Bronco Utah Operations LLC
PO Box 527
Emery Utah, 84522
435-286-2447

February 07, 2019

C/015/0015
Received 3/1/19
Task #5868

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

RE: Bronco Utah Operations LLC
Emery Mine
DOGM Permit No. C/015/0015
Emery Right of Way Revision 120 Acre Additional Adjacent Area

Mr. Christensen:

Please consider this a minor revision to the above mentioned permit which includes an executed C1 form, C2 form, revised pages, and Plates.

This submittal requests development mining only (no subsidence) on a 120 acre tract contained in the recently approved DOI-BLM-UT-G020-2018-0051-EA (Emery Deep Mine Access Right-of-Way). The additional adjacent area is contiguous to the approved adjacent area and BLM LMU.

Cultural and historic consultation was completed and signed off during the EA process. The final Interdisciplinary Team Analysis Checklist depicting this has been inserted in Chapter X.

Chapter VI (Hydrology) has been revised to address the deficiency Task 5769 (full extraction) and included in this submittal.

If you have any questions concerning this request, please contact Kit Pappas at 435-286-2027.

Sincerely,

Kit Pappas
Environmental Manager

Attachments Application for Coal Permit Processing

APPLICATION FOR COAL PERMIT PROCESSING

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

Permittee: Bronco Utah Operations LLC (BUOLLC)

Mine: Emery Mine **Permit Number:** 015/015

Title: Emery Right of Way additional adjacent area

Description, Include reason for application and timing required to implement:

Emery Right of Way additional adjacent area 02/19

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: _____ Disturbed Area: _____ ☐ 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.

BART J HYITA
Print Name

[signature] PRES/CEO, 2/07/19
Sign Name, Position, Date

Subscribed and sworn to before me this 7 day of FEBRUARY, 2019

[signature]
Notary Public

My commission Expires: MARCH 7, 2022

Attest: State of UTAH } ss:
County of CARBON

JOHN CHRISTOPHER PAPPAS
Notary Public - State of Utah
My Commission Expires
March 7, 2022
COMMISSION NUMBER 698870

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: Bronco Utah Operations LLC (BUOLLC)
Mine: Emery Mine **Permit Number:** 015/015
Title: Emery Right of Way additional adjacent area 02/19

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

Add	Replace	Remove	DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	CH I, Page 8
☐ Add	☒ Replace	☐ Remove	CH I, Plate I-1 (Surface & Coal Ownership)
☐ Add	☒ Replace	☐ Remove	CH I Appendix I-2 (Ownership & Leasehold Interests for Surface & Coal)
☐ Add	☐ Replace	☐ Remove	
☐ Add	☒ Replace	☐ Remove	CH IV, Page 1, 2
☐ Add	☒ Replace	☐ Remove	CH IV, Plate IV-2 (UG Opertions Map)
☐ Add	☐ Replace	☐ Remove	
☐ Add	☒ Replace	☐ Remove	CH V Plate V-5 (Subsidence Monitoring Points and Buffer Zones)
☐ Add	☒ Replace	☐ Remove	CH VI Text and Tables
☐ Add	☒ Replace	☐ Remove	CH VI Table VI-17
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-2 (Hydrographs of Wells Completed in Quaternary Deposits)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-3 (TDS Concentrainos of Selected Wells Completed in Quat. Deposits)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-4 (Hydrographs of Wells Completed in the Blue Gate Member)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-5 (Hydrographs of Wells Completed int eh Upper Ferron Sandstone)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-6 (Hydrographs of Wells Completed in the Middle Ferron Sandstone)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-7 (Hydrographs of Wells Completed in the Lower Ferron Sandstone)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-21 (Emery Town Well Data)
☐ Add	☒ Replace	☐ Remove	CH VI Figure VI-22 (Selected Kmf(u) Water-Level and Mine Discharge Data)
☐ Add	☒ Replace	☐ Remove	CH VI Plate VI-4 (Ground Water Monitoring Well & Surface Water Monitoring Site)
☐ Add	☒ Replace	☐ Remove	CH VI Plate VI-6 (Historic & Planned mining & Anticipated Initial Depth to GW I Seam)
☐ Add	☒ Replace	☐ Remove	CH VI Plate VI-7 (Upper Ferron Sandstone Potentiometric Surface 2018)
☐ Add	☒ Replace	☐ Remove	CH VI Plate VI-8 (Lower Ferron Sandstone Potentiometric Surface 2018)
☐ Add	☒ Replace	☐ Remove	CH VI Appendix VI-23 (Baseline Investigaton of Unnamed Ephemeral Washes)
☐ Add	☒ Replace	☐ Remove	CH VIII, Plate VIII-1 (Vegetation and Landuse Map)
☐ Add	☒ Replace	☐ Remove	CH IX, Plate 10-1 (Selected Wildlife information) CONFIDENTIAL
☐ Add	☐ Replace	☐ Remove	CH X Appendix 5-14 placeholder
☐ Add	☒ Replace	☐ Remove	CH X Appendix 5-14 (BLM ROW IDT Team Archeo sign off)
☐ Add	☒ Replace	☐ Remove	CH X Plate X.A-1 (Permit Area Cultural Resources) CONFIDENTIAL

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining
Place the file UNT-3&4 report.pdf (Evaluation of an Unnamed Stream Channel in Emery County, Utah February 2019) in the back of CH VI, App VI-23	

UMC 782,17

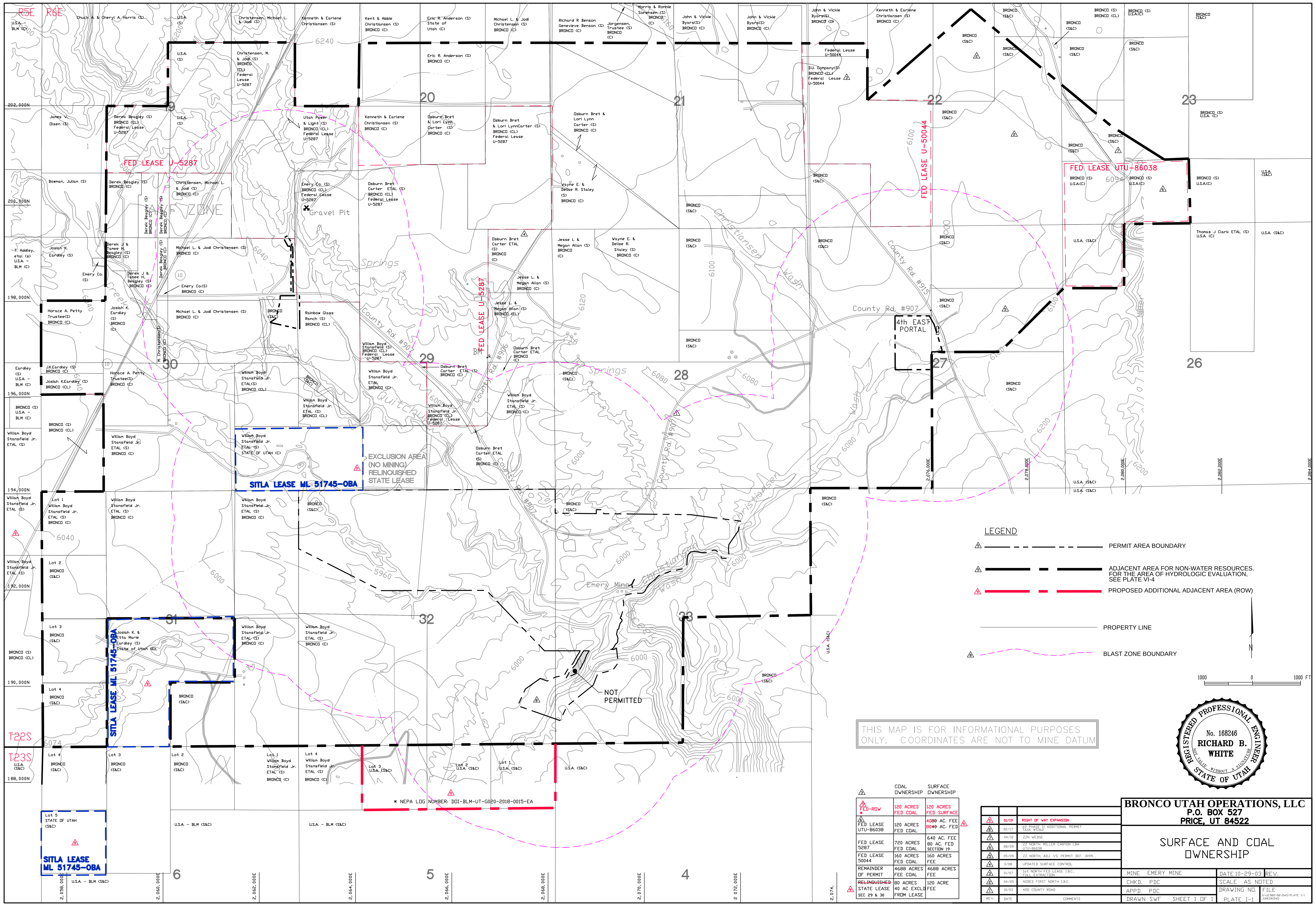
Underground operations at the Emery Mine are an ongoing situation which does not occur in phases. The extent of the underground workings over the life of the permit is shown on Plate IV-2. The approved permit area encompasses approximately 444.8 acres and the additional Emery 2 expansion permit area encompasses 29 acres, for a total of 473.8 acres. The adjacent area encompasses approximately 5,89~~77~~6 acres. A minor permit area adjustment was done due to the disturbed area survey.

It is anticipated that mining activities will continue considerably beyond the five (5) year permit term. This will require renewals at the end of each term.

UMC 782.18, UMC 800.60

Appendix I-5 contains a copy of the insurance certificate, for the Emery Mine, covering personal injury and property damage.

Revised 8-31-95
Revised 4/2005
Revised 9/2006
Revised 5/2009
Revised 8/2009
Revised 4/2010
Revised 2/2017
Revised 1/2019



LEGEND
PERMIT AREA BOUNDARY
ADJACENT AREA FOR NON-WATER RESOURCES. FOR THE AREA OF HYDROLOGIC EVALUATION, SEE PLATE VI-4
PROPOSED ADDITIONAL ADJACENT AREA (ROW)
PROPERTY LINE
BLAST ZONE BOUNDARY
N
1000 0 1000 FT
FED LEASE U-5287
FED LEASE U-50044
FED LEASE UTU-86038
SITLA LEASE ML 51745-OBA
EXCLUSION AREA (NO MINING) RELINQUISHED STATE LEASE
4th EAST PORTAL
NOT PERMITTED
NEPA LOG NUMBER: DOI-BLM-UT-G020-2018-0015-EA
County Rd. #907
Gravel Pit
Emery Mine
R5E R6E
T22S
T23S
THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. COORDINATES ARE NOT TO MINE DATUM
REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
NOT VALID WITHOUT A SIGNATURE
STATE OF UTAH
COAL OWNERSHIP | SURFACE OWNERSHIP
FED-ROW | 120 ACRES FED COAL | 120 ACRES FED SURFACE
FED LEASE UTU-86038 | 120 ACRES FED COAL | 4080 AC. FEE 8040 AC. FED
FED LEASE 5287 | 720 ACRES FED COAL | 640 AC. FEE 80 AC. FED SECTION 19
FED LEASE 50044 | 160 ACRES FED COAL | 160 ACRES FEE
REMAINDER OF PERMIT | 4688 ACRES FEE COAL | 4688 ACRES FEE
RELINQUISHED STATE LEASE SEC 29 & 30 | 80 ACRES 40 AC EXCLD FROM LEASE | 120 ACRE FEE
9 | 01/19 | RIGHT OF WAY EXPANSION
8 | 02/17 | e2 PHASE II ADDITIONAL PERMIT TASK #5362
7 | 04/10 | ZZN WEDGE
6 | 08/09 | ZZ NORTH, MILLER CANYON LBA UTU-86038
5 | 05/09 | ZZ NORTH, ADJ. VS. PERMIT DEF. 3099
4 | 3/08 | UPDATED SURFACE CONTROL
3 | 01/07 | 1st NORTH FED LEASE I.B.C., FULL EXTRACTION
2 | 04/05 | ADDED FIRST NORTH I.B.C.
1 | 10/03 | ADD COUNTY ROAD
REV. | DATE | COMMENTS
BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522
SURFACE AND COAL OWNERSHIP
MINE EMERY MINE
DATE 10-29-03
REV.
CHKD. PDC
SCALE AS NOTED
APPD. PDC
DRAWING NO.
FILE G:\UC982\08\DWG\PLATE I-1 JUNE28.DWG
DRAWN SWF
SHEET 1 OF 1
PLATE I-1

APPENDIX I-2

Ownership and Leasehold Interests
for Surface and Coal

Surface Land Ownership Within and Adjacent to the Permit Area

The following information describes the surface land ownership within and adjacent to the permit. Plate I-1 shows surface land ownership in and adjacent to the permit area.

On December 16, 2015, CONSOL Mining Company LLC conveyed its interest in the surface lands at the Emery Deep Mine and Hidden Valley Mine to Bronco Utah Operations, LLC by (i) Special Warranty Deed, recorded in Emery County on December 22, 2015 at Entry 411521, and recorded in Sevier County on December 23, 2015 at Document No. 00391679, Book 0709, Page 0986 and (ii) Assignment and Assumption Agreement, recorded in Emery County on December 22, 2015 at Entry 411523. The surface interests owned, leased or controlled by Bronco Utah Operations, LLC at the Emery Deep Mine and Hidden Valley Mine are not subject to litigation.

Section 19 T22S, R6E

James Olsen
647 North Main
Spanish Fork, UT 84660
801-798-3322

United States of America (BLM)
Lease No. U-5287
Utah State Offices
440 West 200 South, Suite 500
Salt Lake City, UT 84145-0155

Utah Power and Light
PO Box 899
Salt Lake City, UT 84522
801-748-2570

Wynona P. Olsen (trustee)
3805 Highland Cove Lane
Apt D18
Salt Lake City, UT 84146

M. Christensen
Box 35
Emery, UT 84522
801-286-2348

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
(801) 286-2447

Derek Beagley
PO Box 106
Emery, UT 84522

Julian Bowman
PO Box 141
Huntington, UT 84528-0141

Chuck A. & Cheryl A. Harris
4204 South Bennion Road
Taylorsville, UT 84129

Inserted 12/2007
Revised 9/2009, 12/2013, 3/2016, 02/2017
Replaced 02/2019

Surface Land Ownership Within and Adjacent to the Permit Area

The following information describes the surface land ownership within and adjacent to the permit. Plate I-1 shows surface land ownership in and adjacent to the permit area.

Section 20 T22S, R6E

Emery County
Emery County Courthouse
Castle Dale, UT 84513

Osburn Bret and Lori Lynn Carter
PO Box 24
Emery, UT 84522

Kenneth L. & Earlene Christensen
PO Box 552
Emery, UT 84522

Osburn Bret Carter & J.R. Lawrence
PO Box 24
Emery, UT 84522

Utah Power and Light
P.O. Box 899
Salt Lake City, UT 84110
801-748-2570
Utah Power and Light

Eric Andersen ETAL
PO Box 587
Emery, UT 84522

Michael L. & Jodi Christensen
PO 14
Emery, UT 84522

Kent & Abbie Christensen
PO Box 5
Emery, UT 84522

Section 21 T22S, R6E

Wayne & Delise Staley
482 North 2 W.
Emery, UT 84522
801-286-2213

John & Vicki Byars
PO Box 575
Emery, UT 84522

Bronco Utah Operations LLC.
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

Osburn Bret and Lori Lynn Carter
PO Box 24
Emery, UT 84522

Gayle Jorgensen Trustee
3663 Bountiful Boulevard
Bountiful, UT 84010-3313

Morris & Ronnie Sorensen
PO Box 104
Emery, UT 84522-0104

Richard R. Benson & Genevieve Bensen
PO Box 104
Ferron, UT 84523

Inserted 12/2007
Revised 9/2009, 12/2013, 03/2016, 02/2017
Replaced 02/2019

Surface Land Ownership Within and Adjacent to the Permit Area

The following information describes the surface land ownership within and adjacent to the permit. Plate I-1 shows surface land ownership in and adjacent to the permit area.

Section 22 T22S, R6E

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

John & Vicki Byars
PO Box 575
Emery, UT 84522

Kenneth L. & Earlene Christiansen
PO Box 552
Emery, UT 8452

D.U. Company, Inc.
53 West Angelo Avenue
Salt Lake City, UT 84115

Section 23 T22S, R6E

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

Section 26 T22S, R6E

United States of America BLM

Clark J. Thomas
PO Box 861
St. George, UT 84771

Section 27 T22S, R6E

Bronco Utah Operations LLC.
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

Section 28 T22S, R6E

Wayne & Delise Staley
PO Box 83
Emery, UT 84522
801-286-2213

Bronco Utah Operations LLC.
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

Jesse L. Megan Allan
PO Box 43
Emery, UT 84522

Section 29 T22S, R6E

Emery County
Emery County Courthouse
Castle Dale, UT 84513

Rainbow Glass
PO Box 340
Orangeville, UT 84537

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

Osburn Bret Carter
PO Box 24
Emery, UT 84522

Jesse L. Megan Allan
PO Box 43
Emery, UT 84522

William Boyd Stansfield Jr.
PO Box 553
Emery, UT 84522

Surface Land Ownership Within and Adjacent to the Permit Area

The following information describes the surface land ownership within and adjacent to the permit. Plate I-1 shows surface land ownership in and adjacent to the permit area.

Section 30 T22S, R6E

Josiah K. Eardley
2433 South Highway 10
Price, UT 84501

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2301

Emery County
Emery County Courthouse
Castle Dale, UT 84513

Horace Petty Trustee
PO Box 144
Orangeville, UT 84537

Michael L. Christensen
PO Box 14
Emery, UT 84522

William Boyd Stansfield Jr.
PO Box 553
Emery, UT 84522

Derek Beagley
PO Box 106
Emery, UT 84522

Section 31 T22S, R6E

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2301

Josiah K. & Etta Marie Eardley
2433 South Highway 10
Price, UT 84501

William Boyd Stansfield Jr.
PO Box 553
Emery, UT 84522

Section 32 T22S, R6E

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

William Boyd Stansfield Jr.
PO Box 553
Emery, UT 84522

Surface Land Ownership Within and Adjacent to the Permit Area

The following information describes the surface land ownership within and adjacent to the permit. Plate I-1 shows surface land ownership in and adjacent to the permit area.

Section 33 T22S, R6E

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

Section 34 T22S, R6E

Bronco Utah Operations LLC
Emery Mine
PO Box 527
Emery, UT 84522
801-286-2447

United States of America (BLM)

Section 25 T22S, R5E

Rex Addley
Emery, UT 84522
801-286-2250

George Lewis
75 East 3rd South
Salt Lake City, UT 84111
Phone Unknown

Robert Lewis
107 W. 2 S.
Emery, UT 84522
801-286-2424

United States of America (BLM)

Section 5 T23S, R6E

United States of America BLM

William Boyd Stansfield Jr.
PO Box 553
Emery, UT 84522

Coal Ownership Within and Adjacent to the Permit Area

The following information describes the coal ownership within and adjacent to the permit. Plate I-1 shows coal ownership in and adjacent to the permit area.

On December 16, 2015, CONSOL Mining Company LLC conveyed and assigned its interest in the below holdings (except Federal Coal Leases UTU-5287, UTU-50044, UTU86038 and Federal Logical Mining Unit UTU-73335, the "Federal Leases") to Bronco Utah Operations, LLC by Special Warranty Deed and Assignment and Assumption Agreement, recorded in Emery County on December 22, 2015 at Entry 411521 and 411523, respectively. On December 16, 2015, CONSOL Mining Company LLC assigned the Federal Leases to Bronco Utah Reserves, Inc. by Assignment and Assumption Agreement, recorded in Emery County on December 22, 2015 at Entry 411524. By Sublease Agreement dated December 16, 2015 Bronco Utah Reserves, Inc. subleased its interest in the Federal Leases to Bronco Utah Operations, LLC. Bronco Utah Operations, LLC is the successor in interest to Kemmerer and Consol, and references to Kemmerer and Consol below should be read as Bronco Utah Operations LLC for periods of time after December 16, 2015. The documents and lands listed below pertain only to coal ownership and are not subject to litigation. Plate I-1 shows coal ownership in and adjacent to the permit area.

Bronco currently holds Federal Coal Lease U-5287 in good standing (executed on June 25, 1984). Mining in U-5287 will not occur until 2020 at the earliest. Bronco submitted an R2P2/LMU modification for the Emery 2 expansion and BLM approved it in February 2017. A copy was sent to DOGM by BLM.

Township 22 South, Range 6 East (SLM)

Section 19	NE¼SW¼ NW¼SE¼ E½SE¼ S½NE¼	Lease from USA (BLM) to Kemmerer and Consol dated 7/1/70 (#U-527) Utah State Offices University Club Building Salt Lake City, UT 801-524-5330
	SE¼SW¼	Deed from Emery County to Kemmerer Coal Co. dated 5/14/68
	SW¼SE¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49
	N½NE¼ NW¼	United States of America Not Leased
	W½SW¼	Emery County 95 E. Main Castledale, UT 84513 801-748-2474

Replaced/reordered 09/2009
Revised 03/2016, 02/2017
Replaced 02/2019

Coal Ownership Within and Adjacent to the Permit Area

The following information describes the coal ownership within and adjacent to the permit. Plate I-1 shows coal ownership in and adjacent to the permit area.

Section 20	NW¼SW¼ S½S½ NE¼SE¼	Lease from United States of America (BLM) to Kemmerer and Consol dated 7/1/70 (#U-5287)
	NE¼ E½NW¼ NE¼SW¼ NW¼SE¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	W½NW¼	United States of America Not Leased
Section 21	W½ SE¼ NE¼NE¼ W½NE¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co.
	SE¼NE¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co.
Section 22	NW¼NW¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	SW¼SW¼ SE¼NE¼	San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	SW¼NW¼ N½SW¼ SE¼SW¼	Lease from United States of America (BLM) to Consol dated 7/1/83 (#U-50044)
	W½SE¼ E½NW¼ W½NE¼ NE¼NE¼	Deed from I. Browing to Kemmerer Coal Co. dated 8/23/66
Section 23	SW¼NW¼	Deed from I. Browning to Kemmerer Coal Co. dated 8/23/66
	NW¼SW¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	S½SW¼	Lease from USA (BLM) to Consol dated October 1, 2009 (UTU 86038)
Section 26	NW¼NW¼	Lease from USA (BLM) to Consol dated October 1, 2009 (UTU 86038)

Revised/reordered 09/2009
Revised 03/2016
Replaced 02/2019

Coal Ownership Within and Adjacent to the Permit Area

The following information describes the coal ownership within and adjacent to the permit. Plate I-1 shows coal ownership in and adjacent to the permit area.

Section 27	S½NW¼ SW¼NE¼	Deed from San Rafael Coal Co. to Kemmerer Coal Co. dated 10/1/58
	N½NE¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49
	S½NE¼	Deed from Kemmerer Coal Co.
Section 28	NW¼	Deed from San Rafael Coal Co. to Kemmerer Coal Co. dated 10/1/58
	NE¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	S½	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
Section 29	NW¼NW¼ E½NW¼ W½NE¼ NW¼SE¼	Lease from United States of America (BLM) to Kemmerer and Consol dated 7/1/70 (#U-5287)
Beginning 20 rods South of the NW corner of the SW Quarter of Section 29, thence South 60 rods, thence East 80 rods, thence North 20 rods, thence Northwesterly to the place of the beginning.		Lease from John and Carolyn Lewis to Consol and Kemmerer dated 11/12/80 1163 E. 25th Street Idaho Falls, ID 83401 208-522-3646
SW¼NW¼, beginning at the NW corner of SW¼, thence E 80 rods, thence S 76 rods, thence Northwesterly to the place of the beginning.		Lease from George Olsen to Consolidation Coal Co. dated 12/17/80 15 E. Center Orangeville, UT 810-748-2522
	SE¼NE¼	Lease from R.D. Jensen and D.R. Close to Consolidation Coal Co. dated 12/17/80 520 E. 1 N. Cleveland, UT 84518 801-653-2252

Coal Ownership Within and Adjacent to the Permit Area

The following information describes the coal ownership within and adjacent to the permit. Plate I-1 shows coal ownership in and adjacent to the permit area.

	NE¼NE¼ E½SE¼ SW¼SE¼ NE¼SW¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	SW ¼SW¼ SE ¼ SW ¼	State of Utah SITLA ML 51745-OBA Lease revised and relinquished this ¼ by Consolidation Coal.
Section 30	S½NE¼ E½NW¼ NW¼SE¼ SW¼SE¼ SE¼SW¼	Deed from Emery County to Kemmerer Coal Co. dated 5/14/68
	N½NE¼ SW¼NW¼ NE¼SW¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49
	NW¼NW¼	Private ownership, Ralph Lewis 4053 S. 850 W. Bountiful, UT 84010 801-292-1204
	SW¼SW¼ S½NW¼SW¼	Lease from George Lewis to Consolidation Coal Co. dated 8/30/82
	NE¼SE¼	Lease from John and Carolyn Lewis to Consolidation Coal Co. dated 11/12/80
	SE¼SE¼	State of Utah SITLA ML 51745-OBA
	N½NW¼SW¼	Lease from Robert Lewis to Consolidation Coal Co. dated 10/3/74 107 W. 2 S. Emery, UT 84522 801-286-2424
Section 31	W½NE¼ E½NW¼ NW¼NW¼ SW¼NW¼ W½SW¼ SW¼SE¼	Deed from Emery County to Kemmerer Coal Co. dated 5/14/68 See Note A.
	E½NE¼	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58

Revised/reordered 09/2009
Revised 03/2016
Replaced 02/2019

Coal Ownership Within and Adjacent to the Permit Area

The following information describes the coal ownership within and adjacent to the permit. Plate I-1 shows coal ownership in and adjacent to the permit area.

	NW¼SE¼ NE¼SW¼ SE¼SW¼	State of Utah SITLA ML 51745-OBA
	E½SE¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49
Section 32	NW¼ E½	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	SW¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49
Section 33	All	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
Section 34	N½	Deed from San Rafael Fuel Co. to Kemmerer Coal Co. dated 10/1/58
	S½	United States of America Not Leased

Township 22 South, Range 5 East (SLM)

Section 25	E½E½	United States of America Not Leased
Section 36	All	Utah State, not leased

Township 23 South, Range 5 East (SLM)

Section 1	All	United States of America Not Leased

Township 23 South, Range 6 East (SLM)

Section 6	N½W¼ NW¼NE¼	See Note A.
	NE¼NE¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49

Revised/reordered 09/2009
Revised 03/2016
Inserted 02/2019

Coal Ownership Within and Adjacent to the Permit Area

The following information describes the coal ownership within and adjacent to the permit. Plate I-1 shows coal ownership in and adjacent to the permit area.

Section 5	NW¼NW¼	Deed from L.M. and S.M. Pratt to Kemmerer Coal Co. dated 6/22/49
	N1/2NE1/4 NE1/4NW1/4	United States of America (BM) Bronco Utah Operations LLC has right to enter and mine via signed DR and FONSI dated 2/6/2019 regarding DOI-BLM-UT-G020-2018-0051-EA
	~~E½~~S1/2N1/2 ~~E½W½~~ ~~W½SW¼~~ ~~SW¼NW¼~~ S1/2	United States of America (BLM) Not Leased
Section 4	W½	United States of America (BLM) Not Leased
	E½	United States of America (BLM) Not Leased

Note A: The Kemmerer Coal Company, **and its successors Consol and Bronco Utah Operations**, have been paying taxes on these lands for a number of years. However, during the title investigations, the deed from Ira Browning to Kemmerer was found to be missing, but these lands are not included in the Browning estates. Therefore, it is Bronco-Consol-Kemmerer's contention that these coal lands do indeed belong to Bronco Utah Operations LLC.

CHAPTER IV ENGINEERING DESIGNS

IV.A UNDERGROUND MINE PLAN

This part covers the description of the underground mining operations to be conducted at the Emery Mine.

IV.A.1 UNDERGROUND MINE PLAN

UMC 783.12(a), 783.24(c),783.25(e), 783.25(h), 784.11(a), 784.23(a)

The Adjacent Area for the Emery Mine encompasses approximately 5,89~~77~~6 acres. The approved permit area for the Emery Mine encompasses approximately 444.8 acres. The additional Emery 2 expansion permit area encompasses approximately 29 acres, for a total permit area of 473.8 acres. A minor permit area adjustment was done due to the disturbed area survey. The boundary of the Adjacent Area and permit area is shown on the Permit Boundaries and Bonding Map (Plate III-9). The description of the Adjacent area is as follows:

Township 22 South, Range 6 East

Section 19:	S/2NE/4, SE/4, E/2SW/4
Section 20:	S/2NE/4, SE/4NW/4, S/2
Section 21:	S/2N/2, S/2
Section 22:	S/2, SW/4NW/4, portions of the following E/2SE/4NW/4, SW/4SE/4NW/4, S/2NW/4NE/4, SW/4NE/4, SW/4SW/4NE/4NE/4, W/2SE/4NE/4, S/2NE/4SE/4NE/4, SE/4SE/4NE/4
Section 23:	S/2SW/4, portions of SW/4SW/4NW/4, NW/4SW/4, NE/4SW/4
Section 27:	W/2, W/2NE/4, NE/4NE/4, part of SE/4NE/4
Section 26:	NW1/4NW1/4
Section 28:	All
Section 29:	All
Section 30:	E/2, E/2NW/4, SW/4NW/4, N/2NW/4SW/4, E/2SW/4
Section 31:	N/2, W/2SW/4, E/2SE/4, SW/4SE/4
Section 32:	All
Section 33:	W/2, NE/4

Township 23 South, Range 6 East

Section 5:	NE1/4NW1/4, N1/2NE1/4

The description of the Permit area is as follows:

Township 22 South, Range 6 East

Section 27:	SE/4NW/4, N/2NE/4SW/4, W/2SW/4NE/4, consisting of 4th East Portal
Section 30:	Part of the E/2NE/4 consisting of Borehole Pump No. 3
Section 32:	Part of the NW/4, NE/4, E/2SE/4 consisting of Main Portal
Section 33:	Part of the NW/4, NE/4, N/2SW/4 consisting of Main Portal and Emery 2 Expansion

Mining operations at the Emery Mine are conducted in the IJ Zone utilizing the room and pillar mining method. Plate IV-1 shows the layout, the present mine workings and the projected areas to be mined during the permit term. The existing workings have been marked to show the extent of underground mining operations (1) before August 3, 1977, (2) between August 3, 1977 and May 3, 1978, and (3) after May 3, 1978 up to the permit approval date of January 5, 1986. There are no surface mining operations at the Emery Mine. The projected mine workings are delineated by year for the next five year permit term. Plate IV-2 shows the same plan on a 1"=1000' map to show the extent of the projected life of mine plan in the IJ Zone. The Emery Mine operates under the General Safety Orders, Utah Coal Mines issued by the Industrial Commission of Utah and the applicable regulations issued by the Mine Health and Safety Administration (MSHA). The Emery 2 expansion will mine the same portions of the reserve that were intended to be mined from the Emery main portals and the 4th East portals.

Access to the underground workings is through the portals shown on Plate II-1. All of the present portals are drift openings at the outcrop of the seam. These openings consist of intake, return, and belt entries.

EarthFax

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968.
EMERY EAST 1968, PHOTO REVISED 1978.
MESA BUTTE 1968, PHOTO REVISED 1978.
WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES.
NAD 83 CONUS
ZONE 4302-UTAH, CENTRAL - US FEET
VERTICAL DATUM - NAVD 88-US FEET

EXTERNAL REFERENCE:
G:\UC982\XREF-CURRENT\XREF-USGSMAP.DWG
G:\UC982\XREF-CURRENT\XREF-SECTION.DWG
G:\UC982\XREF-CURRENT\XREF-WORKS-ZZNLBA.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT-e2P2-FEB 17
G:\UC1665\05\XREF\2018 DOGM TIMING
G:\UC1665\05\XREF\FULL EXTRACTION
G:\UC1665\05\XREF\WORKINGS CURRENT

REVISIONS

NO.	DATE	BY	DESCRIPTION	NO.	DATE	BY	DESCRIPTION
1	6/30/05	JAG	ADDED FIRST NORTH I.B.C.	6	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU-86038
2	12/12/06	JAG	1st NORTH FED LEASE IBC, FULL EXTRACTION	7	04/10	JAG	ZZN WEDGE
3	04/7	JAG	UPDATE MINING PLAN	8	02/17	JAG	e2 PHASE II ADDITIONAL PERMIT TASK #5362
4	09/08	JAG	LIFE OF MINE FULL EXTRACTION	9	01/19	JAG	e2 FULL EXTRACTION TASK #5769 DEFICIENCY RESPONSE
5	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT DEF. 3099	10	01/19	JAG	RIGHT OF WAY EXPANSION

0' 1000'
SCALE: 1" = 1000'
CONTOUR INTERVAL = 40'

DRAWN BY: KDS
CHECKED BY: JAG
APPROVED BY: JAG
DWG DATA: G:\UC1665\05\PHASE II DWGS
ORIGINAL DATE: 1/03
RE-DRAWN DATE: 01/19

EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO.
ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522

PLATE IV-2
UG OPERATIONS PLAN

REVISIONS

NO.	DATE	BY	DESCRIPTION	NO.	DATE	BY	DESCRIPTION
1	1/05/05	JAG	ADDED PROPOSED BOUNDARY & PANELS, SUBSIDENCE PTS.	11	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT DEF. 3099
2	5/02/05	JAG	ADDED FIRST SOUTH PROPOSED SUBSIDENCE PTS.	12	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU-86038
3	5/02/05	JAG	ADDED POWER LINE, COUNTY ROAD 907 & STOCK PONDS	13	04/10	JAG	ZZN WEDGE
4	6/30/05	JAG	ADDED FIRST NORTH I.B.C.	14	01/17	JAG	e2 PHASE II ADDITIONAL PERMIT TASK #5362
5	2/07/07	JAG	1st NORTH FED LEASE IBC FULL EXTRACTION	15	01/18	JAG	e2 PHASE II SUBSIDENCE MONITORING PLAN REVISION TASK #5567
6	09/05	JAG	1st SOUTH FULL EXTRACTION				
7	04/07	JAG	14th WEST FULL EXTRACTION PLAN	16	01/19	JAG	2ND LEFT FULL EXTRACTION
8	07/07	JAG	15th WEST, 6th WEST, AND 4th EAST FULL EXTRACTION	17	02/19	JAG	RIGHT OF WAY EXPANSION
9	03/08	JAG	ADDITIONAL FULL EXTRACTION				
10	09/08	JAG	LIFE OF MINE FULL EXTRACTION				

EarthFax

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968.
EMERY EAST 1968, PHOTO REVISED 1978.
MESA BUTTE 1968, PHOTO REVISED 1978.
WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES.
NAD 83 CONUS
ZONE 4302-UTAH, CENTRAL - US FEET
VERTICAL DATUM - NAVD 88-US FEET

EXTERNAL REFERENCE:
G:\UC982\XREF-CURRENT\XREF-USGSMAP.DWG
G:\UC982\XREF-CURRENT\XREF-WORKS-EM2.DWG
G:\UC982\XREF-CURRENT\XREF-SECTION.DWG
G:\UC982\XREF-CURRENT\XREF-HATCH-ZZNW.DWG
G:\UC982\XREF-CURRENT\XREF-LOM.DWG
G:\UC982\XREF-CURRENT\XREF-14THWESTEX.DWG
G:\UC982\XREF-CURRENT\XREF-HATCH-ZZNLBA.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT-e2P2-OCT 17
G:\UC1665\05\XREF\MINE WORKINGSREPLACEMENT08-19-16

0' 1000'
SCALE: 1" = 1000'
CONTOUR INTERVAL = 40'

DRAWN BY: KDS
CHECKED BY: JAG
ORIGINAL DATE: 1/03
RE-DRAWN DATE: 12/05
APPROVED BY: JAG
DWG DATA: G:\UC1665\05\PHASE II DWG

EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO.
ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 1
PRICE, UT 84501

PLATE V-5
SUBSIDENCE MONITORING POINTS AND BUFFER ZONES

G:\UC1665 - Bronco Utah Operations\05 - Emery Mine permit maps\PHASE II DWG\PLATE V-5-e2P2-SUB-SUBMITTAL-JAN 19.dwg, 2/7/2019 12:46 PM

CHAPTER VI

HYDROLOGY

Bronco Utah Operations, LLC
Emery Mine
Emery, Utah

Utah Permit Number ACT015/015

Updated ~~February 2017~~December 2018

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Note: This chapter has been arranged in the format of the R645-301-700 regulations. For example, Section VI.4.2 corresponds to R645-301-742 of the regulations; Section VI.4.2.2 corresponds to R645-301-742.200 of the regulations; etc.

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LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

CHAPTER VI
HYDROLOGY

VI.1 INTRODUCTION

VI.1.1 General Requirements

This chapter presents a description of:

- Existing hydrologic resources within the permit and adjacent areas;
- Mine operations and the potential impacts of these operations to the hydrologic balance;
- Methods of complying with design criteria;
- Applicable hydrologic performance standards; and
- Hydrologic reclamation plans for the Emery Mine.

VI.1.2 Certification

All maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

VI.1.3 Inspection

Impoundments associated with the mining and reclamation operations will be inspected as described in Section 5.1.4.3 of this MRP.

VI.2 ENVIRONMENTAL DESCRIPTION

VI.2.1 General Requirements

This section presents a description of hydrologic resources within the permit and adjacent areas that may be affected or impacted by the coal mining and reclamation operations at the Emery Mine.

VI.2.2 Cross Sections and Maps

VI.2.2.1 Location and Extent of Subsurface Water

A generalized hydrostratigraphic cross section of the permit and adjacent areas is presented in Figure VI-1. Thin deposits of Quaternary alluvium overlie some of the areas but are not shown on Figure VI-1 due to the scale. Estimates of recharge and discharge noted on this figure are from Lines and Morrissey (1983) based on data collected and groundwater modeling conducted in the late 1970s and early 1980s. Actual rates are probably different now than when those earlier estimates were developed.

The Ferron Sandstone Member of the Mancos Shale (in which the coal occurs that is extracted from the Emery Mine) is overlain by the Blue Gate and underlain by the Tununk Members of the Mancos Shale. Both the Blue Gate and the Tununk are relatively impermeable shales that bound the more permeable Ferron Sandstone. For the purpose of this MRP, the portion of the Ferron Sandstone including the “I” coal zone and above is called the upper Ferron Sandstone and is designated by the symbol Kmf(u). The portion laying stratigraphically between the base of the “I” zone and the base of the “A” coal zone is referred to herein as the middle Ferron Sandstone and designated by the symbol Kmf(m). The remaining portion of the Ferron Sandstone lying below the base of the "A" zone is called the lower Ferron Sandstone and designated by the symbol Kmf(l). This partitioning of the Ferron Sandstone is consistent with that of Lines and Morrissey (1983).

The uppermost continuous aquifer beneath the permit and adjacent areas occurs within the Ferron Sandstone. Potentiometric surface maps of this aquifer are presented in Plates VI-1 and VI-2 for the upper and lower Ferron Sandstone, respectively. Plate VI-1 presents data for 1979 while Plate VI-2 portrays conditions in 1985 (the earliest periods of relatively complete data in each zone).

Water rights associated with groundwater within 1 mile of the permit boundary are shown on Plate VI-3. Information concerning these water rights is contained in Appendix VI-4 and summarized in Table VI-1. Seasonal variations in water levels are discussed in Section VI.2.4.1. These fluctuations are not sufficient to result in substantial changes to the potentiometric surface maps (Plates VI-1 and VI-2) or the hydrostratigraphic cross section (Figure VI-1).

VI.2.2.2 Location of Surface Water Bodies

The location of surface water bodies for which water rights have been obtained within the permit and adjacent areas is provided on Plate VI-3. Information concerning these rights is provided in Appendix VI-4 and summarized in Table VI-1. Other water bodies in the area are noted on the base map that comprises Plate VI-3.

VI.2.2.3 Locations of Monitoring Stations

Surface water and groundwater monitoring stations associated with the Emery Mine are shown on Plate VI-4. Approximate surface elevations of the monitoring stations are indicated by the topographic lines on Plate VI-4.

Plate VI-4 contains a line depicting the "approximate area of hydrologic evaluation." This area is approximated by the Joe's Valley-Paradise Fault Zone on the west, Ivie Creek and its adjacent tributaries on the south, Muddy Creek and its adjacent tributaries on the east, and the area of influence associated with the Emery Town wells on the north. The line was drawn to encompass the long-term monitoring points shown on Plate VI-4 as well as most of the temporary monitoring points shown on Figure VI-14, Figure VI-15, and Plate VI-9. The influence of the Joe's Valley-Paradise Fault Zone on groundwater flow in the Ferron Sandstone (as noted on Plates VI-1 and VI-2) was also accounted for when drawing the line. Additional information is found in Section VI.2.8.3 regarding this line and its relationship to the "adjacent area" in the context of the potential impacts of the Emery Mine on the hydrologic balance of the region.

VI.2.2.4 Location and Depth of Water Wells

Water-supply wells and groundwater monitoring wells in the permit and adjacent areas are shown on Plate VI-4. Depths of these wells and other completion details are summarized in Table VI-2.

VI.2.2.5 Surface Topography

Surface topographic features in the permit and adjacent areas are shown on the base maps used for many of the plates in this submittal.

VI.2.3 Sampling and Analysis

All water samples collected under this MRP have been analyzed according to methods in either the "Standard Methods for the Examination of Water and Wastewater" or 40 CFR parts 136 and 434. Where feasible, these same references have been used as the basis for sample collection.

VI.2.4 Baseline Information

Surface and groundwater resource information is presented in this section to assist in understanding hydrologic conditions in the mine area. This information provides a basis for determining if mining operations have had, or can be expected to have, a significant impact on the hydrologic balance of the area. Additional information regarding the hydrology of the Miller Canyon Tract (Zero Zero North mine panel) is provided in Appendix VI-16.

Planned surface disturbances associated with the Emery 2 portal will be located within the currently-approved Mining and Reclamation Plan area for the Emery Mine (i.e., within areas from which baseline hydrologic data have been collected and identified on Plate VI-4 as the “Adjacent Area for Non-Water Resources” and the “Approximate Area of Hydrologic Evaluation”). All underground works currently envisioned to be accessed through the Emery 2 portal are also within those areas of baseline hydrologic data collection identified on Plate VI-4. Thus, the hydrologic baseline information presented below is applicable to the Emery 2 surface facility and its associated underground works. These baseline data are considered adequate to properly revise the Probable Hydrologic Consequences determination and account for construction of the Emery 2 surface facility and its associated underground mining operations.

VI.2.4.1 Groundwater Information

This section presents a discussion of baseline groundwater conditions in the permit and adjacent areas. The locations of wells and springs in the area are presented on Plates VI-3 and VI-4. Lithologic and completion logs for monitoring wells in the permit and adjacent areas are provided in Appendix VI-2.

Geologic conditions in the permit and adjacent areas are described in Volume V of this MRP. Groundwater in the permit and adjacent areas occurs predominantly in the Ferron Sandstone. However, perched aquifers of limited areal extent are present in overlying materials. Hydrogeologic conditions within the permit and adjacent areas are summarized below.

Quaternary Deposits (Qal)

Discontinuous, shallow perched zones are contained within Quaternary alluvial, mud and slope wash, and pediment deposits scattered throughout the Emery area (see Plate VI-5). These Quaternary deposits are generally less than 50 feet thick, with boundaries defined by the contact with the underlying Blue Gate Member of the Mancos Shale.

Recharge to Quaternary *alluvial deposits* in the area occurs primarily by streamflow seepage along adjacent water courses. During the spring and summer months, much of this water consists of irrigation return flow. Groundwater discharges from these Quaternary alluvial deposits primarily via evapotranspiration and horizontal, subsurface outflow to topographically lower areas. Given the relatively impermeable nature of the underlying Blue Gate Member, it is assumed that only minor quantities of alluvial groundwater discharge to the adjacent bedrock.

Most recharge to the Quaternary *mud and slope wash and pediment deposits* occurs via seepage of irrigation water applied to adjacent land. This water, which in the Emery area is diverted predominantly from Muddy Creek, is either evapotranspired or moves horizontally through these deposits and then discharges to the surface at the underlying contact with the relatively impervious Blue Gate Member. Several seepage points representing irrigation return flow from this subsurface mud and slope wash/pediment water are noted on Plate VI-5 (specifically SP-1 through SP-14). Water flowing from some of these seeps becomes trapped in swales which, coupled with the high salinity of the Blue Gate, creates areas of salt accumulation.

Consol Energy (the prior owner of the mine) conducted an inventory of seepage points within one mile of the permit area on October 24, 1979, and again on June 11, 1980. Each point was evaluated in the field for its geologic setting, and field data were collected to define the temperature, pH, specific conductance, dissolved oxygen, and discharge (where possible) of the seepage.

Within the study area, 16 seepage points were identified in 1979-1980. Locations and field measurements for each of the points are exhibited on Plate VI-5 and Table VI-3, respectively. All but two of the seepage points were observed to be issuing from pediment gravels overlying the Bluegate Shale. This seepage originates from infiltrating irrigation water used for farming south of Emery on the weathered pediment gravels. The remaining two springs (SP-15 and SP-16, located east of the permit area) issue from the Ferron Sandstone and are discussed in a subsequent section of this document.

The specific conductance of the seepage water ranged from 658 to 2015 and averaged 1155 umhos/cm at 25°C. The pH ranged from 6.3 to 8.3 with an average of 7.6. Although discharge at most of the seepage sites could not be measured because of the diffuse nature of the discharge and/or vegetative overgrowth, flows were typically less than 10 gpm. The dissolved oxygen of the seepage water is more indicative of a near-surface source and is much higher than would be expected for a natural groundwater source. This observation, coupled with the fact that all seepage appeared to be issuing from the pediment gravels adjacent to irrigated fields, indicates that none of these seepage points would likely exist if not for the adjacent irrigation (i.e., all are considered to have an anthropomorphic source).

Ten monitoring wells were completed in Quaternary deposits in 1982. Wells RDA 1 through 6 were drilled in the Quitchupah Creek drainage and wells SM1-1 through 4 were drilled in the Christiansen Wash drainage. Water-level measurements collected from these wells are summarized in Figure VI-2 and presented in their entirety in Appendix VI-10. No consistent seasonal or long-term variations in water levels are evident in the alluvial monitoring wells. Given the relatively thin nature of the Quaternary deposits in the area, differences in water-level elevations between wells are primarily a function of the ground elevation at the well locations.

A summary of water quality data collected from the Quaternary monitoring wells, together with a limited number of samples from springs, is provided in Table VI-4, with individual sample results presented in Appendix VI-1. The pH of this water tends to be moderately alkaline, averaging 7.3 to 7.7 (field and laboratory measurements, respectively). Total dissolved solids ("TDS") concentrations averaged about 16,600 mg/l and varied by approximately two orders of magnitude (from 940 to nearly 93,000 mg/l) during the period of record (1982 through the present).

TDS concentrations in Quaternary deposits tend to be highest at monitoring wells RDA-5, RDA-6, SM1-1, and SM1-3, being approximately an order of magnitude higher at these wells than the other "RDA" and "SM1" wells. Figure VI-3 indicates that no consistent trends in TDS concentrations are apparent between these high-TDS wells. These trends can also not be correlated with nearby mining activities. Trends at the "RDA" wells (generally decreasing at RDA-5 and generally increasing at RDA-6) suggest wide variations over relatively short distances, especially considering the lower TDS concentrations in the other nearby "RDA" wells. The cause of these variations is uncertain. Wells SM1-1 and SM1-3 are completed in areas where subsurface irrigation seepage accumulates, concentrating salts from the overlying soil and the underlying Blue Gate Member, suggesting a source for the elevated TDS concentrations relative to the other "SM1" wells. However, it is uncertain why TDS concentrations show no consistent trend between wells SM1-1 and SM1-3.

Groundwater in Quaternary deposits is generally categorized as a sodium sulfate type. This characterization exhibits the influence of the underlying gypsiferous Blue Gate Member of the Mancos Shale. Dissolved iron and manganese concentrations in the Quaternary deposits have averaged approximately 3.6 and 0.9 mg/l, respectively, during the period of record.

Blue Gate Member of the Mancos Shale (Kmb)

In the vicinity of the Emery Mine, the Blue Gate consists of massive gray shales with minor intercalated, fine-grained sandstones and thin carbonaceous layers. Several monitoring wells, installed by Consol and the USGS, are completed totally or partially in this zone.

Water-level data collected from the Blue Gate monitoring wells are provided in Appendix VI-10 and summarized in Figure VI-4. The spatial coverage of monitoring wells completed in the Blue Gate is sufficient to define groundwater conditions in the water-bearing stratum above the formation from which coal is mined (i.e., the IJ seam of the upper Ferron Sandstone). No consistent seasonal variations in water levels occur in this unit. Long-term water-level declines are apparent in the Blue Gate at monitoring wells I, R2, and (to a lesser degree) AA. A comparison of Figure VI-4 with information presented on Plate IV-2 indicates that the timing of water-level declines at these wells is not related to mining in nearby areas. The fact that declines are not consistent over the entire area suggests that they are also not climate related. Thus, water-level declines at wells AA, I, and R2 are presumably the result of local changes in irrigation patterns.

Historically, water-quality data have been collected from only one monitoring well completed in the Blue Gate Member within the permit area (well T1-BG – see Table VI-5 and Appendix VI-1). These data indicate that groundwater in the Blue Gate Member has a near-neutral pH with a high salinity (TDS concentrations in the general range of 15,000 to 24,000 mg/L). Dissolved iron and manganese concentrations in the Blue Gate are typically less than 1 mg/l.

The predominant ions in groundwater within the Blue Gate Member are sodium and sulfate, which is indicative of the gypsiferous nature of the formation. The generally saline nature of the Blue Gate Member is also evident from alkali deposits that occur throughout the Emery area.

Ferron Sandstone Member of the Mancos Shale (Kmf)

Groundwater within the Emery Mine permit and adjacent areas occurs primarily in the Ferron Sandstone Member of the Mancos Shale, the unit that also contains the coal that is extracted from the Emery Mine. The Ferron Sandstone is bounded above by the Blue Gate Member and below by the Tununk Member of the Mancos Shale.

Aquifer Characteristics:

Aquifer pumping tests have been conducted in the Ferron Sandstone in the permit and adjacent areas by the U.S. Geological Survey (see Lines and Morrissey, 1983) and Consol (see Appendix VI-3). The results of these pumping tests are summarized in Table VI-6. As indicated, the average transmissivity of the Ferron Sandstone in the permit and adjacent areas is 230 ft^2/day, varying by more than two orders of magnitude from 5 to 800 ft^2/day. The limited amount of data summarized in Table VI-6 suggests that the transmissivity of the upper Ferron Sandstone is about one-tenth that of the lower Ferron Sandstone (averages of 60 ft^2/day vs. 540 ft^2/day, respectively). However, insufficient data exist to draw definitive conclusions from these numbers.

White et al. (2005) concluded, from calibration of a regional groundwater model, that the permeability of aquifers in the Colorado Plateau of Utah is about four orders of magnitude higher than that of aquicludes in the region. Assuming an approximate thickness of 400 feet for the entire Ferron Sandstone (based on a review of Plate V-20), the average hydraulic conductivity of the Ferron Sandstone as a whole in the Emery area would be approximately 0.5 ft/day (230 ft^2/day divided by 400 ft). This would suggest that the hydraulic conductivity of the overlying Blue Gate and underlying Tununk Members in the area is about $5x10^{-5}$ ft/day, based on the calibration results of White et al. (2005).

Lines and Morrissey (1983) indicate that the transmissivity of the Ferron Sandstone generally increases to the northwest as the unit thickens. According to Table VI-6, the average storage coefficient of the Ferron Sandstone in the area is $1.3x10^{-3}$, varying by about one order of magnitude across the area.

Groundwater Recharge, Flow, and Fluctuations:

According to Lines and Morrissey (1983), recharge to groundwater in the Ferron Sandstone within the permit and adjacent areas occurs primarily along the Joe's Valley-Paradise fault zone, with this water originating as precipitation at higher-elevations along the Wasatch Plateau to the west. Lines and Morrissey (1983) estimated that recharge to the Ferron Sandstone aquifer is about 2.4 cfs along the Joe's Valley-Paradise fault zone west of the Emery Mine. Direct recharge from precipitation and from overlying and underlying formations is considered minimal, given the relatively impermeable nature of the Blue Gate and Tununk Members and the limited precipitation that falls on the valley floor (see Figure VI-1).

Potentiometric surface maps of the upper and lower Ferron Sandstone are provided in Plates VI-1 and VI-2 for 1979 and 1985, respectively (the earliest years with relatively complete data sets). A comparison of these maps with data provided by Doelling (2004) indicates that groundwater moves generally updip and in a southeast direction through the permit area. Throughout most of the region, groundwater in the Ferron Sandstone west of the mine has historically been under sufficient artesian pressure to flow at the ground surface.

Plates VI-7 and VI-8 present the potentiometric surface of the upper and lower Ferron Sandstone, respectively, in 20~~06~~18. With coal being extracted from the upper Ferron Sandstone, Plate VI-7 shows the effects of discharging water that is encountered during mining operations. Mining has not affected the potentiometric surface of the lower Ferron Sandstone to the same degree as the upper Ferron Sandstone.

The Bryant well and the “AA” monitoring wells were rehabilitated on December 3, 2018 to provide more complete data concerning groundwater in areas planned for full extraction of coal. This rehabilitation was accomplished by removing the non-functioning pump from the Bryant well (which was preventing access to measure the depth to groundwater in the well) and by removing blockages from the “AA” wells that were preventing the collection of water-level data. Together with data collected from the remaining monitoring wells completed in the upper Ferron Sandstone (H[U], Muddy 1, R2[U], TP, and the Pump 3 monitoring well), data collected from these wells sufficiently define groundwater conditions within and immediately above the zone that contains the coal seam where full extraction will occur.

Figures VI-5 through VI-7 present hydrographs of water-level data collected from the upper, middle, and lower Ferron Sandstone, respectively. As indicated in Figure VI-5, several wells completed in the upper Ferron Sandstone have exhibited substantial water-level declines due to mining activities. For instance, the Bryant and Lewis wells experienced approximately 250 to 300 feet of drawdown beginning in the late 1970s/early 1980s. Water levels have remained relatively constant at these locations since that time. Although these wells are located a mile or more upgradient from areas where mining was occurring at the time, dewatering of the mine is the presumed cause of this drawdown. Consol furnished and installed pumps and ancillary facilities at these private wells to augment water that formerly flowed at the surface.

Figure VI-5 indicates that groundwater levels in wells AA and Muddy #1 (both completed in the upper Ferron Sandstone) have remained essentially unchanged for several years. Thus, the potentiometric surface data provided on Plate VI-7 are considered representative of current (2018) conditions in the vicinity of the proposed Emery 2 portal. These data indicate that the potentiometric surface occurs at an elevation of approximately 5,890 feet at the location of the Emery 2 portal. This is approximately 40 feet below the planned elevation of the mine floor at the portal.

Approximately ~~3~~600 feet of drawdown occurred at well R2 in the upper Ferron Sandstone through the 1980s, after which the water level at this location ~~has~~ remained relatively constant until this well was removed from the monitoring network. Similarly, well TP experienced approximately 300 feet of drawdown in the upper Ferron Sandstone during the 1980s and early 1990s, with relatively constant water levels ~~since that time~~until about 2011, at which time water levels began to rise in well TP (see Figure VI-5). These declines all occurred presumably as a result of nearby mining activities. The approximate 200-foot rise in water levels in well TP coincided with idling of and decreased pumping from the Emery Mine in 2011.

Water levels at well T2 declined by 200 to 300 feet in the upper Ferron Sandstone during the 1980s, with wide fluctuations of 100 to 200 feet (both positive and negative) at this location since 2004. Although additional mining near this location may have caused some of these fluctuations, the relative stability of water levels at the adjacent well TP during this period of time imply that data collection errors may have been the source of some of the recent apparent fluctuations.

According to Figure VI-5, wells AA, Muddy #2, and USGS1-2 in the upper Ferron Sandstone experienced approximately 50 feet of drawdown in the late 1970s and early 1980s, presumably as a result of mining in nearby areas (see well locations on Plate VI-4). Water levels in well AA remained relatively constant ~~since then~~until 2011, when they began to rise (presumably due to idling of the Emery Mine). Obstructions in wells Muddy #2 and USGS1-2 have rendered the data reported from those wells meaningless since about 2006.

Water levels in the upper Ferron Sandstone have remained relatively constant at wells I2 and Muddy #1 throughout the period of record (see Figure VI-5). These wells are located at similar or closer distances to mined areas than other wells where water-level declines have occurred. The reason for the lack of anticipated water-level response at these locations is unknown.

Water levels in well H completed in the upper Ferron Sandstone remained relatively constant until 2005, when they rose for a short period. Since about the beginning 2006, water levels in this well ~~have~~ decreased nearly 200 feet until early 2016, at which time they experienced a sharp rise. The reason for this decrease and subsequent rise is not well understood, as indicated in Section VI-2.8.3.

Selected wells completed in the middle Ferron Sandstone have also shown water level declines through the period of record (see Figure VI-6). Wells AA and I experienced about 80 to 100 feet of drawdown in the 1980s. Water levels in the middle Ferron Sandstone have remained relatively unchanged at well AA since that time, but declined an additional 150 feet at well I in the fourth quarter of 2005 after a several-year period of relative stability. Well AA is located near an area where mining occurred in the late 1970s and early 1980s, suggesting that this mining activity resulted in the drawdown noted in this well. Well I is located near an area where mining occurred in the early to mid-1980s, with additional mining occurring directly beneath this well in 2004 and 2005. The response of water levels in the middle Ferron Sandstone at well I may be indicative of the two phases of mining in the area.

At well R2, the middle Ferron Sandstone experienced a decline of approximately 500 feet in the late 1980s (see Figure VI-6). This decline likely occurred from mining in the immediate area during that time frame (see Plate IV-2). Water levels in this well have been trending upward since about 2003, perhaps due to this well being remote from more recent mining operations.

Water levels in well H monitoring the middle Ferron Sandstone dropped over 300 feet in the late 1980s. The reason for this response is unknown, since similar declines did not occur at well H in the upper Ferron Sandstone (compare Figures VI-5 and VI-6). Underground observations near the area of this well did not indicate any unusual water inflow into the mine nor do discharge records from the mine dewatering system substantiate any sustained increase in water volume entering the mine as would be expected to affect such a sharp decline in water levels. It is possible that the integrity of well H in the middle Ferron Sandstone has been compromised. Field investigations with a water level probe indicate that this well is at least partially blocked above its completion zones.

Except at well H, responses of nested wells completed in the upper and middle Ferron Sandstone were essentially similar, suggesting a hydraulic connection between these two intervals. However, the similar responses may be more related to depressurization than actual dewatering of the middle Ferron Sandstone given the presence of low-permeability mudstone and shale layers underlying the upper Ferron Sandstone and the dominantly lateral groundwater flow with the Ferron Sandstone from the Paradise Valley-Joes Valley Fault Zone located west of the mine (see Lines and Morrissey, 1983).

The water-level response noted at well R2 is likely related to changes in rates of mine dewatering (i.e., well R2 is located within about 1000 feet of the mine dewatering pump). The relative stability of water levels at well AA(M) indicate that baseline groundwater conditions in the middle Ferron Sandstone are well defined in that area of planned full extraction.

Water level records of wells AA, I, WW1, and ZZ completed in the lower Ferron Sandstone show no apparent declines during the period of record (see Figure VI-7). Each of these wells is located in the south or east ~~(i.e., downgradient)~~ portion of the permit area. These data suggest hydraulic separation of the upper/middle and lower Ferron Sandstone in the areas of these wells. However, water-level declines have occurred at ~~the Kemmerer well and~~ wells H and R1 completed in the lower Ferron Sandstone (all located in the north or west portion of the permit and adjacent areas). An apparent decline of about 170 feet occurred at well R1 in the late 1980s/early 1990s when mining was active immediately east of that location. Water levels since that time apparently remained relatively stable at well R1 until 2010 and fluctuated widely since then. However, water-level data collected from this well (in the form of pressure measurements) ~~have been~~were improperly reported for several years (see Appendix VI-19) and are not reliable. Thus, data collected from well R1 should not be considered reliable.

Declines at the Kemmerer well and well H have been more gradual, with a decrease in head of about 40 feet at the Kemmerer well ~~throughout the period of record~~until about 2010, and about 70 feet of decline at well H throughout the 1980s and 1990s. More recent water levels measured in these two wells were similar to those measured in the 1970s and early 1980s. These latter two wells are more remote from mining activities than well R1. Taken together, and in consideration of the unreliable data reported for well R1, the~~se~~ water-level data presented in Figure VI-7 indicate that the potentiometric surface of the lower Ferron Sandstone ~~in upgradient areas is more~~has not been substantially affected by mining activities ~~than in downgradient areas~~.

Monitoring well USGS 2-1, which monitors the lower Ferron Sandstone, was found in the field in November 2018. A log of this monitoring well, which was drilled in 1978 in support of the investigation conducted by Lines and Morrissey (1983), is provided in Appendix VI-2. Data collected from this well, together with the remaining wells monitoring the lower Ferron Sandstone (wells AA[L], Kemmerer, and R1) are sufficient to define groundwater conditions in the basal portion of the Ferron Sandstone underlying the area where full extraction of coal is planned.

Groundwater Discharge:

The USGS used a three-dimensional finite-difference computer model of the Ferron Sandstone to simulate groundwater flow in the vicinity of the Emery Mine (Lines and Morrissey, 1983). The model was calibrated in a steady-state simulation using water levels and discharges from the aquifer that were measured during 1979. Recharge and ~~D~~discharge estimates resulting from that calibration effort are noted on Figure VI-1. The precise recharge and discharge rates noted on Figure VI-1 have probably changed since the work of Lines and Morrissey (1983).

Based on estimates provided in Figure VI-1, the most significant discharges from the Ferron sandstone aquifer in the permit and adjacent areas have historically been leakage to the Blue Gate Member, discharge from the Emery Mine, leakage to streams, and extractions from wells. The largest man-made discharge from the Ferron Sandstone is discharge from the mine.

In a study of the Emery Mine area, Lines (1987) found that “prior to mining, the vertical component of flow was upward from the Ferron into the Blue Gate Member. As mining progressed, ground-water flow was directed toward the mine workings, and much of the aquifer and other rocks above the mined coal bed were dewatered. The steady-state pattern of [predominantly horizontal] flow . . . probably would not develop unless mining ceased and dewatering of the mine continued for several years.” These conditions are depicted in Figure

VI-8. With this in mind, the declines in water levels in the upper Ferron Sandstone suggest that upward leakage from the Ferron Sandstone to the Blue Gate Member is probably minimal over areas where mining has occurred.

Groundwater from the Ferron Sandstone flows into the mine and wereas historically discharged via pumps to holding ponds and thence to Quitchupah Creek. The last of these pumps was shut down in January 2016. Pumping from the mine may resumed in the future, depending on conditions encounteredMay 2018 to provide extra storage space for groundwater that may be encountered in the mine following opening of the Emery 2 portal. All mine-water discharges are regulated under permits issued by the Utah Division of Water Quality through the Utah Pollutant Elimination Discharge System ("UPDES"). The average discharge from the Emery Mine during the period of 1979 through 2015 is shown in Figure VI-9 and Table VI-7. The data contained in Table VI-7 are summarized in four periods: a period of active mining from 1979 through 1990, a period of temporary shutdown from 1991 through 2001, an additional period of active mining from 2001 through 2010, and a period of temporary shutdown from 2011 through 2015. As indicated, the average discharge from the mine during the period of 1979 through 1990 was 0.93 cfs. During the temporary shutdown from 1991 through 2001, Consol pumped water from the mine at an average rate of 1.03 cfs to maintain accessible conditions.

Following the restart of mining in 2002, discharge from the mine averaged 0.63 cfs through 2005 but increased substantially thereafter. As part of the 2002 re-start of mine, additional mining equipment was added to the operation, thus increasing in-mine water usage. The increase in mine-water discharge from 2006 through 2010 was likely due to the effects of subsidence on mine-water inflow as pillars were pulled.

Figure VI-9 shows that the discharge of mine water remained relatively high in 2011 and 2012 as plans were being made to re-enter the mine. As the time frame for re-opening the mine was extended, the decision was made to allow the lower portion of the mine works to flood up to a certain elevation. As a result, the discharge from the mine was reduced in 2013 and was maintained at a lower level until the last pump was shut off in January 2016. Pumping from the mine since May 2018 has averaged 0.50 cfs.

Based on a comparison of the potentiometric surface data presented on Plate VI-7 with bottom-of-coal data presented on Plate V-20, it is anticipated that groundwater will not be encountered in the mine works accessed by the Emery 2 portal until mining has progressed to a point approximately 1,500 feet from the portal entry. ThereafterAs mining progresses, groundwater that is encountered underground will initially be used in underground mining operations and not discharged to the surface. An estimate of the timing and quantity of groundwater that will eventually be discharged from the mine to the surface is provided in Section VI.2.8.3 of this chapter.

Discharge to alluvium is presumed to occur naturally from the Ferron Sandstone at various locations within the general mine area. Lines and Morrissey (1983) simulated groundwater discharge to alluvium along Muddy Creek, Ivie Creek, Christiansen Wash, and Quitchupah Creek within the permit and adjacent areas. They estimated from this simulation that groundwater discharges at a rate of about 0.4 cfs from the Ferron Sandstone to alluvium. As indicated above, discharges from the Emery Mine have averaged 50 to 150% higher than this value, with this water all eventually discharging to Quitchupah Creek. Thus, although discharge in permit-area streams may be locally affected, the net effect of mine-water discharges is an increase in groundwater discharge to local streams above that experienced historically.

Within the general mine area, well discharges from the Ferron sandstone aquifer historically included the Emery municipal well (approximately 90 gpm) and the Bryant and Lewis wells (approximately 30 gpm each). The Emery municipal well is currently used only as a backup supply to the Town's main source of water (treated surface water). The Bryant and Lewis wells have been affected by underground mining in that they no longer flow at the land surface. Consol furnished and installed pumps and surface ancillary facilities in order to replace these water supplies. The pump in the Bryant well ceased functioning several years ago and the landowner decided that the well was no longer necessary to his operations. Therefore, the pump was pulled from the well in December 2018 to allow better access for the collection of water-level data. The Lewis well has been plugged and abandoned and is, therefore, no longer available to monitor. No further effect to these wells is anticipated from present mining operations, given the relative stability of water levels at these locations noted in Figure VI-5 and the fact that future mining is not currently anticipated in the western portion of the permit area near these wells. Given the distance of the Emery municipal well from the permit area, no impacts are anticipated from mining activities on this well.

Two springs are known to discharge from the Ferron Sandstone within the general mine area (see Plate VI-5). Spring SP-15 appears to discharge from the upper Ferron Sandstone and is appropriated for 0.1 cfs by Consol for stock watering purposes. Spring SP-16 appears to discharge from the lower Ferron sandstone and is unappropriated. The USGS measured the discharge of this spring in 1979 and found it to be issuing at 5 gpm.

Groundwater Quality:

A summary of water-quality analyses for groundwater samples (wells, springs and mine inflow) collected from the Ferron Sandstone in the permit and adjacent areas is presented in Table VI-8. Individual sample results are presented in Appendix VI-1. Groundwater-quality samples have historically been collected in the permit and adjacent areas from four wells completed in the upper Ferron Sandstone (the Bryant well, the Lewis well, and monitoring wells TP and USGS1-2), one spring issuing from the upper Ferron Sandstone (SP-15), two wells completed in the lower Ferron Sandstone (the Kemmerer well and monitoring well ZZ), and one well completed in both the upper and middle Ferron Sandstone (EMRIA2). The locations of these wells are noted on Plate VI-4. A review of historic groundwater quality data indicates that baseline groundwater conditions within each section of the Ferron Sandstone have been adequately defined prior to beginning full extraction operations.

The pH of groundwater in the Ferron Sandstone tends to be moderately alkaline, averaging 7.9 in the upper Ferron and 8.2 in the lower Ferron. Although only two groundwater samples from the Ferron Sandstone have been analyzed for acidity, several have been analyzed for alkalinity. These data indicate that the alkalinity of groundwater in the Ferron Sandstone exceeds the acidity by a factor of more than 5. Coupled with the alkaline pH, these data indicate that no substantial risk exists for acidic groundwater to be discharged from the Emery Mine.

The TDS concentration of water in the upper Ferron Sandstone is substantially lower than that of the overlying Quaternary deposits and Blue Gate Member, averaging approximately 1,600 mg/l in the upper Ferron and 690 mg/l in the lower Ferron. In the upper Ferron Sandstone, TDS concentrations tend to increase in the downgradient direction (from west to east), thus indicating the influence of recharging by fresher water from the Wasatch Plateau and natural leaching of salts as groundwater flows downgradient within the Ferron. Lines and Morrissey (1983) indicate that similar spatial variations in TDS concentrations occur in the lower Ferron Sandstone.

Temporal variations in TDS concentrations in the upper Ferron Sandstone are portrayed in Figure VI-10. The increase in TDS concentration at well USGS1-2 in mid-1989 occurred coincident with nearby mining activities (see Plate IV-2). Mine-related fractures in the overlying rock may have increased the hydraulic connection between the Ferron Sandstone and the more saline Blue Gate Member at this location, thereby locally increasing the TDS concentration of the upper Ferron Sandstone. However, similar changes are not evident at well TP, below which mining occurred in 1986. Hence, the effects of mining on TDS concentrations are likely localized.

Groundwater in the upper Ferron Sandstone tends to be a sodium sulfate type, while that in the lower Ferron is a sodium sulfate/bicarbonate type. The indicated differences in TDS concentrations and general chemistry, coupled with differences in water-level responses to mining (as discussed above), suggest at least some hydraulic separation between the upper and lower Ferron Sandstone.

VI.2.4.2 Surface Water Information

Streamflow

The Emery Mine is situated at the confluence of Quitchupah Creek and its tributary, Christiansen Wash. Quitchupah Creek is tributary to Ivie Creek which in turn is a tributary of Muddy Creek. Muddy Creek empties into the Dirty Devil River which flows into the upper Colorado River. Surface facilities associated with the Emery 2 portal will be constructed in an unnamed ephemeral wash that empties into Quitchupah Creek approximately 900 feet downstream from the confluence with Christiansen Wash and approximately 171 river miles upstream from the Colorado River.

Quitchupah Creek is a perennial stream whose headwaters in the eastern flank of the Wasatch Plateau are primarily sustained by snowmelt. Christiansen Wash, also a perennial stream, originates at lower elevation in the Wasatch Plateau north-northwest of the permit area. Given its lower elevation, Christiansen Wash receives less influence from snowmelt than Quitchupah Creek.

The ephemeral nature of the unnamed wash in which the Emery 2 surface facilities will be constructed was verified in an extensive study of that wash conducted in 2008. A copy of the resulting report describing baseline conditions in the wash is provided in Appendix VI-22. Given its ephemeral nature, this unnamed wash flows only sporadically in response to local, high-intensity precipitation.

A similar study was also conducted of two unnamed washes in Sections 30 and 31, T. 22 S., R. 6 E. That investigation, the results of which are presented in Appendix VI-23, concluded that these unnamed washes are also ephemeral. As a result, these unnamed tributaries also experience surface flow only sporadically in response to local, high-intensity precipitation.

Both Quitchupah Creek and Christiansen Wash receive additional flow in the vicinity of the mine from several sources unrelated to the Emery Mine, including:

- Direct irrigation return flow consisting of water whose source is primarily Muddy Creek;
- Irrigation-induced seepage from Quaternary pediment deposits;
- Groundwater discharging from the Ferron Sandstone;
- Water discharged from the Emery Mine; and

- Localized overland flow from storm events.

Quitchupah Creek also receives mine-water discharged from the SUFCO Mine at a point approximately 10 miles northwest (upstream) from the Emery Mine permit area. This discharge represents a substantial quantity of relatively high-quality water.

The assortment of influences affecting both Quitchupah Creek and Christiansen Wash creates considerable fluctuations in both streamflow and water quality. Streamflow data have been collected at least occasionally from the permit and adjacent areas at multiple locations as indicated on Plate VI-9. The U.S. Geological Survey maintained a stream gaging station on Quitchupah Creek, immediately above its confluence with Christiansen Wash (site S-24 on Plate VI-9) from July 1978 through September 1981 (see Appendix VI-11). Average monthly flow at this location during the period of record varied from 2.6 cubic feet per second ("cfs") in August and October to 17 cfs in May. Approximately half of this flow occurred in the months of March through June, presumably as a result of snowmelt runoff. A substantial amount of flow also occurred, on average, in September, probably from thunderstorm activity.

The USGS also maintained a stream gaging station on Christiansen Wash, immediately above its confluence with Quitchupah Creek (site S-14 on Plate VI-9), from August 1978 through September 1984 (see Appendix VI-3). Average monthly flow at this location during the period of record varied from 1.2 cubic feet per second ("cfs") in December to 6.9 cfs in June and July. Most runoff occurred in the period April through September, presumably as a result of snowmelt runoff and thunderstorm activity.

Daily streamflow data collected by the USGS from Quitchupah Creek and Christiansen Wash are presented in Figure VI-11. From these records, it is apparent that both streams experience a wide seasonal variation in flow as well as occasional flood events. Considerable fluctuation in streamflow is evident from day to day during the spring and summer months. This can be explained in the spring by fluctuations in temperature as it affects melting of the mountain snow pack. In the summer and fall, thunderstorms and man-induced irrigation influences are the most likely cause of daily variations in streamflow. In contrast, daily fluctuations are much less substantial during the winter months, when irrigation has stopped and snow is accumulating. Although the period of record on Quitchupah Creek and Christiansen Wash is too short to draw many definitive conclusions, daily variations in streamflow appear to be less extreme than in Christiansen Wash, probably as a result of the discharge of mine water to Quitchupah Creek.

The USGS has also maintained stream gaging stations on Ivie Creek and Muddy Creek for various periods of record at the locations noted on Figure VI-12. A summary of the data collected from these stations is provided in Appendix VI-11. Annual flow data collected by the USGS from these locations, as well as the Quitchupah Creek and Christiansen Wash stations, are summarized in Figure VI-13. As indicated, streamflow varies widely in the region on an annual basis. These annual variations are likely less extreme in Quitchupah Creek than in the surrounding streams, given the consistent discharge of mine water to Quitchupah Creek.

Muddy Creek serves as the main source of irrigation water in the region. This water is diverted primarily from a point approximately 20 miles northwest of the permit area. Additional points of diversion are located about 6 miles north and 4 miles northeast of the permit area. A comparison of flow measurements at up and downstream gaging stations on Muddy Creek indicates that this stream loses approximately 60 percent of its flow between the USGS gaging stations. This dramatic loss in flow is primarily due to the above-noted irrigation diversions.

Between October 1977 and July 1978, Conoco conducted a seasonal streamflow and water quality study along Quitchupah Creek and Christiansen Wash in order to determine seepage and water quality trends within the permit area. Stream gaging data from this investigation are presented in Table VI-9 and gaging sites are indicated on Figure VI-14.

These data indicate that increases in flow generally increased in the downstream direction on both streams. Substantial increases in flow generally occurred between sites "C" and "D" on Christiansen Wash where seepage from irrigation water enters from a tributary. Flow also generally increased between sites "G" and "H" on Quitchupah Creek, where a tributary carrying irrigation return flow and seepage enters. Less consistent fluctuations in flow, including both gains and losses, were measured between the other sites on both streams. These gains and losses may reflect various contributions from groundwater and irrigation return flows, as well as seepage losses to the alluvium. In addition, man-induced and natural streamflow fluctuations during the time period between stream gaging at the various sites may account for some of the apparent gains and losses.

The USGS has also conducted seepage studies along Quitchupah Creek and Christiansen Wash. Available data are given in Table VI-10, with data collected from the locations noted in Figure VI-15. Within the vicinity of the Emery Mine, these data validated the results drawn from the Conoco study, indicating a general downstream increase in flow on both streams.

Due to the complexity of the surface water hydrology of both Christiansen Wash and Quitchupah Creek, it is difficult to determine the individual contributions to streamflow of irrigation return flows and seepage, natural discharge from the Ferron Sandstone, overland flow, and losses to seepage into alluvium. Only the discharges from the mine are practical to measure separately. These data were presented previously in Figure VI-9.

Several small impoundments have been constructed in the permit and adjacent areas to capture water for livestock use. No water rights have been filed on these impoundments. The impoundments capture water from surface runoff local to each pond.

The Emery Mine has eight discharge monitoring points that are regulated under permit number UT0022616 of the Utah Pollutant Discharge Elimination System ("UPDES"). These points are described in Table VI-11 and located as shown on Plate VI-4. Data collected from these points are contained in Appendix VI-12. Consistent discharges have occurred only at UPDES points 001 and 003, where water is discharged from the underground workings. Discharge from UPDES points 001 and 003 has not occurred since August 2011 and October 2015, respectively. Average flow rates associated with these discharge points were presented in Figure VI-9. Eight discharge events, ranging from 100 to 630 gallons per minute, have occurred since 1991 at UPDES point 004. Discharge at this point also represents mine water which is used by a local farmer for irrigation. Discharge has occurred at UPDES point 007 on two occasions since 1994. This pond was constructed in an area initially intended to be the site of a coal preparation plant. The preparation plant was not constructed and no disturbed area drains to the pond, other than that associated with the pond itself. No discharges have occurred from any of the other UPDES points since monitoring began.

Surface Water Quality

Surface water-quality data have been collected from several locations within the permit and adjacent areas, including those locations identified on Plates VI-4 and VI-9. Given the sporadic nature of flow in ephemeral stream channels, water-quality data have not been collected from the unnamed ephemeral wash in which the Emery 2 surface facilities will be constructed. However, sampling equipment will be installed in this wash for the collection of water-quality data up- and downstream from the surface facilities as discussed in Section VI.3.1.2.

The U.S. Geological Survey conducted a water-quality study on Quitchupah Creek from July 1975 through September 1976, collecting samples at site S-18 (See Plate VI-9) where State Highway 10 crosses Quitchupah Creek and at site S-29 on Quitchupah Creek where it joins Ivie Creek. Water-quality analyses for these sites are summarized in Appendix VI-13. Increases in concentration are typical between these two sampling sites, with pH increasing slightly from an average of 8.1 to an average of 8.3; TDS increasing from an average of 939 to an average of 2406 mg/l, and the sodium adsorption ratio ("SAR") increasing from an average of 2.2 to an average of 5.5. The water also changed from a mixed type at S-18 (with Ca, Mg, and Na, being the dominant cations and sulfate and bicarbonate being the dominant anions) to a strongly sodium sulfate type at S-29. At site S-18, the specific conductance of 1346 µmhos/cm at 25°C and SAR of 2.2 classify the water as high salinity, low sodium water which may be used for irrigation of plants with good salt tolerance grown in well drained soils (U.S. Department of Agriculture, 1954). At site S-29, the specific conductance of 3078 µmhos/cm at 25°C and SAR of 5.5 classify the water as very high salinity, medium sodium water which is not suitable for irrigation under ordinary conditions.

Data collected by the USGS on Muddy Creek and its tributaries in the 1970s are also presented in Appendix VI-13. At sample location S-1 located about 6 miles north of the permit are (see Plate VI-9), the quality of water in Muddy Creek was found to be very good, with an average TDS concentration of 212 mg/l. Calcium and magnesium were the dominant cations, while bicarbonate was the dominant anion. The SAR of 0.23 and a mean lab specific conductance of 417 µmhos/cm at 25°C classify this water as medium-salinity, low sodium water suitable for irrigation of plants with moderate salt tolerance. Downstream at site S-5 before its confluence with Ivie Creek, Muddy Creek's water is noticeably more saline, with a mean TDS concentration of 3065 (see Appendix VI-13). Sodium has become the dominant cation and sulfate the dominant anion. The mean lab conductance of 3584 µmhos/cm at 25°C and a SAR of 6.6 classify the water as very high salinity, medium-sodium water which is not suitable for irrigation under ordinary conditions. At site S-6, Ivie Creek dilutes Muddy Creek's waters slightly such that the mean TDS concentration decreases to 2306 mg/l. The water remains a sodium sulfate type, similar to the downstream end of Muddy Creek.

Site S-7 represents water collected from a canal carrying water from Muddy Creek. The quality of this water is very similar to that of Muddy Creek at site S-1. This canal and its associated laterals service the entire Emery area, diverting water from a location near S-1. Thus, the chemical quality of waters sampled at S-1 and S-7 are probably very representative of all irrigation waters in the Emery area.

On three occasions in the late 1970s, Consol conducted water-quality studies on Quitchupah Creek and Christiansen Wash to determine trends along these streams. Grab samples were collected at 19 of the sites indicated on Plate VI-9, with the resulting data contained in Appendix VI-13. These studies indicated that TDS concentrations in Quitchupah Creek increased in the downstream direction, largely as a result of irrigation return flows, seepage from the tributary sampled at site S-20, and mine-water discharges. At this time, the Emery Mine discharged its water into this tributary below site S-20. Notably, Quitchupah Creek after its confluence with Christiansen Wash contained a considerably smaller ionic concentration than that measured in either stream just upstream from the confluence. This decrease in concentrations was probably due to dilution via groundwater inflow from the Ferron Sandstone.

Concentrations of dissolved constituents were also found to increase in the downstream direction in Christiansen Wash above site S-12 as a result of runoff and irrigation return flow south of Emery. Below site S-12, which represents groundwater seepage from the Ferron Sandstone, water quality in Christiansen Wash improves towards its confluence with Quitchupah Creek due to dilution from the groundwater inflow.

Between October 1977 and July 1978, Conoco collected grab samples in conjunction with a stream gaging program along Christiansen Wash and Quitchupah Creek. These data, which are presented in Appendix VI-13, are consistent with the findings of the previously-cited water-quality studies. These investigations also found that total suspended solids concentrations in both Quitchupah Creek and Christiansen Wash are inversely related to streamflow, being generally less than 200 mg/l except during the spring and early summer months when flows are high.

Routine surface water monitoring in the permit and adjacent areas began at several locations in 1979, with the monitoring network being expanded in later years as needed. Data collected from these stations (Plate VI-4), together with statistical analysis of the data, are provided in Appendix VI-5 and summarized in Table VI-12. These data confirm the conclusions drawn from the previously cited short-term studies on water quality types and trends for both Quitchupah Creek and Christiansen Wash.

Routine monitoring data show that Quitchupah Creek can generally be characterized as a sodium sulfate water, becoming more saline in the downstream direction. At Surface Water Monitoring Site ("SWMS") 1A, the average TDS concentration during the period of record has been 908 mg/l (near the upstream edge of the permit boundary). This concentration increases to an average of 1259 at SWMS-1, an average of 1386 mg/l at SWMS-4, and an average of 1445 at SWMS-3 (near the downstream edge of the permit boundary.

Based on the average flows and average TDS concentrations for these sampling sites (see Appendices VI-12 and VI-5), the salt load of Quitchupah Creek has increased an average of 11.2 tons per day ("TPD") between SWMS-1A and SWMS-1 during the period of record (see Table VI-12). Mine water is discharged to Quitchupah Creek between these sampling sites, with the salt load from this mine-water discharge outfall averaging 4.1 TPD during the period of 2000 through 2006 (see data for UPDES discharge point 003). The remaining increase in salt load in this reach of Quitchupah Creek (averaging 7.1 TPD) is attributed to irrigation return flows and natural leaching of saline bedrock and colluvium, particularly that associated with the Blue Gate Member.

The average salt load of Quitchupah Creek also increases (by 8.1 TPD) between SWMS-1 and SWMS-4. A tributary enters Quitchupah Creek between these sites, carrying irrigation return flows (sampled at SWMS-8, contributing 1.4 TPD) and water discharged from the mine (sampled at SWMS-6 [UPDES outfall 001], contributing 2.0 TPD [see Appendix VI-12]). Again, the remaining increase in salt load (4.9 TPD) is attributed to irrigation return flow and natural leaching of saline deposits. The salt load of Quitchupah Creek increases substantially at SWMS-3, primarily due to inflow from Christiansen Wash (see data at SWMS-2 and SWMS-5), which is not impacted by mine-water discharges. Thus it is evident that, while mine-water discharges increase the salt load of Quitchupah Creek, the majority of the salt-load increase in this stream occurs from irrigation return flows and leaching of naturally-saline deposits.

TDS concentrations are generally highest in local streams during periods of low flow, when dilution is at a minimum. Total suspended solids concentrations, on the other hand, tend to be highest in stream during periods of high flow, when streamflow energy is greatest. Mine water concentrations of dissolved and suspended solids show no seasonal variations.

The pH of surface water in the permit and adjacent areas is moderately alkaline. Total iron and manganese concentrations tend to correlate positively with suspended sediment concentrations, as would be expected. All streams included in the routine monitoring network (Quitchupah Creek, Christiansen Wash, and Ivie Creek) can be classified as magnesium-sodium sulfate type at the upstream-most station and strongly sodium sulfate type at downstream stations.

VI.2.4.3 Geologic Information

Geologic information related to the permit and adjacent areas is presented in Chapter V of this MRP. This information is also briefly discussed in this chapter as an aid in understanding hydrologic conditions in the permit and adjacent areas.

VI.2.4.4 Climatological Information

Climatological information is presented in Chapter X, Part B of this MRP.

VI.2.4.5 Supplemental Information

No supplemental information is required at this time.

VI.2.4.6 Survey of Renewable Resource Lands

The existence and recharge of aquifers in the permit and adjacent areas is discussed in Section VI.2.4.1 of this MRP. A description of the probable hydrologic consequences of subsidence on these aquifers and their recharge areas is provided in Section VI.2.8 of this MRP.

VI.2.4.7 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the permit and adjacent areas is presented in Chapter XI of this MRP.

VI.2.5 Baseline Cumulative Impact Area Information

The hydrologic and geologic information required for the Division to develop a Cumulative Hydrologic Impact Assessment is presented in Chapters V and VI of this MRP. Required information not available in these chapters is available from the Utah Division of Water Rights, the Utah Division of Water Resources, the U.S. Geological Survey, and the U.S. Bureau of Land Management.

VI.2.6 Modeling

Numerical and analytical groundwater modeling were conducted to assist in determining the probable hydrologic consequences of mining in the permit area. A discussion of these modeling efforts is presented in section VI.2.8 of this MRP.

VI.2.7 Alternative Water Source Information

No surface coal mining has been or will be conducted in the permit and adjacent areas. Therefore, this section does not apply to the Emery Mine.

VI.2.8 Probable Hydrologic Consequences

This section addresses the probable hydrologic consequences of coal mining and reclamation operations in the mine permit and adjacent areas. Mitigating measures are discussed generally in this section and in detail in subsequent sections of this MRP.

VI.2.8.1 Potential Impacts to Surface and Groundwater

The following potential impacts of coal mining on the quality and quantity of surface and groundwater flow within and adjacent to the Emery Mine permit area were evaluated:

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

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

VI.2.8.2 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter V of this MRP. Baseline hydrologic information is presented in Sections VI.2.4 of this MRP.

VI.2.8.3 PHC Determination

Potential impacts to the hydrologic balance are addressed below.

Contamination from Acid- or Toxic-Forming Materials. Information concerning acid- and toxic-forming materials in rock at the Emery Mine is presented in Sections V.A.4 through V.A.6 of the MRP. As noted, the pH of roof and floor materials ranges from 5.0 to 9.1, with the acid-base potential indicating a net base potential. The alkaline nature of the system is further indicated by the fact that the pH of groundwater in the area is typically alkaline (see Section VI.2.4.1).

Except near outcrops, the electrical conductivity of the rock is generally low. However, naturally-occurring sodium adsorption ratios and exchangeable sodium percentages of the rock are moderately high. As a result, sodium adsorption ratios calculated from the data presented in Appendix VI-1 suggest that groundwater discharged from the mine may have a low to medium sodium hazard if that water is used for irrigation without further treatment. Analyses of rock samples presented in Section V.A.4 indicate that concentrations of trace elements are generally sufficiently low that the rock can be considered non-toxic forming. Thus, with the exception of moderate sodium concentrations in some samples, analytical data obtained from the local rock and mine-water discharges indicate that no significant potential exists for the contamination of surface and groundwater in the permit and adjacent areas by acid- or toxic-forming materials.

Increased Sediment Yield from Disturbed Areas. Mining and reclamation at the Emery Mine has the potential to increase sediment concentrations in the surface waters downstream from disturbed areas. However, sediment-control measures such as sedimentation ponds, diversions, etc. have been installed to minimize this impact. These facilities have been designed to meet applicable regulatory requirements and are regularly inspected and maintained to ensure that they continue to meet those standards (see Sections VI.3 and VI-4).

No discharges have occurred from the Emery Mine sedimentation ponds during their period of operation, other than two incidences of discharge from pond 5 (UPDES outfall 007). This pond was constructed in an area initially intended to be the site of a coal preparation plant. The preparation plant was not constructed and no disturbed area drains to the pond, other than that associated with the pond itself. Thus, the sediment-control measures at the mine are effective at minimizing sediment yields to adjacent streams.

Impacts to Groundwater Availability. As noted previously in this chapter, coal at the Emery Mine occurs in the Ferron Sandstone Member of the Mancos Shale. In the upper Ferron, sandstones are lenticular, channel-shaped bodies that are generally less than 40 feet thick. These channel sandstones are characterized by unidirectional cross-stratification, fining-upward cycles, and lateral interfingering with mudstones. The middle and lower Ferron consists of thin-bedded sandstone and shale at the base that grade upward to thick, cliff-forming sandstones.

The Ferron Sandstone outcrops in a series of prominent cliffs along the eastern edge of the Emery coal field and dips 2 to 10˚ to the northwest beneath the ground surface. The continuity of the Ferron is broken in the subsurface by the Paradise Valley-Joes Valley fault zone, which exists immediately northwest of the permit area. This fault zone extends for about 60 miles northeast and 20 miles southwest of the mine area (Hintze, 1980). A comparison of Plates VI-1 and VI-7 with Plates V-19 through V-22 indicates that the Emery Mine has historically operated within the saturated zone, except along the outcrop to the east and where water levels have been locally altered due to mining activities.

Morrissey et al. (1980) indicate that recharge to the Ferron Sandstone originates in the Wasatch Plateau west of the Emery Mine and discharges to the southeast along the Paradise Valley-Joes Valley fault zone. Hence, this fault zone effectively acts as a linear source of groundwater recharge to the Ferron Sandstone. Groundwater has the potential to enter the Emery Mine through both the floor and roof from permeable, saturated sandstones. Hydrographs of water-level data collected from monitoring wells at the mine (Figures VI-4 through VI-7) show that water level declines have been experienced in all three sections of the Ferron Sandstone and also in the Blue Gate Member. However, data presented in Plates VI-7 and VI-8 indicate that water levels in the upper Ferron Sandstone have been affected to a greater degree than the lower Ferron Sandstone. Significant upward leakage from the middle and lower Ferron is impeded by shales that constitute the floor of the mine. In-mine observations have verified that most inflow to the mine occurs from the roof rather than the floor.

As water flows into the mine, the flow pattern within the Ferron Sandstone is altered. These conditions in turn induce groundwater level declines in the area. Since the principal avenue of inflow to the mine is through the roof of the workings, the upper portion of the Ferron Sandstone is most subject to water level declines.

Average discharge from the Emery Mine during the period of 1979 through 2015 is shown in Figure VI-9 (see also Table VI-7). No data are available for the years prior to 1979. Discharge from the mine continued through a period of temporary shutdown (1991 through 2001) when Consol pumped water to maintain the mine in an accessible condition. Since pillars were pulled prior to the 1991 temporary shutdown, the mine-water discharge during this period is anticipated to be predictive of full-extraction, post-subsidence conditions.

The long-term effect of mining on groundwater availability in the permit and adjacent areas was determined using mass balance calculations and groundwater modeling. The mass balance approach relied on the following water balance equation:

Outflow = Inflow + Change in storage

Direct recharge from precipitation to the Ferron Sandstone is limited in the mine area, given the low amount of precipitation (averaging about 8 inches annually) and the presence of the relatively impermeable Blue Gate Member covering the Ferron Sandstone throughout most of the permit area. This condition of unsubstantial drainage to the mine from shallow aquifers will likely continue following full extraction. According to Kendorski (2006), an aquicludes zone generally develops above the caved and highly fractured zones affected by full extraction mining. This intermediate compressional zone subsides coherently with only minor fracturing. Although groundwater storage in this zone may increase, “no direct or effective hydraulic connection to lower strata or the mine” occurs. Thus, although surface fractures may be evident in the Blue Gate Member following subsidence, it is not anticipated that substantial changes will occur to the hydraulic connection between this layer and the underlying Ferron Sandstone.

As a result, subsurface inflow to the permit area will continue after full extraction to occur~~s~~ predominantly from groundwater that flows from the Paradise Valley-Joes Valley fault zone into the Ferron Sandstone and then toward the mine. Outflow occurs when groundwater is either pumped from the mine or used underground for various purposes (i.e., dust suppression, equipment cooling, etc.) and then removed from the mine as moisture in the coal or in the mine air.

Groundwater inflow to the mine occurs either horizontally (due to the mine being within the flow path) or vertically (due to gravity drainage from the immediately overlying sandstone into the mine void). These conditions are depicted on Figure VI-8 and described in Section VI.2.4.1.

For the mass-balance analysis, it was assumed that the steady state condition identified in Figure VI-8(c) was reached during the several-year shutdown period of 1991 through 2001. Under this condition and assuming no substantial change in underground water storage in the mine during the shutdown, water discharged from the mine during this period would equal the amount of predominantly horizontal inflow to the mine. Data contained in Table VI-7 indicate that discharge from (and therefore horizontal inflow to) the mine during the shutdown period averaged 1.03 cfs. Since groundwater flows horizontally out of the Paradise Valley-Joes Valley fault zone toward the mine, the amount of water flowing into the mine would be a function of the length of mine workings parallel (i.e., exposed) to the fault zone. During the temporary shutdown, this length was 2.17 miles (see Plate IV-2), resulting in a ratio of *horizontal inflow* per unit length of mine exposed to the groundwater flow path of 0.47 cfs/mi. This value was used to predict future quantities of horizontal inflow to the mine as the mine expands.

Following the restart of mining in 2002, some groundwater encountered in the mine was used underground by the mining equipment. The quantity of water used underground was assumed to equal the difference between the mine-water discharge during the period of inactivity (1.03 cfs) and the mine-water discharge following the restart of mining (averaging 0.63 cfs from 2002 through 2005 – see Table VI-7). Since full extraction was not occurring during this period, the difference would be indicative of in-mine usage only (i.e., not influenced by increased inflows due to mine subsidence). Hence, in-mine water usage averaged 0.40 cfs from 2002 through 2005. This value for in-mine water usage compares reasonably with average water usage during a period of full extraction.[1] With an average annual mined area of 42.5 acres from 2002 to 2005 (see Plate IV-2), *in-mine water usage* is estimated to be 0.009 cfs/acre under operational conditions. This value was used to predict future quantities of in-mine water usage as the mine expands.

Although vertical inflow to the mine is likely limited in areas that were mined prior to 1991 (due to the development of steady-state conditions noted in Figure VI-8(c)), a condition more like Figure VI-8(b) probably existed in areas mined during the period of 2002 through 2010 (i.e., components of both vertical and horizontal inflow as the mine expands unto areas where the groundwater has not yet reached static equilibrium). Conditions similar to Figure VI-8(b) are also likely for future operations in the Emery Mine. Under these conditions, it was necessary to estimate the vertical component of inflow to the mine. This was accomplished using two analytical methods, assuming full-extraction conditions, and then comparing the results to pre-1991 conditions to determine the method that most accurately predicts conditions at the mine site.

Each method is limited in its application to simplified flow situations, assuming that the aquifer is of infinite areal extent with uniform thickness. The first method used to estimate vertical mine-water inflow was the tunnel inflow equation presented by Freeze and Cherry (1979). This method assumes that the mine acts as an infinitely long tunnel in a homogeneous, isotropic porous medium. Under this assumption, the rate of ground water inflow Q_o per unit length of mine can be calculated using the following equation:

$$Q_o = \frac{2\pi K H_o}{2.3\log(2H_o / r)}$$

where r is the mine radius, H_o is the depth from the potentiometric surface to the center of the mine, and K is the hydraulic conductivity, with all units being compatible.

The second method used to estimate vertical mine-water inflow was the Hantush equation presented by Singh and Atkins (1985). This equation, which assumes that the aquifer is homogeneous, isotropic, and pumped at a constant rate, is applied to large underground openings as illustrated in Figure VI-16. Inflow to the mine is calculated by:

$$Q = 2\pi TDG(\lambda, r / B)$$

$$\lambda = Tt / r^2 S$$

$$r / B = r(K' / KLL')^{\frac{1}{2}}$$

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[1] The average rate of mine-water discharge during 2006 through 2010 (a period of full extraction) was 1.29 cfs. The average rate of mine-water discharge during 2011 and 2012 (temporary shutdown period when Consol was actively controlling water levels in the mine) was 1.75 cfs. The difference between these two rates was 0.46 cfs, representing the approximate quantity of water used by underground operations during a period of full extraction.

where B is the leakage factor; D is drawdown to a level H from the original head H_o; $G(\lambda,r/B)$ is the Hantush well function; K is the aquifer hydraulic conductivity; K' is the aquitard hydraulic conductivity; L is the thickness of the formation being dewatered; L' is the aquitard thickness, Q is the quantity of inflow; r is the radius at which drawdown occurs; and t is elapsed time, with all units being compatible.

Vertical inflow to the mine was estimated using the two methods described above for the period of 1980 through 1990 when Figure VI-8(b) was again assumed to represent mine hydrologic conditions (i.e., prior to attaining steady-state conditions during the temporary shutdown). Assuming no change in water storage in the mine (i.e., discharge is equal to inflow), and accounting for lateral groundwater inflow and in-mine water usage as outlined above, these calculations were then compared with measured discharge rates during the same period. Based on these calculations, the best approach for estimating future conditions was selected.

Preliminary calculations using the two methods indicated that the Hantush equation was a much better predictor of *vertical mine-water inflow* than was the tunnel inflow equation. To more accurately predict inflow, the average post-subsidence hydraulic conductivity of the aquifer was therefore derived by calibration using the Hantush equation, attempting to mimic measured discharge rates as closely as possible. The average hydraulic conductivity of the Ferron Sandstone overlying the coal seam was thereby determined to be 0.20 ft/day. This value compares well with aquifer data presented previously in this chapter and independent data presented by Lines et al. (1983). Assuming an aquifer thickness of 400 feet (based on a review of Plate V-20), the transmissivity data presented in Table VI-6 convert to hydraulic conductivities ranging from 0.01 to 2.0 ft/day and averaging 0.6 ft/day. Laboratory hydraulic conductivity data provided by Lines et al. (1983) ranged from 2.6×10^{-6} to 0.77 ft/day, averaging 0.11 ft/day in the horizontal direction and 0.076 ft/day in the vertical direction. Hydraulic conductivities derived from field tests summarized by Lines et al. (1983) ranged from 0.025 to 2.0 ft/day, averaging 0.55 ft/day (again assuming an aquifer thickness of 400 feet).

Results of the mine-water inflow/discharge calculations for the period of 1980 through 1990, using the Hantush and tunnel inflow equations, are summarized in Table VI-13 and Figure VI-17 and detailed in Appendix VI-14. Each set of calculations accounted for lateral groundwater inflow and in-mine water usage, and assumed that no change in underground water storage occurred during the period of interest (i.e., that discharge was equal to inflow). The equations were able to account for varying inflow as the mine expanded since vertical inflow was assumed to enter the mine only in the area of current mining. As indicated in Table VI-13 and Figure VI-17, the Hantush equation provides a reasonable estimate of mine water discharge. Hence, this equation was used to predict future mine-water discharge rates under the mass-balance approach, again assuming post-subsidence conditions.

As noted above, the average hydraulic conductivity of the upper Ferron Sandstone was calibrated using the Hantush equation to be 0.20 ft/day assuming full extraction conditions. Elsworth and Liu (1995), Booth and Spande (2012), and Newman et al. (2017) report that hydraulic conductivities in sandstone adjacent to the mine works tend to increase by one to two orders of magnitude due to mining subsidence. Thus, for the sake of this analysis, the pre-subsidence hydraulic conductivity of the Ferron Sandstone was assumed to be one order of magnitude lower than the calibrated post-subsidence value (i.e., a pre-subsidence value of 0.02 ft/day). It was assumed that this hydraulic conductivity would be representative of areas in which only first mining would occur (i.e., in mains and in areas where surface subsidence effects are to be avoided).

~~Predicted mine-water discharge rates through 2013 (the mine plan period at the time of the calculation) are summarized in Table VI-14, based on the Hantush equation and accounting for mine-water inflow and usage as described above. These calculations again assume that no substantial change in underground water storage will occur during the period of evaluation (i.e., discharge is equal to inflow). Spreadsheets detailing these calculations are provided in Appendix VI-14. Based on these calculations, discharge rates were expected to average 1.50 cfs, ranging from about 1.3 to 2.0 cfs during the calculation period while fully extracting the coal. In fact, during the full-extraction period of 2006 through 2010, mine-water discharge rates averaged 1.29 cfs, ranging from 1.12 to 1.86 cfs. Thus, the calculation approach slightly over-predicts discharge rates. Variations in discharge rates are anticipated depending on the depth of mining below the potentiometric surface and the area over which mining will occur. These estimates were based on the assumed hydraulic conductivity of 0.20 ft/day (i.e., the calibrated value arrived at in the comparison with measured historic discharge rates). Since pillars had been pulled prior to the 1991 temporary shutdown, this hydraulic conductivity is assumed to be indicative of average post-subsidence conditions. Hence, the estimates presented in Table VI-14 are considered adequate predictors of full extraction conditions.~~

~~The mine plan currently does not anticipate full extraction of the coal accessed by the Emery 2 portal. It is assumed under this condition that in-mine water usage will continue to amount to 0.009 cfs/acre of mined area (i.e., equivalent to the average unit-area usage in the Emery Mine during the period of 2002 through 2005 prior to pillaring).~~ Until sufficient groundwater is encountered underground, it is currently planned that this operational water will be obtained by leasing waster from a user with an existing right on Quitchupah Creek. This water will be pumped from the creek with temporary equipment. To allow this temporary use of water to occur, an Application for Temporary Change of Water has been filed with the Utah Division of Water Rights to change the point of diversion and use of water right 94-1178 from irrigation and stockwatering to mining. A copy of this change application is provided in Appendix VI-4. Should currently-unforeseen conditions necessitate a quantity of water beyond that anticipated by the aforementioned Application for Temporary Change of Water, Bronco may choose to obtain additional water from a temporary right to divert water from Quitchupah Creek, by leasing additional water from a user with an existing right on Quitchupah Creek, by purchasing municipal water from the Town of Emery (under the arrangement through which the mine currently purchases water for potable use and fire suppression), or by utilizing water from Emery Mine Borehole #1 (water right number 94-285). If water is obtained from Quitchupah Creek, this water will be pumped from the creek with temporary equipment. If water is obtained from Emery Town or Borehole #1, this water will be trucked to the Emery 2 ~~site~~ portal for use.

The applicant will use no water associated with the Emery ~~2~~ Mine operations unless it has a right to use that water. If water is diverted from Quitchupah Creek, this right would consist of either a temporary right issued by the Utah Division of Water Rights directly to Bronco or a legally-valid lease of all or a portion of an existing water right on Quitchupah Creek for which a temporary change in point of diversion and use has been approved by the Utah Division of Water Rights. If water is obtained from the Town of Emery, this water will be regulated by water rights held by the Town and purchased by Bronco. If water is obtained from Borehole #1, the use of this water will occur under water right number 94-285, which is held by Bronco (see Table VI-1).

Eventually, sufficient water will be encountered underground that in-mine water will be used for this purpose. When the quantity of groundwater encountered exceeds the quantity required for underground operations, excess groundwater will be pumped from the Emery ~~2~~ Mine works into the existing works via a horizontal borehole within the underground operations or a vertical borehole in an existing surface disturbed area (i.e., without creating additional surface disturbance). This excess groundwater will then be discharged from the old mine works via existing pumps to Pond 1 or Pond 3 and from thence to Quitchupah Creek in accordance with UPDES permit UT0022616 issued by the Utah Division of Water Quality. Once sufficient water is encountered underground that additional water will not be required from the surface, the use and handling of this water will be regulated by existing rights held by Bronco (water right numbers 94-64 and 94-285).

To estimate the potential inflow of groundwater to mine works accessed by the Emery 2 portal, potentiometric surface data provided on Plate VI-7 were compared with ~~bottom~~top-of-coal elevations presented on Plate V-20. The results of this comparison are presented on Plate VI-6. ~~Although Plate VI-7 is based on data collected in 2006, these data are considered sufficient for this analysis throughout the first 2 years of projected Emery 2 mining since underground operations prior to the December 2010 temporary mine shutdown were conducted in areas that were generally 1 to 2 miles north and east of the future Year 1 and Year 2 mine panels. Water-level data collected from wells Muddy #1 and AA(U) indicate that the elevation of the potentiometric surface was not substantially affected by mine dewatering in the area of the future works after 2006 (see data presented in Figure VI-5). The estimated depth of groundwater shown on Plate VI-6 was adjusted upward in the Year 3 and Year 4 mine panels, based on professional judgment, since data collected from the Pump 3 monitoring well indicates that the cone of depression noted on Plate VI-7 has recovered over 100 feet since pumping ceased.~~

Estimates of the quantity of groundwater expected to flow into and be discharged from mine areas access by the Emery 2 portal are presented in Appendix VI-14 and summarized in Table VI-22. As indicated, it is predicted that water will be required from surface sources for~~ at least the first two years of mining~~ up to three years in areas access by the Emery 2 portal. Thereafter, as the underground mining operation dips deeper beneath the potentiometric surface and closer to the Joes Valley Fault to the west, it is predicted that sufficient underground water will be encountered to require excess water to be pumped to the surface.

Inflow of water to and discharge of water from the mine will continue to influence the shape of the potentiometric surface in the vicinity of the mine. As a result, it is anticipated that the cone of depression noted on Plate VI-7 will change as mining continues. To predict the impact of mining on groundwater levels in the permit and adjacent areas, Consol modeled groundwater conditions in the permit and adjacent areas using the software package MODFLOW. A description of the groundwater modeling effort is presented in Appendix VI-15.

A main purpose of the modeling effort summarized in Appendix VI-15 was to assess the potential impact of mining operations on groundwater availability in the town of Emery. The model assumed that all areas of mining would be fully extracted. A comparison of Figure 1 in Appendix VI-15 with the exiting and projected mine works shown on Plate VI-6 indicates that

1. Although much of the western block of coal was mined, the majority of that block was not~~The model assumed more areas of~~ fully-extracted,~~ coal on the north side of the mine works than actually occurred and~~
2. The northwest portion of the eastern block of coal (i.e., that originally planned for mining in 2013 through 2016) was more extensive than currently planned, and~~unmined areas of full extraction assumed by the model area approximately equal to the area to be mine in Years 3 through 5 (i.e., those portions closest to the town of Emery) without full extraction~~

~~2.~~3. The majority of the eastern block of coal that has been mined was not fully extracted.

Therefore, the MODFLOW results summarized in Appendix VI-15 likely over predict the impacts of anticipated mining on groundwater availability in the vicinity of Emery.

Groundwater in the permit and adjacent areas was modeled using three layers: 1) the Blue Gate Member (where present), 2) the upper Ferron Sandstone, and 3) the "I" coal seam horizon. Geologic structure data were imported into the model to simulate strike, dip, and thickness of the various units. Figure 2 in Appendix VI-15 shows the model in plan view and Figure 3 in Appendix VI-15 shows the model in cross section. Groundwater conditions within the coal seam were simulated using extremely high hydraulic conductivity values for the mine works and low conductivity values for the solid coal surrounding the mine. The initially assumed hydraulic properties of the Blue Gate Member and the Ferron Sandstone were estimated from aquifer tests performed in monitoring wells in the vicinity of Emery Mine. These values were adjusted during calibration to approximate actual mine inflow rates. The initial head values used in the model were based on 2007 groundwater levels in both the Blue Gate Member and the upper Ferron Sandstone. Mine inflow and potentiometric surface changes were predicted from the period of June 2007 through December 2016 (the projected life of mine at the time of modeling).

Three scenarios were run with MODFLOW to approximate a range of future conditions. To simulate worst-case inflow, it was assumed that groundwater levels in the upper Ferron Sandstone do not change in the future (i.e., that the vertical head over the mine remains unchanged beyond 2007). The conservative nature of this set of assumptions is evidenced by the fact that water levels in the upper Ferron Sandstone *have* declined in the vicinity of the mine as mining has progressed, thereby decreasing the head above the mine and the transmissivity of the aquifer.

As a worst case drawdown evaluation, it was assumed that groundwater levels in the upper Ferron Sandstone are allowed to decline as mining progresses. Since water-level declines will likely continue as mining progresses, this scenario is considered more realistic than the worst case inflow scenario discussed above.

As an independent check to the modeled inflows, a relatively simple calculation of predicted inflow based on unit-area inflows measured in the 1st and 2nd South pillared area was used and applied to the remaining areas to be mined. However, since the 1st and 2nd South areas of the mine are near the outcrop, this unit-area approximation may not be representative of the deeper portions of the mine.

The results of the MODFLOW evaluation are summarized in Table VI-15. Predicted mine-water inflow rates under the worst-case drawdown scenario agree reasonably well with the mass balance estimates presented in Table VI-14. These inflow estimates are also considered most realistic since drawdown is expected to continue to occur in the future, based on past observations.

Figure VI-18 shows the predicted potentiometric surface under the worst-case drawdown scenario for the upper Ferron Sandstone at the end of the modeled year 2016 (when all planned mining was to have been completed). With all mining upon which this model was based ceasing in the area in December 2010 and with a substantial decrease in mine-water pumping rates in 2013 and shut-down of mine-water pumping operations in January 2916, the model likely over predicted actual groundwater impacts to the region.

A comparison of Plates VI-1 (1979 data) and VI-7 (20~~06~~18 data) indicate that the potentiometric surface of the upper Ferron Sandstone has been affected by past mining. As would be expected, declines in this groundwater surface have been most pronounced within the permit area, with decreasing effects away from the mine workings. Whereas Plate VI-1 indicates that groundwater in the upper Ferron Sandstone flowed generally southeastward through the permit area prior to significant mining, the trough of depression caused by mine dewatering causes groundwater to flow toward the center of the permit area under current conditions (see Plate VI-7). This trough of depression extended throughout the permit and much of the adjacent areas in 2006. The groundwater modeling results indicate that the area of impact to groundwater levels will likely continue to extend throughout the permit and immediately adjacent areas into the future as long as mine dewatering continues.

The effect of mining on groundwater levels in the lower Ferron Sandstone is much less pronounced than in the upper Ferron Sandstone. Although groundwater levels at individual wells in the middle and lower Ferron Sandstone have dropped over 100 feet since mining began (see Section VI.2.4.1), a comparison of Plates VI-2 (1985 data) and VI-8 (20~~06~~18 data) indicates that the general shape and elevations of the potentiometric surface in the lower Ferron Sandstone have remained quite similar between 1985 and 20~~06~~18. These observations, together with the results of the groundwater modeling effort, suggest that the effects of mining on the potentiometric surfaces within the Ferron Sandstone will decrease in the following order: upper Ferron>middle Ferron>lower Ferron.

Data presented in Appendix VI-15 indicate that the potentiometric surface of the upper Ferron Sandstone will gradually return to pre-mining conditions once pumping ceases. Whereas maximum drawdowns of 350 to 400 feet have occurred in the upper Ferron Sandstone in the center of the permit area during the mining period (compare Plates VI-1 and VI-7), it is predicted that groundwater levels will recover to within 50 to 60 feet of pre-mining conditions approximately 10 years after cessation of pumping from the mine (compare Plate VI-1 with Figure 5 in Appendix VI-15). It is further predicted that groundwater levels in the upper Ferron Sandstone will recover to within about 30 feet of pre-mining conditions throughout most of the permit area within 20 years following cessation of pumping operations (compare Plate VI-1 with Figure 6 in Appendix VI-15).

Artesian conditions in the western portion of the permit area were such that some wells flowed at the surface prior to mining. It is doubtful that these conditions will return within 20 years after mining. Specifically, the modeling results indicate that the Bryant and Lewis wells will likely not flow at the surface, as they did prior to mining, within 20 years of ceasing pumping operations. Consol furnished and installed pumps and ancillary facilities at these locations to compensate the well owners for the decline in water levels (see Section VI.2.4.1).

As groundwater levels return to an approximate pre-mining condition, pre-mining groundwater flow directions will also be re-established. This situation is seen in a comparison of Plate VI-1 with Figure 6 of Appendix VI-15, which indicates that groundwater flow directions in the upper Ferron Sandstone will gradually return to approximate pre-mining conditions following the cessation of pumping.

As noted in Table VI-1, the town of Emery has water rights at two wells located adjacent to each other about 14,500 feet north of the mine permit boundary. A review of data on file with the Utah Division of Water Rights indicates that Emery town Well #1 is completed in the lower Ferron Sandstone while Emery town Well #2 (located about 50 feet to the east) is completed in the middle and upper Ferron Sandstone. These wells were constructed to supply water on a backup basis to the town's distribution system. The pump in Well #1 is functional but there is no means to measure water levels in this well. The pump in Well #2 is not functional, but an air line exists by which water levels can be measured. Hence, water quality samples can be collected from Well #1 and water-level measurements can be collected from Well #2.

Several years ago, the town suggested that water levels at the wells had declined significantly since the beginning of operations at the Emery Mine. However, the town indicated in a meeting between Consol and the town in November 1988 that the apparent water-level declines may have been caused by their own pumping operations. As indicated above, Well #2 is completed in the middle and upper Ferron Sandstone (i.e., that section of the formation where water levels are most impacted by dewatering operations at the Emery Mine). To better assess conditions at the Emery wells, the model output was evaluated to determine the potential effects of mining on the potentiometric surface at the location of these wells. As noted in Figure 2 of Appendix VI-15, the northern boundary of the MODFLOW model was approximately 8,800 feet south of the Emery wells. At this northern model boundary, the model results indicate that groundwater levels in the Upper Ferron sandstone will drop 1.6 feet from 2007 to 2016, the period when active mining ~~is~~was planned to cease. From 2016 to 2026, groundwater levels at the northern model boundary ~~a~~were predicted to increase to approximately 5.4 feet above 2007 levels. Twenty years after mining ceases (model year 2036), the model predict~~s~~ed that the head at the northern model boundary will be approximately 12.7 feet above 2007 levels. The predicted heads in 2026 and 2036 are calculated to be higher than 2007 levels primarily because of the high transmissivity and lateral recharge in the vicinity of the Joe's Valley-Paradise fault zone.

Although the MODFLOW evaluation concentrated on the upper Ferron Sandstone, observations discussed earlier in this section indicate that potentiometric-surface impacts to the middle and lower Ferron Sandstone will be less than those in the upper Ferron Sandstone. Given the distance of the Emery town wells from the modeled area and their completion zones, the effects of mining on water levels at the Emery town wells are predicted to be much less than those predicted to occur in the upper Ferron Sandstone at the model boundary (i.e., these impacts will be minimal at the town wells, if at all).

In 2010, the inoperative pump was pulled from Emery Town Well #2 and the air line used to collect water-level data was found to be faulty. It is not known when the air line became damaged but the 2007 (and perhaps the 1979) data reported for the well may be unreliable. Since the air line was removed, an electronic water-level probe has been used to collect data from this well. Data presented in Figure VI-21 indicate that water levels in Well #2 have ~~remained relatively~~risen slightly constant since 2010 when consistent water-level data collection began. A notable exception to this conclusion occurred in March 2013 when a new water-level probe was put into service. However, given the consistency of the water levels in Well #2 during the period of 2011 through 2012 as well as those since the change in probes, together with the information presented above, is it apparent that mining at the Emery Mine has not adversely impacted the available water at the Emery Town Wells.

Water levels in well H(U) monitoring the Upper Ferron sandstone have declined substantially since mid-2005. This well is located in Section 20, T. 22 S., R. 6 E. immediately north of the permit area boundary, as indicated on Plate VI-4. Mining occurred in an area approximately 2,500 feet southwest of this well in 1989 and, over a period of about 15 years, expanded to a location about 6,000 feet southeast of well H(U). As noted in Figure VI-22, water levels remained fairly constant in this well from 1979 until mid-2005, during the period when mining was occurring in the general area of the well. These levels then increased dramatically in the last half of 2005 and ~~have~~ declined ~~since then~~until late 2016, at which time they increased dramatically and have remained relatively constant since then.~~ Water levels stabilized in 2013 and 2014 and then declined rapidly again in 2015.~~

As a point of comparison, Figure VI-22 also provides water-level data obtained from monitoring well Muddy #1. This well is also completed in the Upper Ferron sandstone and is located in the southeast portion of the permit area, in Section 33, T. 22 S., R. 6 E. Muddy #1 is located about 500 feet east of an area that was mined beginning in 1945 and adjacent to other areas that were mined from 1990 through 2005. Water levels in this well have remained essentially constant since monitoring began in 1979.

Figure VI-22 also depicts average annual rates at which water has been discharged from the Emery Mine since 1979. During the period of 1979 through 2004, average discharge rates varied between a low of 0.54 cfs (in 2002) and a high of 1.33 cfs (in 1993). Water levels increased in well H(U) approximately 27 feet in mid-2005 during a three-year period when the rate of discharge from the mine was lower than in previous years, perhaps suggesting a response to the lower rate of discharge. However, no influence on water levels is obvious at Muddy #1 during the period of decreased pumping rates. Mine-water discharge rates from 2006 through 2010 were within the range when water levels in H(U) were historically unaffected by changes in discharge even though levels in that well experienced a decline of over 50 feet during that period. Water levels in H(U) then stabilized briefly, ~~in spite of a sharp increase in pumping rates in 2011 and~~ then exhibited a dramatic decrease following a period of much lower (or no) discharge from 2013 through 2015, then increase substantially in late 2016. ~~Furthermore, w~~Water levels in well Muddy #1 remained largely unaffected by any changes in mine-water discharge rates during this period of widely fluctuating rates at well H(U).

It is not possible to state that water levels at well H(U) have been unaffected by pumping of groundwater encountered in the Emery Mine. However, it is also obvious that mine-water pumping alone cannot account for the decline in water levels observed at that well. The available data do not allow a definitive conclusion to be drawn concerning the reason for the decreased water levels in well H(U).

The Division of Oil, Gas and Mining has also expressed concern about a decline in water levels in monitoring well RDA-4. This well monitors conditions in the alluvium adjacent to Quitchupah Creek in Section 32, T. 22 S., R. 6 E. (see Plate VI-4). Hydrographs of water-level data measured at this well and adjacent wells are provided in Figure VI-23. This figure also provides data for the Palmer Hydrological Drought Index ("PHDI"). The area where these wells are located has not been subjected to underground mining since the early 1980s.

As indicated, water levels in RDA-4 have declined approximately 6 feet since January 2010. Water levels in RDA-2 and RDA-6 declined approximately 3 feet and 10 feet, respectively, during the same period. The PHDI data indicate that this period has been subject to increasing drought severity. Given the lack of mining in the area and the increasing severity of drought conditions, it is concluded that the declines in water levels in this alluvial aquifer were caused by natural climatic conditions.

Two springs have historically issued from the Ferron Sandstone adjacent to the permit area (SP-15 from the upper Ferron Sandstone and SP-16 from the lower Ferron Sandstone). Both of these springs are located near the formation outcrop, making model predictions less precise. However, the model results indicate that the potentiometric surface will decline approximately 24.1 feet at the location of SP-15 from 2007 to 2016 (the modeled period of active mining and dewatering) and subsequently recover to approximately 4.1 feet below 2007 levels by 2036. Data contained in Appendix VI-1 indicate that no flow has occurred at SP-15 since June 2000. The model data imply that this condition will continue for some time in the future.

Quantitative predictions of potentiometric surface impacts at SP-16 are not possible since modeling concentrated on the upper Ferron Sandstone and since SP-16 is located near the formation outcrop just east of the model boundary. This spring is not currently used for beneficial purposes. Given the generally lesser mining-related impacts on the lower as compared to the upper Ferron Sandstone and the fact that this spring is located updip of the upper Ferron Sandstone outcrop, impacts to the potentiometric surface at this location should be less than those predicted for SP-15. Several seepage points representing irrigation return flow are noted on Plate VI-5 (specifically SP-1 through SP-14). Recharge to these seeps is primarily a function of surface irrigation practices. Since this recharge is not connected to the regional groundwater system contained in the Ferron Sandstone, no impacts to these seeps are anticipated as a result of mine-dewatering activities.

The Emery Mine hydrologic monitoring program has been designed to assess the impacts of mining on groundwater resources in the area. Data collected from this program will provide a much more accurate picture of mining impacts than the current model will provide.

Impacts to Surface Water Availability. Water removed from the mine will be discharged to Quitchupah Creek in the future as it has in the past, increasing the flow of this receiving stream. As noted previously, only limited continuous streamflow data are available for Quitchupah Creek, with the U.S. Geological Survey maintaining a gaging station near the mine office from July 1978 through September 1981. The average annual flow of Quitchupah Creek at this location for the three complete water years of record was 8.43 cfs, ranging from 6.73 to 10.8 cfs (see Appendix VI-11). Estimates presented in Table VI-22 indicate that no discharge will occur to Quitchupah Creek during the first two years of mining from the Emery 2 portal. Thereafter, it is estimated that discharge to Quitchupah Creek will range from 0.64 cfs to 1.67 cfs through the end of the current mine plan. These values represent an 8 to 20% increase in the above-noted average annual flow of Quitchupah Creek.

As noted above, no water has been observed to discharge from the Emery Mine sedimentation ponds. Hence, a small quantity of runoff is precluded from reaching Quitchupah Creek and Christiansen Wash that would discharge to this stream if the mine surface facilities were not present. Given the small amount of precipitation in the area and the relatively small area of the surface facilities, this reduction in the streamflow of Quitchupah Creek and Christiansen Wash is likely minimal. Thus, the net effect of mining on the availability of surface water in the immediate area is an increase in the flow of Quitchupah Creek and downstream waters.

According to Section VI.2.4.2, streamflow in Christiansen Wash and Quitchupah Creek in the permit and adjacent areas is influenced by several factors, including direct irrigation return flow of water that originated in Muddy Creek, groundwater discharge from the Ferron Sandstone, discharge from the Emery Mine, and overland flow from precipitation runoff. Although it is assumed that interception of water in the mine will locally decrease base flow in Christiansen Wash and Quitchupah Creek, the magnitude of this impact cannot be accurately predicted given the multiple factors affecting streamflow in the area.

It should be noted that the discharge of mine water to Quitchupah Creek probably results only in a local increase in flow and not a basin-wide increase. As discussed above, the coal being mined at this location occurs in the Ferron Sandstone Member of the Mancos Shale, which is underlain by the Tununk Shale member of the same formation. The shales of this formation have a low permeability (Waddell et al., 1981), thus forcing groundwater to the surface as streamflow. As a result, although the discharge of water from the mine results in a local loss of groundwater and gain in surface water, this discharge does not disrupt the hydrologic balance of the larger basin.

Given this condition, the only actual loss of groundwater from the hydrologic balance is that water which is contained in the coal and leaves the basin upon mining or is discharged from the mine in the ventilation air. These quantities are estimated in Section II.C, subsection UMC 817.97 of this MRP.

As indicated on Plate V-5, buffer zones have been established to preclude full-extraction mining in the future beneath Christiansen Wash and Quitchupah Creek. Hence, direct impacts to the streambed of these two surface waters are not anticipated. However, subsidence may influence irrigation ditches and stock-watering ponds in areas overlying full-extraction panels. Impacts to irrigation ditches may include the development depressions that cause ponding in areas that would otherwise be free draining. Cracks may also develop in ditch and pond embankments, resulting in seepage outside of the embankments to adjacent ground.

Two conditions make it doubtful that substantial water will be diverted from an irrigation ditch or stock-water pond to the mine as a result of subsidence. First, the Blue Gate member of the Mancos Shale, which exists between the surface and the coal zone throughout the area, contains bentonitic clays (U.S. Geological Survey, 2007). As a result, subsurface cracks will swell and seal when water enters the crack. Second, irrigation ditches and ponds in the area typically contain water only ephemerally, minimizing the time that surface water may come into contact with a crack. Monitoring and mitigation of subsidence impacts, if they occur, will be in accordance with the plan presented in Section V.B.1 of the approved MRP.

The research summarized by Kendorski (2006) indicates that subsidence impacts result in only temporary surface fractures, especially in areas overlain by shales such as the Blue Gate Member. Thus, no substantial potential exists for surface runoff to be diverted into the mine works from ephemeral washes overlying areas of planned full extraction.

Increased Total Dissolved Solids Concentrations in Surface and Groundwater. Data summarized in Table VI-16 indicate that the average TDS concentration of water entering the mine (as measured in roof samples) is 1025 mg/l. Assuming that the equivalent-weight bicarbonate concentration can be calculated by balancing the anions and cations in that table, the roof inflow is a sodium-bicarbonate water with an average sulfate concentration of 264 mg/l. The average TDS concentration of water discharging from the mine to Quitchupah Creek (as measured at Ponds 1 and 6 [UPDES outfalls 001 and 003, respectively] and reported in Table VI-16) is 3110 mg/l. This is a sodium-sulfate water with an average sulfate concentration of 1510 mg/l. It is anticipated that similar conditions will exist in the future once discharge of water from the mine resumes.

These data indicate that the TDS concentration of water flowing through the mine increases by a factor of approximately 3.0. The sulfate concentration of this water increases by a factor of about 5.7. Furthermore, the ratio of calcium to sodium increases as the water flows through the mine. This increase in calcium concentration suggests that the observed changes in TDS and sulfate concentrations are probably the result of dissolution of gypsum rock dust used in the mine.

Bronco operates under a UPDES discharge permit issued by the Utah Division of Water Quality and will control discharges from the mine to be consistent with that permit. As noted in

Section VI.2.4.2, although mine-water discharges increase the salt load of Quitchupah Creek, the majority of the salt-load increase in this stream occurs from irrigation return flows and leaching of naturally-saline deposits. Furthermore, except where overlain by a thin veneer of alluvial deposits, surface water in Quitchupah Creek flows across the Tununk Member of the Mancos Shale immediately downstream from the mine permit area. Since this member is a gypsiferous formation, sulfate and TDS concentrations increase naturally in surface water that flows across areas underlain by this unit. Thus, the additional input of these constituents from the mine waters to local streams is considered minor compared with contributions from natural sources and irrigation return flows.

A TMDL study of the Muddy Creek watershed (of which Quitchupah Creek is a tributary) indicated that Muddy Creek and its major tributaries (including Quitchupah Creek) would not support an agricultural beneficial use classification (MFG, 2004). This lack of beneficial-use support occurs at the location where these streams cross State Highway 10 (i.e., upstream from the mine water discharge point). The study concluded that elevated TDS concentrations in areas downstream from Highway 10 are caused predominantly by changes in surficial geology (i.e., outcropping of the saline Mancos Shale) and irrigated agriculture (i.e., return flows), thereby agreeing with the above conclusions.

According to the U.S. Bureau of Reclamation (2003), the salt load from the Muddy Creek watershed averages 86,000 tons/yr. The Emery Mine UPDES permit currently allows a maximum monthly average TDS concentration of 4,766 mg/L to be discharged from the mine at a maximum monthly average of 1.5 million gallons per day. Assuming that the maximum allowed concentration is discharged constantly at the maximum allowed rate throughout the year, the annual salt load from the mine to the Muddy Creek watershed would be 10, 890 tons/yr (about 13% of the basin-wide salt load).

Only stock watering rights exist on Quitchupah Creek downstream from the mine-water discharge point and on Ivie Creek between the confluence of Quitchupah Creek and Muddy Creek. These rights were taken into consideration when the UPDES permit was issued by the Utah Division of Water Quality. Hence, no substantial water-quality impact to downstream water users is anticipated.

In the post-mining situation, there is a potential for water-quality degradation within the upper Ferron Sandstone as groundwater flows through previously mined areas and then into adjacent un-mined rock. However, it is expected that this condition will be tempered by the diluting effect of better-quality recharge water entering the area from the west. As far as the middle and lower Ferron Sandstones are concerned, a fairly uniform shale floor impedes downward seepage of mine water to lower zones. Thus, groundwater quality in these lower sections of the Ferron should not be substantially affected either during or after mining.

Flooding or Streamflow Alteration. Runoff from all disturbed areas flows through sedimentation ponds or other sediment-control devices prior to discharge to adjacent undisturbed drainages. Three factors indicate that these sediment-control devices minimize or preclude flooding impacts to downstream areas as a result of mining operations:

1. The sediment-control facilities have been designed and constructed to be geotechnically stable. Thus, no substantial potential exists for breaches of the sediment-control devices to occur that could cause downstream flooding.
2. These sediment-control devices are sized sufficiently that no discharges have been recorded. This precludes flooding impacts to downstream areas.

3. By retaining sediment on site in the sediment-control devices, the bottom elevations of stream channels downstream from the disturbed areas are not artificially raised. Thus, the hydraulic capacity of the streams channels is not altered and flooding potential is further precluded.

Following reclamation, stream channels will be returned to a stable state. The reclamation channels have been designed in accordance with the requirements of the Division. Thus, flooding in the reclaimed areas will be precluded. Interim sediment-control measures and maintenance of the reclaimed areas during the post-mining period will preclude deposition of significant amounts of sediment in downstream channels following reclamation, thus maintaining the hydraulic capacity of the channels and further precluding adverse flooding impacts.

The mine has been designed to preclude subsidence in areas occupied by perennial streams (see Plate V-5). Thus, no alteration of perennial streamflow is anticipated.

Subsidence will occur in areas occupied by ephemeral stream channels. Although surface cracks that result from subsidence in the permit area are expected to heal with time in areas overlain by unconsolidated deposits and the Bluegate Member of the Mancos Shale, ephemeral stream flows may be partially intercepted prior to completion of the healing process. In addition, the broad depressions created by subsidence may locally retain runoff that would normally discharge from an area. However, the following factors indicate that the impact of subsidence on ephemeral streamflow will be minimal:

1. Ephemeral streamflow in the area is sporadic, allowing significant periods of time for surface cracks to heal between flow events. Ephemeral streamflow typically carries a high sediment load. This sediment will fill remaining cracks. As the cracks heal, the potential for interception of streamflow is minimized.
2. The depressions created by subsidence are sufficiently broad that changes in slope are not typically of an ample magnitude to cause ponding in anything other than local areas.

Potential Hydrocarbon Contamination. Diesel fuel, oils, greases, and other hydrocarbon products are stored and used at the site for a variety of purposes. Diesel and oil stored in above-ground tanks at the mine surface facilities may spill onto the ground during filling of the storage tank, leakage of the storage tank, or filling of the vehicle tank. Similarly, greases and other oils may be spilled during use in surface and underground operations.

The probable future extent of the contamination caused by diesel and oil spillage is expected to be small for three reasons. First, because the tanks are located above ground, leakage from the tanks can be readily detected and repaired. Second, spillage during filling of the storage or vehicle tanks is minimized to avoid loss of an economically valuable product. Finally, the mine has a Spill Prevention Control and Countermeasure Plan that provides inspection, training, and operation measures to minimize the extent of contamination resulting from the use of hydrocarbons at the site.

Motor oil was introduced into some of the monitoring wells several years ago for reasons that are not clear. An investigation of this issue, conducted in January 2012, concluded that this oil is not causing substantial contamination of the monitored aquifers (see Appendix VI-18).

Coal Spillage During Hauling. Coal is hauled over County roads from the mine to State Highway 10 and other roadways. Past experience has indicated that no substantial quantities of coal have been spilled during transport. If coal is spilled, it may wash into local streams during a runoff event prior to cleanup. Possible impacts to the surface water include increases in total suspended solids and turbidity from the fine coal particulates. The probability of a spill occurring in an area sufficiently close to a stream channel to introduce coal to the stream bed is extremely small.

Potential Alluvial Valley Floor Impacts. Chapter XI of the Emery Mining and Reclamation Plan provides information regarding how mining operations will avoid, during mining and reclamation, interruption, discontinuance, or preclusion of farming on alluvial valley floors. Chapter XI and the information presented in this chapter further indicate how mining and reclamation operations will not materially damage the quantity or quality of water in surface and groundwater systems that supply alluvial valley floors.

A comparison of Plates IV-2 and XI-1 indicates that mining is anticipated in areas beneath potential alluvial valley floors beginning in ~~the second year of mining~~2020. As noted in Section XI.B.5.C of the mining and reclamation plan, mining in this area will be conducted without planned subsidence. Furthermore, mine pillars will be sized large enough to provide a factor of safety against failure of at least 1.75. Additional information is provided in Section V.B of the mining and reclamation plan regarding pillar design and other subsidence protection measures that will be implemented in areas underlying potential alluvial valley floors.

Areal Extent of Probable Hydrologic Consequences. The above discussion indicates that the probable hydrologic consequences of mining at the Emery Mine will be limited in areal extent as follows:

- Contamination from acid- and toxic-forming materials – Very limited areal extent of impact, if any.
- Increased sediment yield from disturbed areas – No impacts downstream from disturbed areas.
- Impacts to groundwater availability – Drawdown of the groundwater potentiometric surface due to mine dewatering may extend northward to an area south of the Emery Town wells, westward to the Joe's Valley-Paradise Fault Zone, eastward to the area of Muddy Creek, and southward to an area north of Ivie Creek.
- Impacts to surface water availability – Increased flow in Quitchupah Creek and immediate downstream portions of Ivie Creek.
- Increased total dissolved solids concentrations in surface and groundwater – Slight increase in TDS concentrations in Quitchupah Creek and immediate downstream portions of Ivie Creek. Temporary increase in TDS concentrations in the upper Ferron Sandstone adjacent to the mine.
- Flooding and streamflow alteration – Very limited areal extent of impact, if any.
- Potential hydrocarbon contamination – Very limited areal extent of impact, if any.
- Coal spillage during hauling – Very limited areal extent of impact, if any.

The above summary indicates that the greatest potential lateral extent of hydrologic impacts due to mining will occur as a result of drawdown of the potentiometric surface. Data presented previously in this document indicate that drawdown due to mine dewatering has not occurred at the Emery Town wells. The results of groundwater modeling presented in Appendix VI-15 indicate that the potentiometric surface in the Upper Ferron sandstone may drop an additional 1.6 feet at a point 8,800 feet south of the Emery Town wells (the northern extent of the groundwater model) prior to the end of mining (drawdown obtained from model output). Impacts to water levels in the Middle and Lower Ferron Sandstone will be less. Given this minimal predicted drawdown at a point 1-2/3 miles south of the wells, the effects of drawdown are not anticipated to extend as far north as the Emery Town wells.

As indicated in Section VI.2.4.1, recharge to groundwater in the Ferron Sandston occurs primarily along the Joe's Valley-Paradise fault zone. Hence, this fault zone serves essentially as a constant-head boundary, beyond which the drawdown effects of mine dewatering will not extend to the west.

The Ferron Sandstone outcrops west of Muddy Creek (see Plate VI-5). Although the groundwater model predicts that some drawdown will occur in this area, model predictions are of limited accuracy at the outcrops. Furthermore, natural recharge to the Ferron Sandstone due to leakage from Muddy Creek will minimize the magnitude of drawdown beyond this area. As a result, it is not anticipated that drawdown impacts of mine dewatering will extend substantially eastward of Muddy Creek.

A comparison of Plates VI-1 and VI-7 indicates that 486 feet of drawdown occurred at well R2(U) between 1979 and 2006, with 109 feet of drawdown occurring at well AA(U) between 1979 and 2006. These two wells are 8,800 feet apart from each other, indicating that the drawdown gradient between the two is 0.043 ft/ft. At this gradient, the point at which no drawdown has occurred would be 11,300 feet south of well R2(U) (i.e., 2,500 feet south of well AA(U)). This point is approximately 1 mile north of Ivie Creek. In actuality, the gradient associated with a cone of depression in the potentiometric surface is not constant, but rather decreases with distance away from the center. Thus, it is anticipated that the drawdown effects of mine dewatering will extend further to the south toward Ivie Creek than indicated by this simple calculation. However, the distance to Ivie Creek as well as natural recharge to the Ferron Sandstone due to leakage from Ivie Creek will minimize the magnitude of drawdown beyond this stream. As a result, it is not anticipated that drawdown impacts of mine dewatering will extend substantially southward of Ivie Creek.

Plate VI-4 contains a line that represents the “approximate area of hydrologic evaluation.” The location of this line was chosen as outlined in Section VI.2.2.3. The above discussion indicates that his line also delineates the maximum areal extent of the “adjacent area” in the context of the potential impacts of the Emery Mine on the hydrologic balance of the region. In other words, it is not anticipated that adverse impacts to the hydrologic balance will extend beyond this line due to mining at the Emery Mine. Furthermore, from the discussion presented previously in this section, it is anticipated that all hydrologic impacts associated with mining will be temporary. With specific reference to the drawdown effects of mine dewatering, the above discussion indicates that the potentiometric surface of the Ferron Sandstone will gradually return to pre-mining conditions once dewatering activities cease.

Zero Zero North Panel. The probable hydrologic consequences of mining in the Zero Zero North panel were evaluated in an environmental assessment published by the U.S. Bureau of Land Management in 2009[2]. Although no additional mining in that area is currently anticipated, the following is presented in the event that future plans include mining in the Zero Zero North area. This is extracted from Section 4.2.1.1 of the BLM environmental assessment and describes the probable hydrologic consequences of mining in the Zero Zero North area:

> No surface disturbances (other than indirect subsidence-caused settling) would occur under the proposed action, thus the accelerated runoff and erosion typical of disturbed areas would not occur. However, within the 55 acres of the Tract where full extraction would occur, planned subsidence may locally alter drainage patterns through slight but non-uniform settling and development of tension cracks. This could change infiltration, ponding, erosion/deposition, and runoff characteristics on a very small and local scale but would not be expected to have off-site impacts or otherwise affect either the Miller Canyon or Christiansen Wash streamflow or sediment regimes. Over time, tension

[2] U.S. Bureau of Land Management. 2009. Environmental Assessment of the Consolidation Coal Company Emery Mine - Miller Canyon Tract Lease UTU-86038, Emery County, Utah. Environmental Assessment UT-070-2008-104. Price, Utah.

cracks would be likely to fill and seal, particularly in the areas where soils have substantial clay components and overly shale parent materials (soil mapping units PCE2 and NME2 - Figure 5 [of the EA]). Similarly, as small depressions collect runoff, conveyed sediments would deposit and over time these depressions would fill, causing local topography to reach pre-subsidence uniformity.

Because the proposed action would simply be an extension of mining, there would be no change to the existing condition regarding other potential surface effects (off of the Tract) such as those related to coal transport, hydrocarbon spillage, surface infrastructure, discharge of intercepted groundwater, etc. Consol would continue to monitor surface and groundwater impacts related to its existing operations to ensure that there are no material damages to the hydrologic balance as per the Emery Mine's already approved MRP.

As mining expands into the Tract, groundwater contained in the Ferron Sandstone would continue to be intercepted. Given the small area (55 acres) of undermining associated with the Tract, as compared to the past, current, and already approved mining, the additional quantity of intercepted groundwater associated with the Emery Mine is not expected to substantially change. Similarly, the discharge of that intercepted groundwater water to Quitchupah Creek would continue, as allowed by the current UPDES Permit, at similar rates and water quality as if the Tract were not mined. In addition, there would be no change in the consumptive use of this groundwater (due to entrainment in the coal, dust control in-mine and on the surface, and evaporative losses due to mine ventilation).

Under existing approvals that are irrespective of the proposed action being evaluated here, it has been predicted that Christiansen Spring (also known as SP -15) will be within the cone of depression due to mining and resultant dewatering of the upper Ferron Sandstone aquifer. Groundwater modeling presented in Consol's approved MRP (Consolidation Coal Company 2008) suggests that the potentiometric surface in the vicinity of the spring will temporarily decline about 24 feet; this decline can be expected to affect the discharge of Ferron Sandstone groundwater at Christiansen Spring. As overall premining groundwater levels reestablish after mining is complete, the spring can be expected to again discharge this groundwater. Mining the Tract would not alter either the diminishment or the reestablishment of the spring as it is already expected to occur under the existing mine plan.

Further, this spring is not within the footprint of the area that would be mined or subsided under the proposed action. As such, its physical setting would not be disturbed.

A reach of the Miller Canyon channel would be undermined and subsided as a result of the proposed action. The small earthen dam mentioned in Section 3.1.1 [of the EA] is within this reach, as is the noted zone of piping and interception of stream flows. As was previously discussed, the dominant source for water stored in the dam and conveyed through Miller Canyon is excess irrigation water that is released under the current flood - irrigation system. As this part of the Tract is mined and subsided, ground movements could occur and it would be possible that the already-compromised dam could fail further, perhaps ceasing to have any impoundment capacity, and that the already occurring piping and interception of flows could be exacerbated.

Because the dam is located on ground that Consol owns, they would have several options: (1) reconstruct the dam at that location for the lessee's use, (2) construct another dam further upstream outside of the Tract, (3) enlarge the excavated impoundments located on their property north of the Tract for the lessee's use, or (4) forego the ability to impound water at this location. The fact that the flood irrigation system may soon be converted to a pressurized sprinkler irrigation system and the fact that this structure is not a State Engineer -permitted structure reduce the level of impact associated with the potential loss of the dam's functionality.

The proposed action's potential exacerbation of the piping and interception of flows that are already occurring within this reach of Miller Canyon would represent a greater concern. Once the channel subsides, the intercepted water may not be able to make its way back into the channel as it currently does. In addition to the physical alteration of the existing piping and joint network, the overall lowering of the channel bed through this reach would locally change the channel gradient. These combined effects could result in less water continuing downstream to lower Miller Canyon and Muddy Creek. Because most Miller Canyon discharge is related to irrigation, and comprised of flow that is regulated but not measured, quantification of this potential water loss is not possible. However, as noted, flows may diminish in Miller Canyon in the near future, irrespective of the proposed action, due to the irrigation system conversion. Any loss of water in Miller Canyon due to the proposed action may simply cause this change to occur sooner that it would otherwise occur. Regardless, the BLM's stockwatering right in lower Miller Canyon, which apparently depends in large part upon irrigation releases, may be affected.

The fate of any Miller Canyon flow that may be lost from the surface within the subsided area cannot be predicted with certainty. It may, as it does currently, move laterally down gradient and reappear in the stream channel downstream of the mined area. Alternatively, its movement may have a greater vertical component, and be conveyed into the mine via tension cracks and/or natural joints. If the latter, it would require handling and subsequent discharge to Quitchupah Creek through Consol's UPDES permit.

VI.2.9 Cumulative Hydrologic Impact Assessment (CHIA)

A Cumulative Hydrologic Impact Assessment to include the permit and adjacent areas has been prepared by the Division.

VI.3 OPERATION PLAN

VI.3.1 General Requirements

This permit application includes an operation plan which addresses the following:

- Groundwater and surface water protection and monitoring plans;
- Design criteria and plans;
- Performance standards; and
- A reclamation plan.

VI.3.1.1 Hydrologic-Balance Protection

Groundwater Protection. To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes acidic, toxic, or other harmful infiltration to the groundwater system. Additionally, the mine will manage excavations and disturbances to prevent or control discharges of pollutants to the groundwater.

Surface Water Protection. To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes acidic or toxic drainage, prevents, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevents water pollution. Additionally, Bronco will maintain adequate runoff- and sediment-control facilities to protect local surface waters.

VI.3.1.2 Water Monitoring

Groundwater Monitoring. Groundwater monitoring is conducted in the permit and adjacent areas according to the water monitoring plans presented in Table VI-17. The locations of the monitoring points are presented on Plate VI-4. The monitoring plans were developed based on information presented in the PHC determination, the baseline hydrologic data, the 2011 re-evaluation presented in Appendix VI-17, and the geology chapter of this document. These monitoring plans are capable of determining whether planned mining operations have or have not produced impacts to the hydrologic balance.

An extensive evaluation of the integrity of the Emery monitoring wells was undertaken in 2015 and 2016. Some wells had been reportedly "obstructed", some of the water-level data had been apparently improperly reported, and other data integrity concerns existed. A summary of this evaluation and the steps taken to correct integrity issues is provided in Appendix VI-19. This information was also considered when developing the groundwater monitoring program presented in Table VI-17 and Plate VI-4.

The monitoring programs provide data that are reviewed and compared to the baseline data. Any significant changes are evaluated to determine their impact on the hydrologic balance. Results of these evaluations are submitted periodically to the Division.

Sampling for the Emery Mine area is accomplished in accordance with the schedule outlined in Table VI-17. Monitoring at locations that are inaccessible during winter months are sampled three times per year. All other sites are monitored quarterly. Groundwater monitoring data are submitted to the Division by the end of the quarter following sampling. Monitoring data are submitted in an annual summary by March 31 of the subsequent year.

Groundwater monitoring will continue through the mining and post-mining periods until bond release. The monitoring requirements, including the analytical parameters and the sampling frequency may be modified in the future in consultation with the Division if the data demonstrate that such a modification is justified.

Equipment, structures, and other devices used in conjunction with monitoring the quality and quantity of groundwater in the permit and adjacent areas have been installed, maintained, and operated in accordance with accepted procedures. Where feasible, this equipment will be removed or properly abandoned by Bronco when no longer needed.

Surface Water Monitoring. Surface water monitoring is conducted in the permit and adjacent areas based upon the monitoring plans contained in Table VI-17. Surface water monitoring locations are located up- and downstream from areas of potential surface impacts and are identified on Plate VI-4. The parameters monitored meet the requirements of R614-301-731.222.1, 40 CFR 122 and 123, R614-301-751, and the applicable UPDES permits.

Two surface-water monitoring stations will be added to the monitoring network to assess impacts associated with the Emery 2 surface facilities. These will be located up- and downstream from the Emery 2 portal disturbed area as indicated on Plate VI-4. If flow occurs at these locations when sampling personnel are present, samples will be collected directly from the stream flow. As a backup, single-stage samplers will be installed at each location in accordance with the designs outlined by the Subcommittee on Sedimentation (1961). These samplers automatically syphon water into an attached sample bottle when the depth of flow in the channel is sufficient (typically at least 12 inches of flow depth).

The Division of Oil, Gas and Mining requested that consideration be given to re-establishing monitoring station SWMS-1 which was located on Quitchupah Creek immediately upstream from the confluence with the unnamed tributary identified in Appendix VI-23 as UNT-2. This is not considered necessary for the following reasons:

1. No substantial potential exists that discernable impacts will occur to UNT-2, as discussed in Section VI.2.8.3 and based on the findings of Kendorski (2006). Given the highly variable nature of ephemeral flow (both in terms of quantity and quality), data generated from Quitchupah Creek immediate upstream from the confluence with UNT-2 would likely not added meaningful information to the current understanding of surface-water conditions in the area.
2. Sampling site SWMS-4 is located on Quitchupah Creek a short distance downstream from the confluence with UNT-2. Together with data collected from SWMS-1A, the data collected from SWMS-4 will provide a sufficient understanding of potential surface water impacts resulting from full-extraction operations in Sections 30, 31, and 32.

The Division of Oil, Gas and Mining also requested that consideration be given to establishing a surface water monitoring location in Section 31, T. 22 S., R. 6 E. The only surface water course in this Section is UNT-2. As noted in Figure 4 of Appendix VI-23, no discernable channel exists along the vast majority of UNT-2 in this section. Therefore, establishment of a monitoring location would not only be difficult but would also not likely result in meaningful data.

Surface water monitoring data are submitted to the Division by the end of the quarter following sampling. Monitoring data are submitted in an annual summary by March 31 of the subsequent year. UPDES reporting requirements will be met for the UPDES discharge sites at the mine.

Surface water monitoring will continue through the mining and post-mining periods until bond release. The monitoring requirements (except those required by UPDES) may be modified in the future in consultation with the Division if the data demonstrate that such a modification is justified.

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

VI.3.1.3 Acid- and Toxic-Forming Materials

Information presented in Section VI.2.8.3 indicates that acid- and toxic-forming materials are not a significant concern at the Emery Mine. In the event that acid- or toxic-forming materials are identified in the future, they will be disposed of as outlined in Chapter II, Section II.C.

VI.3.1.4 Transfer of Wells

Before final release of bond, exploration or monitoring wells will be sealed in a safe and environmentally sound manner in accordance with R614-301-631, R614-301-738, and R614-301-765. Ownership of wells will be transferred only with prior approval of the Division. The conditions of such a transfer will comply with State and local laws. Bronco will remain responsible for the management of such wells until bond release in accordance with R614-301-529, R614-301-551, R614-301-631, R614-301-738, and R614-301-765.

VI.3.1.5 Discharges

The Emery Mine has nine discharge monitoring points that are regulated under the Utah Pollutant Discharge Elimination System (permit number UT0022616). These points are described in Table VI-11. One of these points (Outfall Number 008) was never constructed even though it remains permitted.

The primary discharge from the mine consists of water from the underground workings that is diverted into mined-out areas now used as sumps. These sumps are used to settle fines before the water is discharged to the surface. This water is discharged in accordance with the requirements of R614-301-731.100 through R614-301-731.522 and R614-301-731.800.

Water from the underground workings is pumped to the surface and discharged at Pond 1 (UPDES discharge point 001) and Pond 6 (UPDES discharge point 003). Additional settlement of sediment occurs in these ponds before the water is discharged to Quitchupah Creek. Occasionally, water is discharged from the mine to a location known as the “Farmer’s Pond” (UPDES discharge point 004 – see Plate VI-4) where the water is diverted for irrigation use. All discharge water is monitored for compliance with UPDES permit standards.

Water from disturbed surface areas associated with the mine is collected and conveyed to sedimentation ponds. The mine maintains UPDES permits that allow the discharge of this water if it meets appropriate standards. No discharges have occurred from the sedimentation ponds during their period of operation, other than two incidences of discharge from pond 5 (UPDES outfall 007). This pond was constructed in an area initially intended to be the site of a coal preparation plant. The preparation plant was not constructed and no disturbed area drains to the pond, other than that associated with the pond itself. If discharges occur from sedimentation ponds in the future, the discharge water will be monitored for compliance with the UPDES permit standards prior to release from the ponds.

No discharges of surface water are being made to underground mines and none are planned in the future.

VI.3.1.6 Stream Buffer Zones

All perennial and intermittent streams in the mine area are protected by 100-foot stream buffer zones on either side of these streams. Coal mining and reclamation operations will not cause or contribute to the violation of applicable Utah or federal water standards and will not adversely affect the water quantity and quality or other environmental resources of the stream.

The Emery 2 portal facilities will be constructed in an unnamed ephemeral wash that drains a watershed area of less than 1 square mile. Thus, rule R645-301-731.600 is not applicable to that site. Bronco submitted a Joint Permit Application to the Utah Division of Water Rights and the U.S. Army Corps of Engineers for disturbance of the unnamed ephemeral wash. As stated on the Division of water Rights web site, “the U.S. Army Corps of Engineers issued Programmatic General Permit 10 (PGP-10) which allows an applicant to obtain both state approval and authorization under Section 404 of the Clean Water Act though a single application process.” PGP 10 was most recently re-issued to the State of Utah effective February 22, 2016 and remains effective through February 22, 2021. A copy of the current PGP 10 is provided in Appendix VI-20. As stated in that permit, PGP 10 was issued by the U.S. Army Corps of Engineers “for certain activities in waters of the United States (waters) that have been authorized under the State of Utah's Stream Alteration Program. An activity is verified under PGP 10 when the Utah State Engineer issues a Stream Alteration Permit in compliance with state law and the Corps has determined it meets· the terms and conditions of this general permit.” In other words, the very issuance of a stream alteration permit by the State is proof that the U.S. Army Corps of Engineers has previously determined that the permit is in compliance with PGP 10. Further proof that the proposed mine expansion qualifies under PGP 10 is provided in the email sent on September 26, 2016 from Mike Pectol of the U.S. Army Corps of Engineers to Daren Rasmussen of the Utah Division of Water Rights. A copy of that email is provided in Appendix VI-20 along with a copy of the stream alteration permit that was issued for the mine expansion work on October 11, 2016 by the Utah Division of Water Rights.

Stream Channel Diversions. Temporary or permanent stream channel diversions comply with R614-301-742.300.

Buffer Zone Designation. Areas surrounding the streams that are not to be disturbed are designated as buffer zones, and have been marked as specified in R614-301-521.260.

VI.3.1.7 Cross Sections and Maps

The locations of surface and groundwater rights for current users of water within the permit and adjacent areas are provided on Plate VI-3. Discharges associated with the permit and adjacent areas occur at locations shown on Plate VI-4.

The location of each water diversion, collection, conveyance, treatment, storage, and discharge facility associated with the Emery Mine is presented on Plate VI-10 and its associated Plates VI-10A through VI-10E. Locations and elevations of each station used for water monitoring during coal mining and reclamation operations are presented on Plate VI-4. Existing plans and profiles for the mine-water discharge and sedimentation ponds are shown on Plates VI-14 through VI-20, VI-15B, VI-20A, and Appendix VI-7.

Other relevant cross sections or maps required by Division regulations are presented and discussed in other sections of this chapter, in Chapter V, and other chapters of this MRP.

VI.3.1.8 Water Rights and Replacement

This section applies to surface mining only. Therefore, this section does not apply to the Emery Mine where surface mining does not occur.

VI.3.2 Sediment Control Measures

The existing sediment control measures within the permit area have been designed, constructed, and maintained to prevent additional contributions of sediment to streamflow or to runoff outside the permit area. In addition, they have been designed to meet applicable effluent limitations, and minimize erosion to the extent possible.

The structures to be used for the runoff-control plan for the permit area include disturbed and undisturbed area diversion channels and culverts, sedimentation ponds, containment berms, and silt fences.

VI.3.2.1 Siltation Structures

The siltation structures within the permit area consist of the sedimentation ponds described in Section VI.3.2.2. In addition, construction of the Emery 2 surface facilities, as well as construction in other areas that do not drain to an existing siltation structure, will be performed in accordance with the Emery Mine storm water pollution prevention plan. Temporary sediment control measures to be implemented prior to and maintained during construction will include installation of silt fences and/or straw wattles, in accordance with Plate VI-11B, at the downstream boundary between undisturbed areas and those areas affected by the construction activities. Temporary sediment control measures will be installed in all areas that do not report to a sedimentation pond prior to beginning construction of the Emery 2 ~~mine~~ portal expansion area.

VI.3.2.2 Sedimentation Ponds

Five sedimentation ponds operate at the mine facility, not including the three mine-water discharge ponds. Three of these sedimentation ponds are located in the area of the mine office, where the mine portals formerly existed. Existing sedimentation Pond 3 will provide sediment control in the area disturbed by the Emery 2 portal. The original design of Pond 3 is presented in Appendix VI-7 and Plate VI-15. This pond, which was originally designed for a smaller drainage area, will be modified to control runoff from the Emery 2 surface facilities as indicated in Appendix VI-21 and Plate VI-15B. The information presented in Appendix VI-21 supersedes that presented in Appendix VI-7 with respect to Pond 3 and its associated drainage area. Similarly, Plate VI-15B supersedes Plate VI-15 with respect to Pond 3.

The fourth sedimentation pond associated with the Emery Mine is located at the 4th East portal facility, the former active portal for the mine. The fifth sedimentation pond is located north of the mine office in an area that was formerly under consideration for construction of a preparation plant. The preparation plant was not constructed, and no disturbance exists in this area, outside of that associated with the pond. An additional sedimentation pond (Pond 7) has been designed to provide sediment control in the area of a proposed coarse refuse disposal area (see Plate VI-10B). Neither this refuse disposal area nor the associated pond has been constructed. Yet an additional sedimentation pond (Pond 4) was initially constructed immediately northwest of Pond 5, with Pond 4 designed to serve as an evaporation pond for a planned reverse-osmosis unit. The reverse-osmosis unit was never built, and Pond 4 was subsequently removed from service. Design information concerning this pond is included in Plate VI-16 to serve as background information for future final reclamation of the site where the pond was constructed. Details regarding the design of the mine-water discharge and sedimentation ponds are discussed in Section VI.4.2.2.

Each sedimentation pond was designed to provide treatment or full containment of the total runoff volume from a 10-year, 24-hour precipitation event. Treatment of the design runoff volume is provided by maintaining pool volumes within the pond equal to or greater than the design inflow volume into the pond. The sedimentation ponds were also constructed with a dewatering system consisting of slide gates or valves that remain closed except when dewatering. Dewatering of these ponds will proceed only after a minimum of 24 hours of storm water detention is provided to achieve effluent limitations. These dewatering systems are sufficiently sized to remove the storm water from the ponds once deposition has occurred in a reasonable time, not to exceed 10 days.

The spillways on the sedimentation ponds were designed to safely discharge the peak runoff from a 25-year, 6-hour precipitation event. A minimum of 1.0 foot of freeboard is provided above the peak water surface to the crest of the pond embankment. The discharge from the sedimentation ponds will be controlled by riprap or other methods, as necessary, to reduce erosion and minimize disturbance.

The sedimentation pond embankments were designed and constructed to maintain a combined upstream and downstream slope of not less than 1v:5h, with neither slope steeper than 1v:2h. The minimum top width of the embankment was designed to be greater than the quotient of (H+35)/5, where H is the embankment height measured from the upstream toe, in feet. Construction of the pond embankments was performed using prudent engineering practices to ensure a stable structure.

All sedimentation ponds at the Emery Mine were certified after construction by a registered professional engineer with as-built drawings submitted and approved by the Division. All ponds are inspected in accordance with applicable regulations.

Compliance Requirements. All sedimentation ponds will be maintained until removed in accordance with the approved reclamation plan (see Chapter III of this MRP). When a pond is removed, the land will be revegetated in accordance with the reclamation plan defined in Chapter III.

The sedimentation ponds were designed to contain the volume of sediment equal to 5 years of accumulated sediment inflow, based on the Universal Soil Loss Equation. Sediment removal will be conducted once the volume of sediment accumulates to at least 60% and no more than 100% of the total pond volume designated for sediment storage volume. In addition, the sedimentation ponds will fully contain the runoff from the 10-year, 24-hour storm event. The spillways for the sedimentation ponds will adequately pass the peak flow from the 25-year, 6-hour precipitation event.

Additional design standards for all ponds are presented in Section VI.4.2.

MSHA Requirements. MSHA requirements defined in 30 CFR 77.216 are not applicable since the existing sedimentation ponds do not impound water or sediment to an elevation of 20 feet or more above the upstream toe of the structure. The ponds also store a volume less than 20 acre-feet.

VI.3.2.3 Diversions

The objective of the run-off control plan is to isolate, to the extent possible, run-off from disturbed areas from that of undisturbed areas. This is accomplished by:

- Diverting as much upstream run-off around disturbed areas via a network of ditches, culverts, and other diversions.
- Routing of run-off from undisturbed areas which enters the disturbed area into the sediment control system.

The location of each diversion is presented on Plate VI-10 and its associated Plates VI-10A through VI-10E. A brief list of each diversion structure is provided in Table VI-18. Drawings containing plans, profiles, and cross sections of the development waste disposal site diversion, the preparation plant diversion, and the 4th East portal stream diversion are presented in Plates VI-11, VI-13, and VI-21, respectively. Typical cross sections for these and the other diversions, together with additional design information, are found in Appendix VI-6.

Diversion design calculations associated with the Emery 2 surface facility are provided in Appendix VI-21. Diversion structures associated with this facility include ditches that convey runoff within the disturbed area (labeled on Plate VI-10E as “DD-x”) to the sedimentation pond, berms that control runoff within the disturbed area (“DB-x”), disturbed area swales (“DS-x”), berms that control runoff from the undisturbed area (“UB-x”), culverts that convey undisturbed area runoff around the disturbed area (“UC-x”), and catch basins (“CB-x”). Details regarding these structures are provided on Plate VI-11B. The dimensions of these diversion structures are summarized in Table VI-18.

Runoff that collects in the bottom of the Emery 2 box cut will either be used underground or pumped to diversion DD-2 which discharges into Pond 3. The design calculations presented in Appendix VI-21 indicate that this ditch and pond are adequately sized to handle this flow.

All diversion ditches are maintained with adequate erosion protection in those sections where flow velocities are great enough that a ditch lining is necessary. Adequate ditch capacities are maintained in all ditch sections. Culvert inlets are kept free of debris. Detailed diversion design information is presented in Section VI.4.2.

VI.3.2.4 Road Drainage

Public roads in the permit and adjacent areas are owned and maintained by Emery County. Drainage associated with these roads is the responsibility of the County. Drainage from all routes within disturbed areas that are the responsibility of Bronco is controlled via sedimentation ponds or alternate sediment-control methods. Drainage associated with these roads is addressed in Appendix IV-7, Appendix VI-21, and associated drawings of this MRP.

VI.3.3 Impoundments

VI.3.3.1 General Plans

Five sedimentation ponds and three mine-water discharge ponds operate at the mine. These ponds are located as shown in Figure VI-20 and Plate VI-10. Design information concerning each of these ponds is provided in Appendix VI-7 and Appendix VI-21.

Certification. All maps and cross sections associated with the sedimentation and mine-water discharge ponds have been prepared by or under the direction of and certified by a qualified, registered, professional engineer.

Maps and Cross Sections. Plans and cross sections associated with the mine-water discharge and sedimentation ponds are provided on Plates VI-14 through VI-20, Plate VI-15B, Plate VI-20A, and Appendices VI-7 and VI-21 of this MRP.

Narrative. A description of each sedimentation pond is presented in Sections VI.3.1.5, VI.3.2.2, and VI.4.2 of this MRP.

Subsidence Survey Results. No future subsidence is planned beneath the existing mine-water discharge and sedimentation ponds in the permit area.

Hydrologic Impact. The preliminary hydrologic and geologic information required to assess the hydrologic impacts of the impoundments can be found in Section VI.2.4 and Chapter V, respectively.

Design Plans and Construction Schedule. There are no additional structures proposed for the mining operation at this time. Designs of all existing structures have been described within this MRP.

VI.3.3.2 Permanent and Temporary Impoundments

Requirements. All impoundments have been designed and constructed using current, prudent, engineering practices. Specific design criteria for each impoundment are presented in Section VI.4.3. All impoundments will be inspected at least quarterly.

Permanent Impoundments. There are no permanent impoundment structures associated with the mine facilities.

Temporary Impoundments. The Division authorized the construction of the temporary impoundments at the mine as part of coal mining and reclamation operations.

Hazard Notifications. The sedimentation ponds will be examined for structural weakness and erosion at least four times per year. A report of these findings will be submitted to the Division in accordance with permit requirements.

VI.3.4 Discharge Structures

The discharge structures associated the Emery Mine include spillways on the sedimentation ponds and outlets on the mine-water discharge ponds. These discharge structures are defined in Section VI.4.4.

VI.3.5 Disposal of Excess Spoil

There is no excess spoil generated at the mine.

VI.3.6 Coal Mine Waste

Areas designated for the disposal of coal mine waste and coal mine waste structures are constructed and maintained as described in Chapter II of this MRP.

VI.3.7 Noncoal Mine Waste

Noncoal mine waste is stored and disposed of as described in Chapter II.

VI.3.8 Temporary Casing and Sealing of Wells

Each groundwater monitoring well identified on Plate VI-4 will be operated and maintained as described in Section VI.4.8.

VI.4 DESIGN CRITERIA AND PLANS

VI.4.1 General Requirements

This MRP includes site-specific plans that incorporate minimum design criteria for the control of drainage from disturbed and undisturbed areas.

VI.4.2 Sediment Control Measures

VI.4.2.1 General Requirements

Design. Existing sediment control measures have been designed, constructed, and maintained to accomplish the following:

- Prevent additional contributions of sediment to stream flow or to runoff outside the permit area;
- Meet the effluent limitations defined in Section VI.5.1; and
- Minimize erosion to the extent possible.

Measures and Methods. The sediment control measures at the mine include practices carried out within and adjacent to the disturbed area. Sediment control methods include:

- Retention of sediment within the disturbed area;
- Diversion of runoff away from the disturbed area;
- Diversion of runoff using channels or culverts through disturbed areas to prevent additional erosion;
- Provision of riprap, silt fences, site revegetation, ponds and other measures that reduce overland flow velocities, reduce runoff volumes, or trap sediment; and
- Treatment of mine drainage in underground sumps before being discharged to the surface.
- Implementation of a storm water pollution prevention plan in areas subject to new construction.

VI.4.2.2 Siltation Structures

General Requirements. Additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area is being prevented to the extent possible using various siltation structures. These structures were designed and constructed in accordance with applicable State and Federal regulations. Each structure has been certified by a qualified registered professional engineer. All long-term siltation structures which impound water have been designed, constructed and maintained as described in Chapter III and Sections VI.3.3 and VI.4.3. Temporary siltation structures such as silt fences and straw wattles will be installed prior to and maintained during construction activities in areas that do not drain to an existing siltation structure, in accordance with the mine's storm water pollution prevention plan. Temporary siltation structures will be installed in all areas that do not report to a sedimentation pond prior to beginning construction of the Emery 2 ~~mine~~ portal expansion area.

Siltation structures are also provided at the mine-water discharges points. Water is presently being discharged from the mine at UPDES discharge points 001 and 003. Water discharges from these outfalls to Quitchupah Creek.

Sedimentation Ponds. There are five sedimentation ponds operating within the permit area. These ponds are located in the areas noted in Figure VI-20, Plate VI-10, and Plate VI-15B and are described in Table VI-11. An additional sedimentation pond (Pond 7) has been designed to provide sediment control in the area of a proposed coarse refuse disposal area (see Plates VI-10B and VI-19). Neither this refuse disposal area nor the associated pond has been constructed. Furthermore, Pond 4 (Plate VI-16) has been removed from service and partially reclaimed.

Each sedimentation pond is designed to work individually to manage the design sediment volume and safely convey the peak discharge rate from its drainage area. All sedimentation ponds are located as near as possible to the disturbed areas. None of the ponds are located within a perennial stream channel.

Sediment storage and cleanout quantities (volumes and elevations) are presented in Table VI-19 for each of the mine-water discharge and sedimentation ponds. Calculations used to generate these quantities are presented in Appendices VI-7 and VI-21. Each pond will be cleaned when its actual sediment storage equals at least 60% and no more than 100% of the design volume. A T-post, marked with the elevation of the 60% and 100% accumulation levels, has been installed in each pond to assist in making cleanout decisions.

An adequate detention time will be provided in each pond to allow the effluent to meet UPDES and 40 CFR Part 434 limitations. The decant water will be sampled and discharged from the pond in accordance with the above referenced effluent limitations.

Each mine-water discharge pond and sedimentation pond was designed to fully contain runoff resulting from the 10-year, 24-hour precipitation event. The sedimentation ponds were constructed with slide gates or valves that remain closed except when dewatering. Dewatering of these ponds will proceed only after a minimum of 24 hours of storm water detention is provided to achieve effluent limitations. The ponds have been designed to minimize short circuiting. All mine-water discharge and sedimentation ponds within the permit area have spillway systems that will safely discharge the peak flow resulting from a 25-year, 6-hour precipitation event. Information relating to pond storage capacity and spillway hydraulics is presented in Table VI-20.

All of the ponds within the permit area have been operating for a period long enough to ensure that any settlement which may have occurred is now complete. Excessive settlement has not been observed at any of the mine-water discharge or sedimentation ponds.

During construction of the ponds, the embankment materials were free of sod, large roots, frozen soil, and acid- or toxic forming coal-processing waste. The embankments were compacted during placement of the materials.

MSHA Sedimentation Ponds. MSHA requirements defined in 30 CFR 77.216 are not applicable at this mine since the existing mine-water discharge and sedimentation ponds do not impound water or sediment to an elevation of 20 feet or more above the upstream toe of the structure. The ponds also store a volume less than 20 acre-feet.

Other Treatment Facilities. There are no other water treatment facilities within the mine permit area.

Exemptions. Alternative sediment control methods are provided by the following facilities for surface drainage which does not pass through a sedimentation pond. These alternative treatments provide sufficient sediment control for these areas to meet Division approval, before leaving the permit area. Additional details regarding the following alternative sediment control methods are provided in Appendix VI-8. Locations where alternative sediment control has been installed are listed in Table VI-21.

- Mine Office Catch Basin: The catch basin in the mine office area is located in a depression where the drainage berms cannot effectively direct disturbed area runoff from 0.6 acre to Pond No.2. This evaporative catch basin is sufficiently sized to fully contain the expected runoff from a 25-year, 24-hour storm event. The small amount of runoff entering the depression evaporates, effectively providing complete sediment control for these portions of the surface facilities area without discharging from the permit area. This catch basin is a Division approved treatment facility which has functioned effectively for several years.
- Runoff Collection Berms: Runoff collection berms have been constructed along the perimeter of the disturbed area in several locations to provide total containment of runoff.
- Rock Check Dams: A series of rock check dams have been placed in Ditch No. 6 along the downstream toe of the subsoil stockpile at the development waste disposal site. Runoff from the stockpile enters the ditch and flows to the rock check dams where the velocity is reduced, causing sediment deposition to occur. Design details for Ditch No. 6 are provided in Appendix VI-7.
- Silt Fences: Silt fences are used at several areas of minor disturbance for additional sediment control. These silt fences have been installed in general accordance with Figure VI-19.
- Vegetative Cover: Alternative sediment control for several areas of disturbance is provided by vegetative cover. Vegetation on these disturbed sites has proven to be equivalent to or exceed that of the undisturbed ground adjacent to the site. This comparison of disturbed versus undisturbed sites is the result of a vegetation count conducted February 9, 1994 by the Division's reclamation biologist. This vegetation count was conducted upon request by Consolidation Coal Company in order to resolve sediment control concerns for these relatively small, isolated disturbance areas. These primarily inactive sites have been in place a sufficient number of years to re-establish natural vegetative cover. Any further action to control sediment from these small areas would serve only to disturb additional acreages and destroy the vegetation already established. Based on the disturbance areas meeting or exceeding the vegetation provided on the natural, undisturbed adjacent sites, as verified from vegetation count data,

no additional sediment control measures are anticipated. The vegetative cover on these existing disturbance sites provides an improved condition, as compared to the surrounding, undisturbed areas.

The current disturbed area associated with the Emery Mine is 75.2 acres (see Tables III-1 and III-2), to which 10.3 acres will be added with the Emery 2 surface facilities. The total area for alternate sediment controls is 12.96 acres (see Table VI-21). The total of all alternate sediment control areas represents about 15 percent of the total disturbed area at the mine site.

VI.4.2.3 Diversions

General Requirements. Diversions within the permit area consist of drainage ditches and culverts. All diversions within the permit area have been designed to minimize adverse impacts to the hydrologic balance, to prevent material damage outside the permit area and to assure the safety of the public. All diversions and diversion structures have been designed, located, constructed, maintained and used to:

- Be stable,
- Provide protection against flooding and resultant damage to life and property,
- Prevent, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area, and
- Comply with all applicable local, State, and Federal laws and regulations

All diversions within the permit area are temporary and will be removed when no longer needed. The diversions will be reclaimed in accordance with the plan defined in Chapter III.

Peak discharge rates from the drainages flowing to the diversions were calculated based on design storms varying from the 10-year, 6-hour precipitation event to the 100-year, 24-hour precipitation event, depending on the diversion. Descriptions of the methods used and the resulting calculations required to determine the peak discharge rates are presented in Appendix VI-6 for most of the permit area and in Appendix VI-21 for the disturbed area associated with the Emery 2 portal. The disturbed and undisturbed drainage areas for the facilities area are presented on Plates VI-10 (with its associated Plates VI-10A through VI-10E) and VI-21.

All diversions are located as shown on Plate VI-10 and its associated Plates VI-10A through VI-10E. The capacity and freeboard of each diversion were determined based on the minimum ditch slope, while the maximum velocity and the need for channel armoring were based on the maximum ditch slope. Slopes were measured either in the field or from the design topography. All diversion calculations are presented in Appendix VI-6 and Appendix VI-21.

Diversion of Perennial and Intermittent Streams. Consol constructed a crossing over Quitchupah Creek in the late 1970s using a multi-plate arch on a concrete foundation. This structure was constructed with concrete wingwalls and was equipped with a guardrail. The crossing was installed to allow access to the stockpile area south of Quitchupah Creek. This crossing will also allow access to the Emery 2 portal facilities. The pipe arch replaced two 3-foot-diameter culverts which were determined to be undersized for design flood conditions. Design information concerning this structure is provided in Appendices IV-7 and IV-8.

Diversion of Miscellaneous Flows. Diversion ditches and culverts have been utilized within the permit area to divert miscellaneous flows from ephemeral disturbed- and undisturbed-area drainages. Details regarding these diversions are presented in Appendix VI-6. A summary of these diversions is presented in Table VI-18.

VI.4.2.4 Road Drainage

The access road to the mine is a public road that is owned and maintained by Emery County. Drainage associated with this and other public roads in the permit and adjacent areas is the responsibility of the County. Drainage from all routes within disturbed areas that are the responsibility of Bronco is controlled via sedimentation ponds or alternate sediment-control methods. Drainage associated with these roads is addressed in Appendix IV-7, Appendix VI-21, and associated drawings of this MRP.

VI.4.3 Impoundments

Eight impoundments have been constructed within the permit area, five of which serve as sedimentation ponds and three of which serve as mine-water discharge ponds. These structures are located as indicated on Figure VI-20 and Plate VI-10 and its associated Plates VI-10A through VI-10E. A ninth pond (Pond 7) has been designed to provide sediment control in the area of a proposed coarse refuse disposal area (see Plate VI-10B). Neither this refuse disposal area nor the associated pond has been constructed. Pertinent information regarding these sedimentation ponds is presented in Sections VI.3.2.2 and VI.4.2.2. An additional impoundment (Pond 4) has been removed from service.

VI.4.4 Discharge Structures

Discharge structures within the permit area consist of spillways on each sedimentation pond and outlets on the mine-water discharge ponds. The spillways on all sedimentation ponds within the permit area will adequately pass the peak discharge from the 25-year, 6-hour precipitation event. Detailed information for each sedimentation pond is presented in Sections VI.3.2.2 and VI.4.2.2. The design calculations for the discharge structures are presented in Appendices VI-7 and VI-21. Detailed drawings of each discharge structure are presented on Plates VI-14 through VI-20.

VI.4.4.1 Erosion Protection

The outlets on each sedimentation pond and mine-water discharge pond associated with the Emery Mine are periodically inspected to assess the need for erosion protection. Conditions are currently adequate to reduce erosion, prevent deepening or enlargement of stream channels, and minimize disturbance of the hydrologic balance at the pond outlets.

VI.4.4.2 Design Standards

All discharge structures within the permit area were designed and constructed according to standard engineering design procedures.

VI.4.5 Disposal of Excess Spoil

There is no excess spoil generated within the permit area.

VI.4.6 Coal Mine Waste

VI.4.6.1 General Requirements

All coal mine waste is currently contained within the development waste disposal area. A coarse refuse disposal area has also been proposed, but not yet constructed. Information regarding these disposal areas is provided in Chapter IV. All coal mine waste will be placed in a controlled manner to minimize adverse effects of leachate and surface water runoff on surface and groundwater quality and quantity.

VI.4.6.2 Refuse Piles

Based on the size, configuration, and open graded structure of the coal-mine waste, no underdrains or rock core chimney drains were required. There are no springs or seeps within the fill areas that require special treatment. All surface precipitation falling on the disposal areas is channeled to sedimentation ponds. All surface drainage from the areas above the sites is diverted around the disposal areas using diversion ditches. No permanent impoundments will exist on the completed refuse piles.

VI.4.6.3 Impounding Structures

There are no impounding structures within the permit area that are constructed of coal mine waste or are used to impound coal mine waste.

VI.4.6.4 Return of Coal Processing Waste to Underground Workings

Coal processing waste is not returned to abandoned underground workings at this mine.

VI.4.7 Disposal of Noncoal Mine Waste

Disposal of noncoal mine waste is discussed in Chapter II.

VI.4.8 Casing and Sealing of Wells

Each monitoring well or other borehole associated with the Emery Mine has been cased, sealed, or otherwise managed, as approved by the Division, to prevent acid or other toxic drainage from entering ground or surface water, to minimize disturbance to the hydrologic balance, and to ensure the safety of people, livestock, fish and wildlife, and machinery in the permit and adjacent area. The drill logs and completion diagrams for the water wells are contained in Appendix VI-2.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division (see Section VI.6.5).

VI.5 PERFORMANCE STANDARDS

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

VI.5.1 Water Quality Standards and Effluent Limitations

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

VI.5.2 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections VI.3.2, VI.4.2, and VI.6.

VI.5.2.1 Siltation Structures and Diversions

Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections VI.3.2, VI.4.2, and VI.6.3.

VI.5.2.2 Road Drainage

All roads that are the responsibility of Bronco will be located, designed, constructed, reconstructed, used, maintained and reclaimed according to plans and designs presented in Sections VI.3.2.4, VI.4.2.4, and VI.6.2. Any roads that are the responsibility of Bronco have been constructed to:

- Control or prevent erosion, siltation and the air pollution attendant to erosion by vegetating or otherwise stabilizing all exposed surfaces in accordance with current, prudent engineering practices;
- Control or prevent additional contributions of suspended solids to stream flow or runoff outside the permit area;
- Neither cause nor contribute to, directly or indirectly, the violation of effluent standards given under Section VI.5.1.
- Minimize the diminution to or degradation of the quality or quantity of surface- and ground-water systems; and
- Refrain from significantly altering the normal flow of water in streambeds or drainage channels.

VI.5.3 Impoundments and Discharge Structures

Impoundments and discharge structures will be located, maintained, constructed and reclaimed as described in Sections VI.3.3, VI.3.4, VI.4.3, VI.4.5, and VI.6.

VI.5.4 Disposal of Excess Spoil, Coal Mine Waste and Noncoal Mine Waste

Disposal areas for coal mine waste and noncoal mine waste will be located, maintained, constructed and reclaimed as described in Sections VI.3.6, VI.3.7, VI.4.6, VI.4.7, VI.6 and Chapter II.

VI.5.5 Casing and Sealing of Wells

All wells will be managed as described in Sections VI.4.8 and VI.6.5. Water monitoring wells will be managed on a temporary basis as described in Section VI.3.8.

VI.6 RECLAMATION

VI.6.1 General Requirements

A detailed reclamation plan for the mine is presented in Chapter III. In general, Bronco will ensure that all temporary structures are removed and reclaimed. No permanent sedimentation ponds, diversions, impoundments, or treatment facilities are anticipated under the reclamation plan.

VI.6.2 Roads

A road not to be retained for use under an approved post-mining land use will be reclaimed immediately after it is no longer needed for coal mining and reclamation operations. This will include reclamation of drainage features associated with that road. Additional information regarding reclamation of roads and their associated drainage structures is provided in Chapter III.

VI.6.2.1 Restoring the Natural Drainage Patterns

All natural drainage patterns will be restored during reclamation. This will include establishing drainage channels at their approximate pre-disturbance locations and elevations. Additional information regarding restoration of natural drainage patterns during reclamation is provided in Chapter III and Appendix VI-21.

VI.6.2.2 Reshaping Cut and Fill Slopes

All cut and fill slopes will be reshaped to be compatible with the post-mining land use and to complement the drainage pattern of the surrounding terrain. Additional information regarding reshaping of cut and fill slopes during reclamation is provided in Chapter III.

VI.6.3 Siltation Structures

VI.6.3.1 Maintenance of Siltation Structures

All siltation structures will be maintained until removed in accordance with the approved reclamation plan.

VI.6.3.2 Removal of Siltation Structures

When a siltation structure is removed, the land on which the siltation structure was located will be regraded and revegetated in accordance with the reclamation plan presented in Chapter III.

VI.6.4 Structure Removal

A timetable for the removal of each structure is presented in Section III.A.2 of this MRP.

VI.6.5 Permanent Casing and Sealing of Wells

When no longer needed for monitoring or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well, each monitoring well or borehole associated with the Emery Mine will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division and in accordance with the most current regulations concerning well abandonment as promulgated by the Utah Division of Water Rights. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

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TABLE VI-1

Water Rights Near the Emery Mine

Water Right Number[(a)]	Owner	Source	Quantity	Use[(b)]	Status
94-2	Muddy Creek Irrigation Company	North Fork of Muddy Creek	51.3 AF	Dom, Irr, Stk	Claimed
94-30	Osburn Bret Carter and J.R. Lawrence	Three unnamed springs	0.45 cfs	Irr	Certificated
94-52	Consolidation Coal Company	Underground water well (Mine supply yard)	2400 AF	Ind, Irr	Lapsed
94-53	Town of Emery	Underground water well (Kemmerer well)	3.0 cfs	Ind	Approved
94-54	Town of Emery	Underground mine (Borehole #3) and two proposed wells	5.0 cfs	Ind, Irr, Stk	Approved
94-64	Bronco Utah Operations LLC	Underground water well	5.0 cfs	Ind	Approved
94-65	Town of Emery	Underground water well	0.27 cfs	Dom, Mun	Claimed
94-81	Osburn Bret Carter and J.R. Lawrence	Underground water well	0.037 cfs	Irr, Stk	Claimed
94-92	Bronco Utah Operations LLC	Christiansen spring	--	Stk	Claimed
94-285	Bronco Utah Operations LLC	Underground mine (Borehole #1 and supplemental)	5.0 cfs	Ind, Min, Pwr	Approved
94-303	Town of Emery	Underground water well	0.45 cfs	Dom, Mun	Certificated
94-320	Morgan Robertson	Underground water well (Lewis well)	0.015 cfs	Dom, Irr, Stk	Claimed
94-732	U.S. Bureau of Land Management	Quitchupah Creek	--	Stk	Claimed
94-939	U.S. Bureau of Land Management	Intermittent stream	--	Stk	Claimed
94-1080	U.S. Bureau of Land Management	Intermittent stream	--	Stk	Claimed
94-1180	Morgan Robertson	Quitchupah Creek	--	Stk	Claimed
94-1189	Canyon Fuel Company	Quitchupah Creek	--	Stk	Claimed
94-1191	Osburn Bret Carter and J.R. Lawrence	Quitchupah Creek	5.25 cfs	Irr, Stk	Claimed
94-1193	Osburn Bret Carter and J.R. Lawrence	Unnamed springs	0.011 cfs	Stk	Claimed
94-1215	Castle Valley Ranches	Unnamed springs	0.015 cfs	Stk	Claimed
94-1216	Castle Valley Ranches	Quitchupah Creek	--	Stk	Claimed
94-1217	Castle Valley Ranches	Quitchupah Creek	--	Stk	Claimed
94-1285	Josiah K. and Etta Marie Eardley	Quitchupah Creek	--	Stk	Claimed

Water Right Number[a]	Owner	Source	Quantity	Use[b]	Status
94-1315	Alonzo Olsen	Quitchupah Creek	--	Stk	Claimed
94-1316	George E. Olsen	Quitchupah Creek	--	Stk	Claimed
94-1317	George E. Olsen	Quitchupah Creek	--	Stk	Claimed
94-1318	Josiah K. and Etta Marie Eardley	Quitchupah Creek	--	Stk	Claimed
94-1716	U.S. Bureau of Land Management	Miller Canyon	--	Stk, Wld	Claimed

[a] See Plate VI-3 for locations. See Appendix VI-4 for additional information.
[b] Dom = domestic, Ind = industrial, Irr = irrigation, Min = mining, Mun = municipal, Pwr = power, Stk = stockwatering, Wld = wildlife

TABLE VI-2

Monitoring Well Completion Information

Well Identification	Casing Diameter (in)	Depth Drilled (ft)	Well Depth (ft)	Perforated Interval (ft)
Quaternary Deposits				
RDA1	2	48	48	23-43
RDA2	2	44	44	19-39
RDA3	2	52	52	21-46
RDA4	2	54	54	19-49
RDA5	2	57	57	22-52
RDA6	2	40	40	15-35
SM1-1	2	21	21	14-17
SM1-2	2	14	14	4-9
SM1-3	2	26	24	10-18
SM1-4	2	30	18	8-18
Blue Gate Member				
AA	1	490	79	61-79
H	1	1140	808	755-775
I	1	728	335	60-315
R2	1	825	555	505-525, 545-555
T1	4.5	31	31	5-31
T2	4.5	345	342	31-342
USGS3-1	2	71	71	51-71
USGS4-1	2.5	30	30	10-30
Upper Ferron Sandstone				
AA		490	212	168-188
Bryant	6	466	466	360-466
H	1	1140	869	840-860
I2	1	728	475	440-460
Lewis	4	608	608	590-608
Muddy #1	2.5	162	162	122-162
Muddy #2	2.5	136	136	96-136
R2	1	825	620	600-620
T1	--	Unknown		
T2	2	425	418	338-418
TP	2	419	417	354-417
USGS1-2	2	150	150	Open below 75’
Middle Ferron Sandstone				
AA	1	490	396	336-356
H	1	1140	995	970-990
I	1	728	609	590-610
R2	1	825	820	800-820
Lower Ferron Sandstone				
AA	1	490	460	420-440
H	1	1140	1135	1115-1135
I	1	728	728	700-720
Kemmerer	8 and 12	1551	1543	1368-1543
R1	1	884	880	840-860
WW1	--	Unknown		
ZZ	4	390	390	310-330, 380-390

TABLE VI-3

Field Data from 1979/1980
Irrigation Return Flow Inventory

Location[(a)]	Date	pH (units)	Temperature (°C)	Diss. Oxygen (mg/l)	Sp. Cond. (umhos/cm)	Flow (gpm)[(b)]
SP-1	10/24/79	7.1	13.5	3.0	1196	NM
	06/11/80	7.9	26.4	8.6	1959	NM
SP-2	10/24/79	7.3	13.9	5.0	1613	NM
	06/11/80	7.8	21.1	6.8	1308	NM
SP-3	10/24/79	7.3	12.9	7.6	1307	NM
	06/11/80	7.8	18.3	9.4	1070	NM
SP-4	10/24/79	7.3	14.5	8.1	1295	NM
SP-5	10/24/79	8.1	9.2	10.9	2015	1
SP-6	10/24/79	7.8	15.9	9.2	1086	NM
SP-7	10/24/79	8.2	17.1	11.1	1023	NM
	06/11/80	7.6	18.4	8.4	1012	NM
SP-8	10/24/79	8.3	16.1	9.3	732	NM
	06/11/80	7.8	19.8	8.8	977	NM
SP-9	10/24/79	7.9	13.7	9.3	658	NM
	06/11/80	7.7	16.1	9.6	830	NM
SP-10	10/24/79	7.2	12.9	9.0	1043	NM
	06/11/80	7.5	12.3	9.9	1051	100
SP-11	10/24/79	7.5	13.8	9.2	800	NM
	06/11/80	7.7	14.3	9.2	1272	NM
SP-12	10/24/79	7.9	15.1	8.5	1338	NM
	06/11/80	7.9	22.7	8.1	1040	1
SP-13	10/24/79	7.5	14.3	8.0	1046	NM
	06/11/80	7.3	18.4	10.0	897	NM
SP-14	10/24/79	7.8	13.3	8.3	1022	7
	06/11/80	6.3	14.2	8.4	1280	3

[(a)] See Plate VI-5
[(b)] NM = not measured

TABLE VI-4

Groundwater Quality Summary –
Quaternary Deposit Wells

Parameter	Units	Maximum	Minimum	Mean
pH (lab)	units	11.8	6.7	7.7
Specific conductance (lab)	umhos/cm @25^{o}C	54,500	1020	12,080
Total dissolved solids	mg/l	93,575	471	17,830
Calcium	mg/l	950	43	360
Magnesium	mg/l	6,250	30	960
Potassium	mg/l	780	1	31
Sodium	mg/l	22,900	27	4,330
Bicarbonate	mg/l	9,629	0	555
Carbonate	mg/l	301	0	3
Chloride	mg/l	2,998	3	607
Sulfate	mg/l	94,336	104	11,260
Iron (dissolved)	mg/l	469	0	25.6
Manganese (dissolved)	mg/l	19.6	0	1.51
Acidity	mg/l	0	0	0
Total alkalinity	mg/l	7,893	138	611

TABLE VI-5

Groundwater Quality Summary –
Blue Gate Member Well

Parameter	Units	Maximum	Minimum	Mean
pH (field)	units	7.7	6.8	7.1
Specific conductance (field)	umhos/cm @25^{o}C	21,400	1,463	15,220
Total dissolved solids	mg/l	73,071	4,531	18,830
Calcium	mg/l	622	193	398
Magnesium	mg/l	3520	210	436
Potassium	mg/l	90	21	38
Sodium	mg/l	16,006	268	4,786
Bicarbonate	mg/l	727	304	465
Carbonate	mg/l	<5	<1	<5
Chloride	mg/l	1870	29	421
Sulfate	mg/l	47,790	2,513	11,850
Iron (dissolved)	mg/l	284	0.02	14.6
Manganese (dissolved)	mg/l	11.44	0.20	0.90
Acidity	mg/l	--	--	--
Total alkalinity	mg/l	925	304	582

TABLE VI-6

Summary of Pumping Tests Conducted
in the Ferron Sandstone

Well Location[a]	Geologic Unit Tested	Type of Test	Transmissivity (ft^2/day)	Storage Coefficient	Testing Entity[b]
Bryant	Kmf(u)	Recovery	200	--	USGS
Emery Town	Kmf(l)	Drawdown	800	--	USGS
		Recovery	600	--	USGS
EMRIA #2	Kmf(u), Kmf(m)	Drawdown	100	$7x10^{-4}$	USGS
EMRIA #3	Kmf(u)	Drawdown	20	$2x10^{-3}$	USGS
		Recovery	10	--	USGS
Kemmerer	Kmf(l)	Drawdown	400	--	USGS
		Recovery	600	--	USGS
Mine Water Well	Kmf(l)	Drawdown	750	--	Consol
Muddy #3	Kmf(u)	Recovery	40	--	USGS
T1 (COW[U50])	Kmf(u)	Drawdown	5	$4x10^{-4}$	Consol
USGS1-1	Kmf(l)	Recovery	100	--	USGS
USGS1-2	Kmf(u)	Drawdown	100	$8x10^{-4}$	USGS
USGS1-4	Kmf(u)	Recovery	30	--	USGS
Walker Flat MW-PW	Kmf(u)	Drawdown	15[c]	--	Consol
Walker Flat MW-20	Kmf(u)	Drawdown	71[c]	$1.7x10^{-3}$	Consol
Walker Flat MW-50	Kmf(u)	Drawdown	110[c]	$2.2x10^{-3}$	Consol
Maximum	--	--	800	$2.2x10^{-3}$	--
Minimum	--	--	5	$4x10^{-4}$	--
Average	--	--	230	$1.3x10^{-3}$	--

[a] See Plate VI-4
[b] USGS data are reported by Lines and Morrissey (1983). Consol data are presented in Appendix VI-3.
[c] Average of test analyses, based on a saturated thickness of 115 feet at the test location.

TABLE VI-7

Emery Mine Average Annual Discharge Data

Year	Discharge (cfs)	Year	Discharge (cfs)	Year	Discharge (cfs)	Year	Discharge (cfs)
Prior to initial temporary shutdown		During initial temporary shutdown		After temporary shutdown		During second temporary shutdown	
1979	0.70	1991	0.97	2002	0.54	2011	2.17
1980	1.11	1992	1.10	2003	0.60	2012	1.32
1981	0.68	1993	1.33	2004	0.77	2013	0.23
1982	1.07	1994	0.88	2005	0.62	2014	0.27
1983	1.20	1995	1.18	2006	1.12	2015	0.24
1984	1.00	1996	0.67	2007	1.51		
1985	0.80	1997	1.14	2008	0.95		
1986	0.60	1998	1.09	2009	1.00		
1987	1.00	1999	1.03	2010	1.86		
1988	1.10	2000	1.03				
1989	0.90	2001	0.90				
1990	0.99						
Average	0.93	Average	1.03	Average	1.00	Average	0.85

TABLE VI-8

Groundwater Quality Summary –
Ferron Sandstone Wells

Parameter	Units	Maximum	Minimum	Mean
Upper Ferron Sandstone				
pH (lab)	units	9.9	4.0	7.9
Specific conductance (lab)	umhos/cm @25^{o}C	9,480	871	2,580
Total dissolved solids	mg/l	8,788	429	1,5441
Calcium	mg/l	376	1	91
Magnesium	mg/l	474	1	67
Potassium	mg/l	17	1	4
Sodium	mg/l	2,030	22.7	411
Bicarbonate	mg/l	627	29	301
Carbonate	mg/l	490	0	138
Chloride	mg/l	209	3	44
Sulfate	mg/l	6,884	72	852
Iron (dissolved)	mg/l	24	0.02	1.52
Manganese (dissolved)	mg/l	0.67	0.008	0.20
Acidity	mg/l	0	0	0
Total alkalinity	mg/l	580	88	347
Lower Ferron Sandstone				
pH (lab)	units	10.0	7.3	8.2
Specific conductance (lab)	umhos/cm @25^{o}C	2,200	580	1,110
Total dissolved solids	mg/l	1,320	526	659
Calcium	mg/l	21.6	1	4.2
Magnesium	mg/l	18.8	0.9	10.5
Potassium	mg/l	6	2	3
Sodium	mg/l	348	169	231
Bicarbonate	mg/l	654	80	277
Carbonate	mg/l	424	<1	95.8
Chloride	mg/l	75	11	18
Sulfate	mg/l	660	1	210
Iron (dissolved)	mg/l	19	<0.01	1.7
Manganese (dissolved)	mg/l	0.049	0.001	0.010
Acidity	mg/l	--	--	--
Total alkalinity	mg/l	650	150	311

TABLE VI-9

Results of 1977-1978 Streamflow Study

Location[a]	Instantaneous Discharge (cfs) by Date			
	25-26 Oct 1977	8-9 Feb 1978	12-13 Apr 1978	26-27 Jul 1978
Christiansen Wash				
A	0.129	0.234	0.523	0.441
B	0.223	0.399	0.559	1.682
C	.0267	0.323	0.597	0.980
D	1.100	0.913	1.267	2.020
E	0.646	1.105	0.891	1.722
F	1.025	0.657	1.365	4.321
Quitchupah Creek				
G	0.000	1.071	3.833	0.000
H	0.501	4.274	17.87	0.800
I	0.898	7.018	22.00	0.650
J	0.690	3.902	13.38	0.699
K	0.951	2.650	15.78	2.140
L	1.123	3.869	14.84	2.450

[a] See Figure VI-14

TABLE VI-10

Results of USGS 1978 Seepage Study

Location[a]	Instantaneous Discharge (cfs) by Date			
	13 Aug 1978	9 Sep 1978	18 Nov 1978	19 Nov 1978
Christiansen Wash				
M	1.72	0.11	--	0.43
N	1.69	0.34	--	1.26
Quitchupah Creek				
O	--	0.67	0.34	--
P	0.91	0.69	0.18	--
Q	0.00	0.02	1.42	--
R	0.00	0.00	--	0.04
S	0.26	1.40	--	0.12
T	1.68	2.09	--	2.39

[a] See Figure VI-15

TABLE VI-11

UPDES Discharge Monitoring Point Descriptions[(a)]

Outfall Number	MRP Pond Number	Surface Water Monitoring Site	Source Description
Correlated by UPDES Outfall Number			
001	1	6	Underground mine pump No. 1 to surface discharge pond
002	2	7	Sedimentation pond east of mine office
003	6	12	Underground mine pump No. 3 to surface discharge pond
004	Farmer's Pond	13	Underground mine pump No. 3 (alternate discharge location)
005	3	14	Sedimentation pond southeast of mine office
006	8	--	Sedimentation pond south of mine office
007	5	11	Sedimentation pond at location of formerly proposed preparation plant
008	6	12	Slurry emergency discharge (not used since preparation plant not constructed)
009	9	--	Sedimentation pond at 4th East portal facility

Correlated by Pond Number			Correlated by Surface Water Monitoring Site		
MRP Pond Number	Outfall Number	Surf. Water Mon. Site	Surf. Water Mon. Site	MRP Pond Number	Outfall Number
1	001	6	6	1	001
2	002	7	7	2	002
3	005	14	11	5	007
5	007	11	12	6	003
6	003	12	13	Farmer's	004
8	006	--	14	3	005
9	009	--	--	8	006
Farmer's	004	13	--	9	009

[(a)] All outfall numbers are associated with UPDES permit number UT0022616. Discharge locations are noted on Plate VI-4. Outfall number 008 was intended for a sedimentation pond that was not constructed. MRP pond numbers correspond to information contained in DOGM permit 015/015. Surface water monitoring site numbers correspond to sampling locations noted on Plate VI-4.

TABLE VI-12

Surface Water Quality Summary

Parameter	Average Concentration[a]								
	SWMS-1	SWMS-1A	SWMS-2	SWMS-3	SWMS-4	SWMS-5	SWMS-8	SWMS-9	SWMS-10
pH (field)	7.9	7.9	7.8	7.9	7.8	8.0	8.0	7.8	7.8
Sp. Cond. (field)	1630	1410	3120	1640	1670	1210	5800	3260	1800
Total Diss. Solids	1292	861	2870	1360	1340	1840	10060	2590	1820
Total Salt Load	12.2	23.4	20.5	48.6	31.7	22.0	1.4	--	--
Total Susp. Solids	497	310	759	638	643	617	674	487	468
Calcium	109	91	196	105	105	135	229	193	174
Magnesium	74	61	171	78	73	113	451	208	150
Potassium	4.4	4.2	7.1	4.6	4.5	4.5	15	8.4	5.2
Sodium	204	92	457	202	208	236	2880	338	165
Bicarbonate	333	295	371	322	320	331	456	282	278
Carbonate	9	9	15	14	14	15	43	17	17
Chloride	36	28	49	37	41	32	580	134	126
Sulfate	668	375	1670	705	694	978	6550	1430	922
Iron (diss.)	0.30	0.26	0.4	0.3	0.3	0.4	0.04	0.2	0.2
Iron (total)	6.6	3.8	6.8	5.1	4.9	5.0	8.4	5.3	4.2
Manganese (diss.)	<0.1	0.02	0.14	0.02	0.01	0.06	<0.05	0.06	0.05
Manganese (total)	0.20	0.09	0.34	0.18	0.16	0.24	0.23	0.21	0.17
Acidity	5.8	7.6	7.8	<5	6.0	5.3	<5	5.5	8.6
Total Alkalinity	310	271	347	299	300	306	435	269	251

[a] All concentrations in mg/l except pH (units), specific conductance (umhos/cm @ 25^{o}C), and total salt load (tons/day). Total salt load was calculated using the average TDS concentration and the average flow rate for the period of record.

TABLE VI-13

Comparison of Mine-Water Discharge Rates
Using Two Analytical Methods
(Mass Balance Approach)

Year	Mine-Water Discharge Rate (cfs)		
	Measured discharge	Hantush inflow equation	Tunnel inflow equation
1980	1.11	1.05	11.38
1981	0.68	0.96	1.38
1982	1.07	1.04	7.42
1983	1.20	1.08	1.98
1984	1.00	0.98	2.13
1985	0.80	0.66	7.60
1986	0.60	0.79	1.67
1987	1.00	1.09	2.95
1988	1.10	1.03	7.13
1989	0.90	0.95	12.10
1990	0.99	1.07	2.47
Average	0.95	0.97	5.29

TABLE VI-14

Predicted Mine-Water Discharge Rates
(Mass Balance Approach - 4th East Portal Works)

Year	Predicted Discharge (cfs)
2006	1.29
2007	1.19
2008	1.33
2009	1.77
2010	1.28
2011	1.52
2012	1.63
2013	1.98
Average	1.50

TABLE VI-15

Predicted Mine-Water Inflow and Discharge Rates
(MODFLOW Approach - 4th East Portal Works)

Year	Predicted Inflow (cfs)		
	Worst-Case Drawdown Scenario	Unit-Area Inflow Estimate	Worst-Case Inflow Scenario
2007	1.37	1.57	1.63
2008	1.46	1.92	2.13
2009	1.51	2.17	2.51
2010	1.56	2.38	2.87
2011	1.69	2.70	3.43
2012	1.72	2.85	3.71
2013	1.99	3.22	4.27
2014	1.96	3.33	4.44
2015	2.14	3.76	5.29
2016	2.12	3.89	5.68
Average Inflow	1.75	2.78	3.60
Average Discharge[a]	1.35	2.38	3.20

[a] Based on in-mine water usage of 0.40 cfs (see discussion in text)

TABLE VI-16

Comparison of Average Water Quality Data Collected
From the Ferron Sandstone and the Emery Mine

Source	TDS (mg/l)	Anions (mg/l)			Cations (mg/l)			
		HCO_3	Cl	SO_4	Ca	K	Na	Mg
Upper Ferron SS[a]	1566	303	45	799	86	36	407	65
Lower Ferron SS[a]	685	290	19	203	4	3	231	8
Mine roof samples[b]	1025	--	31	264	9	--	322	22
Other mine samples[b]	4106	--	241	2298	146	--	680	168
Pond 1 mine water[c]	3812	384	140	1923	169	8	838	152
Pond 6 mine water[c]	2410	324	60	1094	38	4	463	32

[a] See Appendix VI-1
[b] Average of limited Consol sampling
[c] See Appendix VI-12

TABLE VI-17

Emery Mine Hydrologic Monitoring Program

Parameter	Surface Water Monitoring Stations	Sampled Wells	Other Wells	Springs/Seeps	UPDES Outfalls
Monitoring Site Names	SWMS-1A, SWMS-2, SWMS-3, SWMS-4, SWMS-5, SWMS-8, SWMS-9, SWMS-10, SWMS-11, SWMS-12	Emery Town Well 1[(a)], Kemmerer, RDA-2, RDA-4, RDA-6, SM1-3, TP-U, T1-B, T1-U, USGS4-1	H-U, MUDDY #1, Pump 3 MW, R-1, R-2B, R-2M, AA-B, AA-U. AA-M, AA-L, USGS2-1, Emery Town Well 2[(a)]	SP-10, SP-11, SP-13, SP-14, SP-15	001, 002, 003, 004, 005, 006, 007, 009
Monitoring Frequency	Quarterly	Quarterly, except RDA wells (annual)	Quarterly	Quarterly flows. Samples in 2nd and 3rd quarters	Per permit
Field Measurements					
Flow	X			X	X
Water Level		X	X		
pH (field)	X	X		X	X
Sp. Cond. (field)	X	X		X	
Water Temp. (field)	X	X		X	
Laboratory Measurements					
Total Settleable Solids	X				
Total Suspended Solids	X				X
Total Dissolved Solids	X	X		X	X
Total Hardness (as $CaCO_3$)	X	X		X	
Oil and Grease	X				X
Acidity (as $CaCO_3$)	X				
Carbonate	X	X		X	
Bicarbonate	X	X		X	
Alkalinity (as $CaCO_3$)					
Calcium, Total	X				
Calcium, Dissolved	X	X		X	
Chloride	X	X		X	
Iron, Total	X				X
Iron, Dissolved		X		X	
Magnesium, Total	X				
Magnesium, Dissolved		X		X	
Manganese, Total	X				
Manganese, Dissolved		X		X	
Potassium, Total	X				
Potassium,		X		X	

Dissolved					
Sodium, Total	X				
Sodium, Dissolved		X		X	
Sulfate		X		X	

[a] Due to physical limitations in the Emery town wells (see text), water-quality samples will be collected from Well #1 and water-level data will be collected from Well #2. Bronco will evaluate data collected from the Emery town wells, using hydrographs and other appropriate means, and submit a report of findings to DOGM with the annual report.

TABLE VI-18

Summary of Operational Diversion Ditches and Culverts

Structure		Design Event	Ditch Features			Culvert Type
			Bottom Width (ft)	Side Slopes (H:V)	Design Flow Depth (ft)	
Waste Disposal Site Diversion		100-yr, 24-hr	14	3:1	2.1	NA
4th East Portal Stream Diversion		10-yr, 24-hr	6	2:1	1.7	NA
Prep. Plant Ditch and Culvert		10-yr, 24-hr	10	2:1	0.3-0.5	30" CMP
Ditch and Culvert No. 1		10-yr, 6-hr	0	4:1	0.7	18" CMP
Ditch No. 2		10-yr, 6-hr	0-2	2:1	0.3-1.0	NA
Ditch No. 2A		100-yr, 6-hr	0	2:1	1.0	NA
Ditch No. 3		10-yr, 24-hr	2	2:1	1.1	NA
Ditch No. 3A		10-yr, 24-hr	2	2:1	0.4	NA
Ditch No. 4		10-yr, 24-hr	2	2:1	0.4-0.6	18" CMP
Ditch No. 5		10-yr, 24-hr	2	2:1	0.8	NA
Ditch No. 6		10-yr, 24-hr	0	2:1	0.6	NA
Arch Culvert on Quitchupah Creek		25-yr, 24-hr	NA	NA	NA	15'x10' pipe arch
Emery 2 Surface Facility	DB-1	10-yr, 6-hr	0	1.5:1	0.27	NA
	DB-2	10-yr, 6-hr	0	1.5:1	0.15	NA
	DB-3	10-yr, 6-hr	0	1.5:1	0.21	NA
	DC-1	10-yr, 6-hr	NA	NA	0.53	18" CHDPE
	DD-1	10-yr, 6-hr	0	2:1	0.40	NA
	DD-2	10-yr, 6-hr	1	1.5:1	0.55	NA
	DD-3	10-yr, 6-hr	0	1.5:1	0.52	NA
	DD-4	10-yr, 6-hr	0	1.5:1	0.35	NA
	DD-5	10-yr, 6-hr	0	1.5:1	0.34	NA
	DS-1	10-yr, 6-hr	0	1.5:1	0.09	NA
	UB-1	100-yr, 6-hr	0	1.5:1	0.97	NA
	UB-2	100-yr, 6-hr	0	2:1	0.95	NA
	UB-3	100-yr, 6-hr	0	2:1	0.77	NA
	UC-1	100-yr, 6-hr	NA	NA	1.50	30" CHDPE
	UC-2	100-yr, 6-hr	NA	NA	1.89	30" CHDPE

TABLE VI-19

Pond Sediment Storage and Cleanout Quantities

Pond No.	Design Quantities		Cleanout Quantities	
	Volume (AF)	Top Elevation (ft)	Volume (AF)	Cleanout Elevation (ft)
1	10.3	5937.7	6.2	5935.7
2	0.83	5905.3	0.50	5903.0
3	0.44	5909.55	0.26	5902.15
5	1.13	5944.6	0.68	5943.8
6	7.5	6014.8	4.5	6012.5
8	2.00	5910.0	1.35	5909.0
9	0.32	6052.5	0.18	6051.7

TABLE VI-20

Pond Storage and Spillway Capacity Data

Pond	Runoff Storage Capacity (AF)	Spillway Capacity	
		Design Storm	Peak Outflow (cfs)
1	0.44	25-yr, 24-hr	7.9
2	0.68	25-yr, 24-hr	1.0
3	0.26	25-yr, 6-hr	0.52
5	3.70	25-yr, 24-hr	4.0
6	9.18	25-yr, 24-hr	3.6
8	1.07	100-yr, 6-hr	1.8
9	0.22	25-yr, 24-hr	3.9

TABLE VI-21

Alternative Sediment Controls

Site	Area (ac)[(a)]	Alternative Sediment Control Method				
		Catch Basin	Berms	Rock Check Dams	Silt Fences	Vegetative Cover
Southeast mine office area	0.6	X				
4th East portal topsoil stockpile	1.0		X			X
4th East portal excavation stockpile	4.0		X			
4th East portal perimeter	0.4				X	
Topsoil stockpile T-3	1.38		X			X
Pond No. 6 topsoil and subsoil stockpiles	0.85		X			X
Waste disposal site – Ditch No. 6 and Subsoil stockpile S-2	1.88			X	X	X
Borehole pump No. 1	0.17					X
Borehole pump No. 2	0.92					X
Borehole pump No. 3	0.86		X		X	X
Revegetation test plot	0.34					X
Fire control area	0.07					X
Emery 2 pad outslope adjacent to Quitchupah Creek	0.49				X	X

(a) Total area included in alternative sediment controls = 12.96 ac

TABLE VI-22

Predicted Mine-Water Discharge Rates
(Mass Balance Approach - Emery 2 Portal Works)

Year	Predicted Inflow (cfs)	Predicted Usage (cfs)	Predicted Discharge (cfs)
~~1~~2019	~~0.70~~0.68	~~1.18~~1.13	~~-0.48~~-0.45
~~2~~2020	~~1.26~~0.97	~~1.32~~1.48	~~-0.05~~-0.51
~~3~~2021	~~2.15~~1.43	~~0.92~~2.30	~~1.24~~-0.87
~~4~~2022	~~2.09~~2.08	~~1.45~~1.72	~~0.64~~0.36
~~5~~2023	~~3.14~~2.19	~~1.47~~1.76	~~1.67~~0.43
2024	2.23	1.61	0.62
2025	2.41	1.61	0.80
2026	2.07	1.54	0.53
2027	1.91	0.51	1.40
Average	~~1.87~~1.77	~~1.27~~1.52	~~0.60~~0.26

Note: Negative discharge represents a net underground requirement to be satisfied by surface sources.

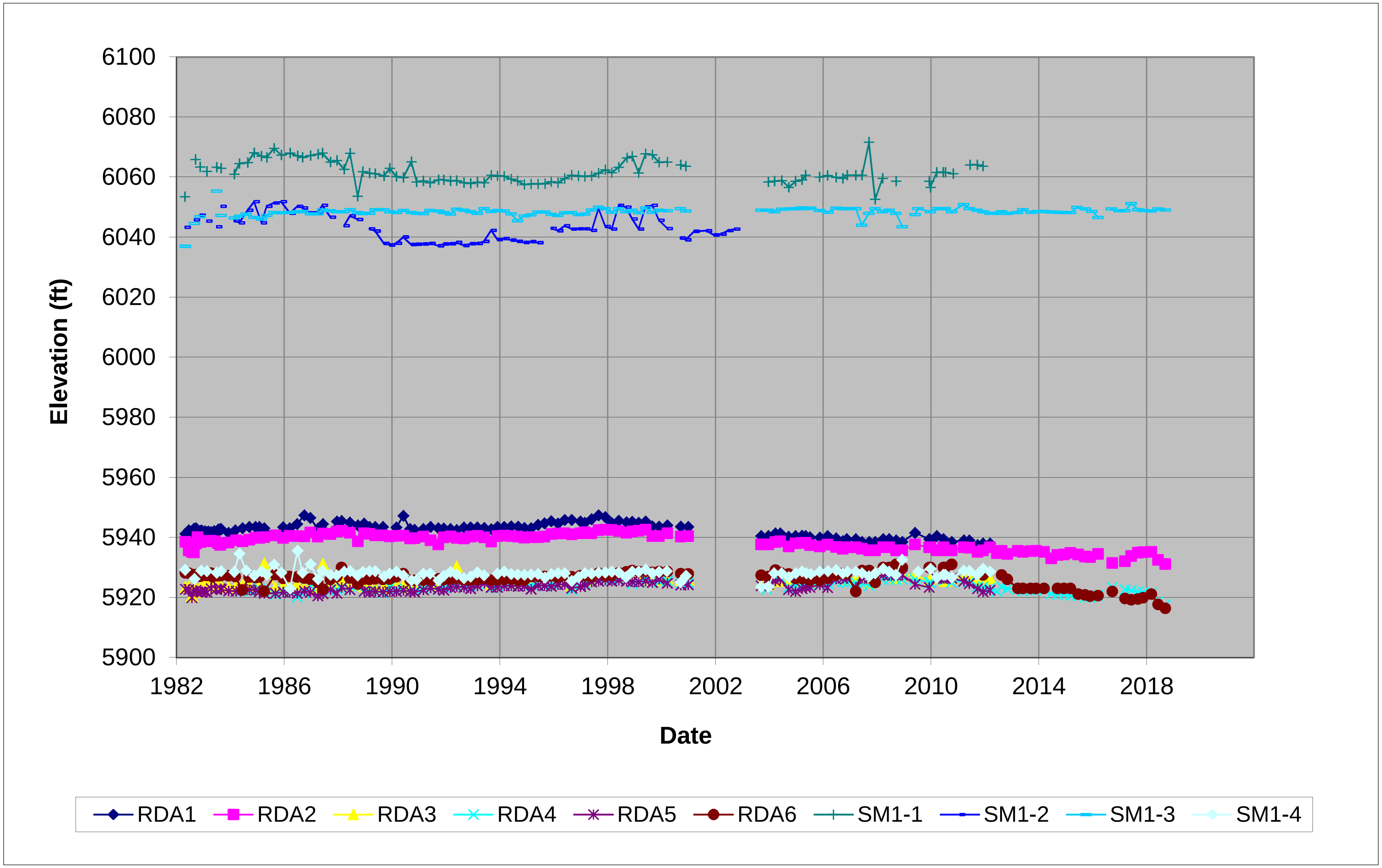


FIGURE VI-2. HYDROGRAPHS OF WELLS COMPLETED IN QUATERNARY DEPOSITS.

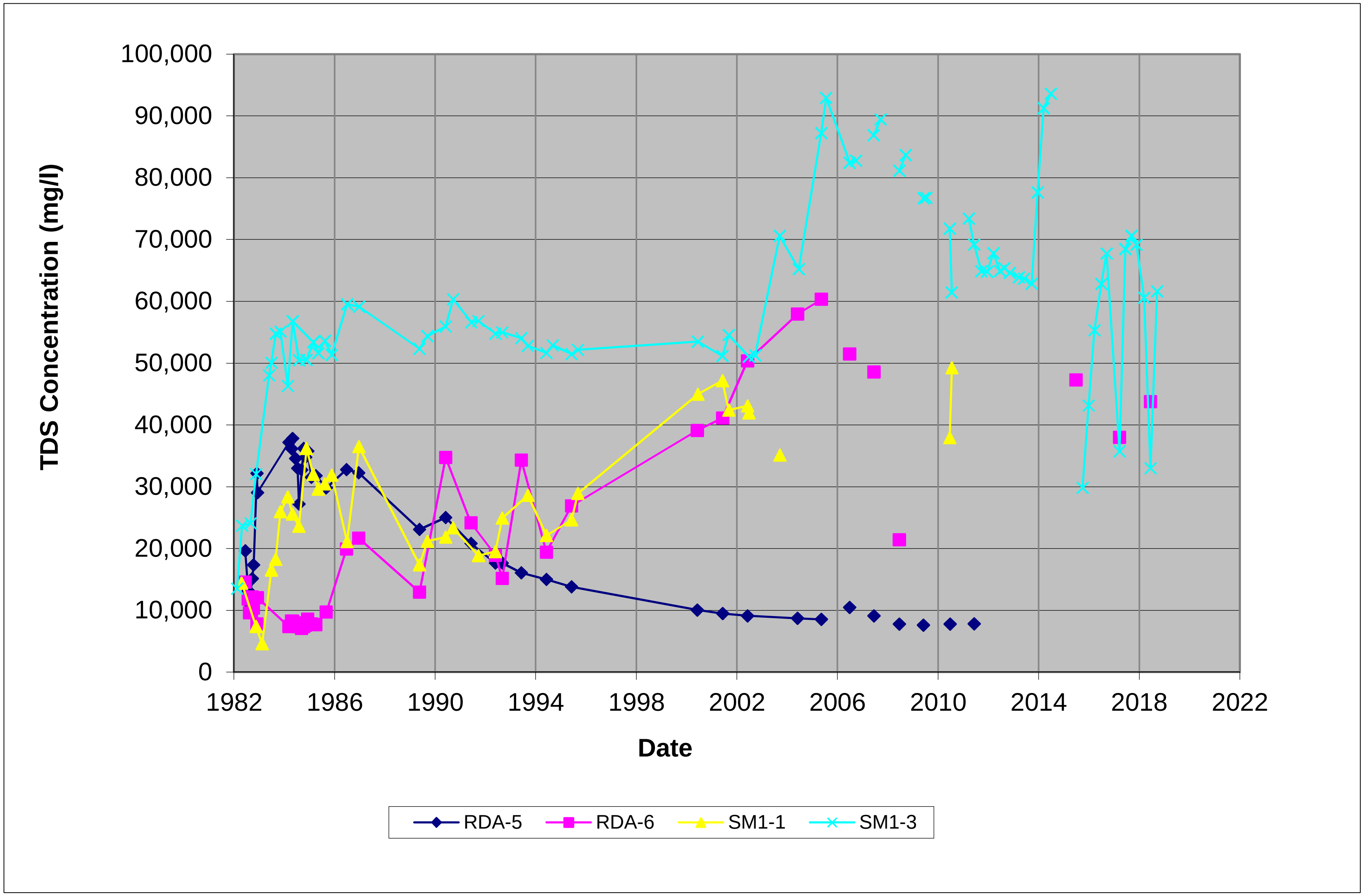


FIGURE VI-3. TDS CONCENTRATIONS OF SELECTED WELLS COMPLETED IN QUATERNARY DEPOSITS.

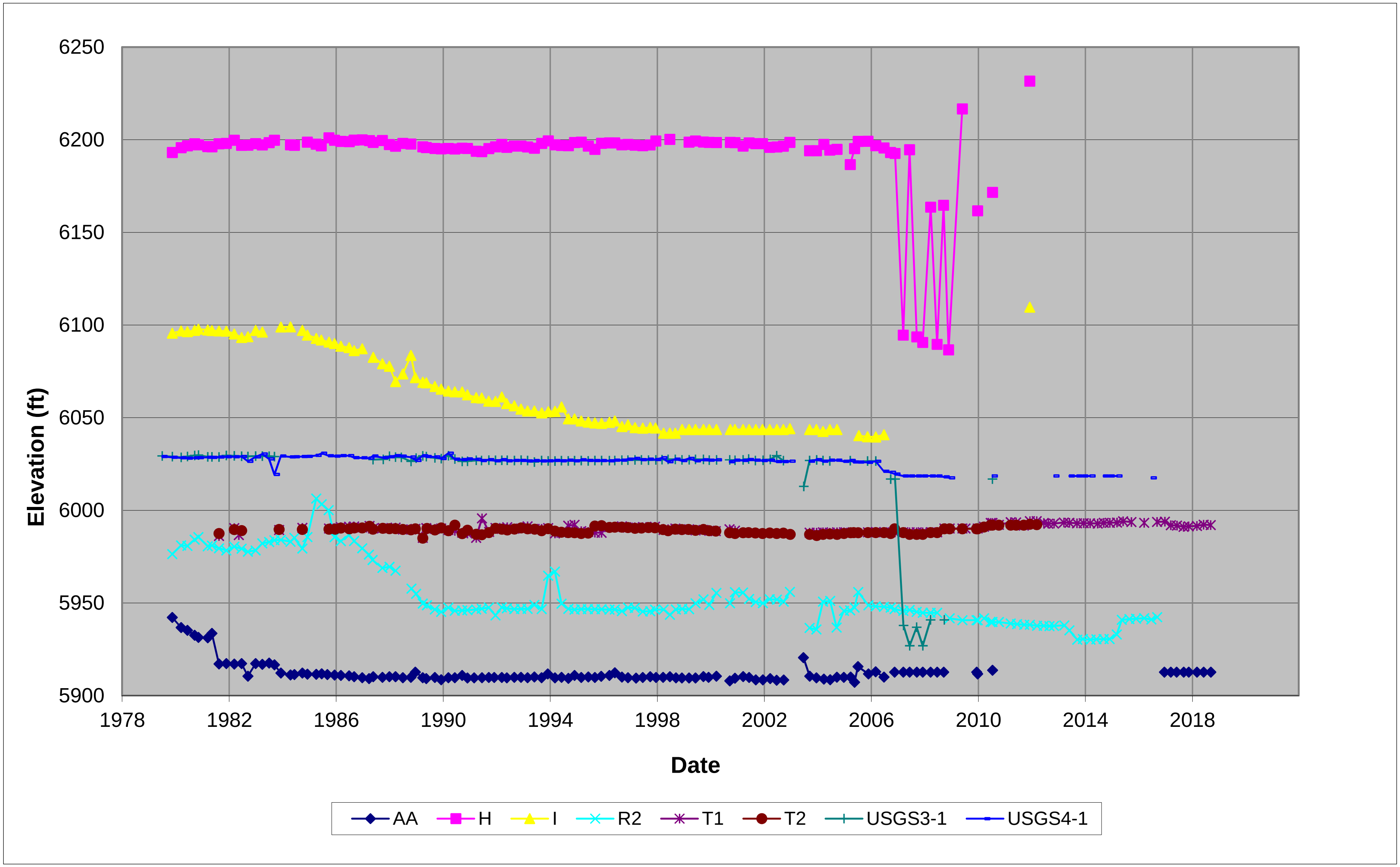


FIGURE VI-4. HYDROGRAPHS OF WELLS COMPLETED IN THE BLUE GATE MEMBER

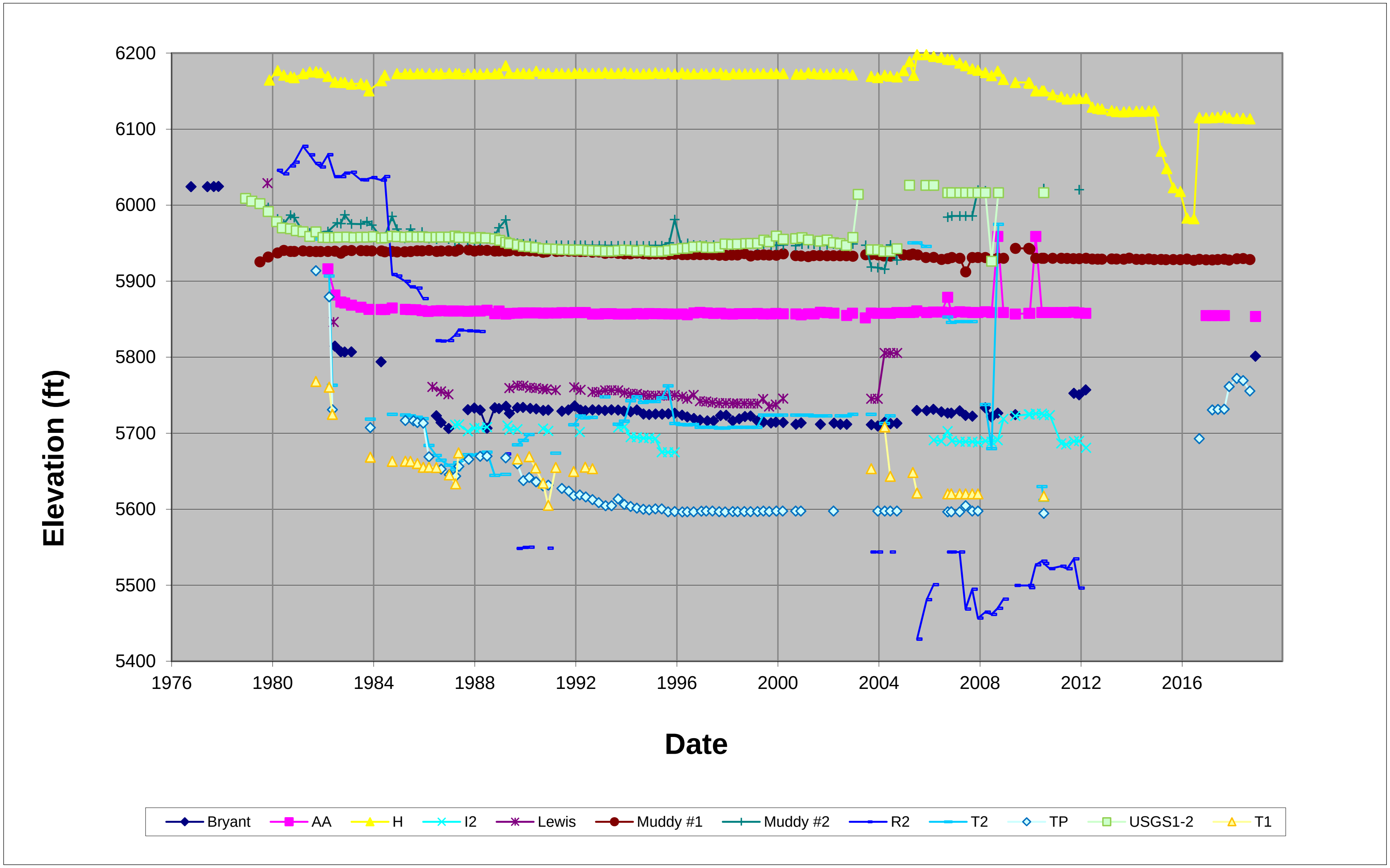


FIGURE VI-5. HYDROGRAPHS OF WELLS COMPLETED IN THE UPPER FERRON SANDSTONE.

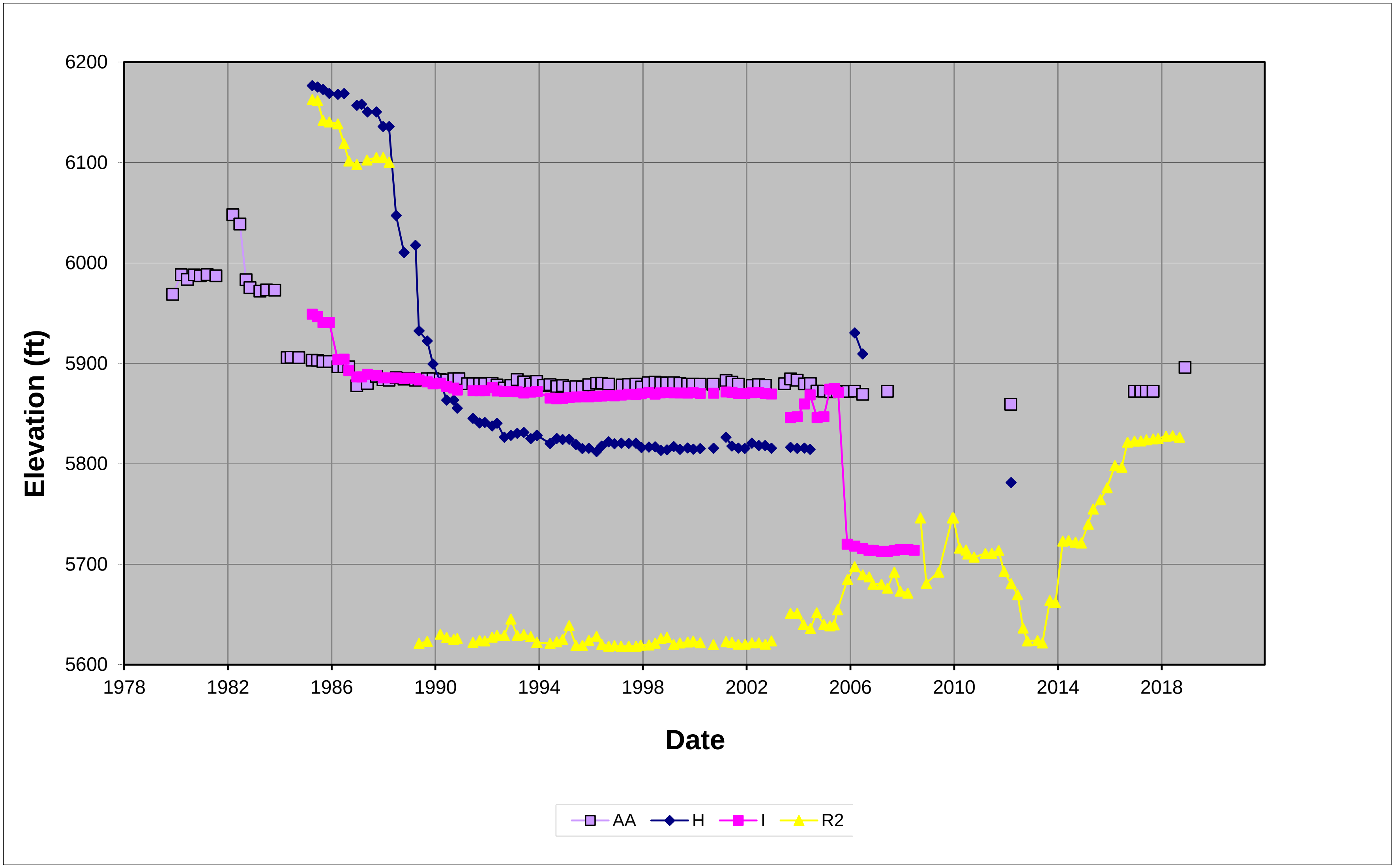


FIGURE VI-6. HYDROGRAPHS OF WELLS COMPLETED IN THE MIDDLE FERRON SANDSTONE.

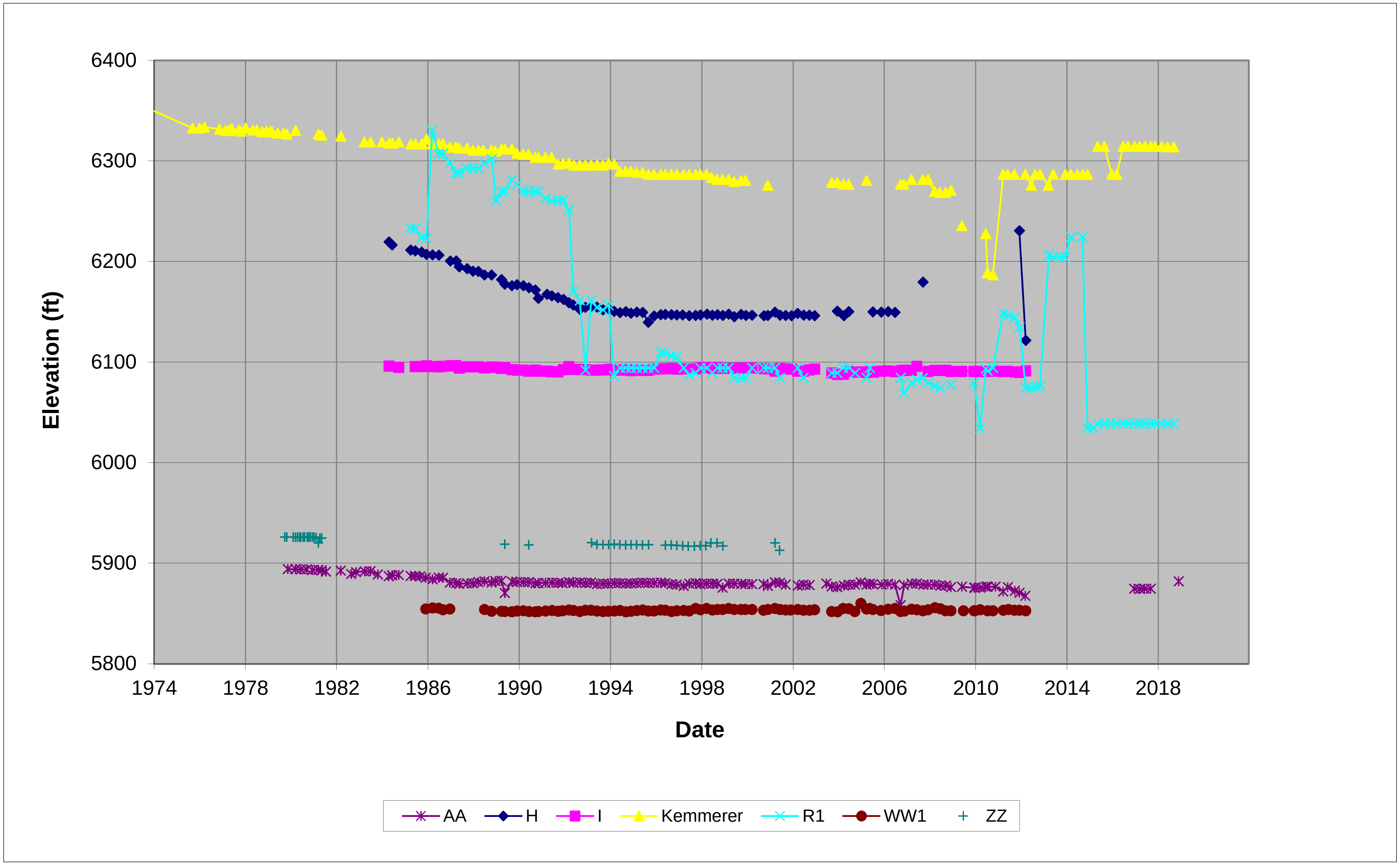
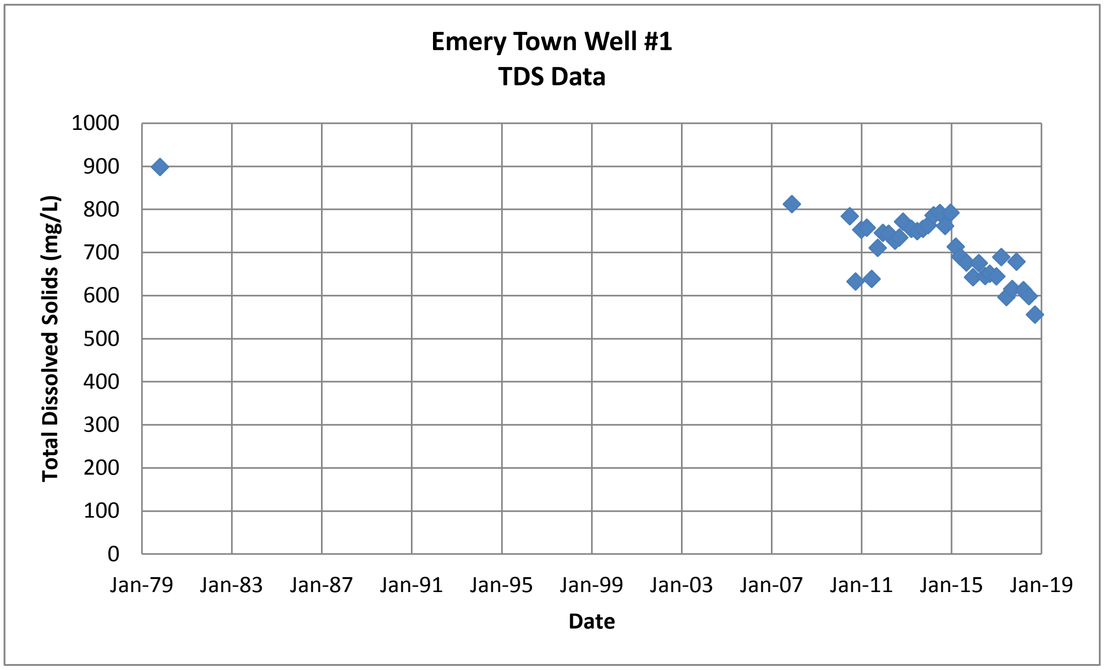


FIGURE VI-7. HYDROGRAPHS OF WELLS COMPLETED IN THE LOWER FERRON SANDSTONE.



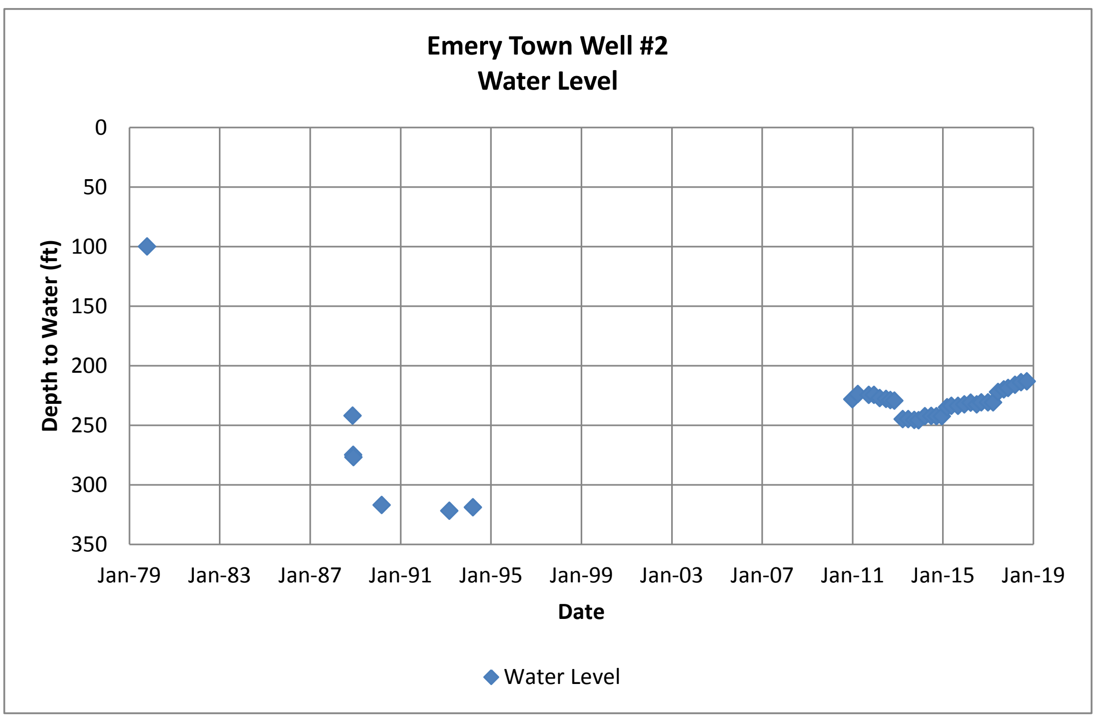


FIGURE VI-21. EMERY TOWN WELL DATA

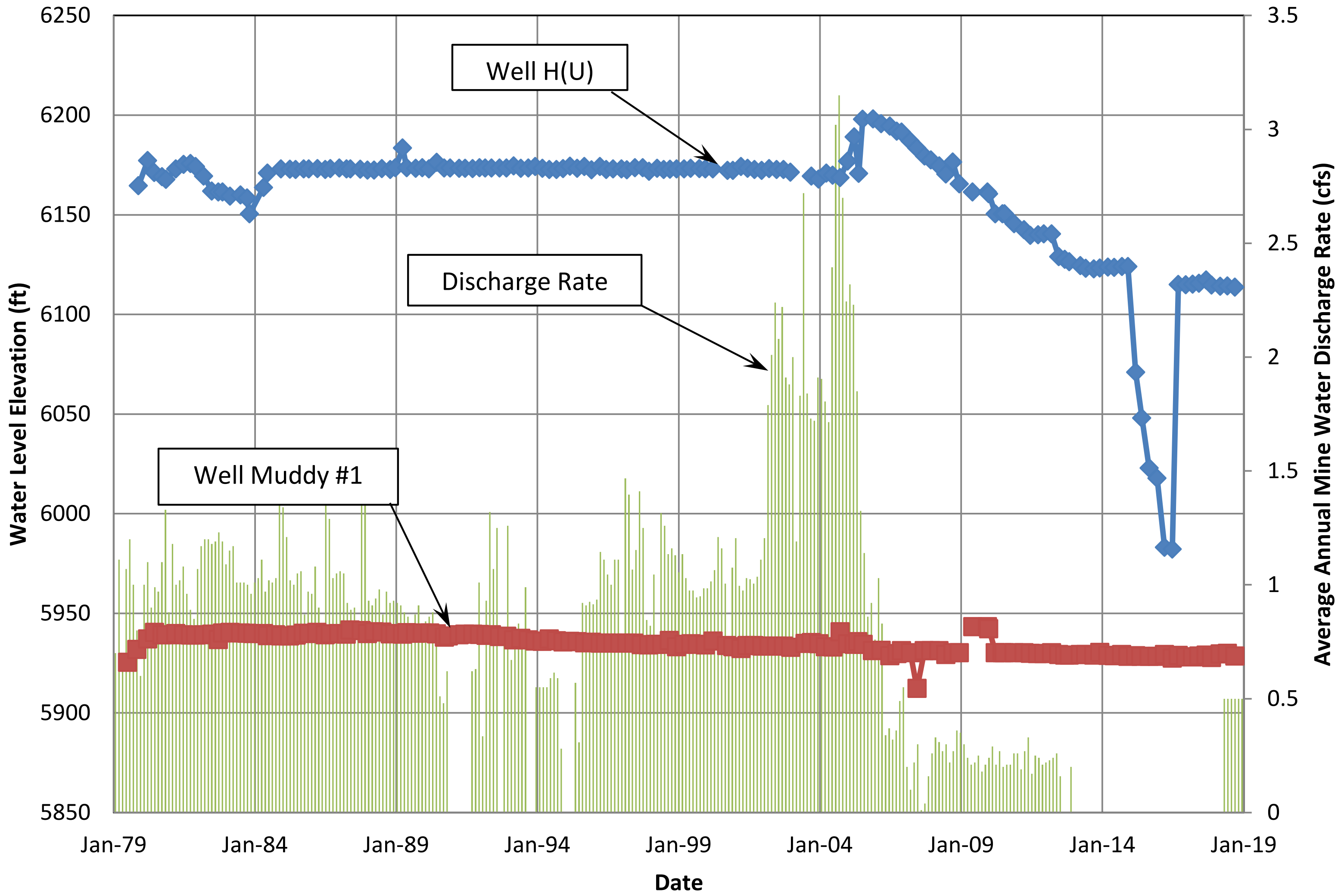
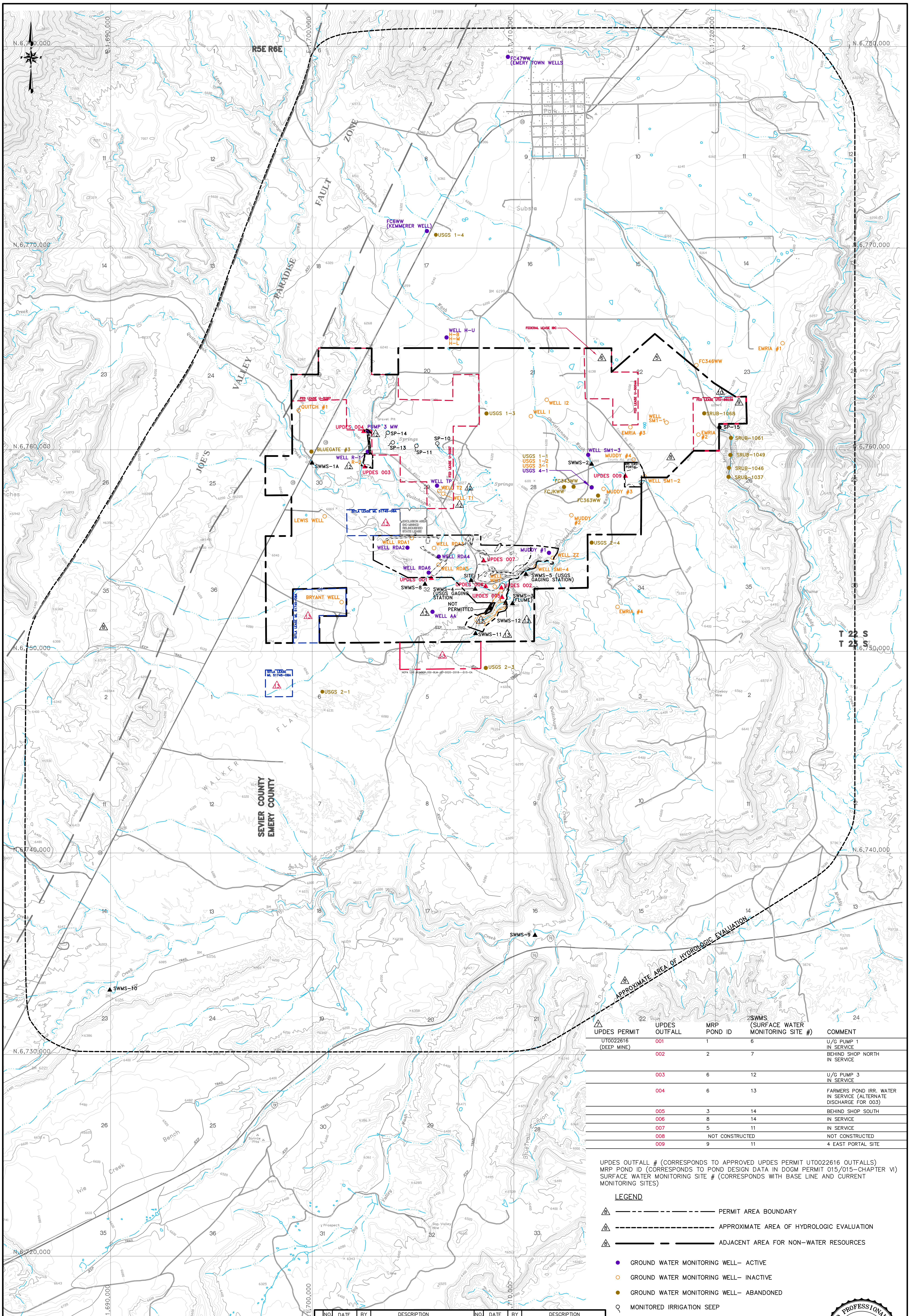


FIGURE VI-22. SELECTED Kmf(u) WATER-LEVEL AND MINE DISCHARGE DATA



UPDES PERMIT	UPDES OUTFALL	MRP POND ID	SWMS (SURFACE WATER MONITORING SITE #)	COMMENT
UT0022616 (DEEP MINE)	001	1	6	U/G PUMP 1 IN SERVICE
	002	2	7	BEHIND SHOP NORTH IN SERVICE
	003	6	12	U/G PUMP 3 IN SERVICE
	004	6	13	FARMERS POND IRR. WATER IN SERVICE (ALTERNATE DISCHARGE FOR 003)
	005	3	14	BEHIND SHOP SOUTH
	006	8	14	IN SERVICE
	007	5	11	IN SERVICE
	008	NOT CONSTRUCTED		NOT CONSTRUCTED
	009	9	11	4 EAST PORTAL SITE

UPDES OUTFALL # (CORRESPONDS TO APPROVED UPDES PERMIT UT0022616 OUTFALLS)
MRP POND ID (CORRESPONDS TO POND DESIGN DATA IN DOGM PERMIT 015/015–CHAPTER VI)
SURFACE WATER MONITORING SITE # (CORRESPONDS WITH BASE LINE AND CURRENT MONITORING SITES)

LEGEND

- PERMIT AREA BOUNDARY
- APPROXIMATE AREA OF HYDROLOGIC EVALUATION
- ADJACENT AREA FOR NON–WATER RESOURCES
- GROUND WATER MONITORING WELL– ACTIVE
- GROUND WATER MONITORING WELL– INACTIVE
- GROUND WATER MONITORING WELL– ABANDONED
- MONITORED IRRIGATION SEEP
- MONITORED SPRING
- SURFACE WATER MONITORING SITE
- UPDES DISCHARGE POINT

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968. EMERY EAST 1968, PHOTO REVISED 1978. MESA BUTTE 1968, PHOTO REVISED 1978. WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES. NAD 83 CONUS ZONE 4302–UTAH, CENTRAL – US FEET VERTICAL DATUM – NAVD 88–US FEET

EXTERNAL REFERENCE:
G:\UC982\XREFS–CURRENT\XREF–USGSMAP.DWG
G:\UC982\XREFS–CURRENT\XREF–SECTION.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT–e2P2–FEB 17

REVISIONS

NO.	DATE	BY	DESCRIPTION	NO.	DATE	BY	DESCRIPTION
2	8/1/89	RJD	ADDITION OF NPDES 0	8	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT, HYDRO BOUNDARY DEF. 3099
3	8/7/90	RJD	ADDITION OF SW SITES 14 & 15	9	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU–86038
4	9/95		AMENDED PERMIT BOUNDARY TO EXCLUDE EXPIRED STATE LEASE	10	04/10	JAG	ZZN WEDGE
5	6/30/05	JAG	ADDED FIRST NORTH I.B.C.	11	09/11	JAG	REVISE GROUNDWATER MONITOR PLAN, ABATE NOV 10088
6	12/12/06	JAG	1st NORTH FED LEASE IBC, FULL EXTRACTION	12	07/16	JAG	REVISE GW MONITOR PLAN
7	03/08	JAG	UPDATE MAP (OLD VI–3)	13	02/17	JAG	e2 PHASE II ADDITIONAL PERMIT REVISE GW MON TASK #5362
				13	01/19	JAG	RIGHT OF WAY EXPANSION

EarthFax

0' 2000'
SCALE: 1" = 2000'
CONTOUR INTERVAL = 40'

DRAWN BY: SWF | CHECKED BY: JAG | ORIGINAL DATE: 1/81 | RE–DRAWN DATE: 7/05
APPROVED BY: JAG | DWG DATA: G:\UC982\14–HYDROLOGY REWRITE\CHAPVI–PLATES\PLATE VI–4.DWG

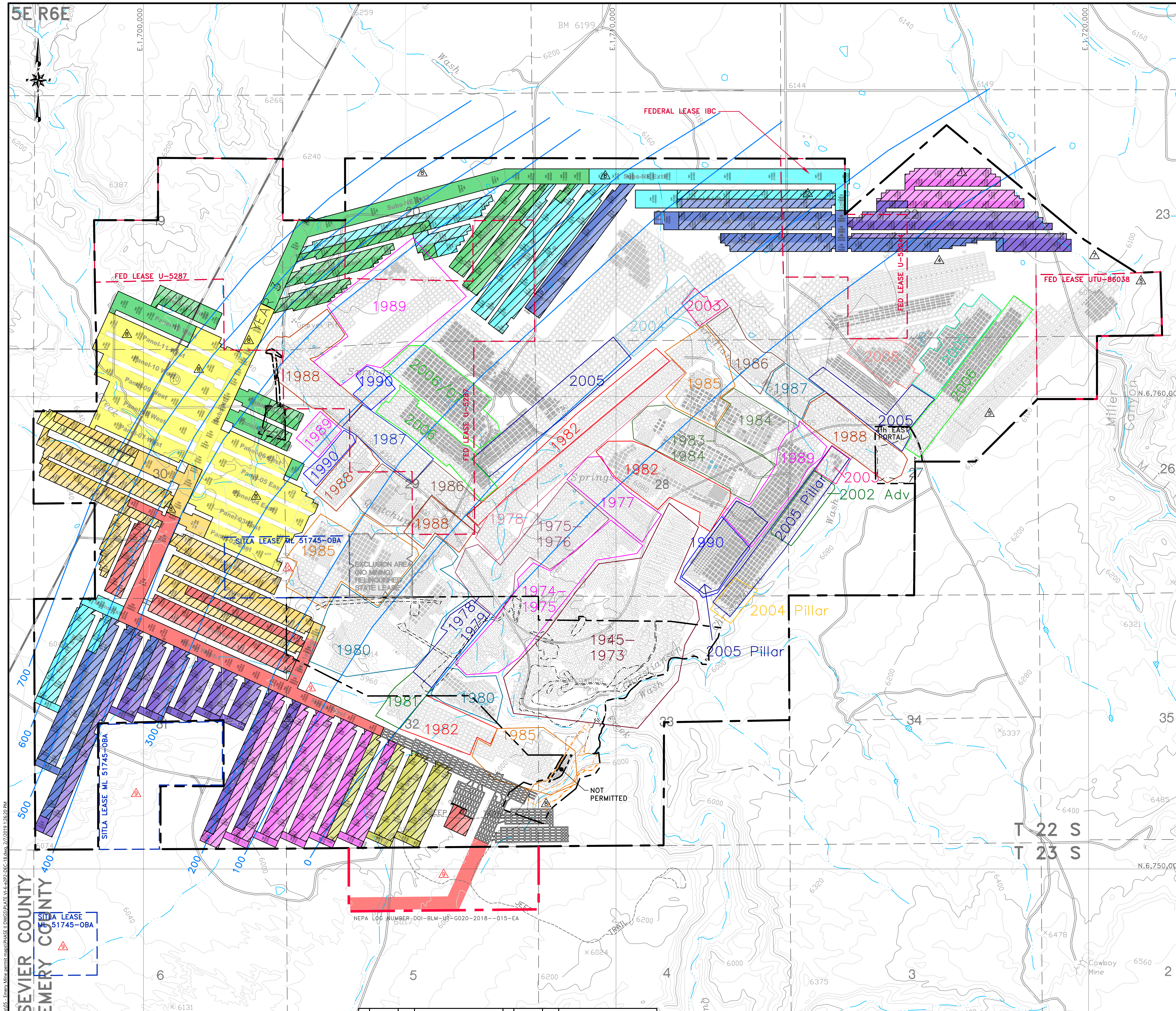
EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO.
ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522

PLATE VI–4
GROUND WATER MONITORING WELL AND SURFACE WATER MONITORING SITE LOCATION MAP

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
NOT VALID WITHOUT A SIGNATURE
STATE OF UTAH

G:\UC1665 - Bronco Utah Operations\05 - Emery Mine permit maps\PHASE II DWGS\PLATE VI-4-e2P2-FEB19.dwg



LEGEND

PERMIT AREA BOUNDARY

ADJACENT AREA FOR NON-WATER RESOURCES. FOR THE AREA OF HYDROLOGIC EVALUATION, SEE PLATE VI-4

PROPOSED ADDITIONAL ADJACENT AREA (ROW)

EXCLUSION AREA (NO MINING) RELINQUISHED STATE LEASE

MINE TIMING BY YEAR

RETREAT (FULL EXTRACTION) MINING / ADVANCE (FIRST) MINING

2019
2020
2021
2022
2023
2024
2025
2026
2027

FIRST MINING ONLY

FULL EXTRACTION

500 ESTIMATED DEPTH OF GROUNDWATER (FT) OVER TOP OF I-SEAM COAL (COMPARE PLATE V-20 AND PLATE VI-7)

REGISTERED PROFESSIONAL ENGINEER No. 168246 RICHARD B. WHITE STATE OF UTAH

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968. EMERY EAST 1968, PHOTO REVISED 1978. MESA BUTTE 1968, PHOTO REVISED 1978. WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES. NAD 83 CONUS ZONE 4302-UTAH, CENTRAL - US FEET VERTICAL DATUM - NAVD 88-US FEET

EXTERNAL REFERENCE:
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G:\UC982\XREF-CURRENT\XREF-SECTION.DWG
G:\UC982\XREF-CURRENT\XREF-WORKS-ZZNLBA.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT-e2P2-FEB 17
G:\UC1665\05\XREF\FULL EXTRACTION.DWG
G:\UC1665\05\XREF\XREF-NEW FORCASTED PANELS.DWG
G:\UC1665\05\XREF\2018 DOGM TIMING.DWG

REVISIONS

NO.	DATE	BY	DESCRIPTION	NO.	DATE	BY	DESCRIPTION
1	6/30/05	JAG	ADDED FIRST NORTH I.B.C.	6	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU-86038
2	12/12/06	JAG	1st NORTH FED LEASE IBC, FULL EXTRACTION	7	04/10	JAG	ZZN WEDGE
3	04/7	JAG	UPDATE MINING PLAN	8	12/17	JAG	e2 PHASE II ADDITIONAL PERMIT TASK #5362
4	09/08	JAG	LIFE OF MINE FULL EXTRACTION	9	01/19	JAG	RIGHT OF WAY EXPANSION
5	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT DEF. 3099				

SCALE: 1" = 1000'
CONTOUR INTERVAL = 40'

DRAWN BY: KDS
CHECKED BY: JAG
APPROVED BY: JAG
ORIGINAL DATE: 1/03
RE-DRAWN DATE: 12/18
DWG DATA: G:\UC1665\05\PHASE II DWGS

EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO.
ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522

PLATE VI-6
HISTORIC AND PLANNED MINING AND ANTICIPATED INITIAL DEPTH OF GROUNDWATER OVER TOP OF I-SEAM

EarthFax

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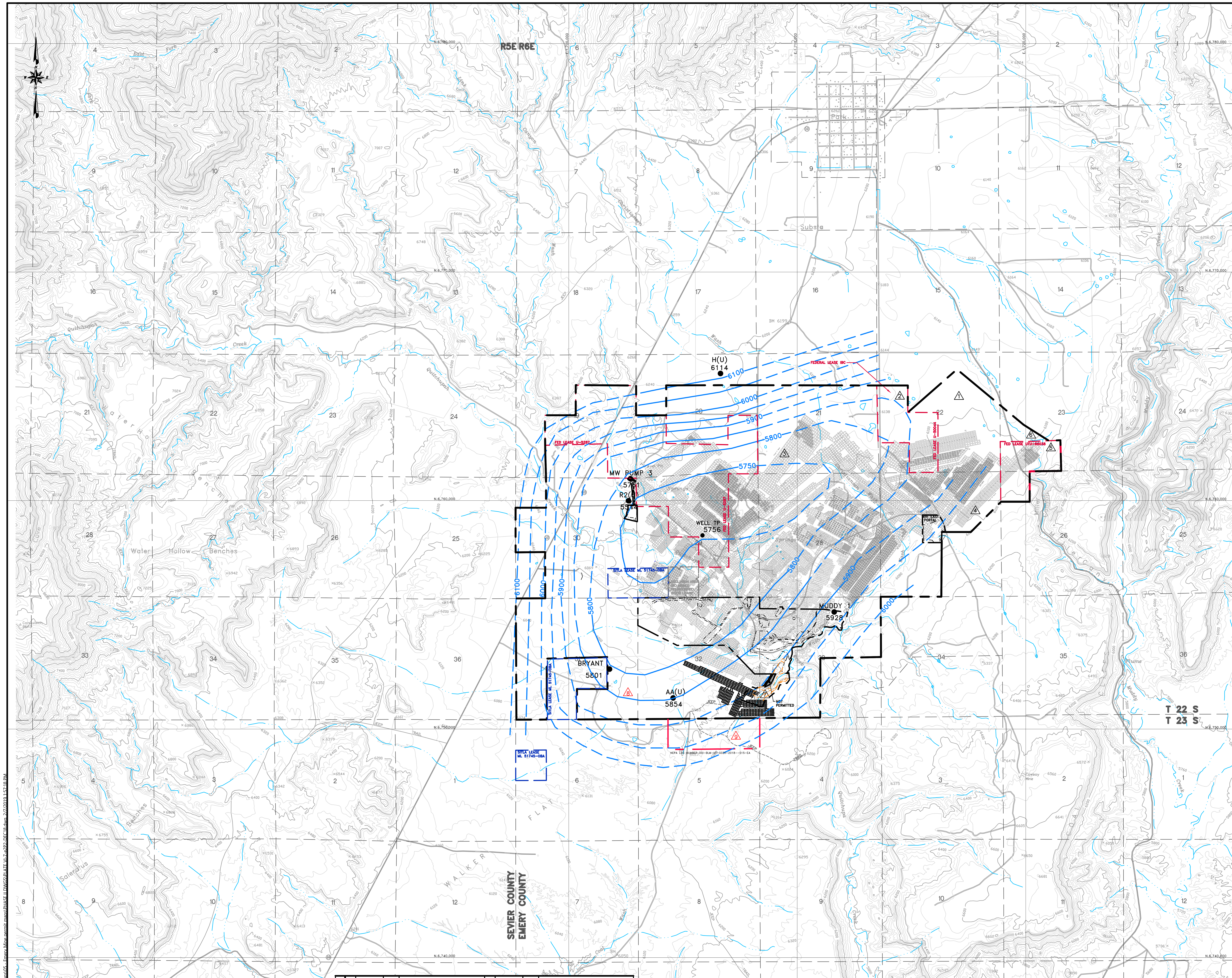

LEGEND

1 — · — · —	PERMIT AREA BOUNDARY
2 — — —	ADJACENT AREA FOR NON-WATER RESOURCES. FOR THE AREA OF HYDROLOGIC EVALUATION, SEE PLATE VI-4
3 — — — (red)	RIGHT OF WAY EXPANSION
—— 5900 — —	POTENTIOMETRIC SURFACE ELEVATION (FT)–DASHED WHERE INFERRED
WELL TP ● 5756	WELL LOCATION WITH NAME AND WATER SURFACE ELEVATION (FT)

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
NOT VALID WITHOUT A SIGNATURE
STATE OF UTAH

EarthFax

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968.
EMERY EAST 1968, PHOTO REVISED 1978.
MESA BUTTE 1968, PHOTO REVISED 1978.
WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES.
NAD 83 CONUS
ZONE 4302–UTAH, CENTRAL – US FEET
VERTICAL DATUM – NAVD 88–US FEET

EXTERNAL REFERENCE:
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G:\UC982\XREFS-CURRENT\XREF-OLDWORKS.DWG
G:\UC982\XREFS-CURRENT\XREF-FAULTZONE.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT-e2P2-OCT 17

REVISIONS

NO.	DATE	BY	DESCRIPTION	NO.	DATE	BY	DESCRIPTION
1	6/30/05	JAG	ADDED FIRST NORTH I.B.C.	6	04/10	JAG	ZZN WEDGE
2	12/12/06	JAG	1st NORTH FED LEASE IBC, FULL EXTRACTION	7	02/17	JAG	e2 PHASE II ADDITIONAL PERMIT TASK #5362
3	03/08	JAG	UPDATED POTENTIOMETRIC SURFACE	8	01/19	JAG	e2 FULL EXTRACTION TASK #5769 DEFICIENCY RESPONSE
4	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT DEF. 3099	9	01/19	JAG	RIGHT OF WAY EXPANSION
5	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU-86038				

0' 2000'
SCALE: 1" = 2000'
CONTOUR INTERVAL = 40'

DRAWN BY: KDS
CHECKED BY: JAG
ORIGINAL DATE: 7/95
RE-DRAWN DATE: 7/05
APPROVED BY: JAG
DWG DATA: G:\UC1665\05\PHASE II DWGS

EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO.
ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522

PLATE VI–7
UPPER FERRON SANDSTONE
POTENTIOMETRIC SURFACE (2018)

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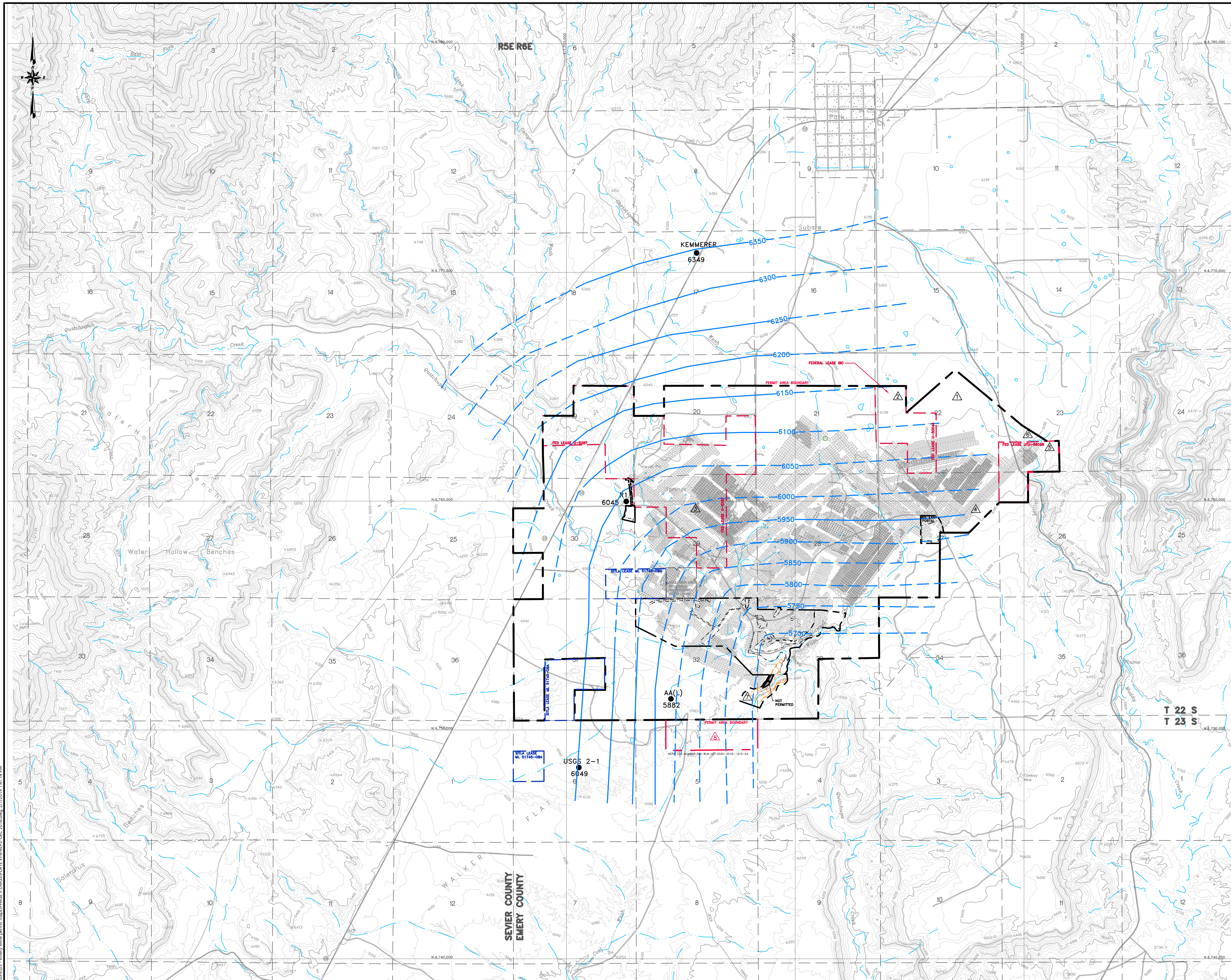

LEGEND

4	PERMIT AREA BOUNDARY
4	ADJACENT AREA FOR NON-WATER RESOURCES. FOR THE AREA OF HYDROLOGIC EVALUATION, SEE PLATE VI-4
8	RIGHT OF WAY EXPANSION
6000	POTENTIOMETRIC SURFACE ELEVATION (FT)-DASHED WHERE INFERRED
AA 5878	WELL LOCATION WITH NAME AND WATER SURFACE ELEVATION (FT)

REGISTERED PROFESSIONAL ENGINEER No. 168246 RICHARD B. WHITE NOT VALID WITHOUT A SIGNATURE STATE OF UTAH

EarthFax

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968.
EMERY EAST 1968, PHOTO REVISED 1978.
MESA BUTTE 1968, PHOTO REVISED 1978.
WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES.
NAD 83 CONUS
ZONE 4302-UTAH, CENTRAL – US FEET
VERTICAL DATUM – NAVD 88-US FEET

EXTERNAL REFERENCE:
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G:\UC982\XREFS-CURRENT\XREF-COORDS.DWG
G:\UC982\XREFS-CURRENT\XREF-WORKS-ZZNLBA.DWG
G:\UC982\XREFS-CURRENT\XREF-FAULTZONE.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT-e2P2-FEB 17

REVISIONS

NO.	DATE	BY	DESCRIPTION	NO.	DATE	BY	DESCRIPTION
1	6/30/05	JAG	ADDED FIRST NORTH I.B.C.	5	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU-86038
2	12/12/06	JAG	1st NORTH FED LEASE IBC, FULL EXTRACTION	6	04/10	JAG	ZZN WEDGE
3	03/08	JAG	UPDATED POTENTIOMETRIC SURFACE	7	02/17	JAG	e2 PHASE II ADDITIONAL PERMIT TASK #5362
4	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT DEF. 3099	8	02/19	JAG	RIGHT OF WAY EXPANSION

0' 2000'
SCALE: 1" = 2000'
CONTOUR INTERVAL = 40'

DRAWN BY: KDS
APPROVED BY: JAG
CHECKED BY: JAG
DWG DATA: G:\UC1665\05\PHASE II DWGS
ORIGINAL DATE: 7/95
RE-DRAWN DATE: 2/19

EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO. ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522

PLATE VI–8
LOWER FERRON SANDSTONE
POTENTIOMETRIC SURFACE (2018)

APPENDIX VI-23

Baseline Investigation of Unnamed Ephemeral Washes

Evaluation of Two Unnamed Tributaries of Quitchupah Creek in Emery County, Utah December 2018

Evaluation of an Unnamed Stream Channel in Emery County, Utah February 2019

EVALUATION OF TWO UNNAMED TRIBUTARIES OF QUITCHUPAH CREEK IN EMERY COUNTY, UTAH

1.0 INTRODUCTION

Bronco Utah Operations, LLC ("Bronco") is planning on fully extracting coal in a portion of their underground Emery 2 Mine located in Emery County, Utah. Subsidence resulting from this full extraction may affect two unnamed tributaries of Quitchupah Creek located in Sections 30 and 31, T. 22 S., R. 6 E., SLBM. These tributaries, which appear on the Emery West and Walker Flat, Utah 7.5-minute USGS quadrangle maps, are shown on Figure 1. Since subsidence may impact these tributaries, the Utah Division of Oil, Gas and Mining ("UDOGM") requested that they be characterized with respect to their hydrologic regime.

Regulations promulgated by UDOGM define perennial, intermittent, and ephemeral streams as follows (see R645-100-200):

> " 'Perennial Stream' means a stream or part of a stream that flows continuously during all of the calendar year as a result of groundwater discharge or surface runoff. The term does not include intermittent stream or ephemeral stream.
>
> " 'Intermittent Stream' means a stream, or reach of a stream, that is below the local water table for at least some part of the year and obtains its flow from both surface runoff and groundwater discharge.
>
> " 'Ephemeral Stream' means a stream which flows only in direct response to precipitation in the immediate watershed, or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table."

UDOGM regulations (R645-301-724.200) require an applicant for a mine permit to characterize baseline surface water conditions in areas of potential impact. Although a cursory evaluation indicates that the subject unnamed tributaries are ephemeral, the purpose of this report is to present the hydrological, physical, and biological attributes of these channels as a means of formally designating their baseline condition.

2.0 METHODOLOGY

This investigation was conducted in general accordance with protocols developed by the Surface Water Quality Bureau of the New Mexico Environment Department (2011). These protocols were developed for determining whether individual streams are ephemeral, intermittent, or perennial to assist in determining potential beneficial uses of the waters in those streams.

Prior to the field survey, topographic mapping, geology and groundwater information from various sources, aerial photography from Google Earth, and soil data obtained from the U.S. Natural Resources Conservation Service Web Soil Survey[1] were examined to provide the initial context for the field observations. The field survey was conducted on November 30, 2018. Although it is desirable to conduct such a survey at least 48 hours after the last precipitation event (to aid in identifying the general moisture content of channel bottoms), the need to obtain data prior to additional snowfall precluded this typical approach.

During the field survey, the entire area surrounding the unnamed tributaries was traversed on foot, initially in an upstream-to-downstream direction (to locate the channels and assess general channel characteristics) and then from downstream to upstream. This latter inspection included frequent stops to take notes, photograph reaches, record GPS locations of various relevant features, and measure the size of the active channel. These stops were made at locations that reflected representative channel characteristics.

3.0 ENVIRONMENTAL SETTING

The northern unnamed tributary (referred to herein as UNT-1) drains a watershed area of approximately 2.2 square miles while the southern tributary (referred to herein as UNT-2) drains an area of about 3.3 square miles. UNT-1 joins Quitchupah Creek approximately 700 feet southeast of the center of Section 30. The confluence of UNT-2 and Quitchupah Creek occurs near the eastern boundary of Section 32, about one mile east of Section 31.

Quitchupah Creek is effectively perennial in the area of interest since the natural flow regime of the creek is supplemented by groundwater pumped from the SUFCO Mine operated by Canyon Fuel Company in the headwaters of the Quitchupah Creek watershed. Groundwater pumped from Bronco's Emery Mine is also discharge to Quitchupah Creek downstream from the confluence of UNT-1 and upstream from the confluence of UNT-2.

The watersheds associated with the unnamed tributaries are essentially undeveloped, ranging in elevation from about 5,990 feet to 6,890 feet in the case of UNT-1 and from about 5,960 feet to 6,940 feet in the case of UNT-2. The Blue Gate Member of the Mancos Shale, or alluvial/colluvial soils derived primarily from weathering of that Member, exists on the surface over most of Sections 30 and 31. The Blue Gate Member is a marine shale that often erodes to form badland topography (Godfrey et al., 2007).

Soil data in the vicinity of UNT-1 and UNT-2, as downloaded from the Web Soil Survey, are provided in Attachments A and B, respectively. As indicated, surficial soils in the immediate vicinity of UNT-1 are classified as loam under the U.S. Department of Agriculture classification system and as CL (low plasticity clay) under the Unified Soil Classification System. These soils consist of approximately 60 to 80 percent silt and clay. As noted in Figure 2, the depth to groundwater may be as shallow as about 76 centimeters (2.5 feet) along some downstream reaches of UNT-1 within the area of interest.

[1] https://websoilsurvey.nrcs.usda.gov/app/

Surficial soils in the immediate vicinity of UNT-2 are generally classified within the area of interest as loam to silt loam under the USDA classification system and as CL (low plasticity clay) and OH (organic silt and clay) under the Unified Soil Classification System. These soils consist of 70 to 80 percent silt and clay. At the downstream end of UNT-2 within the area of interest (within Section 32), the depth to groundwater may be as shallow as 25 centimeters (approximately 10 inches).

Annual precipitation at Emery, Utah averages 7.33 inches, with an average monthly maximum of 1.12 inches in August and an average monthly minimum of 0.33 inch in November.[2] Native vegetation within the area of interest consists of a desert shrub community typical of the general area, but density is typically sparse due to the soil type and climate. Cultivation of some areas adjacent to and within UNT-2 has modified the native vegetative community of that area by introducing pasture grass and alfalfa.

4.0 RESULTS AND DISCUSSION

The November 2018 field survey of the unnamed tributary channels provided ample evidence of the ephemeral nature of flow in the channels. These observations are summarized in the field sheets provided in Attachment C. The hydrological, physical, and biological attributes that are indicative of intermittent or perennial stream flow in natural channels were absent. In fact, definable channels were not evident in reaches of each tributary. All observations supported the classification of each tributary as being ephemeral, as further discussed below.

4.1 UNT-1

Photographs of UNT-1 and its general vicinity are provided in Attachment D. Waypoints at which photographs and observations were taken along UNT-1 are shown on Figure 3. Field observations are summarized in Table 1.

The most distinguishing geomorphic features of UNT-1 are deep headcuts that have formed about 600 to 800 feet upstream from the confluence of this tributary with Quitchupah Creek together with wide gullies downstream from the headcuts and nearly indistinguishable channels upstream from the headcuts. Three primary headcuts are evident in UNT-1, labeled in Attachment D and Table 1 as the north, middle, and south gully headcuts and the resultant north, middle, and south gullies. The fact that multiple headcuts have formed is an indication of the dispersed nature of the upstream flow at that location.

The ground surface at the north and middle headcuts drops approximately 15 to 20 feet with near-vertical sidewalls. The magnitude of the south headcut has been minimized by the landowner, who placed branches in the headcut to arrest its continued migration. Gullies downstream from the headcuts are typically 20 to 30 feet wide near the headcuts and 50 to 55 feet wide near the mouth of UNT-1. Active channel within the cullies are generally 1 to 2 feet wide and about 1 foot deep. These

[2] https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut2484

geomorphic conditions are typical of ephemeral channels that form in arid to semiarid areas where the soils contain high silt and clay fractions. Upstream from the headcuts, the channels are poorly defined, typically being less than 1 foot deep and less 1 foot wide where they can be identified.

Regular and persistent stream flows often create channels that are sinuous, because a regular meander pattern is a function of a stream's attempt to balance its velocity (energy) and the valley gradient. Point bars and well-sorted bed materials are also typical of intermittent and perennial streams. On the other hand, these fluvial features are not typical of ephemeral channels. The channel of UNT-1 does not show any sign of regular or persistent meandering, fully developed point bars, sustained material sorting, or other geomorphic indications of intermittent or perennial flows. Thus, these observations support the classification of UNT-1 as ephemeral.

Observations were also made to identify evidence of recent storm flows such as high water marks (scour lines or deposits), floatable organic debris deposition, fine sediments deposited on bank vegetation, etc. No such evidence was noted in the field.

Tamarisk grows abundantly in the downstream (gullied) end of UNT-1, suggesting a relatively shallow depth to groundwater. This is consistent with the soil information presented in Figure 2. The shallow depth to groundwater in this area is likely affected by nearby Quitchupah Creek, which carries perennial flow due to upstream discharges from the Sufco Mine as noted in Section 3.0. However, no water was flowing or pooling within any portion of UNT-1 during the November 30, 2018 field survey and no evidence was seen in the channel of historic intermittent or perennial flows.

A review of Google Earth aerial photos of UNT-1 indicates slightly enhanced vegetative growth along the flow line in some sections. This observation was verified in the field in discontinuous reaches of the channel. In addition to tamarisk growing near the confluence with Quitchupah Creek, an occasional tamarisk bush and more vigorous growth of greasewood and rabbit brush was noted in some higher reaches of UNT-1. Where this occurred, it appeared that the channel gradient was lower, thereby slowing the flow of runoff, when it is present, allowing more infiltration of that water.

Commonly, streams with even small base flows support some form of filamentous algae or periphytons that cling to the substrate. These organisms were not observed, indicating that flows in UNT-1 are insufficient to allow colonization. No evidence of ponding or groundwater inflow to the channel was evident anywhere within UNT-1.

4.2 UNT-2

Photographs of UNT-2 and its general vicinity are provided in Attachment E. Waypoints at which photographs and observations were taken along UNT-2 are shown on Figure 3. Field observations are summarized in Table 2.

The most distinguishing geomorphic feature of UNT-2 is the absence of a well-defined drainage way in large reaches of the channel delineated on the USGS topographic map. Reaches where a well-defined channel does not exist are indicated on Figure 4. Some of these channel-free reaches are well vegetated where cultivation has occurred (such as between waypoints 11 and 13 and between waypoints 16 and 17), while only sparse, native vegetation occurs in other such areas (such as between waypoints 13 and 14 as well as upstream from waypoint 21). Two diversion ditches have also been constructed by landowners in the area to divert runoff around cultivated fields (which are currently planted in alfalfa and pasture grass). The discontinuous and poorly-defined nature of the channel, together with cultivation of areas in which the channel may have formerly existed, is the reason for the variation in the locations of the USGS-delineated channel and the waypoints on Figure 3. The fact that cultivation can occur in some of the missing reaches is an indication of the lack of intermittent and perennial flow in those reaches.

The lower 300 to 350 feet of UNT-2 is well vegetated with grasses. The channel in this area is 60 to 65 feet wide at the downstream end of the survey area and 12 to 15 feet wide at waypoint 11. Channel depth ranges from 12 to 15 feet at the downstream end to 2 to 3 feet at waypoint 11. The channel effectively disappears through cultivated pasture and natural ground for a distance of about 1/3 mile upstream from that waypoint. The natural channel also disappears where it is diverted around an alfalfa field between waypoints 16 and 17.

Where UNT-2 is well defined, it is generally less than about 1 foot wide and 1 foot deep in its natural condition. The channel has been unnaturally enlarged by erosion in areas downstream from diversions and a farm road which capture runoff from the area.

The channel of UNT-2 does not show any sign of regular or persistent meandering, fully developed point bars, sustained material sorting, or other geomorphic indications of intermittent or perennial flows. These indicators support the classification of UNT-2 as ephemeral.

Observations were also made to identify evidence of recent storm flows such as high water marks (scour lines or deposits), floatable organic debris deposition, fine sediments deposited on bank vegetation, etc. No such evidence was noted in the field.

Vegetative growth is more vigorous in the lower reach of UNT-2 (downstream from waypoint 13), suggesting a shallower depth to groundwater. This is consistent with the soil information presented in Figure 2. However, no water was flowing or pooling within any portion of UNT-2 during the November 30, 2018 field survey and no evidence was seen in the channel of historic intermittent or perennial flows.

A review of Google Earth aerial photos of UNT-2 indicates no substantial enhancement of vegetative growth along the flow line of this channel. Furthermore, no filamentous algae or periphytons were observed. The lack of these organisms indicates that flows in UNT-2 are insufficient to allow colonization. No evidence of ponding or groundwater inflow to the channel was evident anywhere within UNT-2.

5.0 SUMMARY AND CONCLUSIONS

The November 2018 field survey, as well as other supporting evidence obtained prior to the field survey, substantiates the initial assertion that the unnamed tributaries of Quitchupah Creek in Sections 30 and 31, T. 22 S., R. 6 E., SLBM are ephemeral. There are no indications that the channels flow intermittently or perennially. All of the hydrological, physical, and biological attributes that were examined during the survey strongly suggest that the channel bottom is (1) always above the water table, and (2) conveys flow only infrequently and in direct response to either precipitation that is generated within its watershed or snow melt generated therein. Thus, individually and cumulatively, all observations consistently and clearly point to the classification of UNT-1 and UNT-2 as ephemeral.

6.0 REFERENCES

Godfrey, A.E., R.I. Grauch, and M.L.Tuttle. 2007. Geomorphic Differences Between the Tununk and Blue Gate Members of the Mancos Shale Near Caineville, Wayne County, Utah. pp. 205-220 *in* Central Utah: Diverse Geology of a Dynamic Landscape. Utah Geological Association Publication 36. G.C. Willis, M.D. Hyland, D.L. Clark, and T.C. Chidsey, Jr. (Editors). Salt Lake City, UT.

New Mexico Environment Department, Surface Water Quality Bureau. 2011. Statewide Water Quality Management Plan and Continuing Planning Process - Appendix C: Hydrology Protocol for the Determination of Uses Supported by Ephemeral, Intermittent, and Perennial Waters. Santa Fe, NM. Document downloaded from https://www.env.nm.gov/swqb/Hydrology/index.html.

TABLE 1

UNT-1 Observations

Waypoint	Channel Dimensions (ft)		Vegetation	Comments
	Bottom Width	Depth		
1	50-55	20	Tamarisk, greasewood, rabbit brush, grass	At confluence with Quitchupah Creek floodplain. Broad gully with low-flow channel about 1 ft wide and 6-9 in deep.
2	20 (North) 30 (South)	20 (North) 20 (South)	As above	Gully split
3	20-40	15-20	Greasewood, rabbit brush, grass	Dimensions are for north gully headcut. Channel upstream from headcut is about 1 ft wide, 6 in deep with similar vegetation.
4	20-30	12-15	Greasewood, rabbit brush, grass	Dimensions are for middle gully headcut. Poorly-defined channel upstream from headcut is about 1 ft wide, 6 in deep with similar vegetation.
5	12-15	4-5	Greasewood, rabbit brush, dogwood, grass	South gully headcut. Headcut has been filled with branches, probably by the landowner to minimize further erosion. Poorly-defined channel leading to headcut. Upstream vegetation is as indicated without dogwood.
6	3-5	1	Greasewood, rabbit brush, grass with sparse tamarisk	Channel is a broad swale with upland vegetation throughout
7	1-2	1	Greasewood, rabbit brush, grass	Channel is a broad swale with upland vegetation throughout
8	None		Greasewood, rabbit brush, grass	No well-defined channel
9	2-4	1	Greasewood, rabbit brush, grass	Broad, discontinuous swale with upland vegetation throughout

Note: See Figure 3 for waypoint locations.

TABLE 2

UNT-2 Observations

Waypoint	Channel Dimensions (ft)		Vegetation	Comments
	Bottom Width	Depth		
10	60-65	12-15	Grass bottom; grass, greasewood, and rabbit brush sides	Channel is a broad swale. No water in this tributary. However, ponded water exists in the adjacent tributary flowing from the southwest, due to low area in adjacent tributary.
11	5-10	2-3	Grass bottom; grass, greasewood, and rabbit brush sides	Broad swale at upstream end of defined channel. No well-defined channel in immediate upstream area.
12	None		Pasture grass	No channel evident
13	Poorly defined		Sparse greasewood	Small, discontinuous channels without consistent dimensions
14	0.5-1.0	0.5	Sparse greasewood	No change in vegetation near channel.
15	1-2	1	Sparse greasewood	Channel shows unnatural erosion from diversion upstream from nearby cultivated field
16	5-6	3-4	Sparse greasewood	Channel shows unnatural erosion from diversion upstream from nearby cultivated field
17	1	0.5	Sparse greasewood	Dimensions are for area upstream from cultivated field. No natural channel remains in the cultivated field.
18	1-2	2-3	Sparse greasewood	Eroded channel downstream from second ditch
19	1	0.5	Sparse greasewood	Upstream from second ditch
20	3-4	2-3	Sparse greasewood	Dimensions are for eroded channel downstream from low point in farm road
21	None		Sparse greasewood	Hummocky area without defined channel
22	None		Sparse greasewood	Hummocky area without defined channel

Note: See Figure 3 for waypoint locations.

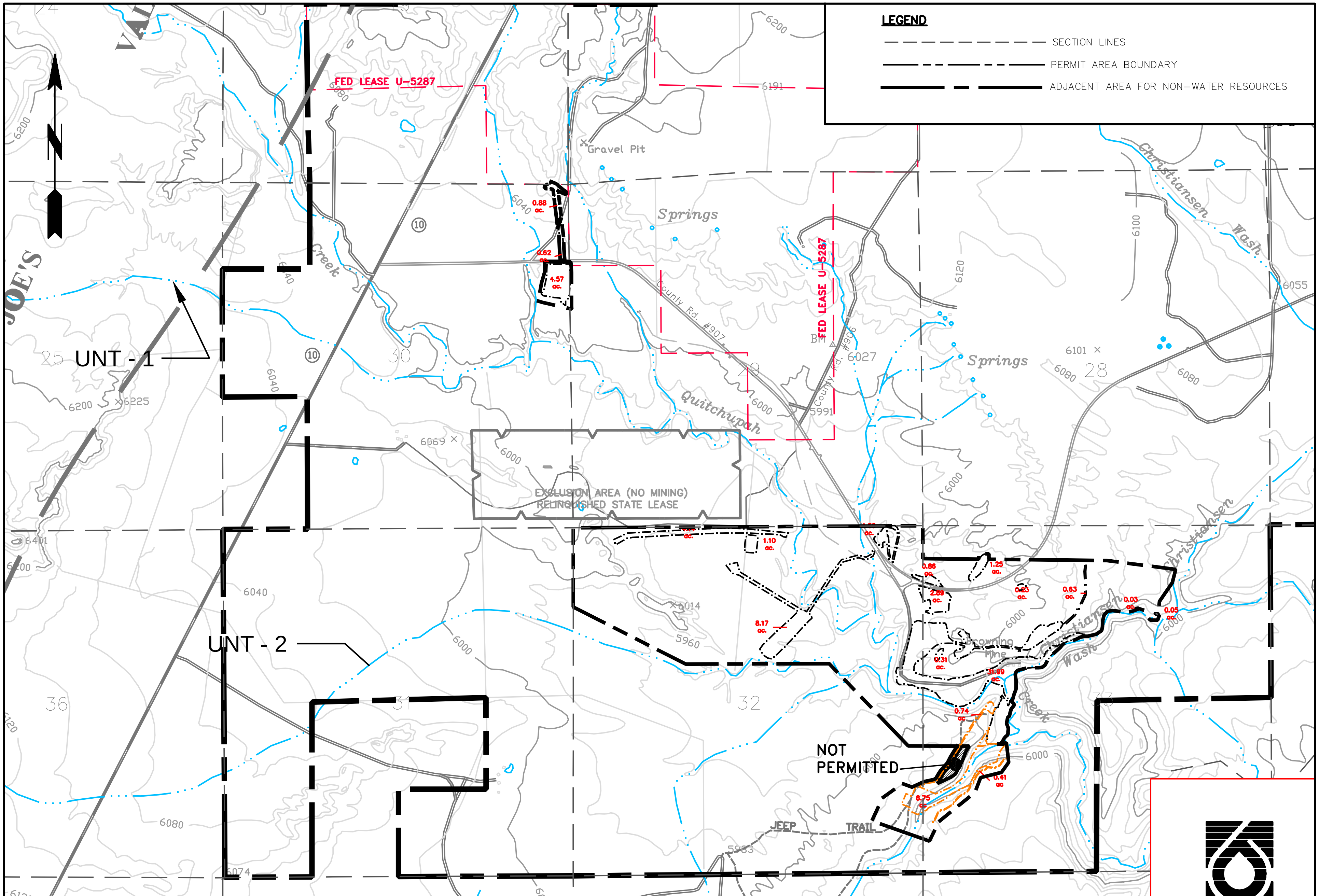

FIGURE 1. GENERAL AREA OF UNNAMED TRIBUTARY EVALUATION

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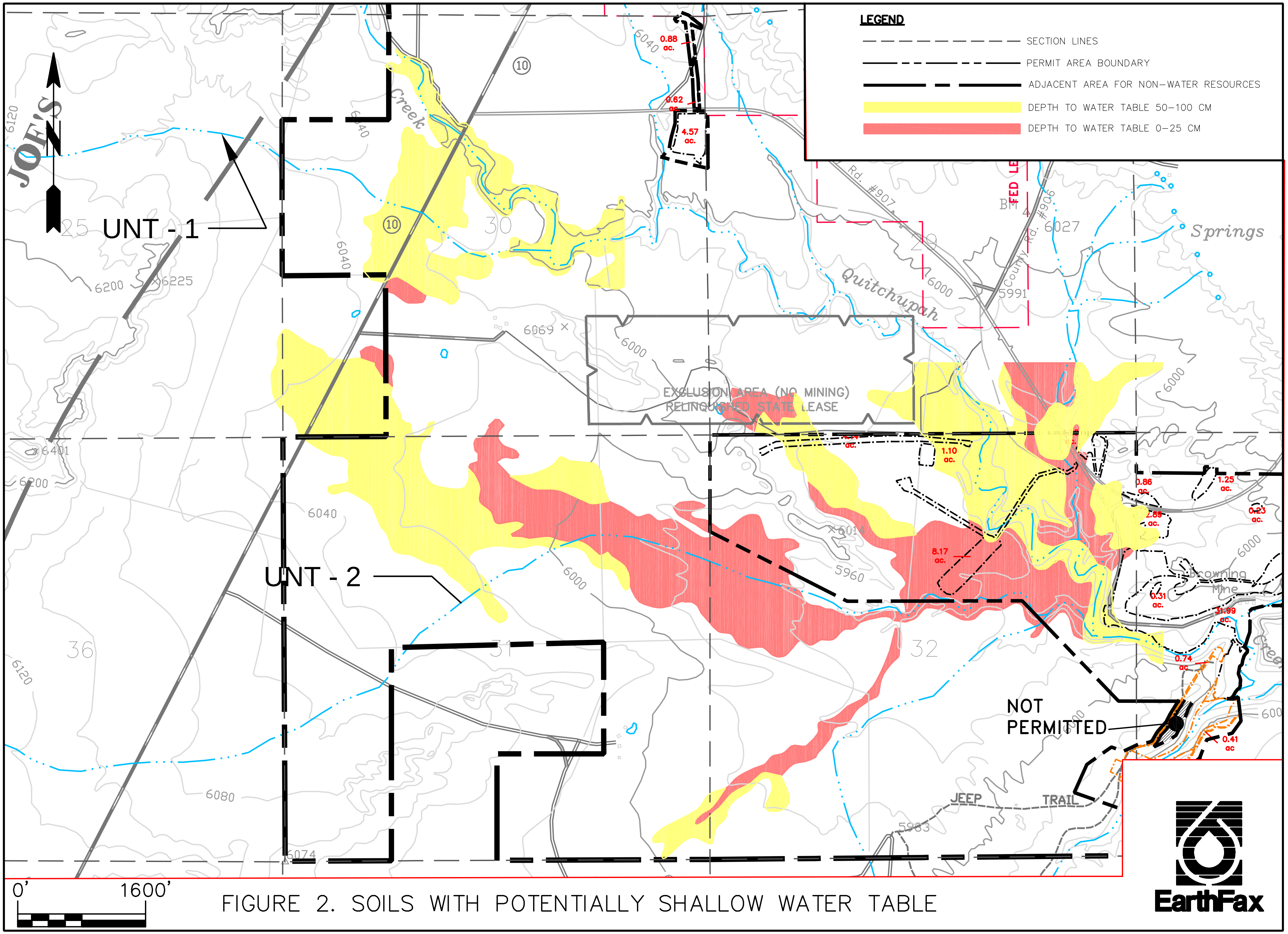

FIGURE 2. SOILS WITH POTENTIALLY SHALLOW WATER TABLE

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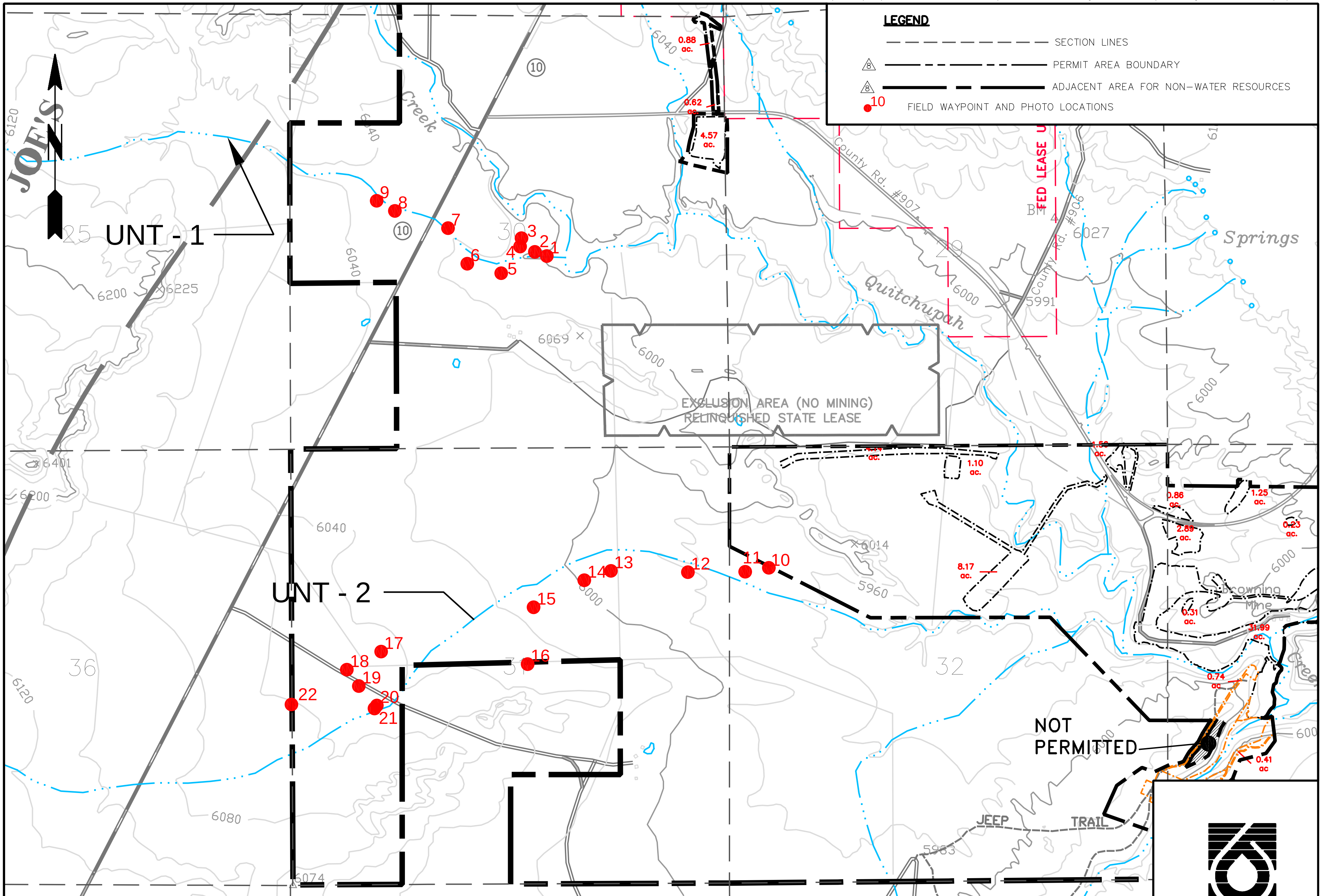


0' 1600'

FIGURE 3. UNNAMED TRIBUTARY WAYPOINTS

EarthFax

G:\1665\10\CHAPTER VI REVISION\Unnamed Tributary Evaluation\Tributary Evaluation 12/7/2018

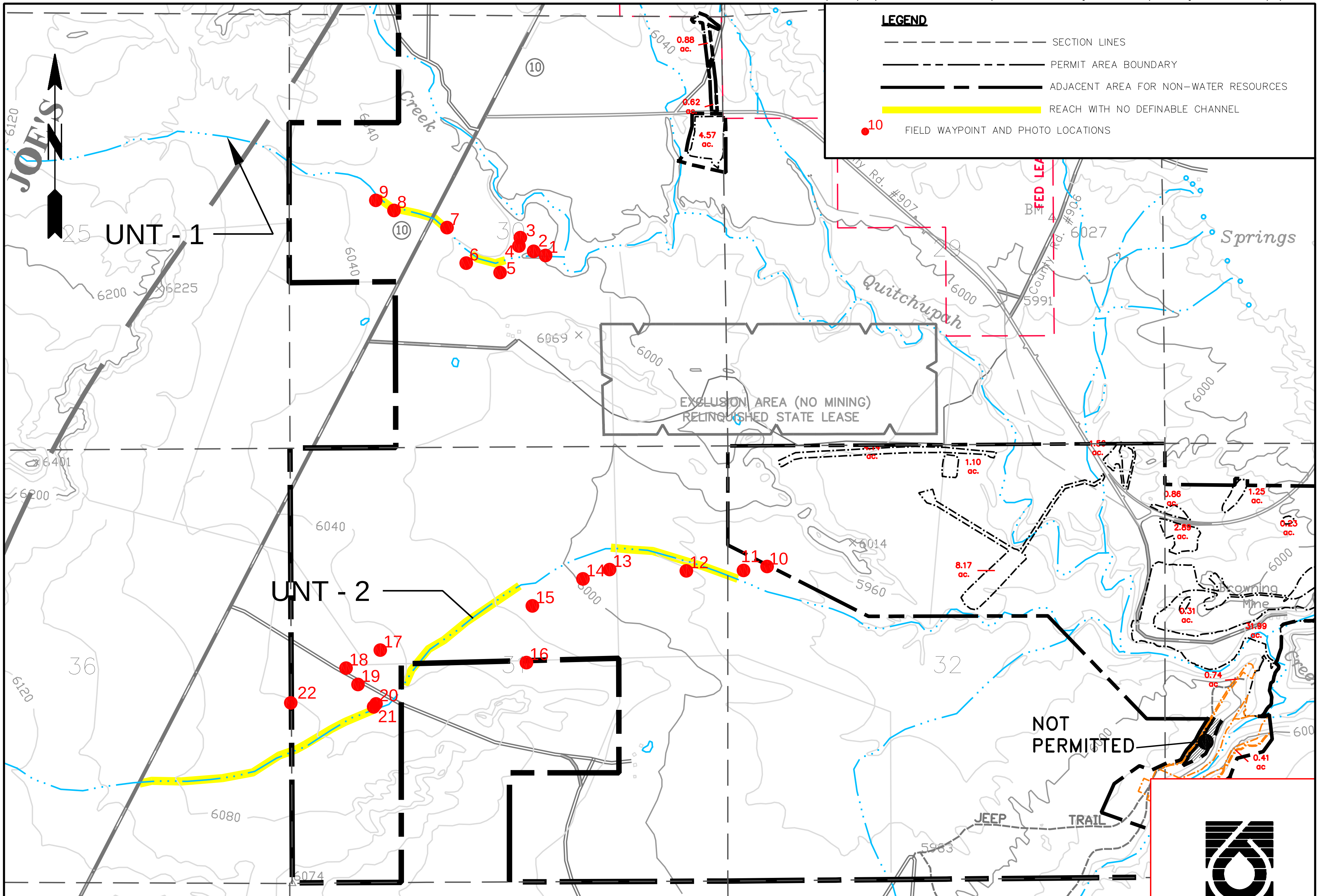


FIGURE 4. REACHES LACKING A WELL DEFINED CHANNEL

ATTACHMENT A

Web Soil Survey Printouts for the
Vicinity of UNT-1

Soil Map—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)

111° 18' 23" W | 111° 16' 51" W

473500 473700 473900 474100 474300 474500 474700 474900 475100 475300 475500

38° 52' 49" N | 38° 52' 49" N

4303400 4303200 4303000 4302800 4302600 4302400 4302200

38° 52' 3" N | 38° 52' 3" N

473500 473700 473900 474100 474300 474500 474700 474900 475100 475300 475500

111° 18' 23" W | 111° 16' 51" W

Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 450 900 1800 2700

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

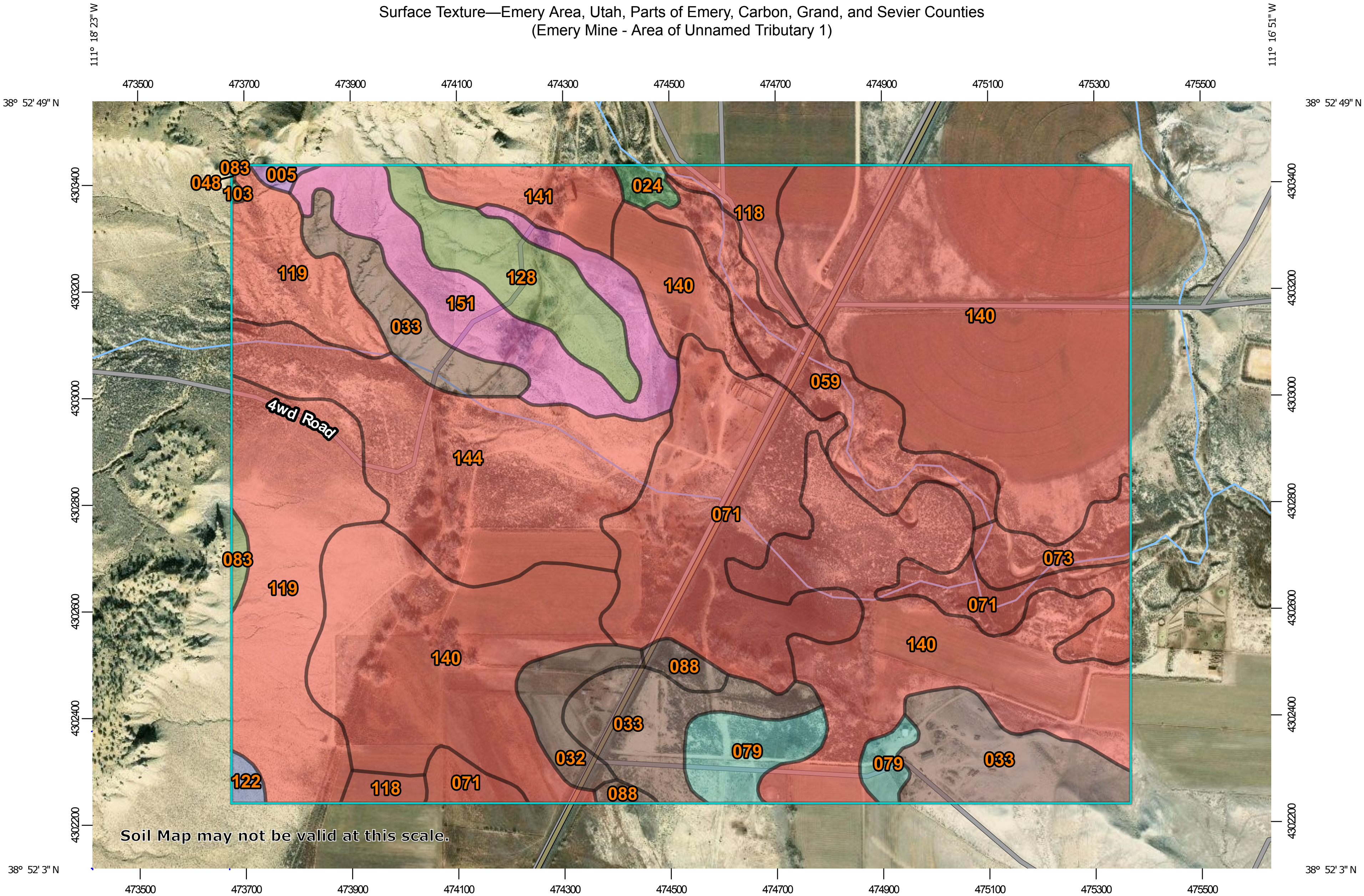
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	194.5	38.7%
141	Ravola loam, 3 to 6 percent slopes	9.6	1.9%
144	Ravola-Homko complex, 1 to 3 percent slopes	47.5	9.4%
151	Sagers-Killpack association, 1 to 8 percent slopes	25.1	5.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Totals for Area of Interest		**502.9**	**100.0%**

Surface Texture—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)



Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 450 900 1800 2700

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Clay
- Clay loam
- Fine sandy loam
- Gravelly loam
- Loam
- Silt loam
- Silty clay loam
- Very cobbly clay loam
- Very fine sandy loam
- Not rated or not available

Soil Rating Lines
- Clay
- Clay loam
- Fine sandy loam
- Gravelly loam
- Loam
- Silt loam
- Silty clay loam
- Very cobbly clay loam
- Very fine sandy loam
- Not rated or not available

Soil Rating Points
- Clay
- Clay loam
- Fine sandy loam
- Gravelly loam
- Loam
- Silt loam
- Silty clay loam
- Very cobbly clay loam
- Very fine sandy loam
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

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Please rely on the bar scale on each map sheet for map measurements.

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Coordinate System: Web Mercator (EPSG:3857)

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Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Surface Texture

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	Clay	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	Fine sandy loam	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	Silty clay loam	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	Silty clay loam	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	Very cobbly clay loam	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	Loam	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	Loam	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	Loam	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	Clay loam	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	Gravelly loam	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	Silty clay loam	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	Fine sandy loam	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	Loam	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	Loam	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	Very fine sandy loam	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	Gravelly loam	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	Loam	194.5	38.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
141	Ravola loam, 3 to 6 percent slopes	Loam	9.6	1.9%
144	Ravola-Homko complex, 1 to 3 percent slopes	Loam	47.5	9.4%
151	Sagers-Killpack association, 1 to 8 percent slopes	Silt loam	25.1	5.0%
Totals for Area of Interest			**502.9**	**100.0%**

Description

This displays the representative texture class and modifier of the surface horizon.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Rating Options

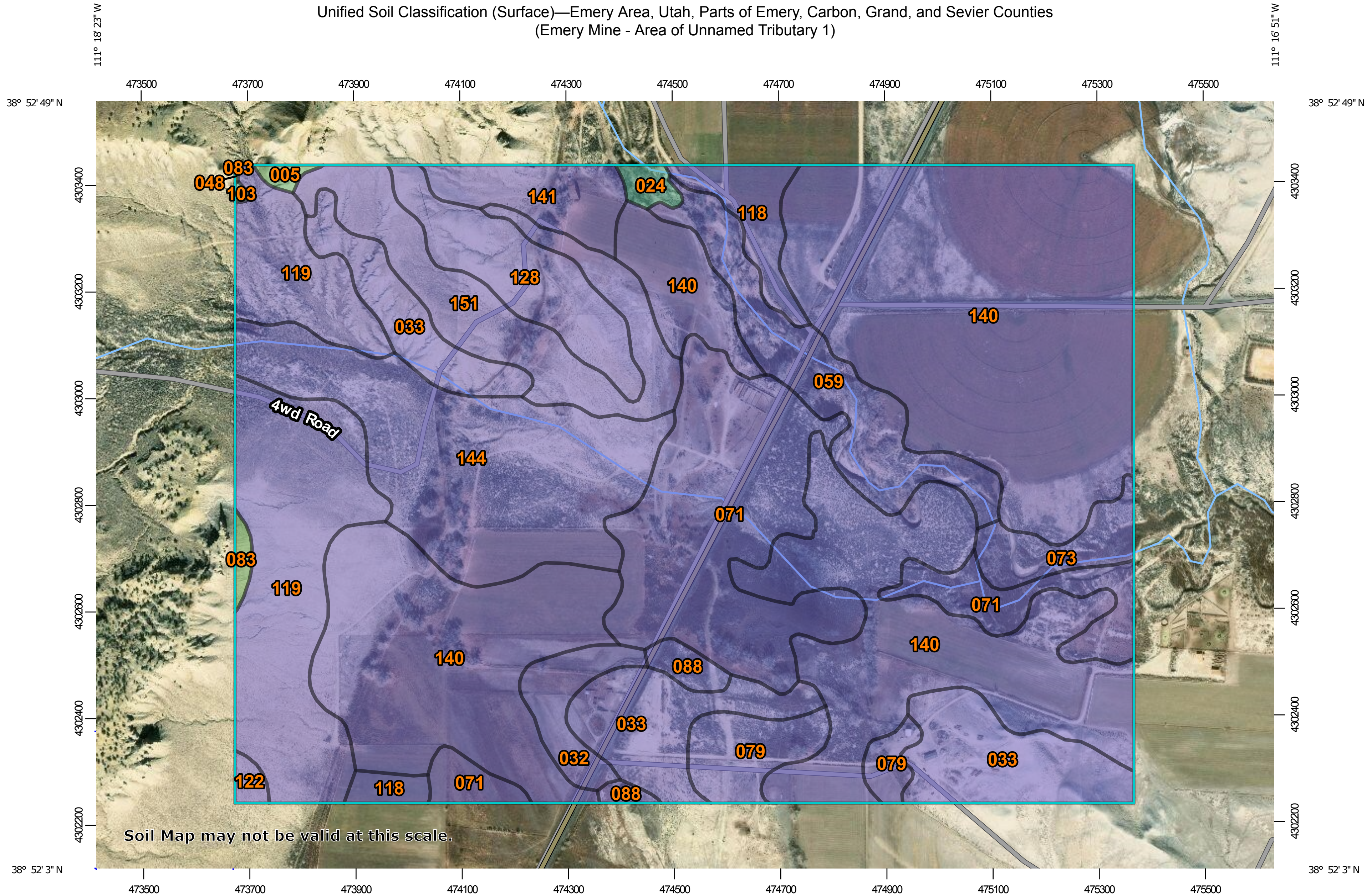
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Unified Soil Classification (Surface)—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)



Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 450, 900, 1800, 2700

N

Map projection: Web Mercator   Corner coordinates: WGS84   Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Lines

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Points

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

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Unified Soil Classification (Surface)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	CH	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	SC-SM	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	CL	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	CL	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	GC	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	CL	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	CL	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	CL	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	CL	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	GC	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	CL	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	SC-SM	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	CL	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	CL	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	CL	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	CL	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	CL	194.5	38.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
141	Ravola loam, 3 to 6 percent slopes	CL	9.6	1.9%
144	Ravola-Homko complex, 1 to 3 percent slopes	CL	47.5	9.4%
151	Sagers-Killpack association, 1 to 8 percent slopes	CL	25.1	5.0%
Totals for Area of Interest			**502.9**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

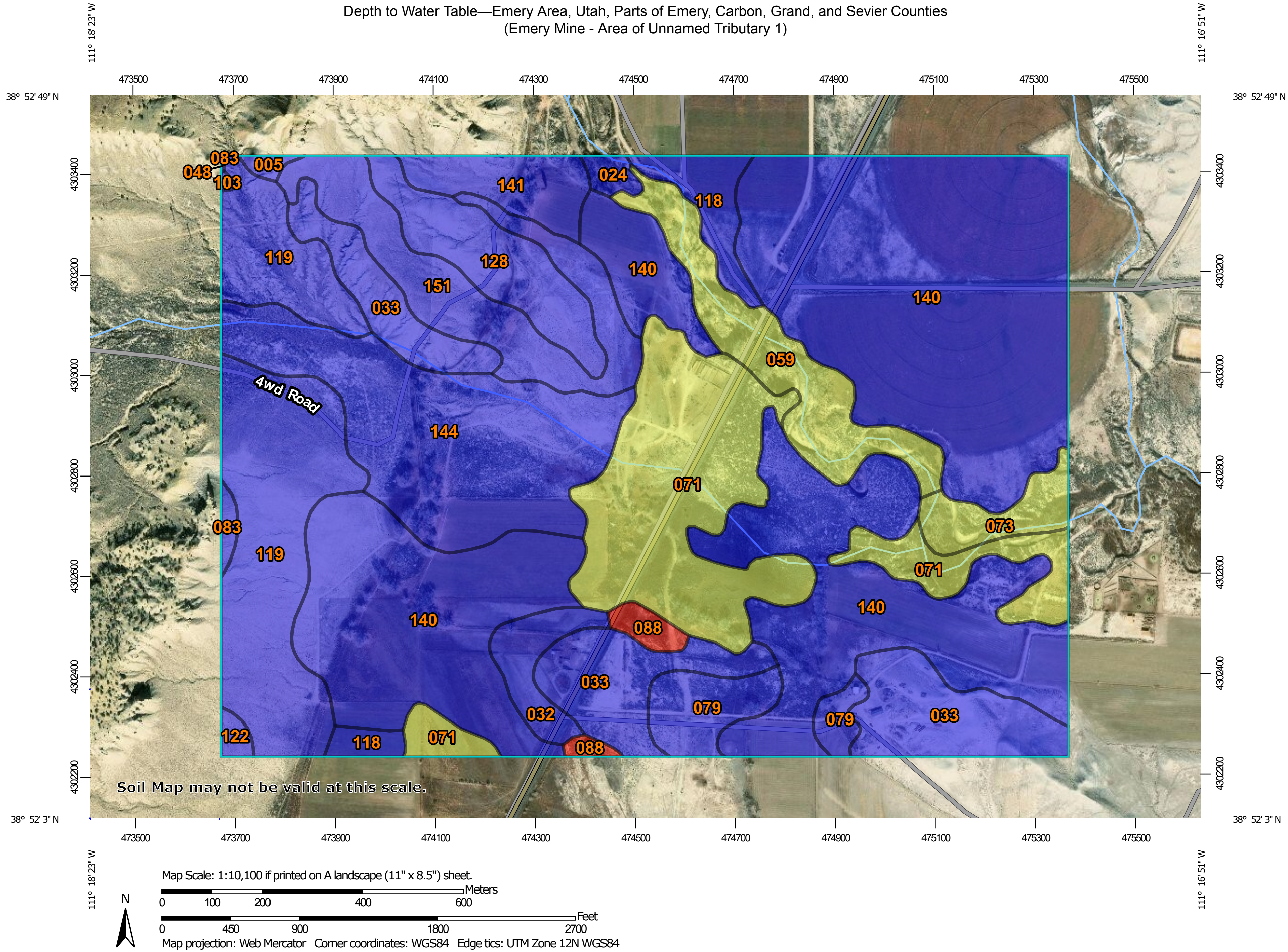
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Depth to Water Table—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	>200	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	>200	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	>200	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	>200	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	>200	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	92	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	76	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	76	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	>200	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	>200	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	25	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	>200	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	>200	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	>200	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	>200	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	>200	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	>200	194.5	38.7%

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
141	Ravola loam, 3 to 6 percent slopes	>200	9.6	1.9%
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151	Sagers-Killpack association, 1 to 8 percent slopes	>200	25.1	5.0%
Totals for Area of Interest			**502.9**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

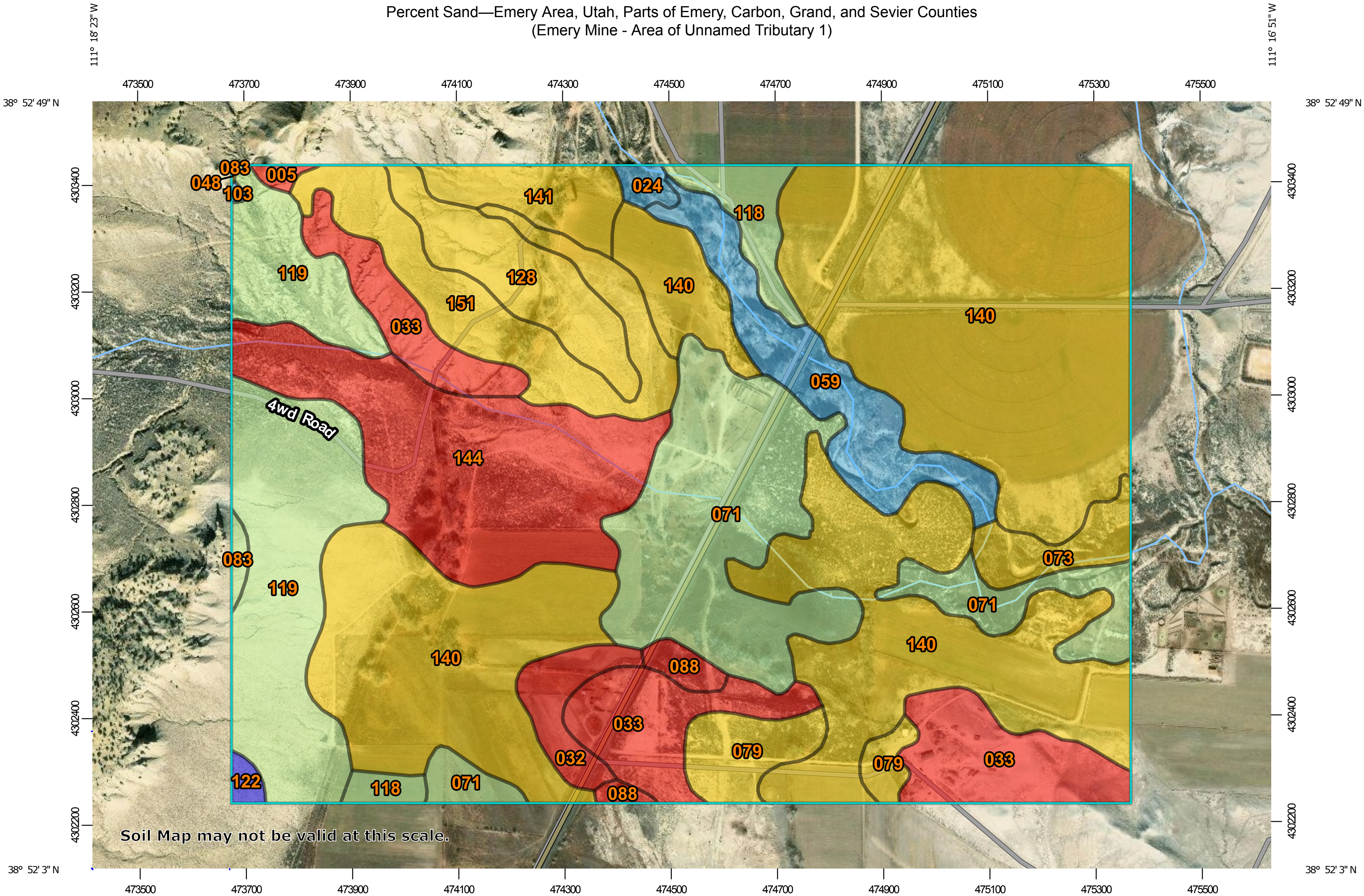
Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Percent Sand—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)



Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 450, 900, 1800, 2700

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 21.0
- > 21.0 and <= 36.0
- > 36.0 and <= 46.0
- > 46.0 and <= 60.1
- > 60.1 and <= 71.1
- Not rated or not available

Soil Rating Lines

- <= 21.0
- > 21.0 and <= 36.0
- > 36.0 and <= 46.0
- > 46.0 and <= 60.1
- > 60.1 and <= 71.1
- Not rated or not available

Soil Rating Points

- <= 21.0
- > 21.0 and <= 36.0
- > 36.0 and <= 46.0
- > 46.0 and <= 60.1
- > 60.1 and <= 71.1
- Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Sand

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	20.0	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	51.6	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	10.2	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	19.0	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	34.4	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	54.2	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	40.6	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	25.7	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	27.3	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	44.5	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	15.2	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	60.1	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	44.6	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	46.0	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	71.1	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	26.5	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	27.4	194.5	38.7%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
141	Ravola loam, 3 to 6 percent slopes	36.0	9.6	1.9%
144	Ravola-Homko complex, 1 to 3 percent slopes	21.0	47.5	9.4%
151	Sagers-Killpack association, 1 to 8 percent slopes	29.9	25.1	5.0%
Totals for Area of Interest			**502.9**	**100.0%**

Description

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In the database, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

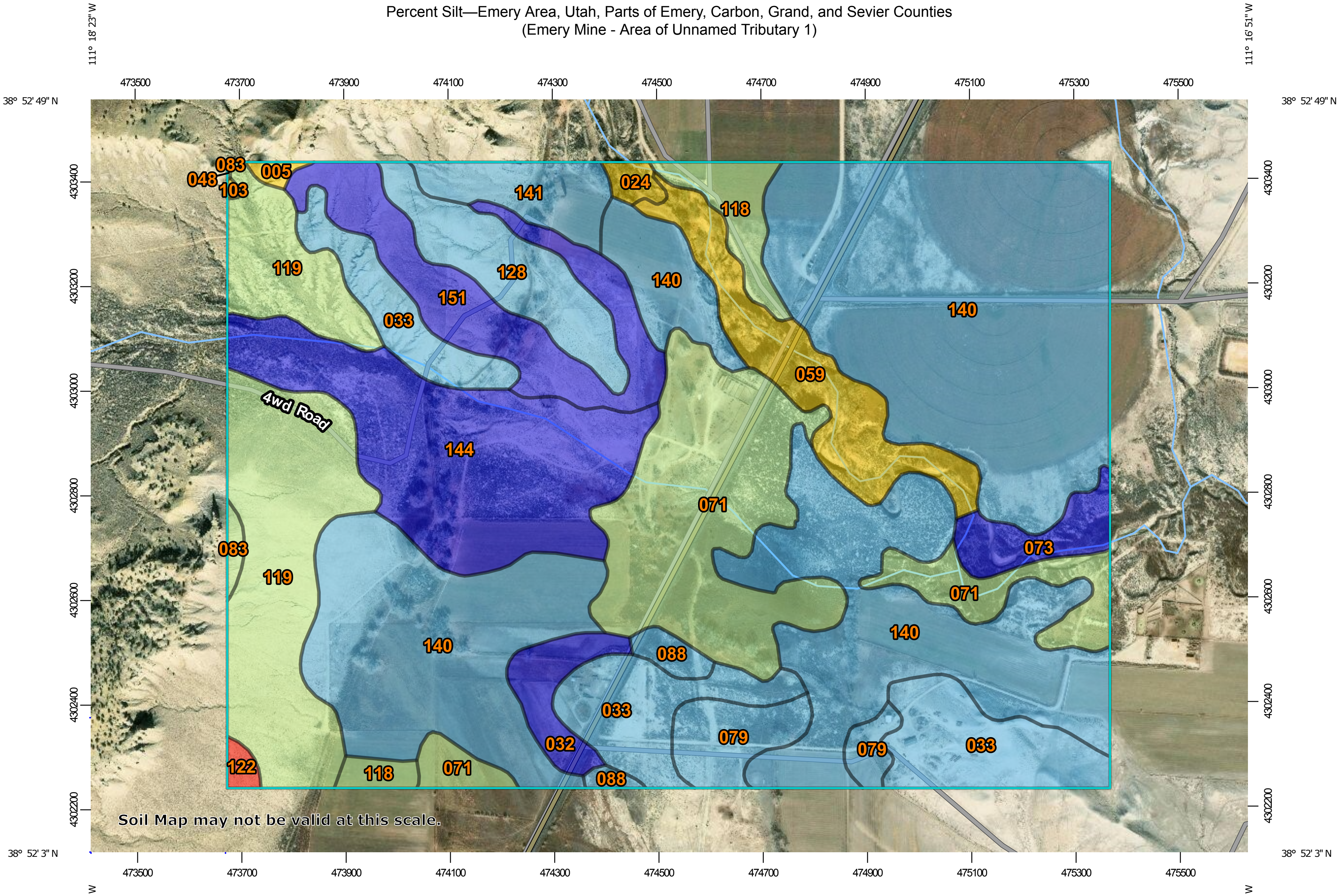
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

Units of Measure: Inches

Percent Silt—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)



Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 450, 900, 1800, 2700

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 16.5
- > 16.5 and <= 32.4
- > 32.4 and <= 39.4
- > 39.4 and <= 46.9
- > 46.9 and <= 52.9
- Not rated or not available

Soil Rating Lines

- <= 16.5
- > 16.5 and <= 32.4
- > 32.4 and <= 39.4
- > 39.4 and <= 46.9
- > 46.9 and <= 52.9
- Not rated or not available

Soil Rating Points

- <= 16.5
- > 16.5 and <= 32.4
- > 32.4 and <= 39.4
- > 39.4 and <= 46.9
- > 46.9 and <= 52.9
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Silt

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	30.0	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	31.7	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	52.9	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	45.0	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	35.8	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	32.4	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	36.4	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	50.0	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	45.2	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	33.9	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	46.8	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	25.9	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	39.4	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	37.0	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	16.5	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	45.0	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	46.9	194.5	38.7%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
141	Ravola loam, 3 to 6 percent slopes	41.7	9.6	1.9%
144	Ravola-Homko complex, 1 to 3 percent slopes	52.0	47.5	9.4%
151	Sagers-Killpack association, 1 to 8 percent slopes	48.5	25.1	5.0%
Totals for Area of Interest			**502.9**	**100.0%**

Description

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In the database, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

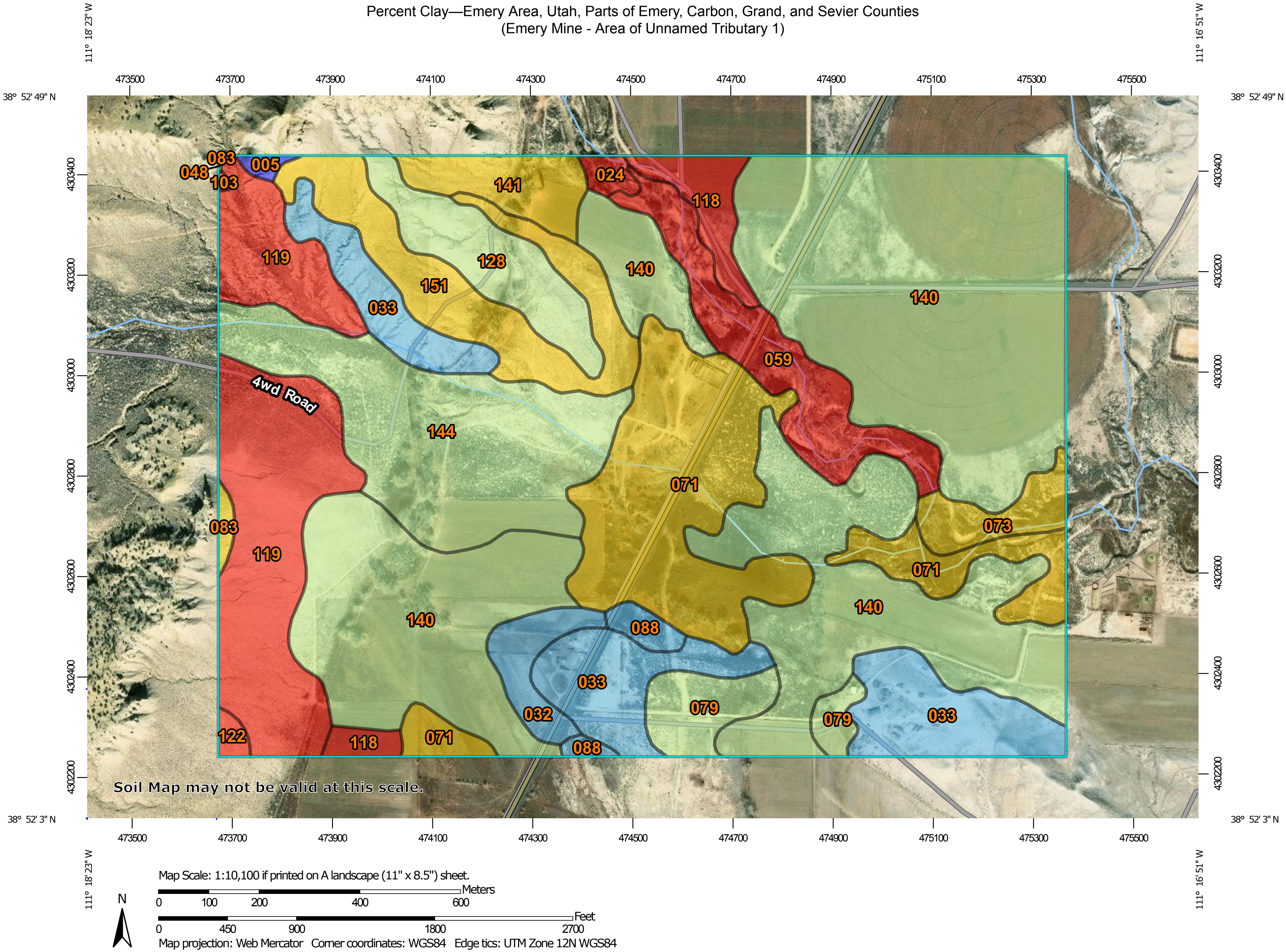
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

Units of Measure: Inches

Percent Clay—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Area of Unnamed Tributary 1)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 17.0
- > 17.0 and <= 24.3
- > 24.3 and <= 29.9
- > 29.9 and <= 37.9
- > 37.9 and <= 50.0
- Not rated or not available

Soil Rating Lines

- <= 17.0
- > 17.0 and <= 24.3
- > 24.3 and <= 29.9
- > 29.9 and <= 37.9
- > 37.9 and <= 50.0
- Not rated or not available

Soil Rating Points

- <= 17.0
- > 17.0 and <= 24.3
- > 24.3 and <= 29.9
- > 29.9 and <= 37.9
- > 37.9 and <= 50.0
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
005	Badland-Persayo-Rock outcrop complex, 35 to 80 percent slopes	50.0	0.9	0.2%
024	Castledale-Colorow-Pherson complex, 1 to 5 percent slopes	16.7	1.8	0.4%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	36.8	6.9	1.4%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	36.0	40.3	8.0%
048	Gerst-Lazear-Badland complex, 8 to 45 percent slopes	29.9	0.0	0.0%
059	Green River-Garley complex, 0 to 4 percent slopes	13.5	20.8	4.1%
071	Hunting loam, 1 to 3 percent slopes	23.0	56.9	11.3%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	24.3	7.2	1.4%
079	Killpack clay loam, 3 to 6 percents slopes	27.5	10.8	2.2%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	21.6	1.1	0.2%
088	Libbings-Saseep complex, 0 to 3 percent slopes	37.9	3.2	0.6%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	14.0	0.2	0.0%
118	Penner loam, 1 to 3 percent slopes	16.1	9.0	1.8%
119	Penner loam, 3 to 6 percent slopes	17.0	50.1	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	12.4	1.2	0.2%
128	Persayo-Vickel complex, 3 to 12 percent slopes	28.5	15.7	3.1%
140	Ravola loam, 1 to 3 percent slopes	25.7	194.5	38.7%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
141	Ravola loam, 3 to 6 percent slopes	22.3	9.6	1.9%
144	Ravola-Homko complex, 1 to 3 percent slopes	27.0	47.5	9.4%
151	Sagers-Killpack association, 1 to 8 percent slopes	21.6	25.1	5.0%
Totals for Area of Interest			**502.9**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

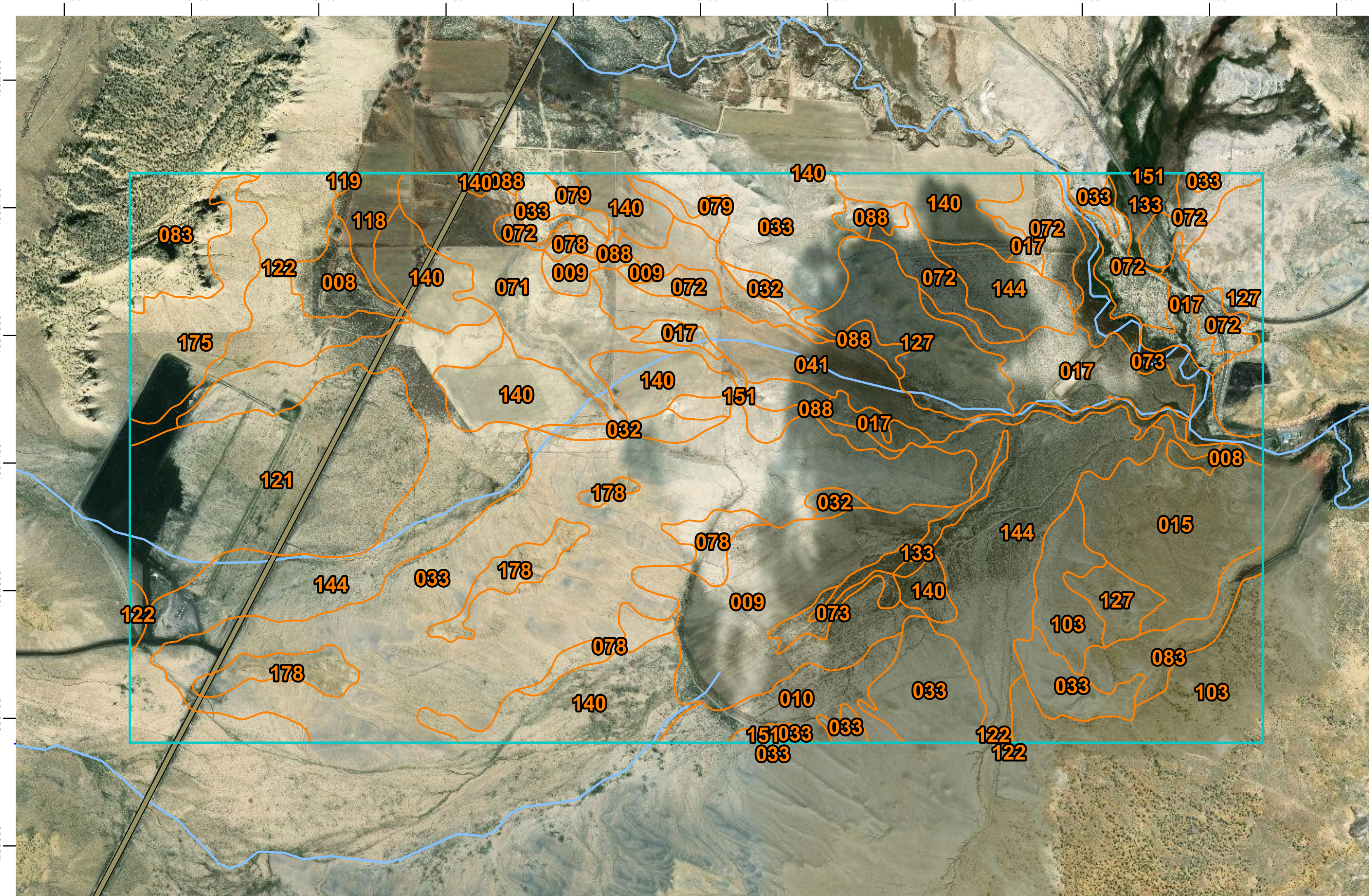
Bottom Depth: 12

Units of Measure: Inches

ATTACHMENT B

Web Soil Survey Printouts for the
Vicinity of UNT-2

Soil Map—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

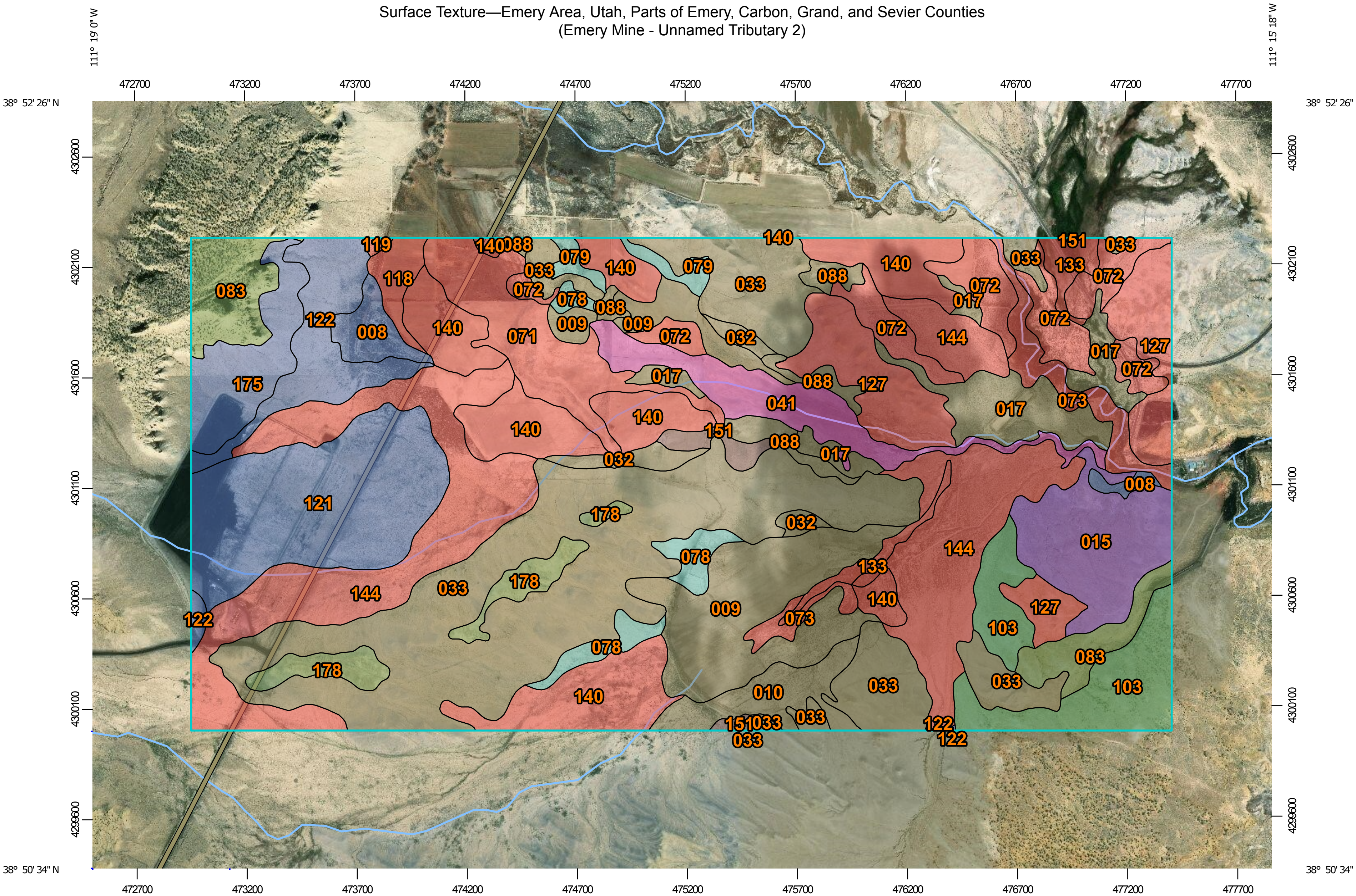
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	16.2	0.7%
119	Penner loam, 3 to 6 percent slopes	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	69.2	2.8%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
127	Persayo-Chipeta association, 3 to 20 percent slopes	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	38.4	1.6%
Totals for Area of Interest		**2,465.0**	**100.0%**

Surface Texture—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Channery fine sandy loam
- Clay loam
- Fine sandy loam
- Gravelly loam
- Loam
- Peaty silt loam
- Silt loam
- Silty clay loam
- Very fine sandy loam
- Not rated or not available

Soil Rating Lines

- Channery fine sandy loam
- Clay loam
- Fine sandy loam
- Gravelly loam
- Loam
- Peaty silt loam
- Silt loam
- Silty clay loam
- Very fine sandy loam
- Not rated or not available

Soil Rating Points

- Channery fine sandy loam
- Clay loam
- Fine sandy loam
- Gravelly loam
- Loam
- Peaty silt loam
- Silt loam
- Silty clay loam
- Very fine sandy loam
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Surface Texture

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	Very fine sandy loam	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	Silty clay loam	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	Silty clay loam	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	Channery fine sandy loam	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	Silty clay loam	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	Silty clay loam	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	Silty clay loam	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	Peaty silt loam	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	Loam	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	Loam	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	Loam	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	Clay loam	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	Clay loam	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	Gravelly loam	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	Silty clay loam	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	Fine sandy loam	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	Loam	16.2	0.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
119	Penner loam, 3 to 6 percent slopes	Loam	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	Very fine sandy loam	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	Very fine sandy loam	69.2	2.8%
127	Persayo-Chipeta association, 3 to 20 percent slopes	Loam	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	Loam	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	Loam	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	Loam	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	Silt loam	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	Very fine sandy loam	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	Gravelly loam	38.4	1.6%
Totals for Area of Interest			**2,465.0**	**100.0%**

Description

This displays the representative texture class and modifier of the surface horizon.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Rating Options

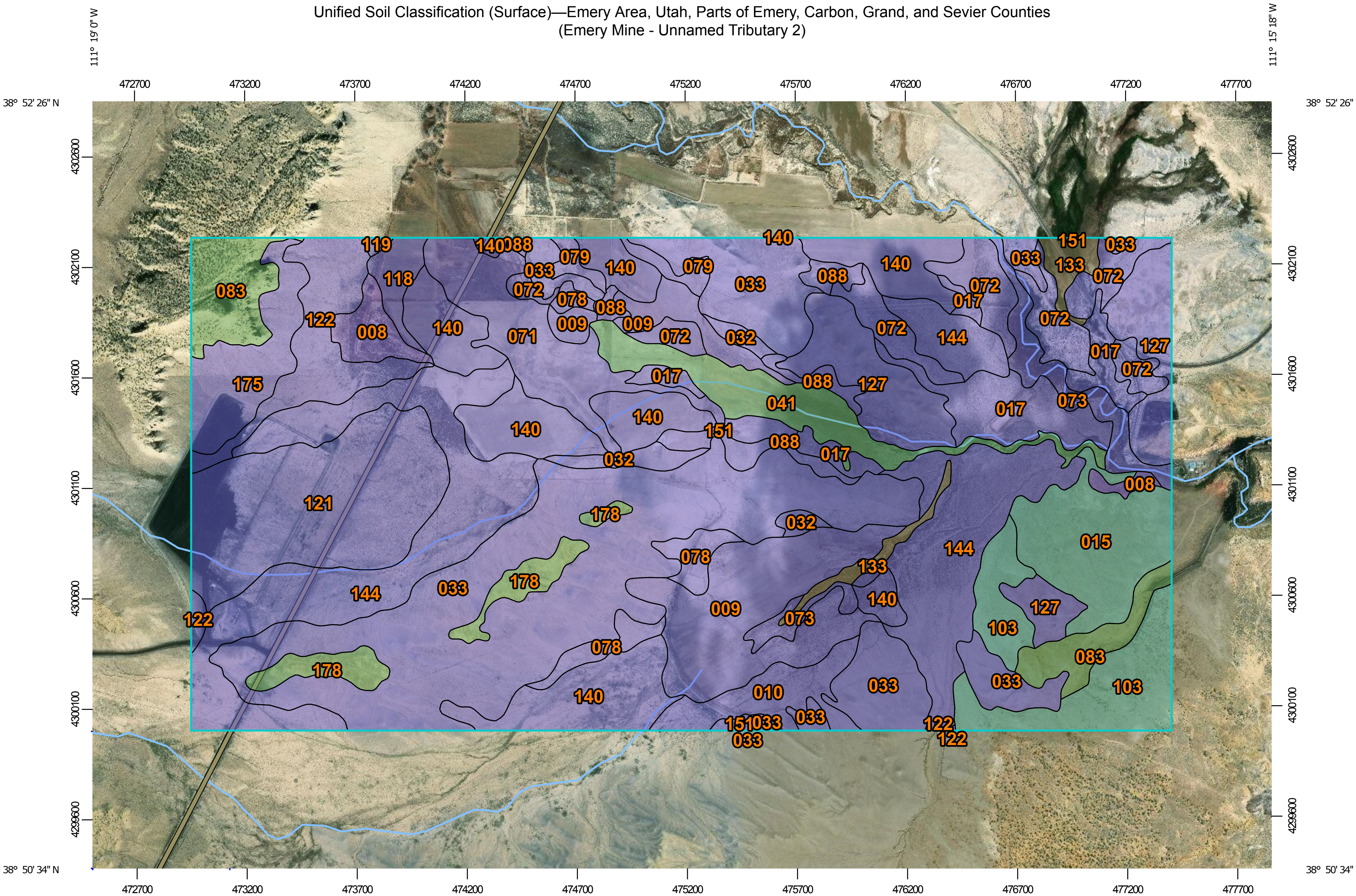
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Unified Soil Classification (Surface)—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Lines

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Points

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Unified Soil Classification (Surface)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	CL-ML	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	CL	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	CL	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	SC-SM	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	CL	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	CL	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	CL	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	OH	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	CL	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	CL	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	CL	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	CL	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	CL	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	GC	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	CL	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	SC-SM	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	CL	16.2	0.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
119	Penner loam, 3 to 6 percent slopes	CL	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	CL	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	CL	69.2	2.8%
127	Persayo-Chipeta association, 3 to 20 percent slopes	CL	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	ML	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	CL	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	CL	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	CL	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	CL	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	GC	38.4	1.6%
Totals for Area of Interest			**2,465.0**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

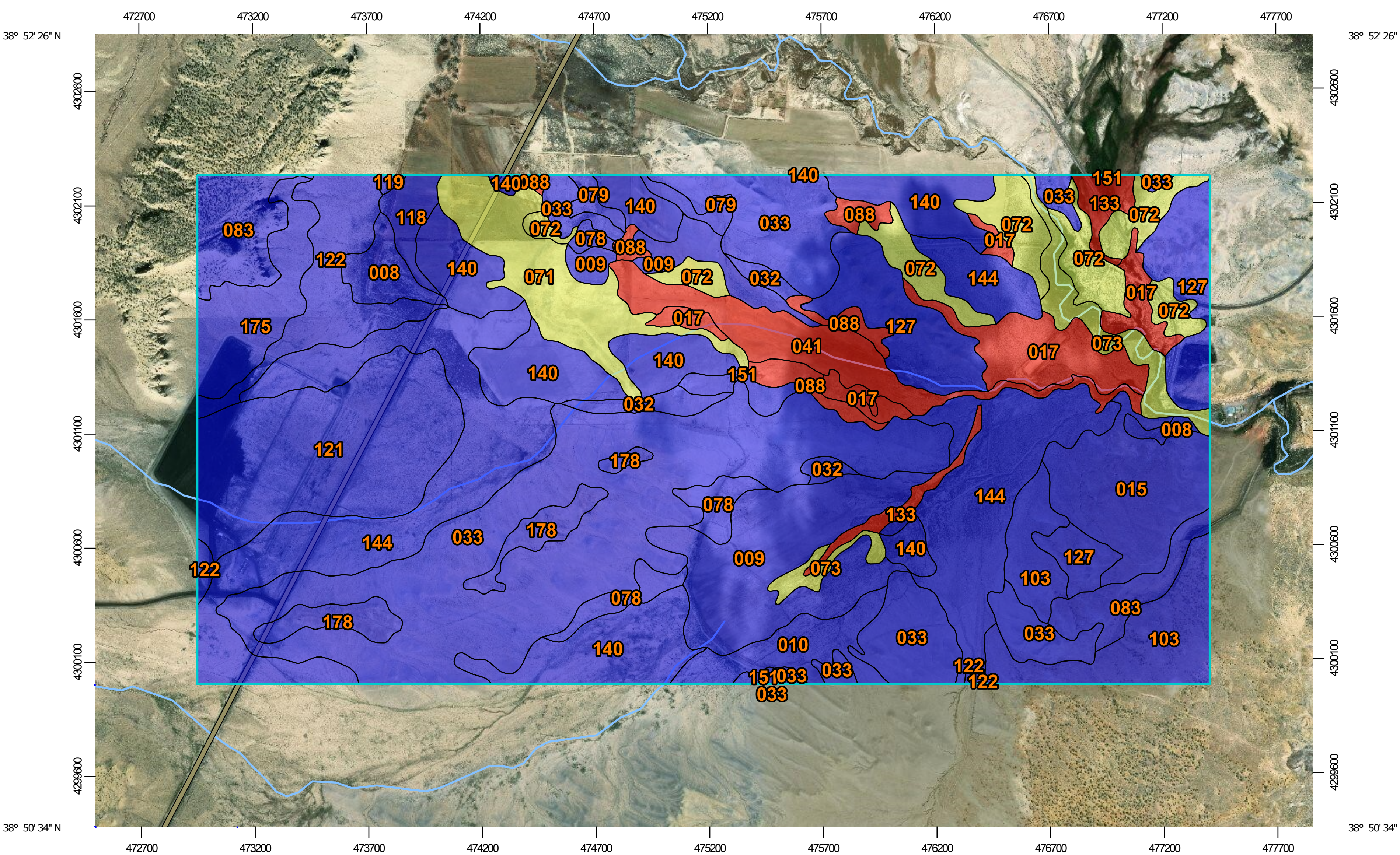
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Depth to Water Table—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	>200	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	>200	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	>200	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	>200	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	25	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	>200	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	>200	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	25	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	76	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	76	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	76	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	>200	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	>200	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	>200	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	25	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	>200	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	>200	16.2	0.7%

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
119	Penner loam, 3 to 6 percent slopes	>200	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	>200	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	>200	69.2	2.8%
127	Persayo-Chipeta association, 3 to 20 percent slopes	>200	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	25	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	>200	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	>200	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	>200	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	>200	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	>200	38.4	1.6%
Totals for Area of Interest			**2,465.0**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

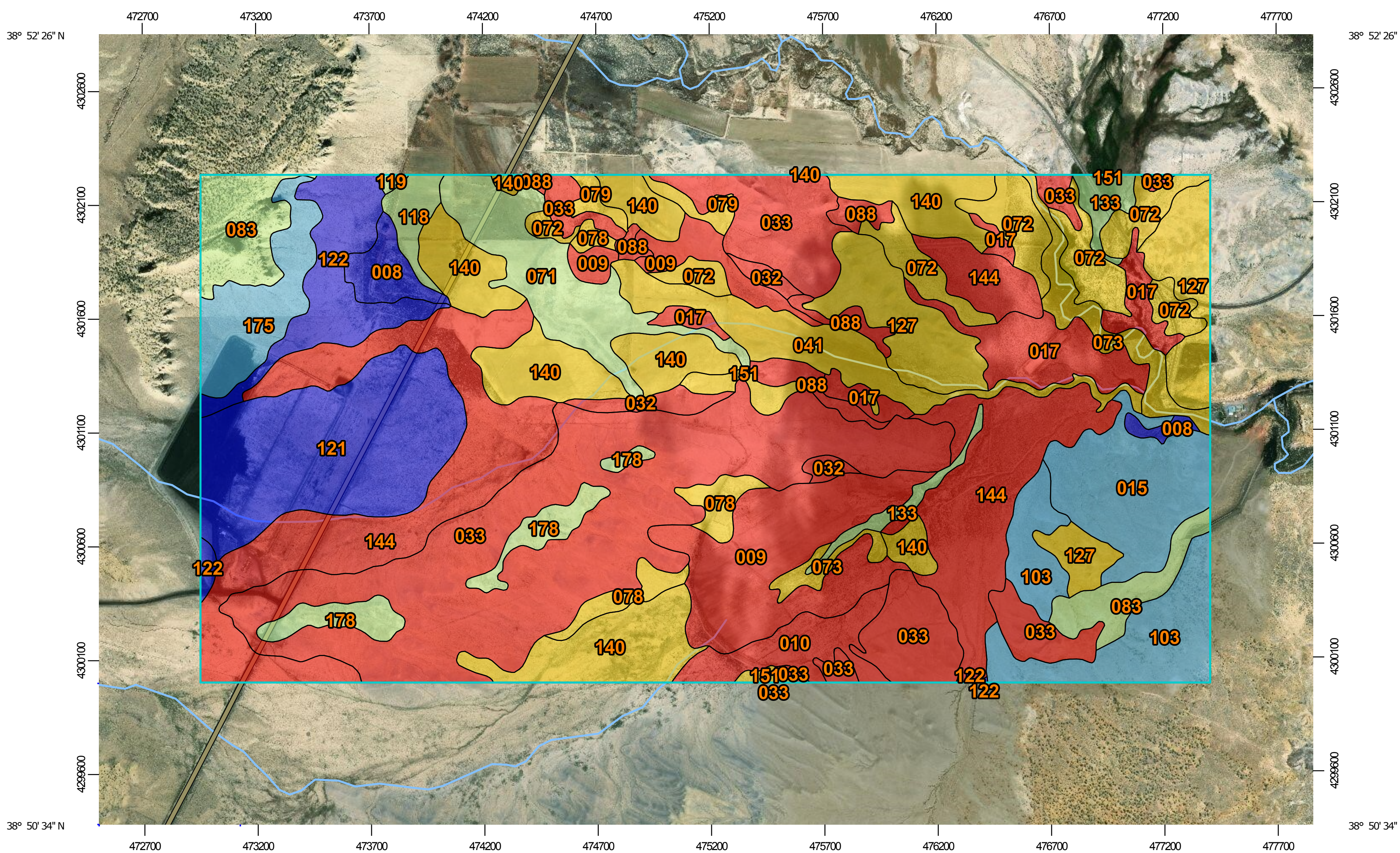
Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Percent Sand—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 21.0
- > 21.0 and <= 30.9
- > 30.9 and <= 46.0
- > 46.0 and <= 60.1
- > 60.1 and <= 77.8
- Not rated or not available

Soil Rating Lines

- <= 21.0
- > 21.0 and <= 30.9
- > 30.9 and <= 46.0
- > 46.0 and <= 60.1
- > 60.1 and <= 77.8
- Not rated or not available

Soil Rating Points

- <= 21.0
- > 21.0 and <= 30.9
- > 30.9 and <= 46.0
- > 46.0 and <= 60.1
- > 60.1 and <= 77.8
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Sand

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	77.8	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	17.5	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	17.3	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	60.0	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	8.6	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	10.2	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	19.0	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	28.4	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	40.6	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	27.7	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	25.7	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	30.9	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	27.3	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	44.5	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	15.2	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	60.1	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	44.6	16.2	0.7%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
119	Penner loam, 3 to 6 percent slopes	46.0	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	71.1	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	71.1	69.2	2.8%
127	Persayo-Chipeta association, 3 to 20 percent slopes	27.8	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	36.8	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	27.4	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	21.0	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	29.9	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	51.2	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	35.5	38.4	1.6%
Totals for Area of Interest			**2,465.0**	**100.0%**

Description

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In the database, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

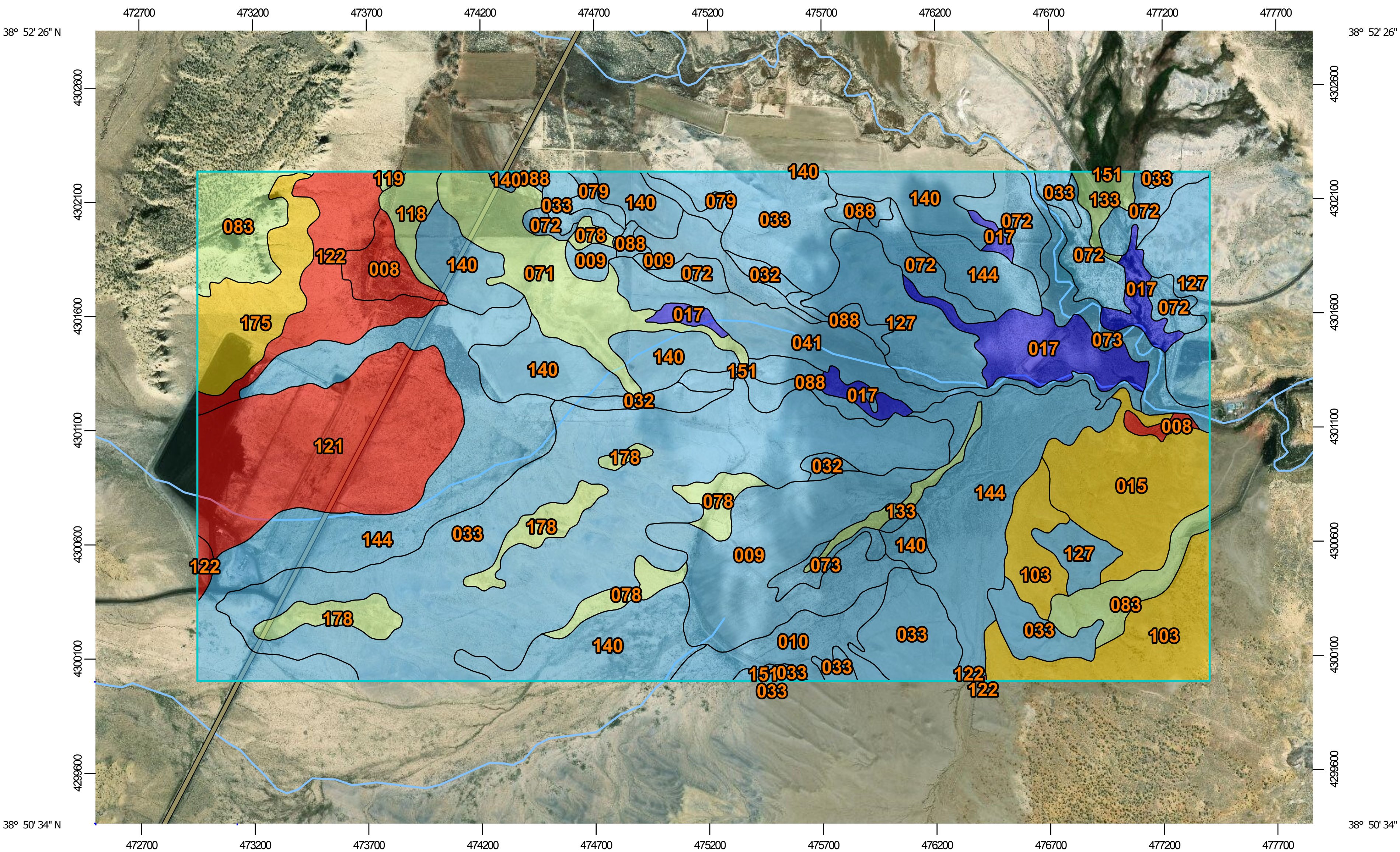
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

Units of Measure: Inches

Percent Silt—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- <= 16.5
- > 16.5 and <= 28.3
- > 28.3 and <= 41.7
- > 41.7 and <= 52.9
- > 52.9 and <= 61.2
- Not rated or not available

Soil Rating Lines
- <= 16.5
- > 16.5 and <= 28.3
- > 28.3 and <= 41.7
- > 41.7 and <= 52.9
- > 52.9 and <= 61.2
- Not rated or not available

Soil Rating Points
- <= 16.5
- > 16.5 and <= 28.3
- > 28.3 and <= 41.7
- > 41.7 and <= 52.9
- > 52.9 and <= 61.2
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Silt

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	15.8	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	50.5	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	50.3	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	22.7	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	61.2	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	52.9	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	45.0	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	49.9	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	36.4	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	47.6	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	50.0	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	41.7	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	45.2	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	33.9	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	46.8	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	25.9	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	39.4	16.2	0.7%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
119	Penner loam, 3 to 6 percent slopes	37.0	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	16.5	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	16.5	69.2	2.8%
127	Persayo-Chipeta association, 3 to 20 percent slopes	46.9	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	39.7	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	46.9	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	52.0	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	48.5	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	28.3	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	37.3	38.4	1.6%
Totals for Area of Interest			**2,465.0**	**100.0%**

Description

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In the database, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

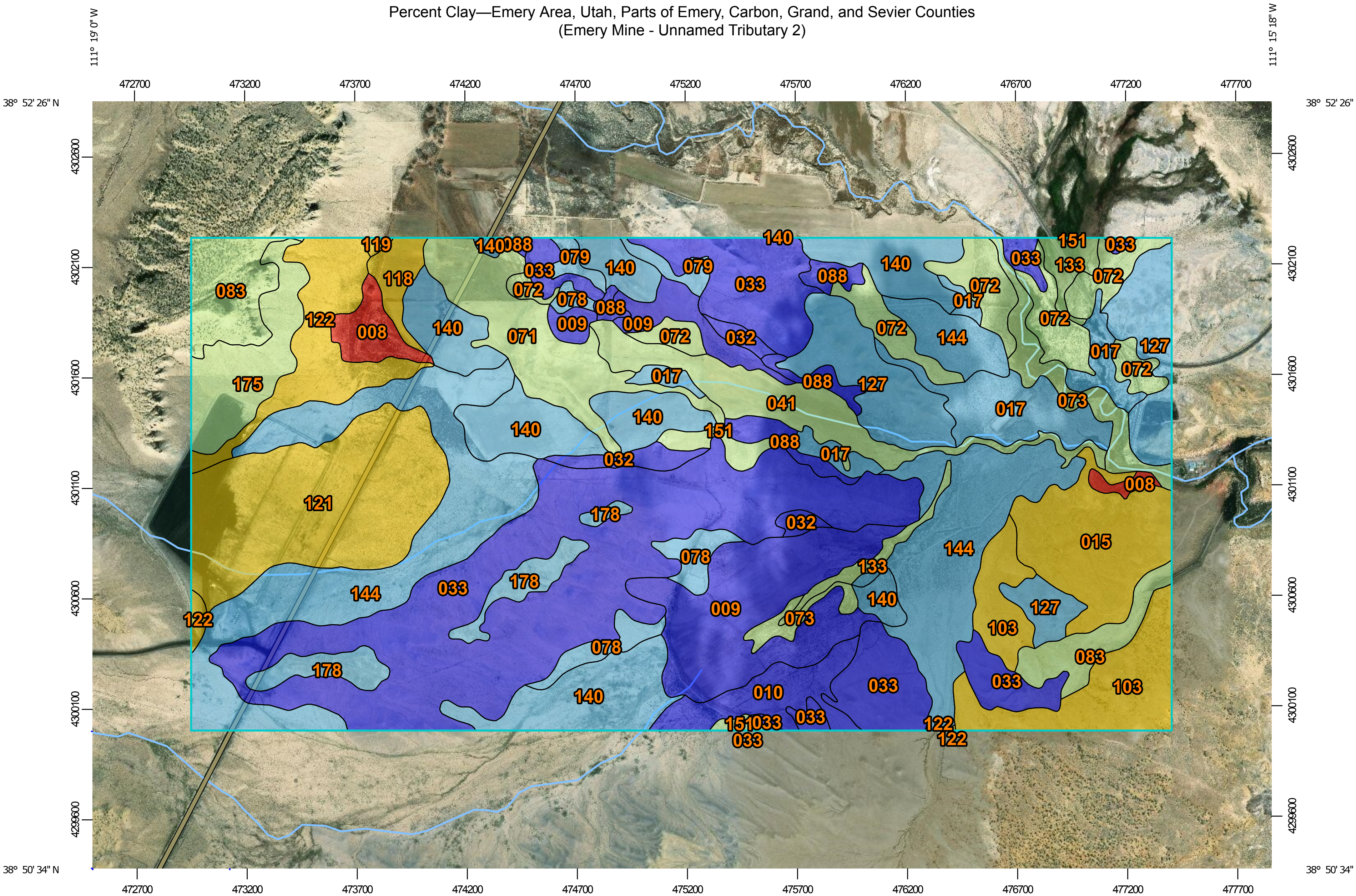
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

Units of Measure: Inches

Percent Clay—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - Unnamed Tributary 2)



Map Scale: 1:24,500 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 6.4
- > 6.4 and <= 17.2
- > 17.2 and <= 24.7
- > 24.7 and <= 30.2
- > 30.2 and <= 37.9
- Not rated or not available

Soil Rating Lines

- <= 6.4
- > 6.4 and <= 17.2
- > 17.2 and <= 24.7
- > 24.7 and <= 30.2
- > 30.2 and <= 37.9
- Not rated or not available

Soil Rating Points

- <= 6.4
- > 6.4 and <= 17.2
- > 17.2 and <= 24.7
- > 24.7 and <= 30.2
- > 30.2 and <= 37.9
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	6.4	25.7	1.0%
009	Billings silty clay loam, 1 to 3 percent slopes	32.0	150.4	6.1%
010	Billings-Gullied land complex, 1 to 6 percent slopes	32.4	39.5	1.6%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	17.2	87.0	3.5%
017	Briny silty clay loam, 0 to 3 percent slopes	30.2	80.2	3.3%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	36.8	21.7	0.9%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	36.0	490.3	19.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	21.7	68.3	2.8%
071	Hunting loam, 1 to 3 percent slopes	23.0	80.4	3.3%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	24.7	99.6	4.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	24.3	41.6	1.7%
078	Killpack clay loam, 1 to 3 percent slopes	27.5	30.2	1.2%
079	Killpack clay loam, 3 to 6 percents slopes	27.5	14.1	0.6%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	21.6	71.6	2.9%
088	Libbings-Saseep complex, 0 to 3 percent slopes	37.9	32.1	1.3%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	14.0	91.5	3.7%
118	Penner loam, 1 to 3 percent slopes	16.1	16.2	0.7%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
119	Penner loam, 3 to 6 percent slopes	17.0	1.8	0.1%
121	Penner very fine sandy loam, 1 to 3 percent slopes	12.4	169.4	6.9%
122	Penner very fine sandy loam, 3 to 6 percent slopes	12.4	69.2	2.8%
127	Persayo-Chipeta association, 3 to 20 percent slopes	25.4	117.7	4.8%
133	Rafael loam, 0 to 3 percent slopes	23.5	23.2	0.9%
140	Ravola loam, 1 to 3 percent slopes	25.7	208.7	8.5%
144	Ravola-Homko complex, 1 to 3 percent slopes	27.0	325.0	13.2%
151	Sagers-Killpack association, 1 to 8 percent slopes	21.6	14.6	0.6%
175	Tusher very fine sandy loam, 3 to 6 percent slopes	20.5	56.3	2.3%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	27.2	38.4	1.6%
Totals for Area of Interest			**2,465.0**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

Units of Measure: Inches

ATTACHMENT C

Stream Classification Field Sheets

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 30 NOV 2018	**Stream Name:** Unnamed	**Latitude:** 38.8733° N
Evaluator(s): RB White	**Site ID:** UNT-1	**Longitude:** 111.2921° W
TOTAL POINTS: *Stream is at least intermittent if ≥ 12*	**Assessment Unit:**	**Drought Index (12-mo. SPI Value):** -0.70

WEATHER CONDITIONS	**NOW:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) 80 %cloud cover ___ clear/sunny	**PAST 48 HOURS:** ___ storm (heavy rain) ✓ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ___ clear/sunny	**Has there been a heavy rain in the last 48 hours?** ___ YES ✓ NO **Field evaluations should be performed <u>at least</u> 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** ___ YES ✓ NO **Diversions** ___ YES ✓ NO **Discharges** ___ YES ✓ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	(2)	1	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.6)	2

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

UNT-1

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	See attachment containing photos	

NOTES:

Tamarisk occurs in the lower reach of this channel, potentially influenced by the adjacent floodplain of Quitchupah Creek. Occasional tamarisk also occurs sporadically along the entire channel within the area of interest. Vegetation in some reaches grows more vigorously along the channel. No evidence of consistent surface flow. This, together with the rating on the first page, leads to the conclusion that this channel is <u>ephemeral</u>.

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 30 NOV 2018	**Stream Name:** Unnamed	**Latitude:** 38.8615° N
Evaluator(s): RB White	**Site ID:** UNT-2	**Longitude:** 111.2864° W
TOTAL POINTS: *Stream is at least intermittent if ≥ 12*	**Assessment Unit:**	**Drought Index (12-mo. SPI Value):** −0.70

WEATHER CONDITIONS	**NOW:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) 80 %cloud cover ___ clear/sunny	**PAST 48 HOURS:** ___ storm (heavy rain) ✓ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ___ clear/sunny	**Has there been a heavy rain in the last 48 hours?** ___ YES ✓ NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** ✓ YES ___ NO **Diversions** ✓ YES ___ NO **Discharges** ___ YES ✓ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.6)	1

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

UNT-2

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	See attachment containing photos	

NOTES:

The middle reach of this channel has been cultivated, thereby eliminating the channel in this reach. A ditch was constructed to direct flow around the cultivated field. Water discharged from this ditch has eroded a new channel. Runoff also collects on a farm road. The point of discharge from this road has eroded a deep, unnatural channel. Vegetation in some reaches grows more vigorously along the channel. No evidence of consistent surface flow. This, together with the rating on the first page, leads to the conclusion that this channel is ephemeral.

ATTACHMENT D

Photographs of UNT-1 and Vicinity

EMERY MINE - EVALUATION OF
UNNAMED TRIBUTARIES OF QUITCHUPAH CREEK

FIELD WAYPOINT AND PHOTO DESCRIPTIONS

Waypoint Number	Latitude	Longitude	Photo Number	Photo Direction	Comment
UNT-1					
1	38.87233	-111.28792	1	Downstream	Confluence of UNT-1 with Quitchupah Creek floodplain
			2	Upstream	At confluence of UNT-1 with Quitchupah Creek floodplain
2	38.87247	-111.28843	3	Upstream	Downstream end of north fork gully
			4	Upstream	Downstream end of south fork gully
			5	Upstream	North fork gully headcut
3	38.87293	-111.28900	6	Downstream	At north fork gully headcut
4	38.87265	-111.28906	7	Upstream	Middle fork gully headcut
			8	Cross-stream	Channel flowing into middle fork gully headcut
5	38.87176	-111.28987	9	Downstream	South fork gully headcut, filled with branches
			10	Upstream	Area flowing into south fork gully headcut
6	38.87208	-111.29132	11	Upstream	Beginning of defined channel
			12	Upstream	Defined channel
7	38.87327	-111.29214	13	Upstream	At County line
Hwy 10	--	--	14	Upstream	Culvert beneath Highway 10
			15	Upstream	Area upstream from highway culvert
8	38.87385	-111.29441	16	Upstream	Lack of defined channel upstream from highway culvert
9	38.87419	-111.29519	17	Upstream	Upstream portion of adjacent area
UNT-2					
10	38.86189	-111.27846	18	Upstream	Downstream end of UNT-2
11	38.86176	-111.27947	19	Downstream	Head of well defined channel
			20	Upstream	Area upstream from well defined channel
12	38.86175	-111.28192	21	Upstream	Note lack of defined channel
13	38.86180	-111.28521	22	Upstream	Occasional, discontinuous channels
14	38.86149	-111.28635	23	Upstream	Beginning of defined channel
15	38.86059	-111.28852	24	Upstream	Downstream from agricultural field
			25	Downstream	Downstream from agricultural field
16	38.85869	-111.28878	26	Upstream	Downstream end of diversion around agricultural field
			27	Downstream	Channel receiving runoff from field diversion
			28	Cross-stream	Agricultural field in area of former natural channel
17	38.85912	-111.29504	29	Upstream	Upstream of agricultural field
			30	Downstream	Channel not evident in field
18	38.85852	-111.29651	31	Upstream	Erosion along fence line, downstream from another ditch
19	38.85797	-111.29600	32	Upstream	Channel upstream from ditch
20	38.85732	-111.29523	33	Upstream	Farm road that acts as a diversion
21	38.85722	-111.29533	34	Upstream	Upstream of farm road
22	38.85736	-111.29888	35	Upstream	No defined channel

UNT-1, Photo 1: Downstream view of confluence with Quitchupah Creek floodplain

UNT-1, Photo 2: Upstream view at confluence with Quitchupah Creek floodplain

UNT-1, Photo 3: Upstream view of north fork gully

UNT-1, Photo 4: Upstream view of south fork gully

UNT-1, Photo 5: North fork gully headcut

UNT-1, Photo 6: Downstream view from north fork gully headcut

UNT-1, Photo 7: Middle fork gully headcut

UNT-1, Photo 8: Poorly-defined channel flowing into north fork gully headcut

UNT-1, Photo 9: South fork gully headcut, filled with branches

UNT-1, Photo 10: Area flowing into south fork gully headcut, showing lack of defined channel

UNT-1, Photo 11: Beginning of defined channel, upstream from headcuts

UNT-1, Photo 12: Defined channel upstream from headcuts

UNT-1, Photo 13: View upstream from County line

UNT-1, Photo 14: Culvert beneath Highway 10

UNT-1, Photo 15: Area upstream from highway culvert

UNT-1, Photo 16: Lack of defined channel

UNT-1, Photo 17: Upstream area of Section 30

ATTACHMENT E

Photographs of UNT-2 and Vicinity

EMERY MINE - EVALUATION OF
UNNAMED TRIBUTARIES OF QUITCHUPAH CREEK

FIELD WAYPOINT AND PHOTO DESCRIPTIONS

Waypoint Number	Latitude	Longitude	Photo Number	Photo Direction	Comment
UNT-1					
1	38.87233	-111.28792	1	Downstream	Confluence of UNT-1 with Quitchupah Creek floodplain
			2	Upstream	At confluence of UNT-1 with Quitchupah Creek floodplain
2	38.87247	-111.28843	3	Upstream	Downstream end of north fork gully
			4	Upstream	Downstream end of south fork gully
			5	Upstream	North fork gully headcut
3	38.87293	-111.28900	6	Downstream	At north fork gully headcut
4	38.87265	-111.28906	7	Upstream	Middle fork gully headcut
			8	Cross-stream	Channel flowing into middle fork gully headcut
5	38.87176	-111.28987	9	Downstream	South fork gully headcut, filled with branches
			10	Upstream	Area flowing into south fork gully headcut
6	38.87208	-111.29132	11	Upstream	Beginning of defined channel
			12	Upstream	Defined channel
7	38.87327	-111.29214	13	Upstream	At County line
Hwy 10	--	--	14	Upstream	Culvert beneath Highway 10
			15	Upstream	Area upstream from highway culvert
8	38.87385	-111.29441	16	Upstream	Lack of defined channel upstream from highway culvert
9	38.87419	-111.29519	17	Upstream	Upstream portion of adjacent area
UNT-2					
10	38.86189	-111.27846	18	Upstream	Downstream end of UNT-2
11	38.86176	-111.27947	19	Downstream	Head of well defined channel
			20	Upstream	Area upstream from well defined channel
12	38.86175	-111.28192	21	Upstream	Note lack of defined channel
13	38.86180	-111.28521	22	Upstream	Occasional, discontinuous channels
14	38.86149	-111.28635	23	Upstream	Beginning of defined channel
15	38.86059	-111.28852	24	Upstream	Downstream from agricultural field
			25	Downstream	Downstream from agricultural field
16	38.85869	-111.28878	26	Upstream	Downstream end of diversion around agricultural field
			27	Downstream	Channel receiving runoff from field diversion
			28	Cross-stream	Agricultural field in area of former natural channel
17	38.85912	-111.29504	29	Upstream	Upstream of agricultural field
			30	Downstream	Channel not evident in field
18	38.85852	-111.29651	31	Upstream	Erosion along fence line, downstream from another ditch
19	38.85797	-111.29600	32	Upstream	Channel upstream from ditch
20	38.85732	-111.29523	33	Upstream	Farm road that acts as a diversion
21	38.85722	-111.29533	34	Upstream	Upstream of farm road
22	38.85736	-111.29888	35	Upstream	No defined channel

UNT-2, Photo 18: Downstream end of channel

UNT-2, Photo 19: Downstream view from head of well-defined channel

UNT-2, Photo 20: Upstream view from head of well-defined channel

UNT-2, Photo 21: Lack of channel upstream from well-defined channel

UNT-2, Photo 22: Area of occasional, discontinuous channels

UNT-2, Photo 23: Beginning of well defined channel

UNT-2, Photo 24: Downstream from cultivated field

UNT-2, Photo 25: Downstream from cultivated field

UNT-2, Photo 26: Downstream end of diversion ditch south of cultivated field

UNT-2, Photo 27: Erosion downstream from diversion ditch discharge

UNT-2, Photo 28: Cultivated field in area of former channel

UNT-2, Photo 29: Area upstream from cultivated field

UNT-2, Photo 30: Cultivated field – channel not evident

UNT-2, Photo 31: Erosion downstream from another diversion ditch

UNT-2, Photo 32: Channel upstream from second diversion ditch

UNT-2, Photo 33: Farm road that collects runoff from upstream area

UNT-2, Photo 34: View upstream from farm road

UNT-2, Photo 34: View upstream from Section 30 west boundary. Note lack of defined channel.

EVALUATION OF AN UNNAMED STREAM CHANNEL IN EMERY COUNTY, UTAH

1.0 INTRODUCTION

Bronco Utah Operations, LLC ("Bronco") has applied for an underground right-of-way through Federal coal to access coal in a portion of their underground Emery 2 Mine located in Emery County, Utah. An unnamed stream channel overlies this right-of-way in Section 32, T. 22 S., R. 6 E., SLBM and Section 5, T. 23 S., R. 6 E., SLBM. This channel, which appears on the Walker Flat, Utah 7.5-minute USGS quadrangle map, is shown on Figure 1.

Regulations promulgated by UDOGM define perennial, intermittent, and ephemeral streams as follows (see R645-100-200):

> " 'Perennial Stream' means a stream or part of a stream that flows continuously during all of the calendar year as a result of groundwater discharge or surface runoff. The term does not include intermittent stream or ephemeral stream.
>
> " 'Intermittent Stream' means a stream, or reach of a stream, that is below the local water table for at least some part of the year and obtains its flow from both surface runoff and groundwater discharge.
>
> " 'Ephemeral Stream' means a stream which flows only in direct response to precipitation in the immediate watershed, or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table."

UDOGM regulations (R645-301-724.200) require an applicant for a mine permit to characterize baseline surface water conditions in areas of potential impact. Although a cursory evaluation indicates that the subject unnamed steam is ephemeral, the purpose of this report is to present the hydrological, physical, and biological attributes of this channel as a means of formally designating its baseline condition.

2.0 METHODOLOGY

This investigation was conducted in general accordance with protocols developed by the Surface Water Quality Bureau of the New Mexico Environment Department (2011). These protocols were developed for determining whether individual streams are ephemeral, intermittent, or perennial to assist in determining potential beneficial uses of the waters in those streams.

Prior to the field survey, topographic mapping, geology and groundwater information from various sources, aerial photography from Google Earth, and soil data obtained from the U.S. Natural Resources

Conservation Service Web Soil Survey[1] were examined to provide the initial context for the field observations. The field survey was conducted on February 26, 2019. Although it is desirable to conduct such a survey without snow on the ground (to aid in identifying the general moisture content of channel bottoms), the need to obtain data prior to snowmelt precluded this typical approach.

During the field survey, the area surrounding the unnamed channel was traversed on foot. The field investigation included frequent stops to take notes, photograph reaches, record GPS locations of various relevant features, and measure the size of the active channel. These stops were made at locations that reflected representative channel characteristics.

3.0 ENVIRONMENTAL SETTING

The subject unnamed stream channel (referred to herein as UNT-3) drains a watershed area of approximately 1.5 square miles. A major tributary of UNT-3 (referred to herein as UNT-4) drains approximately 20% of that area.

The watershed associated with the unnamed steam channel is essentially undeveloped, ranging in elevation from about 5,960 feet to 6,180 feet. The Blue Gate Member of the Mancos Shale, or alluvial/ colluvial soils derived from weathering of that Member, exists on the surface over most of Sections 30 and 31. The Blue Gate Member is a marine shale that often erodes to form badland topography (Godfrey et al., 2007).

Soil data in the vicinity of UNT-3 and UNT-4, as downloaded from the Web Soil Survey, are provided in Attachment A. As indicated, surficial soils in the immediate vicinity of the unnamed channels are classified as loam under the U.S. Department of Agriculture classification system and as CL (low plasticity clay) under the Unified Soil Classification System. These soils consist of approximately 60 to 80 percent silt and clay. The depth to groundwater is generally greater than 200 cm (6.5 feet) except immediately upstream from Quitchupah Creek, where the depth to groundwater may be as shallow as about 25 centimeters (1o inches).

Annual precipitation at Emery, Utah averages 7.33 inches, with an average monthly maximum of 1.12 inches in August and an average monthly minimum of 0.33 inch in November.[2] Native vegetation within the area of interest consists of a desert shrub community typical of the general area, but density is typically sparse due to the soil type and climate.

4.0 RESULTS AND DISCUSSION

The February 2019 field survey of the unnamed channels provided ample evidence of the ephemeral nature of flow in the channels. These observations are summarized in the field sheets provided in Attachment B. The hydrological, physical, and biological attributes that are indicative of intermittent or

[1] https://websoilsurvey.nrcs.usda.gov/app/
[2] https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut2484

perennial stream flow in natural channels were absent. All observations supported the classification of each channel as being ephemeral, as further discussed below.

4.1 UNT-3

Photographs taken during the field investigation are provided in Attachment C. Waypoints at which photographs and observations were taken are shown on Figure 2. Field observations are summarized in Table 1.

UNT-3 is a broad, deep gully, generally 15 to 30 feet wide at the top and 10 to 15 feet deep. The active channel within this broad gull is typically about 2 to 3 feet wide and 1 to 2 feet deep. Thick tamarisk grows at the downstream end of the gully, at the confluence with UNT-2 described by EarthFax Engineering Group (2018). Sparse tamarisk extends approximately 750 to 800 feet upstream from that confluence. The presence of tamarisk is probably influenced by a shallower water table due to the influence of Quitchupah Creek, which exists immediately downstream from the confluence of UNT-3 and UNT-2.

The banks of UNT-3 are actively eroding. Vegetation within the channel and on the upland banks is sparse, consisting predominantly of greasewood, rabbitbrush, and shadscale. Except for the downstream extent of the channel where tamarisk is present, no enhanced vegetative growth occurs along the flow line of UNT-3.

Several short side channels (typically 100 to 300 feet long) are tributary to UNT-3. The primary exception to this generality is UNT-4, which is described in more detail in Section 4.2.

Regular and persistent stream flows often create channels that are sinuous, because a regular meander pattern is a function of a stream's attempt to balance its velocity (energy) and the valley gradient. Point bars and well-sorted bed materials are also typical of intermittent and perennial streams. On the other hand, these fluvial features are not typical of ephemeral channels. The channel of UNT-3 does not show any sign of regular or persistent meandering, fully developed point bars, sustained material sorting, or other geomorphic indications of intermittent or perennial flows. Thus, these observations support the classification of UNT-3 as ephemeral.

Observations were also made to identify evidence of recent storm flows such as high water marks (scour lines or deposits), floatable organic debris deposition, fine sediments deposited on bank vegetation, etc. No such consistent evidence was noted in the field.

No water was flowing or pooling within any portion of UNT-3 during the February 26, 2019 field survey. No evidence was seen in the channel of historic intermittent or perennial flows.

Commonly, streams with even small base flows support some form of filamentous algae or periphytons that cling to the substrate. These organisms were not observed, indicating that flows in UNT-3 are insufficient to allow colonization. No evidence of ponding or groundwater inflow to the channel was evident anywhere within UNT-3.

4.2 UNT-4

Photographs of UNT-4 and its general vicinity are provided in Attachment C. Waypoints at which photographs and observations were taken along UNT-4 are shown on Figure 2. Field observations are summarized in Table 2.

The most distinguishing geomorphic feature of UNT-4 is the straightness of the channel. Beginning a short distance above its confluence with UNT-3, the channel bears nearly due south for about 1,450 feet, makes a slight jog, then again bears nearly due south for another 1,000 feet before veering to the southeast. The extreme straightness of this channel suggests that it may have formed from erosion of an old jeep trail or another linear anthropomorphic feature.

The channel of UNT-4 is actively eroding and is generally less than about 2 to 4 feet wide and 8 to 10 feet deep. Vegetation within the channel and on the upland banks is sparse, consisting predominantly of greasewood, rabbitbrush, and shadscale. No enhanced vegetative growth occurs along the flow line of UNT-4.

The channel of UNT-4 does not show any sign of regular or persistent meandering, fully developed point bars, sustained material sorting, or other geomorphic indications of intermittent or perennial flows. These indicators support the classification of UNT-4 as ephemeral.

Observations were also made to identify evidence of recent storm flows such as high water marks (scour lines or deposits), floatable organic debris deposition, fine sediments deposited on bank vegetation, etc. No such evidence was noted in the field. Furthermore, no filamentous algae or periphytons were observed. The lack of these organisms indicates that flows in UNT-4 are insufficient to allow colonization. No evidence of ponding or groundwater inflow to the channel was evident anywhere within UNT-4.

5.0 SUMMARY AND CONCLUSIONS

The February 2019 field survey, as well as other supporting evidence, substantiates the initial assertion that the unnamed stream channels in Sections 30 and 31, T. 22 S., R. 6 E., SLBM and Section 5, T. 23 S., R. 6 E., SLBM are ephemeral. There are no indications that the channels flow intermittently or perennially. All of the hydrological, physical, and biological attributes that were examined during the survey strongly suggest that the channel bottoms are (1) always above the water table, and (2) convey flow only infrequently and in direct response to either precipitation that is generated within its watershed or snow melt generated therein. Thus, individually and cumulatively, all observations consistently and clearly point to the classification of UNT-3 and UNT-4 as ephemeral.

6.0 REFERENCES

EarthFax Engineering Group, LLC. 2018. Evaluation of Two Unnamed Tributaries of Quitchupah Creek in Emery County, Utah. Project report prepared for Bronco Utah Operations, LLC. Midvale, Utah.

Godfrey, A.E., R.I. Grauch, and M.L. Tuttle. 2007. Geomorphic Differences Between the Tununk and Blue Gate Members of the Mancos Shale Near Caineville, Wayne County, Utah. pp. 205-220 *in* Central Utah: Diverse Geology of a Dynamic Landscape. Utah Geological Association Publication 36. G.C. Willis, M.D. Hyland, D.L. Clark, and T.C. Chidsey, Jr. (Editors). Salt Lake City, UT.

New Mexico Environment Department, Surface Water Quality Bureau. 2011. Statewide Water Quality Management Plan and Continuing Planning Process - Appendix C: Hydrology Protocol for the Determination of Uses Supported by Ephemeral, Intermittent, and Perennial Waters. Santa Fe, NM. Document downloaded from https://www.env.nm.gov/swqb/Hydrology/index.html.

TABLE 1

UNT-3 Observations

Waypoint	Channel Dimensions (ft)		Vegetation	Comments
	Bottom Width	Depth		
1	8-10	6-8	Tamarisk, greasewood, rabbitbrush	Immediately above confluence with UNT-2, a short distance above Quitchupah Creek floodplain.
2	30-40	8-10	As above	Approximate up-stream extent of most tamarisk.
3	30-40	10-12	Greasewood, rabbit brush, shadscale	
4	12-15	15-20	As above	
5	20-30	20-25	As above	Headcut, approximately 10’ high with 3- deep splash basin at toe. Channel dimensions are upstream from headcut.
6	2-3	5-6	As above	Headcut, approximately 10’ high with 3- deep splash basin at toe. Channel dimensions are upstream from headcut.
13	15-20	10-12	As above	
14	20-25	15-20	As above	
15	30-40	8-10	As above	Bedrock in channel bottom
16	15-20	8-10	As above	
17	30-40	8-10	As above	

Note: See Figure 2 for waypoint locations.

TABLE 2

UNT-4 Observations

Waypoint	Channel Dimensions (ft)		Vegetation	Comments
	Bottom Width	Depth		
7	6-8	12-15	Greasewood, rabbit brush, shadscale	Ap-proximately 250' above confluence with UNT-3.
8	1-2	6-8	As above	Sloughed channel bank and substantial channel narrowing.
9	12" HDPE pipe crossing		As above	Jeep trail crossing.
10	4-5	6-8	As above	At confluence with major side channel.
11	2-3	8-10	As above	
12	12-15	12-15	As above	Bedrock in channel bottom.

Note: See Figure 2 for waypoint locations.

G:\1665\10\CHAPTER VI REVISION\Unnamed Tributary Evaluation\Tributary Evaluation 12/7/2018

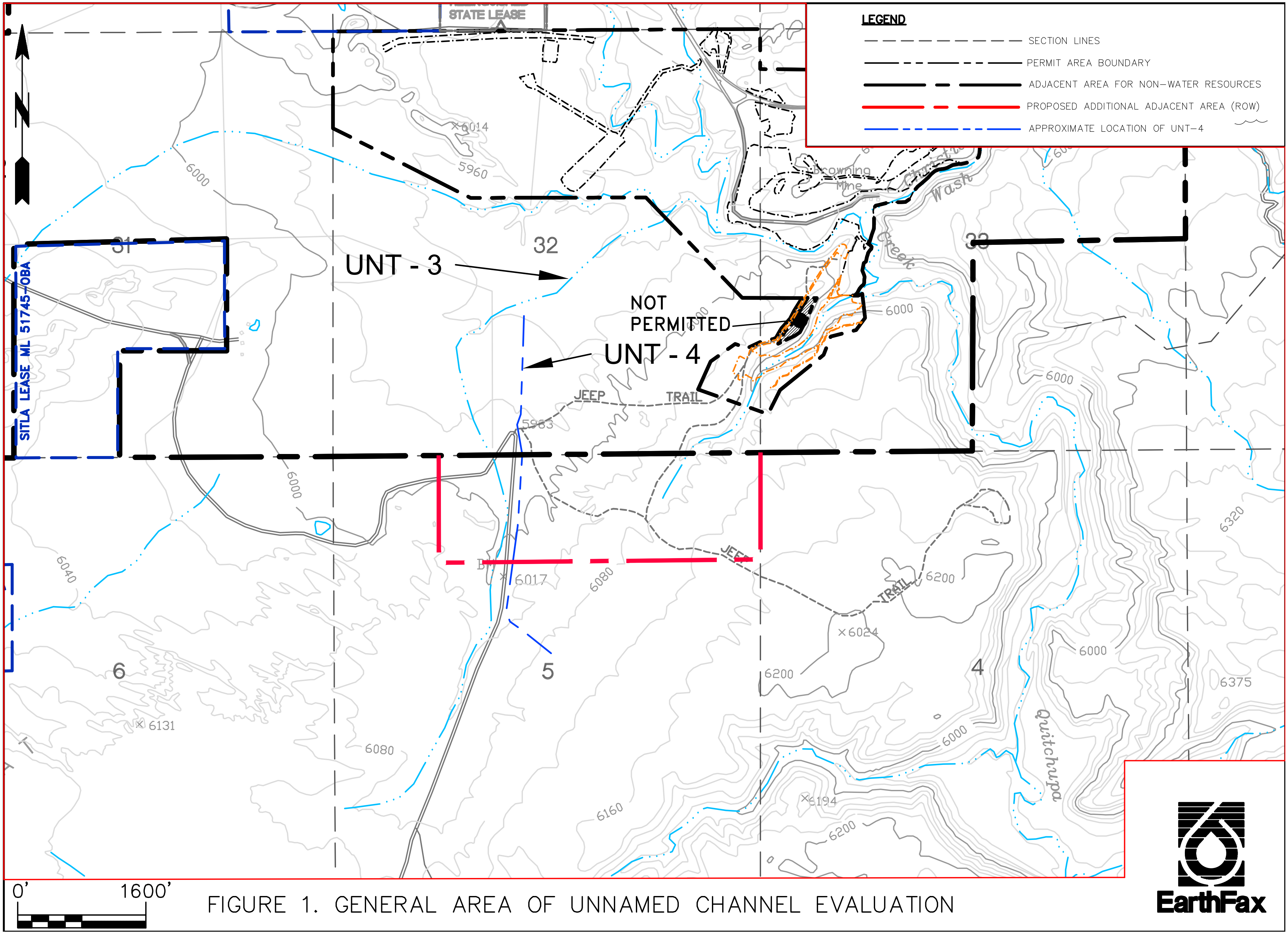


FIGURE 1. GENERAL AREA OF UNNAMED CHANNEL EVALUATION

EarthFax

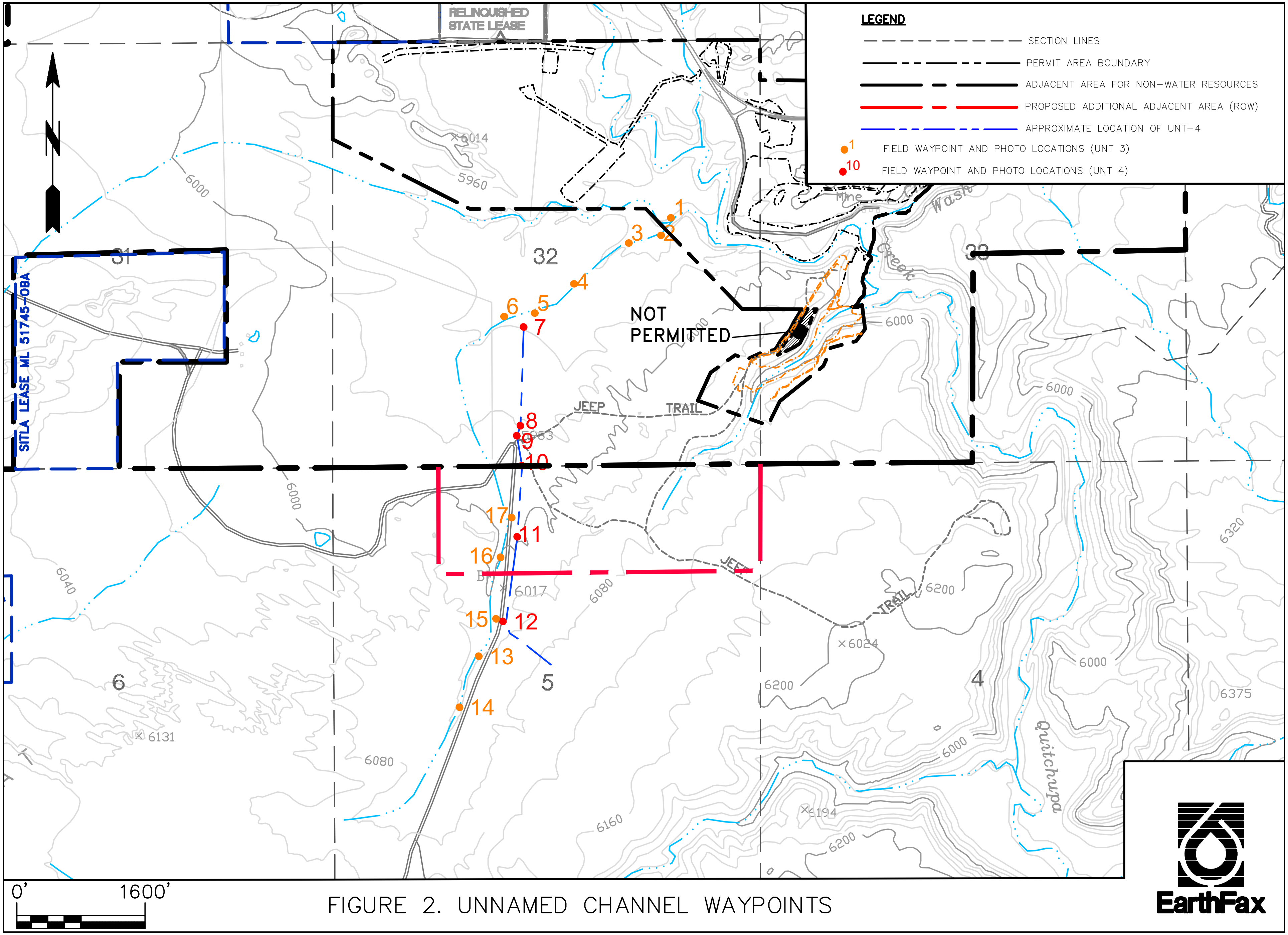
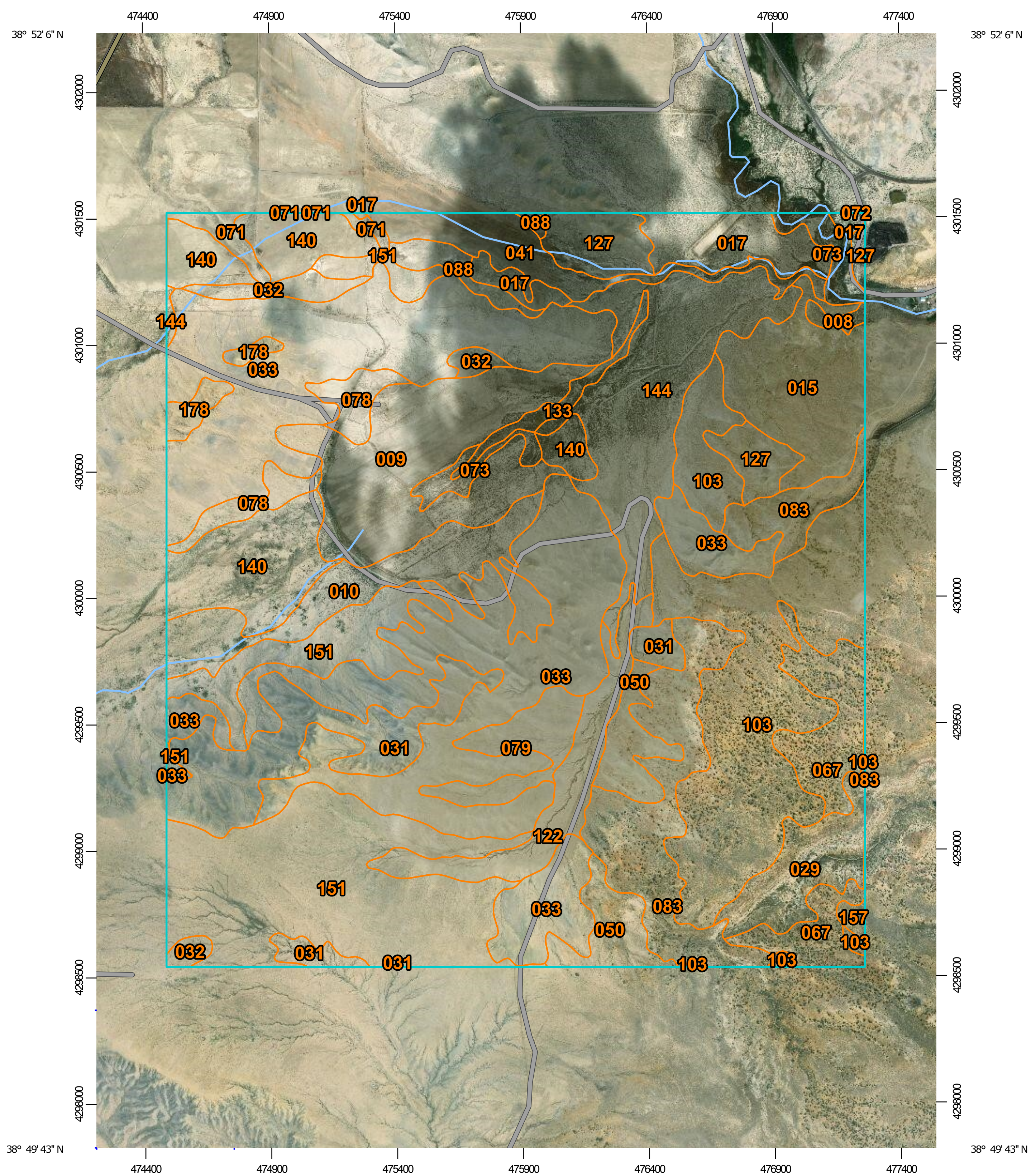


FIGURE 2. UNNAMED CHANNEL WAYPOINTS

ATTACHMENT A

Web Soil Survey Printouts

Soil Map—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - UNT-3 and UNT-4 Area)



Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 300, 600, 1200, 1800

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

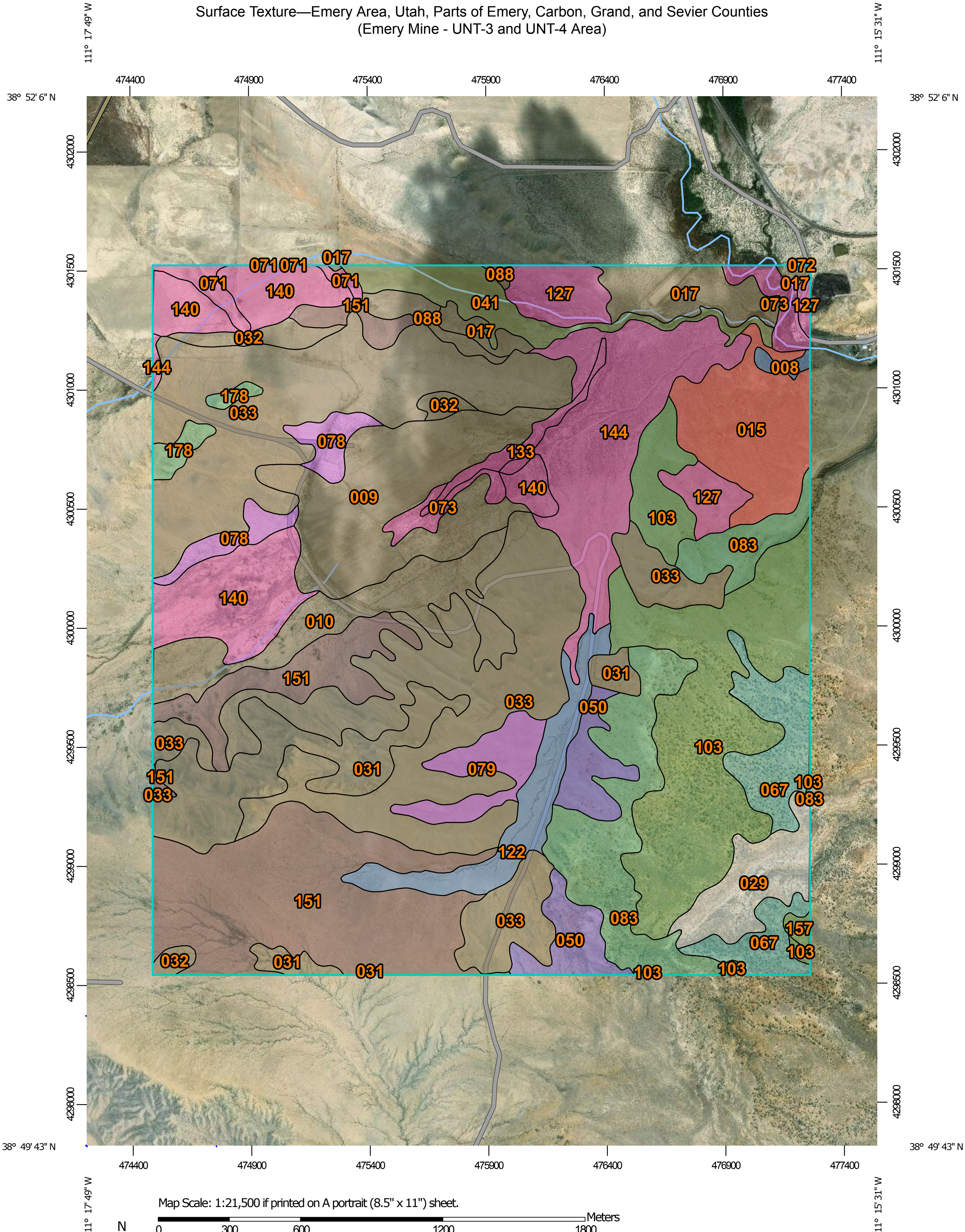
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes	40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	29.4	1.4%
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	204.2	10.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
122	Penner very fine sandy loam, 3 to 6 percent slopes	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	11.2	0.5%
Totals for Area of Interest		**2,049.9**	**100.0%**

Surface Texture—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - UNT-3 and UNT-4 Area)



Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 300, 600, 1200, 1800
Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Channery clay loam

Channery fine sandy loam

Clay loam

Fine sandy loam

Gravelly fine sandy loam

Gravelly loam

Loam

Peaty silt loam

Silt loam

Silty clay loam

Very fine sandy loam

Not rated or not available

Soil Rating Lines

Channery clay loam

Channery fine sandy loam

Clay loam

Fine sandy loam

Gravelly fine sandy loam

Gravelly loam

Loam

Peaty silt loam

Silt loam

Silty clay loam

Very fine sandy loam

Not rated or not available

Soil Rating Points

Channery clay loam

Channery fine sandy loam

Clay loam

Fine sandy loam

Gravelly fine sandy loam

Gravelly loam

Loam

Peaty silt loam

Silt loam

Silty clay loam

Very fine sandy loam

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Surface Texture

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	Very fine sandy loam	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	Silty clay loam	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	Silty clay loam	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	Channery fine sandy loam	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	Silty clay loam	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes		40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	Silty clay loam	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	Silty clay loam	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	Silty clay loam	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	Peaty silt loam	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	Channery clay loam	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	Gravelly fine sandy loam	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	Loam	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	Loam	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	Loam	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	Clay loam	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	Clay loam	29.4	1.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	Gravelly loam	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	Silty clay loam	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	Fine sandy loam	204.2	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	Very fine sandy loam	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	Loam	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	Loam	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	Loam	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	Loam	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	Silt loam	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	Fine sandy loam	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	Gravelly loam	11.2	0.5%
Totals for Area of Interest			**2,049.9**	**100.0%**

Description

This displays the representative texture class and modifier of the surface horizon.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

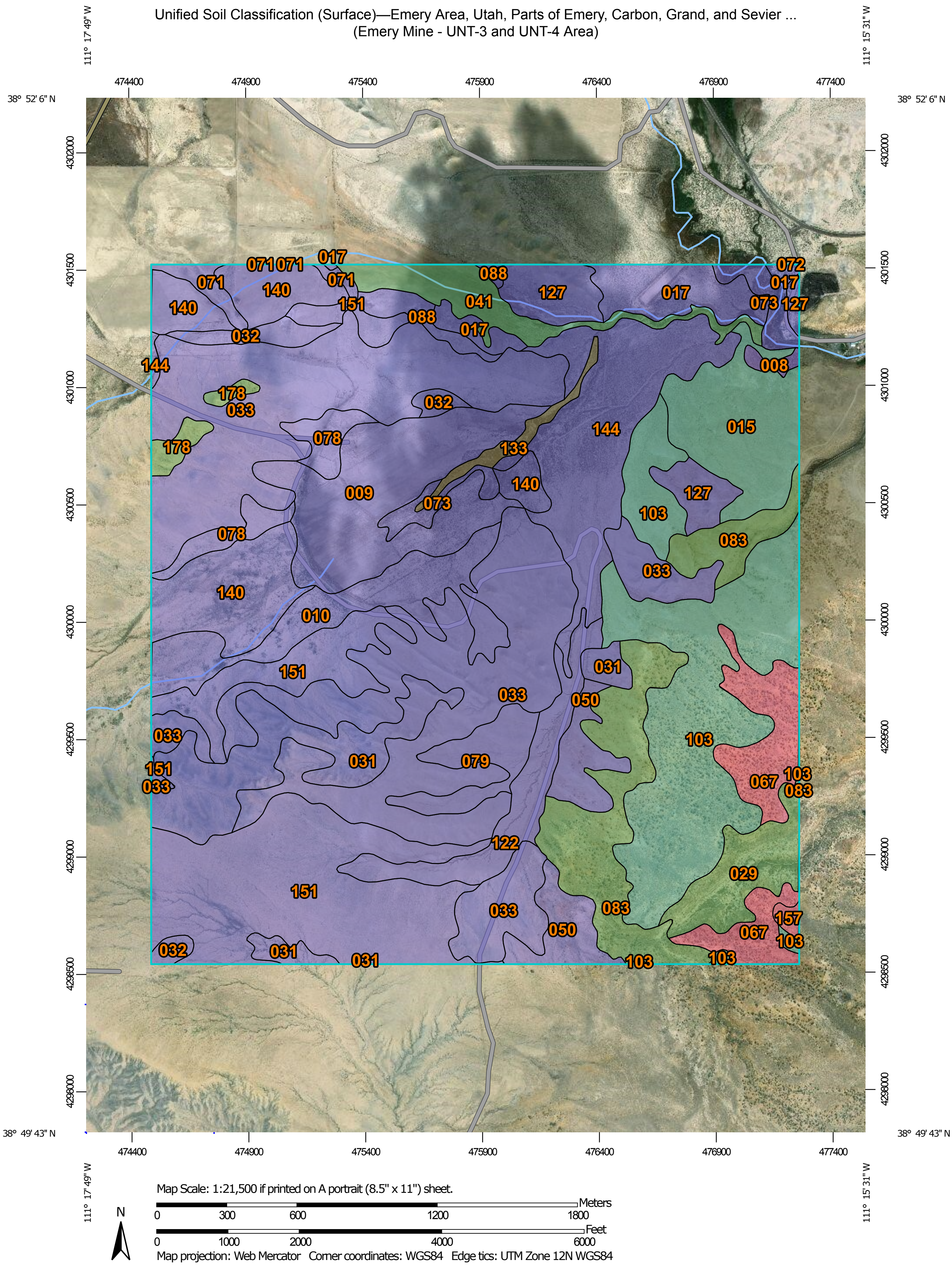
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)


111° 17' 49" W
111° 15' 31" W
474400
474900
475400
475900
476400
476900
477400
38° 52' 6" N
38° 49' 43" N
4302000
4301500
4301000
4300500
4300000
4299500
4299000
4298500
4298000
071
140
017
088
127
072
041
151
088
017
073
144
032
178
033
078
133
009
073
140
103
083
015
008
010
031
050
079
122
029
067
157
032
N
Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.
Meters
0
300
600
1200
1800
Feet
0
1000
2000
4000
6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Lines
- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Points
- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Unified Soil Classification (Surface)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	CL-ML	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	CL	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	CL	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	SC-SM	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	CL	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes	GC	40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	CL	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	CL	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	CL	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	OH	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	CL	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	SC	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	CL	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	CL	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	CL	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	CL	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	CL	29.4	1.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	GC	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	CL	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	SC-SM	204.2	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	CL	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	CL	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	ML	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	CL	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	CL	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	CL	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	SC	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	GC	11.2	0.5%
Totals for Area of Interest			**2,049.9**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

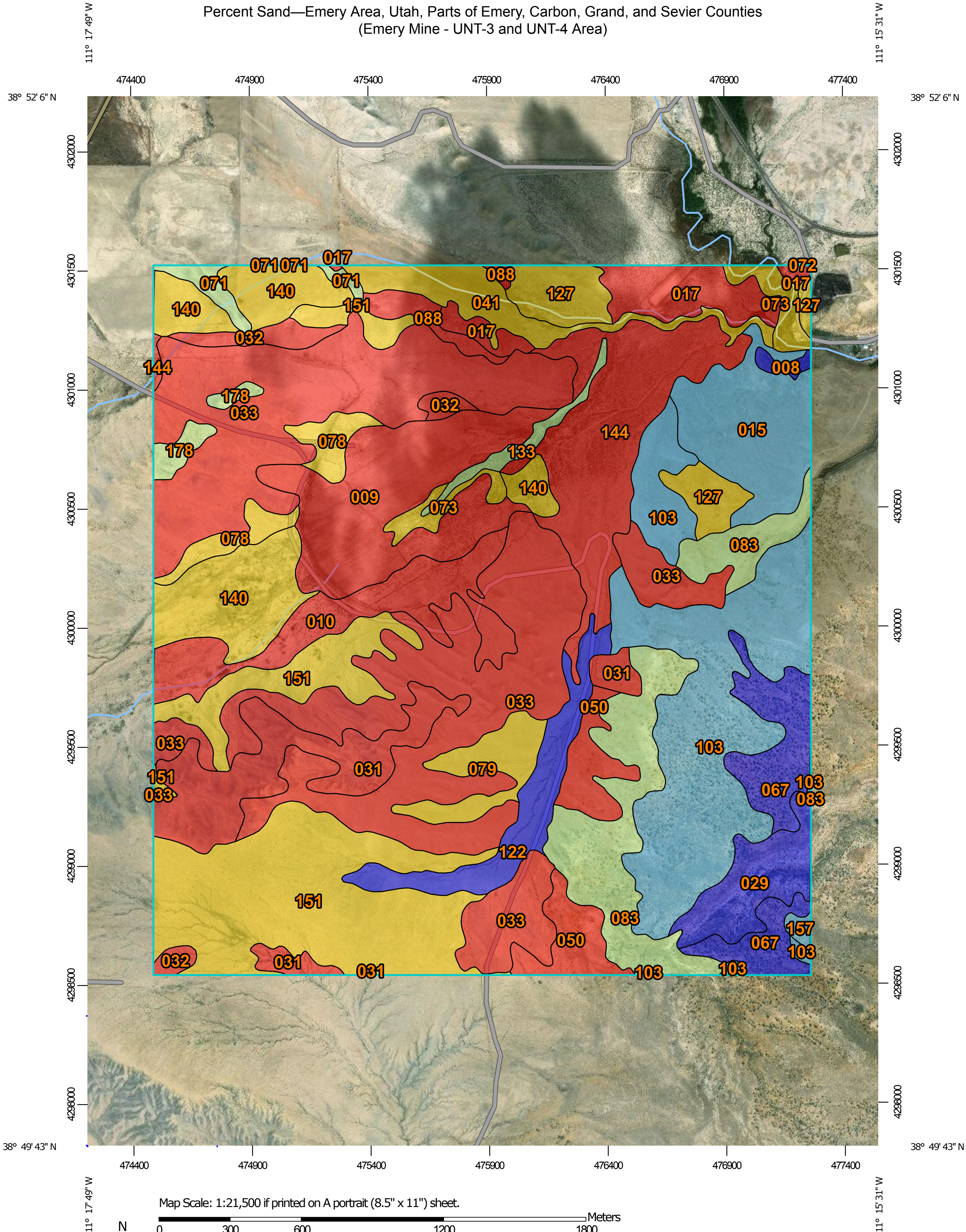
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Percent Sand—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - UNT-3 and UNT-4 Area)



Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 300, 600, 1200, 1800

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 21.0

> 21.0 and <= 30.9

> 30.9 and <= 44.5

> 44.5 and <= 65.8

> 65.8 and <= 77.8

Not rated or not available

Soil Rating Lines

<= 21.0

> 21.0 and <= 30.9

> 30.9 and <= 44.5

> 44.5 and <= 65.8

> 65.8 and <= 77.8

Not rated or not available

Soil Rating Points

<= 21.0

> 21.0 and <= 30.9

> 30.9 and <= 44.5

> 44.5 and <= 65.8

> 65.8 and <= 77.8

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Sand

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	77.8	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	17.5	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	17.3	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	60.0	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	8.6	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes	69.1	40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	17.1	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	10.2	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	19.0	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	28.4	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	13.1	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	68.4	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	40.6	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	27.7	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	25.7	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	30.9	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	27.3	29.4	1.4%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	44.5	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	15.2	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	60.1	204.2	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	71.1	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	27.8	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	36.8	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	27.4	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	21.0	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	29.9	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	65.8	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	35.5	11.2	0.5%
Totals for Area of Interest			**2,049.9**	**100.0%**

Description

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In the database, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

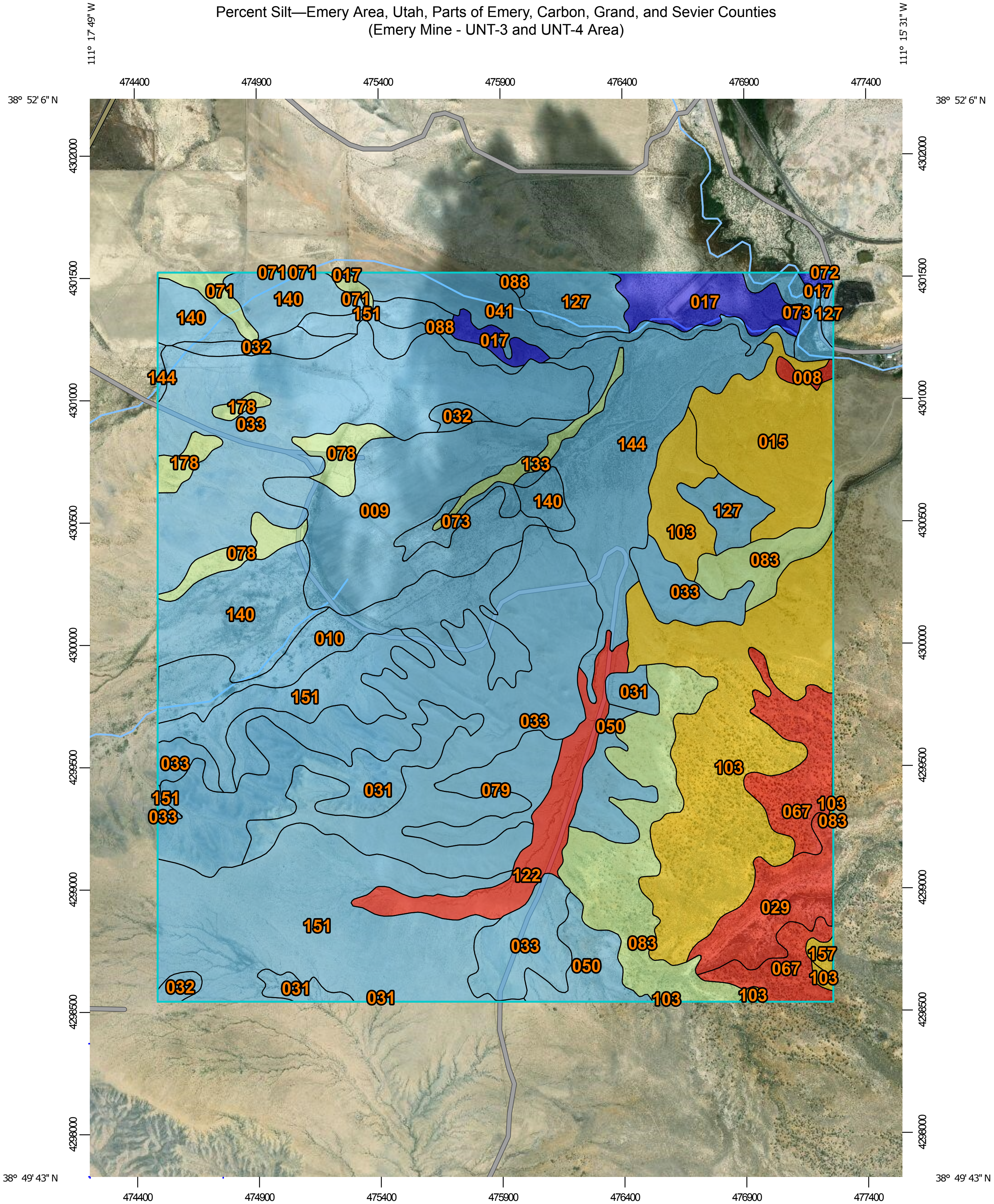
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

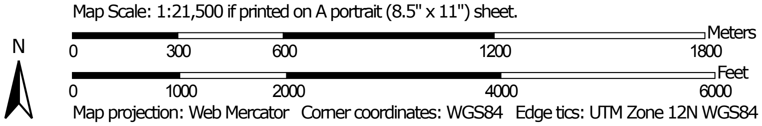
Bottom Depth: 12

Units of Measure: Inches

Percent Silt—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - UNT-3 and UNT-4 Area)



Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 16.5
- > 16.5 and <= 25.9
- > 25.9 and <= 41.7
- > 41.7 and <= 52.9
- > 52.9 and <= 61.2
- Not rated or not available

Soil Rating Lines

- <= 16.5
- > 16.5 and <= 25.9
- > 25.9 and <= 41.7
- > 41.7 and <= 52.9
- > 52.9 and <= 61.2
- Not rated or not available

Soil Rating Points

- <= 16.5
- > 16.5 and <= 25.9
- > 25.9 and <= 41.7
- > 41.7 and <= 52.9
- > 52.9 and <= 61.2
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Silt

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	15.8	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	50.5	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	50.3	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	22.7	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	61.2	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes	16.3	40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	44.5	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	52.9	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	45.0	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	49.9	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	47.0	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	14.9	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	36.4	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	47.6	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	50.0	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	41.7	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	45.2	29.4	1.4%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	33.9	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	46.8	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	25.9	204.2	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	16.5	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	46.9	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	39.7	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	46.9	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	52.0	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	48.5	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	20.3	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	37.3	11.2	0.5%
Totals for Area of Interest			**2,049.9**	**100.0%**

Description

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In the database, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

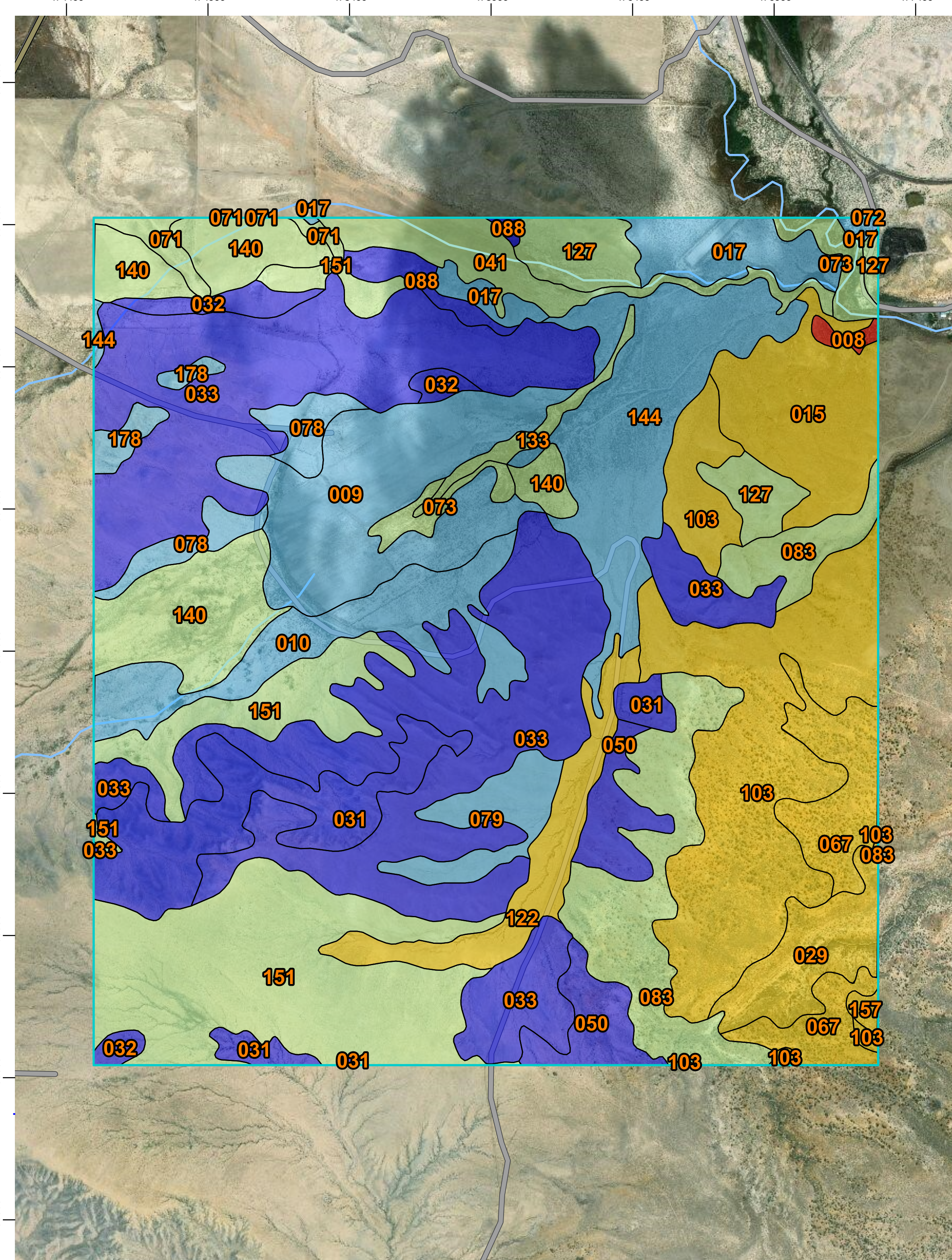
Units of Measure: Inches

Percent Clay—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - UNT-3 and UNT-4 Area)

111° 17' 49" W | 111° 15' 31" W

474400 474900 475400 475900 476400 476900 477400

38° 52' 6" N | 38° 52' 6" N



4302000 4301500 4301000 4300500 4300000 4299500 4299000 4298500 4298000

38° 49' 43" N | 38° 49' 43" N

474400 474900 475400 475900 476400 476900 477400

111° 17' 49" W | 111° 15' 31" W

Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.

N

0 300 600 1200 1800 Meters

0 1000 2000 4000 6000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 6.4

> 6.4 and <= 17.2

> 17.2 and <= 25.7

> 25.7 and <= 32.4

> 32.4 and <= 39.9

Not rated or not available

Soil Rating Lines

<= 6.4

> 6.4 and <= 17.2

> 17.2 and <= 25.7

> 25.7 and <= 32.4

> 32.4 and <= 39.9

Not rated or not available

Soil Rating Points

<= 6.4

> 6.4 and <= 17.2

> 17.2 and <= 25.7

> 25.7 and <= 32.4

> 32.4 and <= 39.9

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

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Percent Clay

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	6.4	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	32.0	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	32.4	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	17.2	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	30.2	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes	14.6	40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	38.4	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	36.8	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	36.0	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	21.7	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	39.9	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	16.8	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	23.0	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	24.7	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	24.3	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	27.5	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	27.5	29.4	1.4%

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	21.6	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	37.9	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	14.0	204.2	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	12.4	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	25.4	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	23.5	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	25.7	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	27.0	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	21.6	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	13.8	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	27.2	11.2	0.5%
Totals for Area of Interest			**2,049.9**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

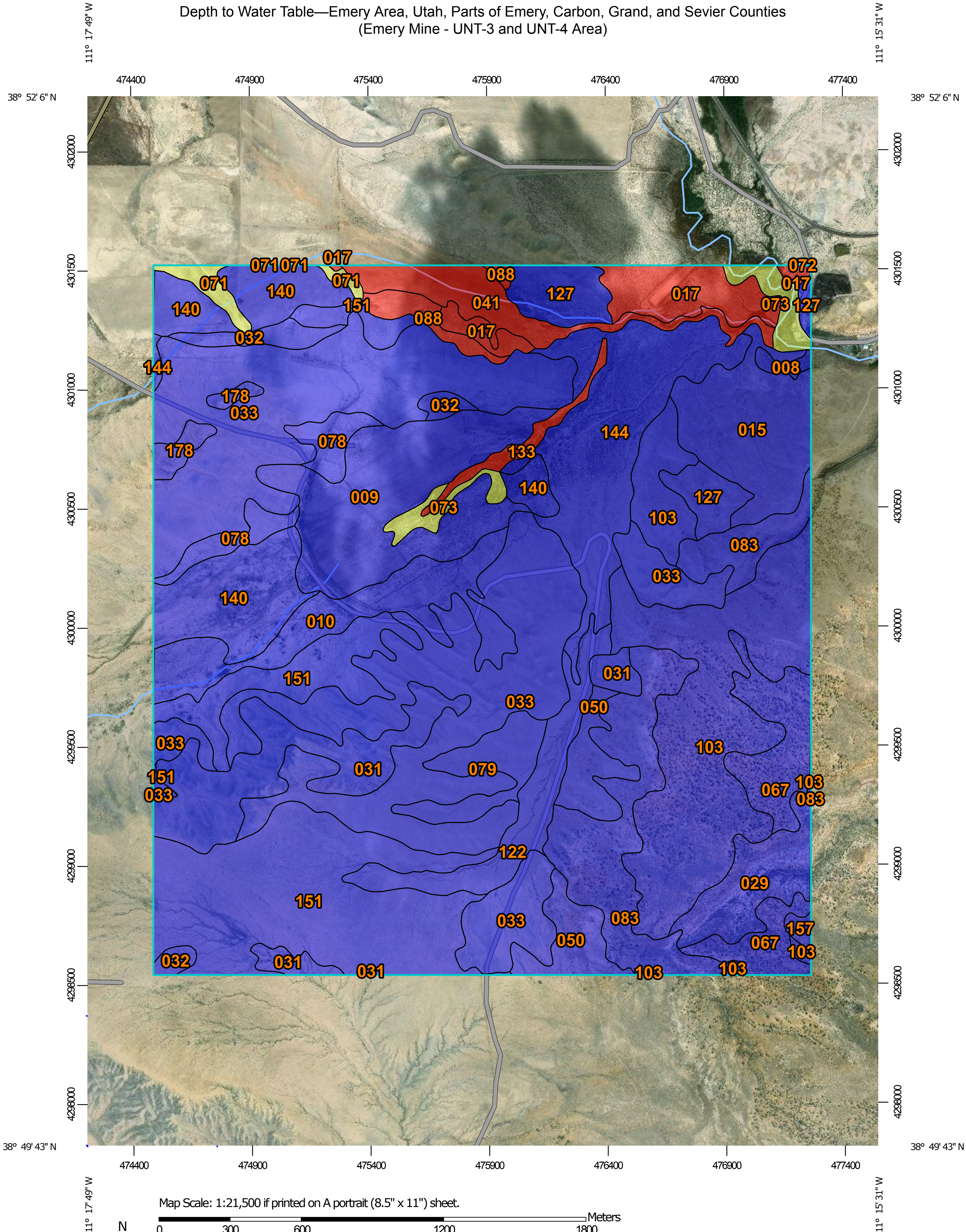
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 12

Units of Measure: Inches

Depth to Water Table—Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
(Emery Mine - UNT-3 and UNT-4 Area)



Map Scale: 1:21,500 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 300, 600, 1200, 1800

Feet: 0, 1000, 2000, 4000, 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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Soil Survey Area: Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties
Survey Area Data: Version 7, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 24, 2010—Nov 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
008	Beebe very fine sandy loam, 1 to 3 percent slopes	>200	3.8	0.2%
009	Billings silty clay loam, 1 to 3 percent slopes	>200	121.2	5.9%
010	Billings-Gullied land complex, 1 to 6 percent slopes	>200	71.3	3.5%
015	Braf-Persayo-Casmos complex, 3 to 20 percent slopes	>200	73.9	3.6%
017	Briny silty clay loam, 0 to 3 percent slopes	25	45.7	2.2%
029	Cheeta-Rock outcrop-Strych complex, 25 to 70 percent slopes	>200	40.8	2.0%
031	Chipeta-Badland complex, 3 to 45 percent slopes	>200	92.0	4.5%
032	Chipeta-Killpack-Persayo association, 1 to 3 percent slopes	>200	20.5	1.0%
033	Chipeta-Persayo-Killpack complex, 3 to 20 percent slopes	>200	448.1	21.9%
041	Ferron peaty silt loam, 0 to 3 percent slopes	25	39.9	1.9%
050	Gerst-Odome complex, 3 to 25 percent slopes	>200	44.7	2.2%
067	Hideout-Gerst-Kaiar association, 3 to 30 percent slopes	>200	60.0	2.9%
071	Hunting loam, 1 to 3 percent slopes	76	10.8	0.5%
072	Hunting loam, strongly saline, 1 to 3 percent slopes	76	0.0	0.0%
073	Hunting-Gullied land-Libbings complex, 0 to 5 percent slopes	76	22.5	1.1%
078	Killpack clay loam, 1 to 3 percent slopes	>200	26.1	1.3%
079	Killpack clay loam, 3 to 6 percents slopes	>200	29.4	1.4%

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
083	Lazear-Gerst-Pacon complex, 3 to 35 percent slopes	>200	109.4	5.3%
088	Libbings-Saseep complex, 0 to 3 percent slopes	25	13.4	0.7%
103	Molen-Lazear-Gerst complex, 2 to 8 percent slopes	>200	204.2	10.0%
122	Penner very fine sandy loam, 3 to 6 percent slopes	>200	49.2	2.4%
127	Persayo-Chipeta association, 3 to 20 percent slopes	>200	42.4	2.1%
133	Rafael loam, 0 to 3 percent slopes	25	10.5	0.5%
140	Ravola loam, 1 to 3 percent slopes	>200	106.2	5.2%
144	Ravola-Homko complex, 1 to 3 percent slopes	>200	119.2	5.8%
151	Sagers-Killpack association, 1 to 8 percent slopes	>200	230.6	11.2%
157	Smithpond fine sandy loam, 2 to 6 percent slopes	>200	3.0	0.1%
178	Vickel-Utaline-Persayo complex, 8 to 45 percent slopes	>200	11.2	0.5%
Totals for Area of Interest			**2,049.9**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

ATTACHMENT B

Stream Classification Field Sheets

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 26 Feb 2019	**Stream Name:** Unnamed	**Latitude:** 38.85989
Evaluator(s): RB White	**Site ID:** UNT-3	**Longitude:** –111.26532
TOTAL POINTS: *Stream is at least intermittent if ≥ 12*	**Assessment Unit:**	**Drought Index (12-mo. SPI Value):** –0.70

WEATHER CONDITIONS	**NOW:**	**PAST 48 HOURS:**	**Has there been a heavy rain in the last 48 hours?**
	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ✓ clear/sunny Snow on ground	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ✓ clear/sunny	___ YES ✓ NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** ___ YES ✓ NO **Diversions** ___ YES ✓ NO **Discharges** ___ YES ✓ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.6)	1

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES UNT-3

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	See attachment containing photos	

NOTES:

Tamarisk occurs in the lower reach of this channel, probably influenced by the adjacent floodplain of Quitchupah Creek. Occasional tamarisk also occurs in the channel bottom for a distance of about 750-800 ft upstream from the confluence with UNT-2. Greasewood, rabbitbrush, and shadscale dominate the upland banks. No evidence of consitent surface flow.

Conclusion → This channel is ephemeral.

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 26 Feb 2019	**Stream Name:** Unnamed	**Latitude:** 38.85663
Evaluator(s): RB White	**Site ID:** UNT-4	**Longitude:** -111.27136
TOTAL POINTS: *Stream is at least intermittent if ≥ 12*	**Assessment Unit:**	**Drought Index (12-mo. SPI Value):** -0.70

WEATHER CONDITIONS	**NOW:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ✓ clear/sunny Snow on ground	**PAST 48 HOURS:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ✓ clear/sunny	**Has there been a heavy rain in the last 48 hours?** ___ YES ✓ NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** ___ YES ✓ NO **Diversions** ___ YES ✓ NO **Discharges** ___ YES ✓ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	1	(0)
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.6)	0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	See attachment containing photographs.	

NOTES:

Greasewood, rabbitbrush, and shadscale dominate the upland banks of this channel. The channel is actively eroding. No evidence of surface flow.

Conclusion → This channel is ephemeral.

ATTACHMENT C

Photographs of UNT-3, UNT-4, and Vicinity

Photo 1 – Downstream view of UNT-3 at Waypoint 1

Photo 2 – Upstream view of UNT-3 at Waypoint 2

Photo 3 – Upstream view of UNT-3 at Waypoint 3

Photo 4 – Upstream view of short side channel at Waypoint 4

Photo 5 – Upstream view of UNT-3 at Waypoint 4

Photo 6 – Upstream view of typical side channel (with headcut) at Waypoint 5

Photo 7 – Downstream view of UNT-3 at Waypoint 5

Photo 8 – Upstream view of headcut in UNT-3 at Waypoint 6

Photo 9 – Upstream view of UNT-3 above headcut at Waypoint 6

Photo 10 – Downstream of UNT-4, approximately 250’ above confluence
with UNT-3 at Waypoint 7

Photo 11 - Downstream view of UNT-4 showing sloughed bank at Waypoint 8

Photo 12 – Upstream view of UNT-4 at Waypoint 8
Showing substantial narrowing of channel

Photo 13 – Upstream view of UNT-4 at Waypoint 9 Jeep trail crossing (12" HDPE pipe)

Photo 14 – Downstream view of UNT-4 at Waypoint 10

Photo 15 – Downstream view of UNT-4 at Waypoint 11

Photo 16 – Downstream view of UNT-4 at Waypoint 12

Photo 17 – Downstream view of UNT-3 at Waypoint 13

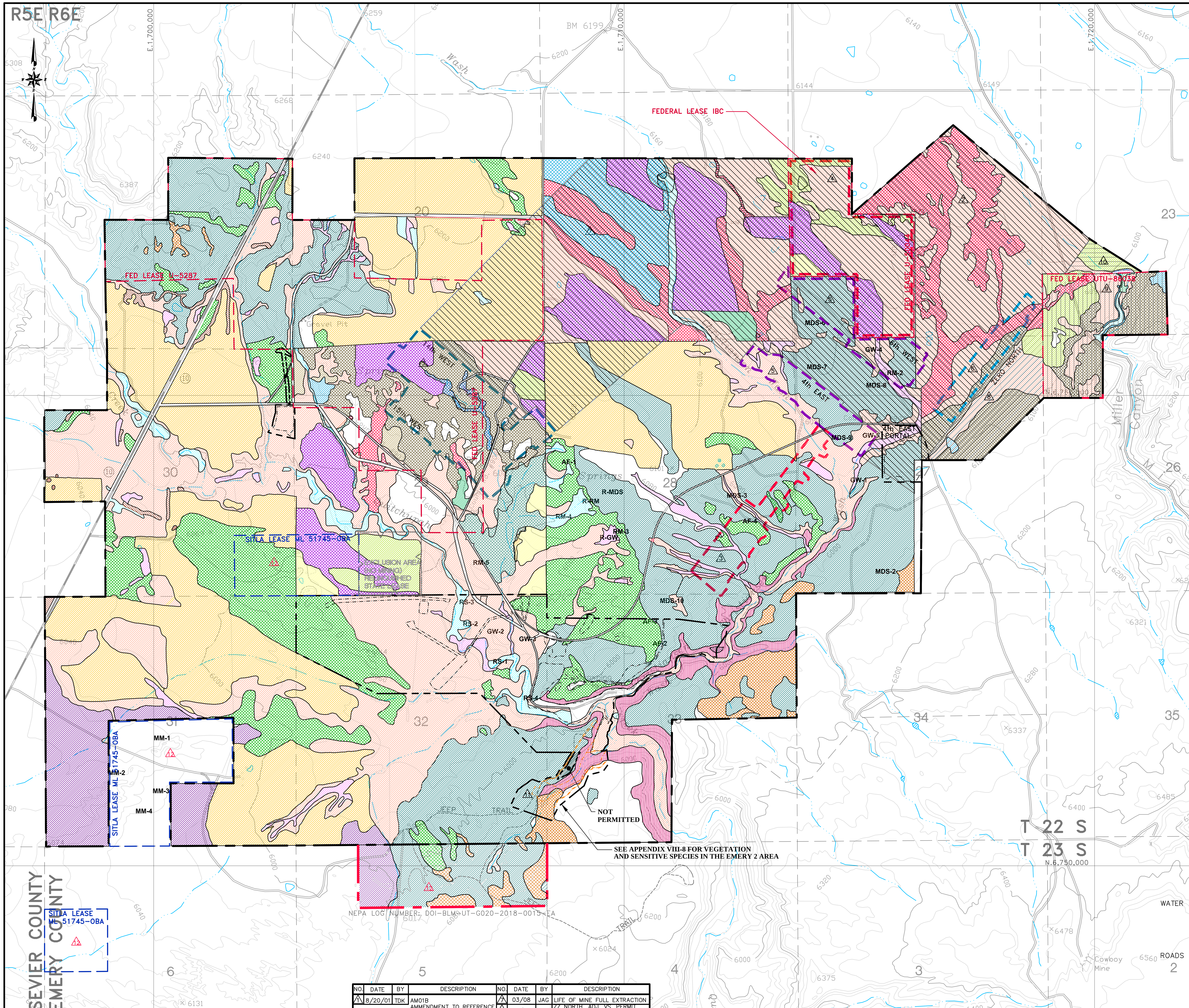
Photo 18 – Downstream view of UNT-3 at Waypoint 14

Photo 19 – Upstream view of UNT-3 at Waypoint 14

Photo 20 – Downstream view of UNT-3 at Waypoint 15

Photo 21 – Downstream view of UNT-3 at Waypoint 16

Downstream view of UNT-3 at Waypoint 17



LEGEND

- PERMIT AREA BOUNDARY (SOME VEGETATION REMOVED)
- ADJACENT AREA FOR NON-WATER RESOURCES. FOR THE AREA OF HYDROLOGIC EVALUATION, SEE PLATE VI-4
- PROPOSED ADDITIONAL ADJACENT AREA (ROW)
- TO BE FULLY EXTRACTED
- TO BE FULLY EXTRACTED SEE CHAPTER VIII APPENDIX VIII-3, FIGURE 1 FOR VEGETATION IN THIS AREA
- TO BE FULLY EXTRACTED SEE CHAPTER VIII APPENDIX VIII-3, FIGURE 2 FOR VEGETATION IN THIS AREA
- FOR ADDITIONAL VEGETATION DETAIL SEE CHAPTER XII

- PASTURE LAND/HAYLAND (143 ACRES)
- PASTURE LAND/DRY (34 ACRES)
- PASTURE LAND/IRRIGATED (155 ACRES)
- RIPARIAN MEADOW
- RIPARIAN SHRUBLAND
- GREASEWOOD SHRUBLAND
- MIXED DESERT SHRUBLAND
- MATSCALE SHRUBLAND
- PINYON-JUNIPER WOODLAND
- COTTONWOOD WOODLAND
- ANNUAL FORBES
- SALT GRASS
- CATTAIL/SALTGRASS
- SHADSCALE
- OTHER SURFACE DISTURBANCE
- ROCK OUTCROP/TALUS
- SHADSCALE/WINTERFAT
- MAT SALTBRUSH
- WIREGRASS/SALTGRASS
- RUSSIAN OLIVE
- SAGEBRUSH
- TAMARISK
- AREA TO BE FULLY EXTRACTED

NOTE:
ALL ACRES IN ( ) ARE RENEWABLE RESOURCE LANDS.

REFERENCE SITE / SAMPLE SITE

MAP SYMBOL	COMMUNITIES	MAP SYMBOL	COMMUNITIES
R-RM	RIPARIAN MEADOW	R-MDS	MIXED DESERT SHRUBLAND
RM-1	RIPARIAN MEADOW	MDS-1	MIXED DESERT SHRUBLAND
RM-2	RIPARIAN MEADOW	MDS-2	MIXED DESERT SHRUBLAND
RM-3	RIPARIAN MEADOW	MDS-3	MIXED DESERT SHRUBLAND
RM-4	RIPARIAN MEADOW	MDS-4	MIXED DESERT SHRUBLAND
RM-5	RIPARIAN MEADOW	MDS-5	MIXED DESERT SHRUBLAND
RS-1	RIPARIAN SHRUBLAND	MDS-6	MIXED DESERT SHRUBLAND
RS-2	RIPARIAN SHRUBLAND	MDS-7	MIXED DESERT SHRUBLAND
RS-3	RIPARIAN SHRUBLAND	MDS-8	MIXED DESERT SHRUBLAND
RS-4	RIPARIAN SHRUBLAND	MDS-9	MIXED DESERT SHRUBLAND
		MDS-10	MIXED DESERT SHRUBLAND
R-GW	GREASEWOOD SHRUBLAND	MM-1	MATSCALE SHRUBLAND
GW-1	GREASEWOOD SHRUBLAND	MM-2	MATSCALE SHRUBLAND
GW-2	GREASEWOOD SHRUBLAND	MM-3	MATSCALE SHRUBLAND
GW-3	GREASEWOOD SHRUBLAND	MM-4	MATSCALE SHRUBLAND
GW-4	GREASEWOOD SHRUBLAND	AF-1	ANNUAL FORBS
GW-5	GREASEWOOD SHRUBLAND	AF-2	ANNUAL FORBS
		AF-3	ANNUAL FORBS
		AF-4	ANNUAL FORBS

SURFACE OPERATIONS AREA

VEGETATION COMMUNITIES	ACRES
PRIME FARMLAND CROPLAND	NONE
PASTURE LAND / HAYLAND	NONE
RIPARIAN MEADOW	10.2
RIPARIAN SHRUBLAND	17.9
WATER	NONE
ROCK/ROCK OUTCROP/TALUS	17.1
GREASEWOOD SHRUBLAND	171.9
MIXED DESERT SHRUBLAND	95.7
MATSCALE SHRUBLAND	NONE
PINYON-JUNIPER WOODLAND	NONE
COTTONWOOD WOODLAND	NONE
ANNUAL FORBS	102.9
ROADS	5.8
INDUSTRIAL (COAL MINING)	19.5
OTHER DISTURBED LANDS	NONE
TOTAL	441.0

LAND USES	ACRES
GRAZING / WILDLIFE HABITAT	415.7
INDUSTRIAL (COAL MINING)	19.5
ROADS	5.8
TOTAL	441.0

REGISTERED PROFESSIONAL ENGINEER No. 168246 RICHARD B. WHITE NOT VALID WITHOUT A SIGNATURE STATE OF UTAH

REVISIONS

NO.	DATE	BY	DESCRIPTION
1	8/20/01	TDK	AM01B AMMENDMENT TO REFERENCE AREA
2	6/30/05	JAG	ADDED FIRST NORTH I.B.C.
3	09/05	JAG	Ist SOUTH FULL EXTRACTION
4	12/12/06	JAG	Ist NORTH FED LEASE IBC, FULL EXTRACTION
5	04/07	JAG	14/15W, 4E, 6W FULL EXTRACT
6	03/08	JAG	ADDITIONAL FULL EXTRACTION ZERO NORTH
7	03/08	JAG	LIFE OF MINE FULL EXTRACTION
8	05/09	JAG	ZZ NORTH, ADJ. VS. PERMIT DEF. 3099
9	08/09	JAG	ZZ NORTH, MILLER CANYON LBA UTU-86038
10	04/10	JAG	ZZN WEDGE
11	02/17	JAG	e2 PHASE II ADDITIONAL PERMIT TASK #5362
12	01/19	JAG	RIGHT OF WAY EXPANSION

EarthFax

BASE MAP:
U.S.G.S 7.5 MINUTE QUADRANGLE'S. EMERY WEST 1968.
EMERY EAST 1968, PHOTO REVISED 1978.
MESA BUTTE 1968, PHOTO REVISED 1978.
WALKER FLATE 1968, PHOTO REVISED 1978.

COORDINATE SYSTEM:
STATE PLANE COORDINATES.
NAD 83 CONUS
ZONE 4302-UTAH, CENTRAL - US FEET
VERTICAL DATUM - NAVD 88-US FEET

ORIGINAL FIELD SURVEY:
3/80 AND REPORT 12/80 BY STOECKER-KEAMMERER AND ASSOC.

EXTERNAL REFERENCE:
G:\UC982\XREF-CURRENT\XREF-USGSMAP.DWG
G:\UC982\XREF-CURRENT\XREF-SECTION.DWG
G:\UC982\XREF-CURRENT\XREF-LOM.DWG
G:\UC1665\05\XREF\EMERY FINAL PERMIT-e2P2-OCT 17

0' 1000'
SCALE: 1" = 1000'
CONTOUR INTERVAL = 40'

DRAWN BY: SWF
CHECKED BY: JAG
APPROVED BY: JAG
ORIGINAL DATE: 8/95
RE-DRAWN DATE: 12/05
DWG DATA: G:\UC1665\05\PHASE II DWGS

EMERY MINE
EMERY COUNTY, UTAH
PERMIT NO.
ACT015/015

BRONCO UTAH OPERATIONS, LLC
P.O. BOX 527
PRICE, UT 84522

PLATE VIII-1
VEGETATION AND LANDUSE MAP

G:\UC1665 - Bronco Utah Operations\05 - Emery Mine permit maps\PHASE II DWGS\PLATE VIII-1-e2P2-Feb 19.dwg, 2/7/2019 1:38:35 PM