

**Bronco Utah Operations LLC**  
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March 14, 2017

VIA E-MAIL

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

C/015/0015  
Received 3/15/2017  
Task ID #5406

**RE: Bronco Utah Operations LLC  
Emery Mine  
DOGM Permit No. C/015/0015  
Phase II Additional Permit Boundary  
Additional Info Canyon Soil Salvage**

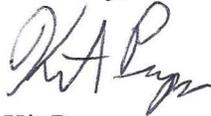
Mr. Haddock:

Per DOGM inspection report #5790 dated March 6, 2017, consider this a submittal of additional information regarding disturbed soil salvage in the canyon. Additional soil sampling was conducted in December 2016 to aid in topsoil salvage operations.

Executed C1 form, C2 form, and additional Appendix VII-6 (Soil Survey of the Emery Deep Mine – Canyon Disturbance Area, February 16, 2017) are included.

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

Sincerely,



Kit Pappas  
Environmental Manager

Attachments

## 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:** 015/0015

**Title:** e2 Phase II Additional Information Canyon Soil Disturbance Area

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

Salvage e2 Phase II Additional Permit Area

Additional info - Canyon Soil Salvage

3/2017

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

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

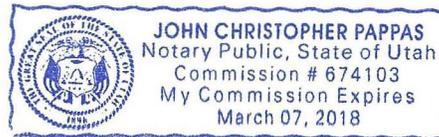
I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

DAVE R. BAKER  
Print Name

Dave R. Baker PRES. & CEO  
Sign Name, Position, Date 3/14/2017

Subscribed and sworn to before me this 14 day of MARCH, 2017

John C. Pappas  
Notary Public  
My commission Expires: UTAH 3-7, 2018 } ss:  
Attest: State of \_\_\_\_\_ }  
County of CARBON



**For Office Use Only:**

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## CHAPTER VII

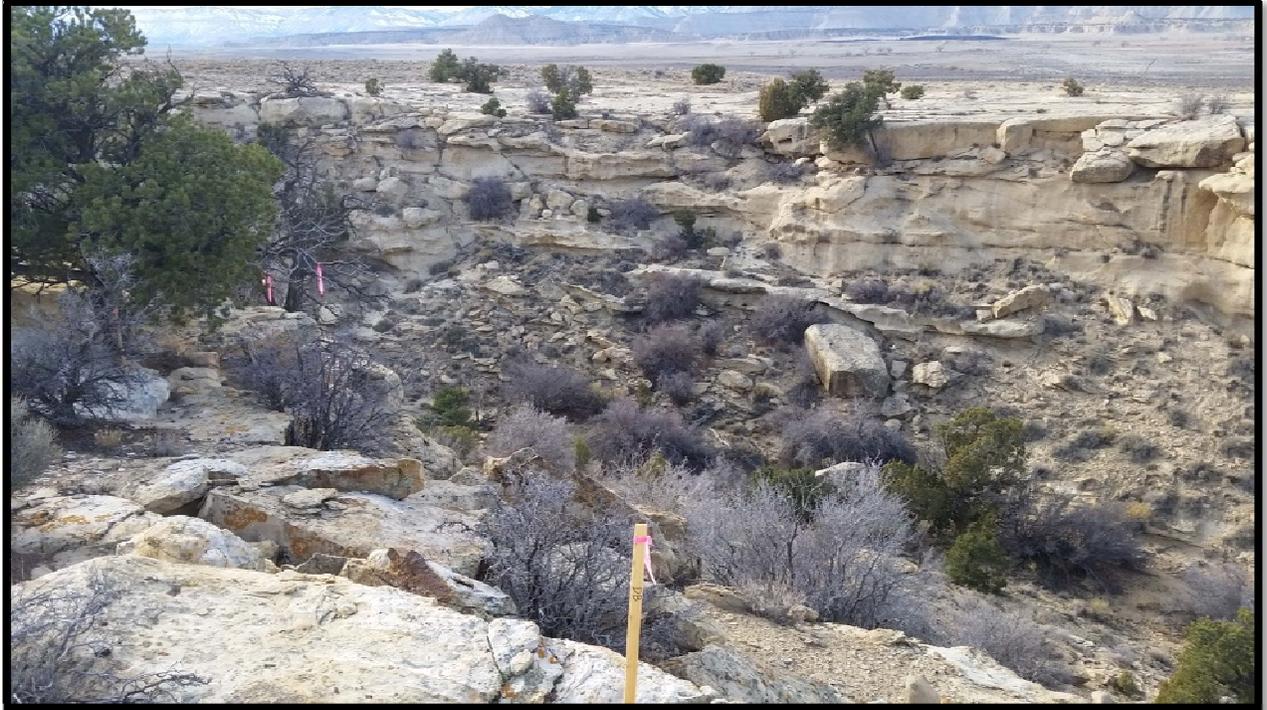
### SOILS

#### APPENDICES

- VII-1 TOPSOIL SUBSTITUTION PLAN, REVEGETATION DEMONSTRATION PLAN FOR AREAS AFFECTED PRIOR TO AUGUST 3, 1977
- VII-2 TOPSOIL SUBSTITUTION PLAN, PERMANENT UNDERGROUND DEVELOPMENT WASTE DISPOSAL SITE
- VII-3 BIOLOGICAL & SOIL RESOURCES AT THE 4<sup>TH</sup> EAST PORTAL AREA
- VII-4 LETTER FROM MT. NEBO CONSULTANTS – APPEND 1.5 AC. AREA TO 4<sup>TH</sup> EAST PORTAL AREA
- VII-5 ORDER 2 SOIL SURVEY OF EMERY 2 MINE PERMIT AREA (LONG RESOURCE CONSULTANTS DEC. 2016)
- VII-6 SOIL SURVEY OF THE EMERY DEEP MINE – CANYON DISTURBANCE AREA (LONG RESOURCE CONSULTANTS FEB. 2017)

Inserted 02/2017  
Revised 03/2017

**CHAPTER VII, APPENDIX VII-6**  
**Soil Survey of the Emery Deep Mine – Canyon Disturbance Area**



## **Soil Survey**

of the

## **Emery Deep Mine - Canyon Disturbance Area**

**Located near Emery, Utah**

Prepared for

**Bronco Utah Operations, LLC**

By

**Long Resource Consultants, Inc.**

**Morgan, Utah**

January 18, 2017

Revised February 16, 2017

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# Introduction

## Purpose of Soil Survey

Soils in the Emery Deep Canyon Disturbance Area (CDA) were previously identified as part of the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016). Soils were mapped in complexes and consociations. Alkaline (pH), saline (conductivity), sodic (SAR), and shallow soil limitations were identified by this soil survey.

The primary purpose of this soil survey was to conduct an in depth evaluation of topsoil and subsoil salvage depths within the Emery Deep CDA prior to construction. This evaluation will be used by the monitoring soil scientist and contractor during construction.

Topsoil and subsoil will be salvaged in the canyon at the commencement of construction of a new mine portal. Soils with *Unacceptable* pH, conductivity, or SAR levels will not be salvaged from the Emery Deep CDA. Soil pH and conductivity will be monitored in the field with a meter during construction.

This soil survey was conducted for the purpose of identifying areas of saline, sodic, and shallow soils within the Emery Deep CDA.

This soil survey does not include the proposed disturbance area on the top of the canyon within the Emery 2 Mine permit boundary (cliff scaling work area on east bench, berm on east bench, access road on west bench, and work area on west bench above the new portal).

## Project Area

The Emery Deep CDA soil survey consists of 6.9 acres within the Emery 2 permit area and 0.4 acres within the existing Emery mine permit area for a total of 7.3 acres. The Emery Deep CDA is shown in Figure 1.

## Climate

The climate of the soil survey is described in detail in the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016). Average annual precipitation at Emery, Utah is 7.33 inches and is evenly distributed throughout the year. The average annual air temperature at Emery, Utah is 46 °F.

The precipitation pattern borders between aridic and ustic aridic depending on aspect, slope, and physiographic setting. Soil temperature regime is mesic (USDA-NRCS 2016b).

## **How This Soil Survey was Conducted**

This soil survey was made in accordance with the guidelines for soil surveys as detailed in the Soil Survey Manual (USDA 1993). Soils were classified using the *Keys to Soil Taxonomy*, Twelfth Edition (USDA 2014). The number of holes described and sampled within the 7.3 acre canyon area qualify as an order 1 soil survey. The dominant soil sub-groups identified in the canyon by this soil survey are Lithic Ustic Torriorthents, Typic Torriorthents, Typic Haplocambids, and Typic Torrfluvents. Soil family names were correlated to soil series of the same using official soil series descriptions (NRCS 2016a). Field descriptions of the soil profiles are in appendix B.

## **Field Evaluation of Soils**

Seven soil profiles were hand dug, described, and sampled in the Emery Deep CDA. In addition, large areas of sandstone outcrop was identified and one soil profile was described and sampled just outside the disturbance area. These soil sample locations were dug, described, and sampled on December 13 and 14, 2016. Soil samples were placed in clean ZipLoc® freezer bags and sealed for shipment.

Soil profile descriptions were completed using the guidelines established in the Field Book for Describing and Sampling Soils (Schoenberger, et. al. 2012).

Soil color was evaluated on dry and moist samples using Munsell color charts (Munsell 2013).

Two soil profiles (EM-6-09 and EM-7-09) located within or immediately adjacent to the Emery Deep CDA soil survey were described and sampled as part of the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016). Soil descriptions, lab analysis, and photographs of these two locations are in the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016).

Two profile locations (EM-1-16 and EM-2-16) were described on June 9, 2016. Soil pH and conductivity were measured on these soils with a field instrument. Soil descriptions and photographs of these are in the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016).

## **Analysis of Soil Samples**

Soil samples collected in December 2016 were shipped to Inter Mountain Laboratories in Sheridan, Wyoming for analysis of pH, conductivity, sodium adsorption ratio, and soil texture in accordance with the procedures outlined in Table 3 of the *Guidelines for Management of Topsoil and Overburden* (Utah DOGM 2008).

The results of the December 2016 analysis are in appendix A.

Laboratory analysis results for the 2009 soil samples can be reviewed in the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016).

## Soils in Survey Area

### Soil Types

Five soil types were identified within or immediately adjacent to the Emery Deep CDA. Five of these soils were previously identified by the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016). The sixth soil type, Cheeta, contains more than 35 percent rock fragments and is similar to Hideout soils. Table 1 lists the taxonomic soil types identified in the Emery Deep CDA soil survey. The limiting features identified in soil profiles located within or immediately adjacent to the Emery Deep CDA are listed in Table 2.

Table 1. Taxonomic classification of soil types identified during the Emery Deep CDA soil survey.

Soil Series of Family	Taxonomic Classification <sup>1,2</sup>
Cheeta	Lithic Ustic Torriorthents loamy-skeletal, mixed, superactive, calcareous, mesic
Hideout	Lithic Ustic Torriorthents loamy, mixed, superactive, calcareous, mesic
Garley	Typic Torrfluvents, coarse-loamy, mixed, active, calcareous, mesic
Monue family	Typic Haplocambids, coarse-loamy, mixed, superactive, mesic
Persayo family	Typic Torriorthents loamy, mixed, active, calcareous, mesic, shallow

1. Classification based on *Keys to Soil Taxonomy*, Twelfth Edition (USDA 2014).
2. Series and family names obtained from Natural Resources Conservation Service web site (USDA 2016a).

Soil suitability ratings of *Good*, *Fair*, *Poor*, and *Unacceptable* used in this report to describe soils in the Emery Deep CDA are based on the *Guidelines for Management of Topsoil and Overburden* (Utah DOGM 2008).

Cheetah and Hideout soils have sandstone bedrock within 20 inches of the soil surface. These soils occur on sandstone structural benches on the very steep canyon sideslopes.

Garley and Monue family soils have depths ranging from approximately 30 to more than 60 inches. *Unacceptable* conductivity and SAR levels have been identified in both soils. These *Unacceptable* levels occur within one foot of the soil surface in Garley soils, but at depths greater than 40 inches in Monue family soils. Both soils are coarse textured. Soil pH in the *Poor* range has also been identified in both soils.

Persayo family soils have weathered shale bedrock within 20 inches of the soil surface. These soils occur on the very steep canyon sideslopes between the sandstone outcrops. Low soil pH (*Poor*) was identified in the upper subsoil in one soil profile.

Table 2. Limiting soil features in profiles located within or immediately adjacent to the Emery Deep CDA.

Soil Profile	Soil Type	Limiting Features <sup>1</sup>
EM-6-09	Persayo family	Weathering shale at 7 inches and very steep slope.
EM-8-09	Garley	<i>Unacceptable</i> sodic, saline, and pH soils below 4 inches.
EM-1-16	Monue family	None identified in upper 43 inches.
EM-2-16	Hideout	Shallow to sandstone at 7 inches; large boulders on surface.
16-EM-03	Cheeta (Hideout similar)	Shallow to sandstone at 17 inches; boulders and stones on surface; and very steep slope.
16-EM-04	Monue family	Sandstone at 34 inches; large rocks or bedrock at 34 inches; <i>Poor</i> pH in 6 to 17 inch horizon.
16-EM-05	Monue family	<i>Unacceptable</i> SAR and conductivity below 41 inches; and <i>Poor</i> pH in 8 to 19 inch horizon and below 41 inches.
16-EM-06	Sandstone Outcrop	Salvageable soil is in small pockets; shallow to sandstone; and very steep slopes.
16-EM-07	Monue family	None identified in upper 59 inches; some large boulders are present in this portion of the canyon bottom.
16-EM-08	Persayo family	<i>Unacceptable</i> pH below 8 inches; boulders and stones on surface; and very steep slope.
16-EM-09	Monue family	<i>Poor</i> conductivity below 9 inches; boulders stones on surface; sandstone bedrock at 31 inches; very steep slope.
16-EM-010	Monue family	Very large sandstone boulders.
16-EM-011	Hideout	Shallow to sandstone at 12 inches boulders and stones on surface; and very steep slope.
1. Suitability based on ranges listed <i>Guidelines for Management of Topsoil and Overburden</i> (Utah DOGM 2008).		

## Map Units

Soils in the Emery Deep CDA were mapped in the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016) with map units Ca and Cb. The components of these map units are listed in Table 3. Soil map unit Ca delineated soil features on the canyon sideslopes and Cb described the canyon bottom.

Table 3. Components of soil map units mapped in the Emery Deep CDA by the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016).

Map Unit	Component Percent	Soil Series or Taxonomic Family
Ca	<u>Persayo family - Rock Outcrop - Hideout complex, 3 to 80 percent slopes</u>	
	50	Persayo family
	20	Sandstone Outcrop
	15	Hideout
	8	Garley
	7	Monue family
Cb	<u>Monue family - Garley complex, 3 to 12 percent slopes</u>	
	60	Monue family
	30	Garley
	10	Begay family

The Ca and Cb soil map units have been separated into the units listed in Table 4 for the soil survey of the Emery Deep CDA. Surface area covered by the soil survey map units is listed in Table 5.

### ***Ca1 Persayo family, 3 to 80 percent slopes***

This map unit is dominated by Persayo family soils which are shallow to weathered shale. Soil profile 16EM08 is representative of Persayo soil in this map units. Surface boulders, stones, and flagstones are a dominant feature of this map unit.

### ***Ca2 Hideout family - Cheeta family complex, 3 to 80 percent slopes***

This map unit is dominated by Hideout and Cheeta soil families. Both soils are shallow to Ferron sandstone. Surface boulders, stones, and flagstones are a dominant feature of this map unit.

### ***Ca3 Sandstone Outcrops, 3 to 80 percent slopes***

This map unit consists of sandstone outcrops on the very steep canyon sideslopes.

***Cb1 Monue family - Garley complex, 3 to 12 percent slopes***

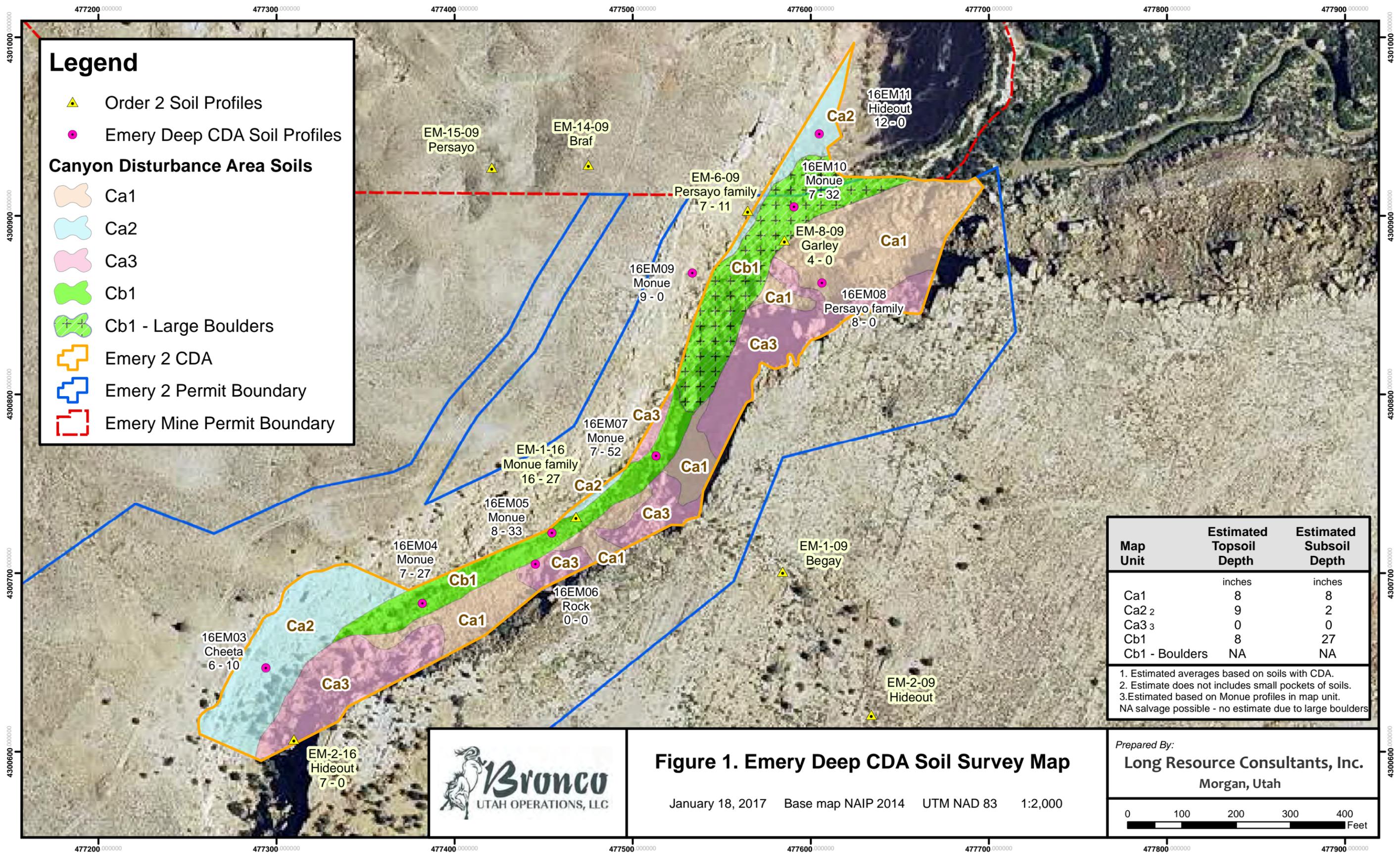
This map unit occurs on the canyon bottom of the Emery Deep CDA. These soils are typically greater than 40 inches deep. *Unacceptable* conductivity, pH, and SAR levels are present in these soils. Monue family soils are deeper to the *Unacceptable* saline and sodic material. Garley soils have *Unacceptable* conductivity, pH and SAR within one foot of the soil surface.

Table 4. Soil map units in the soil survey of the Emery Deep CDA.

Map Unit	Component Percent	Soil Series or Taxonomic Family	Modal Soil Profile
Ca1	<u>Persayo family, 3 to 80 percent slopes</u>		16EM08
	80	Persayo family	
	10	Hideout	
	10	Monue family	
Ca2	<u>Hideout - Cheeta complex, 3 to 80 percent slopes</u>		16EM11 16EM03 16EM03
	70	Hideout	
	15	Cheeta	
	5	Monue family	
	5	Persyao family	
	5	Sandstone outcrops	
Ca3	<u>Sandstone outcrops, 3 to 80 percent slopes</u>		16EM06 EM-2-16
	85	Sandstone outcrop	
	10	Hideout family	
	5	Persayo family	
Cb1	<u>Monue family - Garley complex, 3 to 12 percent slopes</u>		16EM05 EM-8-09
	80	Monue family	
	15	Garley	
	5	Sandstone boulders	

Table 5. Map unit acres in the soil survey of the Emery Deep CDA.

Soil Map Units					
Ca1	Ca2	Ca3	Cb1	Cb1 Boulders	Total
acres	acres	acres	acres	acres	acres
2.0	1.4	2.0	0.8	1.1	7.3



**Legend**

- Order 2 Soil Profiles
  - Emery Deep CDA Soil Profiles
- Canyon Disturbance Area Soils**
- Ca1
  - Ca2
  - Ca3
  - Cb1
  - Cb1 - Large Boulders
  - Emery 2 CDA
  - Emery 2 Permit Boundary
  - Emery Mine Permit Boundary

Map Unit	Estimated Topsoil Depth	Estimated Subsoil Depth
	inches	inches
Ca1	8	8
Ca2 <sub>2</sub>	9	2
Ca3 <sub>3</sub>	0	0
Cb1	8	27
Cb1 - Boulders	NA	NA

1. Estimated averages based on soils with CDA.  
 2. Estimate does not include small pockets of soils.  
 3. Estimated based on Monue profiles in map unit.  
 NA salvage possible - no estimate due to large boulders



**Figure 1. Emery Deep CDA Soil Survey Map**

January 18, 2017 Base map NAIP 2014 UTM NAD 83 1:2,000

Prepared By:  
**Long Resource Consultants, Inc.**  
 Morgan, Utah



# Topsoil and Subsoil Salvage

## Limiting Soil Features

Soil pH, salinity (conductivity), and sodic soils (SAR) are the primary limiting features for soils in the Emery Deep CDA.

The presence of stones and very large boulders on the surface will need to be taken into consideration when salvaging topsoil and subsoil. Steep canyon sideslopes slopes are also a feature that needs to be taken into account during salvage operations.

All salvage operations should be monitored by a Certified Professional Soil Scientist.

## Soil Profile Salvage Depths

Topsoil and subsoil salvage depths for each of the Emery Deep CDA soil profiles are listed in Table 6. These depths are based on the suitability ranges listed in Table 4 of the *Guidelines for Management of Topsoil and Overburden* (Utah DOGM 2008). Depths are based on not salvaging materials rated as *Unacceptable*. Average estimated salvage depths for the soil types are listed in Table 7.

### *Cheeta*

Cheeta soils are a *Fair* source of topsoil due to the shallow depth to sandstone and low available water capacities. These soils are geographically associated with large areas of Ferron sandstone outcrops. The estimated topsoil salvage depth is approximately 6 inches and estimated subsoil salvage depth is 10 inches based on soil profile 16EM03.

Physical and chemical characteristics of the Cheeta topsoil and subsoil are similar. They should be salvaged and stockpiled together as topsoil, if the thickness of the A horizon is less than 6 inches (Utah Code R645-301-200.232.300). The lower salvage depth for Cheeta soils is normally the transition to Ferron sandstone bedrock.

Salvage of these soils should be monitored by a *Certified Professional Soil Scientist*.

Table 6. Topsoil and subsoil salvage depths for soil profiles located within and immediately adjacent to the Emery CDA.

Soil Profile	Soil Type	Topsoil Salvage Depth	Subsoil Salvage Thickness
		Inches	inches
EM-6-09	Persayo family	7	11 <sup>1</sup>
EM-8-09	Garley	4	0 <sup>2,3</sup>
EM-1-16	Monue family	16	27 <sup>4</sup>
EM-2-16	Hideout	7	0 <sup>5</sup>
16-EM-03	Cheeta (Hideout similar)	6	10 <sup>5</sup>
16-EM-04	Monue family	7	27 <sup>5</sup>
16-EM-05	Monue family	8	33 <sup>2</sup>
16-EM-06	Sandstone Outcrop <sup>5,6</sup>	0	0
16-EM-07	Monue family	7	52 <sup>4</sup>
16-EM-08	Persayo family	8	0 <sup>1,4</sup>
16-EM-09	Monue family	9	0 <sup>5,7</sup>
16-EM-010	Monue family	7	32 <sup>4</sup>
16-EM-011	Hideout	12	0 <sup>4</sup>

1. Limited by depth to weathered shale.
2. Limited by depth to *Unacceptable* SAR.
3. Limited by depth to *Unacceptable* pH.
4. Thickness of subsoil salvage depth limited by depth of profile examination.
5. Limited by depth to sandstone.
6. Small pockets of Hideout, Cheeta, or Persayo family soils with sufficient depth and volume to salvage may be present.
7. Conductivities in the subsoil are in upper end of the *Poor* range. Monitoring of pH and conductivity in deep soils on the canyon sideslopes may identify small areas with salvageable subsoil.

### **Garley**

Garley soils are a *Poor* source of topsoil and an *Unacceptable* source of subsoil. The main limiting features of Garley soils, based on the *Guidelines for Management of Topsoil and Overburden* (Utah DOGM 2008), are: 1) *Unacceptable* SAR values that range from 15 to 49 (ESP 25 to 52 percent); 2) *Poor* electrical conductivity values ranging from 8.29 to 15.9 dS/m; 3) *Poor* pH values that correspond directly with the *Unacceptable* SAR levels in Garley soils; 4) loamy sand textures (*Poor*); and 5) *Poor* available water capacity due to the loamy sand textures.

Garley soils are a *Poor* source of topsoil and *Unacceptable* source of subsoil due to the SAR levels. The representative soil profile (EM-08-09) has 4 inches of topsoil with *Poor* SAR value in map unit Cb based on the loamy sand texture. The *Unacceptable* SAR level for coarse textured soil is 20 (DOGM 2008). These soils have developed from numerous fluventic depositions, so the chemical and physical characteristics may vary between locations.

SAR levels in the subsoil range from 32.2 to 48.7 in the 4 to 35 inch horizon of soil profile EM-08-09. These SAR levels are in excess of the *Unacceptable* level. Garley subsoil should not be salvaged or stockpiled with other salvaged subsoil materials which are suitable.

It will be difficult to salvage 4 inches of topsoil and not have some mixing with *Unacceptable* SAR soils. Salvage from areas with Garley soils should be closely monitored in the field by a *Certified Professional Soil Scientist*.

### **Hideout**

Hideout soils are a *Fair* source of topsoil due to the shallow depth to sandstone and low available water capacities. These soils are geographically associated with Ferron sandstone outcrops. The estimated topsoil salvage depth is limited to approximately 10 inches based on soil profiles EM-2-16 and 16EM11.

Physical and chemical characteristics of Hideout topsoil and subsoil are similar. They should be salvaged and stockpiled together as topsoil, if the A horizon is less than 6 inches thick (Utah Code R645-301-200.232.300). The lower salvage depth for Hideout soils is normally the transition to Ferron sandstone bedrock.

Salvage of these soils should be monitored by a *Certified Professional Soil Scientist*.

### **Monue family**

Monue family soils are a *Good* source of topsoil and *Good to Fair* source of subsoil. SAR and salinity levels are *Good to Fair* in the upper 34 to 40 inches based on Monue family profiles examined in the Emery Deep CDA. These soils have low available water capacities due to the sandy loam textures..

The estimated topsoil salvage depth for Monue Family soils is 9 inches based on the average depths of profiles examined within the Emery Deep CDA.

Estimated subsoil salvage is approximately 29 inches based on the representative soil profile, if deep disturbance is required. The separation between topsoil and subsoil is the transition between the A horizon and the Bw horizon (cambic).

Monue family soils are the primary source of topsoil and subsoil within the Emery Deep CDA. All suitable topsoil and subsoil should be salvaged. The lower subsoil that is of *Unacceptable* quality due to increased conductivity and/or SAR should not be salvaged. Salvage of these soils should be monitored by a *Certified Professional Soil Scientist*.

### ***Persayo family***

Persayo family soils are a *Good* source of topsoil and subsoil; but limited by the shallow depth to weathered shale, surface stones and boulders, and steep slopes. These soils are limited by low available water capacities. SAR and conductivity levels were *Good* in soil profile EM-6-09 and 16EM08. Soil pH was identified as *Unacceptable* (4.7) in the C horizon of 16EM08 which contained a large amount of shale parachanners. Soil with *Unacceptable* pH should be not be salvaged.

These soils are on very steep to extremely steep (45 to 80 percent) slopes which will be limiting to topsoil salvage operations.

The estimated topsoil salvage depth for Persayo family soils is limited by the depth to Mancos shale. The average topsoil salvage depth is 8 inches and the average subsoil salvage depth is 6 inches. If either the topsoil horizon is less than 6 inches thick, then all of the suitable soil should be salvaged as topsoil (Utah Code R645-301-200.232.300).

Salvage of these soils should be monitored by a *Certified Professional Soil Scientist*.

### ***Sandstone Outcrops***

The estimated topsoil and subsoil salvage depths for sandstone outcrop areas are zero. However, small pockets of Cheeta, Hideout, or Persayo families do occur amongst the larger Ferron sandstone outcrops. In some cases, it may be feasible to salvage soil from these areas. This determination should be made in the field between *Certified Professional Soil Scientist* and the construction contractor. If there are safety concerns, then the material will not be salvaged.

Table 7. Average estimated salvage depths for soil families in the Emery Deep CDA.

Soil Type	Topsoil Salvage Depth	Subsoil Salvage Depth	Total Salvage Depth
	Inches	Inches	inches
Cheeta	6	10	16
Garley	4	0	4
Hideout	10	0	10
Monue family	9	29	38
Persayo family	8	6	14
Sandstone outcrops	0	0	0

### Map Unit Salvage Depths

Weighted average topsoil and subsoil salvage depth estimates are listed by soil map unit in Table 8. Estimated map unit salvage depths are based on the component percents in Table 4 and the estimated average soil depths in Table 7. These estimates take minor soil inclusions into account. They are provided for planning purposes. Actual salvage depths will vary and will need to be monitored in the field by a *Certified Professional Soil Scientist*.

Table 8. Estimated average topsoil and subsoil salvage depths for map units in the Emery Deep CDA. Depths are provided for general reference, monitoring will be required.

Map Unit	Estimated Average Topsoil Salvage Depth	Estimated Average Subsoil Salvage Depth	Total Salvage Depth
	inches	inches	inches
Ca1	8	8	16
Ca2	9	2	11
Ca3 <sup>1</sup>	0	0	0
Cb1	8	27	35
Cb1 - Boulders <sup>2</sup>	8	27	35

1. It may be possible to salvage topsoil from small pockets of soil in this map unit. For planning purposes the average depths are estimated to be zero.
2. Topsoil salvage in this unit may vary widely.

Table 9 lists estimated salvage volumes for the Emery Deep CDA based on the map unit acres from Table 5 and the estimated average map unit salvage depths in Table 8. Volume estimates could not be made for the *Cb1 with boulders* area, due to the amount of very large boulders.

Table 9. Estimated topsoil and subsoil salvage volumes for the Emery Deep CDA.

Map Unit	Topsoil Salvage Volume <sup>1</sup> cubic yards	Subsoil Salvage volume <sup>2</sup> cubic yards	Total Salvage Volume <sup>3</sup> cubic yards
Ca1	2,151	2,151	4,302
Ca2	1,694	376	2,070
Ca3	0	0	0
Cb1	860	2,904	3,764
Cb1	NA	NA	NA
Totals	4,706	5,432	10,137

1. Weighted topsoil salvage volume for map unit is sum of products of map unit acres from Table 5 and estimated average map unit salvage depths from Table 8 and converted to cubic yards.
2. Weighted subsoil salvage volume for map unit is sum of products of map unit acres from Table 5 and estimated average salvage depths from Table 8 and converted to cubic yards.
3. Sum of weighted topsoil and subsoil volumes.

NA Salvage of topsoil and subsoil is possible, but an estimated quantity cannot be made due to the large boulders.

## Salvage Operations

### Determination of Salvage Suitability

The *Guidelines for Management of Topsoil and Overburden* (DOGM 2008) states in Table 4 that the *Unacceptable* SAR limit for coarse textured soils is 20. Garley and Monue family soils are coarse textured soils. The goal in the Emery Deep CDA will be to only salvage soils with a SAR of 10 or less, which is the Utah DOGM limit for *Fair* suitability (DOGM 2008). These salvage limits will facilitate the majority of the salvaged soil having a SAR of 10 or less.

Review of the lab analysis results indicates that there is a relationship between pH, conductivity, and SAR in the Emery Deep CDA. Table 10 lists the relationships that will be used to determine salvage suitability in the Emery Deep CDA. This relationship is based on soils sampled within or immediately adjacent to the Emery Deep CDA. SAR cannot be measured in the field.

The separation of conductivity at 3 dS/m and 8 dS/m applies to two samples with an 8.8 pH. The SAR in sample 16EM04 (7 to 17 inches) is 5.7 with a conductivity of 0.70 dS/m. The SAR in sample EM-8-09 (13 to 18 inches) is 28.5 with a conductivity of 3.91 dS/m. Conductivity of 8 dS/m is the DOGM limit for *Fair* suitability. Soil pH of 8.6 to 8.8 is in the *Poor* range (DOGM 2008). The amount of soil with *Poor* pH is anticipated to be limited based on the lab analysis.

The majority of the Monue family soil samples that will be salvaged in the Emery Deep CDA have a pH of 8.4 or less and a conductivity less than 8 dS/m. This occurred in 13 of 16 horizon samples or 81 percent. Ten of the 16 samples have a pH of 8.2 or less and a conductivity of 3 dS/m or less. The SAR in these 16 samples ranged from range from 0.24 to 7.24 with 13 samples having an SAR less than 4.

Table 10. Relationship between pH and conductivity (EC) in the Emery Deep CDA that will be used to determine the suitability of topsoil and subsoil for salvage. This relationship only applies to soils within the Emery Deep CDA, *except for the area mapped as Cb1 with boulders* (see Table 11).

Soil pH	EC ≤ 3 dS/m	EC < 3 dS/m and EC < 8 dS/m	EC ≥ 8 dS/m
pH < 8.8	Salvage	Salvage	Reject
pH = 8.8	Salvage	Reject	Reject
pH > 8.8	Reject	Reject	Reject

## **Monitoring Topsoil and Subsoil Salvage**

Soil pH and conductivity will be monitored in the field for all soils salvaged in the Emery Deep CDA. A meter that measures both pH and conductivity will be used to monitor pH and conductivity. The meter will be calibrated with standard solutions on a daily basis or more often as determined necessary by the Certified Professional Soil Scientist monitoring the topsoil and subsoil salvage. If there are safety concerns, then the soil will not be salvaged.

The following information identifies soil features that may be encountered in the soil map units. Inclusions of contrasting soils occur in each mapping unit and should be monitored during the salvage operations.

### ***Ca1***

Persayo family soils are shallow to weathered Mancos shale. Salvage is limited to the soil above the weathered shale. The weathered shale including soil with large amounts of parachanners should not be salvaged. Low soil pH was identified in the C horizon (8 to 13 inches) at sample location 16EM08.

Topsoil and subsoil should be salvaged as a single horizon, if the A horizon is less than 6 inches thick. The soil may be too shallow to feasibly salvage in some localized pockets.

### ***Ca2***

Hideout and Cheeta soils are shallow to Ferron sandstone. The depth of these soils varies from a few inches up to 20 inches in localized areas. Topsoil and subsoil should be salvaged as a single horizon, if the A horizon is less than 6 inches thick. The soil may be too shallow to feasibly salvage in some localized pockets.

### ***Ca3***

This map unit is dominated by Ferron sandstone outcrops. Topsoil and subsoil salvage is limited to small localized pockets of soil that are shallow to weathered shale or Ferron sandstone. Salvage of shallow soils in this map unit should be handled as described in Ca1 and Ca2 above.

### ***Cb1***

This map unit is dominated by very deep coarse textured soils (Monue family and Garley). Three Monue family profiles were described within this map unit delineation (0.8 acres) and did not have any limitations above 41 inches, except for sandstone bedrock at one location (16EM04). One additional Monue family profile (16EM01) that meets this criteria was described (field analysis of pH and conductivity) in the Cb1 area as part of the *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016).

*Unacceptable* SAR was identified in soil profile 16EM05 below 41 inches.

Based on the lab analysis, soils in the upper canyon above the large boulder field, are acceptable for salvage to an estimated average depth of 39 inches or sandstone bedrock, whichever occurs first. All suitable Monue family soils should be salvaged.

Garley soils were not identified in the upper portion of the CDA.

Conductivity and pH should be monitored. Soils with conductivity less than 8.0 dS/m and pH of 8.8 or less will be suitable for salvage in the Cb1 area.

### ***Cb1 with Boulders***

Soils in the lower canyon were mapped as *Cb1 with boulders*. This area is dominated by very large boulders. Salvage depths are estimated to be similar to the Cb1 map unit, but limited to the Monue family soils. Volume estimates could not be made, due to the amount of very large boulders. The delineation of this map unit is approximately 1.1 acres.

Both Garley (EM-8-09) and Monue family (16EM-10) soils were identified in the lower end of the canyon. These profiles were identified on opposite sides of the draw, approximately 64 feet apart. Soil pH is less than 8.0 and conductivity is less than 5 dS/m in the Monue family profile (16EM-10) to 39 inches.

Soil in this area will only be salvaged if the pH is less than or equal to 8.5 and the conductivity is less than 8 dS/m, Table 11. These salvage restrictions are intended to reduce the amount of Garley subsoil salvaged in the lower portion of the canyon. Based on the lab results these lower limits will facilitate the majority of the salvaged soil having a SAR of 10 or less. Utah DOGM limits for *Fair* suitability are pH less than or equal to 8.5 and conductivity less than or equal to 8 dS/m (DOGM 2008).

Table 11. Relationship between pH and conductivity that will be used in the area mapped as *Cb1 with boulders* in the Emery Deep CDA to determine the suitability of topsoil and subsoil for salvage. This relationship only applies to soils mapped as *Cb1 with boulders*.

Soil pH	EC < 8.0 dS/m	EC ≥ 8.0 dS/m
pH ≤ 8.5	Salvage	Reject
pH > 8.5	Reject	Reject

Salvage from the *Cb1 with boulders* area may be limited to the 16EM10 sample location. A large portion of this area has been eroded and covered with very large boulders. Monitoring of soil pH and conductivity may identify additional areas suitable for salvage. All suitable topsoil and subsoil should be salvaged.

## Literature Cited

Long, Robert E. December 2016. Order 2 Soil Survey of Emery 2 Mine Permit Area.

Munsell Soil Color Charts. 2013.

Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Soil Survey Staff . September 2012. *Field book for describing and sampling soils*, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

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USDA – Natural Resources Conservation Service (USDA), 2016b (spatial and tabular files downloaded September 2016). Web Soil Survey – Emery Area, Utah, Parts of Emery, Carbon, Grand, and Sevier Counties. <http://websoilsurvey.nrcs.usda.gov/app/>

Utah Division of Oil Gas and Mining (DOG M), January 2008. *Guidelines for Management of Topsoil and Overburden*. Salt Lake City, Utah.

# **Appendix A**

## **Laboratory Analysis**

Table A-1. Summary of lab analysis for samples collected in Emery 2 CDA on December 13 and 14, 2016.

SampleID	Begin	End	Begin	End	pH	Electrical		Clay	Texture
	Depth	Depth	Depth	Depth		Conductivity	SAR		
	cm	cm	inches	inches	s.u.	dS/m		%	
16EM03	0	16	0.0	6.3	8.0	2.44	0.72	14.0	Loam
16EM03	16	43	6.3	16.9	8.0	2.56	0.68	10.0	Sandy Loam
16EM04	0	17	0.0	6.7	8.2	0.77	1.70	6.0	Sandy Loam
16EM04	17	44	6.7	17.3	8.8	0.70	5.70	6.0	Loamy Sand
16EM04	44	86	17.3	33.9	8.4	7.30	7.24	9.0	Sandy Loam
16EM05	0	20	0.0	7.9	8.0	1.09	0.38	10.0	Sandy Loam
16EM05	20	48	7.9	18.9	8.7	0.59	3.87	10.0	Sandy Loam
16EM05	48	80	18.9	31.5	7.9	2.76	1.31	10.0	Sandy Loam
16EM05	80	105	31.5	41.3	8.1	5.05	5.44	9.0	Loamy Sand
16EM05	105	160	41.3	63.0	8.4	9.16	25.0	6.0	Loamy Sand
16EM07	0	18	0.0	7.1	8.0	0.71	1.18	6.0	Sand
16EM07	18	38	7.1	15.0	8.0	0.37	0.29	5.0	Sand
16EM07	38	64	15.0	25.2	8.1	0.40	0.32	6.0	Sand
16EM07	64	100	25.2	39.4	7.9	2.10	0.34	8.0	Loamy Sand
16EM07	100	150	39.4	59.1	8.0	1.92	0.37	7.0	Loamy Sand
16EM08	0	20	0.0	7.9	7.3	2.18	0.59	14.0	Sandy Loam
16EM08	20	34	7.9	13.4	4.7	3.14	0.20	23.0	Loam
16EM08	34	60	13.4	23.6	6.5	4.31	0.13	25.0	Loam
16EM09	0	23	0.0	9.1	7.7	4.10	3.03	12.0	Loamy Sand
16EM09	23	54	9.1	21.3	7.4	12.0	2.78	12.0	Sandy Loam
16EM09	54	80	21.3	31.5	7.6	13.3	2.90	18.0	Sandy Loam
16EM10	0	17	0.0	6.7	7.9	0.64	0.24	8.0	Loamy Sand
16EM10	17	40	6.7	15.7	7.9	1.13	0.28	8.0	Sandy Loam
16EM10	40	74	15.7	29.1	7.8	3.38	1.37	8.0	Sandy Loam
16EM10	74	100	29.1	39.4	7.7	4.92	3.53	14.0	Sandy Loam
16EM11	0	30	0.0	11.8	8.0	2.75	2.56	12.0	Sandy Loam

DOGM Suitability

Good			Fair	Poor
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**Date:** 12/29/2016

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**CLIENT:** Bronco Utah Operations, LLC  
**Project:** Emery 2 Canyon Construction  
**Lab Order:** S1612225

**CASE NARRATIVE**  
**Report ID:** S1612225001

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Samples 16EM03, 16EM04, 16EM05, 16EM07, 16EM08, 16EM09, 16EM10, and 16EM11 were received on December 19, 2016.

Samples were analyzed using the methods outlined in the following references:

U.S.E.P.A. 600/2-78-054 "Field and Laboratory Methods Applicable to Overburden and Mining Soils", 1978  
American Society of Agronomy, Number 9, Part 2, 1982  
USDA Handbook 60 "Diagnosis and Improvement of Saline and Alkali Soils", 1969  
Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 1, 1984  
New Mexico Overburden and Soils Inventory and Handling Guideline, March 1987  
State of Utah, Division of Oil, Gas, and Mining: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988  
Montana Department of State Lands, Reclamation Division: Soil, Overburden, and Regraded Spoil Guidelines, December 1994  
State of Nevada Modified Sobek Procedure  
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition

All Quality Control parameters met the acceptance criteria defined by EPA and Inter-Mountain Laboratories except as indicated in this case narrative.

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Reviewed by: *Karen A Secor*

Karen Secor, Soil Lab Supervisor



**Soil Analysis Report**  
**Bronco Utah Operations, LLC**

Report ID: S1612225001

Project: Emery 2 Canyon Construction

P.O. Box 527  
 550 West Consol Mine Road  
 Emery, UT 84522

Date Reported: 12/29/2016

Date Received: 12/19/2016

Work Order: S1612225

Lab ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical	Calcium	Magnesium	Potassium	Sodium	SAR
					Conductivity dS/m	PE meq/L	PE meq/L	PE meq/L	PE meq/L	
S1612225-001	16EM03	0-16	8.0		2.44	30.6	6.97	2.12	3.10	0.72
S1612225-002	16EM03	16-43	8.0		2.56	24.3	7.34	1.89	2.69	0.68
S1612225-003	16EM04	0-17	8.2		0.77	1.83	1.39	1.44	2.15	1.70
S1612225-004	16EM04	17-44	8.8		0.70	1.14	0.49	0.33	5.15	5.70
S1612225-005	16EM04	44-86	8.4		7.30	18.0	64.5	1.34	46.5	7.24
S1612225-006	16EM05	0-20	8.0		1.09	7.77	2.23	1.96	0.85	0.38
S1612225-007	16EM05	20-48	8.7		0.59	1.49	0.43	0.15	3.79	3.87
S1612225-008	16EM05	48-80	7.9		2.76	24.6	8.27	0.05	5.32	1.31
S1612225-009	16EM05	80-105	8.1		5.05	23.7	25.6	0.25	27.0	5.44
S1612225-010	16EM05	105-160	8.4	30.6	9.16	22.9	18.0	0.49	113	25.0
S1612225-011	16EM07	0-18	8.0		0.71	3.47	0.90	1.68	1.75	1.18
S1612225-012	16EM07	18-38	8.0		0.37	2.91	0.61	0.20	0.38	0.29
S1612225-013	16EM07	38-64	8.1		0.40	3.03	0.79	0.26	0.44	0.32
S1612225-014	16EM07	64-100	7.9		2.10	25.9	3.66	0.34	1.31	0.34
S1612225-015	16EM07	100-150	8.0		1.92	20.9	3.65	0.30	1.30	0.37
S1612225-016	16EM08	0-20	7.3		2.18	23.3	5.71	0.36	2.26	0.59
S1612225-017	16EM08	20-34	4.7		3.14	21.8	33.2	0.30	1.07	0.20
S1612225-018	16EM08	34-60	6.5		4.31	19.7	51.5	0.12	0.77	0.13
S1612225-019	16EM09	0-23	7.7		4.10	22.2	22.6	2.38	14.3	3.03
S1612225-020	16EM09	23-54	7.4		12.0	19.1	210	0.34	29.7	2.78

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by:

*Karen A Secor*

Karen Secor, Soil Lab Supervisor



**Soil Analysis Report**  
**Bronco Utah Operations, LLC**

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P.O. Box 527  
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Date Reported: 12/29/2016

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Lab ID	Sample ID	Depths cm	pH s.u.	Saturation %	Electrical	Calcium	Magnesium	Potassium	Sodium	SAR
					Conductivity dS/m	PE meq/L	PE meq/L	PE meq/L	PE meq/L	
S1612225-021	16EM09	54-80	7.6		13.3	19.3	236	0.63	32.7	2.90
S1612225-022	16EM10	0-17	7.9		0.64	2.83	1.82	0.64	0.37	0.24
S1612225-023	16EM10	17-40	7.9		1.13	11.0	1.78	0.58	0.70	0.28
S1612225-024	16EM10	40-74	7.8		3.38	29.1	21.4	0.32	6.90	1.37
S1612225-025	16EM10	74-100	7.7		4.92	26.3	40.7	0.32	20.5	3.53
S1612225-026	16EM11	0-30	8.0		2.75	24.2	6.48	1.17	10.0	2.56

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor  
Karen Secor, Soil Lab Supervisor



Soil Analysis Report
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Table with 11 columns: Lab ID, Sample ID, Depths (cm), Sand (%), Silt (%), Clay (%), Texture, CEC (meq/100g), Available Sodium (meq/100g), Exchangeable Sodium (meq/100g), ESP (%). Rows include sample IDs S1612225-001 through S1612225-020.

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor



**Soil Analysis Report**  
**Bronco Utah Operations, LLC**

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P.O. Box 527  
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Date Reported: 12/29/2016

Date Received: 12/19/2016

Work Order: S1612225

Lab ID	Sample ID	Depths cm	Sand %	Silt %	Clay %	Texture	CEC meq/100g	Available	Exchangeable	ESP %
								Sodium meq/100g	Sodium meq/100g	
S1612225-021	16EM09	54-80	68.0	14.0	18.0	Sandy Loam				
S1612225-022	16EM10	0-17	78.0	14.0	8.0	Loamy Sand				
S1612225-023	16EM10	17-40	74.0	18.0	8.0	Sandy Loam				
S1612225-024	16EM10	40-74	72.0	20.0	8.0	Sandy Loam				
S1612225-025	16EM10	74-100	68.0	18.0	14.0	Sandy Loam				
S1612225-026	16EM11	0-30	72.0	16.0	12.0	Sandy Loam				

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor  
Karen Secor, Soil Lab Supervisor

# **Appendix B**

## **Soil Profile Descriptions**

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16EM09 - Monue family .....	14
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## Additional Soil Profiles

Four soil profiles were described in the Emery 2 Canyon Disturbance Area (CDA) as part of the order 2 soil survey. Descriptions for these profiles are in appendix B of *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2016). These profile locations are listed below and shown on Figure 1. Lab analysis data for EM-6-09 and EM-8-09 is in appendix C of *Order 2 Soil Survey of Emery 2 Mine Permit Area* (Long 2008).

EM-6-09	Persayo family
EM-8-09	Garley
16EM-01	Monue family
16EM02	Hideout

## 16EM03 - Cheeta

**Pedon ID:** 16EM03

**Description Date:** 12/13/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Cheeta

**Current Taxonomic Class:** Loamy-skeletal, mixed, superactive, calcareous, mesic  
Lithic Ustic Torriorthents

**Pedon Type:** Correlates to named soil

**Current Taxon Kind:** Series

**Pedon Notes:** this soil profile is similar to the Hideout soils mapped in the canyon, except for a C horizon dominated by weathered sandstone channers. Cheeta family soils are similar to Hideout soils, but have greater than 35 percent rock fragments.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477294.1E, 4300646.9N -- Datum NAD83, Zone 12

**Location Description:**

**Legal Description:** Section 32, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** canyon bench

**Geomorphic Component:** Side Slope

**Profile Pos:** Backslope

**Slope:** 69 percent

**Elevation:** 1833.3 meters (6014.8 feet)

**Aspect:** 130

**Shape: up/down:** Convex; **across:** Convex

**Drainage:** Well drained

**Runoff:** Very high

**Erosion:** Class 3 - Rill erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** ACHY - Indian ricegrass (*Achnatherum hymenoides*); EPHEd - Mormon tea (*Ephedra*); CEMOG - birchleaf mountain mahogany (*Cercocarpus montanus var. glaber*); SAVE4 - black greasewood (*Sarcobatus vermiculatus*); ATCO - shadscale saltbush (*Atriplex confertifolia*)

**Parent Materials:** moderately weathered, residuum weathered from sandstone and shale and/or slightly weathered, residuum weathered from sandstone over strongly weathered, colluvium derived from sandstone and shale

**Bedrock:** Strongly cemented sandstone at 43 centimeters (16.9 inches)

**Particle Size Control Section:** 25 to 43 centimeters (9.8 to 16.9 inches)

**Diagnostic Features:** Lithic contact: 43 centimeters (16.9 inches)

**Restrictions:** Lithic bedrock: 43 centimeters (16.9 inches)

**Surface Fragments:** 3 percent boulders, 5 percent stones, 15 percent gravels, 15 percent flags, and 5 percent channers. Fragments are sandstone.

**A** --- 0 to 16 centimeters (0 to 6.3 inches); pale yellow (2.5Y 7/3) dry, channery loam; light olive brown (2.5Y 5/3) moist; 44 percent sand; 42 percent silt; 14 percent clay; weak medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic finely disseminated carbonates; 30 percent angular sandstone channers; electrical conductivity of 2.44 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; clear smooth boundary; SAR 0.72.

**2C** --- 16 to 43 centimeters (6.3 to 16.9 inches); pale brown (10YR 6/3) dry, extremely channery sandy loam; brown (10YR 5/3) moist; 74 percent sand; 16 percent silt; 10 percent clay; single grain; very friable, slightly hard, nonsticky, nonplastic; 5 percent (few) carbonate coats on bottom surfaces of rock fragments; 10 percent shale parachanners and 70 percent sandstone channers; electrical conductivity of 2.56 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; alternating layers of weathered shale and sandstone; abrupt smooth boundary; SAR 0.68.

**2R** --- 43 centimeters (16.9 inches); sandstone.

**Estimated Salvage Depth:** topsoil 17 cm (6 inches) thick (A horizon); subsoil 27 cm (10 inches) thick (2C horizon).

**Salvage Limitations:** shallow depth to sandstone; boulders and stones on surface; and very steep slopes.

## 16EM04 - Monue family

**Pedon ID:** 16EM04

**Description Date:** 12/30/2016 8:44:42 PM

**Describer:** Robert Long

**Soil Name As Correlated:** Monue family

**Current Taxonomic Class:** Coarse-loamy, mixed, superactive, mesic Typic  
Haplocambids

**Pedon Type:** Correlates to named soil

**Current Taxon Kind:** Family

**Pedon Notes:** moderately deep Monue family soil profile.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477381.9E, 4300683.1N -- Datum NAD83, Zone 12

**Location Description:**

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** stream terrace

**Geomorphic Component:** Base Slope

**Profile Pos:** Toeslope

**Slope:** 9 percent

**Elevation:** 1820.3 meters (5972.1 feet)

**Aspect:** 350°

**Shape: up/down:** Convex; **across:** Linear

**Drainage:** Well drained

**Runoff:** Medium

**Erosion:** Class 3 - Sheet erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** CHRYS9 - rabbitbrush (*Chrysothamnus*); SAVE4 - black greasewood (*Sarcobatus vermiculatus*); ACHY - Indian ricegrass (*Achnatherum hymenoides*); GUTIE - snakeweed (*Gutierrezia*); ATCO - shadscale saltbush (*Atriplex confertifolia*); CEMOG - birchleaf mountain mahogany (*Cercocarpus montanus var. glaber*)

**Parent Materials:** slope alluvium derived from sandstone and shale

**Bedrock:** Sandstone at 86 centimeters (33.9 inches)

**Particle Size Control Section:** 25 to 86 centimeters (9.8 to 33.9 inches)

**Diagnostic Features:** Secondary carbonates: 44 to 86 centimeters (17.3 to 33.9 inches) and Lithic contact: 86 centimeters (33.9 inches)

**Restrictions:** Lithic bedrock: 86 centimeters (33.9 inches)

**Surface Fragments:** 3 percent sandstone gravels.

**A** --- 0 to 17 centimeters (0 to 6.7 inches); very pale brown (10YR 7/3) dry, sandy loam; brown (10YR 4/3) moist; 74 percent sand; 20 percent silt; 6 percent clay; weak medium subangular blocky structure; very friable, hard, nonsticky, nonplastic; 5 percent subangular sandstone gravels; electrical conductivity of 0.77 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8.2, pH meter; clear smooth boundary; SAR 1.7.

**Bw** --- 17 to 44 centimeters (6.7 to 17.3 inches); very pale brown (10YR 7/3) dry, loamy sand; yellowish brown (10YR 5/4) moist; 82 percent sand; 12 percent silt; 6 percent clay; moderate medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; electrical conductivity of 0.7 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; strongly alkaline, pH 8.8, pH meter; clear smooth boundary; SAR 5.7.

**Ck** --- 44 to 86 centimeters (17.3 to 33.9 inches); very pale brown (10YR 7/4) dry, sandy loam; light yellowish brown (10YR 6/4) moist; 72 percent sand; 19 percent silt; 9 percent clay; massive parting to single grain; very friable, slightly hard, nonsticky, nonplastic; 3 percent (very few) carbonate coats on bottom surfaces of rock fragments; 5 percent (common) fine threadlike masses of carbonate in matrix; 5 percent subangular sandstone gravels; electrical conductivity of 7.3 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8.4, pH meter; abrupt smooth boundary; SAR 7.24.

**R** --- 86 centimeters (33.9 inches); sandstone bedrock or large boulder).

**Estimated Salvage Depth:** topsoil 17 cm (7 inches) thick (A horizon); and subsoil 69 cm (27 inches) thick (Bw and Ck horizons).

**Salvage Limitations:** pH of the cambic horizon (Bw, 17 to 44 cm) is in the *Poor* range and will require monitoring to ensure that *Unacceptable* material is not salvaged; depth to sandstone.

## 16EM05 - Monue family

**Pedon ID:** 16EM05

**Description Date:** 12/13/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Monue family

**Current Taxonomic Class:** Coarse-loamy, mixed, superactive, mesic Typic  
Haplocambids

**Pedon Type:** Correlates to named soil

**Current Taxon Kind:** Family

**Pedon Notes:** this soil profile is similar to Monue family profile previously described in the Emery 2 soil survey.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477454.7E, 4300722.4N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** stream terrace

**Geomorphic Component:** Base Slope

**Profile Pos:** Toeslope

**Slope:** 7 percent

**Elevation:** 1820 meters (5971.1 feet)

**Aspect:** 310°

**Shape: up/down:** Linear; **across:** Convex

**Drainage:** Well drained

**Runoff:** Medium

**Erosion:** Class 2 - Gully erosion

**Primary Earth Cover:** Shrub cover

**Existing Vegetation:** ATCA2 - fourwing saltbush (*Atriplex canescens*); GUTIE - snakeweed (*Gutierrezia*); ACHY - Indian ricegrass (*Achnatherum hymenoides*); BRTE - cheatgrass (*Bromus tectorum*); OPPO - plains pricklypear (*Opuntia polyacantha*); ARNO4 - black sagebrush (*Artemisia nova*)

**Parent Materials:** alluvium derived from sandstone and shale

**Particle Size Control Section:** 25 to 100 centimeters (9.8 to 39.4 inches)

**Diagnostic Features:** Secondary carbonates: 48 to 160 centimeters (18.9 to 63 inches)

**Surface Fragments:** 10 percent boulders, 10 percent stones, 5 percent cobbles, 15 percent gravels, and 10 percent channers. Fragments are sandstone.

**A** --- 0 to 20 centimeters (0 to 7.9 inches); light yellowish brown (10YR 6/4) dry, sandy loam; yellowish brown (10YR 5/4) moist; 74 percent sand; 16 percent silt; 10 percent clay; weak medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; 5 percent subangular sandstone gravels; electrical conductivity of 1.09 mmhos/cm by EC meter, saturated paste; by HCl, 1 normal; moderately alkaline, pH 8, pH meter; clear smooth boundary; SAR 0.38.

**Bw** --- 20 to 48 centimeters (7.9 to 18.9 inches); very pale brown (10YR 7/4) dry, gravelly sandy loam; yellowish brown (10YR 5/4) moist; 78 percent sand; 12 percent silt; 10 percent clay; moderate medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout; 2 percent (very few) carbonate coats on bottom surfaces of rock fragments; 20 percent subangular sandstone gravels; electrical conductivity of 0.59 mmhos/cm by EC meter, saturated paste; by HCl, 1 normal; strongly alkaline, pH 8.7, pH meter; gradual smooth boundary; SAR 3.87.

**Bk1** --- 48 to 80 centimeters (18.9 to 31.5 inches); very pale brown (10YR 7/4) dry, gravelly sandy loam; yellowish brown (10YR 5/4) moist; 78 percent sand; 12 percent silt; 10 percent clay; moderate medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout; 5 percent (few) carbonate coats on bottom surfaces of rock fragments finely disseminated carbonates; 15 percent subangular sandstone gravels; electrical conductivity of 2.76 mmhos/cm by EC meter, saturated paste; by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; gradual smooth boundary; SAR 1.31.

**Bk2** --- 80 to 105 centimeters (31.5 to 41.3 inches); very pale brown (10YR 7/4) dry, gravelly loamy sand; yellowish brown (10YR 5/4) moist; 82 percent sand; 9 percent silt; 9 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common very fine roots throughout; 4 percent (very few) carbonate coats on bottom surfaces of rock fragments; 5 percent (common) medium masses of carbonate in matrix; 15 percent subangular sandstone gravels; electrical conductivity of 5.05 mmhos/cm by EC meter, saturated paste; by HCl, 1 normal; moderately alkaline, pH 8.1, pH meter; gradual smooth boundary; SAR 5.44.

**Bk3** --- 105 to 160 centimeters (41.3 to 63 inches); very pale brown (10YR 7/3) dry, very gravelly loamy sand; pale brown (10YR 6/3) moist; 82 percent sand; 12 percent silt; 6 percent clay; single grain; very friable, soft, nonsticky, nonplastic; common very fine roots throughout; 8 percent (few) carbonate coats on bottom surfaces of rock fragments; 8 percent (common) fine threadlike masses of carbonate in matrix; 5 percent nonflat subangular 76 to 250 millimeters (3 to 10 inches) sandstone fragments and 35 percent nonflat subangular 2 to 76 millimeters (0.1 to 3 inches) sandstone fragments; electrical conductivity of 9.16 mmhos/cm by EC meter, saturated paste; by HCl, 1 normal; moderately alkaline, pH 8.4, pH meter; SAR 25.

**Estimated Salvage Depth:** topsoil 20 cm (8 inches) thick (A horizon); and subsoil 85 cm (33 inches) thick (Bk1 and Bk2 horizons).

**Salvage Limitations:** pH of the cambic horizon (Bw, 20 to 48 cm or 8 to 19 inches) is in the *Poor* range and will require monitoring to ensure that *Unacceptable* material is not salvaged; conductivity is *Poor* and SAR is *Unacceptable* below 105 cm (41 inches) and should not be salvaged; boulders and stones on surface.

## 16EM06 - Rock Outcrop

**Pedon ID:** 16EM06

**Description Date:** 12/13/2016

**Describer:** Robert Long

**Site Notes: Text:** This site is located on a very steep northwest facing canyon sideslope. The area is approximately 75 percent rock outcrop, 15 percent Hideout soils, and 10 percent Persayo family soils. It is estimated that there will be very little to no salvageable topsoil or subsoil in this area, based on the small pockets of shallow soils.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477445.5E, 4300704.9N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** canyon wall

**Geomorphic Component:** Free face

**Profile Pos:** Backslope

**Slope:** 44 percent

**Elevation:** 1827.1 meters (5994.4 feet)

**Aspect:** 315°

**Shape: up/down: ; across:**

**Drainage:** Well drained

**Runoff:** Very high

**Estimated Salvage Depth:** Limited to small pockets of Hideout family soils (shallow).

**Salvage Limitations:** sandstone outcrops; and very steep slopes.

## 16EM07 - Monue family sandy taxadjunct

**Pedon ID:** 16EM07

**Description Date:** 12/13/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Monue family sandy taxadjunct

**Current Taxonomic Class:** Sandy, mixed, superactive, mesic Typic Haplocambids

**Current Taxon Kind:** Family

**Pedon Notes:** profile is similar to Monue family profile, but the textures are sand and loamy sand.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477513.7E, 4300765.5N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** stream terrace

**Geomorphic Component:** Base Slope

**Profile Pos:** Toeslope

**Slope:** 8 percent

**Elevation:** 1820.7 meters (5973.4 feet)

**Aspect:** 300°

**Shape: up/down:** Concave; **across:** Concave

**Drainage:** Well drained

**Runoff:** High

**Erosion:** Class 2 - Gully erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** SAVE4 - black greasewood (*Sarcobatus vermiculatus*); ATCA2 - fourwing saltbush (*Atriplex canescens*); BRTE - cheatgrass (*Bromus tectorum*)

**Parent Materials:** alluvium derived from sandstone and shale

**Particle Size Control Section:** 25 to 100 centimeters (9.8 to 39.4 inches)

**Diagnostic Features:** Secondary carbonates: 18 to 150 centimeters (7.1 to 59.1 inches) and Cambic horizon: 18 to 38 centimeters (7.1 to 15 inches)

**Surface Fragments:** 15 percent gravels and 5 percent channers. Fragments are sandstone.

- A** --- 0 to 18 centimeters (0 to 7.1 inches); very pale brown (10YR 7/3) dry, sand; light yellowish brown (10YR 6/4) moist; 88 percent sand; 6 percent silt; 6 percent clay; weak medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common fine roots throughout and common very fine roots throughout; 5 percent subangular sandstone gravels; electrical conductivity of 0.71 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; clear smooth boundary; SAR 1.18.
- Bw** --- 18 to 38 centimeters (7.1 to 15 inches); very pale brown (10YR 7/4) dry, sand; yellowish brown (10YR 5/4) moist; 90 percent sand; 5 percent silt; 5 percent clay; weak medium subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout finely disseminated carbonates; electrical conductivity of 0.37 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; gradual smooth boundary; SAR 0.29.
- C** --- 38 to 64 centimeters (15 to 25.2 inches); very pale brown (10YR 7/4) dry, sand; light yellowish brown (10YR 6/4) moist; 92 percent sand; 2 percent silt; 6 percent clay; single grain; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout finely disseminated carbonates; electrical conductivity of 0.4 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8.1, pH meter; clear wavy boundary; SAR 0.32.
- 2Ck1** --- 64 to 100 centimeters (25.2 to 39.4 inches); light yellowish brown (10YR 6/4) dry, very gravelly loamy sand; yellowish brown (10YR 5/4) moist; 82 percent sand; 10 percent silt; 8 percent clay; single grain; loose, loose, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; 6 percent (few) carbonate coats on bottom surfaces of rock fragments finely disseminated carbonates; 10 percent subangular sandstone channers and 30 percent subangular sandstone gravels; electrical conductivity of 2.1 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; gradual smooth boundary; SAR 0.34.
- 2Ck2** --- 100 to 150 centimeters (39.4 to 59.1 inches); very pale brown (10YR 7/4) dry, extremely gravelly loamy sand; yellowish brown (10YR 5/4) moist; 86 percent sand; 7 percent silt; 7 percent clay; single grain; loose, loose, nonsticky, nonplastic; common very fine roots throughout; 10 percent (few) carbonate coats on bottom surfaces of rock fragments finely disseminated carbonates; 15 percent subangular sandstone channers and 50 percent sub angular sandstone gravels; electrical conductivity of 1.92 mmhos/cm by EC meter, saturated paste; violently effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; SAR 0.37.

**Estimated Salvage Depth:** topsoil 18 cm (7 inches) thick (A horizon); and subsoil 132 cm (52 inches) thick (Bw, C, 2Ck1, and 2Ck2 horizons).

**Salvage Limitations:** sandy textures are in *Fair* range.

## 16EM08 - Persayo family

**Pedon ID:** 16EM08

**Description Date:** 12/14/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Persayo family

**Current Taxonomic Class:** Loamy, mixed, active, calcareous, mesic, shallow Typic Torriorthents

**Pedon Type:** Correlates to named soil

**Current Taxon Kind:** Family

**Pedon Notes:** this soil profile is similar to Persayo family profile previously described in the Emery 2 soil survey.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477606.3E, 4300862.6N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** canyon

**Geomorphic Component:** Side Slope

**Profile Pos:** Backslope

**Slope:** 42 percent

**Elevation:** 1813 meters (5948.2 feet)

**Aspect:** 300°

**Shape: up/down:** Linear; **across:** Convex

**Drainage:** Well drained

**Runoff:** High

**Erosion:** Class 2 - Sheet erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** BRTE - cheatgrass (*Bromus tectorum*); PIDE4 - bud sagebrush (*Picrothamnus desertorum*); ATCO - shadscale saltbush (*Atriplex confertifolia*); ACHY - Indian ricegrass (*Achnatherum hymenoides*)

**Parent Materials:** residuum weathered from shale

**Bedrock:** Moderately cemented shale at 60 centimeters (23.6 inches)

**Particle Size Control Section:** 0 to 34 centimeters (0 to 13.4 inches)

**Diagnostic Features:** Paralithic contact: 34 centimeters (13.4 inches)

**Restrictions:** Paralithic bedrock: 34 to 60 centimeters (13.4 to 23.6 inches) and Paralithic bedrock: 60 centimeters (23.6 inches)

**Surface Fragments:** 10 percent boulders; 5 percent stones, 5 percent cobbles, 40 percent flags, 20 percent channers, and 10 percent gravels. Fragments are sandstone.

**A** --- 0 to 20 centimeters (0 to 7.9 inches); light brownish gray (10YR 6/2) dry, gravelly sandy loam; brown (10YR 5/3) moist; 68 percent sand; 18 percent silt; 14 percent clay; moderate medium subangular blocky parting to single grain structure; very friable, slightly hard, slightly sticky, slightly plastic; common fine roots throughout and common very fine roots throughout; 15 percent subangular sandstone gravels; electrical conductivity of 2.18 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; neutral, pH 7.3, pH meter; clear smooth boundary; SAR 0.59.

**C** --- 20 to 34 centimeters (7.9 to 13.4 inches); dark grayish brown (10YR 4/2) dry, very parachannery loam; very dark grayish brown (10YR 3/2) moist; 38 percent sand; 39 percent silt; 23 percent clay; massive; very friable, slightly hard, slightly sticky, slightly plastic; common fine roots throughout and many very fine roots throughout; 55 percent angular shale parachanners; electrical conductivity of 3.14 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; very strongly acid, pH 4.7, pH meter; clear smooth boundary; SAR 0.2.

**Cr1** --- 34 to 60 centimeters (13.4 to 23.6 inches); extremely parachannery loam; 28 percent sand; 47 percent silt; 25 percent clay; common fine roots throughout and common very fine roots throughout; electrical conductivity of 4.31 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly acid, pH 6.5, pH meter; 55 percent weathering shale parachanners; gradual smooth boundary; SAR 0.13.

**Cr2** --- 60 centimeters (23.6 inches); slightly weathered shale.

**Estimated Salvage Depth:** topsoil 20 cm (8 inches) thick (A horizon); and no subsoil due to *Unacceptable* pH of C horizon.

**Salvage Limitations:** depth to *Unacceptable* pH (4.7) in C horizon (20 to 34 cm or 8 to 13 inches); depth to weathering shale (34 cm or 13 inches); surface boulders and stones.

## 16EM09 - Monue family

**Pedon ID:** 16EM09

**Description Date:** 12/14/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Monue family

**Current Taxonomic Class:** Coarse-loamy, mixed, superactive, mesic Typic  
Haplocambids

**Current Taxon Kind:** Family

**Pedon Notes:** this profile is similar to other Monue family profiles, but it is on a very steep slope.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477533.6E, 4300868N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** canyon bench

**Geomorphic Component:** Head Slope

**Profile Pos:** Backslope

**Slope:** 76 percent

**Elevation:** 1818.3 meters (5965.6 feet)

**Aspect:** 100°

**Shape: up/down:** Linear; **across:** Convex

**Drainage:** Well drained

**Runoff:** High

**Erosion:** Class 3 - Sheet erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** ATCO - shadscale saltbush (*Atriplex confertifolia*); SAVE4 - black greasewood (*Sarcobatus vermiculatus*)

**Parent Materials:** residuum weathered from sandstone

**Bedrock:** Strongly cemented sandstone at 80 centimeters (31.5 inches)

**Particle Size Control Section:** 25 to 80 centimeters (9.8 to 31.5 inches)

**Diagnostic Features:** Cambic horizon: 23 to 54 centimeters (9.1 to 21.3 inches),  
Secondary carbonates: 54 to 80 centimeters (21.3 to 31.5 inches) and Lithic  
contact: 80 centimeters (31.5 inches)

**Restrictions:** Lithic bedrock: 80 centimeters (31.5 inches)

**Surface Fragments:** 20 percent boulders; 20 percent channers, 5 percent flags, and 5 percent gravels. Fragments are sandstone.

**A** --- 0 to 23 centimeters (0 to 9.1 inches); very pale brown (10YR 7/4) dry, channery loamy sand; yellowish brown (10YR 5/4) moist; 84 percent sand; 4 percent silt; 12 percent clay; weak medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout; 10 percent subangular sandstone channers, 5 percent subangular sandstone flags and 5 percent subangular sandstone boulders; electrical conductivity of 4.1 mmhos/cm by EC meter, saturated paste; noneffervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; gradual smooth boundary; SAR 3.03.

**Bw** --- 23 to 54 centimeters (9.1 to 21.3 inches); very pale brown (10YR 7/3) dry, gravelly sandy loam; brown (10YR 5/3) moist; 78 percent sand; 10 percent silt; 12 percent clay; weak medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; 20 percent angular sandstone gravels; electrical conductivity of 12 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.4, pH meter; clear smooth boundary; SAR 2.78.

**Bk** --- 54 to 80 centimeters (21.3 to 31.5 inches); weathering sandstone and shale; extremely parachannery sandy loam; 68 percent sand; 14 percent silt; 18 percent clay; massive; friable, hard, nonsticky, nonplastic; common very fine roots throughout; 5 percent (few) carbonate coats on bottom surfaces of rock fragments; 45 percent shale parachanners and 30 percent subangular sandstone gravels; electrical conductivity of 13.3 mmhos/cm by EC meter, saturated paste; very slightly effervescent by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter; abrupt smooth boundary; SAR 2.9.

**R** --- 80 centimeters (31.5 inches); sandstone.

**Estimated Salvage Depth:** topsoil 23 cm (9 inches) thick (A horizon); and no subsoil due to *Poor* conductivity below 23 cm (9 inches)

**Salvage Limitations:** boulders and stones on surface; *Poor* conductivity below 23 cm (9 inches); depth to sandstone; and very steep slopes.

## 16EM10 - Monue family

**Pedon ID:** 16EM10

**Description Date:** 12/14/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Monue family

**Current Taxonomic Class:** Coarse-loamy, mixed, superactive, mesic Typic  
Haplocambids

**Pedon Type:** Correlates to named soil

**Current Taxon Kind:** Family

**Pedon Notes:** profile similar to other Monue family profiles described in area, unable to dig below 1 meter (39 inches) due large rock.

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477590.6E, 4300905N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** fan apron

**Geomorphic Component:** Base Slope

**Profile Pos:** Toeslope

**Slope:** 5 percent

**Elevation:** 1809.9 meters (5938 feet)

**Aspect:** 15°

**Shape: up/down:** Linear; **across:** Linear

**Drainage:** Well drained

**Runoff:** Low

**Erosion:** Class 4 - Gully erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** PIDE4 - bud sagebrush (*Picrothamnus desertorum*); ACHY - Indian ricegrass (*Achnatherum hymenoides*); SAVE4 - black greasewood (*Sarcobatus vermiculatus*); SPCR - sand dropseed (*Sporobolus cryptandrus*)

**Parent Materials:** alluvium derived from sandstone and shale

**Particle Size Control Section:** 25 to 100 centimeters (9.8 to 39.4 inches)

**Diagnostic Features:** Secondary carbonates: 17 to 100 centimeters (6.7 to 39.4 inches).

**Surface Fragments:** 5 percent very large boulders (substantially more in adjacent areas), 5 percent gravels, and 3 percent channers. Fragments are sandstone.

**A** --- 0 to 17 centimeters (0 to 6.7 inches); light yellowish brown (10YR 6/4) dry, loamy sand; yellowish brown (10YR 5/4) moist; 78 percent sand; 14 percent silt; 8 percent clay; weak medium subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and many very fine roots throughout; 10 percent angular sandstone gravels; electrical conductivity of 0.64 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; clear smooth boundary; SAR 0.24.

**Bw** --- 17 to 40 centimeters (6.7 to 15.7 inches); very pale brown (10YR 7/4) dry, sandy loam; yellowish brown (10YR 5/4) moist; 74 percent sand; 18 percent silt; 8 percent clay; moderate fine subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common fine roots throughout and common very fine roots throughout finely disseminated carbonates; 5 percent angular sandstone gravels; electrical conductivity of 1.13 mmhos/cm by EC meter, saturated paste; strongly effervescent by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter; gradual smooth boundary; SAR 0.28.

**Bk1** --- 40 to 74 centimeters (15.7 to 29.1 inches); very pale brown (10YR 7/3) dry, gravelly sandy loam; light yellowish brown (10YR 6/4) moist; 72 percent sand; 20 percent silt; 8 percent clay; weak fine subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common fine roots throughout and common very fine roots throughout finely disseminated carbonates; 15 percent angular sandstone gravels; electrical conductivity of 3.38 mmhos/cm by EC meter, saturated paste; violently effervescent by HCl, 1 normal; slightly alkaline, pH 7.8, pH meter; gradual smooth boundary; SAR 1.37.

**Bk2** --- 74 to 100 centimeters (29.1 to 39.4 inches); very pale brown (10YR 7/3) dry, gravelly sandy loam; yellowish brown (10YR 5/4) moist; 68 percent sand; 18 percent silt; 14 percent clay; weak fine subangular blocky parting to single grain structure; very friable, slightly hard, nonsticky, nonplastic; common fine roots throughout and common very fine roots throughout; 2 percent (very few) carbonate coats on bottom surfaces of rock fragments; 4 percent (common) fine masses of carbonate in matrix; 25 percent angular sandstone gravels; electrical conductivity of 4.92 mmhos/cm by EC meter, saturated paste; violently effervescent by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter; stopped by large rock or boulder at 100 cm; SAR 3.53.

**Estimated Salvage Depth:** topsoil 17 cm (7 inches); and subsoil 83 cm (32 inches).

**Salvage Limitations:** very large sandstone boulders; *Unacceptable* SAR levels could be present below 100 cm (39 inches).

## 16EM11 - Hideout family

**Pedon ID:** 16EM11

**Description Date:** 12/14/2016

**Describer:** Robert Long

**Soil Name As Correlated:** Hideout

**Current Taxonomic Class:** Loamy, mixed, superactive, calcareous, mesic Lithic Ustic  
Torriorthents

**Current Taxon Kind:** Series

**County or Parish:** UT015 - Emery

**State or Territory:** UT - Utah

**UTM:** 477604.8E, 4300945.9N -- Datum NAD83, Zone 12

**Legal Description:** Section 33, Township 22 South, Range 6 East of the 29 Meridian

**Landscape:** canyonlands

**Landform:** canyon sideslope

**Geomorphic Component:** sideslope

**Profile Pos:** Backslope

**Slope:** 70 percent

**Elevation:** 1791.4 meters (5877.3 feet)

**Aspect:** 152°

**Shape: up/down:** Linear; **across:** Linear

**Drainage:** Well drained

**Runoff:** Very high

**Erosion:** Class 3 - Rill erosion

**Primary Earth Cover:** Shrub cover;

**Existing Vegetation:** PIDE4 - bud sagebrush (*Picrothamnus desertorum*); SAVE4 -  
black greasewood (*Sarcobatus vermiculatus*); ATCO - shadscale saltbush  
(*Atriplex confertifolia*)

**Parent Materials:** residuum

**Bedrock:** Sandstone at 30 centimeters (11.8 inches)

**Particle Size Control Section:** 0 to 30 centimeters (0 to 11.8 inches)

**Diagnostic Features:** Lithic contact: 30 centimeters (11.8 inches)

**Restrictions:** Lithic bedrock: 30 centimeters (11.8 inches)

**Surface Fragments:** 5 percent boulders, 10 percent stones, 5 percent cobbles, 15 percent gravels, and 25 percent channers. Fragments are sandstone.

**AC** --- 0 to 30 centimeters (0 to 11.8 inches); light brown (7.5YR 6/4) dry, very gravelly sandy loam; brown (7.5YR 5/4) moist; 72 percent sand; 16 percent silt; 12 percent clay; moderate medium subangular blocky structure; very friable, hard, nonsticky, nonplastic; common medium roots throughout, common fine roots throughout and common very fine roots throughout; 40 percent subangular sandstone gravels; electrical conductivity of 2.75 mmhos/cm by EC meter, saturated paste; slightly effervescent by HCl, 1 normal; moderately alkaline, pH 8, pH meter; clear smooth boundary; SAR 2.56.

**R** --- 30 centimeters (11.8 inches); sandstone.

**Estimated Salvage Depth:** topsoil 30 cm (12 inches).

**Salvage Limitations:** shallow depth to sandstone (30 cm or 12 inches); boulders and stones on surface; and very steep slope.

## **Appendix C**

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Photo C - 1. . Looking west at 16EM03 profile location at proposed Emery 2 box cut location.



Photo C - 2. Soil profile 16EM03. Surface has 3 percent sandstone boulders and 5 percent sandstone stones.



Photo C - 3. Looking west at location of 16EM03 (center) at proposed location of Emery 2 box cut.



Photo C - 4. Looking north down canyon from 16EM04.



Photo C - 5. Looking southwest up canyon at proposed Emery 2 box cut location from 16EM04.



Photo C - 6. Looking northeast down canyon from 16EM05.



Photo C - 7. Look southwest up canyon at Emery 2 box cut from 16EM05.



Photo C - 8. Location 16EM06 is dominated by sandstone outcrops and small pockets of shallow Hideout soils.



Photo C - 9. Looking northeast at large boulders in bottom of canyon from 16EM07.



Photo C - 10. Looking east at canyon sideslope covered with boulders and stones above 16EM07 from west rim.



Photo C - 11. Looking southeast at canyon sideslope covered with boulders and stones above 16EM07.



Photo C - 12. Profile location 16EM08 on very steep slope covered with sandstone boulders, stones, and flags. Unacceptable pH at 8 inches and weathering shale at 13 inches.



Photo C - 13. Looking east at slope where 16EM08 is located near large rock in center of photo, viewed from 16EM09 location.

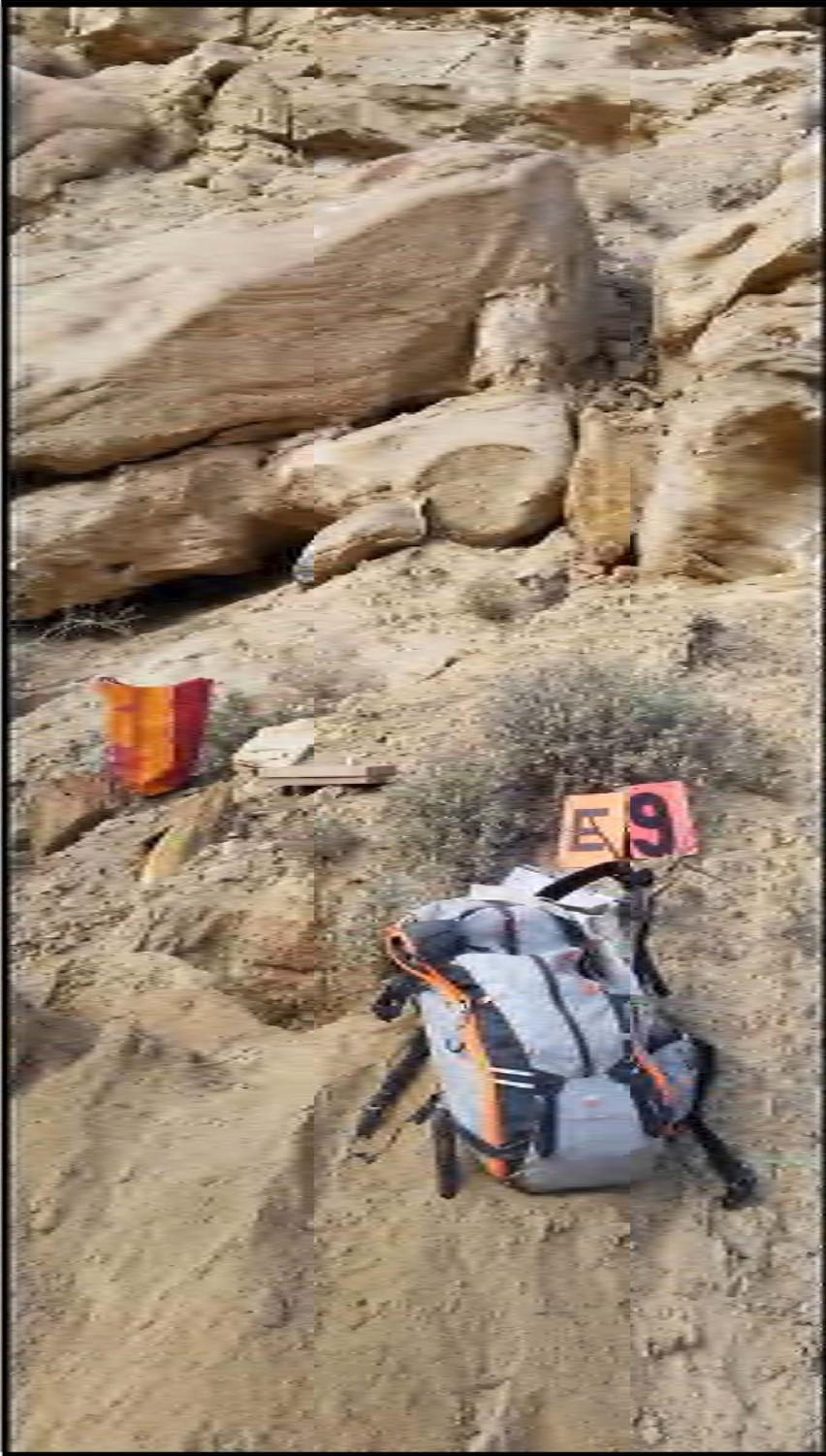


Photo C - 14. Profile location 16EM09 on very steep slope below west rim. Surface is covered with sandstone boulders and flags.



Photo C - 15. Profile location 16EM10 looking south from north end of canyon. Large sandstone boulders can be seen in bottom of canyon.



Photo C - 16. Looking west upslope at profile 16EM11 at north end of proposed disturbance. Sandstone boulders and stones are on surface. Depth to sandstone is 12 inches.



Photo C - 17. Looking north down canyon from east rim.



Photo C - 18. View of large boulders in bottom of canyon at north end, viewed from west rim.



Photo C - 19. Looking east from west rim at proposed rock scaling area on east rim. Profile location 16EM07 is in bottom of canyon (on the right of large boulder in lower center of photo).

## **Appendix D**

### **Profile Box Photographs**



Photo D - 1. Soil profile 16EM03, Cheeta family.



Photo D - 2. Soil profile 16EM04, Monue family.



Photo D - 3. Soil profile 16EM05, Monue family.

No sample box was collect at 16EM06, because it was a sandstone outcrop site.

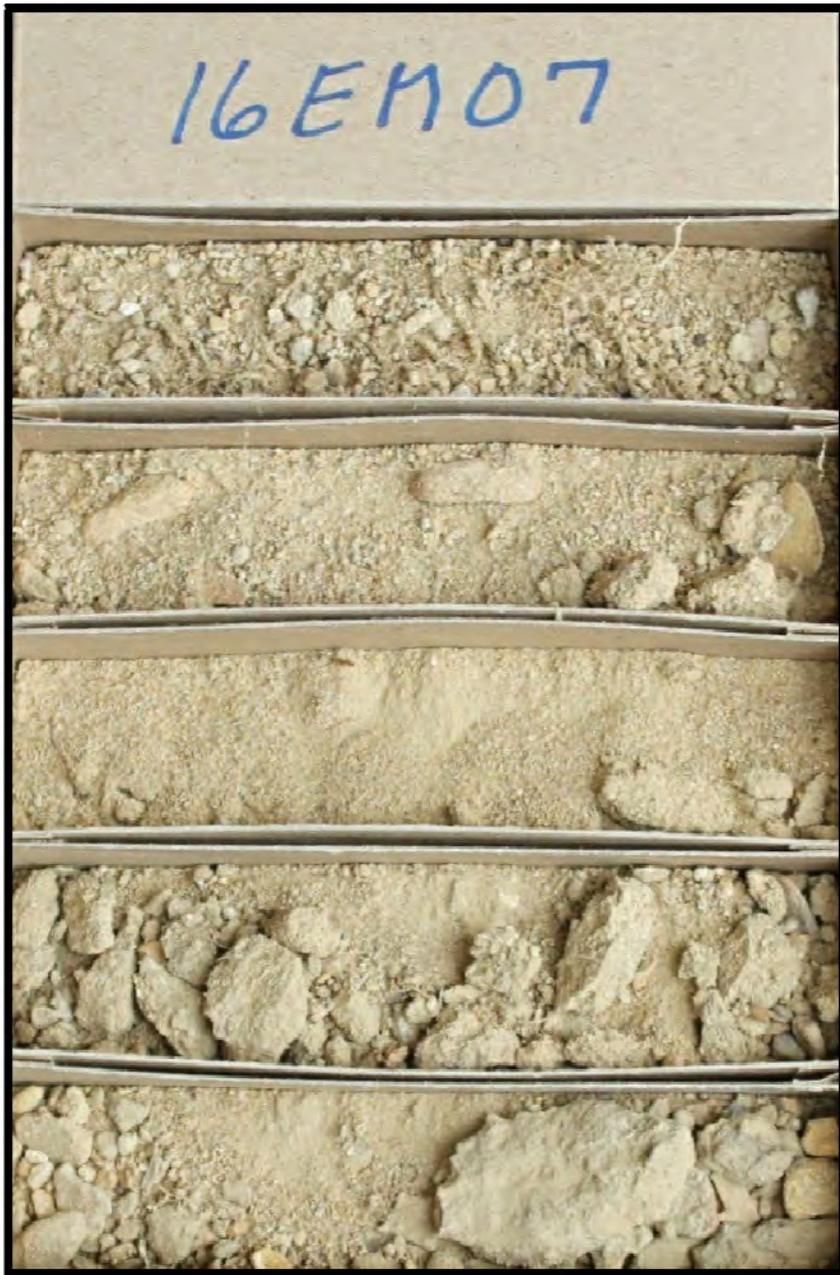


Photo D - 4. Soil profile 16EM07, Monue family.



Photo D - 5. Soil profile 16EM08, Persayo family.

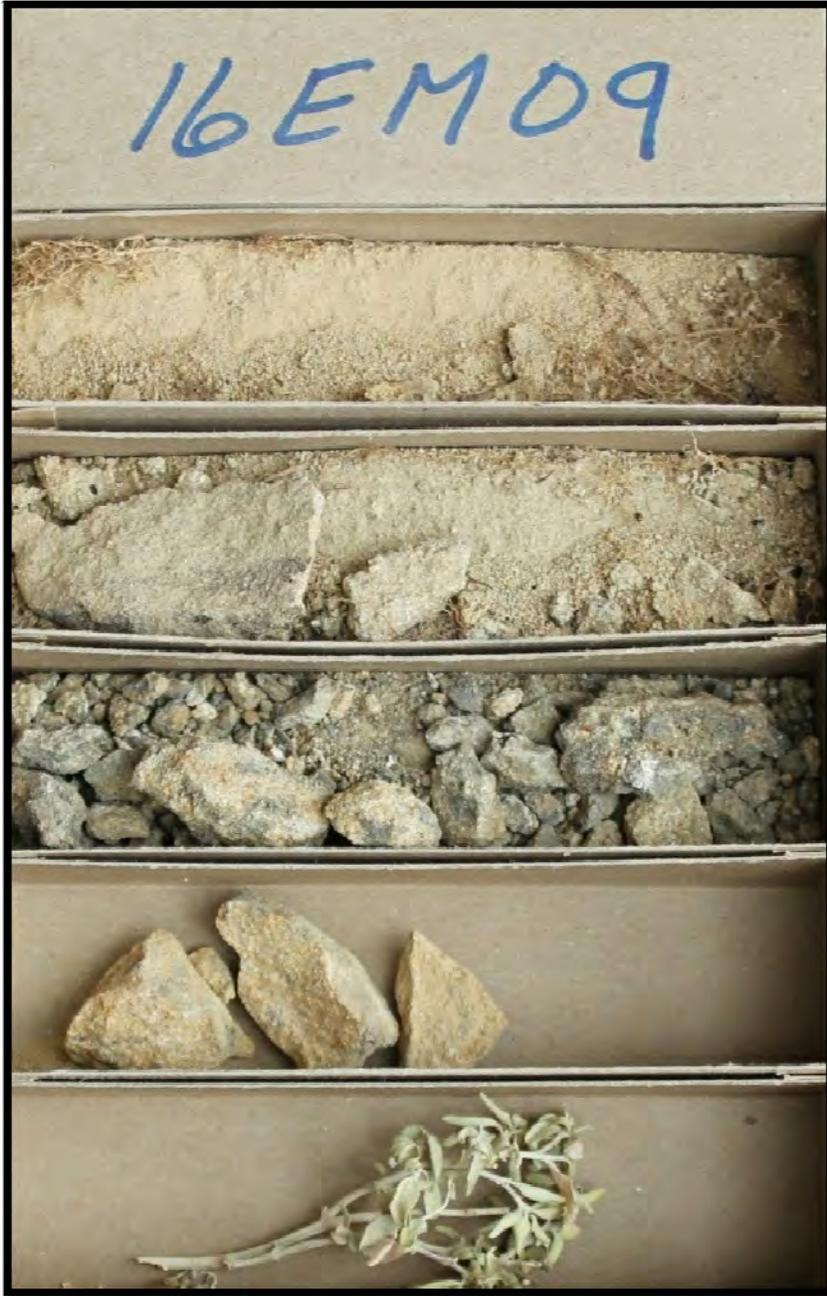


Photo D - 6. Soil profile location 16EM09, Monue family,



Photo D - 7. Soil profile location 16EM10, Monue family.

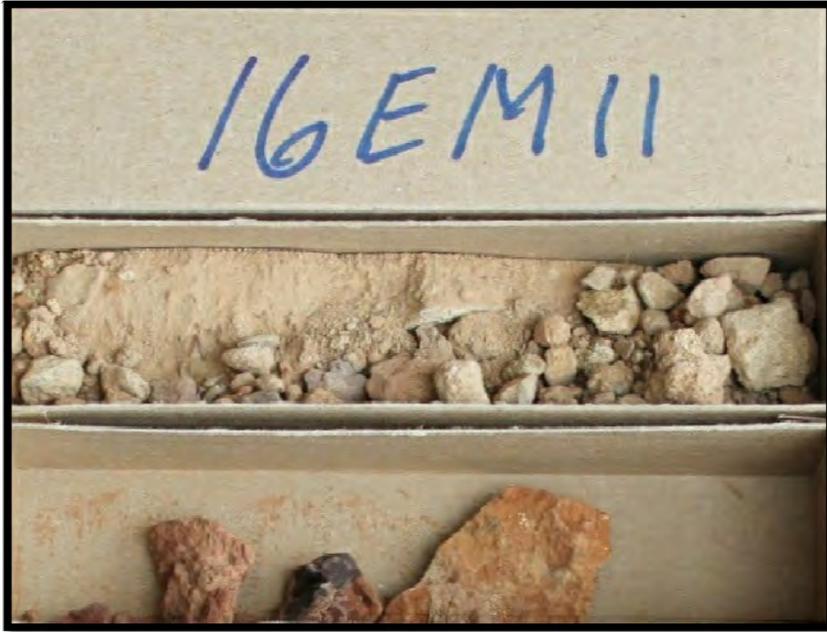


Photo D - 8. Soil profile location 16EM11.