along the eastern edge of the tectonically uplifted mountains of the Sevier Orogenic Belt. Sediments eroded from the uplifted mountains were carried toward the seaway by fluvial systems and deposited as terrestrial, shoreline, marine, and interfingered non-marine and marine sedimentary sequences.

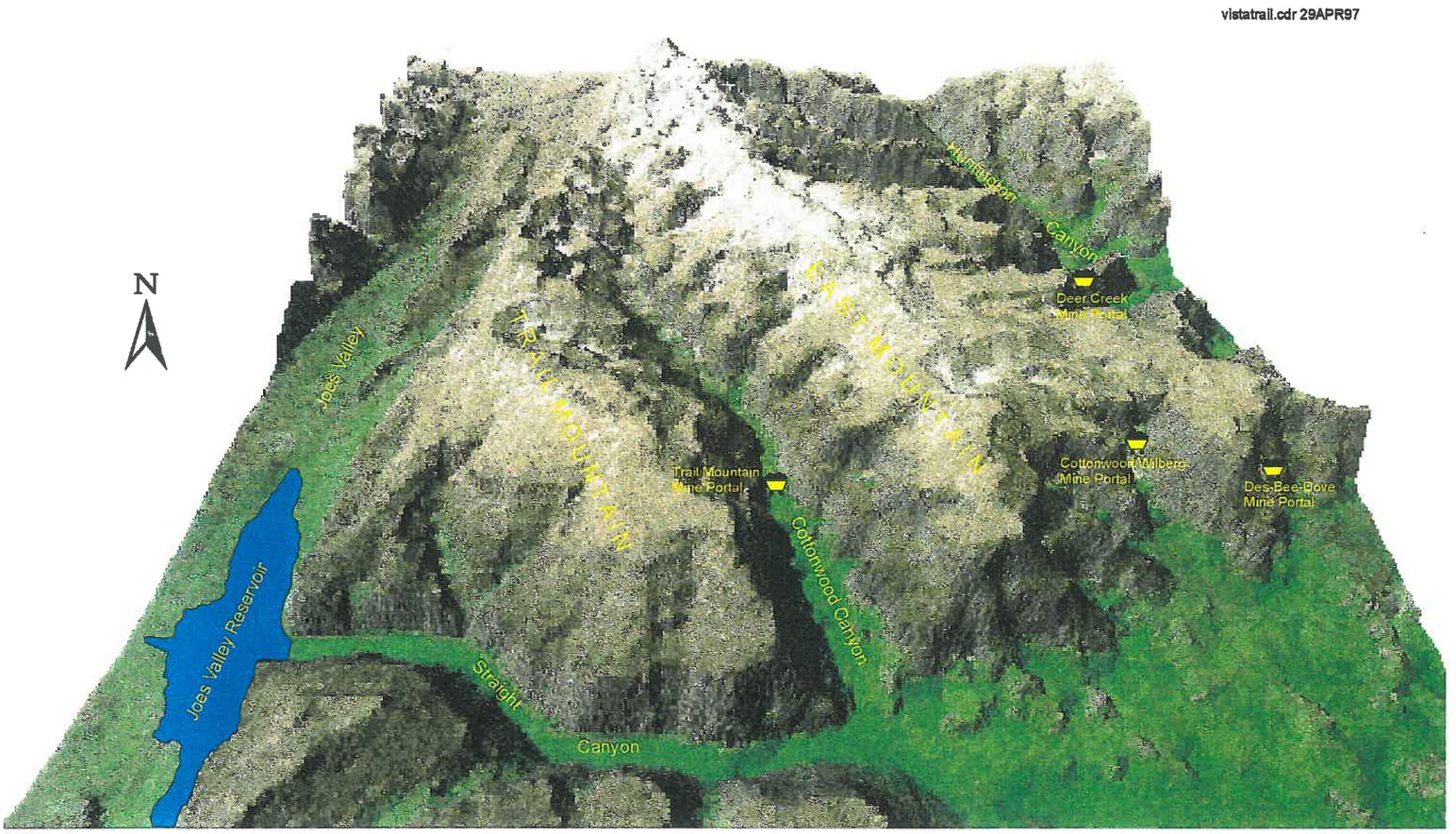


Figure 4 Digital elevation map illustrating topographic features.

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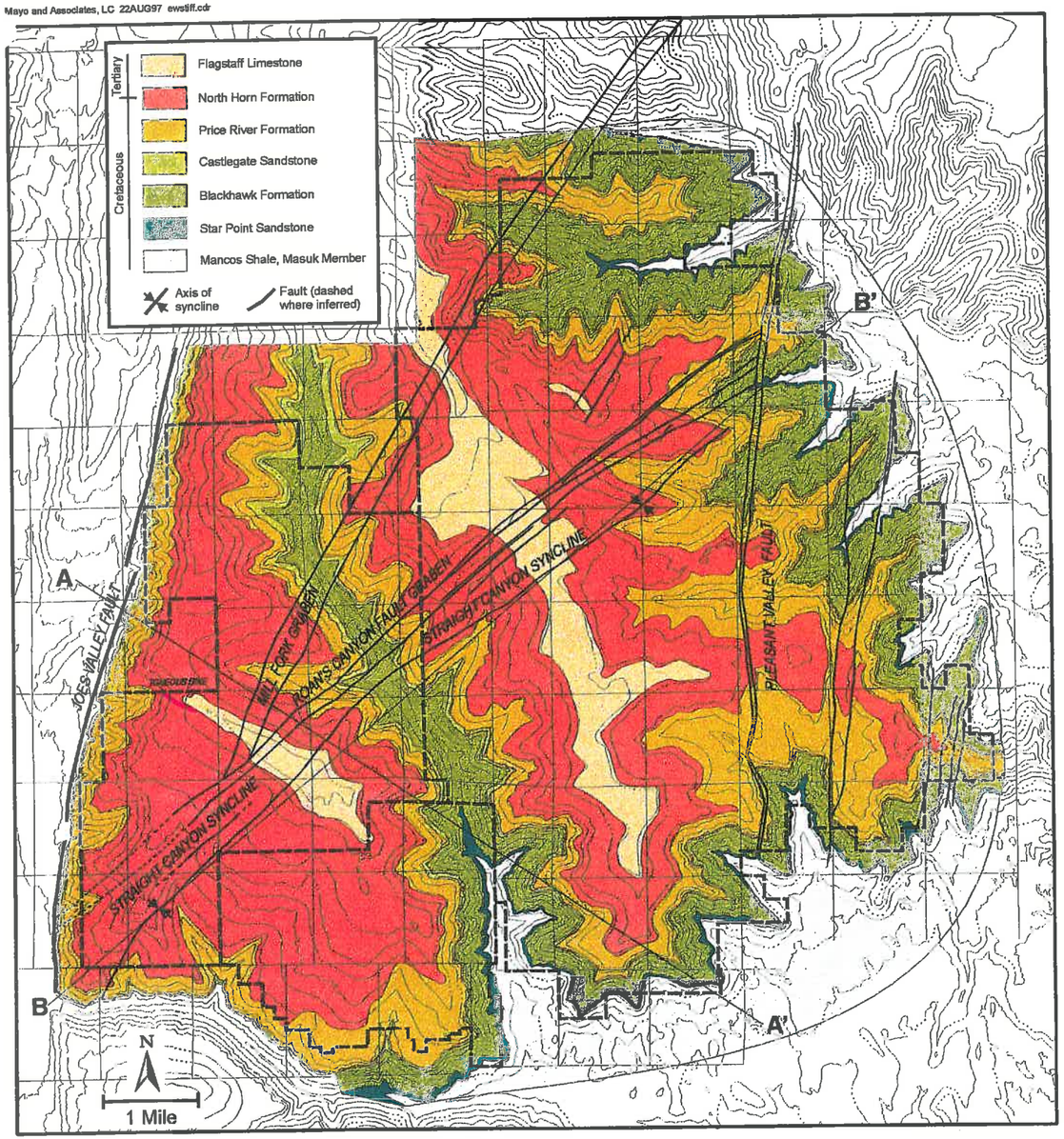

Figure 5 Geologic map of the Energy West lease area. Lines A-A' and B-B' show the location of cross-sections shown on Figure 7.

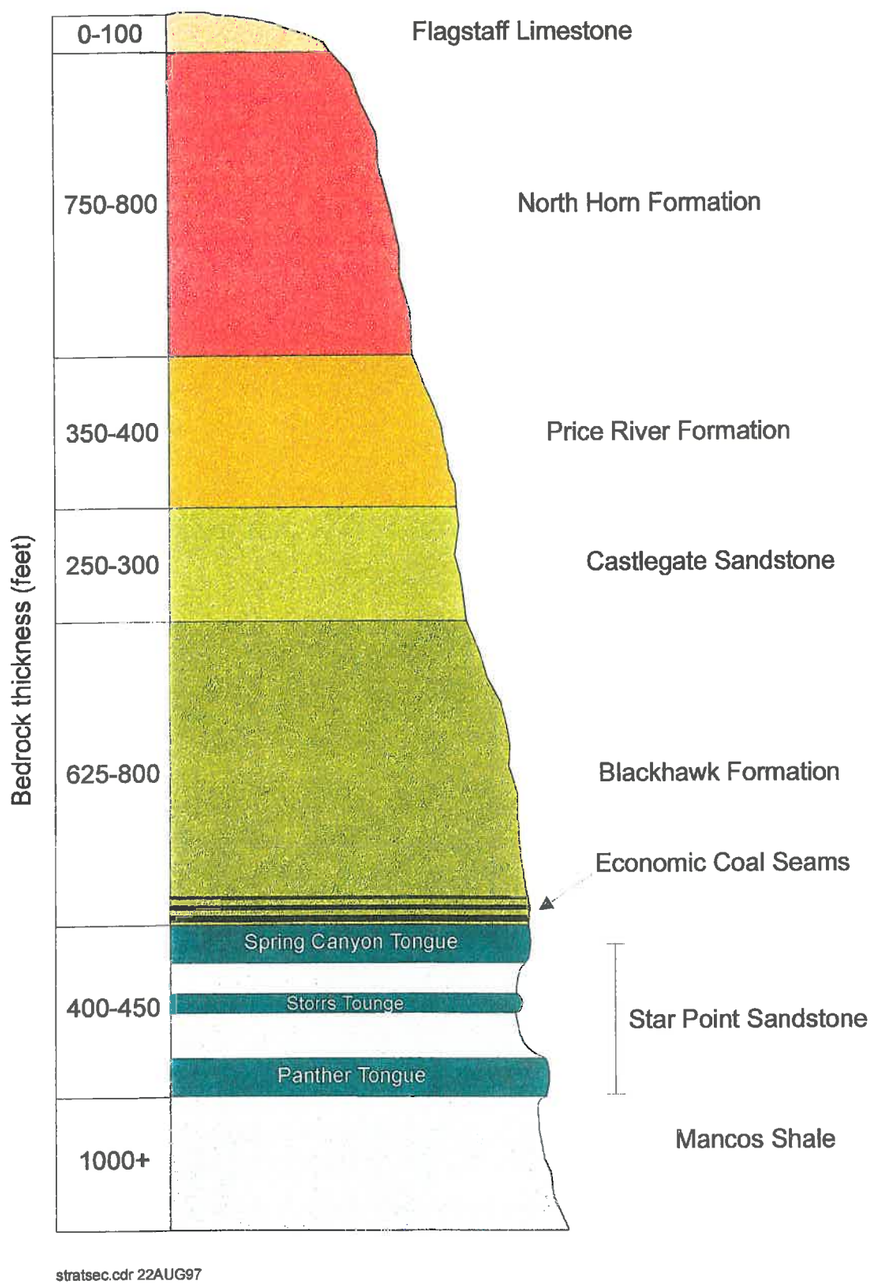

Figure 6 Stratigraphic column of bedrock formations in the mine lease area.

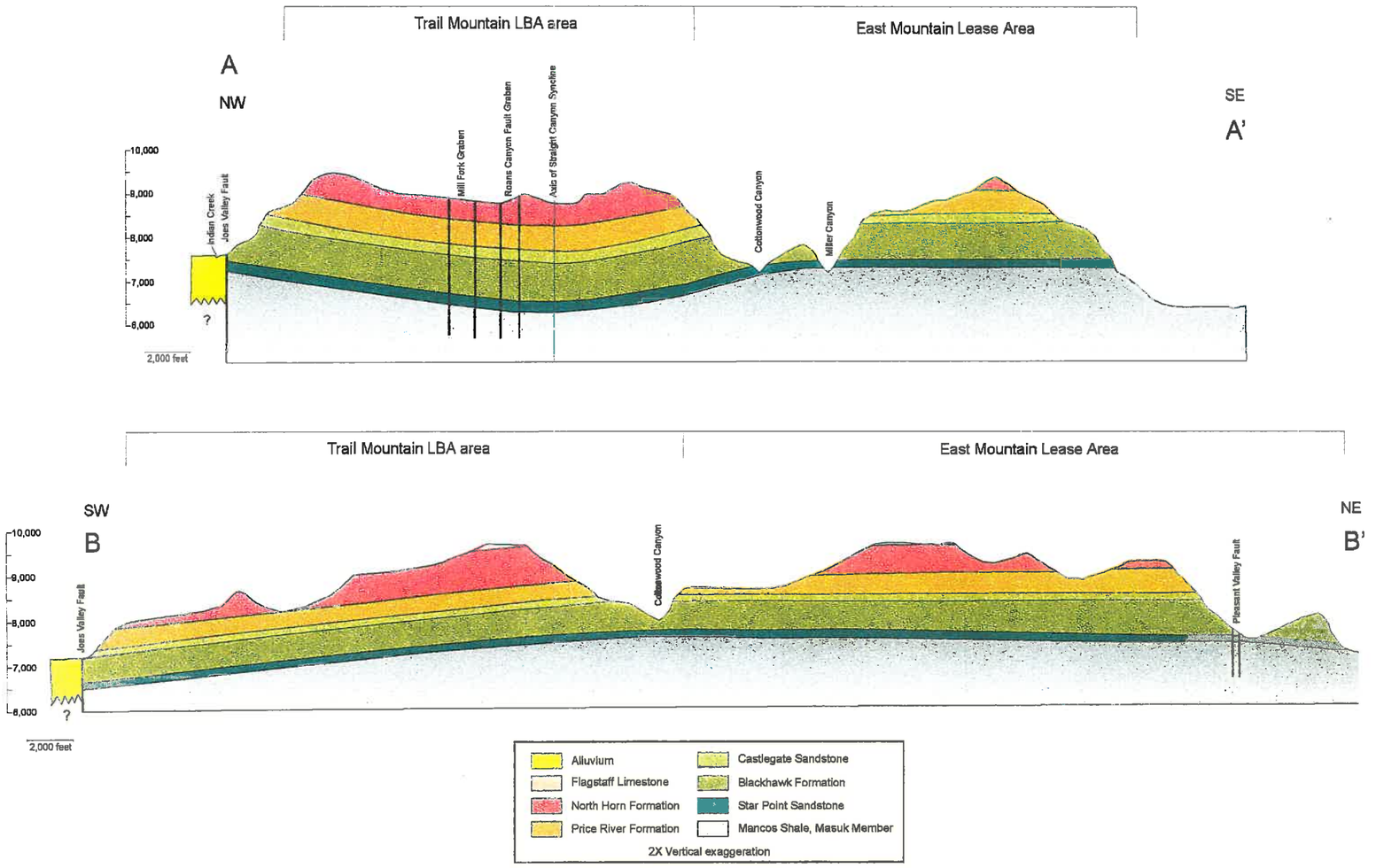

Figure 7 Geologic cross-sections through mine lease area. Cross-sections locations are shown on Figure 5. Figure 7a is a northwest-southeast cross-section perpendicular to the Straight Canyon Syncline. The cross-section in 7b is oriented southwest-northeast parallel to the Straight Canyon Syncline.

On the terrestrial side of the shoreline, sediment deposition occurred in lacustrine (lake carbonates, marls, and sands), alluvial plain (sands and clays), fluvial (stream sands and overbank muds), and carbonaceous backshore (coal swamp) environments. Along the shoreline, marine foreshore deposits (beach sands) accumulated. Offshore, sands swept from the beaches were laid down as bars and blankets of sand in the near-shore shallow marine water. These blankets of sand are known as shoreface deposits. The clay fraction of stream-transported sediments which reached the shoreline was deposited as thick marine muds (shale) in the deeper and more quiescent portions of the seaway. Because the transgression and regression of the shoreline was accompanied by the continued deposition of sediments, a variety of horizontally and vertically discontinuous sediment types occur throughout the coal district. This depositional history has resulted in a heterogeneous rock record that has had a profound effect on the water-bearing characteristics of these rocks.

The internal depositional geometry of the bedrock formations is illustrated in Figure 8. In Figure 8, typical geometric relationships between sandstone channels (white) and intrachannel muds (gray) are shown in the lateral and vertical relations column. In this column, sandstone channels are illustrated as cross-sections cut perpendicular to the long direction of the channel.

The seven bedrock formations are described below from youngest to oldest.

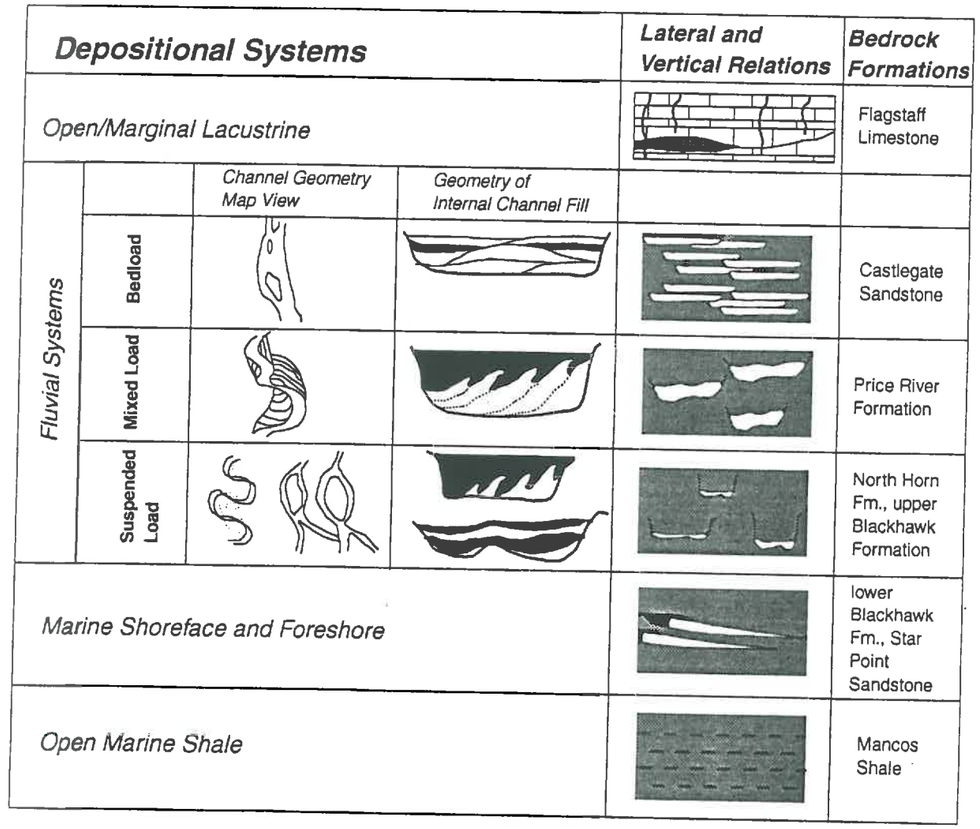

Figure 8 Diagram showing the internal structure of the bedrock formations in the mine lease area. In the geometry of internal channel fill column, mud is shown in black and sand is white. In the lateral and vertical relations column, mudstone is shown in grey and sandstone is shown in white.

4.3.1.1 Flagstaff Limestone (Tertiary Age)

The Flagstaff Limestone, which caps the uppermost portions of the Wasatch Plateau, is the youngest of the bedrock formations exposed in the PacifiCorp lease area (Figure 5). It typically forms a prominent white cliff on top of the plateau. A thickness of 105 feet was measured on Trail Mountain.

The Flagstaff Limestone consists of carbonates, marls, and some thin sandstone stringers deposited in lacustrine, marginal lacustrine, and alluvial plain depositional environments (Garner and Morris, 1996). It primarily consists of light- to medium-gray limestone containing abundant secondary fractures produced during uplift and subaerial exposure. Thin beds of shale and volcanic ash are present in some locations.

4.3.1.2 North Horn Formation (Tertiary-Cretaceous Age)

The North Horn Formation is the caprock of much of East and Trail Mountains where the Flagstaff Limestone has been eroded away. Exposures of the North Horn Formation form purple, red, or brown colored slopes. In the Trail Mountain area, the thickness ranges from 750 to 800 feet and increases to the west.

The North Horn Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Figure 8). In such environments layers of mud are more abundant than sands, which occur in sandstone channels. The sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and interfluvial rocks (Galloway, 1977). In the study area the formation consists primarily of shale with discontinuous

sandstone channels, minor lenses of limestone, and conglomerate. Highly bentonitic mudstones, which swell when wetted, are common in the lower two-thirds of the formation.

4.3.1.3 Price River Formation (Cretaceous Age)

The Price River Formation typically forms a steep, receding slope above the Castlegate Sandstone with alternating ledges and slopes resulting from the interbedding of resistant sandstones with less resistant shales and claystones. In the lease area the formation is 350 to 400 feet thick.

The Price River Formation was deposited from mixed-load fluvial channel systems having sandstone/mudstone ratios intermediate between bed-load and suspended-load channel systems (Figure 8). Sandstones and mudstones occur in about equal proportions. Point bars that develop in this type of system are larger than those in suspended-load channel systems. Mudstone drapes created during low flow stages of the active fluvial system separate the sandstones from each other both horizontally and vertically.

4.3.1.4 Castlegate Sandstone (Cretaceous Age)

The Castlegate Sandstone has a distinctive cliff forming habit and typically forms a resistant cliff above the underlying, less resistant Blackhawk Formation. The thickness of the Castlegate Sandstone ranges from 250 to 300 feet in the lease area

The formation was deposited from bed-load fluvial channel systems (Figure 8; Chan and Pfaff, 1991). The Castlegate Sandstone is made up of coarse-grained, often conglomeratic, fluvial

sandstone with some thin interbeds of siltstone and claystone, especially toward the base of the unit. Sandstone dominates over mudstone and individual sand channels may be thin, wide, or interpenetrating. Although the primary porosity is high, the existence of mudstone drapes and pervasive carbonate and silica cement greatly reduces the overall porosity.

4.3.1.5 Blackhawk Formation (Cretaceous Age)

The Blackhawk Formation generally forms a steep, irregular slope between the cliffs of the underlying Star Point Sandstone and the overlying Castlegate Sandstone.

The formation consists of an upper non-marine, suspended-load fluvial portion and a lower marine shoreface and non-marine foreshore portion. Massive, cliff-forming units are common in the upper portion, and thinner-bedded, slope-forming units are common in the lower portion. The thickness of the Blackhawk Formation ranges from 625 to 800 feet in the study area and generally thickens to the northeast. Most of the thicker coal seams occur in the lower 150 feet of the Blackhawk Formation.

The upper portion of the Blackhawk Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Figure 8). In these delta and flood-plain environments layers of mud are more abundant than channel sands. Sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and interfluvial rocks (Galloway, 1977). The upper portion of the Blackhawk Formation also contains some thin carbonaceous shale layers and thin coal seams which are not of economic interest.

The lower portion of the Blackhawk Formation contains the mineable coal deposits and consists of more thinly bedded sandstone and shale layers (Johnson, 1978). The coal-bearing units of the lower Blackhawk Formation overlie and are laterally juxtaposed to marine shoreface sandstones of the Blackhawk Formation and Star Point Sandstone. On a large scale, these sandstone bodies are laterally continuous but terminate abruptly into the mud- and organic-rich backshore faces in a landward direction (Van Wagoner and others, 1990). However, individual rock layers are lenticular and discontinuous, with abundant shaley interbeds. The fine- to medium-grained sandstones occur as thin- to massively-bedded paleochannel deposits. The paleochannels increase in frequency, thickness, and lateral extent upward in the formation. There is also a vertical repetition of erosional scours within the upper sandstones (Marley and others, 1979).

The PacifiCorp mine workings are within the Hiawatha and Blind Canyon coal seams. In most locations the Hiawatha seam lies directly on top of the Star Point Sandstone. In some locations, a 0-15 foot thick shaley lagoonal deposit is present between the Hiawatha seam and the top of the Star Point Sandstone. The Blind Canyon seam lies approximately 80 feet above the Hiawatha seam. In the Wasatch Plateau, large areas of the Blackhawk Formation have been baked by natural burning of the coal near the surface. These reddish clinker layers are generally more resistant and form steeper slopes than adjacent unburned layers.

4.3.1.6 Star Point Sandstone (Cretaceous)

The Star Point Sandstone, which is present throughout the area, forms massive cliffs where exposed at the surface. The sandstone was deposited as marine shoreface blanket sands which

are laterally continuous, but thin seaward (east). Landward (west), these sandstones terminate abruptly into the mud- and organic-rich backshore facies (Figure 8; Van Wagoner and others, 1990). Because many of the organic-rich facies have been converted to mineable quality coal, locally the Star Point Sandstone has immediate contact with coal seams. Elsewhere sandstone bodies of the Star Point Sandstone are overlain and underlain by lower shoreface and open marine shales of the Mancos Formation. What this means is that the marine shoreface sandstones are three dimensionally encased by low-permeability marine shales and fine-grained carbonaceous backshore coal-bearing facies.

The Star Point Sandstone thins eastward and merges with the underlying Masuk Member of the Mancos Shale. Three prominent tongues of the Star Point Sandstone interfinger with the Mancos Shale. These three sandstone members, from top to bottom, are the Spring Canyon, Storrs, and Panther Sandstones. In the lease area, the Spring Canyon tongue is approximately 100 feet thick, lies about 80 feet above the Storrs tongue, and consists of massive, fine- to medium-grained sandstone. The Storrs tongue lies about 120 feet above the Panther tongue and consists of 50 feet of soft, friable sandstone. The basal Panther tongue is approximately 100 feet thick and consists of massive, crossbedded delta front sandstones.

4.3.1.7 Masuk Member of the Mancos Shale (Cretaceous Age)

The marine Masuk Member of the Mancos Shale was deposited in an open marine environment. The rock is highly erodeable calcareous, gypsiferous, and carbonaceous dark gray shale. It is continuously exposed along the eastern edge of the Wasatch Plateau. The Masuk member is approximately 1,300 feet thick. Westward thinning wedges of the Masuk

interfinger with tongues of the Star Point Sandstone. Castle Valley, to the east of the study area, is developed on the Mancos Shale.

4.3.2 Structure

The PacifiCorp study area is bounded on the east by the eastern erosional escarpment of the Wasatch Plateau and on the west by the Joes Valley Fault System. The dip of the bedrock is controlled primarily by the Straight Canyon Syncline, which runs diagonally through the middle of the lease area, trending approximately north 50° east and plunging to the southwest (Figure 5). Bedrock located northwest of the syncline axis generally dips toward the southeast, whereas bedrock located southeast of the syncline axis dips toward the northwest. The dips of the rocks throughout the study are gentle, rarely exceeding 6°.

Most faults in the study area trend north-south or northeast-southwest (Figure 5). The most significant is the Joes Valley Fault System, which extends more than 20 miles to the north and 40 miles to the south of the Joes Valley Reservoir dam, and has a reported 2,300 feet of vertical displacement (Davis and Doelling, 1977). Joes Valley is a graben formed on the downthrown block west of the fault; Trail Mountain forms the horst block east of the fault. Much of Joes Valley is filled with alluvium that is juxtaposed against the bedrock formations of Trail Mountain.

The Mill Fork and Roans Canyon Fault systems, which have much less displacement than the Joes Valley System, form narrow grabens in the central portion of Trail Mountain and in the northern portion of East Mountain. The Mill Fork and Roans Canyon Fault systems roughly

parallel the Straight Canyon Syncline (Figure 5) and appear to be scissor faults hinged near the center of Trail Mountain. At the hinge location there is essentially no vertical or horizontal displacement. Maximum displacement on these faults in the lease area is estimated to be 30 feet on the Mill Fork Fault, and 160 feet on the Roans Canyon Fault (Semborski, Personal Communication, 1997).

The Pleasant Valley Fault System, which extends for 20 miles north of the lease area, is located along the eastern edge of East Mountain (Figure 5). In the lease area, displacement is less than 150 feet.

Near surface joint sets trending northeast-southwest, and northwest-southeast are common in the lease area (Kadnuck, 1994). Lineament and drainage trace analysis suggest that the major trunk streams in the lease and adjacent area follow a regional northwest-southeast trend and that these drainages follow fracture or joint systems (Peters and Speirer, 1986).

5. SOLUTE AND ISOTOPE CHEMISTRY

5.1 Explanation of chemical reporting units and terms

Reporting units are milligrams per liter (mg L^{-1}) and milliequivalents per liter (meq L^{-1}) for ionic solutes and per mil (‰) for stable isotopes. Stable isotopic reference standards are Standard Mean Oceanic Water (SMOW) for δ^2H and $\delta^{18}O$, Pee Dee Formation Belemnite (PDB) for $\delta^{13}C$, and the Canyon Diablo Meteorite (CD) for $\delta^{34}S$. The radioactive isotope ^{14}C is reported relative to percent modern (1950) carbon (pmc), and the radioactive isotope ^3H is reported in tritium units (TU). One TU is equivalent to 3.2 pCi L^{-1} (pico-Curies per liter).

In addition to the familiar mg L^{-1} concentration unit, laboratory solute data have been converted to meq L^{-1} for analysis and reporting purposes. The meq L^{-1} unit allows direct comparison of reacting concentrations of cations and anions. Conversion factors between meq L^{-1} and mg L^{-1} for major ions follow:

	meq L^{-1}	mg L^{-1}
Ca^{2+}	1	20.0
Mg^{2+}	1	12.2
Na^+	1	23.0
K^+	1	39.1
HCO_3^-	1	61.0
SO_4^{2-}	1	48.0
Cl^-	1	35.5

From the conversion factors it is apparent that heavy anion molecules such as SO_4^{2-} and HCO_3^- contribute disproportionately to TDS relative to their reacting cation counterparts, such as Ca^{2+}.

The stable isotopic composition of a sample is reported as the per mil (‰) difference of the sample relative to the isotopic composition of a standard using the delta (δ) notation defined as:

$$\delta = \frac{(R_{sample} - R_{standard})}{(R_{standard})} x1000 \ (‰)$$

Where R = $^{18}O/^{16}O$, $^{2}H/^{1}H$, $^{13}C/^{12}C$, and $^{34}S/^{32}S$. The δ notation is reported in terms of the heavy isotope in the ratio R (i.e., $\delta^{13}C$ for $^{13}C/^{12}C$).

A summary of the application of isotopic methods to hydrogeologic investigations is included as Appendix B. Readers who are not familiar with the use of isotopes in hydrogeologic investigations are encouraged to read Appendix B prior to proceeding with the remainder of this report.

5.2 Chemical evolution of groundwaters

5.2.1 Chemical reactions

Solute compositions of groundwaters are the result of interactions between groundwaters and bedrock lithologies and between groundwaters and atmospheric and soil gases. The general reactions responsible for the chemical evolution of groundwaters in the vicinity of the PacifiCorp lease area and inside the coal mines are described below:

Groundwater acquires most of its $CO_{2(g)}$ in the soil zone where the partial pressures of CO_2 greatly exceeds atmospheric levels. This CO_2 combines with water to form carbonic acid according to

$$CO_{2(g)} + H_2O = H_2CO_3 \quad (1)$$

Carbonic acid dissociates into H^+ and HCO_3^- as

$$H_2CO_3 = HCO_3^- + H^+ \quad (2)$$

The H^+ ions temporarily decrease the pH of the water but are quickly consumed by the dissolution of carbonate minerals that are abundant in the soil zone and in most aquifers. Carbonate mineral dissolution is represented as

$$2H^+ + \underset{\text{(dolomite)}}{CaMg(CO_3)_2} = Ca^{2+} + Mg^{2+} + 2HCO_3^-, \text{ and} \quad (3)$$

$$H^+ + \underset{\text{(calcite)}}{CaCO_3} = Ca^{2+} + HCO_3^-. \quad (4)$$

The net effect of reactions 2 through 4 is to increase the pH and the Ca^{2+}, Mg^{2+}, and HCO_3^- contents of waters. Dissolution of small amounts of gypsum, which is present in many formations in the region, can elevate the Ca^{2+} and SO_4^{2-} contents in the absence of additional $CO_{2(g)}$ and H^+ according to

$$\underset{\text{(gypsum)}}{CaSO_4 \cdot 2H_2O} = Ca^{2+} + SO_4^{2-} + 2H_2O. \quad (5)$$

Elevated Na^+ concentrations may result from either the dissolution of small amounts of very soluble halite or from ion exchange on clay particles or on sodium zeolites. Halite dissolution will increase the overall solute concentration (i.e. TDS) and will yield equal Na^+ and Cl^- contents when the solute compositions are reported in the meq L^{-1} units. Ion exchange will not directly elevate the overall solute content, but will result in increased Na^+ concentrations

at the expense of reduced Ca^{2+} and/or Mg^{2+} concentrations. Halite dissolution may be represented as

$$NaCl = Na^{+} + Cl^{-}, \quad (6)$$

and ion exchange may be represented by reactions involving the sodium zeolite analcime,

$$2NaAlSi_2O_6 \cdot H_2O + Ca^{2+} = Ca(AlSi_2O_6)_2 \cdot H_2O + 2Na^{+}, \quad (7)$$

$$2NaAlSi_2O_6 \cdot H_2O + Mg^{2+} = Mg(AlSi_2O_6)_2 \cdot H_2O + 2Na^{+}, \quad (8)$$

or clay mineral exchange which may be represented as

$$Ca^{2+} + \text{Na-clay} = 2Na^{+} + \text{Ca-clay} \quad (9)$$

$$Mg^{2+} + \text{Na-clay} = 2Na^{+} + \text{Mg-clay} \quad (10)$$

5.2.2 Groundwater solute compositions

Solute compositions of groundwater from 96 springs, 4 french drains, 5 wells and 46 in-mine sampling locations were analyzed as part of this investigation. Spring and well locations are shown on Figure 9. In-mine sampling locations for the Blind Canyon seam in the Deer Creek Mine and for the Hiawatha seam in the Trail Mountain and Cottonwood/Wilberg Mines are show in Figures 10 and 11, respectively.

Mean solute compositions for each spring and well have been calculated for the high-flow and low-flow conditions (Table 1). The highest discharge from springs generally occurs in July (Semborski, 1997, personal communication) and records with sampling dates in May, June, or July are included in the high flow mean. The low flow mean is calculated using records with dates from August to April. In Table 1 groundwaters issuing from the North Horn Formation are classified as either low or high SO_4^{2-} water.

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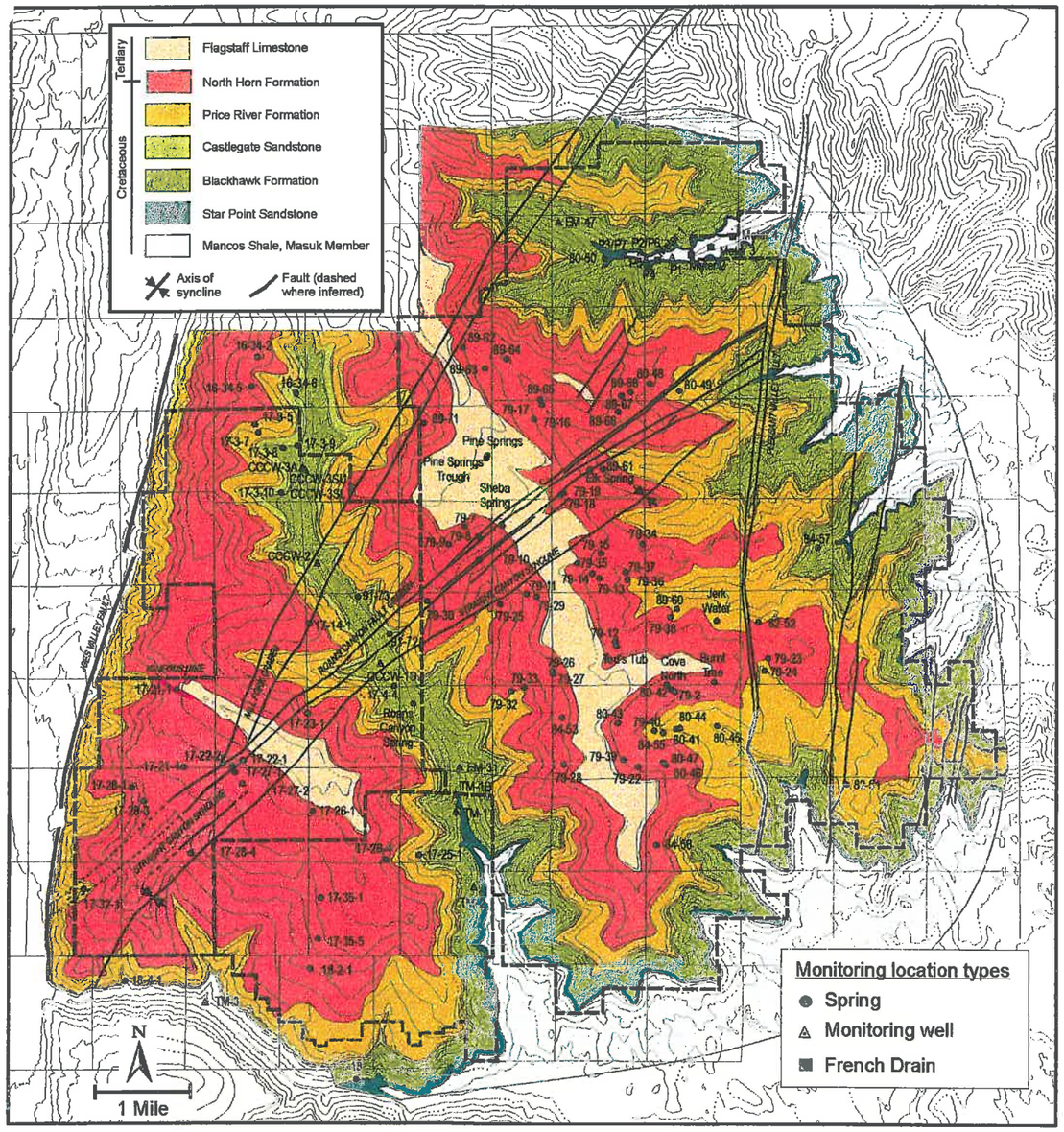

Figure 9 Map showing the locations of springs, monitoring wells, and Rilda Canyon French drains.

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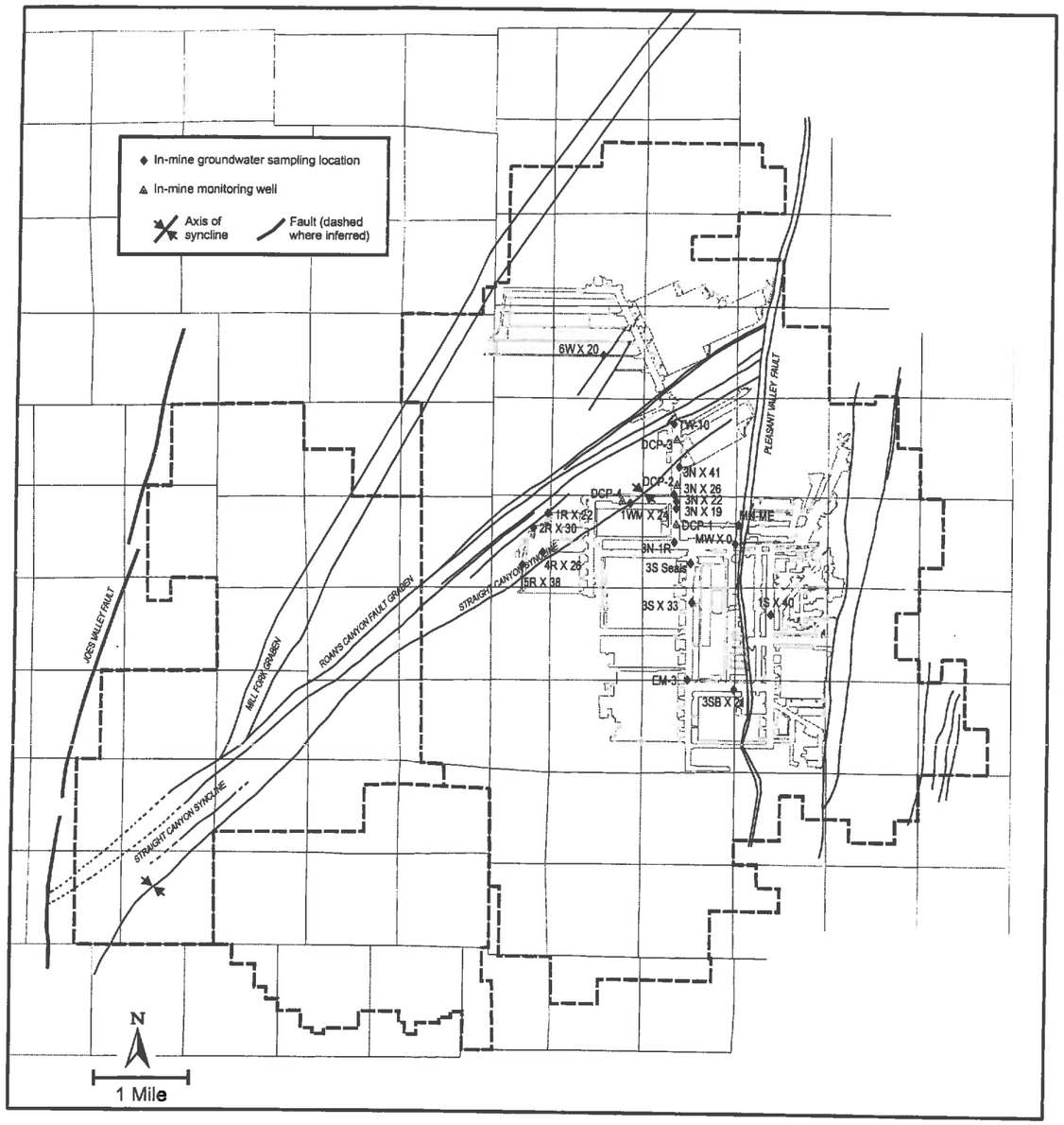

Figure 10 Mine workings of the Deer Creek Mine and locations of in-mine sampling locations and monitoring wells. Mine workings are in the Blind Canyon Seam of the Blackhawk Formation.

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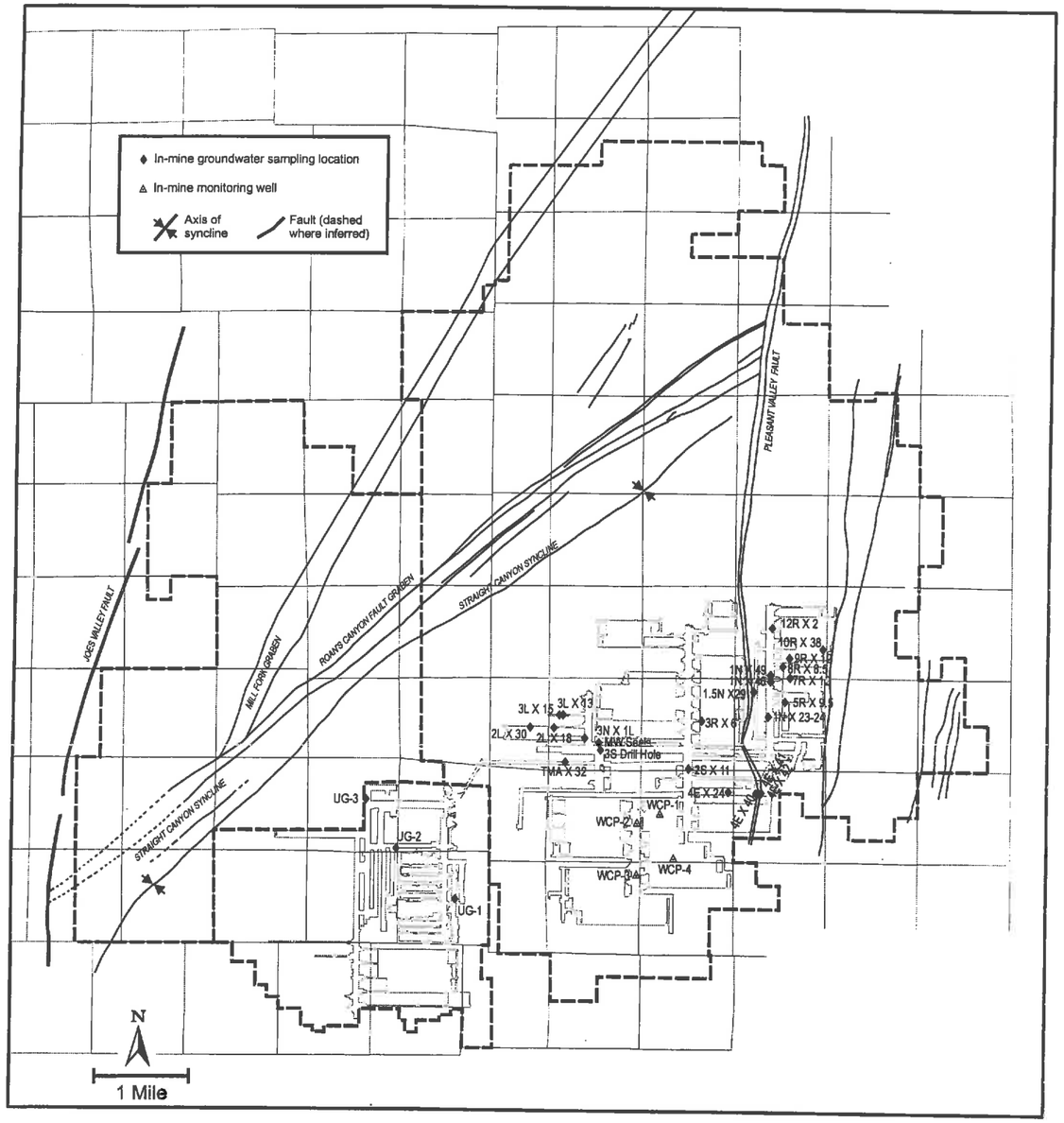

Figure 11 Mine workings of the Trail Mountain and Cottonwood/Wilberg Mines and locations of in-mine sampling locations and monitoring wells. Mine workings are in the Hiawatha Seam of the Blackhawk Formation.

Table 1 Mean solute chemistry of springs during baseflow and highflow conditions

table1.xls 23APR97

Formation	n sites	°C	pH	TDS mg/L	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^{2-}	SO_4^{2-}	Cl^-	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^{2-}	SO_4^{2-}	Cl^-	Na:Cl
					mg/L								meq/L								
Springs--baseflow																					
Alluvium	2	8.0	7.47	424	81.4	46.1	14.6	2.9	405	0.6	75.8	12.2	4.06	3.79	0.64	0.07	6.63	0.02	1.58	0.34	1.86
Flagstaff	3	6.6	7.57	257	90.4	13.9	6.3	2.8	294	0.4	38.2	5.6	4.51	1.14	0.27	0.07	4.82	0.01	0.80	0.16	1.72
North Horn	47	7.1	7.77	358	81.4	30.5	23.7	1.9	356	0.8	62.9	16.0	4.06	2.51	1.03	0.05	5.84	0.03	1.31	0.45	2.28
low sulfate	33	6.4	7.78	309	69.1	29.0	18.9	1.5	345	0.9	21.0	15.3	3.45	2.38	0.82	0.04	5.65	0.03	0.44	0.43	1.91
high sulfate	14	8.6	7.75	474	110.5	34.2	35.0	2.7	383	0.5	161.4	17.7	5.51	2.81	1.52	0.07	6.28	0.02	3.36	0.50	3.04
Price River	7	8.4	7.70	372	93.2	27.5	16.4	2.3	400	0.5	60.2	9.8	4.65	2.26	0.71	0.06	6.55	0.02	1.25	0.28	2.58
Castlegate/Blackhawk	7	8.2	7.90	359	79.3	34.5	10.7	1.4	357	1.3	46.2	11.5	3.96	2.84	0.47	0.04	5.85	0.04	0.96	0.32	1.44
Blackhawk	2	7.4	7.79	562	82.0	59.3	33.8	4.3	439	0.0	175.3	13.5	4.09	4.88	1.47	0.11	7.20	0.00	3.65	0.38	3.87
Springs--highflow																					
Alluvium	4	8.4	7.47	390	68.9	46.6	13.8	1.5	373	1.1	59.9	11.5	3.44	3.83	0.60	0.04	6.12	0.04	1.25	0.33	1.85
Flagstaff	4	6.4	7.41	260	82.8	11.9	4.9	1.7	275	0.4	32.7	4.0	4.13	0.98	0.21	0.04	4.51	0.01	0.68	0.11	1.88
North Horn	63	8.1	7.68	346	79.5	29.6	19.0	2.6	357	1.1	61.9	10.5	3.97	2.44	0.82	0.07	5.85	0.04	1.29	0.30	2.78
low sulfate	40	8.6	7.69	313	64.7	29.1	15.3	1.6	346	1.5	20.0	10.0	3.23	2.40	0.69	0.04	5.68	0.05	0.42	0.28	2.43
high sulfate	23	7.1	7.66	399	105.7	29.7	24.0	4.3	373	0.5	134.0	11.1	5.27	2.45	1.04	0.11	6.11	0.02	2.79	0.31	3.33
Price River	10	8.1	7.65	442	85.4	36.9	24.3	1.8	418	1.3	61.3	10.6	4.26	3.04	1.08	0.05	6.86	0.04	1.28	0.30	3.61
Castlegate/Blackhawk	2	13.5	8.32	370	50.9	42.8	20.6	2.1	315	2.3	70.5	13.7	2.54	3.52	0.90	0.05	5.16	0.08	1.47	0.39	2.33
Blackhawk	1	7.0	7.50	532	143.0	29.5	46.0	12.0	470	0.0	215.0	10.3	7.14	2.43	2.00	0.31	7.70	0.00	4.48	0.29	6.88

A two-tailed paired t-test comparing the mean high flow and low flow solute concentrations of spring and well waters organized by formation was performed (Table 2). If the t-test values is <0.05 there is a statistical probability that the means of the two populations are different at the 95% confidence interval. Table 2 shows that there is not a statistical difference in the high and low flow solute compositions of groundwater issuing from most formations. Exceptions include TDS, Ca^{2+}, and SO_4^{2-} in alluvial groundwater systems and Cl^- in low sulfate North Horn Formation groundwater. The calculated statistical difference in K^+ in high sulfate North Horn Formation groundwater is not considered valid because the difference is the result of a single sample from spring EMS79-19.

The mean solute compositions of groundwaters issuing from each bedrock source, (regardless of discharge rates) are listed in Table 3 and are illustrated on a trilinear diagram (Figure 12). The solute compositions of groundwater issuing from each spring, well, and in-mine sampling location are illustrated as Stiff diagrams on Figures 13 and 14.

Most groundwater discharging from springs in the study area is of the Ca^{2+}-HCO_3^- or Ca^{2+}-Mg^{2+}-HCO_3^- type. The solute compositions of these waters are due to the dissolution of carbonate minerals in the presence of soil zone CO_2 (Eqs. 1-4). Most groundwaters have Na^+ concentrations 2 to 3 times as great as Cl^- when concentrations are expressed as meq L^{-1} (Table 3). Na:Cl ratios appreciably greater than 1 are interpreted to be the result of ion exchange of Ca^{2+} and Mg^{2+} for Na^+ on clays (Eqs. 9 and 10). Ion exchange appears to be particularly prevalent in the Blackhawk, Price River, and high SO_4^{2-} North Horn spring waters.

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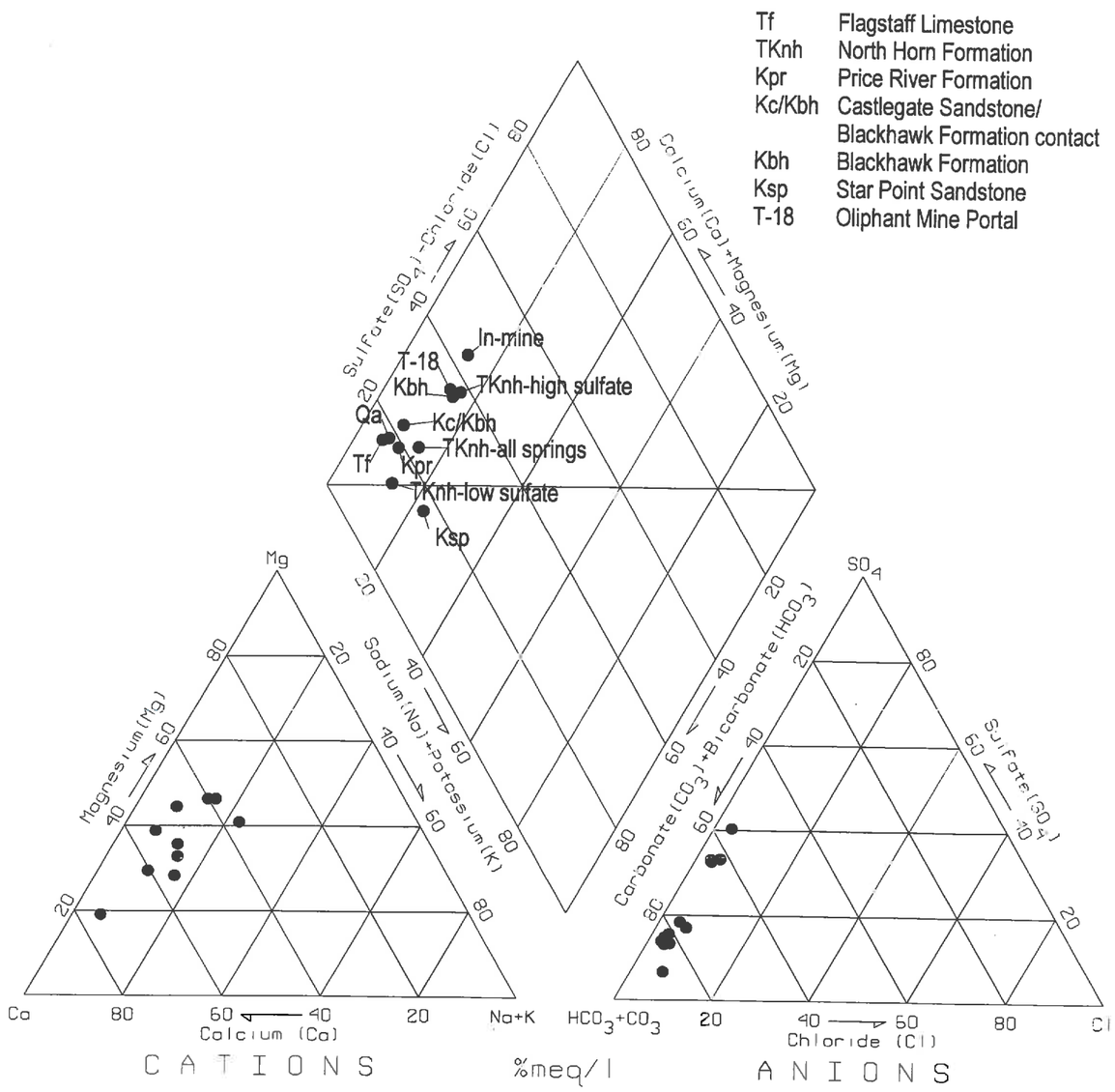

Figure 12 Trilinear diagram of mean solute compositions.

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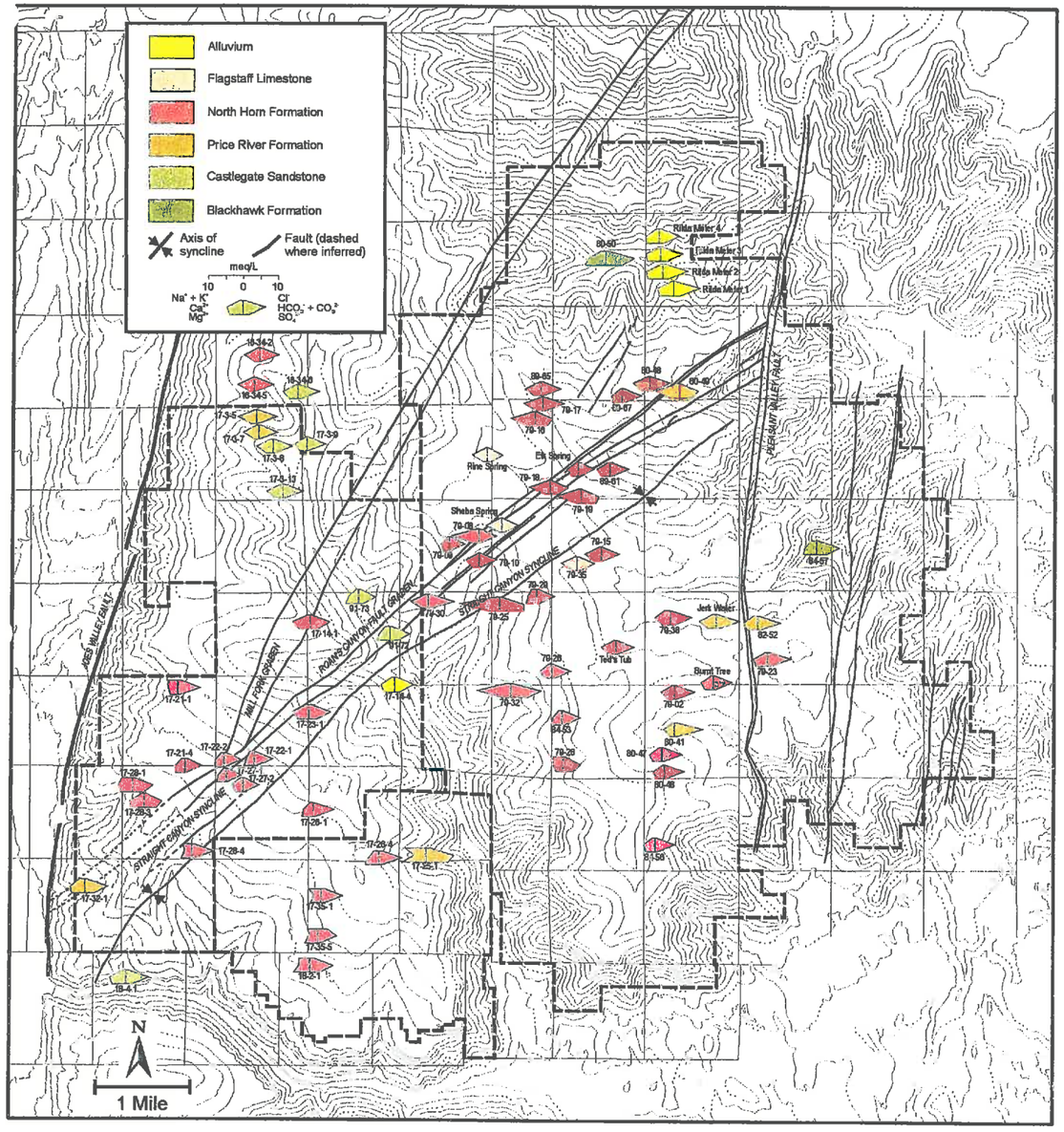

Figure 13 Stiff diagram map of mean spring water compositions for low-flow conditions

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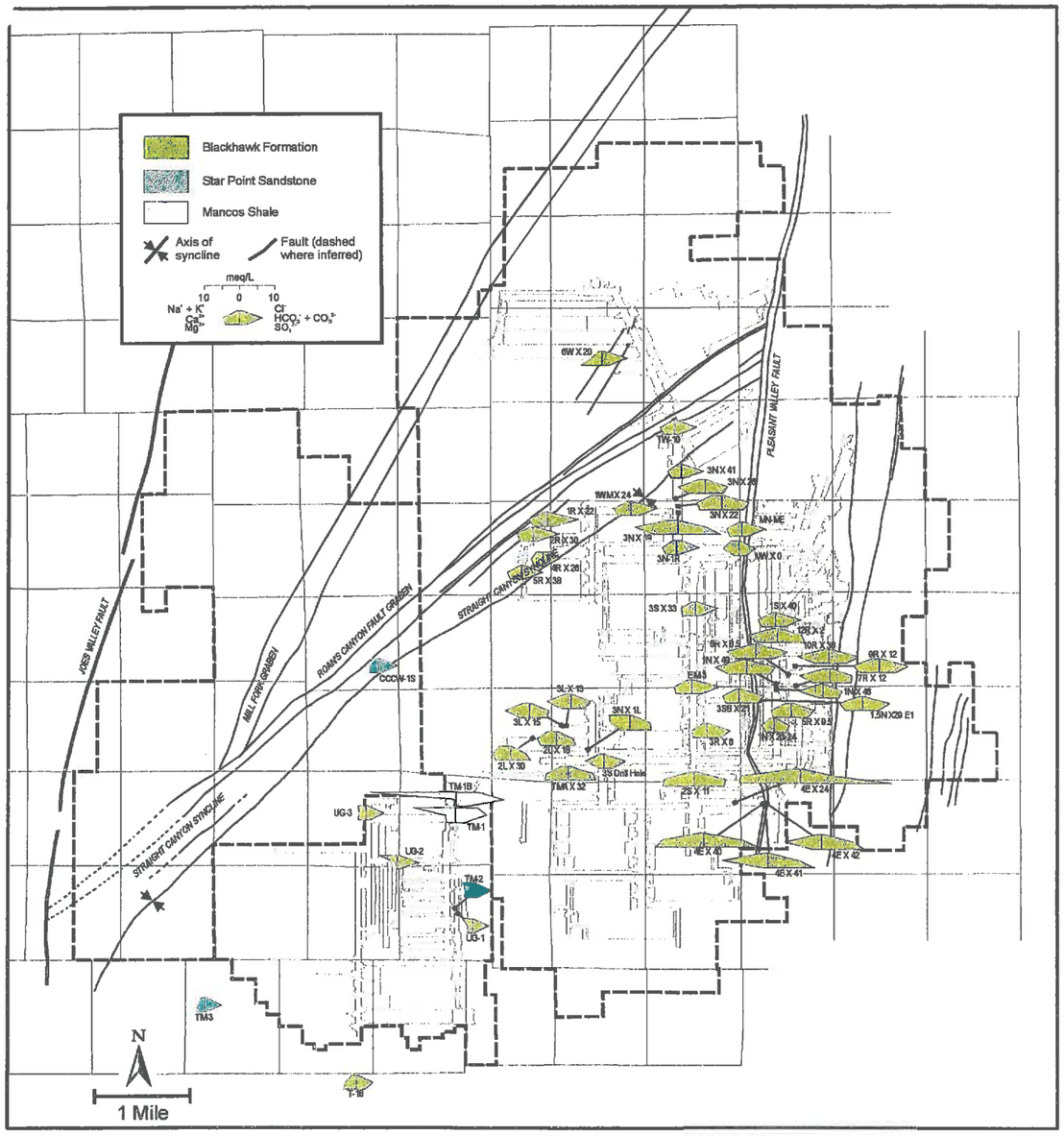

Figure 14 Stiff diagram map of in-mine, monitoring well, and Oliphant Mine (T-18) waters.

Table 2 Paired t-test analysis of spring solute chemistry

table2.xls 21AUG97

Site	High n	Base n	High TDS	Base TDS	High Ca^{2+}	Base Ca^{2+}	High Mg^{2+}	Base Mg^{2+}	High Na^{+}	Base Na^{+}	High K^{+}	Base K^{+}	High HCO_3^{-}	Base HCO_3^{-}	High SO_4^{2-}	Base SO_4^{2-}	High Cl^{-}	Base Cl^{-}
Alluvium																		
RILDA-METER2	5	16	458.0	480.4	85.2	94.0	50.5	51.6	15.4	14.9	2.4	2.5	409	441	83.0	93.8	9.5	13.7
RILDA-METER3	5	17	375.8	423.3	70.7	80.8	43.9	45.6	12.6	13.4	0.7	2.0	373	398	55.4	76.8	11.4	11.1
RILDA-METER4	4	12	351.8	369.6	66.4	71.6	39.1	42.8	11.3	13.5	1.2	1.9	348	359	42.8	59.7	10.9	13.8
17-14-4	4	7	374.0	391.7	53.3	73.1	52.7	38.9	15.9	15.8	1.8	1.8	362	363	58.3	63.9	14.4	13.7
Paired t-test				**0.034**		**0.039**		**0.683**		**0.400**		**0.174**		**0.090**		**0.029**		**0.289**
Flagstaff Limestone																		
EMS 79-35	12	10	268.8	271.7	83.8	93.8	14.9	16.2	5.3	6.4	0.8	1.7	299	302	25.3	38.9	7.9	6.1
PINE SPRING	5	2	281.6	234.0	87.3	86.0	13.2	15.3	7.3	7.8	3.6	4.6	268	273	56.8	52.5	2.6	3.0
SHEBA SPRINGS	12	19	249.2	264.6	82.2	91.4	9.6	10.1	4.9	4.7	2.4	2.1	272	307	27.9	23.3	4.0	7.7
Paired t-test				**0.663**		**0.241**		**0.108**		**0.350**		**0.311**		**0.292**		**0.816**		**0.671**
Low Sulfate North Horn Formation																		
17-21-1	13	18	388.4	402.1	50.8	55.7	31.6	26.5	63.1	59.1	2.0	2.3	397	398	19.7	17.8	32.2	31.5
17-21-4	2	3	302.5	290.7	47.4	54.0	32.5	32.7	17.6	18.6	2.9	2.3	309	314	18.5	11.0	23.4	25.3
17-22-1	10	19	294.3	325.6	54.4	48.4	38.0	35.3	18.8	27.1	1.6	1.8	357	341	15.8	26.9	10.3	11.8
17-22-2	2	3	300.0	269.0	50.6	49.6	33.5	31.4	11.9	15.6	3.6	2.3	345	313	8.5	8.7	9.3	11.7
17-26-1	4	6	334.0	331.3	52.7	56.2	38.9	38.4	18.2	19.3	1.9	1.7	356	367	27.3	19.8	11.0	10.4
17-26-4	9	11	385.9	392.3	55.7	58.0	47.7	48.9	35.3	32.0	2.0	1.5	380	404	33.8	35.2	27.1	27.9
17-27-1	2	3	253.5	247.0	46.5	45.3	26.5	31.9	10.1	13.1	2.8	2.3	270	280	11.5	10.3	16.0	14.0
17-27-2	2	3	272.5	265.0	43.8	61.2	25.5	22.5	9.7	12.2	2.7	2.3	298	300	14.0	7.3	11.3	12.0
17-28-4	2	4	372.0	363.0	38.7	43.8	42.0	36.6	51.8	52.3	3.0	1.8	367	390	26.5	25.3	21.7	23.3
17-35-1	13	20	411.3	445.9	40.2	41.9	39.0	36.3	72.7	77.4	1.5	1.6	378	381	42.2	47.1	41.4	43.4
BURNT TREE	16	19	293.9	284.6	63.0	65.1	28.0	25.8	14.6	14.1	1.3	1.3	333	330	24.5	26.0	6.8	7.5
ELK SPRING	14	16	270.9	244.6	68.3	63.4	22.1	22.2	7.6	9.0	2.2	1.8	290	292	30.3	19.8	4.5	7.9
EMS 79-02	9	9	294.1	284.6	78.4	75.4	22.4	21.0	15.4	15.0	0.8	2.2	366	366	15.7	12.3	5.7	7.9
EMS 79-10	11	13	288.5	266.0	77.6	74.8	22.3	21.9	5.6	4.5	1.6	2.5	315	323	25.3	9.7	6.9	7.8
EMS 79-15	15	14	298.1	271.3	79.9	94.1	23.3	22.9	8.2	7.5	1.6	1.4	329	329	37.2	19.6	6.4	6.2
EMS 79-23	6	1	371.7	392.0	79.7	79.2	37.9	40.4	14.9	14.8	1.7	0.5	422	433	29.5	30.0	11.2	11.8
EMS 79-26	8	5	295.0	320.8	63.4	67.9	29.1	25.6	14.6	17.4	1.4	2.7	320	337	28.4	36.6	8.3	7.2
EMS 79-38	14	9	364.8	388.6	81.8	86.2	26.9	26.0	38.1	38.1	1.5	2.0	404	389	39.1	62.6	10.2	10.8
EMS 80-46	9	7	306.6	304.9	59.2	63.8	29.2	28.0	9.8	9.8	0.7	0.9	366	353	16.7	18.7	5.6	4.3
EMS 80-47	15	13	350.6	305.4	75.0	68.0	31.8	30.7	15.3	14.4	2.3	1.9	362	356	41.0	26.8	7.7	6.7
EMS 84-53	5	2	295.0	313.0	47.2	51.0	31.2	36.8	18.9	20.4	1.0	1.1	323	331	16.2	37.0	8.5	9.5
EMS 84-56	12	12	332.2	316.3	62.2	65.1	34.7	32.4	16.6	16.8	1.0	1.7	345	349	30.8	26.3	10.9	11.0
EMS 89-61	7	6	294.2	294.3	78.7	72.0	26.7	26.8	7.5	9.2	1.9	1.4	366	343	14.2	16.2	6.4	7.2
EMS 89-65	5	2	302.0	317.5	94.7	90.3	27.0	22.5	3.6	3.5	0.4	0.3	359	363	9.6	17.0	7.6	20.0
EMS 89-67	7	6	282.7	284.3	57.0	57.9	33.0	33.8	11.8	14.2	1.1	2.0	310	343	22.3	21.8	9.2	10.0
TED'S TUB	13	14	288.4	290.6	82.5	85.0	19.0	18.5	8.1	9.8	2.3	1.5	319	333	30.8	25.1	5.6	6.5
Paired t-test				**0.757**		**0.150**		**0.088**		**0.054**		**0.656**		**0.312**		**0.772**		**0.044**
High Sulfate North Horn Formation																		
17-23-1	1	2	398.0	399.5	62.1	69.9	33.0	37.5	13.5	25.2	0.7	1.0	368	386	60.0	110.0	10.1	20.5
17-25-1	6	3	710.6	917.3	81.1	67.3	55.6	83.5	79.5	135.2	2.7	3.1	418	501	266.8	302.0	31.6	55.4
18-2-1	14	20	561.6	579.9	61.3	61.5	57.4	55.8	65.9	67.6	1.6	1.7	400	404	136.4	131.0	47.3	46.3
EMS 79-08	1	1	390.0	206.0	121.5	151.7	28.0	21.4	16.5	3.5	6.5	0.7	289	332	230.4	8.6	4.8	4.9
EMS 79-09	1	1	382.0	240.0	121.0	48.3	28.0	20.1	16.0	5.6	7.0	0.3	317	281	193.0	2.1	5.8	7.2
EMS 79-16	1	1	330.0	391.0	136.0	140.0	21.0	21.5	4.0	2.5	2.0	1.5	321	318	156.0	163.0	3.9	3.3
EMS 79-17	1	1	308.0	269.0	120.0	110.6	17.0	19.2	22.0	3.6	8.5	0.6	333	384	132.0	11.1	3.2	4.9
EMS 79-18	1	2	483.0	314.0	173.0	121.0	18.0	15.4	6.0	2.9	3.0	1.6	320	315	274.0	107.8	2.9	3.4
EMS 79-19	1	2	384.0	371.5	149.0	142.0	8.5	9.3	7.0	6.5	20.0	16.3	306	310	189.0	204.0	2.9	3.1
EMS 79-25	2	1	384.0	610.0	95.6	228.0	22.5	32.0	9.9	9.0	1.6	2.0	423	425	97.1	336.0	11.8	7.9
EMS 79-28	14	12	416.1	414.2	60.8	59.2	27.7	25.2	54.9	66.1	2.6	2.2	311	307	110.9	128.4	14.7	15.9
EMS 79-29	13	13	338.0	320.3	51.2	50.0	35.2	36.9	31.9	33.0	2.4	2.7	326	327	53.0	36.5	19.6	19.5
EMS 79-30	1	1	444.0	461.0	120.0	99.1	41.0	23.3	40.0	15.0	9.0	1.9	487	477	169.0	72.4	10.5	17.8
EMS 79-32	7	2	484.6	648.0	91.5	192.4	49.1	25.9	31.8	24.5	2.5	4.8	469	541	116.3	233.2	19.7	18.7
EMS 80-48	6	4	294.5	304.0	91.9	97.1	31.9	29.6	4.8	4.0	1.0	1.5	356	363	63.8	45.5	7.5	9.1
Paired t-test				**0.791**		**0.551**		**0.700**		**0.995**		**0.040**		**0.096**		**0.459**		**0.134**
Price River Formation																		
EMS 80-41	10	1	461.7	396.0	91.1	63.0	38.2	14.0	22.0	14.0	0.9	2.0	409	495	86.4	20.2	10.0	5.7
EMS 80-49	4	1	349.8	354.0	94.2	136.0	35.5	31.5	10.0	6.5	3.2	10.0	415	329	48.3	173.0	6.7	7.0
EMS 82-52	14	17	379.4	375.1	79.0	78.2	36.0	34.3	25.2	24.5	1.5	1.6	424	416	42.9	36.6	10.1	12.6
JERK WATER SPRING	5	5	371.6	372.8	95.6	96.2	28.1	28.3	17.8	23.9	1.1	1.6	429	428	27.1	52.2	8.2	8.3
Paired t-test				**0.403**		**0.830**		**0.280**		**0.647**		**0.270**		**0.953**		**0.661**		**0.815**
Starpoint Sandstone																		
TM-1	7	23	962.1	950.0	27.5	57.0	36.7	33.1	301.3	272.0	4.4	4.9	592	535	86.7	118.5	198.7	224.0
TM-1B	1	5	1120.0	1370.0	5.0	5.6	2.0	5.7	545.0	551.8	3.0	7.3	662	680	35.0	143.5	124.0	226.7
TM-2	1	6	468.0	366.8	24.0	40.7	45.0	26.8	72.2	57.1	6.1	5.9	326	310	112.6	67.1	16.5	12.2
Paired t-test				**0.708**		**0.203**		**0.448**		**0.354**		**0.395**		**0.229**		**0.551**		**0.325**

High = mean value for high flow period
Base = mean value for baseflow period

Table 3 Mean solute chemistry

table3.xls 23APR97

Formation	n sites	°C	pH	TDS mg/L	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Cl^{-}	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Cl^{-}	Na:Cl
					mg/L								meq/L								
Springs																					
Alluvium	5	8.1	7.47	419	78.9	46.8	14.5	2.8	401	0.7	73.1	11.9	3.94	3.85	0.63	0.07	6.58	0.02	1.52	0.33	1.89
Flagstaff	4	6.6	7.45	259	85.3	12.2	5.0	1.8	281	0.4	33.3	4.4	4.25	1.01	0.22	0.05	4.61	0.01	0.69	0.12	1.75
North Horn	69	7.9	7.71	345	80.1	29.7	19.8	2.1	357	1.0	58.3	12.4	3.99	2.44	0.86	0.05	5.85	0.03	1.21	0.35	2.46
low sulfate	44	7.9	7.71	318	65.4	29.2	17.2	1.5	348	1.3	19.3	12.6	3.26	2.40	0.75	0.04	5.70	0.04	0.40	0.36	2.10
high sulfate	25	7.9	7.71	397	105.9	30.5	24.4	3.2	373	0.5	127.0	12.0	5.28	2.51	1.06	0.08	6.11	0.02	2.64	0.34	3.14
Price River	13	8.4	7.70	425	87.6	34.6	22.7	1.6	408	1.2	60.0	10.9	4.37	2.84	0.99	0.04	6.68	0.04	1.25	0.31	3.21
Castlegate/Blackhawk	7	8.8	7.88	358	78.3	34.2	10.7	1.3	356	1.2	45.1	11.2	3.91	2.81	0.47	0.03	5.83	0.04	0.94	0.32	1.48
Blackhawk	2	7.2	7.75	548	89.5	52.3	35.7	5.2	436	0.0	175.5	12.5	4.47	4.30	1.55	0.13	7.15	0.00	3.65	0.35	4.40
In-mine																					
Blackhawk	45	12.2	7.34	636	125.4	52.3	33.5	4.6	414	1.1	235.9	14.3	6.26	4.30	1.46	0.12	6.79	0.04	4.91	0.40	3.61
non-burn-influenced	40	12.3	7.36	524	110.3	45.5	34.6	4.6	396	1.2	173.6	13.6	5.50	3.74	1.50	0.12	6.48	0.04	3.61	0.38	3.92
burn-influenced	5	11.2	7.2	1506	243.3	105.7	25.2	4.8	561	0.7	722.3	19.9	12.14	8.70	1.10	0.12	9.19	0.02	15.04	0.56	1.95
Oliphant Mine Discharge																					
Blackhawk/Star Point	1	9.9	8.21	419	60.8	42.6	21.8	3.8	286	3.7	118.6	9.1	3.03	3.50	0.95	0.10	4.68	0.12	2.47	0.26	3.68
Wells in Spring Canyon Member of Star Point Sandstone																					
Star Point	3	13.0	7.71	323	42.4	28.8	28.1	3.6	318	0.6	39.2	8.3	2.12	2.37	1.22	0.09	5.22	0.02	0.82	0.23	5.24
Wells that intercept the Mancos Shale																					
Star Point/Mancos	2	10.2	8.49	1141	27.8	19.5	414.8	5.7	629	35.7	118.3	213.8	1.39	1.61	18.04	0.15	10.31	1.19	2.46	6.03	2.99

Two types of groundwater issue from the North Horn Formation. The more predominant of the two waters is a Ca^{2+}-Mg^{2+}-HCO_3^- type water with low TDS (Table 3). The second is a Ca^{2+}-HCO_3^--SO_4^{2-} type water which has an elevated TDS as well as elevated Ca^{2+} and SO_4^{2-} concentrations (Table 3). The elevated solute concentrations are interpreted to result from the dissolution of gypsum (Eq. 5). This second group includes waters with SO_4^{2-} concentrations greater than about 50 mg L^{-1}. The distinction between low and high SO_4^{2-} water was determined from an ordered ranking of SO_4^{2-} concentrations (Figure 15).

The Ca^{2+}-HCO_3^--SO_4^{2-} waters issue from two sections of the North Horn Formation. As shown in Figure 16a, high SO_4^{2-} waters are found in springs that issue within 50 feet of the base of the North Horn and between 550 and 600 feet from the base of the formation. Sulfate concentrations do not correlate with discharge rates (Figures 16b and 16c). Although detailed stratigraphic information describing the North Horn Formation is not available, the solute data suggest that there are two gypsiferous sequences in the formation that represent evaporative depositional conditions. Low SO_4^{2-} waters discharge from springs located stratigraphically throughout the formation including from the two sections identified above.

What the distribution of high SO_4^{2-} spring waters means is that flow paths within the North Horn Formation are short and that there is little vertical communication of waters. If water were being communicated vertically, solute concentrations, especially Ca^{2+} and SO_4^{2}, would be more uniform in the formation.

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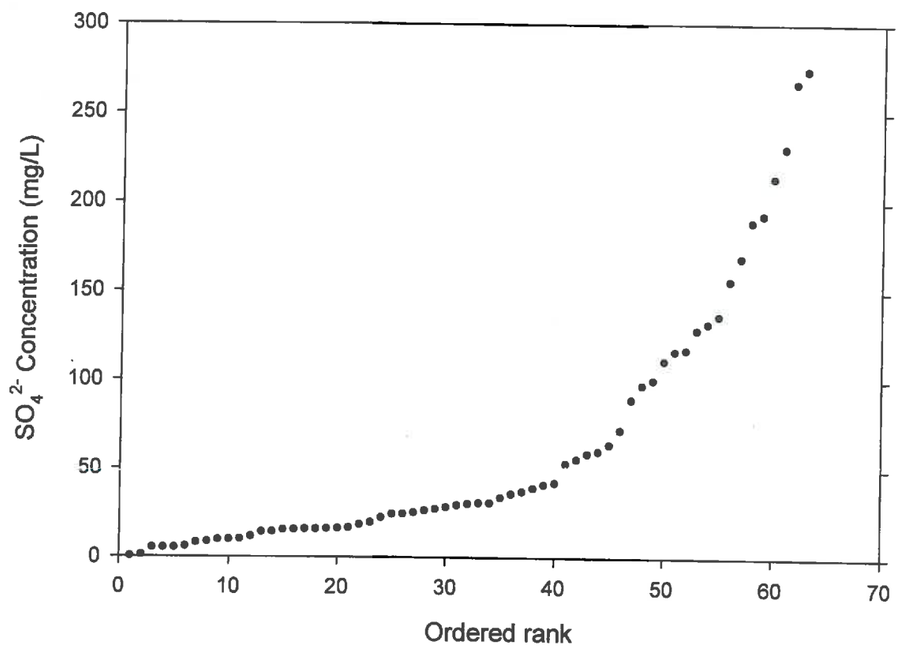

Figure 15 Ordered ranking of SO_4^{2-} concentrations of groundwaters from the North Horn Formation during highflow conditions.

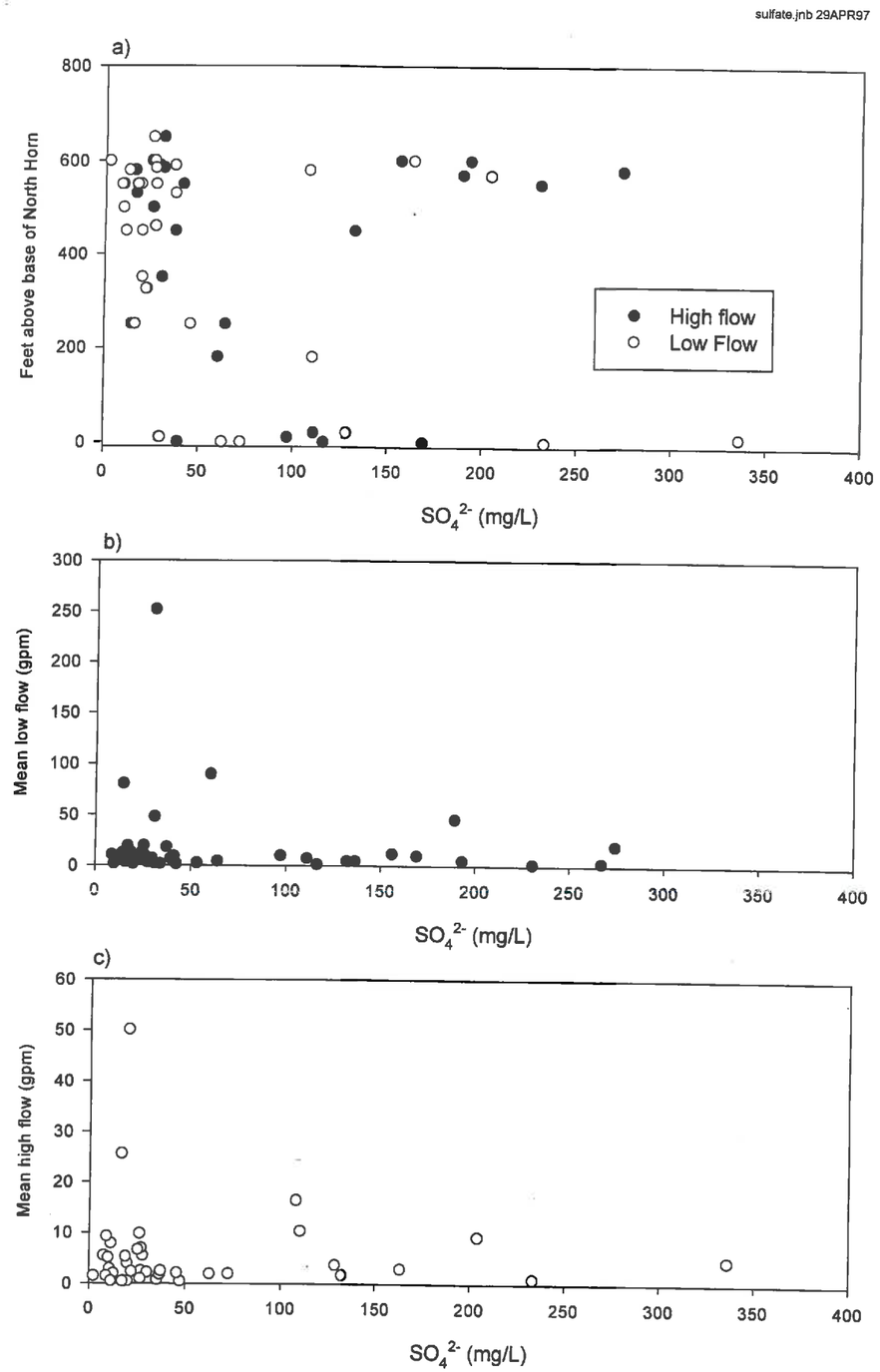

Figure 16 Scatter plots of SO_4^{2-} concentrations in the North Horn Formation vs. stratigraphic location and discharge rate for both low-flow and high-flow conditions.

In-mine roof drip waters and spring waters issuing from the Blackhawk Formation have elevated TDS contents relative to all other groundwater in the study area (Table 3). The elevated TDS is largely the result of elevated Ca^{2+}, Mg^{2+}, Na^{+}, and SO_4^{2-} concentrations (Table 3, Figure 12). These elevated concentrations are the result of a series of interrelated and cascading mineral dissolution and precipitation reactions. These reactions are discussed in detail by Mayo and others (in press). Sources of elevated SO_4^{2-} include the dissolution of evaporative gypsum (Eq. 5), associated with the swamp environments, and the oxidation of pyrite. Gypsum dissolution also elevates the concentration of Ca^{2+} which in turn results in the precipitation of calcite due to the common ion effect. Ca^{2+} and Mg^{2+} are also removed from groundwater by ion exchange on clays and in coal deposits on the Na^{+} zeolite analcime (Eqs. 7-10). The removal of Ca^{2+} and Mg^{2+} triggers the dissolution of additional calcite and dolomite (Eqs. 3 and 4).

Five in-mine samples collected from the Wilberg Mine have very elevated TDS (Table 3; Figure 14). These samples have a mean TDS of about 1,500 mg L^{-1}, which is about 1,000 mg L^{-1} greater than the mean of the other 40 in-mine samples. The samples were collected near an ancient coal burn that has greatly affected their solute compositions.

5.3 δ^2H and $\delta^{18}O$

The δ^2H and $\delta^{18}O$ composition of a water molecule falling as precipitation is determined by the temperature at which nucleation of the water droplet occurs. The stable isotopic compositions of waters are usually analyzed relative to the Meteoric Water Line (MWL). The MWL is empirically derived from the worldwide plotting locations of coastal zone

precipitation and is defined by the equation $\delta^2H = 8\ \delta^{18}O + 10$ (See Appendix B for further discussion of the MWL). Relative to the MWL, precipitation that forms under cooler conditions will plot more negative than precipitation which forms under warmer conditions.

In addition to the nucleation temperature of the water molecule, several other factors may affect the isotopic composition of recharge water. These factors include rainout and orographic effects and the sublimation of snow prior to the springtime snowmelt. Sublimation often causes the isotopic composition of snow to be considerably more negative than the compositions of waters in streams and issuing from springs.

Except for unusual conditions such as geothermal heating above abut 100°C, the δ^2H and $\delta^{18}O$ composition of a groundwater is set at the time of recharge and is not affected by subsurface conditions such as residence time and mineral dissolution and precipitation reactions. In other words, the recharge and flow history of a groundwater can be evaluated independently of the solute content of the water.

The δ^2H and $\delta^{18}O$ composition of both in-mine groundwaters and groundwaters from springs and wells in the lease area are listed in Table 4 and are plotted on Figure 17. All groundwaters in the study area plot near the meteoric water line (MWL) indicating a meteoric recharge origin (i.e. rain and snow; Figure 17). The groundwaters have stable isotopic compositions considerably more positive than snow samples (Table 4). We attribute the differences in the isotopic compositions of snow and groundwater samples to evaporation effects prior to groundwater recharge.

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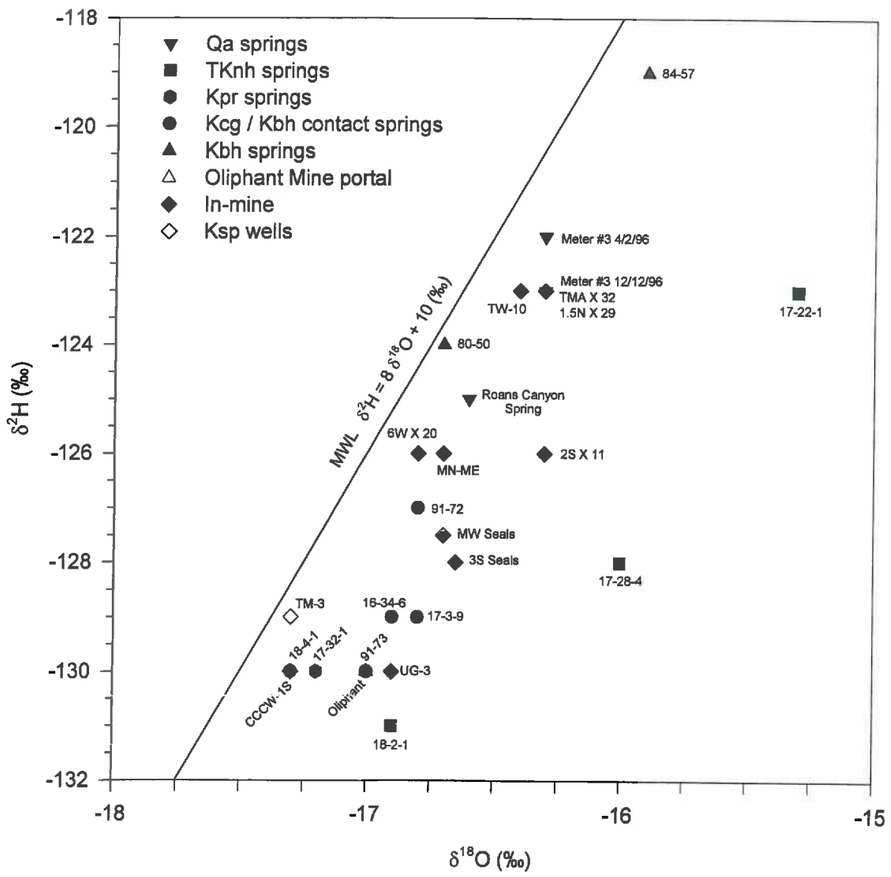

Figure 17 Scatter plot of δ^2H and $\delta^{18}O$ of groundwater samples plotted relative to the meteoric water line (MWL).

Table 4 Isotopic compositions of snow and groundwater

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	Date	$\delta^{2}H$ (‰)	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	$\delta^{34}S$ (‰)	^{14}C (pmc)	^{3}H (TU)
Snow							
DC Portal	2/17/96	-133	-17.7				
E. Joes Valley	2/17/96	-140	-18.5				
E. Mtn	3/21/96	-141	-19.2				8.79
Snow #2	3/21/96	-143	-19.4				7.50
CCC Trail	12/13/96	-140	-18.4				
Cottonwood Canyon	12/13/96	-140	-18.4				
Mean		**-141**	**-18.8**				**8.15**
Alluvial/Blackhawk							
Meter 3	4/2/96	-122	-16.3	-10.9	3.4	82.21	13.7
Meter 3	12/12/96	-123	-16.3	-10.9	8.7	77.66	13.5
Roans Canyon Spring	4/2/96	-125	-16.6	-10.4	-0.4	73.24	11.2
Mean		**-123**	**-16.4**	**-10.7**	**3.9**	**77.70**	**12.8**
North Horn Springs							
17-22-1	8/23/96	-123	-15.3	-10.5	3.0	78.89	18.1
17-28-4	8/23/96	-128	-16.0	-10.3	-2.7	82.93	13.3
18-2-1	8/23/96	-131	-16.9	-11.2	-20.1	76.12	12.2
Mean		**-127**	**-16.1**	**-10.7**	**-6.6**	**79.31**	**14.5**
Price River Springs							
17-32-1	12/13/96	-130	-17.2	-8.6	-13.6	61.55	2.20
Kbh/Kc Contact Springs							
17-3-9	8/23/96	-129	-16.8	-11.2	5.8	91.26	23.0
16-34-6	12/13/96	-129	-16.9	-11.2	16.2	79.12	12.7
91-72	12/14/96	-127	-16.8	-9.9	-4.9	75.47	14.9
91-73	12/15/96	-130	-17.0	-7.9	7.9	79.49	2.63
18-4-1	12/16/96	-130	-17.3	-9.9	0.0	52.65	0.00
Mean		**-129**	**-17.0**	**-10.0**	**5**	**75.60**	**10.6**
Blackhawk Springs							
80-50	12/12/96	-124	-16.7	-9.6	23.2	76.17	10.0
84-57	12/12/96	-119	-15.9	-8.6	1.9	70.55	11.7
Mean		**-122**	**-16.3**	**-9.1**	**13**	**73.36**	**10.9**
In-Mine Roof Drips							
TMA X 32 (Cottonwood)	3/28/96	-123	-16.3	-10.0	21.0	24.97	0.22
2S X 11 (Cottonwood)	3/28/96	-126	-16.3	-7.5	13.3	12.15	0.05
1.5N X 29 (Wilberg)	12/13/96	-123	-16.5	-10.6	6.9	31.97	0.33
UG-3 (Trail Mtn)	3/28/96	-130	-16.9	-14.0	19.0	30.95	0.13
6W X 20 (Deer Creek)	5/2/96	-126	-16.8	-10.3	9.3	42.23	0.14
MN-ME (Deer Creek)	3/29/96	-126	-16.7	-8.1	5.1	22.54	0.10
TW-10 (Deer Creek)	3/29/96	-123	-16.4	-10.5	2.2	62.39	20.8
Mean (w/o TW-10)		**-126**	**-16.6**	**-10.1**	**12.4**	**27.47**	**0.16**
In-Mine Longwall Gob Areas							
MW Seals (Cottonwood)	2/26/97	-128	-16.7	-9.7	11.5	21.99	1.34
3S Seals (Deer Creek)	2/23/97	-128	-16.7	-7.7	13.9	14.40	0.88
Oliphant Mine Discharge							
T-18	12/13/96	-130	-17.0	-15.3	9.8	21.70	0.20
Starpoint Wells							
CCCW-1S	12/9/96	-130	-17.3	-10.3	13.2	46.17	1.10
TM-3	12/11/96	-129	-17.3	-10.3	27.7	24.36	0.00
Mean		**-130**	**-17.3**	**-10.3**	**20.45**	**35.27**	**0.55**

In many groundwater investigations of coal mining areas in the Wasatch Plateau and the Book Cliffs we have found that in-mine groundwaters have isotopic compositions which are distinct from spring and stream waters and which have more negative plotting locations. Although considerable scatter occurs in the δ^2H and $\delta^{18}O$ data from the study area and the data do not fit such a pattern, some preliminary conclusions may be made.

Groundwaters from wells, springs and in-mine samples collected from Trail Mountain tend to have more negative isotopic compositions than do similar samples collected from East Mountain (Figure 17). Such differences may be the result orographic effects associated with the morphology of the lease area and its positioning along the eastern edge of the Wasatch Plateau. Additional sampling needs to be performed to verify this conclusion.

5.4 Groundwater ages (^3H and ^{14}C)

The concept of groundwater age is difficult to define because water arriving at a well or spring seldom travels via pure piston flow. Instead it is usually a mixture of water molecules that recharged at different locations and at different times, thus water has no unique age. It is, therefore, best to think of a groundwater 'age' as the *mean residence time* of the water molecules sampled at the well or spring.

In this investigation, two unstable isotopes, tritium (^3H) and carbon-14 (^{14}C), have been used to evaluate mean residence times. Tritium is a qualitative tool indicating if groundwater has a component of water that recharged since about 1954. Groundwater that recharged prior to about 1954 will contain essentially no tritium. Carbon-14 provides information regarding the

number of years that have elapsed since the groundwater became isolated from soil zone gases and near-surface waters. Like tritium, ^{14}C can indicate if groundwater has a component that recharged since the 1950s. Groundwaters with ^{14}C contents greater than about 50 pmc contain anthropogenic (human-induced) carbon associated with atmospheric nuclear weapons testing. It is not uncommon for groundwater issuing from a spring or occurring in a well to be a mixture of old (i.e. containing no ^{3}H) and younger groundwaters.

Groundwater ages have been calculated for 13 springs, 9 in-mine locations, 2 Star Point Sandstone wells, and the Oliphant Mine discharge (Table 5). All springs waters, except for spring 18-4-1, contain anthropogenic carbon and appreciable amounts of ^{3}H and are, therefore, modern. These springs issue from alluvial systems, the North Horn Formation, the Price River Formation, the Castlegate Sandstone, and Blackhawk Formation.

Spring 18-4-1 issues from the Blackhawk Formation-Castlegate Sandstone contact at the down plunge end of the Straight Canyon Syncline (Figure 13). The spring water does not contain water which recharged since 1954; however, the water was likely recharged less than a few hundred years ago as is indicated by its ^{14}C content.

Most groundwaters collected inside the Cottonwood/Wilberg Mine contain essentially no tritium (Table 5) and have mean ^{14}C ages ranging from 2,000 to 12,000 years. Roof drip waters associated with faults (i.e., 1.5N X 29, 6W X 20, and MN-ME) contain waters 2,000 to 7,000 years old and are not in hydraulic communication with the surface (Table 5).

Table 5 Mean groundwater residence times based on ^{14}C and ^{3}H contents

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	Sample Date	^{14}C (pmc)	^{3}H (TU)	Mean residence time (years)
Alluvial/Blackhawk				
Meter 3	4/2/96	82.21	13.7	Modern
Meter 3	12/12/96	77.66	13.5	Modern
Roans Canyon Spring	4/2/96	73.24	11.2	Modern
North Horn Springs				
17-22-1	8/23/96	78.89	18.1	Modern
17-28-4	8/23/96	82.93	13.3	Modern
18-2-1	8/23/96	76.12	12.2	Modern
Price River Springs				
17-32-1	12/13/96	61.55	2.20	Modern
Kbh/Kc Contact Springs				
17-3-9	8/23/96	91.26	23.0	Modern
16-34-6	12/13/96	79.12	12.7	Modern
91-72	12/14/96	75.47	14.9	Modern
91-73	12/15/96	79.49	2.63	Modern
18-4-1	12/16/96	52.65	0.00	>50
Blackhawk Springs				
80-50	12/12/96	76.17	10.0	Modern
84-57	12/12/96	70.55	11.7	Modern
In-Mine Roof Drips				
TMA X 32 (Cottonwood)	3/28/96	24.97	0.22	6,500
2S X 11 (Cottonwood)	3/28/96	12.15	0.05	12,000
1.5N X 29 (Wilberg)	12/13/96	31.97	0.33	4,500
UG-3 (Trail Mtn)	3/28/96	30.95	0.13	5,500
6W X 20 (Deer Creek)	5/2/96	42.23	0.14	2,000
MN-ME (Deer Creek)	3/29/96	22.54	0.10	7,000
TW-10 (Deer Creek)	3/29/96	62.39	20.8	Modern
In-Mine Longwall Gob Areas				
MW Seals (Cottonwood)	2/26/97	21.99	1.34	8,000
3S Seals (Deer Creek)	2/26/97	14.4	0.88	12,000
Oliphant Mine Discharge				
T-18	12/13/96	21.70	0.20	7,000
Starpoint Wells				
CCCW-1S	12/9/96	46.17	1.10	1,000, mixed
TM-3	12/11/96	24.36	0.00	6,000

A water sample from drill hole TW-10, which intercepts groundwater in the Roans Canon Fault in the Deer Creek mine, contains anthropogenic carbon, appreciable amounts of ^{3}H, and was thus recharged less than 50 years ago. The drill hole intercepted the fault in late 1988 and the initial discharge rate was about 80 gpm. Within about two years the drip rate stabilized at about 4 to 6 gpm. ^{3}H and ^{14}C data indicate that, unlike other mine roof drips and fault waters, the discharge at TW-10 is in hydraulic communication with the surface. However, discharge from TW-10 does not exhibit seasonal fluctuations indicating that the hydrodynamics of this system are buffered. This buffering may be due to a tortuous flow path, which means a longer travel time, or the mixing of modern recharge water with older water. It is possible that the initial water intercepted by the drill hole was of similar old age as other waters encountered in the mine. Prior to intercepting the fault, the fault may have been full and rejected recharge may have occurred. The small, stabilized drip rate, 3-4 gpm, suggests that the impact to near-surface waters is limited. Groundwater associated with the Roans Canyon Fault, which is intercepted by TW-10, is further discussed in Section 6.3.2.2.

Isotopic samples were also collected from gob areas in the Cottonwood and Deer Creek Mines (Figures 10 and 11; Table 4). The gob waters have mean ^{14}C residence times of 8,000 to 12,000 years (Table 5), and they contain approximately 1 TU of ^{3}H. These gob areas received most of their water from fault drainage and a small fraction of their water from process water return flows. The process water was pumped from nearby creeks and is likely responsible for the small ^{3}H contents.

A groundwater sample collected from the Oliphant Mine portal (T-18; Figure 9) has a mean ^{14}C residence time of 7,000 years. The Oliphant Mine is sealed and it is unknown if the discharge water issues from the mine roof or mine floor.

Two wells completed in the Star Point Sandstone, CCCW-1S and TM-3, have mean groundwater residence times of 1,000 and 6,000 years, respectively. These two wells are both completed in the Spring Canyon tongue and appear to be located on approximately the same flow line. CCCW-1S is up gradient and TM-3 is down gradient. Assuming that the two wells intercept groundwater along the same flow line, travel times can be calculated using the method described by Mooke (1980):

$$\Delta T = 8270 \ln (a_{k+1}^{14}/a_k^{14}) \qquad (11)$$

$$\Delta T = 5{,}300 \text{ years}$$

where:

ΔT = travel time (in years)

a_{k+1}^{14} = ^{14}C activity of up-gradient sample

a_k^{14} = ^{14}C activity of down-gradient sample

Assuming the travel time of 5,300 years and a distance of 4 miles, the calculated flow velocity is approximately 0.25 feet per year.

6. GROUNDWATER

6.1 Groundwater occurrence

Groundwater naturally discharges, in greatly varying quantities, from most formations exposed in Trail and East Mountains. Approximately 75% of the identified springs issue from the North Horn Formation, which comprises nearly the entire plateau surface of East and Trail Mountains. No springs have been identified which discharge from the Star Point Sandstone or the Mancos Shale.

Within the mines, groundwater issues from short-lived roof drips, the mine floors in some locations in the Trail Mountain, Deer Creek, Cottonwood, and Wilberg mines, and from the mine roof and mine floor after encountering some faults. Confined groundwater occurs in monitoring wells in the Star Point Sandstone that have been installed in the mines and elsewhere. Groundwater discharge is generally not associated with the Mancos Shale.

6.2 Spring discharge characteristics

More than 100 spring hydrographs were analyzed as part of this investigation. Approximately 75% of the springs discharge from the North Horn Formation. The remainder discharge from creek bottom alluvial systems, the Flagstaff Limestone, the Price River Formation, the Castlegate Sandstone, and the Blackhawk Formation. No springs have been identified which discharge from the Star Point Sandstone or Mancos Shale within the lease area. Because of the great number of springs for which discharge data are available, hydrographs for only selected representative springs are presented and discussed here. The maximum flow rates for

some springs are probably greater than those reported due to the inaccessibly of many springs until mid-July, after the peak of the snowmelt.

6.2.1 Alluvial Springs

6.2.1.1 Rilda Canyon

The North Emery Water Users Association (NEWUA) Rilda Canyon collection system captures groundwater in a series of french drains (Figure 9) in the shallow alluvium in Rilda Canyon (Meters 1-4). Flow meters were first installed in the piping system in September 1990 and monthly monitoring of these meters has occurred since that time. Meter 2 contains flow from the combined discharge from Side Canyon and from the vicinity of South Spring. Meter 3 measures flow from the central portion of the collection system near Rilda Canyon Creek. Previous to 1995, Meter 4 recorded flow from the north side of Rilda Canyon Creek. In 1995, flow from Meter 4 was combined with flow from Meter 3, and monitoring of Meter 4 was discontinued.

It is apparent from the NEWUA meter discharge hydrographs (Figure 18) that flow in this alluvial groundwater system is highly dependent upon seasonal recharge. Springtime maximum flows as great as about 180 gpm have been recorded at Meter 4 while the base flow discharge at Meter 4 has been a low as 1.5 gpm. The decline in discharge from Meter 2, which has the lowest flows of the NEWUA meters (<20 gpm) from 1990 to 1991 is believed to be the result of maintenance problems with the piping system (Personal communication, Chuck Semborski, 1997).

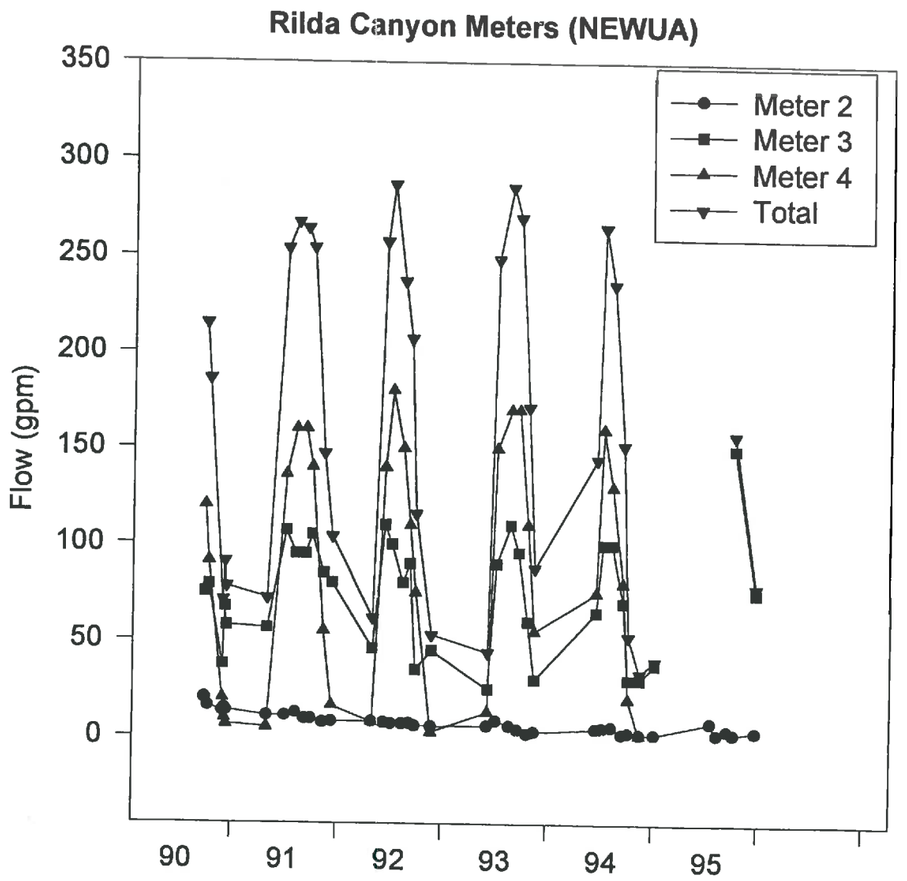

Figure 18 Hydrographs of Rilda Canyon NEWUA meters.

PacifiCorp performed a pump-test during November 1990 in the vicinity of the Rilda Canyon collection system. The results of this testing suggested that at least 90% of the flow to the system could be accounted for by drainage directly from the shallow alluvial sediments (non-bedrock derived). The remaining <10% was believed to be derived from bedrock discharge. However, it was later learned that the thickness of saturated alluvium upgradient from the wells was thicker than that assumed at the time of the testing (Personal communication, Chuck Semborski, 1997). If the greater thickness of saturated alluvium is used in the pump-test equations, a value greater than 90% is calculated for the percentage of flow attributable to alluvial discharge.

Because discharge data for individual meters in the Rilda Canyon collection system are only available since the end of 1990, the effects of long-term climatic fluctuations cannot be determined.

6.2.1.2 Cottonwood Canyon Alluvium

In an attempt to determine the nature of the alluvial groundwater system in Cottonwood Canyon, PacifiCorp carried out a detailed hydrogeologic investigation in 1994. The investigation included construction of monitoring wells, geophysical surveys, and detailed geologic mapping. The results of the geologic mapping, drilling, and resistivity studies indicated that the maximum alluvial thickness in the canyon bottom ranges from 40 to 70 feet. The alluvial sediments consist primarily of lateral and terminal glacial moraine deposits. Below the northwest corner of section 24, the alluvial deposits are fluvial in origin. Nested monitoring wells were installed in the alluvium in Cottonwood Canyon and in the underlying

Spring Canyon member of the Star Point Sandstone. The hydrographs for these wells (discussed in Section 6.4) indicate that the alluvial deposits, which respond to seasonal variations in precipitation, are hydraulically isolated from groundwaters in the underlying Spring Canyon sandstone. The springs discharging near the base of Cottonwood Canyon (e.g. Roans Canyon Spring, Cottonwood Spring) are fed by shallow alluvial systems and are not related to bedrock groundwater systems in the Star Point Sandstone. In 1996, as a part of this investigation, stable and unstable isotopic data were collected from the alluvial groundwater system in Cottonwood Canyon at Roans Spring. The ^{14}C and ^{3}H compositions of this water (Table 5) indicate that it is of modern origin and is not related to the deep groundwater systems encountered within the mines. The interception of groundwaters within the mine workings, therefore, does not adversely impact groundwater flow rates in the alluvial springs in Cottonwood Canyon.

6.2.2 Flagstaff Limestone Springs

Although the Flagstaff Limestone occurs in the highest elevations of the plateau where precipitation is the greatest, only 5 springs have been identified which discharge from the limestone in the mine lease area. Spring discharges respond to both seasonal recharge and climatic factors. Hydrograph recession characteristics indicate that these springs are dependent on annual recharge events. For example, Spring 79-35 had a maximum discharge of about 20 gpm in 1979, but has gone completely dry at least three times since then (Figure 19a). Both climatic and seasonal effects are also illustrated in the Sheba Spring hydrograph (Figure 19b).

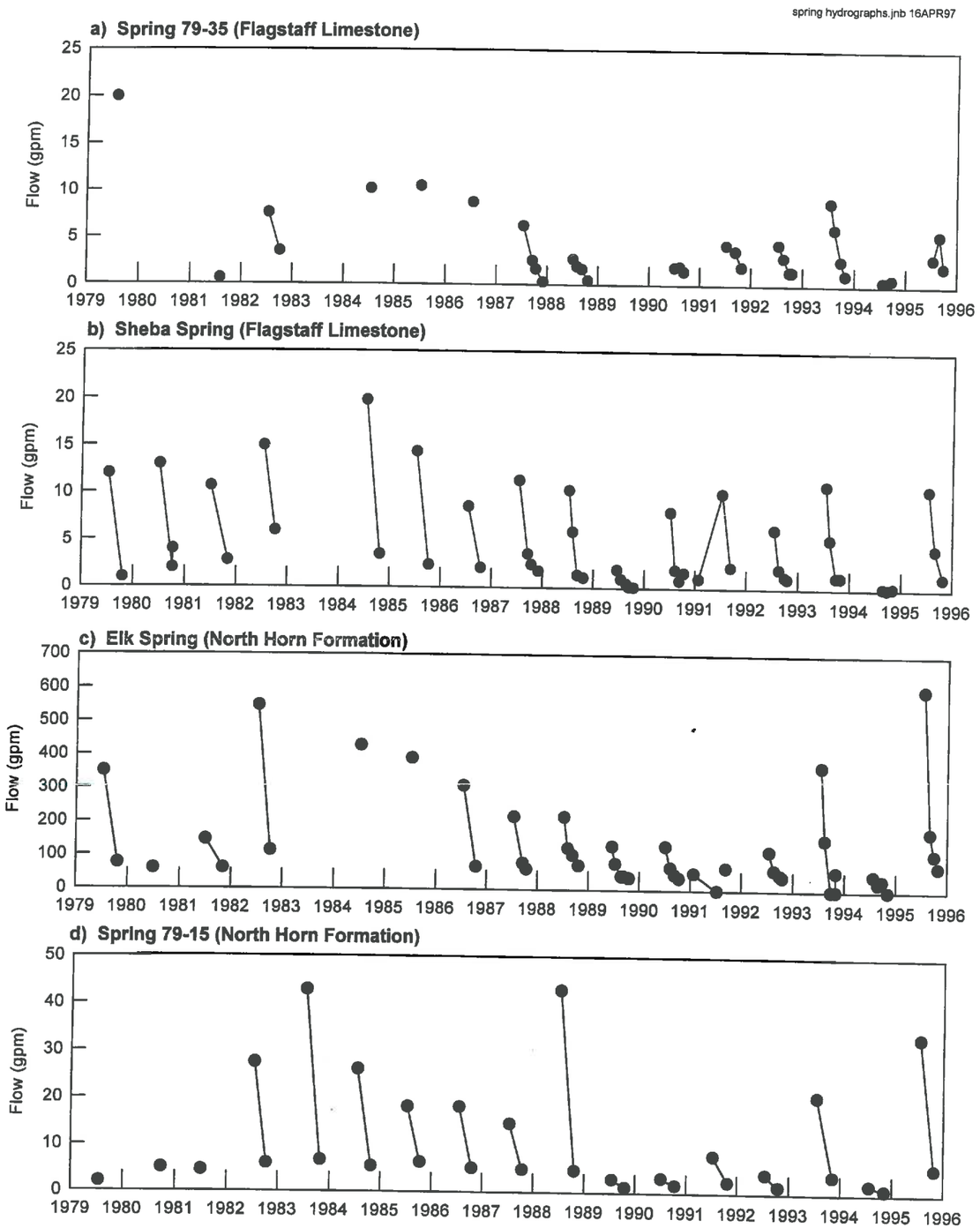

Figure 19 Selected discharge hydrographs for springs issuing from the Flagstaff Limestone, North Horn Formation, Price River Formation, and the Castlegate Sandstone/Blackhawk Formation contact.

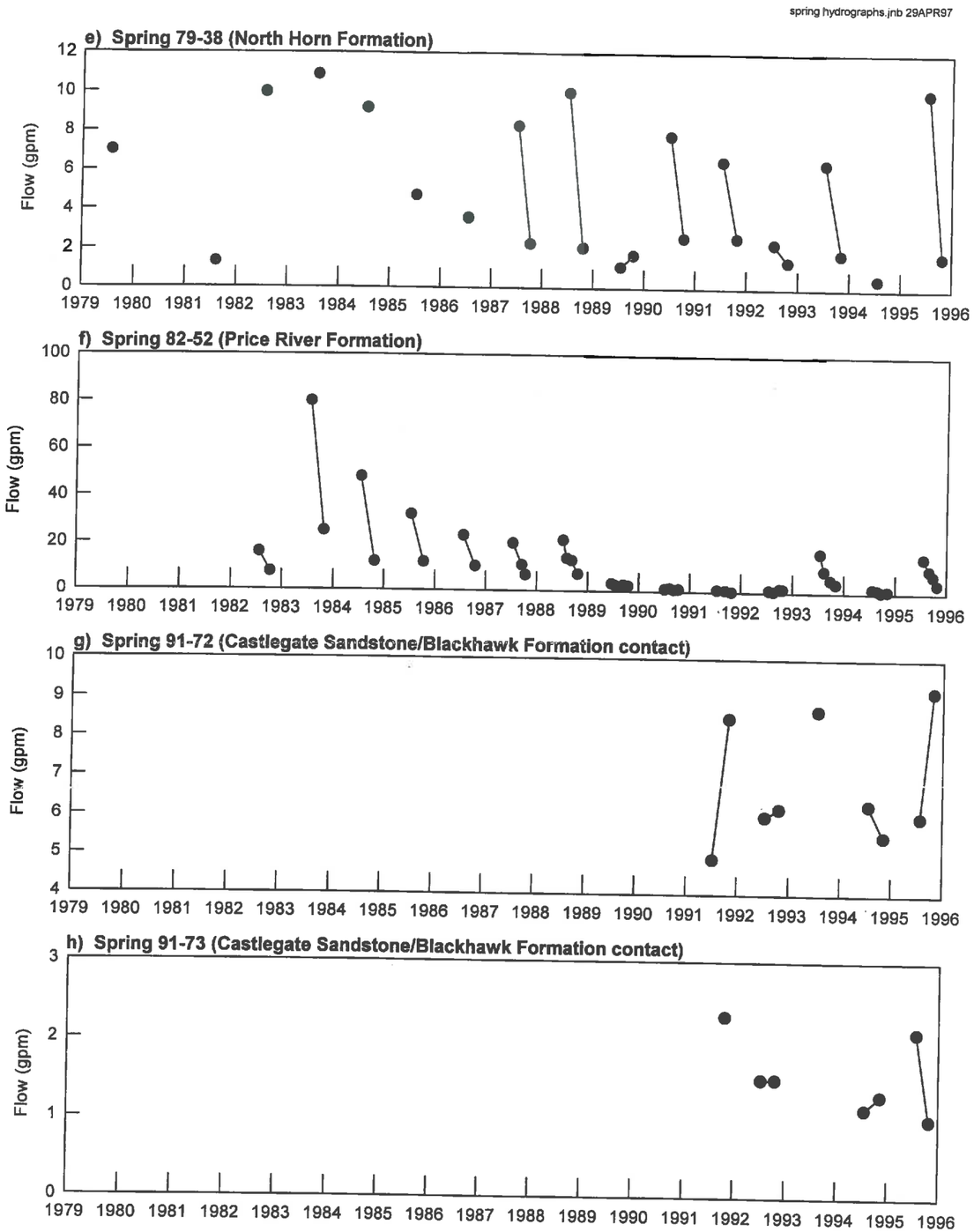

Figure 19 Continued.

The limited number of springs reflects the character of the rock. In the lease area the limestone is relatively thin (<100 feet) and groundwater can only flow in the few fractures which are interconnected. Springs occur where the width of the limestone outcrops is greatest.

6.2.3 North Horn Formation Springs

Seventy-two springs have been identified as discharging from the North Horn Formation. Springs respond to annual recharge from snowmelt events and exhibit a wide range of discharge rates (Figures 19c and 19d). It is not uncommon for these springs to discharge more than 20 gpm during the springtime and to discharge less than 5 gpm during the late fall. The discharge from Elk Spring (Figure 19c) increased from 24 gpm in November 1994 to 600 gpm the following July 1995.

Discharge from most North Horn Formation springs is also dependent on long-term climatic trends. Substantial declines in peak flow discharges are observed in most hydrographs in the late 1980s and spikes in peak flow discharge occurred in the springtime 1994 and 1996 (Figure 19c).

6.2.4 Price River Formation Springs

Thirteen springs have been identified as discharging from the Price River Formation. Although considerably fewer in number than North Horn Formation springs, these springs have similar discharge characteristics as do North Horn Formation springs. Long-term discharge data are only available for one Price River Formation spring. Seasonal variability is

apparent in the hydrograph for Spring 82-52 (Figure 19f) and by comparing maximum and minimum measured discharges of several other springs:

Spring	n	years of record	Maximum (gpm)	Minimum (gpm)	Variability factor
Spring 79-24	5	1979-1988	60	0.7	86
Spring 79-40	11	1979-1995	15	0.1	150
Spring 80-41	12	1980-1995	14	0.4	35
Spring 80-44	10	1980-1993	40	0.5	80
Spring 80-45	5	1980-1985	12	0.5	24
Spring 80-49	5	1981-1994	43	12.0	4
Spring 82-51	7	1980-1995	15	3.0	5
Spring 82-52	46	1982-1995	80	0.2	400
Spring 89-60	6	1989-1995	3	1.0	3
Jerk Water Spring	10	1982-1986	3	2.0	2

where n is the number of measurements, and the variability factor is the maximum measured discharge divided by the minimum measured discharge. Springs with a high variability factor generally are more responsive to seasonal recharge than are springs with a lower variability factor.

Although Spring 17-32-1 (Sportsmans Lodge spring) has a modern ^{14}C age (Table 5) the relatively low ^{3}H content (2.2 TU) suggests a longer flow path than groundwaters in the North Horn Formation.

6.2.5 Blackhawk Formation-Castlegate Sandstone Contact Springs

Seven springs have been identified which discharge from near the Castlegate Sandstone-Blackhawk Formation contact. Limited discharge data are available for two of these (Springs

91-72 and 91-73). Hydrographs for these springs are shown on Figures 19g and 19h. Maximum and minimum measured discharges are listed below:

Spring	n	years record	Maximum (gpm)	Minimum (gpm)	Variability factor
91-72	10	1991-1996	9.2	4.9	1.9
91-73	8	1991-1996	2.3	1.0	2.3

Although the data are limited, the data suggest that the discharges from these springs are somewhat seasonally dependent. Sufficient discharge data is not available to determine the response of these springs to long-term climatic trends.

6.2.6 Blackhawk Formation springs

Only 2 springs (Spring 80-50 and 84-57) have been identified which discharge from the Blackhawk Formation. Only four flow measurements are available from two springs and seasonal discharge data are not available. The discharges measured from these springs are low, averaging only 1.6 gpm.

6.3 In-mine groundwater

PacifiCorp has monitored significant groundwater inflows into each of its mines since 1979. Groundwater encountered within mine openings occurs by three main mechanisms. These mechanisms include: 1) drainage from overlying sandstone channels which are penetrated by roof-bolts and by vertical boring, or which are exposed during mining, 2) interception of water bearing faults and major fracture systems which transmit water from either overlying or

underlying horizons, and 3) upward leakage from the underlying Spring Canyon Member of the Star Point Sandstone.

6.3.1 Sandstone channel groundwater

Numerous sandstone channels directly overlie coal-bearing horizons (Figures 20 and 21). These channels may be several miles long, up to 1000 feet wide and are commonly 25 to 30 feet thick. These channels have varying degrees of water saturation, which results in wet and dry regions of the mine.

It is common in "wet" portions of the mines for roof-drip groundwater to be encountered at the mining-face during mining operations. Most roof-drips typically are short lived, persisting for only a few weeks before the flow completely ceases. Thus, the roof-drips appear to "dry up" behind the mining operations. The discharges from these short-lived inflows into the mine are typically not recorded. In other portions of the mines, the coal seam and adjacent rocks are completely dry.

Occasionally, areas with greater, more persistent inflows are encountered. These sources are usually associated with faults or large sandstone channels that contain greater quantities of water. Such fault-channel systems are discussed in Section 6.3.2.2 below.

Typical hydrographs of roof drips that have not dried up immediately are shown on Figure 22. Carbon-14 ages of 6,500 and 12,000 years (Table 5) have been determined for groundwaters issuing from locations TMA X 32 and 2S X 11, respectively. The discharge

WATER SOURCES LEGEND
LOCATION NUMBER
LONG TERM WATER SOURCES
LOCATION DESCRIPTION
TYPE
PRECOMETRIC DRILL HOLES
LOCATION DESCRIPTION
STATUS
WATER SOURCE DISPOSED TO: AUGUST 1, 1997
LEGEND
U-044025
SL-064607
064621
SUL4
#284
SL-068116
U-02664
U-1358
U-044025
SL-064900
U-47979
U-47978
U-02392
SL-050862
U-014275
U-2810
SL-051221
U-024317
U-06039
U-7653
U-084923
U-083066
U-084924
U-084924A
FEE
CANYON FUEL CO. LLC
CANYON FUEL COMPANY
CANYON SYNCLINE
WATER PROBLEMS FRACTURE
DO-3 (CASING CRUSHED-TERMINATED 9/91)
DO-2 (CASING CRUSHED-TERMINATED 11/90)
DO-4 (SEALED 1-95A TERMINATED 6/91)
R. 6 E.
R. 7 E.
T. 13 S.
T. 14 S.
CAD FILE NAME/DRWG NO.
ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528
EAST MOUNTAIN PROPERTY
BLIND CANYON COAL SEAM
IN-MINE WATER MONITORING LOCATIONS
DRAWN BY: K. LARSEN
SCALE: NTS
FIGURE 20
DATE: DECEMBER 30, 1996

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528
EAST MOUNTAIN PROPERTY
HIAWATHA COAL SEAM
IN-MINE WATER MONITORING LOCATIONS
DRAWN BY: K. LARSEN
SCALE: 1"=1000'
FIGURE 21
DETAILED INFORMATION NOT AVAILABLE IN THIS AREA
DETAILED INFORMATION NOT AVAILABLE IN THIS AREA
SULA #284
SL-066116
SL-064607
064621
U-47979
U-47979
U-024319
U-084923
U-084923
U-084924
U-084924
U-7653
STATE
ML-22509
U-083066
U-02664
U-02664
U-1358
U-0440A
U-02292
SL-070645
U-02292
FEE
FEE
FEE
FEE
T. 17 S.
T. 18 S.
OLD JOHNSON MINE
LEGEND
U-044025
LEASE NUMBER
DRILL HOLES
SECTION LINES
SECTION NUMBERS
DIRECTION OF CURRENT
WATER SOURCES LEGEND
LOCATION NUMBER
LONG TERM WATER SOURCES
PIEZOMETRIC DRILL HOLES
DECEMBER 1, 1996

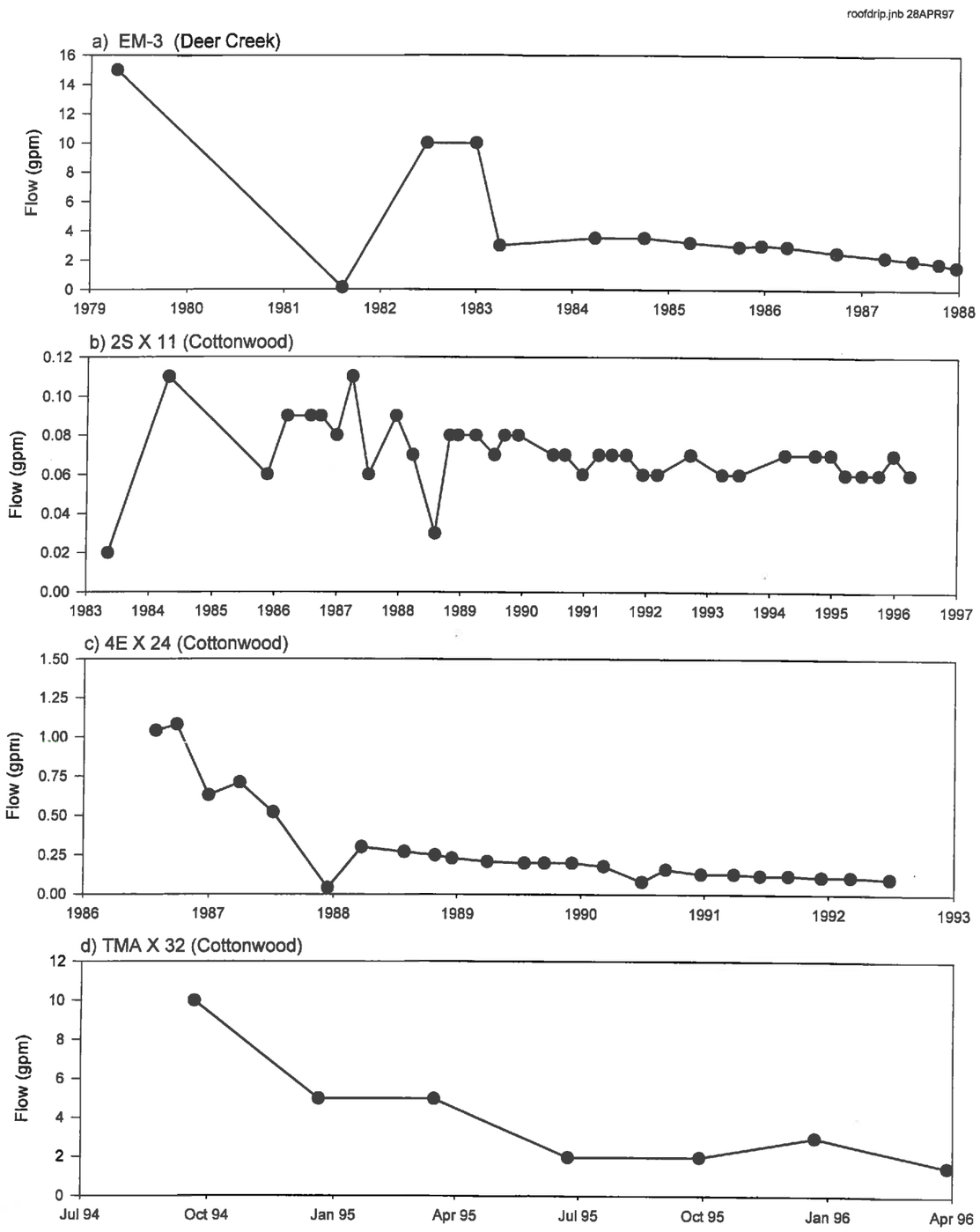

Figure 22 Hydrographs of selected roof drips.

declines of the hydrographs typically follow an exponential decay, with the greatest flow occurring immediately after the source is completely exposed and then falling off rapidly. The tail end of the discharge hydrograph typically trails off gradually, with slowly decreasing rates of discharge. Near the end of the discharge recession, the discharge hydrograph may appear nearly flat. Occasionally, a hydrograph may show a marked increase in discharge after the initial peak has passed. This is usually due to a change in the geometry of the system due to mining activities in the vicinity of the discharge.

In an attempt to quantitatively evaluate saturated sandstone channels, a dripping channel in the 6th West area of the Deer Creek Mine was investigated (site 6W X 20; Figure 10). The channel, located near a minor fault with very limited displacement, has the dimensions of >2,000 feet in length, 150 feet in width and a maximum thickness of 25 feet. An array of up-hole monitoring wells was installed across the width of the channel. The wells were 15 to 25 feet deep and were open along their entire depth. Each well was equipped with a shutoff valve and pressure gauge. The idea was to conduct a pump test by letting selected wells gravity drain and simultaneously measuring pressure change in nearby wells. Because a maximum of about 2 psi was recorded in the well (i.e. ≈ 5 feet of water) we were unable to conduct the test. What the well did demonstrate was that the sandstone channel was not fully saturated and it was a perched, unconfined groundwater system. Water issuing from the channel has a mean ^{14}C age of 2,000 years (Table 5). The perched, unconfined groundwater system evaluated in the 6th West area is consistent with the commonly observed roof drip conditions.

6.3.2 Fault water

Groundwater has been encountered in 3 faults in the PacifiCorp mines. These include the Pleasant Valley Fault in the both the Deer Creek Mine and Cottonwood/Wilberg Mine, the Roans Canyon Fault, and the Left Fork Graben in the Deer Creek Mine. The groundwater flow regimes associated with each of these faults are described below.

6.3.2.1 Pleasant Valley Fault

The Pleasant Valley Fault is a north-south trending fault, which is exposed in both the Wilberg and Deer Creek Mines (Figure 5). The fault was first encountered in the early 1970s by Peabody Coal Co. during the construction of rock slopes and has been encountered in at least 4 different locations in the Wilberg Mine. When the fault was first crossed during mining, groundwater discharge primarily occurred as floor upwelling in the Wilberg mine and as roof drips in the Deer Creek Mine. The discharge rate was small and never exceeded 50 gpm in any location. PacifiCorp's initial monitoring location in the Wilberg Mine discharged 50 gpm. Within 2 or 3 months, the flow from the fault had diminished greatly and the sampling point became only a puddle on the floor (Semborski, Personal Communication, 1997). Groundwater discharge rates from other locations on the Pleasant Valley Fault are also small but are more constant. Groundwater discharging from Pleasant Valley Fault sampled as part of this investigation is of ancient origin.

Three samples of fault-related groundwater were collected as part of this investigation for radiocarbon dating (6W X 20 and MN-ME in the Deer Creek Mine, and 1.5N X 29 Fault in the Wilberg Mine; Table 5). The recession hydrograph for MN-ME (Figure 23) shows that

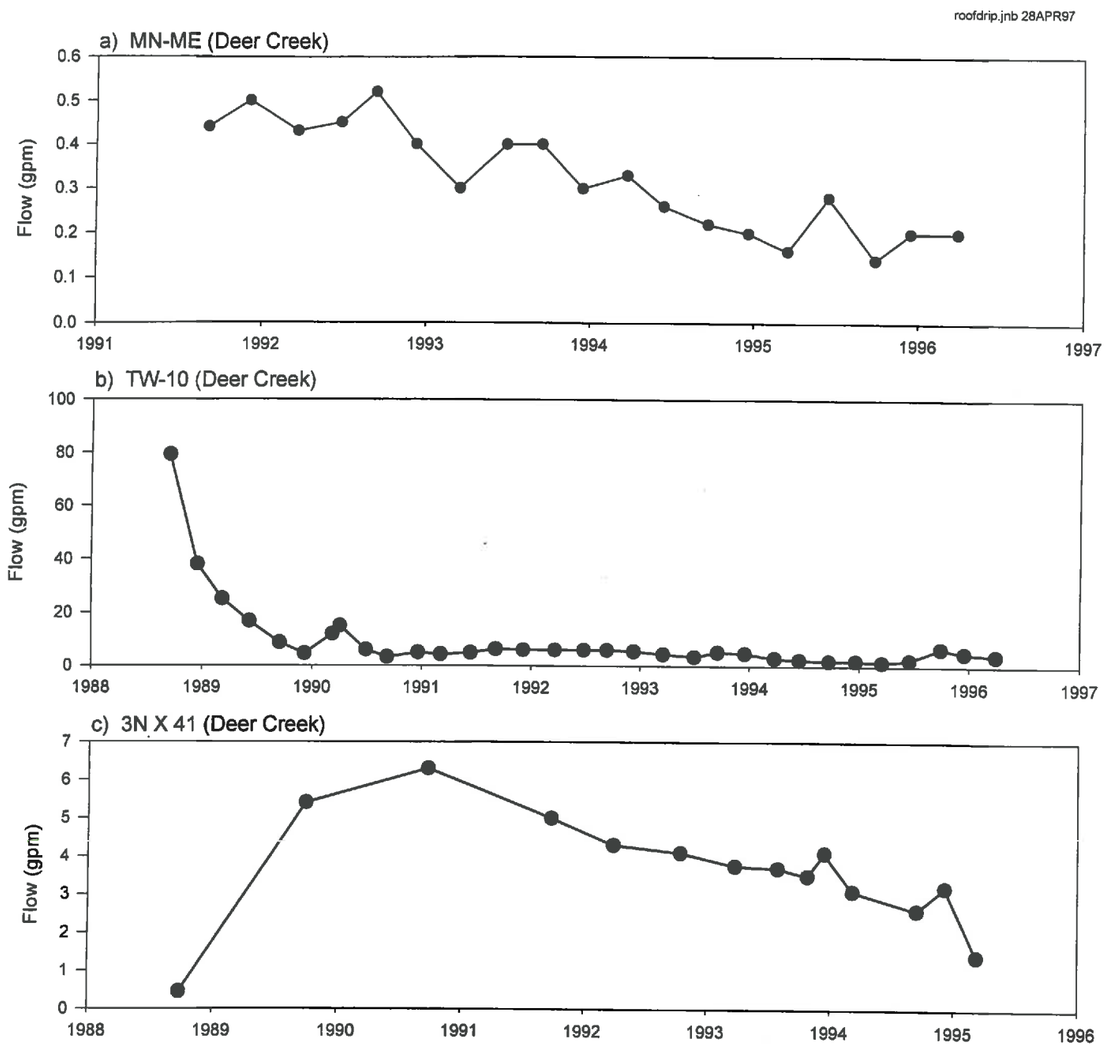

Figure 23 Hydrographs of selected in-mine roof drips associated with faults

discharge has steadily declined from about 0.5 to 0.2 gpm over 4 years. Groundwater issuing from 6W X 20, MN-ME and 1.5N X 29 have ^{14}C ages of 2,000, 7,000 and 4,500 years, respectively (Table 5).

6.3.2.2 Roans Canyon Fault

The Roans Canyon fault system forms a graben which trends in a northeasterly direction through the middle of Trail Mountain and northern East Mountain (Figure 5). The fault is parallel with and adjacent to the axis of the Straight Canyon Syncline. The Roans Canyon Fault was first encountered in the Deer Creek Mine in a series of horizontal drill holes completed in 1985. A second series of horizontal drill holes penetrated the fault system in 1989. The purpose of these drill holes was to evaluate the porosity of the fault system and to evaluate the potential for dewatering of the fault ahead of mining operations. Limited lateral communication along the fault system was suggested by the fact that discharge from drill holes located only 200 feet apart did not significantly affect the discharge rates of the individual holes.

The fault was first encountered in a mine opening in 1st Right in January 1990. Substantial groundwater inflows of several hundred gallons per minute occurred in each of the entries. The water discharging from the fault was entirely from the roof and appeared to be related to a large, overlying sandstone channel. A small sympathetic fault with less than 5 feet of offset associated with the Roans Canyon Fault was subsequently encountered in the 2nd Right entries in April 1990. Peak discharge from was estimated at 5,000 gpm (Semborski, Personal Communication, 1997). The last measurement of discharge from the fault zone, from an

established monitoring point in 1989, was 150 gpm. Currently, the discharge from the fault zone is believed to be less than 150 gpm. The large discharge rate from the Roans Canyon Fault had a profound effect on the discharge rate from the Deer Creek Mine (Figure 24).

Groundwater from the Roans Canyon Fault was encountered with a series of test wells including TW-10, a 1,100 foot long horizontal hole drilled into the fault system in the Deer Creek Mine (Figure 10). It was apparent during drilling that groundwater issuing from TW-10 was from a sandstone channel that had been highly fractured. Ubiquitous iron oxide in the fractured sandstone indicated that water in the fracture had been in good communication with atmospheric gases (Semborski, Personal Communication, 1997). Although TW-10 is under considerable cover (1,200 feet), it is located near the cliff faces. The cliff face rocks are extremely fractured and open to recharge water. The average temperature of groundwater from TW-10 is 7.7°C while the average temperature of other groundwaters in the Deer Creek Mine is 11.8°C. The cooler temperature of water from TW-10 relative to other in-mine groundwaters is attributed to the location of TW-10 near cliff faces.

The discharge rate from TW-10 has declined from about 80 gpm in 1989 to about 5-6 gpm in 1997 (Figure 23). Groundwater sampled from this location in 1996 contained anthropogenic ^{14}C and had a ^{3}H content of 20.8 TU (Table 5). These data indicate that groundwater now discharging from TW-10 is in hydraulic communication with recent recharge water. Discharge from TW-10 does not exhibit seasonal fluctuations indicating that the hydrodynamics of this system are buffered. This buffering may be due to a tortuous flow

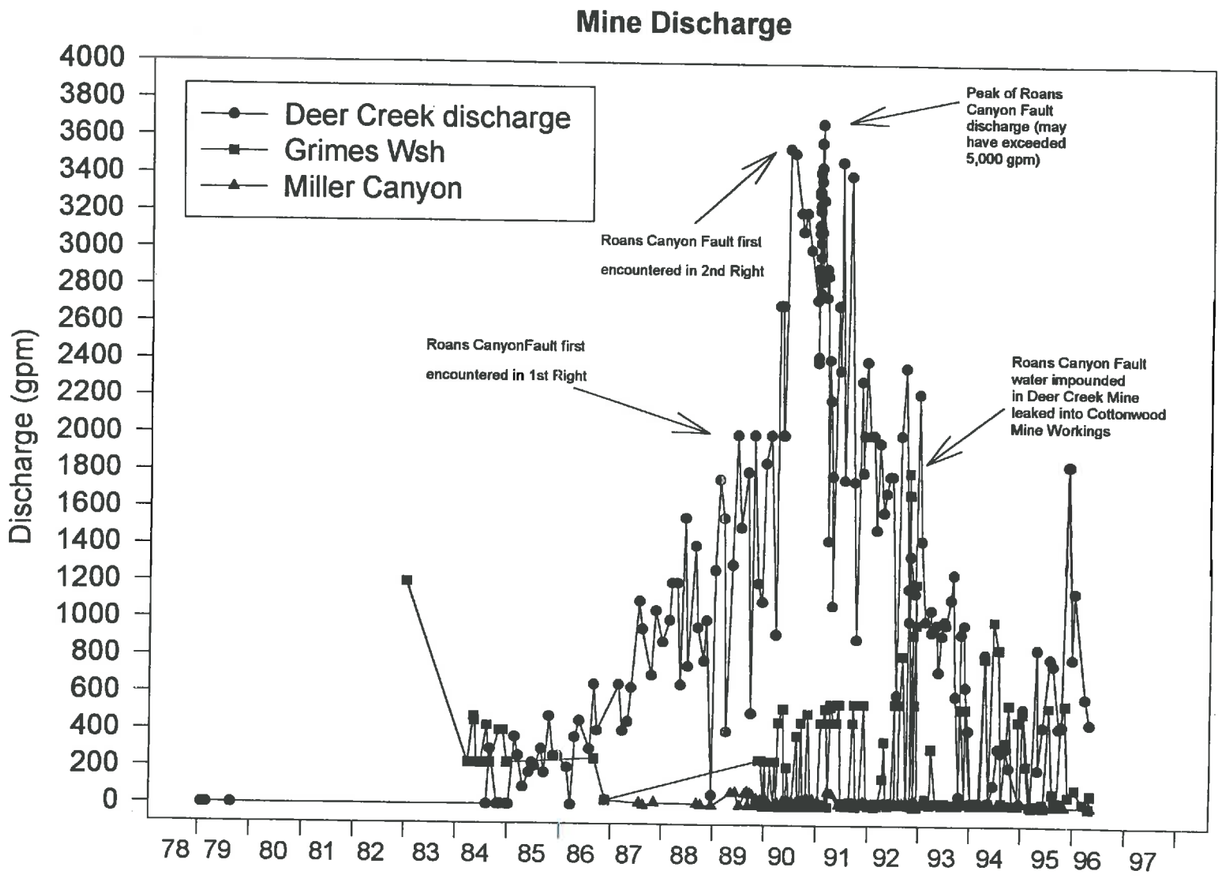

Figure 24 Mine discharge hydrograph.

path, which means a longer travel time, or the mixing of modern recharge water with older water. It is possible that the initial water intercepted by the drill hole was of similar old age as other waters encountered in the mine. Prior to intercepting the fault, the fault may have been full and rejected recharge may have occurred.

In an attempt to determine whether groundwaters discharging from the Roans Canyon Fault deeper within the mine, away from the cliff face, are tied to active, modern groundwater systems, a sample of the longwall gob water (3S Seals) in the Deer Creek Mine was collected and analyzed for isotopic composition. It is important to note, however, that this water is a composite sample of groundwater discharging from the fault and other in-mine sources, and a small percentage of Huntington Creek water used as process water in mining operations. The ^{14}C age of this sample is 12,000 years, with a tritium content of 0.9 TU (Table 5). We believe that the small component of tritium in the water is derived from the creek water. Therefore, we conclude that the groundwater in the Roans Canyon Fault deep within the mine, away from cliff faces, is of ancient origin and is likely not related to overlying shallow groundwater systems.

6.4 Well hydrographs

Historic water-level monitoring information is available for 16 wells from the study area. These wells monitor groundwater levels in alluvial systems, the Blackhawk Formation, and the Star Point Sandstone.

6.4.1 Alluvial system wells

6.4.1.1 Cottonwood Canyon

PacifiCorp currently monitors three wells completed in alluvium in Cottonwood Canyon. These include CCCW-1A, CCCW-2A, and CCCW-3A (Figure 9). Well screen intervals and gravel pack intervals are:

Well	Screen interval (ft)	Gravel pack (ft)
CCCW-1A	96 – 126	40-136
CCCW-2A	96-126	42-136
CCCW-3A	51 – 81	83-101

Hydrographs for each of these wells (Figure 25) show responses to annual precipitation. The somewhat muted hydrograph responses may be the result of depth of the screened intervals.

6.4.1.2 Rilda Canyon

Seven shallow wells were constructed in alluvium in Rilda Canyon in the mid 1980s (Figure 9). Hydrographs for these wells, identified as P-1 through P-7, are shown in Figure 26. All of the wells show the effects of annual precipitation. The hydrographs for P-1 and P-5 show less response to seasonal precipitation than do the other hydrographs. Well P-1 is located downgradient and is likely affected by the discharge from a series of upgradient springs. Well P-5 is located in the creek bottom near the NEWUA collection system. Previous researchers have suggested that the smaller hydraulic fluctuations observed in these wells are likely due to the situation of the wells in the narrow creek bottom above bedrock highs where alluvial groundwater is forced to flow near the surface (Semborski, Personal Communication, 1997).

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cotwells.spw 21AUG97

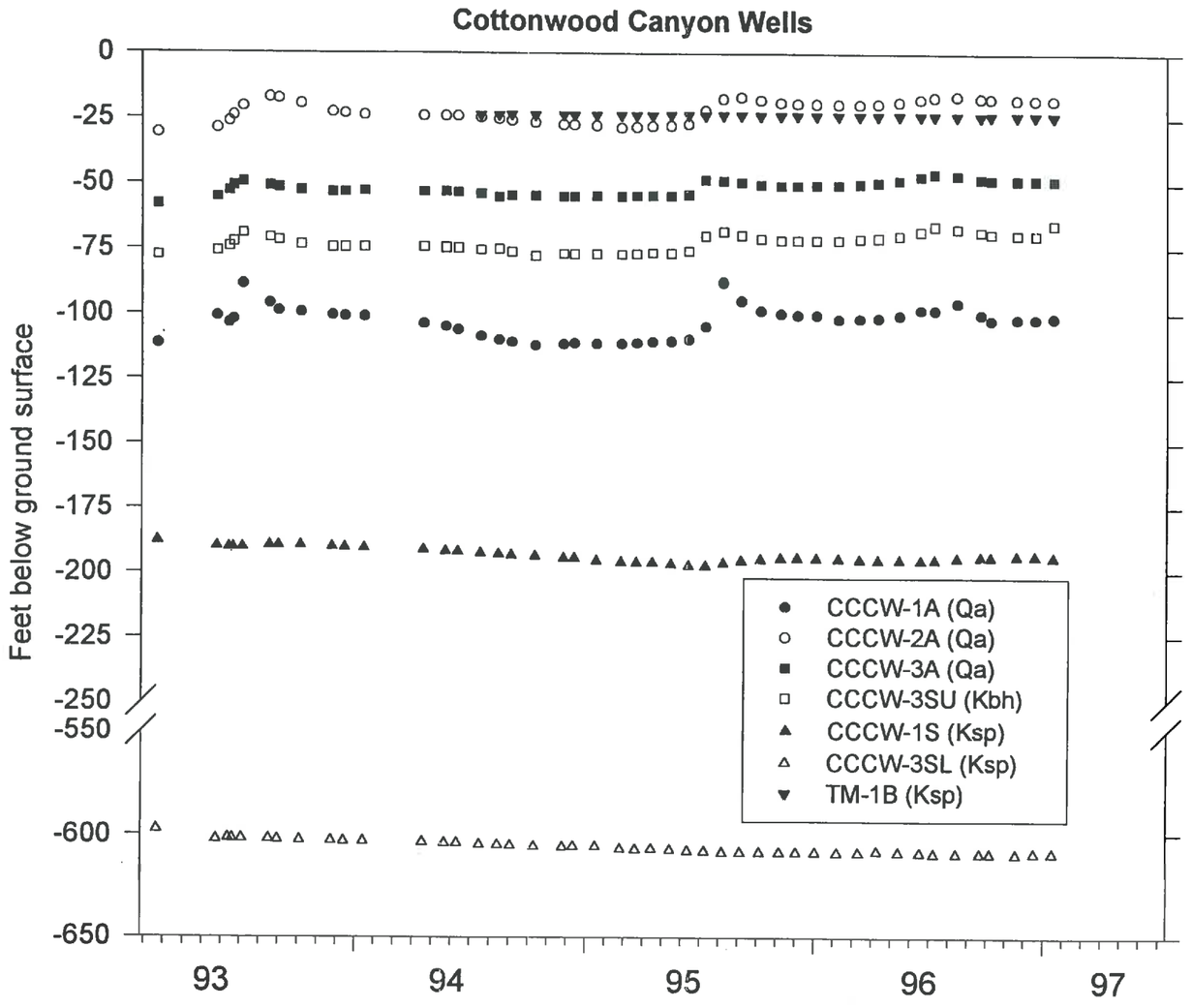

Figure 25 Hydrographs of wells in Cottonwood Canyon.

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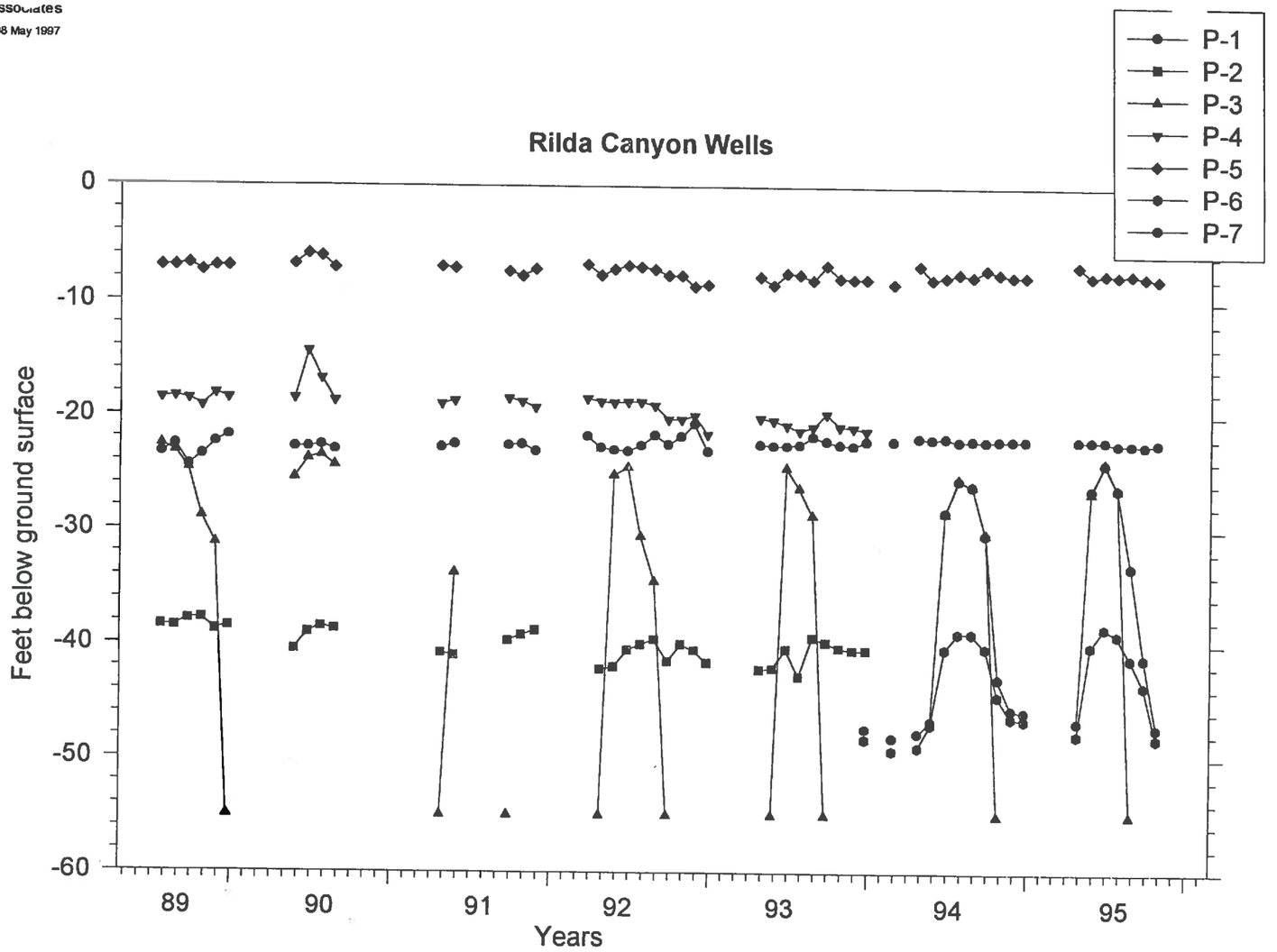

Figure 26 Hydrographs of Rilda Canyon monitoring wells.

6.4.2 Blackhawk Formation wells

Only 1 well, CCCW-3SU, monitors groundwater levels in the lower Blackhawk Formation. The well head is situated atop alluvial deposits in the bottom of Cottonwood Canyon (Figure 9). The well hydrograph (Figure 25) suggests that the formation responds to annual precipitation. However, we attribute the seasonal responses to hydraulic communication between overlying alluvial sediments and the well gravel-pack. The hydrograph response is similar to hydrographs in nearby alluvial system wells and the distance from the base of the alluvial deposits to the top of the gravel-pack zone is only 27 feet. We believe that the water level fluctuations are due to the seasonal groundwater fluctuations in the creek-bottom alluvium.

6.4.3 Star Point Sandstone Wells

Six monitoring wells have been completed in the Star Point Sandstone from the surface. The locations of the wells are shown on Figure 9, and each well is described below:

6.4.3.1 Well CCCW-1S

Well CCCW-1S is located in Cottonwood Canyon near the axis of the Straight Canyon Syncline (Figure 9). The well has a total depth of 720 feet, and is screened between 655 to 705 feet in the Spring Canyon Member. There is approximately 475 feet of potentiometric pressure in water in the well and the potentiometric level declined slightly, approximately 10 feet, between early 1993 and early 1995. Since then the water level in the well has remained relatively constant (Figure 25). The well hydrograph does not respond to seasonal recharge.

6.4.3.2 Well CCCW-3S L

Well CCCW-3SL is located in Cottonwood Canyon (Figure 9). The well has a total depth of 730 feet, and is screened between 680 and 730 feet in the Spring Canyon Member. The well is part of a multiple completion well with well CCCW-3SU. There is approximately 80 feet of potentiometric pressure in water in the well and the potentiometric level declined slightly, approximately 5 feet, between early 1993 and early 1994. Since then the water level in the well has remained relatively constant (Figure 25). The well hydrograph does not respond to seasonal recharge.

6.4.3.3 Well TM-1B

Well TM-1B is located in Cottonwood Canyon stratigraphically below the portal of the Trail Mountain Mine (Figure 9). The well has a total depth of 500 feet, and is screened between 380 and 460 feet in the Panther Tongue. There is approximately 350 feet of potentiometric pressure in water in the well. The potentiometric level has remained constant and the well hydrograph does not respond to seasonal recharge (Figure 25).

6.4.3.4 Well TM-3

Well TM-3 is located at the south end of the Trail Mountain Lease in Straight Canyon (Figure 9). A hydrograph for this well is shown in Figure 27a. The well has a total depth of 560 feet, and is screened between 505 and 555 feet in the Spring Canyon Member. When first completed in September 1993, the well flowed freely at the surface and maintained a constant shut-in pressure of 64 psi (approximately 150 feet) for several years. The well was opened in December 1996 and allowed to free flow at approximately 20 gpm for one week to

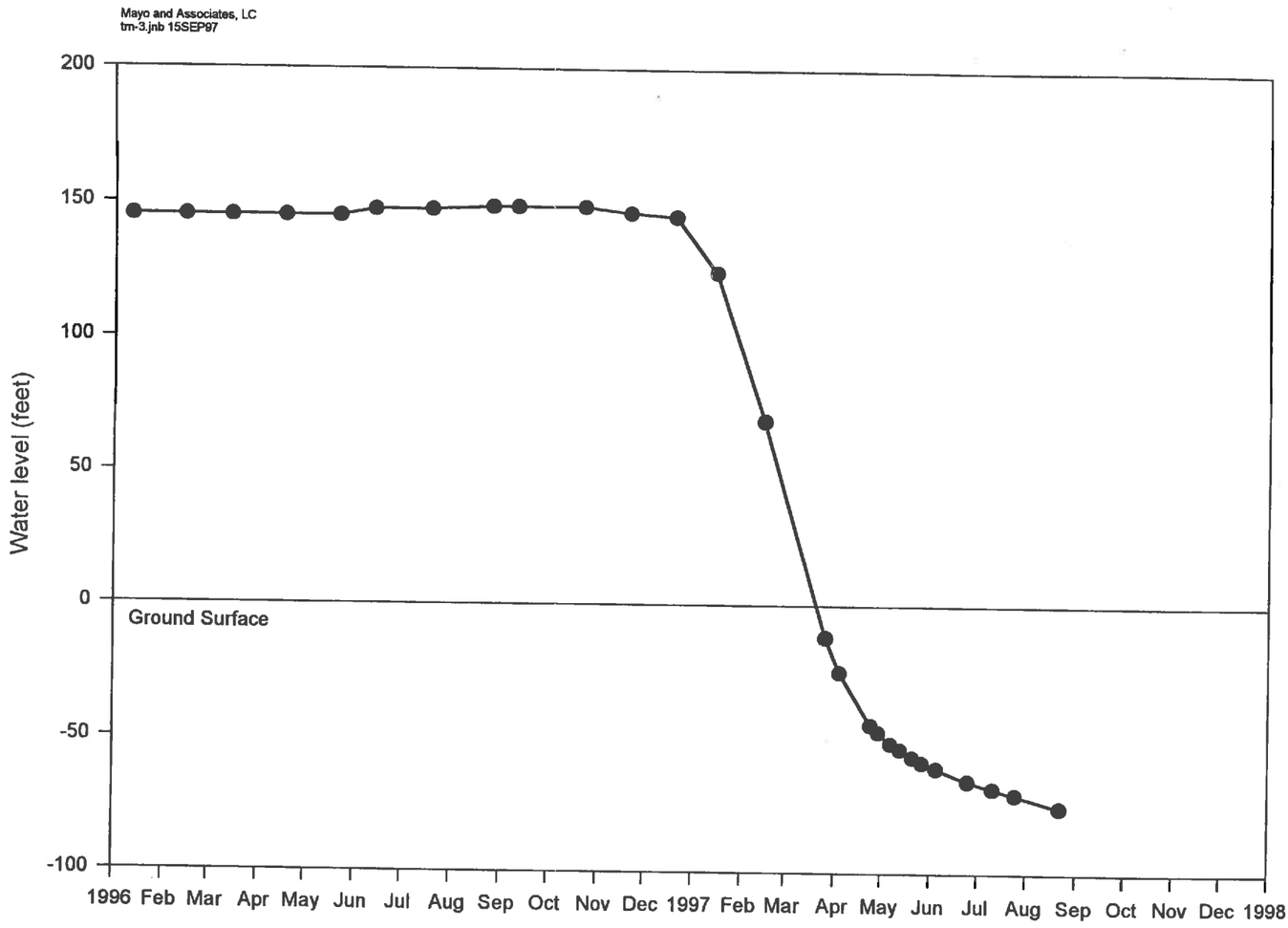

Figure 27a Hydrograph of well TM-3, which monitors water levels in the Spring Canyon Member of the Starpoint Sandstone.

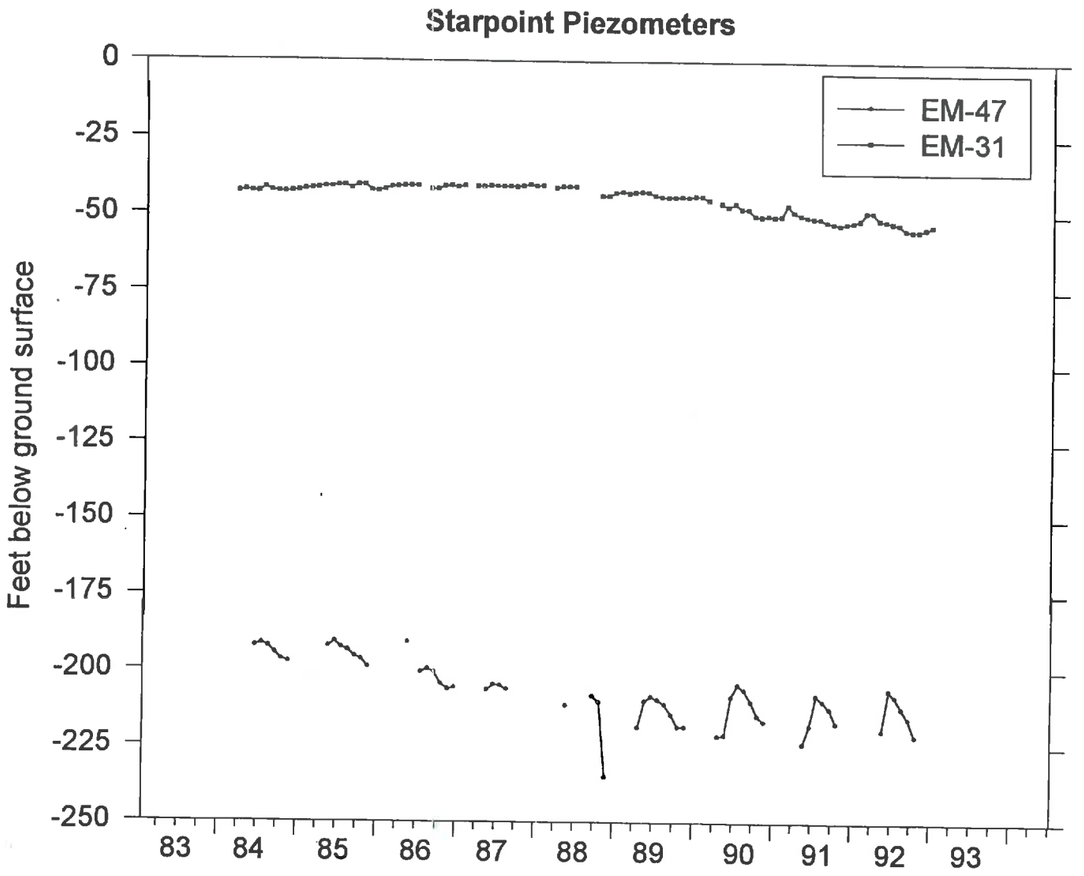

Figure 27b Hydrographs of water levels in two Star Point Sandstone piezometers.

facilitate chemical and isotopic sampling. After the sampling, the well was again shut in and the hydraulic head has decreased steadily since that time. On 22 August 1997, the water level had declined to 75 feet below land surface (Semborski, Personal Communication, 1997).

Although the cause of the reduction of hydraulic head is problematic, it is likely that the decrease is the result of depressurization of the Spring Canyon Member in the vicinity of the well. Mining operations in the Hiawatha seam in the southern portion of the Trail Mountain Mine are currently located approximately 0.5 miles northeast of well TM-3. In the Trail Mountain Mine the Hiawatha seam is located directly on the Spring Canyon Member. Approximately 200 to 300 gpm of groundwater upwells from the Spring Canyon Member to the mine floor in the current mining area. Because the current mining area is located up dip of well TM-3, mining is likely the cause of the depressurization.

Prior to mining, the elevation of the potentiometric level in TM-3 was 6900 feet. The top of the Spring Canyon Member is exposed in Cottonwood Creek 1.7 miles southeast of TM-3 at an elevation of 6500 feet. Because the Spring Canyon Member crops out below the potentiometric level reflected by TM-3, there is a hydrodynamic potential for water to discharge from the Spring Canyon Member to Cottonwood Creek. However, we believe that very little, if any, groundwater discharges to Cottonwood Creek from this horizon and therefore depressurization of the Spring Canyon Member will not decrease flow in Cottonwood Creek. Two lines of evidence support this conclusion. First, natural groundwater discharge would be indicated by springs in the Spring Canyon Member; however no springs have been identified in this unit in the vicinity of Cottonwood Creek (Semborski,

Personal Communication, 1997). Second, we have calculated a maximum potential discharge of 1 gpm based on the assumptions described below. This discharge rate was calculated using Darcy's law:

$$Q = K I A,$$

where,

Q = discharge rate

K = hydraulic conductivity

I = gradient

A= cross sectional area.

PacifiCorp (1994) calculated a hydraulic conductivity of 4.3×10^{-6} feet sec^{-1} for the Spring Canyon Member from a recovery test conducted on well TM-3. A gradient of 0.05 was calculated from the difference between the pre-mining elevation of the potentiometric level in TM-3 (6900 feet) and the outcrop elevation of the Spring Canyon Member in Cottonwood Creek (6450 feet) divided by the distance separating these two points (9000 feet). A cross sectional area of 10,000 ft^2 was calculated using the thickness of the Spring Canyon Member (100 feet) and a 100-foot exposure width.

6.4.3.5 Well EM-31

Well EM-31 is located in Cottonwood Canyon (Figure 9). The well head is located on alluvial deposits just above the Trail Mountain Mine portals. The thickness of the alluvium at the well head is 20 feet. A 20-foot thick layer of sandstone and a 10-foot thick sequence of

interbedded siltstone and mudstone underlie the alluvium. The well was has a total depth of 280 feet. Although the well casing is perforated from 190 to 250 feet, the gravel-pack zone extends from 50 feet to 280 feet which provides opportunity for vertical communication between saturated horizons. The hydrograph of EM-31 (Figure 27b) shows that the well responds subtly to annual precipitation and long-term climatic cycles. We believe that these hydraulic responses are due in large part to hydraulic communication between the gravel-pack zone and shallow, overlying groundwater systems. The Star Point Sandstone, in other locations, does not respond to annual precipitation or climatic trends.

6.4.3.6 EM-47

Well EM-47 is located in Rilda Canyon (Figure 9). The well head is located in alluvial deposits near Rilda Canyon Creek. The well has a total depth of 300 feet, and is screened between 210 and 270 feet in the Spring Canyon Tongue. Water levels in the well respond to annual precipitation events, and since about 1986 there has been a general decline in water levels (Figure 27b). The annual responses are attributed to well completion problems rather than to fluctuations in water levels in the Spring Canyon Member. The coarse gravel-pack interval in this well is from 50 to 300 feet. The gravel used was 0.25 to 0.375 inches in diameter. The thickness of the alluvium at the surface is 25 feet, and the bedrock underlying the alluvium is a continuous sandstone layer that extends to a depth of 70 feet. Thus there is only 25 feet of sandstone separating the gravel-pack from the surface alluvium. The general decline in water surface elevation since about 1986 may be the result of climatic variability.

6.4.4 In-mine piezometers

6.4.4.1 Deer Creek Mine

In late 1989 four piezometers were constructed in the Deer Creek Mine to monitor groundwater levels in the lower portion of the Blackhawk Formation and in the Spring Canyon Member of the Star Point Sandstone beneath the mine workings. The piezometers designated DCP-1 through DCP-4, and are all located in the 3rd North/1st West Mains area (Figure 10). Each of the wells has a 20-foot surface casing and is open for 150 feet below that. Thus, each of the wells is open to Blackhawk Formation sandstones and claystones located above the Hiawatha seam, the Hiawatha coal seam, and the Spring Canyon Member of the Star Point Sandstone. What this means is that water levels represent composite hydraulic heads and are not necessarily representative of the Spring Canyon Member or the lower Blackhawk Formation.

Two of the piezometers (DCP-1 and DCP-4) had initial static water levels which rose to the bottom of the mine workings (Blind Canyon seam), and two of the piezometers (DCP-2 and DCP-3) had initial static water levels which rose to the middle of the lower portion of the Blackhawk Formation. Between mid-1990 and mid-1993 a transient potentiometric level decline occurred in Wells DCP-1, DCP-3, and DCP-4 (Figure 28). Mine workings containing DCP-2 and DCP-4 were sealed in late 1991, workings containing DCP-3 were sealed in late 1993, and data collection ended. By early 1997 the potentiometric level in DCP-1 recovered to the initial static level.

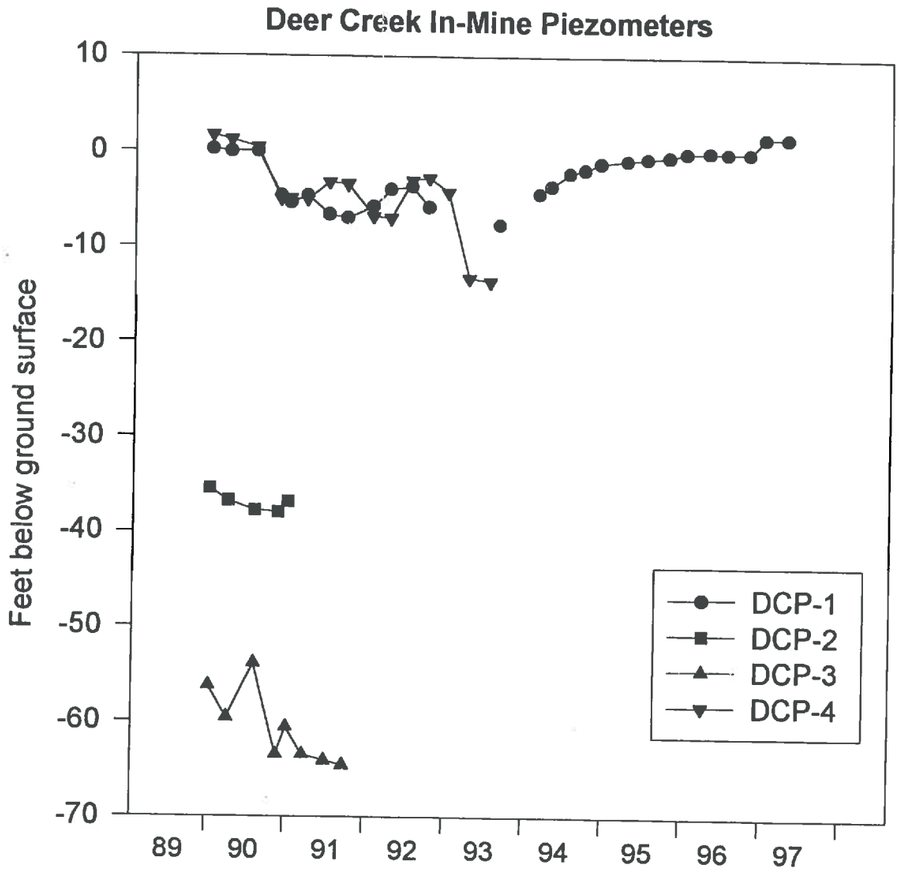

Figure 28 Hydrographs of water levels in in-mine piezometers in the Deer Creek Mine.

There are two possible causes of the transient response. The potentiometric decline approximately coincides with the Roans Canyon Fault dewatering. However, it is difficult to envision a correlative mechanism. The fault drained a sandstone channel located above Blind Canyon Seam and the piezometers are located below the seam 0.3 to 1 mile southwest of the fault. If the decline were related to fault dewatering, there is not a mechanism for piezometric recovery.

The transient response is most likely related to mining along the Straight Canyon Syncline in an area located down dip and to the west of the piezometers and not to depressurization and subsequent repressurization of the Spring Canyon Member. During mining, considerable floor water was encountered. Upon completion of mining, the area was sealed and flooded. We believe that the piezometric decline was the result of the down gradient depressurization and recovery in the lower portion of the Blackhawk Formation.

6.4.4.2 Cottonwood Mine piezometers

In late 1989 four piezometers (WCP-1 through WCP-4) were constructed in the Cottonwood Mine to monitor groundwater levels in the Spring Canyon Member of the Star Point Sandstone (Figure 11). Each of the wells has a 10-foot surface casing and is open holes for 60 to 130 feet below that. Thus, each of the wells is open to Spring Canyon Member and interbedded clays separating the Spring Canyon Member from the Storrs Member. Well WCP-1 is also open to the upper portion of the Storrs Tongue. The workings containing the piezometers were progressively sealed starting in late 1989 to late 1990 and data are not available after that.

Potentiometric levels in wells WCP-2, WCP-3, and WCP-4 show no seasonal variations. Water levels increased slightly in WCP-3 and WCP-4 (Figure 29). The potentiometric record for WCP-1 suggests some fluctuation in the hydraulic head in the well. However, it is believed that the fluctuations in head are the result of a malfunctioning pressure transducer and are not representative of actual conditions in the formation. The pressure transducer was replaced in early 1990. Seasonal variations in potentiometric levels are not observed.

6.5 Steady state recharge-discharge rates in-mine groundwaters

The fact that in-mine groundwaters do not have infinite ^{14}C ages means that there must at some time have been some hydraulic communication between the near-surface and in-mine (deep) groundwater systems. We believe that this communication most likely occurred during a cooler, wetter climatic cycle, when more water was available for groundwater recharge.

An alternative way to view the deep groundwater regime is that the groundwater is in constant flux and that the rate of groundwater movement is slow. If we make the assumption that the water discharging in the mine from deep systems is in equilibrium with its recharge, it is possible to calculate an estimate of the steady-state throughput of the system. These calculations are based on an estimate of the total volume of water in storage in the system being drained, and the calculated radiocarbon age of the water. In the nearby Bear Canyon Mine we calculated a steady state recharge-discharge rate of 1.2 gpm for a sandstone channel containing about 1 billion gallons of water. The 3,250-foot long channel, located above the Blind Canyon seam, contained groundwater with a mean residence time of 1,500 years. These types of calculations give an approximation of the *maximum* flux of water through the

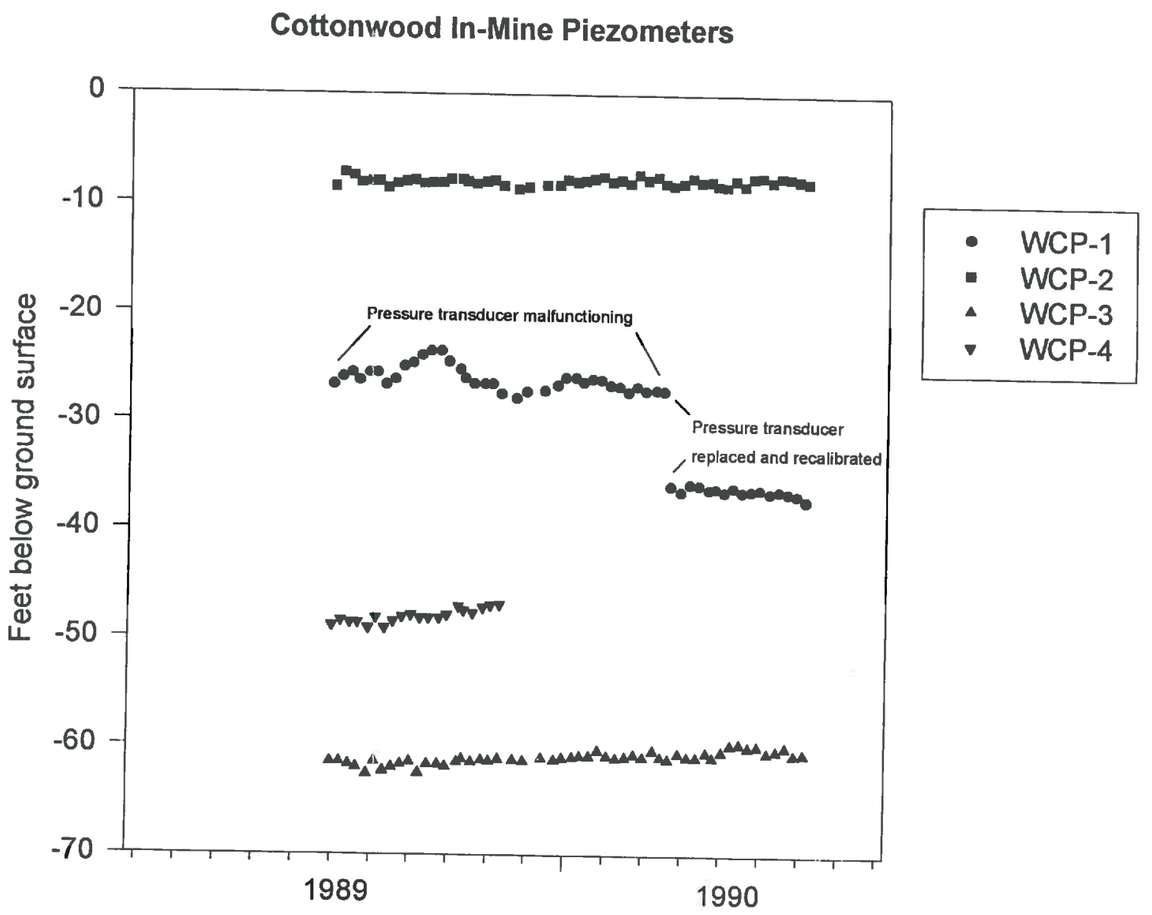

Figure 29 Hydrographs of water levels in in-mine piezometers in the Cottonwood Mine.

system *if* deep systems were currently in hydraulic communication with adjacent active systems. However, we believe that the actual flux of groundwater through these systems is generally less than that calculated because we do not believe that the deep systems are currently in communication with the near-surface systems.

Similar steady state recharge-discharge rate calculations for the Roans Canyon and Pleasant Valley faults, and typical sandstone channels located above the mined coal seams are shown below:

6.5.1 Faults

Roans Canyon Fault/Straight Canyon Syncline:

The largest single influx of water into the mine, about 5×10^9 gallons, was from the Roans Canyon Fault/Straight Canyon Syncline. Carbon-14 ages are not available directly from groundwaters issuing from the fault/syncline. However, water from longwall gob areas (3S Seals and MW Seals), which contain mostly Roans Canyon Fault/Straight Canyon Syncline discharge water, have ^{14}C ages of 8,000 and 12,000 years (Table 5). Based on these data a range of values for steady state recharge-discharge conditions are:

$$\frac{5 \times 10^9 \text{ gallons (storage capacity)}}{8{,}000 \text{ years } (4.2 \times 10^9 \text{ minutes; residence time})} = 1.23 \text{ gpm}$$

$$\frac{5 \times 10^9 \text{ gallons (storage capacity)}}{12{,}000 \text{ years } (6.3 \times 10^9 \text{ minutes; residence time})} = 0.79 \text{ gpm}$$

Pleasant Valley Fault:

Only small discharges have been measured from the Pleasant Valley fault. A more reasonable estimate of the discharge from the Pleasant Valley fault is 25 gpm for 20 years. Groundwater ^{14}C ages of 4,500 to 7,000 years have been calculated for sites 1.5N X 29 (Wilberg Mine) and MN-ME (Deer Creek Mine), respectively (Table 5). Based on these data a range of values for steady state recharge-discharge conditions are:

$$\frac{2.6 \times 10^8 \text{ gallons (storage capacity)}}{7{,}000 \text{ years } (3.7 \times 10^9 \text{ minutes; residence time})} = 0.07 \text{ gpm}$$

$$\frac{2.6 \times 10^8 \text{ gallons (storage capacity)}}{4{,}500 \text{ years } (2{,}4 \times 10^9 \text{ minutes; residence time})} = 0.11 \text{ gpm}$$

6.5.2 Sandstone Channels

Drip rate data and ^{14}C ages are available for three sandstone channels. The channels have been monitored at locations 2S X 11 (Cottonwood Mine), TMA X 32 (Cottonwood Mine) and UG-3 (Trail Mountain Mine). Additional groundwater storage data and the ^{14}C groundwater age is available from 6W X 20 (Deer Creek Mine). Steady state recharge-discharge rate calculations are shown below:

2S X 11 (Cottonwood Mine):

The roof drip (Figure 22a) shows a gradual decline from about 0.11 gpm in 1984 to about 0.06 gpm in 1996. The hydrograph recession suggests the drip will dry flow for

about 30 total years. Based on a mean drip rate of 0.06 gpm the total discharge will be 9.5×10^6 gallons.

$$\frac{9.5 \times 10^6 \text{ gallons (storage capacity)}}{12{,}000 \text{ years } (6.3 \times 10^9 \text{ minutes; residence time})} = 0.002 \text{ gpm}$$

Assuming the drip at 2S X 11 only represented 10% of the total volume of water in the channel the steady state recharge-discharge rate would be 0.02 gpm. If the drip only represented 1% of the total volume of water in the channel the steady state recharge-discharge rate would be 0.2 gpm.

TMA x 32 (Cottonwood Mine):

The roof drip (Figure 22d) shows a decline from about 10 gpm in October 1994 to 2 gpm in April 1996. The hydrograph recession suggests that the drip will flow for 5 years or less and the average drip rate will be 1 gpm or less. Based on a mean drip rate of 1 gpm the total discharge will be 2.6×10^6 gallons.

$$\frac{2.6 \times 10^6 \text{ gallons (storage capacity)}}{6{,}500 \text{ years } (3.4 \times 10^9 \text{ minutes; residence time})} = 0.001 \text{ gpm}$$

Assuming the drip at TMA X 32 only represented 10% of the total volume of water in the channel the steady state recharge-discharge rate would be 0.01 gpm. If the drip only represented 1% of the total volume of water in the channel the steady state recharge-discharge rate would be 0.1 gpm..

UG-3 (Trail Mountain Mine):

Reliable hydrograph data are not available for UG-3. Monitoring by PacifiCorp first occurred in May 1990 when a flow of 25 gpm was measured. In mid-1995 the drip had declined to about 5 gpm. Assuming a drip life of 20 years and a mean drip rate of 5 gpm the total discharge will be 5.3×10^7 gallons.

$$\frac{5.3 \times 10^7 \text{ gallons (storage capacity)}}{5{,}500 \text{ years } (2.9 \times 10^9 \text{ minutes; residence time})} = 0.018 \text{ gpm}$$

assuming the drip at UG-3 only represented 10% of the total volume of water in the channel the steady state recharge-discharge rate would be 0.18 gpm. If the drip only represented 1% of the total volume of water in the channel the steady state recharge-discharge rate would be 1.8 gpm.

6.6 Discussion

The overall pattern of groundwater flow and surface water-groundwater interactions in the mine lease area can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes (Figure 30). Active regime groundwater flow systems contain abundant ^3H, have excellent hydraulic communication with the surface and thus are dependent on annual recharge events and are affected by short term climatic variability. Groundwater in these systems circulates shallowly and has short flow paths. The active regime includes alluvial groundwater, all of the Flagstaff Limestone, near-surface exposures of all other bedrock formations except, perhaps, the Mancos Shale. The "near surface" extends

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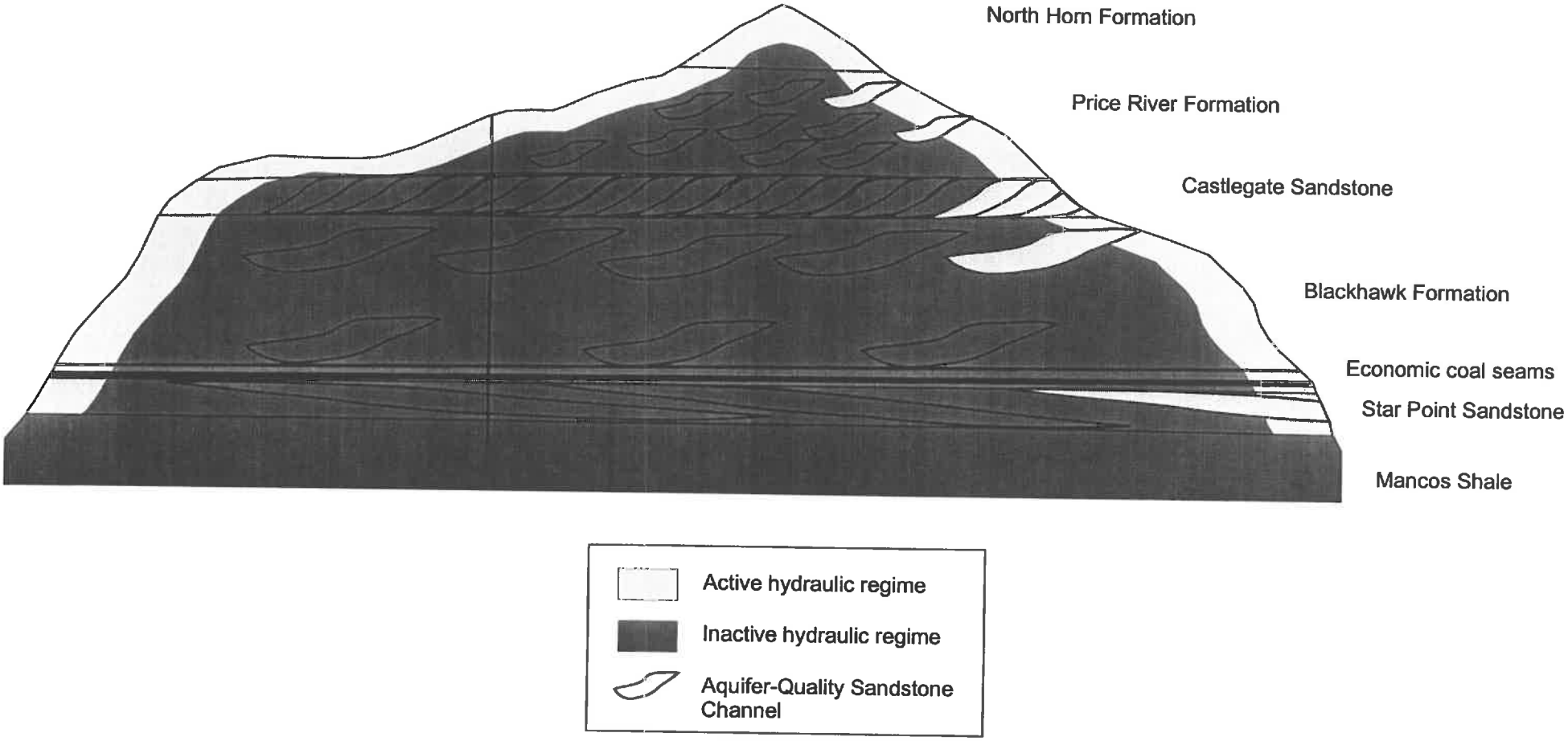

Figure 30 Conceptual model of active and inactive groundwater flow regimes in the mine lease area.

about 500 to 1,000 feet into cliff faces and is controlled by fracturing, weathering, and the surface exposures of fluvial channel sands. Further into the cliff faces the discontinuous character of the channel sands prevents active groundwater flow.

Inactive groundwater flow regimes contain old groundwater (i.e. 2,000 to 12,000 years), have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability. Groundwater in these systems tends to occur in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). These sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. The blanket sands of the Star Point Sandstone are also largely in the inactive zone. For the most part faults encountered in mine workings are part of the inactive regime.

A report by the U.S. Geological Survey (Lines, 1985) states that there exists a regional aquifer in the lower Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau. Lines also postulates that the regional aquifer is recharged by the downward migration of groundwaters from overlying perched groundwater systems in the North Horn and Price River Formations. For several reasons, we believe that these ideas are incorrect. Groundwaters encountered within mine openings in the lowermost Blackhawk Formation occur primarily within discontinuous sandstone channels. It is not uncommon for some of these channels to be completely dry, while others are partially or completely filled with water. Between these

sandstone channels, the surrounding shales and claystones of the Blackhawk Formation are usually dry. The discontinuous nature of the saturated sediments in the lowermost Blackhawk Formation, and the unconfined conditions under which these groundwaters exist do not support the idea of a deep, regional system with groundwater flowing from areas of recharge to areas of discharge. Additionally, the radiocarbon and tritium age dating of waters from the lower Blackhawk Formation (Section 5.4) indicates that, while the groundwaters from the shallow perched groundwater systems are modern (post-1954), groundwaters from the Blackhawk Formation and Star Point Sandstone are thousands of years old. Because the mine workings do not intercept the Star Point Sandstone, less is known about the continuity of groundwater systems there. However, groundwaters in the Star Point Sandstone are thousands of years old (section 5.4) and occur in laterally discontinuous sandstone tongues bounded by nearly impermeable shale units of the Mancos Shale. Because of the lateral discontinuity of these tongues, regional groundwater flow regimes cannot develop.

We believe that the presence of swelling clays and impermeable shales in the rocks in the unsaturated zone between the overlying perched systems and the Blackhawk Formation effectively prohibit downward vertical migration of waters from the perched systems. Lines (1985) analyzed cores taken from well (D-17-6)27bda-1 and found the hydraulic conductivities of the shales and siltstones to be very low (i.e. 10^{-7} to 10^{-8} ft/day). One shale sample was found to be effectively impermeable even when a hydraulic pressure of 5,000 psi was applied.

Because there are no areally extensive groundwater regimes in the lower Blackhawk Formation or Star Point Sandstone within the lease area, it is not possible to draw meaningful potentiometric surface maps of these systems.

Lines (1985) also reported that water was likely leaking from the Joes Valley Reservoir downward into the "lower Blackhawk / Star Point aquifer" in Straight Canyon. We believe that this is incorrect. Groundwater collected from well TM-3, which is completed in the Star Point Sandstone, in Straight Canyon just below the reservoir has a radiocarbon age of 6,000 years, while water in Joes Valley Reservoir is of modern origin. Water levels in TM-3 do not respond to seasonal fluctuations in the water level in Joes Valley Reservoir, indicating that there is little or no hydraulic communication between the reservoir and water in the Star Point Sandstone. Groundwater was sampled at UG-3 in the lower Blackhawk Formation in the Trail Mountain Mine. This water has a radiocarbon age of 5,500 years, which is likewise not consistent with water from the reservoir.

7. SURFACE WATER HYDROLOGY

The PacifiCorp lease area is located in the San Rafael River basin and is drained by two tributary drainage systems: Huntington Creek and Cottonwood Creek. Huntington Creek merges with Cottonwood Creek and Ferron Creek approximately 10 miles southeast of the study area forming the San Rafael River.

During the snowmelt period, ephemeral, intermittent, and perennial streams carry large quantities of runoff water from the highlands of the Wasatch Plateau. As the temperatures warm in the spring and summer months, snow pack melts and both stream flows and spring discharges decrease dramatically.

The northeastern portion of East Mountain is part of the Huntington Creek drainage system. Major tributaries include Rilda Canyon, Meetinghouse, and Deer Creeks (Figure 31). The southwestern portion of East Mountain is drained by Grimes Wash, which is tributary to Cottonwood Creek. The western portion of East Mountain and the eastern portion of Trail Mountain drain into Cottonwood Canyon Creek, which flows south into Cottonwood Creek. The west slope of Trail Mountain drains westward via ephemeral streams into Indian Creek in Joes Valley. These and other surface waters are retained by Joes Valley Reservoir, which in turn discharges into Cottonwood Creek.

The hydrology of each drainage basin is described below.

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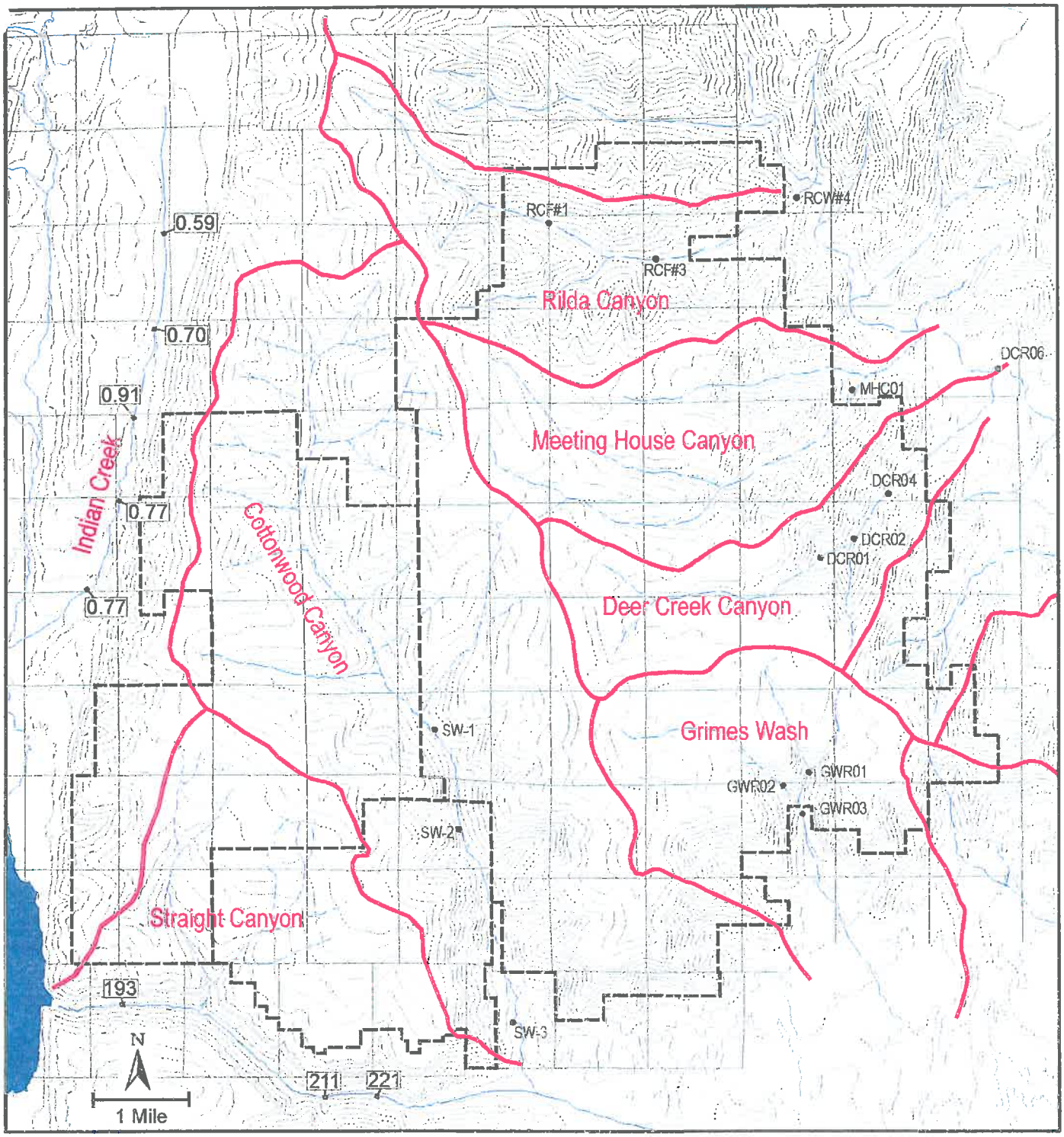

Figure 31 Map showing drainage basins, surface water monitoring locations, and results of gain-loss measurements on Indian Creek and Cottonwood Creek in Straight Canyon. Flow measurements are reported in CFS.

7.1 Huntington Creek Drainage System

7.1.1 Rilda Canyon Creek

The Rilda Canyon Creek drainage overlies the workings of the Deer Creek Mine. Since 1989, monthly flow measurements have been made at monitoring sites RCF1, RCF2, RCF3, and RCW4 (Figure 31). RCF1 is the uppermost monitoring station and RCF2 and RCF3 are located downstream near the North Emery Water Users Association (NEWUA) near-surface water collection system. RCF4 is located below the lease boundary near the confluence with Huntington Creek. Rilda Creek is ephemeral above RCF2 near the NEWUA collection system and is a gaining perennial stream below RCF2. The upper, losing reach of the stream flows across alluvium deposited on the Blackhawk Formation and Star Point Sandstone, whereas the gaining reach of the stream flows on alluvium deposited on Mancos Shale. Discharge in Rilda Creek varies greatly by season (Figure 32). For example, in 1995 discharge at RCF3 was 4,500 gpm in June and was only 149 gpm in September.

7.1.2 Meetinghouse Creek

Ephemeral Meetinghouse Creek overlies portions of both Deer Creek and Cottonwood mines. PacifiCorp has performed monthly flow measurements at monitoring site MHC01 since 1986 (Figure 31). The maximum measured discharge was 6,800 gpm in September 1991; however, there is commonly no flow in the creek during the late summer, fall, and winter (Figure 33). The absence of flow during the dry months means that the North Horn, Price River, Castlegate, Blackhawk and Star Point Formations do not contribute appreciable baseflow to the creek.

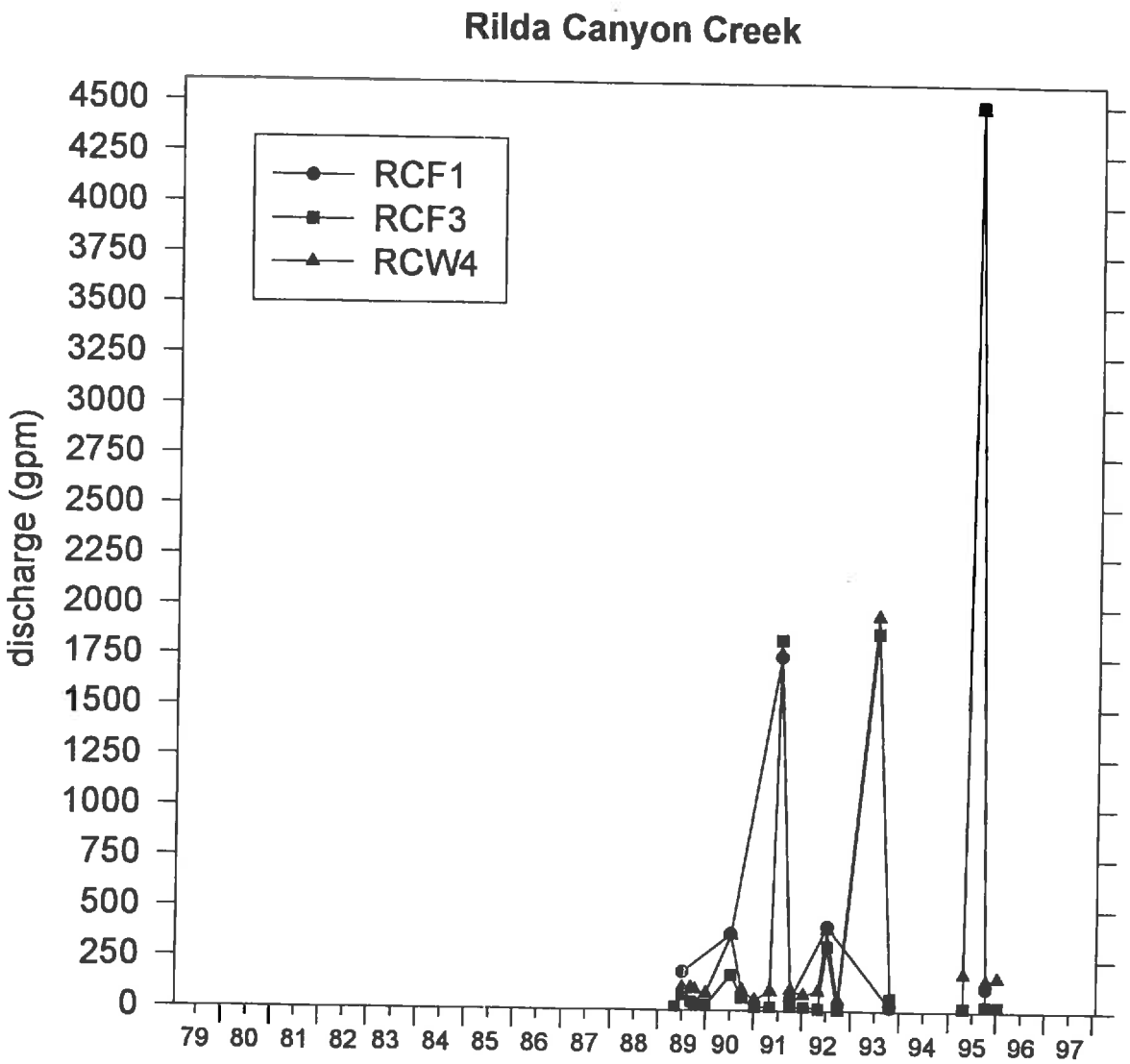

Figure 32 Instantaneous stream-discharge hydrographs for Rilda Canyon Creek.

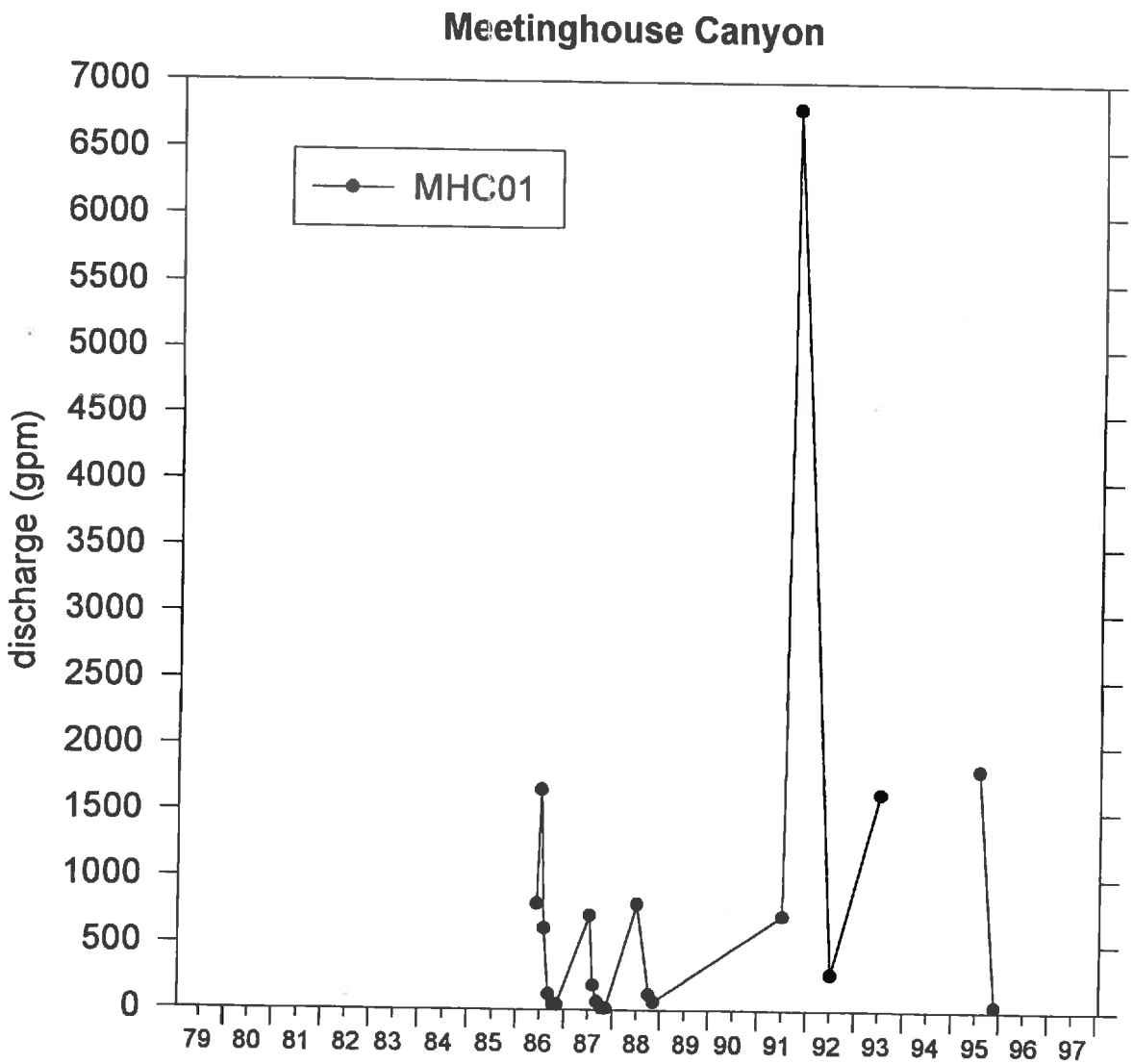

Figure 33 Instantaneous stream-discharge hydrographs for Meetinghouse Canyon Creek.

7.1.3 Deer Creek

Ephemeral Deer Creek overlies portions of both Deer Creek and Cottonwood mines. Discharge is measured monthly at DCR01 (located above the lease area), DCR04 (located at the lower lease boundary), and DCR06 (located below the mine; Figure 31). Flows in Deer Creek range from no discharge during dry years (both above and below Deer Creek Mine) to several thousand gpm during the springtime in wet years (Figure 34). The lack of flow during the dry months indicates that the North Horn, Price River, Castlegate, Blackhawk and Star Point formations do not contribute appreciable base flow to the creek.

7.2 Cottonwood Creek Drainage

7.2.1 Cottonwood Canyon Creek

Cottonwood Creek in Cottonwood Canyon drains the western slopes of East Mountain and most of Trail Mountain (Figure 31). The drainage area is underlain by mine workings of the Trail Mountain and Cottonwood mines. Cottonwood Canyon Creek is ephemeral from its headwaters to near SW-1 and is intermittent from that point to the confluence with Cottonwood Creek in Straight Canyon. Monitoring station SW-1 is located near the lease boundary in the Blackhawk Formation, SW-2 is located within the lease area in the Star Point Sandstone, and SW-3 is located about 1 mile down-stream from the lease boundary in the Mancos Shale (Figure 31). Flow in Cottonwood Canyon Creek varies in response to both season and long-term climate trends (Figure 35). Discharge at SW-1 was measured at 2,500 gpm in 1995. A minimum flow of 3 gpm was measured at SW-1 in 1993. The near absence of flow during dry periods suggests that there is no appreciable contribution to flow from bedrock groundwater systems.

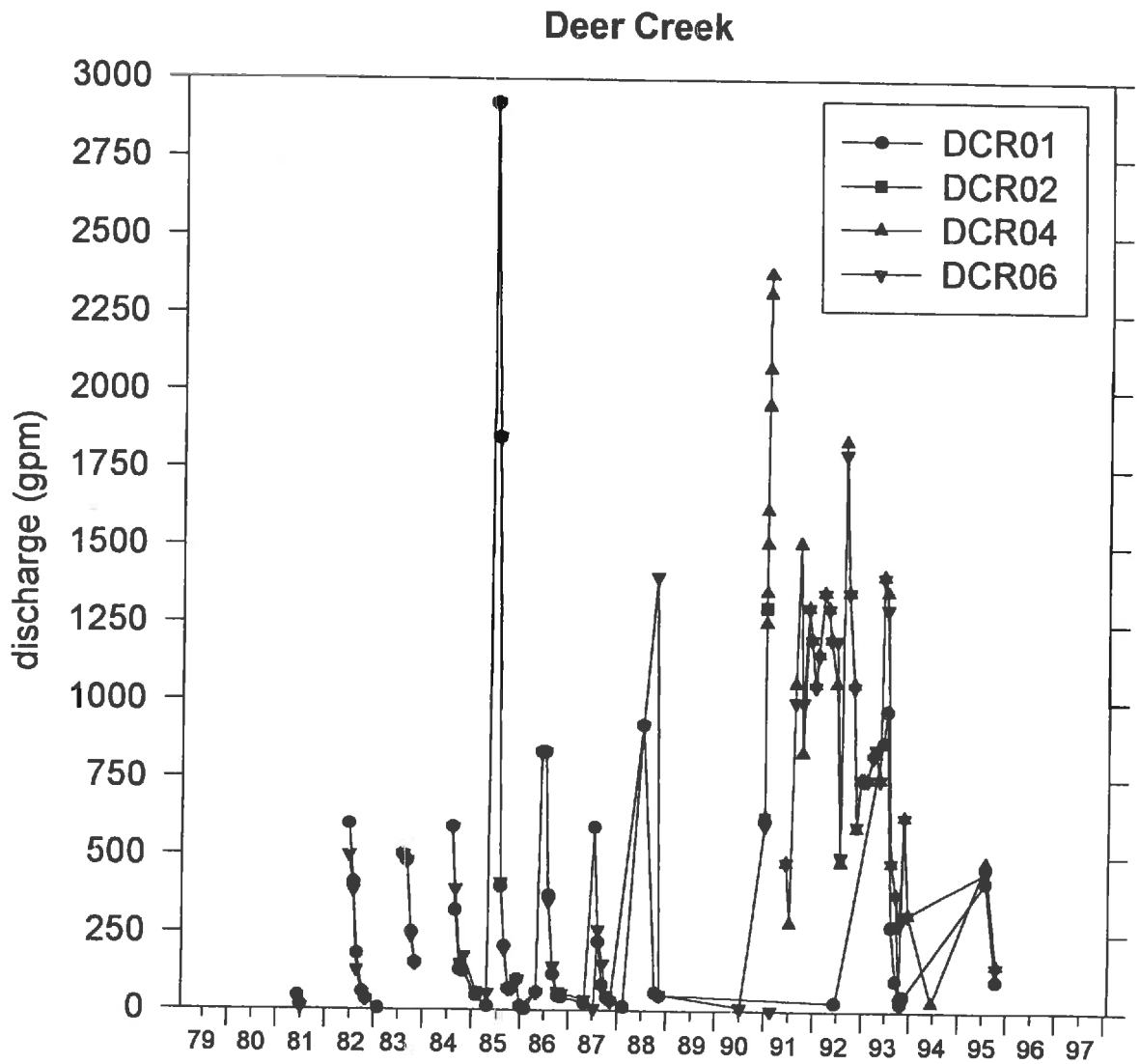

Figure 34 Instantaneous stream-discharge hydrographs for Deer Creek.

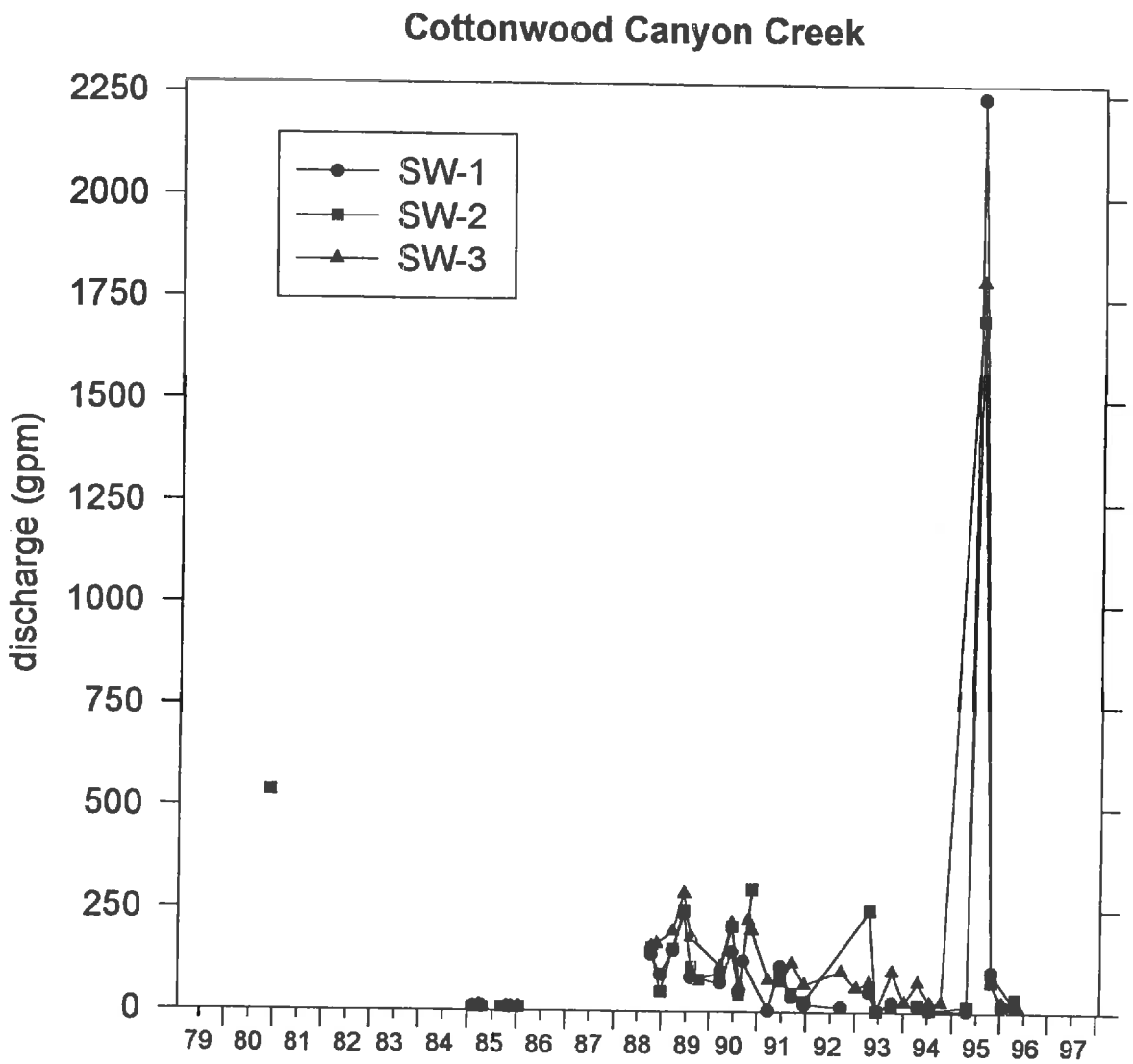

Figure 35 Instantaneous stream-discharge hydrographs for Cottonwood Canyon Creek.

7.2.2 Grimes Wash

Grimes Wash is an ephemeral tributary to Cottonwood Creek. Flow is measured at GWR01 (upper right fork), GWR02 (upper left fork), and GWR03 (below the mine; Figure 31). The right and left forks of Grimes Wash are usually dry except during the springtime snowmelt season. Flow at GWR03 is sustained by discharge from the Wilberg/Cottonwood Mine discharge. Flows in excess of 3,000 gpm during the spring runoff have been measured above the mine (Figure 36). Discharge below the mine is sometimes nearly absent during dry months. The lack of flow below the mine suggests that bedrock groundwater systems are not contributing substantially to the baseflow of the creek.

7.3 Bedrock Contribution to Streamflow

In an attempt to quantify the contributions of bedrock formations to the baseflow of creeks in the study area, Mayo and Associates performed gain-loss measurements on Cottonwood Creek in Straight Canyon and Indian Creek. The location of flow gaging stations and the measured flow rates are indicated on Figure 31. Discharge was gauged at three locations along Cottonwood Creek in Straight Canyon corresponding, from west to east, to the bedrock formation contacts at the top and bottom of the Blackhawk Formation and the bottom of the Star Point Sandstone. From the top of the Blackhawk Formation to the bottom of the Star Point Sandstone the measured flow of Cottonwood Creek increased by almost 15%. Whether this increase represents baseflow contributions from the Blackhawk Formation and Star Point Sandstone or measurement error is uncertain. Lines (1985) reported no significant gains along this same stretch when he gauged streamflows in 1981 and 1982. Lines does report flow increases along the stretch from the top of the Blackhawk Formation to the bottom of

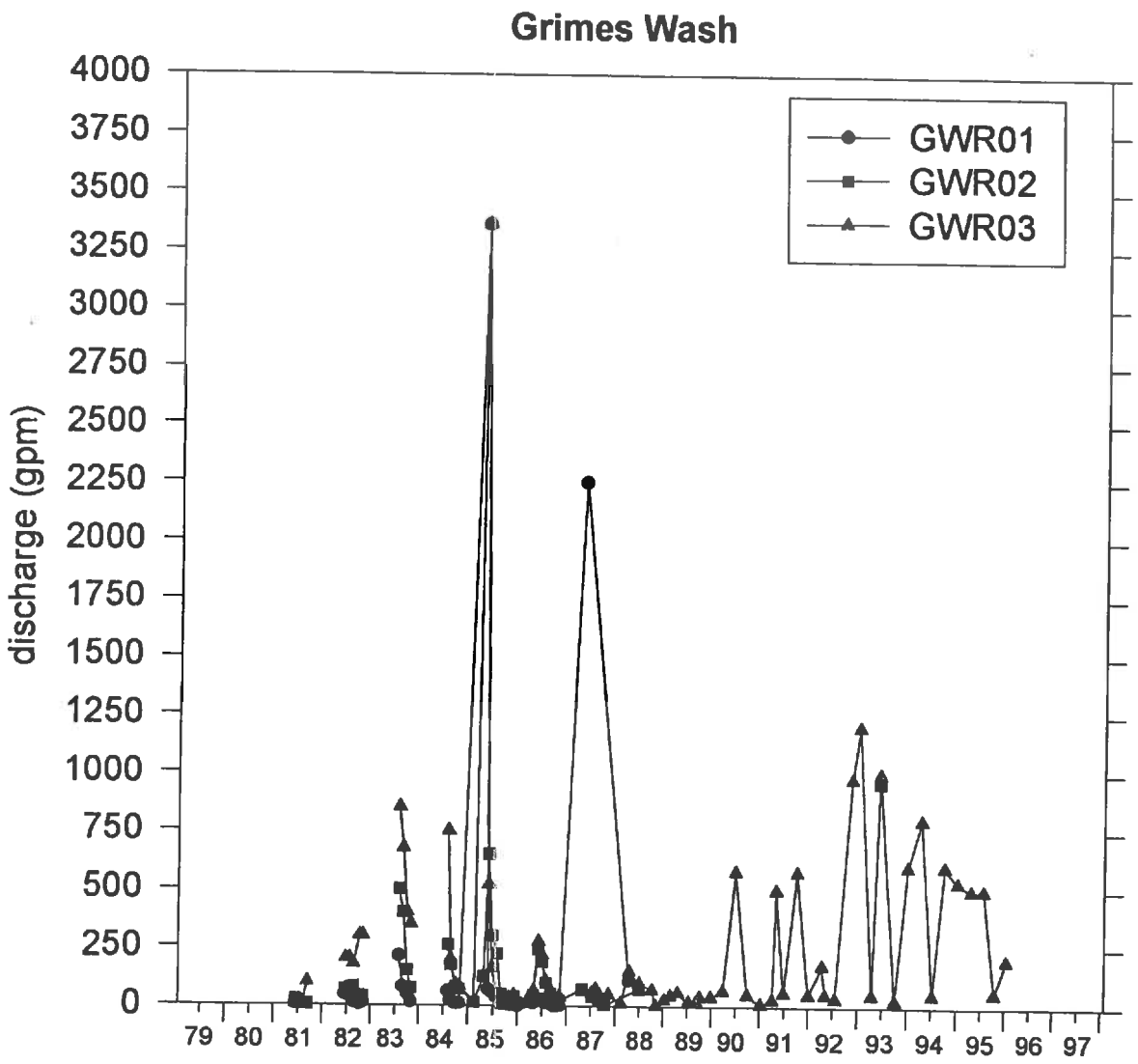

Figure 36 Instantaneous stream-discharge hydrographs for Grimes Wash.

the Star Point Sandstone to Cottonwood Creek in Cottonwood Canyon in 1981 and 1982. This increase is likely a result of interflow contribution or the forcing of water flowing through the alluvium to the surface due to decreased permeability of alluvial sediments derived from the Mancos Shale.

Flow measurements on Indian Creek indicated gains and losses that are greater than the error of measurement. The significance of these fluctuations is difficult to assess because the stream flows entirely on alluvial deposits and has abundant bank vegetation. Gains and losses could be accounted for by flow through alluvial sediments and transpiration by plants. Lines (1985) found only small gains and losses along Indian Creek in 1981 and 1982.

7.4 Discussion

Most of the recharge to creeks within the lease areas occurs from springtime snowmelt and from summer thunderstorms. Discharge rates in the creeks are extremely variable, and the creeks exhibit rapid response to snowmelt and thunderstorm events. The creeks are mostly ephemeral, and are not supported by bedrock groundwater discharge. Recharge to creeks in the study area is not sustained by bedrock groundwater systems and thus, most creeks sometimes dry out completely during the late summer and fall months or during periods of prolonged drought. Most of the streams within the lease areas are losing in their upper reaches and some are gaining in their lower reaches as they cross the Mancos Shale. The stream flow lost in the upper, ephemeral reaches is probably lost to alluvium (Semborski, Personal communication, 1997). As the creeks flow over the impermeable clayey sediments

of the Mancos Shale, the water in the alluvium is forced to the surface and becomes part of the above-ground flow in the creek.

There is no evidence of substantial bedrock discharge from Blackhawk Formation or Star Point Sandstone groundwater systems to the creeks in the lease areas. It is important to note, however, that this does not preclude near-surface drainage of saturated shallow bedrock and interflow. Likewise, we do not believe that creek water flowing in the alluvium is recharging deep bedrock formation groundwater systems in appreciable quantities.

The lack of hydraulic communication between creeks and deep bedrock groundwater systems has important implications to potential mining-related impacts to creek flow. The lack of a significant bedrock-derived baseflow component of creek discharge suggests that mining operations (i.e. the interception of deep groundwater systems in the Blackhawk Formation) will not adversely impact creek flows in the lease areas.

8. CONCLUSIONS

1. The δ^2H and $\delta^{18}O$ compositions demonstrate that all groundwaters are of meteoric origin (i.e. snow and rain).
2. Active and inactive groundwater regimes occur in the mine lease area.
3. The active regime includes alluvial groundwater, groundwater in the Flagstaff Formation, and all near surface exposures of the other bedrock formations except, perhaps, the Mancos Shale. The near surface extends about 500 to 1,000 feet into cliff faces. Groundwaters in the active regime contain abundant ^3H and anthropogenic ^{14}C.
4. Comparison of long-term discharge hydrographs with precipitation records demonstrates that active regime groundwaters: 1) are in direct hydraulic communication with the surface, 2) are recharged by modern precipitation, and 3) have large fluctuations in spring discharge rates which can be attributed to seasonal and climatic variability. High-flow/low-flow discharge rates vary as greatly as 600 gpm to nearly dry; however, most high flow rates are less than 50 gpm.
5. Despite the seasonal variability in discharge rates, the solute concentrations of active region groundwaters do not exhibit significant seasonal variability.
6. The inactive regime includes groundwater in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). Mine workings are largely part of the inactive regime. The sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. Coal seams are hydraulic barriers to groundwater flow. The blanket sands of the Star Point Sandstone are also largely in

the inactive zone. Except where exposed near cliff faces, faults encountered in mine workings are part of the inactive regime. Except near cliff faces, faults are not conduits for vertical hydraulic communication between otherwise hydraulically isolated pockets of groundwater.

7. Inactive region groundwater systems contain old groundwater (i.e. 2,000 to 12,000 years), and are not influenced by annual recharge events or short term climatic variability.

8. In-mine inactive regime groundwaters occur in nearly stagnant, isolated zones which have extremely limited hydraulic communication with other inactive regime groundwaters in the vicinity of mine workings and with near-surface active regime groundwaters as evidenced by the following:

   a) Groundwaters discharging into mine openings have ^{14}C ages ranging from 2,000 to 12,000 years

   b) Roof drip rates rapidly decline when water is encountered in the mine indicating that the saturated zone above the coal seam is not hydraulically continuous and has a limited vertical and horizontal extent.

   c) Unsaturated conditions have been identified in boreholes drilled vertically into sandstone channels located above coal seams.

9. The fact that inactive region groundwaters encountered in mine openings do not have an infinite age means that, at some time, there has been some hydraulic communication with the surface. This communication is extremely limited as illustrated by calculated steady state recharge-discharge rates of faults and sandstone channels in the inactive zone which range from 0.001 to 1.23 gpm.

10. Groundwater in the Star Point Sandstone is part of the inactive regime as evidenced by the 6,000 year ^{14}C age of the sample from well TM-3. In the down dip direction along the axis of the Straight Canyon Syncline, potentiometric pressures in the Spring Canyon member results in upwelling of groundwater into Hiawatha seam mine openings. Such upwelling may locally reduce the pressure in the Spring Canyon member.

11. Areally extensive groundwater regimes in the lower Blackhawk Formation and Star Point Sandstone do not exist within the lease area. Therefore, it is not meaningful to create piezometric surface maps of these systems.

12. Streamflow is dependent on snow melt, precipitation and thunderstorm activity. There is no apparent hydraulic communication between streamflow and groundwater encountered in mine openings.

13. The groundwater discharging into the Rilda Canyon alluvial collection system is of modern origin and is closely tied to seasonal recharge. This is evidenced by its modern radiocarbon and ^{3}H contents and by the discharge hydrographs. The alluvial groundwater is not related to the groundwater encountered in the mines.

14. The groundwater discharging in Cottonwood Canyon near Cottonwood Spring and Roans Spring discharges from glacial deposits and is of modern origin. The radiocarbon and ^{3}H contents of this water indicate a modern origin. The water in the shallow glacial deposits is not related to the groundwater encountered in the mines.

9. PROBABLE HYDROLOGIC CONSEQUENCES

This section describes the probable hydrologic consequences (PHC) of underground coal mining in the Trail Mountain LBA. The determination of the PHC is required by part R645-301-728 of the State of Utah Coal Mining Rules. This determination is based on the data and information presented in Sections 1-8 of this document. A recommended monitoring plan, as required by part R645-301-730.200 of the coal mining rules, is presented in Section 10 of this report.

This description of the PHC is based on the idea that the behavior of hydrologic and hydrogeologic systems in the Trail Mountain LBA is similar to those in East Mountain and the southern portion of Trail Mountain. These areas are nearly identical climatically, physiographically, and stratigraphically, and share many of the same geologic structures. Thus, the hydrologic consequences of underground coal mining in the Trail Mountain LBA will be similar to those at the Deer Creek, Cottonwood, Wilberg, and Trail Mountain mines.

9.1 Potential adverse impacts to the hydrologic balance (section 728.310)

The hydrologic balance is the sum of the flow interactions between surface waters and groundwaters and between various groundwater flow systems. Underground coal mining has the potential to impact the hydrologic balance by:

1. decreasing creek flows and spring discharges by capturing surface waters and/or groundwaters,
2. increasing creek flows by accelerating the rate of groundwater discharge from the mined horizon of the Blackhawk Formation, and

3. increasing groundwater recharge rates to overlying groundwater systems.

Subsidence-related fracturing can affect the hydrologic balance by capturing surface waters and/or groundwaters. In order for fracturing to reduce creek flows and spring discharges, such disturbances would have to result in the propagation of zones of increased vertical hydraulic conductivity. We do not believe that mining activities in the current PacifiCorp lease area have so affected surface and groundwater flows. The basis of this finding is discussed below.

The layout of the PacifiCorp mine plan is designed to minimize subsidence impacts to the steep cliffs of the Castlegate Sandstone (Chapter 3). As a result, nearly all subsidence that has been measured to date (Figure 2) occurs where the North Horn and, to a lesser extent, the Price River Formations are exposed at the surface. Vertical fractures are less likely to extend from the mined horizon into these formations because 1) the thickness of the overburden is from 900 to in excess of 2500 feet and 2) the North Horn Formation contains abundant clayey units that exhibit plastic deformation and swell when wetted (Section 4.3.1.2). This is extremely significant because more than 90% of the springs identified on East and Trail Mountains occur in the Price River and North Horn Formations and the overlying Flagstaff Limestone (Table A-1). These springs are effectively isolated from subsidence-related fracturing.

Numerous springs on East Mountain and several springs on Trail Mountain have been undermined. A smaller number of springs discharge from areas that have experienced

subsidence. As part of this investigation the hydrographs of these springs have been reviewed within the context of the mining history. Although some springs discharge from areas that have subsided as much as 10-12 feet, there is no evidence of discharge declines that can be attributed to mining-induced subsidence or fracturing.

Similarly, ephemeral and intermittent sections of Deer Creek and Grimes Wash have been subsided by as much as 10 feet (Figure 2). These creeks show no discharge declines that are attributable to mining-induced subsidence (Sections 7.1.3 and 7.2.2). Underground mining in the Trail Mountain LBA has the potential to impact intermittent side drainages that are tributary to Cottonwood Canyon Creek, intermittent tributaries to Cottonwood Canyon in Straight Canyon, and, possibly, Indian Creek. However, we do not anticipate that creek flows will be reduced by subsidence-related impacts to any of these creeks. Longwall mining does not occur beneath perennial streams, thus subsidence-related fracturing does not directly capture creek flows. Indian Creek lies beyond the western boundary of the lease area and no perennial streams discharge into the creek from within the Trail Mountain LBA. The boundary of the new LBA has been drawn so as to maintain at least a 1000-foot barrier between mine workings and the Joes Valley Fault system and Joes Valley. Therefore, the potential to detrimentally impact flows to Indian Creek in Joes Valley is negligible.

Appreciable amounts of groundwater are intercepted by underground coal mining. Mining quickly dewaters the saturated horizon immediately above the mined horizon and this water is not replaced as evidenced by the rapid decline and often complete drying of roof drips. In-mine groundwater occurs in isolated, inactive systems as demonstrated by the small ^{3}H

content and radiocarbon ages of mine waters which range from 2,000 to 12,000 years (Section 5.4), with the exception of one site which is discussed below. This indicates that in-mine waters are not in hydraulic connection with near-surface spring waters that respond to seasonal and climatic changes and contain anthropogenic carbon and appreciable amounts of ^{3}H.

Some in-mine groundwater sources have sustained discharges. Steady state calculations (Section 6.5.2) indicate that the recharge rate of 0.001 to 1.23 gpm could sustain these systems. What this means is that the amount of water being communicated from active near-surface groundwater systems to inactive deep systems is negligible. The interception of deep groundwater by mining is not removing water from overlying horizons.

Large groundwater inflows associated with the Roans Canyon fault system and Straight Canyon Syncline have occurred in the Deer Creek Mine (Section 6.3.2.2). Hydrologic concerns regarding the large-volume fault inflows are 1) the capture of water supplying baseflow to creeks or springs, and 2) the discharge of large volumes of fault-related water to creeks. In general, we do not believe that fault-discharge waters are tied to active, modern groundwater systems. Wells drilled into the fault system demonstrate that there is limited lateral communication along the fault system and the radiocarbon age of large volume fault-discharge waters are 8,000 to 12,000 years (Section 5.4).

Modern water does discharge from one point along the Roans Canyon Fault (site TW-10). However, this site is not representative of fault water discharge to the mine. TW-10 is a

horizontal dewatering well that intercepts fractured near-surface cliff rocks. The well is drilled from a rock tunnel driven across the fault to access blocks of coal north of the Roans Canyon Fault. The Deer Creek mine plan has been designed to avoid mining through the Roans Canyon Fault system, minimizing the amount of fault-related water that can be intercepted by mining. The discharge from TW-10 has stabilized at 4-5 gpm suggesting that the impact to near-surface waters is limited.

Mining in the Trail Mountain LBA will encounter the southwestern arms of both the Roans Canyon and Mill Fork fault zones. The Roans Canyon and Mill Fork fault systems are scissor faults hinged near the center of Trail Mountain. There is little vertical offset on these faults in Trail Mountain meaning that these faults may play a much smaller role in the transmission and storage of large quantities of groundwater than was seen in the Deer Creek Mine. However, the southwestern arm of the Roans Canyon fault zone is adjacent to the plunging end of the Straight Canyon Syncline, which is associated with higher confined groundwater pressures. Large quantities of water may be encountered if the Roans Canyon fault zone is intercepted in southwestern Trail Mountain.

Similarly, large quantities of water may be associated with the Star Point Sandstone on the southwesternmost section of the Straight Canyon Syncline. Mining of the Hiawatha Seam removes the confining layer and allows water to seep up into the floor of the mine. We anticipate that any water associated with the Roans Canyon Fault, the Mill Fork Fault, of the Straight Canyon Syncline that is encountered by mining in the southwestern Trail Mountain

will be part of an inactive groundwater system. Therefore, the removal of this water will not affect near-surface active groundwater systems.

The mining plan for the Trail Mountain LBA will be designed such as to minimize encounters with the Roans Canyon and Mill Fork faults. Additionally, wells will be drilled ahead of mining to evaluate potential high volume discharge areas. These areas will be grouted as mining progresses through such locations. Thus, no large groundwater inflows, such as were experienced in the Deer Creek Mine, are anticipated in the Trail Mountain Mine.

9.2 Presence of acid-forming or toxic-forming materials (728.320)

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 PacifiCorp mines. 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 (Eqs. 3 and 4). Iron is readily precipitated as iron-hydroxide and excess iron is not observed in the mine discharge water.

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

9.3 Impact of coal mining on sediment yield from disturbed areas (728.331)

The sediment load of streams can be impacted by increased sediment yield from areas disturbed by mining activities. Disturbed areas include: 1) surface workings, 2) mined-out areas, 3) subsided landscape above mine workings, and 4) sediment load from mine discharge water. Sediment yield from surface workings is minimized by sediment control structures that are installed and maintained according to the specifications in the mine permit. The sediment yield of mine discharge water is minimized through the use of sediment ponds. The sediment load of mine discharge water is monitored monthly according to UPDES permit specifications.

The sediment load of ephemeral and intermittent streams can be increased or decreased as a result of subsidence. Subsidence can locally increase stream gradients, causing higher flow velocities in the stream channel and greater sediment entrainment. The extent to which this phenomenon occurs in the lease area is not known; however, the impact would be localized and short-lived. The sediment load of ephemeral and intermittent streams would be decreased where subsidence causes water to be impounded. Here, stream flows would be decreased and sediment would be deposited in the impoundment. This occurrence would also be short-lived.

9.4 Impacts to important water quality parameters (728.332)

Solute and trace element composition and field parameters of springs, creeks, and mine discharge water have been monitored periodically to detect impacts to water quality. Inspection of the field parameters and solute and trace element composition of springs indicates no mining-related impacts on spring water quality. (It is difficult to envision a

mechanism to affect the water quality of springs in horizons above the mine). Similarly, water quality in creeks above the mine water discharge points has not been impacted.

As mining had progressed into areas near the axis of the Straight Canyon Syncline, groundwater discharge into the mine has exceeded in-mine water requirements and water will be discharged into Cottonwood Canyon Creek. The quality of groundwater intercepted in the Trail Mountain Mine is similar to water that is currently being discharged from the Deer Creek and Cottonwood Mines. This water meets secondary drinking water quality standards and does not have detrimental impacts to the quality of receiving waters. The quality of water discharged by the Trail Mountain Mine will be monitored periodically and be subject to UPDES permit specifications.

9.5 Flooding or streamflow alteration (728.333)

As mining has progressed into areas near the axis of the Straight Canyon Syncline, groundwater discharge into the mine has exceeded in-mine water requirements and water will be discharged into Cottonwood Canyon Creek. The amount of water that will be discharged is difficult to determine. We expect that the discharge will be much less than maximum flows during the springtime runoff and during summer thundershowers. We do not expect that flooding or streamflow alteration will result from mine water discharge to Cottonwood Canyon Creek.

9.6 Groundwater and surface water availability (728.334)

Mining in the new Trail Mountain LBA will not significantly affect the availability of groundwater. As described in Section 6.3, groundwaters in the lower Blackhawk Formation exist in highly compartmentalized partitions, both vertically and horizontally, and the formation does not act as a hydraulically continuous aquifer. The groundwater systems in the Blackhawk Formation were also demonstrated to be hydraulically isolated from overlying, modern groundwaters. 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 mine.

There are no groundwater supply wells in the mine lease 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.

10. RECOMMENDED MONITORING PLAN

The proposed monitoring program for wells, springs, and streams in the Trail Mountain LBA is shown in Figure 37 and is summarized in Tables 6, 7, and 8 and is described below.

10.1 Springs

We recommend that 8 springs be monitored within the Trail Mountain LBA. The proposed spring monitoring program is designed to provide verification that

1. groundwater systems in the formations overlying mined areas operate independently of Blackhawk Formation groundwater systems in the mine,
2. the temporal variability of spring discharges are due to climatic variability (i.e. wet and dry years), and
3. mining will not affect groundwater systems in overlying formations.

The spring monitoring locations have been chosen to provide information from each geologic formation and each significant hydrogeologic feature. Locations within each of the bedrock formations are recommended (with the exception of the Flagstaff Limestone from which no springs are known to discharge). Monitoring locations in the vicinity of the Roans Canyon Fault Graben within each of the North Horn, Price River, and Blackhawk Formations are included.

The chemical character of springs discharging from East and Trail Mountains is well documented. Many of these springs have been continuously monitored for solute chemistry for more than 20 years. As discussed in section 5.2.2, significant temporal variations in the

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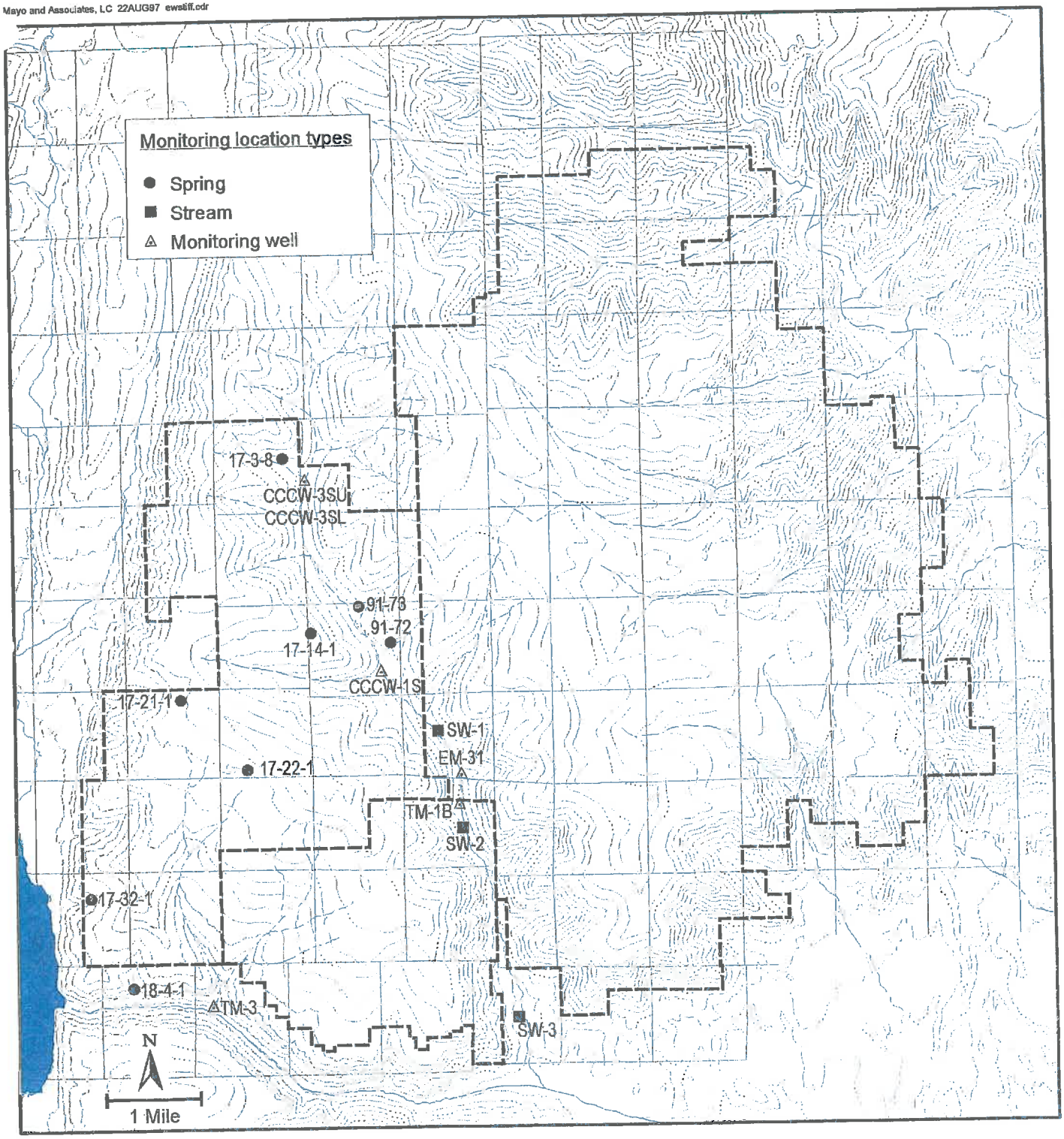

Figure 37 Proposed hydrologic monitoring plan for Trail Mountain LBA

solute chemical composition of springs does not exist. As discussed in Chapter 6 of this report, the active groundwater systems from which most springs in the lease area discharge are not in hydraulic communication with the deep, inactive zone groundwaters encountered in the mine. There is no reasonably likely mechanism by which mining activities can adversely impact the solute composition of groundwater discharging from springs overlying the mine workings. For these reasons we believe that long-term chemical monitoring of these springs is not particularly useful. We, therefore, recommend that the springs in the Trail Mountain LBA be monitored for flow and operational water quality parameters for a period of two years. During this two-year period the baseline chemical composition of the springs will be documented. Following two years of monitoring for operational water quality parameters, the springs need only be monitored for flow and field parameters.

10.1.1 North Horn Formation

We recommend that three springs be monitored within the North Horn Formation. These springs include 17-14-1, 17-21-1, and 17-22-1. It was demonstrated in this investigation that the active-zone groundwater systems of the North Horn Formation are not in hydraulic communication with the groundwater systems encountered within the mine. It was likewise demonstrated that the possibility of mining related subsidence fractures intercepting flow to the North Horn Formation springs is minimal. We, therefore, do not anticipate any detrimental impacts on the flow or solute chemistry of these springs. However, to document the responses of these springs to long-term fluctuations in climate, and to verify that subsidence fractures do not adversely impact spring flows, we recommend that these springs be regularly monitored.

10.1.2 Price River Formation

We recommend that spring 17-32-1 in the Price River Formation be regularly monitored. This spring has historically been utilized as a domestic water source and will likely have sustained flow throughout the year. Spring 17-32-1 discharges near the distal, down-gradient end of the Straight Canyon Syncline in the Roans Canyon Fault Graben.

10.1.3 Castlegate Sandstone and Blackhawk Formation

We recommend the monitoring of four springs near the formational contact between the Castlegate Sandstone and Blackhawk Formation. These include 17-3-8, 91-72, 91-73, and 18-4-1. Spring 18-4-1 discharges from the Castlegate Sandstone near the distal end of the Straight Canyon Syncline. Spring 17-14-2 discharges from the Blackhawk Formation within the Roans Canyon Fault Graben in Cottonwood Canyon. Spring 17-3-8 discharges from the Blackhawk Formation on the western slope of Cottonwood Canyon. Spring 17-14-2 discharges from a shallow, active system on the eastern slope of Cottonwood Canyon.

10.2 Creeks

We recommend regular monitoring of sites SW-1, SW-2, and SW-3 on Cottonwood Canyon Creek. SW-1 is located at the approximate first occurrence of flow in the creek. SW-2 is located within the existing Trail Mountain permit area below the mine discharge points UPDES 001 and 002. SW-3 is located below the mine permit area near the confluence with Cottonwood Creek.

Indian Creek lies beyond the western boundary of the lease area and no perennial streams discharge into the creek from within the Trail Mountain LBA. Likewise, no major springs have been identified which discharge from the western flanks of Trail Mountain that would be available for monitoring. The western boundaries of the LBA have been drawn such that projected mining areas will maintain at least a 1000-foot barrier between mine openings and the Joes Valley Fault. Therefore, the potential to detrimentally impact flows in Indian Creek is negligible and regular monitoring of Indian Creek is not recommended.

Reliable flow monitoring of the upper reaches of Cottonwood Creek below the Joes Valley Reservoir discharge is not possible. Detrimental impacts on the creek flow would need to be determined by stream gauging at an upstream point (at the reservoir discharge) and at a point approximately two miles downstream. We believe that the magnitude of any potential impact on flow to the creek would be many times less than the error of the flow measurement using best available technology. Based on the information gained in this investigation, we do not anticipate significant detrimental impacts on the creek. We, therefore, do not recommend any monitoring of Cottonwood Creek.

10.3 Wells

We recommend the monitoring of six wells within the new Trail Mountain LBA. These include four wells (TM-3, TM-1B, CCCW-3SL, and CCCW-1S) in the Star Point Sandstone below the mined horizon, and two (EM-31, CCCW-3SU) in the Blackhawk Formation.

Table 6 Recommended monitoring locations and protocols.

MONITORING PROTOCOLS

Water level and flow measurements

A Monitoring well: quarterly water level measurements
B Stream: quarterly discharge measurements
C Spring: quarterly discharge measurements

Water quality

1 Stream: quarterly water quality operational laboratory measurements
2 Spring: quarterly water quality operational laboratory measurements for two (2) years, then reverting to field parameters only

MONITORING LOCATIONS AND PROTOCOLS

Monitoring Well	Protocol	Comments
TM-1B	A	Screened in Star Point Sandstone
TM-3	A	Screened in Star Point Sandstone
EM-31	A	Screened in Blackhawk Formation and Star Point Sandstone
CCCW-3S L	A	Screened in Star Point Sandstone
CCCW-3S U	A	Screened in Blackhawk Formation
CCCW-1S	A	Screened in Star Point Sandstone
Streams		
SW-1	B,1	Cottonwood Canyon Creek (upper, first perennial)
SW-2	B,1	Cottonwood Canyon Creek (below UPDES 001 and 002)
SW-3	B,1	Cottonwood Canyon Creek (below lease)
Springs		
17-14-1	C,2	North Horn Formation
17-21-1	C,2	North Horn Formation
17-22-1	C,2	North Horn Formation
17-32-1	C,2	Price River Formation
17-3-8	C,2	Castlegate/Blackhawk contact
17-14-2	C,2	Castlegate/Blackhawk contact
17-14-3	C,2	Castlegate/Blackhawk contact
18-4-1	C,2	Castlegate/Blackhawk contact

Table 7 Recommended groundwater operational water quality monitoring

FIELD MEASUREMENTS	REPORTED AS
pH	pH units
Specific Conductivity	µs/cm @ 25°C
Temperature	°C

LABORATORY MEASUREMENTS	
Total Dissolved Solids	mg L^{-1}
Carbonate	mg L^{-1}
Bicarbonate	mg L^{-1}
Calcium (dissolved)	mg L^{-1}
Chloride	mg L^{-1}
Iron (total)	mg L^{-1} (3rd quarter only)
Magnesium (dissolved)	mg L^{-1}
Manganese (total)	mg L^{-1} (3rd quarter only)
Potassium (dissolved)	mg L^{-1}
Sodium (dissolved)	mg L^{-1}
Sulfate	mg L^{-1}
Cations	meq L^{-1}
Anions	meq L^{-1}

Table 8 Recommended surface water operational water quality monitoring

FIELD MEASUREMENTS	REPORTED AS
pH	pH units
Specific Conductivity	µs/cm @ 25°C
Dissolved Oxygen	mg L^{-1}
Temperature	°C

LABORATORY MEASUREMENTS	
Total Dissolved Solids	mg L^{-1}
Carbonate	mg L^{-1}
Bicarbonate	mg L^{-1}
Calcium (dissolved)	mg L^{-1}
Chloride	mg L^{-1}
Iron (total)	mg L^{-1}
Magnesium (dissolved)	mg L^{-1}
Manganese (total)	mg L^{-1}
Potassium (dissolved)	mg L^{-1}
Sodium (dissolved)	mg L^{-1}
Sulfate	mg L^{-1}
Oil and grease	mg L^{-1}
Cations	meq L^{-1}
Anions	meq L^{-1}

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Appendix A

Isotope laboratory analytical reporting sheets

Application of Selected Isotopes to Hydrogeologic Problems

Mayo and Associates
710 E 100 N
Lindon, UT 84042

Oxygen-18 ($\delta^{18}O$) and deuterium ($\delta^{2}H$)

Worldwide, the $\delta^{2}H$ and $\delta^{18}O$ of precipitation (rain and snow) generally follow the empirical relationship:

$$\delta^{2}H = s\,(\delta^{18}O) + d\ (‰)$$

Where *s* is the slope and *d* is the deuterium excess (Merlivant and Jouzel, 1983). Craig (1961) and Dansgaard (1964) have shown that, on the global scale, *s* approximates 8 and *d* approximates 10 for coastal meteoric water. The meteoric water line (MWL) is therefore defined as:

$$\delta^{2}H = 8(\delta^{18}O) + 10\ (‰)$$

The $\delta^{18}O$ and $\delta^{2}H$ composition of groundwaters can be used to help evaluate the origin and flow and mixing patterns of groundwaters. Groundwater recharged during cooler climates or at higher elevations will have more negative isotopic compositions than groundwater which recharged during warmer climates or at lower elevations. Groundwaters which have been heated above about 100°C during deep circulation will exhibit a positive $\delta^{18}O$ shift relative to the $\delta^{2}H$ composition. Groundwater of non-meteoric origin (i.e. connate and magmatic) will not plot along the MWL.

Carbon-13 ($\delta^{13}C$)

Most groundwater acquires 50 percent of its carbon from soil zone water and 50 percent of its carbon from the dissolution of carbonate minerals in the soil zone or aquifer skeleton. Because the $\delta^{13}C$ of marine carbonate minerals is about 0 ‰ (Muller and Mayo, 1986) and soil zone CO_2 gas has a $\delta^{13}C$ of -18 to -27 ‰, most groundwaters have a $\delta^{13}C$ of ≈ -9 to -13 ‰.

Sulfur-34 ($\delta^{34}S$)

The anticipated range of $\delta^{34}S$ values in Mesozoic early Tertiary gypsum and anhydrite is +10 to +20 ‰ (Holser and Kaplan, 1966). At non-thermal aquifer temperatures, isotopic fractionation accompanying gypsum dissolution may be represented as:

$$\underset{(\delta^{34}S\ = +15\ ‰)}{CaSO_{4(s)}} \quad \underset{\Rightarrow}{^{34}S\ \text{enrichment}} \quad \underset{(\delta^{34}S = +9\ ‰)}{Ca^{2+} + SO_4^{2-}}$$

where the value $\delta^{34}S \approx +15$ ‰ has been arbitrarily selected.

The typical $\delta^{34}S$ value of magmatic pyrite is about 0 ‰ (Faure, 1986). A $\delta^{34}S$ of -2.2 ‰ has been reported for pyrite in the Park City, Utah District (Thode and others, 1961). Mayo and Klauk (1991) found a mean $\delta^{34}S$ of +1.3 ‰ in groundwater from non-carbonate (crystalline rock) aquifers in north central Utah. Mayo and Kravits (unpublished data) found a $\delta^{34}S$ value of pyrite in the SUFCO coal mine, Utah of +3.4 ‰. Sulfur isotopic fractionation does not accompany the dissolution of pyrite.

Tritium (^{3}H)

Tritium (^{3}H), the radioactive isotope of hydrogen, has been used in groundwater investigations to differentiate between groundwaters which recharged prior to or after the advent of atmospheric thermonuclear weapons testing. Tritium, whose half-life is 12.26 years, forms naturally in the upper stratosphere by the interaction of ^{14}N with cosmic ray neutrons according to the reaction:

$$^{14}N + n \Rightarrow {}^{3}H + {}^{12}C$$

Tritium is rapidly incorporated into water molecules and is removed from the atmosphere by precipitation.

Prior to the advent of atmospheric thermonuclear weapons testing in 1952, tritium activity in precipitation ranged from 4 to 25 tritium units (TU). One TU equals one ^{3}H atom per 10^{8} hydrogen atoms. In mountainous areas, larger natural concentrations have been observed (Fontes, 1983). During the peak of atmospheric weapons testing, tritium levels in precipitation rose to m ore than 2,200 TU in some northern hemisphere locations (Fontes, 1983). As of 1987, the ^{3}H concentrations in rain water varied from 25 to 50 TU. Unpublished data of 1991 and 1992 snow samples collected in the central Wasatch Range, Utah have ^{3}H concentrations of 20 TU or more.

Carbon-14 (^{14}C)

Carbon-14, the radioactive isotope of carbon, has a half-life of 5730 ± 30 years (Godwin, 1962). Carbon-14 is produced in the upper atmosphere by a variety of reactions that involve the collision of cosmic radiation (neutrons) with stable isotopes of nitrogen, oxygen, and carbon. The most important of these reactions is between neutrons and ^{14}N according to the reaction:

$$n + {}^{14}N \Rightarrow {}^{14}C + p$$

where n is a neutron and p is a proton (Libby, 1955). Carbon-14 is incorporated into $CO_{2(g)}$ and rapidly mixes throughout the atmosphere and hydrosphere where steady state equilibrium between ^{14}C production and ^{14}C decay is attained (Faure, 1986).

The pre-industrial revolution atmospheric ^{14}C content has been assigned the steady state value of 100 percent modern carbon (pmc). The burning of fossil fuels and the advent of atmospheric thermonuclear weapons testing greatly altered the ^{14}C activity in post-industrial revolution atmosphere. Burning of fossil fuels, whose ^{14}C had previously completely decayed away, decreased the ^{14}C content in the troposphere in the northern hemisphere by about 3% (Houtermans and others, 1967). Atmospheric weapons testing greatly increased the atmospheric ^{14}C activity by the mid 1960's (Ferronsky and Polyakov, 1982).

The post-industrial revolution atmospheric ^{14}C perturbations and laboratory measurement error in measuring the ^{14}C content of groundwater make the reliable lower limit for ^{14}C dating about 450 years. The upper limit of ^{14}C dating, using conventional laboratory analytical methods, is about 35,000 years.

Estimating the age of dead wood or other organic carbon is relatively simple. The ^{14}C activity of pre-industrial revolution organic material is assumed to be 100 pmc. The radiocarbon date is then corrected for systematic variations in atmospheric ^{14}C that have been established by comparing tree ring dates of the wood of Sequoia and Bristlecone Pines with their corresponding radiocarbon ages (LaMarche and Harlan, 1973; Michael and Ralf, 1970).

Estimating the radiocarbon age of groundwaters is not as straightforward as estimating the age of dead organic matter. Groundwater acquires carbon from numerous sources, many of which had initial ^{14}C activities of less than 100 pmc. The ^{14}C content of groundwater is affected by four factors:

1) the addition of "live" carbon (i.e., $^{14}C \approx 100$ pmc) from the biogenic production of $CO_{2(g)}$ in the soil zone,
2) the addition of "dead" carbon from the weathering of minerals in the soil zone and the dissolution of carbonate minerals in the soil zone or aquifer (i.e., $^{14}C \approx 0$ pmc),
3) the addition of "dead" carbon from the soil or aquifer during isotopic exchange reactions, and
4) the addition of both "live" and "dead" carbon by other processes.

The crux of dating groundwater is estimating the initial ^{14}C activity (A_o) of the water at the time of recharge. This may be accomplished by using the solute and isotopic chemistries of the groundwater and applying correction procedures. Correction procedures for estimating A_o are in the form of mathematical equations that attempt to account for the contribution of "dead" carbon and ^{14}C from various sources, and for the effects of the isotopic exchange and fractionation processes.

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Appendix B

Application of selected isotopes to hydrogeologic problems

Cross-reference Information

Laboratory reporting sheet description	Database description
Cottonwood Mine Main West Seals	MW Seals
Deer Creek 3rd South Seals	3S Seals
TMA	TMA X 32
Roans Spring	Roans Canyon Spring
2nd S XC11	2S X 11
6th West Fault	6W X 20
Wilberg Fault E1 X29	1.5N X 29
Rilda Canyon Meter #3	NEWUA meter #3

GEOCHRON LABORATORIES a division of
KRUEGER ENTERPRISES, INC.

711 CONCORD AVENUE ✦ CAMBRIDGE, MASSACHUSETTS 02138 ✦ U.S.A
TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 12/10/96
Date Reported: 01/03/97
Your Reference: Letter of Dec. 2, 1996 Energy West

Our Lab. Number	Your Sample Number	Description	δD*			δ^{18}O*		
HOR-91670	EW-TM-17-3-9	Water	-129	-129	**		-16.8	
HOR-91671	EW-TM-17-22-1	Water	-122	-123	**		-15.3	
HOR-91672	EW-TM-17-28-4	Water	-128	-128	**	-16.0	-16.0	**
HOR-91673	EW-TM-18-2-1	Water	-131				-16.9	

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}‰ = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

Where:

D/H standard is SMOW
$^{18}O/^{16}O$ standard is SMOW

And:

$D/H_{standard}$ = 0.000316**
$^{18}O/^{16}O_{standard}$ = 0.0039948**

**Double atom ratio

GEOCHRON LABORATORIES a division of
KRUEGER ENTERPRISES, INC.

711 CONCORD AVENUE ✦ CAMBRIDGE, MASSACHUSETTS 02138 ✦ U.S.A
TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 12/19/96
Date Reported: 01/10/97
Your Reference: Letter of 16 DEC 1996 Energy West

Our Lab. Number	Your Sample Number	Description	δD*	$\delta^{18}O$*
HOR-91770	91-73	Water	-130	-17.0
HOR-91771	18-4-1	Water	-130	-17.3
HOR-91772	91-72	Water	-127	-16.7 -16.8 **
HOR-91773	16-34-6	Water	-129	-16.9
HOR-91774	~~CCW-15~~ CCCW-15 KLP	Water	-130	-17.3
HOR-91775	17-32-1	Water	-130	-17.2
HOR-91776	~~TW-3~~ TM-3 KLP	Water	-129	-17.3
HOR-91777	80-50	Water	-124	-16.7
HOR-91778	84-57	Water	-119 -119 **	-15.9
HOR-91779	Rilda Canyon Meter #3	Water	-123	-16.3
HOR-91780	Wilberg Fault E1 XC29	Water	-123	-16.2 -16.3 **
HOR-91781	T-18 Oliphant Spring	Water	-130	-17.0

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}‰ = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

Where:

D/H standard is SMOW
$^{18}O/^{16}O$ standard is SMOW

And:

$D/H_{standard}$ = 0.000316**
$^{18}O/^{16}O_{standard}$ = 0.0039948**

**Double atom ratio

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STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 12/19/96
Date Reported: 01/10/97
Your Reference: Letter of 16 DEC 1996 Energy West

Our Lab. Number	Your Sample Number	Description	δD*		$\delta^{18}O$*
HOR-91782	CCC Trail Snow	Water	-139	-141 **	-18.4
HOR-91783	Cottonwood Canyon Snow	Water	-140		-18.4

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}‰ = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

Where:

D/H standard is SMOW
$^{18}O/^{16}O$ standard is SMOW

And:

$D/H_{standard}$ = 0.000316**
$^{18}O/^{16}O_{standard}$ = 0.0039948**

**Double atom ratio

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STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 08/16/96
Date Reported: 02/24/97
Your Reference:

NB: The hydrogen isotope results for these samples, previously reported on 29 AUG 96, were incorrect. The samples have been re-analyzed and the new hydrogen results are reported below:

Our Lab. Number	Your Sample Number	Description	δD*			$\delta^{18}O$*		
HOR-90674	East Mtn Snow #1	Water	-141	-140	**	-19.2		
HOR-90675	Snow #2	Water	-143			-19.4		
HOR-90676	Deer Creek Mine Portal Snow	Water	-133			-17.7		
HOR-90677	E. Joe's Valley Res.	Water	-140			-18.5		
HOR-90678	Roans Spring	Water	-125	-125	**	-16.6		
HOR-90679	NEWUA Meter #3	Water	-122			-16.3		
HOR-90680	TMA	Water	-123			-16.3		
HOR-90681	2nd S. XC11	Water	-126			-16.3		
HOR-90682	UG - 3	Water	-130			-16.9	-16.9	**
HOR-90683	MN - ME	Water	-126			-16.7		
HOR-90684	TW - 10	Water	-123			-16.4		
HOR-90685	6th West Fault	Water	-126			-16.8		

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}‰ = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

Where:

D/H standard is SMOW
$^{18}O/^{16}O$ standard is SMOW

And:

$D/H_{standard}$ = 0.000316**
$^{18}O/^{16}O_{standard}$ = 0.0039948**

**Double atom ratio

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STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 03/06/97
Date Reported: 03/28/97
Your Reference: Letter of March 3, 1997 Energy West

Our Lab. Number	Your Sample Number	Description	δD*		$\delta^{18}O$*	
HOR-92620	Cottonwood Mine Main West Seals	Water	-128	-127 **	-16.7	
HOR-92621	Deer Creek 3rd South Seals	Water	-128		-16.7	-16.6 **

** Duplicate analyses on separate aliquots of original sample.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}‰ = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

Where:

D/H standard is SMOW
$^{18}O/^{16}O$ standard is SMOW

And:

$D/H_{standard}$ = 0.000316**
$^{18}O/^{16}O_{standard}$ = 0.0039948**

**Double atom ratio

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 08/16/96
Date Reported: 09/12/96
Your Reference: Letter of Aug. 13

Our Lab. Number	Your Sample Number	Description	$\delta^{34}S$*
SR-90686	Roans Spring	$BaSO_4$	-0.4
SR-90687	Meter #3	$BaSO_4$	+3.4
SR-90688	TMA	$BaSO_4$	+21.0 +21.0 **
SR-90689	2nd S. XC11	$BaSO_4$	+13.3
SR-90690	UG - 3	$BaSO_4$	+19.0
SR-90691	MN - ME	$BaSO_4$	+5.1
SR-90692	TW - 10	$BaSO_4$	+2.2
SR-90693	6th West Fault	$BaSO_4$	+9.3

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta^{34}S_{sample}‰ = \left[\frac{^{34}S/^{32}S_{sample}}{^{34}S/^{32}S_{standard}} - 1 \right] \times 1000$$

Where:

$^{34}S/^{32}S$ standard is Cañon Diablo troilite

And:

$^{34}S/^{32}S = 0.0450045$

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 12/19/96
Date Reported: 02/04/97
Your Reference: Letter of 16 DEC 1996 Energy West

Our Lab. Number	Your Sample Number	Description	$\delta^{34}S$*
SR-91758	91-73	$BaSO_4$	+ 7.9
SR-91759	18-4-1	$BaSO_4$	0.0
SR-91760	91-72	$BaSO_4$	- 4.9
SR-91761	16-34-6	$BaSO_4$	+16.2
SR-91762	~~CGW-15~~ CCCW-1S KLP	$BaSO_4$	+13.2
SR-91763	17-32-1	$BaSO_4$	-13.7 -13.5 **
SR-91764	~~TW-3~~ TM-3 KLP	$BaSO_4$	+27.7
SR-91765	80-50	$BaSO_4$	+23.2
SR-91766	84-57	$BaSO_4$	+ 1.9
SR-91767	Rilda Canyon Meter #3	$BaSO_4$	+ 8.7
SR-91768	Wilberg Fault E1 XC29	$BaSO_4$	+ 6.9
SR-91769	T-18 Oliphant Spring	$BaSO_4$	+ 9.8

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta^{34}S_{sample}‰ = \left[\frac{^{34}S/^{32}S_{sample}}{^{34}S/^{32}S_{standard}} - 1 \right] \times 1000$$

Where:

$^{34}S/^{32}S$ standard is Cañon Diablo troilite

And:

$^{34}S/^{32}S = 0.0450045$

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STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 12/10/96
Date Reported: 01/03/97
Your Reference: Letter of Dec. 2, 1996 Energy West

Our Lab. Number	Your Sample Number	Description	$\delta^{34}S$*
SR-91666	EW-TM-17-3-9	$BaSO_4$	+5.8
SR-91667	EW-TM-17-22-1	$BaSO_4$	+3.1 +2.9 **
SR-91668	EW-TM-17-28-4	$BaSO_4$	-2.7
SR-91669	EW-TM-18-2-1	$BaSO_4$	-20.1

** Duplicate preparations and analyses.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta^{34}S_{sample}‰ = \left[\frac{^{34}S/^{32}S_{sample}}{^{34}S/^{32}S_{standard}} - 1 \right] \times 1000$$

Where:

$^{34}S/^{32}S$ standard is Cañon Diablo troilite

And:

$^{34}S/^{32}S = 0.0450045$

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STABLE ISOTOPE RATIO ANALYSES

REPORT OF ANALYTICAL WORK

Submitted by: Kelly Payne
Mayo and Associates
710 East 100 North
Lindon, UT 84042

Date Received: 03/06/97
Date Reported: 04/14/97
Your Reference: Letter of March 3, 1997 Energy West

Our Lab. Number	Your Sample Number	Description	$\delta^{34}S$*
SR-92622	Cottonwood Mine Main West Seals	$BaSO_4$	+11.5
SR-92623	Deer Creek 3rd South Seals	$BaSO_4$	+13.8 +13.9 **

** Duplicate analyses on separate aliquots of sample.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta^{34}S_{sample}‰ = \left[\frac{^{34}S/^{32}S_{sample}}{^{34}S/^{32}S_{standard}} - 1 \right] \times 1000$$

Where:

$^{34}S/^{32}S$ standard is Cañon Diablo troilite

And:

$^{34}S/^{32}S = 0.0450045$

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22180

Date Received: 08/16/96

Your Reference: letter of 08/13/96

Date Reported: 08/27/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: TMA (Cottonwood)
groundwater precipitate

AGE = 11,150 +/- 285 C-14 years BP (C-13 corrected).
(24.97 +/- 0.88) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -10.0 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22181

Date Received: 08/16/96

Your Reference: letter of 08/13/96

Date Reported: 08/27/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: 2nd S. XC11 (Cottonwood)
groundwater precipitate

AGE = 16,930 +/- 470 C-14 years BP (C-13 corrected).
(12.15 +/- 0.70) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = - 7.5 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22182

Date Received: 08/16/96

Your Reference: letter of 08/13/96

Date Reported: 08/27/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: UG-3 (Trail Mtn.)
groundwater precipitate

AGE = 9,420 +/- 290 C-14 years BP (C-13 corrected).
(30.95 +/- 1.12) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -14.0 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22183

Date Received: 08/16/96

Your Reference: letter of 08/13/96

Date Reported: 08/27/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: TW-10 (Deer Creek)
groundwater precipitate

AGE = 3,790 +/- 150 C-14 years BP (C-13 corrected).
(62.39 +/- 1.19) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -10.5 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22184

Date Received: 08/16/96

Your Reference: letter of 08/13/96

Date Reported: 08/27/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: 6th West Fault (Deer Creek)
groundwater precipitate

AGE = 6,930 +/- 280 C-14 years BP (C-13 corrected).
(42.23 +/- 1.47) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Small sample; approximately 0.62 grams carbon.

$\delta^{13}C_{PDB}$ = -10.3 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22271 **Date Received:** 08/16/96

Your Reference: telephone instructions 09/16/96 **Date Reported:** 09/30/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Roans Spring
groundwater precipitate

AGE = 2,500 +/- 120 C-14 years BP (C-13 corrected).
(73.24 +/- 1.11) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -10.4 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX-22273 — Date Received: 08/16/96

Your Reference: telephone instructions 09/16/96 — Date Reported: 09/30/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: MN-ME
groundwater precipitate

AGE = 11,970 +/- 540 C-14 years BP (C-13 corrected).
(22.54 +/- 1.51) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Small sample; approximately 0.60 grams carbon.

$\delta^{13}C_{PDB}$ = - 8.1 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22666

Date Received: 12/10/96

Your Reference: letter of 12/02/96

Date Reported: 12/24/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: EW-TM-17-3-9
groundwater precipitate

AGE = 735 +/- 145 C-14 years BP (C-13 corrected).
(91.26 +/- 1.64) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Relatively small sample; approximately 0.84 grams carbon.

$\delta^{13}C_{PDB}$ = -11.2 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22667

Date Received: 12/10/96

Your Reference: letter of 12/02/96

Date Reported: 12/24/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: EW-TM-17-22-1
groundwater precipitate

AGE = 1,905 +/- 175 C-14 years BP (C-13 corrected).
(78.89 +/- 1.70) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Small sample; approximately 0.74 grams carbon.

$\delta^{13}C_{PDB}$ = -10.5 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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711 CONCORD AVENUE ✦ CAMBRIDGE, MASSACHUSETTS 02138 ✦ U.S.A
TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22668

Date Received: 12/10/96

Your Reference: letter of 12/02/96

Date Reported: 12/24/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: EW-TM-17-28-4
groundwater precipitate

AGE = 1,500 +/- 180 C-14 years BP (C-13 corrected).
(82.93 +/- 1.84) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -10.3 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22669

Date Received: 12/10/96

Your Reference: letter of 12/02/96

Date Reported: 12/24/96

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: EW-TM-18-2-1
groundwater precipitate

AGE = 2,190 +/- 195 C-14 years BP (C-13 corrected).
(76.12 +/- 1.83) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Relatively small sample; approximately 0.94 grams carbon.

$\delta^{13}C_{PDB}$ = -11.2 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22675

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 91-73
groundwater precipitate

AGE = 1,840 +/- 140 C-14 years BP (C-13 corrected).
(79.49 +/- 1.38) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Small sample; approximately 0.76 grams carbon.

$\delta^{13}C_{PDB}$ = - 7.9 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.
The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX-22676 — Date Received: 12/19/96

Your Reference: letter of 12/16/96 — Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 18-4-1
groundwater precipitate

AGE = 5,155 +/- 155 C-14 years BP (C-13 corrected).
(52.65 +/- 1.03) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Relatively small sample; approximately 0.95 grams carbon.

$\delta^{13}C_{PDB}$ =- 9.9 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22677

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 91-72
groundwater precipitate

AGE = 2,260 +/- 135 C-14 years BP (C-13 corrected).
(75.47 +/- 1.24) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = - 9.9 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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TELEPHONE. (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22678

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 16-34-6
groundwater precipitate

AGE = 1,880 +/- 190 C-14 years BP (C-13 corrected).
(79.12 +/- 1.87) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -11.2 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX-22679 — Date Received: 12/19/96

Your Reference: letter of 12/16/96 — Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West ~~CCCW-T5~~ CCCW-1S KLP
groundwater precipitate

AGE = 6,210 +/- 210 C-14 years BP (C-13 corrected).
(46.17 +/- 1.23) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Small sample; approximately 0.79 grams carbon.

$\delta^{13}C_{PDB}$ = -10.3 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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KRUEGER ENTERPRISES, INC.
711 CONCORD AVENUE ✦ CAMBRIDGE, MASSACHUSETTS 02138 ✦ U.S.A
TELEPHONE. (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22680

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 17-32-1
groundwater precipitate

AGE = 3,900 +/- 190 C-14 years BP (C-13 corrected).
(61.55 +/- 1.48) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = - 8.6 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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TELEPHONE: (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22681

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West ~~TW-3~~ TM-3 KLP
groundwater precipitate

AGE = 11,340 +/- 280 C-14 years BP (C-13 corrected).
(24.36 +/- 0.84) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -10.3 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22682

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 80-50
groundwater precipitate

AGE = 2,190 +/- 130 C-14 years BP (C-13 corrected).
(76.17 +/- 1.24) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Relatively small sample; approximately 0.95 grams carbon.

$\delta^{13}C_{PDB}$ =- 9.6 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22683

Date Received: 12/19/96

Your Reference: letter of 12/16/96

Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West 84-57
groundwater precipitate

AGE = 2,805 +/- 125 C-14 years BP (C-13 corrected).
(70.55 +/- 1.11) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ =- 8.6 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX-22684 — Date Received: 12/19/96

Your Reference: letter of 12/16/96 — Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West Rilda Canyon Meter #3
groundwater precipitate

AGE = 2,030 +/- 160 C-14 years BP (C-13 corrected).
(77.66 +/- 1.53) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment: Small sample; approximately 0.66 grams carbon.

$\delta^{13}C_{PDB}$ = -10.9 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX-22685 — Date Received: 12/19/96

Your Reference: letter of 12/16/96 — Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West Wilberg Fault E1 XC29
groundwater precipitate

AGE = 9,160 +/- 240 C-14 years BP (C-13 corrected).
(31.97 +/- 0.95) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -10.6 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX-22686 — Date Received: 12/19/96

Your Reference: letter of 12/16/96 — Date Reported: 01/09/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West T-18 Oliphant Spring groundwater precipitate

AGE = 12,270 +/- 490 C-14 years BP (C-13 corrected).
(21.70 +/- 1.33) % of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = -15.3 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.
The age is referenced to the year A.D. 1950.

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TELEPHONE. (617) 876-3691 TELEFAX: (617) 661-0148

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22916

Date Received: 03/06/97

Your Reference: letter of 03/03/97

Date Reported: 04/03/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West Cottonwood Mine Main West Seals groundwater precipitate

AGE = 12,170 +/- 440 C-14 years BP (C-13 corrected).
(21.99 +/- 1.20)% of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = - 9.7 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. GX-22917

Date Received: 03/06/97

Your Reference: letter of 03/03/97

Date Reported: 04/03/97

Submitted by: Mr. Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, Utah 84042

Sample Name: Energy West Deer Creek 3rd South Seals groundwater precipitate

AGE = 15,570 +/- 390 C-14 years BP (C-13 corrected).
(14.40 +/- 0.70)% of the modern (1950) C-14 activity.

Description: Sample of groundwater precipitate.

Pretreatment: The barium salt precipitate was rapidly vacuum filtered and immediately hydrolyzed, under vacuum to recover carbon dioxide from the barium carbonates for the analysis. C-13 analysis was made on a small portion of the same evolved gas.

Comment:

$\delta^{13}C_{PDB}$ = - 7.7 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

UNIVERSITY OF Miami

October 10, 1996

TRITIUM LABORATORY

Data Release #96-80
Job # 878

MAYO & ASSOCIATES
TRITIUM SAMPLES

Dr. H. Gote Ostlund
Head, Tritium Laboratory

Distribution:

Kelly Payne
Mayo & Associates
710 East 100 North
Lindon, UT 84042

Energy West Mining Co.
ATTN: Chuck Semborski
P.O. Box 310
Huntington UT 84528

Rosenstiel School of Marine and Atmospheric Science
Tritium Laboratory
4600 Rickenbacker Causeway
Miami, Florida 33149-1098
(305) 361-4100
Fax (305) 361-4112

Client: MAYO AND ASSOCIATES - ENERGY WEST
Recvd : 96/08/22
Job# : 878
Final : 96/10/09

Purchase Order: 960103
Contact: K. Payne, 801/785-2385,-2387(f)
710 E. 100 N., Lindon, UT 84042
FOR: Energy West Mining Co., 801/637-7925

Cust	LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
MAYO -	EAST MT. SNOW #1	878.01	960315	1000	275	8.79	0.29
MAYO -	SNOW #2	878.02	960315	1000	275	7.50	0.25
MAYO -	ROANS SPRING	878.03	960402	1000	275	11.2	0.4
MAYO -	NEWUA METER 3	878.04	960402	1000	226 *	13.7	0.5
MAYO -	TMA	878.05	960328	1000	274 *	0.22	0.09
MAYO -	2nd S XC11	878.06	960328	1000	270	0.05	0.09
MAYO -	UG-3	878.07	960328	1000	250 *	0.13	0.09
MAYO -	MN-ME	878.08	960329	1000	235 *	0.10	0.09
MAYO -	TW-10	878.09	960329	1000	275	20.8	0.7
MAYO -	6th WEST FAULT	878.10	960502	1000	245 *	0.14	0.09

* Average of duplicate runs

UNIVERSITY OF Miami

January 3, 1997

TRITIUM LABORATORY

Data Release #97-16
Job # 911

MAYO & ASSOCIATES
TRITIUM SAMPLES

Dr H. Gote Ostlund
Head, Tritium Laboratory

Distribution:
Erick C. Petersen
Mayo & Associates
710 East 100 North
Lindon, UT 84042

Rosenstiel School of Marine and Atmospheric Science
Tritium Laboratory
4600 Rickenbacker Causeway
Miami, Florida 33149-1098
(305) 361-4100
Fax (305) 361-4112

Client: MAYO and ASSOCIATES - ENERGY WEST
Recvd : 96/12/05
Job# : 911
Final : 97/01/02

Purchase Order: 96-0108
Contact: E. Petersen, K. Payne, 801/796-0211
710 East 100 North (F)/785-2387
Lindon, Utah 84042

Cust	LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
MAYO-	EW-TM-17-3-9	911.01	960823	1000	275	23.0	0.8
MAYO-	EW-TM-17-22-1	911.02	960823	1000	275	18.1	0.6
MAYO-	EW-TM-17-28-4	911.03	950823	1000	274	13.3	0.4
MAYO-	EW-TM-18-2-1	911.04	950823	1000	275	12.2	0.4

UNIVERSITY OF Miami

February 20, 1997

TRITIUM LABORATORY

Data Release #97-20
Job # 916

MAYO & ASSOCIATES
TRITIUM SAMPLES

Dr. H. Gote Ostlund
Head, Tritium Laboratory

Distribution:
Erick C. Petersen
Mayo & Associates
710 East 100 North
Lindon, UT 84042

Rosenstiel School of Marine and Atmospheric Science
Tritium Laboratory
4600 Rickenbacker Causeway
Miami, Florida 33149-1098
(305) 361-4100
Fax (305) 361-4112

Client: MAYO and ASSOCIATES - ENERGY WEST
Recvd : 96/12/19
Job# : 916
Final : 97/02/18

Purchase Order: 96-0108
Contact: E. Petersen, K. Payne, 801/796-0211
710 East 100 North (F)/785-2387
Lindon, Utah 84042

Cust LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
MAYO ENERGY W.- 91-73	916.01	961213	1000	250	2.63*	0.10
MAYO ENERGY W.- 18-4-1	916.02	961213	1000	275	-0.01	0.09
MAYO ENERGY W.- 91-72	916.03	961213	1000	253	14.9	0.5
MAYO ENERGY W.- 16-34-6 KLP	916.04	961213	1000	267	12.7	0.4
MAYO ENERGY W.- ~~GGW-15~~ CCCW-15	916.05	961209	1000	250	1.10*	0.09
MAYO ENERGY W.- 17-32-1	916.06	961213	1000	276	2.20	0.12
MAYO ENERGY W.- ~~TW-3~~ TM-3 KLP	916.07	961211	1000	265	-0.07	0.09
MAYO ENERGY W.- 80-50	916.08	961212	1000	254	10.0	0.3
MAYO ENERGY W.- 84-57	916.09	961212	1000	275	11.7	0.4
MAYO ENERGY W.- RILDA CAN.M.3	916.10	961212	1000	275	13.5	0.4
MAYO ENERGY W.- WILBERG FEXC29	916.11	961213	1000	275	0.33*	0.09
MAYO ENERGY W.- T-18 OLI SPRING	916.12	961213	1000	272	0.20*	0.09

* Average of duplicate runs

UNIVERSITY OF Miami

E. West

April 8, 1997

TRITIUM LABORATORY

Data Release #97-38
Job # 935

MAYO & ASSOCIATES
TRITIUM SAMPLES

Dr. H. Gote Ostlund
Head, Tritium Laboratory

Distribution:
Erick C. Petersen
Mayo & Associates
710 East 100 North
Lindon, UT 84042

Rosenstiel School of Marine and Atmospheric Science
Tritium Laboratory
4600 Rickenbacker Causeway
Miami, Florida 33149-1098
(305) 361-4100
Fax (305) 361-4112

Client: MAYO and ASSOCIATES - ENERGY WEST
Recvd : 97/03/06
Job# : 935
Final : 97/04/07

Purchase Order: 97-102
Contact: E. Petersen, K. Payne, 801/796-0211
710 East 100 North (F)/785-2387
Lindon, Utah 84042

Cust	LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
MAYO	-COTTONWD MINE MWSEALS	935.01	970226	1000	275	1.34	0.09
MAYO	-DEER CREEK 3 SO SEALS	935.02	970226	1000	250	0.88*	0.09

* Average of duplicate runs

Surface-Water and Groundwater Investigation Of the Mill Fork Lease Area, Emery County, Utah:

Probable Hydrologic Consequences of Coal Mining in the Mill Fork Lease

---

Energy West Mining Co., Huntington, Utah

October 24, 2001

Mayo and Associates
Consultants in Hydrogeology

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Energy West Mining Co., Huntington, Utah

October 24, 2001

Prepared by:

Alan L. Mayo, Ph.D., R.G., P.H.

Mayo and Associates, LC
710 East 100 North
Lindon, Utah 84042
(801) 785-2386

Mayo and Associates
Consultants in Hydrogeology

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1 INTRODUCTION

Energy West Mining Company, a subsidiary of PacifiCorp, has operated the Cottonwood, Wilberg, Deer Creek, Des-Bee-Dove, and Trail Mountain coal mines since 1979. The mines are located in the Wasatch Plateau coal field approximately 15 miles northwest of Huntington, Utah (Figure 1). Energy West Mining Company has recently acquired the Mill Fork Lease and is planning to expand the Deer Creek Mine to include the Mill Fork Lease. The Mill Fork Lease adds an estimated 63 million tons of recoverable coal reserves to Energy West's holdings.

The Mill Fork Lease is located between Energy West's Deer Creek Mine and Genwal's Crandall Canyon Mine. Energy West will access the Mill Fork Lease from underground workings in the Deer Creek Mine. No new surface facilities are proposed.

This report contains a hydrologic characterization of the Mill Fork Lease area and a description of the Probable Hydrologic Consequences of underground mining.

This report is divided into 11 sections including this introduction. These sections include:

Section 1	Introduction
Section 2	Project Overview
Section 3	Presentation of Chemical Data
Section 4	Description of the Mining Operations
Section 5	Location of the Mill Fork Lease

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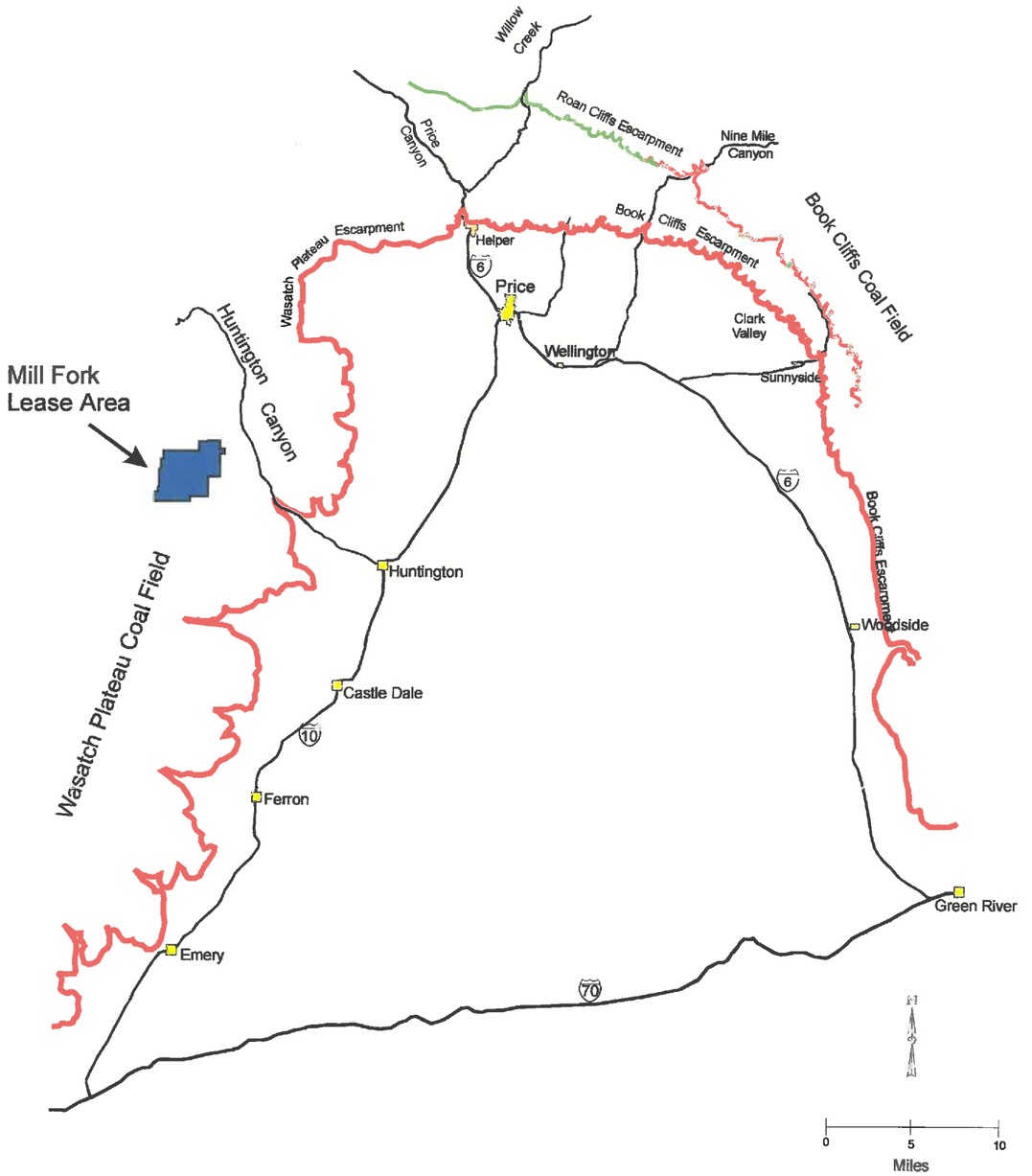

Figure 1 Location map of the Mill Fork Lease area.

Mayo & Associates, LC
Figure 1 Energy West Location Map.cdr
24 Oct 01

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Section 5 Climatic, Physiographic, and Geologic Setting

Section 6 Surface Water Hydrology

Section 7 Groundwater

Section 8 Solute and Isotope Chemistry

Section 9 Discussion

Section 10 Conclusions

Section 11 Probable Hydrologic Consequences

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2 PROJECT OVERVIEW

2.1 Purpose of investigation

The purpose of this investigation is to 1) characterize the groundwater and surface water systems in the Mill Fork Lease area, and 2) determine the probable hydrologic consequences of underground coal mining to surface waters and groundwaters within the Mill Fork Lease.

2.2 Methods of investigation

The hydrology and hydrogeology of the Mill Fork Lease area have been evaluated by analyzing: 1) solute and isotopic compositions of surface waters and groundwaters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information. Specific methods of investigation are described below.

2.2.1 Maps and reports

Existing published and unpublished hydrologic, hydrogeologic, and geologic reports and maps were obtained and reviewed. These documents include three public domain reports regarding Genwal Resources Crandall Canyon Mine and LBA 11 (Mayo and Associates, 1997a, b, c).

Energy West Mining Company provided a geologic map and cross-sections of the Mill Fork Lease area.

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2.2.2 Compilation of historic water quality, piezometric and stream flow data

Historic water quality, piezometric, and discharge data for springs, streams, and wells obtained from Energy West Mining Company and public documents were compiled into electronic format. Additional data were obtained from the North Emery Water Users Association (NEWUA) and the Castle Valley Special Services District.

Energy West Mining Company and its predecessors have monitored springs on East and Trail Mountains since 1979. Both baseline and periodic water quality data have been collected from springs, groundwater monitoring wells, streams, in-mine roof drips and wells, and mine-water discharge points (Mayo and Associates, 1997d). Solute and discharge data were collected at 14 stream sites, 96 springs, and 47 groundwater inflow sites within the mines. Solute and piezometric data are also available for 16 groundwater monitoring wells.

Stable and unstable isotopic compositions from 10 in-mine sites in the Crandall Canyon Mine are in the public domain (Mayo and Associates, 1997a, 1997c) and have been used in this investigation.

Historic spring and seep data, including field parameters and discharge measurements, were obtained for more than 150 locations in Upper Joes Valley, Mill Fork Canyon, Rilda Canyon, and East Mountain from the 1996 LBA 11 data adequacy report (Genwal Resources, 1996). These data include fall measurements for 1993-1995 and springtime measurements in 1996.

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2.2.3 Fall 2000 spring and seep survey and solute and isotopic data

In the Fall of 2000 and Spring 2001, Energy West Mining Company conducted a spring and seep survey of the Mill Fork Lease area. Springs and seeps were identified and described at 195 locations. As part of this survey samples were collected from selected springs for isotopic analysis. Isotopic samples for δ^2H, $\delta^{18}O$, and ^3H analyses were sealed, and preserved in appropriate glass or HDPE plastic bottles. Dissolved inorganic carbon for $\delta^{13}C$, and ^{14}C analysis were precipitated with $BaCl_2 \cdot 2H_2O$ for subsequent laboratory analysis.

Geochron Laboratories of Cambridge, Massachusetts performed isotopic analyses for $\delta^{13}C$ and ^{14}C using conventional counting methods. δ^2H and $\delta^{18}O$ were analyzed by the Brigham Young University Stable Isotope Laboratory. The University of Miami Tritium Laboratory, Miami, Florida performed ^3H analyses using electrolytic enrichment and low level counting methods. Solute analyses were performed by Commercial Testing and Engineering of Huntington, Utah.

2.2.4 Data analysis

Geochemical, isotopic, discharge, and other data were compiled into electronic format and were analyzed by graphical, statistical, and computer methods. Solute compositions were graphically analyzed using Stiff (1951) and Piper (1944) diagrams. Solute data were analyzed using the computer code WATEQF (Plummer

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and others, 1976). Groundwater ^{14}C residence times were calculated using methods described by Fontes (1980), Mooke (1980), and Pearson and Hanshaw (1970).

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3 PRESENTATION OF CHEMICAL DATA

3.1 Solute Compositions

Solute compositions and discharge rates of spring and stream waters collected by Energy West Mining company as part of the 2000-2001 spring and seep survey are included in Table 1. Table 1 also includes data for Indian Creek, Mill Fork Creek, and Rilda Canyon Creek that were obtained electronically from the Utah Divison of Oil Gas and Mining (http://dogm.nr.state.ut.us). Solute compositions of springs, creeks, wells, and in-mine groundwaters from Energy West's Cottonwood, Wilberg, Deer Creek, and Trail Mountain mines are not included in Table 1. These data are available in Mayo and Associates (1997d). Solute compositions in Table 1 are listed in both milligrams per liter (mg/l) and milliequivalents per liter (meq/l) units.

Mean solute compositions and discharge rates of springs and in-mine samples collected from the Mill Fork Lease (i.e. 2000-2001 spring and seep survey), Energy West mines in Trail and East Mountains, and public domain in-mine Crandall Canyon Mine data are included in Table 2. Solute compositions in Table 2 are listed in both mg/l and meq/l units.

Calculated mineral saturation indices (SI) of spring and stream waters in the Mill Fork Lease area and in-mine samples from Energy West mines in Trail and East Mountains are included in Table 3. Solute contents of wells in the Spring Canyon Member of the Star Point Sandstone are included in Table 4.

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Table 1 Solute compositions of springs and streams in the Mill Fork Lease area.

(Table 1chem.xls10/24/01)

	date	Data Source	Discharge (gpm)	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
							mg/L							
SPRINGS														
Joes Valley alluvium														
JV-9	8/16/00	1	1.5	5.9	7.3	585	377	80	34	7	1	384	49	4
JV-16	8/16/00	1	0.4	8.7	7.9	546	361	73	31	7	1	360	47	4
JV-22	10/25/00	1	4.1	6.2	7.3	630	338	83	28	9	<1	364	44	3
JV-34	10/25/00	1	3.6	7.5	8.2	564	300	77	24	8	1	349	24	3
mean			2.4	7.1	7.7	581	344	78.3	29.3	7.8	1.0	364.3	41.0	3.5
std			1.8	1.3	0.4	36	33	4.3	4.3	1.0	0.0	14.6	11.5	0.6
North Horn Formation														
EM Pond	10/11/00	1	0.8	5.6	8.0	467	258	59	23	2	<1	295	7	1
MF-13	10/9/00	1	1.2	2.5	8.0	431	254	57	19	2	<1	249	26	1
MF-10	10/9/00	1	6.8	2.4	8.3	396	225	50	20	2	<1	256	8	<1
MF-16	10/26/00	1	4.8	3.2	8.0	475	259	57	24	6	<1	284	17	<1
MF-18B	10/9/00	1	4.3	3.7	8.1	389	228	52	17	2	<1	250	7	<1
MF-18C	10/26/00	1	1.7	3.2	8.1	497	267	57	26	9	1	300	17	<1
MF-217	10/13/00	1	1.1	2.9	7.9	373	207	53	14	2	<1	235	8	1
MF-221	10/26/00	1	5.0	2.6	7.7	540	275	61	31	4	1	309	33	2
RR-6	10/24/00	1	4.9	5.2	7.8	439	270	57	19	4	<1	268	15	1
RR-7A	10/12/00	1	1.3	3.1	8.0	418	242	60	16	2	<1	268	7	<1
RR-12	10/17/00	1	9.5	5.0	8.0	473	244	65	20	4	<1	293	17	2
RR-15	10/17/00	1	8.0	3.7	7.9	426	247	55	21	3	<1	276	6	<1
RR-22	10/17/00	1	1.6	3.8	8.1	418	246	55	21	2	<1	273	4	1
RR-23A	10/17/00	1	10.0	4.8	7.6	474	275	65	20	3	<1	296	12	<1
RR-26	10/17/00	1	9.0	3.0	8.2	463	271	58	24	3	<1	291	19	1
RR-32	10/24/00	1	0.7	2.8	8.0	487	300	60	24	4	2	302	12	4
SP1-26	10/9/01	1	4.4	4.1	7.6	400	212	56	15	2	<1	247	6	1
UJV-105	10/2/00	1	1.3	7.9	8.2	471	280	54	26	5	1	275	37	3

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	date	Data Source	Discharge (gpm)	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
							mg/L							
UJV-100	10/5/00	1	2.4	3.8	8.3	468	240	56	23	10	<1	297	17	2
mean			4.1	3.9	8.0	448	253	57.2	21.2	3.7	<1	277.1	14.5	1.7
std			3.2	1.4	0.2	43	24	3.9	4.2	2.4	0.5	21.8	9.3	1.0
Price River Formation														
EM-214	10/11/00	1	2.1	5.1	7.8	539	304	70	24	5	1	324	16	4
MF-4A	10/13/00	1	0.5	2.9	7.9	460	262	59	20	7	1	277	26	2
SP2-42	10/09/00	1	3.2	3.5	7.7	441	216	60	19	2	<1	263	20	<1
UJV 206	09/28/00	1	2.1	5.1	7.8	513	276	64	22	7	1	294	33	5
UJV 207	09/28/00	1	0.7	7.0	7.2	558	308	77	21	6	1	337	12	4
UJV 209	09/28/00	1	2.4	5.8	7.3	546	285	76	21	5	1	345	13	4
UJV 209A	09/28/00	1	0.6	5.7	7.3	529	283	75	21	4	<1	330	13	3
UJV109B	09/28/00	1	0.4	6.0	7.7	570	327	63	29	10	1	330	41	6
UJV109South	10/02/00	1	1.3	5.2	7.7	591	343	66	30	11	1	329	56	5
UJV-151	10/02/00	1	0.9	7.2	7.7	548	333	60	26	14	2	321	33	5
mean			0.8	6.0	7.6	560	322	66.0	26.5	9.8	1.1	327.5	35.8	4.2
std			1.0	1.4	0.2	47	38	7.0	3.8	3.6	0.4	27.4	14.5	1.2
Castlegate Sandstone														
UJV 101	10/2/01	1	0.8	8.0	7.6	527	329	67	22	6	1	295	38	6
UJV 208	8/15/00	1	2.7	5.9	7.7	543	298	70	25	4	1	342	15	3
UJV 211	8/15/00	1	0.3	10.4	7.4	527	298	70	23	4	1	330	13	3
UJV 212	8/15/00	1	1.0	7.1	7.5	597	331	73	30	6	2	367	20	4
mean			1.3	7.8	7.6	556	309	71.0	26.0	4.7	1.3	346.3	16.0	3.3
std			1.3	2.3	0.1	37	19	1.7	3.6	1.2	0.6	18.9	3.6	0.6

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	date	Data Source	Discharge (gpm)	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
							mg/L							
Blackhawk Formation														
MF-2	5/9/01	1	6	7.9	7.9	616	264	57	25	3	<1	272	26	2
MF 7	5/9/01	1	30	4.4	7.83	681	298	65	26	4	<1	301	39	2
	8/23/00	1	14	4.3	7.45	562	323	67	29	6	1	326	46	2
MF-8A	5/9/01	1	10	4.8	7.7	680	299	62	25	4	<1	312	32	2
MF 213	8/23/00	1	18	6.9	7.2	527	300	61	29	6	1	323	25	2
	5/9/01	1	26	6.1	8.1	685	299	62	29	5	<1	322	29	2
mean			17	5.7	7.7	625	297	62.3	27.2	4.7	1.0	309.3	32.8	2.0
std			9	1.5	0.3	68	19	3.4	2.0	1.2	0.0	20.5	8.2	0.0
CREEKS														
Joes Valley Creeks														
Indian Creek Below	10/25/00	1	300	5.2	8.2	468	266	65	20	3	1	301	9	2
Indian Creek Above	10/25/00	1	218	6.4	8.1	487	274	69	20	3	<1	313	10	2
Indian Creek Canal	10/25/00	1	50	10.0	8.0	689	459	92	32	10	1	321	125	5
Indian Creek[1]	9/13/00	2		13.8	8.0	390	238	60	20	3	<1.	291	7	2
	6/21/00	2	1243	8	8.5	466	281	70	19	2	<1.	318	5	1
	10/24/96	2	7069	3	8.4	724	262	67	22	3	1	334	6	5
	6/26/96	2			8.3	477	290	67	19	3	<1.	302	5	2
mean			1776	7.7	8.2	529	296	70.0	21.7	3.9	1.0	311.4	48.0	2.7
std			2995	3.8	0.2	126	109	10.2	4.6	2.7	0.0	14.5	44.6	1.6
Mill Fork Creek														
Upper Mill Fork AB Permit[1]	5/14/96	2	63.6	10	7.5	276	370	60	23	5	0.8	279	20	1.87
	5/17/87	2	51	6	8.0	790	480	56	67	18	3.0	328	152	24
	3/19/86	2	18.5	1	8.1	560	488	65	73	16	3.0	272	159	22
	1/15/86	2	0.5	1	8.0	540	224	59	19	1	1.0	192	12	4
MFA1[1]	9/14/98	2	150	6	7.9	413	262	54	26	5	<1.	285	26	3
	6/8/98	2	900	4	7.4	401	264	61	21	5	1	301	19	2
		2	400	8	8.5	398	270	52	19	5	<1.	264	20	4
mean			226	5	8	483	337	58.1	35.4	7.8	1.8	274.4	58.3	8.7
std			327	3	0	166	110	4.4	23.8	6.5	1.1	42.1	66.6	9.8

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	date	Data Source	Discharge (gpm)	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}
							mg/L							
Rilda Canyon														
Right Fork Flume 1[1]	12/3/98	2	50	0	7.9	444	281	62	24	10	2	256	20	3
	9/14/98	2	152	9	8.0	400	254	55	22	7	<1.	247	23	3
	6/8/98	2	2347	4	8.1	424	292	62	21	5	1	237	17	3
	9/15/97	2	200	11	8.6	412	290	56	20	7	1	275	25	4
	6/25/97	2	1200	6	8.0	392	250	52	18	5	<1.	266	18	3
	9/16/96	2	30	7	9.0	408	272	48	23	9	<1.	245	1	11
	6/11/96	2	1712	13	8.7	376	245	54	18	5	<1.	240	<1.	4
mean			813	7	8	408	269	55.6	20.9	6.9	1.3	252.3	17.3	4.4
std			942	4	0	22	20	5.1	2.3	2.0	0.6	14.0	8.5	2.9
Crandall Creek														
UPF-1[1]	12/9/00	2	350	0	8.3	590	333	66	36	4	1	324	73	2
	9/14/00	2	321	9	8.1	557	325	60	34	5	2	281	76	3
	6/20/00	2	949	9	8.3	479	304	59	27	3	<1.	270	45	2
	6/26/96	2			8.4	428	266	52	21	4	<1.	240	24	4
	3/26/96	2	150	1	8.0	580	322	61	29	4	1.3	314	38	5
	9/6/94	2	50	5	7.6	613	266	41	28	6	2.7	241	28	2
	7/15/94	2		13	7.6	430	238	44	26	4	1.1	227	38	2
mean			364	6	8.0	525	293	54.7	28.7	4.3	1.6	271.0	46.0	2.9
std			350	5	0.3	78	37	9.3	5.0	0.9	0.7	37.8	20.7	1.2

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	date	Data Source	(gpm)	°C	pH	Cond us/cm	mg/L TDS	meq/L Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}
SPRINGS														
Joes Valley alluvium														
JV-9	8/16/00	1	1.5	5.9	7.3	585	377	3.99	2.80	0.30	0.03	6.29	1.02	0.11
JV-16	8/16/00	1	0.4	8.7	7.9	546	361	3.64	2.55	0.30	0.03	5.90	0.98	0.11
JV-22	10/25/00	1	4.1	6.2	7.3	630	338	4.14	2.30	0.39	<.03	5.97	0.92	0.08
JV-34	10/25/00	1	3.6	7.5	8.2	564	300	3.84	1.97	0.35	0.03	5.72	0.50	0.08
mean			2.4	7.1	7.7	581	344	3.90	2.41	0.34	0.03	5.97	0.85	0.10
std			1.8	1.3	0.4	36	33	0.21	0.35	0.04	0.00	0.24	0.24	0.02
North Horn Formation														
EM Pond	10/11/00	1	0.8	5.6	8.0	467	258	2.94	1.89	0.09	<0.03	4.84	0.15	0.03
MF-13	10/9/00	1	1.2	2.5	8.0	431	254	2.84	1.56	0.09	<0.03	4.08	0.54	0.03
MF-10	10/9/00	1	6.8	2.4	8.3	396	225	2.50	1.65	0.09	<0.03	4.20	0.17	<0.01
MF-16	10/26/00	1	4.8	3.2	8.0	475	259	2.84	1.97	0.26	<0.03	4.65	0.35	<0.01
MF-18B	10/9/00	1	4.3	3.7	8.1	389	228	2.59	1.40	0.09	<0.03	4.10	0.15	<0.01
MF-18C	10/26/00	1	1.7	3.2	8.1	497	267	2.84	2.14	0.39	0.03	4.92	0.35	<0.01
MF-217	10/13/00	1	1.1	2.9	7.9	373	207	2.64	1.15	0.09	<0.03	3.85	0.17	0.03
MF-221	10/26/00	1	5.0	2.6	7.7	540	275	3.04	2.55	0.17	0.03	5.06	0.69	0.06
RR-6	10/24/00	1	4.9	5.2	7.8	439	270	2.84	1.56	0.17	<0.03	4.39	0.31	0.03
RR-7A	10/12/00	1	1.3	3.1	8.0	418	242	2.99	1.32	0.09	<0.03	4.39	0.15	<0.01
RR-12	10/17/00	1	9.5	5.0	8.0	473	244	3.24	1.65	0.17	<0.03	4.80	0.35	0.06
RR-15	10/17/00	1	8.0	3.7	7.9	426	247	2.74	1.73	0.13	<0.03	4.52	0.12	<0.01
RR-22	10/17/00	1	1.6	3.8	8.1	418	246	2.74	1.73	0.09	<0.03	4.47	0.08	0.03
RR-23A	10/17/00	1	10.0	4.8	7.6	474	275	3.24	1.65	0.13	<0.03	4.85	0.25	<0.01
RR-26	10/17/00	1	9.0	3.0	8.2	463	271	2.89	1.97	0.13	<0.03	4.77	0.40	0.03
RR-32	10/24/00	1	0.7	2.8	8.0	487	300	2.99	1.97	0.17	0.05	4.95	0.25	0.11
SP1-26	10/9/01	1	4.4	4.1	7.6	400	212	2.79	1.23	0.09	<0.03	4.05	0.12	0.03
UJV-105	10/2/00	1	1.3	7.9	8.2	471	280	2.69	2.14	0.22	0.03	4.51	0.77	0.08
UJV-100	10/5/00	1	2.4	3.8	8.3	468	240	2.79	1.89	0.44	<0.03	4.87	0.35	0.04
mean			4.1	3.9	8.0	448	253	2.85	1.75	0.16	0.03	4.54	0.30	0.05
std			3.2	1.4	0.2	43	24	0.20	0.35	0.10	0.01	0.36	0.19	0.03

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	date	Data Source	(gpm)	°C	pH	Cond us/cm	mg/L TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
								meq/L						
Price River Formation														
EM-214	10/11/00	1	2.1	5.1	7.8	539	304	3.49	1.97	0.22	0.03	5.31	0.33	0.11
MF-4A	10/13/00	1	0.5	2.9	7.9	460	262	2.94	1.65	0.30	0.03	4.54	0.54	0.06
SP2-42	10/09/00	1	3.2	3.5	7.7	441	216	2.99	1.56	0.09	<0.03	4.31	0.42	<0.04
UJV 206	09/28/00	1	2.1	5.1	7.8	513	276	3.19	1.81	0.30	0.03	4.82	0.69	0.14
UJV 207	09/28/00	1	0.7	7.0	7.2	558	308	3.84	1.73	0.26	0.03	5.52	0.25	0.11
UJV 209	09/28/00	1	2.4	5.8	7.3	546	285	3.79	1.73	0.22	0.03	5.65	0.27	0.11
UJV 209A	09/28/00	1	0.6	5.7	7.3	529	283	3.74	1.73	0.17	<0.03	5.41	0.27	0.08
UJV109B	09/28/00	1	0.4	6.0	7.7	570	327	3.14	2.39	0.44	0.03	5.41	0.85	0.17
UJV109South	10/02/00	1	1.3	5.2	7.7	591	343	3.29	2.47	0.48	0.03	5.39	1.17	0.14
UJV-151	10/02/00	1	0.9	7.2	7.7	548	333	2.99	2.14	0.61	0.05	5.26	0.69	0.14
mean			1.4	5.4	7.6	530	294	3.34	1.92	0.31	0.03	5.16	0.55	0.12
std			1.0	1.4	0.2	47	38	0.35	0.32	0.16	0.01	0.45	0.30	0.03
Castlegate Sandstone														
UJV 101	10/2/01	1	0.8	8.0	7.6	527	329	3.34	1.81	0.26	0.03	4.84	0.79	0.17
UJV 208	8/15/00	1	2.7	5.9	7.7	543	298	3.49	2.06	0.17	0.03	5.61	0.31	0.08
UJV 211	8/15/00	1	0.3	10.4	7.4	527	298	3.49	1.89	0.17	0.03	5.41	0.27	0.08
UJV 212	8/15/00	1	1.0	7.1	7.5	597	331	3.64	2.47	0.26	0.05	6.02	0.42	0.11
mean			1.2	7.9	7.6	549	314	3.49	2.06	0.22	0.03	5.47	0.45	0.11
std			1.1	1.9	0.1	33	18	0.12	0.29	0.05	0.01	0.49	0.24	0.04
Blackhawk Formation														
MF-2	5/9/01	1	6.4	7.9	7.9	616	264	2.84	2.06	0.13	<0.03	4.46	0.54	0.06
MF 7	5/9/01	1	30	4.4	7.83	681	298	3.24	2.14	0.17	0.10	4.93	0.81	0.06
	8/23/00	1	14.1	4.3	7.45	562	323	3.34	2.39	0.26	0.15	5.34	0.96	0.06
MF-8A	5/9/01	1	9.5	4.8	7.7	680	299	3.09	2.06	0.17	<0.03	5.11	0.67	0.06
MF 213	8/23/00	1	17.6	6.9	7.2	527	300	3.04	2.39	0.26	0.03	5.29	0.52	0.06
	5/9/01	1	26.1	6.1	8.1	685	299	3.09	2.39	0.22	<0.03	5.28	0.60	0.06
mean			17.3	5.7	7.7	625	297	3.11	2.24	0.20	0.09	5.07	0.68	0.06
std			9.3	1.5	0.3	68	19	0.17	0.17	0.05	0.00	0.34	0.17	0.00

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	date	Data Source	(gpm)	°C	pH	Cond us/cm	mg/L TDS	meq/L Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
CREEKS														
Joes Valley Creeks														
Indian Creek Below	10/25/00	1	299.5	5.2	8.2	468	266	3.24	1.65	0.13	0.03	4.93	0.19	0.06
Indian Creek Above	10/25/00	1	218.4	6.4	8.1	487	274	3.44	1.65	0.13	<0.03	5.13	0.21	0.06
Indian Creek Canal	10/25/00	1	50.1	10.0	8.0	689	459	4.59	2.63	0.44	0.03	5.26	2.60	0.14
Indian Creek[1]	9/13/00	2		13.8	8.0	390	238	2.99	1.65	0.13	<0.03	4.77	0.15	0.06
	6/21/00	2	1243	8	8.5	466	281	3.49	1.56	0.09	<0.03	5.21	0.10	0.03
	10/24/96	2	7069	3	8.4	724	262	3.34	1.81	0.13	0.03	5.47	0.12	0.14
	6/26/96	2			8.3	477	290	3.34	1.56	0.13	<0.03	4.95	0.10	0.06
mean			1775.9	7.7	8.2	529	296	3.49	1.79	0.17	0.03	5.10	0.50	0.08
std			2995.0	3.8	0.2	126	74	0.51	0.38	0.12	0.00	0.24	0.93	0.05
Mill Fork Creek														
Upper Mill Fork AB Permit[1]	5/14/96	2	63.6	10	7.5	276	370	2.98	1.87	0.21	0.02	4.57	0.42	0.05
	5/17/87	2	51	6	8.0	790	480	2.79	5.51	0.78	0.08	5.38	3.16	0.68
	3/19/86	2	18.5	1	8.1	560	488	3.24	6.01	0.70	0.08	4.46	3.31	0.62
	1/15/86	2	0.5	1	8.0	540	224	2.94	1.56	0.04	0.03	3.15	0.25	0.11
MFA1[1]	9/14/98	2	150	6	7.9	413	262	2.69	2.14	0.22	<0.03	4.67	0.54	0.08
	6/8/98	2	900	4	7.4	401	264	3.04	1.73	0.22	0.03	4.93	0.40	0.06
	6/26/97	2	400	8	8.5	398	270	2.59	1.56	0.22	<0.03	4.33	0.42	0.11
mean			226	5	8	483	337	2.90	2.91	0.34	0.04	4.50	1.21	0.25
std			327	3	0	166	110	0.22	1.96	0.28	0.03	0.69	1.39	0.28
Rilda Canyon														
Right Fork Flume 1[1]	12/3/98	2	50	0	7.9	444	281	3.09	1.97	0.44	0.05	4.20	0.42	0.08
	9/14/98	2	152	9	8.0	400	254	2.74	1.81	0.30	<0.03	4.05	0.48	0.08
	6/8/98	2	2347	4	8.1	424	292	3.09	1.73	0.22	0.03	3.88	0.35	0.08
	9/15/97	2	200	11	8.6	412	290	2.79	1.65	0.30	0.03	4.51	0.52	0.11
	6/25/97	2	1200	6	8.0	392	250	2.59	1.48	0.22	<0.03	4.36	0.37	0.08
	9/16/96	2	30	7	9.0	408	272	2.40	1.89	0.39	<0.03	4.02	0.02	0.31
	6/11/96	2	1712	13	8.7	376	245	2.69	1.48	0.22	<0.03	3.93	<0.02	0.11
mean			813	7	8.3	408	269	2.77	1.72	0.30	0.03	4.13	0.36	0.12
std			942	4	0.4	22	20	0.25	0.19	0.09	0.01	0.23	0.18	0.08

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	date		(gpm)	°C	pH	Cond us/cm	mg/L TDS	meq/L Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
Crandall Creek														
UPF-1[1]	12/9/00	2	350	0	8.3	590	333	3.29	2.96	0.17	0.03	5.31	1.52	0.06
	9/14/00	2	321	9	8.1	557	325	2.99	2.80	0.22	0.05	4.61	1.58	0.08
	6/20/00	2	949	9	8.3	479	304	2.94	2.22	0.13	<0.03	4.43	0.94	0.06
	6/26/96	2			8.4	428	266	2.59	1.73	0.17	<0.03	3.93	0.50	0.11
	3/26/96	2	150	1	8.0	580	322	3.04	2.39	0.17	0.03	5.15	0.79	0.14
	9/6/94	2	50	5	7.6	613	266	2.05	2.30	0.25	0.07	3.95	0.58	0.06
	7/15/94	2		13	7.6	430	238	2.20	2.14	0.18	0.03	3.72	0.79	0.06
mean			364	6	8.0	525	293	2.73	2.36	0.19	0.04	4.44	0.96	0.08
std			350	5	0.3	78	37	0.47	0.41	0.04	0.02	0.62	0.43	0.03

Data Source

1 Energy West Mining Company (2001)
2 http://dogm.nr.state.ut.us

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Table 2 Mean solute contents of springs and streams in the vicinity of Mill Fork Lease area.

(Table 2 chem.xls 10/24/01)

	n	Q (gpm)	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
						mg/L							
SPRINGS													
Joes Valley alluvium													
Mill Fork Track	4	2.4	7.1	7.7	581	344	78.3	29.3	7.8	1.0	364	41.0	3.5
North Horn Formation													
Mill Fork Track	19	4.1	3.9	8.0	448	253	57.2	21.2	3.7	<1	277	14.5	1.7
Trail & East Mtn mean	69		7.9	7.7		345	80.1	29.7	19.8	2.1	357	58.3	12.4
low sulfate	44		7.9	7.7		316	65.4	29.2	17.2	1.5	348	19.3	12.6
high sulfate	25		7.9	7.7		397	105.9	30.5	24.4	3.2	373	127.0	12.0
Price River Formation													
Mill Fork Track	10	0.8	6.0	7.6	560	322	66.0	26.5	9.8	1.1		35.8	4.2
Trail & East Mtn	13		8.4	7.7		425	87.6	34.6	22.7	1.6	408	60.0	10.9
Castlegate Sandstone													
Mill Fork Track	4	1.3	7.8	7.6	556	309	71.0	26.0	4.7	1.3	346	16.0	3.3
Trail & East Mtn	7		8.8	7.9		358	78.3	34.2	10.7	1.3	356	45.1	11.2
Blackhawk Formation													
Mill Fork Track	6	17.3	5.7	7.7	625	297	62.3	27.2	4.7	1.0	309	32.8	2.0
Trail & East Mtn	2		7.2	7.8		548	89.5	52.3	35.7	5.2	436	175.5	12.5
IN-MINE													
Trail & East Mtn roof drips	45		12.2	7.3		636	125.4	52.3	33.5	4.6	414	235.9	14.3
Wells in Spring Canyon Member of Star Point Sandstone													
Trail & East Mtn	3		10.2	8.16	1481	888	31.3	22.8	296.3	5.7	523	104.6	147.9
Crandal Canyon Mine	4		13.0	7.81	580		50.7	31.5	31.5	6.7	327	39.5	10.5
Wells that intercept the Mancos Shale													
Mill Fork Track	2		10.2	8.49		1141	27.8	19.5	414.8	5.7	629	118.3	213.8
Joes Valley Fault system													
Crandal Canyon Mine	3		10.8	7.88	513		60.3	30.7	4.0	3.7	323	44.0	7.0

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	n	Q (gpm)	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
						mg/L							
CREEKS													
Joes Valley: Indian Creek	7	1776	7.7	8.2	529	296	70	22	3.9	1.0	311	48	2.7
Mill Fork Creek	7	226	5.1	7.9	483	337	58	35	8	1.8	274	58	8.7
Rilda Canyon	7	813	6.9	8.3	408	269	56	21	7	1.3	252	17	4.4
Crandall Creek	7	938	7	8.1	473	301	61	26	6	1	279	41	5

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	n	Q (gpm)	T °C	pH	Cond us/cm	mg/L TDS	meq/L Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
SPRINGS													
Joes Valley alluvium													
Mill Fork Track	4	2.4	7.1	7.7	581	344	3.90	2.41	0.34	0.03	5.97	0.85	0.10
North Horn Formation													
Mill Fork Track	19	4.1	3.9	8.0	448	253	2.85	1.75	0.16	<0.03	4.54	0.30	0.05
Trail & East Mtn mean	69		7.9	7.7		309	3.99	2.44	0.86	0.05	5.85	1.21	0.35
low sulfate	44		7.9	7.7		474	3.26	2.40	0.75	0.04	5.70	0.40	0.36
high sulfate	25		7.9	7.7		313	5.28	2.51	1.06	0.08	6.11	2.64	0.34
Price River Formation													
Mill Fork Track	10	1.4	5.4	7.6	530	294	3.34	1.92	0.31	0.03	5.16	0.55	0.12
Trail & East Mtn	13		8.4	7.7		425	4.37	2.84	0.99	0.04	6.68	1.25	0.31
Castlegate Sandstone													
Mill Fork Track	4	1.2	7.9	7.6	549	314	3.49	2.06	0.22	0.03	5.47	0.45	0.11
Trail & East Mtn	7		8.8	7.9		358	3.91	2.81	0.47	0.03	5.83	0.94	0.32
Blackhawk Formation													
Mill Fork Track	6	17.3	5.7	7.7	625	297	3.11	2.24	0.20	0.09	5.07	0.68	0.06
Trail & East Mtn	2		7.2	7.8		548	4.47	4.30	1.55	0.13	7.15	3.65	0.35
IN-MINE													
Trail & East Mtn roof drips	45		12.2	7.3		636	5.50	3.74	1.50	0.12	6.48	3.61	0.38
Wells in Spring Canyon Member of Star Point Sandstone													
Trail & East Mtn	3		10.2	8.16	1481	888	1.56	1.88	12.89	0.15	8.58	2.15	4.14
Crandal Canyon Mine	4		13.0	7.81	580		2.53	2.59	1.37	0.17	5.36	0.82	0.90
Wells that intercept the Mancos Shale													
Trail & East Mtn	2		10.2	8.49		1141	1.39	1.61	18.04	0.15	10.31	2.46	6.03
Joes Valley Fault system													
Crandal Canyon Mine	3		10.8	7.88	513		3.01	2.53	0.17	0.09	5.29	0.92	0.20

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	n	Q (gpm)	T °C	pH	Cond us/cm	mg/L TDS	meq/L Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
CREEKS													
Joes Valley													
Indian Creek	7	1776	7.7	8.2	529	296	3.49	1.79	0.17	0.03	5.10	1.00	0.08
Mill Fork Creek	7	226	5.1	7.9	483	337	2.90	2.91	0.34	0.04	4.50	1.21	0.25
Rilda Canyon	7	813	6.9	8.3	408	269	2.77	1.72	0.30	0.03	4.13	0.36	0.12
Crandall Creek	7	364	6.2	8.03	525	293	2.73	2.36	0.19	0.04	4.44	0.96	0.08

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Table 3 Calcualted mineral saturation of springs, in-mine and stream waters in the Mill Fork Tract area.

(Table 3 chem.xls 10/23/01)

SPRINGS	Data date	Data Source	(Saturation: log SI = 0.00 +/- 0.1) $SI_{calcite}$	$SI_{dolomite}$	SI_{gypsum}	Log P_{CO2}
Joes Valley alluvium						
JV-9	8/16/00	1	0.00	-0.33	-1.82	-1.84
JV-16	8/16/00	1	0.58	0.88	-1.88	-2.46
JV-22	10/25/00	1	0.00	-0.41	-1.84	-1.86
JV-34	10/25/00	1	0.87	1.31	-2.13	-2.78
mean			0.36	0.36	-1.92	-2.24
std			0.43	0.87	0.14	0.46
North Horn Formation						
EM Pond	10/11/00	1	0.49	0.60	-2.72	-2.65
MF-13	10/9/00	1	0.35	0.20	-2.14	-2.74
MF-10	10/9/00	1	0.61	0.78	-2.70	-3.03
MF-16	10/26/00	1	0.41	0.44	-2.34	-2.68
MF-18B	10/9/00	1	0.44	0.40	-2.74	-2.83
MF-18C	10/26/00	1	0.53	0.70	-2.35	-2.76
MF-217	10/13/00	1	0.22	-0.16	-2.66	-2.66
MF-221	10/26/00	1	0.16	-0.01	-2.05	-2.35
RR-6	10/24/00	1	0.23	0.02	-2.39	-2.49
RR-7A	10/12/00	1	0.42	0.25	-2.68	-2.70
RR-12	10/17/00	1	0.51	0.53	-2.30	-2.66
RR-15	10/17/00	1	0.31	0.19	-2.79	-2.59
RR-22	10/17/00	1	0.50	0.58	-2.97	-2.80
RR-23A	10/17/00	1	0.12	-0.25	-2.44	-2.25
RR-26	10/17/00	1	0.62	0.84	-2.29	-2.88
RR-32	10/24/00	1	0.45	0.49	-2.47	-2.66
SP1-26	10/9/01	1	-0.01	-0.60	-2.77	-2.33

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SPRINGS	date	Data Source	(Saturation: log SI = 0.00 +/- 0.1) $SI_{calcite}$	$SI_{dolomite}$	SI_{gypsum}	Log P_{CO2}
UJV-105	10/2/00	1	0.63	1.04	-2.06	-2.88
UJV-100	10/5/00	1	0.72	1.06	-2.36	-2.97
mean			0.41	0.37	-2.49	-2.68
std			0.19	0.44	0.27	0.21
Price River Formation						
EM-214	10/11/00	1	0.38	0.33	-2.31	-2.42
MF-4A	10/13/00	1	0.31	0.14	-2.14	-2.59
SP2-42	10/09/00	1	0.12	-0.27	-2.24	-2.41
UJV 206	09/28/00	1	0.30	0.17	-2.03	-2.46
UJV 207	09/28/00	1	-0.13	-0.75	-2.41	-1.79
UJV 209	09/28/00	1	-0.04	-0.60	-2.37	-1.88
UJV 209A	09/28/00	1	-0.06	-0.65	-2.37	-1.90
UJV109B	09/28/00	1	0.25	0.20	-1.97	-2.30
UJV109South	10/02/00	1	0.25	0.18	-1.82	-2.31
UJV-151	10/02/00	1	0.24	0.19	-2.07	-2.31
mean			0.16	-0.11	-2.17	-2.24
std			0.18	0.42	0.20	0.28
Castlegate Sandstone						
UJV 101	10/2/01	1	0.17	-0.06	-1.97	-2.24
UJV 208	8/15/00	1	0.32	0.23	-2.35	-2.29
UJV 211	8/15/00	1	0.08	-0.20	-2.42	-1.98
UJV 212	8/15/00	1	0.18	0.03	-2.23	-2.05
mean			0.19	0.02	-2.33	-2.11
std			0.12	0.21	0.10	0.16
Blackhawk Formation						
MF-2	5/9/01	1	0.37	0.46	-2.18	-2.58
MF 7	5/9/01	1	0.33	0.28	-1.96	-2.48
	8/23/00	1	-0.01	-0.37	-1.88	-2.07

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SPRINGS	date	Data Source	$SI_{calcite}$	$SI_{dolomite}$	SI_{gypsum}	Log P_{CO2}
			(Saturation: log SI = 0.00 +/- 0.1)			
MF-8A	5/9/01	1	0.21	0.04	-2.06	-2.33
MF 213	8/23/00	1	-0.25	-0.76	-2.19	-1.81
	5/9/01	1	0.63	0.98	-2.12	-2.72
mean			0.21	0.11	-2.06	-2.33
std			0.31	0.62	0.12	0.34
CREEKS						
Joes Valley Creeks						
Indian Creek Below	10/25/00	1	0.72	0.96	-2.58	-2.85
Indian Creek Above	10/25/00	1	0.68	0.88	-2.52	-2.73
Indian Creek Canal	10/25/00	1	0.71	1.09	-1.41	-2.61
Indian Creek[1]	9/13/00	2	0.61	0.94	-2.74	-2.62
	6/21/00	2	1.10	1.72	-2.82	-3.13
	10/24/96	2	0.93	1.36	-2.74	-3.02
	6/26/96	2	0.85	1.19	-2.82	-2.95
mean			0.80	1.16	-2.52	-2.84
std			0.17	0.30	0.50	0.20
Mill Fork Creek						
Upper Mill Fork AB Permit[1]	5/14/96	2	0.04	-0.21	-2.28	-2.15
	5/17/87	2	0.42	0.98	-1.54	-2.62
	3/19/86	2	0.42	0.84	-1.44	-2.83
	1/15/86	2	0.24	-0.08	-2.44	-2.86
MFA1[1]	9/14/98	2	0.33	0.40	-2.20	-2.57
	6/8/98	2	-0.11	-0.69	-2.27	-2.05
	6/26/97	2	0.90	1.46	-2.32	-3.20
mean			0.32	0.38	-2.07	-2.61
std			0.32	0.76	0.40	0.41

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SPRINGS	date	Data Source	(Saturation: log SI = 0.00 +/- 0.1) $SI_{calcite}$	$SI_{dolomite}$	SI_{gypsum}	Log P_{CO2}
Rilda Canyon						
Right Fork Flume 1[1]	12/3/98	2	0.25	0.00	-2.22	-2.64
	9/14/98	2	0.43	0.57	-2.24	-2.72
	6/8/98	2	0.49	0.51	-2.30	-2.86
	9/15/97	2	1.08	1.86	-2.22	-3.28
	6/25/97	2	0.40	0.39	-2.35	-2.69
	9/16/96	2	1.27	2.29	-3.66	-3.78
	6/11/96	2	1.14	1.99	***	-3.44
mean			0.72	1.09	-2.50	-3.06
std			0.42	0.92	0.57	0.44
Crandall Creek						
UPF-1[1]	12/9/00	2	0.73	1.12	-1.69	-2.95
	9/14/00	2	0.58	1.03	-1.75	-2.77
	6/20/00	2	0.77	1.31	-1.95	-2.99
	6/26/96	2	0.74	1.13	-2.23	-3.15
	3/26/96	2	0.43	0.48	-1.98	-2.65
	9/6/94	2	-0.16	-0.46	-2.26	-2.34
	7/15/94	2	-0.04	-0.12	-2.13	-2.33
mean			0.44	0.64	-2.00	-2.74
std			0.38	0.69	0.22	0.32

Data Source

[1] Energy West Mining Company (2001)

[2] http://www.dogm.nr.state.ut.us

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Table 4 Solute contents of wells in the Spring Canyon Member of the Star Point Sandstone

(Table 4 Chem.xls 10/23/01)

	n	T °C	pH	Cond us/cm	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-
					mg/L							
Trail & East Mtn[1]												
TM-1	31	7.4	8.05	1607	953	50.1	33.9	278.9	4.7	548	114.7	221.3
TM-1B	6	12.95	8.94	2287	1328	5.5	5.1	550.6	6.6	710	125.4	209.6
TM-2	7		7.50	550	381	38.3	29.4	59.3	5.9	312	73.6	12.8
mean		10.2	8.16	1481	888	31.3	22.8	296.3	5.7	523	104.6	147.9
Crandal Canyon Mine[2]												
MW-1	1	12.7	7.95	500		19.0	16.0	73.0	4.0	293.0	18.0	12.0
MW-2	1	10.9	7.30	731		74.0	41.0	14.0	5.0	456.0	39.0	5.0
MW-8	1	14.1	7.80	547		64.0	37.0	17.0	6.0	317.0	40.0	8.0
MW-6A	1	14.2	8.20	544		46.0	32.0	22.0	12.0	243.0	61.0	17.0
mean		13.0	7.81	581		50.8	31.5	31.5	6.8	327.3	39.5	10.5
						meq/L						
Trail & East Mtn[1]												
TM-1	31					2.50	2.79	12.13	0.12	8.98	2.31	6.15
TM-1B	6					0.27	0.42	23.95	0.17	11.64	2.61	5.91
TM-2	7					1.91	2.42	2.58	0.15	5.11	1.53	0.36
mean						1.56	1.88	12.89	0.15	8.58	2.15	4.14
Crandal Canyon Mine[2]												
MW-1	1					0.9	1.32	3.18	0.10	4.80	0.37	0.34
MW-2	1					3.7	3.37	0.61	0.13	7.47	0.81	0.14
MW-8	1					3.2	3.04	0.74	0.15	5.20	0.83	0.23
MW-6A	1					2.3	2.63	0.96	0.31	3.98	1.27	0.48
mean						2.5	2.59	1.37	0.17	5.36	0.82	0.30

[1] Mayo and Associates, 1997d and unpublished data

[2] Public domain doccument (Mayo and Associates, 1997a)

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3.2 Isotopic Compositions

Stable and radiogenic isotopic compositions of spring and stream waters in the Mill Fork Lease area and in-mine groundwater from the Cottonwood, Wilberg, Trial Mountain and Deer Creek Mines as well as public domain data from the Crandall Canyon Mine are included in Table 5. Calculated radiocarbon ages of the groundwaters are also listed in Table 5.

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Table 5 Isotopic compositions and radiocarbon ages of spring, stream and in-mine waters

(Table 5 Chem. xls 10/24/01)

	Date	$\delta^{18}O$ (°/oo)	$\delta^{2}H$ (°/oo)	$\delta^{13}C$ (°/oo)	^{3}H (TU)	^{14}C (pmc)	mean ^{14}C residence time (years)
Snow[1]							
East Mountain	3/21/96				8.79		
East Mountainn #2	3/21/96				7.5		
East and Trial Mountains[1]							
Alluvium	4/2/96			10.9	13.7	82.21	modern
Meter 3	12/12/96			10.9	13.5	77.66	modern
Meter 3	4/2/96			10.9	11.2	73.24	modern
Roans Canyon spring							
North Horn springs							
17-22-1	8/23/96			-10.5	18.1	78.89	modern
17-28-4	8/23/96			-10.3	13.3	82.93	modern
18-2-1	8/23/96			-20.1	12.2	76.12	modern
Price River Formation spring							
17-32-1	12/13/96			-8.6	2.2	61.55	modern
Blackhawk-Castlegate contact spgs							
17-3-9	8/23/96			-11.2	23.0	91.26	modern
16-34-6	12/13/16			-11.2	12.7	79.12	modern
91-72	12/14/96			-9.9	14.9	75.47	modern
91-73	12/15/96			-7.9	2.63	79.49	modern
18-4-1	12/16/96			-9.9	0.0	52.65	> 50
Blackhawk Formation springs							
80-50	12/12/96			-9.6	10.0	76.17	modern
84-57	12/12/96			-8.6	11.7	70.55	modern
Mill Fork Tract Springs							
Joes Valley Alluvium							
JV-9	8/16/00	-16.90	-123.8	-11.0	8	75.2	modern
JV-22	10/25/00	-16.09	-117.3	-11.1	9	100.19	modern
JV-34	10/25/00	-15.47	-112.0	-9.6	13	101.37	modern
North Horn Formation							
RR-12	10/17/00	-16.30	-118.0	-10.8	18	91.25	modern
RR-15	10/17/00	-16.58	-119.5	-11.7	8	94.48	modern
RR-23A	10/17/00	-16.49	-118.6	-11.5	13	91.05	modern
SP1-26	10/0/00	-16.40	-118.4	-12.2	12	97.34	modern
Price River Formation							
UJV-109	10/2/00	-16.70	-122.8	-11.7	19	100.2	modern
UJV-209	9/28/00	-16.52	-121.2	-12.1	12	104.71	modern
Castlegate Sandstone							
UJV-101	10/2/00	-16.73	-122.0	-12.2	16	92.96	modern
Blackhawk Formation							
MF-7	8/23/00	-15.89	-118.4	-9.8	16	78.25	modern
MF-213	8/23/00	-16.53	-118.7	-10.2	13	82.96	modern

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	Date	$\delta^{18}O$ (°/oo)	$\delta^{2}H$ (°/oo)	$\delta^{13}C$ (°/oo)	^{3}H (TU)	^{14}C (pmc)	mean ^{14}C residence time (years)
In-Mine							
Energy West Mines[1]							
Blackhawk Formation							
TMA X 32 (Cottonwood Mine)	3/28/96	-16.3	-123	-10.0	0.22	24.97	6,500
2S X 11 (Cottonwood Mine)	3/28/96	-16.3	-126	-7.5	0.05	12.15	12,000
1.5N X 29 (Wilberg Mine)	12/13/96	-16.5	-123	-10.6	0.33	31.97	4,500
UG-3 (Trail Mtn Mine)	3/28/96	-16.9	-130	-14.0	0.13	30.95	5,500
6W X 20 (Deer Creek Mine)	5/2/96	-16.8	-126	-10.3	0.14	42.23	2,000
MN-ME (Deer Creek Mine)	3/29/96	-16.7	-126	-8.1	0.10	22.54	7,000
TW-10 (Deer Creek Mine)	3/29/96	-16.4	-123	-10.5	20.8	62.39	modern
Longwall Gob Areas							
MW Seals (Cottonwood Mine)	2/26/97	-16.7	-128	-9.7	1.34	21.99	8,000
3S Seals (Deer Creek Mine)	2/23/97	-16.7	-128	-7.7	0.88	14.40	12,000
Star Point Sandstone Wells							
CCCW-1S	12/9/96	-17.3	-130	-10.3	1.10	46.17	1,000/mixed
TM-3	12/11/96	-17.3	-129	-10.3	0.00	24.36	6,000
Crandall Canyon Mine[2]							
Blackhawk Formation							
8th East Roof Drips	2/3/97	-18.2	-134	-8.4	0.02	8.41	14,000
UDH 46-97	6/5/97	-17.4	-131.5	-8.5	0	9.65	13,000
Joes Valley Fault system							
Main West Fault	2/3/97	-17.7	-129.5	-10.7	0.06	40.07	2,500
5th West Fault	6/5/97	-17.5	-131	-11.0	0.95	34.99	3,500 (mixed)
MW-7	6/5/97	-17.3	-131	-10.8	0.01	31.85	5,000
Star Point Sandstone Wells							
Spring Canyon Sandstone							
MW-1	2/3/97	-18.2	-134	---	---	---	---
MW-2	2/3/97	-18.2	-133	-11.2	0.03	5.79	19,000
MW-8	6/5/97	-17.3	-131	-9.0	0.10	4.9	14,500
MW-6A	6/5/97	-17.4	-130	-10.1	0.20	8.75	19,000
Panther Sandstone							
MW-6	6/5/97	-17.2	-131	-12.6	0.43	30.39	6,500

[1] Mayo and Associates, 1997d; $\delta^{2}H$ and $\delta^{18}O$ not included because suspected laboratory errors in $\delta^{2}H$.

[2] Data obtained from public domain report, Mayo and Associates 1997a

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4 DESCRIPTION OF MINING OPERATIONS

Coal produced from the Energy West mines is used to fire electrical power plants in Carbon and Emery Counties. Presently, Energy West Mining Company is actively mining two separate coal seams in the Deer Creek Mines. The Wilberg, Cottonwood Trail Mountain mines are currently in temporary cessation. The Des-Bee-Dove Mine is no longer active and is currently in reclamation.

Energy West currently mines approximately 4.5 to 5.0 million tons of coal per year. This production rate has dropped from 7.5 to 8.0 million tons of coal per year due to the closure of Train Mountain Mine.

Subsidence above mined areas is closely monitored using photogrammetric techniques. Subsidence in excess of 15 feet has been measured. The greatest subsidence effects occur in steep cliff areas where the brittle Castlegate Sandstone is exposed and in areas where mining has occurred next to burned coal and less competent clinker beds which readily collapse under mining-induced compression (PacifiCorp, 1996a). To minimize any potential impacts to the steep sandstone cliffs where the Castlegate Sandstone crops out along the edge of the plateau, longwall mining is generally not carried out near cliff areas. Surface fractures are associated with subsidence in steep cliff areas and along the margins of longwall panels.

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5 CLIMATIC, PHYSIOGRAPHIC, AND GEOLOGIC SETTING

5.1 Climate

Temperatures in the study area range from 32 to 100°F (0 to 38°C) in the summer months and from –10 to 40°F (-23 to 4.4°C) during the winter months. Precipitation in the region varies greatly with elevation. Within the general area mean annual precipitation ranges from about 10 inches in the low elevations to more than 25 inches in the highest elevations (PacifiCorp, 1996b). The Mill Fork Lease area is almost entirely at higher elevations.

Since 1981, Energy West and its predecessors have operated a weather station on East Mountain at an altitude of 8,985 feet. Long-term precipitation data are shown in Figures 2a and 2b. Data from this station indicate that about 50% occurs as summer rains, and about 50% as winter snowfall (Figure 2a). The effects of climatic variability are shown in Figure 2b. Wetter years in the mid-1980s were followed by drier years in the late 1980s and early 1990s.

The Palmer Hydrologic Drought Index (PHDI) for Utah Division 4 is shown in Figure 3. The PHDI (NCDC, 2001; Karl, 1986; Guttman, 1991) indicates the long term climatic trends for the region. The PHDI is a monthly value generated by the National Climatic Data Center (NCDC) that indicates the severity of a wet or dry spell. The PHDI is computed from climatic and hydrologic parameters such as temperature, precipitation, evapotranspiration, soil water recharge, soil water loss, and runoff.

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Mayo and Associates, LC
Figure 2.jnb 10/24/01

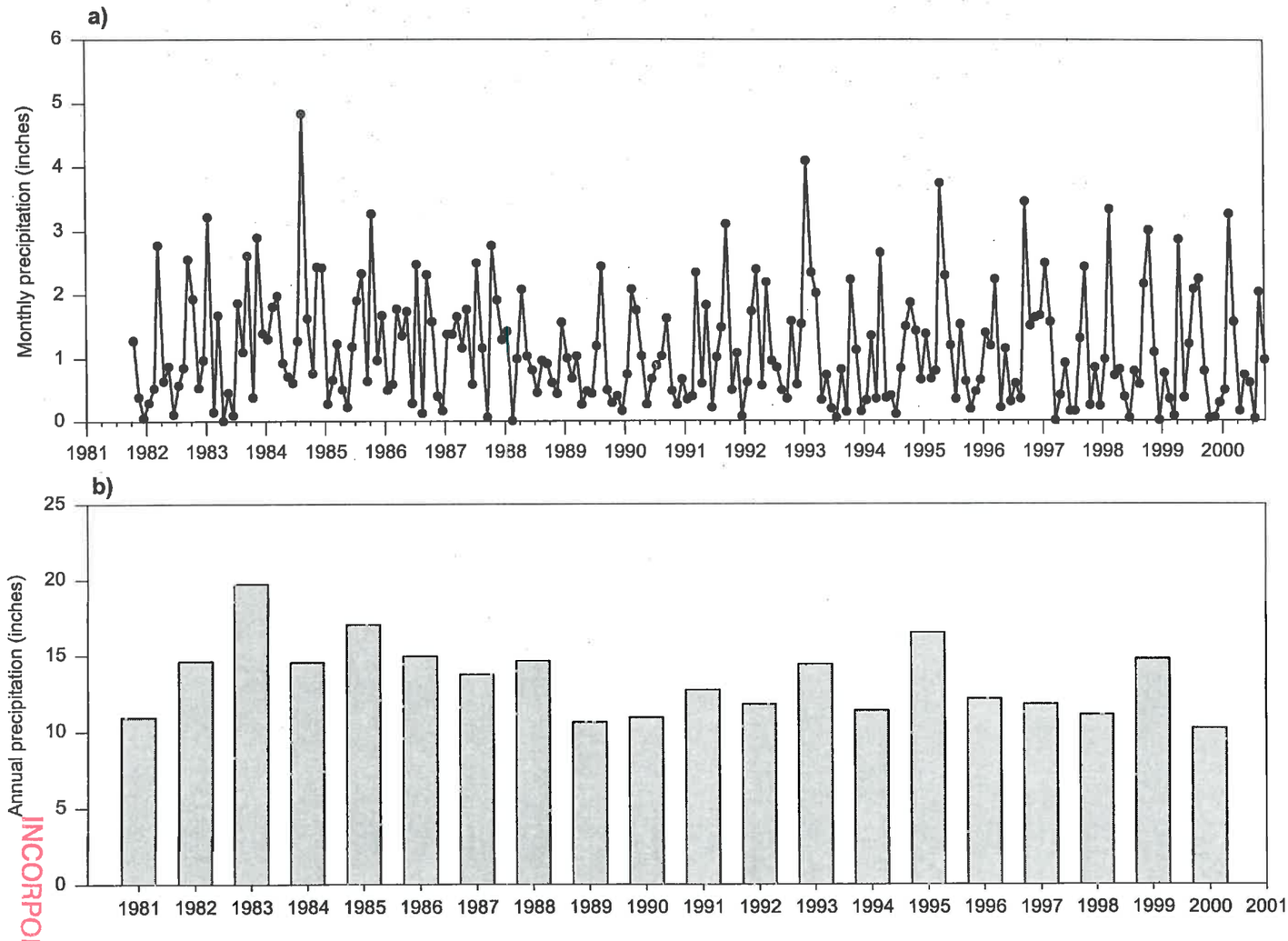

Figure 2 Precipitation at the UP&L East Mountain weather station: a) monthly total and b) annual totals by water year (October-September).

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Mayo and Associates, LC
Figure 3. jnb 10/24/01

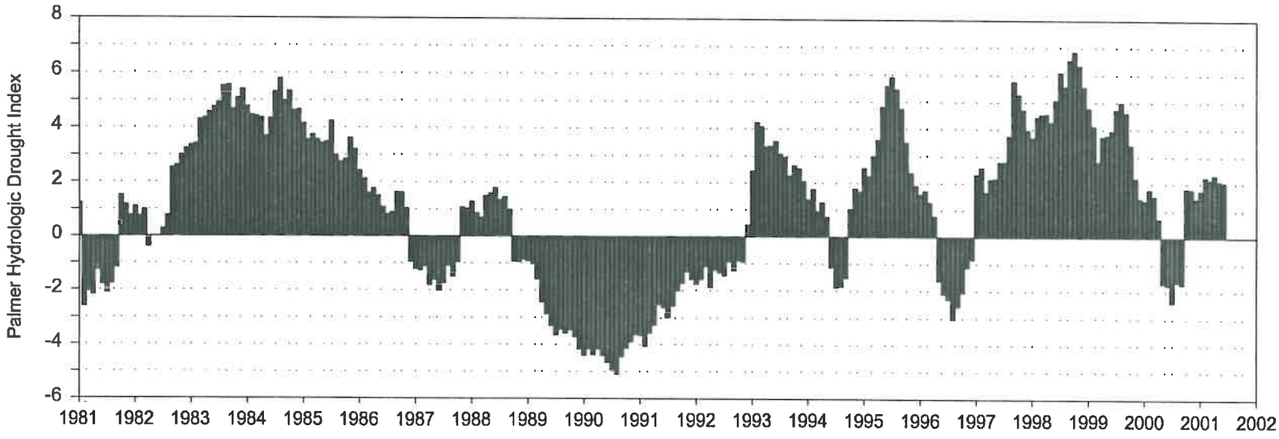

Figure 3 Plot of the Palmer Hydrologic Drought Index for Utah Region 4.

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Because the PHDI takes into account parameters that affect the balance between moisture supply and moisture demand, the index is a useful tool for evaluating the long-term relationship between climate and groundwater recharge and discharge. The PHDI is useful for determining whether variations in spring or stream discharges in the Wasatch Plateau are the result of climate variability or whether they are the result of other factors (Mayo and Morris, 2000). Suflita and Kern (2001) also found that there is a good correlation between the PHDI and spring discharge rates from springs which have not been impacted by anthropogenic activities such as mining operations.

The graph of the PHDI for Utah Division 4 (Figure 3) indicates extremely wet years in the early and late 1980's, followed by several years of drought in the late 1980's and early 1990's. The middle 1990's are characterized by alternating wet and dry spells of short duration. Beginning in early 1997 and continuing until the end of 1999, the region experienced a period of extreme wetness. Following a brief period of drought in early 2000, the region returned to a period of relative wetness.

5.2 Physiography

The Energy West mines and the Mill Fork Lease are located in the central Wasatch Plateau, which lies at the boundary between the Basin and Range province to the west and the Colorado Plateau to the east. The topography of the area consists of narrow, flat-topped mesas surrounded by heavily vegetated slopes that extend to the precipitous cliffs of the eastern escarpment of the plateau. A digital map of the topography of the Mill Fork Lease and surrounding region is shown on Figure 4. The Mill Fork Lease is located on the

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N

1 mile

Figure 4 Digital map of the topography of the Mill Fork Tract area.

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northern end of East Mountain and is bounded by Joes Valley and Huntington Canyons on the west and east, respectively. Crandall and Rilda Canyons are the approximate north and south boundaries, respectively. Elevations in the study area range from approximately 7,000 feet in Huntington Canyon to over 10,700 feet on the top of East Mountain. Joes Valley, a high mountain valley (i.e., greater than 8,500 feet) drains southward into Joes Valley Reservoir about 4 miles away. The land surface on East Mountain is extremely steep and rugged and is not easily accessible. The area is dissected by steep, narrow canyons that are, in most locations, heavily vegetated. The upland areas are vegetated with dense aspen and conifer forests interspersed with alpine meadows. Much of the land surface in the steepest canyons consists of barren cliffs. Above the steep walled canyons are narrow, flat ridge tops that are generally less vegetated than are the canyon walls.

5.3 Geology

5.3.1 Stratigraphy

In the Mill Fork Lease area, seven bedrock formations crop out (Figure 5). In descending order these formations are the Flagstaff Limestone, North Horn Formation, Price River Formation, Castlegate Sandstone, Blackhawk Formation, Star Point Sandstone, and Mancos Shale (Figure 6). The upland plateau of the Mill Fork Lease area is developed on the Flagstaff Limestone, the North Horn Formation, and the Price River Formation. The steep-walled canyons are cut into the Castlegate Sandstone, Blackhawk Formation, and Star Point Sandstone. The Mancos Shale forms a broad expanse of lowland to the east and is not exposed in the Mill Fork Lease. Geologic cross-sections through the Mill Fork Lease area are shown in Figures 7a and 7b.

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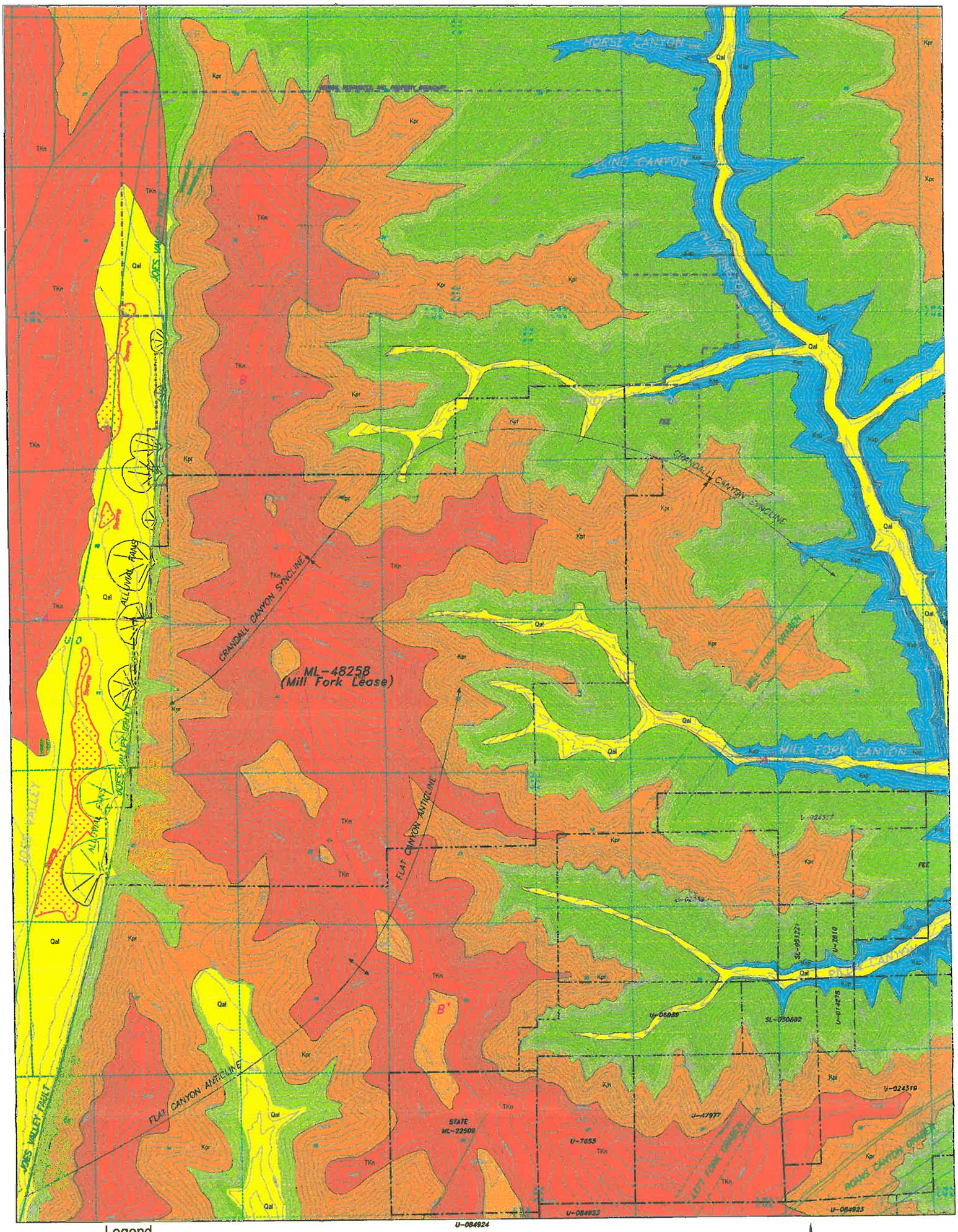

Legend

Age	Symbol	Formation Name
Quaternary	Qal	Alluvial Deposits (Stream bed deposits, Alluvial fans, etc.)
Tertiary		Flagstaff Limestone
Tertiary/Cretaceous	TKn	North Horn Formation
Cretaceous	Kpr	Upper Price River Formation
Cretaceous		Castlegate Sandstone
Cretaceous		Blackhawk Formation
Cretaceous		Star Point Sandstone
Cretaceous		Mancos Shale (Masuk Member)

STRUCTURES:

Anticline

Syncline

Scale: 0 2000' 4000'

N

Figure ~~4~~ 5 Geologic Map of the Mill Fork Tract area.

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Mayo and Associates, LC
Figure 6 stratsec.cdr 10/24/01

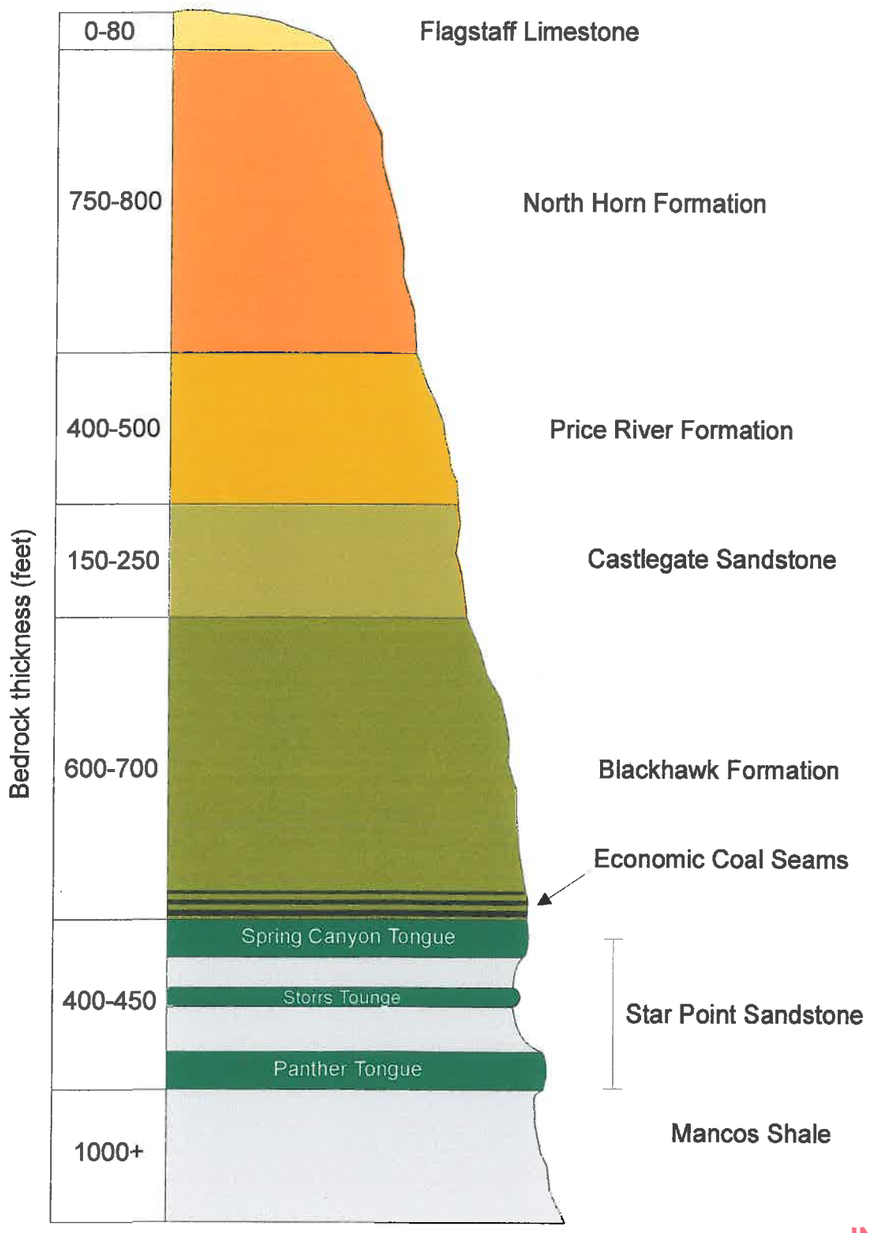

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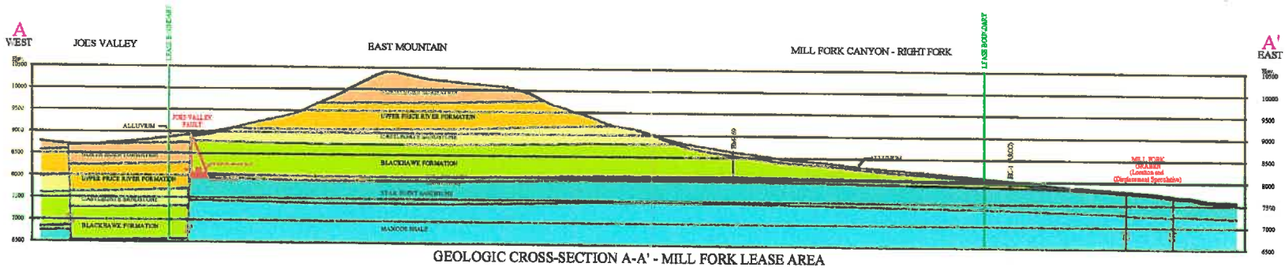
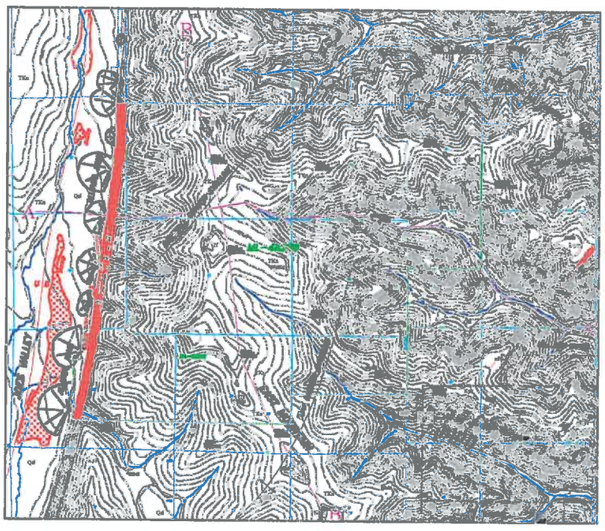
Figure 6 Stratigraphic column of bedrock formations in the Mill Fork Lease area.



GEOLOGIC CROSS-SECTION A-A' - MILL FORK LEASE AREA



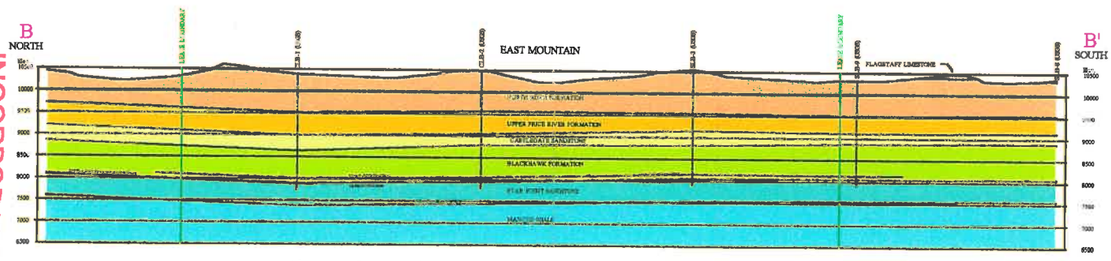


Figure 7 Geologic cross-sections through the Mill Fork Lease area.

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The bedrock formations were deposited during transgressions and regressions of the shoreline of the Western Cretaceous Interior Seaway during the Late Cretaceous and Early Tertiary. This ancient shoreline was located along the eastern edge of the tectonically uplifted mountains of the Sevier Orogenic Belt. Sediments eroded from the uplifted mountains were carried toward the seaway by fluvial systems and deposited as terrestrial, shoreline, marine, and interfingered non-marine and marine sedimentary sequences. On the terrestrial side of the shoreline, sediment deposition occurred in lacustrine (lake carbonates, marls, and sands), alluvial plain (sands and clays), fluvial (stream sands and overbank muds), and carbonaceous backshore (coal swamp) environments. Along the shoreline, marine foreshore deposits (beach sands) accumulated. Offshore, sands swept from the beaches were laid down as bars and blankets of sand in the near-shore shallow marine water. These blankets of sand are known as shoreface deposits. The clay fraction of stream- transported sediments which reached the shoreline was deposited as thick marine muds (shale) in the deeper and more quiescent portions of the seaway. Because the transgression and regression of the shoreline was accompanied by the continued deposition of sediments, a variety of horizontally and vertically discontinuous sediment types occur throughout the coal district. This depositional history has resulted in a heterogeneous rock record that has had a profound effect on the water-bearing characteristics of these rocks.

The internal depositional geometry of the bedrock formations is illustrated in Figure 8. In Figure 8, typical geometric relationships between sandstone channels (white) and intrachannel muds (gray) are shown in the lateral and vertical relations column. In this

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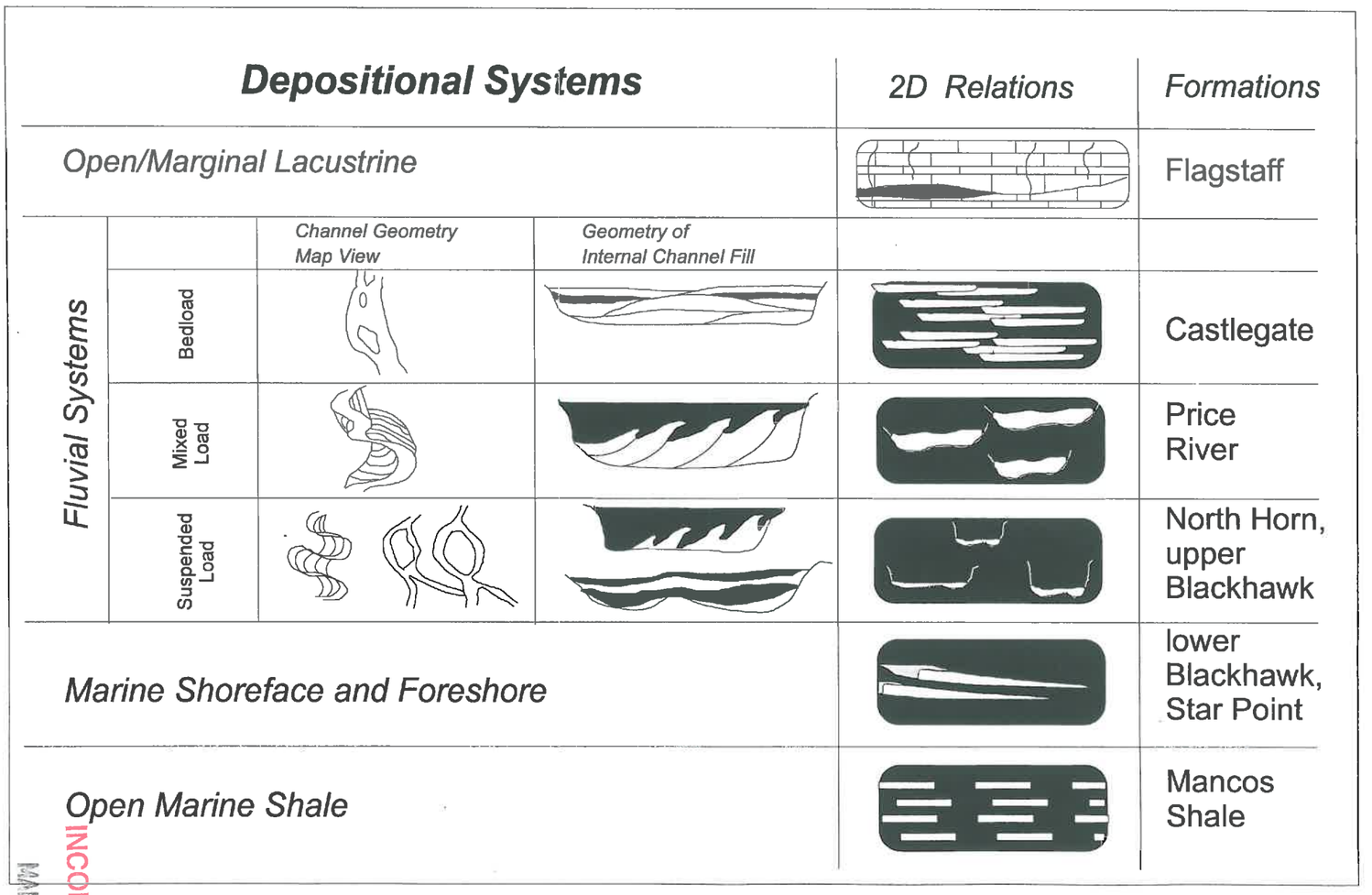

Figure 8 Internal structure of bedrock formations in the Mill Fork Tract area.

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column, sandstone channels are illustrated as cross-sections cut perpendicular to the long direction of the channel.

The seven bedrock formations, from youngest to oldest, are described below.

5.3.1.1 Flagstaff Limestone

The Flagstaff Limestone, which caps the uppermost portions of the Wasatch Plateau, is the youngest of the bedrock formations exposed in the Mill Fork Lease area (Figure 5). It typically forms small exposures on top of the plateau. A thickness of 105 feet was measured on Trail Mountain immediately south of the study area (Davis and Doelling, 1977). Maximum thickness in the Mill Fork lease is about 80 feet.

The Flagstaff Limestone consists of carbonates, marls, and some thin sandstone stringers deposited in lacustrine, marginal lacustrine, and alluvial plain depositional environments (Garner and Morris, 1996). It primarily consists of light- to medium-gray colored limestone containing abundant secondary fractures produced during uplift and subaerial exposure. Thin beds of shale and volcanic ash are present in some locations.

5.3.1.2 North Horn Formation (Tertiary-Cretaceous Age)

The North Horn Formation is the cap rock of much of Mill Fork Lease and elsewhere on East Mountain where the Flagstaff Limestone has been eroded away. Exposures of the North Horn Formation form purple, red, or brown colored slopes. In the Mill Fork Lease area, the thickness ranges from 750 to 800 feet.

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The North Horn Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Figure 8). In such environments layers of mud are more abundant than sands, which occur in sandstone channels. The sandstone channels are generally isolated from each other, both laterally and vertically, by mud-rich overbank and interfluvial rocks (Galloway, 1977). In the study area the formation consists primarily of shale with discontinuous sandstone channels, minor lenses of limestone, and conglomerate. Highly bentonitic mudstones, which swell when wetted, are common in the lower two-thirds of the formation.

5.3.1.3 Price River Formation (Cretaceous Age)

The Price River Formation typically forms a steep, receding slope above the Castlegate Sandstone. The receding slope contains alternating ledges and slopes that result from differential erosion of interbedded resistant sandstone and less resistant shale and claystone. In the Mill Fork Lease area the formation is 400 to 500 feet thick.

The Price River Formation was deposited from mixed-load fluvial channel systems that have sandstone/mudstone ratios intermediate between bed-load and suspended-load channel systems (Figure 8). Sandstones and mudstones occur in about equal proportions. Point bars that develop in this type of system are larger than those in suspended-load channel systems. Mudstone drapes created during low flow stages of the active fluvial system separate the sandstones from each other both horizontally and vertically.

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5.3.1.4 Castlegate Sandstone (Cretaceous Age)

The Castlegate Sandstone has a distinctive cliff forming habit and typically forms a resistant cliff above the underlying, less resistant Blackhawk Formation. The thickness of the Castlegate Sandstone ranges from 150 to 250 feet in the Mill Fork Lease area (Danielson and Sylla, 1983).

The formation was deposited from bed-load fluvial channel systems (Figure 8; Chan and Pfaff, 1991). The Castlegate Sandstone is made up of coarse-grained, often conglomeratic, fluvial sandstone. Thin interbeds of siltstone and claystone occur in lower portion the formaiton. Sandstone dominates over mudstone and individual sand channels may be thin, wide, or interpenetrating. Although the primary porosity is high, the existence of mudstone drapes and pervasive carbonate and silica cement greatly reduces the overall porosity.

5.3.1.5 Blackhawk Formation (Cretaceous Age)

The Blackhawk Formation generally forms a steep, irregular slope between the cliffs of the underlying Star Point Sandstone and the overlying Castlegate Sandstone.

The formation consists of an upper non-marine, suspended-load fluvial portion and a lower marine shoreface and non-marine foreshore portion. Massive, cliff-forming units are common in the upper portion, and thinner-bedded, slope-forming units are common in the lower portion. The thickness of the Blackhawk Formation ranges from 600 to 1,000 feet in Energy West drilling. Most of the thicker coal seams occur in the lower 150 feet of the Blackhawk Formation.

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The upper portion of the Blackhawk Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Figure 8). In these delta and flood-plain environments layers of mud are more abundant than channel sands. Sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and interfluvial rocks (Galloway, 1977). The upper portion of the Blackhawk Formation also contains some thin carbonaceous shale layers and thin coal seams that are not of economic interest.

The lower portion of the Blackhawk Formation contains the mineable coal deposits and consists of more thinly bedded sandstone and shale layers (Johnson, 1978). The coal-bearing units of the lower Blackhawk Formation overlie and are laterally juxtaposed to marine shoreface sandstones of the Blackhawk Formation and Star Point Sandstone. On a large scale, these sandstone bodies are laterally continuous but terminate abruptly into the mud- and organic-rich backshore faces in a landward direction (Van Wagoner and others, 1990). However, individual rock layers are lenticular and discontinuous, with abundant shaley interbeds. The fine- to medium-grained sandstones occur as thin- to massively-bedded paleochannel deposits. The paleochannels increase in frequency, thickness, and lateral extent upward in the formation. There is also a vertical repetition of erosional scours within the upper sandstones (Marley, 1979).

Energy West mine workings are within the Hiawatha and Blind Canyon coal seams. In most locations the Hiawatha seam lies directly on top of the Star Point Sandstone. In some locations, a 0-15 foot thick shaley lagoonal deposit is present between the Hiawatha seam

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and the top of the Star Point Sandstone. The Blind Canyon seam lies approximately 80 feet above the Hiawatha seam. In the Wasatch Plateau, natural burning of the coal beds near the surface has baked large areas of the Blackhawk Formation. These reddish clinker layers are generally more resistant and form steeper slopes than adjacent unburned layers.

5.3.1.6 Star Point Sandstone (Cretaceous)

The Star Point Sandstone forms massive cliffs where exposed at the surface. The sandstone was deposited as seaward thinning (east), marine, shoreface blanket sands that are laterally continuous. Landward (west), these sandstones terminate abruptly into the mud- and organic-rich backshore facies (Figure 8; Van Wagoner and others, 1990). Because many of the organic-rich facies are now mineable quality coal, locally the Star Point Sandstone has immediate contact with coal seams. Elsewhere sandstone bodies of the Star Point Sandstone are overlain and underlain by lower shoreface and open marine shales of the Mancos Formation. What this means is that the marine shoreface sandstones are three dimensionally encased by low-permeability marine shales and fine-grained carbonaceous backshore coal-bearing facies.

The Star Point Sandstone thins eastward and merges with the underlying Masuk Member of the Mancos Shale. Three prominent tongues of the Star Point Sandstone interfinger with the Mancos Shale. These three sandstone members, from top to bottom, are the Spring Canyon, Storrs, and Panther Sandstones (Figure 6). In the Mill Fork Lease area, the Spring Canyon tongue is approximately 100 feet thick, lies about 80 feet above the Storrs tongue, and consists of massive, fine- to medium-grained sandstone. The Storrs tongue lies about 120 feet

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above the Panther tongue and consists of 50 feet of soft, friable sandstone. The basal Panther tongue is approximately 100 feet thick and consists of massive, crossbedded delta front sandstones.

5.3.1.7 Masuk Member of the Mancos Shale (Cretaceous Age)

The marine Masuk Member of the Mancos Shale was deposited in an open marine environment. The member is a highly erodeable calcareous, gypsiferous, and carbonaceous dark gray colored shale. It is continuously exposed along the eastern edge of the Wasatch Plateau, but is not exposed in the Mill Fork Lease. The Masuk member is approximately 1,300 feet thick. Westward thinning wedges of the Masuk interfinger with tongues of the Star Point Sandstone. Castle Valley, located east of the Mill Fork Lease, is developed on the Mancos Shale.

5.3.2 Structure

The dip of the bedrock is controlled primarily by the Crandall Canyon Syncline and the Flat Canyon Anticline. The axis of the syncline is curvilinear along the north portion of the tract, trending northeast to east (Figure 5). The axis of the anticline generally trends north. The dips of the rocks throughout the area are gentle, rarely exceeding 6 degrees.

Most faults in the Mill Fork Lease area trend north-south or northeast-southwest (Figure 5). The Joes Valley Fault system, located on the western edge of the Mill Fork Lease, is the dominant structural feature of the area (Danielson and Sylla, 1983). The fault, which extends more than 20 miles to the north and 40 miles to the south of the Joes Valley Reservoir dam,

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has 2,300 feet of vertical displacement (Davis and Doelling, 1977). Joes Valley, located west of and adjacent to the Mill Fork Lease, is a graben formed on the downthrown block west of the Joes Valley Fault. East Mountain forms the horst block east of the fault. Much of Joes Valley is filled with alluvium that is juxtaposed against the bedrock formations. However, in the northern portion of the Mill Fork Lease area, the North Horn Formation crops out in the valley floor.

The Mill Fork Fault system, which has and estimated maximum displacement of 30 feet (Semborski, Personal Communication, 1997), forms a narrow graben east of the Mill Fork Lease.

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6 SURFACE WATER

Most surface water in the Mill Fork Lease drains eastward into Huntington Creek, which is tributary to the San Rafael River. Several major Huntington Creek tributaries have headwaters which partially or completely originate in the Mill Fork Lease. From north to south these include Crandall, Little Bear, Mill Fork, and Rilda Canyons. Surface waters in the extreme western portion of the Mill Fork Lease drain westward into the Indian Creek drainage, which in turn flows into Joes Valley Reservoir and Cottonwood Creek. These drainages are shown in Figure 9.

During the snowmelt period, appreciable runoff discharges from the highlands of the Wasatch Plateau along ephemeral, intermittent, and perennial streams. As temperatures warm in the spring and summer, the snow pack melts and both stream flows and spring discharge rates increase substantially. Up to 70% of the total yearly stream flow in the mountainous region occurs during the months of May, June, and July (Waddell and others, 1986). The surface water hydrology of each drainage basin, all of which are only partially in the Mill Fork Lease, is described below.

6.1 Huntington Creek drainage

6.1.1 Crandall Canyon Drainage

Crandall Canyon drains an area of approximately 5 square miles about half of which is in the Mill Fork Lease. Crandall Canyon is a steep, highly vegetated, deeply incised canyon with an average gradient of 660 feet per mile. The vegetation on the north-facing slopes consists

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1 mile

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Figure 9 Surface water drainages in the Mill Fork Tract area.

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of dense mixed conifer and aspen forests interspersed with alpine meadows. South facing slopes are less heavily vegetated.

The discharge rate of the creek is highly variable (Figure 10). Reported discharge at UPF-1 (Plate 1) ranges from a low of about 3 gpm to a high of about 7,640 gpm (http://dogm.nr.state.ut.us). Based on numerous personal observations of the creek during all seasons, we believe some of the report data are in error and that the creek flows have not been in the low gpm range. We suspect the problem is that flow rates have been reported to the State in both gpm and cubic feet per second, but have been listed in the State database as gpm. The issue remains problematic.

6.1.2 Little Bear Canyon Drainage

The Little Bear watershed drains an area of 1.36 square miles. The drainage is characterized by very steep canyons, with sharp, narrow ridge tops at the drainage divides. Vegetation in the Little Bear watershed is moderately dense, with north facing slopes covered primarily with conifer forests. The south facing slopes are less heavily vegetated, with vegetation consisting primarily of grasses and shrubs. The land surface in Little Bear Canyon is somewhat less vegetated than in adjacent canyons, and bedrock exposures are more common due to the steepness of the canyon walls.

The gradient of Little Bear Creek is very steep at 1,600 feet per mile (Vaughn Hansen Associates, 1977). Little Bear Creek is a intermittent stream, which may stops flowing during the late summer and fall months and earlier during dry years. Based on information

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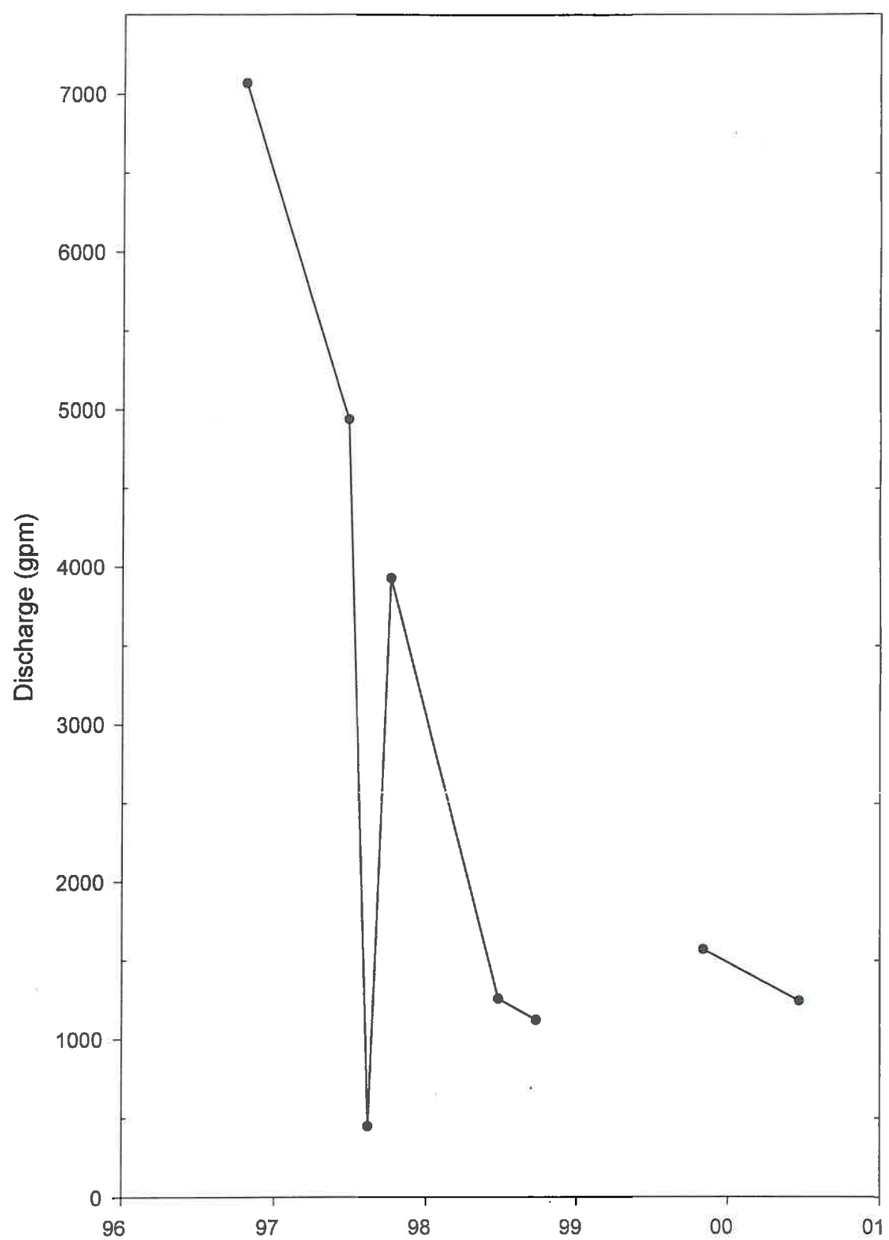

Figure 10a Discharge in Indian Creek.

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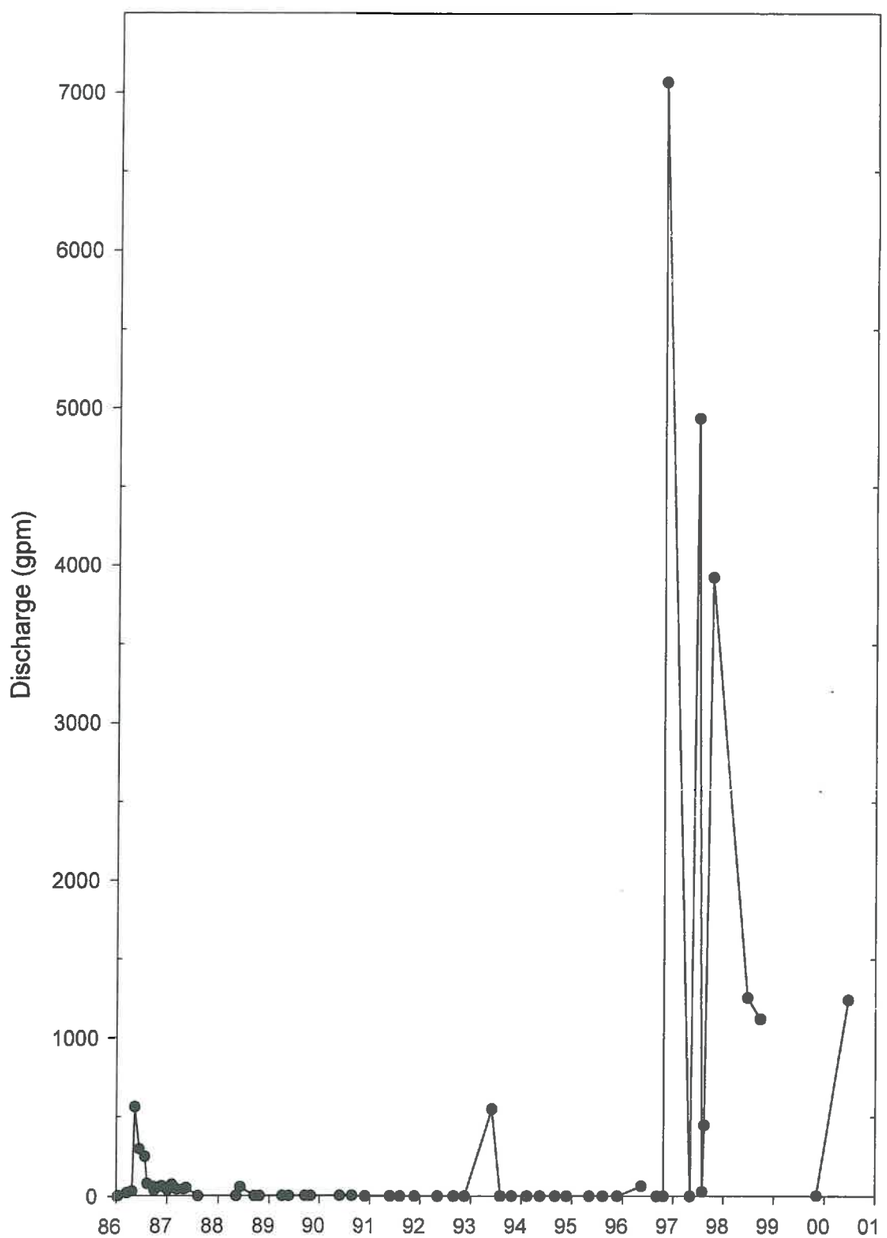

Figure 10b Discharge in Mill Fork Creek above the old Huntington #4 Mine.

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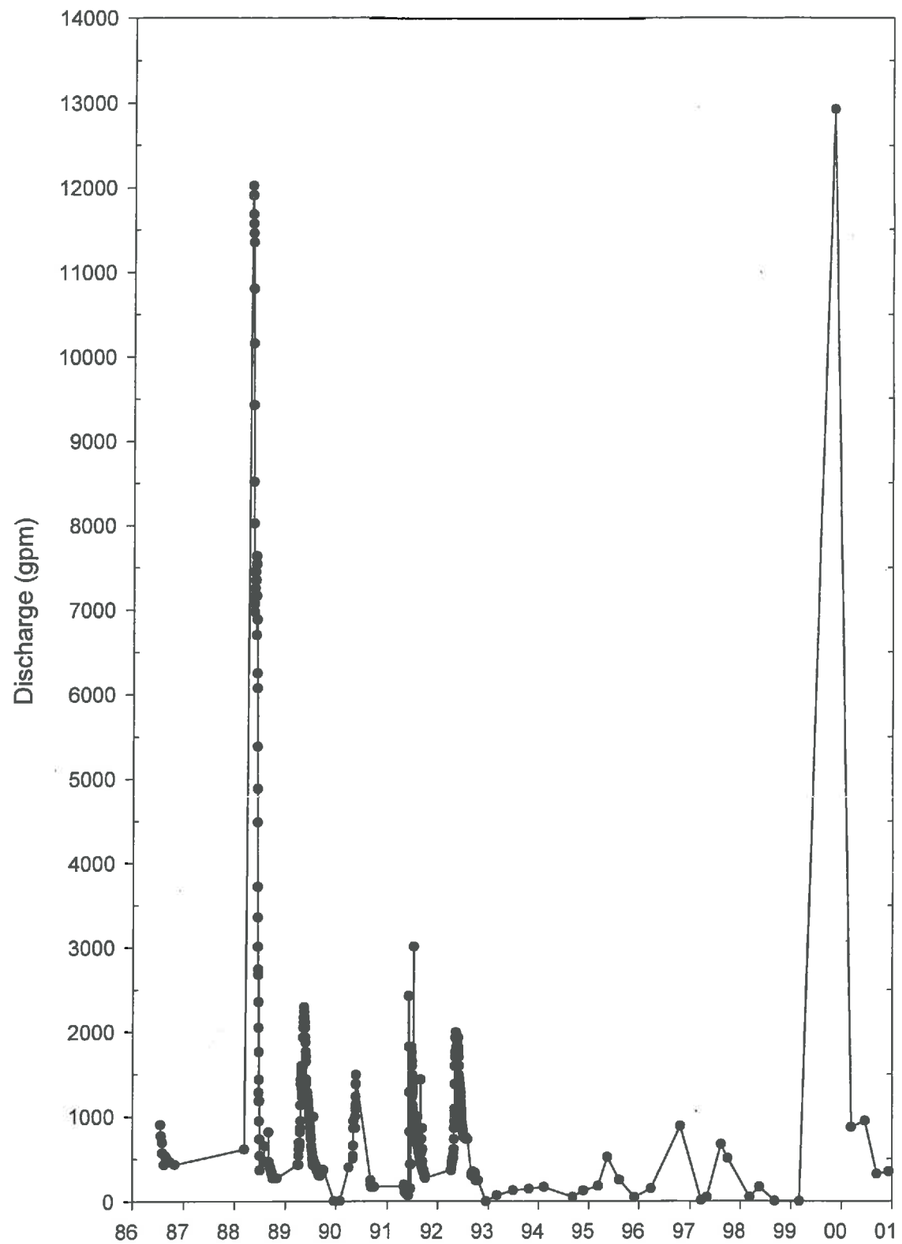

Figure 10c Discharge in upper Crandall Creek.

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from the Huntington Canyon No. 4 Mine permit (Vaughn Hansen Associates, 1977), instantaneous discharge measurements on Little Bear Creek average 76 gpm (0.17 cfs). This discharge rate equals 1.76 inches of precipitation per year over the 1.36 square mile watershed.

6.1.3 Mill Fork Canyon Drainage

Mill Fork Canyon drains a large portion of the west central Mill Fork Lease. Mill Fork Creek is moderately steep, with a gradient of 590 feet per mile (Vaughn Hansen Associates, 1977). The canyon walls in Mill Fork are steep and highly vegetated. North facing slopes are heavily vegetated with conifer forests, whereas the south facing slopes are vegetated with stands of aspen and conifers interspersed with meadows containing mountain grass and bush. The Castlegate Sandstone outcrop forms a prominent cliff on the south facing slope. A thick soil layer has formed on the less prominent north facing cliff.

The discharge rate of the Mill Fork Creek is highly variable. Measured discharge at Old Huntington #4 (Figure 10) ranges from a low of 0 gpm to a high of about 1,000 gpm (http://dogm.nr.state.ut.us).

6.1.4 Rilda Canyon Drainage

The drainage of Rilda Canyon Creek overlies the workings of the Deer Creek Mine and includes about one square mile of the south-central portion of the Mill Fork Lease. The uppermost potion of the Right Fork of Rilda Canyon Creek (about 1.5 miles) is in the Mill Fork Lease. Rilda Canyon drainage is heavily vegetated. The north facing slopes are mostly

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covered with dense conifer forests. The surrounding areas are interspersed with aspens, bush thickets, and alpine meadows. The soils on the steep hillsides are generally thick and well developed. Bedrock is generally not well exposed in Rilda Canyon, with the exception of the Castlegate Sandstone escarpment in the southeast quarter of section 24. In its lower reaches, the creek flows mostly over alluvium consisting primarily of sand and gravel. In the upper reaches, the stream flows over bare bedrock in some locations. In the lower reaches (sections 19 and 29) the alluvial thickness in the canyon bottom increases significantly and the stream sediments consist primarily of clean sand and gravel.

Discharge in Rilda Creek varies greatly by season (Figure 11). For example, in June 1995 discharge at RCF3 was 4,500 gpm was only 149 gpm the following September (http://dogm.nr.state.ut.us).

The North Emery Water Users Association (NEWUA) Rilda Canyon collection system captures groundwater in a series of french drains (Figure 11) in the shallow alluvium in Rilda Canyon (Meters 1-4). Flow meters were first installed in the system in September 1990 and monthly monitoring of these meters has occurred since then. Meter 2 measures flow from the combined discharge from Side Canyon and the vicinity of South Spring. Meter 3 measures flow from the central portion of the collection system near Rilda Canyon Creek. Previous to 1995, Meter 4 measured flow from the north side of Rilda Canyon Creek. In 1995, flow measured by Meter 4 was combined with flow measured by Meter 3, and Meter 4 was disconnected.

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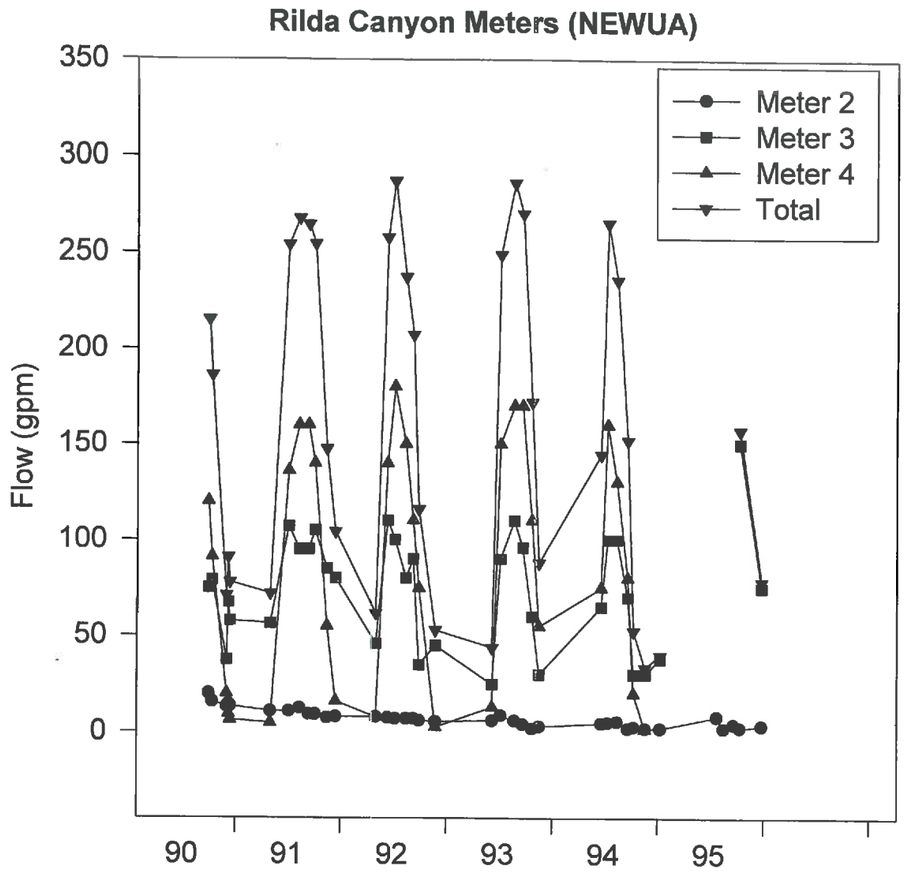

Figure 11 Hydrographs of Rilda Canyon NEWUA meters.

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Rilda Creek is ephemeral above Meter 2 near the NEWUA collection system and is a gaining perennial stream below Meter 2. The upper, losing reach of Rilda Creek flows across alluvium deposited on the Blackhawk Formation and Star Point Sandstone, whereas the gaining reach of Rilda Creek flows on alluvium deposited on Mancos Shale.

Hydrographs of the NEWUA meter discharge rates demonstrate that flow in the alluvial groundwater system is highly dependent on seasonal recharge (Figure 11). Springtime maximum flows as great as about 180 gpm have been recorded at Meter 4 while the base flow discharge at Meter 4 has been a low as 1.5 gpm. The 1990 to 1991 measured decline in discharge measured by Meter 2, which has the lowest measured rates of the NEWUA meters (<20 gpm), is believed to be the result of maintenance problems with the piping system (Personal communication, Chuck Semborski, 2001).

PacifiCorp performed a pump-test during November 1990 in the vicinity of the Rilda Canyon collection system. Results of this testing indicated that 90% of the flow to the system could be accounted for by drainage directly from the shallow alluvial sediments (non-bedrock derived). The remaining <10% was believed to be derived from bedrock discharge. However, it was later determined that the thickness of saturated alluvium upgradient from the wells was greater than that assumed at the time of the testing (Personal communication, Chuck Semborski, 1997). Recalculations using the greater saturated thickness demonstrates that more than 90% of flow attributable to alluvial discharge.

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Because discharge data for individual meters in the Rilda Canyon collection system are only available since the end of 1990, the effects of long-term climatic fluctuations cannot be determined.

6.2 Cottonwood Creek drainage

A small portion of the Mill Fork Lease, in Section 23, T16S R6E, drains directly into Cottonwood Creek. This area, less than a quarter-quarter section, is located along the ridge line of East Mountain at an elevation of above 10,000 feet and is entirely higher than the elevation of the first occurrence of perennial water in Cottonwood Creek.

6.3 Indian Creek Drainage

Approximately the western third of the Mill Fork Lease drains into the Indian Creek drainage. from the western slopes of East Mountain. These slopes are very steep slopes and heavily vegetated. A thick soil mantle is present in most areas. The north facing slopes are covered with thick conifer forests and the surrounding hillsides are covered with aspen groves and alpine meadows. Because of the thick soil and vegetative cover, exposed rock outcrops are few. There are no major drainage systems developed on the western slope of East Mountain, because of the short distance (generally less than a mile) from the East Mountain ridge line to Joes Valley. Rather, a series of ephemeral and intermittent streams flow nearly due-west down the steep west-facing slopes of East Mountain into Indian Creek. No known perennial streams occur on the west slope of East Mountain.

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6.4 Bedrock Contribution to Stream Flow

In an attempt to help quantify the contributions of bedrock formations to the baseflow of creeks in the study area, Mayo and Associates performed a gain-loss measurement on Indian Creek. Flow measurements on Indian Creek indicated gains and losses that are greater than the error of measurement. The significance of these fluctuations is difficult to assess because the stream flows entirely on alluvial deposits and has abundant bank vegetation. Gains and losses could be accounted for by flow through alluvial sediments and transpiration by plants. Lines (1985) found only small gains and losses along Indian Creek in 1981 and 1982.

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7 GROUNDWATER

7.1 Springs

Groundwater naturally discharges, at greatly varying rates, from most formations in the Mill Fork Lease and adjacent areas (Tables 1 and 2). Approximately 200 spring and seeps have been identified as issuing on or near the Mill Fork Lease in the spring and seep survey (Energy West Mining Company, 2001). Additionally, 96 springs have been monitored on the nearby East and Trail Mountains by Energy West, since 1979.

Long-term spring hydrograph data are not available for springs in the Mill Fork Lease. However, such data are available for springs in the vicinity of nearby East and Trail Mountains (Mayo and Associates, 1997d). In the 1997 report more than 100 spring hydrographs were analyzed. The behavior of these springs was consistent with findings of Mayo and Morris (2000), where they found that spring discharge rates respond to both seasonal and climatic factors. Approximately 75% of the springs in the adjacent areas discharge form the North Horn Formation. Selected hydrographs (Figure 12) of representative springs are described below. The hydrographs, originally created in 1997, have been updated to include recent data for this report.

7.1.1 Alluvial Springs - Rilda Canyon

Rilda Canyon springs were described above in section 6.1.4.

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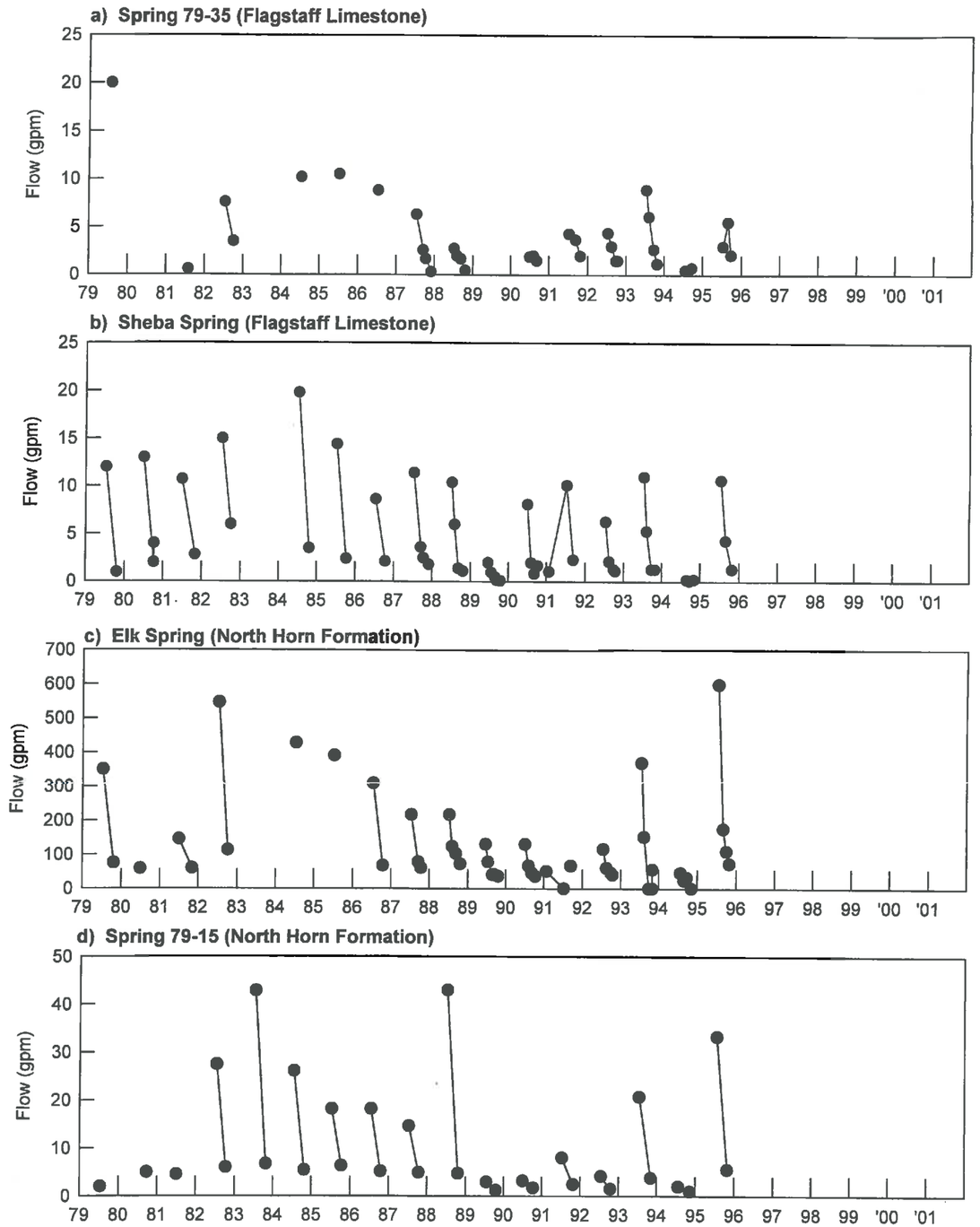

Figure 12 Selected discharge hydrographs for springs issuing from the Flagstaff Limestone, North Horn Formation, Price River Formation, and the Castlegate Sandstone/Blackhawk Formation contact.

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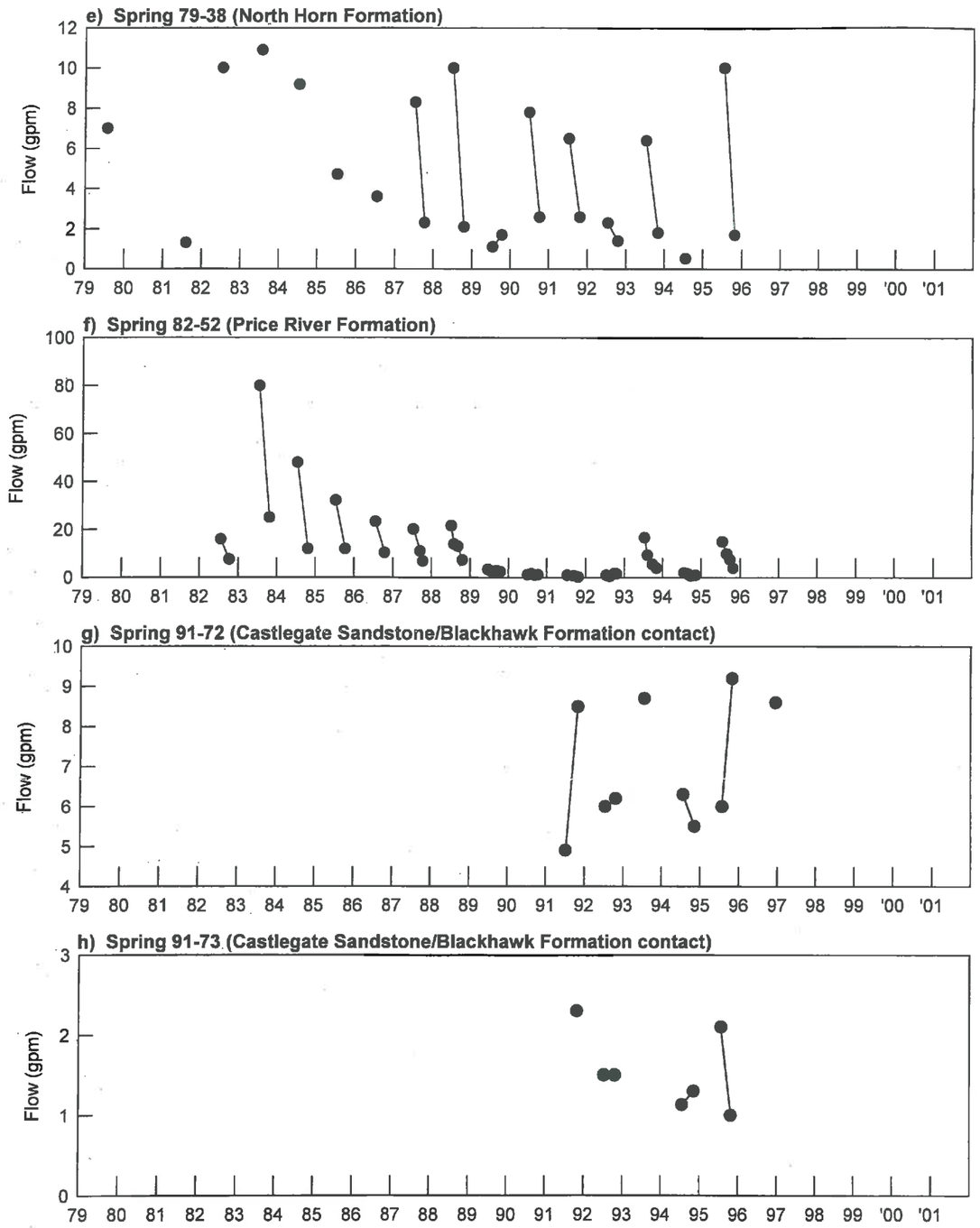

Figure 12 Continued.

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7.1.2 Flagstaff Limestone Springs

Flagstaff Limestone spring discharges respond to both seasonal recharge and climatic factors. Hydrograph recession characteristics indicate that these springs are dependent on annual recharge events. For example, Spring 79-35 had a maximum discharge of about 20 gpm in 1979, but has gone completely dry at least three times since then (Figure 12a). Both climatic and seasonal effects are also illustrated in the Sheba Spring hydrograph (Figure 12b).

7.1.3 North Horn Formation Springs

North Horn Formation Springs respond to annual recharge from snowmelt events and exhibit a wide range of discharge rates (Figures 12c, and e). These springs may have spring time discharges as great as 600 gpm less and than 5 gpm during the late fall. For example, the discharge from Elk Spring (Figure 12c) increased from 24 gpm in November 1994 to 600 gpm the following July 1995.

Discharge from most North Horn Formation springs is also dependent on long-term climatic trends. Substantial declines in peak flow discharges are observed in most hydrographs for data collected in the late 1980s and spikes in peak flow discharge occurred in the springtime 1994 and 1996 (Figure 12c).

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7.1.4 Price River Formation Springs

These springs have similar discharge characteristics as North Horn Formation springs. Long-term discharge data are only available for one Price River Formation spring. Seasonal variability is apparent in the hydrograph for Spring 82-52 (Figure 12f).

7.1.5 Blackhawk Formation-Castlegate Sandstone Contact Springs

Seven springs have been identified which discharge from near the Castlegate Sandstone-Blackhawk Formation contact. Limited discharge data are only available for two of these (Springs 91-72 and 91-73). Hydrographs for these springs are shown on Figures 12g and h. Although the data are limited, the data suggest that the discharges from the springs are somewhat seasonally dependent. Sufficient discharge data are not available to determine the response of these springs to long-term climatic trends.

7.1.6 Blackhawk Formation Springs

Only 2 springs (80-50 and 84-57) have been identified which discharge from the Blackhawk Formation and only four flow measurements are available. The discharges measured from these springs are low, averaging only 1.6 gpm.

7.1.7 Little Bear Spring

Little Bear Spring discharges at about 200-500 gpm from a fracture system in the Panther Member of the Star Point Sandstone in Little Bear Canyon approximately 1.5 miles east of the Mill Fork Lease (Mayo and Associates, 2001b). Little Bear Spring is of particular

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importance in the area because it is a primary culinary water supply for the towns of Huntington, Cleveland, and Elmo.

The fact that Little Bear Spring discharges modern water (Table 5), shows marked seasonal discharge variations and responds to short term climatic cycles indicates that it is supported by shallowly circulating groundwater. The groundwater that supports Little Bear Spring is not related to the deep, old groundwater encountered in area coal mines.

Results of in-mine slug testing of the Star Point Sandstone beneath the Crandall Canyon Mine conducted by Genwal Resources (Mayo and Associates, 1997b) indicate that diffuse, matrix flow of groundwater through the Star Point Sandstone cannot be an important source of recharge to Little Bear Spring. Flow calculations using the hydraulic conductivities obtained from the slug testing and the approximate hydraulic gradient indicate that diffuse flow through the Star Point Sandstone is capable of yielding at most only a few gpm of groundwater discharge, which would represent only a very small percentage of the spring discharge. The ancient age of groundwater encountered in the Star Point Sandstone beneath the Crandall Canyon Mine adjacent to Little Bear Spring (19,000 years; Mayo and Associates, 1997a) supports this conclusion.

Mayo and Associates (2001a,b) suggested that Little Bear Spring is primarily recharged from surface water losses and alluvial groundwater losses in Mill Fork Canyon east of the Mill Fork Lease.

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7.2 In-Mine Groundwater

In the Wasatch Plateau and in mines adjacent to the Mill Fork Lease groundwater enters the mine environment from three sources (Mayo and Associates, 1997a, c, d; Mayo and Morris, 2000). These sources include: 1) drainage from overlying sandstone channels which are penetrated by roof-bolts and by vertical boring, or which are exposed during mining, 2) upward leakage from the underlying Spring Canyon Member of the Star Point Sandstone, and 3) interception of water bearing faults and fracture systems which transmit water from either overlying or underlying horizons. The coal has not been observed to support groundwater systems and permeability studies on unfractured coal samples in the West Elk Mine in Colorado indicate that the coal is essentially impermeable (Mayo and Koontz, 2000).

Energy West has monitored groundwater inflows into each of its mines since 1979. Inflows are described below.

7.2.1 Sandstone Channel Groundwater

The most common source of groundwater entering the mine environment is from sandstone channels that overlie the coal seams. This water issues from both roof bolt holes and from post mining fractures that form in the sandstone. Detailed mapping by Energy West in the Deer Creek, Trail Mountain, and Cottonwood mines illustrate the braided character of the channels (Figures 13 and 14). The channels may be several miles long, up to 1000 feet wide, and are commonly 25 to 30 feet thick. The varying degrees of water saturation of the channel sands and intervening clays result in wet and dry regions of the mine.

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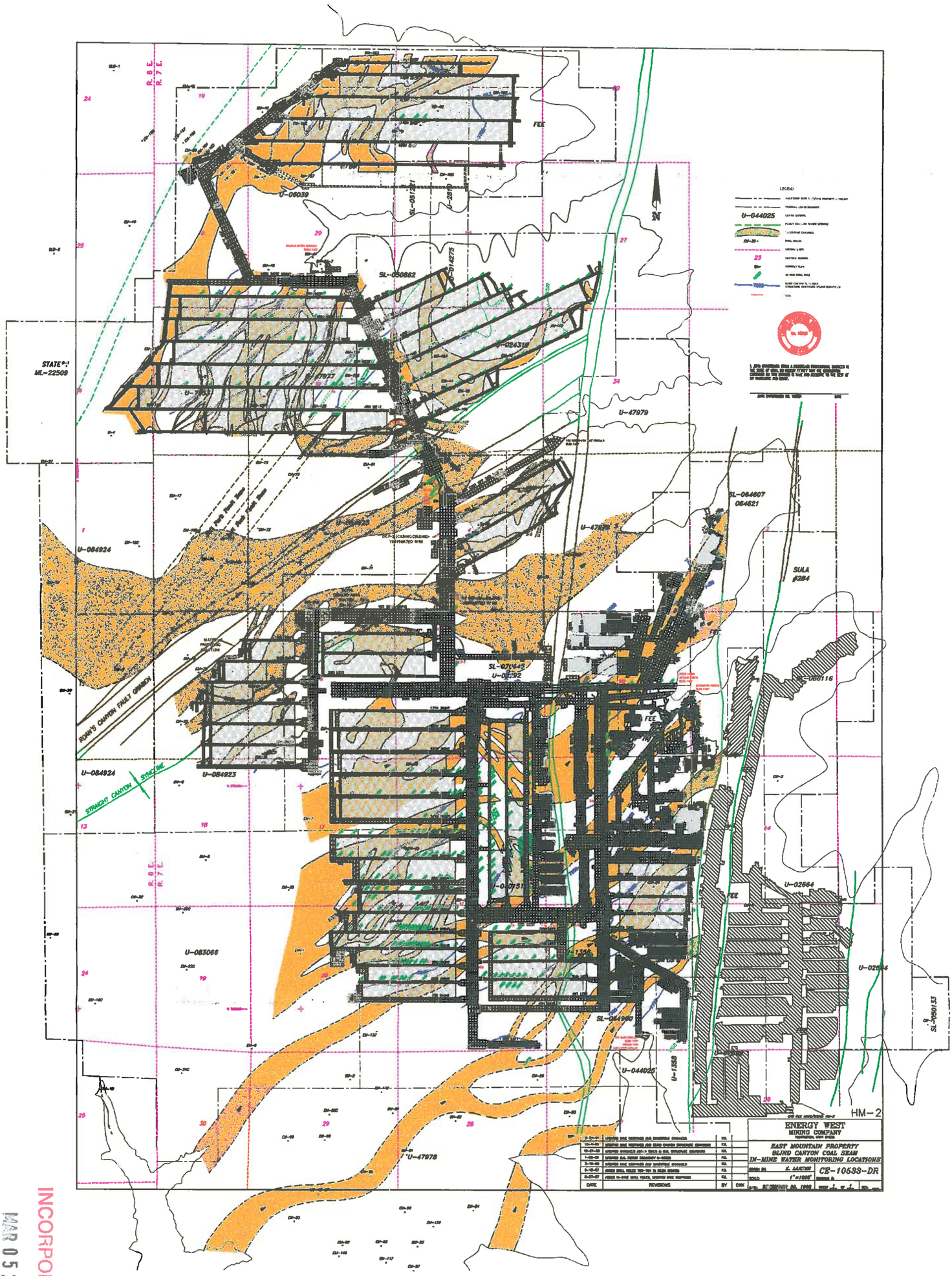

Figure 13 Sandstone Channels in the Deer Creek Mine.

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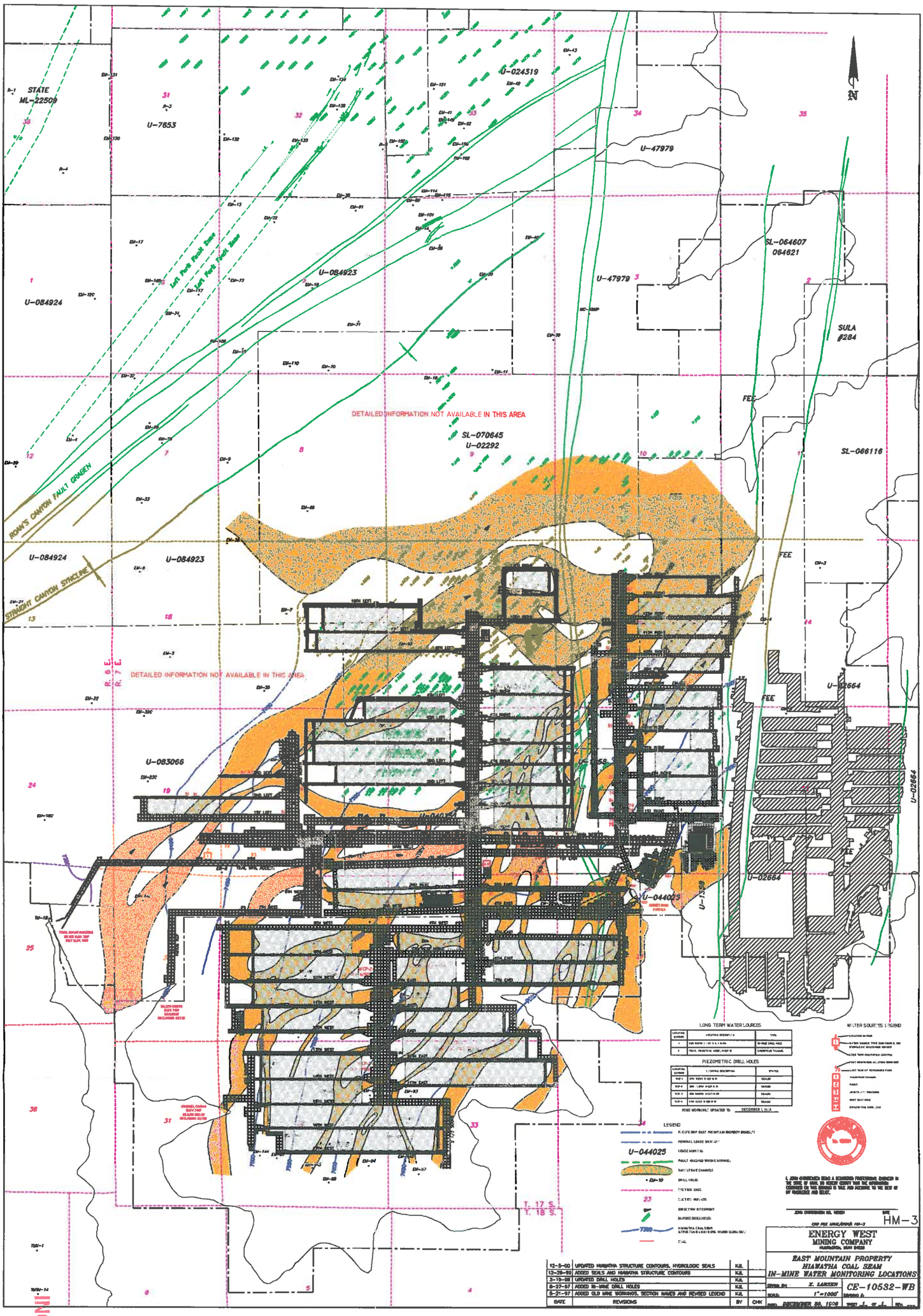

Figure 14 Sandstone channels in the Trail Mountain Mine.

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It is common in "wet" portions of the mines for roof-drip groundwater to be encountered at the mining-face during mining operations. Most roof-drips typically are short lived, persisting for only a few weeks before the flow completely ceases. Thus, the roof-drips appear to "dry up" behind the mining operations. The discharges from these short-lived inflows into the mine are typically not recorded. In other portions of the mines, the coal seam and adjacent rocks are completely dry.

Occasionally, areas with greater, more persistent inflows are encountered. These sources are usually associated with faults or and sandstone channels that contain greater quantities of water. Such fault-channel systems are discussed in Section 7.2.3 below.

Typical hydrographs of roof drips that have not dried up immediately are shown on Figure 15. It is significant to note that the long-term discharge from these sources are typically less than 2 gpm. The discharge declines of the hydrographs typically follow an exponential decay, with the greatest flow occurring immediately after the source is completely exposed and then falling off rapidly. The tail end of the discharge hydrograph typically trails off gradually, with slowly decreasing rates of discharge. Near the end of the discharge recession, the discharge hydrograph may appear nearly flat. Carbon-14 ages of 6,500 and 12,000 years (Table 5) have been determined for groundwater issuing from locations TMA X 32 and 2S X 11, respectively. These ages indicate that the groundwater discharging form roof drips are not in active communication with near surface groundwater or surface water.

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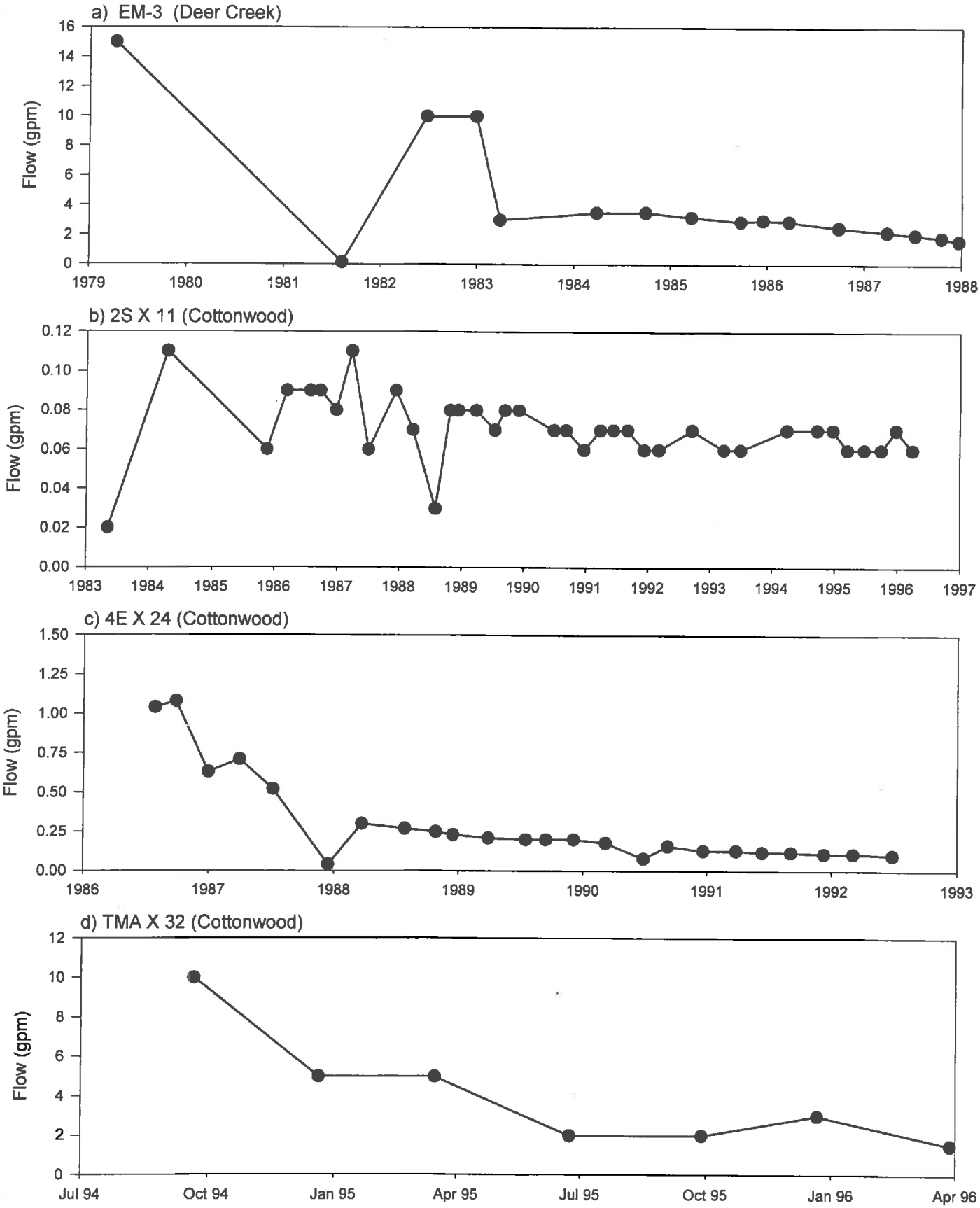

Figure 15 Hydrographs of selected in-mine roof drips.

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In an attempt to quantitatively evaluate saturated sandstone channels, a dripping channel in the 6th West area of the Deer Creek Mine was investigated (site 6W X 20; Mayo and Associates, 1997d). The channel, located near a minor fault with very limited displacement, had the dimensions of >2,000 feet in length, 150 feet in width and a maximum thickness of 25 feet. An array of up-hole monitoring wells was installed across the width of the channel. The wells were 15 to 25 feet deep and were open along their entire depth. Each well was equipped with a shutoff valve and pressure gauge. The idea was to conduct a pump test by letting selected wells gravity drain and simultaneously measuring pressure change in nearby wells. Because the maximum pressure in the wells was about 2 psi (i.e. ≈ 5 feet of water) the test could not be conducted. What the wells demonstrated was that the sandstone channel was not fully saturated and it was a perched, unconfined groundwater system. Water issuing from the channel has a mean ^{14}C age of 2,000 years (Table 5). The perched, unconfined groundwater system evaluated in the 6th West area is consistent with the commonly observed roof drip conditions.

7.2.2 Sandstone in the Mine Floor

Occasionally small amounts of groundwater have been observed to discharge from sandstone underlying coal seams in Energy West's mines and other mines in the Wasatch Plateau. However, in 1997 substantial groundwater inflows issued from the mine floor in Energy West's Trail Mountain Mine (Mayo and Associates, 1997d). In the southern portion of the mine, at the down plunge end of the Straight Canyon syncline, the Hiawatha seam is located directly on the Spring Canyon Member of the Star Point Sandstone. When the coal was

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removed approximately 200 to 300 gpm of groundwater discharged from mine floor. Mine floor discharges continued until the Spring Canyon Member was depressurized.

7.2.3 Fault Zone Groundwater

Groundwater has been encountered in 3 faults in the Energy West mines. These include the Pleasant Valley Fault in the both the Deer Creek Mine and Cottonwood/Wilberg Mine, the Roans Canyon Fault, and the Left Fork Graben in the Deer Creek Mine. Fault water has also been encountered along the Joes Valley Fault system in the Crandall Canyon Mine (Mayo and Associates, 1997a, 1997c). The groundwater flow regimes associated with each of these faults are described below.

7.2.3.1 Pleasant Valley Fault

The Pleasant Valley Fault is a north-south trending fault, which is exposed in both the Wilberg and Deer Creek Mines (Plate 1; Figure 5). The fault was first encountered in the early 1970s by Peabody Coal Company during the construction of rock slopes and has been encountered in at least 4 different locations in the Wilberg Mine. When the fault was first crossed during mining, groundwater discharge primarily occurred as floor upwelling in the Wilberg mine and as roof drips in the Deer Creek Mine. The discharge rate was small and never exceeded 50 gpm in any location. PacifiCorp's initial monitoring location in the Wilberg Mine discharged 50 gpm. Within 2 or 3 months, the flow from the fault had diminished greatly and the sampling point became only a puddle on the floor (Semborski, Personal Communication, 1997). Groundwater discharge rates from other locations on the Pleasant Valley Fault are also small but are more constant.

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Groundwater discharging from the Pleasant Valley Fault, sampled as part of this investigation, is of ancient origin. Three samples of fault-related groundwater were collected in 1997 for radiocarbon dating (6W X 20 and MN-ME in the Deer Creek Mine, and 1.5N X 29 Fault in the Wilberg Mine; Table 5). The recession hydrograph for MN-ME (Figure 16) shows that discharge has steadily declined from about 0.5 to 0.2 gpm over 4 years. Groundwater issuing from 6W X 20, MN-ME and 1.5N X 29 have ^{14}C ages of 2,000, 7,000 and 4,500 years, respectively (section 8.5; Table 5).

7.2.3.2 Roans Canyon Fault

The Roans Canyon fault system forms a graben which trends in a northeasterly direction through the middle of Trail Mountain and northern East Mountain (Plate 1; Figure 5). The fault is parallel with and adjacent to the axis of the Straight Canyon Syncline. The Roans Canyon Fault was first encountered in the Deer Creek Mine in a series of horizontal drill holes completed in 1985. A second series of horizontal drill holes penetrated the fault system in 1989. The purpose of these drill holes was to evaluate the porosity of the fault system and to evaluate the potential for dewatering the fault ahead of mining operations. Limited lateral communication along the fault system was suggested by the fact that discharge from drill holes located only 200 feet apart did not significantly affect the discharge rates of the individual holes.

The fault was first encountered in the mine in the 1st Right entries in January 1990. Substantial groundwater inflows of several hundred gallons per minute occurred in each of

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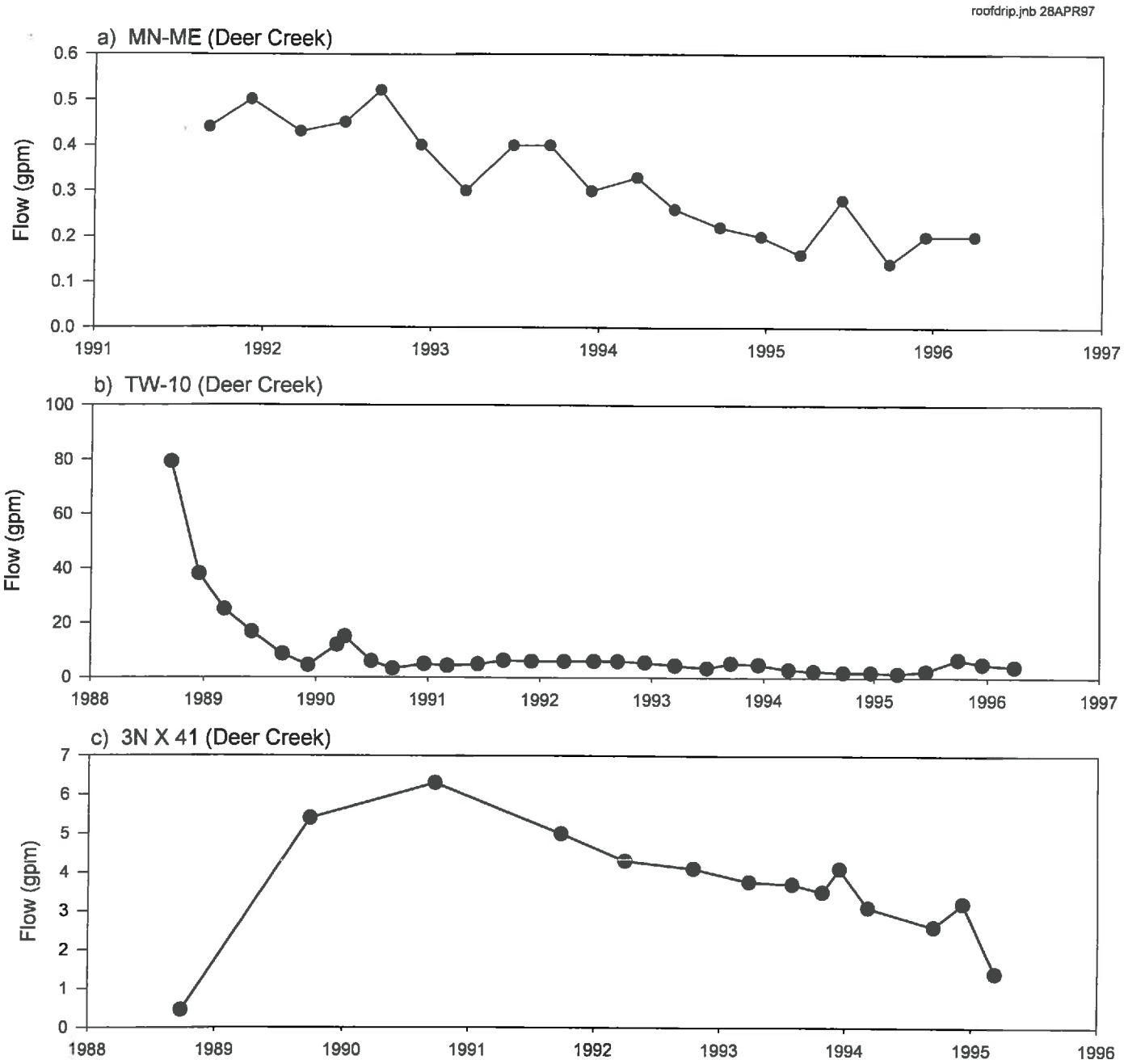

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Figure 16 Hydrographs of selected in-mine roof drips associated with faults

the entries. The water discharging from the fault was entirely from the roof and appeared to be related to a large, overlying sandstone channel. A small synthetic fault with less than 5 feet of offset associated with the Roans Canyon Fault was subsequently encountered in the 2nd Right entries in April 1990. Peak discharge from was estimated at 5,000 gpm (Semborski, Personal Communication, 1997). The last measurement of discharge from the fault zone, from an established monitoring point, was 150 gpm. Currently, the discharge from the fault zone is believed to be less than 150 gpm. The large discharge rate from the Roans Canyon Fault had a profound effect on the rate of Deer Creek Mine discharge.

Groundwater from the Roans Canyon Fault was encountered with a series of test wells including TW-10, a 1,100 foot long horizontal hole drilled into the fault system in the Deer Creek Mine (Plate 1). It was apparent during drilling that groundwater issuing from TW-10 was from a sandstone channel that had been highly fractured. Ubiquitous iron oxide in the fractured sandstone indicated that water in the fracture had been in good communication with atmospheric gases (Semborski, Personal Communication, 1997). Although TW-10 is under considerable cover (1,200 feet), it is located near cliff faces. The cliff face rocks are extremely fractured and open to recharge water. The average temperature of groundwater from TW-10 is 7.7°C while the average temperature of other groundwaters in the Deer Creek Mine is 11.8°C.

The discharge rate from TW-10 has declined from about 80 gpm in 1989 to about 5-6 gpm in 1997. Groundwater sampled from this location in 1996 contained anthropogenic ^{14}C and had a ^{3}H content of 20.8 TU (described below, Table 5). These data indicate that groundwater

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discharging from TW-10 was in hydraulic communication with recent recharge water. Discharge from TW-10 does not exhibit seasonal fluctuations indicating that the hydrodynamics of this system are buffered. This buffering may be due to a tortuous flow path, which means a longer travel time, or the mixing of modern recharge water with older water. It is possible that the initial water intercepted by the drill hole was of similar old age as other waters encountered in the mine. Prior to intercepting the fault, the fault may have been full and rejected recharge may have occurred.

In an attempt to determine whether groundwaters discharging from the Roans Canyon Fault, deeper in the mine and away from the cliff face, are tied to active, modern groundwater systems, a sample of the longwall gob water (3S Seals) in the Deer Creek Mine was collected and analyzed for isotopic composition (Mayo and Associates, 1997d). It is important to note, however, that this water is a composite sample of groundwater discharging from the fault and other in-mine sources, and a small percentage of Huntington Creek water used as process water in mining operations. The ^{14}C age of this sample is 12,000 years, with a tritium content of 0.9 TU (Table 5). We believe that the small component of tritium in the water is derived from the creek water. Therefore, we conclude that the groundwater in the Roans Canyon Fault deep within the mine, away from cliff faces, is of ancient origin and is likely not related to overlying shallow groundwater systems.

7.2.3.3 Joes Valley Fault

Groundwater inflows have occurred in the vicinity of Joes Valley Fault in the Crandall Canyon mine (Mayo and Associates, 1997a, c). Water discharged from the mining face,

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from the mine roof about 200 feet from the fault, and from fractured coal in the floor along an exposed reach of the fault in the mine. The upwelling water did not appear to be under significant confining pressure and the inflow rates were small. Three samples were collected for age dating. A sample collected from Joes Valley Fault, Main West fault, had a radiocarbon age of 2,500 years and did not contain tritium (Table 5). A sample collected from a well completed in the underlying Spring Canyon Member of the Star Point Sandstone, MW-7 which is located 200 feet from Joes Valley Fault, had a radiocarbon age of 5,000 years and did not contain tritium. A sample collected from a fractured sandstone channel in the mine roof, 5th West fault, located about 300 feet from Joes Valley Fault, had a radiocarbon age of 3,500 years and a minor tritium content (0.95 TU).

7.3 Wells

Historic water-level monitoring information is available for 16 wells from the study area. These wells monitor groundwater levels in alluvial systems, the Blackhawk Formation, and the Star Point Sandstone.

7.3.1 Alluvial system wells

7.3.1.1 Cottonwood Canyon

Energy West currently monitors three wells completed in alluvium in Cottonwood Canyon. These include CCCW-1A, CCCW-2A, and CCCW-3A (Plate 1). Well screen intervals and gravel pack intervals are:

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Well	Screen interval (ft)	Gravel pack (ft)
CCCW-1A	96 – 126	40-136
CCCW-2A	96-126	42-136
CCCW-3A	51 – 81	83-101

Hydrographs for each of these wells (Figure 17) show responses to annual precipitation. The somewhat muted hydrograph responses may be the result of depth of the screened intervals.

7.3.1.2 Rilda Canyon

Seven shallow wells were constructed in alluvium in Rilda Canyon in the mid 1980s (Plate 1). Hydrographs for these wells, identified as P-1 through P-7, are shown in Figure 18. All of the wells show the effects of annual precipitation. The hydrographs for P-1 and P-5 show less response to seasonal precipitation than do the other hydrographs. Well P-1 is located downgradient and is likely affected by the discharge from a series of upgradient springs. Well P-5 is located in the creek bottom near the NEWUA collection system. Previous researchers have suggested that the smaller hydraulic fluctuations observed in these wells are likely due to the situation of the wells in the narrow creek bottom above bedrock highs where alluvial groundwater is forced to flow near the surface (Semborski, Personal Communication, 1997).

7.3.2 Blackhawk Formation wells

Only 1 well, CCCW-3SU, monitors groundwater levels in the lower Blackhawk Formation. The well head is situated atop alluvial deposits in the bottom of Cottonwood Canyon (Plate

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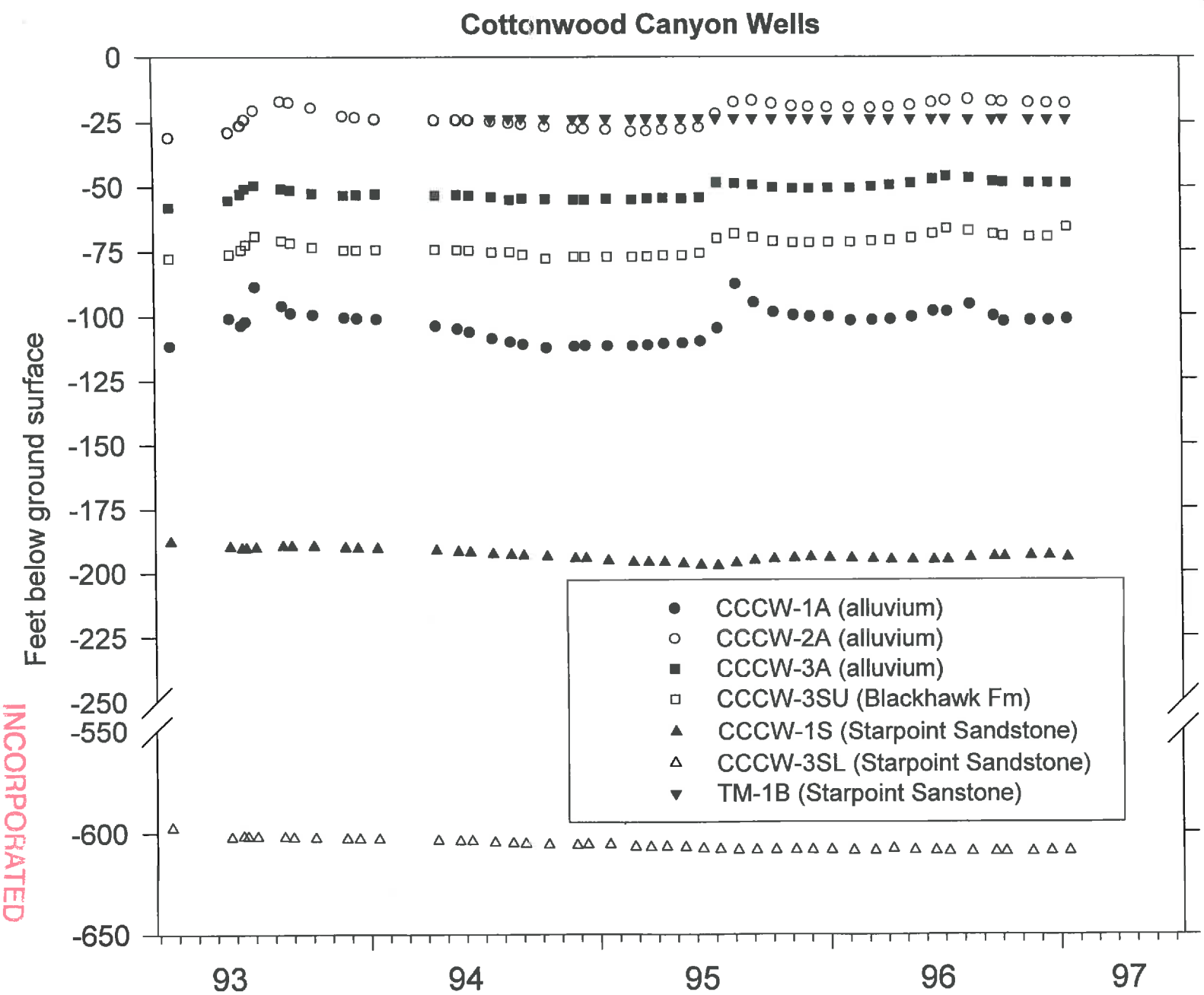

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Figure 17 Hydrographs of wells in Cottonwood Canyon.

Mayo and Associates, LC
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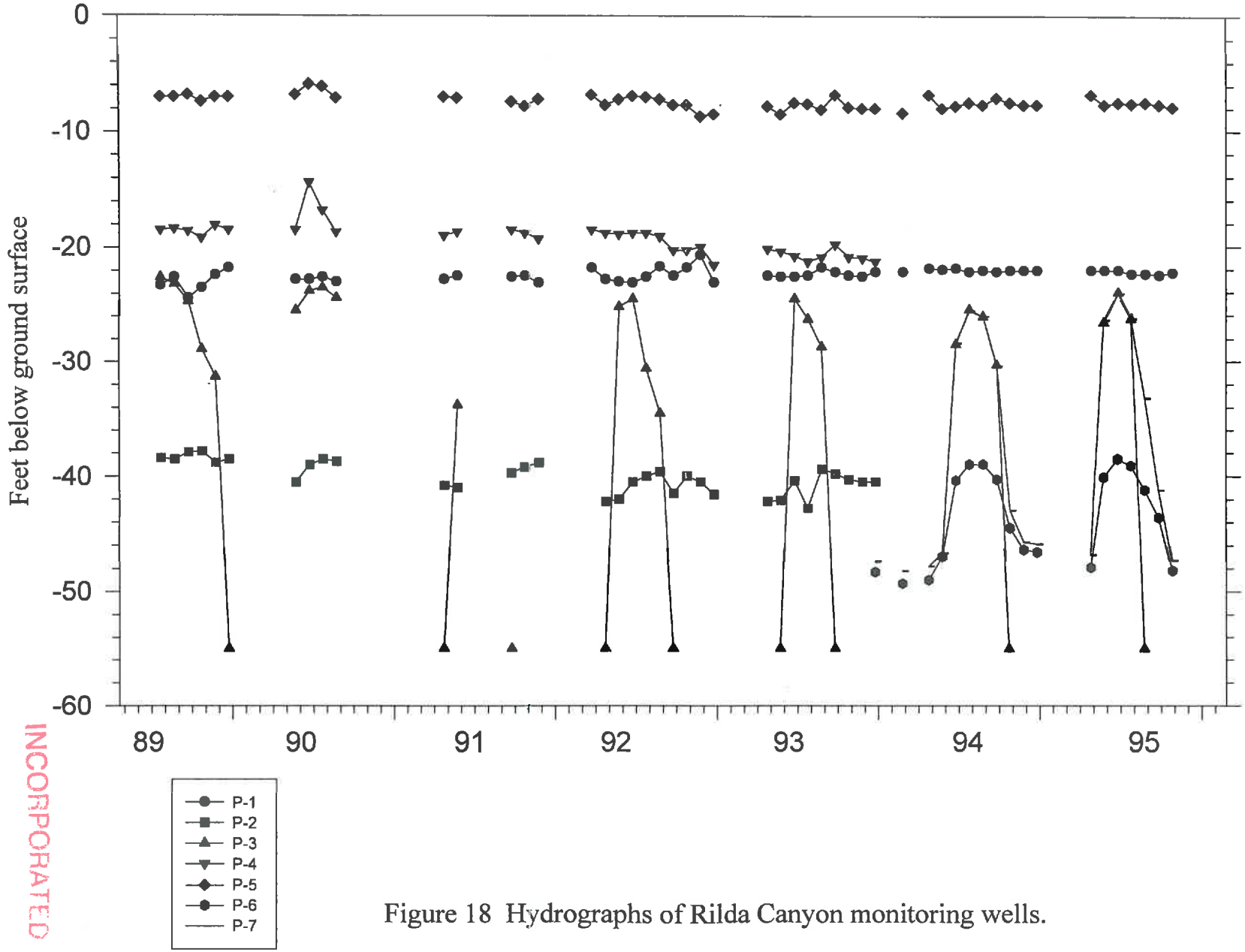

Figure 18 Hydrographs of Rilda Canyon monitoring wells.

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1). The well hydrograph (Figure 17) suggests that near surface outcrops of the Blackhawk Formation responds to annual precipitation. However, the seasonal responses may also be due to hydraulic communication between overlying alluvial sediments and the well gravel-pack. The hydrograph response is similar to hydrographs in nearby alluvial system wells and the distance from the base of the alluvial deposits to the top of the gravel-pack zone is only 27 feet.

7.3.3 Star Point Sandstone Wells

Six monitoring wells have been completed in the Star Point Sandstone from the surface. The locations of the wells are shown on Plate 1, and each well is described below:

7.3.3.1 Well CCCW-1S

Well CCCW-1S is located in Cottonwood Canyon near the axis of the Straight Canyon Syncline (Plate 1). The well has a total depth of 720 feet, and is screened between 655 to 705 feet in the Spring Canyon Member. There is approximately 475 feet of potentiometric pressure in water in the well and the potentiometric level declined slightly, approximately 10 feet, between early 1993 and early 1995. Since then the water level in the well has remained relatively constant (Figure 17). The well hydrograph does not respond to seasonal recharge.

7.3.3.2 Well CCCW-3S L

Well CCCW-3SL is located in Cottonwood Canyon (Plate 1). The well has a total depth of 730 feet, and is screened between 680 and 730 feet in the Spring Canyon Member. The well is part of a multiple completion well with well CCCW-3SU. There is approximately 80 feet

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of potentiometric pressure in the well and the potentiometric level declined slightly, approximately 5 feet, between early 1993 and early 1994. Since then the water level in the well has remained relatively constant (Figure 17). The well hydrograph does not respond to seasonal recharge.

7.3.3.3 Well TM-1B

Well TM-1B is located stratigraphically below the Trail Mountain Mine portal in Cottonwood Canyon (Plate 1). The well has a total depth of 500 feet, and is screened between 380 and 460 feet in the Panther Tongue. There is approximately 350 feet of potentiometric pressure in water in the well. The potentiometric level has remained constant and the well hydrograph does not respond to seasonal recharge (Figure 17).

7.3.3.4 Well TM-3

Well TM-3 is located at the south end of the Trail Mountain Lease in Straight Canyon (Plate 1). The well has a total depth of 560 feet, and is screened between 505 and 555 feet in the Spring Canyon Member. When first completed in September 1993, the well flowed freely at the surface and maintained a constant shut-in pressure of 64 psi (approximately 150 feet) for several years. The well was opened in December 1996 and allowed to free flow at approximately 20 gpm for one week . On August 22, 1997, the water level had declined to 75 feet below land surface (Semborski, Personal Communication, 1997). It is likely that the decrease is the result of depressurization of the Spring Canyon Member as described in Section 7.2.2.

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7.3.3.5 Well EM-31

Well EM-31 is located in Cottonwood Canyon (Plate 1). The well head is located on alluvial deposits just above the Trail Mountain Mine portals. The thickness of the alluvium at the well head is 20 feet. A 20-foot thick layer of sandstone and a 10-foot thick sequence of interbedded siltstone and mudstone underlie the alluvium. The well was has a total depth of 280 feet. Although the well casing is perforated from 190 to 250 feet, the gravel-pack zone extends from 50 feet to 280 feet which provides opportunity for vertical communication between saturated horizons. The hydrograph of EM-31 (Figure 19) shows that the well responds subtly to annual precipitation and long-term climatic cycles. We believe that these hydraulic responses are due in part to hydraulic communication between the gravel-pack zone and shallow, overlying groundwater systems. The Star Point Sandstone, in other locations, does not respond to annual precipitation or climatic trends.

7.3.3.6 EM-47

Well EM-47 is located in Rilda Canyon (Plate 1). The well head is located in alluvial deposits near Rilda Canyon Creek. The well has a total depth of 300 feet, and is screened between 210 and 270 feet in the Spring Canyon Tongue. Water levels in the well respond to annual precipitation events, and since about 1986 there has been a general decline in water levels (Figure 19). The annual responses are attributed to well completion problems rather than to fluctuations in water levels in the Spring Canyon Member. The coarse gravel-pack interval in this well is from 50 to 300 feet. The gravel used was 0.25 to 0.375 inches in diameter. The thickness of the alluvium at the surface is 25 feet, and the bedrock underlying the alluvium is a continuous sandstone layer that extends to a depth of 70 feet. Thus there is

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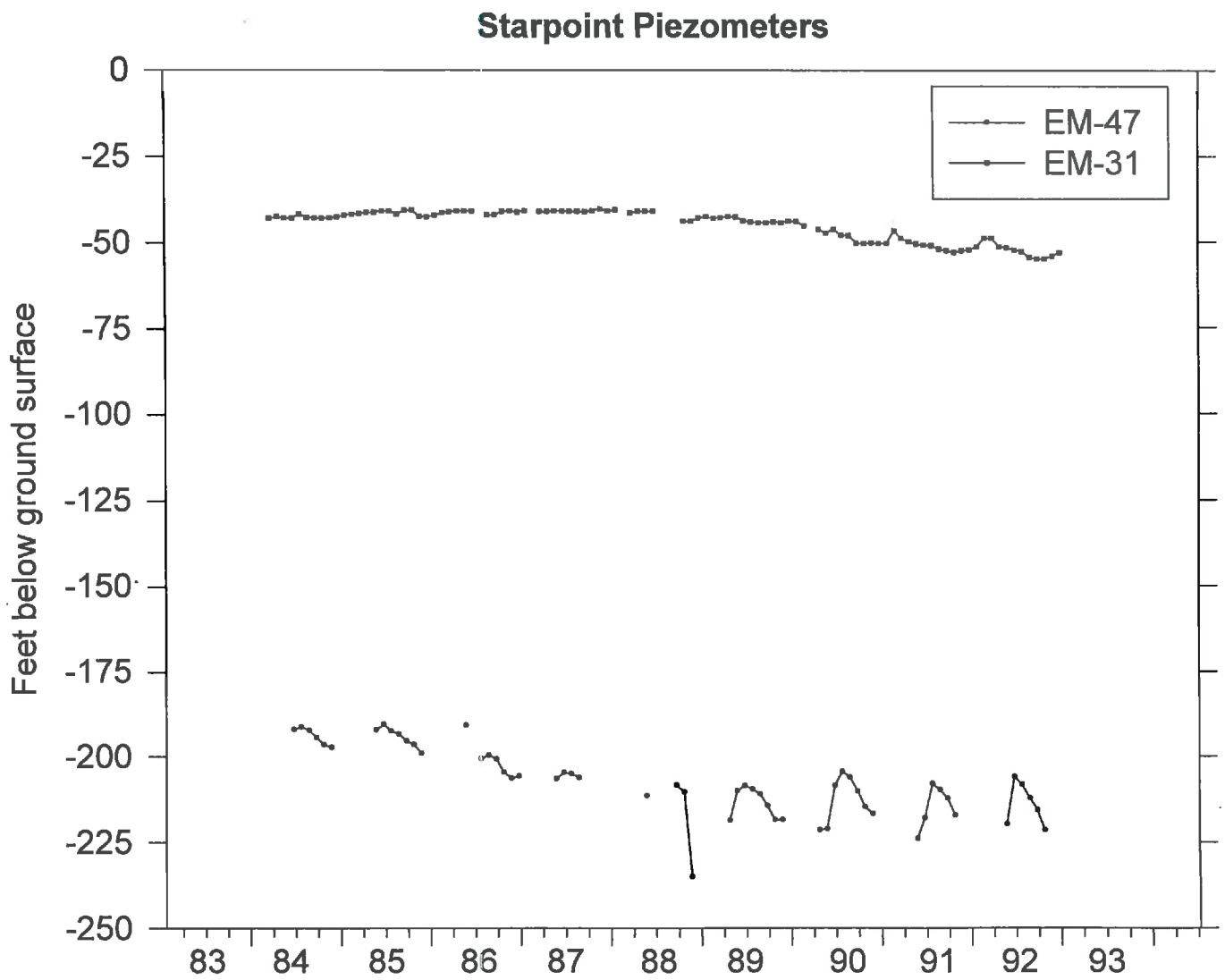

Figure 19 Hydrographs of water levels in two Star Point Sandstone piezometers.

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only 25 feet of sandstone separating the gravel-pack from the surface alluvium. The general decline in water surface elevation since about 1986 may be the result of climatic variability.

7.3.4 In-mine piezometers

7.3.4.1 Deer Creek Mine

In late 1989 four piezometers were constructed in the Deer Creek Mine to monitor groundwater levels in the lower portion of the Blackhawk Formation and in the Spring Canyon Member of the Star Point Sandstone beneath the mine workings. The piezometers designated DCP-1 through DCP-4, and are all located in the 3rd North/ 1st West Mains area (Plate 1). Each of the wells has a 20-foot surface casing and is open for 150 feet below that. Thus, each of the wells is open to Blackhawk Formation sandstones and claystones located above the Hiawatha seam, the Hiawatha coal seam, and the Spring Canyon Member of the Star Point Sandstone. What this means is that water levels represent composite hydraulic heads and are not necessarily representative of the Spring Canyon Member or the lower Blackhawk Formation.

Two of the piezometers (DCP-1 and DCP-4) had initial static water levels which rose to the bottom of the mine workings (Blind Canyon seam), and two of the piezometers (DCP-2 and DCP-3) had initial static water levels which rose to the middle of the lower portion of the Blackhawk Formation. Between mid-1990 and mid-1993 a transient potentiometric level decline occurred in Wells DCP-1, DCP-3, and DCP-4 (Figure 20). Mine workings containing DCP-2 and DCP-4 were sealed in late 1991, workings containing DCP-3 were

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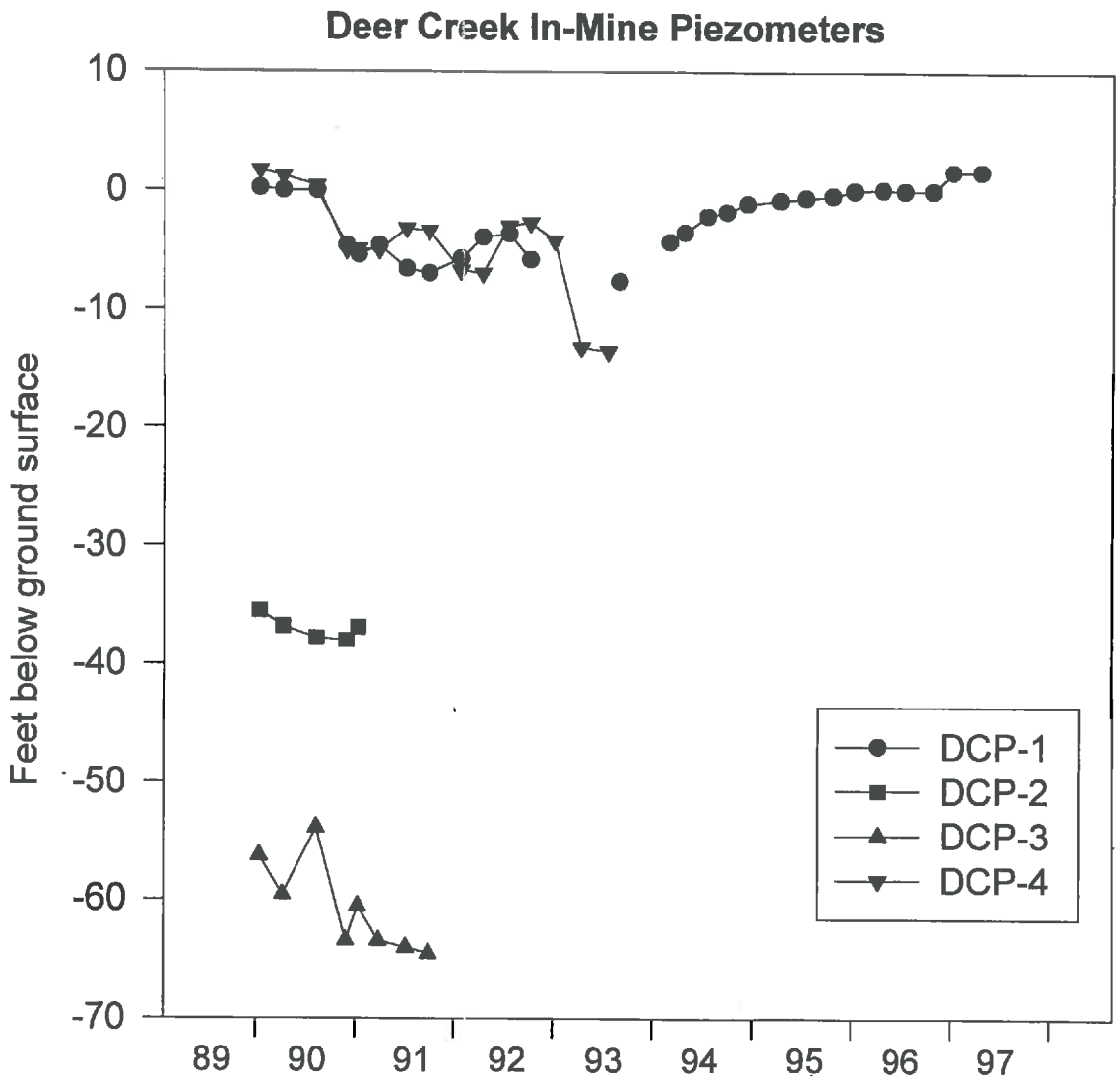

Figure 20 Hydrographs of water levels in in-mine piezometers in the Deer Creek Mine.

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sealed in late 1993, and data collection ended. By early 1997 the potentiometric level in DCP-1 recovered to the initial static level.

There are two possible causes of the transient response. The potentiometric decline approximately coincides with the Roans Canyon Fault dewatering. However, it is difficult to envision a correlative mechanism. The fault drained a sandstone channel located above Blind Canyon Seam and the piezometers are located below the seam 0.3 to 1 mile southwest of the fault. If the decline were related to fault dewatering, there is not a mechanism for piezometric recovery.

The transient response is most likely related to mining along the Straight Canyon Syncline in an area located down dip and to the west of the piezometers and not to depressurization and subsequent repressurization of the Spring Canyon Member. During mining, considerable floor water was encountered. Upon completion of mining, the area was sealed and flooded. We believe that the piezometric decline was the result of the down gradient depressurization and recovery in the lower portion of the Blackhawk Formation.

7.3.4.2 Cottonwood Mine piezometers

In late 1989 four piezometers (WCP-1 through WCP-4) were constructed in the Cottonwood Mine to monitor groundwater levels in the Spring Canyon Member of the Star Point Sandstone (Plate 1). Each of the wells has a 10-foot surface casing and is open hole for 60 to 130 feet below that. Thus, each of the wells is open to Spring Canyon Member and interbedded clays separating the Spring Canyon Member from the Storrs Member. Well

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WCP-1 is also open to the upper portion of the Storrs Tongue. The workings containing the piezometers were progressively sealed starting in late 1989 to late 1990 and data are not available after that.

Potentiometric levels in wells WCP-2, WCP-3, and WCP-4 show no seasonal variations. Water levels increased slightly in WCP-3 and WCP-4 (Figure 21). The potentiometric data for WCP-1 suggests some fluctuation in the hydraulic head in the well. However, it is believed that the fluctuations in head are the result of a malfunctioning pressure transducer and are not representative of actual conditions in the formation. The pressure transducer was replaced in early 1990. Seasonal variations in potentiometric levels are not observed.

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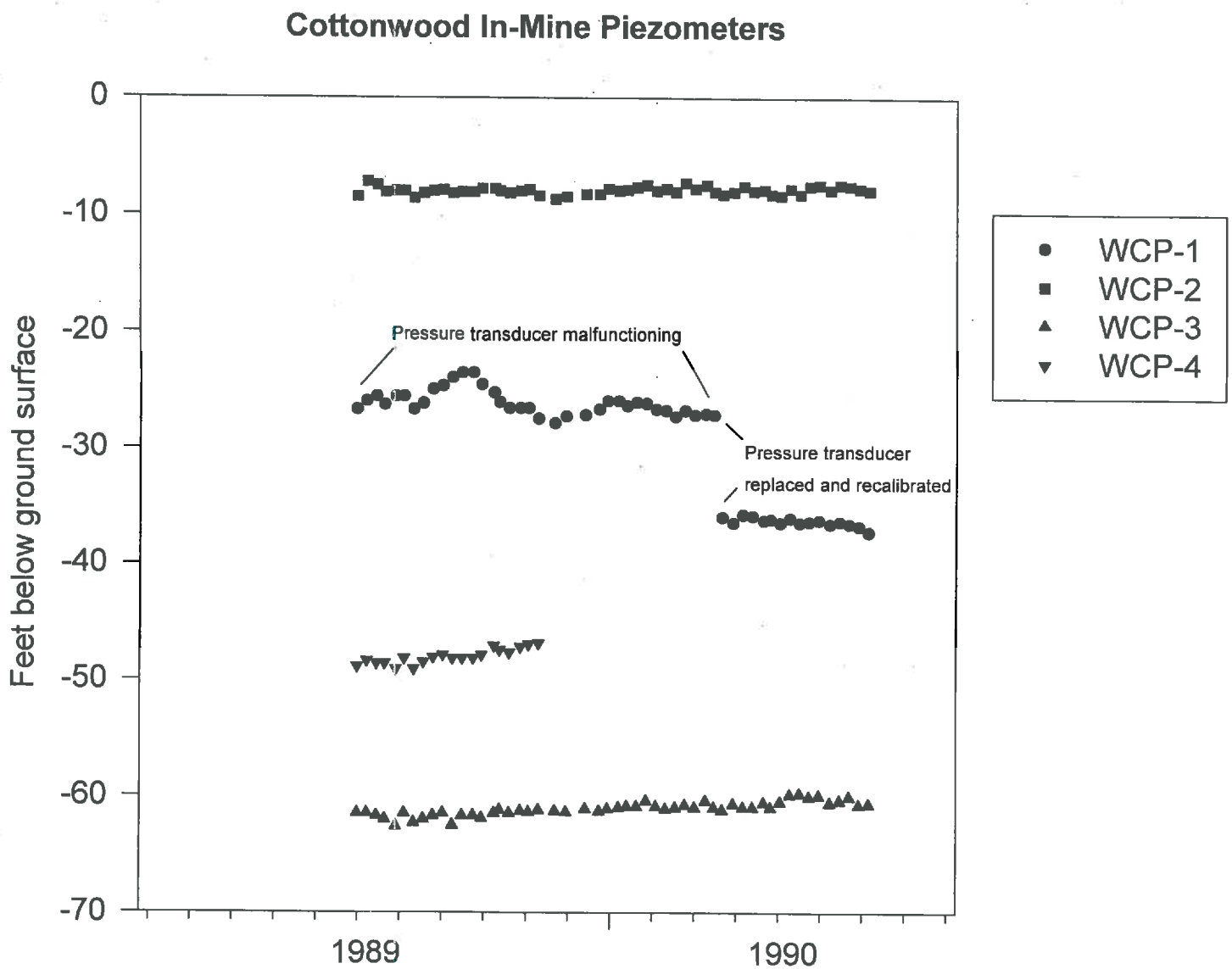

Figure 21 Hydrographs of water levels in in-mine piezometers in the Cottonwood Mine.

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8 SOLUTE AND ISOTOPE CHEMISTRY

8.1 Explanation of chemical reporting units and terms

Reporting units are milligrams per liter (mg/l) and milliequivalents per liter (meq/l) for ionic solutes and per mil (‰) for stable isotopes. Stable isotopic reference standards are Standard Mean Oceanic Water (SMOW) for δ^2H and $\delta^{18}O$, Pee Dee Formation Belemnite (PDB) for $\delta^{13}C$, and the Canyon Diablo Meteorite (CD) for $\delta^{34}S$. The radioactive isotope ^{14}C is reported relative to percent modern (1950) carbon (pmc), and the radioactive isotope ^3H is reported in tritium units (TU). One TU is equivalent to 3.2 pCi/l (pico-Curies per liter).

In addition to the familiar mg/l concentration unit, laboratory solute data have been converted to meq/l for analysis and reporting purposes. The meq/l unit allows direct comparison of reacting concentrations of cations and anions. Conversion factors between meq/l and mg/l for major ions follow:

	meq/l	mg/l
Ca^{2+}	1	20.0
Mg^{2+}	1	12.2
Na^+	1	23.0
K^+	1	39.1
HCO_3^-	1	61.0
SO_4^{2-}	1	48.0
Cl^-	1	35.5

From the conversion factors it is apparent that heavy anion molecules such as SO_4^{2-} and HCO_3^- contribute disproportionately to TDS relative to their reacting cation counterparts, such as Ca^{2+}.

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The stable isotopic composition of a sample is reported as the per mil (‰) difference of the sample relative to the isotopic composition of a standard using the delta (δ) notation defined as:

$$\delta = \frac{(R_{sample} - R_{standard})}{(R_{standard})} x1000 \ (‰)$$

Where R = $^{18}O/^{16}O$, $^{2}H/^{1}H$, $^{13}C/^{12}C$, and $^{34}S/^{32}S$. The δ notation is reported in terms of the heavy isotope in the ratio R (i.e., $\delta^{13}C$ for $^{13}C/^{12}C$).

A summary of the application of isotopic methods to hydrogeologic investigations is included as Appendix A. Readers who are not familiar with the use of isotopes in hydrogeologic investigations are encouraged to read Appendix A prior to proceeding with the remainder of this report.

8.2 Chemical Evolution of Groundwater

8.2.1 Chemical Reactions

Solute compositions of groundwaters are the result of interactions between groundwater and bedrock lithology and between groundwater and atmospheric and soil gases. The general reactions responsible for the chemical evolution of groundwaters in the vicinity of the study area and inside the coal mines are described below:

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Groundwater acquires most of its $CO_{2(g)}$ in the soil zone where the partial pressure of CO_2 greatly exceeds atmospheric levels. This CO_2 combines with water to form carbonic acid according to

$$CO_{2(g)} + H_2O = H_2CO_3 \quad (1)$$

Carbonic acid dissociates into H^+ and HCO_3^- as

$$H_2CO_3 = HCO_3^- + H^+ \quad (2)$$

The H^+ ions temporarily decrease the pH of the water but are quickly consumed by the dissolution of carbonate minerals that are abundant in the soil zone and in most aquifers. Carbonate mineral dissolution is represented as

$$2H^+ + CaMg(CO_3)_2 = Ca^{2+} + Mg^{2+} + 2HCO_3^-, \text{ and} \quad (3)$$

(dolomite)

$$H^+ + CaCO_3 = Ca^{2+} + HCO_3^-. \quad (4)$$

(calcite)

The net effect of reactions 2 through 4 is to increase the pH and the Ca^{2+}, Mg^{2+}, and HCO_3^- contents of waters. Dissolution of gypsum, which is present in minor amounts in many formations in the region, can elevate the Ca^{2+} and SO_4^{2-} contents in the absence of additional $CO_{2(g)}$ and H^+ according to

$$CaSO_4 \cdot 2H_2O = Ca^{2+} + SO_4^{2-} + 2H_2O. \quad (5)$$

(gypsum)

Elevated Na^+ concentrations may result from either the dissolution of halite or from ion exchange on clay particles or on sodium zeolites (Mayo and others, 2000). Halite dissolution will increase the overall solute concentration (i.e. TDS) and will yield equal Na^+ and Cl^- contents when the solute compositions are reported in the meq/l units. Halite is not abundant

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in the study area. Ion exchange will not directly elevate the overall solute content, but will result in increased Na^+ concentrations with corresponding decreases in Ca^{2+} and/or Mg^{2+} concentrations. Halite dissolution may be represented as

$$NaCl = Na^+ + Cl^-, \quad (6)$$

and ion exchange may be represented by reactions involving the sodium zeolite analcime,

$$2NaAlSi_2O_6{\cdot}H_2O + Ca^{2+} = Ca(AlSi_2O_6)_2{\cdot}H_2O + 2Na^+, \quad (7)$$

$$2NaAlSi_2O_6{\cdot}H_2O + Mg^{2+} = Mg(AlSi_2O_6)_2{\cdot}H_2O + 2Na^+, \quad (8)$$

or clay mineral exchange which may be represented as

$$Ca^{2+} + \text{Na-clay} = 2Na^+ + \text{Ca-clay} \quad (9)$$

$$Mg^{2+} + \text{Na-clay} = 2Na^+ + \text{Mg-clay} \quad (10)$$

8.3 Solute Compositions

Stiff (1951) diagrams representing mean solute compositions of groundwater, streams, and springs at the surface are shown in Figure 22. Mean solute compositions of each spring and geologic formation are listed in Table 2. The solute compositions of groundwaters and surface waters in the study area are shown graphically on a Piper plot in Figure 23. Calculated mineral saturation indices are listed in Table 3.

8.3.1 Streams

8.3.1.1 Crandall Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Mill Fork Creek have a mean TDS of about 300 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with lesser

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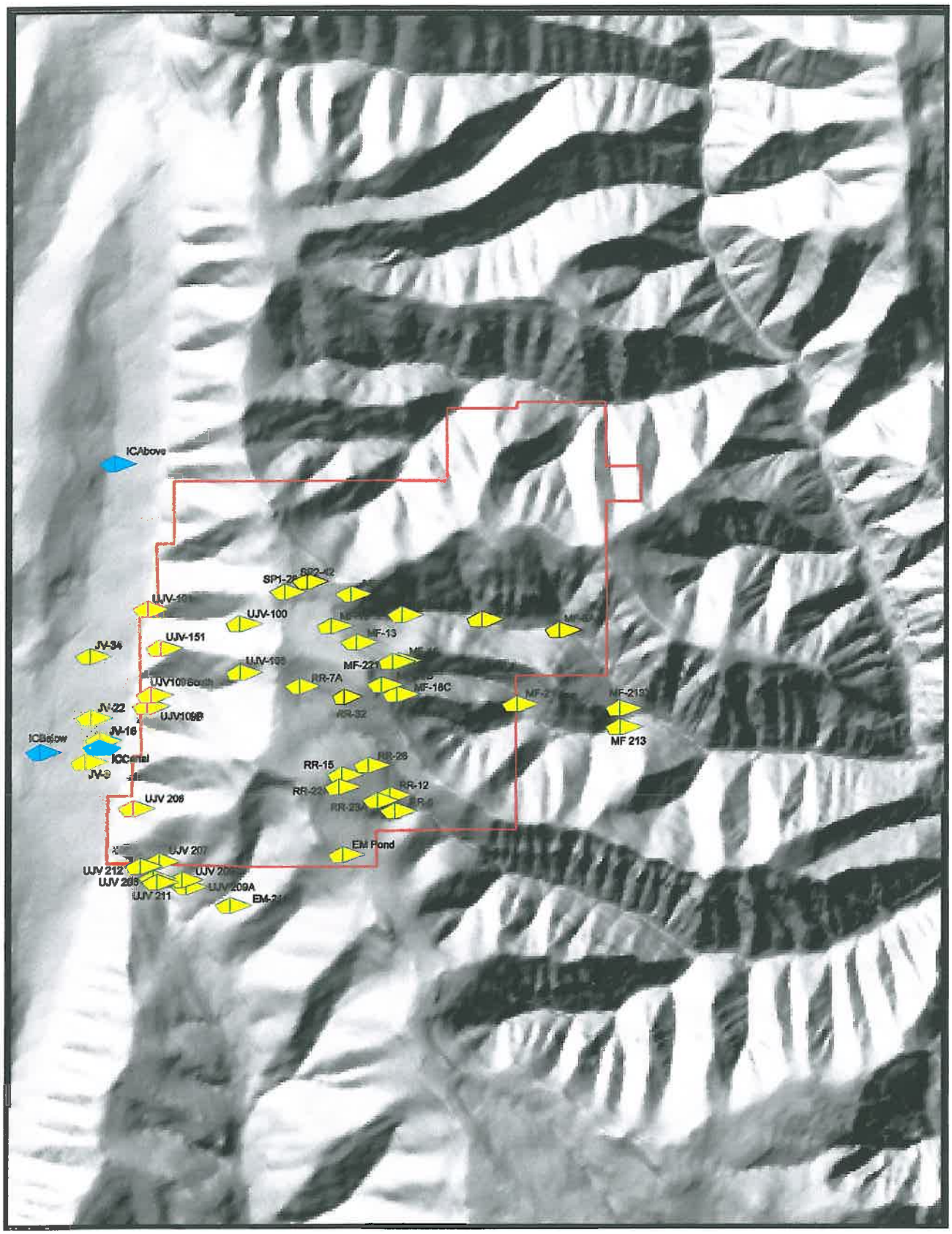

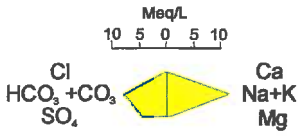

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Figure 22 Stiff diagrams for groundwaters and surface waters in the Mill Fork Tract area.

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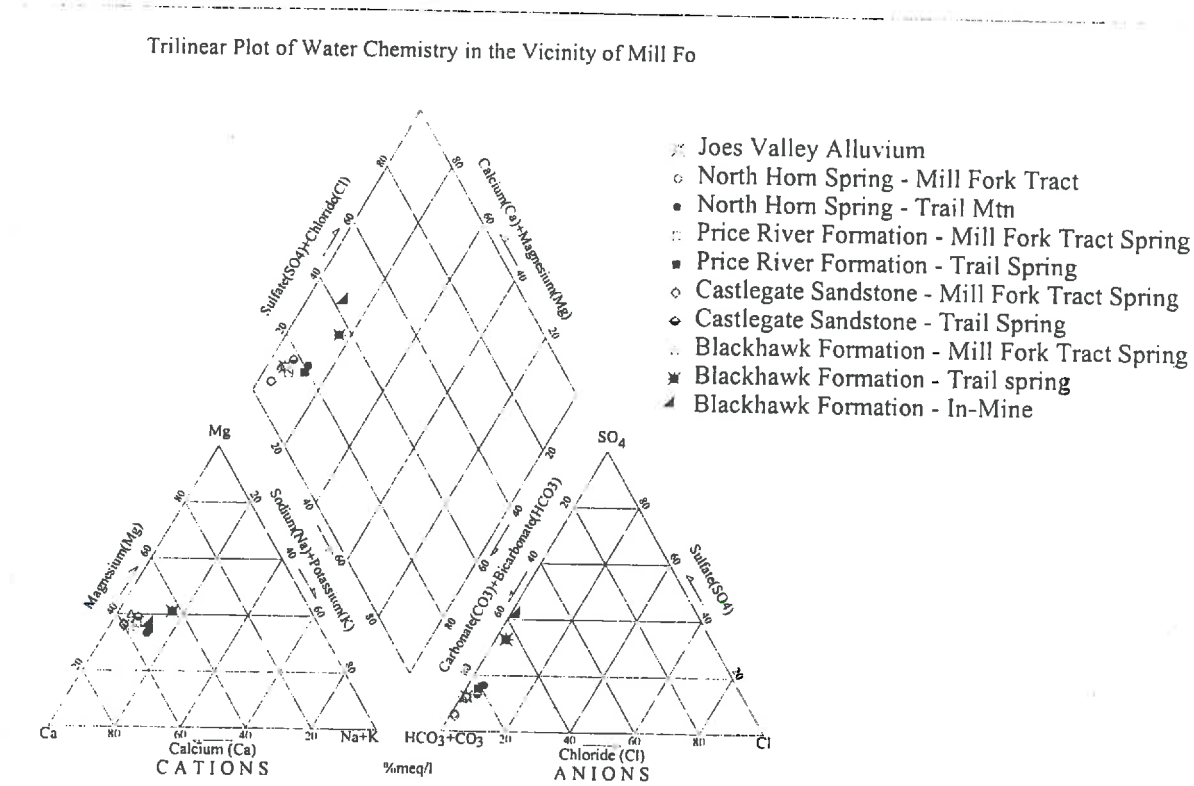

Figure 23 Trilinear (Piper) plot of average TDS concentrations of springs, by formation, discharging in the Mill Fork Tract area and in-mine Blackhawk waters from the Trail and Cottonwood Mines.

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amounts of SO_4^{2-} (Table 2). This water includes drainage from the Mill Fork Lease as well as the area to the north.

8.3.1.2 Mill Fork Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Crandall Creek have a mean TDS of about 480 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with lesser amounts of SO_4^{2-} (Table 2). Most of this water originates in the Mill Fork Lease.

8.3.1.3 Rilda Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Rilda Creek have a mean TDS of about 400 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type (Table 2). This water is mostly drainage from the Mill Fork Lease.

8.3.2 Springs

The solute compositions of groundwaters from nearly all of the springs in the Mill Fork Track area are of similar chemical type (Table 2). This is seen in the similarity of the shapes of the Stiff diagrams in Figure 22, and the clustering of the data points on the Piper plot in Figure 18. All of the springs in the Mill Fork Lease area, for which chemical analyses are available, are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with variable amounts of SO_4^{2-}. This chemical type is consistent with the dissolution of carbonate minerals in the presence of soil zone $CO_{2(gas)}$ according to equations 1-4 above.

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Mineral saturation calculations indicate that most of the springs and streams in the study area are at or above saturation with respect to the carbonate minerals calcite and dolomite (Table 3). What this means is that the chemistry of the spring water is near equilibrium with respect to these minerals, and thus there is not a thermodynamic tendency to dissolve additional carbonate minerals if these are encountered in the groundwater system. Waters with saturation indices less than log = -0.1 have a thermodynamic tendency to dissolve the mineral species should they be encountered in the groundwater system and waters with a saturation indices greater than log = 0.1 have a thermodynamic tendency to precipitate the mineral species.

For additional dissolution of carbonate minerals to occur, an influx of $CO_2(g)$ into the groundwater system must occur. Common sources of $CO_2(g)$ in this environment include CO_2 produced by root respiration and organic decay in the soil zone and bacteriological processes resulting in the oxidation of CH_4 (methane). No surface or groundwater in the study area is near saturation with respect to gypsum. What this indicates is that, if gypsum is encountered along a waters flow path, dissolution of the gypsum will occur, resulting in elevated Ca^{2+} and SO_4^{2-} concentrations. Groundwater from the Blackhawk Formation and Star Point Sandstone encountered in nearby mine environments is supersaturated with respect to both calcite and dolomite (Table 3) indicating that the water has the thermodynamic tendency to precipitate these minerals.

TDS concentrations of springs in the study area fall in the narrow range of 207 to 377 mg/l. A probability plot of the ordered ranking of the TDS of groundwaters collected during the

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2000-2001 spring and seep survey (Figure 24) indicate a single population with a normal distribution. The fact that all of the Mill Fork Lease springs discharging from alluvial systems, the North Horn Formation, Price River Formation, Castlegate Sandstone, and Blackhawk Formation have the same chemical character (Table 2; Figures 22 and 23) is of particular significance. In other areas in the Wasatch Plateau, bedrock springs commonly have a broader range of TDS and chemical type, which is related to the bedrock formation from which the springs discharge (Danielson and others, 1981; Mayo and Associates, 1997d; Mayo and Morris, 2000).

The mean TDS for each geologic formation ranges from 253 mg/l in the North Horn Formation to 322 mg/l in the Price River Formation. That there is not a greater variability in TDS, or a greater number of groundwater types represented in the springs in the study area implies that there is not a great deal of variation in the soil zone processes or mineralogy of the matrix of the groundwater systems from which these springs emanate. We believe that the lack of variability in groundwater solute chemistry occurs because the groundwater systems that support springs in the area flush large quantities of groundwater through the thick soil zone and shallow fractured bedrock. Over thousands of years, some of the soluble minerals which were once present in the shallow bedrock and in the soil have been leached away. Because these groundwater systems do not come into contact with rocks deeper in the geologic formations (which vary substantially in their soluble mineral contents) there is little variation in the chemical type of groundwater.

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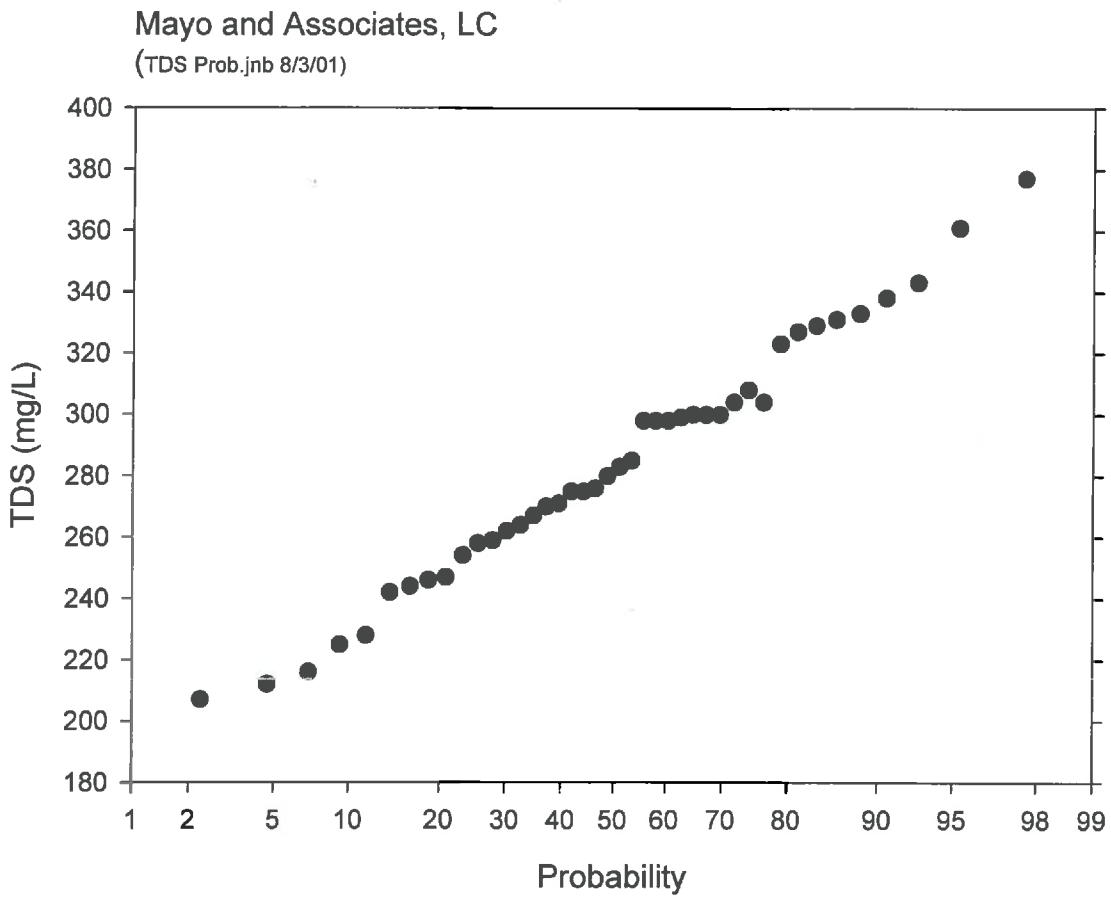

Figure 24 Probability plot of the ordered ranking of the TDS of active zone groundwaters collected during the 2000-2001 spring and seep survey.

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Although there is little variability in the chemical type and TDS of groundwater discharging from springs in the Mill Fork Lease, there is considerable variability in the TDS and solute compositions of spring discharge waters and the solute composition of spring discharging from the Backhawk Formation in the nearby Trail and Cottonwood Mine areas (Table 2, Figure 23). We interpret the overall greater TDS and degree of chemical variability in the Blackhawk Formation in the Trail and Cottonwood Mine waters as a result of great precipitation variability in the Trail and Cottonwood Mine areas. Except for Joes Valley Alluvium, Mill Fork Lease groundwaters recharge and discharge from very wet upland areas. Trail and Cottonwood Mine groundwater recharge and discharge from a variety of elevations and recharge domains.

8.3.3 In-Mine Groundwater

Because the Mill Fork Lease is a new lease area that does not have existing underground workings, the solute compositions of in-mine groundwater can only be inferred from compositions of in-mine waters in nearby mines. Extensive in-mine samples of Blackhawk Formation roof drip water are available from Energy West's mines which include Cottonwood, Wilberg, Trail Mountain, and Deer Creek (Table 2). A limited number of in-mine samples (Table 2) from the Star Point Sandstone are also available from the Deer Creek and Cottonwood Mines (Mayo and Associates, 1997d) and from public documents for the Crandall Canyon Mine (Mayo and Associates, 1997a).

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8.3.3.1 Blackhawk Formation

In-mine roof drips from the Blackhawk Formation are of the Ca^{2+}- Mg^{2+} -HCO_3^- -SO_4^{2-} type with appreciable amounts of Na^+ (Table 2). These groundwaters have elevated TDS contents relative to Blackhawk spring waters in the Mill Fork Lease and are generally chemically dissimilar to springs in the Mill Fork Lease (Figure 23). The two spring samples from the Deer Creek and Cottonwood Mine areas (Table 2) have similar solute contents as the in-mine samples. Mayo and others (2000) found the elevated TDS in coal mine roof drip water to be the result of a cascading series of chemical reactions involving the oxidation of pyrite which increases the SO_4^{2-} concentration and releases H^+ ions. The H^+ ions are consumed by dissolution of additional carbonate minerals (i.e., calcite and dolomite) elevating the Ca^{2+} and Mg^{2+} contents. In the process acid mine drainage (AMD) is prevented. Ion exchange of Ca^{2+} and Mg^{2+} on the sodium zeolite analcime increases the Na^+ contents. We anticipate similar in-mine processes will occur in the Mill Fork Lease.

8.3.3.2 Spring Canyon Member

The solute chemical composition of groundwater in the Spring Canyon Member beneath existing mine workings is highly variable (Table 4). Conductivities range from 500 to 2,287 µS/cm. Ca^{2+} concentrations range from 5.5 to 64 mg/l and Mg^{2+} concentrations range from 5.1to 41 mg/l. Na^+ concentrations range from 14 to 550.6 mg/l and Cl^- concentrations range form 5.0 to 221.3 mg/l. The large spatial variations in solute chemistry are attributed to the influence of interbedded Mancos Shale tongues which are present in some locations and not in others and are known to contain soluble minerals. The variations in Na^+ are likely the result of the presence or absence of clays with ion exchange capacity. Ion exchange

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commonly results in elevated Na^+ concentrations at the expense of decreased Ca^{2+} or Mg^{2+} concentrations.

That the solute chemistry in the Spring Canyon member is not uniform beneath existing mines suggests that there is a partitioning of groundwater systems in the member. This condition is likely the result of interbedded lower-permeability layers in the Star Point Sandstone which partition individual sandstone bodies. These findings are substantiated by monitoring well data from 6 wells in the Trail and East Mountain areas (Section 7.3) and are significant in that they strongly suggest that the Spring Canyon member does not act as a single regionally continuous aquifer, but rather it supports a series of smaller, discrete groundwater systems.

8.3.3.3 Joes Valley Fault System

Groundwaters in the Joes Valley Fault system and associated synthetic faults and fractures have been observed in the Crandall Canyon Mine. Data from a public domain document (Mayo and Associates, 1997a, c) indicate the water is of the Ca^{2+} -Mg^{2+} -HCO_3^- type. This water type is consistent with the dissolution of carbonate minerals in the presence of soil zone $CO_{2\,(gas)}$. Slightly elevated SO_4^{2-} concentrations are consistent with dissolution of minor amounts of gypsum. The relatively low mean Na^+ concentration (3.7 mg/l; 0.17 meq/l) indicates that appreciable ion exchange has not occurred. Na^+ and Cl^- contents, in meq/l, are essentially the same, indicating halite dissolution as the Na^+ source.

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8.4 δ^2H and $\delta^{18}O$

The δ^2H and $\delta^{18}O$ composition of a water molecule falling as precipitation is determined by the temperature at which nucleation of the water droplet occurs. However, other effects related to the bulk composition of the water vapor phase, such as cloud rainout and orographic effects, also can affect the isotopic composition of precipitation.

The stable isotopic compositions of waters are usually analyzed relative to the Meteoric Water Line (MWL). The MWL is empirically derived from the worldwide plotting locations of coastal zone precipitation and is defined by the equation $\delta^2H = 8\ \delta^{18}O + 10$ ‰ (See Appendix A for further discussion of the MWL). Precipitation that forms under cooler conditions will plot lower (i.e. more negatively) along the MWL than will precipitation that forms under warmer conditions.

Except for unusual conditions such as geothermal heating above abut 100°C, the δ^2H and $\delta^{18}O$ composition of a groundwater is set at the time of recharge and is not affected by subsurface conditions such as groundwater residence time and mineral dissolution and precipitation reactions. In other words, the recharge and flow history of a groundwater can be evaluated independently of the solute content of the water using stable isotopic compositions.

The δ^2H and $\delta^{18}O$ composition of both in-mine groundwaters and groundwaters from springs, streams, and wells in the study area are listed in Table 5 and are plotted on Figure 25.

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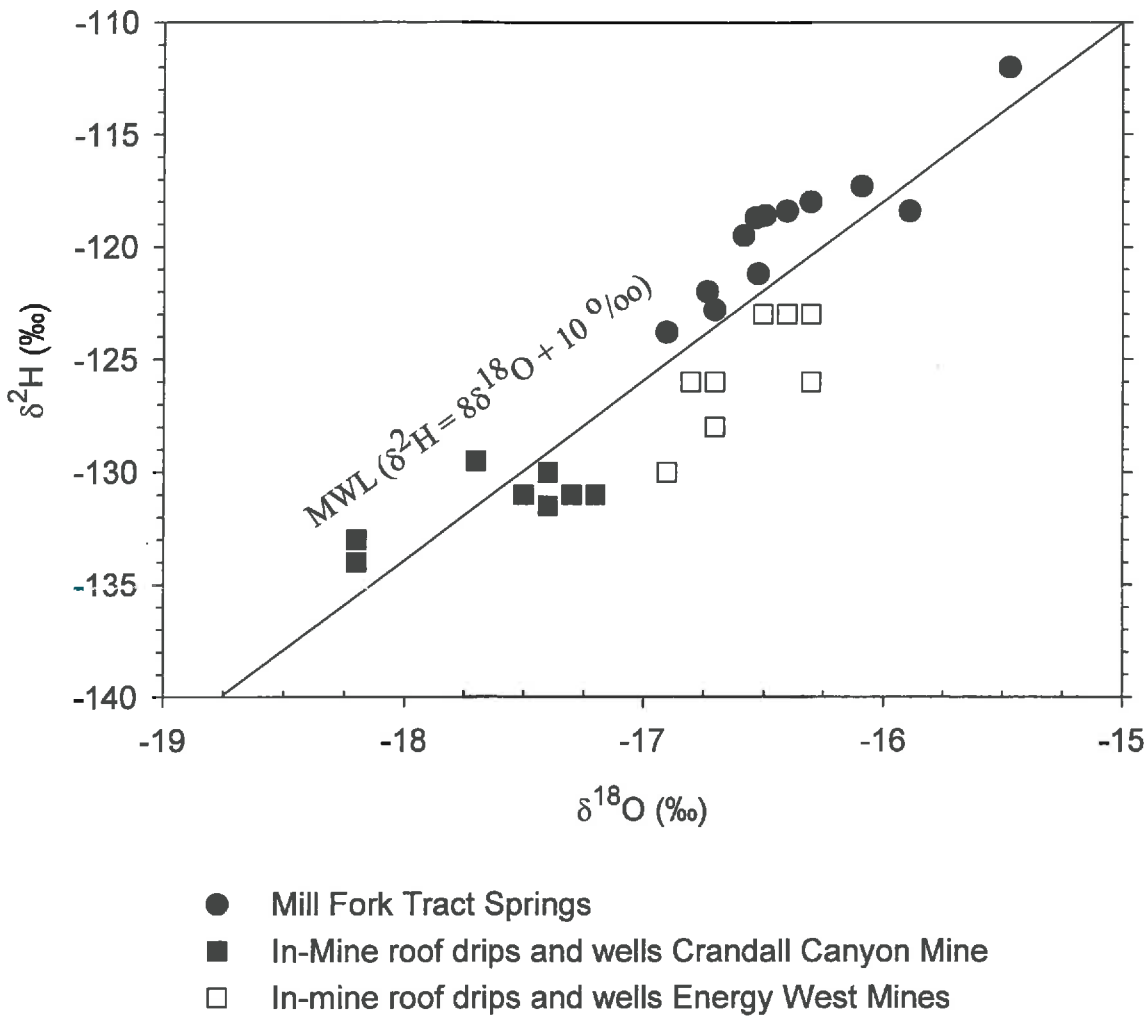

(2H & 18O.spw 8/11/01)

Figure 25 Scatter plot of δ^2h and δ^{18}O compositions of spring, stream and in-mine groundwaters the Mill Fork Tract area.

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All groundwaters in the study area plot near the meteoric water line indicating a meteoric recharge origin (i.e. rain and snow).

Based on their stable isotopic compositions, groundwaters from within both the Energy West and Crandall Canyon Mines are readily distinguishable from each other and from springs and creeks in the Mill Fork Lease area. These three populations are statistically different from each other at the 95% confidence level. The Mill Fork Spring samples tend to plot more positively relative to the meteoric water line than do the in-mine waters, indicating that the near-surface groundwaters recharged under different climatic conditions. The more negative composition of the in-mine groundwaters is probably the result of paleorecharge during cooler, wetter times. The stable isotopic composition of water seldom changes significantly after infiltration into the groundwater system. What this suggests is that modern groundwater systems in the upland areas overlying the mine area is not the primary source of recharge to the groundwater systems encountered in the mines.

8.5 Groundwater ages (^{3}H and ^{14}C)

The concept of groundwater age is difficult to define because water arriving at a well or spring seldom travels via pure piston flow. Instead it is usually a mixture of water molecules that recharged at different locations and at different times, thus water has no unique age. It is therefore best to think of a groundwater "age" as the *mean residence time* of the water sampled at the well or spring.

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In this investigation, two unstable isotopes, tritium (^{3}H) and carbon-14 (^{14}C), have been used to evaluate mean residence times. Tritium is a qualitative tool indicating if groundwater has a component of water that recharged since about 1954. Groundwater that recharged prior to about 1954 will contain essentially no tritium (Appendix A). Carbon-14 provides information regarding the number of years that have elapsed since the groundwater became isolated from soil zone gases and near-surface waters. Like tritium, ^{14}C can indicate if groundwater has a component that recharged since the 1950s. Groundwaters with ^{14}C contents greater than about 50 percent modern carbon (pmc) contain anthropogenic (i.e., human-induced) carbon associated with atmospheric nuclear weapons testing. It is not uncommon for groundwater issuing from a spring or occurring in a well to be a mixture of old (i.e. containing no ^{3}H) and modern water.

Groundwater ages have been calculated for 27 springs, 14 in-mine locations, and 6 Star Point Sandstone wells (Table 5, Figure 26). All spring waters, except for spring 18-4-1 which is located in the southwestern portion of Trail Mountain, contain anthropogenic carbon and appreciable amounts of ^{3}H and are, therefore, modern. These springs issue from alluvial systems, the North Horn Formation, the Price River Formation, the Castlegate Sandstone, and Blackhawk Formation.

Spring 18-4-1 issues from the Blackhawk Formation-Castlegate Sandstone contact at the down plunge end of the Straight Canyon Syncline (Plate 1) and is not in the Mill Fork Lease area.. The spring water does not contain water that recharged since 1954; however, the water was likely recharged less than a few hundred years ago as is indicated by its ^{14}C content.

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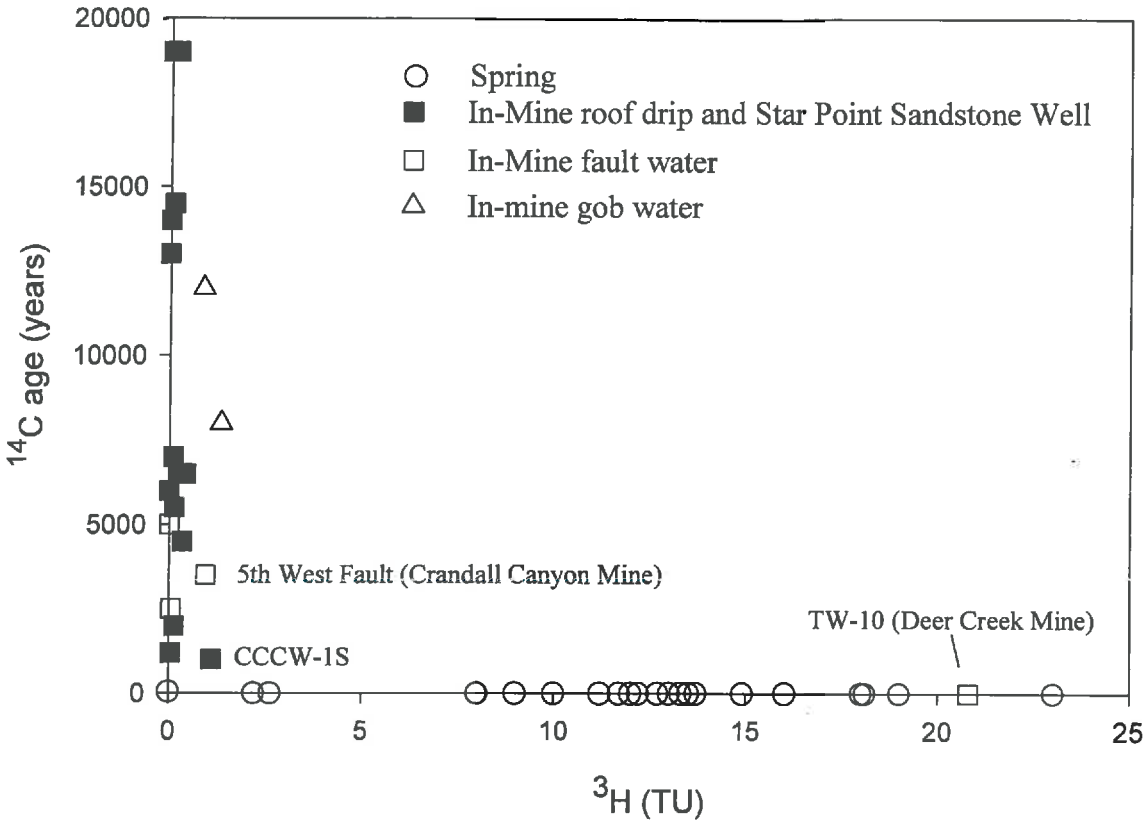

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Most groundwaters collected inside the Cottonwood/Wilberg and Deer Creek Mines contain essentially no tritium (Table 5) and have mean ^{14}C ages ranging from 2,000 to 12,000 years. Roof drip waters associated with faults (i.e., 1.5N X 29, 6W X 20, and MN-ME) contain waters 2,000 to 7,000 years old and are not in hydraulic communication with the surface (Table 5). Both roof drip (i.e. Blackhawk Formation) and wells in the Spring Canyon Sandstone in the Crandall Canyon Mine generally have groundwater ages of 13,000 – 19,000 years. These waters contain essentially no tritium and thus represent groundwater systems that are essentially hydraulically isolated from modern near surface hydrologic phenomena.

As discussed in Section 7.2.3, two in-mine roof drip samples associated with faults, TW-10 (Roans Canyon) in the Deer Creek Mine and 5th West (Joes Valley Fault) in the Crandall Canyon mine, have ^{3}H contents indicating a component of modern recharge.

Two wells completed in the Star Point Sandstone, CCCW-1S and TM-3, have mean groundwater residence times of 1,000 and 6,000 years, respectively. These two wells are both completed in the Spring Canyon tongue and appear to be located on approximately the same flow line. CCCW-1S is up gradient and near the recharge area as evidenced by the young ^{14}C age and the ^{3}H content. TM-3 is down gradient. Assuming that the two wells intercept groundwater along the same flow line, travel times can be calculated using the method described by Mooke (1980):

$$\Delta T = 8270 \ln (a_{k+1}^{14}/a_k^{14}) \quad (11)$$

$$\Delta T = 5{,}300 \text{ years}$$

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where:

ΔT = travel time (in years)

a_{k+1}^{14} = ^{14}C activity of up-gradient sample

a_k^{14} = ^{14}C activity of down-gradient sample

Assuming the travel time of 5,300 years and a distance of 4 miles, the calculated flow velocity is approximately 0.25 feet per year.

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9 DISCUSSION

9.1 Active and In-active Groundwater Zones

The overall pattern of groundwater flow and surface water-groundwater interactions in the Mill Fork Lease and adjacent areas can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes (Mayo and Morris, 2000). The model is illustrated in Figure 27.

Active zone groundwater flow systems contain abundant ^{3}H, have excellent hydraulic communication with the surface, are dependent on annual recharge events, and are affected by short term climatic variability. Tritium and carbon-14 "age" dating of spring waters in the study area demonstrate that all springs, except 18-4-1, issue from active zone groundwater systems and are of modern origin (Table 5, Figure 26). Groundwater in the active zone generally circulates shallowly and has short flow paths. Because the springs in the Mill Fork Lease and adjacent areas are not part of large, regional groundwater systems, hydrographs of their discharge rates show both seasonal and climatic fluctuations (Figure 12). During drought cycles, it is not uncommon for discharge from some springs in the active zone to completely cease.

The $\delta^{2}H$ and $\delta^{18}O$ compositions of Mill Fork Lease springs relative to in-mine groundwaters demonstrate that the Mill Fork Lease springs are not part of the same groundwater systems that discharge in the mines (Figure 25).

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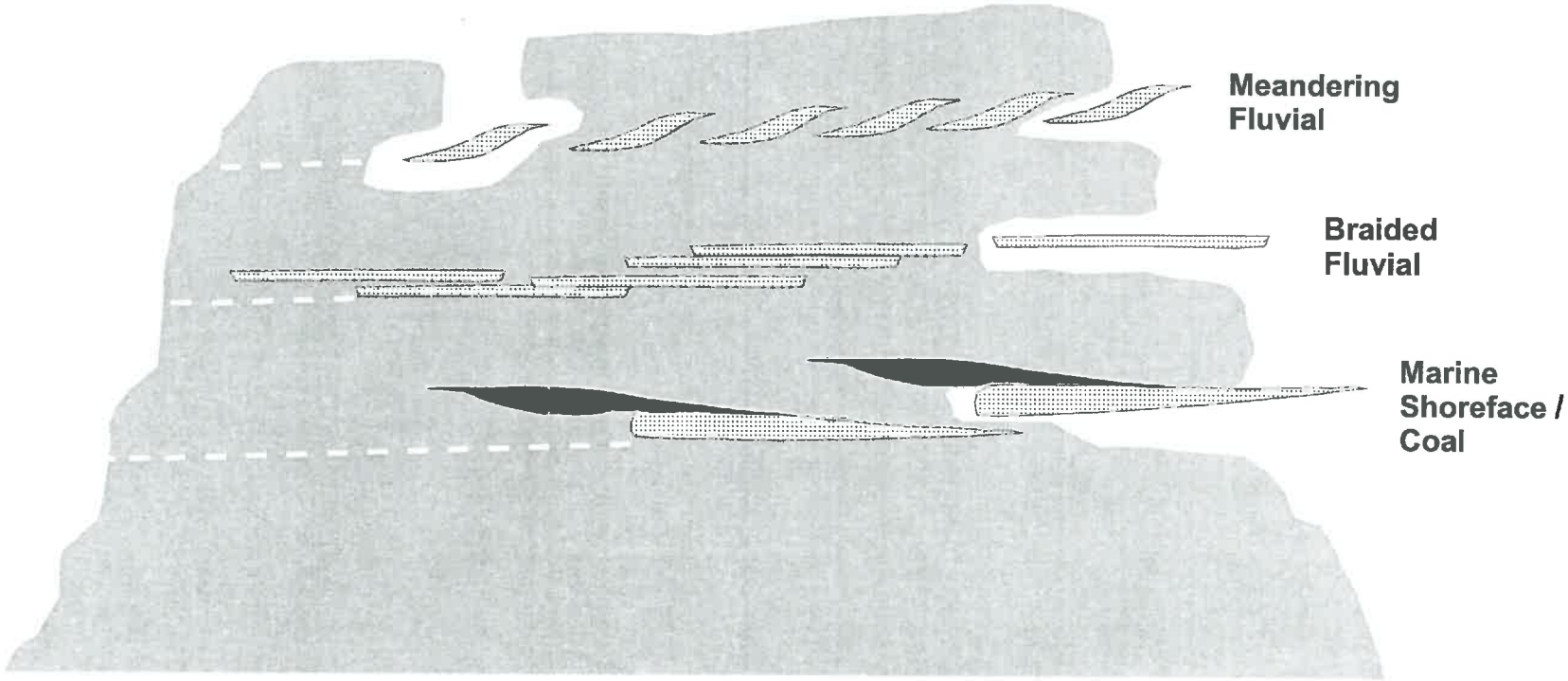

Mayo and Associates, LC 14 Jan 99 model.cdr

ACTIVE SURFACE ZONE

INACTIVE ZONE

RESERVOIR QUALITY SS

COAL

Figure 27 Conceptual model of active and inactive groundwater flow regimes.

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The active regime includes alluvial groundwater, all of the Flagstaff Limestone, and the near-surface exposures of all other bedrock formations. The "near surface" extends a few hundred feet vertically into the subsurface, about 500 to 1,000 feet into cliff faces and is controlled by fracturing, weathering, and the surface exposures of fluvial channel sands. Further into the cliff faces the discontinuous character of the channel sands prevents active groundwater flow.

Except for mountain fronts and cliff faces, the coal bearing lower Blackhawk Formation and the Star Point Sandstone are generally not exposed at the surface in the Mill Fork Lease and are not part of the active zone. In Cottonwood Canyon, located south of Mill Fork Lease, the Star Point Sandstone is within a few hundred feet of land surface and is part of the active zone as evidenced by the tritium content, 1.10 TU, in Well CCCW-1S (Table 5). Elsewhere Star Point Sandstone samples have groundwater ages of 6,000 to 19,000 years. In the Mill Fork Lease the lower Blackhawk Formation and Star Point Sandstone are not exposed near the land surface, except at cliff faces, and are not in the active zone.

Except for mining operations near cliff faces, the in-mine environment is generally not part of the active zone. However, in-mine groundwater containing tritium (i.e., 1 TU or more, Table 5) in TW-10 (Roans Canyon Fault) and 5th West Fault (Joes Valley Fault) indicate that locally the inactive zone extends into the mine environment where fracture zones, that are associated with major faulting, are currently under tensional stress. The extension of the active zone into the mine environment along fractures is localized as evidenced by the absences of tritium and old ^{14}C ages in in-mine groundwater collected elsewhere along the fracture zone (Table 5).

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Inactive zone groundwater systems contain old groundwater (i.e. 2,000 to 19,000 radiocarbon years, Table 5), have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability as evidenced by the decline in roof drip rates (Figure 15). Groundwater in these systems tends to occur in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). These sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. The blanket sands of the Star Point Sandstone are also largely in the inactive zone.

Except for the immediate vicinity of Joes Valley Fault, we believe that groundwater intercepted in the Mill Fork Lease will be part of the inactive zone and will not be in hydraulic communication with either near surface groundwater or surface water systems. Mining within 200 to 300 feet of Joes Valley Fault is problematic in that the area is under tension and deep groundwater may be part of the active zone.

Two fundamentally different groundwater regimes, active (near surface) and inactive (deep subsurface and in-mine) that occur in the vicinity of the Mill Fork Lease and elsewhere in the Utah Coal District are due to the vertical and horizontal heterogeneity of the bedrock (section 5.3). The rock formations consist primarily of alternating and interpenetrating layers of somewhat permeable sandstone and impermeable shale and mudstone. Individual rock

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layers are generally not continuous over great horizontal distances. Rather, one rock facies commonly grades horizontally into another facies. Fluvial deposits consisting of sandstone channels, which locally support groundwater systems, typically interpenetrate with shale and mudstone units. Thus, layers of shale or claystone that have very low permeabilities encase individual sandstone layers both horizontally and vertically. Although the permeability of individual sandstone bodies may locally be relatively high, the ability of these rocks to transmit water horizontally over great distances is low because of the discontinuous nature of the sandstones. Due to the pervasiveness of low permeability shales and mudstones, the potential for vertical groundwater flow is minimal.

Because of the limited potential for groundwater to migrate vertically through the stratigraphic section, active zone recharge waters commonly infiltrate only into the soil zone and shallow, fractured bedrock. Most groundwater moves downward through the shallow subsurface until the first impermeable layer is encountered where it migrates laterally and is discharged at the surface as a spring or seep.

9.2 Regional Groundwater Systems

A report by the U.S. Geological Survey (Lines, 1985) states that there exists a regional aquifer in the lower Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau. Lines also postulates that the regional aquifer is recharged by the downward migration of groundwaters from overlying perched groundwater systems in the North Horn and Price River Formations. This idea is not correct. Groundwaters encountered within mine openings in the lowermost Blackhawk Formation occur primarily within discontinuous sandstone

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channels. It is not uncommon for some of these channels to be completely dry, while others are partially or completely filled with water. Between these sandstone channels, the surrounding shales and claystones of the Blackhawk Formation are usually dry. The discontinuous nature of the saturated sediments in the lowermost Blackhawk Formation, and the unconfined conditions under which these groundwaters exist do not support the idea of a deep, regional system with groundwater flowing from areas of recharge to areas of discharge.

Additionally, radiocarbon and tritium groundwater age dating indicates that groundwater in the shallow perched groundwater systems are modern (post-1954) and in-mine groundwater in the Blackhawk Formation and Star Point Sandstone are thousands of years old.

We believe that the presence of swelling clays and impermeable shales in the rocks in the unsaturated zone between the overlying perched systems and the Blackhawk Formation effectively prohibit downward vertical migration of waters from the perched systems. Lines (1985) analyzed cores taken from well (D-17-6)27bda-1 and found the hydraulic conductivities of the shales and siltstones to be very low (i.e. 10^{-7} to 10^{-8} ft/day). One shale sample was found to be effectively impermeable even when a hydraulic pressure of 5,000 psi was applied.

Because there are no aerially extensive groundwater regimes in the lower Blackhawk Formation or Star Point Sandstone within the lease area, it is not possible to draw meaningful potentiometric surface maps of these systems.

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Lines (1985) also reported that water was likely leaking from the Joes Valley Reservoir downward into the "lower Blackhawk / Star Point aquifer" in Straight Canyon. We believe that this is incorrect. Groundwater collected from well TM-3, which is completed in the Star Point Sandstone in Straight Canyon just below the reservoir, has a radiocarbon age of 6,000 years, while water in Joes Valley Reservoir is of modern origin. Water levels in TM-3 do not respond to seasonal fluctuations in the water level in Joes Valley Reservoir, indicating that there is little or no hydraulic communication between the reservoir and water in the Star Point Sandstone. Groundwater was sampled at UG-3 in the lower Blackhawk Formation in the Trail Mountain Mine. This water has a radiocarbon age of 5,500 years, which is likewise not consistent with water from the reservoir.

9.3 Surface Water

Most of the recharge to creeks within the lease areas occurs from springtime snowmelt and from summer thunderstorms. Discharge rates in the creeks are extremely variable, and the creeks exhibit rapid response to snowmelt and thunderstorm events. The creeks are mostly ephemeral, and are not supported by bedrock groundwater discharge. Recharge to creeks in the study area is not sustained by bedrock groundwater systems and thus, most creeks sometimes dry out completely during the late summer and fall months or during periods of prolonged drought. Most of the streams within the Mill Fork Lease are losing in their upper reaches and some are gaining in their lower reaches as they cross the Mancos Shale beyond the Mill Fork Lease boundaries. Stream flow lost in the upper, ephemeral reaches is probably lost to alluvium (Semborski, Personal communication, 1997). As the creeks flow

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over the impermeable clayey sediments of the Mancos Shale, the water in the alluvium is forced to the surface and becomes part of the above-ground flow in the creek.

There is no evidence of substantial bedrock discharge from Blackhawk Formation or Star Point Sandstone groundwater systems to the creeks in the lease areas. It is important to note, however, that this does not preclude near-surface drainage of saturated shallow bedrock and interflow. Likewise, we do not believe that creek water flowing in the alluvium is recharging deep bedrock formation groundwater systems in appreciable quantities.

The lack of hydraulic communication between creeks and deep bedrock groundwater systems has important implications to potential mining-related impacts to creek flow. The lack of a significant bedrock-derived baseflow component of creek discharge suggests that mining operations (i.e. the interception of deep groundwater systems in the Blackhawk Formation) will not adversely impact creek flows in the lease areas.

9.4 Summary

In summary, all groundwater encountered in springs monitored in the Mill Fork Lease discharge from active, shallow groundwater systems. No evidence exists that suggests a large, regional-type aquifer occurs in the area. All of the springs analyzed in the study area exhibit large-scale fluctuations in discharge rates in response to the annual snowmelt event. The springs are also sensitive to longer-term variations in climate. Carbon-14 and tritium dating of spring and stream waters indicate that the springs contain anthropogenic (human-induced) carbon and levels of tritium consistent with recharge in the past 50 years. Stable

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isotopic δ^2H and $\delta^{18}O$ data from springs and streams at the surface indicate that the recharge sources for these groundwater systems are different from those that recharged the groundwater systems encountered in the mine environment.

Almost all groundwater encountered in in-mine environments is not related to shallow, active zone groundwater systems from which springs and streams discharge. ^{14}C dating indicates that groundwater entering the underground workings in most locations is thousands of years old. When groundwater is encountered in the mine, inflow rates commonly decrease rapidly and most inflows eventually dry up completely. This indicates that the groundwater systems encountered in the mine are not part of large regional groundwater systems. There is no relationship between groundwater inflow rates measured in the mine and the annual snowmelt event or long term climatic trends. This demonstrates a lack of hydraulic communication between the groundwater systems encountered in the mine and active zone groundwater systems near the surface.

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10 CONCLUSIONS

- Groundwaters discharging from springs are part of active zone groundwater systems. Isotopic analysis indicates that groundwater from the active zone is of modern origin (recharged less than 50 years ago). Seasonal variations in discharge rates from active zone springs indicate that flowpath lengths are short and that groundwater travel times from recharge areas to discharge areas are generally less than one year. The abundance of shale and claystone units in the geologic section prohibits significant downward migration of active zone groundwaters into deeper horizons.

- Analysis of the solute chemistry of groundwaters discharging from springs and seeps indicate that depths of circulation in these systems are shallow. The modern groundwater ages of shallow groundwaters in the study area support this conclusion.

- Groundwater encountered in most locations in the mines is many thousands of years old. Groundwater in the Star Point Sandstone ranges from approximately 1,000 to 19,000 years old. Groundwater in the Blackhawk Formation within the mines ranges in age from about 2,000 to 14,000 years, whereas groundwater in the Joes Valley Fault system ranges in age between about 2,500 and 5,000 years. None of these groundwaters have appreciable tritium concentrations, indicating that no recharge has occurred in the past 50 years.

- Groundwater encountered in the northwest corner of the Crandall Canyon Mine discharges from a series of fractures located near the Joes Valley Fault. Tritium data

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indicate that a component of this water recharged in the past 50 years, whereas ^{14}C data indicate that another component recharged more than 3,500 years ago. This groundwater appears to originate from a sandstone channel in the mine roof.

- More than two-thirds of all non-alluvial springs in the Mill Fork Lease discharge from the North Horn Formation. The abundance of springs in the North Horn Formation is the result of the large area of exposed North Horn in the upland areas where precipitation is greatest, and the presence of the abundant claystone and shale layers which inhibit significant downward migration of precipitation into the formation.

- The fact that Little Bear Spring discharges modern water and has large variations in discharge rates suggests that it is the discharge location of an active zone groundwater system. Because inactive zone groundwater systems in the Star Point Sandstone beneath the mine are tens of thousands of years old and do not exhibit seasonal variations in discharge, these groundwater systems are precluded as potential contributors to the discharge from Little Bear Spring. The very low permeability in the Star Point Sandstone beneath the mine indicates that diffuse flow through the Star Point Sandstone beneath the mine cannot contribute significant groundwater to the discharge from the spring.

- Limited data suggest the possibility that Little Bear Spring may receive significant recharge where the fracture system from which it emanates crosses streams and active

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zone groundwater systems in drainages south of Little Bear Canyon. The conditions in Mill Fork Canyon seem favorable for recharge to the spring.

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11 PROBABLE HYDROLOGIC CONSEQUENCES

This section describes the probable hydrologic consequences (PHC) of underground coal mining in the Mill Fork Lease. The determination of the PHC is required by part R645-301-728 of the State of Utah Coal Mining Rules. This determination is based on the data and information presented in Sections 1-11 of this document.

This description of the PHC is based on the idea that the behavior of hydrologic and hydrogeologic systems in the Mill Fork Lease is similar to those in East Mountain and the southern portion of Trail Mountain. These areas have similar climates, physiography, and stratigraphy, and share many of the same geologic structures. Thus, the hydrologic consequences of underground coal mining in the Mill Fork Lease will be similar to those at the Deer Creek, Cottonwood, Wilberg, and Trail Mountain mines.

11.1 Potential adverse impacts to the hydrologic balance (section 728.310)

The hydrologic balance is the sum of the flow interactions between surface waters and groundwaters and between various groundwater flow systems. Underground coal mining has the potential to impact the hydrologic balance by:

1. decreasing creek flows and spring discharges by capturing surface waters and/or groundwaters,
2. increasing creek flows by accelerating the rate of groundwater discharge from the mined horizon of the Blackhawk Formation, and
3. increasing groundwater recharge rates to overlying groundwater systems.

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Subsidence-related fracturing can affect the hydrologic balance by capturing surface waters and/or groundwaters. In order for fracturing to reduce creek flows and spring discharges, such disturbances would have to result in the propagation of zones of increased vertical hydraulic conductivity. We do not believe that mining activities in the current Energy West lease area have so affected surface and groundwater flows. The basis of this finding is discussed below.

The layout of the Energy West mine plan is designed to minimize subsidence impacts to the steep cliffs of the Castlegate Sandstone. As a result, nearly all subsidence that has been measured to date occurs where the North Horn and, to a lesser extent, the Price River Formations are exposed at the surface. Vertical fractures are less likely to extend from the mined horizon into these formations because 1) the thickness of the overburden is from 900 to in excess of 2,500 feet and 2) the North Horn Formation contains abundant clayey units that exhibit plastic deformation and swell when wetted. This is extremely significant because most springs identified on East and Trail Mountains and in the Mill Fork Lease occur in the Price River and North Horn Formations and the overlying Flagstaff Limestone. These springs are effectively isolated from subsidence-related fracturing.

Numerous springs on East Mountain and several springs on Trail Mountain have been undermined. A smaller number of springs discharge from areas that have experienced subsidence. As part of this investigation the hydrographs of these springs have been reviewed within the context of the mining history. Although some springs discharge from

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areas that have subsided as much as 10-12 feet, there is no evidence of discharge declines that can be attributed to mining-induced subsidence or fracturing.

Similarly, ephemeral and intermittent sections of Deer Creek and Grimes Wash have been subsided by as much as 10 feet. These creeks show no discharge declines that are attributable to mining-induced subsidence. Underground mining in the Mill Fork Lease has the potential to impact the portions of the headwater drainages of that are Crandall, Mill Fork and Rilda Creek and intermittent tributaries of Indian Creek. However, we do not anticipate that creek flows will be reduced by subsidence-related impacts to any of these creeks because such impacts have not occurred with existing Energy West mines. Indian Creek lies beyond the western boundary of the lease area and no perennial streams discharge into the creek from within the Mill Fork Lease.

Appreciable amounts of groundwater are intercepted by underground coal mining. Mining quickly dewaters the saturated horizon immediately above the mined horizon and this water is not replaced as evidenced by the rapid decline and often complete drying of roof drips. In-mine groundwater occurs in isolated, inactive systems as demonstrated by the small ^{3}H content and radiocarbon ages of mine waters which range from 2,000 to 19,000 years (Table 5), with the exception of two sites which are discussed below. This indicates that in-mine waters are not in hydraulic connection with near-surface spring waters that respond to seasonal and climatic changes and contain anthropogenic carbon and appreciable amounts of ^{3}H.

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Groundwater inflows associated with the Roans Canyon Fault system have occurred in the Deer Creek Mine and the Joes Valley Fault in the Crandall Canyon Mine. Hydrologic concerns regarding fault inflows are 1) the capture of water supplying baseflow to creeks or springs, and 2) the discharge of fault-related water to creeks. In general, we do not believe that fault-discharge waters are tied to active, modern groundwater systems. However, locally fault related groundwater inflows, associated with the Roans Canyon and Joes Valley faults, have hydraulic communication with the surface as evidenced by their ^{3}H contents.. Wells drilled into and near the fault systems demonstrate that there is limited lateral communication along the fault system and the radiocarbon age most fault-discharge waters are 2,500 or more years. Mining within 200 to 300 feet of the Joes Valley Fault could intercept appreciable quantities modern near surface water.

Substantial groundwater inflows have occurred in the Deer Creek Mine from the Star Point Sandstone. These inflows are associated with the Straight Canyon Syncline. Because a similar structure does not occur in the Mill Fork Lease, a similar inflow is not anticipated.

The potential for mining activities to impact Little Bear Spring is believed to be minimal for several reasons. First, the spring is located 1½ miles from the Mill Fork Lease and more than two miles from the nearest proposed mining activities (Plate 1). Second, Little Bear Spring discharges from an active zone groundwater system that is in good communication with shallow recharge sources. These types of groundwater systems are isolated from the deep, inactive zone groundwater systems encountered in area coal mines.

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Although the headwaters of the Mill Fork drainage is within the Mill Fork Lease, the potential for adversely affecting surface waters in the drainage is remote. In those areas in the headwaters region that are proposed for full extraction mining, the stream channel resides primarily on the North Horn and Price River Formations (Figure 5). The thick sequence of relatively low permeability rock that separates the mined horizon from the stream channel effectively prohibits the downward migration of surface water and groundwater into deeper horizons. Thus, the potential for diminished flow in Mill Fork Creek, and corresponding decreases in the recharge to Little Bear Spring, is minimal.

11.2 Presence of acid-forming or toxic-forming materials (728.320)

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 PacifiCorp mines. 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 (Eqs. 3 and 4). Iron is readily precipitated as iron-hydroxide and excess iron is not observed in the mine discharge water.

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

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11.3 Impact of coal mining on sediment yield from disturbed areas (728.331)

The sediment load of streams can be impacted by increased sediment yield from areas disturbed by mining activities. Disturbed areas include: 1) surface workings, 2) mined-out areas, 3) subsided landscape above mine workings, and 4) sediment load from mine discharge water. Sediment yield from surface workings is minimized by sediment control structures that are installed and maintained according to the specifications in the mine permit. The sediment yield of mine discharge water is minimized through the use of sediment ponds. The sediment load of mine discharge water is monitored monthly according to UPDES permit specifications.

The sediment load of ephemeral and intermittent streams can be increased or decreased as a result of subsidence. Subsidence can locally increase stream gradients, causing higher flow velocities in the stream channel and greater sediment entrainment. The extent to which this phenomenon occurs in the lease area is not known; however, the impact would be localized and short-lived. The sediment load of ephemeral and intermittent streams would be decreased where subsidence causes water to be impounded. Here, stream flows would be decreased and sediment would be deposited in the impoundment. This occurrence would also be short-lived.

11.4 Impacts to important water quality parameters (728.332)

Solute and trace element composition and field parameters of springs, creeks, and mine discharge water have been monitored periodically to detect impacts to water quality. Inspection of the field parameters and solute and trace element composition of springs

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indicates no mining-related impacts on spring water quality. (It is difficult to envision a mechanism to affect the water quality of springs in horizons above the mine). Similarly, water quality in creeks above the mine water discharge points has not been impacted.

The quality of groundwater intercepted in the Mill Fork Lease should be similar to water that is currently being discharged from the Deer Creek and Cottonwood Mines. This water meets secondary drinking water quality standards and does not have detrimental impacts to the quality of receiving waters. The quality of water discharged from the Mill Fork Lease will be monitored periodically and be subject to UPDES permit specifications.

11.5 Flooding or streamflow alteration (728.333)

The amount of water that will be discharged is from the Mill Fork Lease is difficult to determine. We expect that the discharge will be much less than maximum flows during the springtime runoff and during summer thundershowers. We do not expect that flooding or streamflow alteration will result from mine water discharged to Huntington Canyon Creek.

11.6 Groundwater and surface water availability (728.334)

Mining in the Mill Fork Lease will not significantly affect the availability of groundwater. As described above, groundwaters in the lower Blackhawk Formation exist in highly compartmentalized partitions, both vertically and horizontally, and the formation does not act as a hydraulically continuous aquifer. The groundwater systems in the Blackhawk Formation were also demonstrated to be hydraulically isolated from overlying, modern groundwaters. The effects of locally dewatering the Blackhawk Formation adjacent to mine openings will

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not have any significant impact on groundwater availability in the region surrounding the mine.

There are no groundwater supply wells in the mine lease 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.

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Appendix A

Application of Selected Isotopes to Hydrogeologic Problems

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Mayo and Associates, LC
Consultants in Hydrogeology

Application of Selected Isotopes to Hydrogeologic Problems

Oxygen-18 ($\delta^{18}O$) and Hydrogen-2 ($\delta^{2}H$)

Worldwide, the $\delta^{2}H$ and $\delta^{18}O$ of precipitation (rain and snow) generally follow the empirical relationship:

$$\delta^{2}H = 8(\delta^{18}O) + d \ (‰)$$

Where *s* is the slope and *d* is the deuterium (hydrogen-2) excess (Merlivant and Jouzel, 1983). Craig (1961) and Dansgaard (1964) have shown that, on the global scale, *s* approximates 8 and *d* approximates 10 for coastal meteoric water. The Meteoric Water Line (MWL) is therefore defined as:

$$\delta^{2}H = 8(\delta^{18}O) + 10 \ (‰)$$

The $\delta^{18}O$ and $\delta^{2}H$ composition of groundwaters can be used to help evaluate the origin, flow and mixing patterns of groundwaters. Groundwater recharged during cooler climates or at higher elevations will have more negative isotopic compositions than groundwater that recharged during warmer climates or at lower elevations. Groundwaters which have been heated above about 100°C during deep circulation will exhibit a positive $\delta^{18}O$ shift relative to the $\delta^{2}H$ composition. Groundwater of non-meteoric origin (i.e. connate and magmatic) will not plot along the MWL.

Carbon-13 ($\delta^{13}C$)

Most groundwater acquires 50 percent of its carbon from soil zone water and 50 percent of its carbon from the dissolution of carbonate minerals in the soil zone or aquifer skeleton. Because the $\delta^{13}C$ of marine carbonate minerals is about 0‰ (Muller and Mayo, 1986) and soil zone CO_2 gas has a $\delta^{13}C$ of -18 to -27‰, most groundwaters have a $\delta^{13}C$ of approximately -9 to -13‰.

Sulfur-34 ($\delta^{34}S$)

The anticipated range of $\delta^{34}S$ values in Mesozoic early Tertiary gypsum and anhydrite is +10 to +20‰ (Holser and Kaplan, 1966). At non-thermal aquifer temperatures, isotopic fractionation accompanying gypsum dissolution may be represented as:

$$\underset{(\delta^{34}S = +15\ ‰)}{CaSO_{4(s)}} \quad \xRightarrow{^{34}S\ \text{enrichment}} \quad \underset{(\delta^{34}S = +9\ ‰)}{Ca^{2+} + SO_4^{2-}}$$

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atmosphere. Burning of fossil fuels, whose ^{14}C had previously completely decayed away, decreased the ^{14}C content in the troposphere in the northern hemisphere by about 3% (Houtermans and others, 1967). Atmospheric weapons testing greatly increased the atmospheric ^{14}C activity by the mid-1960's (Ferronsky and Polyakov, 1982).

The post-industrial revolution atmospheric ^{14}C perturbations and laboratory measurement error in measuring the ^{14}C content of groundwater make the reliable lower limit for ^{14}C dating about 450 years. The upper limit of ^{14}C dating, using conventional laboratory analytical methods, is about 35,000 years.

Estimating the age of dead wood or other organic carbon is relatively simple. The ^{14}C activity of pre-industrial revolution organic material is assumed to be 100 pmc. The radiocarbon date is then corrected for systematic variations in atmospheric ^{14}C that have been established by comparing tree ring dates of the wood of Sequoia and Bristlecone Pines with their corresponding radiocarbon ages (LaMarche and Harlan, 1973; Michael and Ralf, 1970).

Estimating the radiocarbon age of groundwaters is not as straightforward as estimating the age of dead organic matter. Groundwater acquires carbon from numerous sources, many of which had initial ^{14}C activities of less than 100 pmc. The ^{14}C content of groundwater is affected by four factors:

1) the addition of "live" carbon (i.e., $^{14}C \approx 100$ pmc) from the biogenic production of $CO_{2(g)}$ in the soil zone,
2) the addition of "dead" carbon from the weathering of minerals in the soil zone and the dissolution of carbonate minerals in the soil zone or aquifer (i.e., $^{14}C \approx 0$ pmc),
3) the addition of "dead" carbon from the soil or aquifer during isotopic exchange reactions, and
4) the addition of both "live" and "dead" carbon by other processes.

The crux of dating groundwater is estimating the initial ^{14}C activity (A_o) of the water at the time of recharge. This may be accomplished by using the solute and isotopic chemistries of the groundwater and applying correction procedures. Correction procedures for estimating A_o are in the form of mathematical equations that attempt to account for the contribution of "dead" carbon and ^{14}C from various sources, and for the effects of the isotopic exchange and fractionation processes.

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where the value $\delta^{34}S \approx +15‰$ has been arbitrarily selected.

The typical $\delta^{34}S$ value of magmatic pyrite is about 0 ‰ (Faure, 1986). A $\delta^{34}S$ of -2.2‰ has been reported for pyrite in the Park City, Utah District (Thode and others, 1961). Mayo and Klauk (1991) found a mean $\delta^{34}S$ of +1.3 ‰ in groundwater from non-carbonate (crystalline rock) aquifers in north central Utah. Mayo, Petersen, and Kravits (unpublished data) found a $\delta^{34}S$ value of pyrite in the SUFCO coal mine, Utah of +3.4‰. Sulfur isotopic fractionation does not accompany the dissolution of pyrite.

Tritium (^{3}H)

Tritium (^{3}H), the radioactive isotope of hydrogen, has been used in groundwater investigations to differentiate between groundwaters which recharged prior to or after the advent of atmospheric thermonuclear weapons testing. Tritium, whose half-life is 12.43 years, forms naturally in the upper stratosphere by the interaction of ^{14}N with cosmic ray neutrons according to the reaction:

$$^{14}N + n \Rightarrow {}^{3}H + {}^{12}C$$

Tritium is rapidly incorporated into water molecules and is removed from the atmosphere by precipitation.

Prior to the advent of atmospheric thermonuclear weapons testing in 1952, tritium activity in precipitation ranged from 4 to 25 tritium units (TU). One TU equals one ^{3}H atom per 10^{8} hydrogen atoms. In mountainous areas, larger natural concentrations have been observed (Fontes, 1983). During the peak of atmospheric weapons testing, tritium levels in precipitation rose to more than 2,200 TU in some northern hemisphere locations (Fontes, 1983). As of 1987, the ^{3}H concentrations in rain water varied from 25 to 50 TU. Unpublished data of 1991, 1992, and 1997 snow and rain samples collected in the central Wasatch Range, Utah have ^{3}H concentrations ranging from about 5 to 20 TU or more.

Carbon-14 (^{14}C)

Carbon-14, the radioactive isotope of carbon, has a half-life of 5,730 ± 30 years (Godwin, 1962). Carbon-14 is produced in the upper atmosphere by a variety of reactions that involve the collision of cosmic radiation (neutrons) with stable isotopes of nitrogen, oxygen, and carbon. The most important of these reactions is between neutrons and ^{14}N according to the reaction:

$$n + {}^{14}N \Rightarrow {}^{14}C + p$$

where n is a neutron and p is a proton (Libby, 1955). Carbon-14 is incorporated into $CO_{2(g)}$ and rapidly mixes throughout the atmosphere and hydrosphere where steady state equilibrium between ^{14}C production and ^{14}C decay is attained (Faure, 1986).

The pre-industrial revolution atmospheric ^{14}C content has been assigned the steady state value of 100 percent modern carbon (pmc). The burning of fossil fuels and the advent of atmospheric thermonuclear weapons testing greatly altered the ^{14}C activity in post-industrial revolution

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Plate 1

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LEGEND

- MILL FORK LEASE PPOPERTY BOUNDARY
- PACIFICORP EAST MOUNTAIN PROPERTY BOUNDARY
- FAULT (DASHED WHERE INFERRED)
- BLIND CANYON SEAM MINING PROJECTIONS
- HIAWATHA SEAM MINING PROJECTIONS
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- GENWAL RESOURCES PROPERTY BOUNDARY
- GENWAL RESOURCES LEASE APPLICATION BOUNDARY
- OUTCROP
- *EM–169* DRILL HOLE
- MFB02 SURFACE WATER MONITORING LOCATION

SPRING LEGEND

- SPRING LOCATION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- SPRING LOCATION (1992 SURVEY)
- SPRING LOCATION (1991 SURVEY)

RECEIVED
OCT 2 9 2001
DIV OF OIL GAS & MINING

BLM MOU UT930-FY9701 No. 10-MOU-97-001

MEMORANDUM OF UNDERSTANDING

among:

USDI, Bureau of Land Management, Utah
USDA, Forest Service, Intermountain Region
State of Utah - Division of Oil, Gas and Mining

concerning:

PROCESSING OF REQUESTS TO RELINQUISH FEDERAL COAL LEASES

I. Purpose. This Memorandum of Understanding (MOU) provides procedures and guidance for coordination and cooperation among the Bureau of Land Management (BLM), the Forest Service (FS), and the Utah Division of Oil Gas and Mining (DOGM) on the procedures for processing Federal coal lease relinquishment requests where the Federal lessee no longer wishes to retain a lease or leases.

II. Objective. The processing of a coal lease relinquishment action requires input from the various agencies. The objectives of this MOU are to establish the roles to be played and procedures to be followed by its signatory agencies when responding to relinquishment of a Federal coal lease (i) to insure the protection of public lands and resources in a manner that will not impair the public interest and (ii) to allow the agencies to function in a more timely, effective, efficient and consistent manner, so that the rights of both the lessee and the public are protected.

III. Authority.

A. Federal Land Policy and Management Act of 1976.

B. Mineral Leasing Act of 1920, as amended.

C. Federal Coal Leasing Amendments Act of 1975.

D. National Forest Management Act of 1974.

E. Utah Coal Mining Control and Reclamation Act and the Cooperative Agreement with the Office of Surface Mining. (Surface Mining Control and Reclamation Act), (SMCRA), PL 95-87.

IV. Procedure. The signatory agencies have met at various times to develop consistent procedures for the processing of Federal coal lease relinquishments. Nothing in this MOU shall be construed to require more from a Federal coal lessee than currently required by law, the terms and conditions of the lease instrument, or the current regulations at 43 CFR 3452. The issues and agreed upon procedures are as follows:

JAN-28-98 WED 1:47 PM PRICE FIELD OFFICE FAX NO. 4350350

ISSUE AND PROBLEM STATEMENT:

An issue has developed in Utah concerning the relinquishment of all or part of Federal coal leases on which a company has completed mining and applies for relinquishment. The interested agencies in this matter are: the BLM, FS and Utah DOGM. The primary concern is whether the lessee has met the terms and conditions of the lease, and that prior to relinquishment, impacts on the surface and other resources have been fully delineated and mitigated, if necessary. BLM's existing regulations in 43 CFR 3452.1-3 indicate "no relinquishment shall be approved until the Authorized Officer determines that the relinquishment will not impair the public interest."

BLM has received several applications to relinquish all or parts of Federal coal leases on which underground mining has been concluded or the lease is no longer needed. The companies indicate no remaining interest in maintaining the leases or portions of leases and a desire to reduce Federal lease holdings and costs of holding leases. Initial review of some of the applications indicate concern by State and Federal agencies as to whether lease terms have been met and the potential impacts of mining have been identified.

The criteria for accepting relinquishment are currently contained in 43 CFR 3452.1-3 which indicate approval by the Authorized Officer (AO) is dependent on the following:

- The relinquishment will not impair the public interest,
- The accrued rentals and royalties have been paid, and
- All the obligations of the lessee under the regulations and terms of the lease have been met.

BLM's existing performance standards for underground mines in 43 CFR 3484.1(c)(2) require controlled subsidence and maintenance of the value and use of surface lands consistent with Surface Mining Control and Reclamation Act (SMCRA) requirements and applicable requirements of an approved State program.

The agencies wish to determine the point in time after completion of mining that the authorized officer can find the lessee has met the terms and conditions of the lease and impacts to the surface have been evaluated for possible restoration or mitigation. The agencies have agreed a consistent procedure is necessary to evaluate whether subsidence is substantially complete and impacts from subsidence have been properly treated before lease relinquishment.

FEDERAL COAL LESSEE INPUT TO RELINQUISHMENTS:

Federal coal leases have no expiration dates and remain a valid right of the lessee until lease relinquishment is accepted by the Authorized Officer, a lease is canceled for noncompliance by official action, or terminates by law. Existing Federal Regulations in 43 CFR 3452 are vague as to what information a Federal coal lessee will submit with a request for relinquishment. In order for the signatory agencies to effectively evaluate whether a request for relinquishment is appropriate, it may be

necessary for the coal lessee to submit additional information, as provided by regulation, that will provide a final report concerning mining that has occurred and documentation of surface impacts. To assist Federal coal lessees on relinquishment matters, a checklist is provided to guide lessees in data documentation for relinquishment. (See Attachment 1)

AGENCY RESPONSIBILITIES:

BLM will: Serve as Lead Agency in processing coal lease relinquishment applications by providing initial review and ensuring compliance with applicable BLM regulations including seeking additional data documentation as allowed by regulation. BLM will coordinate review by other parties to the MOU and promptly issue decisions when all inputs are available from other agencies. When BLM is the surface management agency, BLM will review lease stipulations that have been made part of the Federal coal lease and determine whether the lessee has satisfied all terms and conditions of the lease, and whether the surface is stable and surface reclamation, resource restoration or mitigation has been satisfactorily accomplished. In the event reclamation or restoration is necessary to obtain AO approval, signatory agencies will meet to outline requirements before relinquishment will be accepted.

USFS will: When the surface management agency, provide prompt review of applications and data provided by the company and BLM. The FS will be in a position to make a determination after the data documentation has been provided and the surface has been examined. This would normally be 3 to 6 months after receiving a request depending on the accessibility to the area. The FS will review special lease stipulations that have been made a part of Federal coal leases and determine whether the lessee has satisfied terms and conditions of these stipulations. In responding to BLM, the FS, will indicate one of the following: (1) the terms and conditions of the special lease stipulations have been met, (2) the lease area is not stable and adequate time has not lapsed to adequately evaluate potential impacts on other Federal resources, (3) surface reclamation, resource restoration or mitigation is necessary on the lease which will have to be satisfactorily accomplished before relinquishment is acceptable, or (4) sufficient data has not been provided for the FS to make a recommendation. In the event surface reclamation is believed to be required, the FS and DOGM will consult on this matter.

Utah DOGM will: As the mine permitting regulatory authority, require restoration of surface area as required by its authority or by the surface management agency, and will determine whether lease relinquishment would conflict with administration of the mine permit.

STANDARDS FOR RELINQUISHMENT CONSIDERATION:

SUBSIDENCE AND SURFACE STABILIZATION

It has been established that where underground coal mining has occurred, the mining activity has caused surface subsidence ranging from 0 to over 100 percent of the

thickness of the coal removed. The amount is dependent on a wide range of conditions including: the coal field, percent of coal extracted, mining method, overburden thickness, strength of the overburden, length of the mined face, number of seams mined, existence of faults and areas of burned coal and other factors. Monitoring by the mining operators and special studies in the Wasatch Plateau Coal Field indicate that under normal conditions, the surface subsides 35 to 70 percent of the mining height. Surface subsidence may take from a matter of a few months to a few years before active subsidence is complete. Subsidence in the Book Cliffs Coal Field has been less pronounced.

In order for the AO to accept relinquishment of underground mined leases, the parties to this MOU have agreed that a coal lessee may, under current regulations and as a general guide, be required to retain leases or portions of leases throughout the period that active subsidence is continuing until the surface has substantially stabilized. This will be done by showing the cumulative subsidence during this monitoring period (3 years) has been 1 foot or less under normal circumstances. The operator/lessee will demonstrate this through analysis of data collected during the subsidence monitoring program. BLM may request additional raw data be submitted for independent analysis if questions remain on meeting this condition. Anomalies that create uncertainty will require additional analysis and discussion between the agencies and the operator/lessee before a final decision on lease relinquishment is made.

MONITORING STUDIES

Lease stipulations and DOGM permits require monitoring studies that document baseline conditions and locate, measure, and quantify the progressive and final effects of underground mining on the topographic surface, underground and surface hydrology, vegetation and surface improvements. Monitoring plans are usually specified in the approved Mining and Reclamation Plan. The parties of this MOU have agreed that under normal circumstances, a minimum time period for continuation of monitoring studies after mining is completed is for three years. During this time period, the operator/lessee will establish that the surface has substantially stabilized as defined above. For unusual circumstances such as block rotation on an escarpment and where concerns extend beyond this three year period, the signatory agencies will meet with the company on the ground to discuss those items not consistent with lease requirement, and will establish time frames for extending the monitoring period. If any changes in the monitoring program are needed to determine the extent or cause of detected impacts, they will be noted at this time. Hydrologic monitoring within or adjacent to a relinquished lease would need to continue if required to monitor the impacts associated with adjacent leases or permit areas as indicated in SMCRA.

EVALUATION OF POTENTIAL IMPACTS FROM MINING

Lease stipulations and Mining and Reclamation Plans require operators/lessees to establish baseline data for natural resources and monitor potential impacts throughout the life of a lease. The signatory agencies to this MOU have agreed that in order for

the AO to evaluate relinquishment applications and as allowed by law, it will be necessary for lessees to document known and potential impacts at the conclusion of mining after apparent stabilization of the surface. The surface management agency and BLM in conjunction with DOGM will review relevant reports submitted for adequacy and accuracy. Within the monitoring period after active subsidence is complete, the surface management agency in conjunction with other agencies as needed will evaluate reports submitted by the lessee regarding the impacts of mining. This evaluation will be based on a final monitoring report which will summarize all monitoring studies available from the operator and additional documentation from the relinquishment application. The surface management agency will use all available data to evaluate whether adverse impacts to the surface or other resources will require reclamation, restoration or mitigation. The agencies will complete the analysis within a 6 to 12 month period. Where the FS is the surface management agency, a written determination by the FS will be provided to the BLM, State Director. BLM field offices will provide similar documentation pertaining to evaluation of impacts and recommendations to the AO.

Impacts to Surface Topography:

Utilizing monitoring studies the operator has provided and additional documentation provided with the relinquishment application, the surface management agency will inspect impacted and high risk areas to evaluate the significance of the disturbance and possible need for restoration and/or mitigation. The rule of reasonableness will apply with analysis of relative impact to the land surface and resources including the potential for creating or leaving unsafe conditions for users of Federal land.

Impacts to Ground and Surface Water Hydrology:

Among the more difficult impact evaluations, will be that of examining possible consequences of disturbing surface and groundwater. Utilizing baseline studies as to the location, quality and quantity of water, along with monitoring information and key information such as precipitation, the lessee will identify possible deviations from the anticipated normal situation. The lessee will submit the information to the AO. This would normally be provided within six months after the final monitoring period. Additional State or Federal agency expertise may be consulted, if necessary. Changes in the baseline water situation that can be attributed to mining will be identified. The Surface Management Agency will evaluate possible impacts to other resources and possible need for restoration/mitigation. In the event that adverse impact on the hydrology and other resources has occurred, the lessee shall follow the mitigation plan contained in the approved Mining and Reclamation Plan.

Impacts to Vegetation:

Utilizing the baseline established for vegetation and annual monitoring reports, the lessee will document any change to vegetation for analysis by the AO and the surface management agency. Agency assessment will occur as soon as possible after the

monitoring period to determine the need for reclamation, normally within a 6-12 month period.

Impacts to Surface Improvements:

Surface improvements in the lease area influenced by underground mining that are owned by the government or private parties will be evaluated utilizing all available information. A final inspection will be conducted by the signatory agencies once subsidence is established to be substantially complete to identify improvements that will require restoration.

V. Administration.

A. Nothing in this MOU will be construed as affecting the authorities of the participants or as binding beyond their respective authorities or to require any of the participants to obligate or expend funds in excess of available appropriations.

B. Conflicts between the participants concerning procedures under this MOU which cannot be resolved at the operational level will be referred to successively higher levels, as necessary, for resolution.

C. The participants will review this MOU at least every 5 years to determine its adequacy, effectiveness and continuing need.

D. The terms of this MOU may be renegotiated at any time at the initiative of one or more of its participants, following at least 30 days notice to the other participants.

E. This MOU may be canceled at any time by one or more of its participants, following at least 30 days notice to the other participants.

F. Any participant may propose changes to this MOU during its term. Such changes will be in the form of an amendment and will become effective upon signature by all of the participants.

G. This MOU will become effective upon signature by all of its participants.

APPROVED:

G. William Lamb
Utah State Director, BLM

9/18/96
Date

Dale Bosworth
for Regional Forester, USFS Region IV

10/3/96
Date

James W. Carter
Director, Utah Div. Oil, Gas & Mining

9/16/96
Date

(1) Attachment: Checklist for Data Documentation in Federal Coal Lease Relinquishment.

ATTACHMENT 1

CHECKLIST FOR DATA DOCUMENTATION BY LESSEE IN FEDERAL COAL LEASE RELINQUISHMENT

Coal lease number.
Lessee name and address.
DOGM mine number.
Has lessee or (if previously assigned) the former lessee, conducted mining or any surface disturbing activity on this lease?

(Continue if mining/activity has occurred)

Type of mining conducted.
Date of initial mining.
Date of last mining.
Number of seams mined.
Range of thickness of coal removed.
Has subsidence occurred on this lease?

(Continue if subsidence has occurred)

Provide maps that note surface impacts on the lease.
Provide subsidence development curves.
Statement as to whether active subsidence has concluded.
Date and location as to where and when last subsidence occurred.
Note any Federal resources that might have been adversely impacted by subsidence (hydrologic resources, vegetation, improvements, etc.)
Note any impacts to private improvements.
Provide documentation as to how impacts were measured.
Plan for mitigation/restoration.

Full Relinquishment
Federal Coal Lease
UTU-88554

May, 2018

PACIFICORP
A BERKSHIRE HATHAWAY ENERGY COMPANY

Prepared by:

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

Managing Agent
1407 West North Temple, Suite 110
Salt Lake City, UT 84116

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

1407 W. North Temple, Suite 110
Salt Lake City, UT 84116

HAND DELIVERED

May 29, 2018

RECEIVED
MAY 30 2018
Bureau of
Land Management

Kent Hoffman
Deputy State Director
United States Department of the Interior
Bureau of Land Management
Utah State Office
440 West 200 South, Suite 500
Salt lake City, Utah 84101-1345

RE: Overview of Federal Coal Lease Relinquishment Project (20 Federal Leases) East Mountain Logical Mining Unit UTU-73336, Deer Creek and Cottonwood Mines, Emery County, Utah

Dear Mr. Hoffman:

By letter dated February 19, 2018, and on behalf of PacifiCorp, we provided our advance notice of intent to relinquish all or portions of the federal coal leases within the East Mountain Logical Mining Unit (LMU) UTU-73336, with the commitment to eventually provide individual formal federal coal lease relinquishment notices to your office to bring an end to the final chapter to this LMU.

Background and Purpose of Relinquishment

With PacifiCorp's decision and announcement on December 15, 2014, to close the Deer Creek Mine and end production from the LMU, this brought an end to 40+ years of coal production from this LMU. All coal production ceased on January 7, 2015. PacifiCorp has made steadfast efforts to complete all mine closure activities including the construction of permanent portal seals for the entire Deer Creek Mine complex and LMU.

All economically recoverable coal reserves within the entire LMU have been mined out or have been determined uneconomical to mine as acknowledged by BLM's letter dated March 23, 2016 (copy enclosed). Having fully complied with the federal coal lease terms

and their associated federal regulations, PacifiCorp has no intentions to re-open the mines within the LMU. Therefore, the purpose of this relinquishment exercise is to surrender the federal coal lease acreage back to the federal government that is no longer needed and retain selected lease acreage for reclamation purposes only. Refer to Map 1 (enclosed) which depicts the federal coal lease areas being relinquished (yellow) and the areas retained (green) for reclamation purposes.

LMU Lease Relinquishment Project Overview

We have prepared individual relinquishment notifications for 20 of the 21 federal coal leases that have comprised the LMU. Of the 20 federal coal lease relinquishment notifications, 12 leases are full relinquishments and 8 leases are partial relinquishments. Listed below are the 20 federal coal leases included in this relinquishment exercise:

(1) UTU-88554 (Full)
(2) UTU-84285 (Full)
(3) UTU-06039 (Partial)
(4) UTU-24317 (Full)
(5) UTSL-051221 (Partial)
(6) UTU-2810 (Partial)
(7) UTSL-050862 (Partial)
(8) UTU-014275 (Full)
(9) UTU-024319 (Full)
(10) UTU-47977 (Full)
(11) UTU-084924 (Full)
(12) UTU-084923 (Full)
(13) UTU-47979 (Partial)
(14) UTSL-070645/02292 (Full)
(15) UTSL-064607/064621 (Partial)
(16) UTU-083066 (Full)
(17) UTU-040151 (Partial)
(18) UTU-1358 (Full)
(19) UTSL-064900 (Partial)
(20) UTU-47978 (Full)

The eight (8) leases that are being partially relinquished, involve retaining selected portions of these leases for the following purposes:

1. To conduct surface reclamation on the disturbed lands in accordance with the state approved mine permits for the Deer Creek and Cottonwood Mines, and
2. Sustain the legal right-of-entry to these split estate federal lands while reclamation activities are conducted and finalized including the required 10-year minimum bond liability period to achieve Final Phase 3 Bond Release.

The individual lease relinquishment notifications will be submitted to your BLM office under separate cover letters as we get them completed in the order listed above.

Also, please note that federal coal lease UTU-044025 (within the LMU) is **not** included in this overall relinquishment exercise. PacifiCorp will need to retain all of federal coal lease UTU-044025 (total of 40 acres) for reclamation purposes and through the mine permit bond liability period to achieve Final Phase 3 Bond Release.

Conclusion

To the best of its information and belief, PacifiCorp is in compliance with the terms and conditions of this federal coal lease, inclusive of having made all payment obligations relative to rentals and royalties. Furthermore, PacifiCorp represents that the federal lease acres relinquished will not impair the public interest as all obligations under regulation 43 CFR § 3452.1 and all of the lease terms have been met per established BLM guidelines.

All relinquishment notifications have been prepared on behalf of PacifiCorp and have been acknowledged as set forth on each individual notification. We respectfully seek your attention to this matter and request that all twenty (20) lease relinquishments be accepted in a timely manner. Furthermore, with the submittal of these lease relinquishment notifications, this overall action will dissolve the East Mountain LMU UTU-73336 in its entirety.

Should you have any questions, need additional information or wish to discuss this matter with us, please feel free to contact me at 801-220-4612 or by email at Scott.Child@PacifiCorp.com.

Respectfully,

Scott M. Child
Manager, Lands & Regulatory Affairs

Enclosures

cc: D. Ralston, B. Morgan, J. Potter, C. Semborski, K. Fleck, D. Oakley

SMC\Interwest\UTBLM2018-21(EastMtnLMU-FedLeaseRelinqProjOverview)

LEGEND

- LMU BOUNDARY 20,175.11 ACRES
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- U-47977 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE
- FEDERAL COAL LEASE ACREAGE RETAINED
- FEDERAL COAL LEASE ACREAGE RELINQUISHED

Mine Workings Updated To: January 7, 2015

CAD FILE NAME/DISK#: LEASE RELINQUISHMENT BASE MAP

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

PACIFICORP EAST MOUNTAIN LMU UTU-73336
FEDERAL COAL LEASE RELINQUISHMENTS
AND AREAS TO BE RETAINED

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =4400'	DRAWING #:	
DATE:	MAY 8, 2018	SHEET 1 OF 1	REV.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District
Price Field Office
125 South 600 West
Price, UT 84501
http://www.blm.gov/ut/st/en/fo/price.html

MAR 2 3 2016

In Reply Refer To:
3482 (UTG023)
LMU UTU-73336 Mine Closure, UTU-88554, UTU-84285, UTU-06039
SL-070645/U-02292, U-084923, U-084924, U-083066, U-040151
U-044025, U-1358, SL-064607/064621, U-024317, U-024319
U-014275, SL-051221, U-47977, U-47978, U-47979, SL-050862
U-2810, LDS Fee Land, ML-48258/UTU-88554

MAR 2016
Received
Interwest Mining
Company

CERTIFIED MAIL - RETURN RECEIPT REQUESTED
7014-2120-0004-6185-8850

Mr. Scott M. Child
Manager, Lands and Regulatory Affairs
Interwest Mining Company
1407 W. North Temple, Suite 310
Salt Lake City, Utah 84116

Re: Final Resource Recovery and Protection Plan (R2P2) Amendment and Final Disposition of the East Mountain Logical Mining Unit (LMU), Deer Creek Mine and Interwest Mining Company, as Managing Agent

Dear Mr. Child:

On September 25, 2015, the Bureau of Land Management (BLM) received a final R2P2 amendment from Interwest Mining Company for closing the subject mine and sealing the mine openings. This request follows the "Approved – Portal Sealing and Abandonment Plan – Final Closure of the Deer Creek Mine" letter from the BLM to Interwest dated April 10, 2015. In that letter the BLM approved the sealing of the mine. The received information from Interwest fulfills the requirements described in 43 CFR 3482.1(b) and (c).

Affected Leases and Logical Mining Unit (LMU): The idling of the mine affects the LMU UTU-73336, which includes all the leases and properties in the LMU.

Proposed Plan and Justification: Interwest has extracted all equipment out of the mine except those components required for dewatering the mine prior to final implementation of a ground water containment and distribution system. Upon final construction of the underground water management system, all openings to access the coal will be sealed with block walls containing

water drainage P-traps and will be back filled with noncombustible material for at least 30 feet outby. Unauthorized access into the mine and federal coal resources would be secured and the mine workings protected from long term degradation. Justification for the mine closure was PacifiCorp's decision to close the Deer Creek Mine based upon maximum economic recovery. PacifiCorp provided proprietary and confidential information demonstrating that production costs at the mine exceeded market costs and thus provided the decision to close the mine.

Inspection: As equipment has been withdrawn from the mine, the BLM has inspected all areas that have been abandoned before they became inaccessible. The BLM will continue to inspect accessible areas until final sealing has occurred.

Approval and Conditions: The BLM agrees with Interwest's proposal for sealing and securing the mine. The BLM accepts the final R2P2 and the update to the coal reserve as shown in the two-volume "Final Amendment (Per Mine Closure) September 2015 East Mountain LMU UTU-73336 Resource Recovery and Protection Plan for the Deer Creek and Cottonwood/Wilberg Coal Mines".

✓ **Maximum Economic Recovery (MER):** MER has been determined to be achieved due to the mining costs encountered in this mine when compared with coal secured in the open market.

National Environmental Policy Act (NEPA): This approval of a minor modification to an approved R2P2 of an existing underground coal mine is categorically excluded from NEPA analysis, as explained in the Department Manual (5 DM Part 516 11.5 (F) (8)).

The BLM has determined that this R2P2 modification complies with the Mineral Leasing Act of 1920, as amended, the regulations at 43 CFR 3480, and the lease terms and conditions. Interwest is authorized to secure the Deer Creek Mine indefinitely. If you have any questions, please contact Steve Rigby at the Price Field Office (435-636-3604) or Jeff McKenzie at the BLM State Office (801-539-4038).

Sincerely,

Ahmed Mohsen
Field Manager

cc: Roger Bankert, BLM State Office (UT-920)

Office of Natural Resource Revenue
Attn: John Hovanec
DFC, 6th & Kipling, Bldg.85
P.O. Box 25165, MS 63010C
Denver, Colorado 80225-0165

Utah Division of Oil, Gas, and Mining
Daron Haddock
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Mine Safety and Health Administration
Cord Cristando
45 East 1375 South
Price, Utah 84501

COPY

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

1407 W. North Temple, Suite 110
Salt Lake City, UT 84116

HAND DELIVERED

May 29, 2018

RECEIVED
MAY 30 2018
Bureau of
Land Management

Kent Hoffman
Deputy State Director
United States Department of the Interior
Bureau of Land Management
Utah State Office
440 West 200 South, Suite 500
Salt lake City, Utah 84101-1345

RE: Notification of Full Relinquishment of Federal Coal Lease UTU-88554, East Mountain LMU, Deer Creek Mine, Emery County, Utah

Dear Mr. Hoffman:

In accordance with 43 CFR § 3452.1 (2017) and the terms of the referenced federal coal lease, submitted herewith in triplicate is documentation in support of PacifiCorp's full relinquishment of acreage under federal coal lease UTU-88554. The total acreage being surrendered is 6,382.82 acres. Refer to Map 1 for lease location within the East Mountain Logical Mining Unit UTU-73336.

The attachments to this letter contain lease specific information compiled using the Bureau of Land Management (BLM) relinquishment checklist developed by your staff. To assist the reviewer in the process, we've completed the checklist with the best available information known to us given the history of this lease. The supporting information is located in the accompanying appendices.

Background and Purpose of Relinquishment

With PacifiCorp's decision and announcement on December 15, 2014, to close the Deer Creek Mine and end production from the LMU, this brought an end to 40+ years of coal production for this LMU. All coal production ceased on January 7, 2015. PacifiCorp has made steadfast efforts to complete all mine closure activities including the construction of permanent portal seals for the entire Deer Creek Mine complex and LMU.

All economically recoverable coal reserves within the entire LMU inclusive of this federal coal lease has been mined out or has been determined uneconomical to mine as acknowledged by BLM's letter dated March 23, 2016 (copy enclosed). Having fully complied with the federal coal lease terms and their associated federal regulations, PacifiCorp has no intentions to re-open this mine. Therefore, the purpose of this relinquishment is to surrender this federal coal lease acreage back to the federal government and bring final closure to this matter.

Full Relinquishment

The legal description for full relinquishment of UTU-88554 is described below:

Federal Coal Lease UTU-88554		
Lease Issuance Date:		4/1/1999 to 4/1/2019
Lessee of Record:		PacifiCorp
Total Federal Coal Lease Acres:		**6,382.82**
Description of Lease Acreage Being Relinquished		**Acres**
T16S, R6E, SLB&M Emery County, UT		
Sec 1:	SE¼	160.00
Sec 10:	E½E½SE¼	40.00
Sec 11:	All	919.96
Sec 12:	All	640.00
Sec 13:	All	640.00
Sec 14:	All	915.20
Sec 15:	E½E½	160.00
Sec 22:	Lots 1,2,4,5,6,7, E½NE¼, SW¼NE¼, N½SE¼, SE¼SE¼	465.13
Sec 23:	N½, N½S½, S½S½ (All)	640.00
Sec 24:	N½	320.00
Sec 25:	W½W½NW¼, W½NW¼SW¼	60.00
Sec 26:	N½, N½S½	480.00
Sec 27:	E½NE¼, NE¼SE¼	120.00
T16S, R7E, SLB&M Emery County, UT		
Sec 6:	Lots 5,6,7,8, S½SE¼	202.66
Sec 7:	All	413.60
Sec 18:	Lots 1,2, NE¼	206.27
	Total Lease Acres for Full Relinquishment:	**6,382.82**
	Total Lease Acres Remaining:	**0.00**

Conclusion

To the best of its information and belief, PacifiCorp is in compliance with the terms and conditions of this federal coal lease, inclusive of having made all payment obligations relative to rentals and royalties. Furthermore, PacifiCorp represents that the federal lease

acres relinquished will not impair the public interest as all obligations under regulation 43 CFR § 3452.1 and all of the lease terms have been met including having demonstrated substantial completeness per BLM subsidence guidelines.

This relinquishment notification was prepared on behalf of PacifiCorp and is acknowledged as set forth below.

We respectfully seek your attention to this matter and ask that this relinquishment be accepted in a timely manner. Should you have any questions, need additional information or wish to discuss this matter with us, please feel free to contact me at 801-220-4612 or by email Scott.Child@PacifiCorp.com.

Sincerely,

Scott M. Child
Manager, Lands & Regulatory Affairs

Acknowledged and agreed to this 29 of MAY, 2018 by PacifiCorp, the lessee of record:

Dana M. Ralston
Senior Vice President
Thermal Generation & Mining
Rock Mountain Power (a division of PacifiCorp)

Enclosures

cc: B. Morgan, J. Potter, C. Semborski, K. Fleck, D. Oakley

Utah Division of Oil, Gas, and Mining
Daron Haddock
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Mine Safety and Health Administration
Cord Cristando
45 East 1375 South
Price, Utah 84501

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-88554

LEASE ACTIVITIES

1) Coal Lease Number: UTU-88554 *(Full Relinquishment)*

2) Lessee Name and Address:
PacifiCorp
c/o Interwest Mining Company
1407 West North Temple, Suite 110
Salt Lake City, Utah 84116

3) Utah Division of Oil, Gas, and Mining (DOGM) mine permit number: C/015/0018 (Deer Creek Mine).

4) Date of request: _____ Date filed: _____.

5) Acres requested to be relinquished: 6,382.82; Entire lease? YES ☒ NO ☐ (See attached map.) Comments: *Refer to Exhibit A for the legal descriptions of area relinquished. No areas retained. See also Figure 1 (a map depicting the area to be relinquished in its entirety).*

Original Lease Acreage: 6,382.82 Relinquished to date: 0.00 acres Remaining: 6,382.82 acres

6) Have all bonus bid payments been paid? YES ☐ NO ☐ N/A ☒ (If "NO", date anticipated to be paid in full: ___)

7) Are lease rental payments up to date? YES ☒ NO ☐ N/A ☐ (If "NO", date anticipated to be brought up to date: _____)

8) Has the lessee or the former lessee, if previously assigned, conducted mining activities on this lease? YES ☒ NO ☐ (If "NO", complete question 14, then proceed to question 23)

9) Type of mining conducted: Longwall ☒, Room & Pillar ☐, Surface ☐, Other ☐ (Explain) _____

10) If underground mined, excluding surface disturbances associated to subsidence, was there any surface disturbance conducted in association with the underground operation(s)?
YES ☐ NO ☒ (If "YES", describe:

11) Date of initial mining: December 2003; last mining: January 2015.

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-88554

12) Number of coal beds mined: 2 coal seams (Blind Canyon and Hiawatha)

13) Range of thickness of coal removed for each bed: 7' - 11'

14) Have all estimated recoverable coal reserves been recovered? YES ☒ NO ☐ N/A ☐ (If "NO", tons to remain in place: _____; Justification to leave these reserves must be provided.)
    - *Refer to BLM approval letter dated March 23, 2016 (copy enclosed) regarding the final R2P2 for the Deer Creek Mine and final disposition of the East Mountain Logical Mining Unit with a determination that maximum economic recovery has been achieved*

15) Was an R2P2 modification required to account for deficient recovery? YES ☒ NO ☐ (If "NO", explain: _____)
    - *Refer to BLM approval letter dated March 23, 2016 (copy enclosed) regarding the final R2P2 for the Deer Creek Mine and final disposition of the East Mountain Logical Mining Unit with a determination that maximum economic recovery has been achieved*

16) Have all production royalty payments been paid to ONRR? YES ☒ NO ☐ (If "NO", date anticipated to be paid in full: _____)

17) Did subsidence occur? YES ☒ NO ☐ (If "YES", continue; if "NO", proceed to 23)

18) Has it been demonstrated that the surface above subsided areas has been substantially stabilized per the criteria outlined in Appendix A? YES ☒ NO ☐ N/A ☐ (If "YES", please attach supporting documentation.)

19) Has the surface area been inspected to determine impacts to surface topography per the criteria outlined in Appendix B? YES ☒ NO ☐ N/A ☐ (If "YES", attach supporting documentation. If "NO", date when inspection is scheduled: ___)
    - *Surface topography inspections were conducted through annual reconnaissance flights.*

20) Have there been any impacts to surface or groundwater per the criteria outlined in Appendix C? YES ☐ NO ☒ N/A ☐ (If "NO", attach supporting documentation.)
    - *Refer to hydrographs*

21) Have there been any impacts to vegetation per the criteria outlined in Appendix D? YES ☐ NO ☒ N/A ☐ (If "NO", attach supporting documentation.)
    - *Refer to DOGM write up*

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-88554

22) Have there been any impacts to private improvements per the criteria outlined in Appendix E? YES ☐ NO ☒ N/A ☐ (If "NO", attach supporting documentation.)
   - *There are no improvements.*

23) Has CERCLA Certification been submitted per the criteria outlined in Appendix F? YES ☒ NO ☐ N/A ☐ (If "YES", attach supporting documentation.)
   - *As of the date of this submittal. Refer to Appendix F.*

24) Was there any surface disturbance conducted independent of mining activities? YES ☐ NO ☒ (If "YES", describe: _____)

25) Have all concerned agencies commented on this relinquishment request? YES ☐ NO ☐ (If "NO", who has not? _____)

26) After review, BLM proposes the relinquishment of ___ acres (Attach acreage adjustments).

27) Is approval recommended at this time? YES ☐ NO ☐ (If "NO", items deficient or other areas of concern:

_____; Date completed / Satisfied: _____

_____; Date completed / Satisfied: _____

_____; Date completed / Satisfied: _____

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-88554

Exhibit A

Full Relinquishment

The legal description for full relinquishment of UTU-88554 is described below:

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Lessee of Record:		PacifiCorp
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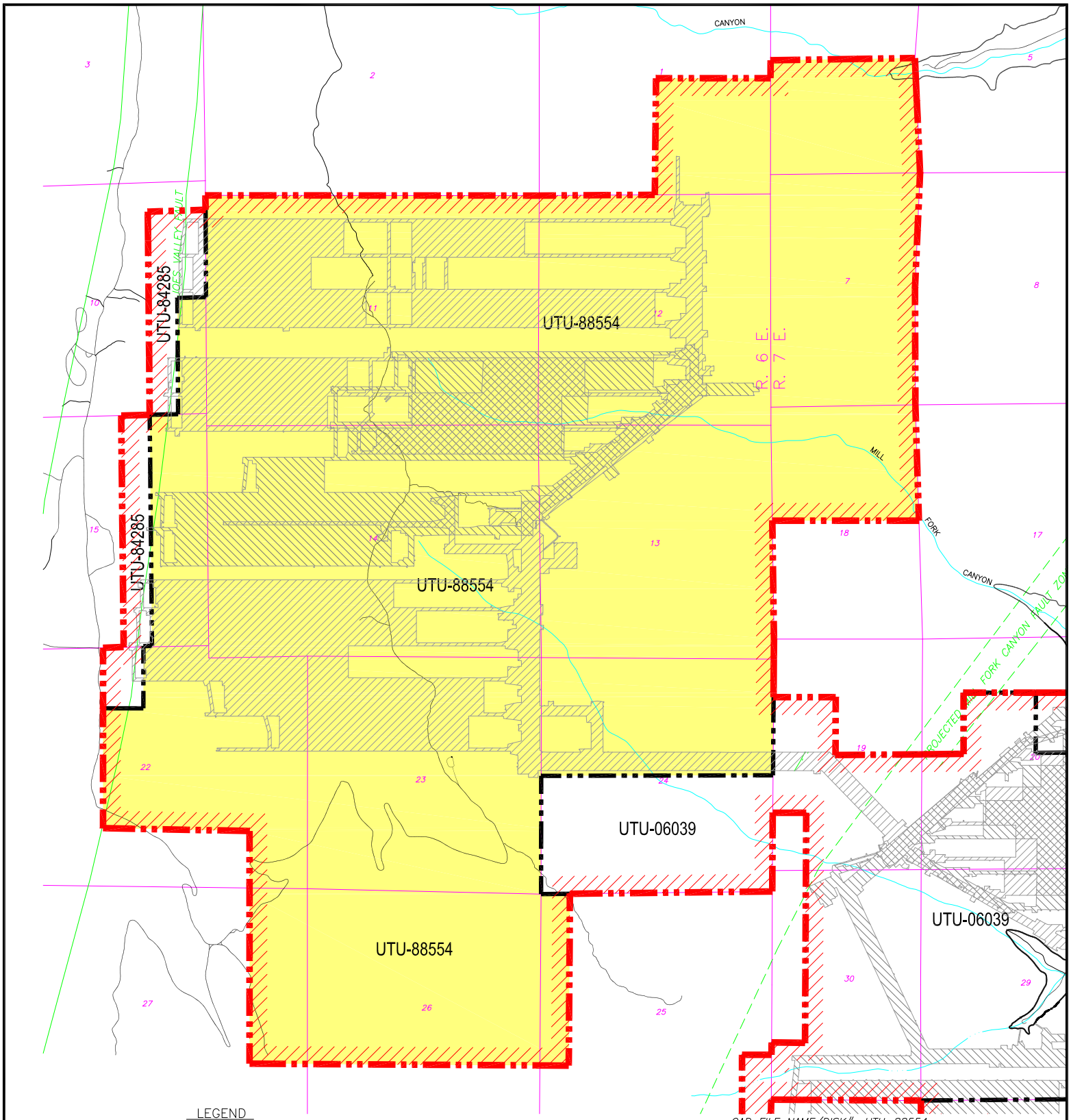
Sec 24:	N½	320.00
Sec 25:	W½W½NW¼, W½NW¼SW¼	60.00
Sec 26:	N½, N½S½	480.00
Sec 27:	E½NE¼, NE¼SE¼	120.00
T16S, R7E, SLB&M Emery County, UT		
Sec 6:	Lots 5,6,7,8, S½SE¼	202.66
Sec 7:	All	413.60
Sec 18:	Lots 1,2, NE¼	206.27
	Total Lease Acres for Full Relinquishment:	**6,382.82**
	Total Lease Acres Remaining:	**0.00**



LEGEND

- LMU BOUNDARY UTU–73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-88554 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE
- FEDERAL COAL LEASE RELINQUISHMENT AREA

N

CAD FILE NAME/DISK#: UTU–88554

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554

DRAWN BY: K. LARSEN	FIGURE 1	
SCALE: 1" =3000'	DRAWING #:	
DATE: MARCH 14, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-88554 Full Lease Relinquishment
Appendix A

Subsidence and Surface Stabilization

Mining History

This lease is comprised of a single contiguous block of coal reserves in the Hiawatha and Blind Canyon seams. Coal reserves were recovered by longwall methods. Mining in the Hiawatha seam took place between 12/2003 and 1/2015. Mining in the Blind Canyon seam took place between 5/2006 and 7/2010. The Blind Canyon mine workings and longwall panels directly overlaid the Hiawatha mine workings.

The following narrative provides details related to PacifiCorp's subsidence monitoring and control plan for East and Trail Mountains, including the Trail Mountain Mine.

Subsidence Monitoring Plan

The establishment of a subsidence monitoring plan is a requirement of the Division of Oil, Gas and Mining (DOGM) detailed in R645-301 -525.440.

PacifiCorp initially adopted a twofold approach to subsidence monitoring:

1) aerial photogrammetry,
2) on-the-ground monumentation.

After seven years of comparing the two types of surveys PacifiCorp determined that both methods effectively document the amount of subsidence which has occurred; however, the aerial photogrammetry method has the advantage of showing more detail because more data points can be monitored with less effort. In 1987, with the concurrence of the State of Utah Division of Oil, Gas & Mining (DOGM), PacifiCorp discontinued on-the-ground monumentation and began collecting subsidence data solely by aerial photogrammetry.

The subsidence monitoring program, conducted since 1980, has produced data which not only document the amount of subsidence that has occurred but also allows the operator to predict the amount of subsidence that is likely to occur when mining in new areas. PacifiCorp submits a comprehensive report annually to the BLM, USFS, and the Utah Division of Oil, Gas, & Mining.

Aerial Photogrammetry

PacifiCorp's subsidence monitoring program is primarily based on aerial photogrammetry. PacifiCorp has been using aerial photogrammetry - based subsidence modeling since 1980. This method has proven to be the best way to collect subsidence data on East Mountain. A baseline photogrammetric survey was conducted in 1980 that included over 21,000 elevations measured on approximate 200-foot spacing grid. In flat areas with limited vegetation, the elevations can be read from the photographs with a precision of one-half foot. In steeper areas, where cliffs are

present, the resolution is not as good, and inaccuracies of greater than ten feet can occur. In steeper areas, photogrammetric monitoring can, and has been, augmented by conventional survey data.

Annual Subsidence Survey Procedures

Aerial photographs of the entire East Mountain LMU area are used in conjunction with widely spaced survey control points on the ground to produce a digital elevation model of the ground surface in successive years from which a surface subsidence map is generated for each year. The ground control points are marked and surveyed using conventional survey methods, then flagged so that they can be seen in photographs taken from the air. Approximately 100 aerial photographs of East Mountain area are taken along 7 flight lines that traverse the LMU area from north to south. Overlapping portions of photographs taken from successive viewpoints along the flight lines produce stereoscopic views of the ground surface. These 93 views of overlapping photograph pairs are called "models" in the photogrammetric process. Elevations of the ground surface over the entire permit area are then calculated using a computer-aided stereo plotter, and verified using the known survey points. Ground elevations are calculated for a grid of approximately 200-foot centers, optimized for terrain. The baseline data, including surveying and flagging ground control points, acquiring the aerial photographs, and generating the surface grid and map, for the East Mountain Area were collected in 1980. These elevations are then compared to elevations measured from the photographs taken annually in the fall. Using this method, ninety percent of the points measured will be accurate to within plus or minus one-half foot.

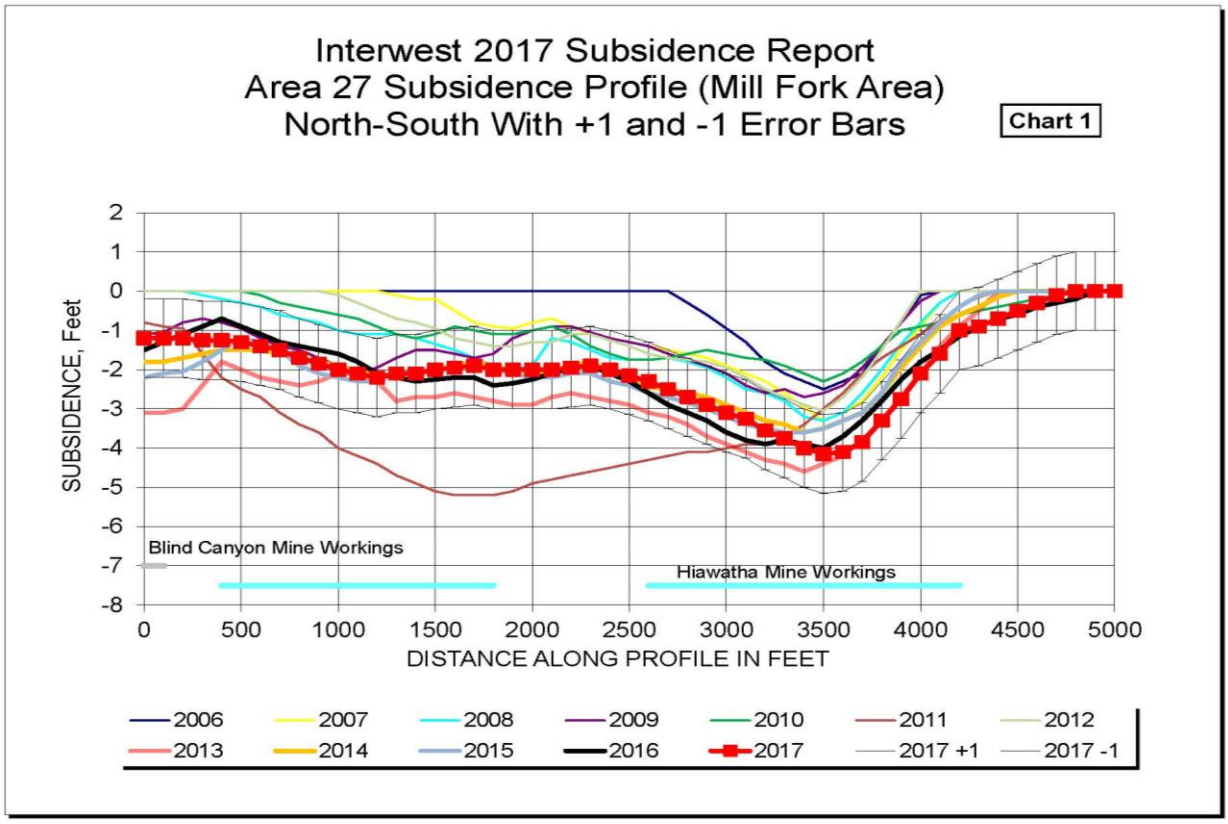
PacifiCorp participated with the governmental agency task force which included representatives from the Bureau of Land Management, Forest Service and the Division of Oil, Gas and Mining, to develop *"Memorandum of Understanding for Processing of Requested to Relinquish Federal Coal Leases (10-MOU-97-001)"*. This document established "Standards for Relinquishment Consideration" including the amount of accepted variation in annual subsidence data. As stated in the MOU, the area will be considered stable, if the cumulative subsidence during the period (3 years) has been 1 foot or less under normal circumstances. Based on this agreement, subsidence measurements and areas and subsidence areas shown on PacifiCorp's annual subsidence maps show areas of total measurable subsidence greater than two feet. PacifiCorp's experience on East Mountain since 1980 has shown that the areas of minimum detectable subsidence, i.e., one foot or more, very rarely extend outside of the outline of the total mine workings, even in areas where more than one seam has been mined.

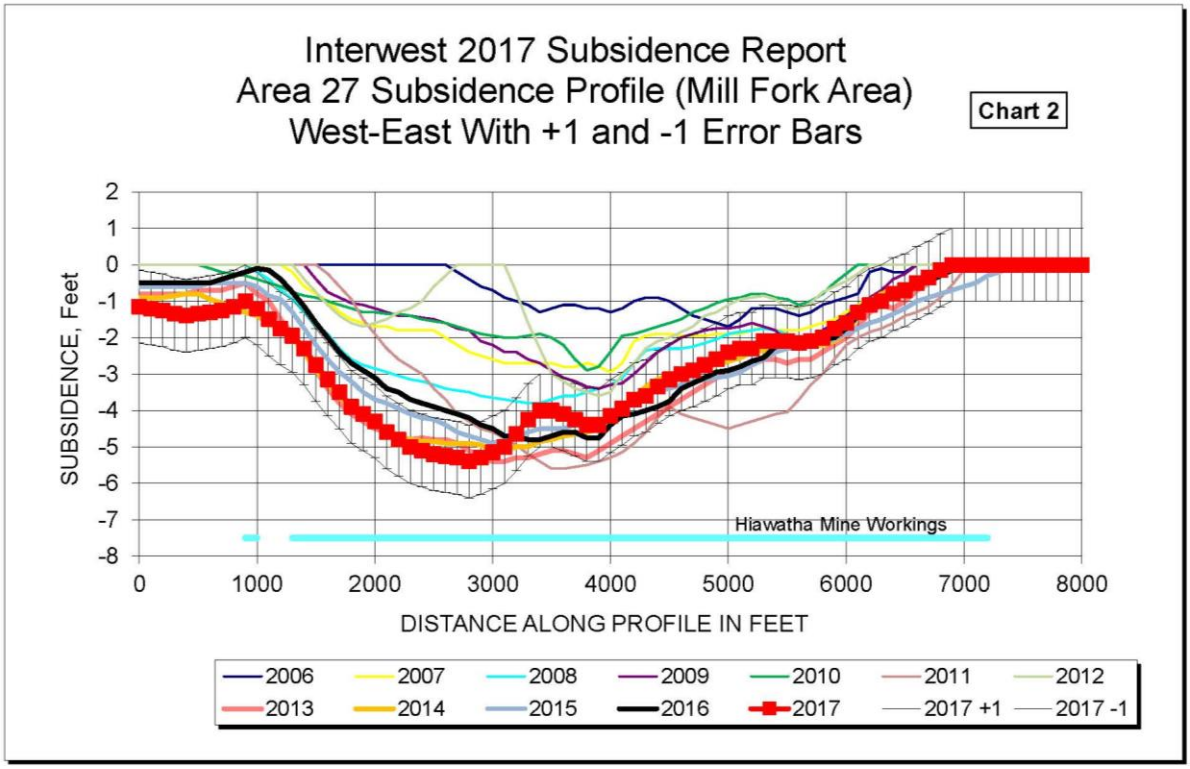
PacifiCorp's contractor maintained survey control aerial targets within the permit boundary necessary to allow the interpretation of coordinate points on photos within $\pm$0.5 foot. Following this procedure the operator conducted an aerial photo survey annually of all areas that were undermined. PacifiCorp has continued monitoring all areas undermined until the operator and DOGM agree that the subsidence in a given area has become stable and no further monitoring is necessary.

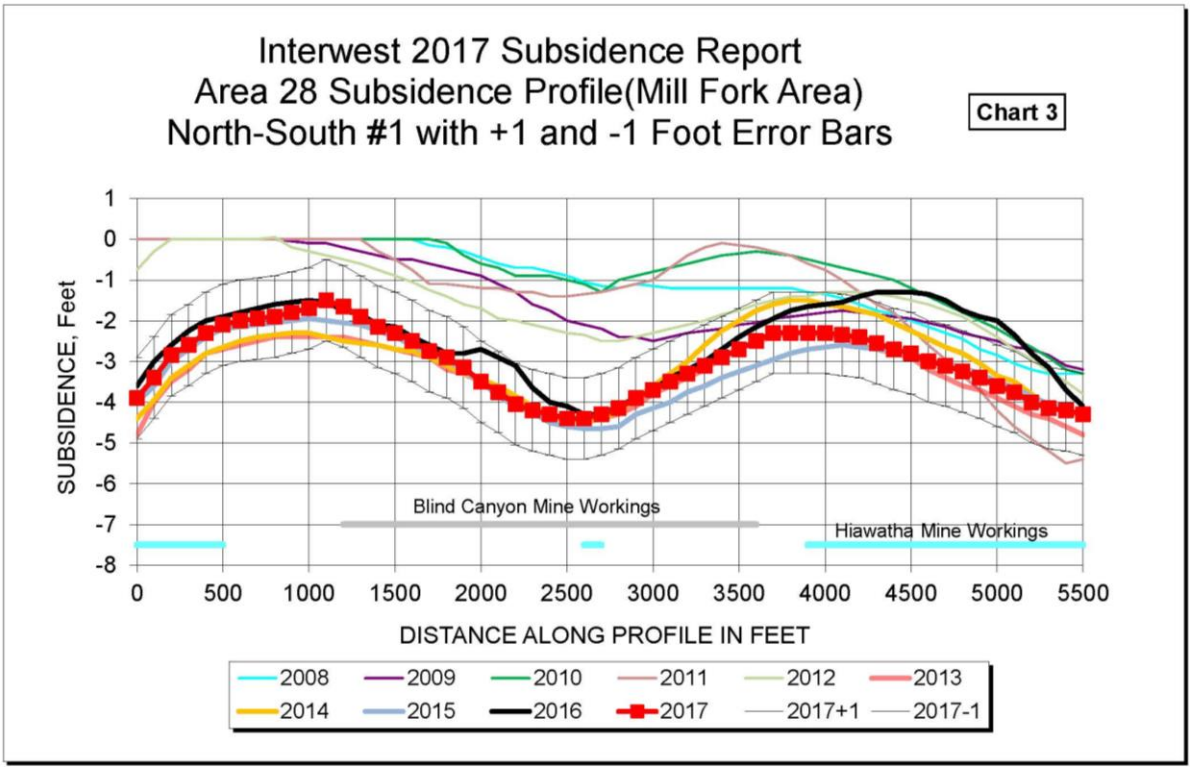
Federal Lease UTU-88554 Subsidence Data

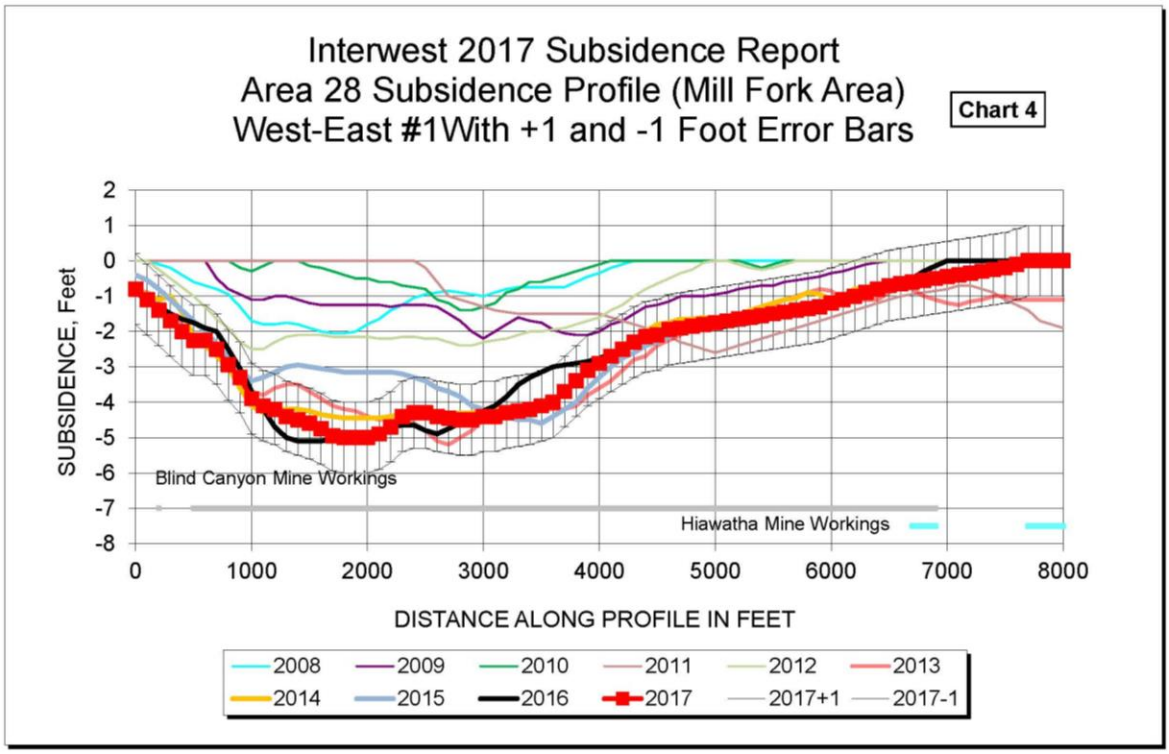
Subsidence in the lease UTU-88554 area has been monitored since 2005. Subsidence measurements by photogrammetric methods have been used, and subsidence profiles (shown on the following figures and accompanying maps) show subsidence measurements made between 2005 and 2017. Photogrammetric methods allow more complete subsidence monitoring coverage in areas that are topographically rugged and difficult to measure using conventional surveying methods.

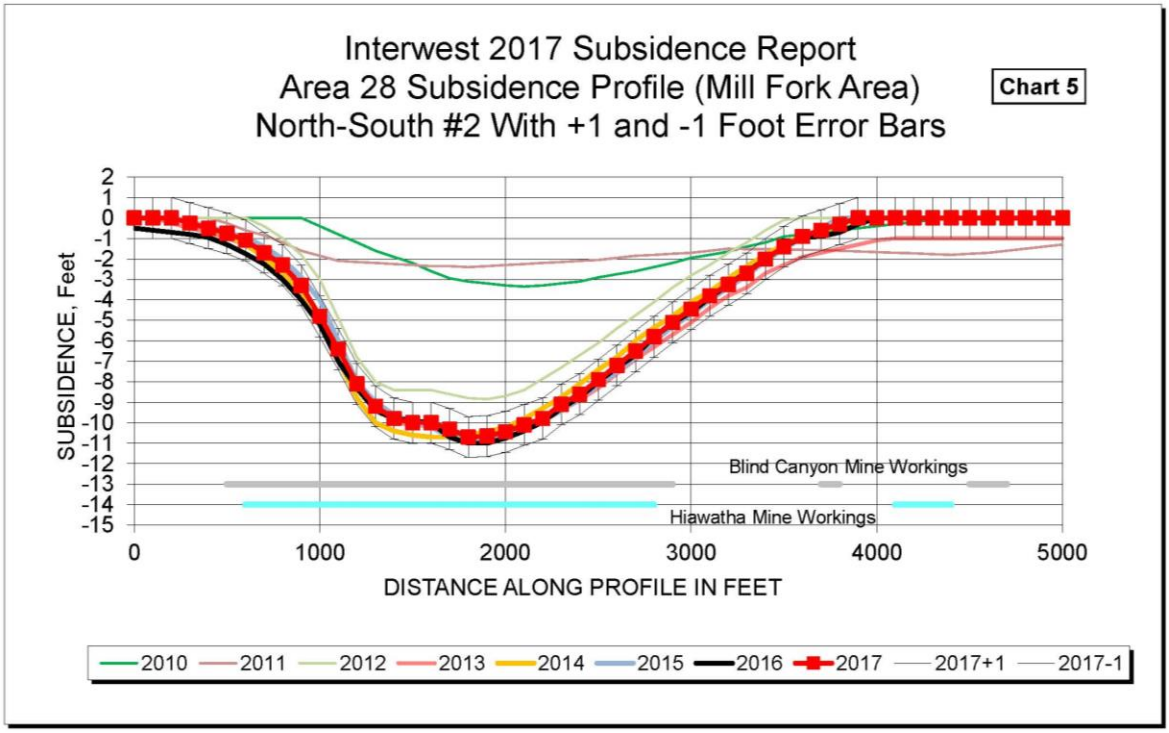
PacifiCorp delineated a series of eight profiles covering the main longwall panel districts of Lease UTU-88554, including the dual-seam mining overlay area, are referred to as profiles A, B, C, and D on the following figures and accompany maps. Subsidence within this area has reached a maximum of just over 7 feet. No change in subsidence has occurred since 2014, and the area is stable (see following figures and map). Also, the subsidence contour maps for 2017, included herein, show no increase in subsidence.

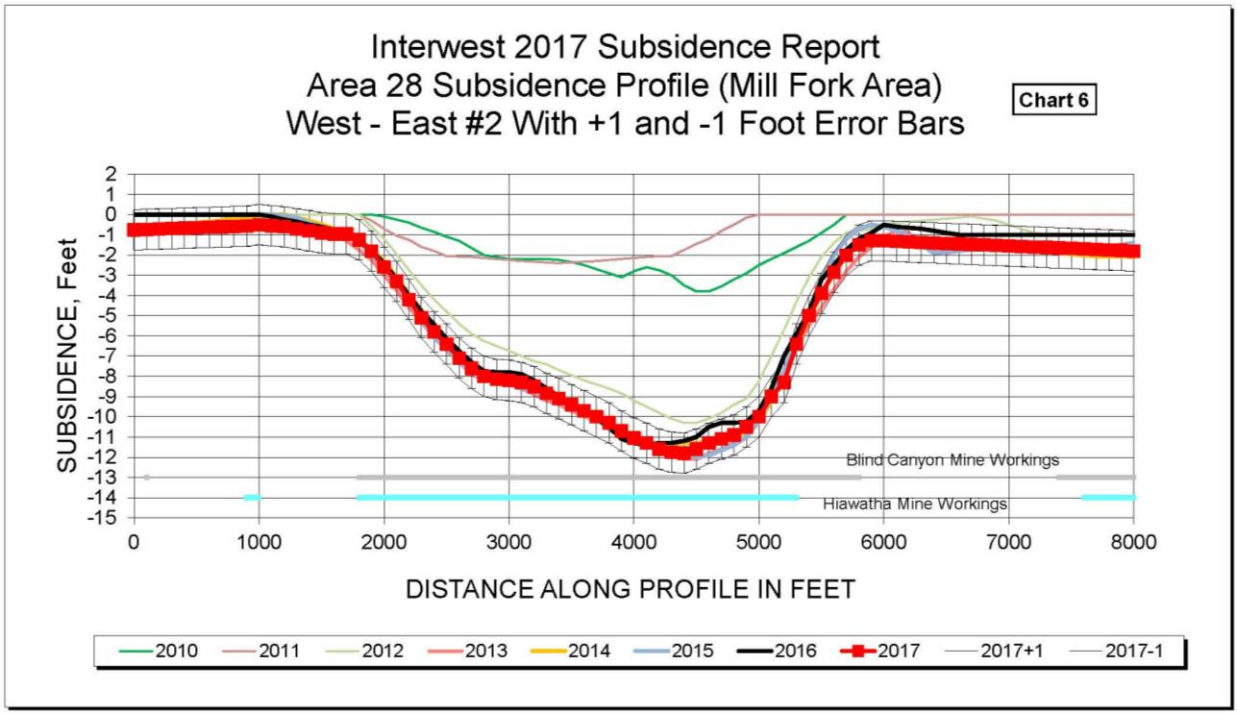


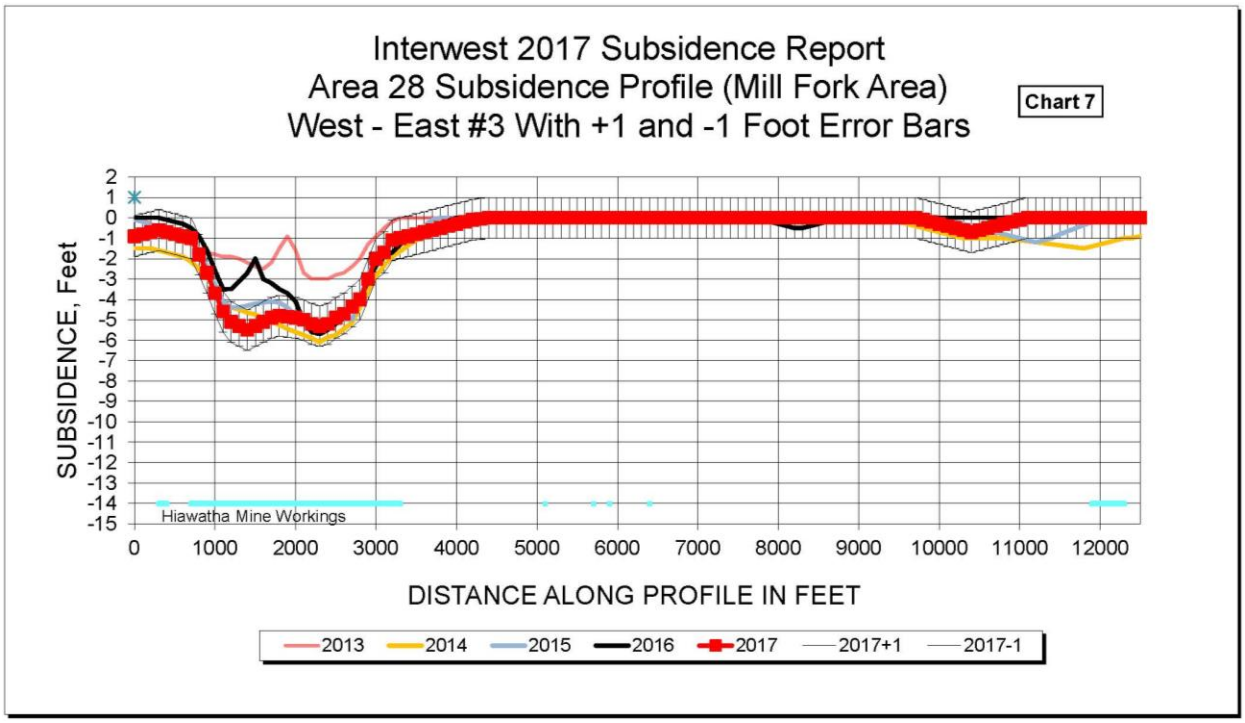

Interwest 2017 Subsidence Report
Area 27 Subsidence Profile (Mill Fork Area)
West-East With +1 and -1 Error Bars
Chart 2
SUBSIDENCE, Feet
DISTANCE ALONG PROFILE IN FEET
Hiawatha Mine Workings
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2017 +1
2017 -1

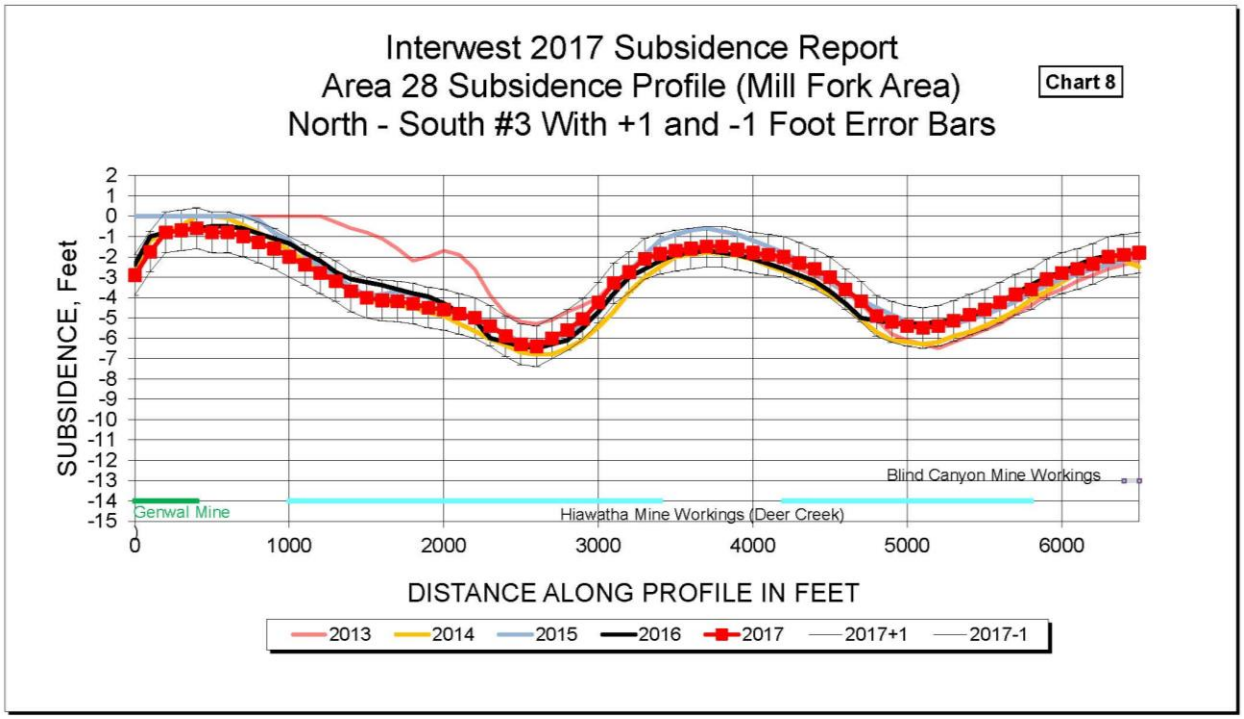

Interwest 2017 Subsidence Report
Area 28 Subsidence Profile(Mill Fork Area)
North-South #1 with +1 and -1 Foot Error Bars
Chart 3
SUBSIDENCE, Feet
DISTANCE ALONG PROFILE IN FEET
Blind Canyon Mine Workings
Hiawatha Mine Workings
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2017+1
2017-1


Interwest 2017 Subsidence Report
Area 28 Subsidence Profile (Mill Fork Area)
West-East #1With +1 and -1 Foot Error Bars
Chart 4
SUBSIDENCE, Feet
DISTANCE ALONG PROFILE IN FEET
Blind Canyon Mine Workings
Hiawatha Mine Workings
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2017+1
2017-1


Interwest 2017 Subsidence Report
Area 28 Subsidence Profile (Mill Fork Area)
North-South #2 With +1 and -1 Foot Error Bars
Chart 5
SUBSIDENCE, Feet
DISTANCE ALONG PROFILE IN FEET
Blind Canyon Mine Workings
Hiawatha Mine Workings
2010
2011
2012
2013
2014
2015
2016
2017
2017+1
2017-1

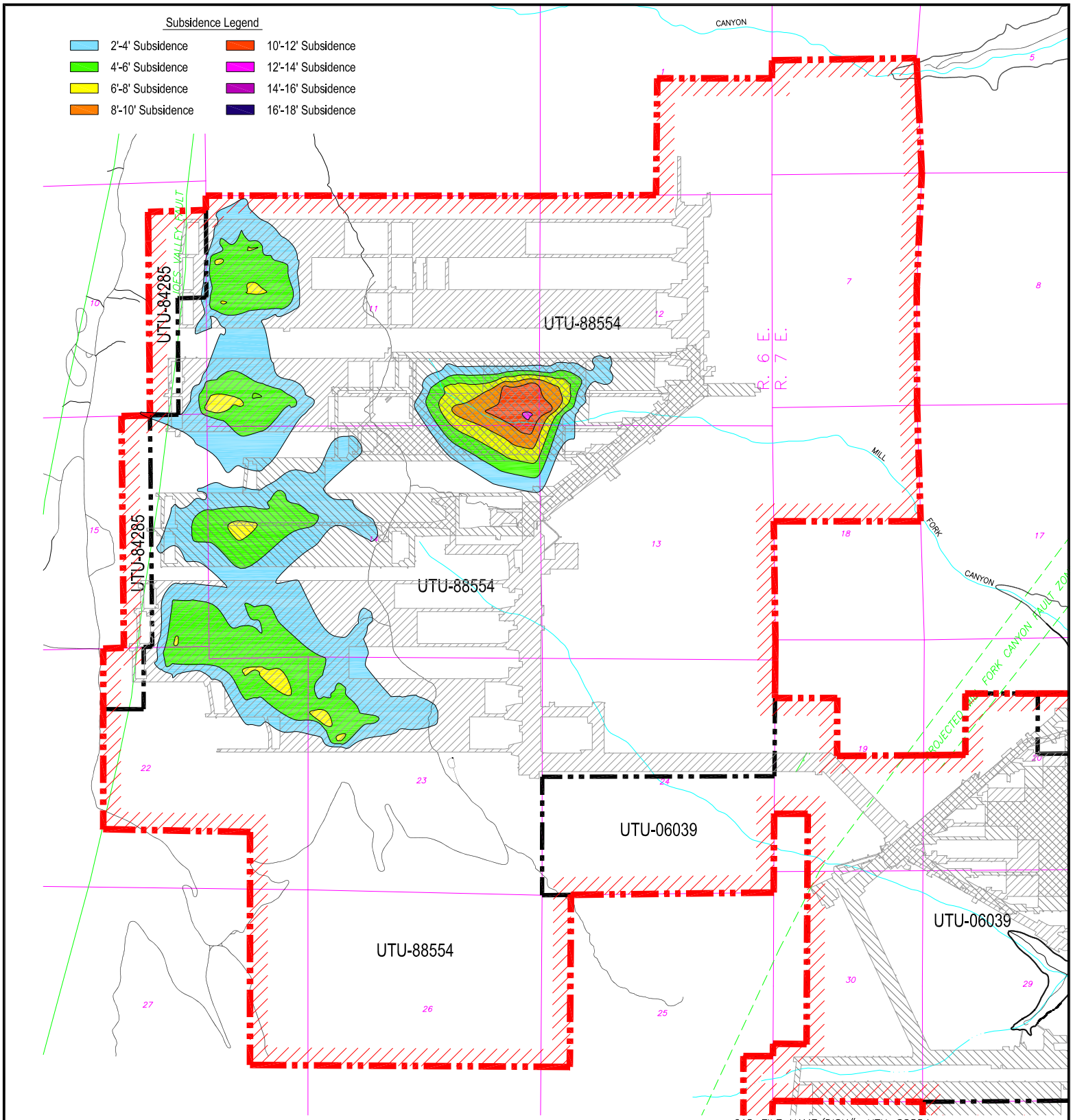

Interwest 2017 Subsidence Report
Area 28 Subsidence Profile (Mill Fork Area)
West - East #2 With +1 and -1 Foot Error Bars
Chart 6
SUBSIDENCE, Feet
DISTANCE ALONG PROFILE IN FEET
Blind Canyon Mine Workings
Hiawatha Mine Workings
2010
2011
2012
2013
2014
2015
2016
2017
2017+1
2017-1


Interwest 2017 Subsidence Report
Area 28 Subsidence Profile (Mill Fork Area)
West - East #3 With +1 and -1 Foot Error Bars
Chart 7
SUBSIDENCE, Feet
DISTANCE ALONG PROFILE IN FEET
Hiawatha Mine Workings
2013
2014
2015
2016
2017
2017+1
2017-1



Aerial surveys conducted annually by helicopter 2006 - 2017 have detected no subsidence-related effects on the surface in UTU-88554. Conventional surveying methods for subsidence were used briefly during 2005 to measure subsidence in the vicinity of gas well Federal 32-23 near the 12th West longwall panel. No effects on the well were noted.

The proposed relinquishment area of Lease UTU-88554 is stable and subsidence is substantially complete.



CAD FILE NAME/DISK#: UTU-88554

LEGEND

- LMU BOUNDARY UTU-73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-88554 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

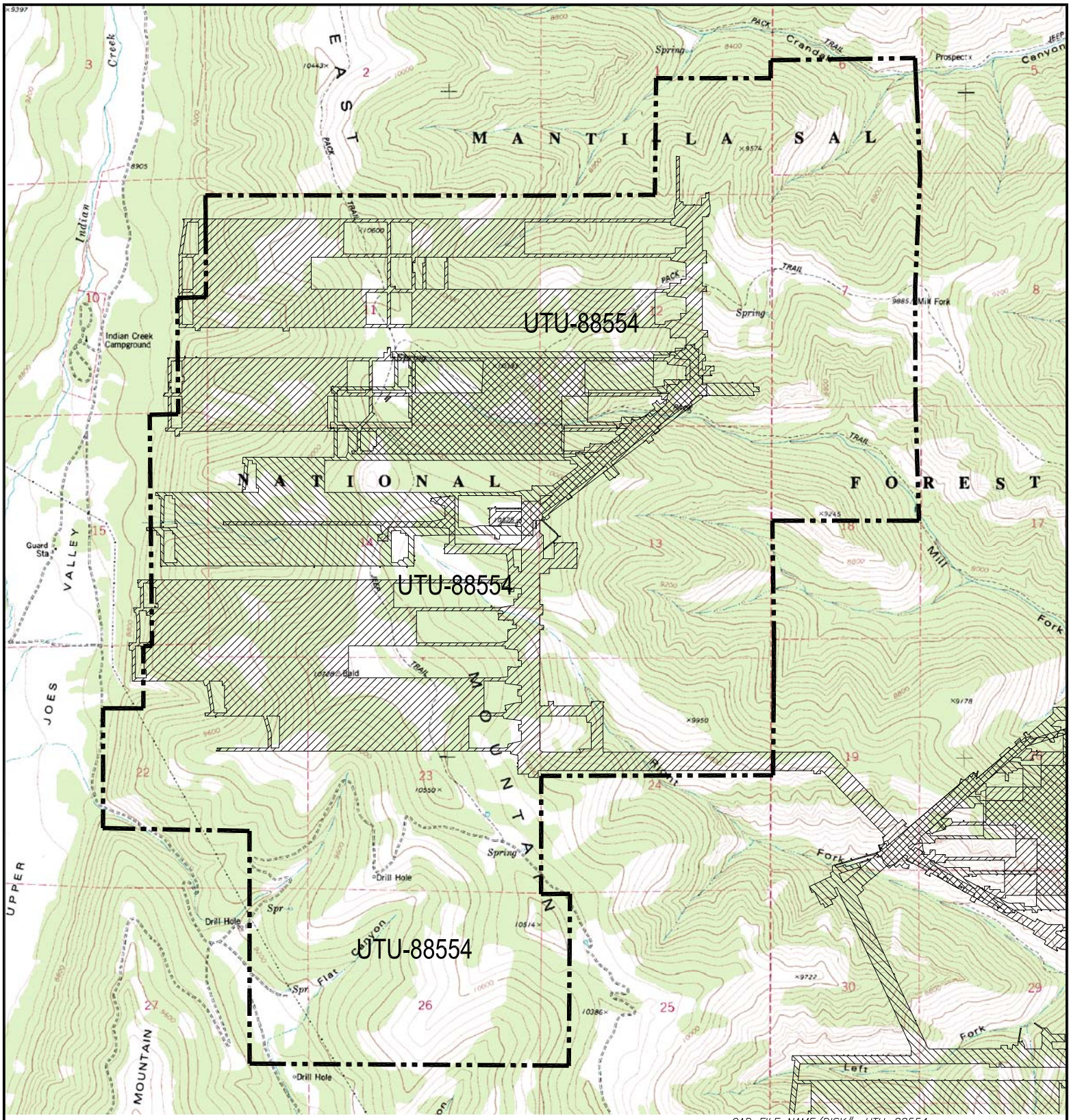
EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
SUBSIDENCE BASE MAP

DRAWN BY: K. LARSEN	APPENDIX A	
SCALE: 1" =3000'	DRAWING #:	
DATE: APRIL 16, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-88554 Full Lease Relinquishment
Appendix B

Evaluation of impacts to Surface Topography

PacifiCorp has demonstrated that subsidence is substantially complete and that the surface has stabilized; refer to Appendix A. Based on the aerial observations and supporting data, the relinquishment area of Lease UTU-88554 is stable and subsidence is substantially complete. No effects from subsidence were noted at the surface. No surface facilities or installations were affected within UTU-88554. No restoration and/or mitigation efforts are required for Lease UTU-88554. Please refer to the Appendix B - Topographic Surface Map. This map shows the relationship between the topographic surface, the mine workings, and the UTU-88554 lease boundary.



CAD FILE NAME/DISK#: UTU-88554

HIAWATHA SEAM MINE WORKINGS

BLIND CANYON SEAM MINE WORKINGS

FEDERAL COAL LEASE RELINQUISHMENT AREA

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INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
TOPOGRAPHIC BASE MAP

DRAWN BY: K. LARSEN	APPENDIX B	
SCALE: 1" =3000'	DRAWING #:	
DATE: APRIL 16, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-88554 Full Lease Relinquishment
Appendix C

Evaluation of Impacts to Ground and Surface Water Hydrology

The following section provides a detailed description of the hydrology, including groundwater and surface water quality and quantity, of the land within UTU-88554 and surrounding area.

Since 1979 detailed data on the hydrology of the East Mountain area have been collected, compiled, and analyzed by PacifiCorp and several government agencies. Information collected by PacifiCorp is the result of exploratory drilling, field investigations, geologic mapping, aerial photography, spring surveys, groundwater tests, monitoring of numerous wells and stream stations, climatological monitoring, and investigations by independent consultants. The data collection program is part of a complete Hydrologic Monitoring Program which has been approved by the State of Utah, Division of Oil, Gas and Mining (DOGM) and the Office of Surface Mining (OSM). All data collected have been and will continue to be submitted to OSM, DOGM, United States Forest Service (USFS), and the Bureau of Land Management (BLM) each year in the annual Hydrologic Monitoring reports.

The hydrologic monitoring plan for the Deer Creek Mine Mill Fork Lease Area is specified in Volume 12 Hydrologic Section in the approved Mining and Reclamation Plan (MRP).

As outlined by the BLM, the interested parties have agreed that under normal circumstances, the minimum time period for continued monitoring will be three years. During this time period the operator/lessee will establish that the surface has substantially stabilized according to Appendix "A".

The following sections will describe and provide detail concerning the groundwater and surface water resources within and adjacent to Federal Lease UTU-88554.

Regional Groundwater Hydrology

The characteristics of a groundwater resource are dependent upon the geology of the water bearing strata and on the geology and hydrology of the recharge area. Groundwater movement and storage characteristics are dependent on the characteristics of the substratum. To facilitate an understanding of groundwater of the Mill Fork Area, a discussion of pertinent regional geologic features is presented below.

Regional Geology

The Mill Fork Area is located in the central portion of the Wasatch Plateau Coal Field in Emery County, Utah. Generally, this area is a flat-topped mesa surrounded by heavily vegetated slopes which extend to precipitous cliffs dropping steeply to the valley below. Relief of up to 5,000 feet is measured from Castle Valley lowland to the plateau above. The following discussion summarizes the structural geology and stratigraphy of the region and the mining areas located within the Mill Fork Area.

The regional geology of the Colorado Plateau in which the Wasatch Plateau coal field is situated is fairly simple. Sedimentary rocks have been accumulating in this region since Permian time. A broad, high, flat region that encompasses southeastern Utah, southwestern Colorado, northwestern New Mexico, and northern Arizona, the Colorado Plateau has been an area of relative stability while mountain-building episodes have occurred in surrounding regions. The thick accumulations of sedimentary rocks in this region are being deeply dissected by erosion, leaving the most recent coal reserves in the higher plateaus, where they are now being mined. The PacifiCorp mining area covers portions of East Mountain and Trail Mountain, which are separated by Cottonwood Canyon, a deep, partially glaciated valley.

The geologic formations exposed in the PacifiCorp mining area range from Upper Cretaceous (100 million years old) to Tertiary and Recent in age. These formations, in ascending order from oldest to youngest, are the Masuk Shale member of the Mancos Shale, the Star Point Sandstone, the Blackhawk Formation, the Castlegate Sandstone, the Upper Price River Formation (all Cretaceous), and the North Horn Formation, and the Flagstaff Limestone (Tertiary). The coal deposits are restricted to the lower portion of the Blackhawk Formation, about 2,500 feet below the top of the Plateau. Recent geologic deposits include numerous stream terrace gravels along streams and rivers, glacial till deposits in the upper reaches of Cottonwood Canyon, and alluvial and colluvial fills in all of the significant drainages.

The Masuk Shale is the upper member of the Mancos Shale and consists of light to medium gray marine mudstones. The marine Masuk Member of the Mancos Shale was deposited in an open marine environment (Mayo and Peterson, 2001). The Masuk Member is a highly erodeable calcareous, gypsiferous, and carbonaceous dark gray colored shale. It is continuously exposed along the eastern edge of the Wasatch Plateau, but is not exposed in the Mill Fork Area. The Masuk Member is approximately 1,300 feet thick. Westward thinning wedges of the Masuk inter-finger with tongues of the Star Point Sandstone. Usually this formation weathers readily, forming slopes which are often covered by debris. It is generally devoid of water.

Overlying and inter-tonguing with the Masuk Shale is the Star Point Sandstone. In the East Mountain area the Star Point Sandstone consists of three or more massive sandstones totaling about 400 feet in thickness.

The Star Point Sandstone forms massive cliffs where exposed at the surface. The sandstone was deposited as seaward thinning (east), marine, shoreface blanket sands that are laterally continuous (Mayo and Peterson, 2001). Landward (west), these sandstones terminate abruptly into the mud- and organic-rich backshore facies (Van Wagoner and others, 1990). Because many of the organic-rich facies are now mineable quality coal, locally the Star Point Sandstone has immediate contact with coal seams. Elsewhere sandstone bodies of the Star Point Sandstone are overlain and underlain by lower shoreface and open marine shales of the Mancos Formation. What this means is that the marine shoreface sandstones are three dimensionally encased by low-permeability marine shales and fine-grained carbonaceous backshore coal-bearing facies (Mayo and Peterson, 2001).

The Star Point Sandstone thins eastward and merges with the underlying Masuk Member of the Mancos Shale. Three prominent tongues of the Star Point Sandstone inter-finger with the Mancos Shale. These three sandstone members, from top to bottom, are the Spring Canyon, Storrs, and Panther Sandstones. In the Mill Fork Area, the Spring Canyon tongue is approximately 100 feet thick, lies about 80 feet above the Storrs tongue, and consists of massive, fine- to medium-grained sandstone. The Storrs tongue lies about 120 feet above the Panther tongue and consists of 50 feet of soft, friable sandstone. The basal Panther tongue is approximately 100 feet thick and consists of massive, cross-bedded delta front sandstones Mayo and Peterson, 2001).

Even though the Star Point Sandstone exists throughout the entire East Mountain property, the low permeability and lack of recharge limit its usefulness as a water producing aquifer. Permeability and the limiting factors of recharge, i.e., very little outcrop exposure and limited vertical groundwater migration caused by the mudstone layers of the North Horn and Blackhawk formations, will be discussed in detail in the section entitled REGIONAL GROUNDWATER CHARACTERISTICS. Locally, the Star Point Sandstone exhibits aquifer characteristics. These are isolated occurrences where regional faults have created secondary permeability and have been intersected by major canyons with perennial streams. An example is Little Bear spring located in Huntington Canyon.

The Blackhawk Formation consists of alternating mudstones, siltstones, sandstones, and coal. Although coal is generally found throughout the Blackhawk Formation, the economic seams are

restricted to the lower 150 feet of the formation. The total thickness of the Blackhawk Formation in the East Mountain area is about 750 feet.

The upper portion of the Blackhawk Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Mayo and Peterson, 2001). In these delta and flood-plain environments layers of mud are more abundant than channel sands. Sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and inter-fluvial rocks (Galloway, 1977). The upper portion of the Blackhawk Formation also contains some thin carbonaceous shale layers and thin coal seams that are not of economic interest.

The lower portion of the Blackhawk Formation contains the mineable coal deposits and consists of more thinly bedded sandstone and shale layers (Johnson, 1978). The coal-bearing units of the lower Blackhawk Formation overlie and are laterally juxtaposed to marine shoreface sandstones of the Blackhawk Formation and Star Point Sandstone (Mayo and Peterson, 2001). On a large scale, these sandstone bodies are laterally continuous but terminate abruptly into the mud- and organic-rich backshore faces in a landward direction (Van Wagoner and others, 1990). However, individual rock layers are lenticular and discontinuous, with abundant shaley interbeds. The fine to medium grained sandstones occur as thin- to massively-bedded paleochannel deposits. The paleochannels increase in frequency, thickness, and lateral extent upward in the formation. There is also a vertical repetition of erosional scours within the upper sandstones (Marley, 1979).

The Castlegate Sandstone, the lower member of the Price River Formation, generally caps the escarpment which surrounds the eastern limit of the property. The Castlegate Sandstone consists of approximately 250 to 350 feet of coarse-grained, light gray, fluvial sandstones; pebble conglomerates; and subordinate zones of mudstones.

The formation was deposited from bed-load fluvial channel systems. The Castlegate Sandstone is made up of coarse-grained, often conglomeratic, fluvial sandstone. Thin inter-beds of siltstone and claystone occur in lower portion the formation. Sandstone dominates over mudstone and individual sand channels may be thin, wide, or interpenetrating. Although the primary porosity is high, the existence of mudstone drapes and pervasive carbonate and silica cement greatly reduces the overall porosity (Mayo and Peterson, 2001, Appendix B).

The Upper Price River Formation, which overlies the Castlegate Sandstone, is about 350 feet thick and forms steep slopes which extend upward from the Castlegate Sandstone.

The Price River Formation was deposited from mixed-load fluvial channel systems that have sandstone/mudstone ratios intermediate between bed-load and suspended-load channel systems (Mayo and Peterson, 2001). Sandstones and mudstones occur in about equal proportions. Point bars that develop in this type of system are larger than those in suspended-load channel systems. Mudstone drapes created during low flow stages of the active fluvial system separate the sandstones from each other both horizontally and vertically (Mayo and Peterson, 2001).

The North Horn Formation forms the cap rock for much of East and Trail mountains where the Flagstaff Limestone has been eroded away. Mudstones dominate the rock types present and are generally gray, light brown, to purple in color. Localized, lenticular sandstone channels are present throughout the formation. The sandstone beds are more common near the upper and lower contacts of the formation. The North Horn Formation is approximately 850 to 1,000 feet thick in the Mill Fork Area.

The North Horn Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Mayo and Peterson, 2001, Appendix B). In such environments layers of mud are more abundant than sands, which occur in sandstone channels. The sandstone channels are generally isolated from each other, both laterally and vertically, by mud-rich overbank and inter-fluvial rocks (Galloway, 1977). In the study area the formation consists primarily of shale with discontinuous sandstone channels, minor lenses of limestone, and conglomerate. Highly bentonitic mudstones, which swell when wetted, are common in the lower two-thirds of the formation.

The Flagstaff Limestone caps the uppermost portions of East Mountain is the youngest formation exposed in the Mill Fork Area. It typically forms small exposures on top of the plateau. A thickness of 105 feet was measured on Trail Mountain immediately south of the study area (Davis and Doelling, 1977). Maximum thickness in the Mill Fork Area is approximately 80-100 feet.

The Flagstaff Limestone consists of carbonates, marls, and some thin sandstone stringers deposited in lacustrine, marginal lacustrine, and alluvial plain depositional environments (Garner and Morris, 1996). It primarily consists of light- to medium-gray colored limestone containing abundant secondary fractures produced during uplift and subaerial exposure (Mayo and Peterson, 2001, Appendix B).

Regional Groundwater Characteristics

Waters entering the groundwater system are mostly from snow melt. The amount of water which enters the groundwater system is highly variable from one site to another. The low surface relief

on the top of East Mountain encourages the infiltration of melting snow. Conversely, the many areas with steep slopes have a much more limited infiltration opportunity. All of the geologic formations which surface in the area have relatively low permeability which further reduces the amount of water entering the groundwater system. Probably less than five percent of the annual precipitation recharges the groundwater supply (Price and Arnow, 1974; U. S. Geological Survey, 1979).

Geology controls the movement of groundwater. Because of the low permeability of the consolidated sedimentary rocks in the East Mountain area, groundwater movement is primarily "through fractures, through openings between beds, and, in the case of the Flagstaff Limestone, through solution openings" (Danielson et al., 1981, p. 25).

The majority of the groundwater which infiltrates the Flagstaff Limestone flows down vertical fractures which intersect sandstone channel systems in the North Horn Formation. The majority of the groundwater reaching this point intersects the surface in springs located in the North Horn Formation. Very little recharge intersects the Price River Formation and Castlegate Sandstone; consequently, they are not water saturated where intersected in the numerous drill holes penetrating those units. The remaining water then flows downdip (to the southeast) from the northern reaches of East Mountain until it discharges in the form of springs.

Data have been collected from numerous coal exploration drill holes, from within the adjacent mine workings, from surface drainages, and from the springs in the area. The data have identified two separate isolated aquifer systems on the East Mountain property; the first is localized perched water tables in the North Horn and the Price River formations, and the second is a combination of localized perched water tables in the Blackhawk Formation and the Star Point Sandstone which exhibits some limited potential as a regional aquifer. Stratigraphy is the main controlling factor restricting groundwater movement and development of regional and perched aquifer systems within the East Mountain property. The following is a description of the various formations and how they influence the groundwater systems. The description is in descending order, which parallels the general groundwater flow.

Flagstaff Limestone

This formation displays a strong joint pattern which permits good groundwater movement both vertically and horizontally through the formation. Exposures of the Flagstaff Limestone are limited to a narrow north-south trending ridge located in the western half of the Mill Fork Area.

North Horn Formation

This formation is comprised of a variety of rock types which range from highly calcareous sandstone to mudstone. Its permeability is variable.

Lenticular sandstone channels are oftentimes present in the upper and lower portions of the formation. Water which percolates down fractures from the overlying Flagstaff Limestone works its way into the sandstones, forming the perched water tables. The actual lateral extent, or correlation, between the perched water tables has not been identified; and it is not practical to do so because the tables are limited in extent and variable in stratigraphic location. Many springs have been identified where the sandstone channels intersect the land surface.

The lower two thirds (upper Cretaceous in age) of the formation is generally highly bentonitic mudstone which is impermeable. It is likely that this material is acting as an aquiclude, preventing adequate recharge from reaching the Upper Price River Formation or Castlegate Sandstone below. The mudstones present swell when they come in contact with water. Therefore, vertical migration of water along fractures through this material is limited because the fractures are sealed by the swelling clays.

The depth of the aquifers in the North Horn Formation is variable due to the rugged topography. The localized perched water tables may either intersect the surface of the ground or be covered by as much as 1,000 feet of overburden. They are located at least 1,400 feet above the coal seam to be mined. Communication of water between the perched aquifers in the North Horn Formation and the water flowing into the mine is limited in quantity and occurs very slowly. The monitoring of the numerous springs located on East Mountain gives PacifiCorp the ability to assess any effects that mining might have on the North Horn Formation perched aquifers.

With the data available it is not possible to compile a piezometric map of the waterbearing strata in the North Horn Formation because the channels are discontinuous and not interconnected.

Upper Price River Formation

The Upper Price River Formation is comprised predominantly of sandstone but commonly contains mudstone beds between the point bar deposits. It is generally devoid of water because it lacks adequate recharge.

Castlegate Sandstone

The formation is thought to be fairly permeable but, where it has been intersected by drill holes, has never been found to be water saturated. It is often dry or slightly damp in some zones. It is devoid of significant water because it lacks.

Blackhawk Formation

The Blackhawk Formation contains only perched or limited aquifers which exist within the strata overlying the coal seams and the upper portion of the Star Point Sandstone Formation. The perched aquifers exist as fluvial channels (ancient river systems) which overlie and scour into the underlying strata. Channel systems were part of a deltaic depositional setting active during and after the coal forming peat accumulation. The largest influx of water encountered during the mining process occurs beneath the fluvial channels. The sandstone channels are mainly composed of a fine to medium grained sand with similar characteristics to the Star Point Sandstone Formation. The semi-permeable and porous nature of the channels allows an effective route for water transport. Other constituents of the Blackhawk Formation (i.e., non-permeable mudstone, carbonaceous mudstone, coal seams, and inter-bedded mudstones/siltstones and sandstones) generally act as aquicludes which impede vertical groundwater flow to the lower stratigraphic units. In areas other than where faulting and fracturing have created secondary permeability, the migration of water from the perched aquifers-sandstone channel systems of the Blackhawk Formation to the Star Point Sandstone Formation is limited. Extensive mining in the Cottonwood/Wilberg complex, which produces coal from the Hiawatha seam, is stratigraphically located directly on top of the upper member of the Star Point Sandstone. Only minor quantities of groundwater have been produced from the Star Point Sandstone. The coal seams of the Blackhawk Formation are effective in impeding vertical groundwater movement. In many areas in the adjacent mines where roof coal was left in place because of abundant thickness or as an additional effort to support the immediate roof, production of groundwater occurred only when roof support was installed or when a roof failure occurred exposing the overlying sandstone channel systems. Listed below are hydrologic characteristics of individual rock types reported by the USGS, Open File 84067.

Lithology: Sh, shale; Slt, siltstone; Ss, sandstone; f, fine grained; m, medium grained. Hydraulic Conductivity: I, impermeable to water even at pressures of 5,000 pounds per square inch (psi).					
				Hydraulic Conductivity (feet per day)	
Geologic Unit	Lithology	Depth below land surface	Porosity %	Horizontal	Vertical
Blackhawk	Ss, f	1,521	14	1.5x10-2	3.7x10-3
Formation	Slt	1,545	3	9.3x10-8	1.2x10-7
	Sh	1,786	2	I	I
	Ss, f	1,792	14	1.1x10-2	3.9x10-3
	Sh	2,170	4	1.1x10-8	---
	Slt	2,265	2	2.0x10-7	2.2x10-6
Star Point	Ss, m	2,466	17	3.1x10-2	1.1x10-2
Sandstone	Ss,	2,493	11	1.5x10-2	6.6x10-3

In the adjacent Cottonwood and Deer Creek mines, the majority of the water flowing into the mines comes from within the limited fluvial channel aquifers; however, water is also transmitted into the mine workings by way of faults, joints or fractures, and in-mine drill holes. Many locations within the mines have been monitored in the past, but a limited number of accessible long term water monitoring locations now exists because most water-producing areas of the mines are dewatered and stop flowing shortly after initial mining in the area.

In several locations in the Deer Creek and Wilberg/Cottonwood mines, such as retreated longwall panels, water is being produced but cannot be measured because the workings are inaccessible. The water entering these areas flows into numerous low areas in the mine which act as temporary sumps. The water is then pumped to the main sump located near the mine portal. Because the pumping system in the mine is ever changing (i.e., portable pumps being moved to various locations within the mine as the need arises), it is not possible to collect meaningful data from specific areas of the mine that can be compared with data collected from years or even months past.

Based on data from the adjacent mines, several observations have been made concerning the Blackhawk water-bearing strata. The sandstone, which is semi-permeable and porous, affords an effective route of water transport; while relatively impervious shale in the Blackhawk Formation prevents significant downward movement of the percolating water. Of the water-producing areas, those closest to the active mining face exhibit the greatest flows. As mining advances the area adjacent to the active face continues to be

excessively wet, and previously mined wet areas experience a decrease in flow. It appears that the water source is being dewatered since mined out areas of the mine do not continue to produce water indefinitely. The water source must be either of limited extent, e.g., a perched aquifer, or have a limited recharge capacity. In an attempt to quantitatively evaluate saturated sandstone channels, a dripping channel in the 6th West area of the Deer Creek Mine was investigated. The channel, located near a minor fault with very limited displacement, has the dimensions of >2,000 feet in length, 150 feet in width and a maximum thickness of 25 feet. An array of uphole monitoring wells was installed across the width of the channel. The wells were 15 to 25 feet deep and were open along their entire depth. Each well was equipped with a shutoff valve and pressure gauge. The idea was to conduct a pump test by letting selected wells gravity drain and simultaneously measuring pressure change in nearby wells. Because a maximum of about 2 psi was recorded in the well (i.e. (5 feet of water) we were unable to conduct the test. What the well did demonstrate was that the sandstone channel was not fully saturated and it was a perched, unconfined groundwater system.

Although much of the water transfer within the Blackhawk Formation is through fractures or faults, data indicate that recharge to the Blackhawk is limited because of the above confining formations and many of the fractures become sealed by swelling bentonitic clays which stop or limit the water transfer, confirmation of which exists along the numerous faults and fractures over the area. A measurable flow of water along a fault existed at only one location in the Wilberg/Cottonwood Mine - along the Pleasant Valley Fault in Main West, Wilberg. This location produced an estimated average flow of 5 gpm from the time it was encountered to 1980 when the flow stopped. The fractures sealed readily because of the ability of the shaley layers to swell and decompose to form an impervious clay, preventing significant downward percolation, collection, or conveyance of water along faults in the Blackhawk Formation.

Significant quantities of groundwater were also encountered in the Deer Creek Mine, 4th South area, where development entries intersected fractures/faults associated with the Roans Canyon Fault system. As with other areas where groundwater has been intercepted, the flow from the 4th South/2nd Right area has decreased rapidly, from approximately 2000 gpm in March 1990 to approximately 120 gpm in December 1990. Exploratory drilling was utilized in the development entries to locate and map the extent of the water producing fracture. The water producing zone was isolated utilizing an inflatable packer and a pressure gauge was installed to monitor the head differential. Pressure readings recorded were similar to those of Roans Canyon Fault crossing at 3rd North, with readings varying from 80-90 pounds per inch. This calculates out to approximately 200 feet of head. The amount of overburden in the area where the water

producing fracture was encountered is approximately 1800-2000 feet. In reviewing the dewatering curve and the initial head differential, groundwater produced from the interception of the water producing fracture was a function of storage and recharge to the fault is limited. To monitor the potential impact of mine dewatering, PacifiCorp installed a series of wells in both the Deer Creek and Cottonwood/Wilberg mines (refer to Volume 9 Hydrologic Section Maps HM-2 and HM-3). These wells were incorporated in the hydrologic monitoring program in 1989. Well development information was detailed in the 1989 Annual Hydrologic Monitoring Report and in Volume 9 - Hydrologic Support Information). Only the wells in the Deer Creek Mine along the axis of the Straight Canyon Syncline revealed a change which could possibly be related to mine dewatering. In addition to the in-mine monitoring PacifiCorp installed a series of surface wells to monitor the potential impacts in Cottonwood Canyon located to the south of Mill Fork and in Rilda Canyon located to the east of Mill Fork. To evaluate the effects on the surface springs and surface drainage systems PacifiCorp maintains an extensive monitoring program. Data collected will be reported annually in the Hydrologic Monitoring reports.

Long-term water producing areas do exist within the current mine workings. Four types of occurrences have been recognized and will be monitored by the applicant and include 1) structural rolls with overlying fluvial channels, 2) Pleasant Valley and Roans Canyon Fault systems, 3) fractures and joints (lineaments), and 4) surface and in-mine drill holes.

Star Point Sandstone

The Star Point Sandstone overlies and inter-tongues with the Masuk Shale. The formation is approximately 350 to 400 feet in thickness and consists of at least three upward coarsening sandstone units. Mudstone units of the Masuk Shale are present above the lower two sandstone members of the Star Point Sandstone due to the inter-fingering nature of the contact between the two units.

The Star Point Sandstone, which immediately underlies the Hiawatha Coal Seam, exhibits some characteristics of an aquifer but experiences little recharge. Studies conducted by the USGS indicate that the Star Point Sandstone is of low permeability, thus limiting its usefulness as a water-producing aquifer. Most of the water discharge from the Star Point Sandstone is where it has been intersected by the major canyons in the plateau or where faulting has caused secondary permeability. This, plus the fact that the Star Point Sandstone is only slightly to moderately permeable, allows only limited flow of groundwater through the formation. Drill holes completed in the Deer Creek, Wilberg/Cottonwood and Genwal mines have defined the piezometric gradient in the lower Blackhawk/Star Point Sandstone system in isolated areas and confirmed the

groundwater flow conforms with the topographic relief and structural features, i.e., regional dip, Straight Canyon Syncline, and regional faulting.

The overall pattern of groundwater flow and surface water-groundwater interactions in the Mill Fork Area and adjacent areas can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes (Mayo and Morris, 2000). Inactive zone groundwater systems contain old groundwater (i.e. 2,000 to 19,000 radiocarbon years), have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability as evidenced by the decline in roof drip rates and lack of fluctuations of in-mine monitoring wells.

Solute chemistry in the Spring Canyon Member is not uniform beneath existing mines suggesting that there is a partitioning of groundwater systems in the member. This condition is likely the result of inter-bedded lower-permeability layers in the Star Point Sandstone which partition individual sandstone bodies. These findings are substantiated by monitoring well data from 6 wells in the Trail and East Mountain areas and are significant in that they strongly suggest that the Spring Canyon Member does not act as a single regionally continuous aquifer, but rather it supports a series of smaller, discrete groundwater systems.

Water in most of the Blackhawk/Star Point aquifer is confined under pressure between shale and siltstone beds within the aquifer (USGS, Lines, Open File Report 84067). Water is released from storage from confined aquifers mainly by compression of the sandstones and less permeable, confining beds as pressure in the aquifer declines. The quantity of water that can be released from storage is dependent on the storage coefficient, which is about 1x10-6 per foot of thickness for most confined aquifers (USGS Lines, Open File Report 84067). Data collected by PacifiCorp on the Roans Canyon Fault System in 1988, 3rd North fault crossing, confirmed the USGS storage coefficient estimations, with values ranging from 1.6x10-4 to 7.0x10-6. Transmissivity values computed for pump tests conducted by the USGS on Trail Mountain on semi-penetrating wells in the Blackhawk/Star Point aquifer ranged from 0.7 to 100 ft^2/day with a majority of the two results ranging from 1 to 10 ft^2/day. The computed transmissivity of 100 ft^2/day was greater than the laboratory data (listed early in this section) and was believed to be due to secondary permeability in the form of fractures. Transmissivity results ranging from 0.7 to 10 ft^2/day are indicative of the low permeability rock in most of the Cretaceous and Tertiary strata within the Wasatch Plateau.

Structural Hydrologic Features

Several important structural features, the Straight Canyon Syncline, Flat Canyon Anticline and Huntington Anticline, the Roans Canyon Fault Graben, Mill Fork Fault Graben, Left Fork Fault Graben, Pleasant Valley Fault, and the Deer Creek Fault, have been identified adjacent to and within the Mill Fork Area.

Folding:

Strata in the Mill Fork area are gently folded in two broad structural features. The Flat Canyon Anticline crosses the southeastern portion of the lease area. This anticline trends southwest to northeast, and plunges to the southwest. Dips in the anticline range from two to six degrees with the south limb dipping the steepest.

To the north, the north limb of the Flat Canyon Anticline becomes the south limb of the Crandall Canyon Syncline, a flat-bottomed syncline. This syncline also trends southwest to northeast. Dips on the northwest side are much steeper than on the southeast side.

Faulting:

The only known fault within the Mill Fork Area is the Joes Valley Fault, which forms the western limit of the coal reserves in this area. The Joes Valley Fault is the largest and most prominent of several north south trending fault zones within the Wasatch Plateau coal field. Displacement of the fault is approximately 1,500 feet, downthrown on the western side. The fault creates a continuous north-south escarpment on the east side of Joes Valley. Several side canyons are cut into this escarpment on the western side of the lease area, all of which drain into Joes Valley. The fault zone itself is not visible along this escarpment, but the fault has been intercepted underground in the Genwal Mine to the north. Where the fault has been intercepted in the Genwal mine workings, a drag fold is present, indicated by a gentle downward folding of the strata along the fault zone, extending for a few hundred feet to the east of the fault.

The nearest known faulting outside of the lease area is the Mill Fork fault graben. The Mill Fork fault graben passes to the southeast of the lease area. This fault graben was crossed in ARCO's Huntington Canyon #4 Mine in Mill Fork Canyon and has a displacement of about twenty five (25) feet on the each side. The trend of this fault zone is approximately N 40° E. Based on projections from maps of #4 Mine, this graben should pass by the southeast corner of the lease area, between the Mill Fork lease and the existing Deer Creek Mine. Where it crosses the northern end of East Mountain, the fault has been mapped to have a displacement of thirty (30) feet down on the northwest side. Deer Creek mine workings have not intercepted this fault zone and exploration drilling in

the right fork of Rilda canyon does not show any displacement, indicating that the displacement of the fault zone is too small to measure with exploration drilling, or that it has disappeared in this area. This fault zone does not appear in any surface outcrops.

Springs and Seeps

Prior to coal leasing, lands administrated by the United States Forest Service require sufficient environmental baseline data to be analyzed during the National Environmental Protection Act (NEPA) analysis process. In preparation for coal leasing through the lease-by-application process, Genwal Resources conducted baseline spring and seep surveys from 1994-1996 (northern portions of the lease were surveyed in 1989-90). Data collected by Genwal Resources was determined by the Forest Service to meet the requirements of the Data Adequacy Standards. Information submitted to the Forest Service included: location, flow and quality (data indicates general trends, date of collection generalized and quality limited to field data). With PacifiCorp's acquisition of the Mill Fork State Coal Lease (reverted to the BLM on August 1, 2011 and designated as federal lease UTU-88554), a complete re-evaluation of groundwater resources was initiated in 2000 and continued through 2002. Evaluation of the data revealed similar geologic occurrences to the southern portion of East Mountain, (majority of the groundwater resources discharge from the North Horn Formation in a down-dip configuration), which has been monitored by PacifiCorp for more than thirty years. The water reconnaissance program of the Mill Fork Area was initiated with an aerial survey via helicopter. During the reconnaissance survey, previous baseline survey data was evaluated for field location accuracy. Based upon initial observations, PacifiCorp commenced a field program in 2000 to completely map, field mark and photograph each groundwater source. Previous baseline studies were utilized as a guide of potential groundwater resources. The entire area of the Mill Fork Area (including leases UTU-88554 and UTU-84285) and adjacent area was traversed. During the field reconnaissance process, when water resources were encountered, they were tracked to the source. At the sources, the sites were located utilizing GPS surveying techniques (GPS - equipment: Trimble Asset Surveyor, differentially corrected, horizontal accuracy sub-meter), digitally photographed, field marked with a brass tag and measurements were taken of flow and temperature. PacifiCorp retained identification system established during the previous surveys, except for the Joes Valley area and Mill Fork Ridge. In these two areas, several springs were labeled with multiple tags of different numbers and separate springs were labeled the same identification. In addition to the field measurements, PacifiCorp collected baseline water quality samples. Not all sites were sampled, collection of water quality samples were restricted to sites where representative samples could be obtained. At selected sites, springs were also sampled for isotopic data. These sites were selected based on geographic location, geologic formation, and occurrence.

During the 2000-2002 baseline evaluation, a total of 198 springs were identified within and adjacent to the Mill Fork Area. Each spring site on East Mountain has been studied to determine the geologic circumstances that cause the springs to occur. The mode of occurrence for each spring has been tabulated on the "Springs Geologic Conditions Inventory" sheets included in the Deer Creek Mine MRP. The springs on East Mountain originate in several different ways; however, many springs share the same mode of occurrence and, in some cases, are related.

The most frequent occurrences of springs are those located about 150 to 350 feet below the top of the North Horn Formation. Field observations along with drill hole data show a predominance of fluvial siltstone and sandstone at that stratigraphic interval. These sedimentary rocks represent many isolated fluvial systems which are water-bearing. The springs are formed where the fluvial channels intersect the land surface. Because the fluvial channels within this zone are generally not interconnected, the springs are not interrelated but share the same mode of occurrence.

Numerous springs located in the lower portion of the North Horn Formation occur when water flowing through fluvial sandstones which are underlain by a thin zone of impervious mudstone at the base of the North Horn Formation intersects the land surface. Field observations along with drill hole data indicate that impervious mudstone units occur at the upper and lower portion of the North Horn Formation. Even though these individual mudstone layers are discontinuous, the occurrence of this type of strata exists throughout the East Mountain Property. The springs related to this mode of occurrence are not generally interrelated because they are fed by waters flowing through isolated fluvial channel sandstones and siltstones.

Numerous springs are located along and within the Joes Valley Graben. Generally, the springs are located within the North Horn Formation (Bald Mountain Ridge located west of the Mill Fork Area) along the fault zone and the alluvial valley deposits. Many of the largest springs surveyed for the Mill Fork Area are located along this fault system west of the Mill Fork Area. The springs located along this fault zone are generally interrelated.

A few springs are located within both the Flagstaff and Price River formations; however, their occurrence is insignificant in comparison to springs located in the North Horn Formation.

Generally springs with discharges exceeding 50 gpm are associated with faulting where permeability has been increased by fracturing (example: Bald Ridge area). The discharge of the springs varies directly with the amount of precipitation and also varies seasonally. Discharge is greatest during the snow melt period, normally from late April through the month of June. Following periods of groundwater recharge the discharge recedes fairly rapidly at first, then

gradually, indicating a double porosity effect. At the end of the water year, the remaining discharge is only twenty to thirty percent (20-30%) of the peak discharge. Seasonal flow variation collected for the Mill Fork Area compares directly to the data collected for the southern portion of East Mountain and data collected by Genwal resources to the north.

The following table provides a breakdown of spring locations by geologic formation and surface drainage:

MILL FORK PERMIT AREA (Energy West 2000-2002 Surveys) SPRINGS by GEOLOGIC FORMATION and SURFACE DRAINAGE						
Drainage System	Geologic Formation					
	Alluvium	Flagstaff	North Horn	Upper Price River	Castle Gate	Blackhawk
Huntington Drainage						
Crandall Canyon	0	0	0	7	1	0
Mill Fork Canyon	0	0	44	10	1	5
Right Fork of Rilda Canyon	0	1	39	1	0	0
Cottonwood Drainage						
Un-Named Drainages of Joes Valley	35		29	19	6	0
Total Number of Springs = 198						

Groundwater Quality

Groundwater chemical quality is very good in strata above the Mancos Shale. The USGS reported a range in dissolved solids from 50 to 750 mg/l for samples from 140 springs in the region issuing from the Star Point Sandstone Formation and overlying formations (Danielson et al., 1981). During the Energy West 2000 - 2002 seep and spring surveys, a total of one hundred twenty-nine (129) samples were collected with a range of dissolved solids from 207 to 390 mg/l. Danielson et al. (1981) identified the regional trends of decreasing water quality from north to south and west to east across the Wasatch Plateau. Waters percolating through the underlying

Mancos Shale quickly deteriorate, with total dissolved solids concentrations frequently exceeding 3000 mg/l.

Additional studies by PacifiCorp have confirmed the primary findings of the USGS concerning regional trends in quality. Originally, decreasing quality from north to south was believed to depict the groundwater flow direction, and the quality decreased as a function of the time it traveled through the strata. Although the time travel component is probably an important factor, in 1985 a surface exploration program identified the existence of an area of residual heat from an ancient burn on the outcrop throughout the southern extreme of East Mountain. The high temperature was also explored within the mine and a portion of reserves were lost because of the situation. It is now theorized that the high temperature water dissolved the mineral constituents of the formations, thereby altering the water chemistry. The quality also decreases vertically downward because of the influence of marine sediments along with the trend of decreasing quality from north to south.

An examination of the data indicates that a relationship exists between elevation and the total dissolved solids concentration of the springs. The data indicate that concentrations of dissolved materials increase with diminishing elevation for both surface streams and springs. The change in quality is a function of the differences in the chemical character of geologic formations which outcrop at different elevations.

To more closely identify springs which are related, water samples are analyzed to determine the percentage of cations and anions in solution. The purpose of the diagrams is to identify groups of related springs by water chemistry. The diagrams clearly show the similarity of water quality of springs originating in the same geologic formation. Historical data from PacifiCorp's on-going East Mountain Hydrologic Program has demonstrated is that, even though the quality varies slightly from individual sites as well as from different formations, seasonal variations do not exist. Data collected in 2000-2001 confirms the trends historical in data collected for southern East Mountain, i.e., despite the seasonal variability in discharge rates, the solute concentrations of active region ground waters do not exhibit significant seasonal variability.

PacifiCorp began in-mine quality monitoring in 1977 (Cottonwood/Wilberg and Deer Creek mines). With the collection of numerous samples throughout the extent of the mine workings, the quality has remained relatively constant. As with the springs the quality varies from individual sites, but quality from the individual sites remains constant versus time.

The predominant dissolved chemical constituents of the groundwater from both surface springs and samples collected in the mine are calcium, bicarbonate, magnesium, and sulfate.

Concentrations of magnesium are normally about one-half the concentration of calcium. Sulfate concentrations are typically higher in water from springs issuing from the Star Point Sandstone-Blackhawk aquifer zone or confined aquifers intersected by mine workings. As mentioned earlier, water quality degrades from the north to the south and also vertically.

PacifiCorp contracted Mayo & Associates in 1996 to conduct comprehensive study to characterize the hydrology and hydrogeology of the East and Trail Mountains. The hydrogeology of the PacifiCorp leases were evaluated by analyzing: 1) solute and isotopic composition of surface and ground waters, 2) surface and groundwater discharge data, 3) piezometric data, and 4) geologic information. The following lists the key points and conclusions from the 1996 study:

Conclusions from the 1996 Mayo & Associates Hydrologic Investigation

1. The $\delta 2H$ and $\delta 18O$ compositions demonstrate that all ground waters are of meteoric origin (i.e. snow and rain).
2. Active and inactive groundwater regimes occur in the mine lease area.
3. The active regime includes alluvial groundwater, groundwater in the Flagstaff Formation, and all near surface exposures of the other bedrock formations except, perhaps, the Mancos Shale. The near surface extends about 500 to 1,000 feet into cliff faces. Ground waters in the active regime contain abundant 3H and anthropogenic 14C.
4. Comparison of long-term discharge hydrographs with precipitation records demonstrates that active regime ground waters: 1) are in direct hydraulic communication with the surface, 2) are recharged by modern precipitation, and 3) have large fluctuations in spring discharge rates which can be attributed to seasonal and climatic variability. High-flow/low-flow discharge rates vary as greatly as 600 gpm to nearly dry; however, most high flow rates are less than 50 gpm.
5. Despite the seasonal variability in discharge rates, the solute concentrations of active region ground waters do not exhibit significant seasonal variability.
6. The inactive regime includes groundwater in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). Mine workings are largely part of the inactive regime. The sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. Coal seams are hydraulic barriers to groundwater flow. The blanket sands of the Star Point Sandstone are also largely in the inactive zone. Except where exposed near cliff faces, faults encountered in mine workings are part of the inactive regime. Except

near cliff faces, faults are not conduits for vertical hydraulic communication between otherwise hydraulically isolated pockets of groundwater.

7. Inactive region groundwater systems contain old groundwater (i.e. 2,000 to 12,000 years), and are not influenced by annual recharge events or short term climatic variability.
8. In-mine inactive regime ground waters occur in nearly stagnant, isolated zones which have extremely limited hydraulic communication with other inactive regime ground waters in the vicinity of mine workings and with near-surface active regime ground waters as evidenced by the following:

   a) Ground waters discharging into mine openings have 14C ages ranging from 2,000 to 12,000 years
   b) Roof drip rates rapidly decline when water is encountered in the mine indicating that the saturated zone above the coal seam is not hydraulically continuous and has a limited vertical and horizontal extent.
   c) Unsaturated conditions have been identified in boreholes drilled vertically into sandstone channels located above coal seams.

9. The fact that inactive region ground waters encountered in mine openings do not have an infinite age means that, at some time, there has been some hydraulic communication with the surface. This communication is extremely limited as illustrated by calculated steady state recharge-discharge rates of faults and sandstone channels in the inactive zone which range from 0.001 to 1.23 gpm.
10. Groundwater in the Star Point Sandstone is part of the inactive regime as evidenced by the 6,000 year 14C age of the sample from well TM-3. In the down dip direction along the axis of the Straight Canyon Syncline, potentiometric pressures in the Spring Canyon member results in upwelling of groundwater into Hiawatha seam mine openings. Such upwelling may locally reduce the pressure in the Spring Canyon member.
11. Aerially extensive groundwater regimes in the lower Blackhawk Formation and Star Point Sandstone do not exist within the lease area. Therefore, it is not meaningful to create piezometric surface maps of these systems.
12. Stream flow is dependent on snow melt, precipitation and thunderstorm activity. There is no apparent hydraulic communication between stream flow and groundwater encountered in mine openings.
13. The groundwater discharging into the Rilda Canyon alluvial collection system is of modern origin and is closely tied to seasonal recharge. This is evidenced by its modern radiocarbon and 3H contents and by the discharge hydrographs. The alluvial groundwater is not related to the groundwater encountered in the mines.

14. The groundwater discharging in Cottonwood Canyon near Cottonwood Spring and Roans Spring discharges from glacial deposits and is of modern origin. The radiocarbon and 3H contents of this water indicate a modern origin. The water in the shallow glacial deposits is not related to the groundwater encountered in the mines.

In addition to the study conducted in 1996, Mayo & Associates were retained in 2000 to investigate hydrologic resources of the Mill Fork Area and adjacent areas. The purpose of this investigation is to 1) characterize the groundwater and surface water systems in the Mill Fork Area, and 2) determine the probable hydrologic consequences of underground coal mining to surface waters and ground waters within the Mill Fork Area. The hydrology and hydrogeology of the Mill Fork Area area have been evaluated by analyzing: 1) solute and isotopic compositions of surface waters and ground waters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information (refer to Appendix B for complete details).

Chemical Evolution of Groundwater (excerpt from Mayo & Associates Study)

a. Chemical Reactions

Solute compositions of groundwaters are the result of interactions between groundwater and bedrock lithology and between groundwater and atmospheric and soil gases. The general reactions responsible for the chemical evolution of groundwaters in the vicinity of the study area and inside the coal mines are described below:

Groundwater acquires most of its $CO_2(g)$ in the soil zone where the partial pressure of CO_2 greatly exceeds atmospheric levels. This CO_2 combines with water to form carbonic acid according to

$$CO_2(g) + H_2O = H_2CO_3 \quad (1)$$

Carbonic acid dissociates into H^+ and HCO_3^- as

$$H_2CO_3 = HCO_3^- + H^+ \quad (2)$$

The H^+ ions temporarily decrease the pH of the water but are quickly consumed by the dissolution of carbonate minerals that are abundant in the soil zone and in most aquifers. Carbonate mineral dissolution is represented as

$$2H^+ + \underset{\text{(dolomite)}}{CaMg(CO_3)_2} = Ca^{2+} + Mg^{2+} + 2HCO_3^-, \text{ and} \quad (3)$$

$$H^+ + CaCO_3 = Ca^{2+} + HCO_3^- \quad (4)$$

(calcite)

The net effect of reactions 2 through 4 is to increase the pH and the Ca^{2+}, Mg^{2+}, and HCO_3^- contents of waters. Dissolution of gypsum, which is present in minor amounts in many formations in the region, can elevate the Ca^{2+} and SO_4^{2-} contents in the absence of additional $CO_{2(g)}$ and H^+ according to

$$CaSO_4 \bullet 2H_2O = Ca^{2+} + SO_4^{2-} + 2H_2O \quad (5)$$

(gypsum)

Elevated Na^+ concentrations may result from either the dissolution of halite or from ion exchange on clay particles or on sodium zeolites (Mayo and others, 2000). Halite dissolution will increase the overall solute concentration (i.e. TDS) and will yield equal Na^+ and Cl^- contents when the solute compositions are reported in the meq/l units. Halite is not abundant in the study area. Ion exchange will not directly elevate the overall solute content, but will result in increased Na+ concentrations with corresponding decreases in $Ca2^+$ and/or Mg^{2+} concentrations. Halite dissolution may be represented as

$$NaCl = Na+ + Cl^- \quad (6)$$

And the ion exchange may be represented by reactions involving the sodium zeolite analcime,

$$2NaAlSi_2O_6 \bullet H_2O + Ca2+ = Ca(AlSi_2O_6)2 \bullet H_2O + 2Na^+, \quad (7)$$

$$2NaAlSi_2O_6 \bullet H_2O + Mg^{2+} = Mg(AlSi_2O_6)2 \bullet H_2O + 2Na^+, \quad (8)$$

or clay mineral exchange which may be represented as

$$Ca^{2+} + Na\text{-}clay = 2Na^+ + Ca\text{-}clay \quad (9)$$

$$Mg^{2+} + Na\text{-}clay = 2Na^+ + Mg\text{-}clay \quad (10)$$

Solute Compositions

a. Streams

(1) Crandall Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Mill Fork Creek have a mean TDS of about 300 mg/l and are of the Ca^2+-Mg^2+-HCO^{3-} type with lesser amounts of SO_4^{2-}. This water includes drainage from the Mill Fork Area as well as the area to the north.

(2) Mill Fork Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Crandall Creek have a mean TDS of about 480 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with lesser amounts of SO_4^{2-}. Most of this water originates in the Mill Fork Area.

(3) Rilda Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Rilda Creek have a mean TDS of about 400 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type. This water is mostly drainage from the Mill Fork Area.

b. Springs

The solute compositions of ground waters from nearly all of the springs in the Mill Fork Area are of similar chemical type. This is seen in the similarity of the shapes of the Stiff diagrams and the clustering of the data points on the Piper plot. All of the springs in the Mill Fork Area for which chemical analyses are available are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with variable amounts of SO_4^{2-}. This chemical type is consistent with the dissolution of carbonate minerals in the presence of soil zone CO_2(gas) according to equations 1-4 above.

Mineral saturation calculations indicate that most of the springs and streams in the study area are at or above saturation with respect to the carbonate minerals calcite and dolomite. What this means is that the chemistry of the spring water is near equilibrium with respect to these minerals, and thus there is not a thermodynamic tendency to dissolve additional carbonate minerals if these are encountered in the groundwater system. Waters with saturation indices less than log = -0.1 have a thermodynamic tendency to dissolve the mineral species should they be encountered in the groundwater system and waters with a saturation indices greater than log = 0.1 have a thermodynamic tendency to precipitate the mineral species.

For additional dissolution of carbonate minerals to occur, an influx of $CO_{2(g)}$ into the groundwater system must occur. Common sources of $CO_{2(g)}$ in this environment include CO_2 produced by root respiration and organic decay in the soil zone and bacteriological processes resulting in the oxidation of CH_4 (methane). No surface or groundwater in the study area is near saturation with respect to gypsum. What this indicates is that, if gypsum is encountered along a waters flow path, dissolution of the gypsum will occur, resulting in elevated Ca^{2+} and SO_4^{2-} concentrations. Groundwater from the Blackhawk Formation and Star Point Sandstone encountered in nearby mine environments is

supersaturated with respect to both calcite and dolomite indicating that the water has the thermodynamic tendency to precipitate these minerals.

TDS concentrations of springs in the study area fall in the narrow range of 207 to 390 mg/l. A probability plot of the ordered ranking of the TDS of ground waters collected during the 2000-2001 spring and seep survey indicate a single population with a normal distribution. The fact that all of the Mill Fork Area springs discharging from alluvial systems, the North Horn Formation, Price River Formation, Castlegate Sandstone, and Blackhawk Formation have the same chemical character is of particular significance. In other areas in the Wasatch Plateau, bedrock springs commonly have a broader range of TDS and chemical type, which is related to the bedrock formation from which the springs discharge (Danielson and others, 1981; Mayo and Associates, 1997d; Mayo and Morris, 2000).

The mean TDS for each geologic formation ranges from 253 mg/l in the North Horn Formation to 322 mg/l in the Price River Formation. That there is not a greater variability in TDS, or a greater number of groundwater types represented in the springs in the study area implies that there is not a great deal of variation in the soil zone processes or mineralogy of the matrix of the groundwater systems from which these springs emanate. We believe that the lack of variability in groundwater solute chemistry occurs because the groundwater systems that support springs in the area flush large quantities of groundwater through the thick soil zone and shallow fractured bedrock. Over thousands of years, some of the soluble minerals which were once present in the shallow bedrock and in the soil have been leached away. Because these groundwater systems do not come into contact with rocks deeper in the geologic formations (which vary substantially in their soluble mineral contents) there is little variation in the chemical type of groundwater.

Although there is little variability in the chemical type and TDS of groundwater discharging from springs in the Mill Fork Area, there is considerable variability in the TDS and solute compositions of spring discharge waters and the solute composition of spring discharging from the Blackhawk Formation in the nearby Trail and Cottonwood Mine areas. We interpret the overall greater TDS and degree of chemical variability in the Blackhawk Formation in the Trail and Cottonwood Mine waters as a result of great precipitation variability in the Trail and Cottonwood Mine areas. Except for Joes Valley Alluvium, Mill Fork Area ground waters recharge and discharge from very wet upland areas. Trail and Cottonwood Mine groundwater recharge and discharge from a variety of elevations and recharge domains.

In-Mine Groundwater

Because the Mill Fork State Lease (now UTU-88554) was a new lease area that did not have existing underground workings, the solute compositions of in-mine groundwater can only be inferred from compositions of in-mine waters in nearby mines. Extensive in-mine samples of Blackhawk Formation roof drip water are available from Energy West's mines which include Cottonwood, Wilberg, Trail Mountain, and Deer Creek. A limited number of in-mine samples from the Star Point Sandstone are also available from the Deer Creek and Cottonwood Mines (Mayo and Associates, 1997d) and from public documents for the Crandall Canyon Mine (Mayo and Associates, 1997a).

(1) Blackhawk Formation

In-mine roof drips from the Blackhawk Formation are of the Ca^{2+}- Mg^{2+} -HCO_3- -SO_4^{2-} type with appreciable amounts of Na^+. These ground waters have elevated TDS contents relative to Blackhawk spring waters in the Mill Fork Area and are generally chemically dissimilar to springs in the Mill Fork Area. The two spring samples from the Deer Creek and Cottonwood Mine areas have similar solute contents as the in-mine samples. Mayo and others (2000) found the elevated TDS in coal mine roof drip water to be the result of a cascading series of chemical reactions involving the oxidation of pyrite which increases the SO_4^{2-} concentration and releases H^+ ions. The H^+ ions are consumed by dissolution of additional carbonate minerals (i.e., calcite and dolomite) elevating the Ca^{2+} and Mg^{2+} contents. In the process acid mine drainage (AMD) is prevented. Ion exchange of Ca^{2+} and Mg^{2+} on the sodium zeolite analcime increases the Na^+ contents. We anticipate similar in-mine processes will occur in the Mill Fork Area.

(2) Spring Canyon Member

The solute chemical composition of groundwater in the Spring Canyon Member beneath existing mine workings is highly variable (Appendix B Table 4). Conductivities range from 500 to 2,287 µS/cm. Ca^{2+} concentrations range from 5.5 to 64 mg/l and Mg2+ concentrations range from 5.1to 41 mg/l. Na^+ concentrations range from 14 to 550.6 mg/l and Cl^- concentrations range from 5.0 to 221.3 mg/l. The large spatial variations in solute chemistry are attributed to the influence of inter-bedded Mancos Shale tongues which are present in some locations and not in others and are known to contain soluble minerals. The variations in Na^+ are likely the result of the presence or absence of clays with ion exchange capacity. Ion exchange commonly results in elevated Na^+ concentrations at the expense of decreased Ca^{2+} or Mg^{2+} concentrations.

That the solute chemistry in the Spring Canyon Member is not uniform beneath existing mines suggests that there is a partitioning of groundwater systems in the member. This

condition is likely the result of inter-bedded lower-permeability layers in the Star Point Sandstone which partition individual sandstone bodies. These findings are substantiated by monitoring well data from 6 wells in the Trail and East Mountain areas and are significant in that they strongly suggest that the Spring Canyon Member does not act as a single regionally continuous aquifer, but rather it supports a series of smaller, discrete groundwater systems.

(3) Joes Valley Fault System

Ground waters in the Joes Valley Fault system and associated sympathetic faults and fractures have been observed in the Crandall Canyon Mine. Data from a public domain document (Mayo and Associates, 1997a, c) indicate the water is of the Ca^{2+} -Mg^{2+} -HCO_3^- type. This water type is consistent with the dissolution of carbonate minerals in the presence of soil zone CO_2 (gas). Slightly elevated SO_4^{2-} concentrations are consistent with dissolution of minor amounts of gypsum. The relatively low mean Na+ concentration (3.7 mg/l; 0.17 meq/l) indicates that appreciable ion exchange has not occurred. Na^+ and Cl^- contents, in meq/l, are essentially the same, indicating halite dissolution as the Na^+ source.

δ^2H and δ^{18}O

The δ^2H and δ^{18}O composition of a water molecule falling as precipitation is determined by the temperature at which nucleation of the water droplet occurs. However, other effects related to the bulk composition of the water vapor phase, such as cloud rainout and orographic effects, also can affect the isotopic composition of precipitation.

The stable isotopic compositions of waters are usually analyzed relative to the Meteoric Water Line (MWL). The MWL is empirically derived from the worldwide plotting locations of coastal zone precipitation and is defined by the equation $\delta^2H = 8\ \delta^2O + 10$). Precipitation that forms under cooler conditions will plot lower (i.e. more negatively) along the MWL than will precipitation that forms under warmer conditions.

Except for unusual conditions such as geothermal heating above about 100°C, the δ^2H and δ^{18}O composition of a groundwater is set at the time of recharge and is not affected by subsurface conditions such as groundwater residence time and mineral dissolution and precipitation reactions. In other words, the recharge and flow history of a groundwater can be evaluated independently of the solute content of the water using stable isotopic compositions.

All ground waters in the study area plot near the meteoric water line indicating a meteoric recharge origin (i.e. rain and snow).

Based on their stable isotopic compositions, ground waters from within both the Energy West and Crandall Canyon Mines are readily distinguishable from each other and from springs and creeks in the Mill Fork Area. These three populations are statistically different from each other at the 95% confidence level. The Mill Fork Spring samples tend to plot more positively relative to the meteoric water line than do the in-mine waters, indicating that the near-surface ground waters recharged under different climatic conditions. The more negative composition of the in-mine ground waters is probably the result of paleo-recharge during cooler, wetter times. The stable isotopic composition of water seldom changes significantly after infiltration into the groundwater system. What this suggests is that modern groundwater systems in the upland areas overlying the mine area are not the primary source of recharge to the groundwater systems encountered in the mines.

Groundwater Ages (^{3}H and ^{14}C)

The concept of groundwater age is difficult to define because water arriving at a well or spring seldom travels via pure piston flow. Instead it is usually a mixture of water molecules that recharged at different locations and at different times, thus water has no unique age. It is therefore best to think of a groundwater "age" as the mean residence time of the water sampled at the well or spring.

In this investigation, two unstable isotopes, tritium (^{3}H) and carbon-14 (^{14}C) have been used to evaluate mean residence times. Tritium is a qualitative tool indicating if groundwater has a component of water that recharged since about 1954. Groundwater that recharged prior to about 1954 will contain essentially no tritium. Carbon-14 provides information regarding the number of years that have elapsed since the groundwater became isolated from soil zone gases and near-surface waters. Like tritium, ^{14}C can indicate if groundwater has a component that recharged since the 1950s. Ground waters with ^{14}C contents greater than about 50 percent modern carbon (pmc) contain anthropogenic (i.e., human-induced) carbon associated with atmospheric nuclear weapons testing. It is not uncommon for groundwater issuing from a spring or occurring in a well to be a mixture of old (i.e. containing no ^{3}H) and modern water.

Groundwater ages have been calculated for 27 springs, 14 in-mine locations, and 6 Star Point Sandstone wells. All spring waters, except for spring 18-4-1 which is located in the southwestern portion of Trail Mountain, contain anthropogenic carbon and appreciable amounts of ^{3}H and are, therefore, modern. These springs issue from alluvial systems, the North Horn Formation, the Price River Formation, the Castlegate Sandstone, and Blackhawk Formation.

Spring 18-4-1 issues from the Blackhawk Formation-Castlegate Sandstone contact at the down plunge end of the Straight Canyon Syncline and is not in the Mill Fork Area. The spring water does not contain water that recharged since 1954; however, the water was likely recharged less than a few hundred years ago as is indicated by its ^{14}C content.

Most groundwaters collected inside the Cottonwood/Wilberg and Deer Creek Mines contain essentially no tritium (Appendix B Table 5) and have mean ^{14}C ages ranging from 2,000 to 12,000 years. Roof drip waters associated with faults (i.e., 1.5N X 29, 6W X 20, and MN-ME) contain waters 2,000 to 7,000 years old and are not in hydraulic communication with the surface. Both roof drip (i.e. Blackhawk Formation) and wells in the Spring Canyon Member of the Star Point Sandstone in the Crandall Canyon Mine generally have groundwater ages of 13,000 – 19,000 years. These waters contain essentially no tritium and thus represent groundwater systems that are essentially hydraulically isolated from modern near surface hydrologic phenomena.

Two in-mine roof drip samples associated with faults, TW-10 (Roans Canyon) in the Deer Creek Mine and 5th West (Joes Valley Fault) in the Crandall Canyon mine, have ^{3}H contents indicating a component of modern recharge.

Active and Inactive Groundwater Zones

The overall pattern of groundwater flow and surface water-groundwater interactions in the Mill Fork Area and adjacent areas can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes (Mayo and Morris, 2000).

Active zone groundwater flow systems contain abundant ^{3}H, have excellent hydraulic communication with the surface, are dependent on annual recharge events, and are affected by short term climatic variability. Tritium and carbon-14 “age” dating of spring waters in the study area demonstrate that all springs, except 18-4-1, issue from active zone groundwater systems and are of modern origin. Groundwater in the active zone generally circulates shallowly and has short flow paths. Because the springs in the Mill Fork Area and adjacent areas are not part of large, regional groundwater systems, hydrographs of their discharge rates show both seasonal and climatic fluctuations. During drought cycles, it is not uncommon for discharge from some springs in the active zone to completely cease.

The $\delta^{2}H$ and $\delta^{18}O$ compositions of Mill Fork Area springs relative to in-mine ground waters demonstrate that the Mill Fork Area springs are not part of the same groundwater systems that discharge in the mines.

The active regime includes alluvial groundwater, all of the Flagstaff Limestone, and the near-surface exposures of all other bedrock formations. The "near surface" extends a few hundred feet vertically into the subsurface, about 500 to 1,000 feet into cliff faces and is controlled by fracturing, weathering, and the surface exposures of fluvial channel sands. Further into the cliff faces the discontinuous character of the channel sands prevents active groundwater flow.

Except for mountain fronts and cliff faces, the coal bearing lower Blackhawk Formation and the Star Point Sandstone are generally not exposed at the surface in the Mill Fork Area and are not part of the active zone. In Cottonwood Canyon, located south of Mill Fork Area, the Star Point Sandstone is within a few hundred feet of land surface and is part of the active zone as evidenced by the tritium content, 1.10 TU, in Well CCCW-1S. Elsewhere Star Point Sandstone samples have groundwater ages of 6,000 to 19,000 years. In the Mill Fork Area the lower Blackhawk Formation and Star Point Sandstone are not exposed near the land surface, except at cliff faces, and are not in the active zone.

Except for mining operations near cliff faces, the in-mine environment is generally not part of the active zone. However, in-mine groundwater containing tritium (i.e., 1 TU or more) in TW-10 (Roans Canyon Fault) and 5th West Fault (Joes Valley Fault-Genwal Mine) indicate that locally the inactive zone extends into the mine environment where fracture zones, that are associated with major faulting, are currently under tensional stress. The extension of the active zone into the mine environment along fractures is localized as evidenced by the absences of tritium and old ^{14}C ages in in-mine groundwater collected elsewhere along the fracture zone.

Inactive zone groundwater systems contain old groundwater (i.e. 2,000 to 19,000 radiocarbon years, have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability as evidenced by the decline in roof drip rates. Groundwater in these systems tends to occur in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). These sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. The blanket sands of the Star Point Sandstone are also largely in the inactive zone.

Except for the immediate vicinity of Joes Valley Fault, we believe that groundwater intercepted in the Mill Fork Area will be part of the inactive zone and will not be in hydraulic communication with either near surface groundwater or surface water systems. Mining within 200 to 300 feet of Joes Valley Fault is problematic in that the area is under tension and deep

groundwater may be part of the active zone.

Two fundamentally different groundwater regimes, active (near surface) and inactive (deep subsurface and in-mine) that occur in the vicinity of the Mill Fork Area and elsewhere in the Utah Coal District are due to the vertical and horizontal heterogeneity of the bedrock. The rock formations consist primarily of alternating and interpenetrating layers of somewhat permeable sandstone and impermeable shale and mudstone. Individual rock layers are generally not continuous over great horizontal distances. Rather, one rock facies commonly grades horizontally into another facies. Fluvial deposits consisting of sandstone channels, which locally support groundwater systems, typically interpenetrate with shale and mudstone units. Thus, layers of shale or claystone that have very low permeabilities encase individual sandstone layers both horizontally and vertically. Although the permeability of individual sandstone bodies may locally be relatively high, the ability of these rocks to transmit water horizontally over great distances is low because of the discontinuous nature of the sandstones. Due to the pervasiveness of low permeability shales and mudstones, the potential for vertical groundwater flow is minimal.

Because of the limited potential for groundwater to migrate vertically through the stratigraphic section, active zone recharge waters commonly infiltrate only into the soil zone and shallow, fractured bedrock. Most groundwater moves downward through the shallow subsurface until the first impermeable layer is encountered where it migrates laterally and is discharged at the surface as a spring or seep.

Regional Groundwater Systems

A report by the U.S. Geological Survey (Lines, 1985) states that there exists a regional aquifer in the lower Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau. Lines also postulates that the regional aquifer is recharged by the downward migration of ground waters from overlying perched groundwater systems in the North Horn and Price River Formations. This idea is not correct. Ground waters encountered within mine openings in the lowermost Blackhawk Formation occur primarily within discontinuous sandstone channels. It is not uncommon for some of these channels to be completely dry, while others are partially or completely filled with water. Between these sandstone channels, the surrounding shales and claystones of the Blackhawk Formation are usually dry. The discontinuous nature of the saturated sediments in the lowermost Blackhawk Formation, and the unconfined conditions under which these ground waters exist do not support the idea of a deep, regional system with groundwater flowing from areas of recharge to areas of discharge.

Additionally, radiocarbon and tritium groundwater age dating indicates that groundwater in the

shallow perched groundwater systems are modern (post-1954) and in-mine groundwater in the Blackhawk Formation and Star Point Sandstone are thousands of years old.

We believe that the presence of swelling clays and impermeable shales in the rocks in the unsaturated zone between the overlying perched systems and the Blackhawk Formation effectively prohibit downward vertical migration of waters from the perched systems. Lines (1985) analyzed cores taken from well (D-17-6) 27bda-1 and found the hydraulic conductivities of the shales and siltstones to be very low (i.e. 10-7 to 10-8 ft/day). One shale sample was found to be effectively impermeable even when a hydraulic pressure of 5,000 psi was applied.

Because there are no regionally extensive groundwater regimes in the lower Blackhawk Formation or Star Point Sandstone within the lease area, it is not possible to draw meaningful potentiometric surface maps of these systems.

Lines (1985) also reported that water was likely leaking from the Joes Valley Reservoir downward into the "lower Blackhawk / Star Point aquifer" in Straight Canyon. We believe that this is incorrect. Groundwater collected from well TM-3, which is completed in the Star Point Sandstone in Straight Canyon just below the reservoir, has a radiocarbon age of 6,000 years, while water in Joes Valley Reservoir is of modern origin. Water levels in TM-3 do not respond to seasonal fluctuations in the water level in Joes Valley Reservoir, indicating that there is little or no hydraulic communication between the reservoir and water in the Star Point Sandstone. Groundwater was sampled at UG-3 in the lower Blackhawk Formation in the Trail Mountain Mine. This water has a radiocarbon age of 5,500 years, which is likewise not consistent with water from the reservoir.

Summary of 2001 Mayo & Associates Study

In summary, all groundwater encountered in springs monitored in the Mill Fork permit Area discharge from active, shallow groundwater systems. No evidence exists that suggests a large, regional-type aquifer occurs in the area. All of the springs analyzed in the study area exhibit large-scale fluctuations in discharge rates in response to the annual snowmelt event. The springs are also sensitive to longer-term variations in climate. Carbon-14 and tritium dating of spring and stream waters indicate that the springs contain anthropogenic (human-induced) carbon and levels of tritium consistent with recharge in the past 50 years. Stable isotopic δ^2H and $\delta^{18}O$ data from springs and streams at the surface indicate that the recharge sources for these groundwater systems are different from those that recharged the groundwater systems encountered in the mine environment.

Almost all groundwater encountered in in-mine environments is not related to shallow, active zone groundwater systems from which springs and streams discharge. ^{14}C dating indicates that

groundwater entering the underground workings in most locations is thousands of years old. When groundwater is encountered in the mine, inflow rates commonly decrease rapidly and most inflows eventually dry up completely. This indicates that the groundwater systems encountered in the mine are not part of large regional groundwater systems. There is no relationship between groundwater inflow rates measured in the mine and the annual snowmelt event or long term climatic trends. This demonstrates a lack of hydraulic communication between the groundwater systems encountered in the mine and active zone groundwater systems near the surface.

Conclusions from 2001 Mayo & Associates Study

- Ground waters discharging from springs are part of active zone groundwater systems. Isotopic analysis indicates that groundwater from the active zone is of modern origin (recharged less than 50 years ago). Seasonal variations in discharge rates from active zone springs indicate that flowpath lengths are short and that groundwater travel times from recharge areas to discharge areas are generally less than one year. The abundance of shale and claystone units in the geologic section prohibits significant downward migration of active zone ground waters into deeper horizons.

- Analysis of the solute chemistry of ground waters discharging from springs and seeps indicate that depths of circulation in these systems are shallow. The modern groundwater ages of shallow ground waters in the study area support this conclusion.

- Groundwater encountered in most locations in the mines is many thousands of years old. Groundwater in the Star Point Sandstone ranges from approximately 1,000 to 19,000 years old. Groundwater in the Blackhawk Formation within the mines ranges in age from about 2,000 to 14,000 years, whereas groundwater in the Joes Valley Fault system ranges in age between about 2,500 and 5,000 years. None of these groundwaters have appreciable tritium concentrations, indicating that no recharge has occurred in the past 50 years.

- Groundwater encountered in the northwest corner of the Crandall Canyon Mine discharges from a series of fractures located near the Joes Valley Fault. Tritium data indicate that a component of this water recharged in the past 50 years, whereas ^{14}C data indicate that another component recharged more than 3,500 years ago. This groundwater appears to originate from a sandstone channel in the mine roof.

- More than two-thirds of all non-alluvial springs in the Mill Fork Area discharge from the North Horn Formation. The abundance of springs in the North Horn Formation is the result of the large area of exposed North Horn in the upland areas where precipitation is greatest, and the presence of the abundant claystone and shale layers which inhibit significant downward migration of precipitation into the formation.

- The fact that Little Bear Spring discharges modern water and has large variations in discharge rates suggests that it is the discharge location of an active zone groundwater system. Because inactive zone groundwater systems in the Star Point Sandstone beneath the mine are tens of thousands of years old and do not exhibit seasonal variations in discharge, these groundwater systems are precluded as potential contributors to the discharge from Little Bear Spring. The very low permeability in the Star Point Sandstone beneath the mine indicates that diffuse flow through the Star Point Sandstone beneath the mine cannot contribute significant groundwater to the discharge from the spring.

  Limited data suggest the possibility that Little Bear Spring may receive significant recharge where the fracture system from which it emanates crosses streams and active zone groundwater systems in drainages south of Little Bear Canyon. The conditions in Mill Fork Canyon seem favorable for recharge to the spring.

WATER MONITORING – MILL FORK AREA

A. GROUNDWATER

Groundwater within the Mill Fork Area was monitored according to the schedules in established in the Deer Creek MRP. PacifiCorp has conducted baseline and operational monitoring of spring sources in and adjacent to the lease area. The data collected have provided information useful in the understanding of potential hydrologic consequence of mining.

East Mountain Springs - Mill Fork

In preparation for coal leasing, Genwal Resources conducted baseline spring and seep surveys from 1994-1996 (northern portions of the lease were surveyed in 1989-90). With PacifiCorp's acquisition of the Mill Fork State Coal Lease (reverted to the BLM on August 1, 2011 and designated as federal lease UTU-88554), a complete re-evaluation of groundwater resources was initiated in 2000 and continued through 2001. During the 2000-2002 baseline evaluation, a total of 198 springs were identified within and adjacent to the lease plan area. Each spring site on East Mountain has been studied to determine the geologic circumstances that cause the springs to

occur. The mode of occurrence for each spring was tabulated on the "Springs Geologic Conditions Inventory" sheets located in the Deer Creek MRP. The springs on East Mountain originate in several different ways (see Springs and Hydrologic Drainage Maps and HM-1A Hydrology Data Map); however, many springs share the same mode of occurrence and, in some cases, are related.

The ground water monitoring plan in Appendix A includes a selection of springs based on the following criteria:

- Stratigraphic position
- Area of potential influence from subsidence
- Aerial distribution
- Established water rights
- Measurable flow based on historical surveys
- Reliable measuring point(s)

The following table outlines the rationale for springs selected for long term monitoring. Selection of the springs to be monitored was based upon the factors listed along with discussions with the water users (CVSSD, Emery Conservancy District, NEWUSSD) and the surface management agency.

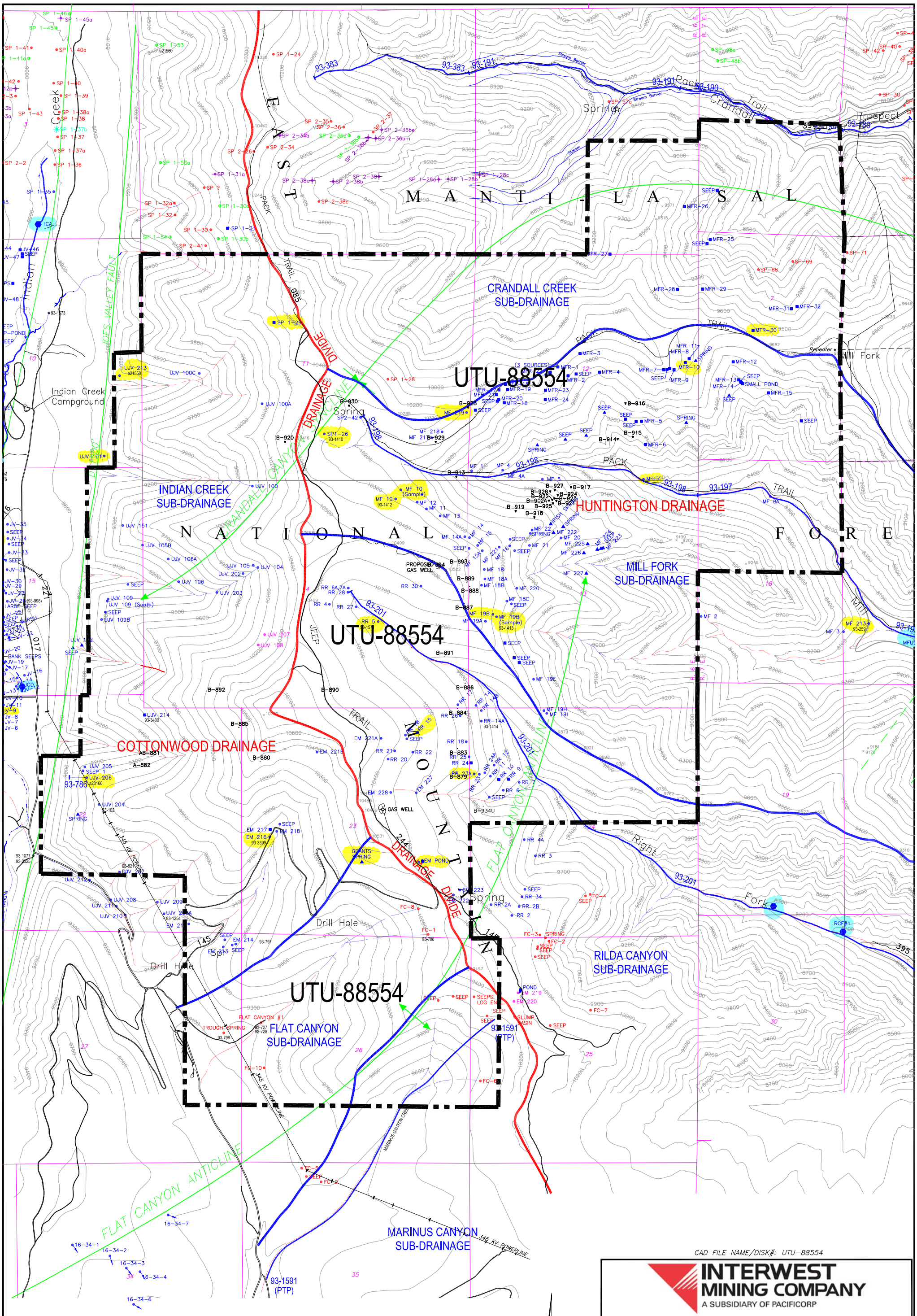
MILL FORK GROUNDWATER MONITORING PLAN - SPRINGS							
Spring	Stratigraphic Position	Projected Subsidence Zone	Regional Location	Water Rights	Historical Measurable Flow	Reliable Measuring Point	Comment
SP1-29	✓	✓	✓		✓	✓	
UJV-213	✓		✓	✓	✓	✓	
UJV-101	✓		✓		✓	✓	
JV-34	✓		✓			✓	Located outside projected zone of subsidence. Monitored to detect impacts to the Joes Valley alluvium
JV-9	✓		✓			✓	Located outside projected zone of subsidence. Monitored to detect impacts to the Joes Valley alluvium
UJV-206	✓	✓	✓	✓	✓	✓	
MF-219	✓	✓	✓	✓	✓	✓	
SP1-26	✓	✓	✓	✓	✓	✓	
MF-10	✓	✓	✓	✓	✓	✓	
MF-19B	✓		✓	✓	✓	✓	
RR-5	✓	✓	✓	✓	✓	✓	
EM-216	✓		✓	✓	✓	✓	Located outside projected zone of subsidence
GRANTS SPRING					✓	✓	Added to the spring monitoring program at the request of the USFS
RR-15	✓	✓	✓		✓	✓	
RR-23A	✓		✓		✓	✓	Large spring within a series of springs located downdip from projected mining
EM POND					✓	✓	Added to the spring monitoring program at the request of the USFS
MFR-30	✓	✓	✓		✓	✓	
MFR-10	✓	✓	✓		✓	✓	Large spring denoted by USGS
MF-7	✓		✓		✓	✓	Located outside projected zone of subsidence
MF-213	✓		✓	✓	✓	✓	Large spring located in the Blackhawk Formation downdip from projected mining
LITTLE BEAR SPRING	✓		✓	✓	✓	✓	Located outside projected zone of subsidence. Added to the spring monitoring program at the request of the DOGM

Water samples were collected and analyzed during the months of July and October. Parameters analyzed are those listed in the "DOGM Guidelines for Groundwater Water Quality." Monitoring of groundwater sites will continued for a minimum of three years after the last date of mining (date of last mining - January 2015). PacifiCorp will submit a formal application to reduce hydrologic monitoring after the minimum three year time period.

Surface Hydrology

The Deer Creek Mine area is located in the headwater region of the San Rafael River Basin. The surface drainage system of the Federal Lease UTU-88554 forms part of the Huntington Creek drainage.

Most of the drainages in and adjacent to Lease UTU-88554 are ephemeral. The majority of the surface flow from the lease block drains to the east in Crandall, Mill Fork and Rilda Canyons and un-named drainages which report to Huntington Creek. On the west side of the East Mountain drainage divide minor drainages report to the Cottonwood Creek drainage system. As detailed in Appendices A and B, the amount of subsidence is limited and effects of subsidence did not alter surface flow characteristics of the ephemeral drainages.

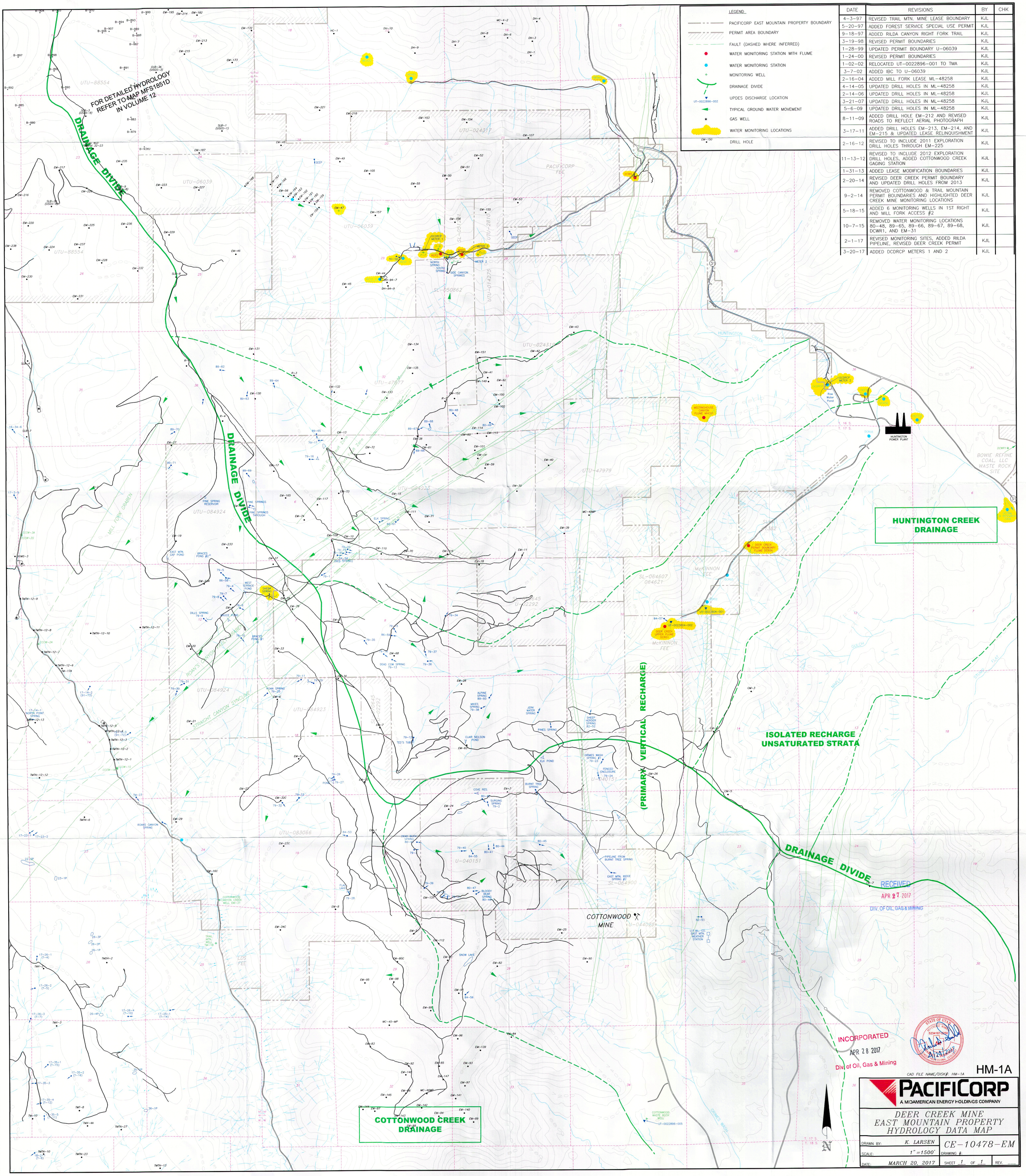


CAD FILE NAME/DISK#: UTU–88554

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
HYDROLOGIC DRAINAGE MAP

DRAWN BY:	K. LARSEN	APPENDIX C	
SCALE:	1"=2000'	DRAWING #:	
DATE:	APRIL 17, 2018	SHEET 1 OF 1	REV. ___



LEGEND
PACIFICORP EAST MOUNTAIN PROPERTY BOUNDARY
PERMIT AREA BOUNDARY
FAULT (DASHED WHERE INFERRED)
WATER MONITORING STATION WITH FLUME
WATER MONITORING STATION
MONITORING WELL
DRAINAGE DIVIDE
UT-0022896-002 UPDES DISCHARGE LOCATION
TYPICAL GROUND WATER MOVEMENT
GAS WELL
WATER MONITORING LOCATIONS
EM-150 DRILL HOLE

DATE	REVISIONS	BY	CHK
4-3-97	REVISED TRAIL MTN. MINE LEASE BOUNDARY	KJL	
5-20-97	ADDED FOREST SERVICE SPECIAL USE PERMIT	KJL	
9-18-97	ADDED RILDA CANYON RIGHT FORK TRAIL	KJL	
3-19-98	REVISED PERMIT BOUNDARIES	KJL	
1-28-99	UPDATED PERMIT BOUNDARY U-06039	KJL	
1-24-00	REVISED PERMIT BOUNDARIES	KJL	
1-02-02	RELOCATED UT-0022896-001 TO TMA	KJL	
3-7-02	ADDED IBC TO U-06039	KJL	
2-16-04	ADDED MILL FORK LEASE ML-48258	KJL	
4-14-05	UPDATED DRILL HOLES IN ML-48258	KJL	
2-14-06	UPDATED DRILL HOLES IN ML-48258	KJL	
3-21-07	UPDATED DRILL HOLES IN ML-48258	KJL	
5-6-09	UPDATED DRILL HOLES IN ML-48258	KJL	
8-11-09	ADDED DRILL HOLE EM-212 AND REVISED ROADS TO REFLECT AERIAL PHOTOGRAPH	KJL	
3-17-11	ADDED DRILL HOLES EM-213, EM-214, AND EM-215 & UPDATED LEASE RELINQUISHMENT	KJL	
2-16-12	REVISED TO INCLUDE 2011 EXPLORATION DRILL HOLES THROUGH EM-225	KJL	
11-13-12	REVISED TO INCLUDE 2012 EXPLORATION DRILL HOLES, ADDED COTTONWOOD CREEK GAGING STATION	KJL	
1-31-13	ADDED LEASE MODIFICATION BOUNDARIES	KJL	
2-20-14	REVISED DEER CREEK PERMIT BOUNDARY AND UPDATED DRILL HOLES FROM 2013	KJL	
9-2-14	REMOVED COTTONWOOD & TRAIL MOUNTAIN PERMIT BOUNDARIES AND HIGHLIGHTED DEER CREEK MINE MONITORING LOCATIONS	KJL	
5-18-15	ADDED 6 MONITORING WELLS IN 1ST RIGHT AND MILL FORK ACCESS #2	KJL	
10-7-15	REMOVED WATER MONITORING LOCATIONS 80-48, 89-65, 89-66, 89-67, 89-68, DCWR1, AND EM-31	KJL	
2-1-17	REVISED MONITORING SITES, ADDED RILDA PIPELINE, REVISED DEER CREEK PERMIT	KJL	
3-20-17	ADDED DCDRCP METERS 1 AND 2	KJL	

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3-20-2017

HM-1A

CAD FILE NAME/DISK#: HM-1A

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

DEER CREEK MINE
EAST MOUNTAIN PROPERTY
HYDROLOGY DATA MAP

DRAWN BY:	K. LARSEN	DRAWING #:	CE-10478-EM
SCALE:	1"=1500'		
DATE:	MARCH 20, 2017	SHEET 1 OF 1	REV. ___

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
UJV-213	First Mining	Hiawatha: 25th West Bleeder Feb. 2012	Within Relinquishment	10	16S	6E	NA
UJV-101	First Mining	Hiawatha: 22nd West Bleeder Mar. 2011	Within ½ mile Offset Within Lease UTU-84285	10	16S	6E	NA
JV-34	Not Undermined	NA Nearest second mining: 2670' Aug. 2008	Within ½ mile Offset	15	16S	6E	NA
JV-9	Not Undermined	NA Nearest second mining: 1940' Jun. 2005	Within ½ mile Offset	22	16S	6E	NA
UJV-206	Not Undermined	NA Nearest second mining: 1825' Dec. 2005	Within Relinquishment	22	16S	6E	NA
MF-219	First Mining - BC Longwall – BC First Mining – Hia.	Blind Canyon: First Mining 7th Left Sep. 2009 Second Mining 7th Left Apr. 2010 Hiawatha: 23rd West Feb. 2011	Within Relinquishment	11	16S	6E	1

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
SPI-26	Not Undermined	NA Nearest second mining: 460' Feb. 2010	Within Relinquishment	11	16S	6E	NA
MF-10	Longwall Panels	Blind Canyon: 5th Left Jul. 2009 Hiawatha: 21st West Jan. 2011	Within Relinquishment	14	16S	6E	7
MF-19B	First Mining	Hiawatha: 7th North Sump Feb. 2006	Within Relinquishment	13	16S	6E	0
RR-5	Not Undermined	NA Nearest second mining: 1000' Feb. 2009	Within Relinquishment	14	16S	6E	NA
EM-216	Not Undermined	NA Nearest second mining: 975' Sep. 2005	Within Relinquishment	23	16S	6E	NA
GRANTS SPRING	Not Undermined	NA Nearest second mining: 1560' Nov. 2005	Within Relinquishment	23	16S	6E	NA
RR-15	Not Undermined	NA Nearest second mining: 55' Mar. 2006	Within Relinquishment	14	16S	6E	NA

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
EMPOND	Not Undermined	NA Nearest second mining: 1620' Dec. 2005	Within Relinquishment	23	16S	6E	NA
MFR-30	Not Undermined	NA Nearest second mining: 4000' Mar. 2014	Within Relinquishment	7	16S	7E	NA
MFR-10	Not Undermined	NA Nearest second mining: 2380' Mar. 2014	Within Relinquishment	12	16S	6E	NA
MF-7	Not Undermined	NA Nearest second mining: 1707' Jul. 2010	Within Relinquishment	12	16S	6E	NA
MF-213	Not Undermined	NA Nearest second mining: 7915' Jul. 2010	Within ½ mile Offset	17	16S	7E	NA
LB10/ LB-11 Little Bear	Not Undermined	NA Nearest second mining: 13050' Mar. 2014	Adjacent to Lease	9	16S	7E	NA

SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 1 OF 10	REV. ___

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring SPI-29 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat on February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of SPI-26 in the Hiawatha Seam, 26th West gateroad, on October 2012. Spring SPI-29 is located in barrier pillar south of 26th West. Nearest seconding mining is approximately 295' north, 27th West longwall panel.

Subsidence: No subsidence has been detected near SPI-29. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. SPI-29 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring SPI-29. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - SPI-29 is a low volume spring/seep located below trail in a small clearing on west facing slope surrounded with conifers and aspens. Spring drains to small shallow basin adjacent to source. Crandall Canyon Mine developed the trail into an access road during the 2007 mine collapse. Roadway reclaimed in 2013. Flow from spring SPI-29 generally ranges from 0.0/seep to a maximum of <3.0 gpm. Area near and spring site disturbed/re-developed post Crandall Canyon mine collapse. Wet area developed on nearby access road, flow from original source dissipated (see following Geologic Occurrence – photos).

Geologic Mode of Occurrence for spring SPI-29:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 150' below top.

Justification for removal from monitoring: SPI-29 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site SPI-29 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **SP1-29**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1630' S.	3070' E.	NW	11	16S	6E	10360

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	1 ½ " Steel Pipe Non-functioning post Crandall Canyon drill hole disturbance	None	150' below top

Location Comments: Spring located below trail in a small clearing on west facing slope surrounded with conifers and aspens.

Probable Recharge Area: Areas of higher elevation located to the east (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as SP1-31.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

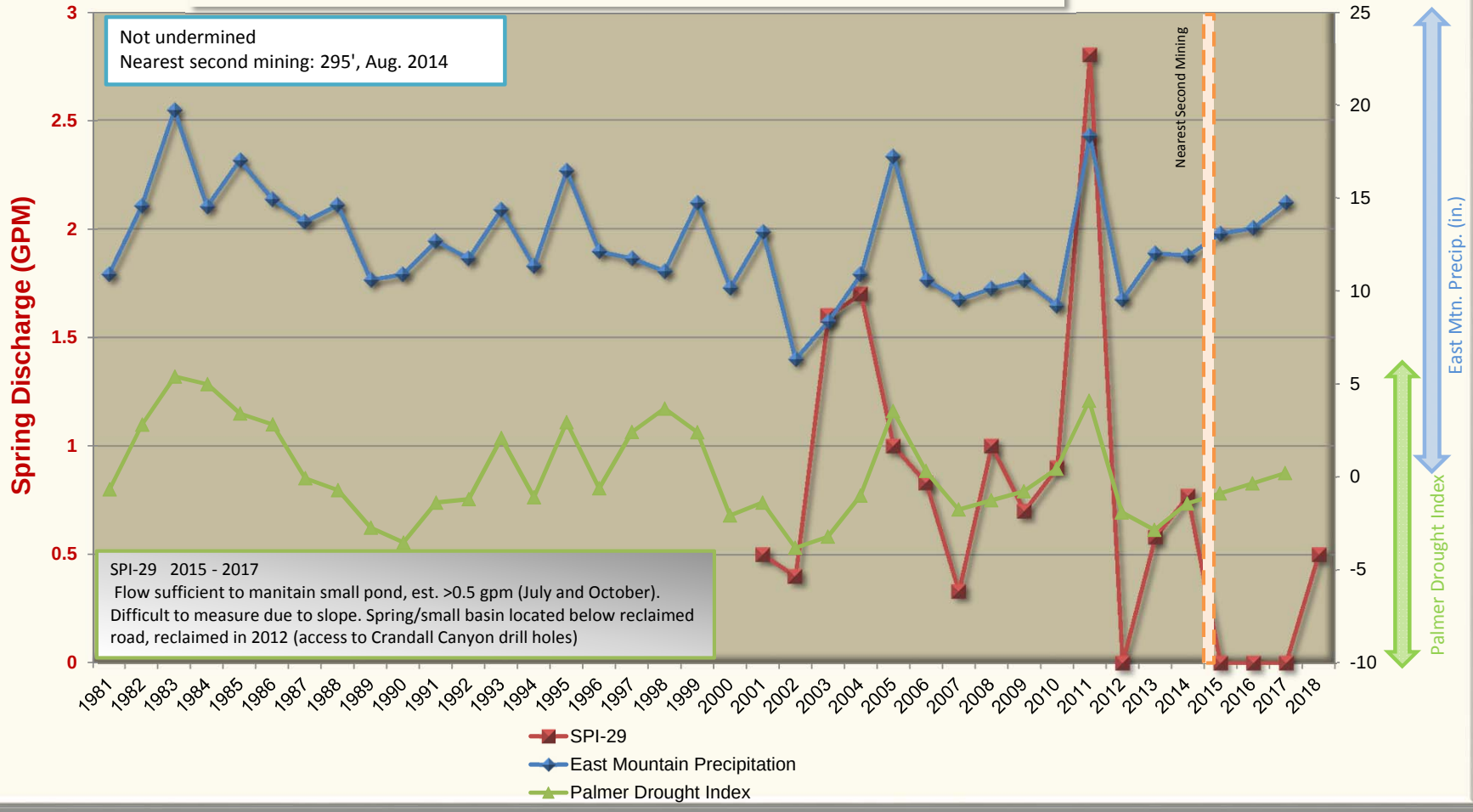
SPI-29 spring source, August 9, 2001

Small basin below SPI-29 post Crandall Canyon drill hole disturbance. View from reclaimed road, May 23, 2018

SPI-29 Spring source, May 23, 2018 (same view as August 9, 2001 photo)

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: SPI-29 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: SP1-29
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 295'
Date of Nearest Mining: Aug. 2014

	Pre-Mining Data: 20000101 THROUGH 20140701				Post-Mining Data: 20140701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	322	238	271	18	- No Sample Data -				BICARBONATE
CALCIUM	76.6	64	69.1122	18					CALCIUM
CARBONATE	0	0	0	8					CARBONATE
CHLORIDE	3	2	2.17222	18					CHLORIDE
CONDUCTIVITY	555	457	501.777	18					CONDUCTIVITY
DISSOLVED OXYGEN	0								DISSOLVED OXYGEN
FLOW	2.8	0.09	0.89444	18					FLOW
HARDNESS	288	246	266.277	18					HARDNESS
TOTAL IRON	0.06	0	0.0075	8					TOTAL IRON
DISSOLVED IRON	0	0	0	8					DISSOLVED IRON
MAGNESIUM	24.78	20.7	22.7277	18					MAGNESIUM
DISSOLVED MANGANESE	0.015	0	0.00225	8					DISSOLVED MANGANESE
MANGANESE	0.012	0	0.0015	8					MANGANESE
OIL AND GREASE	0								OIL AND GREASE
PH	7.96	7.24	7.64611	18					PH
POTASSIUM	2	0.98	1.35277	18					POTASSIUM
SET SOLIDS	0								SET SOLIDS
SODIUM	7.41	2.57	3.34333	18					SODIUM
SULFATE	9	5	6.74444	18					SULFATE
SUSPENDED SOLIDS	255	255	255	1					SUSPENDED SOLIDS
TEMPERATURE	8.8	3.6	5.04444	18					TEMPERATURE
TOTAL DISSOLVED SOLIDS	315	249	269.555	18					TOTAL DISSOLVED SOLIDS

Location: Section 10, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring UJV-213 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat on February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of UJV-213 in the Hiawatha Seam, 25th West Bleeder, in February 2012.

Subsidence: No subsidence has been detected near UJV-213. Maximum subsidence in area 400' east of UJV-213 has stabilized at approximately 2 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2012. UJV-213 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-213. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 – 2001 and 2007 – 2017 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV-213 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west. Flow from spring UJV-213 generally ranges from 0.0/seep to a maximum of 3.0 gpm. Spring flow dissipates rapidly below spring source.

Geologic Mode of Occurrence for spring UJV-213:

- Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Castle Gate (refer to Geologic Occurrence sheet).

- Stratigraphic Position: Mid-formation.

Justification for removal from monitoring: UJV-213 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-213 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-213**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
261' N.	889' W.	SW	10	16S	6E	8960

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Castle Gate	None	a21560 Change application is to allow the applicant the right to develop the 3 unnamed springs to draw a portion of the stock away from the Spoon Creek riparian area.	Middle

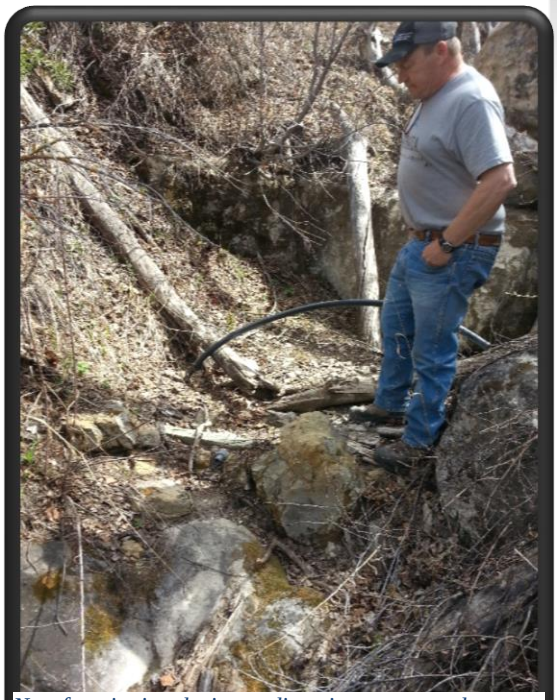
Location Comments: Spring located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area

Geologic Occurrence of Spring:

Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

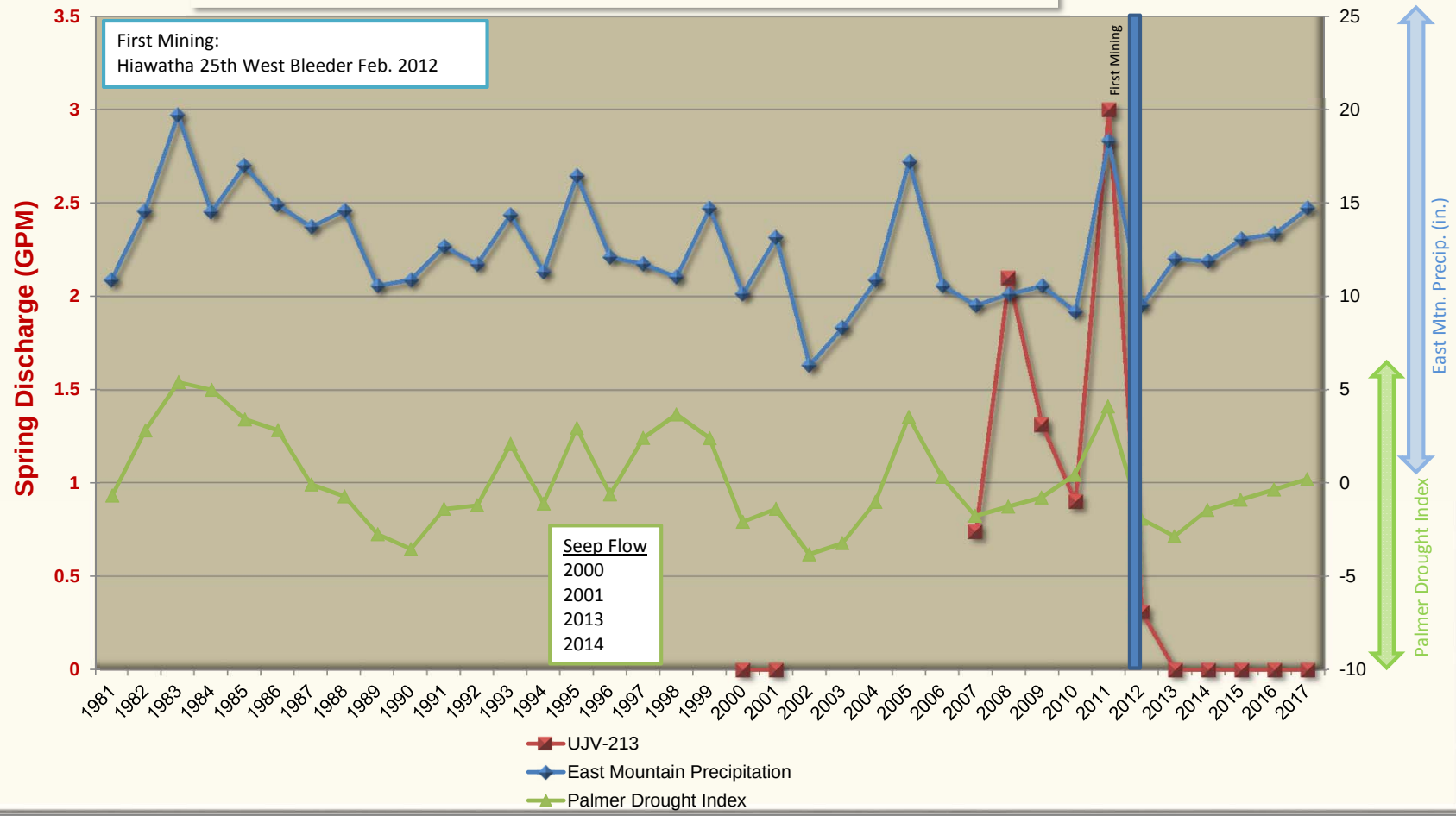


Non-functioning drainage diversion, un-named drainage near UJV-213

Non-functioning trough below UJV-213, source from un-named drainage

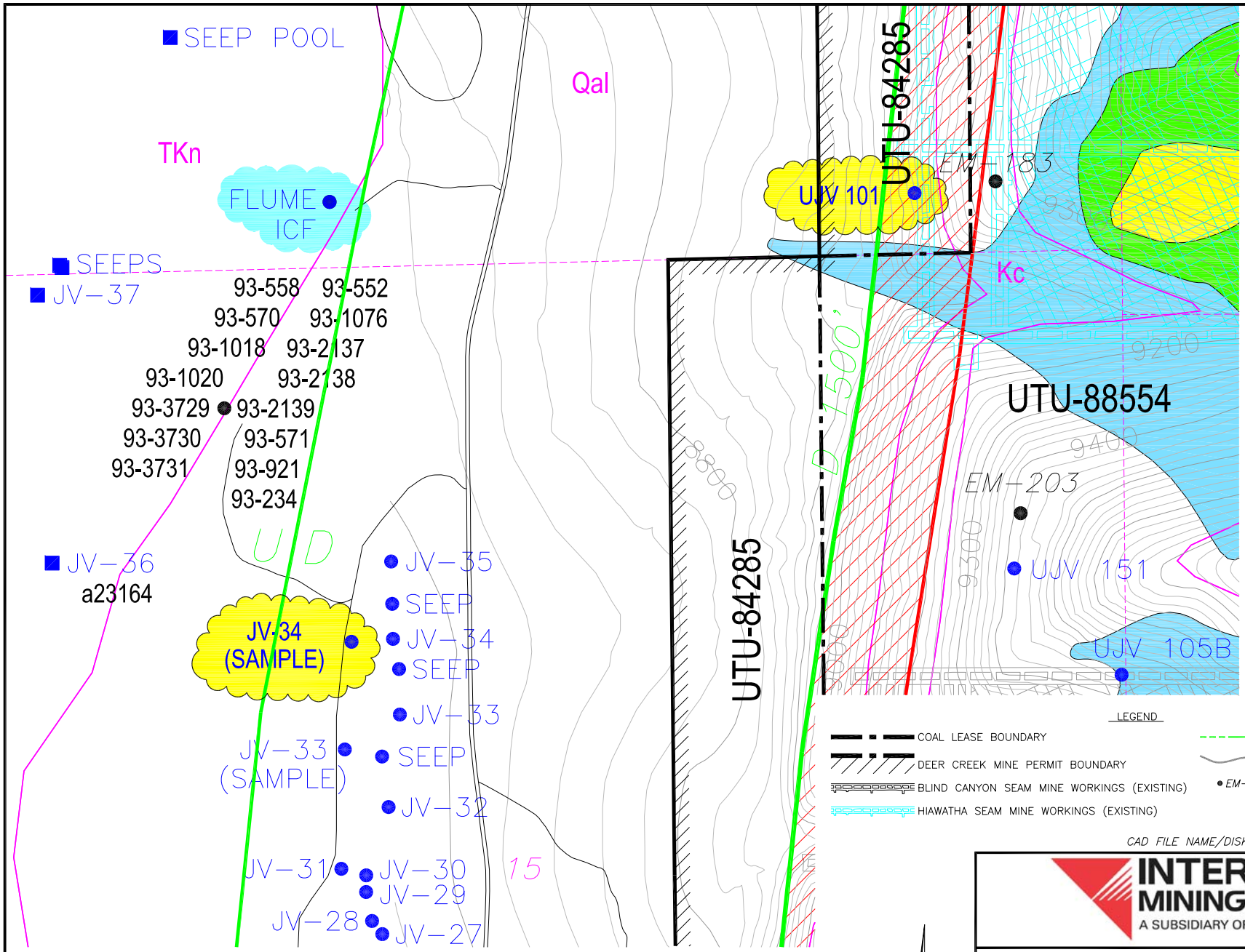
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-213 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-213
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb. 2012
Date of Second Mining: Not undermined
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20120131				Post-Mining Data: 20120201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	241	220	227.888	9	220	217	218.5	2	BICARBONATE
CALCIUM	71.32	62.92	68.4644	9	67.09	62.63	64.86	2	CALCIUM
CARBONATE	0	0	0	7	0	0	0	2	CARBONATE
CHLORIDE	4	3	3.66666	9	4	4	4	2	CHLORIDE
CONDUCTIVITY	583	478	511.222	9	489	467	478	2	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	3	0.21	1.12777	9	0.31	0.16	0.235	2	FLOW
HARDNESS	275	240	263.777	9	262	241	251.5	2	HARDNESS
TOTAL IRON	0.44	0	0.19333	9	0.97	0.15	0.56	2	TOTAL IRON
DISSOLVED IRON	0	0	0	7	0	0	0	2	DISSOLVED IRON
MAGNESIUM	23.81	20.15	22.5577	9	23.01	20.47	21.74	2	MAGNESIUM
DISSOLVED MANGANESE	0.011	0	3.44444	9	0.031	0.019	0.025	2	DISSOLVED MANGANESE
MANGANESE	0	0	0	7	0.003	0	0.0015	2	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.17	7.68	7.90888	9	8.18	7.64	7.91	2	PH
POTASSIUM	1.52	0.97	1.15555	9	1.3	1.11	1.205	2	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8.94	5.78	7.00222	9	5.85	5.77	5.81	2	SODIUM
SULFATE	40	33	36.5555	9	33	31	32	2	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	9.9	6.5	7.94444	9	10.3	9.5	9.9	2	TEMPERATURE
TOTAL DISSOLVED SOLIDS	320	284	298.222	9	277	273	275	2	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 2	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 2 OF 10	REV. ___

Location: Section 10, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-84285.

Lease Association: Spring UJV-101 is located within Federal Coal lease UTU-84285 adjacent to UTU-88554. The lease was originally acquired from Bureau of Land Management on November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. First mining occurred in vicinity of UJV-101 in the Hiawatha Seam, 23rd West Bleeder, in March 2011.

Subsidence: An area of minor subsidence occurs adjacent to spring UJV-101. Maximum subsidence in area 200' south of UJV-101 has stabilized at approximately 2 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2013. UJV-101 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-101. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1993 through 1995 by Genwal Resources and 2000 through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV101 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Flow from spring UJV-101 generally ranges from 0.0/seep to a maximum of < 4.0 gpm. Spring flow dissipates rapidly below spring source.

Geologic Mode of Occurrence for spring UJV-101:

- Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Castle Gate (refer to Geologic Occurrence sheet).
- Stratigraphic Position: Mid-formation.

Justification for removal from monitoring: UJV-101 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-101 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-101**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
261' N.	889' W.	SW	10	16S	6E	8960

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Castle Gate	None	None	Middle

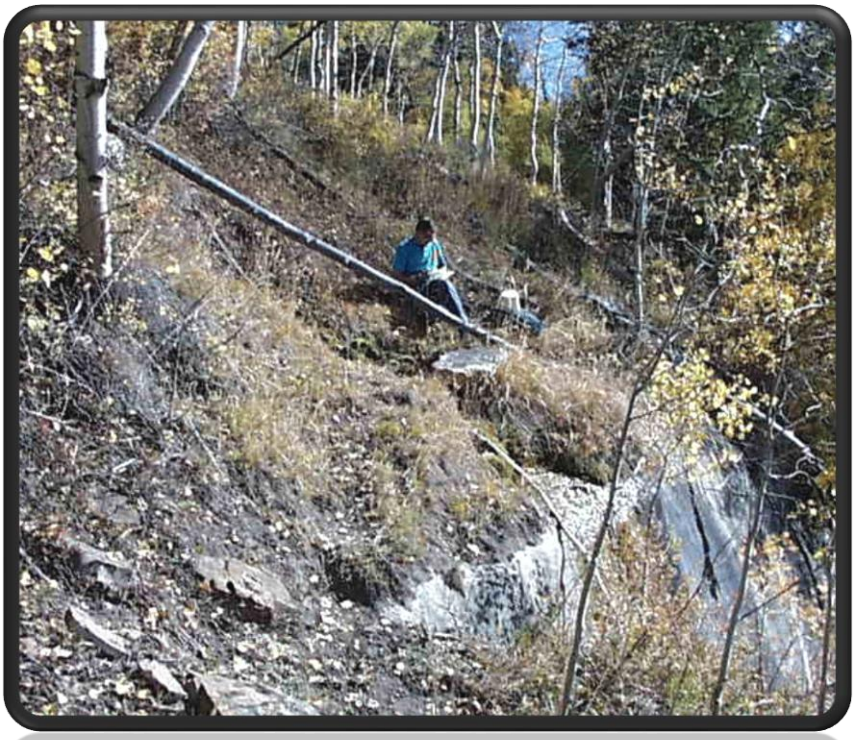
Location Comments: Spring located above small cliff (Joes Valley Fault) overlooking Joes Valley on west facing slope covered with aspens and mountain brush.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area

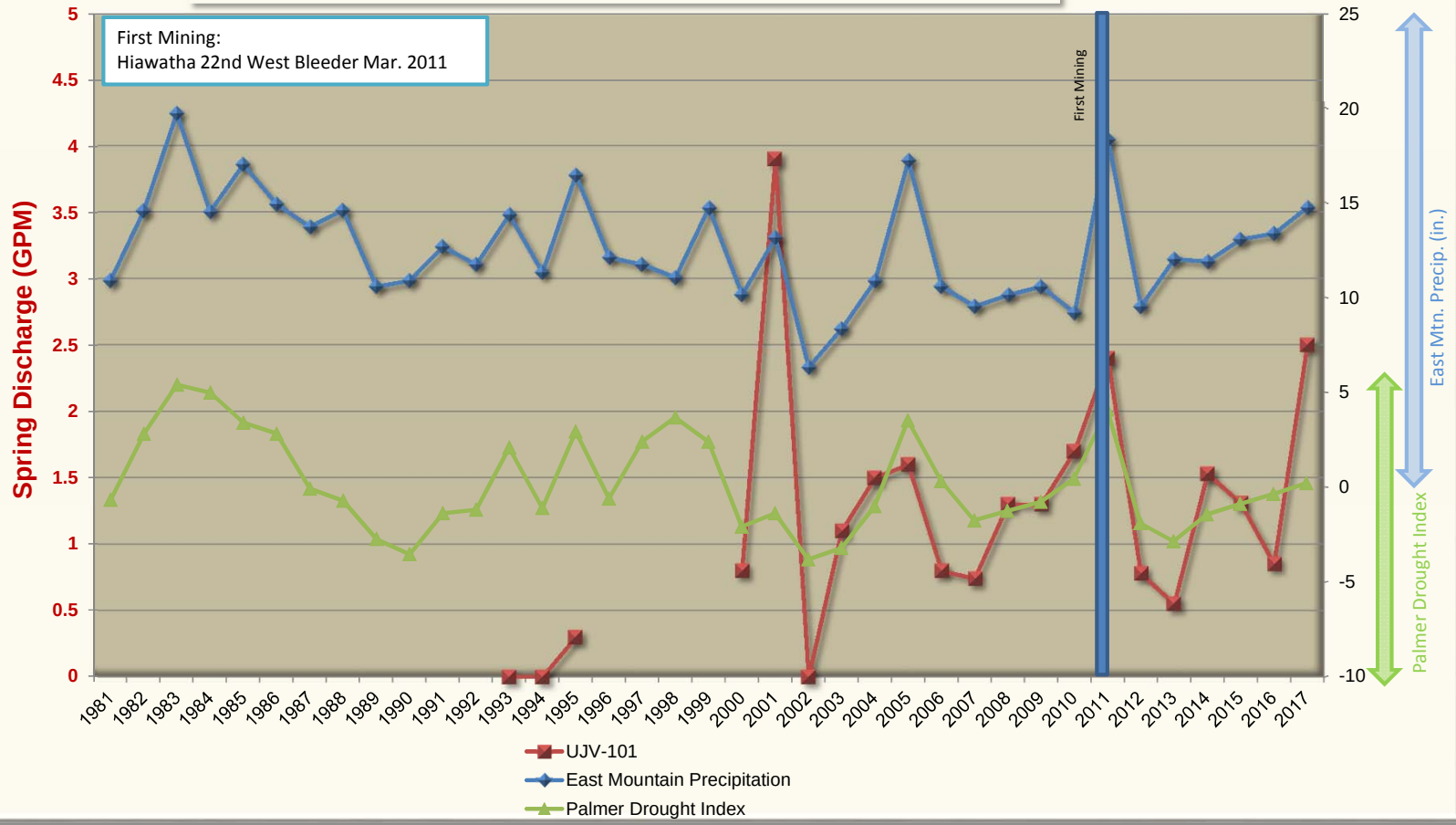
Geologic Occurrence of Spring:

Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.



EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-101 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-101
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Mar-11
Date of Second Mining: Not undermined
Location of Nearest Mining: NA
Date of Nearest Mining: NA

	Pre-Mining Data: 20000101 THROUGH 20110228				Post-Mining Data: 20110228 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	295	212	239.5625	16	249	216	230.428	14	BICARBONATE
CALCIUM	74.22	64.9	70.0531	16	81.82	66.61	72.7107	14	CALCIUM
CARBONATE	0	0	0	6	0	0	0	14	CARBONATE
CHLORIDE	6	4	4.525	16	4	3	3.92857	14	CHLORIDE
CONDUCTIVITY	690	475	533.0625	16	570	494	537.571	14	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	1.69	0.2	1.049375	16	2.5	0.38	1.04285	14	FLOW
HARDNESS	286	253	269.9375	16	317	257	285.571	14	HARDNESS
TOTAL IRON	0.88	0	0.28788	9	1.98	0	0.3	14	TOTAL IRON
DISSOLVED IRON	0	0	0	6	0	0	0	14	DISSOLVED IRON
MAGNESIUM	24.68	21.8	23.0556	16	27.32	22.04	25.2585	14	MAGNESIUM
DISSOLVED MANGANESE	0.019	0	6.11111	9	0.088	0	1.25714	14	DISSOLVED MANGANESE
MANGANESE	0.002	0	2.85714	7	0	0	0	14	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.38	7.5	7.9275	16	8.41	8.12	8.25142	14	PH
POTASSIUM	2	0.92	1.24875	16	1.82	1.17	1.37571	14	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	6.45	5.22	5.73625	16	6.66	5	6.085	14	SODIUM
SULFATE	51	27	39.34375	16	65	39	52.4285	14	SULFATE
SUSPENDED SOLIDS	293	293	293	1	0				SUSPENDED SOLIDS
TEMPERATURE	9.6	5.2	6.9125	16	10.6	4.1	7.38571	14	TEMPERATURE
TOTAL DISSOLVED SOLIDS	330	259	303.0625	16	365	289	325.142	14	TOTAL DISSOLVED SOLIDS

Location: Section 15, Township 16 South, Range 6 East, SLB&M. This site is located within the ½ mile offset of the Deer Creek mine permit boundary adjacent to Federal Coal leases UTU-84285 and UTU-88554.

Lease Association: Spring JV-34 is located adjacent to Federal Coal leases UTU-84285 and UTU-88554. The lease UTU-88554 was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Lease UTU-84285 was originally acquired from Bureau of Land Management on November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. No mining occurred in the vicinity of JV-34.

Subsidence: No subsidence has been detected near JV-34. For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring JV-34. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - JV-34 spring located in Joes Valley alluvial basin near the 345 kV powerline. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-34 varies dramatically based on winter pack on spring runoff, generally ranges from 0.0/seep to a maximum of 80.0 gpm.

Geologic Mode of Occurrence for spring JV-34:

- Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.
- Geologic Formation: Joes Valley Alluvium (refer to Geologic Occurrence sheet).

- Stratigraphic Position: NA.

Justification for removal from monitoring: UJV-34 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-34 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **JV-34**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1565' S.	1860' E	NW	15	16S	6E	8692

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Joes Valley Alluvium	None	None	NA

Location Comments: Spring with multiple sources located near power line. Measured flow at confluence of several sources near road. Brass tag attached to brush.

Probable Recharge Area: Areas of higher elevation located to the north and east.

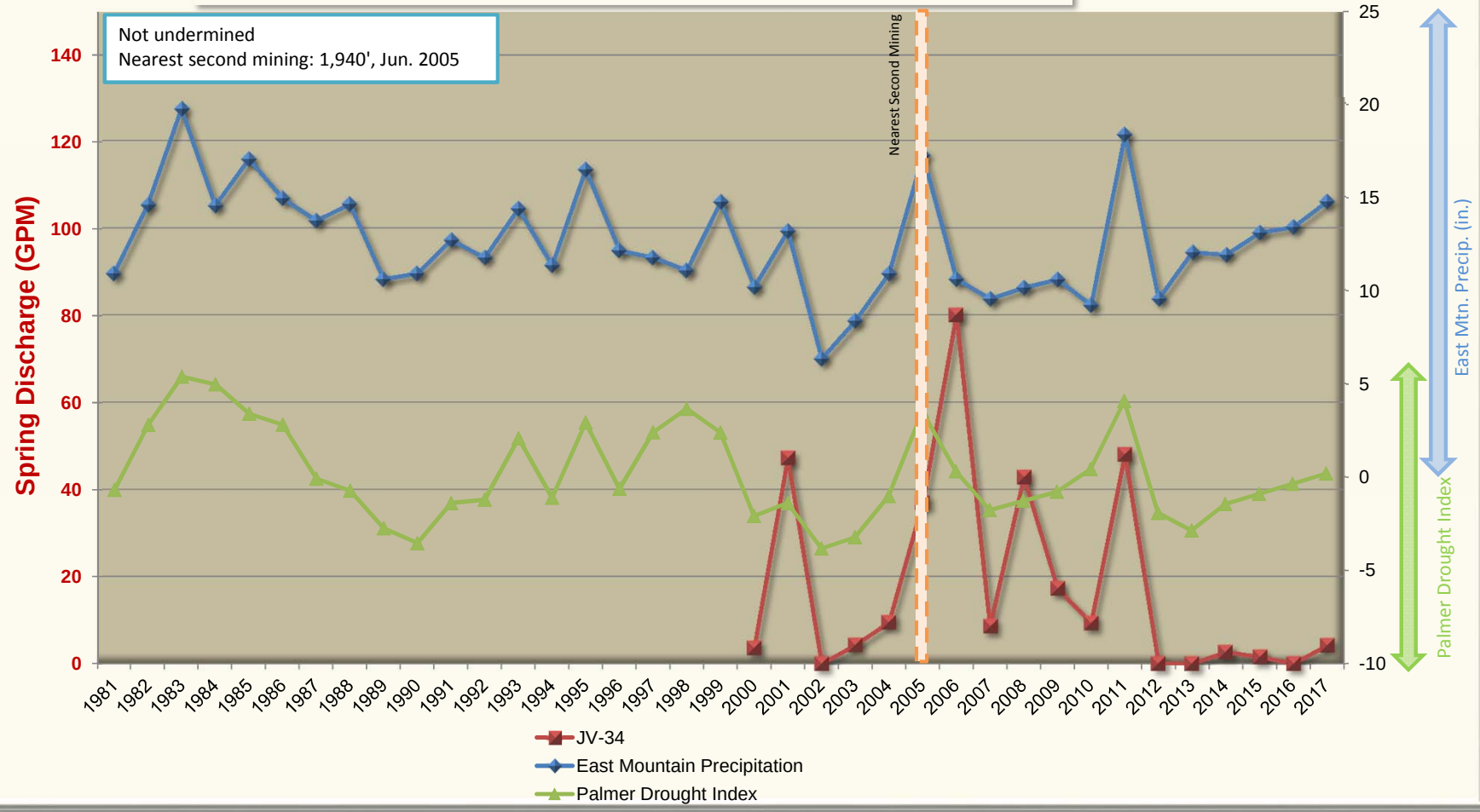
Relationship to Adjacent Springs: This spring occurs in the same manner as numerous springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

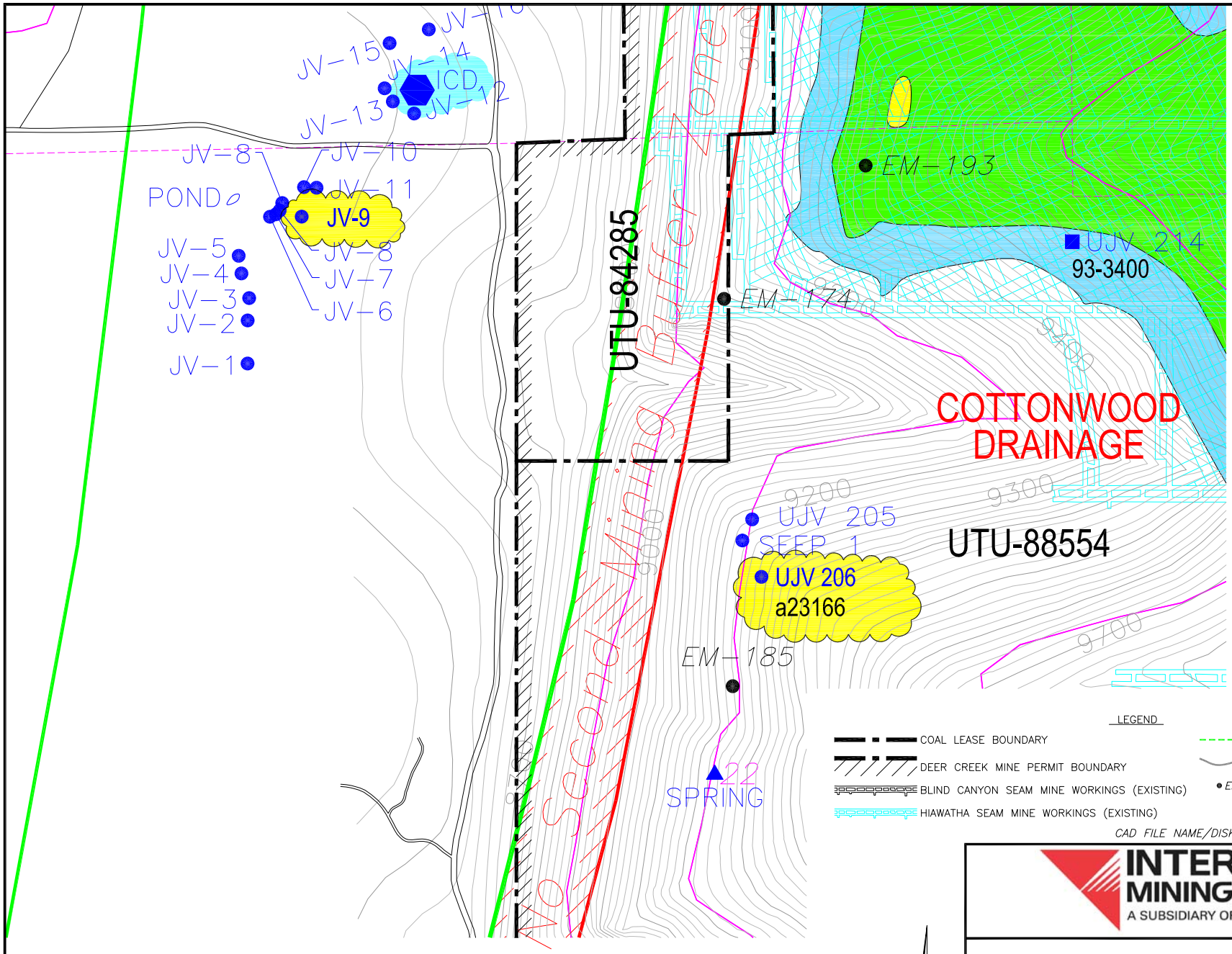
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: JV-34 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: JV-34
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 2670'
Date of Nearest Mining: Aug-08

	Pre-Mining Data: 20000101 THROUGH 20080801				Post-Mining Data: 20080831 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	400	282	323.285	14	351	278	310.538	13	BICARBONATE
CALCIUM	96.8	77	83.2414	14	101.05	73.39	87.3284	13	CALCIUM
CARBONATE	0	0	0	1	0	0	0	13	CARBONATE
CHLORIDE	5	1	3.02142	14	6	2	2.92307	13	CHLORIDE
CONDUCTIVITY	706	539	602.5	14	708	533	608.769	13	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	80	2.3	19.5071	14	48	0.23	8.82461	13	FLOW
HARDNESS	350	281	308.928	14	366	276	324.307	13	HARDNESS
TOTAL IRON	2.45	0.2	0.59161	13	1.36	0	0.23384	13	TOTAL IRON
DISSOLVED IRON	0.008	0	0.004	2	0	0	0	13	DISSOLVED IRON
MAGNESIUM	28.6	21	24.5685	14	28.54	22.51	25.83	13	MAGNESIUM
DISSOLVED MANGANESE	0.131	0.005	0.0495	10	0.074	0.004	2.56923	13	DISSOLVED MANGANESE
MANGANESE	0.052	0.003	0.0128	10	0.038	0	9.30769	13	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.26	7.84	8.06428	14	8.36	7.9	8.11615	13	PH
POTASSIUM	3.5	0.26	1.38615	13	2.1	0.4	1.13384	13	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8.75	6	7.41	14	8.78	6.65	7.88461	13	SODIUM
SULFATE	30	8	17.15	14	51	10	21.3846	13	SULFATE
SUSPENDED SOLIDS	304	304	304	1	0				SUSPENDED SOLIDS
TEMPERATURE	20.3	5	8.68571	14	20	3.8	11.3153	13	TEMPERATURE
TOTAL DISSOLVED SOLIDS	377	255	325.071	14	403	310	354.846	13	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED
- OUTCROP
- EM-169 DRILL HOLE

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 3	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 3 OF 10	REV. ___

Location: Section 22, Township 16 South, Range 6 East, SLB&M. This site is located within the ½ mile offset of the Deer Creek mine permit boundary adjacent to Federal Coal leases UTU-84285 and UTU-88554.

Lease Association: Spring JV-9 is located adjacent to Federal Coal leases UTU-84285 and UTU-88554. Lease UTU-88554 was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Lease UTU-84285 was originally acquired from Bureau of Land Management in November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. No mining occurred in the vicinity of JV-9.

Subsidence: No subsidence has been detected near JV-9. For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring JV-9. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - JV-9 spring is located in Joes Valley alluvial basin south of the Joes Valley cutoff road. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-9 varies dramatically based on winter pack on spring runoff, and generally ranges from 0.0/seep to a maximum of 3.0 gpm.

Geologic Mode of Occurrence for spring JV-9:

- Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

- Geologic Formation: Joes Valley Alluvium (refer to Geologic Occurrence sheet).
- Stratigraphic Position: NA.

Justification for removal from monitoring: JV-9 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-9 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **JV-9**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
299' S.	1836' E	NW	22	16S	6E	8618

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Joes Valley Alluvium	None	None	NA

Location Comments: Spring (boiling up from small hole) located in Joes Valley south of FDR 040.

Probable Recharge Area: Areas of higher elevation located to the north and east.

Relationship to Adjacent Springs: This spring occurs in the same manner as numerous springs in the immediate vicinity.

Geologic Occurrence of Spring:

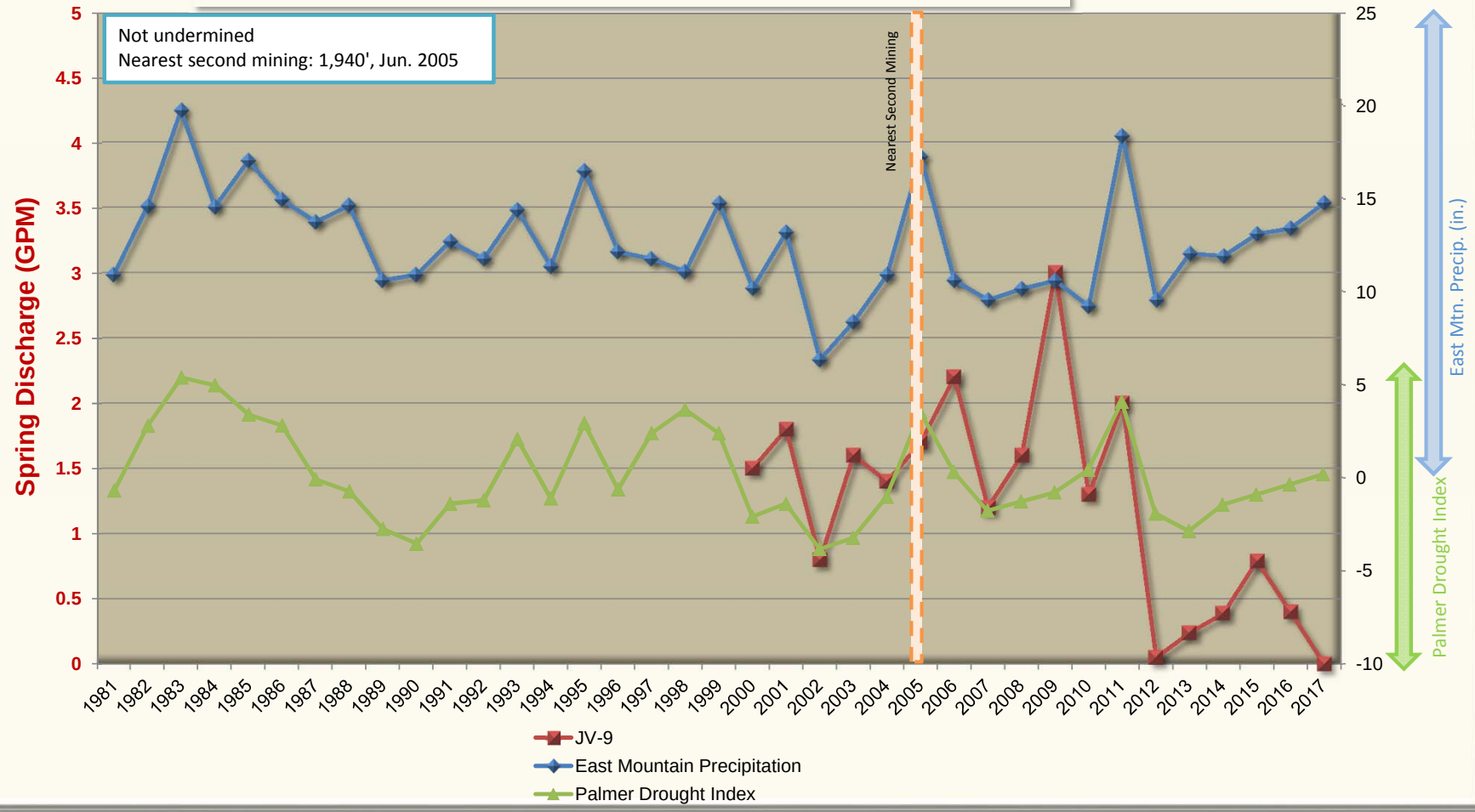
Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

Field reconnaissance October 19, 2000

Field reconnaissance May 9, 2018

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: JV-9 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: JV-9
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1940'
Date of Nearest Mining: Jun-05

	Pre-Mining Data: 20000101 THROUGH 20050601				Post-Mining Data: 20050630 THROUGH 201712311				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	395	318	371.444	9	330	293	310.3	20	BICARBONATE
CALCIUM	89.7	80	86.0333	9	91.7	81.62	87.961	20	CALCIUM
CARBONATE	0				0	0	0	14	CARBONATE
CHLORIDE	5	4	4.36666	9	9	4	4.85	20	CHLORIDE
CONDUCTIVITY	750	639	676.333	9	762	516	677.95	20	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	1.8	0.8	1.29222	9	3	0.24	1.206	20	FLOW
HARDNESS	371	262	345.888	9	377	344	362.45	20	HARDNESS
TOTAL IRON	0.298	0.298	0.298	1	0.51	0	9.88235	17	TOTAL IRON
DISSOLVED IRON	0				0	0	0	14	DISSOLVED IRON
MAGNESIUM	35.8	33	34.5111	9	36.7	31.88	34.671	20	MAGNESIUM
DISSOLVED MANGANESE	0.014	0.002	0.008	2	0.054	0	0.01	18	DISSOLVED MANGANESE
MANGANESE	0.005	0.005	0.005	1	0.02	0	4.61111	18	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	7.64	7.22	7.35888	9	8.06	6.88	7.4085	20	PH
POTASSIUM	1.5	1	1.17888	9	2.66	1.22	1.4335	20	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8	6.83	7.14222	9	8.42	6.71	7.4375	20	SODIUM
SULFATE	59	48	52.0888	9	58	38	50.05	20	SULFATE
SUSPENDED SOLIDS	387	387	387	1	0				SUSPENDED SOLIDS
TEMPERATURE	6.9	4.9	6.13333	9	12.3	5.6	8.095	20	TEMPERATURE
TOTAL DISSOLVED SOLIDS	404	357	380	9	411	241	378	20	TOTAL DISSOLVED SOLIDS

Location: Section 22, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring UJV-206 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred near spring UJV-206.

Subsidence: No subsidence has been detected near UJV-206. The 2017 Annual Subsidence Report reported that the subsidence north of the spring has been stable since at least 2009. UJV-206 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-206. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1993 through 1995 by Genwal Resources and by PacifiCorp from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV-206 is located along power line corridor on a west facing slope overlooking Joes Valley surrounded by aspens and conifers. Spring drains to a trough adjacent to the spring. In 2003, Division of Water Rights approved a Change Application (a23166) was approved allowing the right to develop UJV-206 for use in recreational cabin and stock watering from a trough in the vicinity of the cabin.

Geologic Mode of Occurrence for spring UJV-206:

- Water flowing down through fractures in the lower section of the Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Upper Price River (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 80' above base.

Justification for removal from monitoring: UJV-206 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-206 be removed from the monitoring program.

EAST MOUNTAIN
MILL FORK SPRING & SEEP SURVEY
GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-206**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
3567' N.	3604' W	SE	22	16S	6E	9200

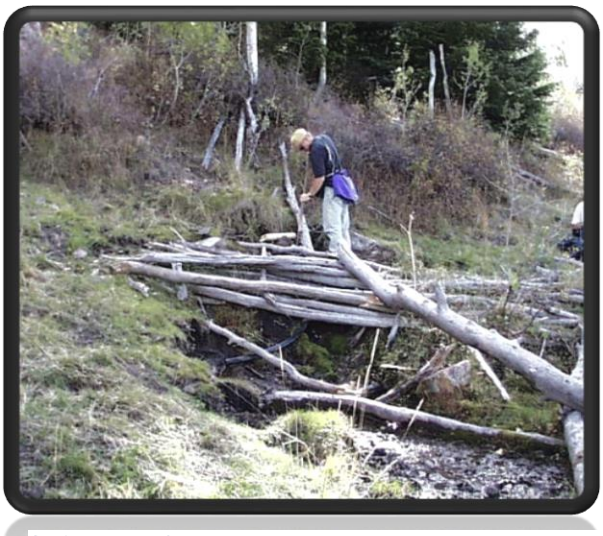
Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Upper Price River	Developed With Vertical CMP, Diverted To Trough (not functioning)	93-3400 A23166	80' above base

Location Comments: Spring located along power line corridor on west facing slope overlooking Joes Valley surrounded with aspens and conifers.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring occurs in the same manner as UJV-204 and UJV-205.

Geologic Occurrence of Spring: Water flowing down through fractures in the lower section of the Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

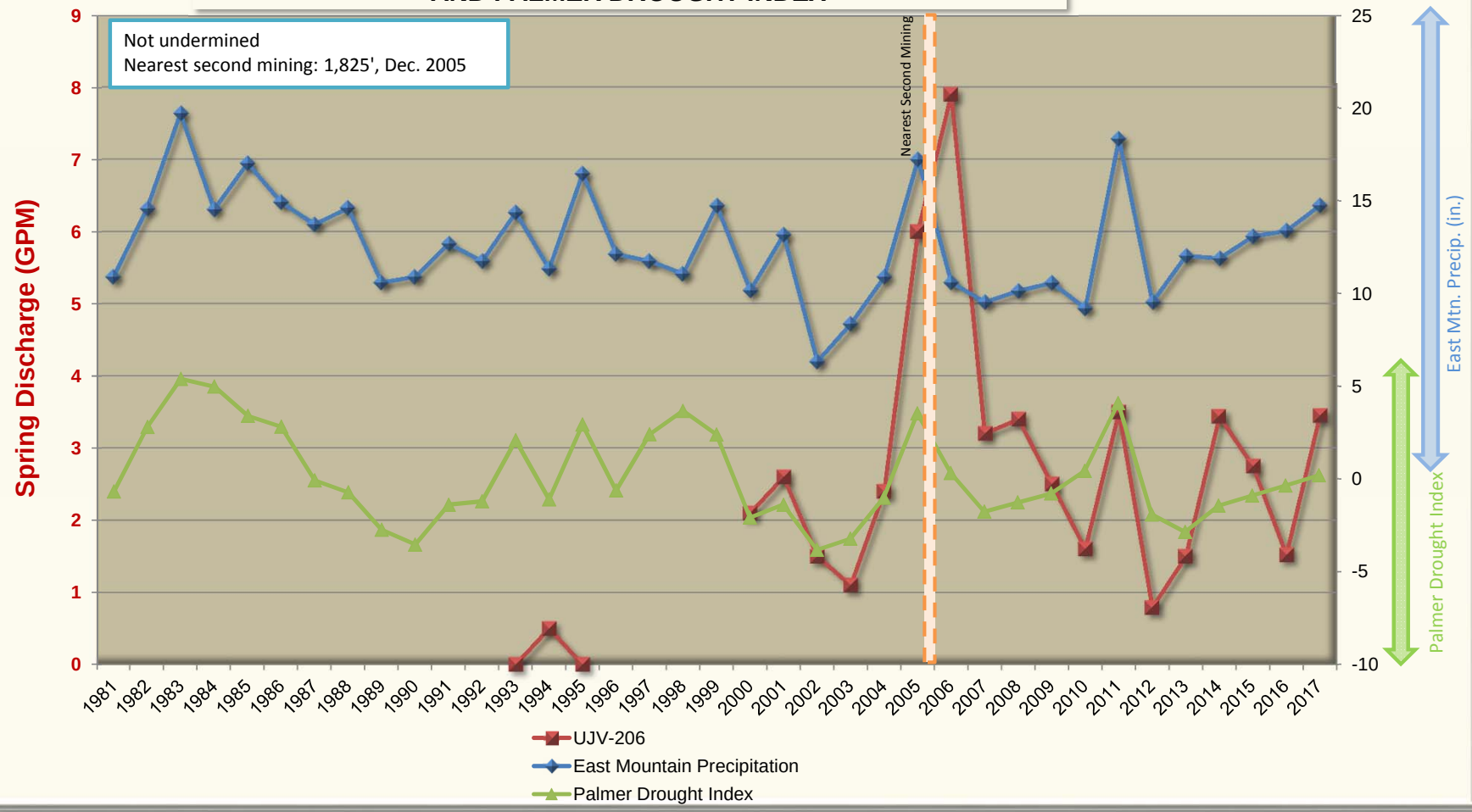


Spring UJV-206

UJV-206 Trough

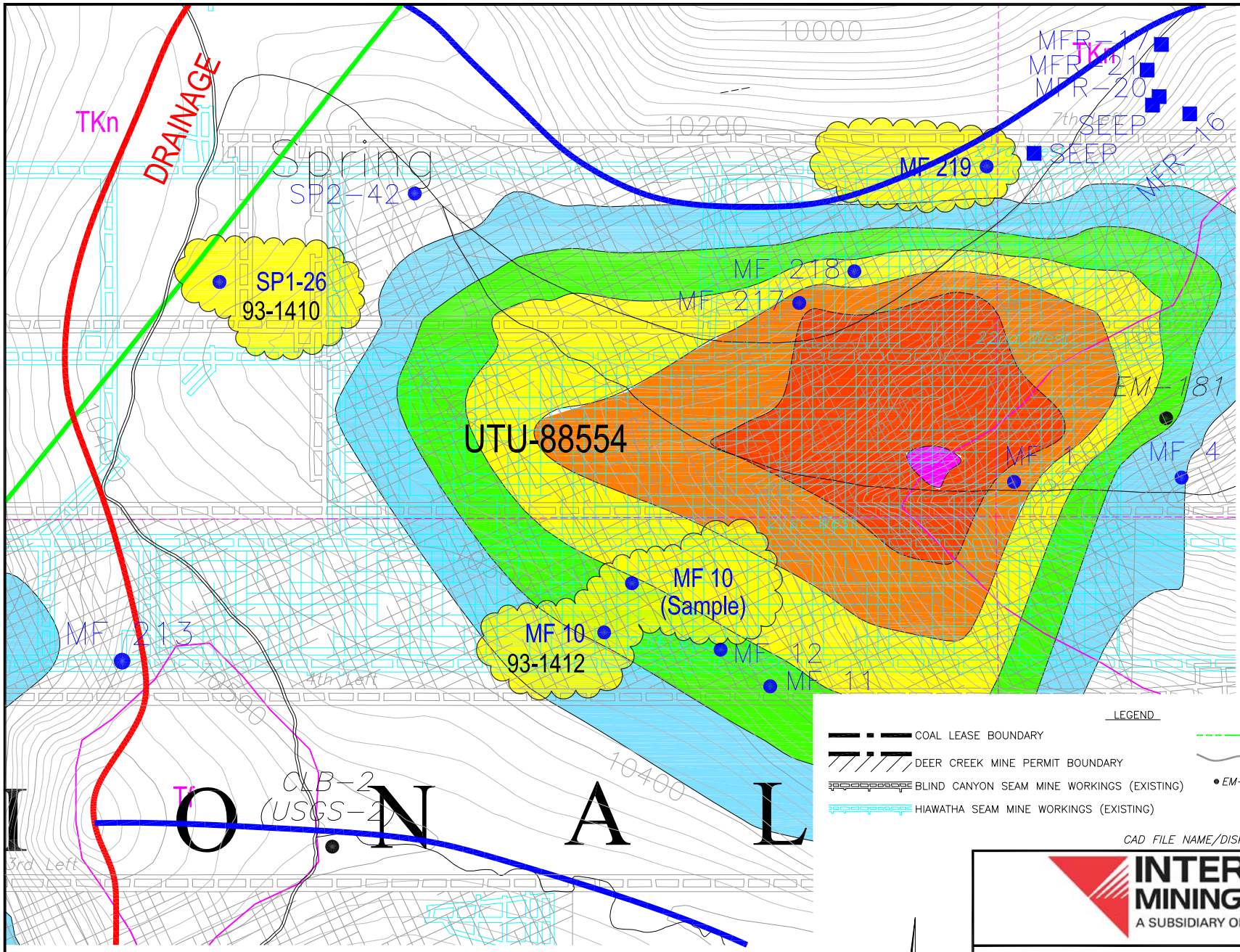
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-206 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-206
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1825'
Date of Nearest Mining: Dec. 2005

	Pre-Mining Data: 20000101 THROUGH 20051130				Post-Mining Data: 20051201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	294	239	270.545	11	259	221	235.086	23	BICARBONATE
CALCIUM	69.7	61	66.5727	11	76.27	61.98	67.7221	23	CALCIUM
CARBONATE	0				0	0	0	20	CARBONATE
CHLORIDE	6	4	4.5	11	6	4	4.7826	23	CHLORIDE
CONDUCTIVITY	615	490	521.727	11	672	438	521.26	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	6	0.5	2.33181	11	8.5	0.38	2.58608	23	FLOW
HARDNESS	271	243	262	11	303	243	267.086	23	HARDNESS
TOTAL IRON	0.11	0.1	0.105	2	0.06	0	2.85714	21	TOTAL IRON
DISSOLVED IRON	0				0	0	0	20	DISSOLVED IRON
MAGNESIUM	24.9	22	23.2636	11	27.45	21.31	23.796	23	MAGNESIUM
DISSOLVED MANGANESE	0				0.006	0	0.0003	20	DISSOLVED MANGANESE
MANGANESE	0				0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.33	7.79	8.04363	11	8.1	7.35	7.88956	23	PH
POTASSIUM	2	1	1.49	11	2.03	1.42	1.68434	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8	5.83	6.37909	11	6.73	5.16	6.29652	23	SODIUM
SULFATE	42	23	31.809	11	46	21	33.6956	23	SULFATE
SUSPENDED SOLIDS	290	290	290	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.4	4.7	5	11	8.2	4.6	6.26956	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	309	257	288	11	328	246	297.217	23	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 4	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 4 OF 10	REV. ___

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-219 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First and second mining occurred in vicinity of MF-219 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, second mining 7th Left longwall panel April 2010 and Hiawatha, first mining 23rd West gateroad, on February 2011).

Subsidence: No subsidence has been detected near MF-219. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MF-219 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-219. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-219 is a spring/seep located along the reclaimed access road to Mill Fork Ridge originally developed as a fire access road and later used to access coal exploration sites for ARCO Coal. Access road reclaimed in the 1980's. MF-219 is located on a south facing slope surrounded with conifers. Flow from spring MF-219 generally ranges from 0.0/seep to a maximum of <15.0 gpm.

Geologic Mode of Occurrence for spring MF-219:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 260' below top.

Justification for removal from monitoring: MF-219 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-219 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-219**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1508' N.	47' W.	SE	11	16S	6E	10220

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	260' below top

Location Comments: Spring located above reclaimed road on south facing slope covered with conifers. Seep located between MF-218 and MF-219.

Probable Recharge Area: Areas of higher elevation located to the northwest.

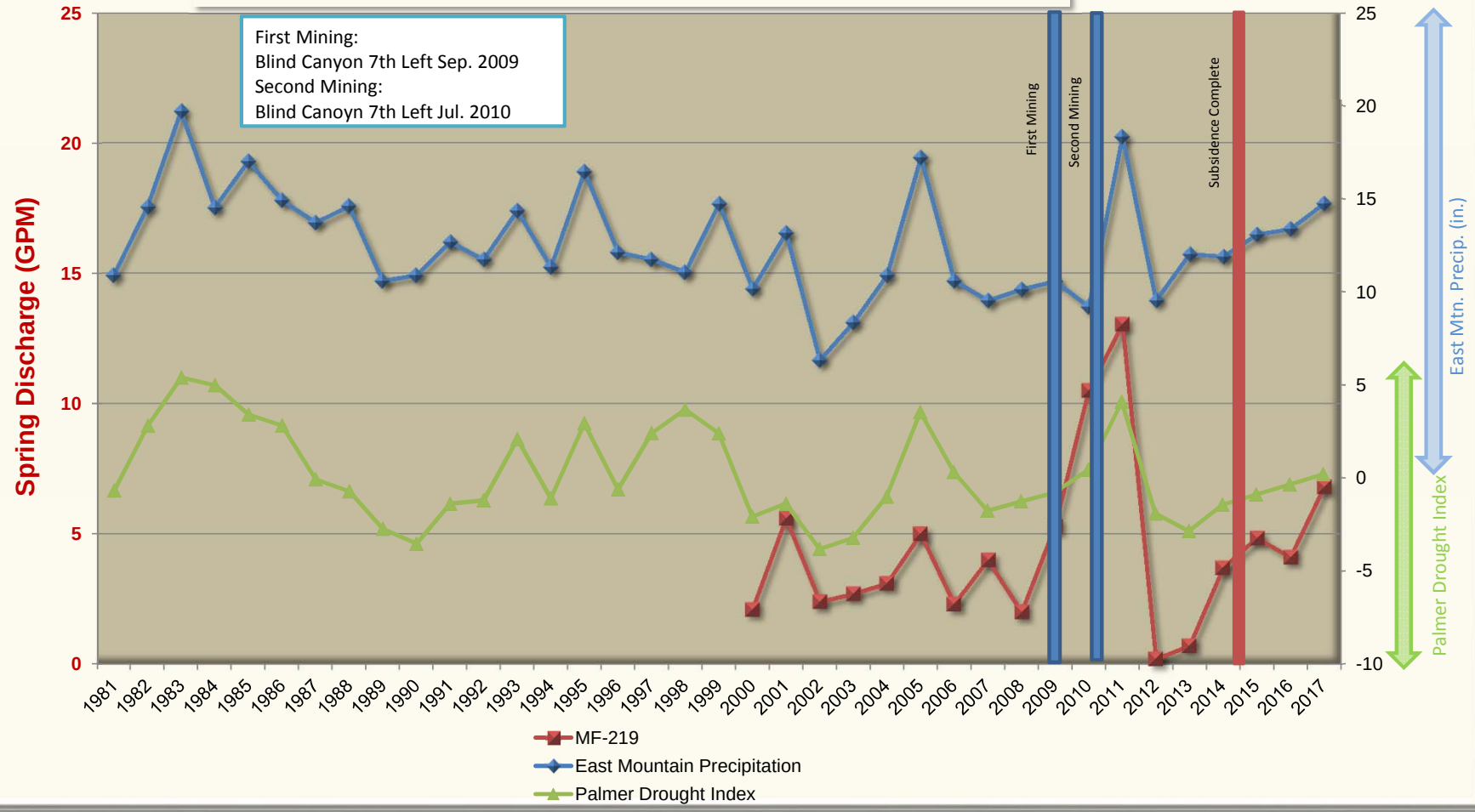
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-217 and MF-218.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-219 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-219
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb-11 Hiawatha 23rd West
Date of Second Mining: Apr-10 Blind Canyon 7th Left
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20110201 THROUGH 201712311				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	292	210	240.833	18	258	207	225.357	14	BICARBONATE
CALCIUM	70.7	59	66.1916	18	75.08	55.59	63.0285	14	CALCIUM
CARBONATE	0	0	0	4	0	0	0	14	CARBONATE
CHLORIDE	3	1	1.98333	18	3	1	1.85714	14	CHLORIDE
CONDUCTIVITY	557	417	500.611	18	574	410	479.714	14	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	5.5	2	3.24277	18	13.04	0.09	4.04	14	FLOW
HARDNESS	285	224	261.666	18	320	239	262.571	14	HARDNESS
TOTAL IRON	1.04	0.06	0.285	12	0.09	0	0.01	14	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	14	DISSOLVED IRON
MAGNESIUM	26.4	16.4	23.4016	18	32.29	22.14	25.5328	14	MAGNESIUM
DISSOLVED MANGANESE	0.134	0.002	1.94166	12	0.009	0	2.64285	14	DISSOLVED MANGANESE
MANGANESE	0.04	0	8.22222	9	0.004	0	5.71428	14	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.15	7.45	7.83888	18	8.52	7.82	8.11	14	PH
POTASSIUM	1.6	1	1.17352	17	2.52	1.34	1.69357	14	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.7	2.40333	18	3.01	1.99	2.44071	14	SODIUM
SULFATE	36	8	27.65	18	65	19	32.5	14	SULFATE
SUSPENDED SOLIDS	268	268	268	1	0				SUSPENDED SOLIDS
TEMPERATURE	8.7	2	5.41666	18	48.4	2.9	11.9928	14	TEMPERATURE
TOTAL DISSOLVED SOLIDS	331	205	272.555	18	322	204	273.714	14	TOTAL DISSOLVED SOLIDS

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring SPI-26 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of SPI-26 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, 7th Left longwall panel bleeder June 2009 and Hiawatha, 23rd West inter-panel barrier, in November 2010).

Subsidence: No subsidence has been detected near SPI-26. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. SPI-26 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring SPI-26. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - SPI-26 is a spring located near the main Mill Fork ridge road. SPI-26 is located on east facing slope surrounded with conifers. Site crudely developed with 1" PVC diverting flow to old steel bath tub. Flow from spring SPI-26 generally ranges from ~ 2 gpm to a maximum of 55.0 gpm.

Geologic Mode of Occurrence for spring SPI-26:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 260' below top.

Justification for removal from monitoring: SPI-26 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site SPI-26 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **SP1-26**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1041' N.	3349' W.	SE	11	16S	6E	10340

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	1" PVC Pipe Feeds Old Bath Tub	93-1410	170' below top

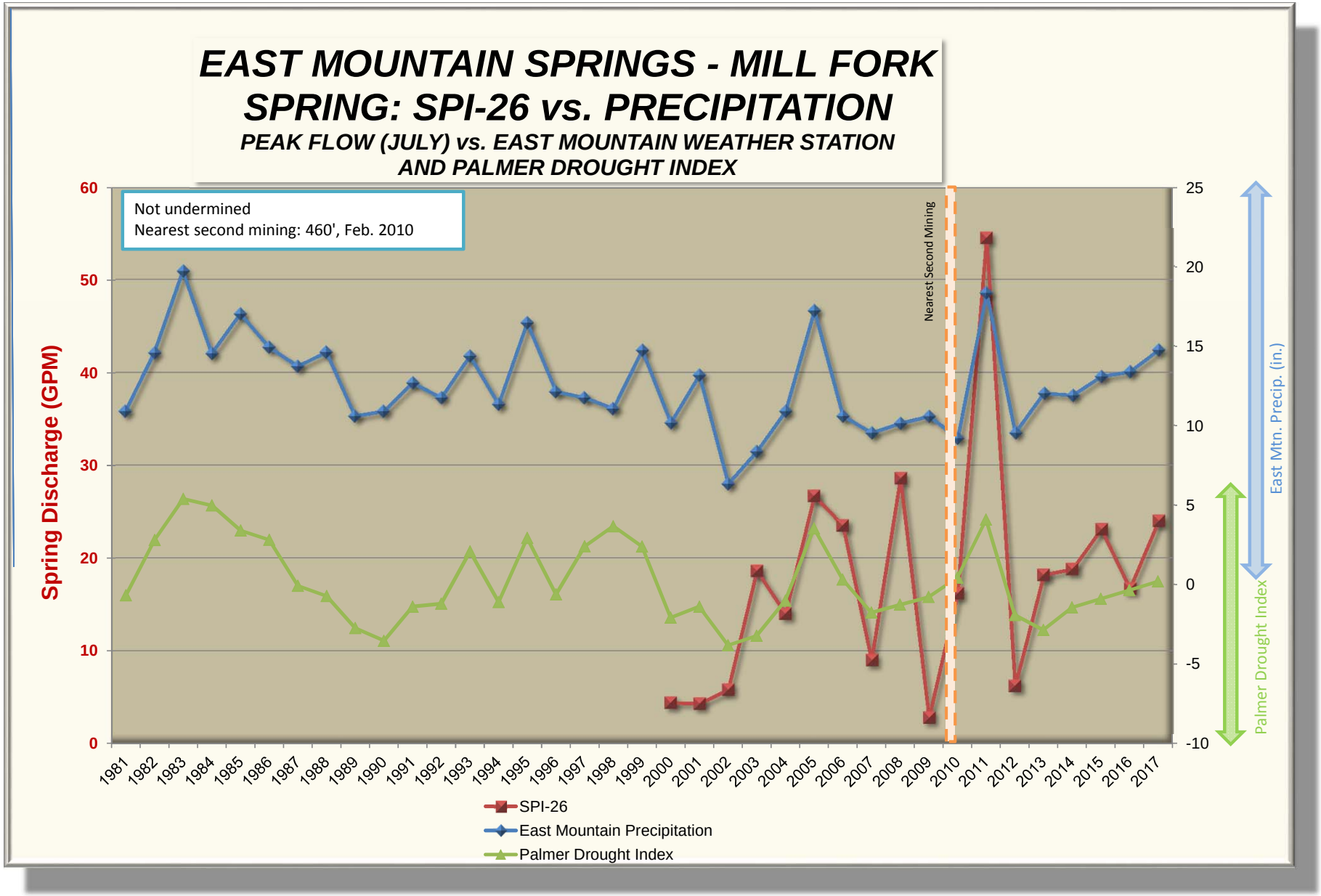
Location Comments: Spring near main reclaimed road on east facing slope covered with conifers. Flow measured below multiple sources.

Probable Recharge Area: Areas of higher elevation located to the west (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as SP2-42.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.


EAST MOUNTAIN SPRINGS - MILL FORK SPRING: SPI-26 vs. PRECIPITATION
PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX
Not undermined
Nearest second mining: 460', Feb. 2010
Nearest Second Mining
Spring Discharge (GPM)
East Mtn. Precip. (in.)
Palmer Drought Index
SPI-26
East Mountain Precipitation
Palmer Drought Index

East Mountain Spring: SP1-26
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 460'
Date of Nearest Mining: Feb. 2010

	Pre-Mining Data: 20000101 THROUGH 20100131				Post-Mining Data: 20100201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	253	185	213.21	19	226	184	203.588	17	BICARBONATE
CALCIUM	66	55	60.2105	19	72.65	49.56	59.9947	17	CALCIUM
CARBONATE	0	0	0	4	0	0	0	17	CARBONATE
CHLORIDE	4	1	2.57368	19	3	1	2.17647	17	CHLORIDE
CONDUCTIVITY	525	391	431.157	19	530	378	419.176	17	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	28.6	2.5	9.41666	18	54.5	0.7	12.85875	16	FLOW
HARDNESS	238	199	213.789	19	282	204	217.058	17	HARDNESS
TOTAL IRON	1.63	0	0.44571	7	0.31	0	0.11058	17	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0.04	0	2.35294	17	DISSOLVED IRON
MAGNESIUM	17.8	14	15.4068	19	24.68	14.09	16.3558	17	MAGNESIUM
DISSOLVED MANGANESE	0.07	0	1.95714	7	0.047	0	9.7647	17	DISSOLVED MANGANESE
MANGANESE	0.003	0	0.0018	5	0	0	0	17	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.4	7.44	7.79526	19	8.57	7.69	8.04117	17	PH
POTASSIUM	1.06	0.566	0.71464	14	1.51	0.51	0.79823	17	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.79	2.22	19	6.43	1.61	2.47235	17	SODIUM
SULFATE	10	5	7.06842	19	58	5	9.11764	17	SULFATE
SUSPENDED SOLIDS	214	214	214	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.5	3.8	4.67894	19	12.6	4.1	5.85882	17	TEMPERATURE
TOTAL DISSOLVED SOLIDS	273	206	233.052	19	336	217	239	17	TOTAL DISSOLVED SOLIDS

Location: Section 14, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-10 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred in vicinity of MF-10 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, 5th Left longwall panel, July 2009 and Hiawatha, 21st West panel, January 2011).

Subsidence: Approximately 4' of subsidence has been detected near MF-10. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2013.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-10. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-10 is a spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers. Flow from spring MF-10 generally ranges from ~ 5 gpm to a maximum of 60 gpm.

Geologic Mode of Occurrence for spring MF-10:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 200' below top.

Justification for removal from monitoring: MF-10 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-10 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-10**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
282' S.	1572' W.	NE	14	16S	6E	10250

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1412	200' below top

Location Comments: Spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers.

Probable Recharge Area: Areas of higher elevation located to the southwest.

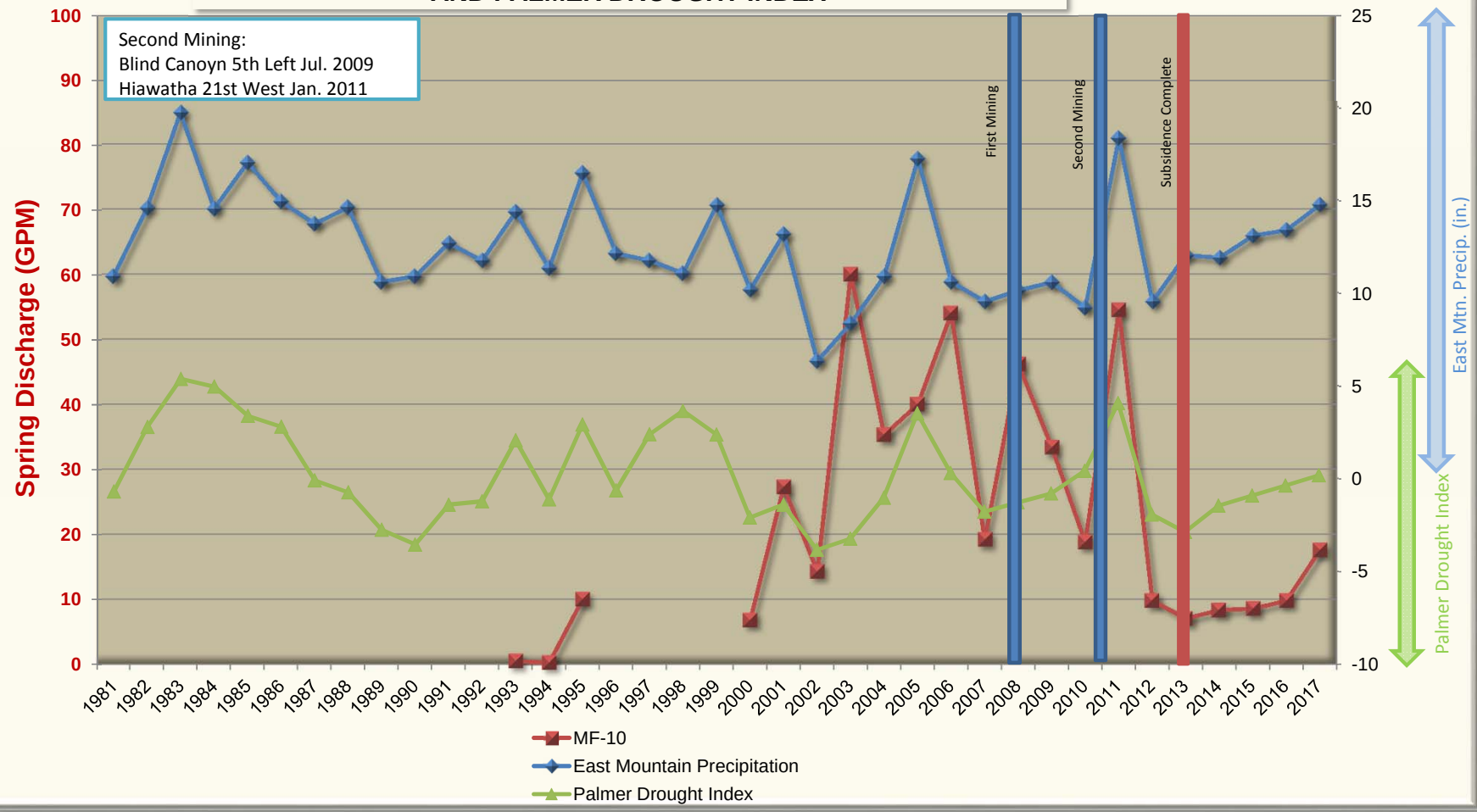
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

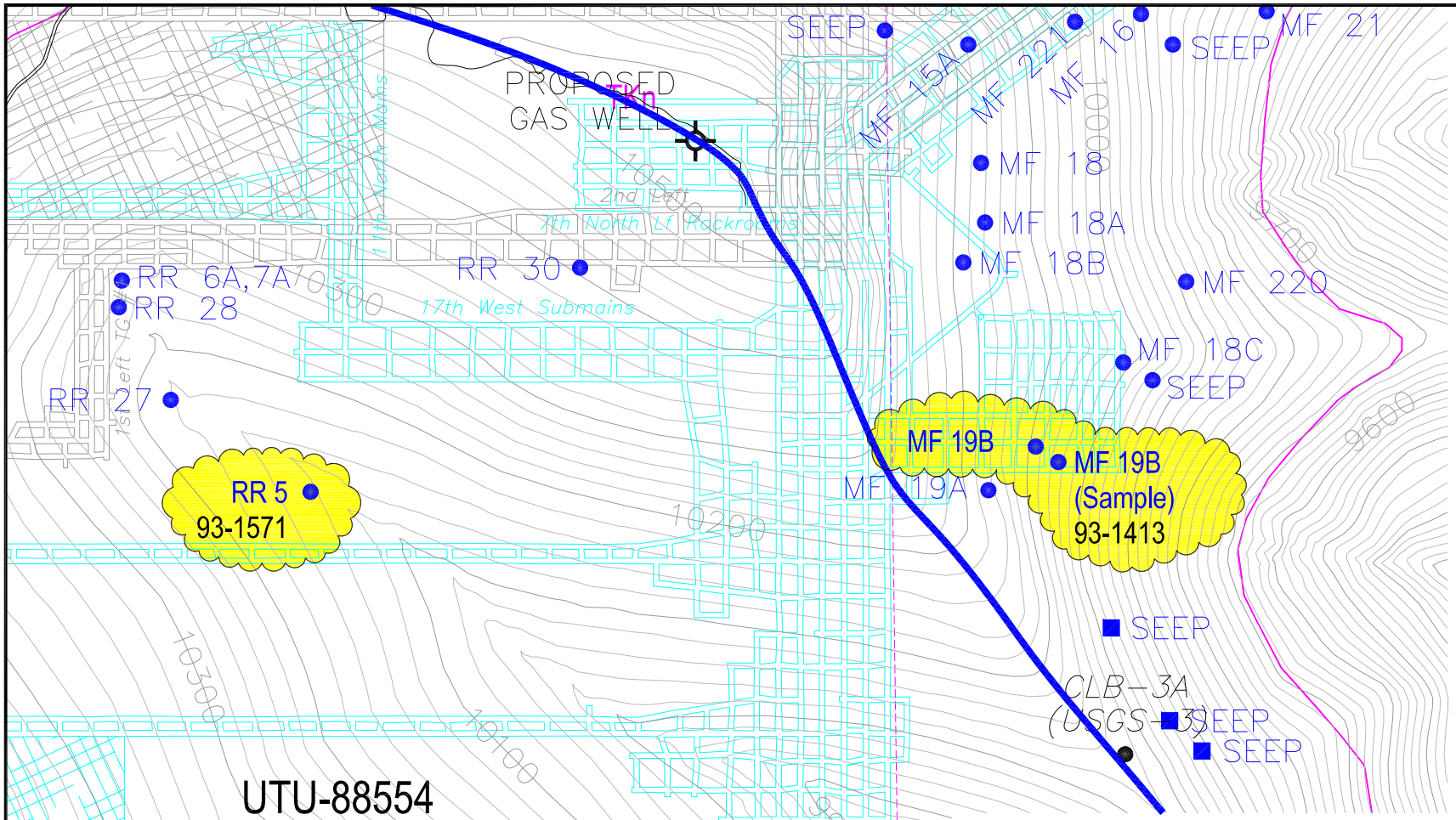
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-10 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-10
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Na
Date of Second Mining: Jul-09 Blind Canyon 5th Left
Jan-11 Hiawatha 21st West
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20090630				Post-Mining Data: 20090701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	256	181	217.882	17	228	178	193.941	17	BICARBONATE
CALCIUM	61.3	50	55.6664	17	60.36	46.7	51.0194	17	CALCIUM
CARBONATE	5	0	1.66666	3	10	0	0.58823	17	CARBONATE
CHLORIDE	4	1	1.7125	16	2	0	0.7647	17	CHLORIDE
CONDUCTIVITY	464	394	423.882	17	412	352	388.882	17	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	60	6.8	21.8647	17	54.5	0.41	10.6233	15	FLOW
HARDNESS	234	206	218.411	17	221	193	207.705	17	HARDNESS
TOTAL IRON	0	0	0	2	0	0	0	17	TOTAL IRON
DISSOLVED IRON	0	0	0	2	0	0	0	17	DISSOLVED IRON
MAGNESIUM	21	16.9	19.2717	17	22.17	16.43	19.5064	17	MAGNESIUM
DISSOLVED MANGANESE	0.006	0	0.002	3	0.01	0	8.23529	17	DISSOLVED MANGANESE
MANGANESE	0.006	0	0.002	3	0.01	0	5.88235	17	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.46	7.41	8.09764	17	8.46	7.76	8.18823	17	PH
POTASSIUM	2.18	0.49	0.9065	12	1.89	0.49	0.91	17	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.57	2.23235	17	2.66	1.64	2.13176	17	SODIUM
SULFATE	9	5	7.45294	17	11	4	6.94117	17	SULFATE
SUSPENDED SOLIDS	216	216	216	1	0				SUSPENDED SOLIDS
TEMPERATURE	23	1.6	4.15294	17	6.4	0.2	3.3	17	TEMPERATURE
TOTAL DISSOLVED SOLIDS	254	199	229.764	17	241	193	221.47	17	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 5	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 5 OF 10	REV. ___

Location: Section 13, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-19B is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of MF-19B in the Hiawatha seam, (7th North Sump, January 2006).

Subsidence: No subsidence has been detected near MF-19B. The 2017 Annual Subsidence Report reported that the subsidence north of the spring has been stable since at least 2013. MF-19B is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-19B. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-19B is located along natural bench directly below a massive sandstone channel on an east facing slope covered with conifers. Sampled approximately 100' below spring source. Flow from spring MF-19B generally ranges from 0 gpm to a maximum of 2.5 gpm.

Geologic Mode of Occurrence for spring MF-19B:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 400' below top.

Justification for removal from monitoring: MF-19B has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-19B be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-19B**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2136' N.	529' E.	SW	13	16S	6E	10111

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1413	400' below top

Location Comments: Spring located along natural bench directly below massive sandstone channel on east facing slope covered with conifers. Sampled approximately 100' below spring source.

Probable Recharge Area: Areas of higher elevation located to the west.

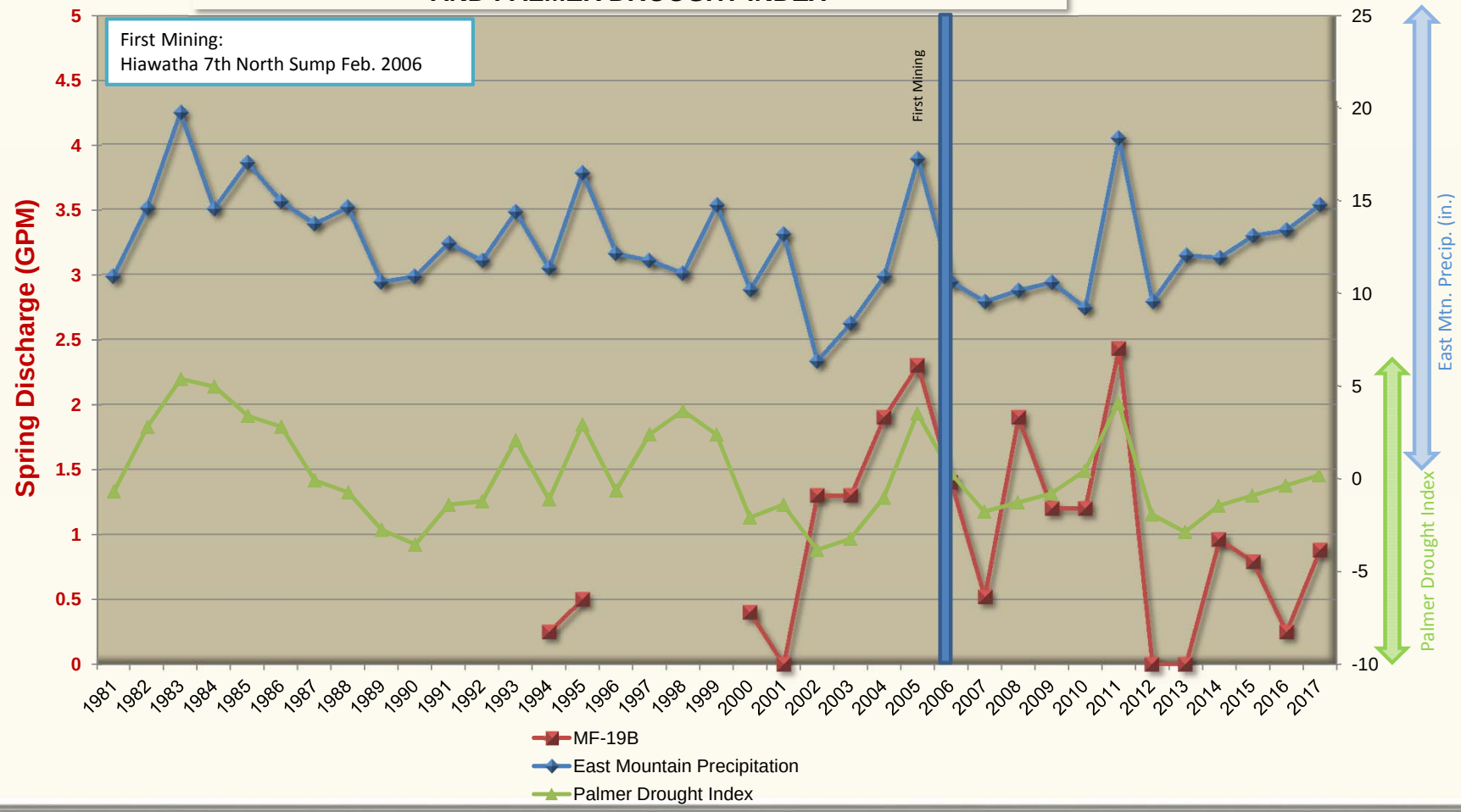
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-19B vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-19B
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb-10 Hiawatha 7th North Sump
Date of Second Mining: Not undermined
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20060131				Post-Mining Data: 20060201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	286	215	245.857	7	246	209	226.944	18	BICARBONATE
CALCIUM	67.3	58	64.7285	7	78.71	62.6	66.6505	18	CALCIUM
CARBONATE	0				19	0	2.86666	15	CARBONATE
CHLORIDE	2	1	1.16666	6	6	0	2	18	CHLORIDE
CONDUCTIVITY	462	420	431.428	7	551	430	460.944	18	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	2.3	0.52	1.26142	7	2.48	0.22	0.92588	17	FLOW
HARDNESS	245	231	238.428	7	287	232	246.055	18	HARDNESS
TOTAL IRON	4.59	0.18	1.1488	5	0.31	0	0.088125	16	TOTAL IRON
DISSOLVED IRON	0				0	0	0	14	DISSOLVED IRON
MAGNESIUM	21	17.5	18.6428	7	21.99	17.2	19.325	18	MAGNESIUM
DISSOLVED MANGANESE	0.055	0.005	0.02275	4	0.02	0	7.26666	15	DISSOLVED MANGANESE
MANGANESE	0.293	0.002	0.10366	3	0.003	0	3.33333	15	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.39	8.06	8.27857	7	8.52	8	8.29611	18	PH
POTASSIUM	1.28	0.32	0.6372	5	2.1	0.31	0.97222	18	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.53	1.83571	7	4.44	1.09	1.95888	18	SODIUM
SULFATE	7	4	6.14285	7	12	4	6.38888	18	SULFATE
SUSPENDED SOLIDS	237	237	237	1	0				SUSPENDED SOLIDS
TEMPERATURE	9.6	3.9	6.18571	7	12.8	3.7	8.16666	18	TEMPERATURE
TOTAL DISSOLVED SOLIDS	252	211	235.571	7	287	222	258.444	18	TOTAL DISSOLVED SOLIDS

Location: Section 14, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-5 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-5 in the Hiawatha seam, (17th West gateroad development, December 2006).

Subsidence: No subsidence has been detected near RR-5. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2011. RR-5 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-5. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-5 is located in a clearing on an east facing slope surrounded by conifers. Flow from spring RR-5 generally ranges from 0/seep to a maximum of 34 gpm.

Geologic Mode of Occurrence for spring RR-5:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 360' below top.

Justification for removal from monitoring: RR-5 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-5 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-5**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1952' N.	2140' W.	SE	14	16S	6E	10160

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1571	360' below top

Location Comments: Spring located in clearing on east facing slope surrounded with conifers.

Probable Recharge Area: Areas of higher elevation located to the west (recharge limited).

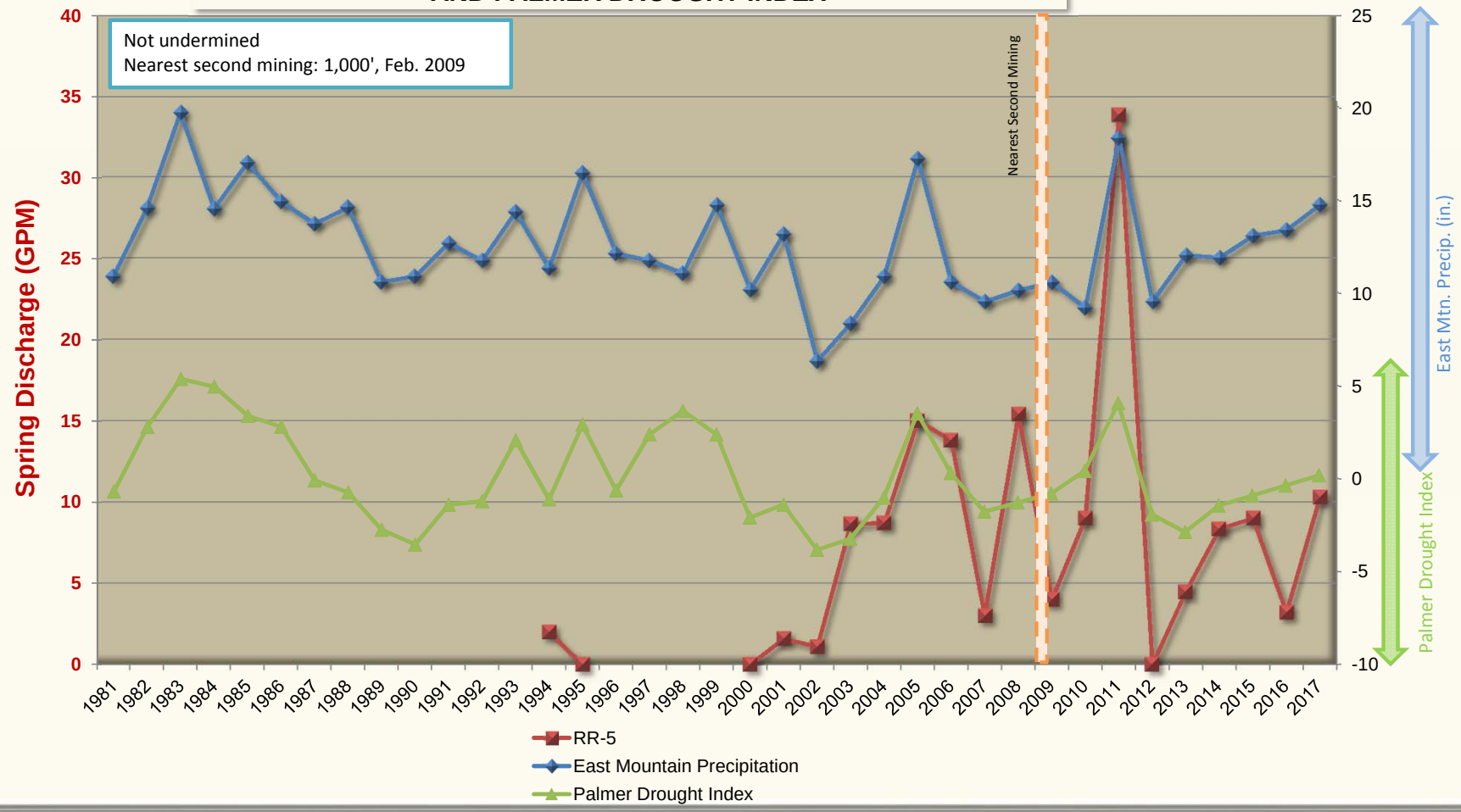
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity (RR-28, RR-6, RR-7A, RR-27, RR-4).

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

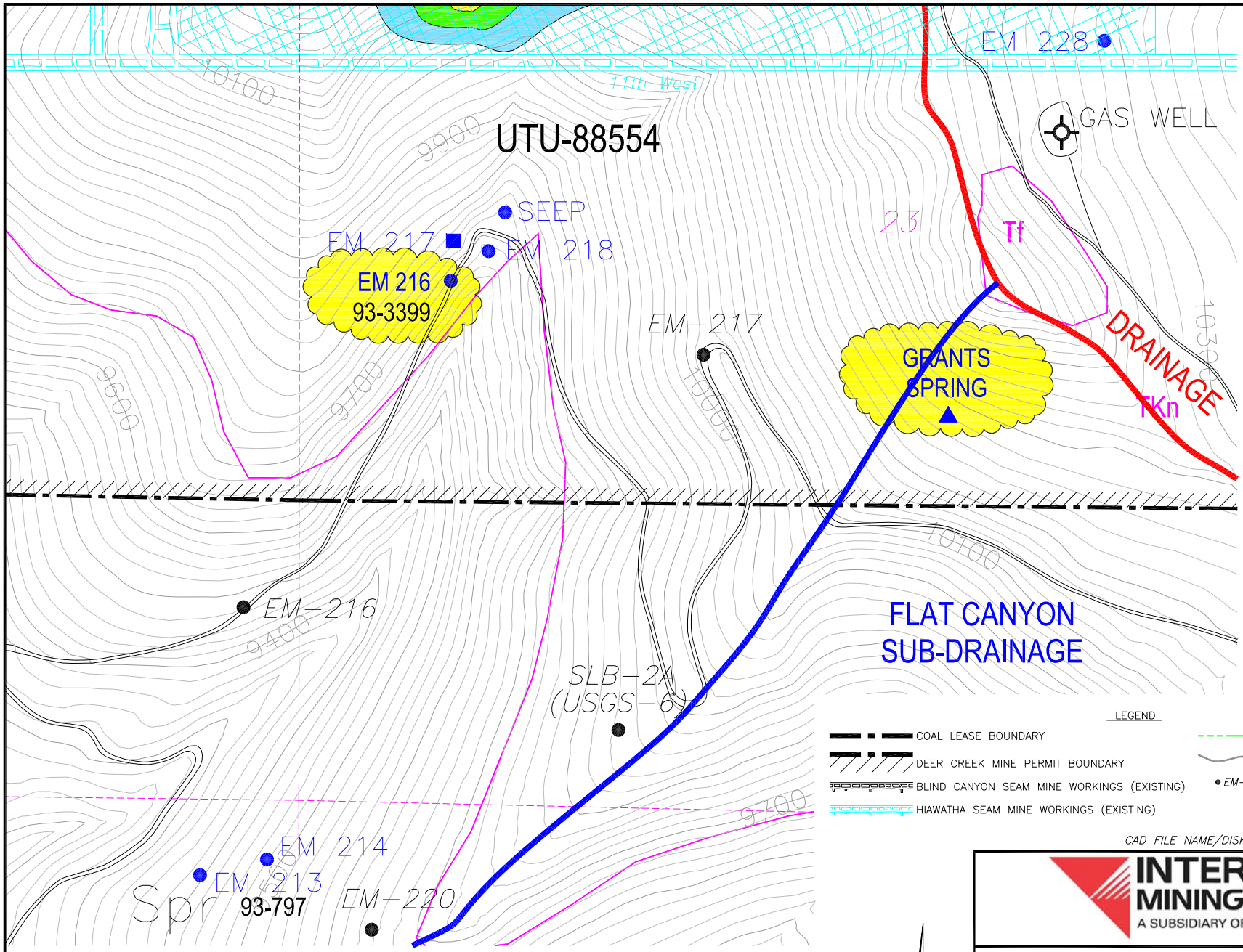
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-5 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-5
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1000'
Date of Nearest Mining: Feb-09

	Pre-Mining Data: 20000101 THROUGH 20090131				Post-Mining Data: 20090228 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	286	192	216.181	11	221	192	205.25	12	BICARBONATE
CALCIUM	74.39	61.7	64.5018	11	66.55	52.85	60.9233	12	CALCIUM
CARBONATE	0	0	0	2	0	0	0	12	CARBONATE
CHLORIDE	2	1	1.72727	11	2	0	0.75	12	CHLORIDE
CONDUCTIVITY	504	407	442.818	11	432	386	409.833	12	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	15.4	0.5	7.22909	11	33.8	0.42	7.58083	12	FLOW
HARDNESS	249	220	229.454	11	235	205	220.333	12	HARDNESS
TOTAL IRON	0.78	0.1	0.300125	8	1.65	0	0.24166	12	TOTAL IRON
DISSOLVED IRON	0	0	0	2	0	0	0	12	DISSOLVED IRON
MAGNESIUM	17.3	15.44	16.6318	11	17.89	14.53	16.62	12	MAGNESIUM
DISSOLVED MANGANESE	0.045	0.002	1.27142	7	0.055	0	1.20833	12	DISSOLVED MANGANESE
MANGANESE	0.013	0	0.0034	5	0.012	0	0.001	12	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.23	7.33	7.8009	11	8.4	7.55	7.96583	12	PH
POTASSIUM	0.99	0.31	0.50444	9	0.99	0.35	0.5675	12	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.52	1.81	11	2.16	1.52	1.8325	12	SODIUM
SULFATE	10	7	8.72727	11	10	6	8.08333	12	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	5.6	3	4.17272	11	10.4	3.7	5.425	12	TEMPERATURE
TOTAL DISSOLVED SOLIDS	274	209	243.363	11	255	223	238	12	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 6	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 6 OF 10	REV. ___

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring EM-216 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 975' north of EM-216 in the Hiawatha Seam on September 2005.

Subsidence: Maximum subsidence in area 975' north of EM-216 has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. EM-216 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring EM-216. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. EM-216 is a low volume spring/seep located along the Mill Fork access road. Flow from spring EM-216 generally ranges from 0.0 gpm to a maximum of 1.3 gpm. Flow from EM-216 normally occurs early in the year and dissipates rapidly with recordable flow rarely existing after the month of July.

Geologic Mode of Occurrence for spring EM-216:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 75' above base.

Justification for removal from monitoring: EM-216 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site EM-216 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **EM-216**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2250' N.	651' E.	SW	23	16S	6E	9740

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-3399	75' above base

Location Comments: Spring located on south facing slope adjacent to East Mountain Access Road.

Probable Recharge Area: Highlands area to the north.

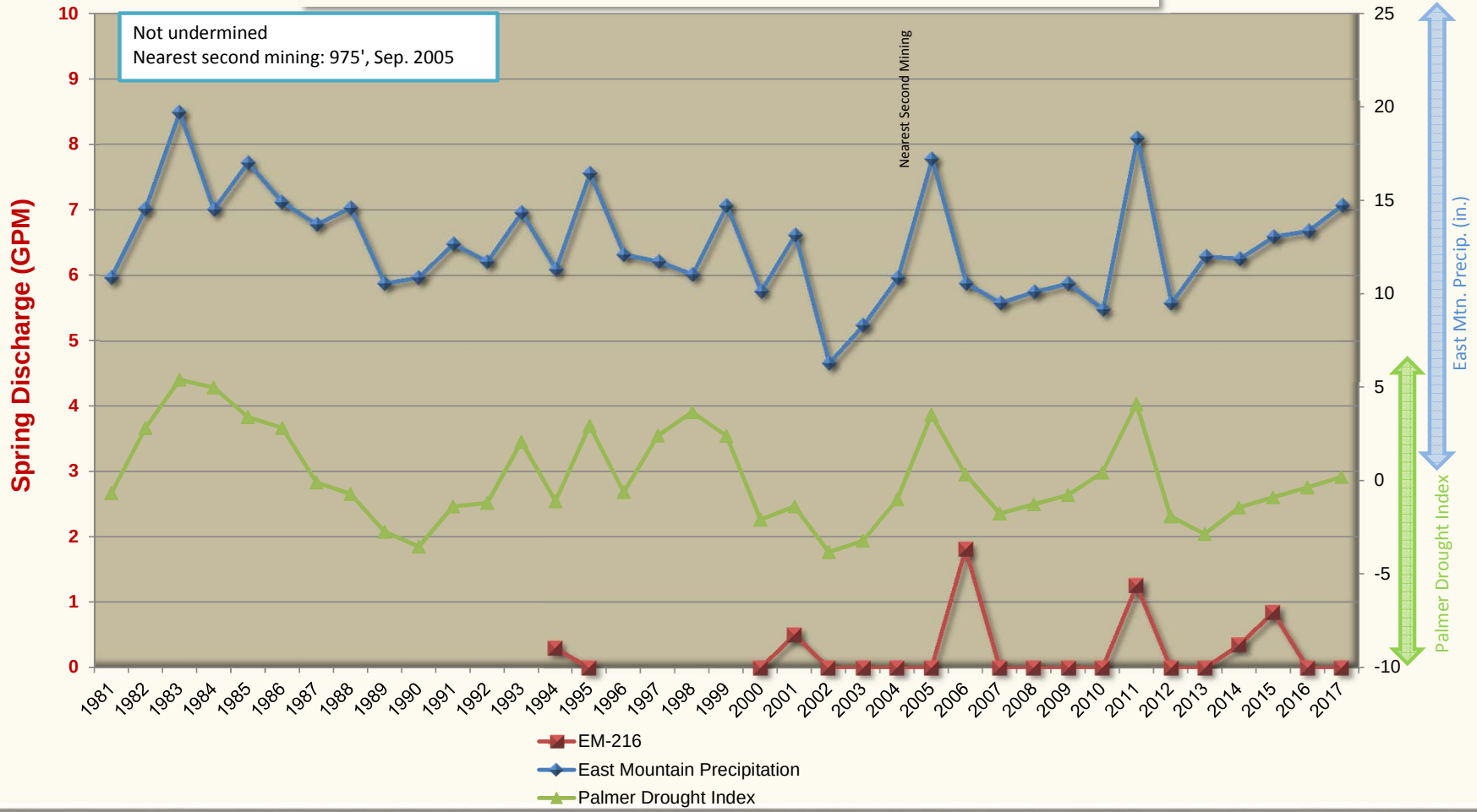
Relationship to Adjacent Springs: This spring occurs in the same manner as EM-218.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: EM-216 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: EM-216
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 975'
Date of Nearest Mining: Sep-05

	Pre-Mining Data: 2000101 THROUGH 20050801				Post-Mining Data: 20050831 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	- No Sample Data -				298	240	272.75	4	BICARBONATE
CALCIUM					94.6	70.16	81.235	4	CALCIUM
CARBONATE					0	0	0	3	CARBONATE
CHLORIDE					3	2	2.5	4	CHLORIDE
CONDUCTIVITY					663	502	579.25	4	CONDUCTIVITY
DISSOLVED OXYGEN					0				DISSOLVED OXYGEN
FLOW					1.8	0.35	1.06	4	FLOW
HARDNESS					344	273	304.25	4	HARDNESS
TOTAL IRON					0.19	0	8.66666	3	TOTAL IRON
DISSOLVED IRON					0	0	0	3	DISSOLVED IRON
MAGNESIUM					26.2	22.52	24.6675	4	MAGNESIUM
DISSOLVED MANGANESE					0.022	0	0.00825	4	DISSOLVED MANGANESE
MANGANESE					0.012	0	0.0055	4	MANGANESE
OIL AND GREASE					0				OIL AND GREASE
PH					8.36	7.66	7.965	4	PH
POTASSIUM					0.89	0.57	0.75	4	POTASSIUM
SET SOLIDS					0				SET SOLIDS
SODIUM					4.31	3.76	4.025	4	SODIUM
SULFATE					31	13	22.75	4	SULFATE
SUSPENDED SOLIDS					0				SUSPENDED SOLIDS
TEMPERATURE					17.7	9.3	13.575	4	TEMPERATURE
TOTAL DISSOLVED SOLIDS					319	278	304	4	TOTAL DISSOLVED SOLIDS

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Grants Spring is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 1,560' north of Grants Spring in the Hiawatha Seam in November 2005.

Subsidence: Maximum subsidence in area 1,560' north of Grants Spring has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. Grants Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Grants Spring Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 2002 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. Grants Spring is a low volume spring/seep located below ridge on west facing slope above main Mill Fork access road vegetated with conifers and aspens. Flow from spring Grants Spring generally ranges from 0.5 gpm to a maximum of <3 gpm.

Geologic Mode of Occurrence for spring Grants Spring:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 160' below top.

Justification for removal from monitoring: Grants Spring has been monitored by PacifiCorp since 2002. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Grants Spring be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **GRANTS SPRING**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1692' N.	2542' W.	SE	23	16S	6E	10280

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Developed With Steel Pipe Diverted to Trough (not functioning)	None	160' below top

Location Comments: Spring located below ridge on west facing slope above main access road. Area surrounding the spring source vegetated with conifers and aspens.

Probable Recharge Area: Highlands area to the northeast (recharge limited).

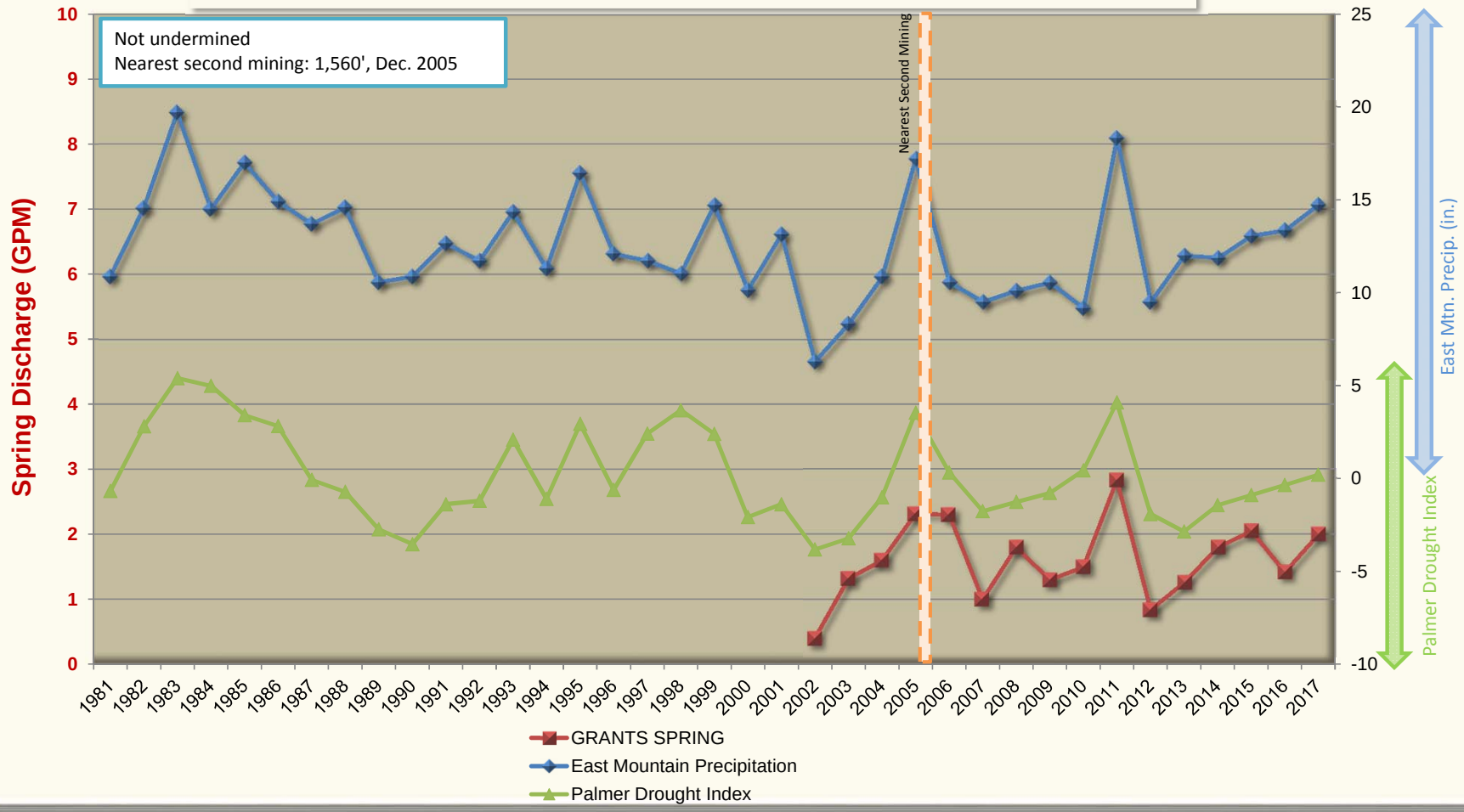
Relationship to Adjacent Springs: This spring occurs in the same manner as EMPOND.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

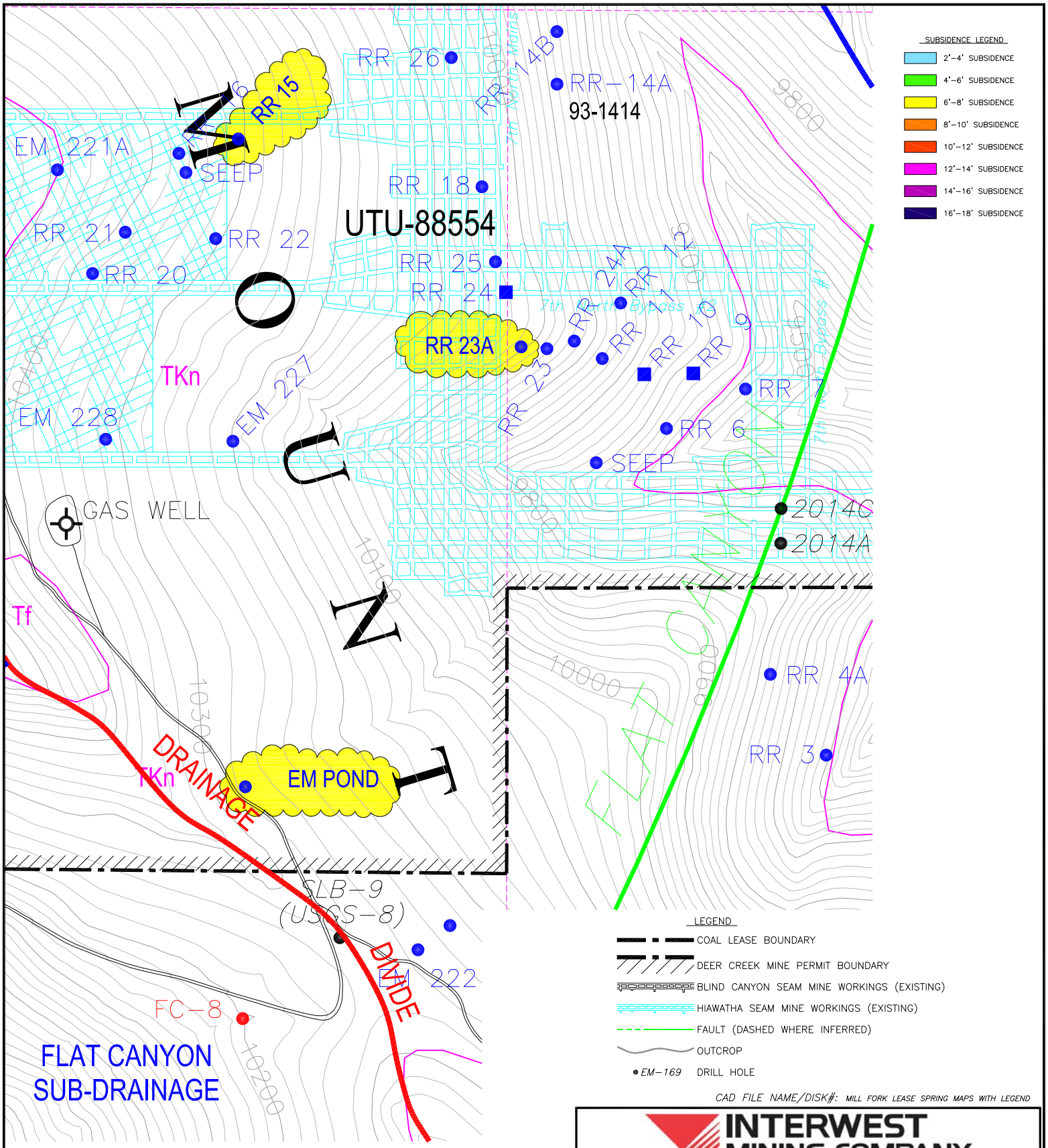
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: GRANTS SPRING vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: GRANTS SPRING
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1560'
Date of Nearest Mining: Nov-05

	Pre-Mining Data: 20000101 THROUGH 20051101				Post-Mining Data: 20051201 THROUGH 201712313				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	290	221	253.428	7	235	205	221.916	24	BICARBONATE
CALCIUM	56.7	54.1	55.7571	7	58.97	48.46	52.7758	24	CALCIUM
CARBONATE	0				8	0	0.4	20	CARBONATE
CHLORIDE	4	3	3.57142	7	7	2	3.20833	24	CHLORIDE
CONDUCTIVITY	491	457	473.285	7	508	422	454.791	24	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	2.31	0.3	1.11285	7	2.83	0.58	1.25541	24	FLOW
HARDNESS	256	241	248.857	7	255	211	235.708	24	HARDNESS
TOTAL IRON	0				0	0	0	20	TOTAL IRON
DISSOLVED IRON	0				0	0	0	20	DISSOLVED IRON
MAGNESIUM	27.7	25.4	26.6	7	28.1	15.59	25.2425	24	MAGNESIUM
DISSOLVED MANGANESE	0				0.002	0	0.0001	20	DISSOLVED MANGANESE
MANGANESE	0				0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.01	7.51	7.74428	7	7.94	7.47	7.77041	24	PH
POTASSIUM	1.34	1.11	1.24857	7	5.36	0.65	1.5	24	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3.62	3.41	3.48857	7	3.85	1.45	3.49416	24	SODIUM
SULFATE	15	11	13	7	12	6	10.2083	24	SULFATE
SUSPENDED SOLIDS	258	258	258	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.4	4.3	4.81428	7	8.3	4.7	6.3625	24	TEMPERATURE
TOTAL DISSOLVED SOLIDS	272	226	248.714	7	377	217	251.583	24	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 7	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 7 OF 10	REV. ___

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-15 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-15 in the Hiawatha seam, (14th West, June 2005). Extraction face of the 14th West longwall panel is 55' west of RR-15.

Subsidence: No subsidence has been detected near RR-15. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2008. RR-15 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-15. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1994 through 1995 by Genwal Resources and 2000 through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-15 located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District). Per request from Emery Conservancy District, PacifiCorp removed the weir and recorder in August 2002. Flow from spring RR-15 generally ranges from 10 gpm to a maximum of 55 gpm.

Geologic Mode of Occurrence for spring RR-15:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 170' below top.

Justification for removal from monitoring: RR-15 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-15 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-15**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
610' S.	1257'W.	NE	23	16S	6E	10350

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Diverted To Weir (not functioning)	None	170' below top

Location Comments: Spring located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District).

Probable Recharge Area: Areas of higher elevation located to the west.

Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area.

Geologic Occurrence of Spring:

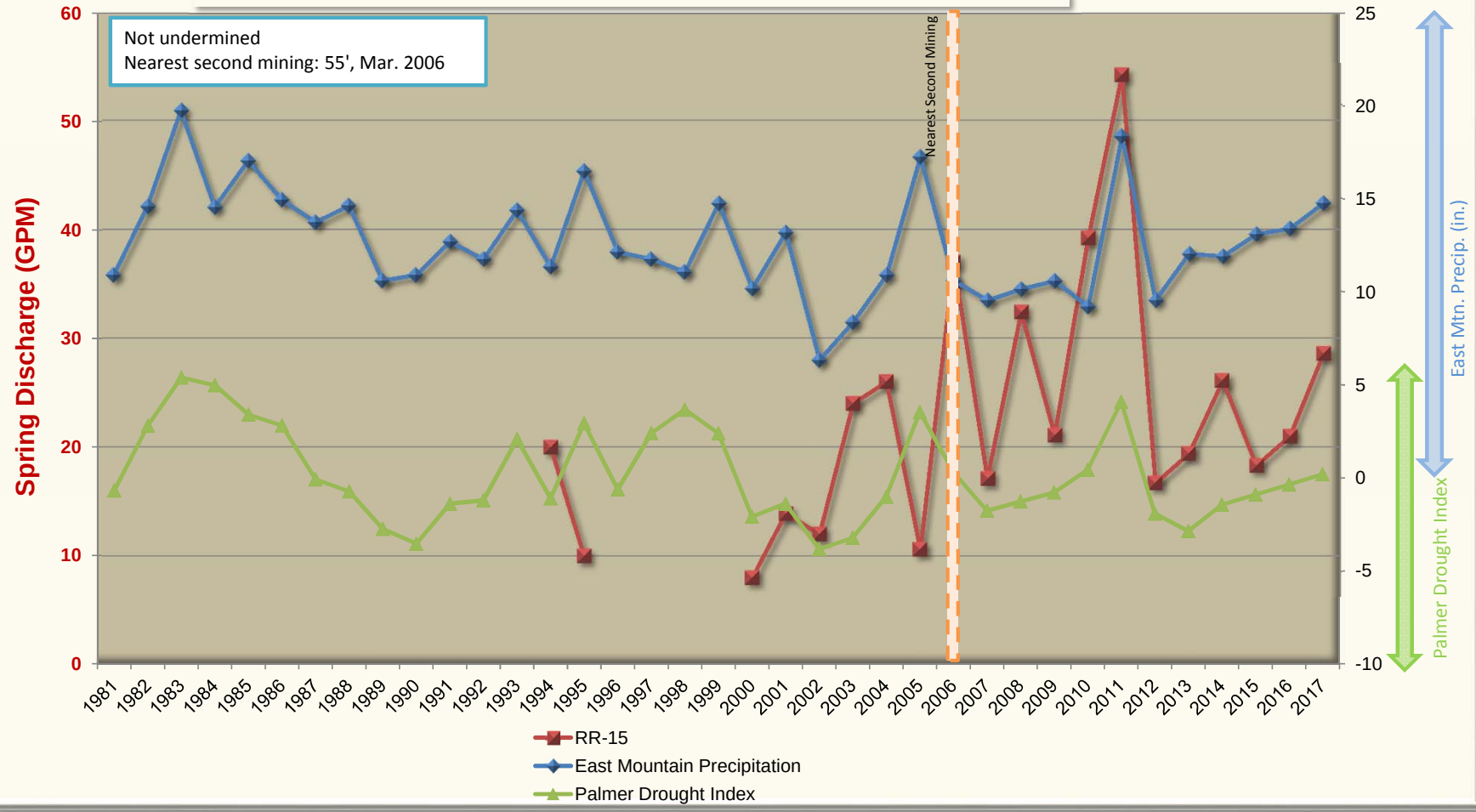
Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

RR-15 spring source

RR-15 Weir and recorder (removed August 22, 2002)

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-15 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-15
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 55'
Date of Nearest Mining: May-06

	Pre-Mining Data: 20000101 THROUGH 20060430				Post-Mining Data: 20060501 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	285	207	253.727	11	233	204	216.608	23	BICARBONATE
CALCIUM	65.8	55	59.3181	11	60.9	54	57.4321	23	CALCIUM
CARBONATE	0				0	0	0	20	CARBONATE
CHLORIDE	2	1	1.12	10	2	0	0.91304	23	CHLORIDE
CONDUCTIVITY	498	419	440	11	479	356	430.956	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	26	6	12.2363	11	54.2	0.52	19.3426	23	FLOW
HARDNESS	241	218	229.636	11	243	210	226.739	23	HARDNESS
TOTAL IRON	0.832	0.121	0.3106	5	0	0	0	20	TOTAL IRON
DISSOLVED IRON	0.084	0.084	0.084	1	0	0	0	20	DISSOLVED IRON
MAGNESIUM	21.4	16.6	19.809	11	23.2	17.12	20.23	23	MAGNESIUM
DISSOLVED MANGANESE	0.159	0.003	0.058	3	0	0	0	20	DISSOLVED MANGANESE
MANGANESE	0.012	0.003	0.0075	2	0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.43	7.53	8.04181	11	8.03	7.37	7.80695	23	PH
POTASSIUM	0.73	0.34	0.5978	5	1.32	0.59	0.8	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.96	2.77181	11	6.5	2.23	3.21565	23	SODIUM
SULFATE	11	4	6.04545	11	10	5	6.95652	23	SULFATE
SUSPENDED SOLIDS	214	214	214	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.8	3	4.01818	11	8.5	3.4	4.36086	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	259	213	237.727	11	272	215	243.086	23	TOTAL DISSOLVED SOLIDS

Location: Section 24, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-23A is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-23A in the Hiawatha seam, (7th North Mains, August 2004).

Subsidence: No subsidence has been detected near RR-23A. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2009. RR-23A is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-23A. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-23A is located in a clearing on an east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms a small drainage. Flow from spring RR-23A generally ranges from 10 gpm to a maximum of 50 gpm.

Geologic Mode of Occurrence for spring RR-23A:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 360' above base.

Justification for removal from monitoring: RR-23A has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-23A be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-23A**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1571' S.	64' E.	NW	24	16S	6E	10023

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	360' above base

Location Comments: Spring located in clearing on east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms small drainage.

Probable Recharge Area: Areas of higher elevation located to the west.

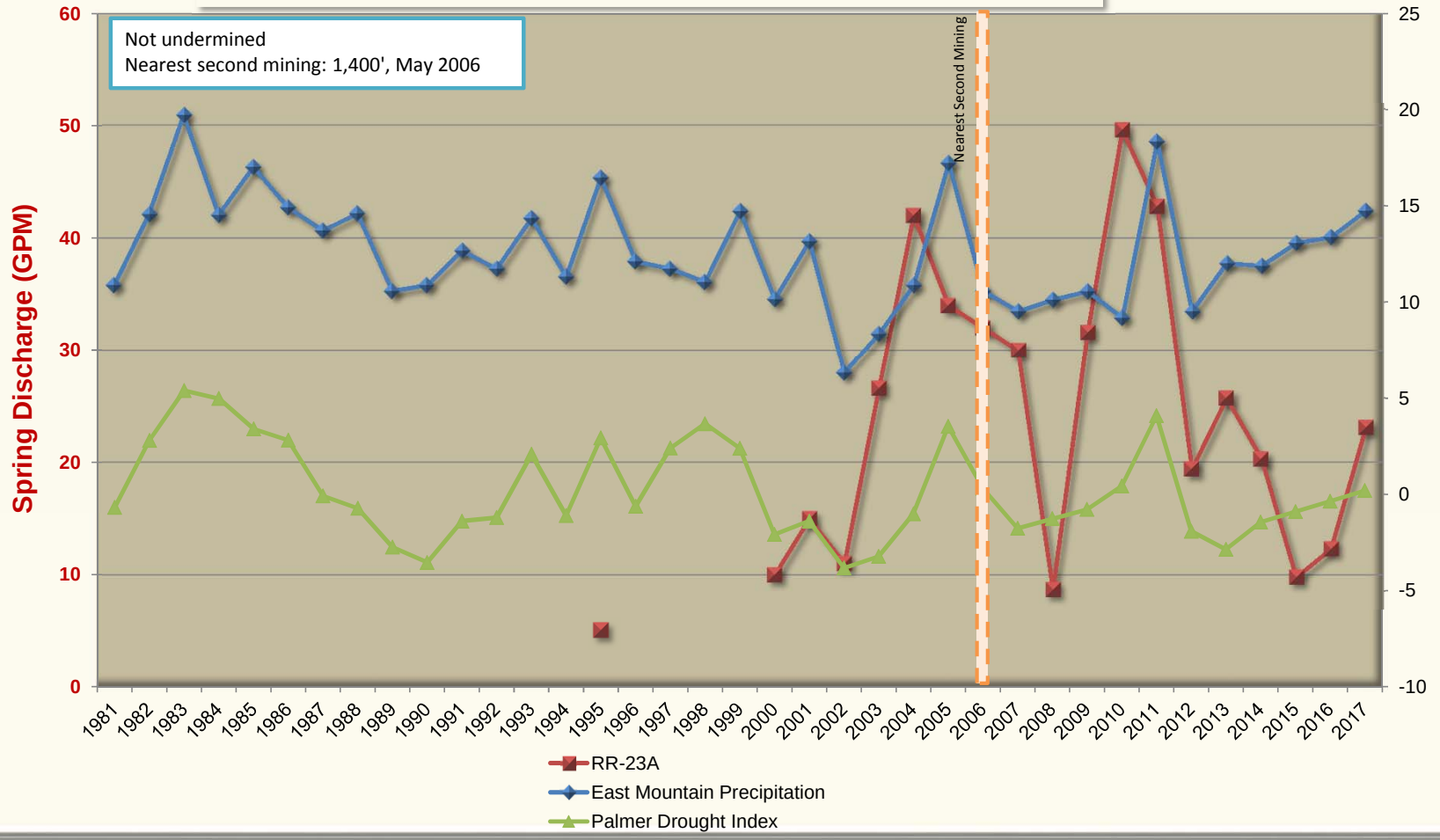
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-23A vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-23A
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1400'
Date of Nearest Mining: May-06

	Pre-Mining Data: 20000101 THROUGH 20060430				Post-Mining Data: 20060501 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	309	237	276.181	11	258	217	240.304	23	BICARBONATE
CALCIUM	73.1	65	68.8454	11	75.2	63.42	69.6313	23	CALCIUM
CARBONATE	0				0	0	0	19	CARBONATE
CHLORIDE	2	1	1.59	10	3	0	1.47826	23	CHLORIDE
CONDUCTIVITY	566	461	493.272	11	560	411	489.173	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	42	8.32	17.5381	11	49.6	5.7	18.6495	23	FLOW
HARDNESS	272	245	255.636	11	282	232	258.086	23	HARDNESS
TOTAL IRON	1.12	0.3	0.54725	4	1.19	0	0.12238	21	TOTAL IRON
DISSOLVED IRON	0.008	0.008	0.008	1	0	0	0	19	DISSOLVED IRON
MAGNESIUM	21.7	19.5	20.3181	11	22.8	17.95	20.4526	23	MAGNESIUM
DISSOLVED MANGANESE	0.265	0.012	0.1385	2	0.066	0	4.38095	21	DISSOLVED MANGANESE
MANGANESE	0.011	0.011	0.011	1	0	0	0	19	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.28	7.21	7.69818	11	8.3	7.15	7.53913	23	PH
POTASSIUM	0.714	0.51	0.60866	6	1.1	0.56	0.72043	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	2.22	2.89545	11	3.78	1.97	2.78608	23	SODIUM
SULFATE	14	10	11.9181	11	15	8	12.2173	23	SULFATE
SUSPENDED SOLIDS	280	280	280	1	0				SUSPENDED SOLIDS
TEMPERATURE	8.2	4	5.21818	11	8.6	3.9	5.1	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	304	226	271.545	11	312	249	277.043	23	TOTAL DISSOLVED SOLIDS

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: EMPOND Spring is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat on August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 1,620' north of EMPOND in the Hiawatha Seam in December 2005.

Subsidence: Maximum subsidence in area 1,560' north of Grants Spring has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. EMPOND is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Grants Spring Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 1993 through 1995 by Genwal Resources and 2000 and through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. EMPOND is a located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring is dominated by conifers. Flow from spring EMPOND generally ranges from 1 gpm to a maximum of <10 gpm.

Geologic Mode of Occurrence for spring EMPOND:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 160' below top.

Justification for removal from monitoring: EMPOND has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site EMPOND be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **EMPOND**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1744' N.	1223' W.	SE	23	16S	6E	10280

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	160' below top

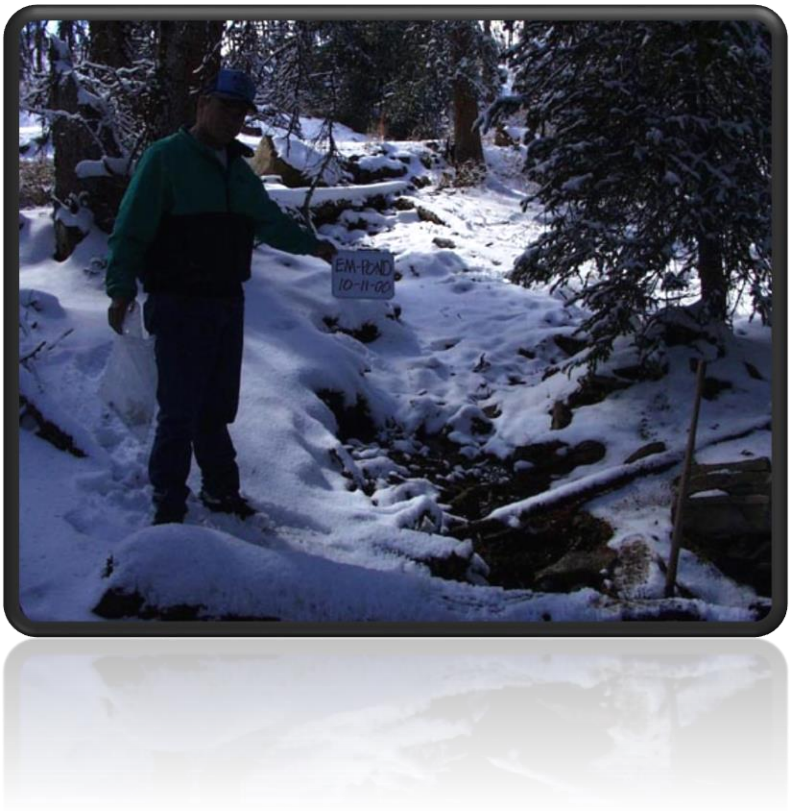
Location Comments: Spring located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring dominated by conifers.

Probable Recharge Area: Highlands area to the northwest (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as EM-222 and EM-223.

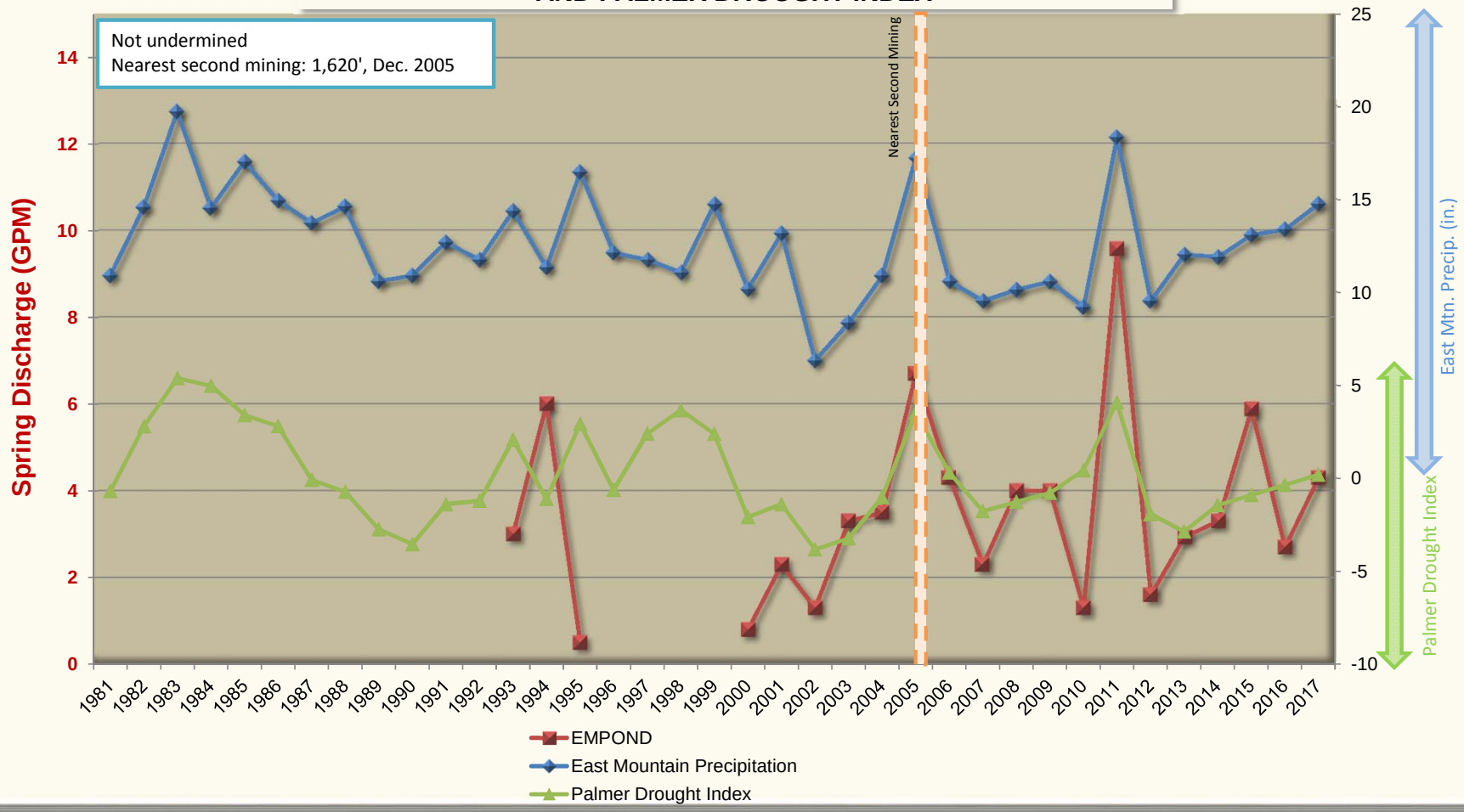
Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.



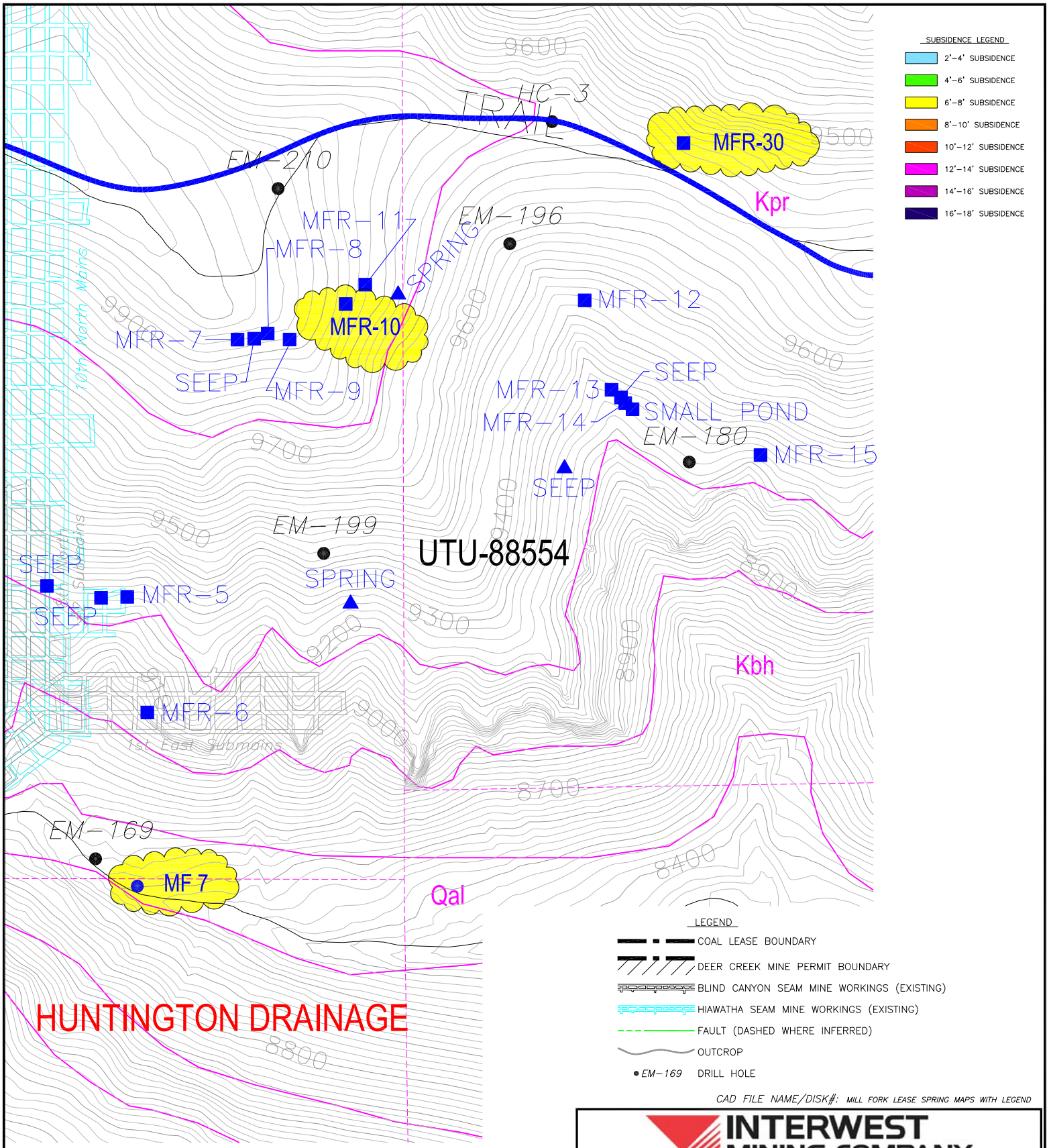
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: EMPOND vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: EMPOND
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1620'
Date of Nearest Mining: Dec-05

	Pre-Mining Data: 20000101 THROUGH 20051130				Post-Mining Data: 20051201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	296	228	269.1	10	239	213	225.875	24	BICARBONATE
CALCIUM	62	57.4	60	10	62.74	54.49	58.16125	24	CALCIUM
CARBONATE	0				12	0	0.6	20	CARBONATE
CHLORIDE	2	1	1.13	10	3	0	1.33333	24	CHLORIDE
CONDUCTIVITY	525	446	468.7	10	491	371	445.125	24	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	6.7	0.5	2.175	10	9.57	0.37	2.78333	24	FLOW
HARDNESS	249	231	242.7	10	254	221	236.375	24	HARDNESS
TOTAL IRON	1.5	0.088	0.4452	5	1.4	0	0.20695	23	TOTAL IRON
DISSOLVED IRON	0.056	0.056	0.056	1	0	0	0	20	DISSOLVED IRON
MAGNESIUM	23.7	21.3	22.57	10	24.1	20.45	22.137	24	MAGNESIUM
DISSOLVED MANGANESE	0.07	0.002	0.02	5	0.063	0	8.29166	24	DISSOLVED MANGANESE
MANGANESE	0.008	0.007	0.0075	2	0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.21	7.84	7.983	10	8.15	7.67	7.91791	24	PH
POTASSIUM	0.697	0.539	0.60433	6	0.92	0.53	0.65375	24	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	2	2.385	10	2.56	1.35	2.06583	24	SODIUM
SULFATE	7	4.8	5.38	10	6	3	3.79166	24	SULFATE
SUSPENDED SOLIDS	239	239	239	1	0				SUSPENDED SOLIDS
TEMPERATURE	6	3.8	5.24	10	10.6	4.9	6.9	24	TEMPERATURE
TOTAL DISSOLVED SOLIDS	280	231	251.6	10	287	204	245.333	24	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY: K. LARSEN	MAP 8	
SCALE: 1" =600'	DRAWING #:	
DATE: MAY 7, 2018	SHEET 8 OF 10	REV. ___

Location: Section 7, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MFR-30 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MFR-30.

Subsidence: No subsidence has been detected near MFR-30. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MFR-30 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MFR-30. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MFR-30 is located in small clearing on a north facing slope. Area surrounding the spring source is vegetated with mountain brush, aspens and conifers. Flow from spring MFR-30 generally ranges from 0/seep to a maximum of <3 gpm.

Geologic Mode of Occurrence for spring MFR-30:

- Water flowing down through fractures in the Upper Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Upper Price River (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 80' below top.

Justification for removal from monitoring: MFR-30 has been monitored by PacifiCorp since 2001. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MFR-30 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MFR-30**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2298' S.	1304' E.	NW	7	16S	7E	9680

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Upper Price River	None	None	80' below top

Location Comments: Spring located in small clearing on north facing slope. Area surrounding the spring source vegetated with mountain brush, aspens and conifers.

Probable Recharge Area: Areas of higher elevation located to the west.

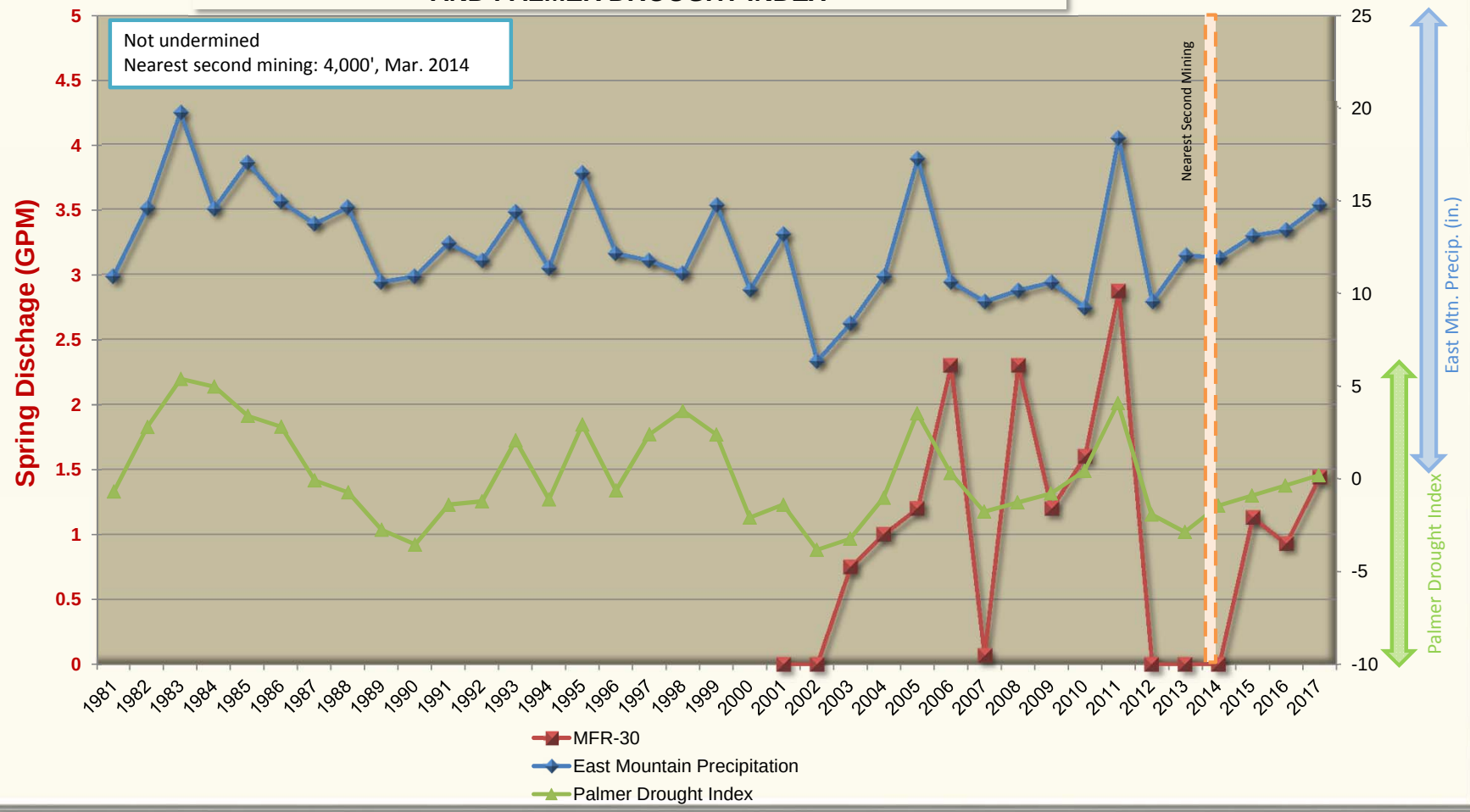
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area (MFR-28, MFR-29).

Geologic Occurrence of Spring:

Water flowing down through fractures in the Upper Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MFR-30 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MFR-30
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 4000'
Date of Nearest Mining: Mar-14

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	383	258	305.166	12	316	252	278.666	3	BICARBONATE
CALCIUM	89.22	77	84.275	12	83.94	63.67	71.8366	3	CALCIUM
CARBONATE	0	0	0	5	0	0	0	3	CARBONATE
CHLORIDE	3	1	2.25	12	3	2	2.33333	3	CHLORIDE
CONDUCTIVITY	698	593	624.833	12	633	552	587.333	3	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	26.6	0.22	3.41833	12	1.44	0.93	1.16666	3	FLOW
HARDNESS	327	287	311	12	318	266	283.666	3	HARDNESS
TOTAL IRON	1.23	0	0.4207	10	2.62	0	0.93	3	TOTAL IRON
DISSOLVED IRON	0	0	0	5	0	0	0	3	DISSOLVED IRON
MAGNESIUM	26.11	21	24.4258	12	26.24	23.72	25.33	3	MAGNESIUM
DISSOLVED MANGANESE	0.012	0	0.0036	5	0.061	0	2.13333	3	DISSOLVED MANGANESE
MANGANESE	0.026	0	0.00625	8	0	0	0	3	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.27	7.56	7.95416	12	8.55	7.89	8.19333	3	PH
POTASSIUM	1.04	0.73	0.81072	11	1.35	0.83	1.12	3	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	16.5	8	12.96	12	14.42	12.69	13.4433	3	SODIUM
SULFATE	39	22	32.25	12	36	31	33.6666	3	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.2	3	6.28333	12	61.3	6.2	25.6666	3	TEMPERATURE
TOTAL DISSOLVED SOLIDS	400	308	351.083	12	338	283	313	3	TOTAL DISSOLVED SOLIDS

Location: Section 12, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MFR-10 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MFR-10.

Subsidence: No subsidence has been detected near MFR-10. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MFR-10 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MFR-10. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2001 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MFR-10 is located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source is vegetated with conifers and aspens. Flow from spring MFR-10 generally ranges from 10 gpm to a maximum of 45 gpm (recorded flow of 2001 was 0.0 gpm).

Geologic Mode of Occurrence for spring MFR-10:

- Water flowing down through fractures in the lower section of the North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel.
- Geologic Formation: North Horn Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 140' above base.

Justification for removal from monitoring: MFR-10 has been monitored by PacifiCorp since 2001. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MFR-10 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MFR-10**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2680' N.	270' W	SE	12	16S	6E	9900

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Developed With Steel Pipe, Diverted To Trough (not functioning)	None	140' above base

Location Comments: Spring located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source vegetated with conifers and aspens.

Probable Recharge Area: Areas of higher elevation located to the west.

Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area.

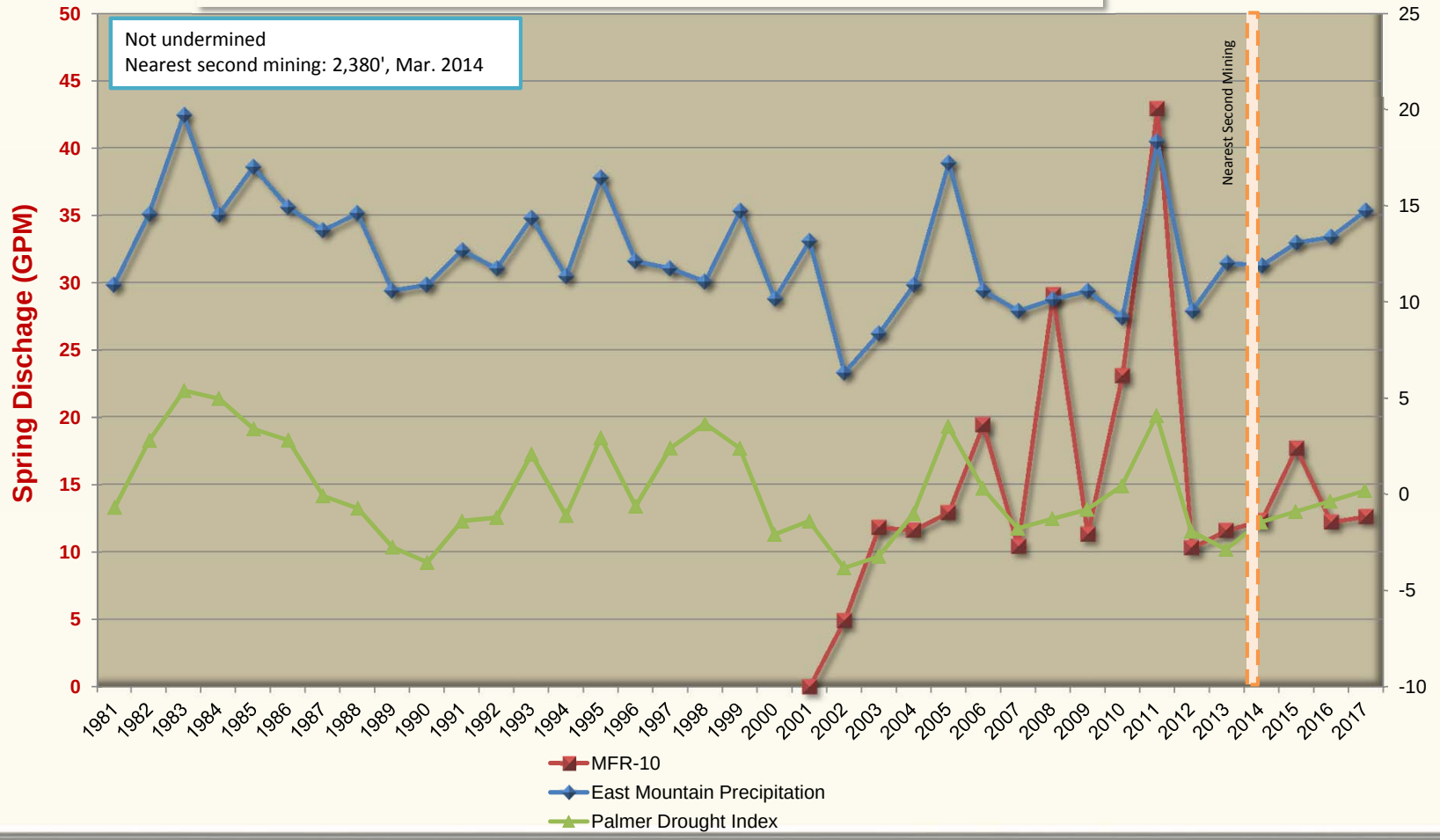
Geologic Occurrence of Spring: Water flowing down through fractures in the lower section of the North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel.

MFR-10 Spring Source

MFR-10 Trough

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MFR-10 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MFR-10
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 2380'
Date of Nearest Mining: Mar-14

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	326	228	263.73	26	260	229	244.75	8	BICARBONATE
CALCIUM	82.6	65	73.1584	26	74.25	58.28	65.83	8	CALCIUM
CARBONATE	6	0	0.46153	13	0	0	0	8	CARBONATE
CHLORIDE	4	2	2.38846	26	2	2	2	8	CHLORIDE
CONDUCTIVITY	618	380	525.5	26	545	497	517.25	8	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	151	2.4	15.4926	26	17.65	1.7	8.1375	8	FLOW
HARDNESS	305	253	279.653	26	288	236	261.75	8	HARDNESS
TOTAL IRON	1.34	0	0.19225	20	0	0	0	8	TOTAL IRON
DISSOLVED IRON	0	0	0	12	0	0	0	8	DISSOLVED IRON
MAGNESIUM	25.8	22	23.563	26	25.76	20.57	23.7175	8	MAGNESIUM
DISSOLVED MANGANESE	0.04	0	0.00431	16	0	0	0	8	DISSOLVED MANGANESE
MANGANESE	0	0	0	12	0	0	0	8	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.41	7.31	8.07038	26	8.54	8.16	8.2625	8	PH
POTASSIUM	1.15	0.48	0.82054	22	1.2	0.64	0.82875	8	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	6	2	4.04692	26	5.86	2.81	4.30125	8	SODIUM
SULFATE	29	11	23.073	26	31	19	25.375	8	SULFATE
SUSPENDED SOLIDS	267	267	267	1	0				SUSPENDED SOLIDS
TEMPERATURE	44.9	3.9	7.99615	26	50.1	2.4	11.675	8	TEMPERATURE
TOTAL DISSOLVED SOLIDS	341	262	295.346	26	314	269	291.75	8	TOTAL DISSOLVED SOLIDS

Location: Section 13, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

Lease Association: Spring MF-7 is located in Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MF-7.

Subsidence: No subsidence has been detected near MF-7. Nearest second mining is 1,707' west of MF-7. MF-7 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-7. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-7 is located on hillside near Mill Fork drainage on a north facing slope covered with spruce trees. Flow from spring MF-7 generally ranges from 10 gpm to a maximum of 65 gpm.

Geologic Mode of Occurrence for spring MF-7:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: MF-7 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-7 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-7**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
34' S.	1244' W.	NE	13	16S	6E	8580

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	None	320' below top

Location Comments: Spring located on hillside near Mill Fork drainage on north facing slope covered with spruce trees.

Probable Recharge Area: Areas of higher elevation located to the southwest.

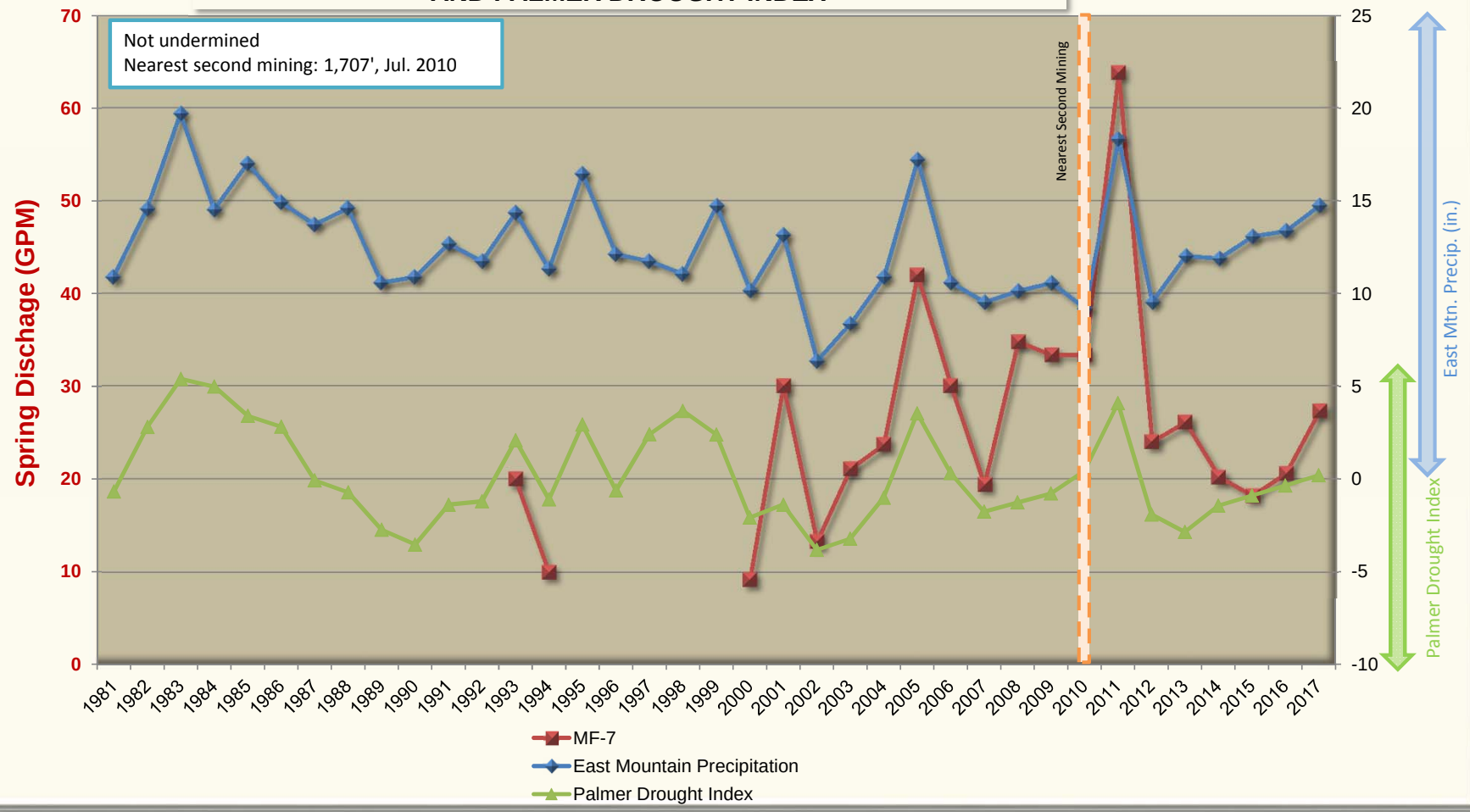
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-8A.

Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

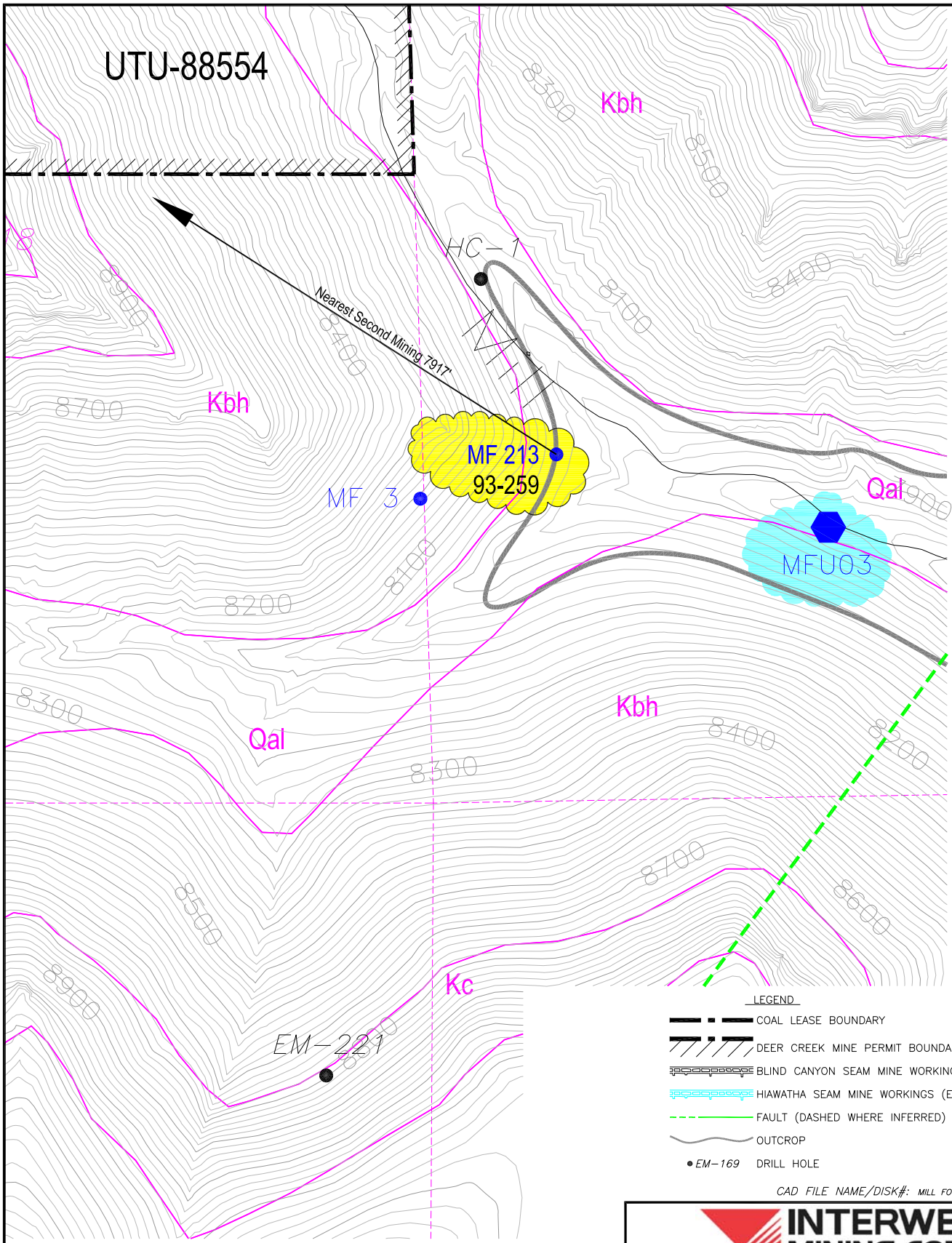
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-7 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-7
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1707'
Date of Nearest Mining: Jul-10

	Pre-Mining Data: 20000101 THROUGH 20100630				Post-Mining Data: 20100701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	335	242	279.21	19	277	250	262.9375	16	BICARBONATE
CALCIUM	77.1	65	72.901	19	77.13	36.37	70.0975	16	CALCIUM
CARBONATE	0	0	0	4	12	0	0.75	16	CARBONATE
CHLORIDE	4	2	2.71052	19	3	2	2.5	16	CHLORIDE
CONDUCTIVITY	681	512	583.263	19	670	532	593.4375	16	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	42	9.3	21.5315	19	63.8	12.8	24.5931	16	FLOW
HARDNESS	325	269	303.105	19	325	160	293.0625	16	HARDNESS
TOTAL IRON	0.1	0	0.02	5	1.18	0	0.101875	16	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	16	DISSOLVED IRON
MAGNESIUM	32.3	26	29.4015	19	32.32	16.75	28.665	16	MAGNESIUM
DISSOLVED MANGANESE	0	0	0	4	0.139	0	0.010125	16	DISSOLVED MANGANESE
MANGANESE	0	0	0	4	0	0	0	16	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8	7.45	7.80842	19	8.5	7.7	7.875625	16	PH
POTASSIUM	1.46	1	1.15833	18	1.84	1.04	1.34625	16	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	7	4	6.07789	19	68.11	6.87	13.59375	16	SODIUM
SULFATE	55	39	45.8315	19	74	29	51.8125	16	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	18.8	3.5	5.38333	18	40.5	4.4	7.25625	16	TEMPERATURE
TOTAL DISSOLVED SOLIDS	360	298	326.947	19	415	298	345.0625	16	TOTAL DISSOLVED SOLIDS



SUBSIDENCE LEGEND

- 2'-4' SUBSIDENCE
- 4'-6' SUBSIDENCE
- 6'-8' SUBSIDENCE
- 8'-10' SUBSIDENCE
- 10'-12' SUBSIDENCE
- 12'-14' SUBSIDENCE
- 14'-16' SUBSIDENCE
- 16'-18' SUBSIDENCE

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 DRILL HOLE

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

SPRING LEGEND

- MFB02 SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994-1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010-2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 GROUND WATER RIGHTS
- 93-198 SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989-1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY - DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 9	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 9 OF 10	REV. ___

Location: Section 17, Township 16 South, Range 7 East, SLB&M. This site is located within ½ mile offset of the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

Lease Association: Spring MF-213 is located within ½ mile offset of Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MF-213.

Subsidence: No subsidence has been detected near MF-213. Nearest second mining is 7,915' west of MF-213. MF-213 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-213. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-213 is located near drainage bottom (Mill Fork - Right Fork) on an east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits. Flow from spring MF-213 generally ranges from 15 gpm to a maximum of 70 gpm.

Geologic Mode of Occurrence for spring MF-213:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: MF-213 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-213 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-213**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1489' N.	584' E.	SW	17	16S	R7E	8030

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	93-259	At base

Location Comments: Spring located near drainage bottom (Mill Fork - Right Fork) on east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits.

Probable Recharge Area: Areas of higher elevation located to the west.

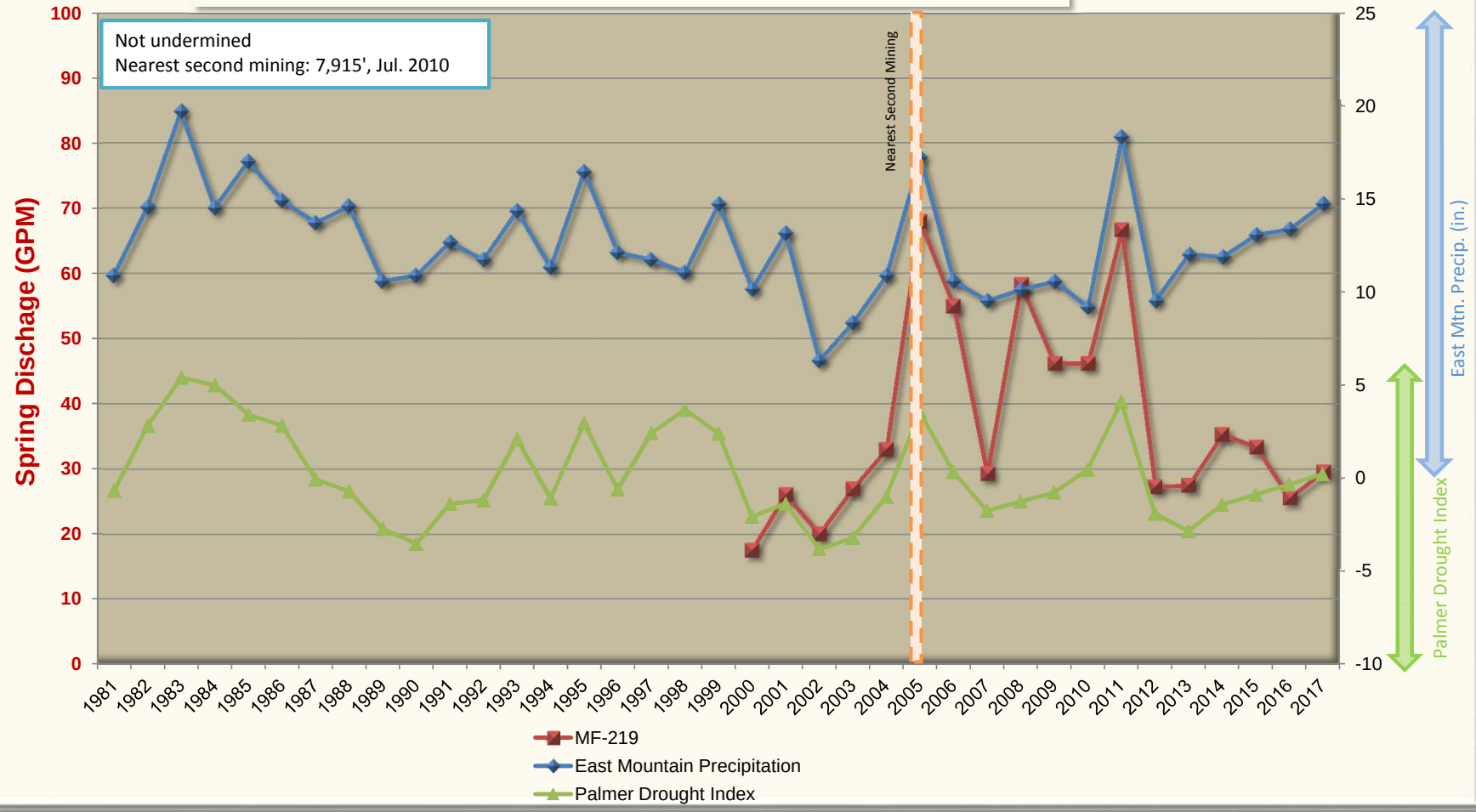
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-3.

Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-213 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-213
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 7915'
Date of Nearest Mining: Jul-10

	Pre-Mining Data: 20000101 THROUGH 20100630				Post-Mining Data: 20100630 THROUGH 20172131				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	332	241	279.842	19	261	226	252.25	16	BICARBONATE
CALCIUM	69.1	61	65.341	19	68.57	52.08	63.3456	16	CALCIUM
CARBONATE	9	0	1.8	5	5	0	0.3125	16	CARBONATE
CHLORIDE	4	2	2.66315	19	3	2	2.4375	16	CHLORIDE
CONDUCTIVITY	752	435	551.105	19	551	497	525.8125	16	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	68	10	28.2315	19	66.7	14.3	28.2075	16	FLOW
HARDNESS	294	272	283.157	19	290	227	273.75	16	HARDNESS
TOTAL IRON	0.313	0	6.88333	6	1.16	0	0.0725	16	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	16	DISSOLVED IRON
MAGNESIUM	31	27.4	29.1584	19	29.96	23.53	28.0681	16	MAGNESIUM
DISSOLVED MANGANESE	0.004	0	0.0008	5	0.067	0	0.00418	16	DISSOLVED MANGANESE
MANGANESE	0.004	0	0.0008	5	0	0	0	16	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.22	7.21	7.95105	19	8.45	8.03	8.138125	16	PH
POTASSIUM	1.2	0.93	1.02982	17	1.39	0.95	1.085	16	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	7	4.61	5.55	19	8.86	5.08	6.72375	16	SODIUM
SULFATE	29	23	25.4526	19	52	23	28.375	16	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.6	5.6	7.85789	19	50.8	6.1	11.4125	16	TEMPERATURE
TOTAL DISSOLVED SOLIDS	324	264	294.473	19	352	280	299.5	16	TOTAL DISSOLVED SOLIDS

Location: Section 9, Township 16 South, Range 7 East, SLB&M. This site is located 1 ½ mile east of the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

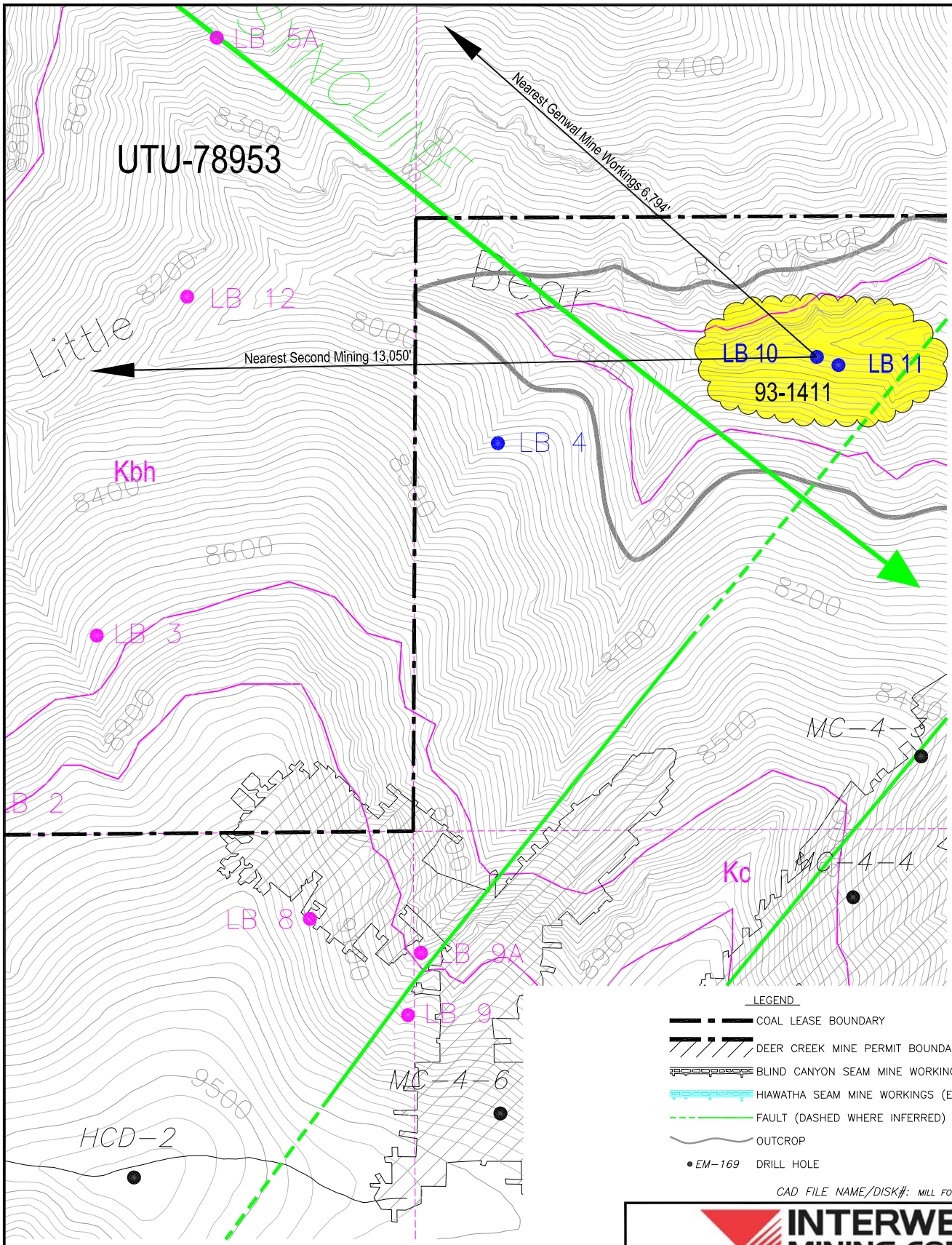
Lease Association: Little Bear Spring is located 1 ½ mile east of Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of Little Bear Spring.

Subsidence: No subsidence has been detected near Little Bear Spring. Nearest second mining is 13,050' west of Little Bear Spring. Little Bear Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Little Bear Spring. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1982 and has continued through 2017 by Castle Valley Special Service District. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - Little Bear Spring is located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo). Flow from spring Little Bear Spring generally ranges from 225 gpm to a maximum of 475 gpm.



SUBSIDENCE LEGEND

- 2'-4' SUBSIDENCE
- 4'-6' SUBSIDENCE
- 6'-8' SUBSIDENCE
- 8'-10' SUBSIDENCE
- 10'-12' SUBSIDENCE
- 12'-14' SUBSIDENCE
- 14'-16' SUBSIDENCE
- 16'-18' SUBSIDENCE

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 DRILL HOLE

SPRING LEGEND

- MFB02 SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994-1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010-2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 GROUND WATER RIGHTS
- 93-198 SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989-1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY - DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 10	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 10 OF 10	REV. ___

Geologic Mode of Occurrence for spring Little Bear Spring:

- Multiple potential recharge sources have been identified; south: fracturing related to the Mill Fork Graben, west: fractures - Little Bear Canyon, north: fractures - Huntington Creek Drainage.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: Little Bear Spring has been monitored by Castle Valley Special Service District since 1982 and by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Little Bear Spring be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **Little Bear Spring**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2028' N.	1726' E	SW	9	16S	6E	7540

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Star Point Sandstone Panther Member	Developed With Collection Boxes & Pipeline	93-1411	near base

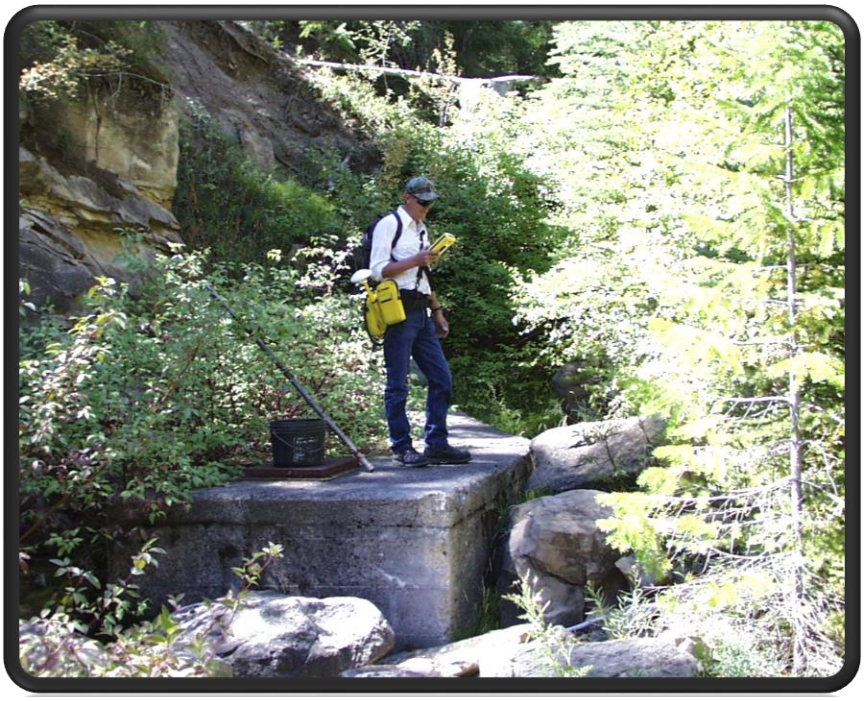
Location Comments: Spring located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo).

Probable Recharge Area: Multiple potential recharge sources have been identified; south: fracturing related to the Mill Fork Graben, west: fractures - Little Bear Canyon, north: fractures - Huntington Creek Drainage

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area.

Geologic Occurrence of Spring:

Water flowing through fractures in the lower section of the Star Point Sandstone (Panther Member) intersects the surface.

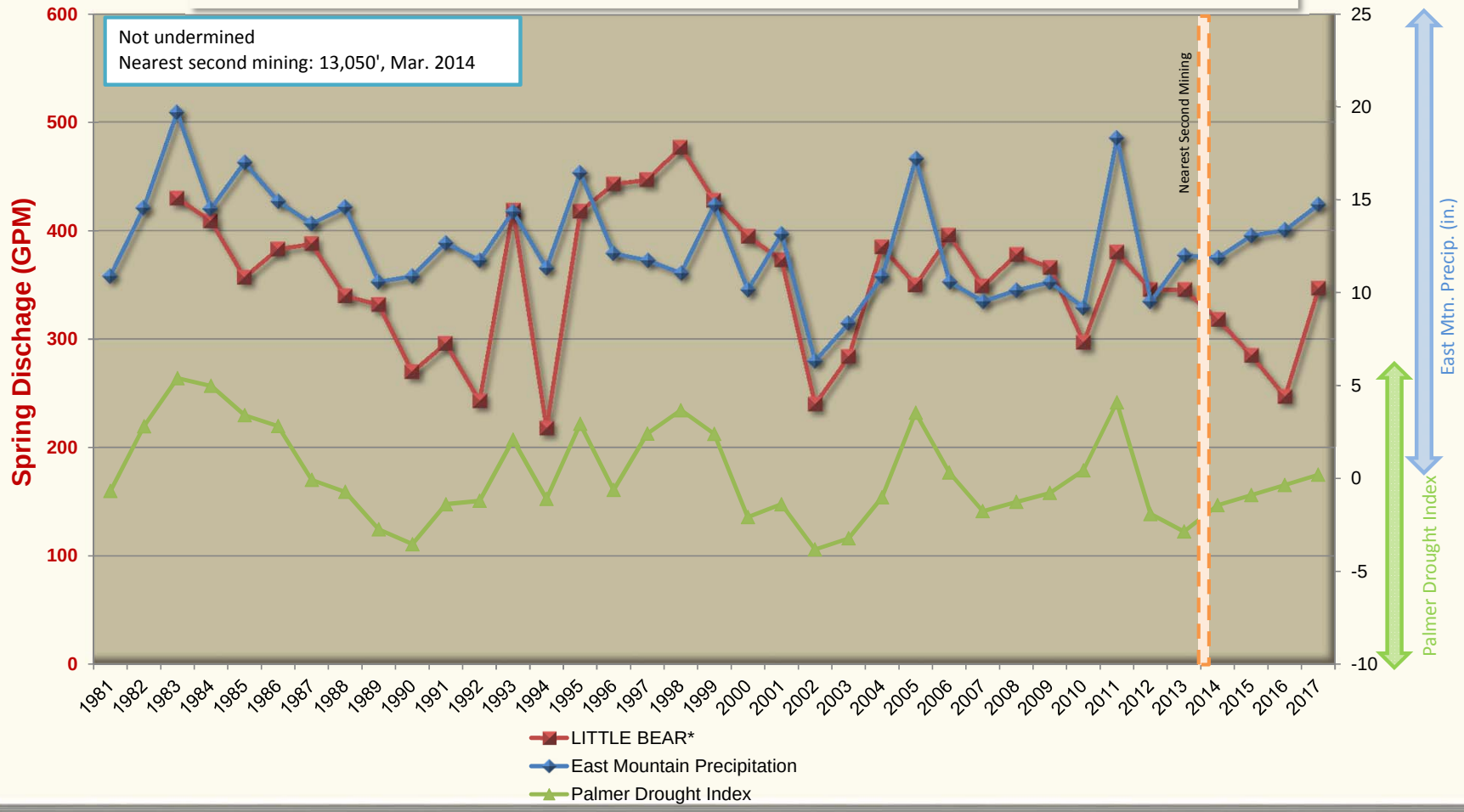


Little Bear Collection System

Little Bear Collection System

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: LITTLE BEAR SPRING vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: Little Bear
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 13,050'
Date of Nearest Mining: Mar. 2014

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	354	265	284.523	21	290	265	277.25	8	BICARBONATE
CALCIUM	68.85	63.45	66.4838	21	67.46	60.63	63.78	8	CALCIUM
CARBONATE	0	0	0	10	0	0	0	8	CARBONATE
CHLORIDE	6	3	3.95238	21	9	3	4.25	8	CHLORIDE
CONDUCTIVITY	650	559	592.142	21	596	526	576.625	8	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	387	270	338.1	14	347	247	294.625	8	FLOW
HARDNESS	330	294	315.571	21	321	293	306.5	8	HARDNESS
TOTAL IRON	0.21	0	2.66153	13	0.27	0	0.04625	8	TOTAL IRON
DISSOLVED IRON	0.006	0	5.45454	11	0	0	0	8	DISSOLVED IRON
MAGNESIUM	38.5	32.91	36.2995	21	38.17	33.28	35.75	8	MAGNESIUM
DISSOLVED MANGANESE	0.003	0	0.0003	10	0.008	0	0.00225	8	DISSOLVED MANGANESE
MANGANESE	0.007	0	6.36363	11	0	0	0	8	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	7.68	7.04	7.4138	21	7.67	7.39	7.50375	8	PH
POTASSIUM	3.4	1.36	1.65619	21	2.1	1.37	1.58125	8	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	11.2	6.41	7.29238	21	9.91	7.57	8.83875	8	SODIUM
SULFATE	41	31	36.9047	21	44	38	41.625	8	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.6	5.4	9.07	20	10.1	8.3	9.2125	8	TEMPERATURE
TOTAL DISSOLVED SOLIDS	356	298	324.523	21	383	311	335.625	8	TOTAL DISSOLVED SOLIDS

Deer Creek Mine
Federal Coal Lease UTU-88554 Full Lease Relinquishment
Appendix D

Evaluation of Impacts to Vegetation

Vegetation of Lease UTU-88554 is diverse, ranging from sagebrush, pinyon – juniper to brush, with groves of aspen trees and spruce - fir. A breakdown of vegetation type in the relinquishment area is shown below (mid-level vegetation provided by the Manti-LaSal National Forest Price Office):

Vegetation Types – UTU-88554:

Aspen	AS
Aspen/Conifer	AS/C
Bristlecone Pine/Limber Pine	BC/LM
Douglas Fir Mix	DFmix
Gambel Oak	GO
Mountain Big Sagebrush	MSB
Mountain Mahogany	MM
Mountain Shrubland	MS
Spruce/Fir	SF
Upland Herbaceous	UHE

Previous relinquishment documents submitted by PacifiCorp have included comparative sets of periodic infrared aerial photographs to detect changes in vegetation that might be related to mining. Until 2011, PacifiCorp had submitted aerial photographs on 1-year intervals and color infrared photographs on 5-year intervals. PacifiCorp attempted to detect changes in vegetation that might be caused by mining using both the color and color infrared images without success. The inability to detect changes in vegetation that might be caused by mining is due to several factors – spreading insect infestations in forests, forest fires, variations in precipitation from year to year, variations in the time of year when each set of photographs is taken, and the quality of the photographs themselves. These factors make it difficult or impossible to detect any changes that might be caused by mining activities. PacifiCorp amended the Deer Creek Mine permit to exclude this requirement in 2011; UDOGM approved the amendment on July 28, 2011 (see following correspondence and permit changes).

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

P.O. Box 310
15 North Main Street
Huntington, Utah 84528

July 7, 2011

Utah Division of Oil, Gas, and Mining
Utah Coal Program
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Subj: **Amendment to Remove the Commitment to Conduct Periodic Vegetation Surveys using Color and Color Infrared Aerial Photographs, Pacificorp, Deer Creek Mine, C/015/0018, Emery County, Utah**

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company ("Energy West") as mine operator, hereby submits an amendment to remove the commitment to conduct periodic vegetation surveys using color and color infrared photographs from the Deer Creek Mine Permit. Submission of this amendment is in response to the 2010 Annual Report Review Completion, Task ID #3793, requesting submission of aerial photography for vegetation monitoring purposes.

Energy West has had aerial photographs taken of the active mining areas in black and white every year, and color and color infrared every 5 years. Energy West has attempted to detect changes in vegetation that might be caused by mining by interpreting these sets of photographs without success. The inability to detect changes in vegetation that might be caused by mining using color and color infrared images is due to several factors - spreading insect infestations in forest stands, variations in precipitation from year to year, variations in the time of year when the photographs are taken, and the quality of the photographs themselves. These factors make it difficult or impossible to detect any changes that might be caused by mining activities. Aerial photography, whether color or color infrared, will no longer be used for this purpose.

This amendment includes changes in Volume 1 as outlined below. Please refer to redline/strikeout text herein:

- Volume 1, Part 2 Environmental Resources, page 2-174

A redline/strike copy of the amended page has been included with this submittal. The required C1/C2 forms are also included. If you have any question or concern with this submittal please feel free to call myself at (435) 687-4712 or Dennis Oakley at (435) 687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Manager of Geology and Environmental Affairs

Enclosures: C1/C2 Forms
Volume 1, Part 2 Environmental Resources, page 2-174

cc file

VEGETATION MONITORING PLAN - DEER CREEK MINE R645-301-321

The purpose of this monitoring plan is to define and establish a system to locate, measure, and quantify the progressive or regressive impacts ~~and final effects of the underground mining activities~~ on vegetation at the Deer Creek mine ~~on vegetation~~. The monitoring system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points located on surface areas ~~that will be impacted by underground mining~~. The monitoring shall be an extension of the baseline data as outlined in the Deer Creek PAP Volume 1.

Aerial photography taken annually up to present (2009) ~~will be~~ has been used for delineation of vegetative types, documentation of changes in vegetation and detection and monitoring of stressed vegetation. There has been no detected stress or any other impacts to vegetation using aerial photography.

Because stress to vegetation within the permit area is so much more subject to the natural forces in nature, (fire, insect infestation, drought, etc.) aerial photography will no longer be used.

~~Infrared photography was taken of impacted surface areas during September, 1987. This will be repeated in 1992 and continued on a five year schedule.~~ Reference area qualitative and quantitative monitoring at the Deer Creek Mine has been conducted at least on five year intervals in the past. Qualitative and quantitative monitoring was last conducted in 2007 and will continue on five year intervals through mine through reclamation and bond release.

~~Each vegetation type mapped and monitored will be based on a~~

~~dominant overstory and a dominant understory species to be consistent with Utah Southwestern Coal Region Data Adequacy Standards. The details of monitoring and analyses will be developed in cooperation with the US Forest Service.~~

The vegetation monitoring information for reference areas and reclamation sites ~~and an~~ will be evaluat~~ion~~ed ~~of the impacts of mining on vegetation will be~~ and submitted in an annual report following the year in which monitoring is conducted.

SOILS INFORMATION R645-301-200

Portal and support facility areas for the Deer Creek Mine are cut into steep, nearly perpendicular rock cliffs. The areas are dominated by rock outcrop, rubble land, and shallow soils.

Nowhere in the vicinity of the mine is there a source of material which would usually be referred to as "topsoil". Soil tests on the disturbed and undisturbed areas and coal waste show that the materials in the portal area should support selected vegetative materials. These test results, therefore, preclude the recommendation for procurement of topsoil for reclamation since the exposed materials are suitable growth media if properly managed. The one exception is that if during mining operations toxic substances are concentrated, it will be necessary to sample these areas periodically and take the necessary reclamation measures to dispose of or cover the areas in order to assure success of revegetation attempts. Results of soil analyses are summarized in Part 4, Reclamation Plan.

The applicant commits to fulfilling the requirements of

GARY R. HERBERT
Governor
GREGORY S. BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
MICHAEL R. STYLER
Executive Director
Division of Oil, Gas and Mining
JOHN R. BAZA
Division Director

July 28, 2011

Kenneth S. Fleck, Geology and Environmental Affairs Manager
Energy West Mining Company
P.O. Box 310
Huntington, Utah 84528

Subject: Final Approval, Deer Creek Mine, C/015/0018, Remove Vegetation Survey Commitment, Task ID #3869

Dear Mr. Fleck:

The above-referenced amendment was conditionally approved on July 21, 2011 upon receipt of 8 clean copies. We received the requested clean copies on July 28, 2011. Enclosed is a stamped incorporated copy for insertion into your copy of the Mining and Reclamation Plan.

Thank you for your help during this process. If you have any questions, please feel free to call me at (801) 538-5325.

Sincerely,

Daron R. Haddock
Coal Program Manager

DRH/sqs
Enclosure
cc: Kenneth Walker, OSM
Jeff McKenzie, BLM
Pam Brown, USFS
Larry Crist, USFWS w/o
Marc Stilson, Water Rights w/o
Dave Ariotti, DEQ w/o
Chris Wood, DWR w/o
Kevin Carter, TLA w/o
Price Field Office
O:\015018.DER\WG3869\FinApp.doc

1594 West North Temple, Suite 1210, PO Box 145801, Salt Lake City, UT 84114 -5801
telephone (801) 538-5340 • facsimile (801) 359-3940 • TTY (801) 538-7458 • www.ogm.utah.gov

UTAH DNR
OIL, GAS & MINING

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

P.O. Box 310
15 North Main Street
Huntington, Utah 84528

July 27, 2011

Utah Coal Program
Utah Division of Oil, Gas, and Mining
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Subj: Clean Copy Submittal for Task ID #3869, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company "Energy West" as mine operator, hereby submits the clean copies to the above approved amendment to update the Deer Creek Mine Mining and Reclamation Plan.

Actions to finalize this amendment include removing and/or replacing the noted pages. As noted above, all clean copy pages are included with this submittal. After stamping "Approved" on the clean copy pages, the Division needs to complete the following:

- Volume 1: Replace Page 2-174

Eight (8) complete clean copies of this amendment are submitted for Division certification. A C2 form is included for organization of removal or replacement of items into the Deer Creek MRP. If you have any questions concerning this amendment, please contact myself at 435-687-4712 or Dennis Oakley at 435-687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Geology and Environmental Affairs Manager

Cc: file

VEGETATION MONITORING PLAN - DEER CREEK MINE R645-301-321

The purpose of this monitoring plan is to define and establish a system to locate, measure, and quantify the progressive or regressive impacts on vegetation at the Deer Creek mine. The monitoring system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points located on surface areas. The monitoring shall be an extension of the baseline data as outlined in the Deer Creek PAP Volume 1.

Aerial photography taken annually up to present (2009) has been used for delineation of vegetative types, documentation of changes in vegetation and detection and monitoring of stressed vegetation. There has been no detected stress or any other impacts to vegetation using aerial photography.

Because stress to vegetation within the permit area is so much more subject to the natural forces in nature, (fire, insect infestation, drought, etc.) aerial photography will no longer be used.

Reference area qualitative and quantitative monitoring at the Deer Creek Mine has been conducted at least on five year intervals in the past. Qualitative and quantitative monitoring was last conducted in 2007 and will continue on five year intervals through mine through reclamation and bond release.

The vegetation monitoring information for reference areas and reclamation sites will be evaluated and submitted in an annual report following the year in which monitoring is conducted.

SOILS INFORMATION R645-301-200

Portal and support facility areas for the Deer Creek Mine are cut into steep, nearly perpendicular rock cliffs. The areas are

INCORPORATED
JUL 28 2011
Div. of Oil, Gas & Mining

Replaced

VEGETATION MONITORING PLAN - DEER CREEK MINE R645-301-321

The purpose of this monitoring plan is to define and establish a system to locate, measure, and quantify the progressive and final effects of the underground mining activities at the Deer Creek mine on vegetation. The monitoring system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points located on surface areas that will be impacted by underground mining. The monitoring shall be an extension of the baseline data as outlined in the Deer Creek PAP Volume 1.

Aerial photography taken annually will be used for delineation of vegetative types, documentation of changes in vegetation and detection and monitoring of stressed vegetation.

Infrared photography was taken of impacted surface areas during September, 1987. This will be repeated in 1992 and continued on a five year schedule.

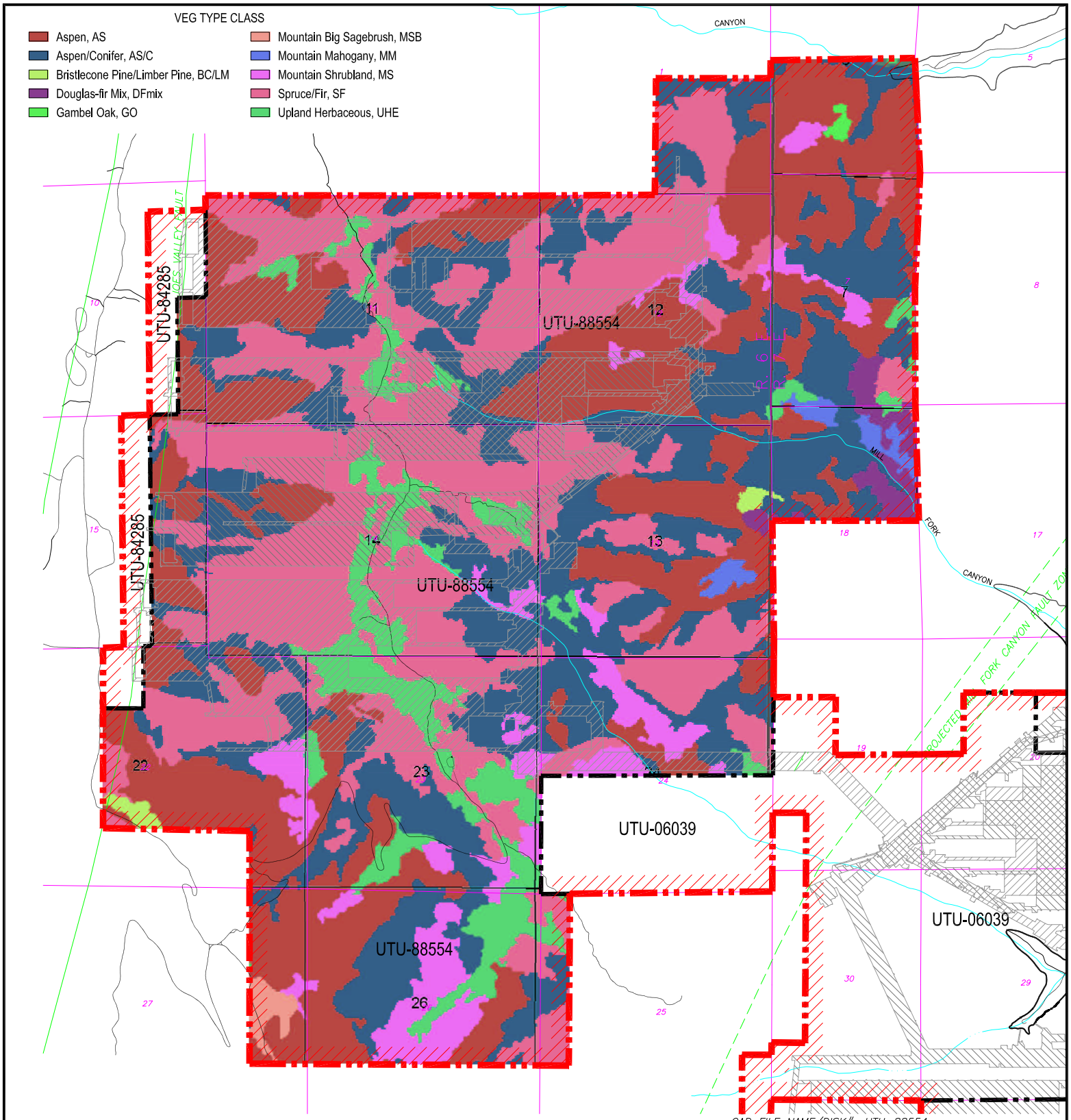
Each vegetation type mapped and monitored will be based on a dominant overstory and a dominant understory species to be consistent with Unita-Southwestern Coal Region Data Adequacy Standards. The details of monitoring and analyses will be developed in cooperation with the US Forest Service.

The vegetation monitoring information and an evaluation of the impacts of mining on vegetation will be submitted in an annual report following the year in which monitoring is conducted.

SOILS INFORMATION R645-301-200

Portal and support facility areas for the Deer Creek Mine are cut into steep, nearly perpendicular rock cliffs. The areas are

Based on PacifiCorp's observations, no mining-related impacts to vegetation have been witnessed observed or reported in the UTU-88554 area. There were no surface facilities or installations on this lease.



CAD FILE NAME/DISK#: UTU-88554

LEGEND

- LMU BOUNDARY UTU-73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-88554 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
VEGETATION BASE MAP

DRAWN BY: K. LARSEN	APPENDIX D	
SCALE: 1" =3000'	DRAWING #:	
DATE: APRIL 16, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-88554 Full Lease Relinquishment
Appendix E

Evaluation of Impacts to Private Improvements

There are two private surface improvements in Lease UTU-88554. The first of these is the 345 KV power transmission line that crosses the southwest corners of the lease. It is owned by PacifiCorp / Rocky Mountain Power. Two separate studies of the potential subsidence beneath this line were conducted in 1997 and 2004. The power line crosses the southwest corners of the lease, where underground mining did not reach.

The gas well Federal 32-23, located near the center of Section 23, T.16 S., R. 6 E. was surveyed and observed during nearby longwall mining in 2005. Minor subsidence occurred with no effect on the well.

To the best of the knowledge of the lessee through due inquiry including reconnaissance flights, subsidence surveys and periodic surface topography inspections, there are no mining-related impacts associated with the Deer Creek Mine to any private surface improvements on the lease area being relinquished.

Appendix "F"

ENVIRONMENTAL AND CERCLA CERTIFICATION

CERCLA certification documents for sealing various districts of panels within the UTU-88554 lease have been submitted when those districts were sealed. Previous CERCLA inspections within UTU-88554 have taken place in March 2008, April 2009, September 2010, October 2014, February 2015, March 2015, and November, 2017. CERCLA documents for the remaining portions of the mine workings sealed and abandoned in 2017 are included with this relinquishment request.

On November 29, 2017, a hazardous/toxic waste inspection was conducted underground at Deer Creek Mine to clear the remaining open areas of the mine for permanent sealing. Full documentation of this inspection is included.

UPDES discharge water quality information derived from UPDES DMR submittal forms is presented here in graph form. The original monthly UPDES DMR reports were filed with Utah Division of Oil, Gas, and Mining, Utah Division of Water Quality, and the Environmental Protection Agency.

ENVIRONMENTAL AND CERCLA CERTIFICATION

Submittal Date: 5-29-2018

Lease(s) # UTU-88554 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains, 24th through 27th West Sections and Remainder of Mine Workings

Coal Bed: Blind Canyon and Hiawatha Coal Seams

The Environmental Protection Agency promulgated final regulations to implement requirements established in Section 120(h) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by Superfund Amendments Reauthorization Act (SARA). Under section 120(h), whenever a Federal agency enters into any contract/agreement for the sale or transfer of public land/real property, and on which any hazardous substance was stored for one year or more, or known to have been released or disposed of, the contract (conveyance document) must include notice of the type and quantity of such hazardous substance, and the time at which such storage, release or disposal was originated. This final rule making became effective October 17, 1990.

Federal coal leases, if developed, result in the operator conducting mining operations on all or parts of the Federal lands. The lessee/operator, under appropriate circumstances, may utilize hazardous substances on the surface or underground on Federal lands. At the time of lease relinquishment, or at the time of any sealing or potentially sealing operation conducted by a Federal lessee, it is necessary for the lessee to inform the BLM and any other surface managing agency of any activities of a lessee that might be subject to CERCLA notification. This information will be utilized to satisfy the requirements under Section 120(h) of CERCLA as amended by SARA.

BLM requires the following information to the extent it is applicable to the Federal coal lease relinquishment area, area or any time that a mining operation seals or places structures possibly sealing an area. BLM will make the company proprietary information public only upon transfer or exchange of the affected lands.

Explanation:
Items 1-5 deal with hazardous substances and environmental issues. Item 6 is a CERCLA certification by an officer of the lessee. Suggested formats follow.

Required Information:

1. A list of any hazardous substances as defined in SARA Title III Consolidated List (40 CER 302.4) used on the lease (by date) or products that contain such substances. This shall include all hazardous substances and materials along with their Chemical Abstract Services Registry Numbers (CASRN), and petroleum based oil and other petroleum products that were used, stored or delivered to the lease. Quantities at this time are not necessary. This is for disclosure purposes only.

2. A copy of all reports of spills occurring on the lease or sealed area.

3. A copy of all reports submitted to the State of Utah listing any spill of petroleum based oil or other petroleum products on the lease exceeding 25 gallons or that cause a threat to human health or the environment.

4. A mine map covering the lease showing the location, type and model of any equipment or machinery that is known to be remaining underground. (this does not include materials and supplies, and hand tools). For every piece of equipment that will be left underground upon lease cessation of operations, please list the quantities of oil, batteries, or other fluids that are remaining, or could be remaining in the equipment.

5. A summary analysis of water quality reports showing whether or not the water quality has been affected by mining. The data that has been collected throughout the years should be the basis for this summary report. The UPDES/NPDES discharge permit requirements for the mine and copies of certifications or samples to show that these requirements have not been exceeded should be part of this analysis. The analysis should compare the water quality at the time of cessation of operations with the water quality that existed prior to mining in the base line analysis. This shall be for all waters that are affected by mining. The company should list any mitigation that was done to alleviate any water quality concerns.

6. An officer of the lessee shall sign and submit a certificate in the form attached for each lease or portion thereof where operations have ceased.

a. Based upon a complete search of all known records of the lessee(s), sublessee(s) and operator(s) (i) for the specified lease or portion thereof relinquished, operations ceased or sealed and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed; and upon our knowledge of past operations, there have been no reportable quantities of hazardous substances (per 40 CFR 302.4) and Part 373 or used oil (per Utah State Management Rule R-3 15-15), deposited or released within the lease, either on the surface or underground that will harm human health and the environment with respect to any such substances remaining on the property.

b. Based upon a complete search of all known records for the lessee(s), sublessee(s) and operator(s) for the specified lease or portion thereof relinquished, operations ceased or sealed and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed; and upon our knowledge of past operations, there has been a release or disposal of a reportable quantity of **hazardous substance** (per 40 CFR 302.4) and Part 373 or **used oil** (per Utah State Management Rule R-315-15) on the surface of the lease or underground, and all remedial action necessary has been taken to protect human health ~ and the environment with respect to any such substances remaining on the property. This shall be documented with sample analytical data from the remediation or removal process.

(Officer of the Lessee) 5/29/18 (Date)

HAZARDOUS SUBSTANCE REPORT

Submittal Date: 5-29-2018

Lease(s) # _ UTU-88554 Full Relinquishment
Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains, 24th through 27th West Sections and Remainder of Mine Workings

Coal Bed _Blind Canyon and Hiawatha Coal Seams _

Hazardous Substance / Product	**Date Utilized**	**CASRN** (if applicable)	**Location Used** (Cross-cut if known)
None Spilled -			
See Attached CASRN List			

Hazardous Substance Report CERCLA Page One of Two
Lease(s) UTU-88554
Deer Creek Mine - MSHA # 42-00121
Sealed Mine Sections: Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains
24th - 27th West Sections (Longwall Panels 25th, 26th, 27th West), and remainder of mine workings

Coal Bed Hiawatha Seam

Note: While these substances were likely transported into, used, or stored in the referenced leases during the time interval shown, (11/05 - 01/15) there are no reports or evidence that any of these substances were spilled or left within the sealed area. No complete list exists that shows all hazardous materials transported into, used, or stored within the referenced area.

Product Name	Date Utilized	Hazardous Ingredient Name	Component Percentage	CASRN	Location Used
D Cell Nickel Cadmium Battery, 4.8 VDC	12/03 - 12/17	Nickel and Nickel Hydroxide	20 - 32%	Unknown	All Sections
	12/03 - 12/17	Cadmium and Cadmium Hydroxide	13 - 22%	Unknown	All Sections
	12/03 - 12/17	Sodium Hydroxide	0 - 4%	Unknown	All Sections
	12/03 - 12/17	Potassium Hydroxide	0 - 4%	Unknown	All Sections
	12/03 - 12/17	Cobalt Hydroxide	0.5 - 2%	Unknown	All Sections
Chevron Superla White Oil	12/03 - 12/17	White Mineral Oil	100%	8042-47-5	All Sections
Blaster PB Penetrating Catalyst	12/03 - 12/17	Naptha	40 - 50%	64742-94-5	All Sections
	12/03 - 12/17	Petroleum Distillates, hydrotreated	30 - 40%	64742-47-8	All Sections
	12/03 - 12/17	Petroleum Distillates, solvent-dewaxed	20 - 30%	64742-65-0	All Sections
	12/03 - 12/17	Alcohols, C11-15 secondary ethoxylated	0 - 3%	68131408	All Sections
	12/03 - 12/17	Carbon Dioxide Propellant	0 - 3%	124389	All Sections
Krylon Spray Paints	12/03 - 12/17	Propane	14%	74-98-6	All Sections
	12/03 - 12/17	Butane	13%	106-97-8	All Sections
	12/03 - 12/17	Toluene	17%	108-88-3	All Sections
	12/03 - 12/17	Medium Aromatic Hydrocarbons	3%	64742-94-5	All Sections
	12/03 - 12/17	Napthalene	0.40%	91-20-3	All Sections
	12/03 - 12/17	Acetone	41%	67-64-1	All Sections
	12/03 - 12/17	Ethyl 3-Ethoxypropionate	4%	763-69-9	All Sections
Hand Cleaner, Brody Chemical	12/03 - 12/17	Aliphatic Petroleum Distillate	25 - 35%	64742-96-7	All Sections
RD-90 Spray Lubricant	12/03 - 12/17	Petroleum Lube Oil	10 - 20%	64742-65-0	All Sections
	12/03 - 12/17	Deodorized Kerosene	30 - 40%	64742-47-8	All Sections
	12/03 - 12/17	Mineral Oil	20 - 25%	8042-47-5	All Sections
	12/03 - 12/17	Mineral Spirits	5 - 10%	64741-65-7	All Sections
	12/03 - 12/17	Liquified Petroleum Gas	10 - 20%	68476-85-7	All Sections
Extreme Blue Windshield Washer Fluid	12/03 - 12/17	Methanol	<20%	67-56-1	All Sections
	12/03 - 12/17	Denatonium Benzoate	<2%	3734-33-6	All Sections
Carquest Starting Fluid	12/03 - 12/17	Heptane	69 - 79%	142-82-5	All Sections
	12/03 - 12/17	Ethyl Ether	11 - 21%	60-29-7	All Sections
	12/03 - 12/17	Carbon Dioxide	1 - 11%	124-38-9	All Sections
	12/03 - 12/17	Hexane	2.80%	110-54-3	All Sections
Blend #0019A Premium Starting Fluid	12/03 - 12/17	Heptane	60 - 70%	142-82-5	All Sections
	12/03 - 12/17	Ethyl Ether ACS Reagent Grade	23 - 33%	60-29-7	All Sections
	12/03 - 12/17	Carbon Dioxide	1 - 11%	124-38-9	All Sections
Diesel Engine Oil	12/03 - 12/17	Zinc Dithiophosphate	<2.5%	68649-42-3	All Sections
Cat Hydraulic Oil SAE 10W	12/03 - 12/17	None			All Sections
Cat Transmission and Drive Train Oil	12/03 - 12/17	None			All Sections
Solcenic 3B-BLK (Emulsion Oil)	12/03 - 12/17	Monoethanolamine	<10%	141-41-3	All Sections
	12/03 - 12/17	Triethanolamine	<5%	102-71-6	All Sections
Chevron Delo 400	12/03 - 12/17	Mineral Oil	70 - 95%	Mixture	All Sections
	12/03 - 12/17	Zinc alkyl dithiophosphate	1 - 5%	68649-42-3	All Sections
Conoco HD Fleet Engine Oil	12/03 - 12/17	Lubricant base oil	87 - 91%	Various	All Sections
	12/03 - 12/17	Zinc Compounds	1.0 - 1.5%	Proprietary	All Sections
	12/03 - 12/17	Additives	9 - 13%	Proprietary	All Sections
Conoco Transformer Oil	12/03 - 12/17	Hydrotreated dist., Lt. Napthenic	>99%	64742-53-6	All Sections
	12/03 - 12/17	Additives	<1%	Proprietary	All Sections
Contact Cleaner 2000	12/03 - 12/17	Decafluoropentane (HFC-43-10mee)	5 - 15%	138495-42-8	All Sections
	12/03 - 12/17	Cozol 401	80 - 95%	Proprietary Blend	All Sections
	12/03 - 12/17	Carbon Dioxide	3 - 8%	124-38-9	All Sections
Heavy Duty Degreaser	12/03 - 12/17	Trichloroethylene	95 - 99%	79-01-6	All Sections
	12/03 - 12/17	1,2 Butylene Oxide	0.50%	106-88-7	All Sections
	12/03 - 12/17	Carbon Dioxide	1 - 5%	124-38-9	All Sections
Shellzone All-Season Antifreeze/Coolant	12/03 - 12/17	Ethylene Glycol	90 - 98%	107-21-1	All Sections
	12/03 - 12/17	Deionized Water	1 - 3%	7732-18-5	All Sections
	12/03 - 12/17	Phosphoric Acid	1 - 3%	7664-38-2	All Sections

Hazardous Substance Report CERCLA Page Two of Two
Lease(s) UTU-88554, UTU-84285
Deer Creek Mine - MSHA # 42-00121
Sealed Mine Sections: Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North mians, 10th North Mains 24th - 27th West Sections (Longwall Panels 25th, 26th, 27th West), and remainder of mine workings

Coal Bed Hiawatha Seam

Note: While these substances were likely transported into, used, or stored in the referenced leases during the time interval shown, (11/05 - 01/15) there are no reports or evidence that any of these substances were spilled or left within the sealed area. No complete list exists that shows all hazardous materials transported into, used, or stored within the referenced area.

Product Name	Date Utilized	Hazardous Ingredient Name	Component Percentage	CASRN	Location Used
Holcim Portland Cement	12/03 - 12/17	Tri-calcium silicate	20 - 70%	12168-85-3	All Sections
	12/03 - 12/17	Di-calcium silicate	10 - 60%	10034-77-2	All Sections
	12/03 - 12/17	Tetra-calcium-alumino-ferrite	5 - 15%	12068-35-8	All Sections
	12/03 - 12/17	Calcium sulfate	2 - 10%		All Sections
	12/03 - 12/17	Tri-calcium aluminate	1 - 15%	12042-78-3	All Sections
	12/03 - 12/17	Magnesium oxide	0 - 4%	1309-48-4	All Sections
	12/03 - 12/17	Crystalline silica (quartz)	0 - 1%	14808-60-7	All Sections
	12/03 - 12/17	Hexivalent chromium		18540-29-9	All Sections
Shot-Set 250 Liquid Accelerator	12/03 - 12/17	Silicic Acid, Sodium Salt	1%	1344-09-S	All Sections
Johnson Controls Lead-Acid Battery	12/03 - 12/17	Lead	34%	7439-92-1	All Sections
	12/03 - 12/17	Lead Dioxide	31%	1309-60-0	All Sections
	12/03 - 12/17	Lead Sulfate	<1%	7446-14-2	All Sections
	12/03 - 12/17	Sulfuric Acid (35%)	34%	7664-93-9	All Sections
Johnsens Heavy Duty DOT 3 Brake Fluid	12/03 - 12/17	Diethylene Glycol Monobutyl Ether	5 - 20%	112-34-5	All Sections
	12/03 - 12/17	Triethylene Glycol	6 - 25%	112-35-6	All Sections
	12/03 - 12/17	Triethelyne Glycol Monoethyl Ether	6 - 25%	112-50-5	All Sections
	12/03 - 12/17	Triethylene Glycol Monobutyl Ether	20 - 39%	143-22-6	All Sections
	12/03 - 12/17	Tetraethylene Glycol Monobutyl Ether	5 - 20%	1559-34-8	All Sections
	12/03 - 12/17	Polyalkylene Glycol Monomethyl Ether	5 - 20%	23783-42-8	All Sections
	12/03 - 12/17	Polyethylene Glycol	5 - 20%	25322-68-3	All Sections
	12/03 - 12/17	Polyethylene glycol monobutyl ether	5 - 20%	9004-77-7	All Sections
	12/03 - 12/17	Polyalkylene Glycols	5 - 20%	9038-95-3	All Sections
	12/03 - 12/17	Diethylene Glycol	5 - 15%	111-46-6	All Sections
	12/03 - 12/17	Diethylene Glycol Monomethyl Ether	<5%	111-90-0	All Sections
Koehler Bright Star Lamp Battery Fluid	12/03 - 12/17	Sulfuric Acid (38%)	100%	7664-93-9	All Sections
Q-Bond Surface Bonding Cement	12/03 - 12/17	Portland Cement		65997-15-1	All Sections
	12/03 - 12/17	Crystalline Silicon Dioxide		13397-24-5	All Sections
	12/03 - 12/17	Calcium Hydroxide		001-305-620	All Sections
	12/03 - 12/17	Calcium Stearate		1592-23-0	All Sections
Roklok 70A	12/03 - 12/17	Polymethylene polyphenyl isocyanate	100%	009016-87-9	15 W
Roklok 70B	12/03 - 12/17	Polyglycols	60 - 100%	Mixture (2)	15 W
	12/03 - 12/17	Dimethylene Glycol	10 - 30%	111-46-6	15 W
Minova Lokset Resin Cartridge	12/03 - 12/17	Calcium Carbonate	60 - 100%	1317-65-3	All Sections
	12/03 - 12/17	Polyester Resin	5 - 15%	Not Reported	All Sections
	12/03 - 12/17	Styrene Monomer	3 - 7%	100-42-5	All Sections
	12/03 - 12/17	Diethylene Glycol	0.5 - 1.5%	57-55-6	All Sections
	12/03 - 12/17	Benzoyl Peroxide	0.5 - 1.5%	94-36-0	All Sections
Foamy Engine Bright Engine Cleaner	12/03 - 12/17	2-Butoxyethanol	2 - 10%	111-76-2	All Sections
	12/03 - 12/17	Aromatic Petroleum Naphtha	2 - 10%	64742-95-6	All Sections
	12/03 - 12/17	Isobutane	2 - 10%	75-28-5	All Sections
	12/03 - 12/17	Petroleum Base Oil	2 - 10%	8008-20-6	All Sections
	12/03 - 12/17	Propane	2 - 10%	74-98-6	All Sections
WD-40 Aerosol	12/03 - 12/17	Aliphatic Hydrocarbon	45 - 50%	64742-47-8	All Sections
	12/03 - 12/17			64742-48-9	All Sections
	12/03 - 12/17			64742-88-7	All Sections
	12/03 - 12/17	Petroleum Base Oil	15 - 25%	64742-65-0	All Sections
	12/03 - 12/17	LVP Aliphatic Hydrocarbon	12 - 18%	64742-47-8	All Sections
	12/03 - 12/17	Carbon Dioxide	2 - 3%	124-38-9	All Sections
Conoco Super Hydraulic Oil (all grades)	12/03 - 12/17	Lubricant base oil	>99	Various	All Sections
	12/03 - 12/17	Additives	<1	Proprietary	All Sections
Conoco Power Tran Fluid	12/03 - 12/17	Lubricant base oil	87 - 91%	Various	All Sections
	12/03 - 12/17	Zinc Compounds	1.0 - 1.5%	Proprietary	All Sections
	12/03 - 12/17	Additives	9 - 13%	Proprietary	All Sections
Powergear EP 5 - 35LB MPL	12/03 - 12/17	Mineral Oil	>95%	Proprietary	All Sections

CERCLA CERTIFICATION

Lease(s) # _ UTU-88554 Full Relinquishment
Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains, 24th through 27th West Sections and Remainder of Mine Workings

Coal Bed: Blind Canyon and Hiawatha Coal Seams

a. Based upon a complete search of all known records of the lessee(s), sublessee(s) and operator(s) (i) for the specified lease or portion thereof relinquished, sealed or potentially sealed, and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed or potentially sealed; and upon our knowledge of past operations, there have been **no** reportable quantities of **hazardous substances** (per 40 CFR 302.4) and Part 373 or **used oil** (per Utah State Management Rule R-315-15), deposited or released within the lease, either on the surface or underground that will harm human health and the environment with respect to any such substances remaining on the property.

b. Based upon a complete search of all known records for the lessee(s), sublessee(s) and operator(s) for the specified lease or portion thereof relinquished, operations ceased or sealed and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed; and upon our knowledge of past operations, there has been a release or disposal of a reportable quantity of **hazardous substance** (per 40 CFR 302.4) and Part 373 or **used oil** (per Utah State Management Rule R-315-15) on the surface of the lease or underground, and all remedial action necessary has been taken to protect human health ~ and the environment with respect to any such substances remaining on the property. This shall be documented with sample analytical data from the remediation or removal process.

(Officer of the Lessee) 5/29/18 (Date)

PETROLEUM PRODUCT REPORT

Submittal Date 5-29-2018

Lease(s) # UTU-88554 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains, 24th through 27th West Sections and Remainder of Mine Workings

Coal Bed Blind Canyon and Hiawatha Coal Seams

Oil or Petroleum product spilled	**Date spilled**	**Amount Spilled** (If > 25 gallons)	**Location Spilled** (Cross-cut if known)
None			

EQUIPMENT REMAINING UNDERGROUND REPORT

Submittal Date: 5-29-2018

Lease(s) # UTU-88554 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains, 24th through 27th West Sections and Remainder of Mine Workings

Coal Bed Blind Canyon and Hiawatha Coal Seams

Equipment name & model number	**Date Inspected**	**Fluid types/batteries and amount**	**Final location** (Cross-cut if known)
See Attached List			

Deer Creek Mine

Federal Lease UTU-88554 Full Lease Relinquishment

Equipment Remaining In Lease UTU-88554 as of December 20, 2017

Pumps and D-Boxes, Grouped by Location

Description	HP	Location
27th West		
D/Box		27W X80
D/Box		27W X84
D/Box		27W X88
Pump	6.4	27W X84 #2
26th West		
D/Box		26W X41 #1
D/Box		26W X44 #1
D/Box		26W X45 #1
D/Box		26W X49 #1
D/Box		26W X49
D/Box		26W X57 (322)
D/Box		26W X57 (218)
D/Box		26W X57 (065)
D/Box		26W X61
Pump	6.4	26W X32 #2
Pump	5	26W X34 #1
Pump	5	26W X39 #1

Pump	6.4	26W X41 #1
Pump	5	26W X43 #1
Pump	6.4	26W X45 #1
Pump	6.4	26W X48 #1
Pump	6.4	26W X50 #1
Pump	6.4	26W X56 #1
Pump	6.4	26W X56 #2
Pump	6.4	26W X57 O/C
Pump	6.4	26W X58 #1
Pump	6.4	26W CR 27-26
Pump	6.4	26W X61#1
Pump	6.4	26W X65

25th West

D/Box	25W X14 (2540)
D/Box	25W X14 (3399)
D/Box	25W X23
D/Box	25W X25 (114)
D/Box	25W X25 (1396)
D/Box	25W X30
D/Box	25W X35
D/Box	25W X42
D/Box	25W X45
D/Box	25W X51
D/Box	25W X56

Pump	13	25W X15 #2
Pump	6.4	25W X18 #2
Pump	5	25W X23 #2
Pump	6.4	25W X26.5 #2
Pump	6.4	25W X30.5 #2
Pump	6.4	25W X34 #2
Pump	6.4	25W X42 #2
Pump	6.4	25W X45 #2
Pump	5	25W X51 #2
Pump	6.4	25W X56 #2
Pump	6.4	25W X57 #2

24th West Upper

D/Box		24W X58
D/Box		24W X63
D/Box		24W X68
D/Box		24W X74
D/Box		24W X79
D/Box		24W X87
D/Box		24W X91
D/Box		24W X92
D/Box		24W X94
Pump	28	24W X57 #1
Pump	13	24W X64 #1
Pump	5	24W X69 #1

Pump	13	24W X75 tub
Pump	5	24W X80 #1
Pump	6.4	24W X87 #1
Pump	5	24W X90 #1
Pump	13	24W X92 s
Pump	6.4	24W X95 #1
Pump	13	24W X95 #1B

<u>24th West Lower</u>

D/Box		24W X16
D/Box		24W X27
D/Box		24W X31 (050)
D/Box		24W X31 (116)
D/Box		24W X35 (110)
D/Box		24W X35 (022)
D/Box		24W X42
D/Box		24W X50
D/Box		24W X57
Pump	6.4	24W X14 #1
Pump	28	24W X32 #1
Pump	6.4	24W X32 #1
Pump	5	24W X34 #1
Pump	5	24W X36 #1
Pump	5	24W X42 #1
Pump	5	24W X46 #1

Pump	6.4	24W X57 #2
Pump	6.4	24W X57 #2

SUMMARY WATER ANALYSIS REPORT

Lease(s) # _UTU-88554 Full Relinquishment

Mine Name and MSHA Mine #_Deer Creek Mine #42-00121_

Mine Section (if applicable) Mill Fork Access #2, 7th North Bypass #1 & #2, 7th North Mains, 9th North Mains, 10th North Mains, 24th through 27th West Sections and Remainder of Mine Workings

Coal Bed _Blind Canyon and Hiawatha Coal Seams _

Dates: 11/05 – 01/15 (No Mine Discharge Since 1/15)

Submittal Date: 5-29-2018

SUMMARY WATER ANALYSIS REPORT

DEER CREEK MINE

Federal Lease UTU-88554 and UTU-84258
Lease Relinquishment

Mine ID
Utah Pollution Discharge Elimination System (UPDES) Permit Data
- **Quantity - Historical Data**
- **Quality - Historical Data (UPDES Parameters)**
  - **Total Suspended Solids**
  - **Iron (Total & Dissolved)**
  - **Oil & Grease**
  - **Total Dissolved Solids**
  - **Ph**

UPDES Permit Data:

Deer Creek Mine UPDES Permit: UT0023604
Mine Discharge - Site 002
Permit Renewed on February 1, 2015
Permit Expires on January 31, 2020

Permit Limitations (water discharged to Deer Creek Drainage):

Deer Creek Mine Water Discharge Site 002

	Effluent Limitations				Monitoring Requirements	
Effluent Characteristics	**Average 30 - Day**	**Average 7 - Day**	**Daily Minimum**	**Daily Maximum**	**Measurement Frequency**	**Sample Type**
Flow, MGD	5.0 MGD	NA	NA	NA	Monthly	Measured
Total Suspend Solids, mg/l	15	25	NA	NA	Monthly	Grab
Total Iron, mg/l	NA	NA	NA	1.0	Monthly	Grab
Oil & Grease, mg/l	NA	NA	NA	10	Monthly	Grab
TDS, mg/l	NA	NA	NA	1200	Monthly	Grab
pH, Units	NA	NA	6.5	9.0	Monthly	Grab
Sanitary Waste	NA	NA	NA	None	Monthly	Visual
Oil and Grease, floating, visible foam	NA	NA	NA	None	Monthly	Visual

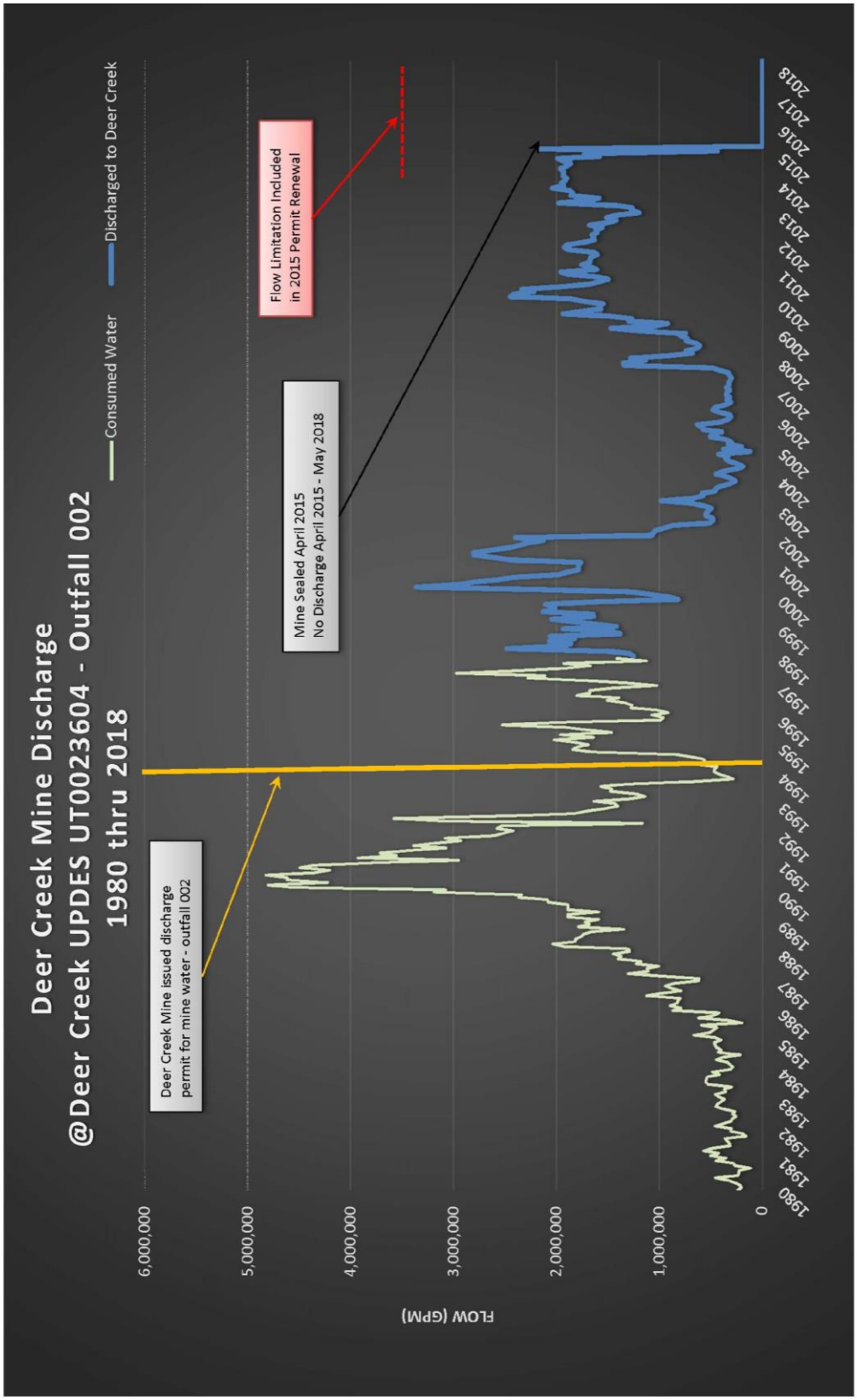
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Mine Water Discharge Site 002: 1980 – 2017

Mine Discharge Quantity



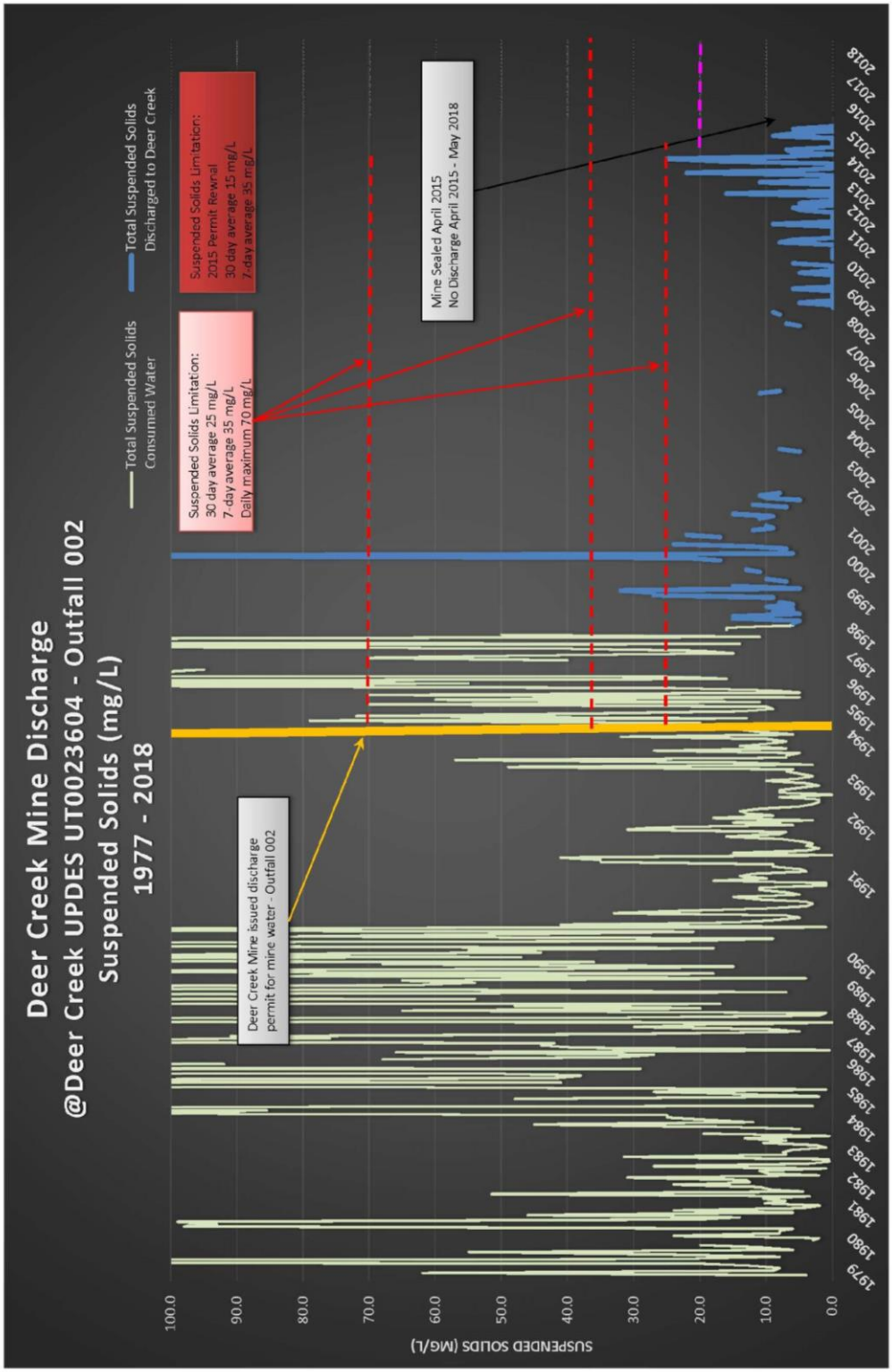
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Water Discharge Water Quality

Parameter: Total Suspended Solids



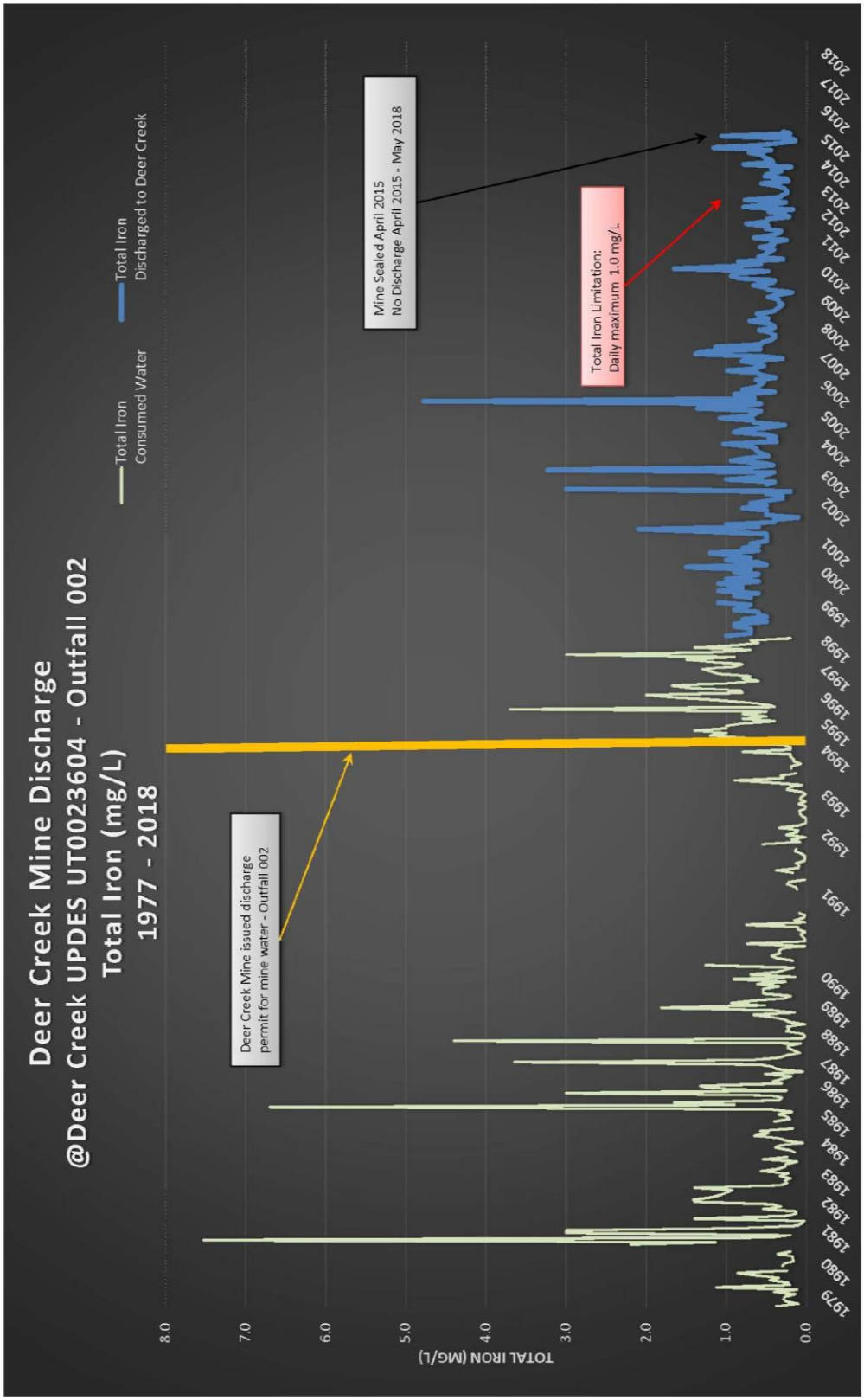
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Mine Water Discharge Water Quality

Parameter: Total Iron



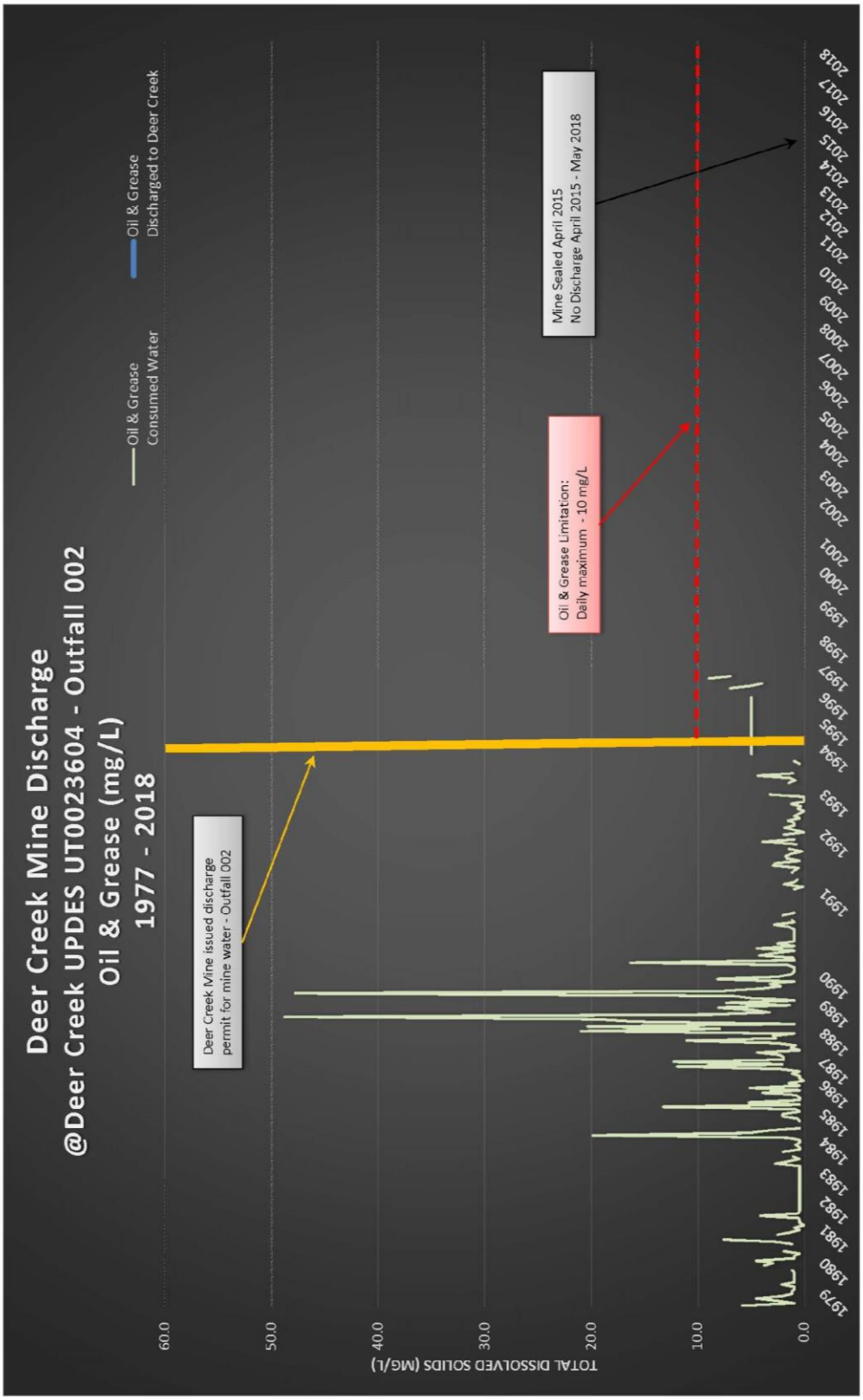
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Mine Water Discharge Water Quality

Parameter: Oil & Grease



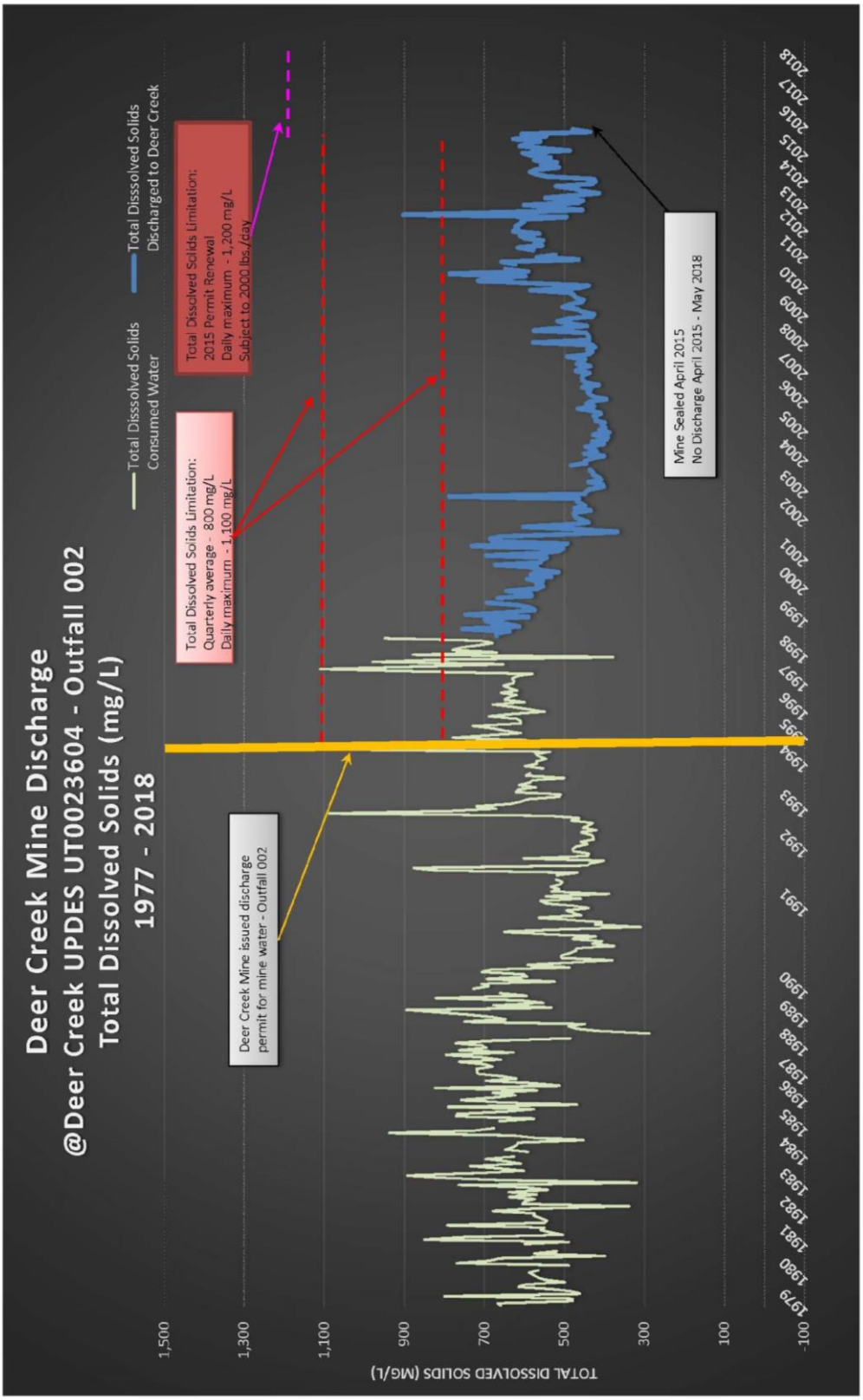
MINE ID

DEER CREEK MINE

UPDES - 23604

Deer Creek Mine Water Discharge Water Quality

Parameter: Total Dissolved Solids



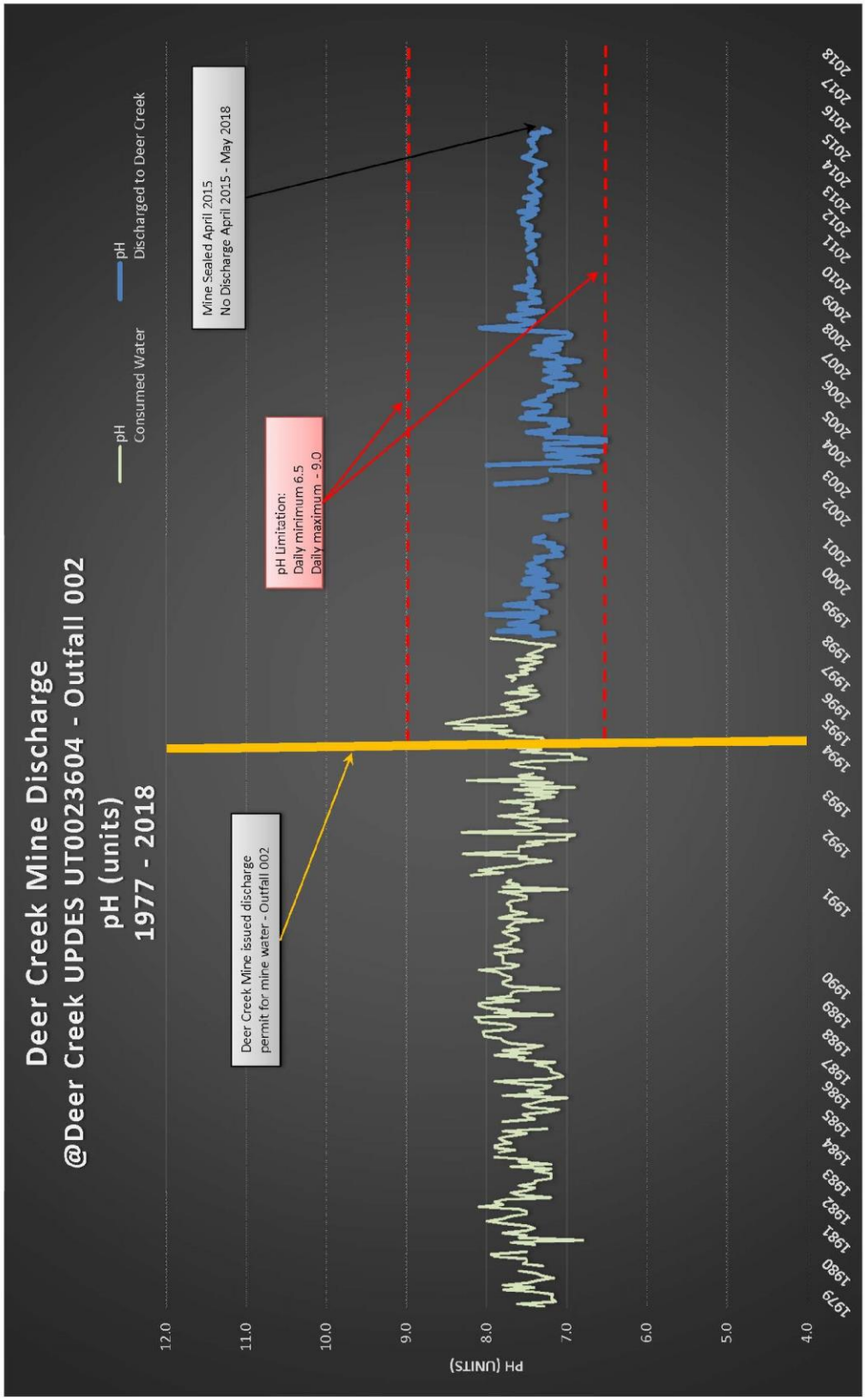
MINE ID

DEER CREEK MINE

UPDES - 23604

Deer Creek Mine Water Discharge Water Quality

Parameter: pH



Full Relinquishment
Federal Coal Lease
UTU-84285

May, 2018

Prepared by:

Managing Agent
1407 West North Temple, Suite 110
Salt Lake City, UT 84116

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

1407 W. North Temple, Suite 110
Salt Lake City, UT 84116

HAND DELIVERED

May 29, 2018

RECEIVED
MAY 30 2018
Bureau of
Land Management

Kent Hoffman
Deputy State Director
United States Department of the Interior
Bureau of Land Management
Utah State Office
440 West 200 South, Suite 500
Salt lake City, Utah 84101-1345

RE: Overview of Federal Coal Lease Relinquishment Project (20 Federal Leases) East Mountain Logical Mining Unit UTU-73336, Deer Creek and Cottonwood Mines, Emery County, Utah

Dear Mr. Hoffman:

By letter dated February 19, 2018, and on behalf of PacifiCorp, we provided our advance notice of intent to relinquish all or portions of the federal coal leases within the East Mountain Logical Mining Unit (LMU) UTU-73336, with the commitment to eventually provide individual formal federal coal lease relinquishment notices to your office to bring an end to the final chapter to this LMU.

Background and Purpose of Relinquishment

With PacifiCorp's decision and announcement on December 15, 2014, to close the Deer Creek Mine and end production from the LMU, this brought an end to 40+ years of coal production from this LMU. All coal production ceased on January 7, 2015. PacifiCorp has made steadfast efforts to complete all mine closure activities including the construction of permanent portal seals for the entire Deer Creek Mine complex and LMU.

All economically recoverable coal reserves within the entire LMU have been mined out or have been determined uneconomical to mine as acknowledged by BLM's letter dated March 23, 2016 (copy enclosed). Having fully complied with the federal coal lease terms

and their associated federal regulations, PacifiCorp has no intentions to re-open the mines within the LMU. Therefore, the purpose of this relinquishment exercise is to surrender the federal coal lease acreage back to the federal government that is no longer needed and retain selected lease acreage for reclamation purposes only. Refer to Map 1 (enclosed) which depicts the federal coal lease areas being relinquished (yellow) and the areas retained (green) for reclamation purposes.

LMU Lease Relinquishment Project Overview

We have prepared individual relinquishment notifications for 20 of the 21 federal coal leases that have comprised the LMU. Of the 20 federal coal lease relinquishment notifications, 12 leases are full relinquishments and 8 leases are partial relinquishments. Listed below are the 20 federal coal leases included in this relinquishment exercise:

(1) UTU-88554 (Full)
(2) UTU-84285 (Full)
(3) UTU-06039 (Partial)
(4) UTU-24317 (Full)
(5) UTSL-051221 (Partial)
(6) UTU-2810 (Partial)
(7) UTSL-050862 (Partial)
(8) UTU-014275 (Full)
(9) UTU-024319 (Full)
(10) UTU-47977 (Full)
(11) UTU-084924 (Full)
(12) UTU-084923 (Full)
(13) UTU-47979 (Partial)
(14) UTSL-070645/02292 (Full)
(15) UTSL-064607/064621 (Partial)
(16) UTU-083066 (Full)
(17) UTU-040151 (Partial)
(18) UTU-1358 (Full)
(19) UTSL-064900 (Partial)
(20) UTU-47978 (Full)

The eight (8) leases that are being partially relinquished, involve retaining selected portions of these leases for the following purposes:

1. To conduct surface reclamation on the disturbed lands in accordance with the state approved mine permits for the Deer Creek and Cottonwood Mines, and
2. Sustain the legal right-of-entry to these split estate federal lands while reclamation activities are conducted and finalized including the required 10-year minimum bond liability period to achieve Final Phase 3 Bond Release.

The individual lease relinquishment notifications will be submitted to your BLM office under separate cover letters as we get them completed in the order listed above.

Also, please note that federal coal lease UTU-044025 (within the LMU) is **not** included in this overall relinquishment exercise. PacifiCorp will need to retain all of federal coal lease UTU-044025 (total of 40 acres) for reclamation purposes and through the mine permit bond liability period to achieve Final Phase 3 Bond Release.

Conclusion

To the best of its information and belief, PacifiCorp is in compliance with the terms and conditions of this federal coal lease, inclusive of having made all payment obligations relative to rentals and royalties. Furthermore, PacifiCorp represents that the federal lease acres relinquished will not impair the public interest as all obligations under regulation 43 CFR § 3452.1 and all of the lease terms have been met per established BLM guidelines.

All relinquishment notifications have been prepared on behalf of PacifiCorp and have been acknowledged as set forth on each individual notification. We respectfully seek your attention to this matter and request that all twenty (20) lease relinquishments be accepted in a timely manner. Furthermore, with the submittal of these lease relinquishment notifications, this overall action will dissolve the East Mountain LMU UTU-73336 in its entirety.

Should you have any questions, need additional information or wish to discuss this matter with us, please feel free to contact me at 801-220-4612 or by email at Scott.Child@PacifiCorp.com.

Respectfully,

Scott M. Child
Manager, Lands & Regulatory Affairs

Enclosures

cc: D. Ralston, B. Morgan, J. Potter, C. Semborski, K. Fleck, D. Oakley

SMC\Interwest\UTBLM2018-21(EastMtnLMU-FedLeaseRelinqProjOverview)

LEGEND

- LMU BOUNDARY 20,175.11 ACRES
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- U-47977 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE
- FEDERAL COAL LEASE ACREAGE RETAINED
- FEDERAL COAL LEASE ACREAGE RELINQUISHED

Mine Workings Updated To: January 7, 2015

CAD FILE NAME/DISK#: LEASE RELINQUISHMENT BASE MAP

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

PACIFICORP EAST MOUNTAIN LMU UTU-73336
FEDERAL COAL LEASE RELINQUISHMENTS
AND AREAS TO BE RETAINED

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =4400'	DRAWING #:	
DATE:	MAY 8, 2018	SHEET 1 OF 1	REV.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District
Price Field Office
125 South 600 West
Price, UT 84501
http://www.blm.gov/ut/st/en/fo/price.html

MAR 2 3 2016

In Reply Refer To:
3482 (UTG023)
LMU UTU-73336 Mine Closure, UTU-88554, UTU-84285, UTU-06039
SL-070645/U-02292, U-084923, U-084924, U-083066, U-040151
U-044025, U-1358, SL-064607/064621, U-024317, U-024319
U-014275, SL-051221, U-47977, U-47978, U-47979, SL-050862
U-2810, LDS Fee Land, ML-48258/UTU-88554

MAR 2016
Received
Interwest Mining
Company

CERTIFIED MAIL - RETURN RECEIPT REQUESTED
7014-2120-0004-6185-8850

Mr. Scott M. Child
Manager, Lands and Regulatory Affairs
Interwest Mining Company
1407 W. North Temple, Suite 310
Salt Lake City, Utah 84116

Re: Final Resource Recovery and Protection Plan (R2P2) Amendment and Final Disposition of the East Mountain Logical Mining Unit (LMU), Deer Creek Mine and Interwest Mining Company, as Managing Agent

Dear Mr. Child:

On September 25, 2015, the Bureau of Land Management (BLM) received a final R2P2 amendment from Interwest Mining Company for closing the subject mine and sealing the mine openings. This request follows the "Approved – Portal Sealing and Abandonment Plan – Final Closure of the Deer Creek Mine" letter from the BLM to Interwest dated April 10, 2015. In that letter the BLM approved the sealing of the mine. The received information from Interwest fulfills the requirements described in 43 CFR 3482.1(b) and (c).

Affected Leases and Logical Mining Unit (LMU): The idling of the mine affects the LMU UTU-73336, which includes all the leases and properties in the LMU.

Proposed Plan and Justification: Interwest has extracted all equipment out of the mine except those components required for dewatering the mine prior to final implementation of a ground water containment and distribution system. Upon final construction of the underground water management system, all openings to access the coal will be sealed with block walls containing

water drainage P-traps and will be back filled with noncombustible material for at least 30 feet outby. Unauthorized access into the mine and federal coal resources would be secured and the mine workings protected from long term degradation. Justification for the mine closure was PacifiCorp's decision to close the Deer Creek Mine based upon maximum economic recovery. PacifiCorp provided proprietary and confidential information demonstrating that production costs at the mine exceeded market costs and thus provided the decision to close the mine.

Inspection: As equipment has been withdrawn from the mine, the BLM has inspected all areas that have been abandoned before they became inaccessible. The BLM will continue to inspect accessible areas until final sealing has occurred.

Approval and Conditions: The BLM agrees with Interwest's proposal for sealing and securing the mine. The BLM accepts the final R2P2 and the update to the coal reserve as shown in the two-volume "Final Amendment (Per Mine Closure) September 2015 East Mountain LMU UTU-73336 Resource Recovery and Protection Plan for the Deer Creek and Cottonwood/Wilberg Coal Mines".

✓ **Maximum Economic Recovery (MER):** MER has been determined to be achieved due to the mining costs encountered in this mine when compared with coal secured in the open market.

National Environmental Policy Act (NEPA): This approval of a minor modification to an approved R2P2 of an existing underground coal mine is categorically excluded from NEPA analysis, as explained in the Department Manual (5 DM Part 516 11.5 (F) (8)).

The BLM has determined that this R2P2 modification complies with the Mineral Leasing Act of 1920, as amended, the regulations at 43 CFR 3480, and the lease terms and conditions. Interwest is authorized to secure the Deer Creek Mine indefinitely. If you have any questions, please contact Steve Rigby at the Price Field Office (435-636-3604) or Jeff McKenzie at the BLM State Office (801-539-4038).

Sincerely,

Ahmed Mohsen
Field Manager

cc: Roger Bankert, BLM State Office (UT-920)

Office of Natural Resource Revenue
Attn: John Hovanec
DFC, 6th & Kipling, Bldg.85
P.O. Box 25165, MS 63010C
Denver, Colorado 80225-0165

Utah Division of Oil, Gas, and Mining
Daron Haddock
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Mine Safety and Health Administration
Cord Cristando
45 East 1375 South
Price, Utah 84501

COPY

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

1407 W. North Temple, Suite 110
Salt Lake City, UT 84116

HAND DELIVERED

May 29, 2018

RECEIVED
MAY 30 2018
Bureau of
Land Management

Kent Hoffman
Deputy State Director
United States Department of the Interior
Bureau of Land Management
Utah State Office
440 West 200 South, Suite 500
Salt lake City, Utah 84101-1345

RE: Notification of Full Relinquishment of Federal Coal Lease UTU-84285, East Mountain LMU, Deer Creek Mine, Emery County, Utah

Dear Mr. Hoffman:

In accordance with 43 CFR § 3452.1 (2017) and the terms of the referenced federal coal lease, submitted herewith in triplicate is documentation in support of PacifiCorp's full relinquishment of acreage under federal coal lease UTU-84285. The total acreage being surrendered is 213.57 acres. Refer to Map 1 for lease location within the East Mountain Logical Mining Unit UTU-73336.

The attachments to this letter contain lease specific information compiled using the Bureau of Land Management (BLM) relinquishment checklist developed by your staff. To assist the reviewer in the process, we've completed the checklist with the best available information known to us given the history of this lease. The supporting information is located in the accompanying appendices.

Background and Purpose of Relinquishment

With PacifiCorp's decision and announcement on December 15, 2014, to close the Deer Creek Mine and end production from the LMU, this brought an end to 40+ years of coal production for this LMU. All coal production ceased on January 7, 2015. PacifiCorp has made steadfast efforts to complete all mine closure activities including the construction of permanent portal seals for the entire Deer Creek Mine complex and LMU.

All economically recoverable coal reserves within the entire LMU inclusive of this federal coal lease has been mined out or has been determined uneconomical to mine as acknowledged by BLM's letter dated March 23, 2016 (copy enclosed). Having fully complied with the federal coal lease terms and their associated federal regulations, PacifiCorp has no intentions to re-open this mine. Therefore, the purpose of this relinquishment is to surrender this federal coal lease acreage back to the federal government and bring final closure to this matter.

Full Relinquishment

The legal description for full relinquishment of UTU-84285 is described below:

Federal Coal Lease UTU-84285		
Lease Issuance Date:		11/1/2006 to 11/1/2026
Lessee of Record:		PacifiCorp
Federal Coal Lease Acres:		**213.57**
Description of Lease Acreage Being Relinquished		**Acres**
T16S, R6E, SLB&M Emery County, UT		
Sec 10	S½NE¼NE¼, SE¼NE¼, W½E½SE¼	100.00
Sec 15:	E½W½E½	80.00
Sec 22:	Lot 3	33.57
	Total Lease Acres for Full Relinquishment:	**213.57**
	Total Lease Acres Remaining:	**0.00**

Conclusion

To the best of its information and belief, PacifiCorp is in compliance with the terms and conditions of this federal coal lease, inclusive of having made all payment obligations relative to rentals and royalties. Furthermore, PacifiCorp represents that the federal lease acres relinquished will not impair the public interest as all obligations under regulation 43 CFR § 3452.1 and all of the lease terms have been met including having demonstrated substantial completeness per BLM subsidence guidelines.

This relinquishment notification was prepared on behalf of PacifiCorp and is acknowledged as set forth below.

We respectfully seek your attention to this matter and ask that this relinquishment be accepted in a timely manner. Should you have any questions, need additional information or wish to discuss this matter with us, please feel free to contact me at 801-220-4612 or by email Scott.Child@PacifiCorp.com.

Sincerely,

Scott M. Child
Manager, Lands & Regulatory Affairs

Acknowledged and agreed to this 29 of MAY, 2018 by PacifiCorp, the lessee of record:

Dana M. Ralston
Senior Vice President
Thermal Generation & Mining
Rock Mountain Power (a division of PacifiCorp)

Enclosures

cc: B. Morgan, J. Potter, C. Semborski, K. Fleck, D. Oakley

SMC\InterwestUTBLM2018-02(UTU-84285FullRelinq)

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-84285

LEASE ACTIVITIES

1) Coal Lease Number: UTU-84285 *(Full Relinquishment)*

2) Lessee Name and Address:
PacifiCorp
c/o Interwest Mining Company
1407 West North Temple, Suite 110
Salt Lake City, Utah 84116

3) Utah Division of Oil, Gas, and Mining (DOGM) mine permit number: C/015/0018 (Deer Creek Mine).

4) Date of request: _____ Date filed: _____.

5) Acres requested to be relinquished: 213.57; Entire lease? YES ☒ NO ☐ (See attached map.) Comments: *Refer to Exhibit A for the legal descriptions of area relinquished. No areas retained. See also Figure 1 (a map depicting the area to be relinquished in its entirety).*

Original Lease Acreage: 213.57 Relinquished to date: 0.00 acres Remaining: 213.57 acres

6) Have all bonus bid payments been paid? YES ☐ NO ☐ N/A ☒ (If "NO", date anticipated to be paid in full: ___)

7) Are lease rental payments up to date? YES ☒ NO ☐ N/A ☐ (If "NO", date anticipated to be brought up to date: _____)

8) Has the lessee or the former lessee, if previously assigned, conducted mining activities on this lease? YES ☒ NO ☐ (If "NO", complete question 14, then proceed to question 23)

9) Type of mining conducted: Longwall ☒, Room & Pillar ☐, Surface ☐, Other ☐ (Explain) _____

10) If underground mined, excluding surface disturbances associated to subsidence, was there any surface disturbance conducted in association with the underground operation(s)? YES ☐ NO ☒ (If "YES", describe:

11) Date of initial mining: March 2006; last mining: March 2014.

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-84285

12) Number of coal beds mined: 2 coal seams (Blind Canyon and Hiawatha)

13) Range of thickness of coal removed for each bed: 7' - 10'

14) Have all estimated recoverable coal reserves been recovered? YES ☒ NO ☐ N/A ☐
(If "NO", tons to remain in place: _____; Justification to leave these reserves must be provided.)
   - *Refer to BLM approval letter dated March 23, 2016 (copy enclosed) regarding the final R2P2 for the Deer Creek Mine and final disposition of the East Mountain Logical Mining Unit with a determination that maximum economic recovery has been achieved.*

15) Was an R2P2 modification required to account for deficient recovery? YES ☒ NO ☐
(If "NO", explain: _____)
   - *Refer to BLM approval letter dated March 23, 2016 (copy enclosed) regarding the final R2P2 for the Deer Creek Mine and final disposition of the East Mountain Logical Mining Unit with a determination that maximum economic recovery has been achieved.*

16) Have all production royalty payments been paid to ONRR? YES ☒ NO ☐ (If "NO", date anticipated to be paid in full: _____)

17) Did subsidence occur? YES ☒ NO ☐ (If "YES", continue; if "NO", proceed to 23)

18) Has it been demonstrated that the surface above subsided areas has been substantially stabilized per the criteria outlined in Appendix A? YES ☒ NO ☐ N/A ☐ (If "YES", please attach supporting documentation.)

19) Has the surface area been inspected to determine impacts to surface topography per the criteria outlined in Appendix B? YES ☒ NO ☐ N/A ☐ (If "YES", attach supporting documentation. If "NO", date when inspection is scheduled: ___)
   - *Surface topography inspections were conducted through annual reconnaissance flights.*

20) Have there been any impacts to surface or groundwater per the criteria outlined in Appendix C? YES ☐ NO ☒ N/A ☐ (If "NO", attach supporting documentation.)
   - *Refer to hydrographs*

21) Have there been any impacts to vegetation per the criteria outlined in Appendix D?
YES ☐ NO ☒ N/A ☐ (If "NO", attach supporting documentation.)
   - *Refer to DOGM write up*

Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-84285

22) Have there been any impacts to private improvements per the criteria outlined in Appendix E? YES ☐ NO ☒ N/A ☐ (If "NO", attach supporting documentation.)
   - *There are no improvements*

23) Has CERCLA Certification been submitted per the criteria outlined in Appendix F? YES ☒ NO ☐ N/A ☐ (If "YES", attach supporting documentation.)
   - *As of the date of this submittal. Refer to Appendix F.*

24) Was there any surface disturbance conducted independent of mining activities? YES ☐ NO ☒ (If "YES", describe: _____)

25) Have all concerned agencies commented on this relinquishment request? YES ☐ NO ☐ (If "NO", who has not? _____)

26) After review, BLM proposes the relinquishment of ___ acres (Attach acreage adjustments).

27) Is approval recommended at this time? YES ☐ NO ☐ (If "NO", items deficient or other areas of concern:

_____; Date completed / Satisfied: _____

_____; Date completed / Satisfied: _____

_____; Date completed / Satisfied: _____

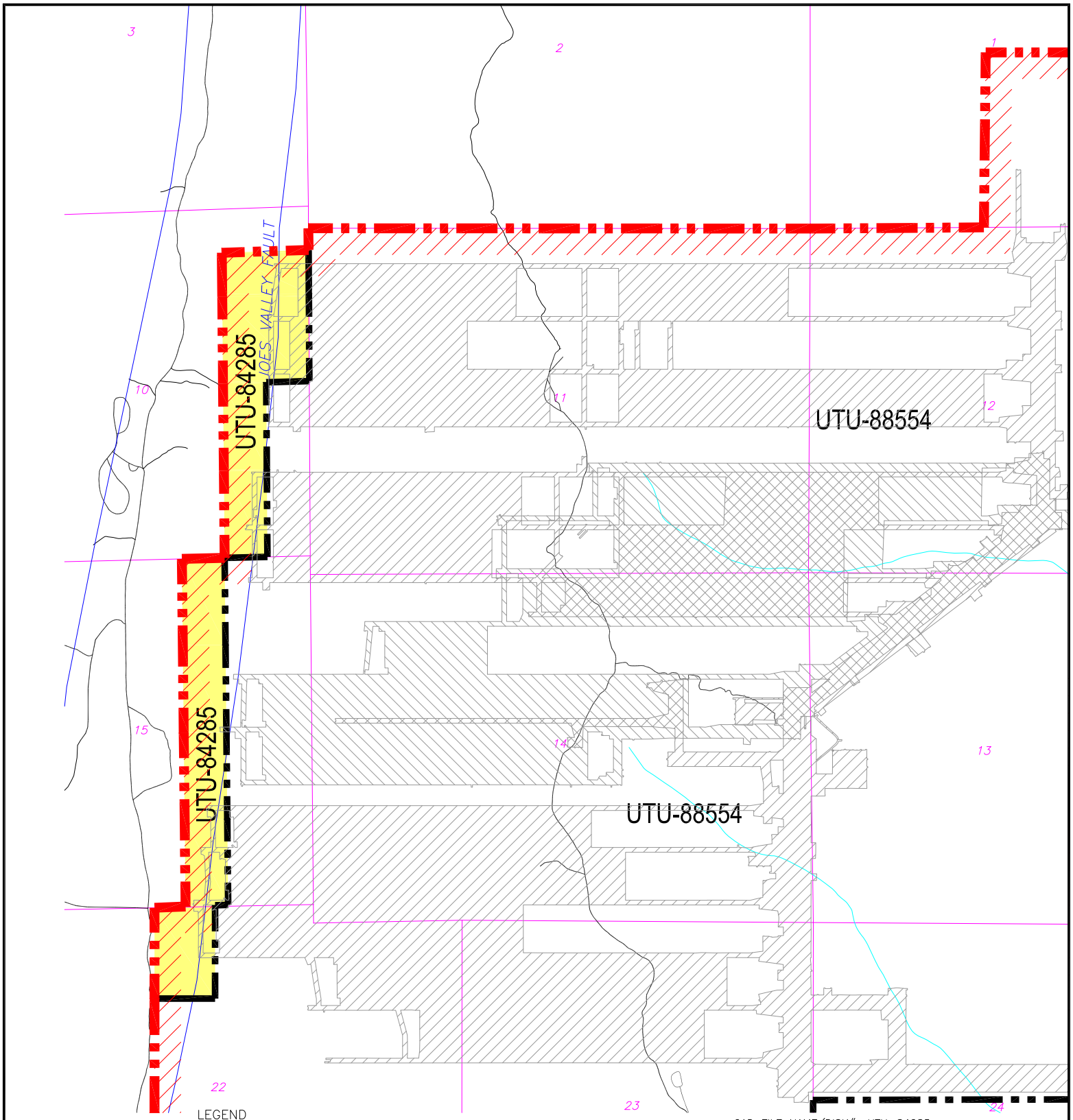
Checklist and Documentation of Findings
Federal Coal Lease Relinquishment
Under 43 CFR 3452
UTU-84285

Exhibit A

Full Relinquishment

The legal description for full relinquishment of UTU-84285 is described below:

Federal Coal Lease UTU-84285		
Lease Issuance Date:		11/1/2006 to 11/1/2026
Lessee of Record:		PacifiCorp
Federal Coal Lease Acres:		**213.57**
Description of Lease Acreage Being Relinquished		**Acres**
T16S, R6E, SLB&M Emery County, UT		
Sec 10	S½NE¼NE¼, SE¼NE¼, W½E½SE¼	100.00
Sec 15:	E½W½E½	80.00
Sec 22:	Lot 3	33.57
	Total Lease Acres for Full Relinquishment:	**213.57**
	Total Lease Acres Remaining:	**0.00**



LEGEND

- LMU BOUNDARY UTU-73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-84285 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE
- FEDERAL COAL LEASE RELINQUISHMENT AREA

N

CAD FILE NAME/DISK#: UTU-84285

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-84285

DRAWN BY:	K. LARSEN	FIGURE 1	
SCALE:	1" =2000'	DRAWING #:	
DATE:	APRIL 23, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-84285 Full Lease Relinquishment
Appendix A

Subsidence and Surface Stabilization

Mining History

This lease is comprised of a single contiguous block of coal reserves in the Hiawatha and Blind Canyon seams on the east side of the Joes Valley Fault. This lease was issued on November 1, 2006 so that longwall mining in the adjacent lease UTU-88554 could reach the farthest mining extents possible to the west and have the bleeder and setup entries as close to the fault as was practicable. Mining of gateroads and bleeder entries was extended into UTU-84285, as long as no mining took place within 200 feet of the fault plane at mine level as determined by horizontal directional drilling, and no second mining took place within a 22 degree angle of draw from the surface expression of the fault. The final arrangement of gateroad and bleeder entries did allow for some longwall (second mining) recovery in UTU-84285. Coal reserves were recovered by continuous miner and longwall methods. The Blind Canyon mine workings did not directly overlie the Hiawatha mine workings. Mining in the Hiawatha seam took place between 3/2006 and 3/2014. Mining in the Blind Canyon seam took place for only a few days in 11/2007.

The following narrative provides details related to PacifiCorp's subsidence monitoring and control plan for East and Trail Mountains, including the Trail Mountain Mine.

Subsidence Monitoring Plan

The establishment of a subsidence monitoring plan is a requirement of the Division of Oil, Gas and Mining (DOGM) detailed in R645-301 -525.440.

PacifiCorp initially adopted a twofold approach to subsidence monitoring:

1) aerial photogrammetry,
2) on-the-ground monumentation.

After seven years of comparing the two types of surveys PacifiCorp determined that both methods effectively document the amount of subsidence which has occurred; however, the aerial photogrammetry method has the advantage of showing more detail because more data points can be monitored with less effort. In 1987, with the concurrence of the State of Utah Division of Oil, Gas & Mining (DOGM), PacifiCorp discontinued on-the-ground monumentation and began collecting subsidence data solely by aerial photogrammetry.

The subsidence monitoring program, conducted since 1980, has produced data which not only document the amount of subsidence that has occurred but also allows the operator to predict the amount of subsidence that is likely to occur when mining in new areas. PacifiCorp submits a comprehensive report annually to the BLM, USFS, and the Utah Division of Oil, Gas, & Mining.

Aerial Photogrammetry

PacifiCorp's subsidence monitoring program is primarily based on aerial photogrammetry. PacifiCorp has been using aerial photogrammetry - based subsidence modeling since 1980. This method has proven to be the best way to collect subsidence data on East Mountain. A baseline photogrammetric survey was conducted in 1980 that included over 21,000 elevations measured on approximate 200-foot spacing grid. In flat areas with limited vegetation, the elevations can be read from the photographs with a precision of one-half foot. In steeper areas, where cliffs are present, the resolution is not as good, and inaccuracies of greater than ten feet can occur. In steeper areas, photogrammetric monitoring can, and has been, augmented by conventional survey data.

Annual Subsidence Survey Procedures

Aerial photographs of the entire East Mountain LMU area are used in conjunction with widely spaced survey control points on the ground to produce a digital elevation model of the ground surface in successive years from which a surface subsidence map is generated for each year. The ground control points are marked and surveyed using conventional survey methods, then flagged so that they can be seen in photographs taken from the air. Approximately 100 aerial photographs of East Mountain area are taken along 7 flight lines that traverse the LMU area from north to south. Overlapping portions of photographs taken from successive viewpoints along the flight lines produce stereoscopic views of the ground surface. These 93 views of overlapping photograph pairs are called “models” in the photogrammetric process. Elevations of the ground surface over the entire permit area are then calculated using a computer-aided stereo plotter, and verified using the known survey points. Ground elevations are calculated for a grid of approximately 200-foot centers, optimized for terrain. The baseline data, including surveying and flagging ground control points, acquiring the aerial photographs, and generating the surface grid and map, for the East Mountain Area were collected in 1980. These elevations are then compared to elevations measured from the photographs taken annually in the fall. Using this method, ninety percent of the points measured will be accurate to within plus or minus one-half foot.

PacifiCorp participated with the governmental agency task force which included representatives from the Bureau of Land Management, Forest Service and the Division of Oil, Gas and Mining, to develop *“Memorandum of Understanding for Processing of Requested to Relinquish Federal Coal Leases (10-MOU-97-001)”*. This document established “Standards for Relinquishment Consideration” including the amount of accepted variation in annual subsidence data. As stated in the MOU, the area will be considered stable, if the cumulative subsidence during the period (3 years) has been 1 foot or less under normal circumstances. Based on this agreement, subsidence measurements and areas and subsidence areas shown on PacifiCorp’s annual subsidence maps show areas of total measurable subsidence greater than two feet. PacifiCorp’s experience on East Mountain since 1980 has shown that the areas of minimum detectable subsidence, i.e., one foot or more, very rarely extend outside of the outline of the total mine workings, even in areas where more than one seam has been mined.

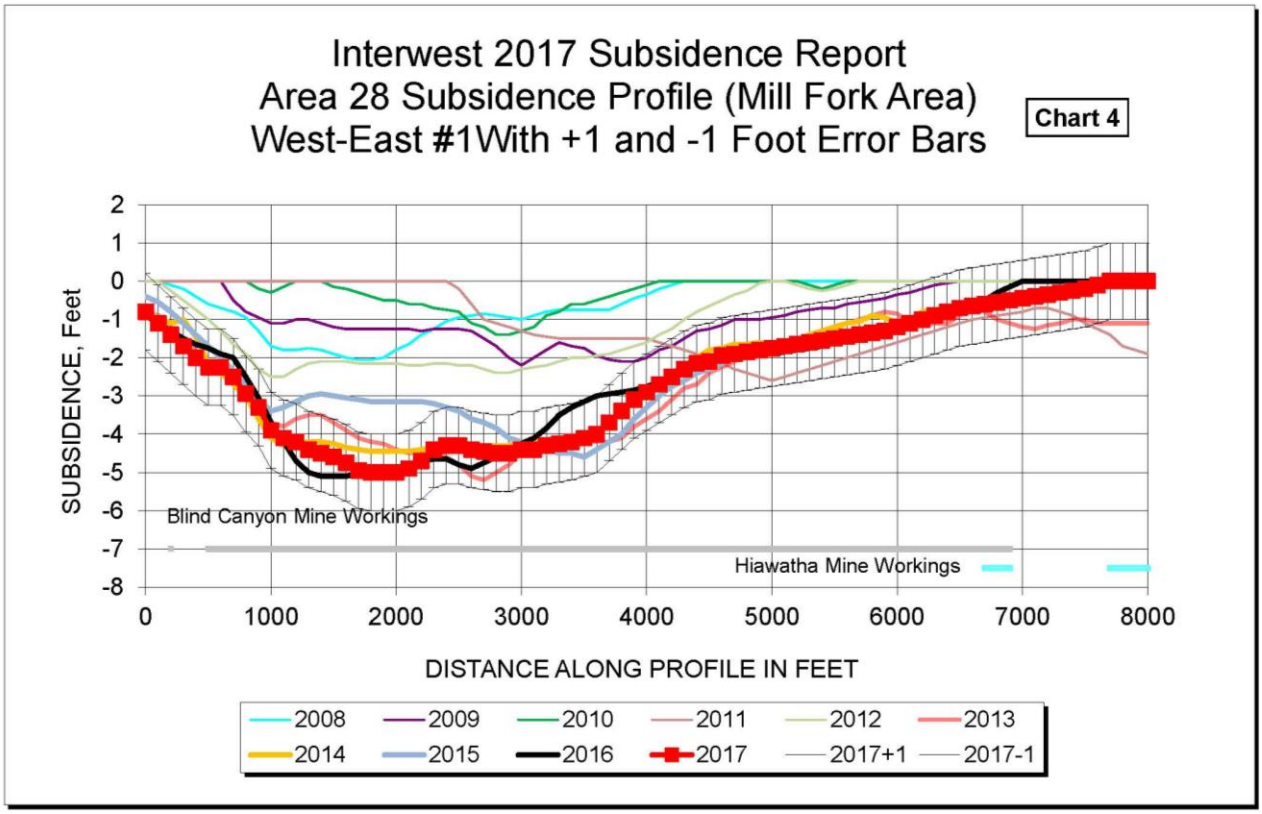
PacifiCorp’s contractor maintained survey control aerial targets within the permit boundary

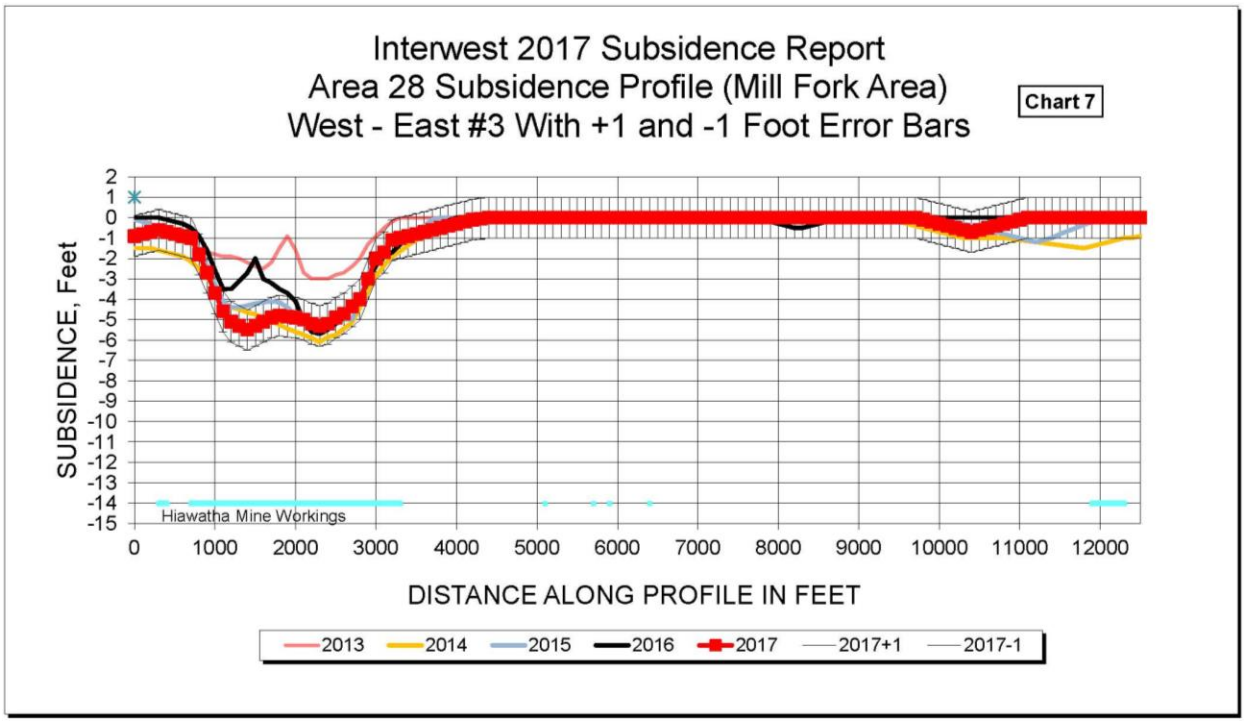
necessary to allow the interpretation of coordinate points on photos within ±0.5 foot. Following this procedure the operator conducted an aerial photo survey annually of all areas that were undermined. PacifiCorp has continued monitoring all areas undermined until the operator and DOGM agree that the subsidence in a given area has become stable and no further monitoring is necessary.

Federal Lease UTU-84285 Subsidence Data

Lease stipulations for UTU-84285 prohibited first mining within 200 feet of the Joes Valley fault and second mining within a 22-degree angle of draw of the surface expression of the Joes Valley Fault. Subsidence adjacent to the lease UTU-84285 area has been monitored since 2005. Subsidence measurements by photogrammetric methods have been used, and subsidence profiles (shown on the following figures and accompanying maps) show subsidence measurements made between 2005 and 2017. Photogrammetric methods allow more complete subsidence monitoring coverage in areas that are topographically rugged and difficult to measure using conventional surveying methods.

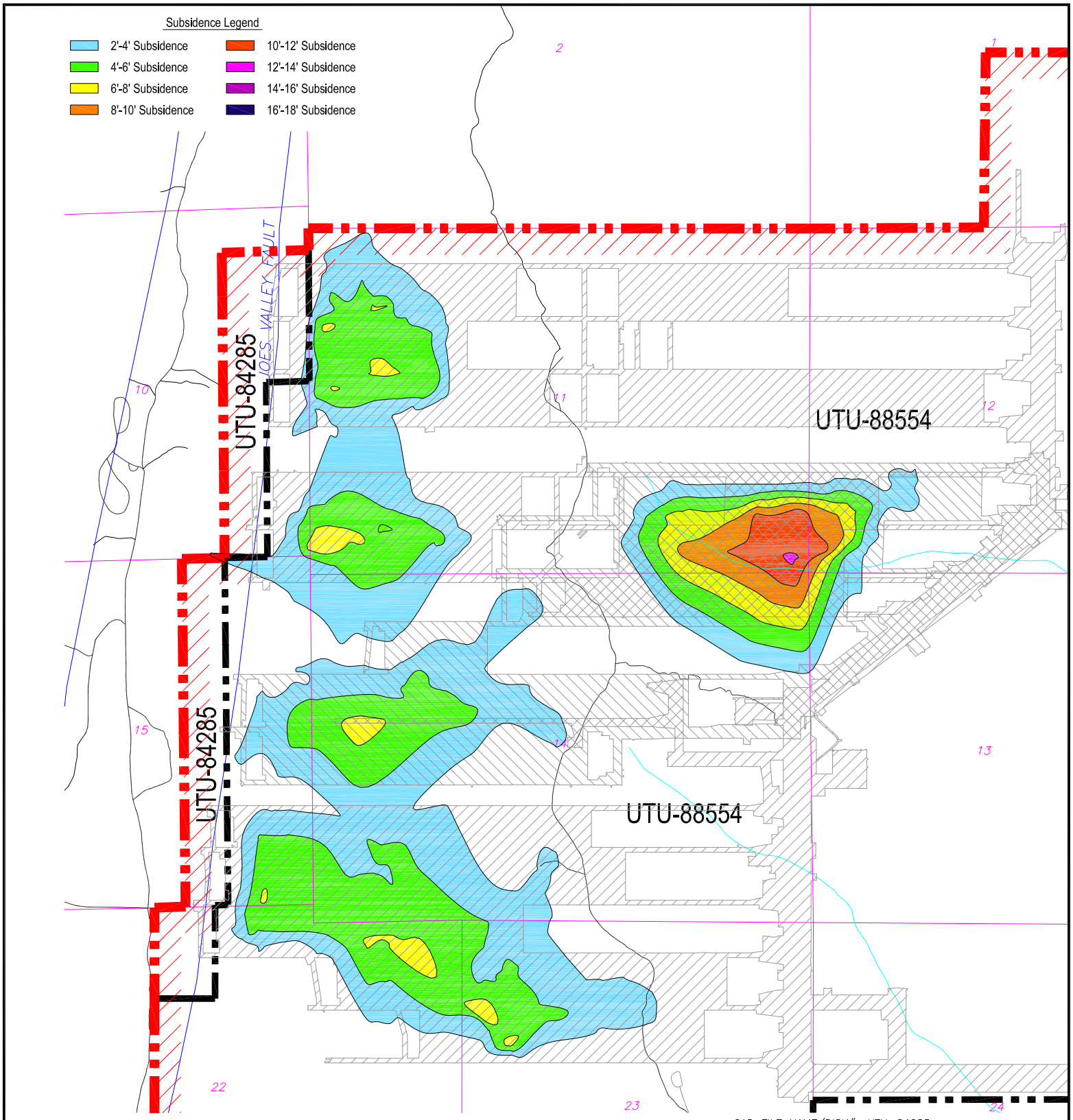
PacifiCorp delineated a series of eight profiles covering the main longwall panel districts of Lease UTU-88554 and UTU-84285, including the dual-seam mining overlay area. The west ends of two of these profiles extend into the UTU-84285 lease. Subsidence within this area has reached a maximum of just over 1 foot. No change in subsidence has occurred since 2014, and the area is stable (see following figures and map). Also, the subsidence contour maps for 2017, included herein, show no increase in subsidence.





Aerial surveys conducted annually by helicopter 2006 - 2017 have detected no subsidence-related effects on the surface in UTU-84285.

The proposed relinquishment area of Lease UTU-84285 is stable and subsidence is substantially complete.



CAD FILE NAME/DISK#: UTU-84285

LEGEND

- LMU BOUNDARY UTU-73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-84285 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

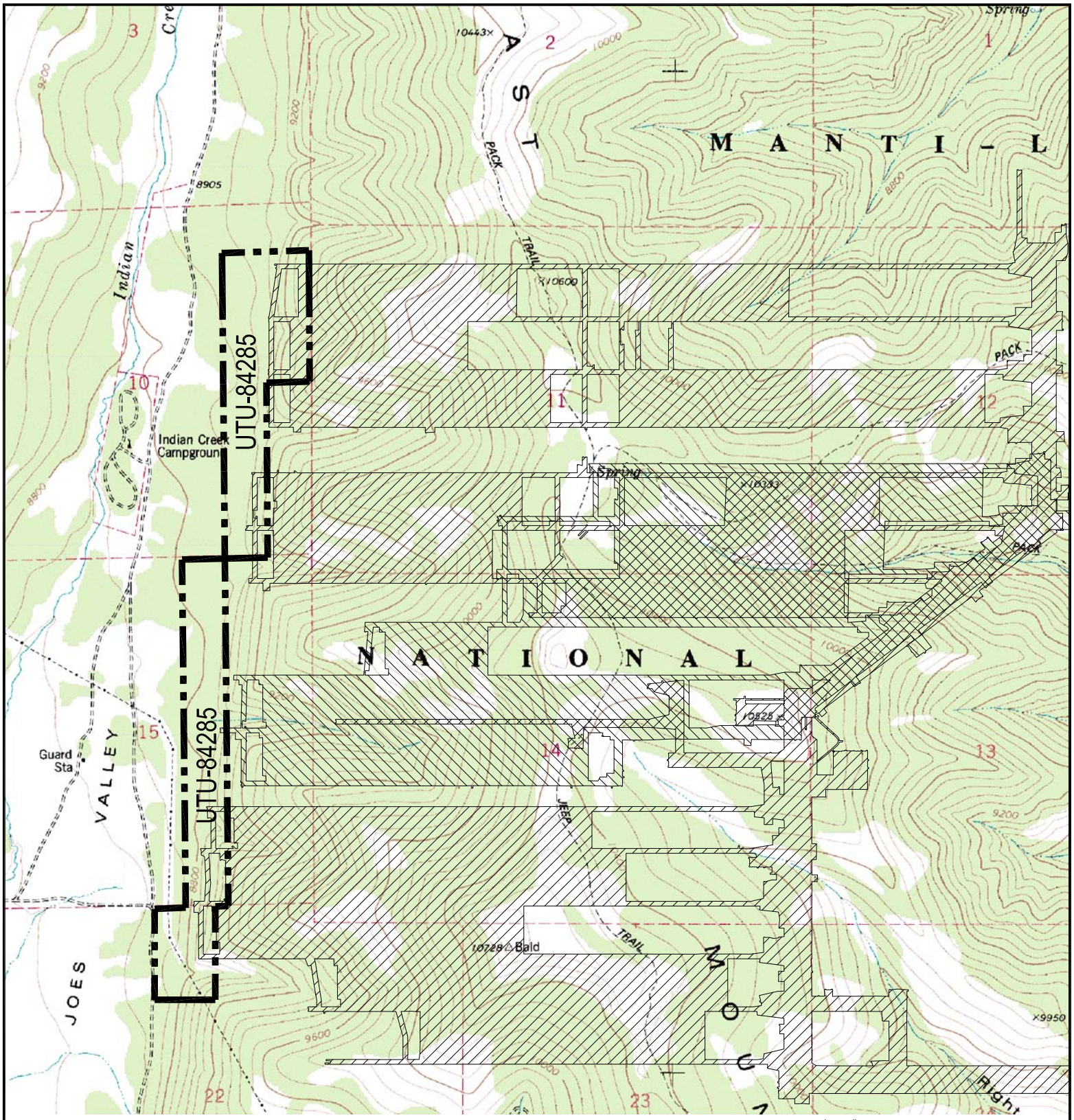
EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COALLEASE RELINQUISHMENT UTU-84285
SUBSIDENCE BASE MAP

DRAWN BY: K. LARSEN	APPENDIX A	
SCALE: 1" =2000'	DRAWING #:	
DATE: APRIL 23, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-84285 Full Lease Relinquishment
Appendix B

Evaluation of impacts to Surface Topography

PacifiCorp has demonstrated that subsidence is substantially complete and that the surface has stabilized; refer to Appendix A. Based on the aerial observations and supporting data, the relinquishment area of Lease UTU-84285 is stable and subsidence is substantially complete. No surface facilities or installations were located within UTU-84285. No restoration and/or mitigation efforts are required for Lease UTU-84285. Please refer to the Appendix B - Topographic Surface Map. This map shows the relationship between the topographic surface, the mine workings, and the UTU-84285 lease boundaries.



CAD FILE NAME/DISK#: UTU-84285

HIAWATHA SEAM MINE WORKINGS

BLIND CANYON SEAM MINE WORKINGS

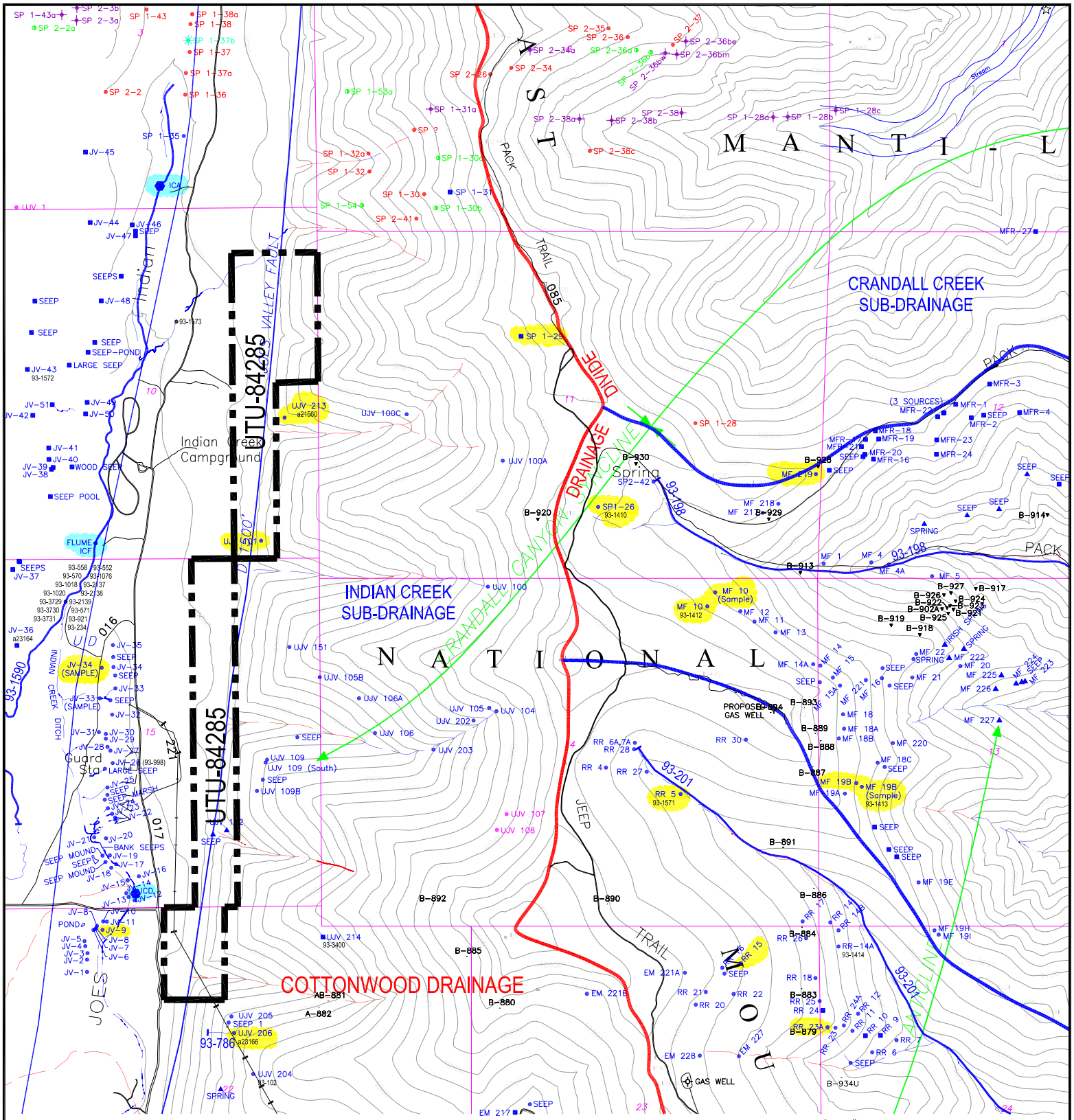
FEDERAL COAL LEASE RELINQUISHMENT AREA

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–84285
TOPOGRAPHIC BASE MAP

DRAWN BY: K. LARSEN	APPENDIX B	
SCALE: 1" =2000'	DRAWING #:	
DATE: APRIL 23, 2018	SHEET 1 OF 1	REV. ___



CAD FILE NAME/DISK#: UTU-84285

SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- MONITORING LOCATIONS (GENWAL RESOURCES)
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- FEDERAL LEASE ACREAGE RELINQUISHED

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INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–84285
HYDROLOGIC DRAINAGE MAP

DRAWN BY: K. LARSEN	APPENDIX C	
SCALE: 1" =2000'	DRAWING #:	
DATE: APRIL 23, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-84285 Full Lease Relinquishment
Appendix C

Evaluation of Impacts to Ground and Surface Water Hydrology

The following section provides a detailed description of the hydrology, including groundwater and surface water quality and quantity, of the land within UTU-84285 and surrounding area.

Since 1979 detailed data on the hydrology of the East Mountain area have been collected, compiled, and analyzed by PacifiCorp and several government agencies. Information collected by PacifiCorp is the result of exploratory drilling, field investigations, geologic mapping, aerial photography, spring surveys, groundwater tests, monitoring of numerous wells and stream stations, climatological monitoring, and investigations by independent consultants. The data collection program is part of a complete Hydrologic Monitoring Program which has been approved by the State of Utah, Division of Oil, Gas and Mining (DOGM) and the Office of Surface Mining (OSM). All data collected have been and will continue to be submitted to OSM, DOGM, United States Forest Service (USFS), and the Bureau of Land Management (BLM) each year in the annual Hydrologic Monitoring reports.

The hydrologic monitoring plan for the Deer Creek Mine Mill Fork Lease Area is specified in Volume 12 Hydrologic Section in the approved Mining and Reclamation Plan (MRP).

As outlined by the BLM, the interested parties have agreed that under normal circumstances, the minimum time period for continued monitoring will be three years. During this time period the operator/lessee will establish that the surface has substantially stabilized according to Appendix "A".

The following sections will describe and provide detail concerning the groundwater and surface water resources within and adjacent to Federal Lease UTU-84285.

Regional Groundwater Hydrology

The characteristics of a groundwater resource are dependent upon the geology of the water bearing strata and on the geology and hydrology of the recharge area. Groundwater movement and storage characteristics are dependent on the characteristics of the substratum. To facilitate an understanding of groundwater of the Mill Fork Area, a discussion of pertinent regional geologic features is presented below.

Regional Geology

The Mill Fork Area is located in the central portion of the Wasatch Plateau Coal Field in Emery County, Utah. Generally, this area is a flat-topped mesa surrounded by heavily vegetated slopes which extend to precipitous cliffs dropping steeply to the valley below. Relief of up to 5,000 feet is measured from Castle Valley lowland to the plateau above. The following discussion summarizes the structural geology and stratigraphy of the region and the mining areas located within the Mill Fork Area.

The regional geology of the Colorado Plateau in which the Wasatch Plateau coal field is situated is fairly simple. Sedimentary rocks have been accumulating in this region since Permian time. A broad, high, flat region that encompasses southeastern Utah, southwestern Colorado, northwestern New Mexico, and northern Arizona, the Colorado Plateau has been an area of relative stability while mountain-building episodes have occurred in surrounding regions. The thick accumulations of sedimentary rocks in this region are being deeply dissected by erosion, leaving the most recent coal reserves in the higher plateaus, where they are now being mined. The PacifiCorp mining area covers portions of East Mountain and Trail Mountain, which are separated by Cottonwood Canyon, a deep, partially glaciated valley.

The geologic formations exposed in the PacifiCorp mining area range from Upper Cretaceous (100 million years old) to Tertiary and Recent in age. These formations, in ascending order from oldest to youngest, are the Masuk Shale member of the Mancos Shale, the Star Point Sandstone, the Blackhawk Formation, the Castlegate Sandstone, the Upper Price River Formation (all Cretaceous), and the North Horn Formation, and the Flagstaff Limestone (Tertiary). The coal deposits are restricted to the lower portion of the Blackhawk Formation, about 2,500 feet below the top of the Plateau. Recent geologic deposits include numerous stream terrace gravels along streams and rivers, glacial till deposits in the upper reaches of Cottonwood Canyon, and alluvial and colluvial fills in all of the significant drainages.

The Masuk Shale is the upper member of the Mancos Shale and consists of light to medium gray marine mudstones. The marine Masuk Member of the Mancos Shale was deposited in an open marine environment (Mayo and Peterson, 2001). The Masuk Member is a highly erodeable calcareous, gypsiferous, and carbonaceous dark gray colored shale. It is continuously exposed along the eastern edge of the Wasatch Plateau, but is not exposed in the Mill Fork Area. The Masuk Member is approximately 1,300 feet thick. Westward thinning wedges of the Masuk inter-finger with tongues of the Star Point Sandstone. Usually this formation weathers readily, forming slopes which are often covered by debris. It is generally devoid of water.

Overlying and inter-tonguing with the Masuk Shale is the Star Point Sandstone. In the East Mountain area the Star Point Sandstone consists of three or more massive sandstones totaling about 400 feet in thickness.

The Star Point Sandstone forms massive cliffs where exposed at the surface. The sandstone was deposited as seaward thinning (east), marine, shoreface blanket sands that are laterally continuous (Mayo and Peterson, 2001). Landward (west), these sandstones terminate abruptly into the mud- and organic-rich backshore facies (Van Wagoner and others, 1990). Because many of the organic-rich facies are now mineable quality coal, locally the Star Point Sandstone has immediate contact with coal seams. Elsewhere sandstone bodies of the Star Point Sandstone are overlain and underlain by lower shoreface and open marine shales of the Mancos Formation. What this means is that the marine shoreface sandstones are three dimensionally encased by low-permeability marine shales and fine-grained carbonaceous backshore coal-bearing facies (Mayo and Peterson, 2001).

The Star Point Sandstone thins eastward and merges with the underlying Masuk Member of the Mancos Shale. Three prominent tongues of the Star Point Sandstone inter-finger with the Mancos Shale. These three sandstone members, from top to bottom, are the Spring Canyon, Storrs, and Panther Sandstones. In the Mill Fork Area, the Spring Canyon tongue is approximately 100 feet thick, lies about 80 feet above the Storrs tongue, and consists of massive, fine- to medium-grained sandstone. The Storrs tongue lies about 120 feet above the Panther tongue and consists of 50 feet of soft, friable sandstone. The basal Panther tongue is approximately 100 feet thick and consists of massive, cross-bedded delta front sandstones Mayo and Peterson, 2001).

Even though the Star Point Sandstone exists throughout the entire East Mountain property, the low permeability and lack of recharge limit its usefulness as a water producing aquifer. Permeability and the limiting factors of recharge, i.e., very little outcrop exposure and limited vertical groundwater migration caused by the mudstone layers of the North Horn and Blackhawk formations, will be discussed in detail in the section entitled REGIONAL GROUNDWATER CHARACTERISTICS. Locally, the Star Point Sandstone exhibits aquifer characteristics. These are isolated occurrences where regional faults have created secondary permeability and have been intersected by major canyons with perennial streams. An example is Little Bear spring located in Huntington Canyon.

The Blackhawk Formation consists of alternating mudstones, siltstones, sandstones, and coal. Although coal is generally found throughout the Blackhawk Formation, the economic seams are

restricted to the lower 150 feet of the formation. The total thickness of the Blackhawk Formation in the East Mountain area is about 750 feet.

The upper portion of the Blackhawk Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Mayo and Peterson, 2001). In these delta and flood-plain environments layers of mud are more abundant than channel sands. Sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and inter-fluvial rocks (Galloway, 1977). The upper portion of the Blackhawk Formation also contains some thin carbonaceous shale layers and thin coal seams that are not of economic interest.

The lower portion of the Blackhawk Formation contains the mineable coal deposits and consists of more thinly bedded sandstone and shale layers (Johnson, 1978). The coal-bearing units of the lower Blackhawk Formation overlie and are laterally juxtaposed to marine shoreface sandstones of the Blackhawk Formation and Star Point Sandstone (Mayo and Peterson, 2001). On a large scale, these sandstone bodies are laterally continuous but terminate abruptly into the mud- and organic-rich backshore faces in a landward direction (Van Wagoner and others, 1990). However, individual rock layers are lenticular and discontinuous, with abundant shaley interbeds. The fine to medium grained sandstones occur as thin- to massively-bedded paleochannel deposits. The paleochannels increase in frequency, thickness, and lateral extent upward in the formation. There is also a vertical repetition of erosional scours within the upper sandstones (Marley, 1979).

The Castlegate Sandstone, the lower member of the Price River Formation, generally caps the escarpment which surrounds the eastern limit of the property. The Castlegate Sandstone consists of approximately 250 to 350 feet of coarse-grained, light gray, fluvial sandstones; pebble conglomerates; and subordinate zones of mudstones.

The formation was deposited from bed-load fluvial channel systems. The Castlegate Sandstone is made up of coarse-grained, often conglomeratic, fluvial sandstone. Thin inter-beds of siltstone and claystone occur in lower portion the formation. Sandstone dominates over mudstone and individual sand channels may be thin, wide, or interpenetrating. Although the primary porosity is high, the existence of mudstone drapes and pervasive carbonate and silica cement greatly reduces the overall porosity (Mayo and Peterson, 2001, Appendix B).

The Upper Price River Formation, which overlies the Castlegate Sandstone, is about 350 feet thick and forms steep slopes which extend upward from the Castlegate Sandstone.

The Price River Formation was deposited from mixed-load fluvial channel systems that have sandstone/mudstone ratios intermediate between bed-load and suspended-load channel systems (Mayo and Peterson, 2001). Sandstones and mudstones occur in about equal proportions. Point bars that develop in this type of system are larger than those in suspended-load channel systems. Mudstone drapes created during low flow stages of the active fluvial system separate the sandstones from each other both horizontally and vertically (Mayo and Peterson, 2001).

The North Horn Formation forms the cap rock for much of East and Trail mountains where the Flagstaff Limestone has been eroded away. Mudstones dominate the rock types present and are generally gray, light brown, to purple in color. Localized, lenticular sandstone channels are present throughout the formation. The sandstone beds are more common near the upper and lower contacts of the formation. The North Horn Formation is approximately 850 to 1,000 feet thick in the Mill Fork Area.

The North Horn Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment (Mayo and Peterson, 2001, Appendix B). In such environments layers of mud are more abundant than sands, which occur in sandstone channels. The sandstone channels are generally isolated from each other, both laterally and vertically, by mud-rich overbank and inter-fluvial rocks (Galloway, 1977). In the study area the formation consists primarily of shale with discontinuous sandstone channels, minor lenses of limestone, and conglomerate. Highly bentonitic mudstones, which swell when wetted, are common in the lower two-thirds of the formation.

The Flagstaff Limestone caps the uppermost portions of East Mountain is the youngest formation exposed in the Mill Fork Area. It typically forms small exposures on top of the plateau. A thickness of 105 feet was measured on Trail Mountain immediately south of the study area (Davis and Doelling, 1977). Maximum thickness in the Mill Fork Area is approximately 80-100 feet.

The Flagstaff Limestone consists of carbonates, marls, and some thin sandstone stringers deposited in lacustrine, marginal lacustrine, and alluvial plain depositional environments (Garner and Morris, 1996). It primarily consists of light- to medium-gray colored limestone containing abundant secondary fractures produced during uplift and subaerial exposure (Mayo and Peterson, 2001, Appendix B).

Regional Groundwater Characteristics

Waters entering the groundwater system are mostly from snow melt. The amount of water which enters the groundwater system is highly variable from one site to another. The low surface relief

on the top of East Mountain encourages the infiltration of melting snow. Conversely, the many areas with steep slopes have a much more limited infiltration opportunity. All of the geologic formations which surface in the area have relatively low permeability which further reduces the amount of water entering the groundwater system. Probably less than five percent of the annual precipitation recharges the groundwater supply (Price and Arnow, 1974; U. S. Geological Survey, 1979).

Geology controls the movement of groundwater. Because of the low permeability of the consolidated sedimentary rocks in the East Mountain area, groundwater movement is primarily "through fractures, through openings between beds, and, in the case of the Flagstaff Limestone, through solution openings" (Danielson et al., 1981, p. 25).

The majority of the groundwater which infiltrates the Flagstaff Limestone flows down vertical fractures which intersect sandstone channel systems in the North Horn Formation. The majority of the groundwater reaching this point intersects the surface in springs located in the North Horn Formation. Very little recharge intersects the Price River Formation and Castlegate Sandstone; consequently, they are not water saturated where intersected in the numerous drill holes penetrating those units. The remaining water then flows downdip (to the southeast) from the northern reaches of East Mountain until it discharges in the form of springs.

Data have been collected from numerous coal exploration drill holes, from within the adjacent mine workings, from surface drainages, and from the springs in the area. The data have identified two separate isolated aquifer systems on the East Mountain property; the first is localized perched water tables in the North Horn and the Price River formations, and the second is a combination of localized perched water tables in the Blackhawk Formation and the Star Point Sandstone which exhibits some limited potential as a regional aquifer. Stratigraphy is the main controlling factor restricting groundwater movement and development of regional and perched aquifer systems within the East Mountain property. The following is a description of the various formations and how they influence the groundwater systems. The description is in descending order, which parallels the general groundwater flow.

Flagstaff Limestone

This formation displays a strong joint pattern which permits good groundwater movement both vertically and horizontally through the formation. Exposures of the Flagstaff Limestone are limited to a narrow north-south trending ridge located in the western half of the Mill Fork Area.

North Horn Formation

This formation is comprised of a variety of rock types which range from highly calcareous sandstone to mudstone. Its permeability is variable.

Lenticular sandstone channels are oftentimes present in the upper and lower portions of the formation. Water which percolates down fractures from the overlying Flagstaff Limestone works its way into the sandstones, forming the perched water tables. The actual lateral extent, or correlation, between the perched water tables has not been identified; and it is not practical to do so because the tables are limited in extent and variable in stratigraphic location. Many springs have been identified where the sandstone channels intersect the land surface.

The lower two thirds (upper Cretaceous in age) of the formation is generally highly bentonitic mudstone which is impermeable. It is likely that this material is acting as an aquiclude, preventing adequate recharge from reaching the Upper Price River Formation or Castlegate Sandstone below. The mudstones present swell when they come in contact with water. Therefore, vertical migration of water along fractures through this material is limited because the fractures are sealed by the swelling clays.

The depth of the aquifers in the North Horn Formation is variable due to the rugged topography. The localized perched water tables may either intersect the surface of the ground or be covered by as much as 1,000 feet of overburden. They are located at least 1,400 feet above the coal seam to be mined. Communication of water between the perched aquifers in the North Horn Formation and the water flowing into the mine is limited in quantity and occurs very slowly. The monitoring of the numerous springs located on East Mountain gives PacifiCorp the ability to assess any effects that mining might have on the North Horn Formation perched aquifers.

With the data available it is not possible to compile a piezometric map of the waterbearing strata in the North Horn Formation because the channels are discontinuous and not interconnected.

Upper Price River Formation

The Upper Price River Formation is comprised predominantly of sandstone but commonly contains mudstone beds between the point bar deposits. It is generally devoid of water because it lacks adequate recharge.

Castlegate Sandstone

The formation is thought to be fairly permeable but, where it has been intersected by drill holes, has never been found to be water saturated. It is often dry or slightly damp in some zones. It is devoid of significant water because it lacks.

Blackhawk Formation

The Blackhawk Formation contains only perched or limited aquifers which exist within the strata overlying the coal seams and the upper portion of the Star Point Sandstone Formation. The perched aquifers exist as fluvial channels (ancient river systems) which overlie and scour into the underlying strata. Channel systems were part of a deltaic depositional setting active during and after the coal forming peat accumulation. The largest influx of water encountered during the mining process occurs beneath the fluvial channels. The sandstone channels are mainly composed of a fine to medium grained sand with similar characteristics to the Star Point Sandstone Formation. The semi-permeable and porous nature of the channels allows an effective route for water transport. Other constituents of the Blackhawk Formation (i.e., non-permeable mudstone, carbonaceous mudstone, coal seams, and inter-bedded mudstones/siltstones and sandstones) generally act as aquicludes which impede vertical groundwater flow to the lower stratigraphic units. In areas other than where faulting and fracturing have created secondary permeability, the migration of water from the perched aquifers-sandstone channel systems of the Blackhawk Formation to the Star Point Sandstone Formation is limited. Extensive mining in the Cottonwood/Wilberg complex, which produces coal from the Hiawatha seam, is stratigraphically located directly on top of the upper member of the Star Point Sandstone. Only minor quantities of groundwater have been produced from the Star Point Sandstone. The coal seams of the Blackhawk Formation are effective in impeding vertical groundwater movement. In many areas in the adjacent mines where roof coal was left in place because of abundant thickness or as an additional effort to support the immediate roof, production of groundwater occurred only when roof support was installed or when a roof failure occurred exposing the overlying sandstone channel systems. Listed below are hydrologic characteristics of individual rock types reported by the USGS, Open File 84067.

Lithology: Sh, shale; Slt, siltstone; Ss, sandstone; f, fine grained; m, medium grained. Hydraulic Conductivity: I, impermeable to water even at pressures of 5,000 pounds per square inch (psi).					
				Hydraulic Conductivity (feet per day)	
Geologic Unit	Lithology	Depth below land surface	Porosity %	Horizontal	Vertical
Blackhawk Formation	Ss, f	1,521	14	1.5x10-2	3.7x10-3
	Slt	1,545	3	9.3x10-8	1.2x10-7
	Sh	1,786	2	I	I
	Ss, f	1,792	14	1.1x10-2	3.9x10-3
	Sh	2,170	4	1.1x10-8	---
	Slt	2,265	2	2.0x10-7	2.2x10-6
Star Point Sandstone	Ss, m	2,466	17	3.1x10-2	1.1x10-2
	Ss,	2,493	11	1.5x10-2	6.6x10-3

In the adjacent Cottonwood and Deer Creek mines, the majority of the water flowing into the mines comes from within the limited fluvial channel aquifers; however, water is also transmitted into the mine workings by way of faults, joints or fractures, and in-mine drill holes. Many locations within the mines have been monitored in the past, but a limited number of accessible long term water monitoring locations now exists because most water-producing areas of the mines are dewatered and stop flowing shortly after initial mining in the area.

In several locations in the Deer Creek and Wilberg/Cottonwood mines, such as retreated longwall panels, water is being produced but cannot be measured because the workings are inaccessible. The water entering these areas flows into numerous low areas in the mine which act as temporary sumps. The water is then pumped to the main sump located near the mine portal. Because the pumping system in the mine is ever changing (i.e., portable pumps being moved to various locations within the mine as the need arises), it is not possible to collect meaningful data from specific areas of the mine that can be compared with data collected from years or even months past.

Based on data from the adjacent mines, several observations have been made concerning the Blackhawk water-bearing strata. The sandstone, which is semi-permeable and porous, affords an effective route of water transport; while relatively impervious shale in the Blackhawk Formation prevents significant downward movement of the percolating water. Of the water-producing areas, those closest to the active mining face exhibit the greatest flows. As mining advances the area adjacent to the active face continues to be

excessively wet, and previously mined wet areas experience a decrease in flow. It appears that the water source is being dewatered since mined out areas of the mine do not continue to produce water indefinitely. The water source must be either of limited extent, e.g., a perched aquifer, or have a limited recharge capacity. In an attempt to quantitatively evaluate saturated sandstone channels, a dripping channel in the 6th West area of the Deer Creek Mine was investigated. The channel, located near a minor fault with very limited displacement, has the dimensions of >2,000 feet in length, 150 feet in width and a maximum thickness of 25 feet. An array of uphole monitoring wells was installed across the width of the channel. The wells were 15 to 25 feet deep and were open along their entire depth. Each well was equipped with a shutoff valve and pressure gauge. The idea was to conduct a pump test by letting selected wells gravity drain and simultaneously measuring pressure change in nearby wells. Because a maximum of about 2 psi was recorded in the well (i.e. (5 feet of water) we were unable to conduct the test. What the well did demonstrate was that the sandstone channel was not fully saturated and it was a perched, unconfined groundwater system.

Although much of the water transfer within the Blackhawk Formation is through fractures or faults, data indicate that recharge to the Blackhawk is limited because of the above confining formations and many of the fractures become sealed by swelling bentonitic clays which stop or limit the water transfer, confirmation of which exists along the numerous faults and fractures over the area. A measurable flow of water along a fault existed at only one location in the Wilberg/Cottonwood Mine - along the Pleasant Valley Fault in Main West, Wilberg. This location produced an estimated average flow of 5 gpm from the time it was encountered to 1980 when the flow stopped. The fractures sealed readily because of the ability of the shaley layers to swell and decompose to form an impervious clay, preventing significant downward percolation, collection, or conveyance of water along faults in the Blackhawk Formation.

Significant quantities of groundwater were also encountered in the Deer Creek Mine, 4th South area, where development entries intersected fractures/faults associated with the Roans Canyon Fault system. As with other areas where groundwater has been intercepted, the flow from the 4th South/2nd Right area has decreased rapidly, from approximately 2000 gpm in March 1990 to approximately 120 gpm in December 1990. Exploratory drilling was utilized in the development entries to locate and map the extent of the water producing fracture. The water producing zone was isolated utilizing an inflatable packer and a pressure gauge was installed to monitor the head differential. Pressure readings recorded were similar to those of Roans Canyon Fault crossing at 3rd North, with readings varying from 80-90 pounds per inch. This calculates out to approximately 200 feet of head. The amount of overburden in the area where the water

producing fracture was encountered is approximately 1800-2000 feet. In reviewing the dewatering curve and the initial head differential, groundwater produced from the interception of the water producing fracture was a function of storage and recharge to the fault is limited. To monitor the potential impact of mine dewatering, PacifiCorp installed a series of wells in both the Deer Creek and Cottonwood/Wilberg mines (refer to Volume 9 Hydrologic Section Maps HM-2 and HM-3). These wells were incorporated in the hydrologic monitoring program in 1989. Well development information was detailed in the 1989 Annual Hydrologic Monitoring Report and in Volume 9 - Hydrologic Support Information). Only the wells in the Deer Creek Mine along the axis of the Straight Canyon Syncline revealed a change which could possibly be related to mine dewatering. In addition to the in-mine monitoring PacifiCorp installed a series of surface wells to monitor the potential impacts in Cottonwood Canyon located to the south of Mill Fork and in Rilda Canyon located to the east of Mill Fork. To evaluate the effects on the surface springs and surface drainage systems PacifiCorp maintains an extensive monitoring program. Data collected will be reported annually in the Hydrologic Monitoring reports.

Long-term water producing areas do exist within the current mine workings. Four types of occurrences have been recognized and will be monitored by the applicant and include 1) structural rolls with overlying fluvial channels, 2) Pleasant Valley and Roans Canyon Fault systems, 3) fractures and joints (lineaments), and 4) surface and in-mine drill holes.

Star Point Sandstone

The Star Point Sandstone overlies and inter-tongues with the Masuk Shale. The formation is approximately 350 to 400 feet in thickness and consists of at least three upward coarsening sandstone units. Mudstone units of the Masuk Shale are present above the lower two sandstone members of the Star Point Sandstone due to the inter-fingering nature of the contact between the two units.

The Star Point Sandstone, which immediately underlies the Hiawatha Coal Seam, exhibits some characteristics of an aquifer but experiences little recharge. Studies conducted by the USGS indicate that the Star Point Sandstone is of low permeability, thus limiting its usefulness as a water-producing aquifer. Most of the water discharge from the Star Point Sandstone is where it has been intersected by the major canyons in the plateau or where faulting has caused secondary permeability. This, plus the fact that the Star Point Sandstone is only slightly to moderately permeable, allows only limited flow of groundwater through the formation. Drill holes completed in the Deer Creek, Wilberg/Cottonwood and Genwal mines have defined the piezometric gradient in the lower Blackhawk/Star Point Sandstone system in isolated areas and confirmed the

groundwater flow conforms with the topographic relief and structural features, i.e., regional dip, Straight Canyon Syncline, and regional faulting.

The overall pattern of groundwater flow and surface water-groundwater interactions in the Mill Fork Area and adjacent areas can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes (Mayo and Morris, 2000). Inactive zone groundwater systems contain old groundwater (i.e. 2,000 to 19,000 radiocarbon years), have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability as evidenced by the decline in roof drip rates and lack of fluctuations of in-mine monitoring wells.

Solute chemistry in the Spring Canyon Member is not uniform beneath existing mines suggesting that there is a partitioning of groundwater systems in the member. This condition is likely the result of inter-bedded lower-permeability layers in the Star Point Sandstone which partition individual sandstone bodies. These findings are substantiated by monitoring well data from 6 wells in the Trail and East Mountain areas and are significant in that they strongly suggest that the Spring Canyon Member does not act as a single regionally continuous aquifer, but rather it supports a series of smaller, discrete groundwater systems.

Water in most of the Blackhawk/Star Point aquifer is confined under pressure between shale and siltstone beds within the aquifer (USGS, Lines, Open File Report 84067). Water is released from storage from confined aquifers mainly by compression of the sandstones and less permeable, confining beds as pressure in the aquifer declines. The quantity of water that can be released from storage is dependent on the storage coefficient, which is about 1x10-6 per foot of thickness for most confined aquifers (USGS Lines, Open File Report 84067). Data collected by PacifiCorp on the Roans Canyon Fault System in 1988, 3rd North fault crossing, confirmed the USGS storage coefficient estimations, with values ranging from 1.6x10-4 to 7.0x10-6. Transmissivity values computed for pump tests conducted by the USGS on Trail Mountain on semi-penetrating wells in the Blackhawk/Star Point aquifer ranged from 0.7 to 100 ft^2/day with a majority of the two results ranging from 1 to 10 ft^2/day. The computed transmissivity of 100 ft^2/day was greater than the laboratory data (listed early in this section) and was believed to be due to secondary permeability in the form of fractures. Transmissivity results ranging from 0.7 to 10 ft^2/day are indicative of the low permeability rock in most of the Cretaceous and Tertiary strata within the Wasatch Plateau.

Structural Hydrologic Features

Several important structural features, the Straight Canyon Syncline, Flat Canyon Anticline and Huntington Anticline, the Roans Canyon Fault Graben, Mill Fork Fault Graben, Left Fork Fault Graben, Pleasant Valley Fault, and the Deer Creek Fault, have been identified adjacent to and within the Mill Fork Area.

Folding:

Strata in the Mill Fork area are gently folded in two broad structural features. The Flat Canyon Anticline crosses the southeastern portion of the lease area. This anticline trends southwest to northeast, and plunges to the southwest. Dips in the anticline range from two to six degrees with the south limb dipping the steepest.

To the north, the north limb of the Flat Canyon Anticline becomes the south limb of the Crandall Canyon Syncline, a flat-bottomed syncline. This syncline also trends southwest to northeast. Dips on the northwest side are much steeper than on the southeast side.

Faulting:

The only known fault within the Mill Fork Area is the Joes Valley Fault, which forms the western limit of the coal reserves in this area. The Joes Valley Fault is the largest and most prominent of several north south trending fault zones within the Wasatch Plateau coal field. Displacement of the fault is approximately 1,500 feet, downthrown on the western side. The fault creates a continuous north-south escarpment on the east side of Joes Valley. Several side canyons are cut into this escarpment on the western side of the lease area, all of which drain into Joes Valley. The fault zone itself is not visible along this escarpment, but the fault has been intercepted underground in the Genwal Mine to the north. Where the fault has been intercepted in the Genwal mine workings, a drag fold is present, indicated by a gentle downward folding of the strata along the fault zone, extending for a few hundred feet to the east of the fault.

The nearest known faulting outside of the lease area is the Mill Fork fault graben. The Mill Fork fault graben passes to the southeast of the lease area. This fault graben was crossed in ARCO's Huntington Canyon #4 Mine in Mill Fork Canyon and has a displacement of about twenty five (25) feet on the each side. The trend of this fault zone is approximately N 40° E. Based on projections from maps of #4 Mine, this graben should pass by the southeast corner of the lease area, between the Mill Fork lease and the existing Deer Creek Mine. Where it crosses the northern end of East Mountain, the fault has been mapped to have a displacement of thirty (30) feet down on the northwest side. Deer Creek mine workings have not intercepted this fault zone and exploration drilling in

the right fork of Rilda canyon does not show any displacement, indicating that the displacement of the fault zone is too small to measure with exploration drilling, or that it has disappeared in this area. This fault zone does not appear in any surface outcrops.

Springs and Seeps

Prior to coal leasing, lands administrated by the United States Forest Service require sufficient environmental baseline data to be analyzed during the National Environmental Protection Act (NEPA) analysis process. In preparation for coal leasing through the lease-by-application process, Genwal Resources conducted baseline spring and seep surveys from 1994-1996 (northern portions of the lease were surveyed in 1989-90). Data collected by Genwal Resources was determined by the Forest Service to meet the requirements of the Data Adequacy Standards. Information submitted to the Forest Service included: location, flow and quality (data indicates general trends, date of collection generalized and quality limited to field data). With PacifiCorp's acquisition of the Mill Fork State Coal Lease (reverted to the BLM on August 1, 2011 and designated as federal lease UTU-88554), a complete re-evaluation of groundwater resources was initiated in 2000 and continued through 2002. Evaluation of the data revealed similar geologic occurrences to the southern portion of East Mountain, (majority of the groundwater resources discharge from the North Horn Formation in a down-dip configuration), which has been monitored by PacifiCorp for more than thirty years. The water reconnaissance program of the Mill Fork Area was initiated with an aerial survey via helicopter. During the reconnaissance survey, previous baseline survey data was evaluated for field location accuracy. Based upon initial observations, PacifiCorp commenced a field program in 2000 to completely map, field mark and photograph each groundwater source. Previous baseline studies were utilized as a guide of potential groundwater resources. The entire area of the Mill Fork Area (including leases UTU-88554 and UTU-84285) and adjacent area was traversed. During the field reconnaissance process, when water resources were encountered, they were tracked to the source. At the sources, the sites were located utilizing GPS surveying techniques (GPS - equipment: Trimble Asset Surveyor, differentially corrected, horizontal accuracy sub-meter), digitally photographed, field marked with a brass tag and measurements were taken of flow and temperature. PacifiCorp retained identification system established during the previous surveys, except for the Joes Valley area and Mill Fork Ridge. In these two areas, several springs were labeled with multiple tags of different numbers and separate springs were labeled the same identification. In addition to the field measurements, PacifiCorp collected baseline water quality samples. Not all sites were sampled, collection of water quality samples were restricted to sites where representative samples could be obtained. At selected sites, springs were also sampled for isotopic data. These sites were selected based on geographic location, geologic formation, and occurrence.

During the 2000-2002 baseline evaluation, a total of 198 springs were identified within and adjacent to the Mill Fork Area. Each spring site on East Mountain has been studied to determine the geologic circumstances that cause the springs to occur. The mode of occurrence for each spring has been tabulated on the "Springs Geologic Conditions Inventory" sheets included in the Deer Creek Mine MRP. The springs on East Mountain originate in several different ways; however, many springs share the same mode of occurrence and, in some cases, are related.

The most frequent occurrences of springs are those located about 150 to 350 feet below the top of the North Horn Formation. Field observations along with drill hole data show a predominance of fluvial siltstone and sandstone at that stratigraphic interval. These sedimentary rocks represent many isolated fluvial systems which are water-bearing. The springs are formed where the fluvial channels intersect the land surface. Because the fluvial channels within this zone are generally not interconnected, the springs are not interrelated but share the same mode of occurrence.

Numerous springs located in the lower portion of the North Horn Formation occur when water flowing through fluvial sandstones which are underlain by a thin zone of impervious mudstone at the base of the North Horn Formation intersects the land surface. Field observations along with drill hole data indicate that impervious mudstone units occur at the upper and lower portion of the North Horn Formation. Even though these individual mudstone layers are discontinuous, the occurrence of this type of strata exists throughout the East Mountain Property. The springs related to this mode of occurrence are not generally interrelated because they are fed by waters flowing through isolated fluvial channel sandstones and siltstones.

Numerous springs are located along and within the Joes Valley Graben. Generally, the springs are located within the North Horn Formation (Bald Mountain Ridge located west of the Mill Fork Area) along the fault zone and the alluvial valley deposits. Many of the largest springs surveyed for the Mill Fork Area are located along this fault system west of the Mill Fork Area. The springs located along this fault zone are generally interrelated.

A few springs are located within both the Flagstaff and Price River formations; however, their occurrence is insignificant in comparison to springs located in the North Horn Formation.

Generally springs with discharges exceeding 50 gpm are associated with faulting where permeability has been increased by fracturing (example: Bald Ridge area). The discharge of the springs varies directly with the amount of precipitation and also varies seasonally. Discharge is greatest during the snow melt period, normally from late April through the month of June. Following periods of groundwater recharge the discharge recedes fairly rapidly at first, then

gradually, indicating a double porosity effect. At the end of the water year, the remaining discharge is only twenty to thirty percent (20-30%) of the peak discharge. Seasonal flow variation collected for the Mill Fork Area compares directly to the data collected for the southern portion of East Mountain and data collected by Genwal resources to the north.

The following table provides a breakdown of spring locations by geologic formation and surface drainage:

MILL FORK PERMIT AREA (Energy West 2000-2002 Surveys) SPRINGS by GEOLOGIC FORMATION and SURFACE DRAINAGE						
Drainage System	Geologic Formation					
	Alluvium	Flagstaff	North Horn	Upper Price River	Castle Gate	Blackhawk
Huntington Drainage						
Crandall Canyon	0	0	0	7	1	0
Mill Fork Canyon	0	0	44	10	1	5
Right Fork of Rilda Canyon	0	1	39	1	0	0
Cottonwood Drainage						
Un-Named Drainages of Joes Valley	35		29	19	6	0
Total Number of Springs = 198						

Groundwater Quality

Groundwater chemical quality is very good in strata above the Mancos Shale. The USGS reported a range in dissolved solids from 50 to 750 mg/l for samples from 140 springs in the region issuing from the Star Point Sandstone Formation and overlying formations (Danielson et al., 1981). During the Energy West 2000 - 2002 seep and spring surveys, a total of one hundred twenty-nine (129) samples were collected with a range of dissolved solids from 207 to 390 mg/l. Danielson et al. (1981) identified the regional trends of decreasing water quality from north to south and west to east across the Wasatch Plateau. Waters percolating through the underlying

Mancos Shale quickly deteriorate, with total dissolved solids concentrations frequently exceeding 3000 mg/l.

Additional studies by PacifiCorp have confirmed the primary findings of the USGS concerning regional trends in quality. Originally, decreasing quality from north to south was believed to depict the groundwater flow direction, and the quality decreased as a function of the time it traveled through the strata. Although the time travel component is probably an important factor, in 1985 a surface exploration program identified the existence of an area of residual heat from an ancient burn on the outcrop throughout the southern extreme of East Mountain. The high temperature was also explored within the mine and a portion of reserves were lost because of the situation. It is now theorized that the high temperature water dissolved the mineral constituents of the formations, thereby altering the water chemistry. The quality also decreases vertically downward because of the influence of marine sediments along with the trend of decreasing quality from north to south.

An examination of the data indicates that a relationship exists between elevation and the total dissolved solids concentration of the springs. The data indicate that concentrations of dissolved materials increase with diminishing elevation for both surface streams and springs. The change in quality is a function of the differences in the chemical character of geologic formations which outcrop at different elevations.

To more closely identify springs which are related, water samples are analyzed to determine the percentage of cations and anions in solution. The purpose of the diagrams is to identify groups of related springs by water chemistry. The diagrams clearly show the similarity of water quality of springs originating in the same geologic formation. Historical data from PacifiCorp's on-going East Mountain Hydrologic Program has demonstrated is that, even though the quality varies slightly from individual sites as well as from different formations, seasonal variations do not exist. Data collected in 2000-2001 confirms the trends historical in data collected for southern East Mountain, i.e., despite the seasonal variability in discharge rates, the solute concentrations of active region ground waters do not exhibit significant seasonal variability.

PacifiCorp began in-mine quality monitoring in 1977 (Cottonwood/Wilberg and Deer Creek mines). With the collection of numerous samples throughout the extent of the mine workings, the quality has remained relatively constant. As with the springs the quality varies from individual sites, but quality from the individual sites remains constant versus time.

The predominant dissolved chemical constituents of the groundwater from both surface springs and samples collected in the mine are calcium, bicarbonate, magnesium, and sulfate.

Concentrations of magnesium are normally about one-half the concentration of calcium. Sulfate concentrations are typically higher in water from springs issuing from the Star Point Sandstone-Blackhawk aquifer zone or confined aquifers intersected by mine workings. As mentioned earlier, water quality degrades from the north to the south and also vertically.

PacifiCorp contracted Mayo & Associates in 1996 to conduct comprehensive study to characterize the hydrology and hydrogeology of the East and Trail Mountains. The hydrogeology of the PacifiCorp leases were evaluated by analyzing: 1) solute and isotopic composition of surface and ground waters, 2) surface and groundwater discharge data, 3) piezometric data, and 4) geologic information. The following lists the key points and conclusions from the 1996 study:

Conclusions from the 1996 Mayo & Associates Hydrologic Investigation

1. The $\delta 2H$ and $\delta 18O$ compositions demonstrate that all ground waters are of meteoric origin (i.e. snow and rain).
2. Active and inactive groundwater regimes occur in the mine lease area.
3. The active regime includes alluvial groundwater, groundwater in the Flagstaff Formation, and all near surface exposures of the other bedrock formations except, perhaps, the Mancos Shale. The near surface extends about 500 to 1,000 feet into cliff faces. Ground waters in the active regime contain abundant 3H and anthropogenic 14C.
4. Comparison of long-term discharge hydrographs with precipitation records demonstrates that active regime ground waters: 1) are in direct hydraulic communication with the surface, 2) are recharged by modern precipitation, and 3) have large fluctuations in spring discharge rates which can be attributed to seasonal and climatic variability. High-flow/low-flow discharge rates vary as greatly as 600 gpm to nearly dry; however, most high flow rates are less than 50 gpm.
5. Despite the seasonal variability in discharge rates, the solute concentrations of active region ground waters do not exhibit significant seasonal variability.
6. The inactive regime includes groundwater in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). Mine workings are largely part of the inactive regime. The sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. Coal seams are hydraulic barriers to groundwater flow. The blanket sands of the Star Point Sandstone are also largely in the inactive zone. Except where exposed near cliff faces, faults encountered in mine workings are part of the inactive regime. Except

near cliff faces, faults are not conduits for vertical hydraulic communication between otherwise hydraulically isolated pockets of groundwater.

7. Inactive region groundwater systems contain old groundwater (i.e. 2,000 to 12,000 years), and are not influenced by annual recharge events or short term climatic variability.
8. In-mine inactive regime ground waters occur in nearly stagnant, isolated zones which have extremely limited hydraulic communication with other inactive regime ground waters in the vicinity of mine workings and with near-surface active regime ground waters as evidenced by the following:

   a) Ground waters discharging into mine openings have 14C ages ranging from 2,000 to 12,000 years
   b) Roof drip rates rapidly decline when water is encountered in the mine indicating that the saturated zone above the coal seam is not hydraulically continuous and has a limited vertical and horizontal extent.
   c) Unsaturated conditions have been identified in boreholes drilled vertically into sandstone channels located above coal seams.

9. The fact that inactive region ground waters encountered in mine openings do not have an infinite age means that, at some time, there has been some hydraulic communication with the surface. This communication is extremely limited as illustrated by calculated steady state recharge-discharge rates of faults and sandstone channels in the inactive zone which range from 0.001 to 1.23 gpm.
10. Groundwater in the Star Point Sandstone is part of the inactive regime as evidenced by the 6,000 year 14C age of the sample from well TM-3. In the down dip direction along the axis of the Straight Canyon Syncline, potentiometric pressures in the Spring Canyon member results in upwelling of groundwater into Hiawatha seam mine openings. Such upwelling may locally reduce the pressure in the Spring Canyon member.
11. Aerially extensive groundwater regimes in the lower Blackhawk Formation and Star Point Sandstone do not exist within the lease area. Therefore, it is not meaningful to create piezometric surface maps of these systems.
12. Stream flow is dependent on snow melt, precipitation and thunderstorm activity. There is no apparent hydraulic communication between stream flow and groundwater encountered in mine openings.
13. The groundwater discharging into the Rilda Canyon alluvial collection system is of modern origin and is closely tied to seasonal recharge. This is evidenced by its modern radiocarbon and 3H contents and by the discharge hydrographs. The alluvial groundwater is not related to the groundwater encountered in the mines.

14. The groundwater discharging in Cottonwood Canyon near Cottonwood Spring and Roans Spring discharges from glacial deposits and is of modern origin. The radiocarbon and 3H contents of this water indicate a modern origin. The water in the shallow glacial deposits is not related to the groundwater encountered in the mines.

In addition to the study conducted in 1996, Mayo & Associates were retained in 2000 to investigate hydrologic resources of the Mill Fork Area and adjacent areas. The purpose of this investigation is to 1) characterize the groundwater and surface water systems in the Mill Fork Area, and 2) determine the probable hydrologic consequences of underground coal mining to surface waters and ground waters within the Mill Fork Area. The hydrology and hydrogeology of the Mill Fork Area area have been evaluated by analyzing: 1) solute and isotopic compositions of surface waters and ground waters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information (refer to Appendix B for complete details).

Chemical Evolution of Groundwater (excerpt from Mayo & Associates Study)

a. Chemical Reactions

Solute compositions of groundwaters are the result of interactions between groundwater and bedrock lithology and between groundwater and atmospheric and soil gases. The general reactions responsible for the chemical evolution of groundwaters in the vicinity of the study area and inside the coal mines are described below:

Groundwater acquires most of its $CO_2(g)$ in the soil zone where the partial pressure of CO_2 greatly exceeds atmospheric levels. This CO_2 combines with water to form carbonic acid according to

$$CO_2(g) + H_2O = H_2CO_3 \quad (1)$$

Carbonic acid dissociates into H^+ and HCO_3^- as

$$H_2CO_3 = HCO_3^- + H^+ \quad (2)$$

The H^+ ions temporarily decrease the pH of the water but are quickly consumed by the dissolution of carbonate minerals that are abundant in the soil zone and in most aquifers. Carbonate mineral dissolution is represented as

$$2H^+ + \underset{\text{(dolomite)}}{CaMg(CO_3)_2} = Ca^{2+} + Mg^{2+} + 2HCO_3^-, \text{ and} \quad (3)$$

$$H^+ + CaCO_3 = Ca^{2+} + HCO_3^- \quad (4)$$

(calcite)

The net effect of reactions 2 through 4 is to increase the pH and the Ca^{2+}, Mg^{2+}, and HCO_3^- contents of waters. Dissolution of gypsum, which is present in minor amounts in many formations in the region, can elevate the Ca^{2+} and SO_4^{2-} contents in the absence of additional $CO_{2(g)}$ and H^+ according to

$$CaSO_4 \bullet 2H_2O = Ca^{2+} + SO_4^{2-} + 2H_2O \quad (5)$$

(gypsum)

Elevated Na^+ concentrations may result from either the dissolution of halite or from ion exchange on clay particles or on sodium zeolites (Mayo and others, 2000). Halite dissolution will increase the overall solute concentration (i.e. TDS) and will yield equal Na^+ and Cl^- contents when the solute compositions are reported in the meq/l units. Halite is not abundant in the study area. Ion exchange will not directly elevate the overall solute content, but will result in increased Na+ concentrations with corresponding decreases in $Ca2^+$ and/or Mg^{2+} concentrations. Halite dissolution may be represented as

$$NaCl = Na+ + Cl^- \quad (6)$$

And the ion exchange may be represented by reactions involving the sodium zeolite analcime,

$$2NaAlSi_2O_6 \bullet H_2O + Ca2+ = Ca(AlSi_2O_6)2 \bullet H_2O + 2Na^+, \quad (7)$$

$$2NaAlSi_2O_6 \bullet H_2O + Mg^{2+} = Mg(AlSi_2O_6)2 \bullet H_2O + 2Na^+, \quad (8)$$

or clay mineral exchange which may be represented as

$$Ca^{2+} + Na\text{-}clay = 2Na^+ + Ca\text{-}clay \quad (9)$$

$$Mg^{2+} + Na\text{-}clay = 2Na^+ + Mg\text{-}clay \quad (10)$$

Solute Compositions

a. Streams

(1) Crandall Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Mill Fork Creek have a mean TDS of about 300 mg/l and are of the Ca^2+-Mg^2+-HCO^{3-} type with lesser amounts of SO_4^{2-}. This water includes drainage from the Mill Fork Area as well as the area to the north.

(2) Mill Fork Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Crandall Creek have a mean TDS of about 480 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with lesser amounts of SO_4^{2-}. Most of this water originates in the Mill Fork Area.

(3) Rilda Canyon Drainage

Water quality samples taken below the confluence of the north and south forks of Rilda Creek have a mean TDS of about 400 mg/l and are of the Ca^{2+}-Mg^{2+}-HCO_3^- type. This water is mostly drainage from the Mill Fork Area.

b. Springs

The solute compositions of ground waters from nearly all of the springs in the Mill Fork Area are of similar chemical type. This is seen in the similarity of the shapes of the Stiff diagrams and the clustering of the data points on the Piper plot. All of the springs in the Mill Fork Area for which chemical analyses are available are of the Ca^{2+}-Mg^{2+}-HCO_3^- type with variable amounts of SO_4^{2-}. This chemical type is consistent with the dissolution of carbonate minerals in the presence of soil zone CO_2(gas) according to equations 1-4 above.

Mineral saturation calculations indicate that most of the springs and streams in the study area are at or above saturation with respect to the carbonate minerals calcite and dolomite. What this means is that the chemistry of the spring water is near equilibrium with respect to these minerals, and thus there is not a thermodynamic tendency to dissolve additional carbonate minerals if these are encountered in the groundwater system. Waters with saturation indices less than log = -0.1 have a thermodynamic tendency to dissolve the mineral species should they be encountered in the groundwater system and waters with a saturation indices greater than log = 0.1 have a thermodynamic tendency to precipitate the mineral species.

For additional dissolution of carbonate minerals to occur, an influx of $CO_{2(g)}$ into the groundwater system must occur. Common sources of $CO_{2(g)}$ in this environment include CO_2 produced by root respiration and organic decay in the soil zone and bacteriological processes resulting in the oxidation of CH_4 (methane). No surface or groundwater in the study area is near saturation with respect to gypsum. What this indicates is that, if gypsum is encountered along a waters flow path, dissolution of the gypsum will occur, resulting in elevated Ca^{2+} and SO_4^{2-} concentrations. Groundwater from the Blackhawk Formation and Star Point Sandstone encountered in nearby mine environments is

supersaturated with respect to both calcite and dolomite indicating that the water has the thermodynamic tendency to precipitate these minerals.

TDS concentrations of springs in the study area fall in the narrow range of 207 to 390 mg/l. A probability plot of the ordered ranking of the TDS of ground waters collected during the 2000-2001 spring and seep survey indicate a single population with a normal distribution. The fact that all of the Mill Fork Area springs discharging from alluvial systems, the North Horn Formation, Price River Formation, Castlegate Sandstone, and Blackhawk Formation have the same chemical character is of particular significance. In other areas in the Wasatch Plateau, bedrock springs commonly have a broader range of TDS and chemical type, which is related to the bedrock formation from which the springs discharge (Danielson and others, 1981; Mayo and Associates, 1997d; Mayo and Morris, 2000).

The mean TDS for each geologic formation ranges from 253 mg/l in the North Horn Formation to 322 mg/l in the Price River Formation. That there is not a greater variability in TDS, or a greater number of groundwater types represented in the springs in the study area implies that there is not a great deal of variation in the soil zone processes or mineralogy of the matrix of the groundwater systems from which these springs emanate. We believe that the lack of variability in groundwater solute chemistry occurs because the groundwater systems that support springs in the area flush large quantities of groundwater through the thick soil zone and shallow fractured bedrock. Over thousands of years, some of the soluble minerals which were once present in the shallow bedrock and in the soil have been leached away. Because these groundwater systems do not come into contact with rocks deeper in the geologic formations (which vary substantially in their soluble mineral contents) there is little variation in the chemical type of groundwater.

Although there is little variability in the chemical type and TDS of groundwater discharging from springs in the Mill Fork Area, there is considerable variability in the TDS and solute compositions of spring discharge waters and the solute composition of spring discharging from the Blackhawk Formation in the nearby Trail and Cottonwood Mine areas. We interpret the overall greater TDS and degree of chemical variability in the Blackhawk Formation in the Trail and Cottonwood Mine waters as a result of great precipitation variability in the Trail and Cottonwood Mine areas. Except for Joes Valley Alluvium, Mill Fork Area ground waters recharge and discharge from very wet upland areas. Trail and Cottonwood Mine groundwater recharge and discharge from a variety of elevations and recharge domains.

In-Mine Groundwater

Because the Federal Lease UTU-84285 was a new lease area that did not have existing underground workings, the solute compositions of in-mine groundwater can only be inferred from compositions of in-mine waters in nearby mines. Extensive in-mine samples of Blackhawk Formation roof drip water are available from Energy West's mines which include Cottonwood, Wilberg, Trail Mountain, and Deer Creek. A limited number of in-mine samples from the Star Point Sandstone are also available from the Deer Creek and Cottonwood Mines (Mayo and Associates, 1997d) and from public documents for the Crandall Canyon Mine (Mayo and Associates, 1997a).

(1) Blackhawk Formation

In-mine roof drips from the Blackhawk Formation are of the Ca^{2+}- Mg^{2+} -HCO_3- -SO_4^{2-} type with appreciable amounts of Na^+. These ground waters have elevated TDS contents relative to Blackhawk spring waters in the Mill Fork Area and are generally chemically dissimilar to springs in the Mill Fork Area. The two spring samples from the Deer Creek and Cottonwood Mine areas have similar solute contents as the in-mine samples. Mayo and others (2000) found the elevated TDS in coal mine roof drip water to be the result of a cascading series of chemical reactions involving the oxidation of pyrite which increases the SO_4^{2-} concentration and releases H^+ ions. The H^+ ions are consumed by dissolution of additional carbonate minerals (i.e., calcite and dolomite) elevating the Ca^{2+} and Mg^{2+} contents. In the process acid mine drainage (AMD) is prevented. Ion exchange of Ca^{2+} and Mg^{2+} on the sodium zeolite analcime increases the Na^+ contents. We anticipate similar in-mine processes will occur in the Mill Fork Area.

(2) Spring Canyon Member

The solute chemical composition of groundwater in the Spring Canyon Member beneath existing mine workings is highly variable (Appendix B Table 4). Conductivities range from 500 to 2,287 µS/cm. Ca^{2+} concentrations range from 5.5 to 64 mg/l and Mg2+ concentrations range from 5.1to 41 mg/l. Na^+ concentrations range from 14 to 550.6 mg/l and Cl^- concentrations range from 5.0 to 221.3 mg/l. The large spatial variations in solute chemistry are attributed to the influence of inter-bedded Mancos Shale tongues which are present in some locations and not in others and are known to contain soluble minerals. The variations in Na^+ are likely the result of the presence or absence of clays with ion exchange capacity. Ion exchange commonly results in elevated Na^+ concentrations at the expense of decreased Ca^{2+} or Mg^{2+} concentrations.

That the solute chemistry in the Spring Canyon Member is not uniform beneath existing mines suggests that there is a partitioning of groundwater systems in the member. This

condition is likely the result of inter-bedded lower-permeability layers in the Star Point Sandstone which partition individual sandstone bodies. These findings are substantiated by monitoring well data from 6 wells in the Trail and East Mountain areas and are significant in that they strongly suggest that the Spring Canyon Member does not act as a single regionally continuous aquifer, but rather it supports a series of smaller, discrete groundwater systems.

(3) Joes Valley Fault System

Ground waters in the Joes Valley Fault system and associated sympathetic faults and fractures have been observed in the Crandall Canyon Mine. Data from a public domain document (Mayo and Associates, 1997a, c) indicate the water is of the Ca^{2+} -Mg^{2+} -HCO_3^- type. This water type is consistent with the dissolution of carbonate minerals in the presence of soil zone CO_2 (gas). Slightly elevated SO_4^{2-} concentrations are consistent with dissolution of minor amounts of gypsum. The relatively low mean Na+ concentration (3.7 mg/l; 0.17 meq/l) indicates that appreciable ion exchange has not occurred. Na^+ and Cl^- contents, in meq/l, are essentially the same, indicating halite dissolution as the Na^+ source.

δ^2H and δ^{18}O

The δ^2H and δ^{18}O composition of a water molecule falling as precipitation is determined by the temperature at which nucleation of the water droplet occurs. However, other effects related to the bulk composition of the water vapor phase, such as cloud rainout and orographic effects, also can affect the isotopic composition of precipitation.

The stable isotopic compositions of waters are usually analyzed relative to the Meteoric Water Line (MWL). The MWL is empirically derived from the worldwide plotting locations of coastal zone precipitation and is defined by the equation $\delta^2H = 8\ \delta^2O + 10$). Precipitation that forms under cooler conditions will plot lower (i.e. more negatively) along the MWL than will precipitation that forms under warmer conditions.

Except for unusual conditions such as geothermal heating above about 100°C, the δ^2H and δ^{18}O composition of a groundwater is set at the time of recharge and is not affected by subsurface conditions such as groundwater residence time and mineral dissolution and precipitation reactions. In other words, the recharge and flow history of a groundwater can be evaluated independently of the solute content of the water using stable isotopic compositions.

All ground waters in the study area plot near the meteoric water line indicating a meteoric recharge origin (i.e. rain and snow).

Based on their stable isotopic compositions, ground waters from within both the Energy West and Crandall Canyon Mines are readily distinguishable from each other and from springs and creeks in the Mill Fork Area. These three populations are statistically different from each other at the 95% confidence level. The Mill Fork Spring samples tend to plot more positively relative to the meteoric water line than do the in-mine waters, indicating that the near-surface ground waters recharged under different climatic conditions. The more negative composition of the in-mine ground waters is probably the result of paleo-recharge during cooler, wetter times. The stable isotopic composition of water seldom changes significantly after infiltration into the groundwater system. What this suggests is that modern groundwater systems in the upland areas overlying the mine area are not the primary source of recharge to the groundwater systems encountered in the mines.

Groundwater Ages (^{3}H and ^{14}C)

The concept of groundwater age is difficult to define because water arriving at a well or spring seldom travels via pure piston flow. Instead it is usually a mixture of water molecules that recharged at different locations and at different times, thus water has no unique age. It is therefore best to think of a groundwater "age" as the mean residence time of the water sampled at the well or spring.

In this investigation, two unstable isotopes, tritium (^{3}H) and carbon-14 (^{14}C) have been used to evaluate mean residence times. Tritium is a qualitative tool indicating if groundwater has a component of water that recharged since about 1954. Groundwater that recharged prior to about 1954 will contain essentially no tritium. Carbon-14 provides information regarding the number of years that have elapsed since the groundwater became isolated from soil zone gases and near-surface waters. Like tritium, ^{14}C can indicate if groundwater has a component that recharged since the 1950s. Ground waters with ^{14}C contents greater than about 50 percent modern carbon (pmc) contain anthropogenic (i.e., human-induced) carbon associated with atmospheric nuclear weapons testing. It is not uncommon for groundwater issuing from a spring or occurring in a well to be a mixture of old (i.e. containing no ^{3}H) and modern water.

Groundwater ages have been calculated for 27 springs, 14 in-mine locations, and 6 Star Point Sandstone wells. All spring waters, except for spring 18-4-1 which is located in the southwestern portion of Trail Mountain, contain anthropogenic carbon and appreciable amounts of ^{3}H and are, therefore, modern. These springs issue from alluvial systems, the North Horn Formation, the Price River Formation, the Castlegate Sandstone, and Blackhawk Formation.

Spring 18-4-1 issues from the Blackhawk Formation-Castlegate Sandstone contact at the down plunge end of the Straight Canyon Syncline and is not in the Mill Fork Area. The spring water does not contain water that recharged since 1954; however, the water was likely recharged less than a few hundred years ago as is indicated by its ^{14}C content.

Most groundwaters collected inside the Cottonwood/Wilberg and Deer Creek Mines contain essentially no tritium (Appendix B Table 5) and have mean ^{14}C ages ranging from 2,000 to 12,000 years. Roof drip waters associated with faults (i.e., 1.5N X 29, 6W X 20, and MN-ME) contain waters 2,000 to 7,000 years old and are not in hydraulic communication with the surface. Both roof drip (i.e. Blackhawk Formation) and wells in the Spring Canyon Member of the Star Point Sandstone in the Crandall Canyon Mine generally have groundwater ages of 13,000 – 19,000 years. These waters contain essentially no tritium and thus represent groundwater systems that are essentially hydraulically isolated from modern near surface hydrologic phenomena.

Two in-mine roof drip samples associated with faults, TW-10 (Roans Canyon) in the Deer Creek Mine and 5th West (Joes Valley Fault) in the Crandall Canyon mine, have ^{3}H contents indicating a component of modern recharge.

Active and Inactive Groundwater Zones

The overall pattern of groundwater flow and surface water-groundwater interactions in the Mill Fork Area and adjacent areas can be described by a fairly simple conceptual model involving both active and inactive groundwater flow regimes (Mayo and Morris, 2000).

Active zone groundwater flow systems contain abundant ^{3}H, have excellent hydraulic communication with the surface, are dependent on annual recharge events, and are affected by short term climatic variability. Tritium and carbon-14 “age” dating of spring waters in the study area demonstrate that all springs, except 18-4-1, issue from active zone groundwater systems and are of modern origin. Groundwater in the active zone generally circulates shallowly and has short flow paths. Because the springs in the Mill Fork Area and adjacent areas are not part of large, regional groundwater systems, hydrographs of their discharge rates show both seasonal and climatic fluctuations. During drought cycles, it is not uncommon for discharge from some springs in the active zone to completely cease.

The $\delta^{2}H$ and $\delta^{18}O$ compositions of Mill Fork Area springs relative to in-mine ground waters demonstrate that the Mill Fork Area springs are not part of the same groundwater systems that discharge in the mines.

The active regime includes alluvial groundwater, all of the Flagstaff Limestone, and the near-surface exposures of all other bedrock formations. The "near surface" extends a few hundred feet vertically into the subsurface, about 500 to 1,000 feet into cliff faces and is controlled by fracturing, weathering, and the surface exposures of fluvial channel sands. Further into the cliff faces the discontinuous character of the channel sands prevents active groundwater flow.

Except for mountain fronts and cliff faces, the coal bearing lower Blackhawk Formation and the Star Point Sandstone are generally not exposed at the surface in the Mill Fork Area and are not part of the active zone. In Cottonwood Canyon, located south of Mill Fork Area, the Star Point Sandstone is within a few hundred feet of land surface and is part of the active zone as evidenced by the tritium content, 1.10 TU, in Well CCCW-1S. Elsewhere Star Point Sandstone samples have groundwater ages of 6,000 to 19,000 years. In the Mill Fork Area the lower Blackhawk Formation and Star Point Sandstone are not exposed near the land surface, except at cliff faces, and are not in the active zone.

Except for mining operations near cliff faces, the in-mine environment is generally not part of the active zone. However, in-mine groundwater containing tritium (i.e., 1 TU or more) in TW-10 (Roans Canyon Fault) and 5th West Fault (Joes Valley Fault-Genwal Mine) indicate that locally the inactive zone extends into the mine environment where fracture zones, that are associated with major faulting, are currently under tensional stress. The extension of the active zone into the mine environment along fractures is localized as evidenced by the absences of tritium and old ^{14}C ages in in-mine groundwater collected elsewhere along the fracture zone.

Inactive zone groundwater systems contain old groundwater (i.e. 2,000 to 19,000 radiocarbon years, have very limited hydraulic communication with the surface and with other active groundwater flow systems, and are not influenced by either annual recharge events or short term climatic variability as evidenced by the decline in roof drip rates. Groundwater in these systems tends to occur in sandstone channels in the North Horn, Price River, and Blackhawk Formations which are not in direct hydraulic communication with the surface (i.e. greater than about 500 to 1,000 feet from cliff faces). These sandstone channels are vertically and horizontally isolated from each other and when encountered in mine workings are usually drained quickly. The blanket sands of the Star Point Sandstone are also largely in the inactive zone.

Except for the immediate vicinity of Joes Valley Fault, we believe that groundwater intercepted in the Mill Fork Area will be part of the inactive zone and will not be in hydraulic communication with either near surface groundwater or surface water systems. Mining within 200 to 300 feet of Joes Valley Fault is problematic in that the area is under tension and deep

groundwater may be part of the active zone.

Two fundamentally different groundwater regimes, active (near surface) and inactive (deep subsurface and in-mine) that occur in the vicinity of the Mill Fork Area and elsewhere in the Utah Coal District are due to the vertical and horizontal heterogeneity of the bedrock. The rock formations consist primarily of alternating and interpenetrating layers of somewhat permeable sandstone and impermeable shale and mudstone. Individual rock layers are generally not continuous over great horizontal distances. Rather, one rock facies commonly grades horizontally into another facies. Fluvial deposits consisting of sandstone channels, which locally support groundwater systems, typically interpenetrate with shale and mudstone units. Thus, layers of shale or claystone that have very low permeabilities encase individual sandstone layers both horizontally and vertically. Although the permeability of individual sandstone bodies may locally be relatively high, the ability of these rocks to transmit water horizontally over great distances is low because of the discontinuous nature of the sandstones. Due to the pervasiveness of low permeability shales and mudstones, the potential for vertical groundwater flow is minimal.

Because of the limited potential for groundwater to migrate vertically through the stratigraphic section, active zone recharge waters commonly infiltrate only into the soil zone and shallow, fractured bedrock. Most groundwater moves downward through the shallow subsurface until the first impermeable layer is encountered where it migrates laterally and is discharged at the surface as a spring or seep.

Regional Groundwater Systems

A report by the U.S. Geological Survey (Lines, 1985) states that there exists a regional aquifer in the lower Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau. Lines also postulates that the regional aquifer is recharged by the downward migration of ground waters from overlying perched groundwater systems in the North Horn and Price River Formations. This idea is not correct. Ground waters encountered within mine openings in the lowermost Blackhawk Formation occur primarily within discontinuous sandstone channels. It is not uncommon for some of these channels to be completely dry, while others are partially or completely filled with water. Between these sandstone channels, the surrounding shales and claystones of the Blackhawk Formation are usually dry. The discontinuous nature of the saturated sediments in the lowermost Blackhawk Formation, and the unconfined conditions under which these ground waters exist do not support the idea of a deep, regional system with groundwater flowing from areas of recharge to areas of discharge.

Additionally, radiocarbon and tritium groundwater age dating indicates that groundwater in the

shallow perched groundwater systems are modern (post-1954) and in-mine groundwater in the Blackhawk Formation and Star Point Sandstone are thousands of years old.

We believe that the presence of swelling clays and impermeable shales in the rocks in the unsaturated zone between the overlying perched systems and the Blackhawk Formation effectively prohibit downward vertical migration of waters from the perched systems. Lines (1985) analyzed cores taken from well (D-17-6) 27bda-1 and found the hydraulic conductivities of the shales and siltstones to be very low (i.e. 10-7 to 10-8 ft/day). One shale sample was found to be effectively impermeable even when a hydraulic pressure of 5,000 psi was applied.

Because there are no regionally extensive groundwater regimes in the lower Blackhawk Formation or Star Point Sandstone within the lease area, it is not possible to draw meaningful potentiometric surface maps of these systems.

Lines (1985) also reported that water was likely leaking from the Joes Valley Reservoir downward into the "lower Blackhawk / Star Point aquifer" in Straight Canyon. We believe that this is incorrect. Groundwater collected from well TM-3, which is completed in the Star Point Sandstone in Straight Canyon just below the reservoir, has a radiocarbon age of 6,000 years, while water in Joes Valley Reservoir is of modern origin. Water levels in TM-3 do not respond to seasonal fluctuations in the water level in Joes Valley Reservoir, indicating that there is little or no hydraulic communication between the reservoir and water in the Star Point Sandstone. Groundwater was sampled at UG-3 in the lower Blackhawk Formation in the Trail Mountain Mine. This water has a radiocarbon age of 5,500 years, which is likewise not consistent with water from the reservoir.

Summary of 2001 Mayo & Associates Study

In summary, all groundwater encountered in springs monitored in the Mill Fork permit Area discharge from active, shallow groundwater systems. No evidence exists that suggests a large, regional-type aquifer occurs in the area. All of the springs analyzed in the study area exhibit large-scale fluctuations in discharge rates in response to the annual snowmelt event. The springs are also sensitive to longer-term variations in climate. Carbon-14 and tritium dating of spring and stream waters indicate that the springs contain anthropogenic (human-induced) carbon and levels of tritium consistent with recharge in the past 50 years. Stable isotopic δ^2H and $\delta^{18}O$ data from springs and streams at the surface indicate that the recharge sources for these groundwater systems are different from those that recharged the groundwater systems encountered in the mine environment.

Almost all groundwater encountered in in-mine environments is not related to shallow, active zone groundwater systems from which springs and streams discharge. ^{14}C dating indicates that

groundwater entering the underground workings in most locations is thousands of years old. When groundwater is encountered in the mine, inflow rates commonly decrease rapidly and most inflows eventually dry up completely. This indicates that the groundwater systems encountered in the mine are not part of large regional groundwater systems. There is no relationship between groundwater inflow rates measured in the mine and the annual snowmelt event or long term climatic trends. This demonstrates a lack of hydraulic communication between the groundwater systems encountered in the mine and active zone groundwater systems near the surface.

Conclusions from 2001 Mayo & Associates Study

- Ground waters discharging from springs are part of active zone groundwater systems. Isotopic analysis indicates that groundwater from the active zone is of modern origin (recharged less than 50 years ago). Seasonal variations in discharge rates from active zone springs indicate that flowpath lengths are short and that groundwater travel times from recharge areas to discharge areas are generally less than one year. The abundance of shale and claystone units in the geologic section prohibits significant downward migration of active zone ground waters into deeper horizons.

- Analysis of the solute chemistry of ground waters discharging from springs and seeps indicate that depths of circulation in these systems are shallow. The modern groundwater ages of shallow ground waters in the study area support this conclusion.

- Groundwater encountered in most locations in the mines is many thousands of years old. Groundwater in the Star Point Sandstone ranges from approximately 1,000 to 19,000 years old. Groundwater in the Blackhawk Formation within the mines ranges in age from about 2,000 to 14,000 years, whereas groundwater in the Joes Valley Fault system ranges in age between about 2,500 and 5,000 years. None of these groundwaters have appreciable tritium concentrations, indicating that no recharge has occurred in the past 50 years.

- Groundwater encountered in the northwest corner of the Crandall Canyon Mine discharges from a series of fractures located near the Joes Valley Fault. Tritium data indicate that a component of this water recharged in the past 50 years, whereas ^{14}C data indicate that another component recharged more than 3,500 years ago. This groundwater appears to originate from a sandstone channel in the mine roof.

- More than two-thirds of all non-alluvial springs in the Mill Fork Area discharge from the North Horn Formation. The abundance of springs in the North Horn Formation is the result of the large area of exposed North Horn in the upland areas where precipitation is greatest, and the presence of the abundant claystone and shale layers which inhibit significant downward migration of precipitation into the formation.

- The fact that Little Bear Spring discharges modern water and has large variations in discharge rates suggests that it is the discharge location of an active zone groundwater system. Because inactive zone groundwater systems in the Star Point Sandstone beneath the mine are tens of thousands of years old and do not exhibit seasonal variations in discharge, these groundwater systems are precluded as potential contributors to the discharge from Little Bear Spring. The very low permeability in the Star Point Sandstone beneath the mine indicates that diffuse flow through the Star Point Sandstone beneath the mine cannot contribute significant groundwater to the discharge from the spring.

  Limited data suggest the possibility that Little Bear Spring may receive significant recharge where the fracture system from which it emanates crosses streams and active zone groundwater systems in drainages south of Little Bear Canyon. The conditions in Mill Fork Canyon seem favorable for recharge to the spring.

WATER MONITORING – MILL FORK AREA

A. GROUNDWATER

Groundwater within the Mill Fork Area was monitored according to the schedules in established in the Deer Creek MRP. PacifiCorp has conducted baseline and operational monitoring of spring sources in and adjacent to the lease area. The data collected have provided information useful in the understanding of potential hydrologic consequence of mining.

East Mountain Springs - Mill Fork

In preparation for coal leasing, Genwal Resources conducted baseline spring and seep surveys from 1994-1996 (northern portions of the lease were surveyed in 1989-90). With PacifiCorp's acquisition of the Mill Fork State Coal Lease (reverted to the BLM on August 1, 2011 and now designated as federal lease UTU-88554), a complete re-evaluation of groundwater resources was initiated in 2000 and continued through 2001. During the 2000-2002 baseline evaluation, a total of 198 springs were identified within and adjacent to the lease plan area. Federal Coal Lease UTU-84285 was created on November 1, 2006, immediately adjacent to the western boundary of

UTU-88554. Each spring site on East Mountain has been studied to determine the geologic circumstances that cause the springs to occur. The mode of occurrence for each spring was tabulated on the "Springs Geologic Conditions Inventory" sheets located in the Deer Creek MRP. The springs on East Mountain originate in several different ways (see Springs and Hydrologic Drainage Maps and HM-1A Hydrology Data Map); however, many springs share the same mode of occurrence and, in some cases, are related.

The ground water monitoring plan in Appendix A includes a selection of springs based on the following criteria:

- Stratigraphic position
- Area of potential influence from subsidence
- Aerial distribution
- Established water rights
- Measurable flow based on historical surveys
- Reliable measuring point(s)

The following table outlines the rationale for springs selected for long term monitoring. Selection of the springs to be monitored was based upon the factors listed along with discussions with the water users (CVSSD, Emery Conservancy District, NEWUSSD) and the surface management agency.

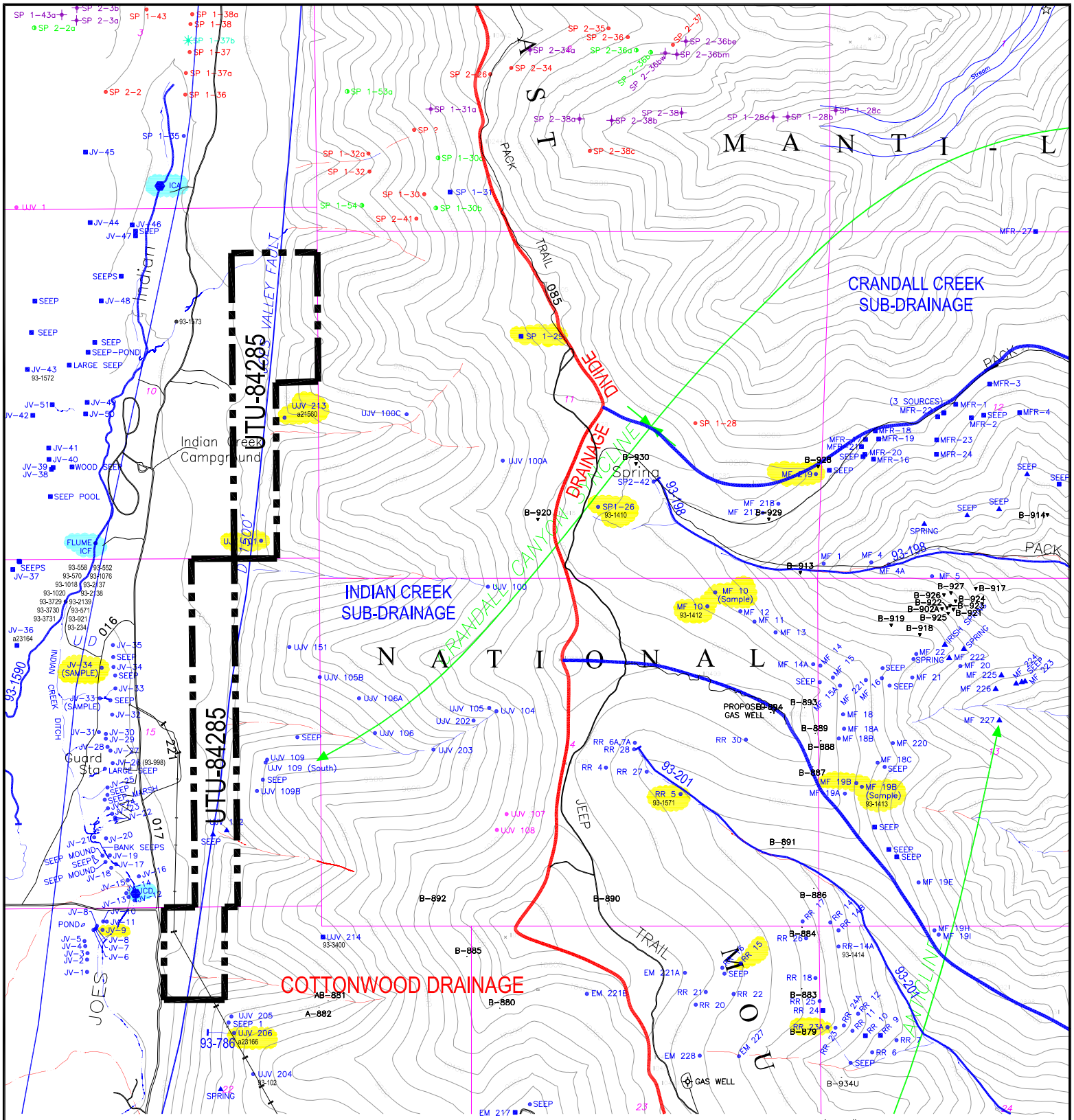
MILL FORK GROUNDWATER MONITORING PLAN - SPRINGS							
Spring	Stratigraphic Position	Projected Subsidence Zone	Regional Location	Water Rights	Historical Measurable Flow	Reliable Measuring Point	Comment
SP1-29	✓	✓	✓		✓	✓	
UJV-213	✓		✓	✓	✓	✓	
UJV-101	✓		✓		✓	✓	
JV-34	✓		✓			✓	Located outside projected zone of subsidence. Monitored to detect impacts to the Joes Valley alluvium
JV-9	✓		✓			✓	Located outside projected zone of subsidence. Monitored to detect impacts to the Joes Valley alluvium
UJV-206	✓	✓	✓	✓	✓	✓	
MF-219	✓	✓	✓	✓	✓	✓	
SP1-26	✓	✓	✓	✓	✓	✓	
MF-10	✓	✓	✓	✓	✓	✓	
MF-19B	✓		✓	✓	✓	✓	
RR-5	✓	✓	✓	✓	✓	✓	
EM-216	✓		✓	✓	✓	✓	Located outside projected zone of subsidence
GRANTS SPRING					✓	✓	Added to the spring monitoring program at the request of the USFS
RR-15	✓	✓	✓		✓	✓	
RR-23A	✓		✓		✓	✓	Large spring within a series of springs located downdip from projected mining
EM POND					✓	✓	Added to the spring monitoring program at the request of the USFS
MFR-30	✓	✓	✓		✓	✓	
MFR-10	✓	✓	✓		✓	✓	Large spring denoted by USGS
MF-7	✓		✓		✓	✓	Located outside projected zone of subsidence
MF-213	✓		✓	✓	✓	✓	Large spring located in the Blackhawk Formation downdip from projected mining
LITTLE BEAR SPRING	✓		✓	✓	✓	✓	Located outside projected zone of subsidence. Added to the spring monitoring program at the request of the DOGM

Water samples were collected and analyzed during the months of July and October. Parameters analyzed are those listed in the "DOGM Guidelines for Groundwater Water Quality". Monitoring of groundwater sites will continued for a minimum of three years after the last date of mining (date of last mining - January 2015). PacifiCorp will submit a formal application to reduce hydrologic monitoring after the minimum three year time period.

S***urface Hydrology***

The East Mountain mine area is located in the headwater region of the San Rafael River Basin. The surface drainage system of the Federal Lease UTU-84285 forms part of the Cottonwood Creek drainage.

All drainages in and adjacent to Lease UTU-84285 are ephemeral. The majority of the surface flow from the lease block drains to the west in un-named drainages of Upper Joes Valley which report to Cottonwood Creek. As detailed in Appendices A and B, subsidence is limited and affects of subsidence did not alter surface flow characteristics of the ephemeral drainages.



CAD FILE NAME/DISK#: UTU-84285

SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- MONITORING LOCATIONS (GENWAL RESOURCES)
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- FEDERAL LEASE ACREAGE RELINQUISHED

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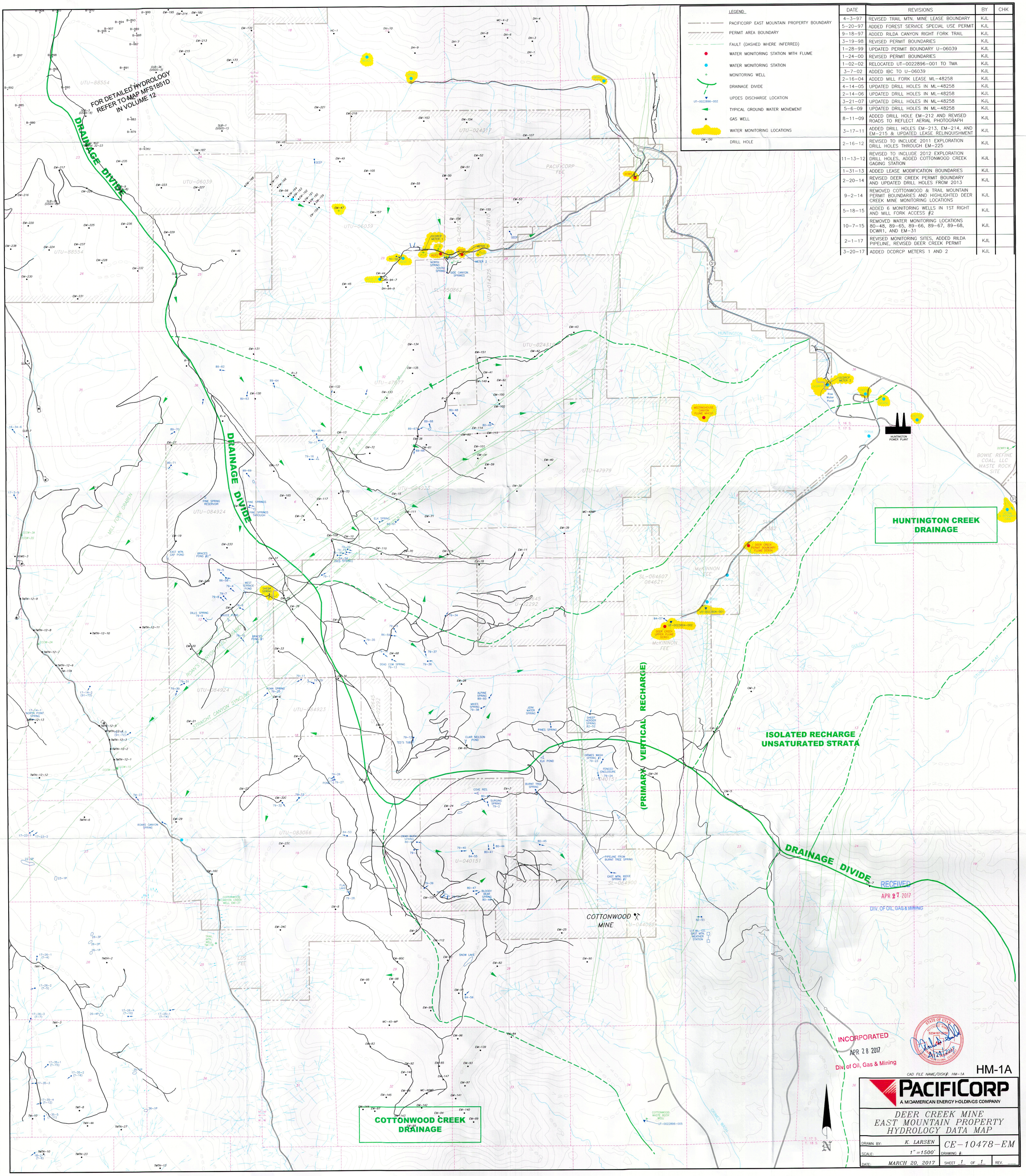
INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–84285
HYDROLOGIC DRAINAGE MAP

DRAWN BY: K. LARSEN	APPENDIX C	
SCALE: 1" =2000'	DRAWING #:	
DATE: APRIL 23, 2018	SHEET 1 OF 1	REV. ___



LEGEND
PACIFICORP EAST MOUNTAIN PROPERTY BOUNDARY
PERMIT AREA BOUNDARY
FAULT (DASHED WHERE INFERRED)
WATER MONITORING STATION WITH FLUME
WATER MONITORING STATION
MONITORING WELL
DRAINAGE DIVIDE
UT-0022896-002 UPDES DISCHARGE LOCATION
TYPICAL GROUND WATER MOVEMENT
GAS WELL
WATER MONITORING LOCATIONS
EM-150 DRILL HOLE

DATE	REVISIONS	BY	CHK
4-3-97	REVISED TRAIL MTN. MINE LEASE BOUNDARY	KJL	
5-20-97	ADDED FOREST SERVICE SPECIAL USE PERMIT	KJL	
9-18-97	ADDED RILDA CANYON RIGHT FORK TRAIL	KJL	
3-19-98	REVISED PERMIT BOUNDARIES	KJL	
1-28-99	UPDATED PERMIT BOUNDARY U-06039	KJL	
1-24-00	REVISED PERMIT BOUNDARIES	KJL	
1-02-02	RELOCATED UT-0022896-001 TO TMA	KJL	
3-7-02	ADDED IBC TO U-06039	KJL	
2-16-04	ADDED MILL FORK LEASE ML-48258	KJL	
4-14-05	UPDATED DRILL HOLES IN ML-48258	KJL	
2-14-06	UPDATED DRILL HOLES IN ML-48258	KJL	
3-21-07	UPDATED DRILL HOLES IN ML-48258	KJL	
5-6-09	UPDATED DRILL HOLES IN ML-48258	KJL	
8-11-09	ADDED DRILL HOLE EM-212 AND REVISED ROADS TO REFLECT AERIAL PHOTOGRAPH	KJL	
3-17-11	ADDED DRILL HOLES EM-213, EM-214, AND EM-215 & UPDATED LEASE RELINQUISHMENT	KJL	
2-16-12	REVISED TO INCLUDE 2011 EXPLORATION DRILL HOLES THROUGH EM-225	KJL	
11-13-12	REVISED TO INCLUDE 2012 EXPLORATION DRILL HOLES, ADDED COTTONWOOD CREEK GAGING STATION	KJL	
1-31-13	ADDED LEASE MODIFICATION BOUNDARIES	KJL	
2-20-14	REVISED DEER CREEK PERMIT BOUNDARY AND UPDATED DRILL HOLES FROM 2013	KJL	
9-2-14	REMOVED COTTONWOOD & TRAIL MOUNTAIN PERMIT BOUNDARIES AND HIGHLIGHTED DEER CREEK MINE MONITORING LOCATIONS	KJL	
5-18-15	ADDED 6 MONITORING WELLS IN 1ST RIGHT AND MILL FORK ACCESS #2	KJL	
10-7-15	REMOVED WATER MONITORING LOCATIONS 80-48, 89-65, 89-66, 89-67, 89-68, DCWR1, AND EM-31	KJL	
2-1-17	REVISED MONITORING SITES, ADDED RILDA PIPELINE, REVISED DEER CREEK PERMIT	KJL	
3-20-17	ADDED DCDRCP METERS 1 AND 2	KJL	

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APR 27 2017
DIV. OF OIL, GAS & MINING

INCORPORATED
APR 28 2017
Div. of Oil, Gas & Mining

STATE OF UTAH
5234167-2020
REGISTERED PROFESSIONAL ENGINEER
3-20-2017

HM-1A

CAD FILE NAME/DISK#: HM-1A

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

DEER CREEK MINE
EAST MOUNTAIN PROPERTY
HYDROLOGY DATA MAP

DRAWN BY:	K. LARSEN	DRAWING #:	CE-10478-EM
SCALE:	1"=1500'		
DATE:	MARCH 20, 2017	SHEET 1 OF 1	REV. ___

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
UJV-213	First Mining	Hiawatha: 25th West Bleeder Feb. 2012	Within Relinquishment	10	16S	6E	NA
UJV-101	First Mining	Hiawatha: 22nd West Bleeder Mar. 2011	Within ½ mile Offset Within Lease UTU-84285	10	16S	6E	NA
JV-34	Not Undermined	NA Nearest second mining: 2670' Aug. 2008	Within ½ mile Offset	15	16S	6E	NA
JV-9	Not Undermined	NA Nearest second mining: 1940' Jun. 2005	Within ½ mile Offset	22	16S	6E	NA
UJV-206	Not Undermined	NA Nearest second mining: 1825' Dec. 2005	Within Relinquishment	22	16S	6E	NA
MF-219	First Mining - BC Longwall – BC First Mining – Hia.	Blind Canyon: First Mining 7th Left Sep. 2009 Second Mining 7th Left Apr. 2010 Hiawatha: 23rd West Feb. 2011	Within Relinquishment	11	16S	6E	1

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
SPI-26	Not Undermined	NA Nearest second mining: 460' Feb. 2010	Within Relinquishment	11	16S	6E	NA
MF-10	Longwall Panels	Blind Canyon: 5th Left Jul. 2009 Hiawatha: 21st West Jan. 2011	Within Relinquishment	14	16S	6E	7
MF-19B	First Mining	Hiawatha: 7th North Sump Feb. 2006	Within Relinquishment	13	16S	6E	0
RR-5	Not Undermined	NA Nearest second mining: 1000' Feb. 2009	Within Relinquishment	14	16S	6E	NA
EM-216	Not Undermined	NA Nearest second mining: 975' Sep. 2005	Within Relinquishment	23	16S	6E	NA
GRANTS SPRING	Not Undermined	NA Nearest second mining: 1560' Nov. 2005	Within Relinquishment	23	16S	6E	NA
RR-15	Not Undermined	NA Nearest second mining: 55' Mar. 2006	Within Relinquishment	14	16S	6E	NA

EAST MOUNTAIN SPRING DATA
Mill Fork Area

Federal Lease UTU-88554 and UTU-84285							
SPRING	**MINING HISTORY**		**STATUS**	**LOCATION**			**Approximate Subsidence (feet)**
	Type of Mining	**Date of Mining** (Pre/Post water quality analysis based on dates listed for each spring)		**Sec.**	**T.**	**R.**	
EMPOND	Not Undermined	NA Nearest second mining: 1620' Dec. 2005	Within Relinquishment	23	16S	6E	NA
MFR-30	Not Undermined	NA Nearest second mining: 4000' Mar. 2014	Within Relinquishment	7	16S	7E	NA
MFR-10	Not Undermined	NA Nearest second mining: 2380' Mar. 2014	Within Relinquishment	12	16S	6E	NA
MF-7	Not Undermined	NA Nearest second mining: 1707' Jul. 2010	Within Relinquishment	12	16S	6E	NA
MF-213	Not Undermined	NA Nearest second mining: 7915' Jul. 2010	Within ½ mile Offset	17	16S	7E	NA
LB10/ LB-11 Little Bear	Not Undermined	NA Nearest second mining: 13050' Mar. 2014	Adjacent to Lease	9	16S	7E	NA

SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 1	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 1 OF 10	REV. ___

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring SPI-29 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat on February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of SPI-26 in the Hiawatha Seam, 26th West gateroad, on October 2012. Spring SPI-29 is located in barrier pillar south of 26th West. Nearest seconding mining is approximately 295' north, 27th West longwall panel.

Subsidence: No subsidence has been detected near SPI-29. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. SPI-29 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring SPI-29. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - SPI-29 is a low volume spring/seep located below trail in a small clearing on west facing slope surrounded with conifers and aspens. Spring drains to small shallow basin adjacent to source. Crandall Canyon Mine developed the trail into an access road during the 2007 mine collapse. Roadway reclaimed in 2013. Flow from spring SPI-29 generally ranges from 0.0/seep to a maximum of <3.0 gpm. Area near and spring site disturbed/re-developed post Crandall Canyon mine collapse. Wet area developed on nearby access road, flow from original source dissipated (see following Geologic Occurrence – photos).

Geologic Mode of Occurrence for spring SPI-29:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 150' below top.

Justification for removal from monitoring: SPI-29 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site SPI-29 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **SP1-29**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1630' S.	3070' E.	NW	11	16S	6E	10360

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	1 ½ " Steel Pipe Non-functioning post Crandall Canyon drill hole disturbance	None	150' below top

Location Comments: Spring located below trail in a small clearing on west facing slope surrounded with conifers and aspens.

Probable Recharge Area: Areas of higher elevation located to the east (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as SP1-31.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

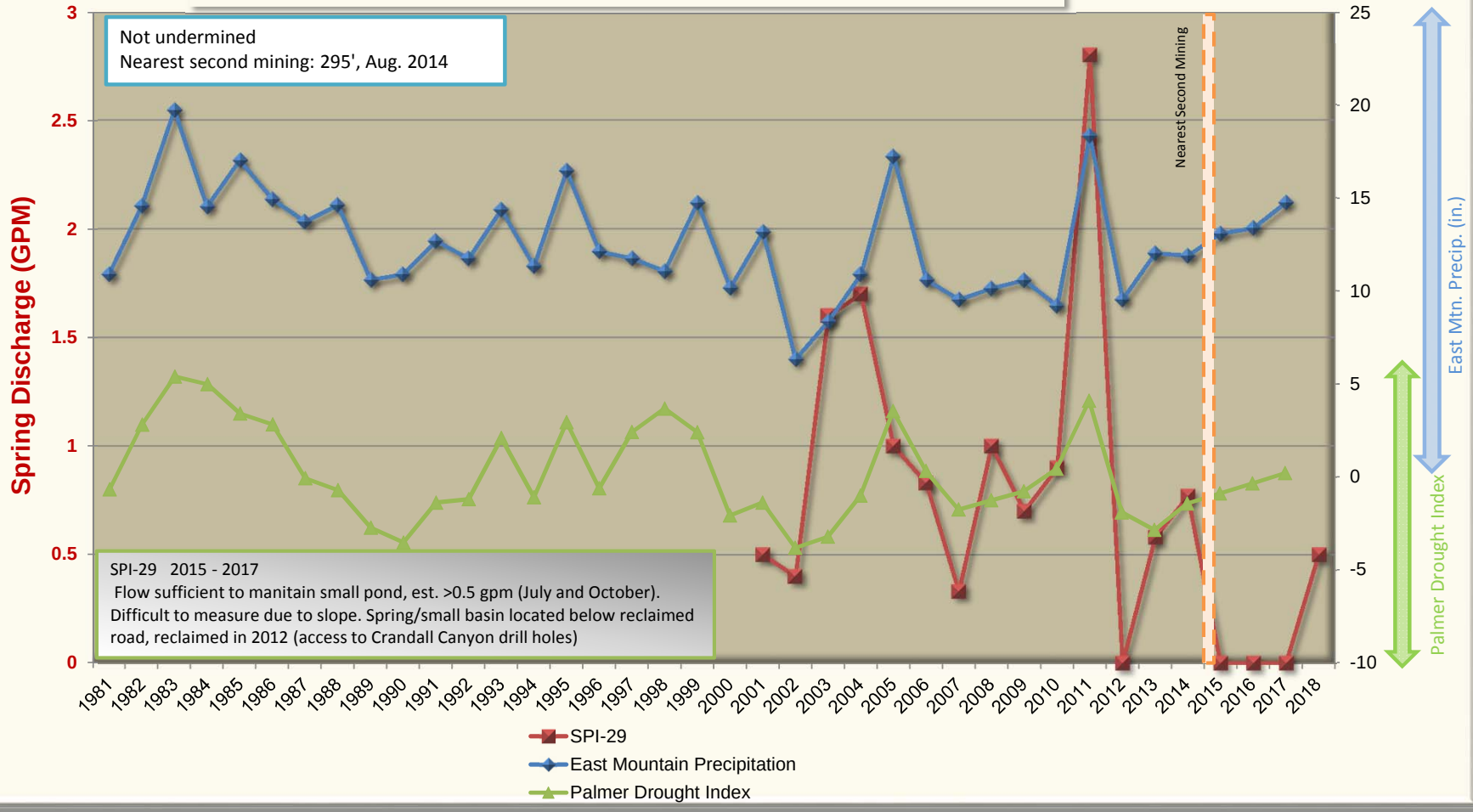
SPI-29 spring source, August 9, 2001

Small basin below SPI-29 post Crandall Canyon drill hole disturbance. View from reclaimed road, May 23, 2018

SPI-29 Spring source, May 23, 2018 (same view as August 9, 2001 photo)

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: SPI-29 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: SP1-29
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 295'
Date of Nearest Mining: Aug. 2014

	Pre-Mining Data: 20000101 THROUGH 20140701				Post-Mining Data: 20140701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	322	238	271	18	- No Sample Data -				BICARBONATE
CALCIUM	76.6	64	69.1122	18					CALCIUM
CARBONATE	0	0	0	8					CARBONATE
CHLORIDE	3	2	2.17222	18					CHLORIDE
CONDUCTIVITY	555	457	501.777	18					CONDUCTIVITY
DISSOLVED OXYGEN	0								DISSOLVED OXYGEN
FLOW	2.8	0.09	0.89444	18					FLOW
HARDNESS	288	246	266.277	18					HARDNESS
TOTAL IRON	0.06	0	0.0075	8					TOTAL IRON
DISSOLVED IRON	0	0	0	8					DISSOLVED IRON
MAGNESIUM	24.78	20.7	22.7277	18					MAGNESIUM
DISSOLVED MANGANESE	0.015	0	0.00225	8					DISSOLVED MANGANESE
MANGANESE	0.012	0	0.0015	8					MANGANESE
OIL AND GREASE	0								OIL AND GREASE
PH	7.96	7.24	7.64611	18					PH
POTASSIUM	2	0.98	1.35277	18					POTASSIUM
SET SOLIDS	0								SET SOLIDS
SODIUM	7.41	2.57	3.34333	18					SODIUM
SULFATE	9	5	6.74444	18					SULFATE
SUSPENDED SOLIDS	255	255	255	1					SUSPENDED SOLIDS
TEMPERATURE	8.8	3.6	5.04444	18					TEMPERATURE
TOTAL DISSOLVED SOLIDS	315	249	269.555	18					TOTAL DISSOLVED SOLIDS

Location: Section 10, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring UJV-213 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat on February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of UJV-213 in the Hiawatha Seam, 25th West Bleeder, in February 2012.

Subsidence: No subsidence has been detected near UJV-213. Maximum subsidence in area 400' east of UJV-213 has stabilized at approximately 2 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2012. UJV-213 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-213. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 – 2001 and 2007 – 2017 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV-213 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west. Flow from spring UJV-213 generally ranges from 0.0/seep to a maximum of 3.0 gpm. Spring flow dissipates rapidly below spring source.

Geologic Mode of Occurrence for spring UJV-213:

- Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Castle Gate (refer to Geologic Occurrence sheet).

- Stratigraphic Position: Mid-formation.

Justification for removal from monitoring: UJV-213 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-213 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-213**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
261' N.	889' W.	SW	10	16S	6E	8960

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Castle Gate	None	a21560 Change application is to allow the applicant the right to develop the 3 unnamed springs to draw a portion of the stock away from the Spoon Creek riparian area.	Middle

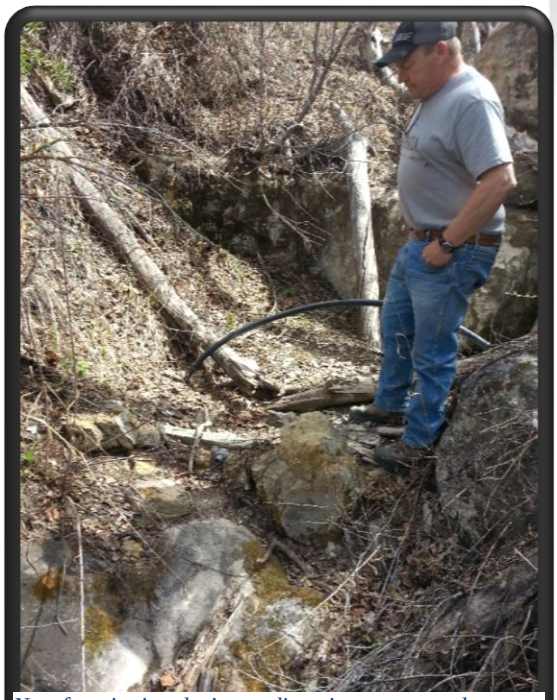
Location Comments: Spring located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Spring not identified during previous surveys. Below spring, drainage diverted through 1" poly pipe to trough located approximately 300' to the west.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area

Geologic Occurrence of Spring:

Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

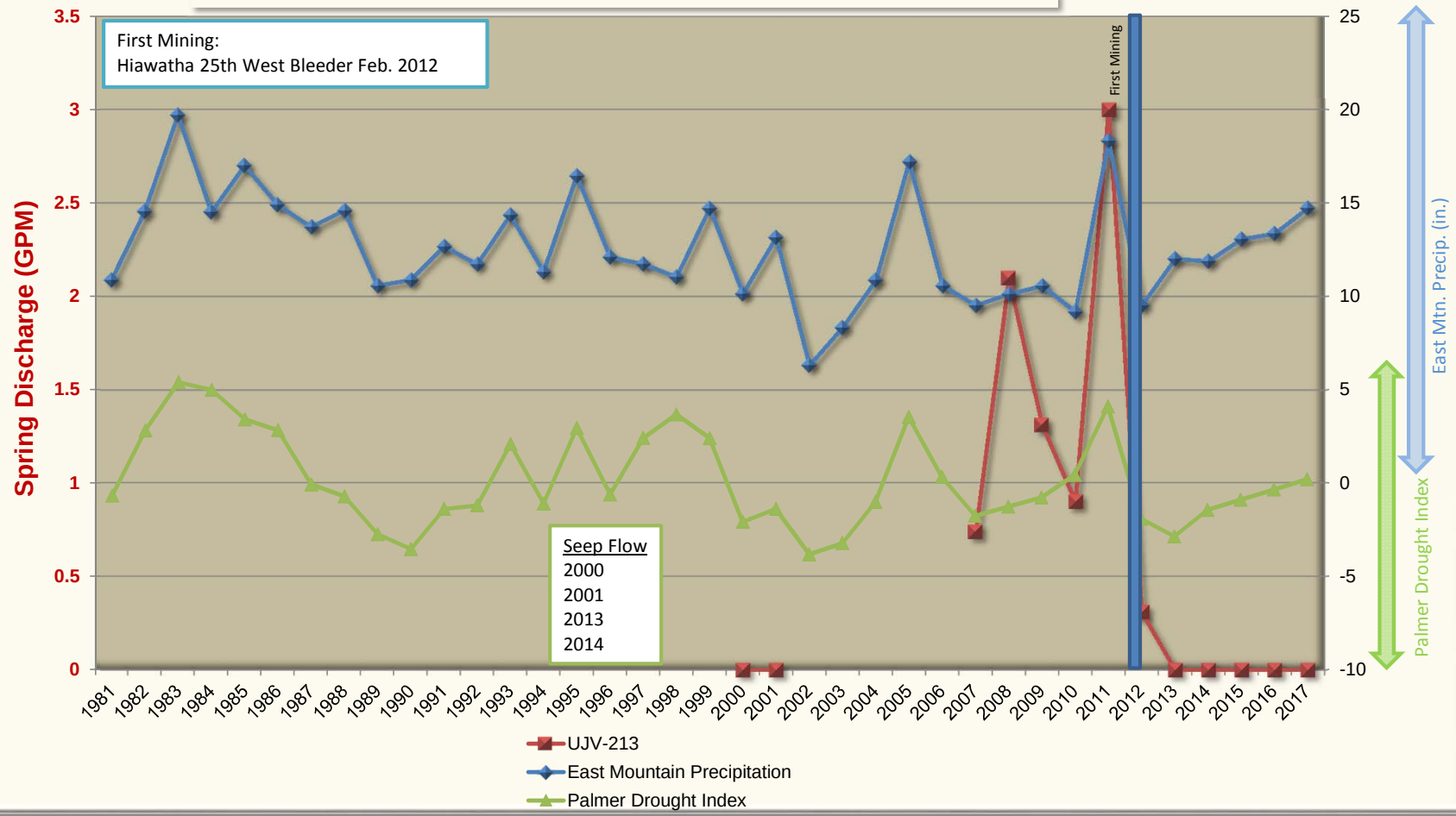


Non-functioning drainage diversion, un-named drainage near UJV-213

Non-functioning trough below UJV-213, source from un-named drainage

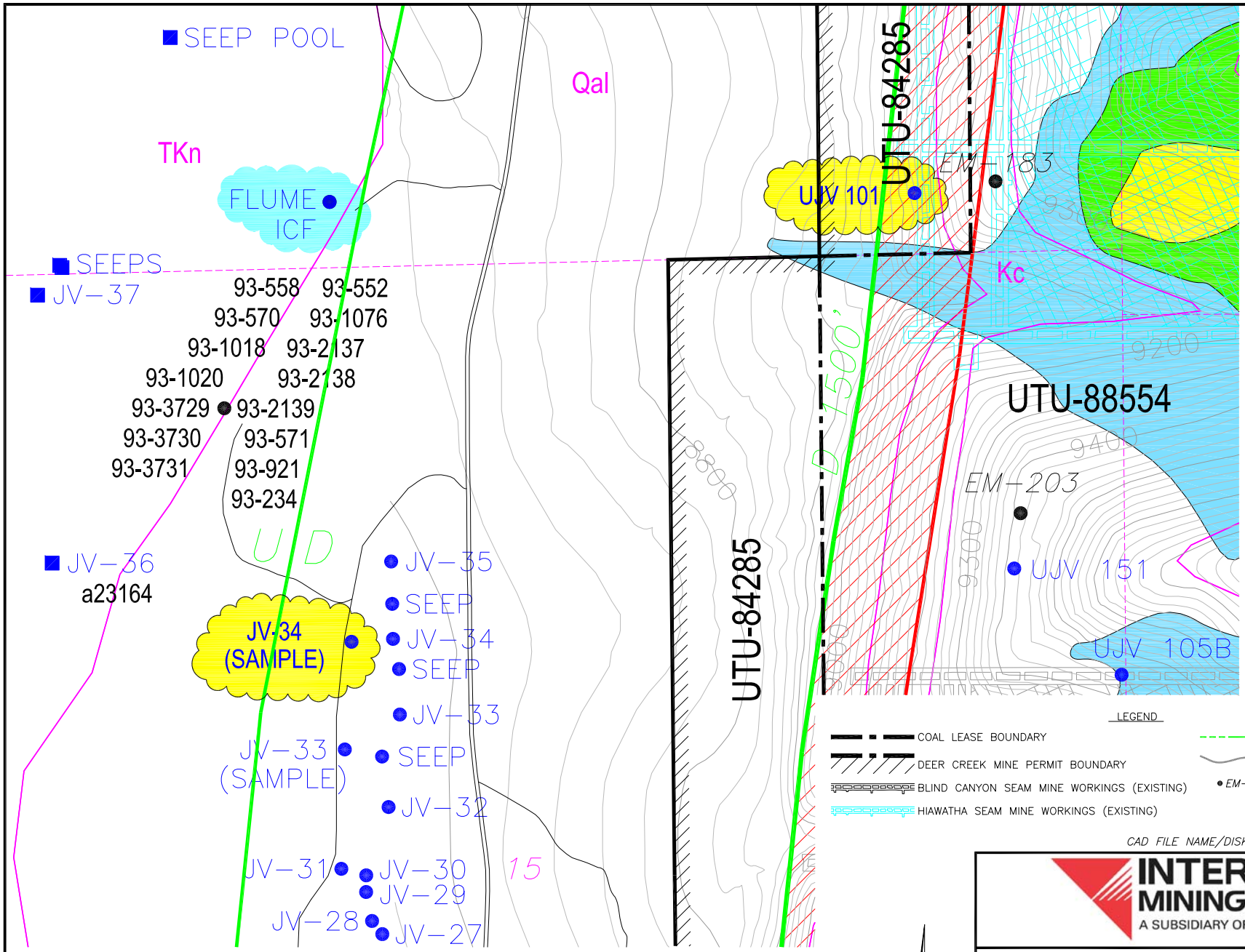
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-213 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-213
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb. 2012
Date of Second Mining: Not undermined
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20120131				Post-Mining Data: 20120201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	241	220	227.888	9	220	217	218.5	2	BICARBONATE
CALCIUM	71.32	62.92	68.4644	9	67.09	62.63	64.86	2	CALCIUM
CARBONATE	0	0	0	7	0	0	0	2	CARBONATE
CHLORIDE	4	3	3.66666	9	4	4	4	2	CHLORIDE
CONDUCTIVITY	583	478	511.222	9	489	467	478	2	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	3	0.21	1.12777	9	0.31	0.16	0.235	2	FLOW
HARDNESS	275	240	263.777	9	262	241	251.5	2	HARDNESS
TOTAL IRON	0.44	0	0.19333	9	0.97	0.15	0.56	2	TOTAL IRON
DISSOLVED IRON	0	0	0	7	0	0	0	2	DISSOLVED IRON
MAGNESIUM	23.81	20.15	22.5577	9	23.01	20.47	21.74	2	MAGNESIUM
DISSOLVED MANGANESE	0.011	0	3.44444	9	0.031	0.019	0.025	2	DISSOLVED MANGANESE
MANGANESE	0	0	0	7	0.003	0	0.0015	2	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.17	7.68	7.90888	9	8.18	7.64	7.91	2	PH
POTASSIUM	1.52	0.97	1.15555	9	1.3	1.11	1.205	2	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8.94	5.78	7.00222	9	5.85	5.77	5.81	2	SODIUM
SULFATE	40	33	36.5555	9	33	31	32	2	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	9.9	6.5	7.94444	9	10.3	9.5	9.9	2	TEMPERATURE
TOTAL DISSOLVED SOLIDS	320	284	298.222	9	277	273	275	2	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 2	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 2 OF 10	REV. ___

Location: Section 10, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-84285.

Lease Association: Spring UJV-101 is located within Federal Coal lease UTU-84285 adjacent to UTU-88554. The lease was originally acquired from Bureau of Land Management on November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. First mining occurred in vicinity of UJV-101 in the Hiawatha Seam, 23rd West Bleeder, in March 2011.

Subsidence: An area of minor subsidence occurs adjacent to spring UJV-101. Maximum subsidence in area 200' south of UJV-101 has stabilized at approximately 2 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2013. UJV-101 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-101. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1993 through 1995 by Genwal Resources and 2000 through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV101 is a low volume spring/seep located above drainage near Joes Valley Fault on south facing slope covered with aspens and mountain brush. Flow from spring UJV-101 generally ranges from 0.0/seep to a maximum of < 4.0 gpm. Spring flow dissipates rapidly below spring source.

Geologic Mode of Occurrence for spring UJV-101:

- Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Castle Gate (refer to Geologic Occurrence sheet).
- Stratigraphic Position: Mid-formation.

Justification for removal from monitoring: UJV-101 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-101 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-101**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
261' N.	889' W.	SW	10	16S	6E	8960

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Castle Gate	None	None	Middle

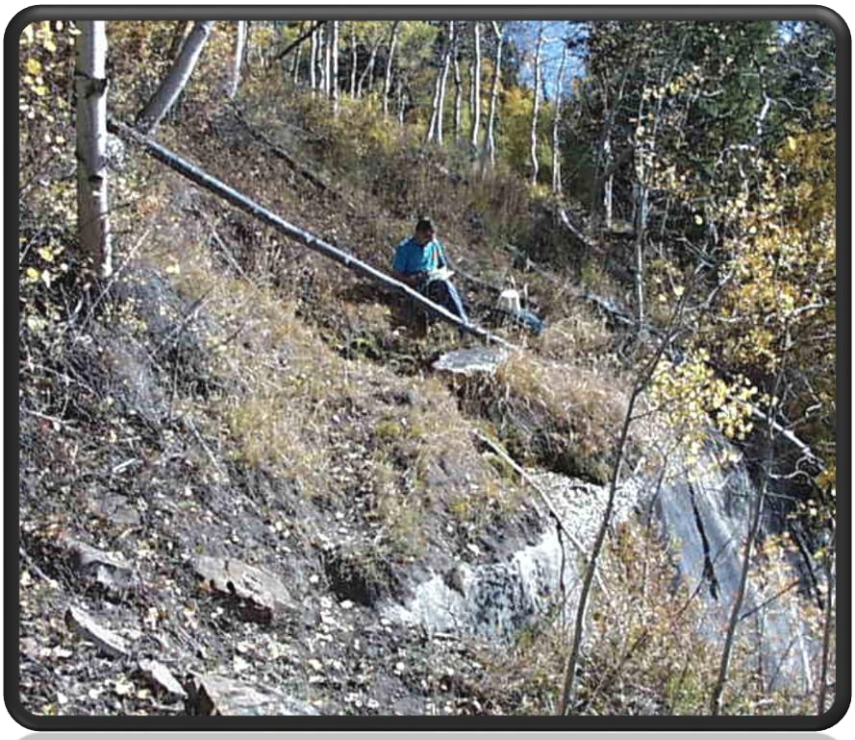
Location Comments: Spring located above small cliff (Joes Valley Fault) overlooking Joes Valley on west facing slope covered with aspens and mountain brush.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area

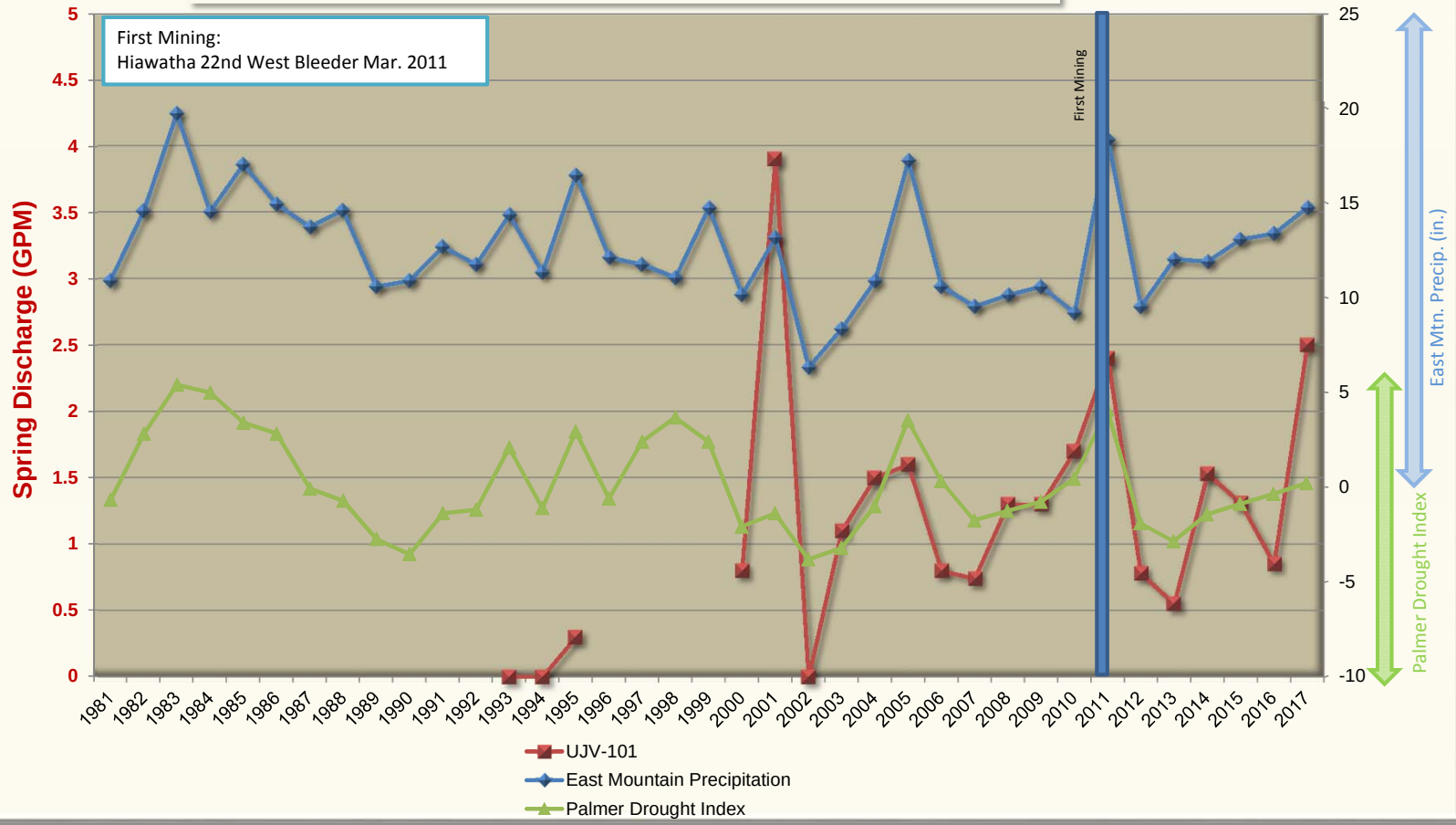
Geologic Occurrence of Spring:

Water flowing down through fractures in the Price River Formation intersects the top of the Castle Gate Sandstone and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.



EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-101 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-101
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Mar-11
Date of Second Mining: Not undermined
Location of Nearest Mining: NA
Date of Nearest Mining: NA

	Pre-Mining Data: 20000101 THROUGH 20110228				Post-Mining Data: 20110228 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	295	212	239.5625	16	249	216	230.428	14	BICARBONATE
CALCIUM	74.22	64.9	70.0531	16	81.82	66.61	72.7107	14	CALCIUM
CARBONATE	0	0	0	6	0	0	0	14	CARBONATE
CHLORIDE	6	4	4.525	16	4	3	3.92857	14	CHLORIDE
CONDUCTIVITY	690	475	533.0625	16	570	494	537.571	14	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	1.69	0.2	1.049375	16	2.5	0.38	1.04285	14	FLOW
HARDNESS	286	253	269.9375	16	317	257	285.571	14	HARDNESS
TOTAL IRON	0.88	0	0.28788	9	1.98	0	0.3	14	TOTAL IRON
DISSOLVED IRON	0	0	0	6	0	0	0	14	DISSOLVED IRON
MAGNESIUM	24.68	21.8	23.0556	16	27.32	22.04	25.2585	14	MAGNESIUM
DISSOLVED MANGANESE	0.019	0	6.11111	9	0.088	0	1.25714	14	DISSOLVED MANGANESE
MANGANESE	0.002	0	2.85714	7	0	0	0	14	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.38	7.5	7.9275	16	8.41	8.12	8.25142	14	PH
POTASSIUM	2	0.92	1.24875	16	1.82	1.17	1.37571	14	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	6.45	5.22	5.73625	16	6.66	5	6.085	14	SODIUM
SULFATE	51	27	39.34375	16	65	39	52.4285	14	SULFATE
SUSPENDED SOLIDS	293	293	293	1	0				SUSPENDED SOLIDS
TEMPERATURE	9.6	5.2	6.9125	16	10.6	4.1	7.38571	14	TEMPERATURE
TOTAL DISSOLVED SOLIDS	330	259	303.0625	16	365	289	325.142	14	TOTAL DISSOLVED SOLIDS

Location: Section 15, Township 16 South, Range 6 East, SLB&M. This site is located within the ½ mile offset of the Deer Creek mine permit boundary adjacent to Federal Coal leases UTU-84285 and UTU-88554.

Lease Association: Spring JV-34 is located adjacent to Federal Coal leases UTU-84285 and UTU-88554. The lease UTU-88554 was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Lease UTU-84285 was originally acquired from Bureau of Land Management on November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. No mining occurred in the vicinity of JV-34.

Subsidence: No subsidence has been detected near JV-34. For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring JV-34. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - JV-34 spring located in Joes Valley alluvial basin near the 345 kV powerline. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-34 varies dramatically based on winter pack on spring runoff, generally ranges from 0.0/seep to a maximum of 80.0 gpm.

Geologic Mode of Occurrence for spring JV-34:

- Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.
- Geologic Formation: Joes Valley Alluvium (refer to Geologic Occurrence sheet).

- Stratigraphic Position: NA.

Justification for removal from monitoring: UJV-34 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-34 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **JV-34**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1565' S.	1860' E	NW	15	16S	6E	8692

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Joes Valley Alluvium	None	None	NA

Location Comments: Spring with multiple sources located near power line. Measured flow at confluence of several sources near road. Brass tag attached to brush.

Probable Recharge Area: Areas of higher elevation located to the north and east.

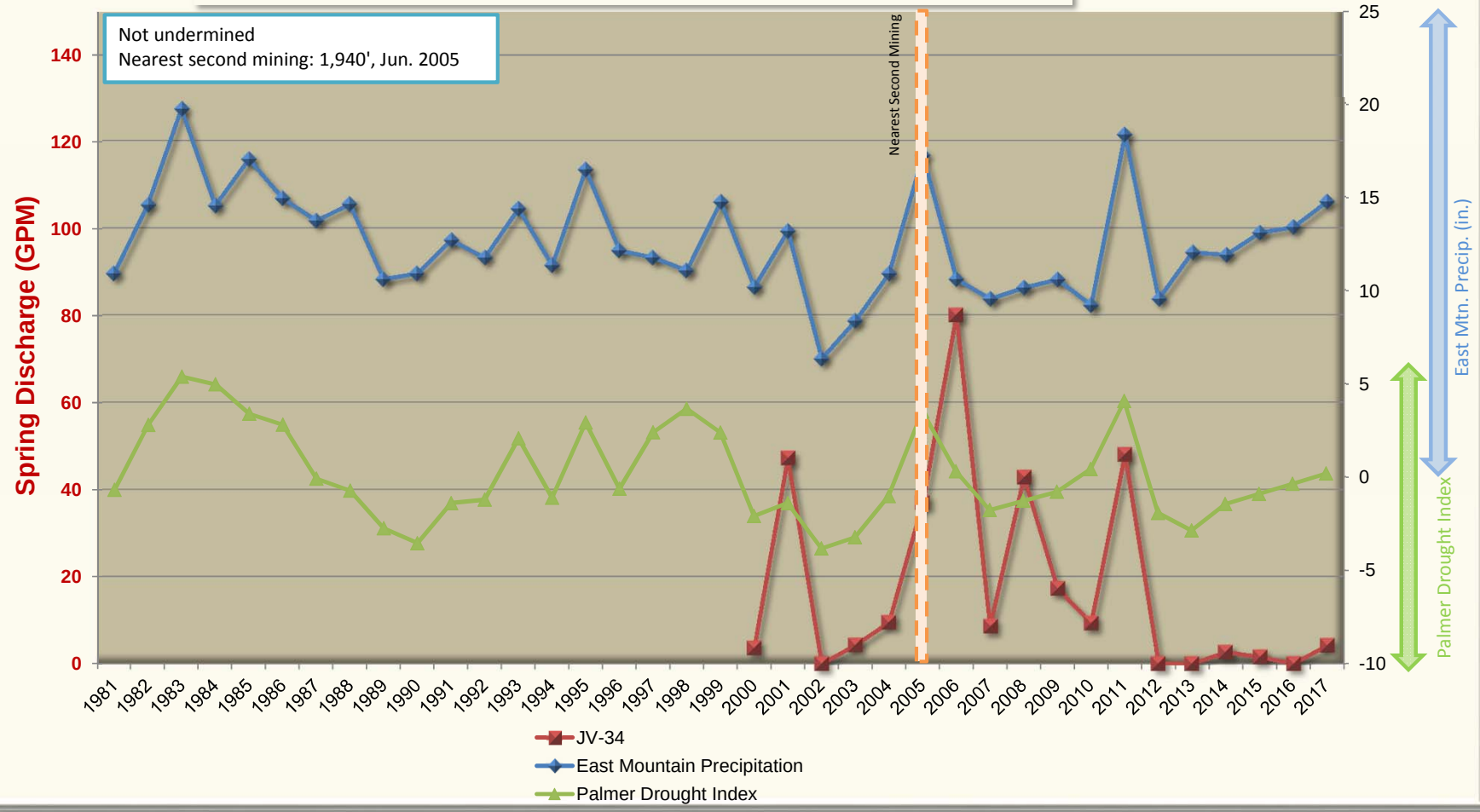
Relationship to Adjacent Springs: This spring occurs in the same manner as numerous springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

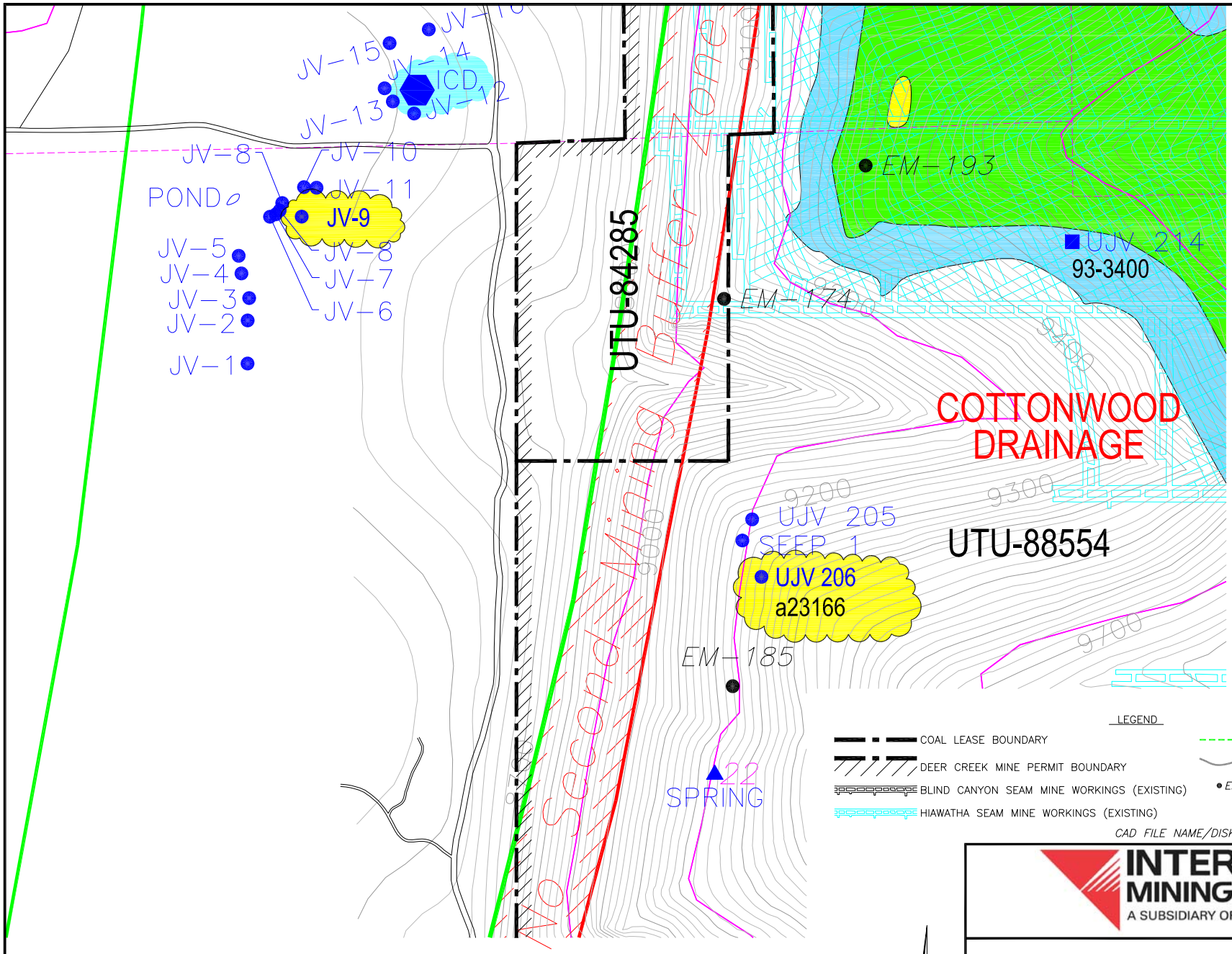
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: JV-34 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: JV-34
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 2670'
Date of Nearest Mining: Aug-08

	Pre-Mining Data: 20000101 THROUGH 20080801				Post-Mining Data: 20080831 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	400	282	323.285	14	351	278	310.538	13	BICARBONATE
CALCIUM	96.8	77	83.2414	14	101.05	73.39	87.3284	13	CALCIUM
CARBONATE	0	0	0	1	0	0	0	13	CARBONATE
CHLORIDE	5	1	3.02142	14	6	2	2.92307	13	CHLORIDE
CONDUCTIVITY	706	539	602.5	14	708	533	608.769	13	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	80	2.3	19.5071	14	48	0.23	8.82461	13	FLOW
HARDNESS	350	281	308.928	14	366	276	324.307	13	HARDNESS
TOTAL IRON	2.45	0.2	0.59161	13	1.36	0	0.23384	13	TOTAL IRON
DISSOLVED IRON	0.008	0	0.004	2	0	0	0	13	DISSOLVED IRON
MAGNESIUM	28.6	21	24.5685	14	28.54	22.51	25.83	13	MAGNESIUM
DISSOLVED MANGANESE	0.131	0.005	0.0495	10	0.074	0.004	2.56923	13	DISSOLVED MANGANESE
MANGANESE	0.052	0.003	0.0128	10	0.038	0	9.30769	13	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.26	7.84	8.06428	14	8.36	7.9	8.11615	13	PH
POTASSIUM	3.5	0.26	1.38615	13	2.1	0.4	1.13384	13	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8.75	6	7.41	14	8.78	6.65	7.88461	13	SODIUM
SULFATE	30	8	17.15	14	51	10	21.3846	13	SULFATE
SUSPENDED SOLIDS	304	304	304	1	0				SUSPENDED SOLIDS
TEMPERATURE	20.3	5	8.68571	14	20	3.8	11.3153	13	TEMPERATURE
TOTAL DISSOLVED SOLIDS	377	255	325.071	14	403	310	354.846	13	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED
- OUTCROP
- EM-169 DRILL HOLE

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 3	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 3 OF 10	REV. ___

Location: Section 22, Township 16 South, Range 6 East, SLB&M. This site is located within the ½ mile offset of the Deer Creek mine permit boundary adjacent to Federal Coal leases UTU-84285 and UTU-88554.

Lease Association: Spring JV-9 is located adjacent to Federal Coal leases UTU-84285 and UTU-88554. Lease UTU-88554 was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Lease UTU-84285 was originally acquired from Bureau of Land Management in November 1, 2006. Mining in Lease UTU-84285 was prohibited to first mining only. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in April 2006 under the provisions of a Federal Exploration License. Blind Canyon seam development began in November 2007. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production in Lease UTU-84285 occurring in August 2013. No mining occurred in the vicinity of JV-9.

Subsidence: No subsidence has been detected near JV-9. For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring JV-9. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - JV-9 spring is located in Joes Valley alluvial basin south of the Joes Valley cutoff road. A series of springs emerge vertically through the alluvium creating marsh/wetland area. Flow from spring JV-9 varies dramatically based on winter pack on spring runoff, and generally ranges from 0.0/seep to a maximum of 3.0 gpm.

Geologic Mode of Occurrence for spring JV-9:

- Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

- Geologic Formation: Joes Valley Alluvium (refer to Geologic Occurrence sheet).
- Stratigraphic Position: NA.

Justification for removal from monitoring: JV-9 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-9 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **JV-9**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
299' S.	1836' E	NW	22	16S	6E	8618

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Joes Valley Alluvium	None	None	NA

Location Comments: Spring (boiling up from small hole) located in Joes Valley south of FDR 040.

Probable Recharge Area: Areas of higher elevation located to the north and east.

Relationship to Adjacent Springs: This spring occurs in the same manner as numerous springs in the immediate vicinity.

Geologic Occurrence of Spring:

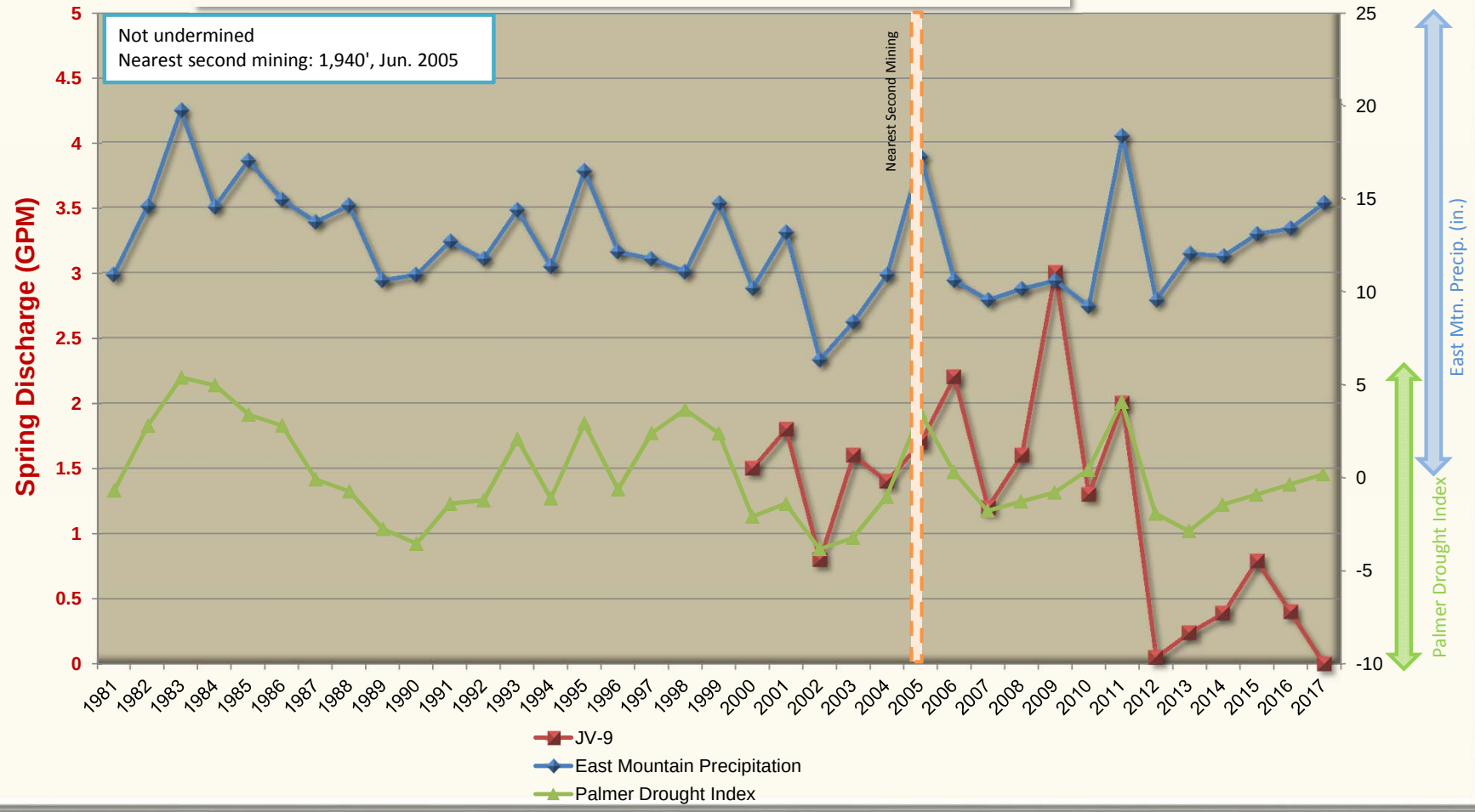
Water flowing through the alluvial deposits intersects un-named fault and migrates vertically to the land surface forming a spring.

Field reconnaissance October 19, 2000

Field reconnaissance May 9, 2018

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: JV-9 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: JV-9
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1940'
Date of Nearest Mining: Jun-05

	Pre-Mining Data: 20000101 THROUGH 20050601				Post-Mining Data: 20050630 THROUGH 201712311				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	395	318	371.444	9	330	293	310.3	20	BICARBONATE
CALCIUM	89.7	80	86.0333	9	91.7	81.62	87.961	20	CALCIUM
CARBONATE	0				0	0	0	14	CARBONATE
CHLORIDE	5	4	4.36666	9	9	4	4.85	20	CHLORIDE
CONDUCTIVITY	750	639	676.333	9	762	516	677.95	20	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	1.8	0.8	1.29222	9	3	0.24	1.206	20	FLOW
HARDNESS	371	262	345.888	9	377	344	362.45	20	HARDNESS
TOTAL IRON	0.298	0.298	0.298	1	0.51	0	9.88235	17	TOTAL IRON
DISSOLVED IRON	0				0	0	0	14	DISSOLVED IRON
MAGNESIUM	35.8	33	34.5111	9	36.7	31.88	34.671	20	MAGNESIUM
DISSOLVED MANGANESE	0.014	0.002	0.008	2	0.054	0	0.01	18	DISSOLVED MANGANESE
MANGANESE	0.005	0.005	0.005	1	0.02	0	4.61111	18	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	7.64	7.22	7.35888	9	8.06	6.88	7.4085	20	PH
POTASSIUM	1.5	1	1.17888	9	2.66	1.22	1.4335	20	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8	6.83	7.14222	9	8.42	6.71	7.4375	20	SODIUM
SULFATE	59	48	52.0888	9	58	38	50.05	20	SULFATE
SUSPENDED SOLIDS	387	387	387	1	0				SUSPENDED SOLIDS
TEMPERATURE	6.9	4.9	6.13333	9	12.3	5.6	8.095	20	TEMPERATURE
TOTAL DISSOLVED SOLIDS	404	357	380	9	411	241	378	20	TOTAL DISSOLVED SOLIDS

Location: Section 22, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring UJV-206 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred near spring UJV-206.

Subsidence: No subsidence has been detected near UJV-206. The 2017 Annual Subsidence Report reported that the subsidence north of the spring has been stable since at least 2009. UJV-206 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring UJV-206. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1993 through 1995 by Genwal Resources and by PacifiCorp from 2000 through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - UJV-206 is located along power line corridor on a west facing slope overlooking Joes Valley surrounded by aspens and conifers. Spring drains to a trough adjacent to the spring. In 2003, Division of Water Rights approved a Change Application (a23166) was approved allowing the right to develop UJV-206 for use in recreational cabin and stock watering from a trough in the vicinity of the cabin.

Geologic Mode of Occurrence for spring UJV-206:

- Water flowing down through fractures in the lower section of the Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Upper Price River (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 80' above base.

Justification for removal from monitoring: UJV-206 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site UJV-206 be removed from the monitoring program.

EAST MOUNTAIN
MILL FORK SPRING & SEEP SURVEY
GEOLOGIC OCCURRENCE

Spring Name/Number: **UJV-206**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
3567' N.	3604' W	SE	22	16S	6E	9200

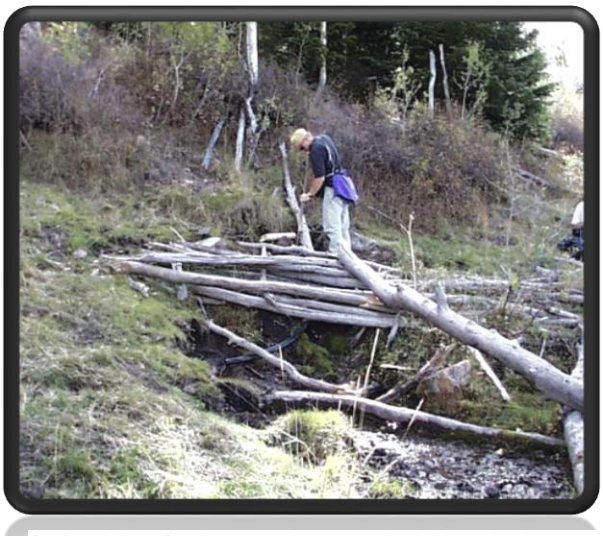
Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Upper Price River	Developed With Vertical CMP, Diverted To Trough (not functioning)	93-3400 A23166	80' above base

Location Comments: Spring located along power line corridor on west facing slope overlooking Joes Valley surrounded with aspens and conifers.

Probable Recharge Area: Areas of higher elevation located to the east.

Relationship to Adjacent Springs: This spring occurs in the same manner as UJV-204 and UJV-205.

Geologic Occurrence of Spring: Water flowing down through fractures in the lower section of the Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

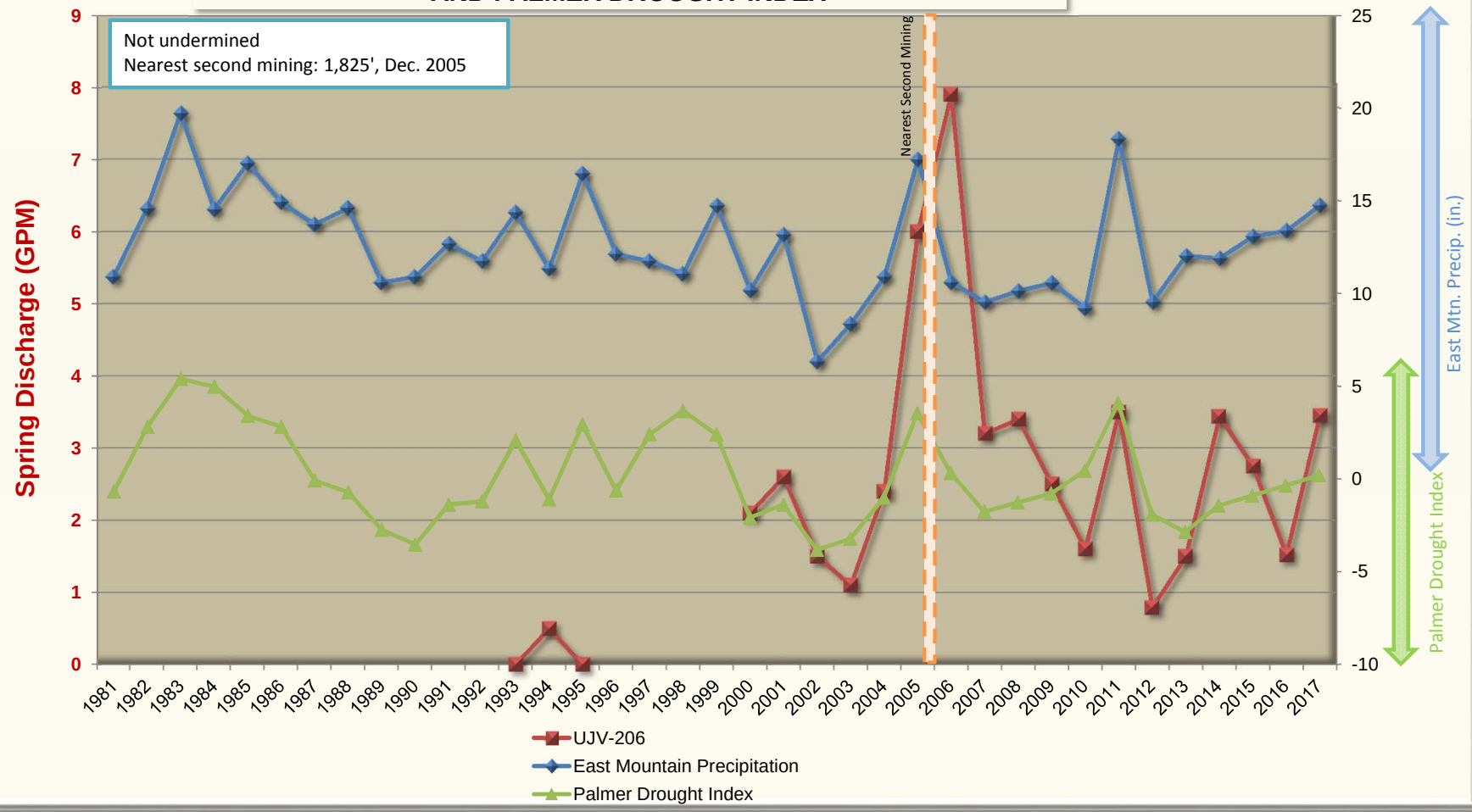


Spring UJV-206

UJV-206 Trough

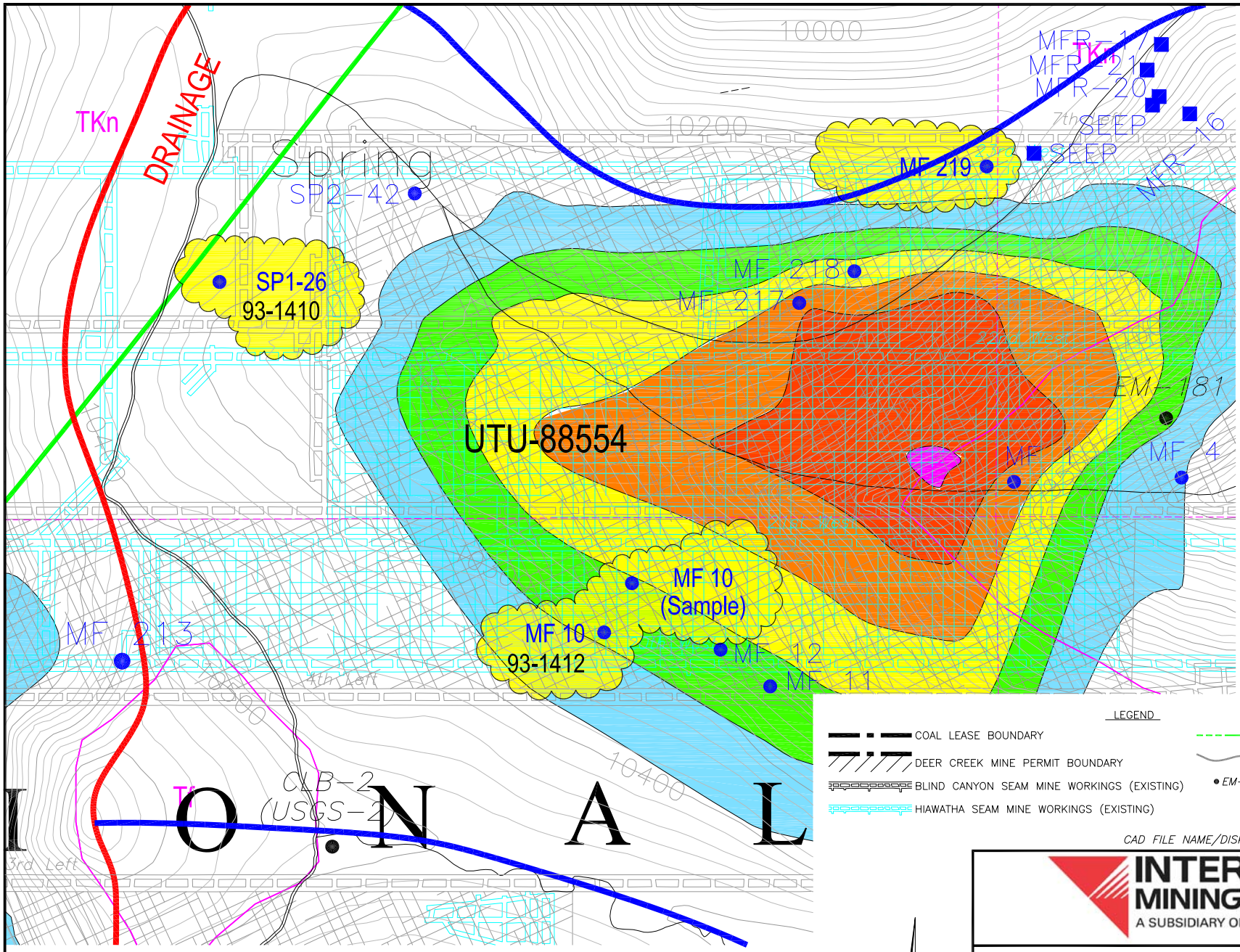
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: UJV-206 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: UJV-206
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1825'
Date of Nearest Mining: Dec. 2005

	Pre-Mining Data: 20000101 THROUGH 20051130				Post-Mining Data: 20051201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	294	239	270.545	11	259	221	235.086	23	BICARBONATE
CALCIUM	69.7	61	66.5727	11	76.27	61.98	67.7221	23	CALCIUM
CARBONATE	0				0	0	0	20	CARBONATE
CHLORIDE	6	4	4.5	11	6	4	4.7826	23	CHLORIDE
CONDUCTIVITY	615	490	521.727	11	672	438	521.26	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	6	0.5	2.33181	11	8.5	0.38	2.58608	23	FLOW
HARDNESS	271	243	262	11	303	243	267.086	23	HARDNESS
TOTAL IRON	0.11	0.1	0.105	2	0.06	0	2.85714	21	TOTAL IRON
DISSOLVED IRON	0				0	0	0	20	DISSOLVED IRON
MAGNESIUM	24.9	22	23.2636	11	27.45	21.31	23.796	23	MAGNESIUM
DISSOLVED MANGANESE	0				0.006	0	0.0003	20	DISSOLVED MANGANESE
MANGANESE	0				0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.33	7.79	8.04363	11	8.1	7.35	7.88956	23	PH
POTASSIUM	2	1	1.49	11	2.03	1.42	1.68434	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	8	5.83	6.37909	11	6.73	5.16	6.29652	23	SODIUM
SULFATE	42	23	31.809	11	46	21	33.6956	23	SULFATE
SUSPENDED SOLIDS	290	290	290	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.4	4.7	5	11	8.2	4.6	6.26956	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	309	257	288	11	328	246	297.217	23	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU–88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 4	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 4 OF 10	REV. ___

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-219 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First and second mining occurred in vicinity of MF-219 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, second mining 7th Left longwall panel April 2010 and Hiawatha, first mining 23rd West gateroad, on February 2011).

Subsidence: No subsidence has been detected near MF-219. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MF-219 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-219. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-219 is a spring/seep located along the reclaimed access road to Mill Fork Ridge originally developed as a fire access road and later used to access coal exploration sites for ARCO Coal. Access road reclaimed in the 1980's. MF-219 is located on a south facing slope surrounded with conifers. Flow from spring MF-219 generally ranges from 0.0/seep to a maximum of <15.0 gpm.

Geologic Mode of Occurrence for spring MF-219:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 260' below top.

Justification for removal from monitoring: MF-219 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-219 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-219**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1508' N.	47' W.	SE	11	16S	6E	10220

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	260' below top

Location Comments: Spring located above reclaimed road on south facing slope covered with conifers. Seep located between MF-218 and MF-219.

Probable Recharge Area: Areas of higher elevation located to the northwest.

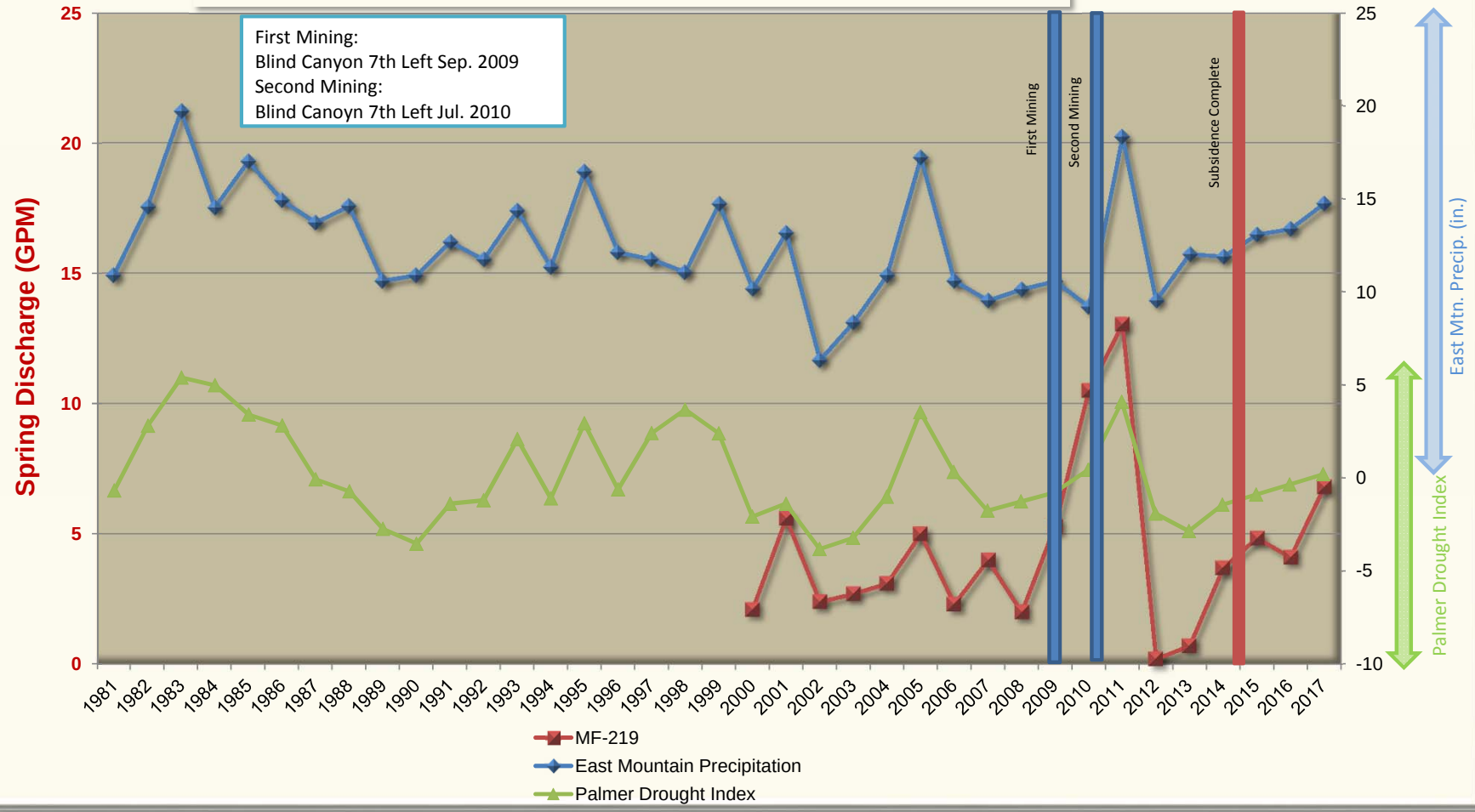
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-217 and MF-218.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-219 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-219
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb-11 Hiawatha 23rd West
Date of Second Mining: Apr-10 Blind Canyon 7th Left
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20110201 THROUGH 201712311				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	292	210	240.833	18	258	207	225.357	14	BICARBONATE
CALCIUM	70.7	59	66.1916	18	75.08	55.59	63.0285	14	CALCIUM
CARBONATE	0	0	0	4	0	0	0	14	CARBONATE
CHLORIDE	3	1	1.98333	18	3	1	1.85714	14	CHLORIDE
CONDUCTIVITY	557	417	500.611	18	574	410	479.714	14	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	5.5	2	3.24277	18	13.04	0.09	4.04	14	FLOW
HARDNESS	285	224	261.666	18	320	239	262.571	14	HARDNESS
TOTAL IRON	1.04	0.06	0.285	12	0.09	0	0.01	14	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	14	DISSOLVED IRON
MAGNESIUM	26.4	16.4	23.4016	18	32.29	22.14	25.5328	14	MAGNESIUM
DISSOLVED MANGANESE	0.134	0.002	1.94166	12	0.009	0	2.64285	14	DISSOLVED MANGANESE
MANGANESE	0.04	0	8.22222	9	0.004	0	5.71428	14	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.15	7.45	7.83888	18	8.52	7.82	8.11	14	PH
POTASSIUM	1.6	1	1.17352	17	2.52	1.34	1.69357	14	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.7	2.40333	18	3.01	1.99	2.44071	14	SODIUM
SULFATE	36	8	27.65	18	65	19	32.5	14	SULFATE
SUSPENDED SOLIDS	268	268	268	1	0				SUSPENDED SOLIDS
TEMPERATURE	8.7	2	5.41666	18	48.4	2.9	11.9928	14	TEMPERATURE
TOTAL DISSOLVED SOLIDS	331	205	272.555	18	322	204	273.714	14	TOTAL DISSOLVED SOLIDS

Location: Section 11, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring SPI-26 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of SPI-26 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, 7th Left longwall panel bleeder June 2009 and Hiawatha, 23rd West inter-panel barrier, in November 2010).

Subsidence: No subsidence has been detected near SPI-26. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. SPI-26 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring SPI-26. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - SPI-26 is a spring located near the main Mill Fork ridge road. SPI-26 is located on east facing slope surrounded with conifers. Site crudely developed with 1" PVC diverting flow to old steel bath tub. Flow from spring SPI-26 generally ranges from ~ 2 gpm to a maximum of 55.0 gpm.

Geologic Mode of Occurrence for spring SPI-26:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 260' below top.

Justification for removal from monitoring: SPI-26 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site SPI-26 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **SP1-26**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1041' N.	3349' W.	SE	11	16S	6E	10340

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	1" PVC Pipe Feeds Old Bath Tub	93-1410	170' below top

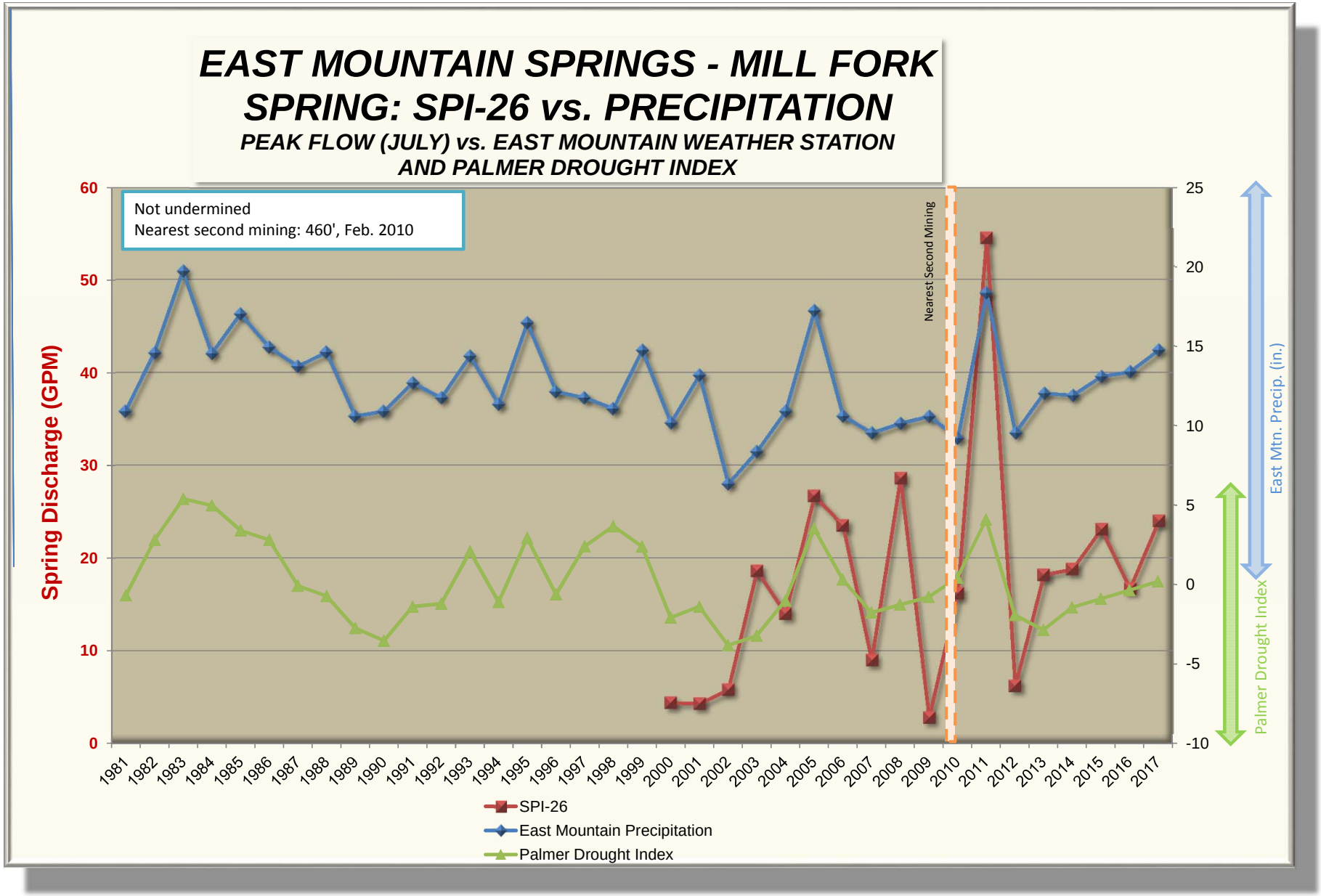
Location Comments: Spring near main reclaimed road on east facing slope covered with conifers. Flow measured below multiple sources.

Probable Recharge Area: Areas of higher elevation located to the west (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as SP2-42.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.


EAST MOUNTAIN SPRINGS - MILL FORK SPRING: SPI-26 vs. PRECIPITATION
PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX
Not undermined
Nearest second mining: 460', Feb. 2010
Nearest Second Mining
Spring Discharge (GPM)
East Mtn. Precip. (in.)
Palmer Drought Index
SPI-26
East Mountain Precipitation
Palmer Drought Index

East Mountain Spring: SP1-26
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 460'
Date of Nearest Mining: Feb. 2010

	Pre-Mining Data: 20000101 THROUGH 20100131				Post-Mining Data: 20100201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	253	185	213.21	19	226	184	203.588	17	BICARBONATE
CALCIUM	66	55	60.2105	19	72.65	49.56	59.9947	17	CALCIUM
CARBONATE	0	0	0	4	0	0	0	17	CARBONATE
CHLORIDE	4	1	2.57368	19	3	1	2.17647	17	CHLORIDE
CONDUCTIVITY	525	391	431.157	19	530	378	419.176	17	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	28.6	2.5	9.41666	18	54.5	0.7	12.85875	16	FLOW
HARDNESS	238	199	213.789	19	282	204	217.058	17	HARDNESS
TOTAL IRON	1.63	0	0.44571	7	0.31	0	0.11058	17	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0.04	0	2.35294	17	DISSOLVED IRON
MAGNESIUM	17.8	14	15.4068	19	24.68	14.09	16.3558	17	MAGNESIUM
DISSOLVED MANGANESE	0.07	0	1.95714	7	0.047	0	9.7647	17	DISSOLVED MANGANESE
MANGANESE	0.003	0	0.0018	5	0	0	0	17	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.4	7.44	7.79526	19	8.57	7.69	8.04117	17	PH
POTASSIUM	1.06	0.566	0.71464	14	1.51	0.51	0.79823	17	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.79	2.22	19	6.43	1.61	2.47235	17	SODIUM
SULFATE	10	5	7.06842	19	58	5	9.11764	17	SULFATE
SUSPENDED SOLIDS	214	214	214	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.5	3.8	4.67894	19	12.6	4.1	5.85882	17	TEMPERATURE
TOTAL DISSOLVED SOLIDS	273	206	233.052	19	336	217	239	17	TOTAL DISSOLVED SOLIDS

Location: Section 14, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-10 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred in vicinity of MF-10 in both the Blind Canyon and Hiawatha seams, (Blind Canyon, 5th Left longwall panel, July 2009 and Hiawatha, 21st West panel, January 2011).

Subsidence: Approximately 4' of subsidence has been detected near MF-10. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2013.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-10. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-10 is a spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers. Flow from spring MF-10 generally ranges from ~ 5 gpm to a maximum of 60 gpm.

Geologic Mode of Occurrence for spring MF-10:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 200' below top.

Justification for removal from monitoring: MF-10 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-10 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-10**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
282' S.	1572' W.	NE	14	16S	6E	10250

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1412	200' below top

Location Comments: Spring located along natural bench directly below a massive sandstone channel on north facing slope covered with conifers.

Probable Recharge Area: Areas of higher elevation located to the southwest.

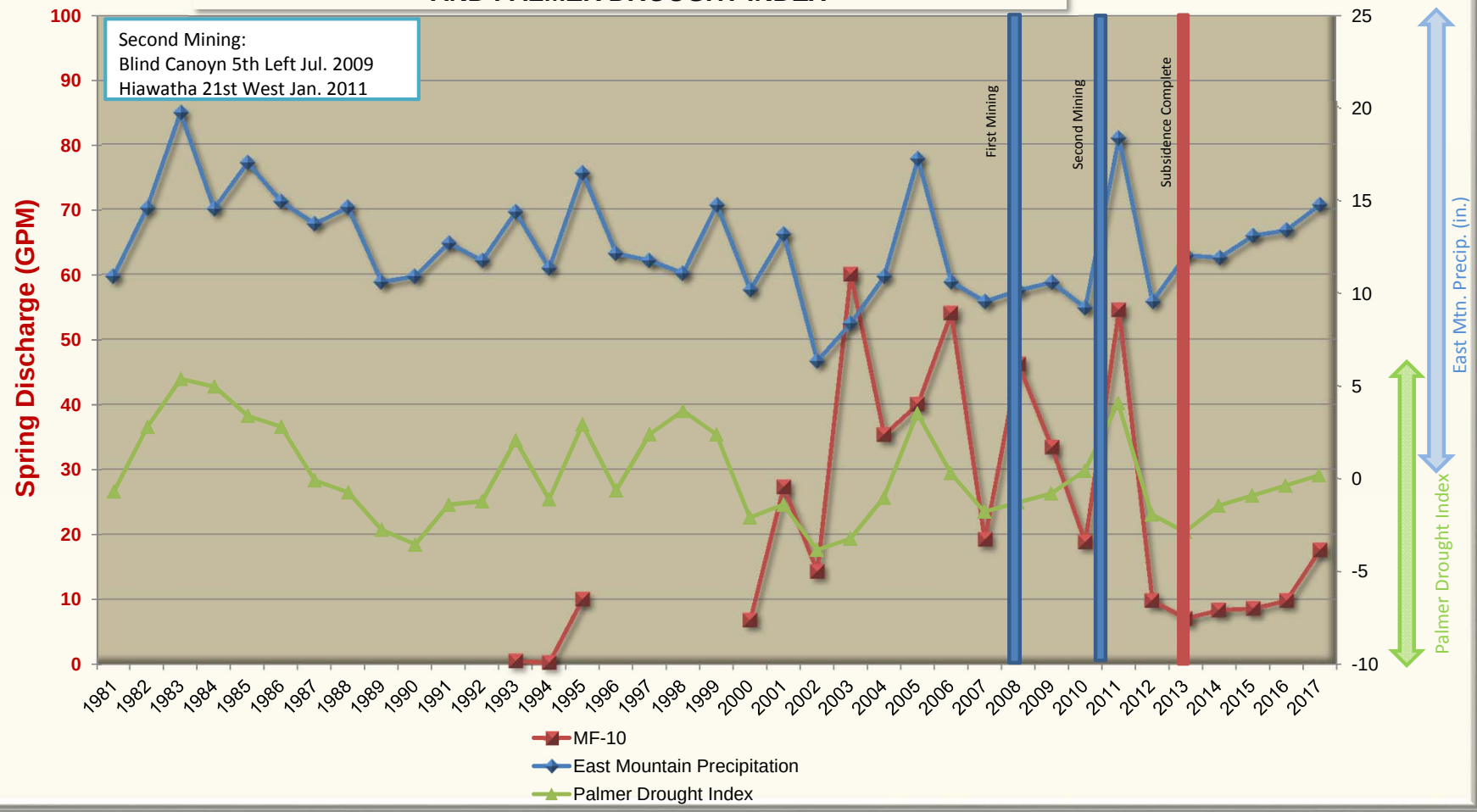
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

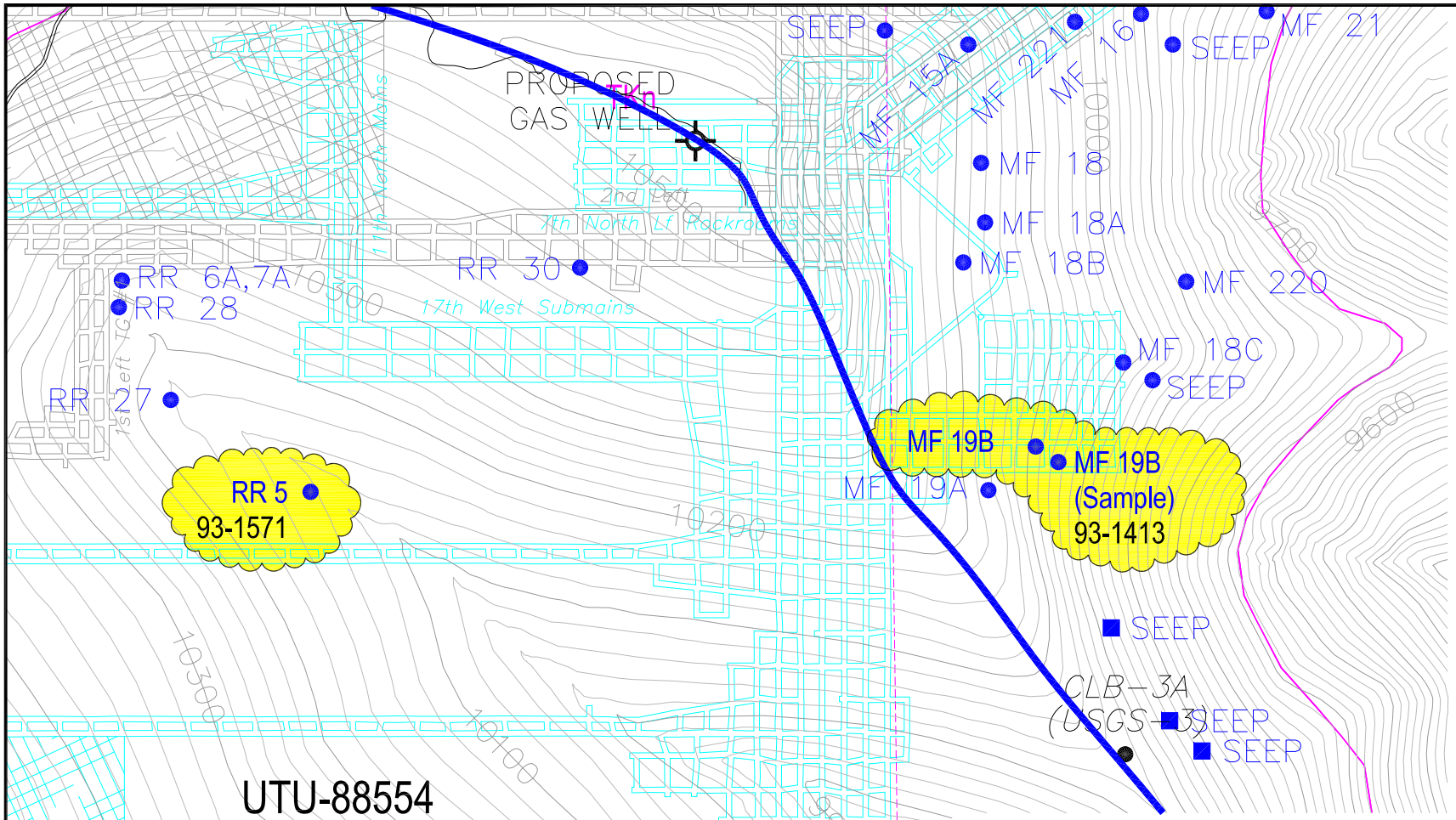
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-10 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-10
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Na
Date of Second Mining: Jul-09 Blind Canyon 5th Left
Jan-11 Hiawatha 21st West
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20090630				Post-Mining Data: 20090701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	256	181	217.882	17	228	178	193.941	17	BICARBONATE
CALCIUM	61.3	50	55.6664	17	60.36	46.7	51.0194	17	CALCIUM
CARBONATE	5	0	1.66666	3	10	0	0.58823	17	CARBONATE
CHLORIDE	4	1	1.7125	16	2	0	0.7647	17	CHLORIDE
CONDUCTIVITY	464	394	423.882	17	412	352	388.882	17	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	60	6.8	21.8647	17	54.5	0.41	10.6233	15	FLOW
HARDNESS	234	206	218.411	17	221	193	207.705	17	HARDNESS
TOTAL IRON	0	0	0	2	0	0	0	17	TOTAL IRON
DISSOLVED IRON	0	0	0	2	0	0	0	17	DISSOLVED IRON
MAGNESIUM	21	16.9	19.2717	17	22.17	16.43	19.5064	17	MAGNESIUM
DISSOLVED MANGANESE	0.006	0	0.002	3	0.01	0	8.23529	17	DISSOLVED MANGANESE
MANGANESE	0.006	0	0.002	3	0.01	0	5.88235	17	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.46	7.41	8.09764	17	8.46	7.76	8.18823	17	PH
POTASSIUM	2.18	0.49	0.9065	12	1.89	0.49	0.91	17	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.57	2.23235	17	2.66	1.64	2.13176	17	SODIUM
SULFATE	9	5	7.45294	17	11	4	6.94117	17	SULFATE
SUSPENDED SOLIDS	216	216	216	1	0				SUSPENDED SOLIDS
TEMPERATURE	23	1.6	4.15294	17	6.4	0.2	3.3	17	TEMPERATURE
TOTAL DISSOLVED SOLIDS	254	199	229.764	17	241	193	221.47	17	TOTAL DISSOLVED SOLIDS



SPRING LEGEND

- MFB02 — SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994–1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010–2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 — GROUND WATER RIGHTS
- 93-198 — SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989–1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 — DRILL HOLE

SUBSIDENCE LEGEND

- 2'–4' SUBSIDENCE
- 4'–6' SUBSIDENCE
- 6'–8' SUBSIDENCE
- 8'–10' SUBSIDENCE
- 10'–12' SUBSIDENCE
- 12'–14' SUBSIDENCE
- 14'–16' SUBSIDENCE
- 16'–18' SUBSIDENCE

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 5	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 5 OF 10	REV. ___

Location: Section 13, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MF-19B is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of MF-19B in the Hiawatha seam, (7th North Sump, January 2006).

Subsidence: No subsidence has been detected near MF-19B. The 2017 Annual Subsidence Report reported that the subsidence north of the spring has been stable since at least 2013. MF-19B is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-19B. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-19B is located along natural bench directly below a massive sandstone channel on an east facing slope covered with conifers. Sampled approximately 100' below spring source. Flow from spring MF-19B generally ranges from 0 gpm to a maximum of 2.5 gpm.

Geologic Mode of Occurrence for spring MF-19B:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 400' below top.

Justification for removal from monitoring: MF-19B has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-19B be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-19B**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2136' N.	529' E.	SW	13	16S	6E	10111

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1413	400' below top

Location Comments: Spring located along natural bench directly below massive sandstone channel on east facing slope covered with conifers. Sampled approximately 100' below spring source.

Probable Recharge Area: Areas of higher elevation located to the west.

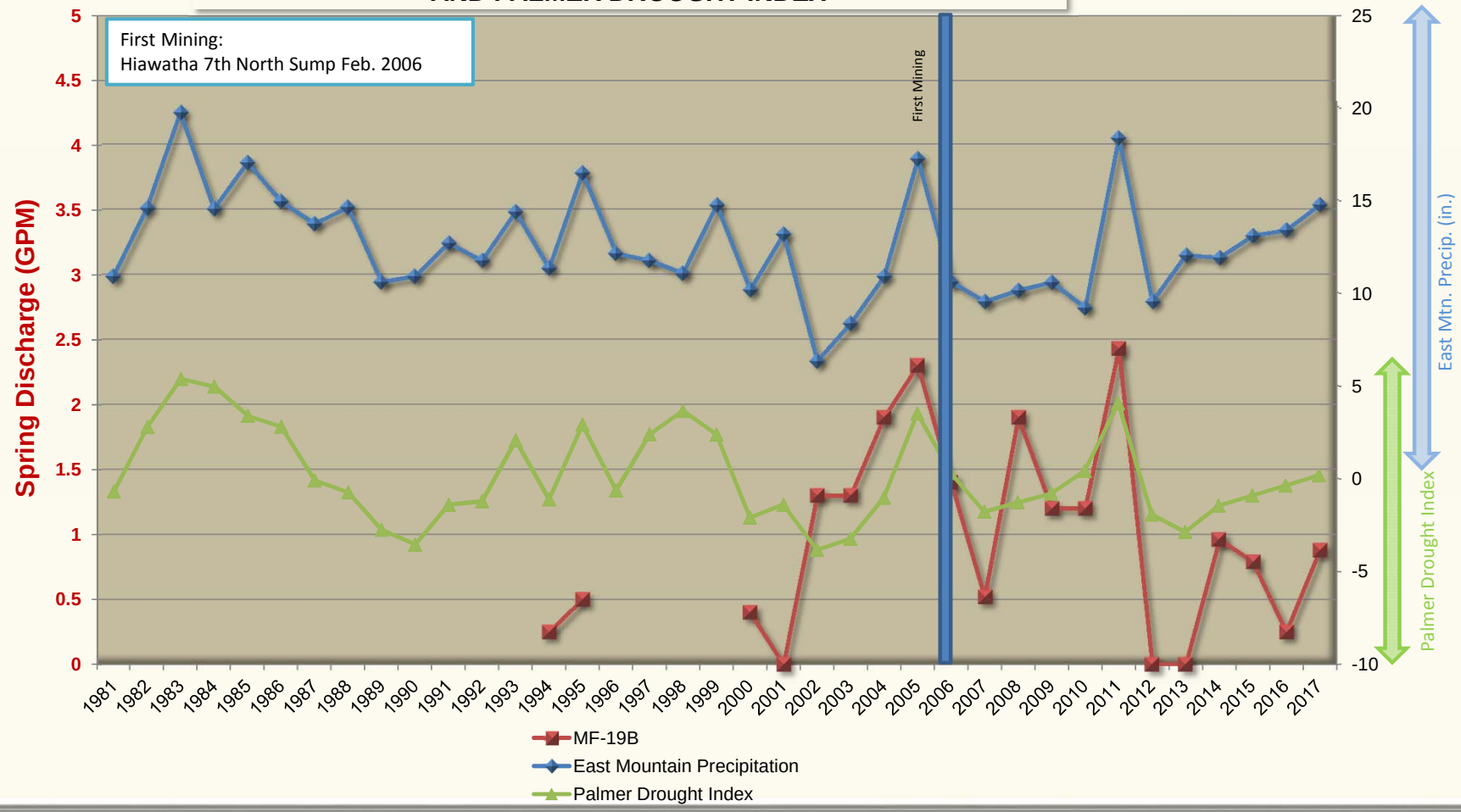
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-19B vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-19B
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Feb-10 Hiawatha 7th North Sump
Date of Second Mining: Not undermined
Location of Nearest Mining: Na
Date of Nearest Mining: Na

	Pre-Mining Data: 20000101 THROUGH 20060131				Post-Mining Data: 20060201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	286	215	245.857	7	246	209	226.944	18	BICARBONATE
CALCIUM	67.3	58	64.7285	7	78.71	62.6	66.6505	18	CALCIUM
CARBONATE	0				19	0	2.86666	15	CARBONATE
CHLORIDE	2	1	1.16666	6	6	0	2	18	CHLORIDE
CONDUCTIVITY	462	420	431.428	7	551	430	460.944	18	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	2.3	0.52	1.26142	7	2.48	0.22	0.92588	17	FLOW
HARDNESS	245	231	238.428	7	287	232	246.055	18	HARDNESS
TOTAL IRON	4.59	0.18	1.1488	5	0.31	0	0.088125	16	TOTAL IRON
DISSOLVED IRON	0				0	0	0	14	DISSOLVED IRON
MAGNESIUM	21	17.5	18.6428	7	21.99	17.2	19.325	18	MAGNESIUM
DISSOLVED MANGANESE	0.055	0.005	0.02275	4	0.02	0	7.26666	15	DISSOLVED MANGANESE
MANGANESE	0.293	0.002	0.10366	3	0.003	0	3.33333	15	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.39	8.06	8.27857	7	8.52	8	8.29611	18	PH
POTASSIUM	1.28	0.32	0.6372	5	2.1	0.31	0.97222	18	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.53	1.83571	7	4.44	1.09	1.95888	18	SODIUM
SULFATE	7	4	6.14285	7	12	4	6.38888	18	SULFATE
SUSPENDED SOLIDS	237	237	237	1	0				SUSPENDED SOLIDS
TEMPERATURE	9.6	3.9	6.18571	7	12.8	3.7	8.16666	18	TEMPERATURE
TOTAL DISSOLVED SOLIDS	252	211	235.571	7	287	222	258.444	18	TOTAL DISSOLVED SOLIDS

Location: Section 14, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-5 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-5 in the Hiawatha seam, (17th West gateroad development, December 2006).

Subsidence: No subsidence has been detected near RR-5. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2011. RR-5 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-5. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-5 is located in a clearing on an east facing slope surrounded by conifers. Flow from spring RR-5 generally ranges from 0/seep to a maximum of 34 gpm.

Geologic Mode of Occurrence for spring RR-5:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 360' below top.

Justification for removal from monitoring: RR-5 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-5 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-5**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1952' N.	2140' W.	SE	14	16S	6E	10160

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-1571	360' below top

Location Comments: Spring located in clearing on east facing slope surrounded with conifers.

Probable Recharge Area: Areas of higher elevation located to the west (recharge limited).

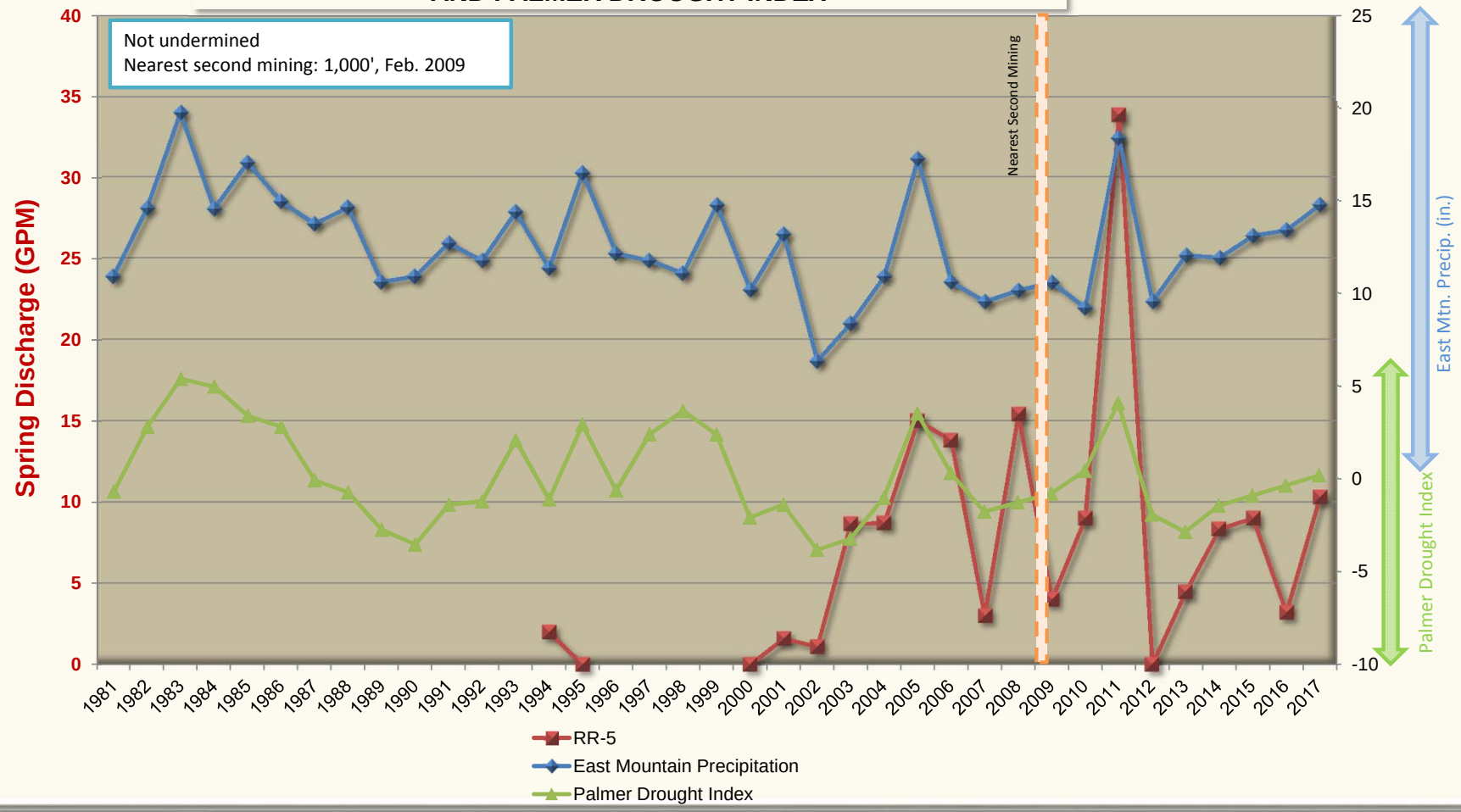
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity (RR-28, RR-6, RR-7A, RR-27, RR-4).

Geologic Occurrence of Spring:

Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

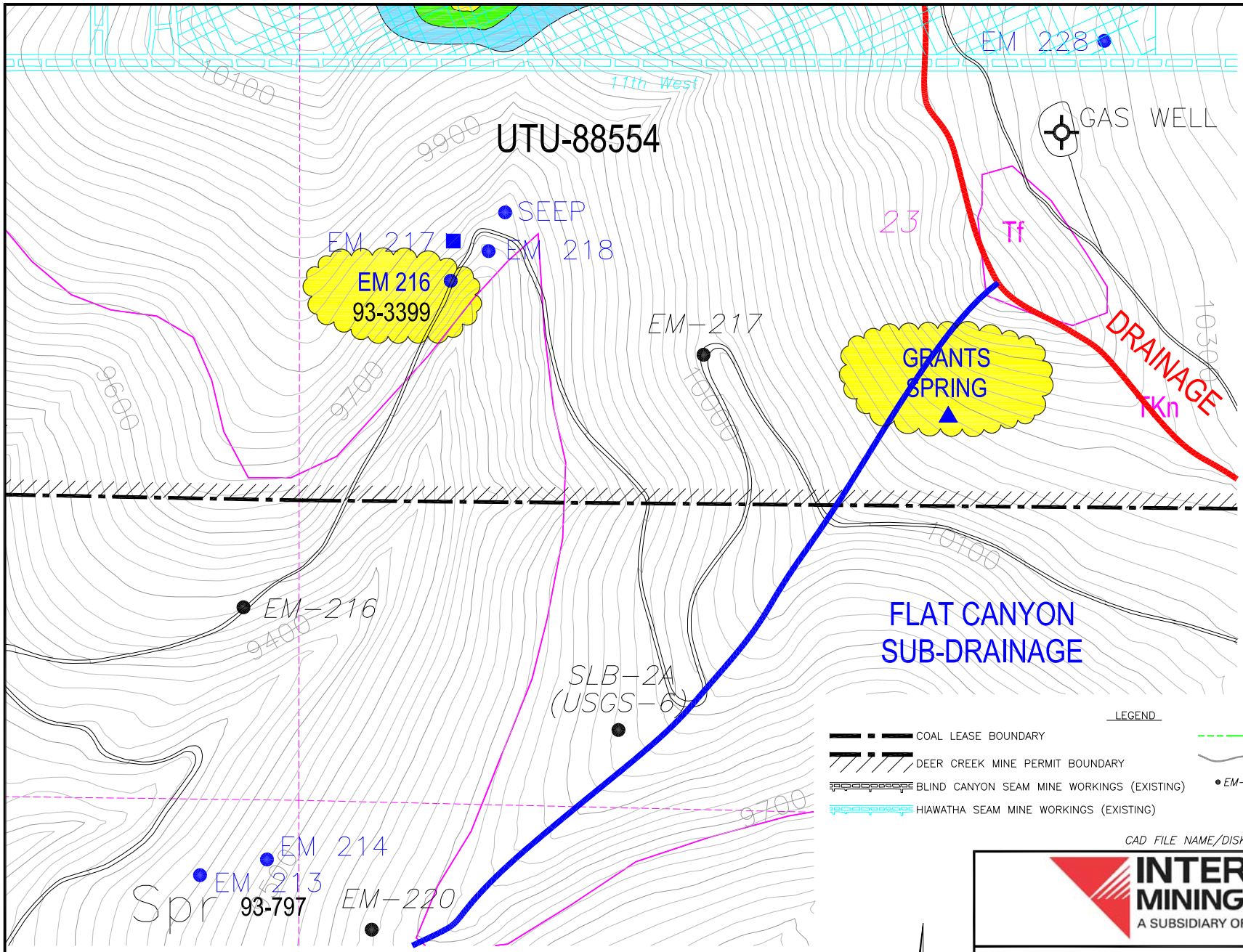
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-5 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-5
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1000'
Date of Nearest Mining: Feb-09

	Pre-Mining Data: 20000101 THROUGH 20090131				Post-Mining Data: 20090228 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	286	192	216.181	11	221	192	205.25	12	BICARBONATE
CALCIUM	74.39	61.7	64.5018	11	66.55	52.85	60.9233	12	CALCIUM
CARBONATE	0	0	0	2	0	0	0	12	CARBONATE
CHLORIDE	2	1	1.72727	11	2	0	0.75	12	CHLORIDE
CONDUCTIVITY	504	407	442.818	11	432	386	409.833	12	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	15.4	0.5	7.22909	11	33.8	0.42	7.58083	12	FLOW
HARDNESS	249	220	229.454	11	235	205	220.333	12	HARDNESS
TOTAL IRON	0.78	0.1	0.300125	8	1.65	0	0.24166	12	TOTAL IRON
DISSOLVED IRON	0	0	0	2	0	0	0	12	DISSOLVED IRON
MAGNESIUM	17.3	15.44	16.6318	11	17.89	14.53	16.62	12	MAGNESIUM
DISSOLVED MANGANESE	0.045	0.002	1.27142	7	0.055	0	1.20833	12	DISSOLVED MANGANESE
MANGANESE	0.013	0	0.0034	5	0.012	0	0.001	12	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.23	7.33	7.8009	11	8.4	7.55	7.96583	12	PH
POTASSIUM	0.99	0.31	0.50444	9	0.99	0.35	0.5675	12	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3	1.52	1.81	11	2.16	1.52	1.8325	12	SODIUM
SULFATE	10	7	8.72727	11	10	6	8.08333	12	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	5.6	3	4.17272	11	10.4	3.7	5.425	12	TEMPERATURE
TOTAL DISSOLVED SOLIDS	274	209	243.363	11	255	223	238	12	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 6	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 6 OF 10	REV. ___

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring EM-216 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 975' north of EM-216 in the Hiawatha Seam on September 2005.

Subsidence: Maximum subsidence in area 975' north of EM-216 has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. EM-216 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring EM-216. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. EM-216 is a low volume spring/seep located along the Mill Fork access road. Flow from spring EM-216 generally ranges from 0.0 gpm to a maximum of 1.3 gpm. Flow from EM-216 normally occurs early in the year and dissipates rapidly with recordable flow rarely existing after the month of July.

Geologic Mode of Occurrence for spring EM-216:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 75' above base.

Justification for removal from monitoring: EM-216 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site EM-216 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **EM-216**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2250' N.	651' E.	SW	23	16S	6E	9740

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	93-3399	75' above base

Location Comments: Spring located on south facing slope adjacent to East Mountain Access Road.

Probable Recharge Area: Highlands area to the north.

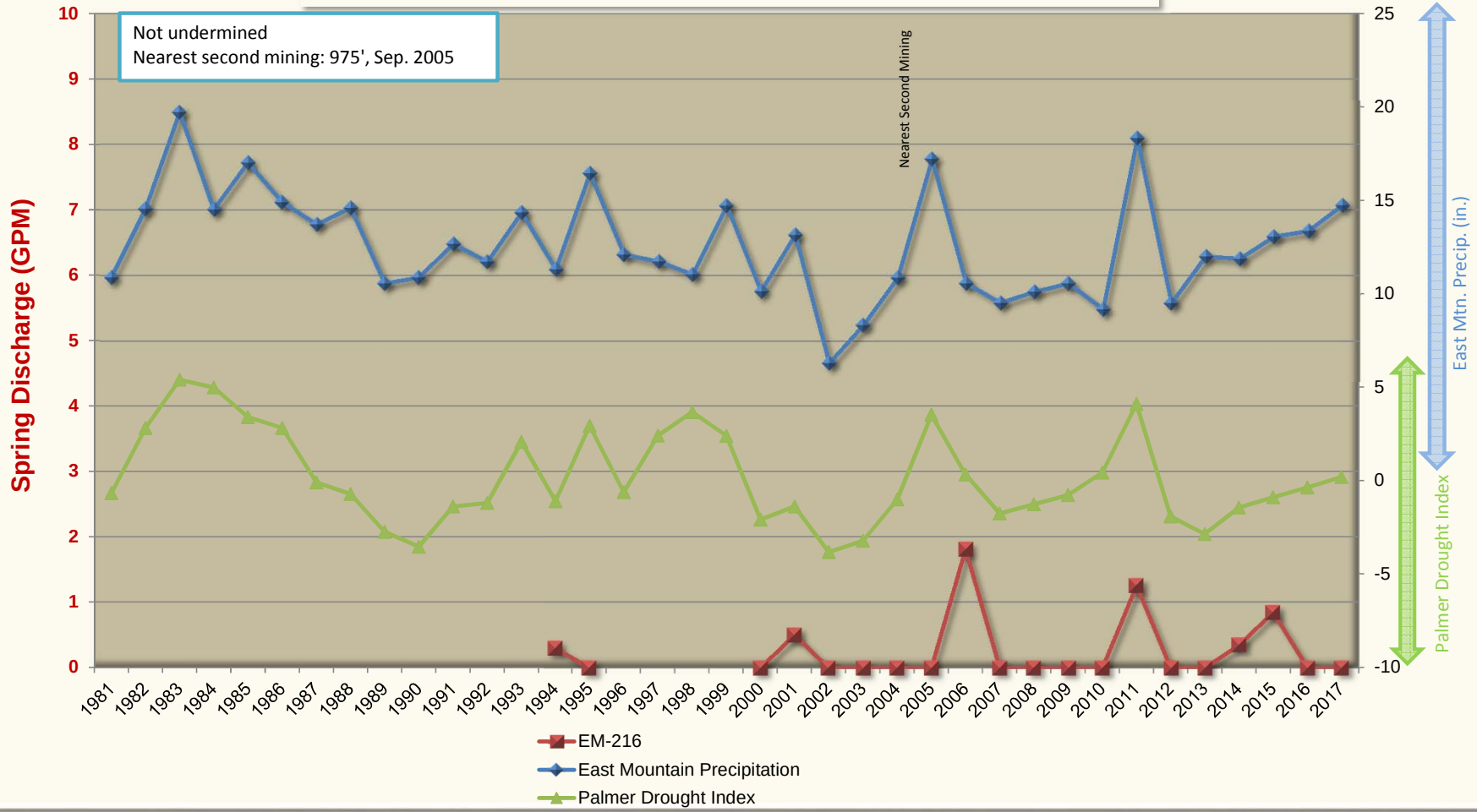
Relationship to Adjacent Springs: This spring occurs in the same manner as EM-218.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: EM-216 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: EM-216
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 975'
Date of Nearest Mining: Sep-05

	Pre-Mining Data: 2000101 THROUGH 20050801				Post-Mining Data: 20050831 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	- No Sample Data -				298	240	272.75	4	BICARBONATE
CALCIUM					94.6	70.16	81.235	4	CALCIUM
CARBONATE					0	0	0	3	CARBONATE
CHLORIDE					3	2	2.5	4	CHLORIDE
CONDUCTIVITY					663	502	579.25	4	CONDUCTIVITY
DISSOLVED OXYGEN					0				DISSOLVED OXYGEN
FLOW					1.8	0.35	1.06	4	FLOW
HARDNESS					344	273	304.25	4	HARDNESS
TOTAL IRON					0.19	0	8.66666	3	TOTAL IRON
DISSOLVED IRON					0	0	0	3	DISSOLVED IRON
MAGNESIUM					26.2	22.52	24.6675	4	MAGNESIUM
DISSOLVED MANGANESE					0.022	0	0.00825	4	DISSOLVED MANGANESE
MANGANESE					0.012	0	0.0055	4	MANGANESE
OIL AND GREASE					0				OIL AND GREASE
PH					8.36	7.66	7.965	4	PH
POTASSIUM					0.89	0.57	0.75	4	POTASSIUM
SET SOLIDS					0				SET SOLIDS
SODIUM					4.31	3.76	4.025	4	SODIUM
SULFATE					31	13	22.75	4	SULFATE
SUSPENDED SOLIDS					0				SUSPENDED SOLIDS
TEMPERATURE					17.7	9.3	13.575	4	TEMPERATURE
TOTAL DISSOLVED SOLIDS					319	278	304	4	TOTAL DISSOLVED SOLIDS

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Grants Spring is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 1,560' north of Grants Spring in the Hiawatha Seam in November 2005.

Subsidence: Maximum subsidence in area 1,560' north of Grants Spring has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. Grants Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Grants Spring Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 2002 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. Grants Spring is a low volume spring/seep located below ridge on west facing slope above main Mill Fork access road vegetated with conifers and aspens. Flow from spring Grants Spring generally ranges from 0.5 gpm to a maximum of <3 gpm.

Geologic Mode of Occurrence for spring Grants Spring:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 160' below top.

Justification for removal from monitoring: Grants Spring has been monitored by PacifiCorp since 2002. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Grants Spring be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **GRANTS SPRING**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1692' N.	2542' W.	SE	23	16S	6E	10280

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Developed With Steel Pipe Diverted to Trough (not functioning)	None	160' below top

Location Comments: Spring located below ridge on west facing slope above main access road. Area surrounding the spring source vegetated with conifers and aspens.

Probable Recharge Area: Highlands area to the northeast (recharge limited).

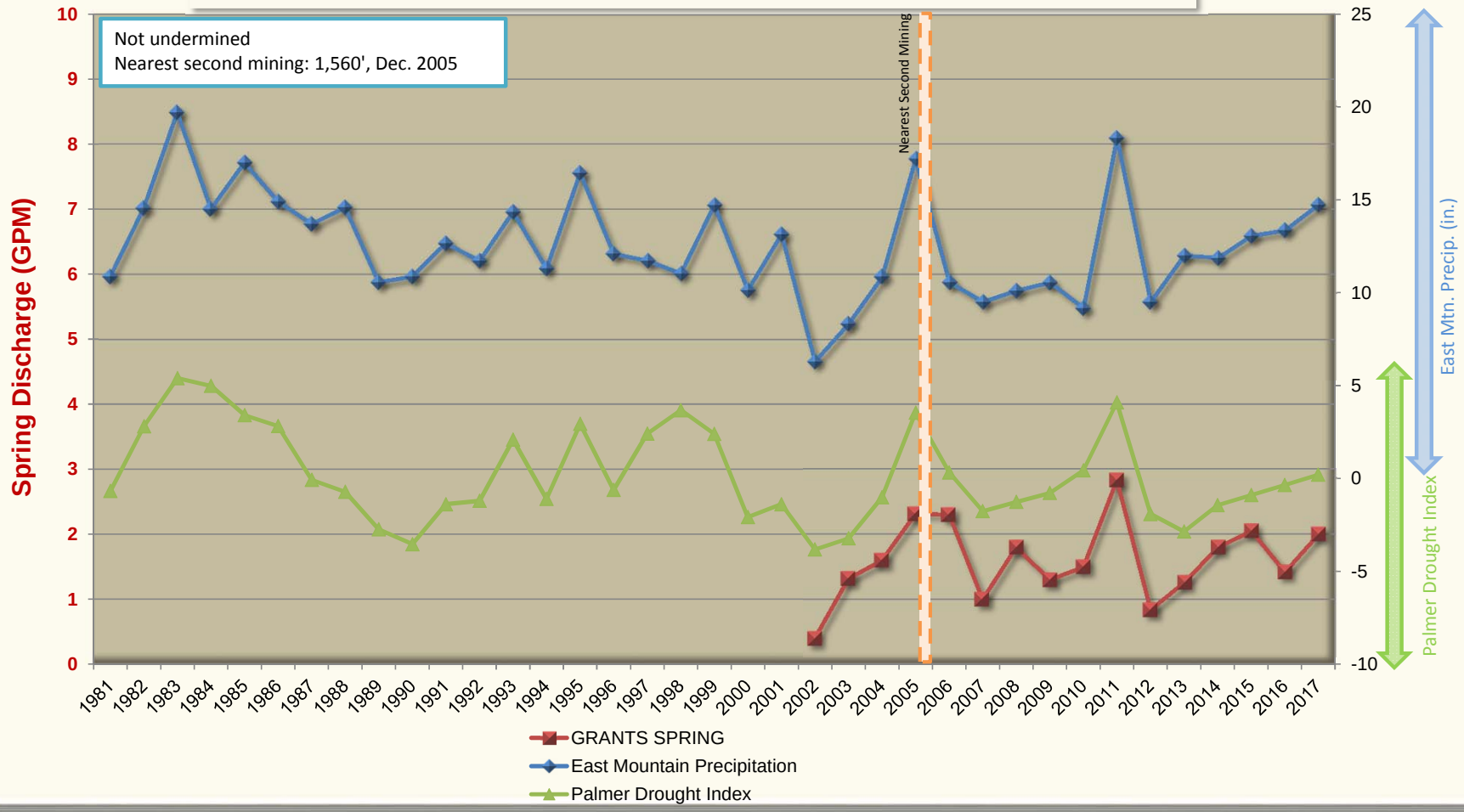
Relationship to Adjacent Springs: This spring occurs in the same manner as EMPOND.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

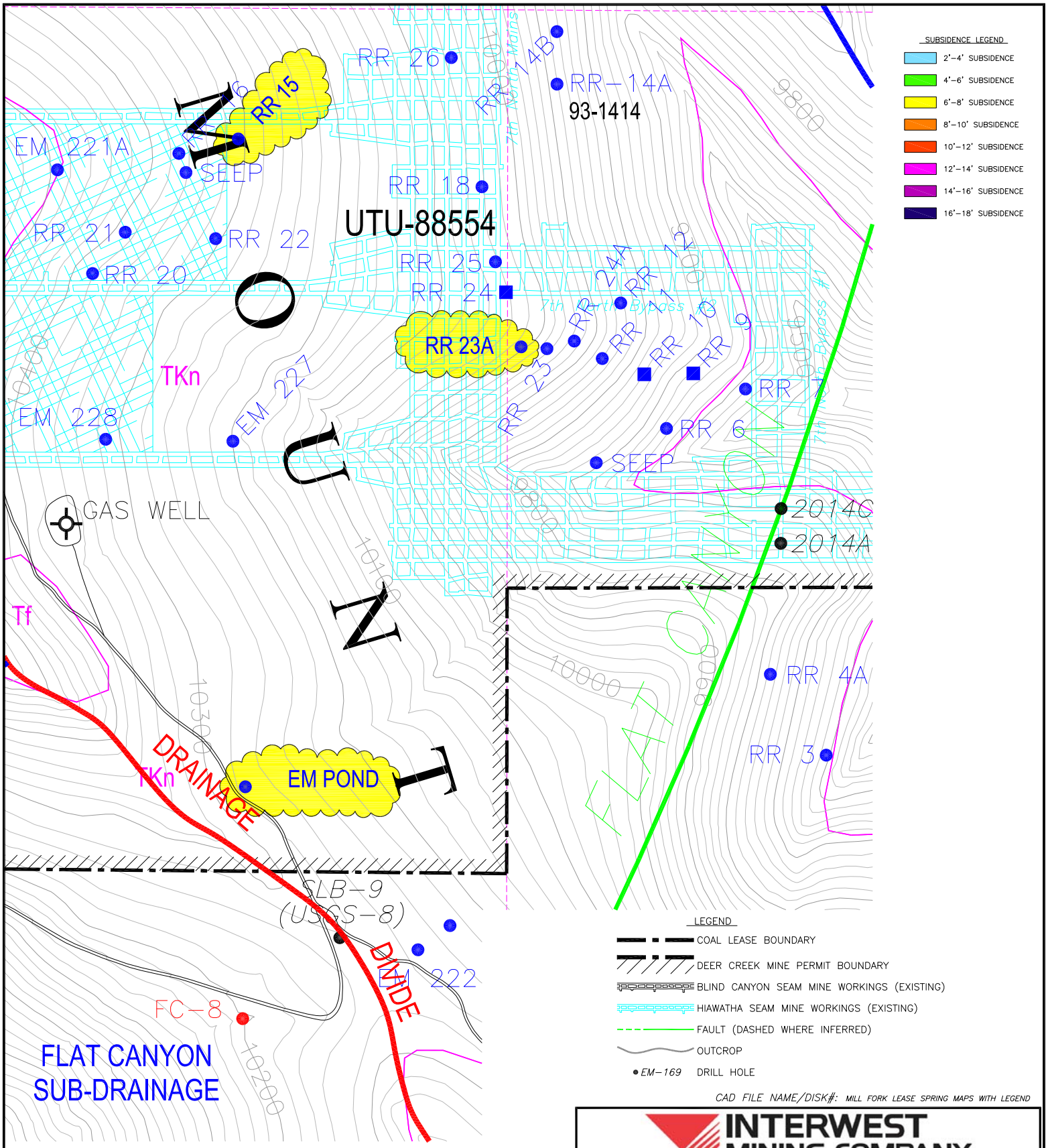
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: GRANTS SPRING vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: GRANTS SPRING
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1560'
Date of Nearest Mining: Nov-05

	Pre-Mining Data: 20000101 THROUGH 20051101				Post-Mining Data: 20051201 THROUGH 201712313				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	290	221	253.428	7	235	205	221.916	24	BICARBONATE
CALCIUM	56.7	54.1	55.7571	7	58.97	48.46	52.7758	24	CALCIUM
CARBONATE	0				8	0	0.4	20	CARBONATE
CHLORIDE	4	3	3.57142	7	7	2	3.20833	24	CHLORIDE
CONDUCTIVITY	491	457	473.285	7	508	422	454.791	24	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	2.31	0.3	1.11285	7	2.83	0.58	1.25541	24	FLOW
HARDNESS	256	241	248.857	7	255	211	235.708	24	HARDNESS
TOTAL IRON	0				0	0	0	20	TOTAL IRON
DISSOLVED IRON	0				0	0	0	20	DISSOLVED IRON
MAGNESIUM	27.7	25.4	26.6	7	28.1	15.59	25.2425	24	MAGNESIUM
DISSOLVED MANGANESE	0				0.002	0	0.0001	20	DISSOLVED MANGANESE
MANGANESE	0				0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.01	7.51	7.74428	7	7.94	7.47	7.77041	24	PH
POTASSIUM	1.34	1.11	1.24857	7	5.36	0.65	1.5	24	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	3.62	3.41	3.48857	7	3.85	1.45	3.49416	24	SODIUM
SULFATE	15	11	13	7	12	6	10.2083	24	SULFATE
SUSPENDED SOLIDS	258	258	258	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.4	4.3	4.81428	7	8.3	4.7	6.3625	24	TEMPERATURE
TOTAL DISSOLVED SOLIDS	272	226	248.714	7	377	217	251.583	24	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 7	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 7 OF 10	REV. ___

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-15 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-15 in the Hiawatha seam, (14th West, June 2005). Extraction face of the 14th West longwall panel is 55' west of RR-15.

Subsidence: No subsidence has been detected near RR-15. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2008. RR-15 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-15. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1994 through 1995 by Genwal Resources and 2000 through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-15 located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District). Per request from Emery Conservancy District, PacifiCorp removed the weir and recorder in August 2002. Flow from spring RR-15 generally ranges from 10 gpm to a maximum of 55 gpm.

Geologic Mode of Occurrence for spring RR-15:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 170' below top.

Justification for removal from monitoring: RR-15 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-15 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-15**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
610' S.	1257'W.	NE	23	16S	6E	10350

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Diverted To Weir (not functioning)	None	170' below top

Location Comments: Spring located on northeast facing slope surrounded with conifers. Flow from springs RR-16 and RR-15 diverted to weir with recorder (Emery Water Conservancy District).

Probable Recharge Area: Areas of higher elevation located to the west.

Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area.

Geologic Occurrence of Spring:

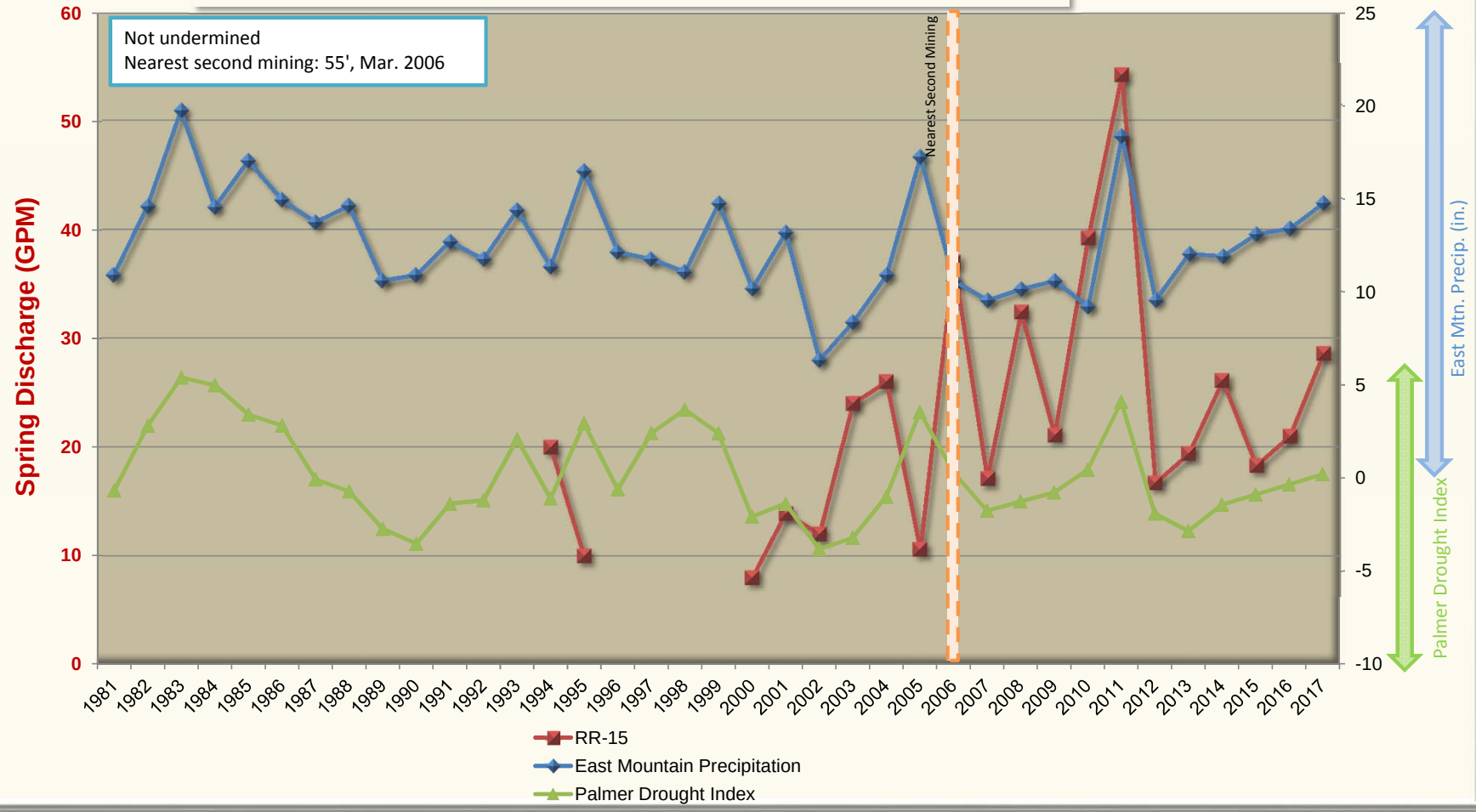
Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

RR-15 spring source

RR-15 Weir and recorder (removed August 22, 2002)

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-15 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-15
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 55'
Date of Nearest Mining: May-06

	Pre-Mining Data: 20000101 THROUGH 20060430				Post-Mining Data: 20060501 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	285	207	253.727	11	233	204	216.608	23	BICARBONATE
CALCIUM	65.8	55	59.3181	11	60.9	54	57.4321	23	CALCIUM
CARBONATE	0				0	0	0	20	CARBONATE
CHLORIDE	2	1	1.12	10	2	0	0.91304	23	CHLORIDE
CONDUCTIVITY	498	419	440	11	479	356	430.956	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	26	6	12.2363	11	54.2	0.52	19.3426	23	FLOW
HARDNESS	241	218	229.636	11	243	210	226.739	23	HARDNESS
TOTAL IRON	0.832	0.121	0.3106	5	0	0	0	20	TOTAL IRON
DISSOLVED IRON	0.084	0.084	0.084	1	0	0	0	20	DISSOLVED IRON
MAGNESIUM	21.4	16.6	19.809	11	23.2	17.12	20.23	23	MAGNESIUM
DISSOLVED MANGANESE	0.159	0.003	0.058	3	0	0	0	20	DISSOLVED MANGANESE
MANGANESE	0.012	0.003	0.0075	2	0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.43	7.53	8.04181	11	8.03	7.37	7.80695	23	PH
POTASSIUM	0.73	0.34	0.5978	5	1.32	0.59	0.8	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	1.96	2.77181	11	6.5	2.23	3.21565	23	SODIUM
SULFATE	11	4	6.04545	11	10	5	6.95652	23	SULFATE
SUSPENDED SOLIDS	214	214	214	1	0				SUSPENDED SOLIDS
TEMPERATURE	5.8	3	4.01818	11	8.5	3.4	4.36086	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	259	213	237.727	11	272	215	243.086	23	TOTAL DISSOLVED SOLIDS

Location: Section 24, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring RR-23A is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. First mining occurred in vicinity of RR-23A in the Hiawatha seam, (7th North Mains, August 2004).

Subsidence: No subsidence has been detected near RR-23A. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2009. RR-23A is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring RR-23A. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - RR-23A is located in a clearing on an east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms a small drainage. Flow from spring RR-23A generally ranges from 10 gpm to a maximum of 50 gpm.

Geologic Mode of Occurrence for spring RR-23A:

- Water flowing down through fractures in the upper North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 360' above base.

Justification for removal from monitoring: RR-23A has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site RR-23A be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **RR-23A**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1571' S.	64' E.	NW	24	16S	6E	10023

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	360' above base

Location Comments: Spring located in clearing on east facing slope surrounded by aspens. Abundant tufa deposits. Spring forms small drainage.

Probable Recharge Area: Areas of higher elevation located to the west.

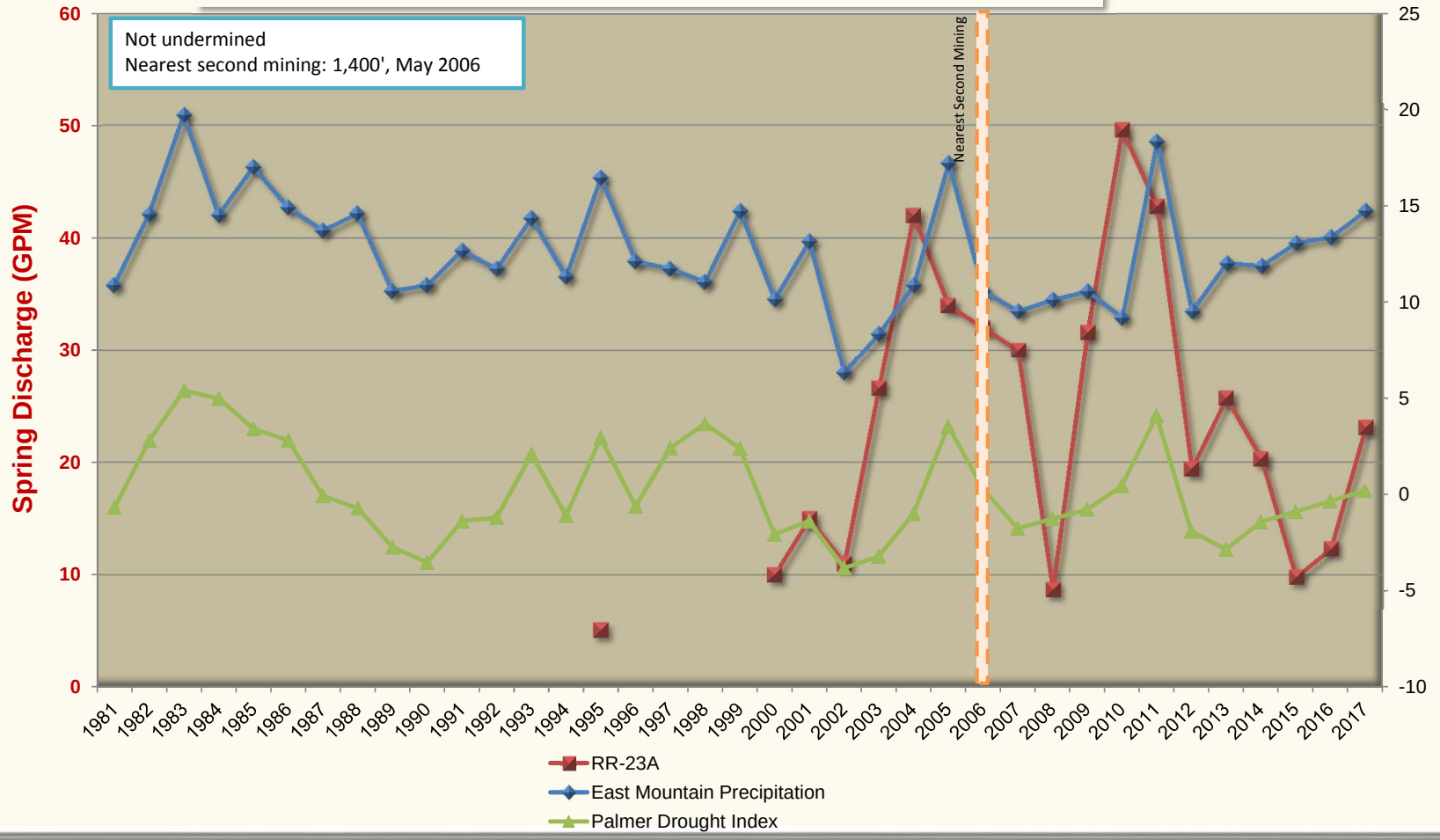
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate vicinity.

Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: RR-23A vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: RR-23A
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1400'
Date of Nearest Mining: May-06

	Pre-Mining Data: 20000101 THROUGH 20060430				Post-Mining Data: 20060501 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	309	237	276.181	11	258	217	240.304	23	BICARBONATE
CALCIUM	73.1	65	68.8454	11	75.2	63.42	69.6313	23	CALCIUM
CARBONATE	0				0	0	0	19	CARBONATE
CHLORIDE	2	1	1.59	10	3	0	1.47826	23	CHLORIDE
CONDUCTIVITY	566	461	493.272	11	560	411	489.173	23	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	42	8.32	17.5381	11	49.6	5.7	18.6495	23	FLOW
HARDNESS	272	245	255.636	11	282	232	258.086	23	HARDNESS
TOTAL IRON	1.12	0.3	0.54725	4	1.19	0	0.12238	21	TOTAL IRON
DISSOLVED IRON	0.008	0.008	0.008	1	0	0	0	19	DISSOLVED IRON
MAGNESIUM	21.7	19.5	20.3181	11	22.8	17.95	20.4526	23	MAGNESIUM
DISSOLVED MANGANESE	0.265	0.012	0.1385	2	0.066	0	4.38095	21	DISSOLVED MANGANESE
MANGANESE	0.011	0.011	0.011	1	0	0	0	19	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.28	7.21	7.69818	11	8.3	7.15	7.53913	23	PH
POTASSIUM	0.714	0.51	0.60866	6	1.1	0.56	0.72043	23	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	2.22	2.89545	11	3.78	1.97	2.78608	23	SODIUM
SULFATE	14	10	11.9181	11	15	8	12.2173	23	SULFATE
SUSPENDED SOLIDS	280	280	280	1	0				SUSPENDED SOLIDS
TEMPERATURE	8.2	4	5.21818	11	8.6	3.9	5.1	23	TEMPERATURE
TOTAL DISSOLVED SOLIDS	304	226	271.545	11	312	249	277.043	23	TOTAL DISSOLVED SOLIDS

Location: Section 23, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: EMPOND Spring is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat on August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. Second mining occurred 1,620' north of EMPOND in the Hiawatha Seam in December 2005.

Subsidence: Maximum subsidence in area 1,560' north of Grants Spring has stabilized at approximately 6 feet. The 2017 Annual Subsidence Report reported that the subsidence has been stable since at least 2008. EMPOND is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Grants Spring Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected since 1993 through 1995 by Genwal Resources and 2000 and through 2017 by PacifiCorp. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, 5, and 6. The East Mountain weather station is located on the southern tip of East Mountain. EMPOND is a located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring is dominated by conifers. Flow from spring EMPOND generally ranges from 1 gpm to a maximum of <10 gpm.

Geologic Mode of Occurrence for spring EMPOND:

- Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.
- Geologic Formation: North Horn (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 160' below top.

Justification for removal from monitoring: EMPOND has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site EMPOND be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **EMPOND**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1744' N.	1223' W.	SE	23	16S	6E	10280

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	None	None	160' below top

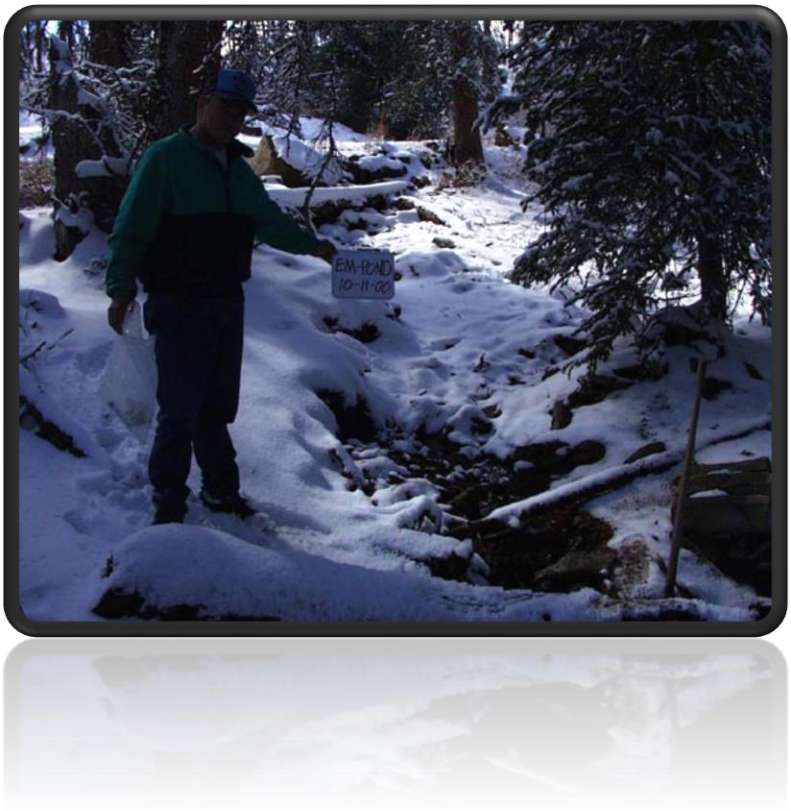
Location Comments: Spring located below ridge on east facing slope above small pond adjacent to road. Vegetation of the area surrounding the spring dominated by conifers.

Probable Recharge Area: Highlands area to the northwest (recharge limited).

Relationship to Adjacent Springs: This spring occurs in the same manner as EM-222 and EM-223.

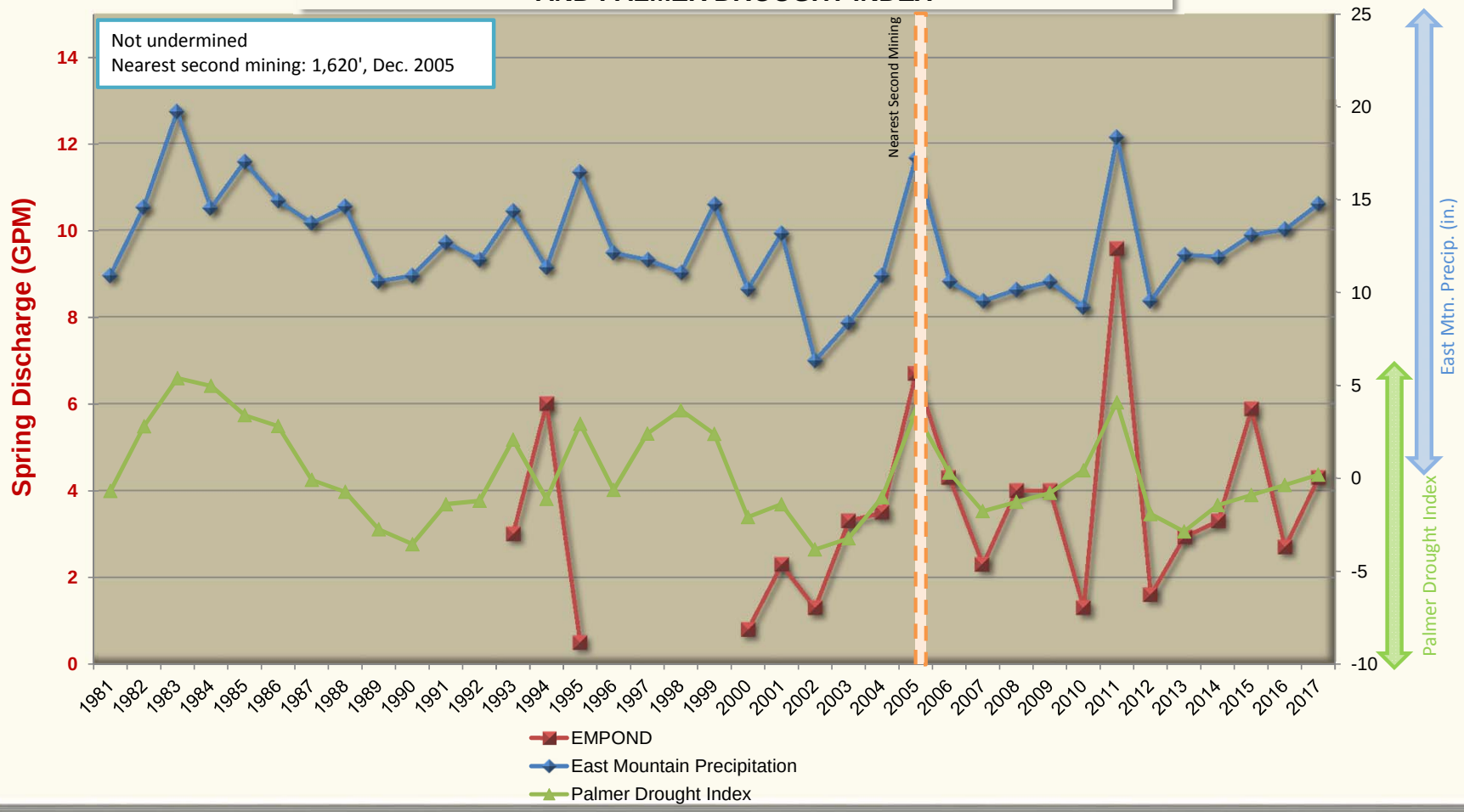
Geologic Occurrence of Spring:

Water flows laterally through sandstone channels underlain by impermeable mudstones of the North Horn Formation and intersects the land surface forming a spring.



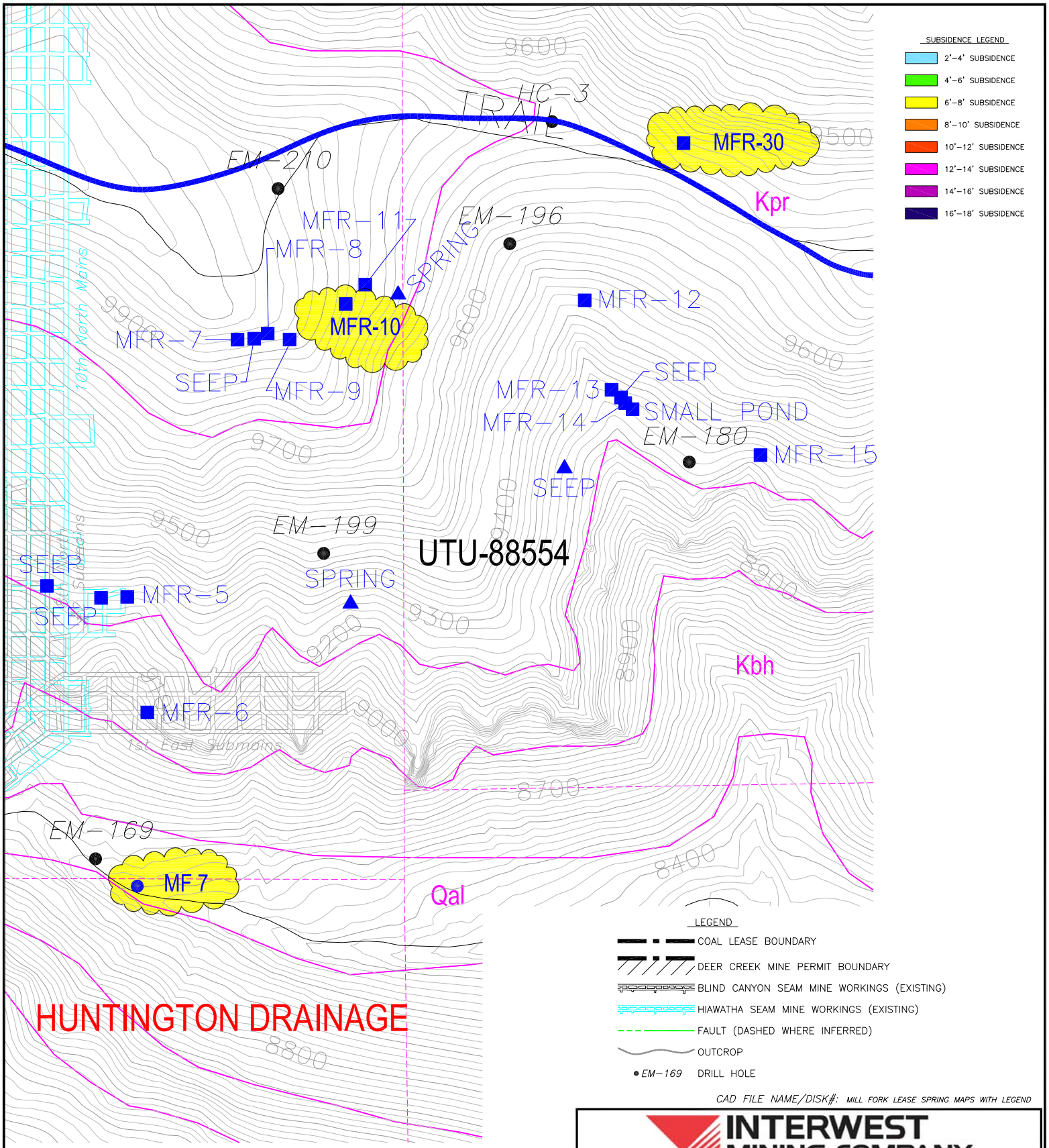
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: EMPOND vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: EMPOND
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1620'
Date of Nearest Mining: Dec-05

	Pre-Mining Data: 20000101 THROUGH 20051130				Post-Mining Data: 20051201 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	296	228	269.1	10	239	213	225.875	24	BICARBONATE
CALCIUM	62	57.4	60	10	62.74	54.49	58.16125	24	CALCIUM
CARBONATE	0				12	0	0.6	20	CARBONATE
CHLORIDE	2	1	1.13	10	3	0	1.33333	24	CHLORIDE
CONDUCTIVITY	525	446	468.7	10	491	371	445.125	24	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	6.7	0.5	2.175	10	9.57	0.37	2.78333	24	FLOW
HARDNESS	249	231	242.7	10	254	221	236.375	24	HARDNESS
TOTAL IRON	1.5	0.088	0.4452	5	1.4	0	0.20695	23	TOTAL IRON
DISSOLVED IRON	0.056	0.056	0.056	1	0	0	0	20	DISSOLVED IRON
MAGNESIUM	23.7	21.3	22.57	10	24.1	20.45	22.137	24	MAGNESIUM
DISSOLVED MANGANESE	0.07	0.002	0.02	5	0.063	0	8.29166	24	DISSOLVED MANGANESE
MANGANESE	0.008	0.007	0.0075	2	0	0	0	20	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.21	7.84	7.983	10	8.15	7.67	7.91791	24	PH
POTASSIUM	0.697	0.539	0.60433	6	0.92	0.53	0.65375	24	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	4	2	2.385	10	2.56	1.35	2.06583	24	SODIUM
SULFATE	7	4.8	5.38	10	6	3	3.79166	24	SULFATE
SUSPENDED SOLIDS	239	239	239	1	0				SUSPENDED SOLIDS
TEMPERATURE	6	3.8	5.24	10	10.6	4.9	6.9	24	TEMPERATURE
TOTAL DISSOLVED SOLIDS	280	231	251.6	10	287	204	245.333	24	TOTAL DISSOLVED SOLIDS



CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY: K. LARSEN	MAP 8	
SCALE: 1" =600'	DRAWING #:	
DATE: MAY 7, 2018	SHEET 8 OF 10	REV. ___

Location: Section 7, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MFR-30 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MFR-30.

Subsidence: No subsidence has been detected near MFR-30. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MFR-30 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MFR-30. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MFR-30 is located in small clearing on a north facing slope. Area surrounding the spring source is vegetated with mountain brush, aspens and conifers. Flow from spring MFR-30 generally ranges from 0/seep to a maximum of <3 gpm.

Geologic Mode of Occurrence for spring MFR-30:

- Water flowing down through fractures in the Upper Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.
- Geologic Formation: Upper Price River (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 80' below top.

Justification for removal from monitoring: MFR-30 has been monitored by PacifiCorp since 2001. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MFR-30 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MFR-30**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2298' S.	1304' E.	NW	7	16S	7E	9680

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Upper Price River	None	None	80' below top

Location Comments: Spring located in small clearing on north facing slope. Area surrounding the spring source vegetated with mountain brush, aspens and conifers.

Probable Recharge Area: Areas of higher elevation located to the west.

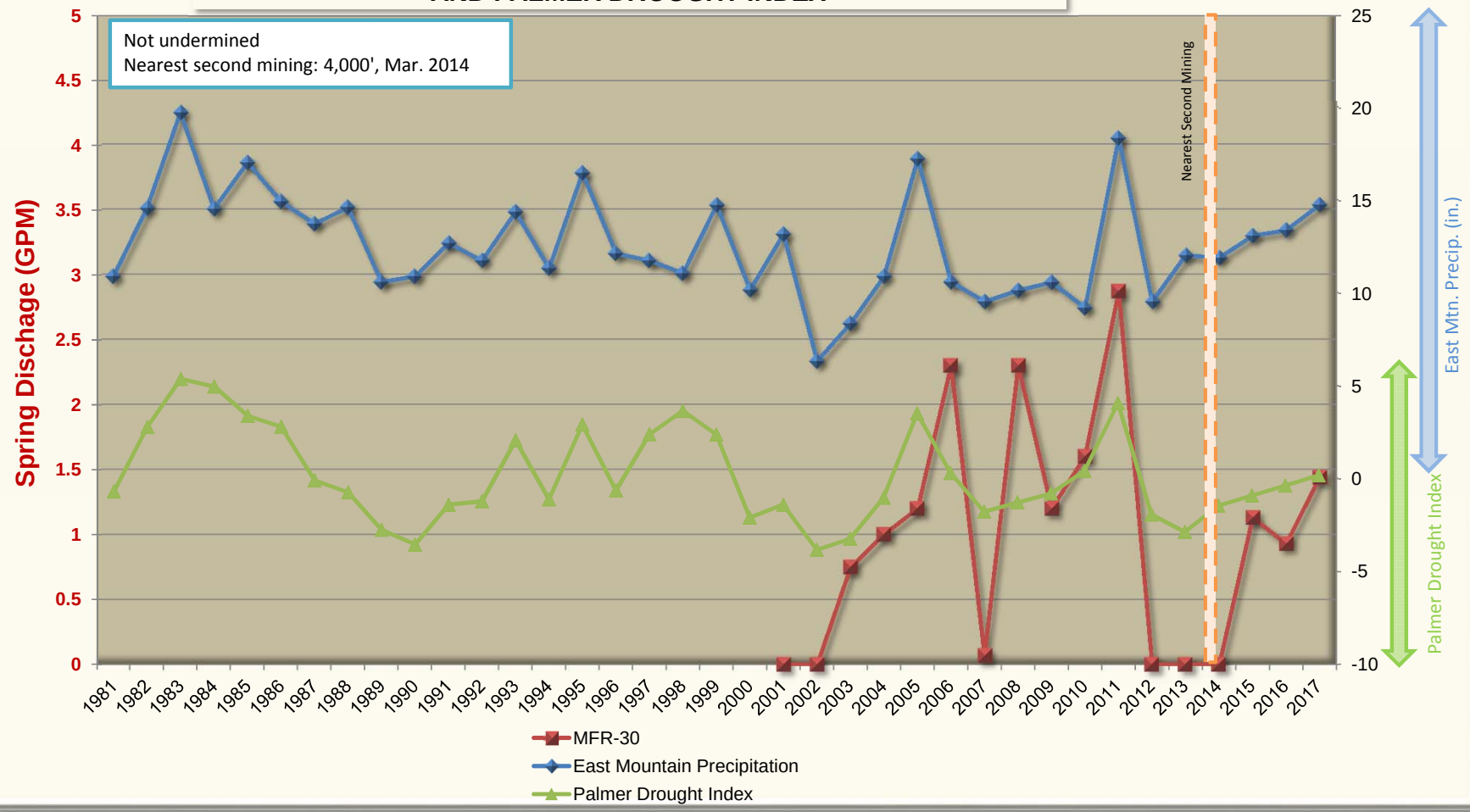
Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area (MFR-28, MFR-29).

Geologic Occurrence of Spring:

Water flowing down through fractures in the Upper Price River Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel intersects the surface.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MFR-30 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MFR-30
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 4000'
Date of Nearest Mining: Mar-14

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	383	258	305.166	12	316	252	278.666	3	BICARBONATE
CALCIUM	89.22	77	84.275	12	83.94	63.67	71.8366	3	CALCIUM
CARBONATE	0	0	0	5	0	0	0	3	CARBONATE
CHLORIDE	3	1	2.25	12	3	2	2.33333	3	CHLORIDE
CONDUCTIVITY	698	593	624.833	12	633	552	587.333	3	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	26.6	0.22	3.41833	12	1.44	0.93	1.16666	3	FLOW
HARDNESS	327	287	311	12	318	266	283.666	3	HARDNESS
TOTAL IRON	1.23	0	0.4207	10	2.62	0	0.93	3	TOTAL IRON
DISSOLVED IRON	0	0	0	5	0	0	0	3	DISSOLVED IRON
MAGNESIUM	26.11	21	24.4258	12	26.24	23.72	25.33	3	MAGNESIUM
DISSOLVED MANGANESE	0.012	0	0.0036	5	0.061	0	2.13333	3	DISSOLVED MANGANESE
MANGANESE	0.026	0	0.00625	8	0	0	0	3	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.27	7.56	7.95416	12	8.55	7.89	8.19333	3	PH
POTASSIUM	1.04	0.73	0.81072	11	1.35	0.83	1.12	3	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	16.5	8	12.96	12	14.42	12.69	13.4433	3	SODIUM
SULFATE	39	22	32.25	12	36	31	33.6666	3	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.2	3	6.28333	12	61.3	6.2	25.6666	3	TEMPERATURE
TOTAL DISSOLVED SOLIDS	400	308	351.083	12	338	283	313	3	TOTAL DISSOLVED SOLIDS

Location: Section 12, Township 16 South, Range 6 East, SLB&M. This site is located within the Deer Creek mine permit boundary and within the Federal Coal lease UTU-88554.

Lease Association: Spring MFR-10 is located within Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MFR-10.

Subsidence: No subsidence has been detected near MFR-10. The 2017 Annual Subsidence Report reported that the subsidence west of the spring has been stable since at least 2014. MFR-10 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MFR-10. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2001 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MFR-10 is located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source is vegetated with conifers and aspens. Flow from spring MFR-10 generally ranges from 10 gpm to a maximum of 45 gpm (recorded flow of 2001 was 0.0 gpm).

Geologic Mode of Occurrence for spring MFR-10:

- Water flowing down through fractures in the lower section of the North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel.
- Geologic Formation: North Horn Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: 140' above base.

Justification for removal from monitoring: MFR-10 has been monitored by PacifiCorp since 2001. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MFR-10 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MFR-10**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2680' N.	270' W	SE	12	16S	6E	9900

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
North Horn	Developed With Steel Pipe, Diverted To Trough (not functioning)	None	140' above base

Location Comments: Spring located at the end of a trail which leads to reclaimed road. Denoted as "Spring" on Rilda Quad. map. Area surrounding the spring source vegetated with conifers and aspens.

Probable Recharge Area: Areas of higher elevation located to the west.

Relationship to Adjacent Springs: This spring occurs in the same manner as several springs in the immediate area.

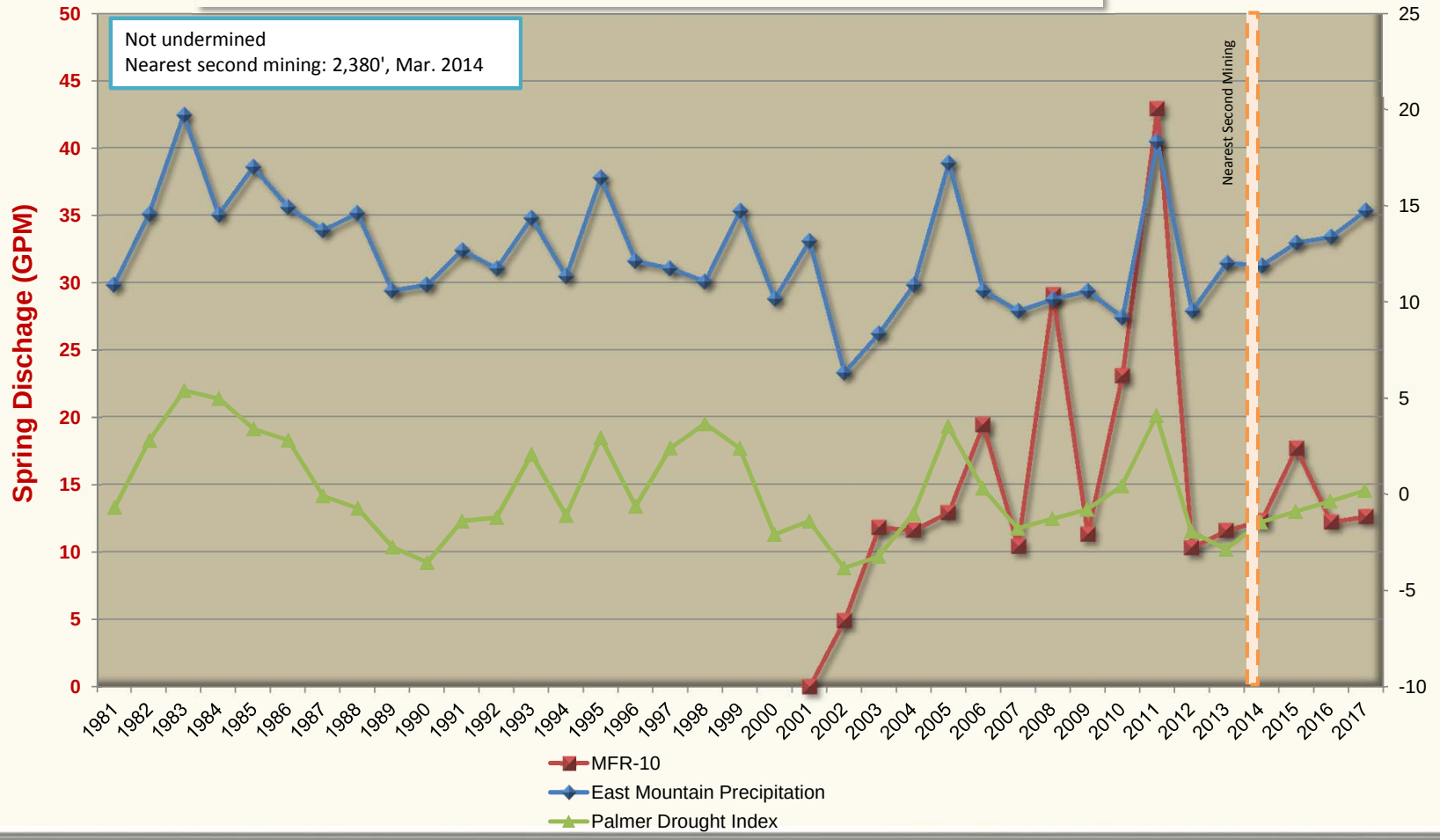
Geologic Occurrence of Spring: Water flowing down through fractures in the lower section of the North Horn Formation intersects channel sandstones and flows laterally through the formation. A spring is formed when the sandstone channel.

MFR-10 Spring Source

MFR-10 Trough

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MFR-10 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MFR-10
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 2380'
Date of Nearest Mining: Mar-14

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	326	228	263.73	26	260	229	244.75	8	BICARBONATE
CALCIUM	82.6	65	73.1584	26	74.25	58.28	65.83	8	CALCIUM
CARBONATE	6	0	0.46153	13	0	0	0	8	CARBONATE
CHLORIDE	4	2	2.38846	26	2	2	2	8	CHLORIDE
CONDUCTIVITY	618	380	525.5	26	545	497	517.25	8	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	151	2.4	15.4926	26	17.65	1.7	8.1375	8	FLOW
HARDNESS	305	253	279.653	26	288	236	261.75	8	HARDNESS
TOTAL IRON	1.34	0	0.19225	20	0	0	0	8	TOTAL IRON
DISSOLVED IRON	0	0	0	12	0	0	0	8	DISSOLVED IRON
MAGNESIUM	25.8	22	23.563	26	25.76	20.57	23.7175	8	MAGNESIUM
DISSOLVED MANGANESE	0.04	0	0.00431	16	0	0	0	8	DISSOLVED MANGANESE
MANGANESE	0	0	0	12	0	0	0	8	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.41	7.31	8.07038	26	8.54	8.16	8.2625	8	PH
POTASSIUM	1.15	0.48	0.82054	22	1.2	0.64	0.82875	8	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	6	2	4.04692	26	5.86	2.81	4.30125	8	SODIUM
SULFATE	29	11	23.073	26	31	19	25.375	8	SULFATE
SUSPENDED SOLIDS	267	267	267	1	0				SUSPENDED SOLIDS
TEMPERATURE	44.9	3.9	7.99615	26	50.1	2.4	11.675	8	TEMPERATURE
TOTAL DISSOLVED SOLIDS	341	262	295.346	26	314	269	291.75	8	TOTAL DISSOLVED SOLIDS

Location: Section 13, Township 16 South, Range 7 East, SLB&M. This site is located within the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

Lease Association: Spring MF-7 is located in Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MF-7.

Subsidence: No subsidence has been detected near MF-7. Nearest second mining is 1,707' west of MF-7. MF-7 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-7. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-7 is located on hillside near Mill Fork drainage on a north facing slope covered with spruce trees. Flow from spring MF-7 generally ranges from 10 gpm to a maximum of 65 gpm.

Geologic Mode of Occurrence for spring MF-7:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: MF-7 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-7 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-7**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
34' S.	1244' W.	NE	13	16S	6E	8580

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	None	320' below top

Location Comments: Spring located on hillside near Mill Fork drainage on north facing slope covered with spruce trees.

Probable Recharge Area: Areas of higher elevation located to the southwest.

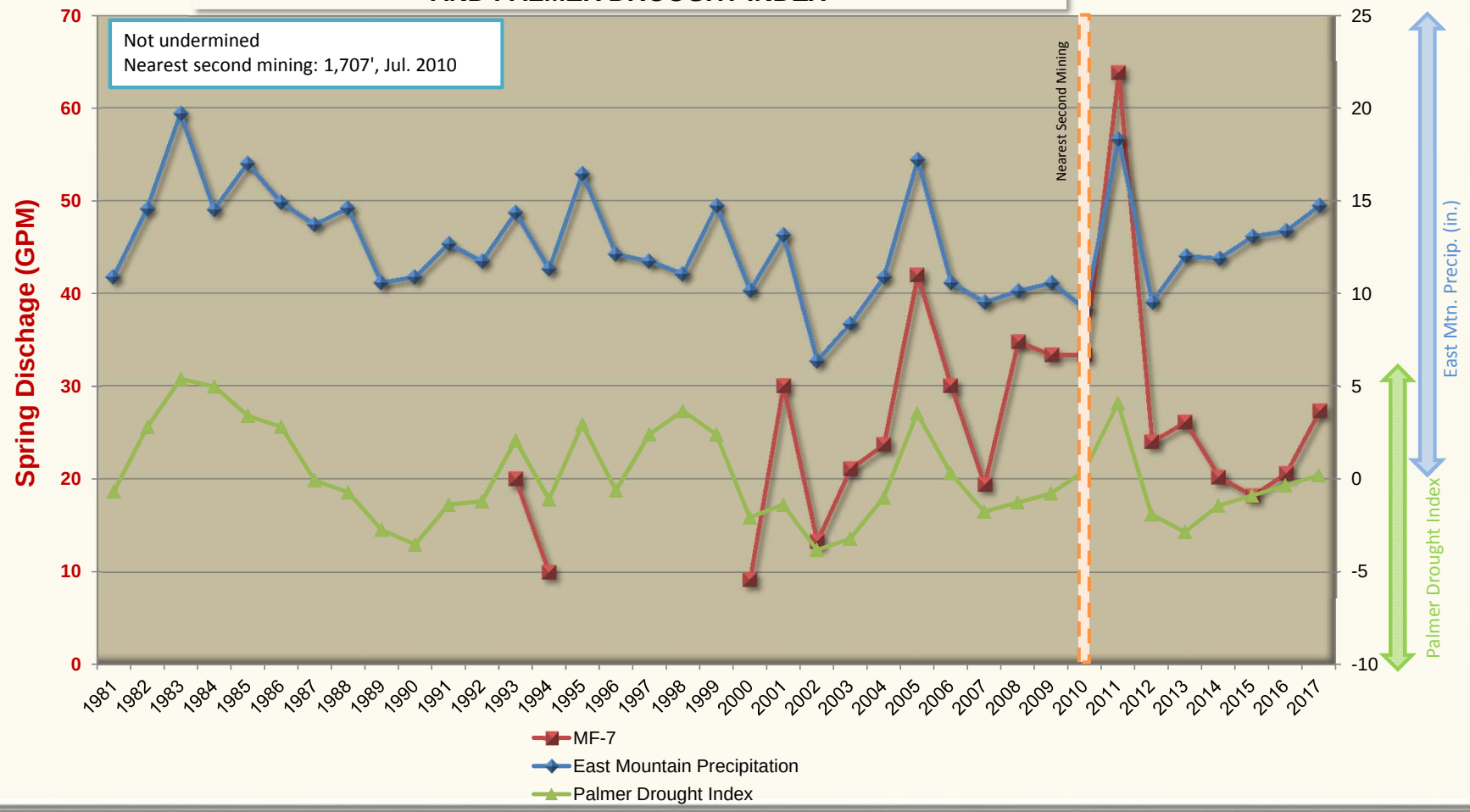
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-8A.

Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

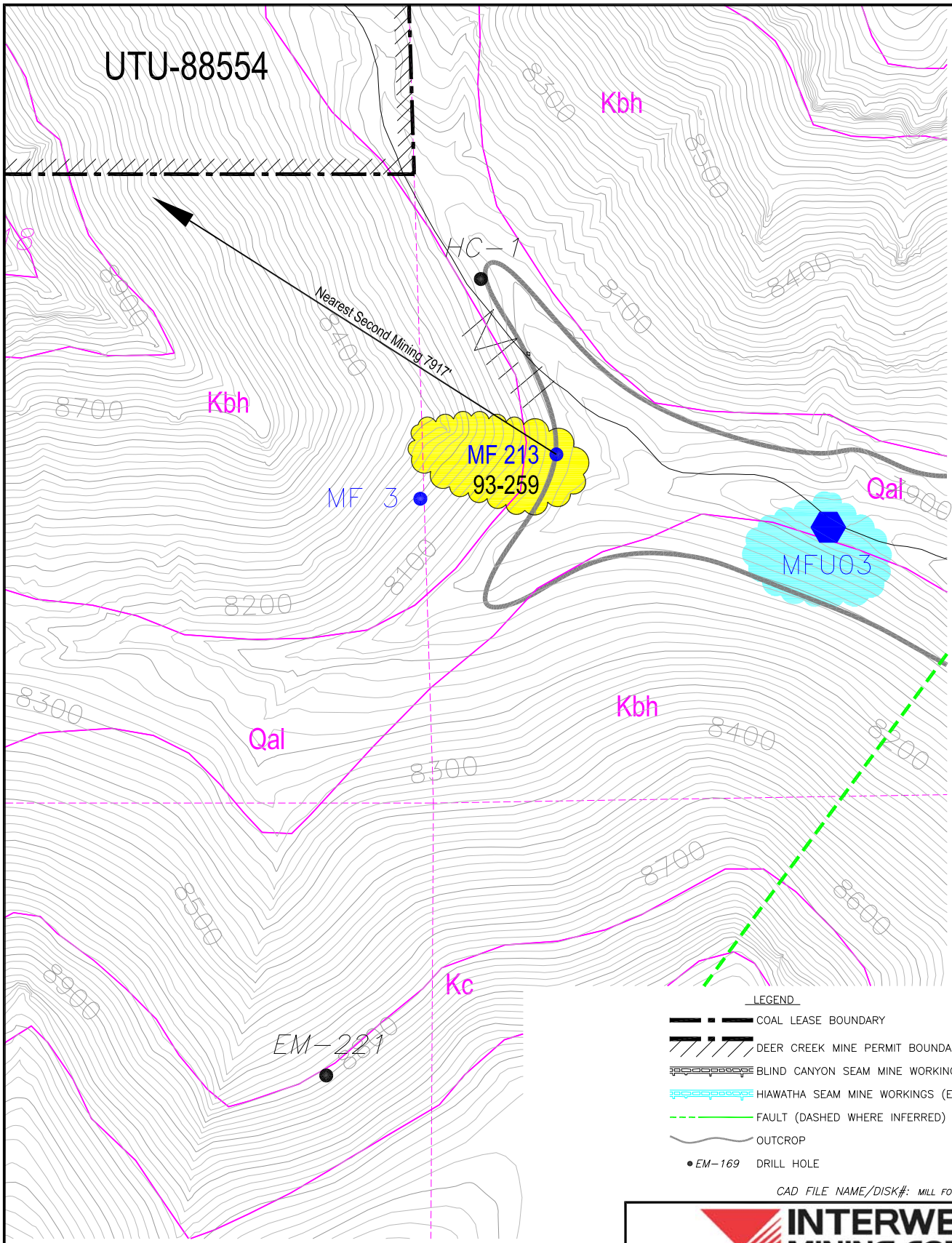
EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-7 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-7
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 1707'
Date of Nearest Mining: Jul-10

	Pre-Mining Data: 20000101 THROUGH 20100630				Post-Mining Data: 20100701 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	335	242	279.21	19	277	250	262.9375	16	BICARBONATE
CALCIUM	77.1	65	72.901	19	77.13	36.37	70.0975	16	CALCIUM
CARBONATE	0	0	0	4	12	0	0.75	16	CARBONATE
CHLORIDE	4	2	2.71052	19	3	2	2.5	16	CHLORIDE
CONDUCTIVITY	681	512	583.263	19	670	532	593.4375	16	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	42	9.3	21.5315	19	63.8	12.8	24.5931	16	FLOW
HARDNESS	325	269	303.105	19	325	160	293.0625	16	HARDNESS
TOTAL IRON	0.1	0	0.02	5	1.18	0	0.101875	16	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	16	DISSOLVED IRON
MAGNESIUM	32.3	26	29.4015	19	32.32	16.75	28.665	16	MAGNESIUM
DISSOLVED MANGANESE	0	0	0	4	0.139	0	0.010125	16	DISSOLVED MANGANESE
MANGANESE	0	0	0	4	0	0	0	16	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8	7.45	7.80842	19	8.5	7.7	7.875625	16	PH
POTASSIUM	1.46	1	1.15833	18	1.84	1.04	1.34625	16	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	7	4	6.07789	19	68.11	6.87	13.59375	16	SODIUM
SULFATE	55	39	45.8315	19	74	29	51.8125	16	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	18.8	3.5	5.38333	18	40.5	4.4	7.25625	16	TEMPERATURE
TOTAL DISSOLVED SOLIDS	360	298	326.947	19	415	298	345.0625	16	TOTAL DISSOLVED SOLIDS



SUBSIDENCE LEGEND

- 2'-4' SUBSIDENCE
- 4'-6' SUBSIDENCE
- 6'-8' SUBSIDENCE
- 8'-10' SUBSIDENCE
- 10'-12' SUBSIDENCE
- 12'-14' SUBSIDENCE
- 14'-16' SUBSIDENCE
- 16'-18' SUBSIDENCE

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 DRILL HOLE

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

SPRING LEGEND

- MFB02 SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994-1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010-2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 GROUND WATER RIGHTS
- 93-198 SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989-1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY - DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 9	
SCALE:	1" =600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 9 OF 10	REV. ___

Location: Section 17, Township 16 South, Range 7 East, SLB&M. This site is located within ½ mile offset of the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

Lease Association: Spring MF-213 is located within ½ mile offset of Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of MF-213.

Subsidence: No subsidence has been detected near MF-213. Nearest second mining is 7,915' west of MF-213. MF-213 is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring MF-213. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 2000 and has continued through 2017. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - MF-213 is located near drainage bottom (Mill Fork - Right Fork) on an east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits. Flow from spring MF-213 generally ranges from 15 gpm to a maximum of 70 gpm.

Geologic Mode of Occurrence for spring MF-213:

- Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: MF-213 has been monitored by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site MF-213 be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **MF-213**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
1489' N.	584' E.	SW	17	16S	R7E	8030

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Blackhawk	None	93-259	At base

Location Comments: Spring located near drainage bottom (Mill Fork - Right Fork) on east/southeast facing slope covered with mountain brush, conifers and aspens. Large tufa deposits.

Probable Recharge Area: Areas of higher elevation located to the west.

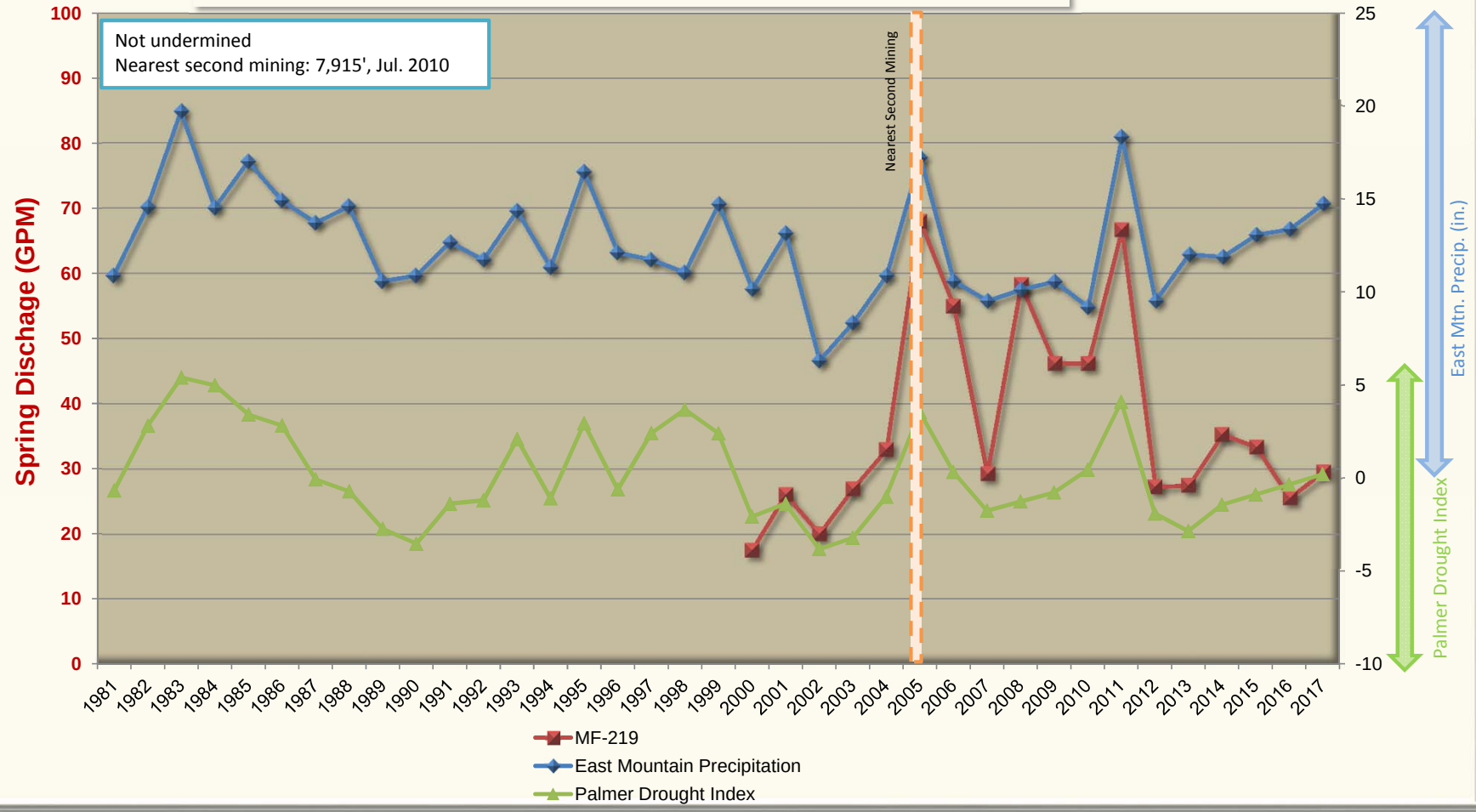
Relationship to Adjacent Springs: This spring occurs in the same manner as MF-3.

Geologic Occurrence of Spring:

Water flowing along fractures in the Blackhawk Formation intersects the land surface forming a spring.

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: MF-213 vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: MF-213
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 7915'
Date of Nearest Mining: Jul-10

	Pre-Mining Data: 20000101 THROUGH 20100630				Post-Mining Data: 20100630 THROUGH 20172131				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	332	241	279.842	19	261	226	252.25	16	BICARBONATE
CALCIUM	69.1	61	65.341	19	68.57	52.08	63.3456	16	CALCIUM
CARBONATE	9	0	1.8	5	5	0	0.3125	16	CARBONATE
CHLORIDE	4	2	2.66315	19	3	2	2.4375	16	CHLORIDE
CONDUCTIVITY	752	435	551.105	19	551	497	525.8125	16	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	68	10	28.2315	19	66.7	14.3	28.2075	16	FLOW
HARDNESS	294	272	283.157	19	290	227	273.75	16	HARDNESS
TOTAL IRON	0.313	0	6.88333	6	1.16	0	0.0725	16	TOTAL IRON
DISSOLVED IRON	0	0	0	4	0	0	0	16	DISSOLVED IRON
MAGNESIUM	31	27.4	29.1584	19	29.96	23.53	28.0681	16	MAGNESIUM
DISSOLVED MANGANESE	0.004	0	0.0008	5	0.067	0	0.00418	16	DISSOLVED MANGANESE
MANGANESE	0.004	0	0.0008	5	0	0	0	16	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	8.22	7.21	7.95105	19	8.45	8.03	8.138125	16	PH
POTASSIUM	1.2	0.93	1.02982	17	1.39	0.95	1.085	16	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	7	4.61	5.55	19	8.86	5.08	6.72375	16	SODIUM
SULFATE	29	23	25.4526	19	52	23	28.375	16	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.6	5.6	7.85789	19	50.8	6.1	11.4125	16	TEMPERATURE
TOTAL DISSOLVED SOLIDS	324	264	294.473	19	352	280	299.5	16	TOTAL DISSOLVED SOLIDS

Location: Section 9, Township 16 South, Range 7 East, SLB&M. This site is located 1 ½ mile east of the Deer Creek mine permit boundary and Federal Coal lease UTU-88554.

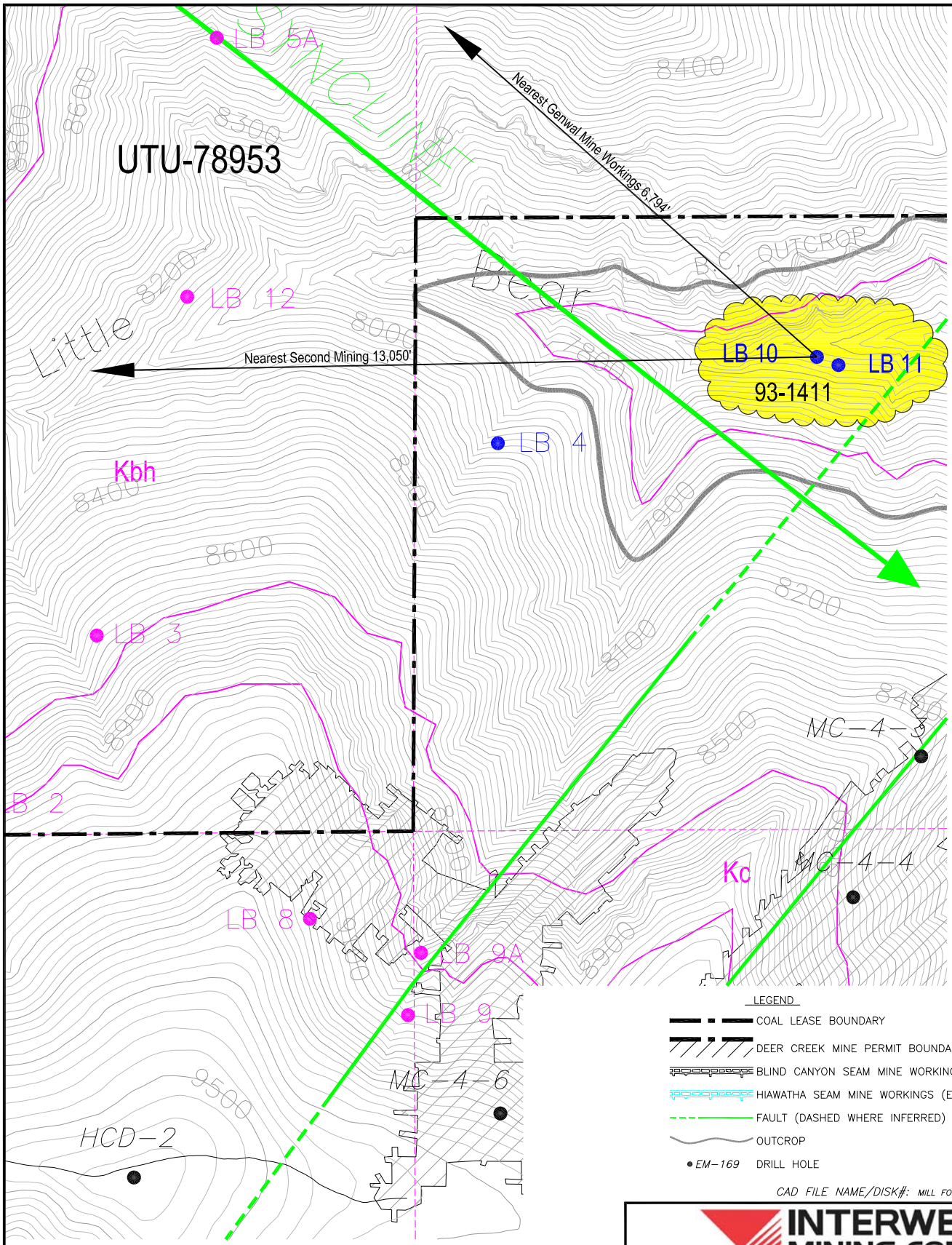
Lease Association: Little Bear Spring is located 1 ½ mile east of Federal Coal lease UTU-88554. The lease was originally acquired from the State Institutional Trust Lands Administration on April 1, 1999 and designated as ML-48258. State Lease ML-48258 reverted to the Bureau of Land Management on July 11, 2011 and was assigned the lease number of UTU-88554. Both the Hiawatha and Blind Canyon seams have been mined in this lease. Room and pillar mining began in the Hiawatha Seam in December 2003 with the first longwall retreat in August 2003. Blind Canyon seam development began in May 2006 with the first longwall retreat in February 2008. After completion of mining in the Blind Canyon seam, production resumed in the Hiawatha seam with final production occurring on January 7, 2015. No mining occurred in vicinity of Little Bear Spring.

Subsidence: No subsidence has been detected near Little Bear Spring. Nearest second mining is 13,050' west of Little Bear Spring. Little Bear Spring is outside of the subsided area.

For additional data related to subsidence refer to the 2017 Annual Subsidence Report.

Hydrologic Data (Quality and Quantity):

- Quality
  - Historic pre/post mining water quality data is included for spring Little Bear Spring. Date of database query for pre/post mining determination for each spring is based on the date of the nearest mining. Data show no abnormalities in the water quality parameters for this area of East Mountain.
- Quantity
  - Historic flow data has been collected from 1982 and has continued through 2017 by Castle Valley Special Service District. This information is found on the following page where July spring flow is plotted against precipitation data collected from the East Mountain weather station, as well as the Palmer Drought Index for regions 4, and 5. The East Mountain weather station is located on the southern tip of East Mountain.
  - Little Bear Spring is located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo). Flow from spring Little Bear Spring generally ranges from 225 gpm to a maximum of 475 gpm.



SUBSIDENCE LEGEND

- 2'-4' SUBSIDENCE
- 4'-6' SUBSIDENCE
- 6'-8' SUBSIDENCE
- 8'-10' SUBSIDENCE
- 10'-12' SUBSIDENCE
- 12'-14' SUBSIDENCE
- 14'-16' SUBSIDENCE
- 16'-18' SUBSIDENCE

LEGEND

- COAL LEASE BOUNDARY
- DEER CREEK MINE PERMIT BOUNDARY
- BLIND CANYON SEAM MINE WORKINGS (EXISTING)
- HIAWATHA SEAM MINE WORKINGS (EXISTING)
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- EM-169 DRILL HOLE

SPRING LEGEND

- MFB02 SURFACE WATER MONITORING LOCATION
- SPRING LOCATAION (1994-1995 SURVEY)
- GPS LOCATED 2000
- GPS LOCATED 2001
- GPS LOCATED 2002
- GPS LOCATED 2010-2011
- SPRING LOCATION (1992 SURVEY)
- SPRING MONITORING LOCATION (ENERGY WEST)
- 93-2139 GROUND WATER RIGHTS
- 93-198 SURFACE WATER RIGHTS
- SPRING LOCATION (1991 SURVEY)
- SPRING LOCATION (1989-1990 SURVEY)
- SPRING LOCATION (1987 SURVEY
- SPRING LOCATION (1985 SURVEY)
- MONITORING LOCATIONS (GENWAL RESOURCES)

N

CAD FILE NAME/DISK#: MILL FORK LEASE SPRING MAPS WITH LEGEND

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY - DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-88554
MILL FORK SPRINGS DETAILED SUBSIDENCE DATA

DRAWN BY:	K. LARSEN	MAP 10	
SCALE:	1"=600'	DRAWING #:	
DATE:	MAY 7, 2018	SHEET 10 OF 10	REV. ___

Geologic Mode of Occurrence for spring Little Bear Spring:

- Multiple potential recharge sources have been identified; south: fracturing related to the Mill Fork Graben, west: fractures - Little Bear Canyon, north: fractures - Huntington Creek Drainage.
- Geologic Formation: Blackhawk Formation (refer to Geologic Occurrence sheet).
- Stratigraphic Position: At base.

Justification for removal from monitoring: Little Bear Spring has been monitored by Castle Valley Special Service District since 1982 and by PacifiCorp since 2000. There have been no reported occurrences in which mining has impacted this site. Historic quality and quantity data have not indicated such impacts to the site.

All mining activities in Lease UTU-88554 and adjacent Federal Lease UTU-84285 ceased as of January 7, 2015. Deer Creek Mine portals were sealed April 17, 2015 as a facet of the Deer Creek mine closure process. All mining equipment including the mine dewatering system was removed from the mine prior to sealing. Withdrawal of all mining equipment inby the parallel plug locations commenced upon completion of mining PacifiCorp coordinated removal of the mining equipment, including conducting environmental inspections, with the subsurface management agency and State of Utah regulators. A double redundant French drain system (two separate well screen intake setups installed in two separate portals) was installed in the two lowest elevation portals at the Deer Creek Mine site to allow for a permanent post mine gravity discharge of groundwater from the southern portion of the mine. The remaining Rilda Canyon portion was left open while implementing mitigation measures to handle anticipated intercepted groundwater. Final sealing of the Rilda Canyon 1st Right portals consisted of first constructing a water drainage system including an in-mine collection gallery together with the construction and permanent placement of a water pipeline from Rilda Canyon 1st Right to the Huntington Power Plant raw water pond. The pipeline project was completed in November 2017. The final Rilda Canyon 1st Right portal sealing consisted of two 25-foot thick concrete portal plugs with water drains, one each in the 1st Right facility fan and roadway portals, that were constructed on November 8 and 10, 2017, and high strength panel seals, one each in the Left Fork facility fan and roadway portals completed on December 18 and December 20, 2017. The portal seals were constructed to meet or exceed regulatory requirements of 30CFR 75.1711. With the completion of the Rilda Canyon Left Fork Portals seals, final abandonment and closure of the Deer Creek Mine has been concluded. PacifiCorp will commence with final reclamation activities of the entire Deer Creek Mine complex per the approved reclamation plan.

With the completion of three years of hydrologic monitoring after the last date of mining, PacifiCorp formally requests that site Little Bear Spring be removed from the monitoring program.

EAST MOUNTAIN

MILL FORK SPRING & SEEP SURVEY

GEOLOGIC OCCURRENCE

Spring Name/Number: **Little Bear Spring**

Location		From Section Corner	Section	Township	Range	Elevation (above mean sea level)
Feet	Feet					
2028' N.	1726' E	SW	9	16S	6E	7540

Geologic Formation	*Development*	*Water Right*	*Stratigraphic Position*
Star Point Sandstone Panther Member	Developed With Collection Boxes & Pipeline	93-1411	near base

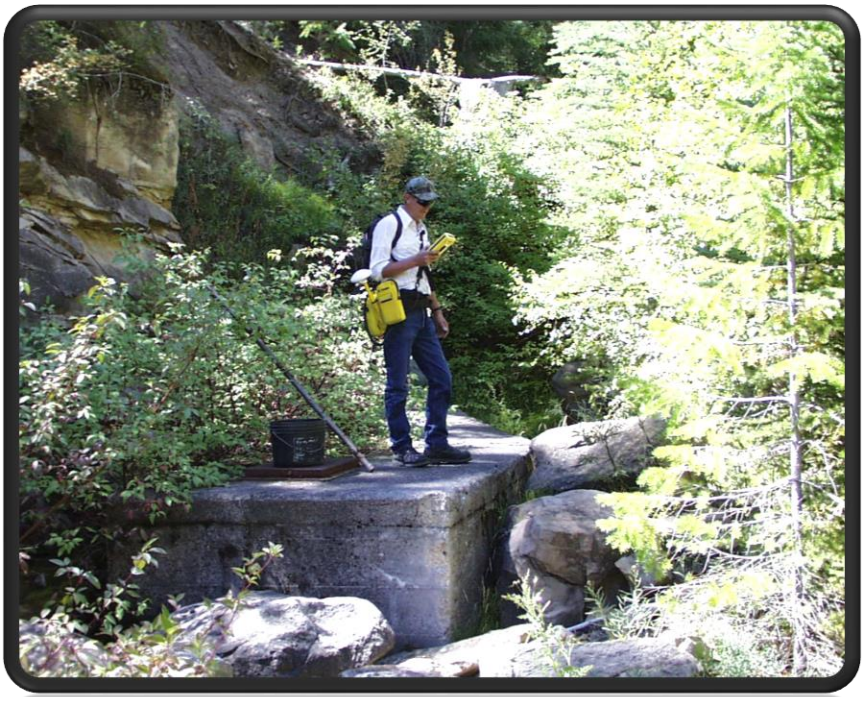
Location Comments: Spring located on the south slope of Little Bear Canyon. Main culinary supply to CVSSD (Cities of Huntington, Cleveland and Elmo).

Probable Recharge Area: Multiple potential recharge sources have been identified; south: fracturing related to the Mill Fork Graben, west: fractures - Little Bear Canyon, north: fractures - Huntington Creek Drainage

Relationship to Adjacent Springs: This spring is not related to other springs within the immediate area.

Geologic Occurrence of Spring:

Water flowing through fractures in the lower section of the Star Point Sandstone (Panther Member) intersects the surface.

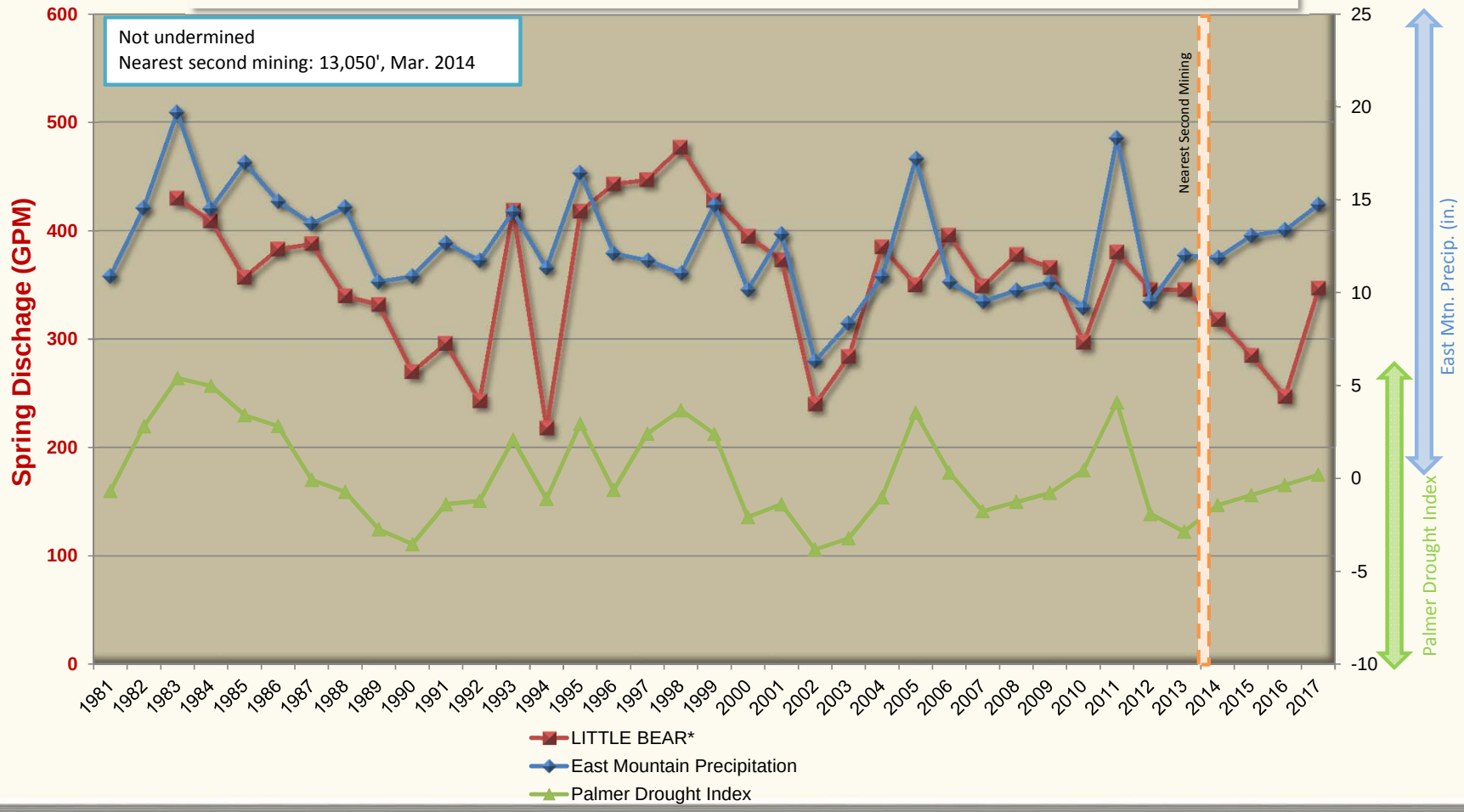


Little Bear Collection System

Little Bear Collection System

EAST MOUNTAIN SPRINGS - MILL FORK SPRING: LITTLE BEAR SPRING vs. PRECIPITATION

PEAK FLOW (JULY) vs. EAST MOUNTAIN WEATHER STATION AND PALMER DROUGHT INDEX



East Mountain Spring: Little Bear
Water Quality Data: Operational
Mine Association: Deer Creek Mine - Mill Fork
Date of Development: Not undermined
Date of Second Mining: Not undermined
Location of Nearest Mining: 13,050'
Date of Nearest Mining: Mar. 2014

	Pre-Mining Data: 20000101 THROUGH 20140228				Post-Mining Data: 20140301 THROUGH 20171231				
PARAMETER	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	MAXIMUM	MINIMUM	AVERAGE	# ANALYSIS	
BICARBONATE	354	265	284.523	21	290	265	277.25	8	BICARBONATE
CALCIUM	68.85	63.45	66.4838	21	67.46	60.63	63.78	8	CALCIUM
CARBONATE	0	0	0	10	0	0	0	8	CARBONATE
CHLORIDE	6	3	3.95238	21	9	3	4.25	8	CHLORIDE
CONDUCTIVITY	650	559	592.142	21	596	526	576.625	8	CONDUCTIVITY
DISSOLVED OXYGEN	0				0				DISSOLVED OXYGEN
FLOW	387	270	338.1	14	347	247	294.625	8	FLOW
HARDNESS	330	294	315.571	21	321	293	306.5	8	HARDNESS
TOTAL IRON	0.21	0	2.66153	13	0.27	0	0.04625	8	TOTAL IRON
DISSOLVED IRON	0.006	0	5.45454	11	0	0	0	8	DISSOLVED IRON
MAGNESIUM	38.5	32.91	36.2995	21	38.17	33.28	35.75	8	MAGNESIUM
DISSOLVED MANGANESE	0.003	0	0.0003	10	0.008	0	0.00225	8	DISSOLVED MANGANESE
MANGANESE	0.007	0	6.36363	11	0	0	0	8	MANGANESE
OIL AND GREASE	0				0				OIL AND GREASE
PH	7.68	7.04	7.4138	21	7.67	7.39	7.50375	8	PH
POTASSIUM	3.4	1.36	1.65619	21	2.1	1.37	1.58125	8	POTASSIUM
SET SOLIDS	0				0				SET SOLIDS
SODIUM	11.2	6.41	7.29238	21	9.91	7.57	8.83875	8	SODIUM
SULFATE	41	31	36.9047	21	44	38	41.625	8	SULFATE
SUSPENDED SOLIDS	0				0				SUSPENDED SOLIDS
TEMPERATURE	10.6	5.4	9.07	20	10.1	8.3	9.2125	8	TEMPERATURE
TOTAL DISSOLVED SOLIDS	356	298	324.523	21	383	311	335.625	8	TOTAL DISSOLVED SOLIDS

Deer Creek Mine
Federal Coal Lease UTU-84285 Full Lease Relinquishment
Appendix D

Evaluation of Impacts to Vegetation

Vegetation of Lease UTU-84285 is diverse, ranging from sagebrush, pinyon – juniper to brush, with groves of aspen trees and spruce - fir. A breakdown of vegetation type in the relinquishment area is shown below (mid-level vegetation provided by the Manti-LaSal National Forest Price Office):

Vegetation Types – UTU-84285:

Aspen	AS
Aspen/Conifer	AS/C
Riparian Woody	RW
Spruce/Fir	SF

Previous relinquishment documents submitted by PacifiCorp have included comparative sets of periodic infrared aerial photographs to detect changes in vegetation that might be related to mining. Until 2011, PacifiCorp had submitted aerial photographs on 1-year intervals and color infrared photographs on 5-year intervals. PacifiCorp attempted to detect changes in vegetation that might be caused by mining using both the color and color infrared images without success. The inability to detect changes in vegetation that might be caused by mining is due to several factors – spreading insect infestations in forests, forest fires, variation in precipitation from year to year, variations in the time of year when each set of photographs is taken, and the quality of the photographs themselves. These factors make it difficult or impossible to detect any changes that might be caused by mining activities. PacifiCorp amended the Deer Creek Mine permit to exclude this requirement in 2011; UDOGM approved the amendment on July 28, 2011 (see following correspondence and permit changes).

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

P.O. Box 310
15 North Main Street
Huntington, Utah 84528

July 7, 2011

Utah Division of Oil, Gas, and Mining
Utah Coal Program
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Subj: **Amendment to Remove the Commitment to Conduct Periodic Vegetation Surveys using Color and Color Infrared Aerial Photographs, Pacificorp, Deer Creek Mine, C/015/0018, Emery County, Utah**

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company ("Energy West") as mine operator, hereby submits an amendment to remove the commitment to conduct periodic vegetation surveys using color and color infrared photographs from the Deer Creek Mine Permit. Submission of this amendment is in response to the 2010 Annual Report Review Completion, Task ID #3793, requesting submission of aerial photography for vegetation monitoring purposes.

Energy West has had aerial photographs taken of the active mining areas in black and white every year, and color and color infrared every 5 years. Energy West has attempted to detect changes in vegetation that might be caused by mining by interpreting these sets of photographs without success. The inability to detect changes in vegetation that might be caused by mining using color and color infrared images is due to several factors - spreading insect infestations in forest stands, variations in precipitation from year to year, variations in the time of year when the photographs are taken, and the quality of the photographs themselves. These factors make it difficult or impossible to detect any changes that might be caused by mining activities. Aerial photography, whether color or color infrared, will no longer be used for this purpose.

This amendment includes changes in Volume 1 as outlined below. Please refer to redline/strikeout text herein:

- Volume 1, Part 2 Environmental Resources, page 2-174

A redline/strike copy of the amended page has been included with this submittal. The required C1/C2 forms are also included. If you have any question or concern with this submittal please feel free to call myself at (435) 687-4712 or Dennis Oakley at (435) 687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Manager of Geology and Environmental Affairs

Enclosures: C1/C2 Forms
Volume 1, Part 2 Environmental Resources, page 2-174

cc file

VEGETATION MONITORING PLAN - DEER CREEK MINE R645-301-321

The purpose of this monitoring plan is to define and establish a system to locate, measure, and quantify the progressive or regressive impacts ~~and final effects of the underground mining activities~~ on vegetation at the Deer Creek mine ~~on vegetation~~. The monitoring system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points located on surface areas ~~that will be impacted by underground mining~~. The monitoring shall be an extension of the baseline data as outlined in the Deer Creek PAP Volume 1.

Aerial photography taken annually up to present (2009) ~~will be~~ has been used for delineation of vegetative types, documentation of changes in vegetation and detection and monitoring of stressed vegetation. There has been no detected stress or any other impacts to vegetation using aerial photography.

Because stress to vegetation within the permit area is so much more subject to the natural forces in nature, (fire, insect infestation, drought, etc.) aerial photography will no longer be used.

~~Infrared photography was taken of impacted surface areas during September, 1987. This will be repeated in 1992 and continued on a five year schedule.~~ Reference area qualitative and quantitative monitoring at the Deer Creek Mine has been conducted at least on five year intervals in the past. Qualitative and quantitative monitoring was last conducted in 2007 and will continue on five year intervals through mine through reclamation and bond release.

~~Each vegetation type mapped and monitored will be based on a~~

~~dominant overstory and a dominant understory species to be consistent with Uinta Southwestern Coal Region Data Adequacy Standards. The details of monitoring and analyses will be developed in cooperation with the US Forest Service.~~

The vegetation monitoring information for reference areas and reclamation sites ~~and an~~ will be evaluat~~ion~~ed ~~of the impacts of mining on vegetation will be~~ and submitted in an annual report following the year in which monitoring is conducted.

SOILS INFORMATION R645-301-200

Portal and support facility areas for the Deer Creek Mine are cut into steep, nearly perpendicular rock cliffs. The areas are dominated by rock outcrop, rubble land, and shallow soils.

Nowhere in the vicinity of the mine is there a source of material which would usually be referred to as "topsoil". Soil tests on the disturbed and undisturbed areas and coal waste show that the materials in the portal area should support selected vegetative materials. These test results, therefore, preclude the recommendation for procurement of topsoil for reclamation since the exposed materials are suitable growth media if properly managed. The one exception is that if during mining operations toxic substances are concentrated, it will be necessary to sample these areas periodically and take the necessary reclamation measures to dispose of or cover the areas in order to assure success of revegetation attempts. Results of soil analyses are summarized in Part 4, Reclamation Plan.

The applicant commits to fulfilling the requirements of

GARY R. HERBERT
Governor
GREGORY S. BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
MICHAEL R. STYLER
Executive Director
Division of Oil, Gas and Mining
JOHN R. BAZA
Division Director

July 28, 2011

Kenneth S. Fleck, Geology and Environmental Affairs Manager
Energy West Mining Company
P.O. Box 310
Huntington, Utah 84528

Subject: Final Approval, Deer Creek Mine, C/015/0018, Remove Vegetation Survey Commitment, Task ID #3869

Dear Mr. Fleck:

The above-referenced amendment was conditionally approved on July 21, 2011 upon receipt of 8 clean copies. We received the requested clean copies on July 28, 2011. Enclosed is a stamped incorporated copy for insertion into your copy of the Mining and Reclamation Plan.

Thank you for your help during this process. If you have any questions, please feel free to call me at (801) 538-5325.

Sincerely,

Daron R. Haddock
Coal Program Manager

DRH/sqs
Enclosure
cc: Kenneth Walker, OSM
Jeff McKenzie, BLM
Pam Brown, USFS
Larry Crist, USFWS w/o
Marc Stilson, Water Rights w/o
Dave Ariotti, DEQ w/o
Chris Wood, DWR w/o
Kevin Carter, TLA w/o
Price Field Office
O:\015018.DER\WG3869\FinApp.doc

1594 West North Temple, Suite 1210, PO Box 145801, Salt Lake City, UT 84114 -5801
telephone (801) 538-5340 • facsimile (801) 359-3940 • TTY (801) 538-7458 • www.ogm.utah.gov

UTAH DNR OIL, GAS & MINING

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

P.O. Box 310
15 North Main Street
Huntington, Utah 84528

July 27, 2011

Utah Coal Program
Utah Division of Oil, Gas, and Mining
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Subj: Clean Copy Submittal for Task ID #3869, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company "Energy West" as mine operator, hereby submits the clean copies to the above approved amendment to update the Deer Creek Mine Mining and Reclamation Plan.

Actions to finalize this amendment include removing and/or replacing the noted pages. As noted above, all clean copy pages are included with this submittal. After stamping "Approved" on the clean copy pages, the Division needs to complete the following:

- Volume 1: Replace Page 2-174

Eight (8) complete clean copies of this amendment are submitted for Division certification. A C2 form is included for organization of removal or replacement of items into the Deer Creek MRP. If you have any questions concerning this amendment, please contact myself at 435-687-4712 or Dennis Oakley at 435-687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Geology and Environmental Affairs Manager

Cc: file

VEGETATION MONITORING PLAN - DEER CREEK MINE R645-301-321

The purpose of this monitoring plan is to define and establish a system to locate, measure, and quantify the progressive or regressive impacts on vegetation at the Deer Creek mine. The monitoring system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points located on surface areas. The monitoring shall be an extension of the baseline data as outlined in the Deer Creek PAP Volume 1.

Aerial photography taken annually up to present (2009) has been used for delineation of vegetative types, documentation of changes in vegetation and detection and monitoring of stressed vegetation. There has been no detected stress or any other impacts to vegetation using aerial photography.

Because stress to vegetation within the permit area is so much more subject to the natural forces in nature, (fire, insect infestation, drought, etc.) aerial photography will no longer be used.

Reference area qualitative and quantitative monitoring at the Deer Creek Mine has been conducted at least on five year intervals in the past. Qualitative and quantitative monitoring was last conducted in 2007 and will continue on five year intervals through mine through reclamation and bond release.

The vegetation monitoring information for reference areas and reclamation sites will be evaluated and submitted in an annual report following the year in which monitoring is conducted.

SOILS INFORMATION R645-301-200

Portal and support facility areas for the Deer Creek Mine are cut into steep, nearly perpendicular rock cliffs. The areas are

INCORPORATED
JUL 28 2011
Div. of Oil, Gas & Mining

Replaced

VEGETATION MONITORING PLAN - DEER CREEK MINE R645-301-321

The purpose of this monitoring plan is to define and establish a system to locate, measure, and quantify the progressive and final effects of the underground mining activities at the Deer Creek mine on vegetation. The monitoring system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points located on surface areas that will be impacted by underground mining. The monitoring shall be an extension of the baseline data as outlined in the Deer Creek PAP Volume 1.

Aerial photography taken annually will be used for delineation of vegetative types, documentation of changes in vegetation and detection and monitoring of stressed vegetation.

Infrared photography was taken of impacted surface areas during September, 1987. This will be repeated in 1992 and continued on a five year schedule.

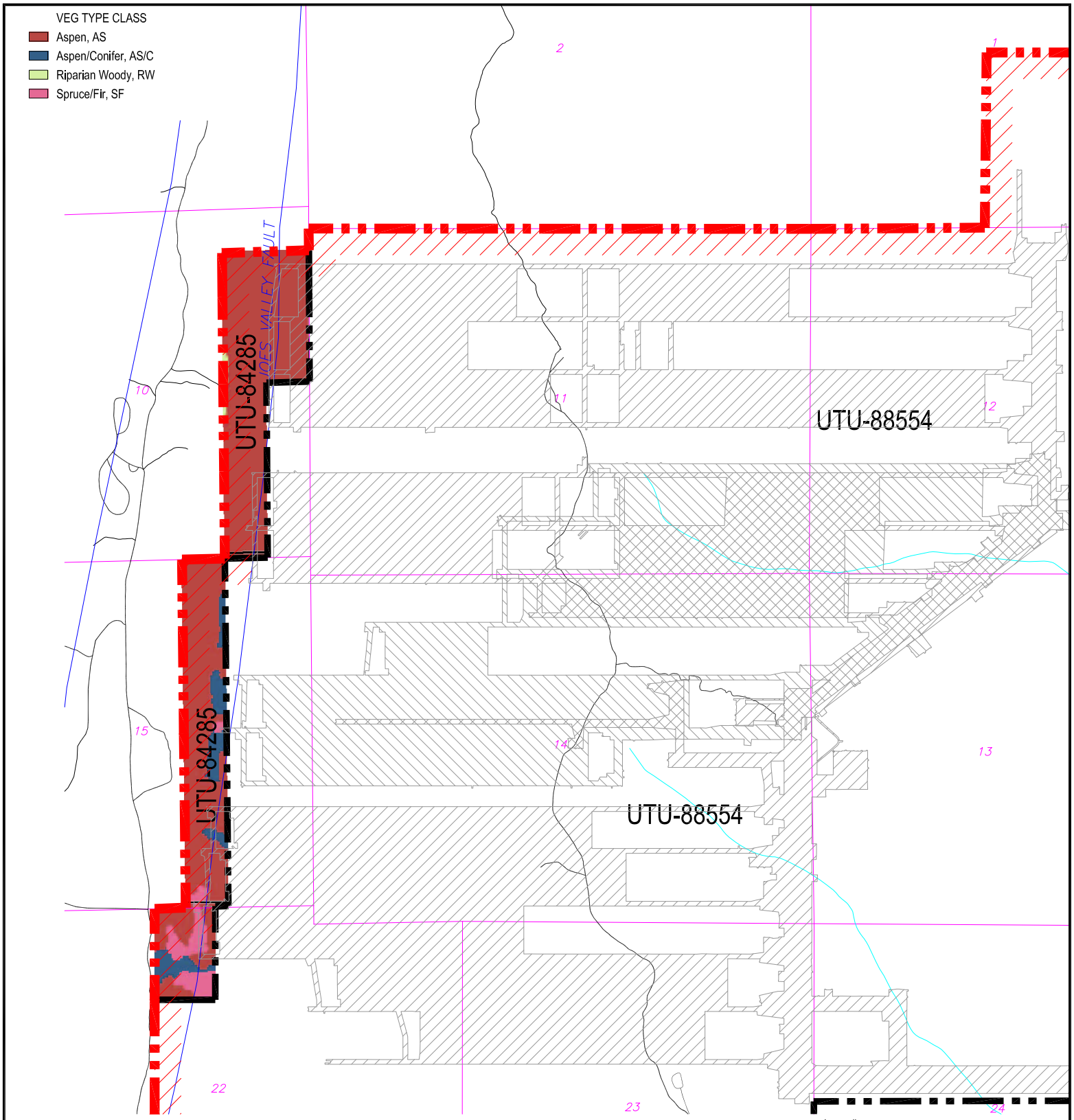
Each vegetation type mapped and monitored will be based on a dominant overstory and a dominant understory species to be consistent with Unita-Southwestern Coal Region Data Adequacy Standards. The details of monitoring and analyses will be developed in cooperation with the US Forest Service.

The vegetation monitoring information and an evaluation of the impacts of mining on vegetation will be submitted in an annual report following the year in which monitoring is conducted.

SOILS INFORMATION R645-301-200

Portal and support facility areas for the Deer Creek Mine are cut into steep, nearly perpendicular rock cliffs. The areas are

Based on PacifiCorp's observations, no mining-related impacts to vegetation have been witnessed observed or reported in the UTU-84285 area. There were no surface facilities or installations on this lease.



CAD FILE NAME/DISK#: UTU-84285

LEGEND

- LMU BOUNDARY UTU-73336
- COAL OUTCROP
- HIAWATHA SEAM MINE WORKINGS
- BLIND CANYON SEAM MINE WORKINGS
- FAULTS
- UTU-84285 FEDERAL LEASE NUMBER
- FEDERAL LEASE LINE
- ROADS
- DRAINAGE

N

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY – DEER CREEK MINE
FEDERAL COAL LEASE RELINQUISHMENT UTU-84285
VEGETATION BASE MAP

DRAWN BY: K. LARSEN	APPENDIX D	
SCALE: 1" =2000'	DRAWING #:	
DATE: APRIL 23, 2018	SHEET 1 OF 1	REV. ___

Deer Creek Mine
Federal Coal Lease UTU-84285 Full Lease Relinquishment
Appendix E

Evaluation of Impacts to Private Improvements

There is one private surface improvement in Lease UTU-84285. This is the 345 KV power transmission line that crosses the southwest corner of the lease. It is owned by PacifiCorp / Rocky Mountain Power. Two separate studies of the potential subsidence beneath this line were conducted in 1997 and 2004. The power line crosses the southwest corner of the lease. The 345 KV power line was not undermined within Lease UTU-84285 (see map in Appendix B).

To the best of the knowledge of the lessee through due inquiry including reconnaissance flights, subsidence surveys and periodic surface topography inspections, there are no mining-related impacts associated with the Deer Creek Mine to any private surface improvements on the lease area being relinquished.

Appendix "F"

ENVIRONMENTAL AND CERCLA CERTIFICATION

CERCLA certification documents for sealing various districts of panels within the UTU-84285 lease have been submitted when those districts were sealed. Previous CERCLA inspections within UTU-84285 have taken place in March 2008, January 2012, and October 2014. These inspections covered all areas of mining that took place within the UTU-84285 lease and the areas were approved for sealing.

On November 29, 2017, a hazardous/toxic waste inspection was conducted underground at Deer Creek Mine to clear the remaining open areas of the mine for permanent sealing. Full documentation of this inspection is included.

ENVIRONMENTAL AND CERCLA CERTIFICATION

Submittal Date: 5-29-2018

Lease(s) # UTU-84285 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) 2nd Left, 14th – 17th West, 22nd -27th West, and Remainder of Mine Workings

Coal Bed: Blind Canyon and Hiawatha Coal Seams

The Environmental Protection Agency promulgated final regulations to implement requirements established in Section 120(h) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by Superfund Amendments Reauthorization Act (SARA). Under section 120(h), whenever a Federal agency enters into any contract/agreement for the sale or transfer of public land/real property, and on which any hazardous substance was stored for one year or more, or known to have been released or disposed of, the contract (conveyance document) must include notice of the type and quantity of such hazardous substance, and the time at which such storage, release or disposal was originated. This final rule making became effective October 17, 1990.

Federal coal leases, if developed, result in the operator conducting mining operations on all or parts of the Federal lands. The lessee/operator, under appropriate circumstances, may utilize hazardous substances on the surface or underground on Federal lands. At the time of lease relinquishment, or at the time of any sealing or potentially sealing operation conducted by a Federal lessee, it is necessary for the lessee to inform the BLM and any other surface managing agency of any activities of a lessee that might be subject to CERCLA notification. This information will be utilized to satisfy the requirements under Section 120(h) of CERCLA as amended by SARA.

BLM requires the following information to the extent it is applicable to the Federal coal lease relinquishment area, area or any time that a mining operation seals or places structures possibly sealing an area. BLM will make the company proprietary information public only upon transfer or exchange of the affected lands.

Explanation:
Items 1-5 deal with hazardous substances and environmental issues. Item 6 is a CERCLA certification by an officer of the lessee. Suggested formats follow.

Required Information:

1. A list of any hazardous substances as defined in SARA Title III Consolidated List (40 CER 302.4) used on the lease (by date) or products that contain such substances. This shall include all hazardous substances and materials along with their Chemical Abstract Services Registry Numbers (CASRN), and petroleum based oil and other petroleum products that were used, stored or delivered to the lease. Quantities at this time are not necessary. This is for disclosure purposes only.

2. A copy of all reports of spills occurring on the lease or sealed area.

3. A copy of all reports submitted to the State of Utah listing any spill of petroleum based oil or other petroleum products on the lease exceeding 25 gallons or that cause a threat to human health or the environment.

4. A mine map covering the lease showing the location, type and model of any equipment or machinery that is known to be remaining underground. (this does not include materials and supplies, and hand tools). For every piece of equipment that will be left underground upon lease cessation of operations, please list the quantities of oil, batteries, or other fluids that are remaining, or could be remaining in the equipment.

5. A summary analysis of water quality reports showing whether or not the water quality has been affected by mining. The data that has been collected throughout the years should be the basis for this summary report. The UPDES/NPDES discharge permit requirements for the mine and copies of certifications or samples to show that these requirements have not been exceeded should be part of this analysis. The analysis should compare the water quality at the time of cessation of operations with the water quality that existed prior to mining in the base line analysis. This shall be for all waters that are affected by mining. The company should list any mitigation that was done to alleviate any water quality concerns.

6. An officer of the lessee shall sign and submit a certificate in the form attached for each lease or portion thereof where operations have ceased.

a. Based upon a complete search of all known records of the lessee(s), sublessee(s) and operator(s) (i) for the specified lease or portion thereof relinquished, operations ceased or sealed and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed; and upon our knowledge of past operations, there have been no reportable quantities of hazardous substances (per 40 CFR 302.4) and Part 373 or used oil (per Utah State Management Rule R-3 15-15), deposited or released within the lease, either on the surface or underground that will harm human health and the environment with respect to any such substances remaining on the property.

b. Based upon a complete search of all known records for the lessee(s), sublessee(s) and operator(s) for the specified lease or portion thereof relinquished, operations ceased or sealed and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed; and upon our knowledge of past operations, there has been a release or disposal of a reportable quantity of **hazardous substance** (per 40 CFR 302.4) and Part 373 or **used oil** (per Utah State Management Rule R-315-15) on the surface of the lease or underground, and all remedial action necessary has been taken to protect human health ~ and the environment with respect to any such substances remaining on the property. This shall be documented with sample analytical data from the remediation or removal process.

(Officer of the Lessee) (Date) 5/29/18

HAZARDOUS SUBSTANCE REPORT

Submittal Date: 5-29-2018

Lease(s) # UTU-84285 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) 2nd Left, 14th – 17th West, 22nd -27th West, and Remainder of Mine Workings

Coal Bed Blind Canyon and Hiawatha Coal Seams

Hazardous Substance / Product	**Date Utilized**	**CASRN** (if applicable)	**Location Used** (Cross-cut if known)
None Spilled -			
See Attached CASRN List			

Hazardous Substance Report CERCLA Page One of Two
Lease(s) UTU-84285
Deer Creek Mine - MSHA # 42-00121
Sealed Mine Sections: 2nd Left, 14th - 17th West, 22nd - 27th West, and remainder of mine workings

Coal Bed Hiawatha Seam

Note: While these substances were likely transported into, used, or stored in the referenced leases during the time interval shown, (03/06 - 04/15) there are no reports or evidence that any of these substances were spilled or left within the sealed area. No complete list exists that shows all hazardous materials transported into, used, or stored within the referenced area.

Product Name	Date Utilized	Hazardous Ingredient Name	Component Percentage	CASRN	Location Used
D Cell Nickel Cadmium Battery, 4.8 VDC	3/06 - 4/15	Nickel and Nickel Hydroxide	20 - 32%	Unknown	All Sections
	3/06 - 4/15	Cadmium and Cadmium Hydroxide	13 - 22%	Unknown	All Sections
	3/06 - 4/15	Sodium Hydroxide	0 - 4%	Unknown	All Sections
	3/06 - 4/15	Potassium Hydroxide	0 - 4%	Unknown	All Sections
	3/06 - 4/15	Cobalt Hydroxide	0.5 - 2%	Unknown	All Sections
Chevron Superla White Oil	3/06 - 4/15	White Mineral Oil	100%	8042-47-5	All Sections
Blaster PB Penetrating Catalyst	3/06 - 4/15	Naptha	40 - 50%	64742-94-5	All Sections
	3/06 - 4/15	Petroleum Distillates, hydrotreated	30 - 40%	64742-47-8	All Sections
	3/06 - 4/15	Petroleum Distillates, solvent-dewaxed	20 - 30%	64742-65-0	All Sections
	3/06 - 4/15	Alcohols, C11-15 secondary ethoxylated	0 - 3%	68131408	All Sections
	3/06 - 4/15	Carbon Dioxide Propellant	0 - 3%	124389	All Sections
Krylon Spray Paints	3/06 - 4/15	Propane	14%	74-98-6	All Sections
	3/06 - 4/15	Butane	13%	106-97-8	All Sections
	3/06 - 4/15	Toluene	17%	108-88-3	All Sections
	3/06 - 4/15	Medium Aromatic Hydrocarbons	3%	64742-94-5	All Sections
	3/06 - 4/15	Napthalene	0.40%	91-20-3	All Sections
	3/06 - 4/15	Acetone	41%	67-64-1	All Sections
	3/06 - 4/15	Ethyl 3-Ethoxypropionate	4%	763-69-9	All Sections
Hand Cleaner, Brody Chemical	3/06 - 4/15	Aliphatic Petroleum Distillate	25 - 35%	64742-96-7	All Sections
RD-90 Spray Lubricant	3/06 - 4/15	Petroleum Lube Oil	10 - 20%	64742-65-0	All Sections
	3/06 - 4/15	Deodorized Kerosene	30 - 40%	64742-47-8	All Sections
	3/06 - 4/15	Mineral Oil	20 - 25%	8042-47-5	All Sections
	3/06 - 4/15	Mineral Spirits	5 - 10%	64741-65-7	All Sections
	3/06 - 4/15	Liquified Petroleum Gas	10 - 20%	68476-85-7	All Sections
Extreme Blue Windshield Washer Fluid	3/06 - 4/15	Methanol	<20%	67-56-1	All Sections
	3/06 - 4/15	Denatonium Benzoate	<2%	3734-33-6	All Sections
Carquest Starting Fluid	3/06 - 4/15	Heptane	69 - 79%	142-82-5	All Sections
	3/06 - 4/15	Ethyl Ether	11 - 21%	60-29-7	All Sections
	3/06 - 4/15	Carbon Dioxide	1 - 11%	124-38-9	All Sections
	3/06 - 4/15	Hexane	2.80%	110-54-3	All Sections
Blend #0019A Premium Starting Fluid	3/06 - 4/15	Heptane	60 - 70%	142-82-5	All Sections
	3/06 - 4/15	Ethyl Ether ACS Reagent Grade	23 - 33%	60-29-7	All Sections
	3/06 - 4/15	Carbon Dioxide	1 - 11%	124-38-9	All Sections
Diesel Engine Oil	3/06 - 4/15	Zinc Dithiophosphate	<2.5%	68649-42-3	All Sections
Cat Hydraulic Oil SAE 10W	3/06 - 4/15	None			All Sections
Cat Transmission and Drive Train Oil	3/06 - 4/15	None			All Sections
Solcenic 3B-BLK (Emulsion Oil)	3/06 - 4/15	Monoethanolamine	<10%	141-41-3	All Sections
	3/06 - 4/15	Triethanolamine	<5%	102-71-6	All Sections
Chevron Delo 400	3/06 - 4/15	Mineral Oil	70 - 95%	Mixture	All Sections
	3/06 - 4/15	Zinc alkyl dithiophosphate	1 - 5%	68649-42-3	All Sections
Conoco HD Fleet Engine Oil	3/06 - 4/15	Lubricant base oil	87 - 91%	Various	All Sections
	3/06 - 4/15	Zinc Compounds	1.0 - 1.5%	Proprietary	All Sections
	3/06 - 4/15	Additives	9 - 13%	Proprietary	All Sections
Conoco Transformer Oil	3/06 - 4/15	Hydrotreated dist., Lt. Napthenic	>99%	64742-53-6	All Sections
	3/06 - 4/15	Additives	<1%	Proprietary	All Sections
Contact Cleaner 2000	3/06 - 4/15	Decafluoropentane (HFC-43-10mee)	5 - 15%	138495-42-8	All Sections
	3/06 - 4/15	Cozol 401	80 - 95%	Proprietary Blend	All Sections
	3/06 - 4/15	Carbon Dioxide	3 - 8%	124-38-9	All Sections
Heavy Duty Degreaser	3/06 - 4/15	Trichloroethylene	95 - 99%	79-01-6	All Sections
	3/06 - 4/15	1,2 Butylene Oxide	0.50%	106-88-7	All Sections
	3/06 - 4/15	Carbon Dioxide	1 - 5%	124-38-9	All Sections
Shellzone All-Season Antifreeze/Coolant	3/06 - 4/15	Ethylene Glycol	90 - 98%	107-21-1	All Sections
	3/06 - 4/15	Deionized Water	1 - 3%	7732-18-5	All Sections
	3/06 - 4/15	Phosphoric Acid	1 - 3%	7664-38-2	All Sections

Hazardous Substance Report CERCLA Page Two of Two
Lease(s) UTU-84285
Deer Creek Mine - MSHA # 42-00121
Sealed Mine Sections: 2nd Left, 14th - 17th West, 22nd - 27th West, and remainder of mine workings

Coal Bed Hiawatha Seam

Note: While these substances were likely transported into, used, or stored in the referenced leases during the time interval shown, (11/05 - 01/15) there are no reports or evidence that any of these substances were spilled or left within the sealed area. No complete list exists that shows all hazardous materials transported into, used, or stored within the referenced area.

Product Name	Date Utilized	Hazardous Ingredient Name	Component Percentage	CASRN	Location Used
Holcim Portland Cement	3/06 - 4/15	Tri-calcium silicate	20 - 70%	12168-85-3	All Sections
	3/06 - 4/15	Di-calcium silicate	10 - 60%	10034-77-2	All Sections
	3/06 - 4/15	Tetra-calcium-alumino-ferrite	5 - 15%	12068-35-8	All Sections
	3/06 - 4/15	Calcium sulfate	2 - 10%		All Sections
	3/06 - 4/15	Tri-calcium aluminate	1 - 15%	12042-78-3	All Sections
	3/06 - 4/15	Magnesium oxide	0 - 4%	1309-48-4	All Sections
	3/06 - 4/15	Crystalline silica (quartz)	0 - 1%	14808-60-7	All Sections
	3/06 - 4/15	Hexivalent chromium		18540-29-9	All Sections
Shot-Set 250 Liquid Accelerator	3/06 - 4/15	Silicic Acid, Sodium Salt	1%	1344-09-S	All Sections
Johnson Controls Lead-Acid Battery	3/06 - 4/15	Lead	34%	7439-92-1	All Sections
	3/06 - 4/15	Lead Dioxide	31%	1309-60-0	All Sections
	3/06 - 4/15	Lead Sulfate	<1%	7446-14-2	All Sections
	3/06 - 4/15	Sulfuric Acid (35%)	34%	7664-93-9	All Sections
Johnsens Heavy Duty DOT 3 Brake Fluid	3/06 - 4/15	Diethylene Glycol Monobutyl Ether	5 - 20%	112-34-5	All Sections
	3/06 - 4/15	Triethylene Glycol	6 - 25%	112-35-6	All Sections
	3/06 - 4/15	Triethelyne Glycol Monoethyl Ether	6 - 25%	112-50-5	All Sections
	3/06 - 4/15	Triethylene Glycol Monobutyl Ether	20 - 39%	143-22-6	All Sections
	3/06 - 4/15	Tetraethylene Glycol Monobutyl Ether	5 - 20%	1559-34-8	All Sections
	3/06 - 4/15	Polyalkylene Glycol Monomethyl Ether	5 - 20%	23783-42-8	All Sections
	3/06 - 4/15	Polyethylene Glycol	5 - 20%	25322-68-3	All Sections
	3/06 - 4/15	Polyethylene glycol monobutyl ether	5 - 20%	9004-77-7	All Sections
	3/06 - 4/15	Polyalkylene Glycols	5 - 20%	9038-95-3	All Sections
	3/06 - 4/15	Diethylene Glycol	5 - 15%	111-46-6	All Sections
	3/06 - 4/15	Diethylene Glycol Monomethyl Ether	<5%	111-90-0	All Sections
Koehler Bright Star Lamp Battery Fluid	3/06 - 4/15	Sulfuric Acid (38%)	100%	7664-93-9	All Sections
Q-Bond Surface Bonding Cement	3/06 - 4/15	Portland Cement		65997-15-1	All Sections
	3/06 - 4/15	Crystalline Silicon Dioxide		13397-24-5	All Sections
	3/06 - 4/15	Calcium Hydroxide		001-305-620	All Sections
	3/06 - 4/15	Calcium Stearate		1592-23-0	All Sections
Roklok 70A	3/06 - 4/15	Polymethylene polyphenyl isocyanate	100%	009016-87-9	15 W
Roklok 70B	3/06 - 4/15	Polyglycols	60 - 100%	Mixture (2)	15 W
	3/06 - 4/15	Dimethylene Glycol	10 - 30%	111-46-6	15 W
Minova Lokset Resin Cartridge	3/06 - 4/15	Calcium Carbonate	60 - 100%	1317-65-3	All Sections
	3/06 - 4/15	Polyester Resin	5 - 15%	Not Reported	All Sections
	3/06 - 4/15	Styrene Monomer	3 - 7%	100-42-5	All Sections
	3/06 - 4/15	Diethylene Glycol	0.5 - 1.5%	57-55-6	All Sections
	3/06 - 4/15	Benzoyl Peroxide	0.5 - 1.5%	94-36-0	All Sections
Foamy Engine Bright Engine Cleaner	3/06 - 4/15	2-Butoxyethanol	2 - 10%	111-76-2	All Sections
	3/06 - 4/15	Aromatic Petroleum Naphtha	2 - 10%	64742-95-6	All Sections
	3/06 - 4/15	Isobutane	2 - 10%	75-28-5	All Sections
	3/06 - 4/15	Petroleum Base Oil	2 - 10%	8008-20-6	All Sections
	3/06 - 4/15	Propane	2 - 10%	74-98-6	All Sections
WD-40 Aerosol	3/06 - 4/15	Aliphatic Hydrocarbon	45 - 50%	64742-47-8	All Sections
	3/06 - 4/15			64742-48-9	All Sections
	3/06 - 4/15			64742-88-7	All Sections
	3/06 - 4/15	Petroleum Base Oil	15 - 25%	64742-65-0	All Sections
	3/06 - 4/15	LVP Aliphatic Hydrocarbon	12 - 18%	64742-47-8	All Sections
	3/06 - 4/15	Carbon Dioxide	2 - 3%	124-38-9	All Sections
Conoco Super Hydraulic Oil (all grades)	3/06 - 4/15	Lubricant base oil	>99	Various	All Sections
	3/06 - 4/15	Additives	<1	Proprietary	All Sections
Conoco Power Tran Fluid	3/06 - 4/15	Lubricant base oil	87 - 91%	Various	All Sections
	3/06 - 4/15	Zinc Compounds	1.0 - 1.5%	Proprietary	All Sections
	3/06 - 4/15	Additives	9 - 13%	Proprietary	All Sections
Powergear EP 5 - 35LB MPL	3/06 - 4/15	Mineral Oil	>95%	Proprietary	All Sections

CERCLA CERTIFICATION

Lease(s) # UTU-84285 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) 2nd Left, 14th – 17th West, 22nd -27th West, and Remainder of Mine Workings

Coal Bed: Blind Canyon and Hiawatha Coal Seams

a. Based upon a complete search of all known records of the lessee(s), sublessee(s) and operator(s) (i) for the specified lease or portion thereof relinquished, sealed or potentially sealed, and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed or potentially sealed; and upon our knowledge of past operations, there have been **no** reportable quantities of **hazardous substances** (per 40 CFR 302.4) and Part 373 or **used oil** (per Utah State Management Rule R-315-15), deposited or released within the lease, either on the surface or underground that will harm human health and the environment with respect to any such substances remaining on the property.

b. Based upon a complete search of all known records for the lessee(s), sublessee(s) and operator(s) for the specified lease or portion thereof relinquished, operations ceased or sealed and (ii) for the operations conducted on the specified lease or portion thereof relinquished, operations ceased or sealed; and upon our knowledge of past operations, there has been a release or disposal of a reportable quantity of **hazardous substance** (per 40 CFR 302.4) and Part 373 or **used oil** (per Utah State Management Rule R-315-15) on the surface of the lease or underground, and all remedial action necessary has been taken to protect human health ~ and the environment with respect to any such substances remaining on the property. This shall be documented with sample analytical data from the remediation or removal process.

D. M R

(Officer of the Lessee)

5/29/18

(Date)

PETROLEUM PRODUCT REPORT

Submittal Date 5-29-2018

Lease(s) #UTU-84285 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) 2nd Left, 14th – 17th West, 22nd -27th West, and Remainder of Mine Workings

Coal Bed Blind Canyon and Hiawatha Coal Seams

Oil or Petroleum product spilled	**Date spilled**	**Amount Spilled** (If > 25 gallons)	**Location Spilled** (Cross-cut if known)
None			

EQUIPMENT REMAINING UNDERGROUND REPORT

Submittal Date: 5-29-2018

Lease(s) # UTU-84285 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) 2nd Left, 14th – 17th West, 22nd -27th West, and Remainder of Mine Workings

Coal Bed Blind Canyon and Hiawatha Coal Seams

Equipment name & model number	**Date Inspected**	**Fluid types/batteries and amount**	**Final location** (Cross-cut if known)
None			

SUMMARY WATER ANALYSIS REPORT

Lease(s) # UTU-84285 Full Relinquishment

Mine Name and MSHA Mine # Deer Creek Mine #42-00121

Mine Section (if applicable) 2nd Left, 14th – 17th West, 22nd -27th West, and Remainder of Mine Workings

Coal Bed Blind Canyon and Hiawatha Coal Seams

Dates: 1/1980 – 05/18 (No Mine Discharge after 01/15)

Submittal Date: 5-29-2018

SUMMARY WATER ANALYSIS REPORT

DEER CREEK MINE

Federal Lease UTU-88554 and UTU-84258
Lease Relinquishment

Mine ID
Utah Pollution Discharge Elimination System (UPDES) Permit Data
- **Quantity - Historical Data**
- **Quality - Historical Data (UPDES Parameters)**
  - **Total Suspended Solids**
  - **Iron (Total & Dissolved)**
  - **Oil & Grease**
  - **Total Dissolved Solids**
  - **Ph**

UPDES Permit Data:

Deer Creek Mine UPDES Permit: UT0023604
Mine Discharge - Site 002
Permit Renewed on February 1, 2015
Permit Expires on January 31, 2020

Permit Limitations (water discharged to Deer Creek Drainage):

Deer Creek Mine Water Discharge Site 002

	Effluent Limitations				Monitoring Requirements	
Effluent Characteristics	**Average 30 - Day**	**Average 7 - Day**	**Daily Minimum**	**Daily Maximum**	**Measurement Frequency**	**Sample Type**
Flow, MGD	5.0 MGD	NA	NA	NA	Monthly	Measured
Total Suspend Solids, mg/l	15	25	NA	NA	Monthly	Grab
Total Iron, mg/l	NA	NA	NA	1.0	Monthly	Grab
Oil & Grease, mg/l	NA	NA	NA	10	Monthly	Grab
TDS, mg/l	NA	NA	NA	1200	Monthly	Grab
pH, Units	NA	NA	6.5	9.0	Monthly	Grab
Sanitary Waste	NA	NA	NA	None	Monthly	Visual
Oil and Grease, floating, visible foam	NA	NA	NA	None	Monthly	Visual

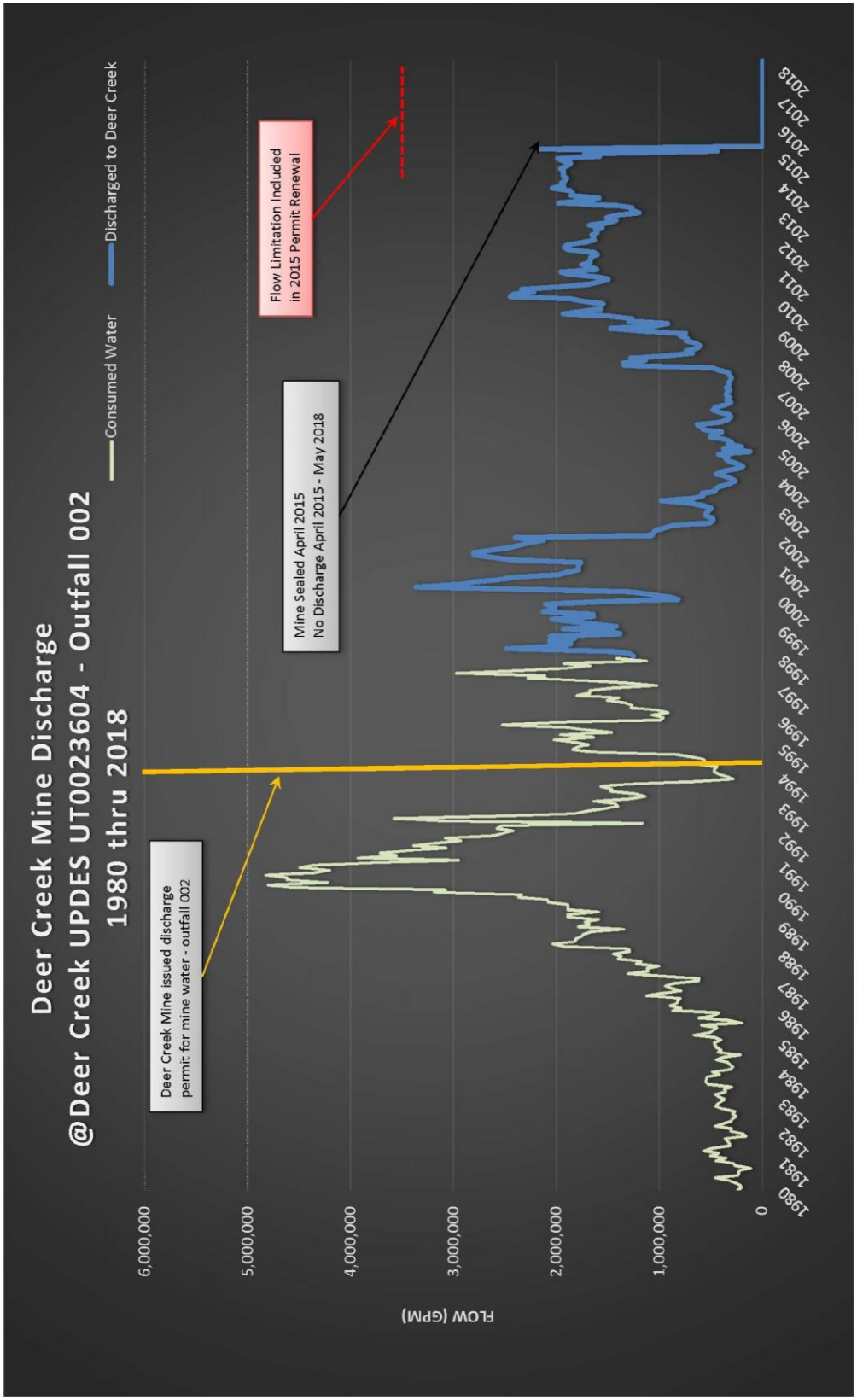
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Mine Water Discharge Site 002: 1980 – 2017

Mine Discharge Quantity



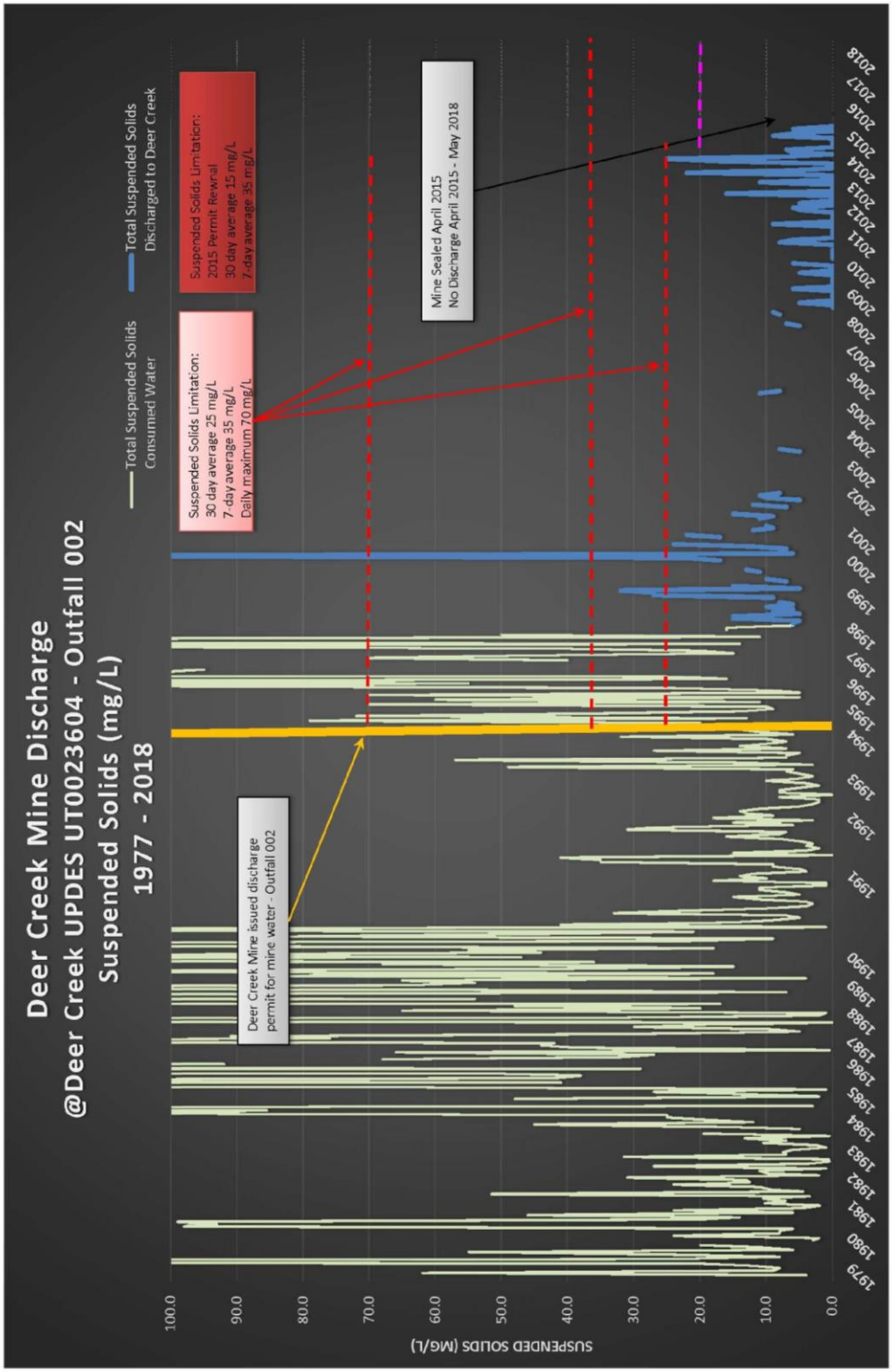
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Water Discharge Water Quality

Parameter: Total Suspended Solids



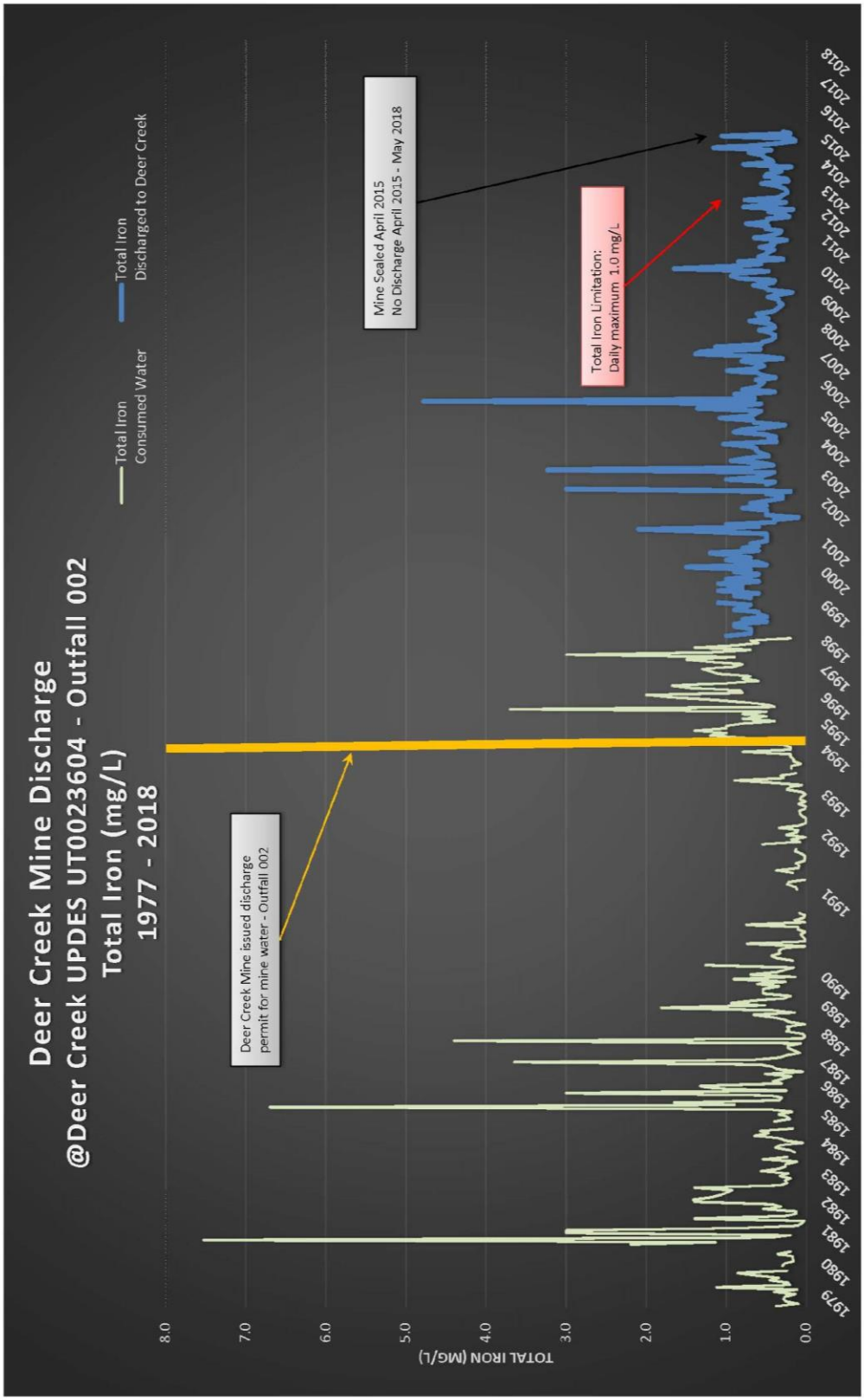
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Mine Water Discharge Water Quality

Parameter: Total Iron



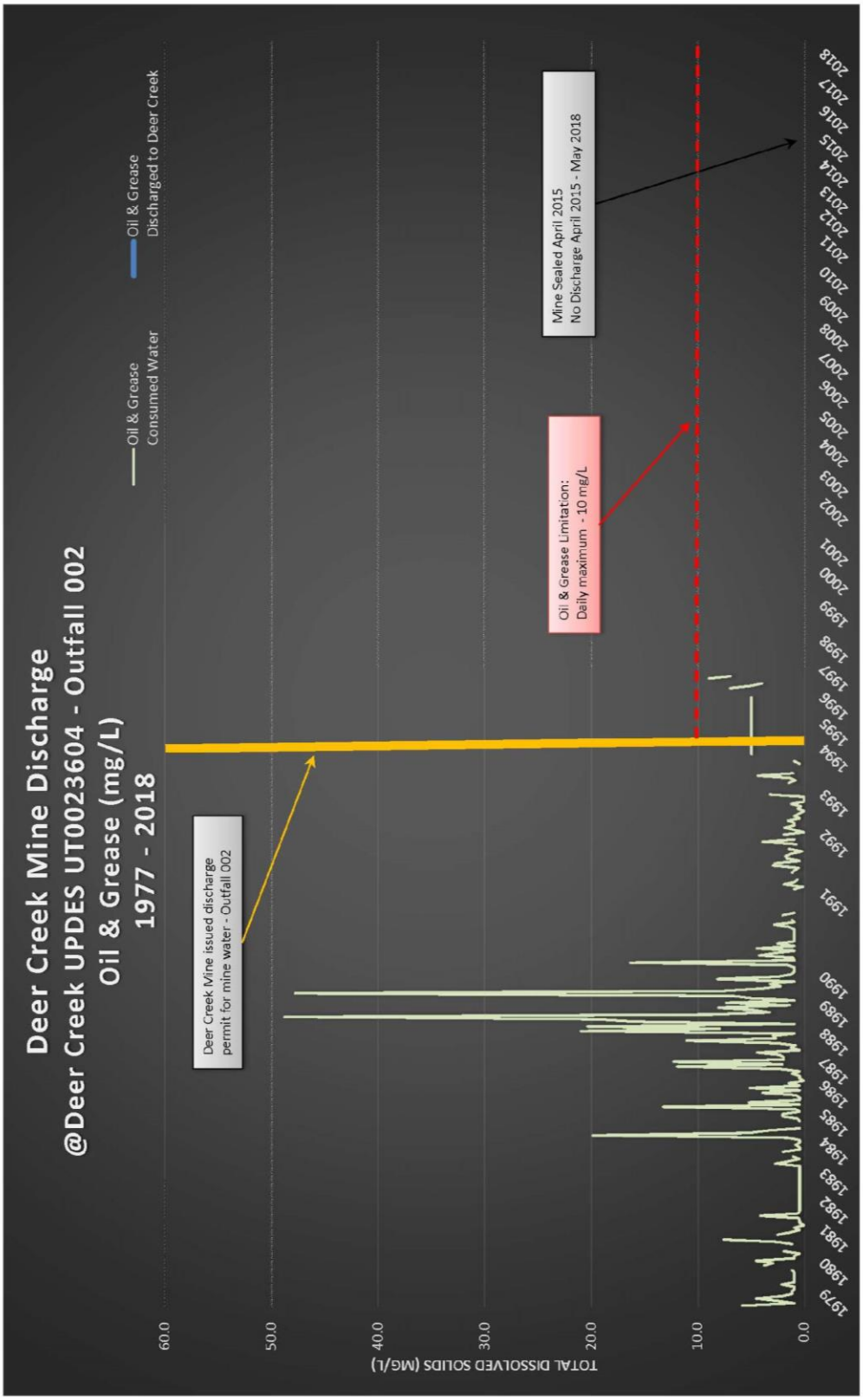
MINE ID

DEER CREEK MINE

UPDES - 0023604

Deer Creek Mine Water Discharge Water Quality

Parameter: Oil & Grease



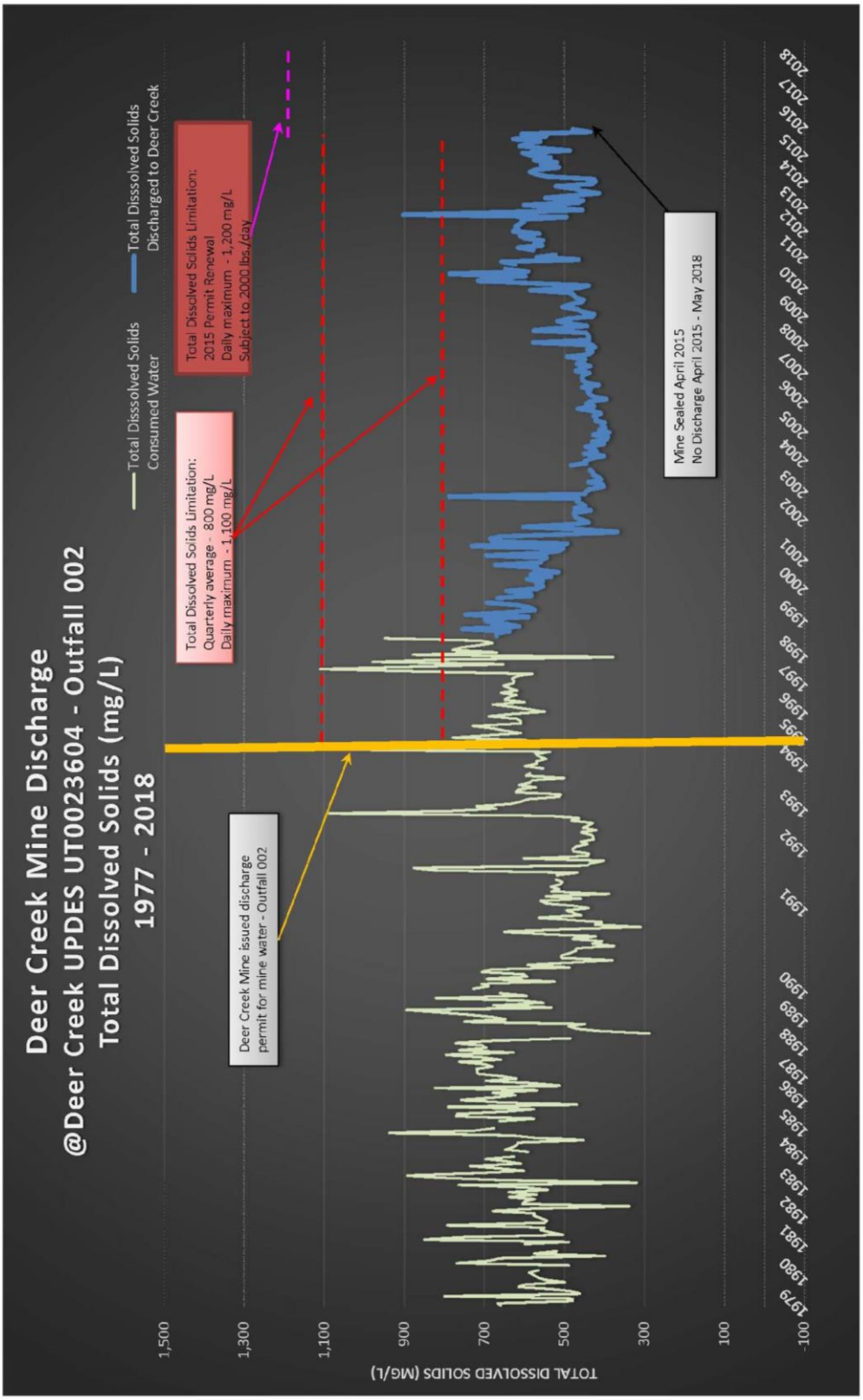
MINE ID

DEER CREEK MINE

UPDES - 23604

Deer Creek Mine Water Discharge Water Quality

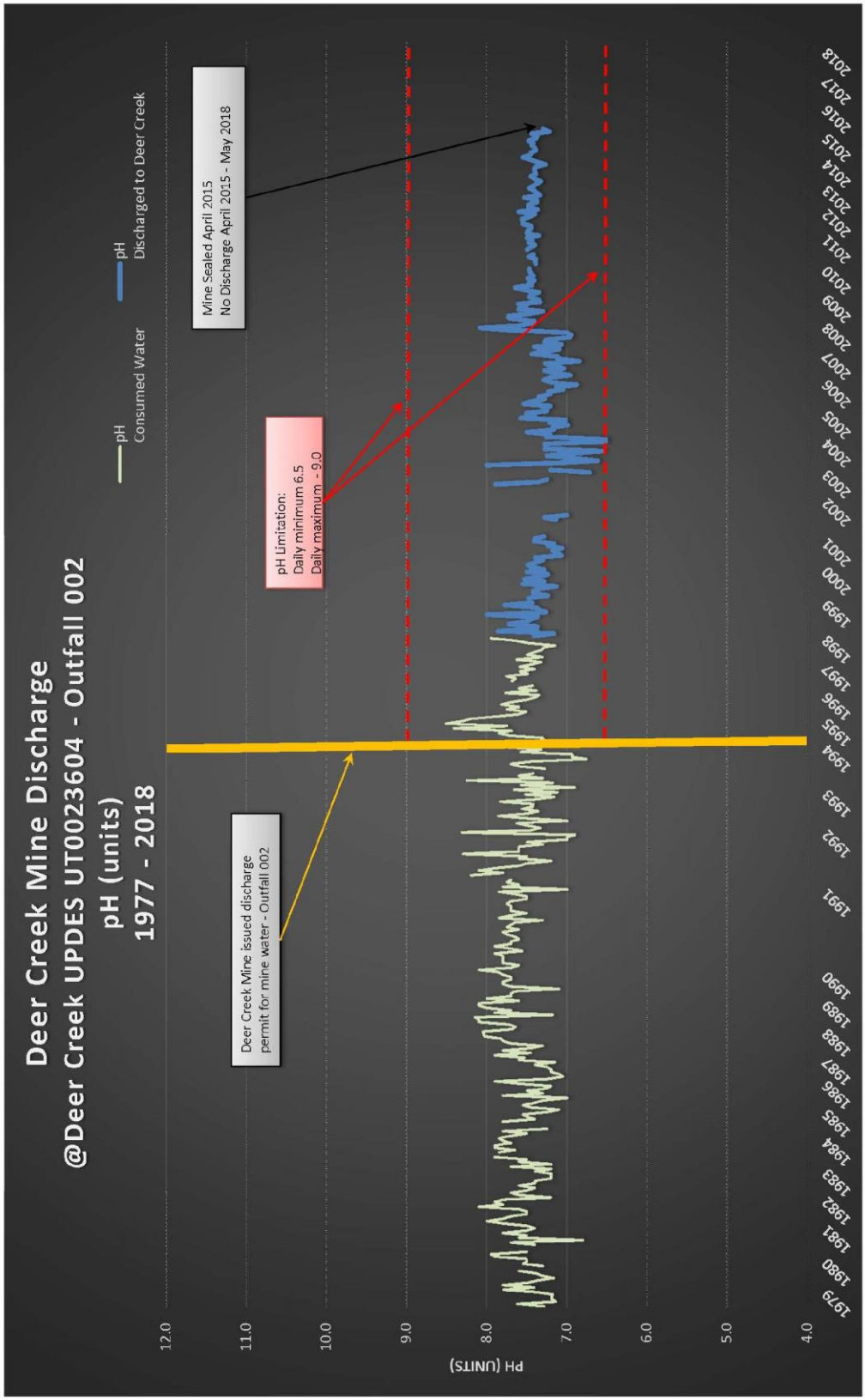
Parameter: Total Dissolved Solids



MINE ID

DEER CREEK MINE

UPDES - 23604

Deer Creek Mine Water Discharge Water Quality

Parameter: pH