Attachment MU1 3-1

Lost Creek Project - Mine Unit One
Order 1 Soil Survey

Lost Creek ISR, LLC
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FIGURES

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ADDENDA

ABBREVIATIONS AND ACRONYMS

AATA	AATA International, Inc.
GIS	Geographic Information System
LQD	Land Quality Division
NCSS	National Cooperative Soil Survey
NRCS	National Resource Conservation Service
Permit Area	Lost Creek Permit Area
Project	Lost Creek Project
SMU	Soil Mapping Unit
TFN	Temporary Filing Number
WDEQ	Wyoming Department of Environmental Quality

1.0 Introduction

The Lost Creek Project (Project), a proposed in-situ uranium mine, is located in Sweetwater County, on the northeastern edge of the Great Divide Basin of south-central Wyoming, approximately 38 miles northwest of Rawlins. This report describes the soils in Mine Unit 1 (MU1) of the Lost Creek Permit Area (**Figure MU1 A3-1-1**).

Soils in Sweetwater County have not been mapped as part of the National Cooperative Soil Survey (NCSS), although two empirical studies were conducted at the 1:100,000 and the 1:500,000 scales (Munn and Arneson, 1998 and 1999). AATA International, Inc. (AATA) of Fort Collins, Colorado completed an Order 3 field survey of the Permit Area in the summer of 2006. The results of the Order 3 survey were submitted to the Land Quality Division (LQD) of the Wyoming Department of Environmental Quality (WDEQ) in December 2007 as Appendix D7 of the Lost Creek Permit application (LQD Temporary Filing Number [TFN] 4 6/269).

In accordance with LQD Guideline No. 1 (WDEQ-LQD, 1994), a more detailed Order 1 soil survey is needed for the portions of the Permit Area, where mining-related surface disturbance is proposed. Order 1 soil surveys were conducted in 2008 and 2009 for the Plant site (2008), the deep injection well locations (2009), and MU1 (2008). The results of the surveys for the Plant site and the deep well locations are discussed briefly in Section D7.4 and in more detail in Attachments OP-5a and OP-5b to the Operations Plan in the main permit document. The results of the survey of MU1 are included in this addendum to the MU1 package. As the areas for additional mine units are delineated in more detail, Order 1 surveys will be conducted and the results submitted with the respective mine unit packages.

Before commencing the Order 1 soil survey in 2008, AATA discussed the scope of the survey, via e-mail, with WDEQ-LQD. The e-mail correspondence is included as **Addendum MU1 A3-1-1**.

2.0 Methodology

The Order 1 soil survey work plan was developed based on LQD Guideline No. 1 (WDEQ-LQD, 1994). The soil survey was conducted according to protocols in the National Soil Survey Handbook, which provides the major principles and practices used in standard soil surveys (Soil Survey Staff, 1993). Information was recorded on Soil Description Field Sheets. Copies of all the original sheets are included in **Addendum MU1 A3-1-2**.

Due to the irregular shape of MU1, the study area was defined and mapped as a geometric block for easier reference. The MU1 study area includes the MU1 pattern area and connecting roadways (**Figure MU1 A3-1-1**). Mine Unit 1 has an anticipated disturbance area of about 50 acres. The Mine Unit 1 study area includes approximately 140 acres. The exact boundaries of Mine Unit 1 depend on delineation drilling, which is still underway; hence, the study area is larger than the anticipated disturbance area to ensure adequate coverage.

The Order 1 soil survey fieldwork was completed in September 2008 by Dr. Jan Cipra with the assistance of Ethan Brown and Duncan Eccleston of AATA. The soil samples were analyzed by Energy Labs in Casper, Wyoming, in September and October 2008. The field survey data were digitized and incorporated in a Geographic Information System (GIS) database by AATA. The soil field mapping was done on high-resolution black and white satellite images of the study area at a scale of 1:4,800.

2.1 Soil Survey

A reconnaissance survey was conducted from September 2 through 5, 2008, in order to select locations for backhoe excavation of soil pits and profiles, and for soil sampling. The reconnaissance survey was conducted by traversing the MU1 study area and visually examining the surface variations. Soils were examined in more detail at 28 locations, where a 3-inch diameter hand-held soil auger and a 16-inch tile spade were used to excavate soil "pits". The pits were excavated to a depth of 60 inches, or to the C horizon. The soil characteristics were observed and recorded with depth. Photographs of all the soil pits are included as **Addendum MU1 A3-1-3a**. In addition to the 28 pit locations, observations were also made at several of the mud pits excavated for Project-related drilling in the Permit Area. Pits from the MU1 study area were also compared to pits at the Plant site, which were excavated during the same field session in September 2008 (Attachment OP-5a to the Operations Plan in the main permit document).

Based on the soil pit and the mud pit observations, ten soil "profile" locations were selected to describe and sample. Three soil mapping units (SMUs) were described and sampled: the Poposhia Loam, the Teagulf Sandy Loam, and the Pepal Sandy Loam. In the Poposhia Loam mapping unit, two locations were described and sampled. In the Teagulf Sandy Loam mapping unit, three locations were described and sampled. Five locations were described and sampled in the Pepal Sandy Loam mapping unit, which comprises the largest areal extent in the MU1 study area.

Some soil profile locations were selected to correspond with soil pit locations in order to ensure sampling was adequate to represent the spatial variability of the soils. The soil profiles were excavated by a backhoe, which allowed for more detailed observations. Each excavation was approximately 15 feet in length, five feet in depth, and four to five feet in width, oriented in an east-west direction to provide good lighting on the north soil face for descriptions and pictures. The bottom of each profile was flat for a length of five feet, with a 45-degree slope at one end for access.

The profiles were excavated and described from September 8 through 10, 2008. Soil samples were collected from September 8 through 11, 2008. Between three and seven horizons or sub-horizons were described and sampled at each soil profile. The upper and lower boundary of each layer was delineated with a nail, and then representative, depth-integrated samples were collected by scraping the exposed soil into a Ziploc bag. Each sample was labeled with a unique identification code. Photographs of all the soil profiles are included in **Addendum MU1 3-1-3b**. A preliminary soil map was developed based on observations from the soil pits, profiles, and mud pits.

Four additional pits were excavated on September 12, 2008, to verify and fine-tune the soil map. **Table MU1 A3-1-1** lists all the pits and profiles in the MU1 study area.

2.2 Laboratory Analysis

After examining the soil profile descriptions, samples from four of the eight soil profiles were selected for laboratory analysis (The numbers of samples were not proportional to the areal extent of each SMU.). Laboratory analyses included the topsoil suitability criteria noted in LQD Guideline No. 1, soil texture, and soil fertility parameters. The analyses were performed by Energy Laboratories in Casper, Wyoming.

The soil profile samples were generally taken from a single horizon but, in some cases, adjacent horizons or sub-horizons were combined if morphologically similar. The sampling locations are shown on **Figure 1**. **Table 2** lists the sampling locations and depths. Samples from MU1PR23 (MU1PIT23) were selected for laboratory analysis. MU1PR23 occurs near the soil boundary between the Teagulf SMU and the Pepal SMU. However, examination of the soil profile indicated that MU1PR23 is representative of the Teagulf SMU.

3.0 Results and Discussion

3.1 Soil Survey

Three SMUs were identified in the MU1 study area: the Poposhia Loam, the Teagulf Sandy Loam, and the Pepal Sandy Loam as described below. The SMUs were identified based on comparable soils near the Permit Area that were officially surveyed and described by the National Resource Conservation Service (NRCS). The color of the SMUs is described as moist, crushed and broken.

Poposhia Loam: This soil formed in calcareous loamy alluvium. This deep, well-drained soil occurs in narrow swales and comprises a small proportion of the study area. Typically, the surface layer is about a six-inch-thick dark brown sandy loam. The next layer is about an 18-inch-thick dark yellowish brown clay loam or sandy clay loam. The substratum is a brown or yellowish brown loam or coarse sandy loam to a depth of 60 inches or more. Its slopes range from zero to one percent.

Teagulf Sandy Loam: This soil formed in calcareous loamy or sandy alluvium, and is influenced by sandstone, siltstone, and mudstone or shale bedrock. Comprising a small proportion of the study area, this shallow, well-drained soil occurs on side slopes and upland ridges of slightly dissected plains. Its slopes range from three to seven percent Typically, the surface layer is about a three-inch-thick brown or dark yellowish brown loam. The next layer is about a seven-inch-thick dark yellowish brown sandy clay loam or heavy sandy loam. The substratum is a brown or yellowish brown loamy coarse sand or coarse sand to a depth of 60 inches or more. Substrata consisting of silt loam or sandy clay loam, also occur but are less prevalent.

Pepal Sandy Loam: This soil formed in calcareous loamy alluvium. This moderately deep, well-drained soil occurs on gently (one- to three-percent slopes) undulating uplands and comprises a large proportion of the study area. Typically, the surface layer is about a four-inch-thick dark brown or brown coarse sandy loam. The next layer is about a 15-inch-thick dark yellowish brown clay loam or sandy clay loam. The substratum is a dark yellowish brown loamy coarse sand or coarse sandy loam to a depth of 60 inches or more.

3.2 Laboratory Analysis

The laboratory report is included as **Addendum MU1 A3-1-4**, and the laboratory results are summarized in **Table MU1 A3-1-2**. The term “topsoil” in this report refers to soil horizons that occur at the surface of undisturbed soils. The term “subsoil” refers to soil horizons that occur below the topsoil. All topsoil and subsoil laboratory samples were within the Suitability Criteria for topsoil listed in WDEQ-LQD Guideline No. 1 (shown in **Table MU1 A3-1-2**).

The analyzed topsoil samples had textures of loam and clay loam. The topsoil depths generally ranged from six to 12 inches, with the exception of one sample depth of 24 inches. The organic matter contents ranged from 0.8 to 5.6 percent. Although organic matter is not a criterion, a higher organic matter content is, in general, directly related to revegetation potential. The saturation values ranged from 27 to 54 percent, which is at the lower end of the prescribed range.

The subsoil samples were loams and sandy loams, with depths ranging from six to 60 inches. Their organic matter content ranged from 0.3 to 1.2 percent. The organic matter in subsoil samples taken outside the Poposhia Loam unit ranged from 0.3 to 0.5 percent. These values are low, and are not favorable to vegetation establishment. The percent saturation (ranging from 31 to 43 percent) of the subsurface samples was at the low end of the prescribed range.

4.0 Evaluation of Soil Suitability

The topsoil of all three SMUs provides a favorable medium for plant growth, though the depth of topsoil varies between units. The primary suitable characteristics are organic matter content and favorable water holding capacity due to texture. The Poposhia Loam provides about 19 to 24 inches of topsoil material favorable for plant growth. The Teagulf Sandy Loam provides about six to 12 inches of topsoil material favorable for plant growth. The Pepal Sandy Loam provides 14 to 18 inches of topsoil material favorable for plant growth.

REFERENCES

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