# ATTACHMENT OP-5a

# Order 1 Soil Survey
# Lost Creek Project - Plant Site
# September 2008

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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 at the Plant site of the Lost Creek Permit Area (Permit Area; **Figure OP-5a-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 Mine Unit One (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 this attachment and Attachment OP-5b, respectively. The results of the survey of Mine Unit One will be included with the mine unit 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 OP-5a-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 OP-5a-2**.

The Plant study area includes the Plant site and connecting roadways (**Figure OP-5a-1**). The Plant site has an anticipated disturbance area of about 14 acres. The total Plant study area, including the roads, is approximately 25 acres. The Plant 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 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 Plant study area and visually examining the surface variations. Soils were examined in more detail at seven locations in the Plant study area, 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 OP-5a-3a**. In addition to the seven pit locations, observations were also made at several of the mud pits excavated for Project-related drilling in the Permit Area. Pits from the Plant site were also compared to pits in the Mine Unit One study area, which will be included in the mine unit package.

Based on the soil pit and the mud pit observations, two soil "profile" locations were selected to describe and sample. Two soil mapping units (SMUs) were described and sampled: the Poposhia Loam and the Pepal Sandy Loam. In the Poposhia Loam mapping unit, one location was described and sampled. One location was described and sampled in the Pepal Sandy Loam mapping unit, which comprises the largest areal extent in the Plant site. A third SMU, the Teagulf Sandy Loam was identified and sampled in the Mine Unit 1 site. A description of the Teagulf Sandy Loam is included as **Addendum OP-5a-4** to this report in order to provide a comprehensive reference for all soil types known to exist in the Permit Area.

The 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 on September 9, 2008.  Soil samples were collected.  Between four 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 the soil profiles are included in **Addendum OP-5a-3b**.  A preliminary soil map was developed based on observations from the soil pits, profiles, and mud pits.

**Table OP-5a-1** lists the pits and profiles in the Plant study area.

## 2.2 Laboratory Analysis

After examining the two soil profile descriptions, samples from each SMU 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 OP-5a-1**.  **Table OP-5a-2** lists the sampling locations and depths.

# 3.0 Results and Discussion

## 3.1 Soil Survey

Three soil types were identified during the Order 1 surveys in 2008 and 2009, and these three soil types can generally be identified by surface indicators. Pepal Sandy Loam is the dominant soil type, found in areas of upland big sagebrush habitat, where sagebrush is moderate to dense. The Poposhia Loam is found exclusively in drainages, where there is Lowland Big Sagebrush habitat and dense, larger sagebrush. The Teagulf Sandy Loam occurs in upland areas on subtle ridges and west-facing slopes where the sagebrush is sparse, cushion plants are common, and there is a concentration of pebbles and gravels on the soil surface due to aeolian erosion.

Two SMUs were identified in the Plant study area: the Pepal Sandy Loam and the Poposhia Loam as described in more detail 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.

**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.

**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.

## 3.2 Laboratory Analysis

The laboratory report is included as **Addendum OP-5a-4**, and the laboratory results for the Plant study area sites are summarized in **Table OP-5a-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 OP-5a-2**).

The analyzed topsoil samples had textures of loam and sandy loam. The topsoil depths ranged from eight to 12 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, clay loams, and loamy sands with depths ranging from eight to 48 inches. The organic matter content of the Poposhia Loam subsoil samples ranged from 0.7 to 1.2 percent. The organic matter of the Pepal Sandy Loam subsoil sample was 0.5 percent. This value is low and not favorable to vegetation establishment. The percent saturation (ranging from 34 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 the two 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 approximately 19 to 24 inches of topsoil material favorable for plant growth. The Pepal Sandy Loam provides approximately 14 to 18 inches of topsoil material favorable for plant growth. In both soils, the salvage depth can be identified in the field by a change in color from dark to light, accompanied by a change in texture from fine to coarse. The stripping depth is somewhat variable, and should be guided by local conditions, as it has been during the exploration phase of the project.

## REFERENCES


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