



**6111 91 Street
Edmonton, AB T6E 6V6
tel: 780.496.9048
fax: 780.496.9049**

Suite 325, 1925 18 Avenue NE
Calgary, AB T2E 7T8
tel: 403.592.6180
fax: 403.283.2647

#106, 10920 84 Avenue
Grande Prairie, AB T8V 6H2
tel: 780.357.5500
fax: 780.357.5501

**toll free: 888.722.2563
www.mems.ca**

Grassy Mountain Coal Project Baseline Soil Survey and Impact Assessment

Prepared for:
**Benga Mining Limited
Operating as Riversdale Resources**

Prepared by:
Millennium EMS Solutions Ltd.
6111 – 91 Street
Edmonton, Alberta
T6E 6V6

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1.0 INTRODUCTION

1.1 Project Description

Benga Mining Limited (Benga), a wholly owned subsidiary of Riversdale Resources Limited (Riversdale), is proposing to develop the Grassy Mountain Coal Project (the Project). The Project is located in south-west Alberta near the Crowsnest Pass, approximately 7 km north of the community of Blairmore ([Figure 1.1-1](#)). The Project involves a surface coalmine, a coal preparation plant and associated infrastructure including a coal conveyor system, a rail load-out facility, an access corridor, maintenance shops, environmental management systems, and other necessary facilities.

Benga have been conducting pre-feasibility study work, and re-evaluating the historical coal quality data as well as taking fresh samples to update the coal quality evaluation. The current focus of exploration, technical, and environmental work centres on the Grassy Mountain surface mine area, which comprises approximately 2,800 ha of the total Crowsnest Pass acquisition purchased by Benga. The Crowsnest Pass, located in south-west Alberta, is an area known for its extensive mining history dating back to the early 1900s. The Grassy Mountain property has been the subject of considerable previous surface and underground coal mining activities. The proposed development will occur on lands that are privately owned (the majority owned by Benga, with remaining private currently under land acquisition negotiations with Benga) and other lands that are owned by the crown. The proposed Project area (area within which all activities will occur) is approximately 1,520.7 ha in size.

This baseline soils and terrain report and associated effects assessment support the Environmental Impact Assessment (EIA) for the Project.

1.2 Soil Assessment Objectives

Objectives of the baseline soil survey and effects assessment were based on the Terms of Reference (ToR) for the Project issued by the Alberta Energy Regulator (AER) (Appendix 1 of the Application – Benga 2015), as well as the Canadian Environmental Assessment Agency (CEAA) *Guidelines for the Preparation of an Environmental Impact Statement* for the Grassy Mountain Coal Project (Appendix 2 of the Application – Benga 2015). The AER ToR for terrain and soil are summarized in [Table 1.2-1](#), with CEAA requirements summarized in [Table 1.2-2](#).

Table 1.2-1 Alberta Energy Regulator Final Terms of Reference Concordance Table.

TOR Section Number	Information Requirements*	Reference Section in this Report
3.1	Air Quality, Climate and Noise	
3.1.2 <i>Impact Assessment [A]</i>	Identify areas that exceed Potential Acid Input (PAI) critical loading criteria.	Section 4.4
	Discuss interactive effects that may occur resulting from co-exposure of a receptor to all emissions.	Section 4.4
3.9	Terrain and Soils	
3.9.1 <i>Baseline Information [A]</i>	Provide Descriptions and maps of the Terrain and soils conditions, including:	
	Surficial geology and topography.	Section 2.3.2, Figure 3.3-1, 3.3-2 to 3.3-5
	Soil types and their distribution. Provide an ecological context to the soil resource by supplying a soil survey report and maps to Survey Intensity Level 2 for the Project Area.	Sections 3.2 & 3.3, Figures 3.3-2 to 3.3-5
	Suitability and availability of soils within the Project Area for reclamation.	Section 4.2, Figures 4.1-2, 4.1-3, and 4.1-4
	Soil types that could be affected by the Project with emphasis on potential acidification (by soil type).	Section 4.4
	Descriptions and locations of erosion sensitive soils.	Section 4.3
3.9.2 <i>Impact Assessment [A]</i>	Describe Project activities and other related issues that could affect soil quality (e.g., compaction, contaminants).	Sections 6.2, 6.3, & 7.1
	Indicate the amount (ha) of surface disturbance from plant, mine, overburden disposal, reclamation material stockpiles, infrastructure (pipelines, power lines, access roads), aggregate and borrow sites, construction camps, waste disposal and other construction and operation activities.	Section 2.1.1 (Table 2.1-1)
	Provide an inventory of the pre- and post-disturbance land capability classes for the soils in both the Project Area and the Local Study Area and describe the impacts to land capability resulting from the Project. Indicate the size and location of the soil types and land capability classes that will be disturbed.	Section 4.5 & 7.4
	Discuss the relevance of any changes for the local and regional landscapes, biodiversity, productivity, ecological integrity, aesthetics, and future use resulting from disturbance during the life of the Project.	Sections 7.2, 7.3, & 7.4
	Describe potential sources of soil contamination.	Sections 6.3 & 7.1
	Describe the impact of the Project on the soil types and reclamation suitability and the approximate volume of soil materials for	Sections 7.1 & 7.4 Soil volumes located in

Table 1.2-1 Alberta Energy Regulator Final Terms of Reference Concordance Table.

TOR Section Number	Information Requirements*	Reference Section in this Report
	reclamation. Discuss any constraints or limitations to achieving vegetation / habitat reclamation based on the anticipated soil conditions (<i>e.g.</i> , compaction, contaminants, salinity, soil moisture, nutrient depletion, erosion, <i>etc.</i>).	the C&R Plan, Section F (Sections F.2.2) of Application
	Discuss the potential for soil erosion during the life of the Project.	Sections 4.3 & 7.1
3.9.2 Impact Assessment [B]	Discuss the potential impacts caused by the mulching and storage of woody debris considering, but not limited to vulnerability to fire, degradation of soil quality and increased footprint, <i>etc.</i>	C&R Plan, Section F (Section F.3.4.1) of Application
8	Mitigation Measures	
8 Mitigation Measures [A]	Discuss mitigation measures to avoid, minimize or eliminate the potential impacts for all stages of the Project.	Sections 7.1.3, 7.2.3, & 7.3.3
8 Mitigation Measures [B]	Identify those mitigation measures that will be implemented for each associated impact and provide rationale for their selection.	Sections 7.1.3, 7.2.3, & 7.3.3
8 Mitigation Measures [C]	Discuss the effectiveness of the proposed mitigation.	Sections 6.3, 7.1.3, 7.2.3, & 7.3.3
9	Residual Impacts	
9 Residual Impacts [A]	Describe the residual impacts of the Project following implementation of the Proponent's mitigation measures and the Proponent's plans to manage those residual impacts.	Sections 6.3, 7.1.4, 7.2.4, 7.3.4, & 7.4
10	Monitoring	
10 Monitoring [A]	Describe the Proponent's current and proposed monitoring programs.	Sections 6.3, 7.1.3, 7.2.3, & 7.3.3
10 Monitoring [B]	Describe the monitoring programs proposed to assess any Project impacts and to measure the effectiveness of mitigation plans.	Sections 6.3, 7.1.3, 7.2.3, & 7.3.3

* Information requirements extracted from the Final Terms of Reference Environmental Impact Assessment Report for Riversdale Grassy Mountain Coal Project (AEW 2015).

** Information requirements addressed in other areas of the Project Application.

Table 1.2-2 Canadian Environmental Assessment Agency Guidelines Concordance Table.

Guidelines Section Number	Information Requirements*	Reference Section in this Report
3.2.2.0	Operation	
	Characterisation and management of coal, waste rock, tailings, overburden, and reject material (volumes generated, mineralogical characterisation, potential for metal leaching and acid rock drainage)	Section 5.0
3.2.3	Decommissioning and Abandonment	
	The preliminary outline of a decommissioning and reclamation plan for any components associated with the Project.	C&R Plan, Section F of Application
6.1.3.	Topography and Soil	
	Baseline mapping and description of landforms and soils within the local and regional project area.	Section 3.3, Figures 3.3-1, 3.3-2 to 3.3-5
	Maps depicting soil depth by horizon and soil order within the mine site area to support soil salvage and reclamation efforts, and to outline potential for soil erosion.	Figures 3.3-2 to 3.3-5, and 4.1-1, Section 4.3
	Suitability of topsoil and overburden for use in the rehabilitation of disturbed areas.	Sections 4.2 (Table 4.1-2) and 5.3 (Table 5.3-1)
6.2.3	Changes to Terrestrial Environment	
	Overall description of changes related to landscape disturbance.	Sections 7.1.1, 7.2.1, 7.3.1, and 7.4.1
6.4	Mitigation	
	Terrain and soils.	Sections 7.1.3, 7.2.3, 7.3.3, and 7.4.3
6.5	Significant Residual Effects	
	Terrain and soils.	Sections 7.1.4, 7.2.4, 7.3.4, and 7.4.4
6.6.2	Cumulative Effects Assessment	
	Identify and provide a rationale for the valued components that will constitute the focus of the cumulative effects assessment, emphasizing this assessment on the VCs most likely to be affected by the Project and other projects and activities.	Section 6.3
	Identify and justify the spatial and temporal boundaries for the cumulative effect assessment for each VC selected.	Sections 7.1.2, 7.2.2, 7.3.2, and 7.4.2
	Identify the sources of potential cumulative effects.	Sections 7.1.2, 7.2.2, 7.3.2, and 7.4.2

Table 1.2-2 Canadian Environmental Assessment Agency Guidelines Concordance Table.		
Guidelines Section Number	Information Requirements*	Reference Section in this Report
	Describe the mitigation measures that are technically and economically feasible.	Sections 7.1.3, 7.2.3, 7.3.3, and 7.4.3
	Determine the significance of the cumulative effects.	Sections 7.1.2, 7.2.2, 7.3.2, and 7.4.2
7	SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT	
	A table summarising the following key information: - potential environmental effects; - proposed mitigation measures to address the effects identified above; and - potential residual effects and the significance of the residual environmental effects.	Table 7.5-1

This report outlines the methods used for the collection of relevant soil and terrain information, classification of soil data, and development of a baseline soil map. This report also covers interpretation of the soil survey data in order to better understand and depict the baseline conditions. Interpretive classifications were based on the following guidelines:

- reclamation suitability – *Soil Quality Criteria Relative to Disturbance and Reclamation* (Soil Quality Criteria Working Group (SQCWG), 1987);
- soil erosion risk (wind and/or water) – based on inspection data (slopes, soil textures), and the following documents:
 - *Revised Universal Soil Loss Equation for Application in Canada (RUSLEFAC)* (Wall *et al.*, 2002); and
 - *Wind Erosion Risk, Alberta* (Coote and Pettapiece, 1989);
- acid deposition – *Alberta Acid Deposition Management Framework* (Alberta Environment, 2008); and
- land capability – *A Forest Land Capability Classification for the East Slopes Area, Alberta* (Duffy and Nemeth, 1969).

Baseline soil data was used to determine the potential environmental effects that the Project may have on soil resources in the proposed development and study areas, and to assist in preparation of a C&R Plan with appropriate site mitigation and monitoring activities designed to achieve reclamation success. The proposed C&R Plan is included as [Section F](#) of the Project Application.

2.0 PROJECT LOCATION

2.1 Soils and Terrain Study Areas

2.1.1 Local Study Area (LSA)

The local study area (LSA) for the soils and terrain baseline study includes lands associated with the proposed Project footprint ([Figure 2.1-1](#)). The Project footprint will involve a surface metallurgical coal mine (for steel making), a coal handling and preparation plant (CHPP), and associated infrastructure including a coal conveyor system, a rail load-out facility, an access corridor, maintenance shops, and other pertinent facilities. The rail load out facility area will displace a portion of the Crowsnest Pass Golf and Country Clubs golf course. The replacement golf course development is included in this assessment to ensure potential impacts are considered and mitigated. Soils were investigated within the soils specific LSA boundary (1,520.7 hectares (ha)) and is located within Townships 8 and 9, Ranges 3 and 4, West of the 5th Meridian ([Figure 2.1-1](#)). A summary of the components that comprise the LSA is provided in [Table 2.1-1](#).

Table 2.1-1 Summary of Spatial Extent and Percentage of the Soils Local Study Area for the Primary Project Components		
Project Component	Component Area (ha)	Percentage of Development (%)
Coal Handling Processing Plant and Infrastructure	94.1	6.2
Coal Load-Out and Railway Loop	33.1	2.2
Construction Camp	1.9	0.1
Haul Road	0.3	<0.1
Ponds and Ditches	74.6	4.9
Powerline, Access and Conveyor RoW	15.2	1.0
Proposed Pipeline/Service Road Right of Way	1.5	0.1
Reclamation Material Storage	37.9	2.5
Ultimate Pit Extent	632.4	41.6
Ultimate Rock Disposal Extent	589.9	38.8
Proposed Replacement Golf Course Area ¹	38.1	2.5
Proposed Helipad Access ¹	1.6	0.1

Table 2.1-1 Summary of Spatial Extent and Percentage of the Soils Local Study Area for the Primary Project Components		
Project Component	Component Area (ha)	Percentage of Development (%)
Total Mining Activities Reclamation Area	1481.0	97.4
Total Non-Mining (Recreational) Area ¹	39.7	2.6
TOTALS²	1,520.7	100

¹ Benga Reclamation Responsibility include “incidental physical activities” identified by CEAA (Canadian Environmental Assessment Agency 2015).

² Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

2.1.2 Regional Study Area (RSA)

The regional study area (RSA) for soils was based as the spatial boundary used to assess the potential cumulative effects associated with soils and terrain (Figure 2.1-1). The soils RSA encompasses the Project footprint and the mine permit boundary originally proposed in 2015. Of note, the mine permit boundary has been revised for 2016 (Figure 2.1-1). The soils RSA defines an area within which the residual effects of the Project to soil and terrain resources can cumulatively interact with the residual effects of other past, present, and reasonably foreseeable future projects and activities. This accounts for all or portions of 24 sections of land totalling approximately 4,549.8 ha. The area selected as the RSA is deemed sufficient to evaluate cumulative effects as relating to direct disturbance of soil and terrain from other industries / operations within this selected area.

2.2 Site Physiography

The entirety of the RSA and LSA are located within the Rocky Mountain Natural Region (NRC, 2006). The Rocky Mountain Natural Region is comprised of mountains, high foothills, and deep glacial valleys (NRC, 2006). Within the Rocky Mountain Natural Region, the RSA and LSA are located within two distinct Natural Subregions. Figure 2.2-1 displays the Subregion boundaries in relation to the RSA.

Approximately 60% of the RSA and 75% of the LSA is located within the Subalpine Natural Subregion of Alberta (NRC, 2006). Short, cool, wet summers and long, cold winters with heavy snows are typical of the Subalpine Natural Subregion. The Subalpine Natural Subregion occurs at high elevations below the Alpine Natural Subregion on rolling to inclined shallow morainal and residual materials over bedrock (NRC, 2006). The unstable parent materials over steeply sloping bedrock contribute to the development of Brunisols (Eutric and Dystric) as well as Regosols and non-soils (*i.e.*, colluvium, exposed bedrock) (NRC, 2006). In areas of less pronounced terrain and somewhat

finer textured soils, Orthic and Brunisolic Gray Luvisols have developed (NRC, 2006). Wetland soils are usually Gleysols but Organic soils also do occur (NRC, 2006). Vegetation patterns in this subregion are influenced by elevation, topography and latitude.

The Project is situated within the south-central mountains latitudinal division (south of the North Saskatchewan River). At low to middle elevations in the south-central mountains, dry sites, often on south- or west-facing slopes, are forested by lodgepole pine with an understory of bearberry and hairy wild rye on loamy Brunisols and Luvisols, or by bearberry – mountain rough fescue grasslands on Brunisols and Chernozems. Lodgepole pine, Engelmann spruce, and subalpine fir stands with understories of false azalea, grouseberry, Canada buffaloberry, low bilberry, hairy wild rye, pine reed grass and feathermosses occur with medium textured Brunisols on mesic sites. The short fire return interval is responsible for the dominance of young to mid-seral lodgepole pine stands. On moister sites, thimbleberry may also be found in the understory, and is indicative of Montane climatic influences. Luvisols and Gleyed subgroups are associated with these sites. Sedge fens, dwarf birch - tufted hair grass communities, and Engelmann spruce - horsetail communities occur on very moist to wet sites with Organic, Regosolic and Gleysolic soils.

At upper elevations in the south-central mountains, cooler, wetter conditions have resulted in a longer fire return interval, and mature Engelmann spruce – subalpine fir forests are typical. Heather, mountain-heather, willow, grouseberry and feathermosses are typical understory associates. These sites are nutrient-poor and soils are usually thin, stony Brunisols over bedrock. Subalpine larch and whitebark pine occur with subalpine fir and Engelmann spruce in open stands near treeline (NRC, 2006).

Approximately 40% of the RSA and 25% of the LSA is located within the Montane Natural Subregion. The Montane Natural Subregion occurs on the lower slopes and valley bottoms of the Front Ranges (NRC, 2006). Mild summers, a summer-high precipitation pattern, frequent Chinook winds and warm winters are characteristics of the Montane Natural Subregion. Surficial materials are mainly medium textured, weakly calcareous tills (NRC, 2006). In major river valleys, fluvial and glaciofluvial sands and gravels form level to gently undulating terraces on valley bottoms with till and colluvial deposits of various textures occurring on the lower slopes (NRC, 2006). Bedrock exposures can also occur (NRC, 2006). The soils found within the Montane Natural Subregion consist of Chernozems, Brunisols, Regosols, Luvisols, Gleysols, and Organics (NRC, 2006). Orthic Black Chernozems are typical under grasslands and Orthic Dark Gray Chernozems are dominant in wooded areas (NRC, 2006). In the valleys, Eutric Brunisols are dominant on fluvial and glaciofluvial deposits (NRC, 2006). Regosols are typical of both fluvial terraces adjacent to rivers and side slopes where there have been recent occurrences of erosion or slope movement (NRC, 2006). On the valley side slopes that are stable enough for soil development, Luvisols and Dystric Brunisols can occur

(NRC, 2006). Gleysols and Organic soils are typically associated with fens (NRC, 2006). Highly variable microclimates produced by differing aspects, slope positions and wind exposures produce abrupt changes in vegetation over very short distances.

The Project is situated within the southern and central mountain valley district (includes the Crowsnest Pass, Bow Valley and Ya-ha-Tinda area). At lower elevations on south and west facing slopes, areas may be vegetated by open forests or grasslands (NRC, 2006). The open forest areas consist of lodgepole pine, Douglas fir, aspen, and white spruce with an understory of bearberry, Canada buffaloberry, hairy wild rye, pine reed grass, and forbs (NRC, 2006). The grasslands consist of mountain rough fescue, bluebunch fescue, and Parry oatgrass (NRC, 2006). With higher elevations, lodgepole pine stands are dominant with mixedwood and Douglas fir forests also occurring (NRC, 2006). Moist sites consist of Douglas fir, aspen, lodgepole pine, and white spruce stands with diverse understories (NRC, 2006). The wettest sites are dominated with willow or sedge fens, with treed fens being very uncommon (NRC, 2006).

2.3 Geology

2.3.1 Bedrock Geology

The LSA and RSA are underlain by bedrock strata of the Blairmore Group (Lower Cretaceous), Fernie Formation and Kootenay Group (Jurassic and Lower Cretaceous), and the Mississippian Strata (Mississippian) (Hamilton *et al.*, 1999). The Blairmore Group, underlying approximately 63% of the LSA, is characterized by sandstone and mudstone that are marginally marine to non-marine. The Fernie Formation and Kootenay Group, underlying 32% of the LSA, is characterized by shale, siltstone, sandstone, and limestone that are marine to non-marine. The Mississippian Strata, underlying 5% of the LSA, is characterized by limestone, shale, dolomite, and siltstone that are marine.

2.3.2 Surficial Geology and Terrain

2.3.2.1 Surficial Materials

Surficial deposits within the LSA and RSA are composed mainly of colluvial or leached Cordilleran till deposits. Other significant surficial materials in the LSA and RSA include alluvial deposits. Surficial material patterns within the LSA and RSA correlate with the physiography of the region.

Surficial deposits within the LSA and RSA are composed mainly of colluvium (Bayorock and Reimchen, 1975). Colluvium is soil and rock creep material overlying bedrock. The composition is determined by the underlying bedrock and ranges from predominantly weathered carbonates to weathered sandstone, siltstone, and shale. Colluvium often has poor to well defined layering parallel to slope. The term is here restricted to bedrock-derived sediment while colluvium derived from

surficial materials is grouped with that sediment. Thickness of the colluvial materials can vary from 1.5 m deep on 15-45% slopes to >3 m at the base of the slopes (Bayorock and Reimchen, 1975). Walker *et al.* (1991) noted that discontinuous, shallow, and locally deep deposits of colluvium occurred on the steep slopes in the area. The colluvium varied from gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly sandy loam-loam-silty loam), and weakly to extremely calcareous (Walker *et al.*, 1991). On very steep slopes, colluvium is absent and rock outcrops occur (Bayorock and Reimchen, 1977). The bedrock underlying colluvium is weathered and weathering depth ranges from a few feet to 30 feet. The texture and lithology of weathered bedrock depends primarily on original composition of the formation (Bayorock and Reimchen, 1977).

A significant portion of the RSA is composed of slightly and moderately leached till (Cordilleran provenance) (Bayorock and Reimchen, 1975). It is a silty sand till that has been slightly leached (15-45 cm) or moderately leached (0-1.5 m). Thickness is variable and the matrix texture is usually loam (Bayorock and Reimchen, 1975). These are considered mountain tills from the Cordilleran glaciation (Walker *et al.*, 1991). They are characterized by variability and having a consistent coarse fragment content of 15-35%. Textures can vary from sandy loam to silty clay loam, but are mostly clay loam or loam. Tills associated with the Mesozoic strata, like the Grassy Mountain Ridges, are mainly non- to weakly-calcareous (Walker *et al.*, 1991). Till is shallow across much of the roughest terrain. Underlying materials may be consolidated bedrock or weathered bedrock (residuum).

Along the streams within the RSA, the main surficial deposit is coarse stream alluvium (Bayorock and Reimchen, 1975). The alluvium is non-glacial fluvial sediment deposited along most streams in the Rocky Mountains and major streams in the Foothills. The sediment consists of gravelly sand to gravel material that can form terraces and valley bottom deposits. In some areas, the coarse stream alluvium can be overlain by 0.25-2 m of fine alluvium. Clasts are generally well-rounded carbonates and quartzites in the mountains but can contain clasts that are derived from Mesozoic clastics if found in the Foothills. These areas vary from having flat to rolling, low relief surface forms with generally <2 m relief. The thickness of these deposits are usually >3 m but may be considerably in certain locals. The main textures of these materials are loamy sand and sandy loam (Bayorock and Reimchen, 1975).

Glaciofluvial deposits occur along major rivers and creeks. These materials vary from medium to coarse textured and non-gravelly to very gravelly. Veneer and blanket of deposits likely represent waning glaciofluvial influence and shift to fluvial regime. Glaciofluvial deposits have appreciably higher carbonate content than surrounding till (Walker *et al.*, 1991). Organic deposits are generally small in area and distributed more or less uniformly throughout the region (Bayorock and Reimchen, 1977).

2.3.2.2 General Landforms

Surficial deposits of the RSA are also described in terms of the general terrain types in which they occur. Landform type and spatial distribution are closely linked to the physiography of the region.

Within the study areas, the dominant landforms are associated with colluvium deposits of different thickness and reflect underlying bedrock topography (Bayorock and Reimchen, 1975). They feature incline to steep slopes.

Veneers of morainal material over bedrock also reflect underlying bedrock topography. The morainal landscapes are characterized by subdued, flat to rolling topography with relief generally less than 3 m (Bayorock and Reimchen, 1975). The RSA includes a number of stream channels with flat to rolling low relief.

2.4 Soil Overview

The LSA and RSA boundaries for the Project are located primarily within Soil Correlation Area (SCA) 16. SCA 16 occurs in the Montane and Subalpine Areas of South-Western Alberta (Bock *et al.*, 2006). SCA 16 includes the area in the southern Alberta foothills from the Morley Indian Reserve, south to Waterton Park, and includes the Porcupine Hills (Pedocan, 1993). Mineral landscapes are largely comprised of till and colluvium, often occurring over shallow bedrock (Pedocan, 1993). Soil types vary widely and include Dark Brown to Dark Gray Chernozems, Luvisols, Brunisols, and Gleysols (Pedocan, 1993).

The most recent version of the Alberta Soil Names File (ASNF) (ASIC, 2001, Brierley *et al.*, 2006) indicates that there are approximately 56 soil series and variants identified within SCA 16. To supplement the soil series list for SCA 16 various soil series from SCA 15 were used to expand on the series and variant list for the Project in instances where a particular soil was not identified to the series level within SCA 16.

3.0 BASELINE SOIL & TERRAIN INFORMATION

This section provides information on the baseline soil survey, including:

- methods of soil investigation, including field, laboratory, and data analysis and mapping;
- description of major soil series and variants;
- description of the terrain that comprises the RSA;
- description of soil map units;
- description of mapping methods and data sources utilized to create the soils map for the RSA; and

- distribution of soil map units within the LSA and RSA.

3.1 Soil Investigation Methods

3.1.1 Survey Design – Intensity Levels

Soil and terrain information was obtained during the summer of 2014. Sufficient soil inspection data was obtained to achieve a survey intensity level as defined in the AER ToR for the Project. Survey guidelines were based on accepted methodologies used in Canada for baseline soil survey (Mapping System Working Group (MSWG), 1981). A total of 457 soil inspection sites have been recorded ([Figures 3.1-1 to 3.1-3](#)) within or adjacent to the LSA and RSA, including 26 soil profiles sampled. Samples of at least one soil horizon or layer were collected at 24 of the soil inspection sites to confirm soil classification (*e.g.*, Ah horizons for Chernozemic soils classification). All of this data was utilized in the mapping and interpretations of soil and landscapes within the LSA and RSA.

The survey intensity achieved within the LSA was one inspection per 6.6 ha of land (230 sites over 1520.7 ha). The survey intensity achieved within the RSA was one inspection per 11.2 ha of land (407 site inspections over 4,549.8 ha). Sufficient soil inspection data was obtained to achieve a survey intensity level (SIL) 2 (MSWG, 1981) as defined in the AER ToRs for the Project. This level of detail is adequate for creating a baseline soil map at a 1:15,000 production scale for presenting a soil and terrain inventory within the RSA.

Inspection densities in all areas varied according to access, terrain, and observed complexity of soil patterns. Soil inspection sites were selected to adequately represent local soil-terrain patterns. The site inspection data is provided in [Appendix A](#). [Figures 3.1-1 to 3.1.3](#) display the site inspections collected within the RSA and immediately adjacent lands.

3.1.1.1 Site and Soil Characteristics

Various site characteristics were documented at each inspection location to facilitate a better understanding of soil distribution as well as corresponding landscape and vegetation relationships, throughout the RSA.

Site characteristics recorded at each inspection site included:

- surficial (parent) material type;
- surface expression , slope gradient, aspect, and position;
- soil drainage;
- general vegetation identification; and
- information related to existing disturbances.

At each inspection site, the soil profile was investigated to a depth of approximately 100 cm (if not restricted by coarse fragments content and bedrock) for upland soils, while Organic soils were investigated to mineral contact or a maximum depth of 220 cm. If depth of profile investigated was restricted by shallow bedrock or high coarse fragments content investigated depth was recorded. A spade and 5-cm Dutch auger were used to investigate soils to the appropriate depths. Site and soil characteristics were observed and recorded on field forms, following accepted guidelines and classification systems (Expert Committee on Soil Survey (ECSS), 1983 and 1987, Soil Classification Working Group (SCWG), 1998).

Documented soil profile characteristics included:

- horizon types;
- horizon depths;
- soil texture by manual (field) tests;
- structure and consistence;
- colour (Munsell soil colour);
- presence of mottles, including appropriate mottle descriptors;
- coarse fragment content (by volume);
- presence or lack of carbonates, using a 10% hydrochloric acid (HCl) solution; and
- other pertinent horizon or parent material features as required to aid in soil classification and/or description (*i.e.*, unique soil attributes).

Global positioning system (GPS) coordinates (UTM/NAD83) were captured by hand-held GPS units and transferred to the soil-site database.

3.1.1.2 Soil Sampling

Soil horizons at 50 locations within the RSA were sampled and analyzed. This number of samples provided good representation of most common soils found in the RSA.

Approximately 0.5 kg of soil from each sampled horizon, excluding very thin (*i.e.*, <2 cm thick) and discontinuous horizons, was collected and placed into a clean, labeled plastic bag. All samples were then sealed and transported to the laboratory for physical and chemical analyses.

3.1.2 Laboratory Methods

Soil samples were delivered to an approved laboratory within appropriate delivering times. Methods used were cross-referenced with acceptable analytical methods such as outlined in the *Soil Quality Criteria Relative to Disturbance and Reclamation* (Soil Quality Criteria Working Group (SQCWG), 1987).

Representative soil series results are summarized in [Appendix A](#) and a complete listing of all sampled profiles and chemistry required for the completion of reclamation suitability rating (SQCWG, 1987) are displayed in [Appendix C](#). Original Laboratory Results for all soil samples analyzed is provided in [Appendix D](#).

3.1.3 Data Analysis and Mapping Methods

All data was entered into a database designed for baseline soil surveys. The database was used to filter and query the soil data to establish trends and patterns. This process was used as a tool to assist in determining soil map units and landscape models and baseline characteristics (*i.e.*, soil horizon thickness).

In addition to the database, a variety of tools were used to develop the soils and terrain map. These tools included:

- air photo imagery of the area (1998; 1:20,000);
- satellite imagery;
- light detection and ranging (LiDAR) bare earth imagery of the area;
- Agricultural Region of Alberta Soil Inventory Database (AGRASID) (ASIC, 2013; Bock *et al.*, 2006);
- earlier soil survey reports in the region – Pincher Creek – Crowsnest Pass area (1:50,000; Walker *et al.*, 1991);
- PurVIEW™ softcopy mapping software coupled with a geographic information system (ArcView GIS™); and
- the mappers' knowledge of soil patterns in the survey area and similar areas.

Soil polygons were delineated by soil scientists using PurVIEW™ (3D digital imagery) and ArcGIS applications. The combination of these technologies allows a mapper to view medium to small-scale aerial photography (*e.g.*, 1:30,000) in a digital environment at much larger scales and allow for interpretation of the landscape and soil distribution based on local relief, landforms, vegetative indices and field inspection data. The ability to view imagery in a 3D format at detailed scales provides better delineation and classification of soil and terrain polygons. Soil polygons were digitized directly to the imagery based on similarities and patterns between landscapes, associated vegetation types, and soil profile data. Soil map unit names were then created for the polygons to depict a mapping legend for the Project.

3.2 Classification – Soil Series and Variants

Prior to creating soil map units, soil information within the study area was analyzed to understand the relationship between soil types, vegetation and terrain patterns.

Soil classification to the series level (required for baseline mapping) involved three steps:

- classification of each profile (inspection site) to the soil subgroup level (SCWG, 1998) based on morphological features (*e.g.*, types and arrangement of identified horizons, degree of gleying presence and/or thickness of organic layers, *etc.*);
- classification of soil parent materials according to mode of deposition plus textural characteristics (*i.e.*, coarse textured material over medium textured till); and
- merging the two classifications to define soil series level based on the AGRASID 4.0 name file (ASIC, 20013; Bock *et al.*, 2006).

Soil Subgroup Classification

All soil inspection sites were reviewed in the database and field level classification to the subgroup was either confirmed or updated based on the guidelines in the *Canadian System of Soil Classification – Third Edition* (SCWG, 1998).

Soil Parent Material Classification

Assigning a parent material grouping each to soil inspection site is required to classify a soil subgroup to the series level. A review of all inspection sites was conducted in order to evaluate layering (*i.e.*, layered parent materials), thickness of layers, textures, coarse fragment shape and content, and other morphological information.

Soil Series

Soil subgroup classification and parent material groupings were integrated in order to assign soil series or variants to soils for all inspection sites. Soil names were derived mainly from SCA 16 and 15. The latest edition of the Alberta Soil Names File (ASIC, 2013; Bock *et al.*, 2006) was used to select soil series.

Soil Variants

Soil variants define soil entities that are sufficiently different from established soil series to warrant recognition, but do not justify a new soil name due to limited geographic extent. Variants are applied as lower case letters after the series name.

The following soil series variants were used in this study to further differentiate recorded soil series:

- **aa** – not modal to soil correlation area;
- **ca** – soils having a calcareous B horizon;
- **co** – one textural group coarser than modal or greater than 10% coarse fragments;
- **cr** – soil with secondary carbonates;
- **cu** – soils having cumulic profile;
- **er** – soils having a moderately eroded surface;
- **fi** – one textural group finer than modal;
- **gl** – gleyed, increased soil moisture, imperfectly drained within 100 cm;
- **gr** – soil with 20-50% coarse fragments (>2 mm – 7.5 cm) by volume;
- **pt** – soils having a 15-40 cm accumulation of surface peat;
- **tk** – soils having a thicker than modal A horizon;
- **xg** – gravel (20-50% coarse fragments <7.5 cm in diameter) substrate at 30-99 cm;
- **xl** – lithic (bedrock) contact within 30-99 cm;
- **xp** – paralithic contact within 30-99 cm;
- **xs** – coarse textured material within 30-99 cm;
- **xt** – till within 30-99 cm;
- **zb** – brunisolic, soils having Bm horizon;
- **zh** – soils having dark-coloured A horizon at least 10 cm thick;
- **zl** – luvisolic, soils having Bt horizon;
- **zr** – soils having Rego/Regosolic profile; and
- **zz** – atypical subgroup.

In total, 38 major soil series and variants were identified within the RSA and LSA. [Table 3.2-1](#) lists the series and variants, including associated parent materials.

Table 3.2-1 Major Soil Series and Variants of the Regional and Local Study Areas

Soil Name (Code)	Subgroup¹	Most Common Variant Description	Parent Material & Comments
Bellevue – CO (BEVco)	Orthic Dark Brown Chernozem	co – coarser than modal	Moderately coarse textured colluvium or weathered bedrock (residuum)
Beaupre (BPE, BPEgr)	Orthic Eutric Brunisol	gr – gravelly	Gravelly and non-gravelly, medium to moderately fine textured till
Cadomin – AA (CDMaa, CDMaazz)	Eluviated Dystric Brunisol and Orthic Dystric Brunisol	aa – not modal SCA zz – atypical subgroup	Medium textured weathered bedrock (residuum) or medium textured colluvium veneer overlying bedrock
Connop (CON)	Eluviated Eutric Brunisol		Coarse textured glaciofluvial deposits
Copper – AA (CPXaa, CPXaazz)	Orthic Dystric Brunisol and Eluviated Dystric Brunisol	aa – not modal SCA zz – atypical subgroup	Coarse textured weathered bedrock (residuum) or coarse textured colluvium veneer overlying bedrock
Darnell (DNL)	Typic Mesisol		Fen peat >160 cm thick
Frank (FRK, FRKzz)	Orthic Eutric Brunisol and Eluviated Eutric Brunisol	zz – atypical subgroup	Gravelly to non-gravelly, medium textured colluvial deposits
Fireside – AA (FRXaa, FRXaafixt)	Orthic Eutric Brunisol	aa – not modal SCA fi – finer than modal xt – medium textured till material within 30-99 cm	Stratified (L, SiL, Sl, LS) fluvial deposits commonly overlying medium to moderately fine textured till
Fairview Mountain – AA (FVXaa, FVXaazz)	Eluviated Dystric Brunisol and Orthic Dystric Brunisol	aa – not modal SCA zz – atypical subgroup	Gravelly coarse textured colluvial deposits
Fairview Mountain – AA, FI (FVXaafi, FVXaazzfi)	Eluviated Dystric Brunisol and Orthic Dystric Brunisol	aa – not modal SCA fi – finer than modal zz – atypical subgroup	Gravelly medium textured colluvial deposits

Table 3.2-1 Major Soil Series and Variants of the Regional and Local Study Areas

Soil Name (Code)	Subgroup ¹	Most Common Variant Description	Parent Material & Comments
Hillsdale – AA (HDXaa, DXaazzco)	Cumulic Regosol and Orthic Regosol	aa – not modal SCA co – coarser than modal zz – atypical subgroup	Gravelly and non-gravelly, coarse textured, stratified (L, SiL, SL, LS) fluvial deposits
Heather – AA (HEXaa, HEXaazz)	Orthic Dystric Brunisol and Eluviated Dystric Brunisol	aa – not modal SCA zz – atypical subgroup	Gravelly, medium textured colluvial deposits overlying bedrock
Leighton Centre (LTC, LTCgr)	Dark Gray Luvisol	gr – gravelly	Gravelly and non-gravelly, medium to moderately fine textured till
Mitford (MTF)	Terric Mesisol		Peat (40-159 cm) overlying medium textured material
Nickerson – AA, GR (NKNaagr)	Orthic Humic Regosol	aa – not modal SCA gr – gravelly	Gravelly medium to moderately fine textured colluvium or weathered bedrock (residuum)
Porcupine – AA (PPEaa, PPEaaco)	Orthic Black Chernozem	aa – not modal SCA gr – gravelly	Gravelly and non-gravelly, medium to moderately coarse textured colluvium
Redoubt – AA (RDXaa, RDXaafi)	Orthic Regosol	aa – not modal SCA fi – finer than modal	Gravelly coarse to medium textured colluvium or weathered bedrock (residuum)
Redoubt – AA, ZH (RDXaazh)	Orthic Humic Regosol	aa – not modal SCA zh – humic (having an Ah horizon at least 10 cm thick)	Gravelly coarse textured colluvium or weathered bedrock (residuum)
Spruce Ridge (SPR, SPRgr)	Orthic Gray Luvisol	gr – gravelly	Non-gravelly and gravelly medium to moderately fine textured till
Twin Bridges – AA (TBRaaco, TBRaazz, TBRaazzco)	Gleyed Humic Regosol and Orthic Humic Regosol	aa – not modal SCA co – coarser than modal zz – atypical subgroup	Gravelly and non-gravelly, coarse textured fluvial deposits
Tough Creek (TUC)	Orthic Gray Luvisol		Medium textured till overlying bedrock

Table 3.2-1 Major Soil Series and Variants of the Regional and Local Study Areas			
Soil Name (Code)	Subgroup¹	Most Common Variant Description	Parent Material & Comments
Willoughby (WLB and WLBzz)	Eluviated Dystric Brunisol and Orthic Dystric Brunisol	zz – atypical subgroup	Gravelly and non-gravelly, medium to moderately fine textured till

¹ Soil classification to the subgroup level based on the *Canadian System of Soil Classification* (SCWG, 1998).

3.3 Soil Map Units

3.3.1 Soil Map Unit Symbol

The soil map unit (SMU) symbol combines soil patterns and associated terrain information. The **Numerator**, termed the Soil Model, describes the soil patterns of a soil polygon and the **Denominator**, termed the Landform Model, describes the terrain.

3.3.2 Soil Model

The Soil Model is created by using one or two soil series symbols (*e.g.*, SPR and LTC, displayed as SPLT) that are considered dominant (>50% coverage) or co-dominant in a polygon (>30% coverage). Additionally, a numbering system is applied (*e.g.*, FVX4) that identifies patterns of significant soils (10-30% coverage) within a polygon. The following Soil Model numbers are used in the baseline mapping of the study area (adapted from ASIC, 2013):

- 1 soil map unit features significant soils that are either not identified in polygon or not strongly contrasting from dominant or co-dominant soils.
- 4 soil map unit feature significant soils that have Rego profiles are calcareous or eroded.
- 5 soil map unit feature significant finer textured soils than the dominant soil or co-dominant soils.
- 11 soil map unit features significant soils that have Rego profiles and significant soils that contain coarser textured profiles than the dominant or co-dominant soils.
- 16 soil map unit feature significant Chernozemic soils.
- 18 soil map unit features significant poorly drained soils and significant soils that contain finer textured profiles than the dominant or co-dominant soils.
- 20 soil map unit features significant¹ freely or imperfectly drained soils where the dominant or co-dominant soil types are poorly drained.

3.3.3 Landform Model

The Landform Model was used to describe terrain characteristics such as surficial material, landform surface shape and topography. Landform Model is composed of a group of letters and numbers, that provide information about the type of the surficial material (upper-case letters), surface expression (lower-case letters), and topographic slope class range given in brackets (*e.g., Ft (2-3)*). If one surficial material overlies another slash symbol was used (*e.g., Mv/Ri*).

Surficial Material

Surficial materials are of relatively young geological age and they constitute the parent material of most soils. The following surficial material symbols and definitions were used (adopted from SCWG (1998) and Terrain Classification System of British Columbia (Howes and Kenk, 1997)):

- A Anthropogenic.** These materials are artificial or modified by people and include those associated with mineral exploitation and waste disposal. They include materials constructed or deposited by people or geological materials modified by people so that their physical properties (structure, cohesion and compaction) have been drastically altered. These materials commonly possess a wide range of textures. The process is assumed to be active.
- C Colluvial.** These sediments are massive to moderately well stratified and non-sorted to poorly sorted with any range of particle sizes, from clay to boulders, and blocks that have reached their present position by direct, gravity-induced. They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches). The process is assumed to be active. Some residual material was mapped together with colluvial material. Colluvial material, which is derived from unconsolidated Quaternary sediments, that overlies and resembles its parent unit is mapped as the parent unit.
- F Fluvial.** These sediments generally consist of gravel and sand with a minor fraction of silt and rarely of clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately – to well-sorted and display stratification, but massive, non-sorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. The process is assumed to be inactive.
- FG Glaciofluvial.** These materials typically range from non-sorted and non-bedded gravel made up of a wide range of particle sizes, such as that resulting from very rapid aggradation at an ice front, to moderately – to well-sorted, stratified gravel. These materials exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice. The process is assumed to be inactive.
- M Morainal (till).** These sediments generally consist of well-compacted material that is non-stratified and contains a heterogeneous mixture of particle sizes. It commonly comprises a

mixture of sand, silt, and clay that has been transported beneath, beside, on, within, and in front of a glacier and not modified by any intermediate agent. The process is assumed to be inactive.

- O Organic.** These sediments composed largely of organic materials resulting from the accumulation of vegetative matter. They contain at least 30% organic matter by weight (17% or more organic carbon). The process is assumed to be active.
- R Bedrock.** Tightly packed, indurated materials of bedrock origin. The materials include igneous, metamorphic, sedimentary, and consolidated volcanic rocks used mostly as underlying material.
- U Undifferentiated.** This classification is used for a layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Surface Expression

The surface expression of genetic materials describes the form (shape) of the land surface or the thickness of the materials. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials (R), form refers to the product of their modification by geological processes. Surface expression also indicates how unconsolidated genetic materials relate to the underlying unit.

The following surface expression symbols and definitions were used (adopted from SCWG (1998) and Terrain Classification System of British Columbia (Howes and. Kenk, 1997)):

- b Blanket.** A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography. A blanket is greater than 1 m thick and possesses no constructional forms typical of the material's genesis; outcrops of the underlying unit are rare.
- h Hummocky.** A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular or conical knolls or knobs. The surface generally lacks concordance between knolls or depressions. Slopes are generally 9-70% (5-35°).
- i Inclined.** A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities.
- l Level.** A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1°).
- t Terraced.** A single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or gently inclined surface (tread) above it.

- v **Veneer.** Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer ranges from 10-100 cm in thickness and possesses no form typical of the material's genesis.
- w **Mantle of Variable Thickness.** A layer or discontinuous layer of surficial material of variable thickness (typically 0 to 3 m) that fills or partly fills depressions in an irregular substrate. It is generally too thin to mask prominent irregularities in the underlying material.

Slope Classes

A set of slope classes has been provided to make it possible to quantify the dominant but not necessarily most abundant slopes within a mapped unit of a local landform. Slope classes identified within the LSA and RSA were estimated through GIS analysis of the available LiDAR imagery, digital elevation models (slope analysis data) and data of the field inspections. There were eight slope classes used. Each slope is defined in terms of percent and degrees. The slope classes found in the study areas are summarized in [Table 3.3-1](#) (adopted from SCWG (1998)).

Table 3.3-1 Slope Classes Used for Mapping		
Slope class	Percent slope (%)	Approximate degrees (°)
1	0-0.5	0
2	>0.5-2	0.3-1.1
3	>2-5	>1.1-3
4	>5-10	>3-5
5	>10-15	>5-8.5
6	>15-30	>8.5-16.5
7	>30-45	>16.5-24
8	>45-70	>24-35
9	>70-100	>35-45

3.3.4 Soil Map Units

Thirty eight representative soil series and variants ([Table 3.2-1](#)) were organized into 21 soil models (SMs) representing common soil patterns found in the RSA and LSA. [Table 3.3-2](#) lists the SMs and provides a summary of selected features. Descriptions of the SMUs are provided in [Appendix B](#).

Table 3.3-2 Descriptive Summary of Soil Models of the Regional and Local Study Areas

Soil Model (SM)	Soil Patterns	Parent Material
CON5	Dom.: Connop (CON) – Eluviated Eutric Brunisol Signif.: Spruce Ridge-GR (SPRgr) – Orthic Gray Luvisol	Coarse textured glacial fluvial deposits; significant coarse textured veneer overlying till and moderately fine to medium textured till
DNL1	Dom.: Darnell (DNL) – Typic Mesisol Signif.: Mitford (MTF) – Terric Mesisol	Fen peat >160 cm thick, as well as scattered areas of thinner peat deposits
FVCP16	Co-Dom.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Co-Dom.: Copper-AA (CPXaa) – Orthic Dystric Brunisol Signif.: Bellevue-CO (BEVco) – Orthic Dark Brown Chernozem	Gravelly, coarse textured colluvial deposits; coarse textured weathered bedrock (residuum) or coarse textured colluvium overlying bedrock
FVCP4	Co-Dom.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Co-Dom.: Copper-AA (CPXaa) – Orthic Dystric Brunisol Signif.: Redoubt-AA (RDXaa) – Orthic Regosol	Gravelly, coarse textured colluvial deposits; coarse textured weathered bedrock (residuum), coarse textured colluvium overlying bedrock
FVHE4	Co-Dom.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Co-Dom.: Heather-AA (HEXaa) – Orthic Dystric Brunisol Signif.: Redoubt-AA (RDXaa) – Orthic Regosol	Gravelly, coarse textured colluvial deposits; medium textured colluvium overlying bedrock. Bedrock outcrops may occur.
FVNK16	Co-Dom.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Co-Dom.: Nickerson-AA (NKNaa) – Orthic Humic Regosol Signif.: Bellevue-CO (BEVco) – Orthic Dark Brown Chernozem	Gravelly, medium to moderately coarse textured colluvium or weathered bedrock (residuum)

Table 3.3-2 Descriptive Summary of Soil Models of the Regional and Local Study Areas

Soil Model (SM)	Soil Patterns	Parent Material
FVRD5	Co-Dom.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Co-Dom.: Redoubt-AA (RDXaa) – Orthic Regosol Signif.: Heather-AA (HEXaa) – Orthic Dystric Brunisol Signif.: Nickerson-AA (NKNaa) – Orthic Humic Regosol	Gravelly, coarse textured colluvium or weathered bedrock (residuum), significant medium textured colluvium and medium textured colluvium overlying bedrock
FVX4	Dom.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Signif.: Redoubt-AA (RDXaa) – Orthic Regosol	Gravelly, moderately coarse textured colluvial deposits; significant moderately coarse textured weather bedrock (residuum)
FVXfi11	Dom.: Fairview Mountain-AA, FI (FVXaafi) – Eluviated Dystric Brunisol Signif.: Fairview Mountain-AA (FVXaa) – Eluviated Dystric Brunisol Signif.: Redoubt-AA (RDXaa) – Orthic Regosol	Gravelly, medium textured colluvial deposits; significant moderately coarse textured colluvial deposits or weathered bedrock (residuum)
HDFR18	Co-Dom.: Hillsdale-AA (HDXaa) – Cumulic Regosol Co-Dom.: Fireside-AA (FRXaa) – Orthic Eutric Brunisol Signif.: Fireside-AA, FI (FVXaafi) – Orthic Eutric Brunisol Signif.: Miscellaneous Gleysols	Coarse to medium textured, often stratified fluvial materials
HDTB18	Co-Dom.: Hillsdale-AA (HDXaa) – Cumulic Regosol Co-Dom.: Twin Bridges-AA (TBRaa) – Gleyed Humic Regosol Signif.: Miscellaneous Gleysols	Gravelly and non-gravelly coarse to medium textured, often stratified fluvial materials
MTF20	Dom.: Mitford (MTF) – Terric Mesisol Signif.: Miscellaneous Gleysols	Peat overlying moderately fine textured material
NKRD1	Co-Dom.: Nickerson-AA (NKNaa) – Orthic Humic Regosol Co-Dom.: Redoubt-AA (RDXaa) – Orthic Regosol	Gravelly medium to coarse textured colluvium or weather bedrock (residuum)

Table 3.3-2 Descriptive Summary of Soil Models of the Regional and Local Study Areas		
Soil Model (SM)	Soil Patterns	Parent Material
SPgrWL1	Co-Dom.: Spruce Ridge-GR (SPRgr) – Orthic Gray Luvisol Co-Dom.: Willoughby (WLB) – Eluviated Dystric Brunisol	Gravelly, medium to moderately fine textured till
SPLT4	Co-Dom.: Spruce Ridge (SPR) – Orthic Gray Luvisol Co-Dom.: Leighton Centre (LTC) – Dark Gray Luvisol Signif.: Redoubt-AA (RDXaa) – Orthic Regosol	Medium to moderately fine textured till; significant gravelly, medium to moderately coarse textured weather bedrock (residuum) or colluvium
SPR1	Dom.: Spruce Ridge (SPR) – Orthic Gray Luvisol Signif.: Leighton Centre (LTC) – Dark Gray Luvisol	Medium to moderately fine textured till
SPRgr1	Dom.: Spruce Ridge-GR (SPRgr) – Orthic Gray Luvisol Signif.: Leighton Centre-GR (LTCgr) – Dark Gray Luvisol	Gravelly, medium to moderately fine textured till
TUCD1	Co-Dom.: Tough Creek (TUC) – Orthic Gray Luvisol Co-Dom.: Cadomin-AA (CDMaa) – Eluviated Dystric Brunisol	Medium textured till overlying bedrock and medium textured weathered bedrock (residuum)
NS	Non-soil Unit (<i>e.g.</i> , rock slides)	Colluvium
ZDL	Disturbed Lands	Anthropogenic
ZWA	Open Water	

During the baseline survey, 27 terrain types described as Landform Models (LMs) were recognized as being large enough to map at the 1:15,000-production scale. The terrain types and associated slope classes used to describe the terrain for the soil and terrain map is summarized in [Table 3.3-3](#).

[Figure 3.3-1](#) displays the distribution of the slope classes recorded within the RSA and LSA.

Table 3.3-3 Descriptive Summary of Landform Models of the Regional and Local Study Areas

Surficial Material and Surface Expression Code	Associated Slope Classes and Slope Gradient (%)	Description
Cb/Ri	6-7 (15-45) 7-8 (30-70)	Colluvium blanket overlying bedrock (bedrock-controlled topography)
Cw/Rh	5-7 (10-45)	Colluvium mantle of variable thickness over hummocky bedrock. Bedrock outcrop may occur.
Cw/Ri	5-6 (10-30) 5-7 (10-45) 6-7 (15-45) 7-8 (30-70) 8-9 (45-100)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography). Bedrock outcrop may occur.
FGt	3-4 (2-10)	Terraces made up of glaciofluvial deposits
Fl	1-3 (0-5)	Fluvial plain (floodplain)
Fi	3-4 (2-10)	fluvial deposits on slope
Ft	3-4 (2-10) 4-7 (5-45)	Terraces made up of fluvial deposits
Mb/Ri	4-5 (5-15) 5-6 (10-30) 6-7 (15-45)	Till blanket overlying bedrock (bedrock-controlled topography)
Mv/Ri	6-7 (15-45) 7-8 (30-70)	Till veneer overlying bedrock (bedrock-controlled topography). Bedrock outcrop are common
Mw/Rh	4-6 (5-30) 6-8 (15-70)	Till mantle of variable thickness over hummocky bedrock. Bedrock outcrops may occur.
Mw/Ri	5-6 (10-30) 5-7 (10-45) 6-7 (15-45) 7-8 (30-70)	Till mantle of variable thickness over bedrock (bedrock-controlled topography). Bedrock outcrops may occur.
Ol	1-2 (0-2)	Level, flat peatland
Ov/Mi	3-5 (2-15)	Organic veneer over sloping morainal deposits of unknown thickness (more likely overlying bedrock)
Ui	7-9 (30-100)	Undifferentiated material (till, colluvium, or bedrock material) outcropping on a steep creek bank escarpment.

3.3.5 Soil Map Unit Areas – Local Study Area and Regional Study Area

The LSA was surveyed to achieve a higher survey intensity level than lands located outside of the LSA ([Section 3.1.1](#)). The available soil and terrain information located within the LSA can support a baseline soil and terrain map appropriate for a 1:10,000 production scale. The SIL achieved within the RSA (excluding the LSA) is capable of supporting a production scale of 1:15,000. Due to the differences in the RSA and LSA survey intensity levels, the baseline soil and terrain maps produced for this Project provide soil and terrain information to the smallest production scale based on achieved survey intensities (1:15,000).

[Figures 3.3-2 to 3.3-5](#) display the baseline soil and terrain map for the RSA. [Table 3.3-4](#) presents map unit summary information for the RSA and LSA.

Table 3.3-4 Soil Map Unit Count and Area Calculations for the Regional and Local Study Areas				
Soil Map Unit (SMU)	Distribution within the RSA		Distribution within the LSA	
	Area (ha)	Percent Cover (%)	Area (ha)	Percent Cover (%)
<u>CON5</u> FGt(3-4)	6.6	0.1	1.7	0.1
<u>DNL1</u> Ol(1-2)	16.2	0.4	15.8	1.0
<u>FVCP16</u> Cw/Ri(7-8)	79.3	1.7	36.0	2.4
<u>FVCP16</u> Cw/Ri(8-9)	22.7	0.5	22.7	1.5
<u>FVCP4</u> Cw/Ri(5-6)	85.5	1.9	14.6	1.0
<u>FVCP4</u> Cw/Ri(6-7)	466.3	10.2	214.9	14.1
<u>FVCP4</u> Cw/Ri(7-8)	415.1	9.1	24.6	1.6
<u>FVCP4</u> Cw/Ri(8-9)	85.5	1.9	75.7	5.0
<u>FVHE4</u> Cw/Ri(5-7)	27.6	0.6	0	0
<u>FVHE4</u> Cw/Ri(7-8)	269.4	5.9	0.3	<0.1

Table 3.3-4 Soil Map Unit Count and Area Calculations for the Regional and Local Study Areas

Soil Map Unit (SMU)	Distribution within the RSA		Distribution within the LSA	
	Area (ha)	Percent Cover (%)	Area (ha)	Percent Cover (%)
<u>FV NK16</u> Cw/Ri(6-7)	28.9	0.6	24.1	1.6
<u>FVRD5</u> Cw/Ri(6-7)	32.0	0.7	32.0	2.1
<u>FVRD5</u> Cw/Ri(7-8)	346.0	7.6	311.8	20.5
<u>FV X4</u> Cb/Ri(6-7)	20.2	0.4	0	0
<u>FV X4</u> Cb/Ri(7-8)	186.4	4.1	32.1	2.1
<u>FV X4</u> Cw/Rh(5-7)	33.8	0.7	33.8	2.2
<u>FV X4</u> Cw/Ri(5-6)	7.7	0.2	0	0
<u>FV Xfi11</u> Cw/Ri(6-7)	58.8	1.3	31.3	2.1
<u>FV Xfi11</u> Cw/Ri(7-8)	316.8	7.0	122.6	8.1
<u>HDFR18</u> Fl(1-3)	114.6	2.5	3.5	0.2
<u>HDFR18</u> Ft(4-7)	34.9	0.8	0	0
<u>HDTB18</u> Fi(3-4)	33.4	0.7	22.8	1.5
<u>HDTB18</u> Ft(3-4)	77.9	1.7	4.2	0.3
<u>MTF20</u> Ol(1-2)	6.4	0.1	3.1	0.2
<u>MTF20</u> Ov/Mi(3-5)	4.4	0.1	0	0
<u>NKRD1</u> Ui(7-9)	74.7	1.6	2.5	0.2

Table 3.3-4 Soil Map Unit Count and Area Calculations for the Regional and Local Study Areas

Soil Map Unit (SMU)	Distribution within the RSA		Distribution within the LSA	
	Area (ha)	Percent Cover (%)	Area (ha)	Percent Cover (%)
<u>NS</u> Cw/Ri(7-8)	40.6	0.9	27.8	1.8
<u>NS</u> Cw/Ri(8-9)	6.9	0.2	6.1	0.4
<u>SPgrWL1</u> Mb/Ri(4-5)	144.8	3.2	6.9	0.5
<u>SPgrWL1</u> Mb/Ri(5-6)	39.9	0.9	15.7	1.0
<u>SPgrWL1</u> Mw/Ri(5-6)	75.8	1.7	3.6	0.2
<u>SPgrWL1</u> Mw/Ri(5-7)	118.3	2.6	31.4	2.1
<u>SPLT4</u> Mw/Ri(6-7)	109.5	2.4	2.4	0.2
<u>SPR1</u> Mb/Ri(5-6)	246.1	5.4	55.0	3.6
<u>SPR1</u> Mb/Ri(6-7)	60.4	1.3	16.1	1.1
<u>SPR1</u> Mw/Rh(4-6)	9.9	0.2	1.7	0.1
<u>SPRgr1</u> Mb/Ri(5-6)	135.7	3.0	21.4	1.4
<u>SPRgr1</u> Mb/Ri(6-7)	124.5	2.7	0	0
<u>SPRgr1</u> Mw/Rh(6-8)	26.9	0.6	8.6	0.6
<u>SPRgr1</u> Mw/Ri(6-7)	58.2	1.3	47.5	3.1
<u>SPRgr1</u> Mw/Ri(7-8)	17.8	0.4	6.1	0.4
<u>TUCD1</u> Mv/Ri(6-7)	93.7	2.1	3.8	0.3

Table 3.3-4 Soil Map Unit Count and Area Calculations for the Regional and Local Study Areas				
Soil Map Unit (SMU)	Distribution within the RSA		Distribution within the LSA	
	Area (ha)	Percent Cover (%)	Area (ha)	Percent Cover (%)
TUCD1 Mv/Ri(7-8)	17.2	0.4	0.6	<0.1
ZDL	372.6	8.2	236.2	15.5
ZWA	0.3	<0.1	0.1	<0.1
TOTALS ¹	4,549.8	100	1,520.7	100

¹ Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

BOLD – Bolded value (ha and %) represents the largest 3 numbers within each column.

4.0 BASELINE SOIL INTERPRETATIONS

Soil interpretations detailed in [Section 4.1](#) to [4.4](#) describe the current baseline conditions (Baseline Case) of the soil and terrain assessment. This information is used in the impact assessment to help determine Project specific and cumulative effects. Baseline soil and terrain interpretations include soil layer thickness, soil suitability as reclamation material, and erosion assessment of soil and terrain patterns. Land capability relating to pre and post disturbance (as defined in the TOR Section 3.9.2 [A] (b)) ([Table 1.2-1](#)) is assessed quantitatively based on baseline conditions, expected soils handling and reclamation processes, expected reclaimed land uses and desired end land use objectives.

Morphological and analytical data from the following sources were utilized in assessing the baseline soil and terrain conditions within the LSA and RSA:

- 457 soil inspection sites; and
- laboratory analysis of 26 sampled soil profiles.

4.1 Thickness of Soil Layers

Estimating average soil layer depths assists in determining suitable soil salvage and stockpiling requirements for reclamation purposes. For the purpose of volume calculations the litter material, surface peat and mineral soil layers were defined as follows:

- Surface litter/shallow organics – under forested vegetation the surface litter is commonly comprised of L, F, and H layers (L – forest litter; F – fibric; and H – humic) of various thicknesses and shallow organic layers (peaty overlays) are organic layers (Of, Om, and Oh) <40 cm thick (SCWG, 1998). Shallow organic layers are considered to constitute mainly transitional landscapes. Organic material thicknesses >40 cm typically occur in organic landscapes (termed deep organics). In instances where the dominant organic material is fibric, the total thickness to qualify as a deep organic is >60 cm (SCWG, 1998).
- Deep Organics – organic material profiles differentiated by degree of decomposition (Of, Om, and Oh) layers that have a total thickness of >40 cm. If the dominant organic material is fibric, a total thickness of >60 cm is required to qualify as a deep organic (SCWG, 1998).
- A horizons - this mineral horizons form at or near the surface in the zone of leaching or eluviation of materials in solution or suspension, or of maximum in situ accumulation of organic matter or both (SCWG, 1998).
- B horizons- this mineral horizon is characterized by enrichment in organic matter, sesquioxides, or clay; or by the development of soil structure; or by a change of color denoting hydrolysis, reduction, or oxidation (SCWG, 1998).
- C horizons- this mineral horizon is comparatively unaffected by the pedogenic processes operating in the A and B horizons (SCWG, 1998).
- Upland surface soil – a stratum salvaged from an upland soil that includes the forest floor, A horizon and in some cases part or all of the B horizon (AEW, 2012), and is referred to as reclamation material in the ToR (Section 3.2.8[A]h).

All soil data collected was analyzed to determine average thicknesses of soil layers for the soil map units. Layer thickness data was grouped by SMU (*e.g.*, HDFS18/F1 (1-3) to provide a spatial framework for the calculated means and account for variability in soil thickness caused by landscape influence. Determining profile thicknesses in this manner allows for a good representation of typical profile orientations based on the landscape in which these profiles were formed. Sites deemed to be inclusions within each SLM were excluded from the averaging calculation. Non-soil map units (ZDL, NS and ZWA) were not included in the determination of soil thickness. Horizon/layer thickness averages were rounded to the nearest 5 cm.

The majority of landscapes within the proposed soil disturbance area are colluvium/bedrock controlled. Soils developed in this environment are usually juvenile with little or no profile

development. The upland areas have thin leaf litter and A horizons; therefore, salvage of a part or all of the B horizon is recommended to meet the reclamation materials balance requirements. Along with meeting reclamation materials balance requirements this will minimize the risk of degrading the quality of the reclamation material via the incorporation of marginal reclamation material substrates from greater depths. This also provides an adequate volume of good-quality soil for use in reclamation to achieve end land use objectives. Benga will salvage the available upland surface soil and deep organic material prior to mining commencing. Material that has been salvaged for reclamation activities is called reclamation material as per ToR (Section 3.2.8[A]h). [Table 4.1-1](#) displays the estimated horizon/layers thicknesses per map unit. The results are displayed spatially in [Figure 4.1-1](#).

Table 4.1-1 Baseline Soil Layer Thicknesses by Soil Model

Soil Map Unit	Map Unit contains Upland Surface Soil (as per AER) (Yes/No)	Thickness (cm)						Estimated Average Depth to Bedrock (cm) (lithic/paralithic contact) ²
		Number of Sites within Map unit	Deep Organics	Upland Surface Soil			Estimated Upland Surface Soil Available ¹	
				Litter / Shallow Organics	A horizons	B Horizons		
<u>CON5</u> FGt(3-4) ³	Yes	1	-	5	10	10	25	>65
<u>DNL1</u> Ol(1-2)	No	2	200	-	-	-	-	>200
<u>FVCP16</u> Cw/Ri(7-8)	Yes	15	-	0	10	15	25	30-80+
<u>FVCP16</u> Cw/Ri(8-9)	Yes	7	-	0	10	10	20	30-100+
<u>FVCP4</u> Cw/Ri(5-6)	Yes	6	-	0	5	10	15	15-35+
<u>FVCP4</u> Cw/Ri(6-7)	Yes	8	-	5	0	20	25	40-75+
<u>FVCP4</u> Cw/Ri(7-8)	Yes	4	-	5	5	35	45	40-95+
<u>FVCP4</u> Cw/Ri(8-9)	Yes	25	-	5	10	25	40	40-100+
<u>FVHE4</u> Cw/Ri(5-7)	Yes	3	-	5	0	25	30	35-100+
<u>FVHE4</u> Cw/Ri(7-8)	Yes	3	-	5	10	15	30	50-90+

Table 4.1-1 Baseline Soil Layer Thicknesses by Soil Model

Soil Map Unit	Map Unit contains Upland Surface Soil (as per AER) (Yes/No)	Thickness (cm)						Estimated Average Depth to Bedrock (cm) (lithic/paralithic contact) ²
		Number of Sites within Map unit	Deep Organics	Upland Surface Soil			Estimated Upland Surface Soil Available ¹	
				Litter / Shallow Organics	A horizons	B Horizons		
<u>FVNK16</u> Cw/Ri(6-7)	Yes	2	-	0	20	0	20	20-100+
<u>FVRD5</u> Cw/Ri(6-7)	Yes	5	-	0	10	5	15	40-100+
<u>FVRD5</u> Cw/Ri(7-8)	Yes	55	-	5	5	20	30	25-100+
<u>FVX4</u> Cb/Ri(6-7) ³	Yes	2	-	5	0	40	45	>55
<u>FVX4</u> Cb/Ri(7-8)	Yes	22	-	5	5	25	35	50-100+
<u>FVX4</u> Cw/Rh(5-7)	Yes	5	-	0	10	20	30	30-100+
<u>FVX4</u> Cw/Ri(5-6)	Yes	2	-	5	10	10	25	45-65+
<u>FVXfi11</u> Cw/Ri(6-7)	Yes	7	-	0	15	30	45	30-100+
<u>FVXfi11</u> Cw/Ri(7-8)	Yes	44	-	5	10	25	40	30-100+
<u>HDFR18</u> Fl(1-3) ³	Yes	4	-	5	5	10	20	>30

Table 4.1-1 Baseline Soil Layer Thicknesses by Soil Model								
Soil Map Unit	Map Unit contains Upland Surface Soil (as per AER) (Yes/No)	Thickness (cm)						Estimated Average Depth to Bedrock (cm) (lithic/paralithic contact) ²
		Number of Sites within Map unit	Deep Organics	Upland Surface Soil			Estimated Upland Surface Soil Available ¹	
				Litter / Shallow Organics	A horizons	B Horizons		
<u>HDFR18</u> Ft(4-7) ³	Yes	3	-	0	10	5 ⁵	15	>30 ⁵
<u>HDTB18</u> Fi(3-4) ³	Yes	4	-	5	10	15	30	>100
<u>HDTB18</u> Ft(3-4) ³	Yes	8	-	0	10	5	15	>40
<u>MTF20</u> Ol(1-2)	No	1	50	-	-	-	-	>100
<u>MTF20</u> Ov/Mi(3-5)	No	2	50	-	-	-	-	>100
<u>NKRD1</u> Ui(7-9)	Yes	7	-	0	10	5	15	35-70+
<u>NS</u> Cw/Ri(7-8)	-	14	NR	NR	NR	NR	NR	NR
<u>NS</u> Cw/Ri(8-9)	-	0	NR	NR	NR	NR	NR	NR
<u>SPgrWL1</u> Mb/Ri(4-5) ³	Yes	5	-	5	15	20	40	>40
<u>SPgrWL1</u> Mb/Ri(5-6) ³	Yes	5	-	5	10	25	40	>50
<u>SPgrWL1</u> Mw/Ri(5-6) ³	Yes	5	-	5	10	25	40	>65

Table 4.1-1 Baseline Soil Layer Thicknesses by Soil Model								
Soil Map Unit	Map Unit contains Upland Surface Soil (as per AER) (Yes/No)	Thickness (cm)						Estimated Average Depth to Bedrock (cm) (lithic/paralithic contact) ²
		Number of Sites within Map unit	Deep Organics	Upland Surface Soil			Estimated Upland Surface Soil Available ¹	
				Litter / Shallow Organics	A horizons	B Horizons		
<u>SPgrWL1</u> Mw/Ri(5-7) ³	Yes	16	-	5	10	25	40	>50
<u>SPLT4</u> Mw/Ri(6-7) ³	Yes	12	-	5	15	15	35	>30
<u>SPR1</u> Mb/Ri(5-6) ³	Yes	16	-	5	10	35	50	>60
<u>SPR1</u> Mb/Ri(6-7) ³	Yes	6	-	5	10	35	50	>65
<u>SPR1</u> Mw/Rh(4-6) ³	Yes	2	-	0	10	40	50	>50
<u>SPRgr1</u> Mb/Ri(5-6) ³	Yes	13	-	5	10	30	45	>50
<u>SPRgr1</u> Mb/Ri(6-7) ³	Yes	13	-	5	10	25	40	>50
<u>SPRgr1</u> Mw/Rh(6-8)	Yes	1 ⁴	-	5	10	20	35	>55
<u>SPRgr1</u> Mw/Ri(6-7)	Yes	16	-	5	15	30	50	40-100+
<u>SPRgr1</u> Mw/Ri(7-8)	Yes	1	-	0	10	30 ⁵	40	25-100+ ⁵
<u>TUCD1</u> Mv/Ri(6-7)	Yes	3	-	5	5	25	35	40

Table 4.1-1 Baseline Soil Layer Thicknesses by Soil Model

Soil Map Unit	Map Unit contains Upland Surface Soil (as per AER) (Yes/No)	Thickness (cm)						Estimated Average Depth to Bedrock (cm) (lithic/paralithic contact) ²
		Number of Sites within Map unit	Deep Organics	Upland Surface Soil			Estimated Upland Surface Soil Available ¹	
				Litter / Shallow Organics	A horizons	B Horizons		
<u>TUCD1</u> Mv/Ri(7-8)	Yes	3	-	5	10	30	45	80
ZDL	-	30	NR	NR	NR	NR	NR	10-100+
ZWA	-	-	NR	NR	NR	NR	NR	NR

¹Upland Surface Soil includes the mineral A and B horizons plus the litter/surface organic layer. In mineral soils, this is the salvage depth for the reclamation material.

²Estimated depth to lithic / paralithic contact is based on a soil investigation to a target of 100 cm.

³Bedrock contact was not made due to coarse fragment refusal.

⁴Soil inspections immediately adjacent to the RSA was utilized

⁵Data from the same SM with similar terrain were also utilized.

NR – Not rated for soil thickness.

Soil volumes for the Project are provided in the C&R Plan for the Project ([Section F](#) of the Application) in [Table F.2.2-2](#).

4.2 Reclamation Suitability

Reclamation suitability ratings provide information that is useful for making soil handling recommendations, and guidance as to soil types that may present challenges for reclamation. Reclamation suitability was assessed for the various soil horizons (*i.e.*, A, B and C horizons), of sampled soils in the RSA and LSA that constitute root zone material. This assessment followed the *Soil Quality Criteria Relative to Disturbance and Reclamation Guidelines* as specified for the Eastern Slopes Region of Alberta (SQCWG, 1987). Ratings parameters include: soil reaction (pH), salinity (measured by electrical conductivity (EC)), sodicity (measured by sodium adsorption ratio (SAR)), saturation percentage (sat %), coarse fragment (% volume), soil texture, consistency, and calcium carbonate equivalent (CCE). The pH values used in the rating system for the Eastern slopes are most appropriate for trees, primarily conifers (SQCWG, 1987).

Ratings categories included:

- **Good (G):** no or slight limitations that affect use as a plant growth medium;
- **Fair (F):** moderate limitations that affect use but can be overcome by proper planning and good management;
- **Poor (P):** severe limitations that make use questionable. This does not mean the material cannot be used, but rather careful planning and very good management is required; and
- **Unsuitable (U):** chemical or physical properties are so severe reclamation would not be economically feasible or in some cases impossible (*i.e.*, special reclamation strategies must be implemented and land use may be severely restricted) (SQCWG 1987).

More details on the application of the *Soil Quality Criteria Relative to Disturbance and Reclamation Guidelines* are provided in [Appendix C \(Table C-1\)](#).

All sampled soil series in the RSA and LSA were rated for reclamation suitability based on the rating parameters listed in the reclamation suitability document ([Appendix C, Table C-2](#) for series ratings).

Reclamation suitability ratings were determined for Soil Models (*i.e.*, FVCP4) through amalgamation of individual soil series ratings of dominant and co-dominant soils estimated to occur in each Soil Model. SMs dominated by Organic soils (*i.e.*, soils with >40 cm of peat) were not included in the assessment as the guidelines are specific to mineral soils. A more detailed description of the methodology and assumptions used to calculate reclamation suitability is provided in [Appendix C](#).

Soil Model ratings are listed in [Table 4.1-2](#) and include ratings for A, B and C horizons materials. [Figure 4.1-2](#) displays reclamation suitability ratings for the A horizons and [Figure 4.1-3](#) and [4.1-4](#) display suitability ratings for B and C horizons materials, respectively.

Table 4.1-2 Reclamation Suitability Ratings for Soil Models				
Soil Model (SM)	Reclamation Suitability Ratings			Comments/Limitations
	A horizons	B Horizons	C Horizons ¹	
CON5	P	P	P	A – coarse texture B – coarse texture C – alkaline pH, coarse texture
DNL1	-	-	-	Organic Material – not rated
FVCP16	P	G-F	F	A – high coarse fragment content B – high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content
FVCP4	P	G-F	F	A – high coarse fragment content B – high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content
FVHE4	P	F	F	A – high coarse fragment content B – slightly acidic pH, high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content
FVNK16	P	F	F-U	A – high coarse fragment content B – high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content
FVRD5	P	F	F-P	A – high coarse fragment content B – high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content

Table 4.1-2 Reclamation Suitability Ratings for Soil Models

Soil Model (SM)	Reclamation Suitability Ratings			Comments/Limitations
	A horizons	B Horizons	C Horizons ¹	
FVX4	P	F	F	A – high coarse fragment content B – high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content
FVXfi11	P	F	F	A – high coarse fragment content B – high saturation %, high coarse fragment content C – high saturation %, high coarse fragment content
HDFR18	-	U	P-U	A – minimal to no mineral A in soils of the SM B – high coarse fragment content C – alkaline pH, coarse texture, high coarse fragment content
HDTB18	U	-	P-U	A – high saturation % B – minimal to no B in soils of the SM C – alkaline pH, coarse texture, high coarse fragment content
MTF20	-	-	F-P	Organic Material – slightly alkaline pH A – minimal to no mineral A in soils of the SM B – minimal to no B in soils of the SM C – alkaline pH, high saturation %, sticky/firm consistence
NKRD1	P	-	P-U	A – high coarse fragment content B – minimal to no B in soils of the SM C – high coarse fragment content
NS	-	-	-	Non-soil Unit – not rated
SPgrWL1	F	G-P	G-P	A – slightly alkaline pH, high saturation % B – alkaline pH C – alkaline pH
SPLT4	G-F	F	P	A – high coarse fragment content B – slightly alkaline pH, finer textures, firm consistence C – alkaline pH

Table 4.1-2 Reclamation Suitability Ratings for Soil Models

Soil Model (SM)	Reclamation Suitability Ratings			Comments/Limitations
	A horizons	B Horizons	C Horizons ¹	
SPR1	F	F	P	A – high coarse fragment content B – slightly alkaline pH, finer textures, firm consistence C – alkaline pH
SPRgr1	F	P	P	A – slightly alkaline pH B – alkaline pH C – alkaline pH
TUCD1	G-U	G	G-U	A – high saturation % B – no limitations C – high coarse fragment content
ZDL	-	-	-	Disturbed Land – not rated
ZWA	-	-	-	Open Water – not rated

¹ BC horizon was rated together with C horizon

4.2.1 A Horizons Ratings

The A horizon soil material ranged mostly from fair (F) to poor (P) as reclamation growth media. The most common limitations for A horizons were high coarse fragment content and slightly alkaline soil pH. A horizons in soils from two Soil Models (HDTB18 and TUCD1) were rated as unsuitable for reclamation due to very high saturation percentage. No severe limitations on pH, salinity or sodicity were found in these soils.

4.2.2 B Horizons Ratings

The B horizons ranged from good (G) to poor (P) as reclamation media. Limitations included high coarse fragment content, high saturation percentage and slightly alkaline pH. The B horizon was rated as unsuitable (U) in one Soil Model (HDFR18) due to very high coarse fragment content.

4.2.3 BC and C Horizons Ratings

BC and C horizons ranged mostly from fair to (F) to poor (F-P) as reclamation media. Limitations were similar to those in B horizons and included high coarse fragment content, high saturation

percentage and slightly alkaline pH. BC/C horizons in five Soil Models (FVNK16, HDFR18, HDTB18, NKRD1, TUCD1) were rated as unsuitable due to very high coarse fragment content.

4.2.4 Ratings Summary

The A and B horizon material are considered to be fair material for reclamation. With proper management and reclamation planning, these soils will provide a suitable growth media for reclamation and revegetation of the Project. Issues related to coarse fragment content are not seen as reclamation barriers for establishment of forested ecosystems and will likely provide for a range of microhabitats and moisture regimes post reclamation. No severe limitations on pH, salinity or sodicity were found.

Lithic contacts occur in select map units. It is expected that, through Project development and subsequent overburden removal, shallow bedrock outcrops will be removed and sufficient soil material will be replaced post reclamation such that lithic/paralithic contact (within 100 cm of surface) will be minimized. Evaluation of organic materials indicates that this material is suitable for use in reclamation.

4.3 Baseline Erosion Risk Assessment

Soil erosion by wind or water can affect soil profiles and distribution of soils in the landscape. Soil erosion is dependent on soil texture, slope gradient, length of slope, and vegetation type and cover. In areas where vegetation has been cleared and the soil surface disturbed, the risk of erosion generally increases. Bare soil has higher erosion potential than undisturbed profiles due to the lack of mechanisms that can reduce or minimize the erosive energy of wind or water.

The following erosion risk assessment provides existing erosion ratings for baseline conditions as well as estimated erosion potential for reclamation material based on scenarios (mitigated and unmitigated) during soil salvage and replacement. The scenarios consider the reclaimed landscapes in which these soils are likely to occur. It is expected that the reclaimed landscapes will be comprised of different landscape forms; however, it is expected that the range of slope lengths and slope gradients recorded at baseline will occur in the reclaimed landscape. Therefore, the resultant erosion estimates are applicable for comparison to a reclaimed setting.

4.3.1 Soil Erosion Risk - Water

Soil erosion via water was evaluated for the dominant and co-dominant soils of all soil map units within the RSA. The rate of water erosion was estimated using the *Revised Universal Soil Loss Equation for Application in Canada* (RUSLEFAC) (Wall *et al.*, 2002). The RUSLEFAC was developed to predict average soil loss by water erosion, taking into account rainfall, soil and landscape characteristics, and management practices for the different conditions encountered in the various regions of Canada. Factors considered when estimating soil loss via water (A) include: rainfall and runoff (R), soil erodibility factor (K), slope factor (LS), crop/vegetation and management Factor (C), and support or management practices (P).

Variables used in calculating the water erosion risk ratings included:

- The rainfall and runoff factor (R) was estimated to be 370 based on Figure R-3a and R-3b of the RUSLEFAC document (Wall *et al.*, 2002).
- The soil erodibility factor (K) was calculated using laboratory analysis data and Soil Erodibility nomograph (Figure K-1 (Wall *et al.*, 2002)). Coarse fragments content was used to adjust soil profile permeability. If particle size analysis was unavailable field texture data and associated information from Table K-3 (Wall *et al.*, 2002) were used. K factor values ranged from 0.004 to 0.052.
- Average slope length used for calculation of LS (Slope or Topographic Factor) ranged from 5 to 300 m, average slope gradient ranged from 1 to 60%. LS values for baseline conditions were determined using Table LS-1 of RUSLEFAC (Wall *et al.*, 2002), *i.e.*, LS for consolidated soil conditions with cover. LS values for construction and reclaimed conditions were determined using Table LS-3, *i.e.*, LS for highly disturbed soil conditions and freshly prepared construction sites, with little or no cover. LS values ranged from 0.2 for short gentle slopes to 50.43 for longer steep slopes.
- The crop/vegetation and management factor (C) for baseline condition was determined according to Table C-5, C values for permanent pasture, range, and idle land, Table C-6, C values for undisturbed forest land. C ratings ranged from 0.001 to 0.04 depending on site conditions. For construction and reclaimed conditions with no mitigations, “bare soil” was evaluated, where the C factor was given a value of 1. For mitigated conditions C factor was taken from Table C-8 – Mulch values and slope limits for construction slopes, using minimal application of wood mulch (7 tons/acre), where the C factor was given a value of 0.08;

- management practices (P) factor was deemed irrelevant to the existing and post-construction land use and so was given the value of 1 (*e.g.*, having zero effect on the erosion calculation); and
- potential soil loss (A) in tonnes/ha/year was calculated by the equation $A=R*K*LS*C*P$ for each series and condition. An overall SMU erosion potential estimate was then calculated by adding the proportional values contributed by each series as per estimated distribution within each map unit. The resulting SMU “A” value in tonnes/ha was then ranked into one of five erodibility classes as per Table 1.1 in Wall *et al.*, (2002) The five potential erodibility classes are Very Low, Low, Moderate, High, and Severe.

Due to the variations of vegetation in the area, baseline calculations were run for three vegetation systems. The three vegetation systems assessed included grassland (C values of 0.01-0.04, depending on percent ground cover), open canopy forest (C values of 0.01-0.04), and closed canopy forest areas (C value of 0.001) (Wall *et al.*, 2002). The “C” value used for each soil map unit was chosen based on the vegetation observed in field and airphoto interpretation.

As most of the area is made up of complex slopes where the slope gradient and slope length are very variable within each landform model, the landscape system were calculated as a “mosaic” of slopes for each landform model. To simulate this landscape system, “A” values were calculated for various LS situations that would occur within each landform model. These “A” values were then averaged to create an amalgamated “A” value for each landform model for each dominant and co-dominant soil series. The slope gradients and slope lengths that were used for each landform model were based off of field notes and LIDAR data.

Table 4.3-1 lists water risk ratings for the following scenarios:

- Baseline conditions: estimated current water erosion risk ratings under current vegetated conditions.
- Recently reclaimed landscapes (no mitigation) – bare upland surface soil replaced on re-contoured slopes, slope lengths and slope gradients estimated to be similar to baseline conditions. This scenario assumes that slope steepness and lengths of the reclaimed areas will have similar attributes to the slope descriptors used to map the RSA.
- Recently reclaimed landscapes (mitigation activities implemented) – replaced upland surface soil on re-contoured slopes then a mulch or tackifier added for soil stabilization until vegetation establishment and slope length limited (*i.e.*, limited by slope breaks).

- Subsoil: (no mitigation) – subsoil material that is exposed due to upland surface soil being recently removed (at salvage) or upland surface soil not yet replaced on subsoil material (reclamation stage).
- Subsoil: (mitigation activities implemented) – subsoil material that is exposed due to upland surface soil being recently removed (at salvage) or upland surface soil not yet replaced on subsoil material (reclamation stage). Assumes mitigation is in place; such as mulch or tackifier added for soil stabilization, and slope length limited.

The scenarios were selected to display various water erosion risk ratings estimated to be applicable to soil materials during different stages of the project development above existing baseline conditions. The estimated ratings after the implementation of mitigative measures are not meant to indicate that the addition of mulch or tackifier is a requirement to address potential water erosion. The mitigation factor provided is meant to demonstrate the decrease of erosion potential of soils within the RSA when effective mitigation is implemented on reclaimed landscapes with a range of slopes and slope lengths.

Water erosion risk for this assessment will be based on the information provided in [Table 4.3-1](#). Soils estimated to be at risk via water erosion are soil map units that were rated as to be at moderate or higher water erosion risk after implementation of the aforementioned example of mitigation.

Table 4.3-1 Water Erosion Risk Ratings for Soil Map Units

Soil Map Unit	Baseline Conditions ¹	Upland Surface Soil		Subsoil		Comments
		Recently Reclaimed, no Mitigations	Mitigation Implemented ²	Exposed Subsoil, no Mitigations	Mitigation Implemented ²	
<u>CON5</u> FGt(3-4)	Very Low	Very Low	Very Low	Very Low	Very Low	-
<u>DNL1</u> OI(1-2)	Very Low	Very Low	Very Low	Very Low	Very Low	-
<u>FVCP16</u> Cw/Ri(7-8)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVCP16</u> Cw/Ri(8-9)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied

Table 4.3-1 Water Erosion Risk Ratings for Soil Map Units

Soil Map Unit	Baseline Conditions ¹	Upland Surface Soil		Subsoil		Comments
		Recently Reclaimed, no Mitigations	Mitigation Implemented ²	Exposed Subsoil, no Mitigations	Mitigation Implemented ²	
<u>FVCP4</u> Cw/Ri(5-6)	Very Low	Severe	Very Low	Severe	Low	-
<u>FVCP4</u> Cw/Ri(6-7)	Very Low	Severe	Low	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVCP4</u> Cw/Ri(7-8)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVCP4</u> Cw/Ri(8-9)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVHE4</u> Cw/Ri(5-7)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVHE4</u> Cw/Ri(7-8)	Very Low	Severe	High	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVNK16</u> Cw/Ri(6-7)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVRD5</u> Cw/Ri(6-7)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVRD5</u> Cw/Ri(7-8)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVX4</u> Cb/Ri(6-7)	Very Low	Severe	Low	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied

Table 4.3-1 Water Erosion Risk Ratings for Soil Map Units

Soil Map Unit	Baseline Conditions ¹	Upland Surface Soil		Subsoil		Comments
		Recently Reclaimed, no Mitigations	Mitigation Implemented ²	Exposed Subsoil, no Mitigations	Mitigation Implemented ²	
<u>FVX4</u> Cb/Ri(7-8)	Very Low	Severe	Low	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVX4</u> Cw/Rh(5-7)	Very Low	Severe	Very Low	Severe	Low	-
<u>FVX4</u> Cw/Ri(5-6)	Very Low	Severe	Very Low	Severe	Very Low	-
<u>FVXfi11</u> Cw/Ri(6-7)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>FVXfi11</u> Cw/Ri(7-8)	Very Low	Severe	High	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>HDFR18</u> Fi(1-3)	Very Low	Very Low	Very Low	Very Low	Very Low	-
<u>HDFR18</u> Ft(4-7)	Very Low	Very Low	Very Low	Very Low	Very Low	-
<u>HDTB18</u> Fi(3-4)	Very Low	Very Low	Very Low	Very Low	Very Low	-
<u>HDTB18</u> Ft(3-4)	Very Low	Very Low	Very Low	Very Low	Very Low	-
<u>MTF20</u> Ol(1-2)	Very Low	Very Low	Very Low	Very Low	Very Low	Susceptible to water erosion if peat layer removed
<u>MTF20</u> Ov/Mi(3-5)	Very Low	Very Low	Very Low	Severe	Very Low	Susceptible to water erosion if peat layer removed
<u>NKRD1</u> Ui(7-9)	Very Low	Severe	Moderate	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>NS</u> Cw/Ri(6-7)	NR	NR	NR	NR	NR	-
<u>NS</u> Cw/Ri(7-8)	NR	NR	NR	NR	NR	-

Table 4.3-1 Water Erosion Risk Ratings for Soil Map Units

Soil Map Unit	Baseline Conditions ¹	Upland Surface Soil		Subsoil		Comments
		Recently Reclaimed, no Mitigations	Mitigation Implemented ²	Exposed Subsoil, no Mitigations	Mitigation Implemented ²	
<u>SPgrWL1</u> Mb/Ri(4-5)	Very Low	Severe	Low	Severe	Very Low	-
<u>SPgrWL1</u> Mb/Ri(5-6)	Very Low	Severe	Moderate	Severe	Low	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPgrWL1</u> Mw/Ri(5-6)	Very Low	Severe	Moderate	Severe	Low	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPgrWL1</u> Mw/Ri(5-7)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPLT4</u> Mw/Ri(6-7)	Very Low	Severe	High	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPR1</u> Mb/Ri(5-6)	Very Low	Severe	Moderate	Severe	Low	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPR1</u> Mb/Ri(6-7)	Very Low	Severe	High	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPR1</u> Mw/Rh(4-6)	Very Low	Severe	Low	Severe	Very Low	-
<u>SPRgr1</u> Mb/Ri(5-6)	Very Low	Severe	Moderate	Severe	Low	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPRgr1</u> Mb/Ri(6-7)	Very Low	Severe	High	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPRgr1</u> Mw/Rh(6-8)	Very Low	Severe	Moderate	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied

Table 4.3-1 Water Erosion Risk Ratings for Soil Map Units

Soil Map Unit	Baseline Conditions ¹	Upland Surface Soil		Subsoil		Comments
		Recently Reclaimed, no Mitigations	Mitigation Implemented ²	Exposed Subsoil, no Mitigations	Mitigation Implemented ²	
<u>SPRgr1</u> Mw/Ri(6-7)	Very Low	Severe	High	Severe	Moderate	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>SPRgr1</u> Mw/Ri(7-8)	Very Low	Severe	Severe	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>TUCD1</u> Mv/Ri(6-7)	Very Low	Severe	High	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
<u>TUCD1</u> Mv/Ri(7-8)	Very Low	Severe	High	Severe	High	Extremely severe potential soil loss without vegetation cover or no mitigation practices applied
ZDL	NR	NR	NR	NR	NR	-
ZWA	NR	NR	NR	NR	NR	-

¹Baseline conditions were based on vegetation cover for each soil map unit.

²For the assessment scenario mitigation included: the addition of mulch (7 tonnes/acre) assuming a 50 foot slope length.

NR –Soil map units disturbed lands (ZDL), non-soils (NS) and open water (ZWA) were not rated for water erosion potential.

The risk of water erosion for baseline conditions is typically very low as the soil surface is currently well protected by tree and understory cover resulting in minimal exposure of surface soil material to water.

When assessing water erosion, slope gradient is an important factor. As slope gradient increases, so does the potential risk for water erosion. If mineral soil is exposed, the risk of water erosion increases. The majority of upland soils occur on gentle to very strong slopes and soils in these landscapes are highly susceptible to water erosion upon complete removal of all vegetation and debris. If mitigation measures (*i.e.*, application of mulch or suitable tackifier) are applied to stockpiles post construction and to reclaimed lands, post reclamation water erosion risk can be reduced and managed throughout the life of the Project.

Thirty-three Soil Map Units were estimated to be at risk via water erosion for upland surface soil, and thirty-four Soil Map Units were at risk for subsoil material. Those Soil Map Units were usually located on steeper slopes, of class 6, and higher.

Grazing may also have an impact on soil erodibility. If vegetative cover is removed or heavily disturbed by grazing or human activity, soils become more susceptible to erosion.

4.3.2 Soil Erosion Risk - Wind

Soil erosion via wind was evaluated for the dominant or co-dominant soils of all Soil Models in the RSA. Wind erosion risk ratings were modified from the *Wind Erosion Risk, Alberta* (Coote and Pettapiece, 1989), Alberta Agriculture (1985) and United States department of Agriculture (USDA) (2014, Internet site). Wind erosion risk under current conditions is considered to be very low to negligible due to the vegetation cover. Sufficient vegetative cover currently minimizes the potential for erosion of these soils.

The wind erosion ratings estimated for the soil models are based on the assumption that vegetation has been removed and bare soil is exposed. This assumption provides a risk rating applicable to conditions during soil replacement during progressive reclamation or stockpiles prior to mitigation.

Soils that are poorly to very poorly drained were assigned a low wind erosion risk rating because their higher water contents would decrease their susceptibility to wind erosion.

Table 4.3-2 lists wind erosion risk ratings for soil models within the RSA and LSA.

Table 4.3-2 Wind Erosion Risk Ratings for Soil Models within the Regional and Local Study Areas		
Soil Model	Upland Surface Soil (Bare)	Subsoil (Upland Surface Soil Removed)
CON5	High	High
DNL1	Low	Low
FVCP16	High	High
FVCP4	High	High
FVHE4	Moderate-High	Moderate-High
FVNK16	Moderate-High	Moderate-High
FVRD5	Moderate-High	Moderate-High
FVX4	High	High

Table 4.3-2 Wind Erosion Risk Ratings for Soil Models within the Regional and Local Study Areas

Soil Model	Upland Surface Soil (Bare)	Subsoil (Upland Surface Soil Removed)
FVXfi11	High	High
HDFR18	High	High
HDTB18	High	High
MTF20	Low	Moderate
NKRD1	Moderate	Moderate
NS	NR	NR
SPgrWL1	Moderate-High	Moderate
SPLT4	Moderate	High
SPR1	Moderate	High
SPRgr1	Moderate	Moderate
TUCD1	Moderate-High	Moderate
ZDL	NR	NR
ZWA	NR	NR

NR –Soil map units non-soil units (NS) and disturbed lands (ZDL) were not rated for wind erosion potential.

Soil units in the Project would generally be at moderate to high risk of wind erosion (assuming no vegetative cover). Eight soil models within the RSA have high wind erosion potential due to their coarse surface texture. Moderate-High wind erosion potential in five soil models is related to high wind erosion potential due to coarse texture of the co-dominant soils. If the vegetation is removed and the stabilizing effect of plant roots and organic matter is removed, these soils could potentially become unstable and may become highly susceptible to erosion by wind. Upon implementation of mitigation ([Section 7.1.3 – Mitigation and Monitoring](#)), the wind erosion risk is expected to be low for all reclaimed landscapes within the proposed disturbance area.

4.4 Soil Sensitivity - Acidification

Soil acid sensitivity rating for mineral soils is based on system developed by Holowaychuk and Fessenden (1987). Based upon soil characteristics such as pH and cation exchange capacity (CEC) of the surface horizon, the sensitivity of each soil type to base cation loss, acidification, and aluminum mobilization was rated as low, medium or high, and from these ratings the overall sensitivity rating for the soil type was derived. Turchenek *et al.*, (1998) reviewed the international literature on the

responses and sensitivity of organic (peat) soils to acidic input, and proposed a revision of the Holowaychuk and Fessenden (1987) sensitivity classification of peat systems. The criteria used for classifying soils into high, moderate, or low acid sensitivity classes are listed in [Table 4.4-1](#) for mineral soils, and [Table 4.4-2](#) for organic soils.

Table 4.4-1 Criteria for Rating the Sensitivity of Mineral Soils to Acidic Inputs					
Soil Property		Sensitivity to:			
Cation Exchange Capacity (CEC) (cmol/kg)	pH	Base loss	Acidification	Al Solubilization	Overall Sensitivity
<6	<4.6	High	Low	High	High
	4.6-5.0	High	Low	High	High
	5.1-5.5	High	Medium	High	High
	5.6-6.0	High	High	Medium	High
	6.1-6.5	High	High	Low	High
	>6.5	Low	Low	Low	Low
6-15	<4.6	High	Low	High	High
	4.6-5.0	Medium	Low	High	Medium
	5.1-5.5	Medium	Low-Medium	Medium	Medium
	5.6-6.0	Medium	Low-Medium	Low-Medium	Medium
	>6.0	Low	Low	Low	Low
>15	<4.6	High	Low	High	High
	4.6-5.0	Medium	Low	High	Medium
	5.1-5.5	Medium	Low	Medium	Medium
	5.6-6.0	Low	Low-Medium	Low-Medium	Low
	>6.0	Low	Low	Low	Low

Table 4.4-2 Criteria for Rating Organic Soils Sensitivity to Acidic Inputs

Peatland Type	Acid Sensitivity
Extreme rich fen	Low
Moderate rich fen	Low
Poor fen	Medium
Bog	Medium

Soils sensitivity rating to acidic inputs was determined for every Soil Model using soil characteristics of dominant and co-dominant soil series. Soils sensitivity ratings for Soil Model are shown in [Table 4.4-3](#).

Table 4.4-3 Soils Sensitivity Ratings to Acidic Inputs for Soil Models

Soil Model (SM)	CEC ¹ (meq / 100g) ²	pH	Overall Sensitivity
CON5	90	4.4	High
DNL1*	154	7.4	Low
FVCP16	89-98	5.9-6.3	Low
FVCP4	89-98	5.9-6.3	Low
FVHE4	89-75	5.9-5.1	Low-Medium
FVNK16	89-97	5.9-6.5	Low
FVRD5	89-51	5.9-4.7	Medium
FVX4	89	5.9	Low
FVXfi11	89	5.9	Low
HDFR18	81-75	7.6	Low
HDTB18	81-33	7.6-6.8	Low
MTF20*	124	7.4	Low
NKRD1	97-51	6.5-4.7	Low-Medium
NS	NA	NA	NA
SPgrWL1	76-75	6.7-6.1	Low
SPLT4	76-80	6.7	Low

Table 4.4-3 Soils Sensitivity Ratings to Acidic Inputs for Soil Models

Soil Model (SM)	CEC ¹ (meq / 100g) ²	pH	Overall Sensitivity
SPR1	76	6.7	Low
SPRgr1	76	6.7	Low
TUCD1	90-83	5.5-6.2	Low-Medium
ZDL	NA	NA	NA
ZWA	NA	NA	NA

*Organic dominated SMs are rated as having Low sensitivity as they are rich fens.

1 – Adapted from AGRASID4.0 data base

2 – 1 meq/100 g = 1 cmol/kg

NA – Not Applicable.

Majority of Soil Models were rated as having low sensitivity to acidic input. Three Soil Models (FVHE4, NKRD1 and TUCD1) we rated of having low to medium sensitivity. FVRD5 Soil Model was rated as medium sensitive to acidic input. The only Soil Model rated as sensitive to acidic input was CON5.

Air modelled PAI isopleths were overlaid onto soil the sensitivity map to determine critical load exceedances for the soil RSA. According to Alberta Acid Deposition Management Framework (AENV, 2008) the critical, target and monitoring load for provincial scale applications are set to be:

Critical load – the highest load that will not lead to long-term, harmful changes to a receptor.

Trigger levels:

0.25 keq H⁺ ha⁻¹ yr⁻¹ for sensitive grid cells

0.50 keq H⁺ ha⁻¹ yr⁻¹ for moderately sensitive grid cells

1.00 keq H⁺ ha⁻¹ yr⁻¹ for grid cells of low sensitivity

Target load – the level of deposition that consider the critical load and is practically and politically achievable.

Trigger levels:

0.22 keq H⁺ ha⁻¹ yr⁻¹ for sensitive grid cells

0.45 keq H⁺ ha⁻¹ yr⁻¹ for moderately sensitive grid cells

0.90 keq H⁺ ha⁻¹ yr⁻¹ for grid cells of low sensitivity

Monitoring load – the level of deposition predicted or estimated by a dispersion model and deposition model that trigger monitoring and/or research.

Trigger levels:

0.17 keq H⁺ ha⁻¹ yr⁻¹ for sensitive grid cells

0.35 keq H⁺ ha⁻¹ yr⁻¹ for moderately sensitive grid cells

0.70 keq H⁺ ha⁻¹ yr⁻¹ for grid cells of low sensitivity

Based on a review of the modelled PAI isopleths, there are no PAI isopleths that contain values that trigger critical, target or monitoring load exceedances for the soils within the LSA or the RSA (Figure 4.4-1).

The soil acidification via atmospheric deposition is not expected to be a potential impact that will result in an environmental effect on the soil resources within the LSA or RSA. The impact of the Project with respect to potential soil acidification is negligible at the local and regional scale for all assessment cases and not considered to pose a potential impact to soils.

4.5 Forest Land Capability

Land capability for the RSA has been catalogued by rating the Soil Map Units (SMUs) according to *A Forest Land Capability Classification for the East Slopes Area, Alberta* (Duffy and Nemeth, 1969). This classification system was used to evaluate the soils based on the following soil and landscape features:

- Climate:
 - Drought or aridity;
 - Frost pockets;
- Relief:
 - Elevation/altitude;
 - Exposure/aspect;
- Soil Conditions:
 - Surficial materials;
 - Drainage;
 - Moisture deficiency or excess;
 - Restriction of root zone by bedrock;
 - Low fertility;
 - Stoniness;

- Erosion:
 - Active erosion;
 - Inundation (soils periodically inundated by streams or lakes).

The capability classes are based on mean annual increment (m.a.i.) at 100 years and can be seen in [Table 4.5-1](#). Gross merchantable volume data were used to calculate m.a.i. at stand age and these data were converted to m.a.i. at 100 years using Smithers' m.a.i. curves (Duffy and Nemeth, 1969).

Table 4.5-1 Land Capability Classes		
Capability Class	m.a.i. at 100 Years (cubic feet per acre per annum) ¹	m.a.i. at 100 Years (m³ per ha per annum)
3	71-90	5.0-6.3
4	51-70	3.6-4.9
5	31-50	2.2-3.5
6	11-30	0.8-2.1
7	Less than 10	Less than 0.7

¹ Adapted from A Forest Land Capability Classification for the East Slopes Area, Alberta (Duffy and Nemeth, 1969).

Drainage classes and parent materials are utilized along with [Table 4.1-2](#) to provide a maximum possible capability class for each soil profile.

Table 4.5-2 Maximum Capability Classes by Surficial Materials – Drainage¹ Under the 4,500 foot Contour, East Slopes Area, Alberta						
	Rapidly Drained	Well Drained	Moderately Well Drained	Imperfectly Drained	Poorly Drained	Very Poorly Drained
Aeolian Sand	6	6	5	5	5-6	-
Alluvium	5	5	4	4	5	5-6
Colluvium	5-6	5	4	4	-	-
Residual	5-6	4	-	-	-	-

Table 4.5-2 Maximum Capability Classes by Surficial Materials – Drainage¹
Under the 4,500 foot Contour, East Slopes Area, Alberta

	Rapidly Drained	Well Drained	Moderately Well Drained	Imperfectly Drained	Poorly Drained	Very Poorly Drained
Till/Bedrock	5	4	4	4	5	5-6
Till	5	4	3	4	5	5-6
Alluvial-Lacustrine	5	4	4	4	5	5-6
Muskeg	-	-	6	6	7	-

¹ Adapted from A Forest Land Capability Classification for the East Slopes Area, Alberta (Duffy and Nemeth, 1969).

This rating is adjusted by “limiting factors” as determined in the classification system. Applicable limiting factors include restriction of rooting zone by bedrock (subclass R), exposure (subclass U), excess soil moisture (subclass W), stoniness (subclass P) and elevation (subclass Z) (Duffy and Nemeth, 1969).

Forest soil capabilities were determined for SMUs (i.e., *HDFR18/ FI(1-3)*) for dominant (>50%) and co-dominant (>30%) soils.

Within the RSA, capability ratings ranged from Class 4 to Class 7. The main limitations to soils within the RSA include restriction of rooting zone by bedrock (subclass R), exposure (subclass U) and excess soil moisture (subclass W).

4.5.1 Baseline Ratings

The baseline forested land capabilities for SMUs of the RSA and LSA are listed in [Table 4.5-3](#). Distribution of land capability classes (LCC) within the RSA and LSA are provided in [Table 4.5-4](#) and are shown on [Figure 4.5-1](#).

Table 4.5-3 Baseline Land Capability Ratings for Soil Map Units for the Regional and Local Study Areas

Soil Map Unit (SMU)	Drainage	Parent Material	Maximum Possible Capability Class ¹	Limitations (Subclasses)			Baseline Capability Class ²
				Elevation Range (masl)	Restriction of Rooting Zone by Bedrock	Unfavourable Aspects	
<u>CON5</u> FGt(3-4)	Rapid	Glacial Fluvial	5	4500-5500	No	No	5
<u>DNL1</u> <u>Ol(1-2)</u>	Very Poor	Organic	7	4500-5500	No	No	7W
<u>FVCP16</u> Cw/Ri(7-8)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	Yes	No	5-7R
						Yes	5-7UR ³
<u>FVCP16</u> Cw/Ri(8-9)	Rapid-Well	Colluvium/Residual	5-6	5500+	Yes	No	5-7R
						Yes	5-7UR
<u>FVCP4</u> Cw/Ri(5-6)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	Yes	No	5-7R
<u>FVCP4</u> Cw/Ri(6-7)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	No	No	5-6
						Yes	5-7U
<u>FVCP4</u> Cw/Ri(7-8)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	No	No	5-6
						Yes	5-7U
<u>FVCP4</u> Cw/Ri(8-9)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	No	No	5-6
<u>FVHE4</u> Cw/Ri(5-7)	Rapid-Well	Colluvium/Residual	5-6	5500+	No	No	5-6
						Yes	5-7U
<u>FVHE4</u> Cw/Ri(7-8)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	No	No	5-6
						Yes	5-7U
<u>FVNK16</u> Cw/Ri(6-7)	Rapid-Well	Colluvium/Residual	5-6	4500-5500	Yes	No	5-7R
						Yes	5-7UR
<u>FVRD5</u> Cw/Ri(6-7)	Rapid-Well	Colluvium/Residual	5-6	4500-5500	No	No	5-6
						Yes	5-7U
<u>FVRD5</u> Cw/Ri(7-8)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	Yes	No	5-7R
						Yes	5-7UR
<u>FVX4</u> Cb/Ri(6-7)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	No	No	5-6
						Yes	5-7U
<u>FVX4</u> Cb/Ri(7-8)	Rapid-Well	Colluvium/Residual	5-6	5500+	No	No	5-6
<u>FVX4</u> Cw/Rh(5-7)	Rapid-Well	Colluvium/Residual	5-6	4500-5500	Yes	No	5-7R
						Yes	5-7UR
<u>FVX4</u> Cw/Ri(5-6)	Rapid-Well	Colluvium/Residual	5-6	4500-5500	No	No	5-6
						Yes	5-7U
<u>FVXfi11</u> Cw/Ri(6-7)	Rapid-Well	Colluvium/Residual	5-6	4500-5500+	Yes	No	5-7R
						Yes	5-7UR
<u>FVXfi11</u> Cw/Ri(7-8)	Rapid-Well	Colluvium/Residual	5-6	<4500-5500+	Yes	No	5-7R
						Yes	5-7UR
<u>HDFR18</u> Fl(1-3)	Rapid-Well	Fluvial	5	4500-5500	No	No	6P

Table 4.5-3 Baseline Land Capability Ratings for Soil Map Units for the Regional and Local Study Areas

Soil Map Unit (SMU)	Drainage	Parent Material	Maximum Possible Capability Class ¹	Limitations (Subclasses)			Baseline Capability Class ²
				Elevation Range (masl)	Restriction of Rooting Zone by Bedrock	Unfavourable Aspects	
<u>HDFR18</u> Ft(4-7)	Rapid-Well	Fluvial	5	<4500-5500+	No	No Yes	6P 6-7UP
<u>HDTB18</u> Fi(3-4)	Rapid-Imperfect	Fluvial	4-5	4500-5500+	No	No	5-6P
<u>HDTB18</u> Ft(3-4)	Rapid-Imperfect	Fluvial	4-5	<4500-5500	No	No	5-6P
<u>MTF20</u> Ol(1-2)	Very Poor	Organic	7	<4500-5500	No	No	7W
<u>MTF20</u> Ov/Mi(3-5)	Very Poor	Organic	7	4500-5500	No	No	7W
<u>NKRD1</u> Ui(7-9)	Rapid-Well	Undifferentiated	5-6	<4500-5500	No	No Yes	5-6 5-7U
<u>NS</u> Cw/Ri(7-8)	NA	Colluvium/Residual	7	>5500	Yes	No Yes	7R 7UR
<u>NS</u> Cw/Ri(8-9)	NA	Colluvium/Residual	5-6	>5500	Yes	Yes/No	7RP
<u>SPgrWL1</u> Mb/Ri(4-5)	Well	Till/Residual	4	4500-5500+	No	No	4-5Z
<u>SPgrWL1</u> Mb/Ri(5-6)	Well	Till/Residual	4	4500-5500	No	No Yes	4 4-5U
<u>SPgrWL1</u> Mw/Ri(5-6)	Well	Till/Residual	4	4500-5500+	No	No	4-5Z
<u>SPgrWL1</u> Mw/Ri(5-7)	Well	Till/Residual	4	4500-5500+	No	No Yes	4-5Z 4-6U
<u>SPLT4</u> Mw/Ri(6-7)	Well	Till/Residual	4	<4500-5500	No	No Yes	4 4-5U
<u>SPR1</u> Mb/Ri(5-6)	Well	Till/Residual	4	4500-5500	No	No Yes	4 4-5U
<u>SPR1</u> Mb/Ri(6-7)	Well	Till/Residual	4	4500-5500	No	No Yes	4 4-5U
<u>SPR1</u> Mw/Rh(4-6)	Well	Till/Residual	4	<4500	No	No Yes	4 4-5U
<u>SPRgr1</u> Mb/Ri(5-6)	Well	Till/Residual	4	4500-5500	No	No	4
<u>SPRgr1</u> Mb/Ri(6-7)	Well	Till/Residual	4	4500-5500	No	No	4
<u>SPRgr1</u> Mw/Rh(6-8)	Well	Till/Residual	4	<4500	No	No Yes	4 4-5U
<u>SPRgr1</u> Mw/Ri(6-7)	Well	Till/Residual	4	4500-5500	No	No Yes	4 4-5U

Table 4.5-3 Baseline Land Capability Ratings for Soil Map Units for the Regional and Local Study Areas

Soil Map Unit (SMU)	Drainage	Parent Material	Maximum Possible Capability Class ¹	Limitations (Subclasses)			Baseline Capability Class ²
				Elevation Range (masl)	Restriction of Rooting Zone by Bedrock	Unfavourable Aspects	
SPRgr1 Mw/Ri(7-8)	Well	Till/Residual	4	4500-5500	Yes	No	4-6R
						Yes	4-6UR
TUCD1 Mv/Ri(6-7)	Rapid-Well	Till/Residual	4-5	4500-5500+	No	No	4-5
						Yes	4-6U
TUCD1 Mv/Ri(7-8)	Rapid-Well	Till/Residual	4-5	4500-5500	No	No	4-5
ZDL ⁴	NA	NA	7	<4500-5500+	NA	No	7
						Yes	7
ZWA	NA	NA	NA	NA	NA	NA	NA

¹ Ratings are adapted from *A Forest Land Capability Classification for the East Slopes Area, Alberta* (Duffy and Nemeth, 1969).

² Subclass Notations: R – restriction of rooting zone by bedrock, U – exposure, W – excess soil moisture, Z – elevation

³ Some areas do not support forest production due to dry moisture conditions and/or unstable slopes.

⁴ Currently does not support forest production.

Table 4.5-4 Extent of Soil Capability in the RSA and LSA

LCCS Ratings Classes	RSA		LSA	
	Area (ha)	% of LSA	Area (ha)	% of Footprint
4	438.8	9.6	59.6	3.9
4-5	722.4	15.9	134.1	8.8
4-6	117.3	2.6	27.1	1.8
5	6.6	0.1	1.7	0.1
5-6	1,213.0	26.7	326.3	21.5
5-7	1,454.7	32.0	679.6	44.7
6	130.6	2.9	3.5	0.2
6-7	19.0	0.4	0	0.0
7	447.1	9.8	288.9	19.0
NA	0.3	<0.1	0.1	<0.1
TOTAL¹	4,549.8	100	1,520.7	100

¹ Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

Classes 5-6 and 5-7 are the most extensive within the RSA, totalling for approximately 58.6% of the area. The same classes are the most common within the LSA, covering approximately 66.1% of the LSA. Class 7 soils account for 19.0% of the LSA.

4.5.2 Reclaimed Ratings

The main goal for the reclamation program is to achieve land capability equivalent or higher than pre-disturbance conditions. The reclaimed ratings are estimated based on construction and reclamation procedure outlined in the C&R Plan for the Project ([Section F](#)) in [Sections F.2.2 Reclamation Schedule](#), [F.2.3 Adaptive Management for Reclamation](#), [F.3.4 Soil Conservation Program](#), [F.3.6 Mine Reclamation](#) and [F.4.2 Soil Management](#), predicted composition of the reclaimed profile, projected drainage and projected landform model created post reclamation.

The reclaimed capability ratings were calculated using physical characteristics of representative soil series and variants recorded in the baseline conditions and landform models of each SMU and based on the anticipated soil salvage, storage, planned recontouring and eventual replacement and implementation of mitigative measures (*e.g.*, decompaction activities). The following assumptions were made:

- forest litter (LFH), A and B horizons would be salvaged in one lift and blended to be used as a reclamation material;
- no unsuitable overburden material will be incorporated in the root zone of the reclaimed profile;
- reclaimed textures would become less sandy and more loam-like (Knapik and Rosentreter, 1999);
- reclaimed soils would become more aggregated and become less friable (Knapik and Rosentreter, 1999);
- soil drainage on reclaimed sites would be well to moderately well; and
- a suitable growing medium (upland surface soil) at average thickness of 20 cm would be applied on all reclaimed areas.

Post-reclamation suitability was only evaluated for SMUs in the LSA that are expected to be disturbed over the life of the Project. [Table 4.5-5](#) displays the baseline and predicted reclaimed capability classes for the SMUs.

Table 4.5-5 Baseline and Reclaimed Forest Land Capability Classes for Soil Map Units within the Local Study Area

Soil Map Unit (SMU)	Baseline Capability Class	Estimated Reclaimed Capability Class
<u>CON5</u> FGt(3-4)	5	5
<u>DNL1</u> Ol(1-2)	7	5-6
<u>FVCP16</u> Cw/Ri(7-8)	5-7	4-6
<u>FVCP16</u> Cw/Ri(8-9)	5-7	4-6
<u>FVCP4</u> Cw/Ri(5-6)	5-7	4-5
<u>FVCP4</u> Cw/Ri(6-7)	5-6	4-5
	5-7	4-6
<u>FVCP4</u> Cw/Ri(7-8)	5-6	4-5
	5-7	4-6
<u>FVCP4</u> Cw/Ri(8-9)	5-6	4-5
<u>FVHE4</u> Cw/Ri(7-8)	5-6	4-5
	5-7	4-6
<u>FVNK16</u> Cw/Ri(6-7)	5-7	4-6
<u>FVRD5</u> Cw/Ri(6-7)	5-6	4-5
	5-7	4-6
<u>FVRD5</u> Cw/Ri(7-8)	5-7	4-6
<u>FVX4</u> Cb/Ri(7-8)	5-6	4-5
<u>FVX4</u> Cw/Rh(5-7)	5-7	4-6
<u>FVX4</u> Cw/Ri(5-6)	5-6	4-5
	5-7	4-6
<u>FVXfi11</u> Cw/Ri(6-7)	5-7	4-6

Table 4.5-5 Baseline and Reclaimed Forest Land Capability Classes for Soil Map Units within the Local Study Area

Soil Map Unit (SMU)	Baseline Capability Class	Estimated Reclaimed Capability Class
<u>FVXfi11</u> Cw/Ri(7-8)	5-7	4-6
<u>HDFR18</u> Fi(1-3)	5	4-5
<u>HDTB18</u> Fi(3-4)	5-6	5-6
<u>HDTB18</u> Ft(3-4)	5-6	5-6
<u>MTF20</u> Oi(1-2)	7	5-6
<u>NKRD1</u> Ui(7-9)	5-6	4-5
	5-7	4-6
<u>NS³</u> Cw/Ri(7-8)	7	5-6
<u>NS</u> Cw/Ri(8-9)	7	5-6
<u>SPgrWL1</u> Mb/Ri(4-5)	4-5	4-5
<u>SPgrWL1</u> Mb/Ri(5-6)	4	4
	4-5	4-5
<u>SPgrWL1</u> Mw/Ri(5-6)	4-5	4-5
<u>SPgrWL1</u> Mw/Ri(5-7)	4-5	4-5
	4-6	4-6
<u>SPLT4</u> Mw/Ri(6-7)	4	4
	4-5	4-5
<u>SPR1</u> Mb/Ri(5-6)	4	4
	4-5	4-5
<u>SPR1</u> Mb/Ri(6-7)	4	4
	4-5	4-5
<u>SPR1</u>	4	4

Table 4.5-5 Baseline and Reclaimed Forest Land Capability Classes for Soil Map Units within the Local Study Area

Soil Map Unit (SMU)	Baseline Capability Class	Estimated Reclaimed Capability Class
Mw/Rh(4-6)	4-5	4-5
<u>SPRgr1</u> Mw/Rh(6-8)	4	4
	4-5	4-5
<u>SPRgr1</u> Mw/Ri(6-7)	4	4
	4-5	4-5
<u>SPRgr1</u> Mw/Ri(7-8)	4-6	4-5
	4-5	4
<u>TUCD1</u> Mv/Ri(6-7)	4-5	4
	4-6	4-5
<u>TUCD1</u> Mv/Ri(7-8)	4-5	4
ZDL	7	4-6
ZWA	NA	NA

All SMUs contain the same or higher final capability ratings for reclaimed landscapes than compared to pre-disturbance conditions.

5.0 OVERBURDEN ASSESSMENT

For the purpose of this assessment, overburden is defined as the material located below the soil profile (about 1 m depth in this study) and above, between, and below the coal strata that are to be mined in the Project. The following describes the general geology of the region, evaluates physical and chemical data collected on overburden samples, and rates the suitability of overburden as a backfill material using the Soil Quality Criteria Relative to Disturbance and Reclamation Guidelines as specified for the Eastern Slopes Region of Alberta (SQCWG 1987, [Table 4.3-1](#)).

5.1 Geological Correlation

Surficial deposits are composed predominantly of colluvium or leached Cordilleran till deposits, with inclusions of alluvial (fluvial) deposits. Localized deposits of lesser extent include glaciofluvial and organic deposits. The colluvium is comprised of soil and rock creep material overlying bedrock. The composition of the colluvium is determined by the underlying bedrock and ranges from predominantly weathered carbonates to weathered sandstone, siltstone, and shale. Based on the soil data collected for this Project, the colluvium is predominantly medium (very fine sandy loam, loam, silt loam, silt) to moderately coarse (sandy loam, fine sandy loam) textured, non to extremely calcareous, non-saline, and moderately stony to stony. Thickness of the colluvial deposits can vary from 1.5 m deep to >3 m deep (at the base of slopes). The till is a silty sand till that has been slightly leached (15-45 cm) or moderately leached (0-1.5 m). Based on the soil data collected for this Project, the till is predominantly medium (very fine sandy loam, loam, silt loam, silt) to moderately fine (sandy clay loam, clay loam, silty clay loam) textured, non to weakly calcareous, non-saline, and moderately stony to stony. The till is commonly shallow across much of the roughest terrain and the underlying material may be consolidated bedrock or weathered bedrock (residuum).

The Blairmore Formation, consisting of a basal conglomeratic member of unknown age overlain by sandstones with subordinate shales or limestones of early Cretaceous age, underlies the surficial deposits.

The Kootenay Formation, which underlies the Blairmore Formation, consists of light to dark gray to grayish brown weathered siltstone, silty shale, mudstone, sandstone, and thin to thick coal seams, at least partly of Jurassic age. The Kootenay Formation in the Grassy Mountain area has been divided into four members, from top to bottom, named the Mutz, Hillcrest, Adanac, and Moose Mountain members. The Kootenay Formation is overlain unconformably by thick-bedded to massive conglomerate of the Cadomin Formation at the base of the Blairmore Group. On Grassy Mountain, at the base of the Cadomin Formation, erosional truncation has removed the upper half of the Kootenay Formation.

Underlying the Kootenay Formation is the Fernie Formation that consists mainly of brown and dark gray to black shales of Jurassic age. Phosphatic sandstone and limestone, including cherty limestone, occur locally in the lower parts of the formation.

The precise position of the Jurassic-Cretaceous contact remains controversial of late Jurassic to early Cretaceous age. The gradational contact of the Kootenay Group with the underlying Fernie Formation marks the initiation of non-marine sedimentation from western sources.

Grassy Mountain coals in the Kootenay Formation outcrop on the property in a general north-south direction for a strike length of approximately 7 km. The Kootenay Formation consists of 120 to 200 vertical metres of strata and is overlain by prominent, weather-resistant Blairmore (Cadomin) conglomerate. The strata of the Grassy Mountain area were strongly folded and faulted during mountain building, so that the Kootenay sediments and the principal coal seams are repeated within a number of parallel bands. These bands trend in a general north-south direction. The strong deformation of the strata has also cause structural thickening of the coal in some locations.

The Mutz Member, which is up to 90 m thick, contains coal in Seam No. 1, at the top, and Seam No. 2 at the base. The Hillcrest Member, 20 to 30 m thick, contains no major coal seams. Coal Zone 4 is located at the top of the Adanac Member, which ranges in thickness from 20 to 30 m. An internal erosional truncation at the base of the Hillcrest Member has apparently eroded Seam No. 3 found in other localities.

The three coal zones in the Kootenay Formation (Seams No. 1, 2, and 4) have been identified as mining targets. All three zones consist of sequences of interbedded coal plies and rock bands. The thickness and distribution of the coal plies and rock bands in all zones change across the property, and changes can occur over relatively short distances. Thicknesses of inter-seam strata also vary. These variations are due in part to changes in the original depositional environment, and in part to the tectonic effects of folding and faulting. The descriptions of the coal zones are:

- Seam No. 1: the uppermost unit of the Mutz Member and is commonly represented by several thin seams with an aggregate thickness of up to 5 m separated by carbonaceous mudstone and siltstone interbeds, over a stratigraphic interval of 5 to 20 m. The seam is principally split into three distinct units (from top to bottom, 1C, 1B, and 1A). Unit 1A is fairly carbonaceous, high ash and density layer that is modelled more for correlation and structural control than for resource purposes. Not all areas of Grassy Mountain contain Seam No. 1 due to the erosional truncation provided by the overlying Cadomin Conglomerate (base of the Blairmore Formation). The conglomerate is typically massive and consists of well-rounded pebbles, cobbles, and boulders of white, gray, and green chert, and white and gray quartzite, in a matrix of quartzose sand.

- Seam No. 2: the lower most unit of the Mutz Member that generally occurs about 10 to 50 m below Seam No. 1 and is comprised of a thick (approximately 5 to 15 m; average of 8 m) band of coal that is split into two plies (2B and 2A) and a thinner (approximately 0.5 m) and often carbonaceous lower ply (2A0) located centimetres to a few metres below the main seam. Ply 2A0 tends to pinch out randomly and could be considered to exist as a lenticular layer across the deposit. Structural thickening of Seam No. 2 through repetition of imbricates has resulted in thicknesses of more than 25 m in places.
- Seam No. 4: comprises all of the Adanac Member and generally occurs about 5 to 40 m below Seam No. 2 separated by siltstone with interbeds of sandstone and mudstone. The seam is comprised by two thicker approximately plies (4C and 4A), generally 2 to 5 m thick, with a 0.5 to 1 m ply (4B) between them. The correlation of the three plies of Seam No. 3 is apparent over much of the Grassy Mountain area. Beneath Seam No. 4 is the Moose Mountain Member (hard, medium gray, siliceous sandstone) that acts as the basement unit in the area and the floor of the proposed open cut pit.

5.2 Overburden Samples

A total of seven drill holes were completed throughout the lease and mine permit boundaries (drill hole locations and logs can be found in [Appendix E](#) and Geochemical Characterization Progress Report (SRK 2015)). A total of 176 overburden samples were analyzed from seven test holes logged throughout the lease and mine permit boundaries. Samples were collected during geotechnical, geochemical and hydrogeological investigations. Test hole sampling locations are shown on [Figure 5.1-1](#). Various samples were analyzed for detailed salinity (pH, EC, SAR), saturation percentage, calcium carbonate equivalent, Modified Neutralization Potential (NP) (Coastech Research, 1991), and trace metals as defined by Canadian Council of Ministers of the Environment (CCME 2011). The majority of samples collected were from bedrock units; other samples from the overlying surficial materials were also collected.

The samples represent the material that will be utilized to backfill the mine blocks and re-contour mined areas prior to replacement of salvaged surface soils. The backfill material that forms the lower rooting zone will be comprised of various surficial materials and bedrock units. The test hole locations sampled for analysis are listed in [Table 5.2-1](#). Analytical results are provided in [Appendix D](#) and Geochemical Characterization Progress Report (SRK (2015), and summarized in [Section 5.5 \(Trace Elements\) of this report](#).

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
RGOH3001	685357	5504917	0-12.5	Claystone and siltstone
			12.5-34.75	Cadomin conglomerate
			34.75-39	Siltstone
			39-40	Claystone; coal stony at top
			40-43	Coal; portions of claystone and carbonaceous mudstone
			43-48	Claystone; occasional coal
			48-51	Coal; some carbonaceous mudstone
			51-78	Shale; some coal, claystone, carbonaceous mudstone, siltstone, and sandstone
			78-87	Coal; layer of carbonaceous mudstone
			87-103	Shale; layers of claystone and siltstone
			103-109	Siltstone
			109-114	Sandstone and siltstone
			114-127.5	Siltstone and clay; layers of claystone and carbonaceous mudstone
			127.5-130.5	Sandstone
			130.5-134.5	Moose Mountain sandstone
			134.5-135-.9	Sandstone
RGOH3002	685581	5504340	0-3	Sandstone
			3-7	Siltstone
			7-15	Claystone and coal; layers of carbonaceous mudstone
			15-18	Sandstone
			18-29.5	Siltstone majority; layers of claystone, carbonaceous mudstone, and sandstone.
			29.5-39.5	Shale
			39.5-52.5	Coal and claystone; some carbonaceous mudstone
			52.5-57.5	Siltstone; layer of sandstone; minor coal
			57.5-60	Claystone
			60-66	Sandstone; layer of siltstone
			66-71.5	Siltstone; layer of sandstone; some carbonaceous mudstone
			71.5-77	Coal; layer of claystone; some carbonaceous mudstone
			77-91	Siltstone; layers of coal; some sandstone and carbonaceous mudstone
			91-100	Moose Mountain sandstone
RGOH3003	686194	5506263	0-3	Sandstone

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
			3-14	Siltstone
			14-29.5	Cadomin conglomerate; layer of siltstone
			29.5-34	Siltstone; some coal and claystone
			34-52.5	Shale; layer of sandstone
			52.5-78.5	Coal; layer of carbonaceous mudstone
			78.5-83	Shale
			83-100	Coal; layers of carbonaceous mudstone and claystone
			100-104	Siltstone and claystone; layer of coal
			104-108.5	Shale
			108.5-117	Claystone and coal; layers of carbonaceous mudstone
			117-121	Sandstone and siltstone
			121-125.5	Shale
			125.5-127.5	Claystone
			127.5-134	Coal; layers of claystone and carbonaceous mudstone
			134-143	Siltstone, claystone, and coal; some carbonaceous mudstone
			143-150	Sandstone
RGSC0006	685577	5507161	12-14.5	Cadomin Siltstone
			14.5-17.2	Cadomin Claystone
			17.2-20	Cadomin Claystone
			20-25	Cadomin Sandstone
			25-30	Cadomin Sandstone
			30-35	Cadomin Sandstone
			35-40	Cadomin Sandstone
			40-45	Cadomin Sandstone
			45-50	Cadomin Sandstone
			50-55.3	Cadomin Sandstone
			55.3-57.7	Cadomin Siltstone
			57.7-60.8	Cadomin Sandstone
			60.8-63	Cadomin Sandstone
			63-67	Cadomin Conglomerate
			67-70	Cadomin Conglomerate

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
			73-77.9	Mutz Claystone
			77.9-78.8	Mutz Claystone
			80.4-80.6	Mutz Claystone
			80.6-85.1	Mutz Claystone
			85.2-90.2	Mutz Claystone
			90.2-94.6	Mutz Claystone
			94.6-99.7	Mutz Sandstone
			99.7-101.3	Mutz Claystone
			101.3-103.2	Mutz Siltstone
			103.2-107.3	Mutz Sandstone
			107.3-107.5	Mutz Claystone
			110.8-111	Hillcrest Sandstone
			111-116.1	Hillcrest Claystone
			116.1-121.1	Hillcrest Sandstone
			121.1-125.1	Hillcrest Sandstone
			125.1-129.1	Hillcrest Sandstone
			129.1-134.4	Hillcrest Sandstone
			134.4-140.9	Hillcrest Sandstone
			140.9-144.4	Adanac Claystone
			144.4-144.6	Adanac Claystone
			144.7-144.8	Adanac Claystone
			149.3-149.7	Adanac Claystone
			150.8-151	Adanac Claystone
			151-155.3	Adanac Claystone
			155.3-155.5	Adanac Claystone
			157.2-157.4	Adanac Claystone
			157.4-161.2	Adanac Siltstone
RGSC0008	686638	5507638	59.7-59.9	Adanac Claystone
			59.9-62.2	Adanac Siltstone
			62.2-67.2	Moose Sandstone
			67.2-72.2	Moose Sandstone

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
			72.2-77.2	Moose Sandstone
			77.2-82.2	Moose Sandstone
			82.2-87.2	Moose Sandstone
RGSC0009	686742	5509160	29.7-32.2	Cadomin Sandstone
			32.2-36.3	Cadomin Sandstone
			36.3-38.5	Cadomin Claystone
			38.5-41.6	Cadomin Siltstone
			41.6-44.6	Cadomin Sandstone
			44.6-47.7	Cadomin Sandstone
			47.7-50.6	Cadomin Claystone
			50.6-53.2	Cadomin Sandstone
			53.2-57.2	Cadomin Conglomerate
			57.2-62.2	Cadomin Conglomerate
			62.9-66.3	Mutz Claystone
			66.3-69.9	Mutz Claystone
			69.9-73.2	Mutz Claystone
			73.2-73.4	Mutz Claystone
			74.9-77.9	Mutz Claystone
			77.9-80.7	Mutz Claystone
			80.7-81.5	Mutz Carb.
			81.5-86	Mutz Claystone
			86-89.6	Mutz Sandstone
			89.6-91.3	Mutz Claystone
			91.3-95.3	Mutz Siltstone
			95.3-98.6	Mutz Siltstone
			100.3-103.3	Mutz Sandstone
			103.3-107.3	Mutz Sandstone
			107.3-109	Mutz Claystone
			109-112.1	Mutz Sandstone
			112.1-115.5	Mutz Sandstone
			115.5-116.5	Mutz Claystone

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
			117-118.6	Mutz Siltstone
			118.6-118.8	Mutz Siltstone
			126.8-127	Hillcrest Claystone
			127-129.5	Hillcrest Claystone
			129.5-129.7	Hillcrest Claystone
			130.3-130.5	Hillcrest Claystone
			130.5-134.6	Hillcrest Claystone
			134.6-137.4	Hillcrest Fault
			138.6-138.9	Hillcrest Claystone
			140-140.2	Adanac Claystone
			140.2-143	Adanac Claystone
			143-145.1	Adanac Siltstone
			145.1-145.3	Adanac Sandstone
			146.3-146.5	Moose Claystone
			146.5-151.5	Moose Sandstone
			151.5-156.5	Moose Sandstone
			156.5-158.9	Moose Sandstone
RGSC0010	686807	5510108	17.7-19	Cadomin Sandstone
			19-20.3	Cadomin Siltstone
			20.3-22	Cadomin Siltstone
			22-28.1	Cadomin Sandstone
			28.1-29.5	Cadomin Siltstone
			29.5-34	Cadomin Siltstone
			34-36.7	Cadomin Sandstone
			36.7-39.7	Cadomin Conglomerate
			39.7-43.2	Cadomin Conglomerate
			44.3-45.5	Mutz Claystone
			47.7-48.5	Mutz Claystone
			50.3-53.1	Mutz Claystone
			53.8-54	Mutz Claystone
			54-55.6	Mutz Claystone

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
			55.6-55.8	Mutz Claystone
			58.8-59	Mutz Claystone
			59-63	Mutz Claystone
			63-68.1	Mutz Claystone
			68.1-72.1	Mutz Siltstone
			72.1-74.8	Mutz Claystone
			74.8-78.8	Mutz Sandstone
			78.8-82.8	Mutz Sandstone
			82.8-87.8	Mutz Sandstone
			87.8-91.8	Mutz Siltstone
			91.8-96.8	Mutz Siltstone
			96.8-101.3	Mutz Claystone
			101.3-102.2	Mutz Carb.
			102.2-105.4	Mutz Claystone
			105.4-108.1	Mutz Claystone
			108.1-108.3	Mutz Carb.
			116.4-116.5	Mutz Claystone
			116.5-118.4	Mutz Claystone
			118.4-118.6	Mutz Claystone
			119.8-120	Hillcrest Claystone
			120-123.9	Hillcrest Claystone
			123.9-127.6	Hillcrest Siltstone
			127.6-127.8	Hillcrest Claystone
			129-129.3	Hillcrest Carb.
			131.5-131.7	Adanac Claystone
			131.7-135.7	Adanac Claystone
			135.7-137.8	Adanac Sandstone
			137.8-138	Adanac Claystone
			139.6-139.8	Adanac Claystone
			139.8-143.8	Adanac Claystone
			143.8-149.1	Adanac Claystone

Table 5.2-1 Summary of Overburden Samples

Drill Hole ID	As-Built Coordinates (UTM Zone 11)		Depth* (m)	Description of Materials*
	Easting (m)	Northing (m)		
			149.1-149.5	Adanac Claystone
			154.6-154.8	Adanac Siltstone
			154.8-159.8	Adanac Siltstone
			159.8-162.8	Adanac Claystone
			162.8-163	Adanac Carb.
			165-165.2	Adanac Carb.
			165.2-170.9	Adanac Sandstone

*depth and materials description interpreted from drilling logs

Geochemical characterization of legacy waste rock and sampling of site waters as an analog for future waste rock was also conducted (SRK 2015).

5.3 Overburden Characterization

The overburden material has the potential to become part of the lower rooting zone; consequently, the overburden material was rated for reclamation suitability following the *Soil quality criteria relative to disturbance and reclamation guidelines*, as specified for the eastern slopes region of Alberta (SQCWG 1987). The assessment methodology and rating system is detailed in [Section 4.2](#), Reclamation Suitability.

The overburden has been evaluated and categorized as either Suitable (good, fair or poor) or Unsuitable for subsoil material based on the reclamation suitability criteria for the eastern slopes region of Alberta (SQCWG 1987). [Table 5.3-1](#) lists the reclamation suitability ratings for overburden samples collected.

Table 5.3-1 Reclamation Suitability Ratings for the Overburden Samples*

Sample ID (overburden sample type)	Depth (m)	Material Type ¹	Lab Texture ₂	Sat (%)	Sat Rating	pH Paste	pH Tree Rating	pH Grass Rating	EC (dS/m)	EC Rating	SAR	SAR Rating	CaCO ₃ (%)	CaCO ₃ Rating	Most Limiting Rating ³	Overburden Suitability
RGOH3001	1-12	CS/SiS	S	29.9	F	7.79	P	F	0.72	G	0.14	G	1.9	G	P(1)	S
	14-20	CN	S	25.5	F	6.72	F	G	2.52	F	<0.1	G	1.29	G	F(1,2,5)	S
	21-32	CN	S	26.6	F	6.19	G	F	2.85	F	<0.1	G	3.07	F	F(1,2,4,5)	S
	33-39 &44-49	CN/SiS/ CS/CO	LS	24.5	F	7.86	P	F	0.84	G	0.15	G	4.26	F	P(1)	S
	53-59	SH/CS	S	27.3	F	8.17	P	F	0.35	G	0.31	G	6.42	F	P(1)	S
	60-70	SH/SiS	S	26.7	F	8.3	P	F	0.35	G	0.5	G	9.06	F	P(1)	S
	71-77	SH	S	26.6	F	8.19	P	F	0.47	G	1.03	G	8.89	F	P(1)	S
	88-97	SH	LS	25.2	F	9.05	U	U	0.8	G	no calc*	no calc*	9.01	F	U(1)	U(1)
	98-105	SH/SiS	S	29.1	F	9.07	U	U	0.78	G	no calc*	no calc*	7.91	F	U(1)	U(1)
	106-113	SiS/SS	S	28.7	F	9.07	U	U	0.75	G	no calc*	no calc*	16.8	F	U(1)	U(1)
	129-135	SS	S	22.9	F	8.47	P	F	2.04	F	18.7	U	3.71	F	U(3)	U(3)
RGOH3002	1-8	SS/SiS	S	27.3	F	7.59	P	F	0.41	G	0.13	G	2.18	F	P(1)	S
	16-25	SS/SiS	S	30.3	G	8.08	P	F	1.06	G	0.11	G	15.7	F	P(1)	S
	25-33	SiS/SH	S	27.9	F	7.71	P	F	0.82	G	0.11	G	3.32	F	P(1)	S
	34-41	SH/CS	LS	25.4	F	7.99	P	F	1.04	G	<0.1	G	7.46	F	P(1)	S
	53-61	SiS/CS	LS	25.1	F	8.01	P	F	0.42	G	0.21	G	3.25	F	P(1)	S
	62-70	SS/SiS	S	27.4	F	8.03	P	F	0.65	G	0.23	G	17.6	F	P(1)	S
	77-93	SiS/CO/ SS	S	28.4	F	7.61	P	F	1.00	G	0.13	G	5.52	F	P(1)	S

Table 5.3-1 Reclamation Suitability Ratings for the Overburden Samples*

Sample ID (overburden sample type)	Depth (m)	Material Type ¹	Lab Texture ₂	Sat (%)	Sat Rating	pH Paste	pH Tree Rating	pH Grass Rating	EC (dS/m)	EC Rating	SAR	SAR Rating	CaCO ₃ (%)	CaCO ₃ Rating	Most Limiting Rating ³	Overburden Suitability
RGOH3003	4-14	SiS	LS	25.5	F	7.75	P	F	0.42	G	<0.1	G	3.51	F	P(1)	S
	15-25	CN	S	24.0	F	7.78	P	F	0.53	G	<0.1	G	1.46	G	P(1)	S
	26-30	SiS/CN	S	23.7	F	7.69	P	F	0.45	G	<0.1	G	<0.8	G	P(1)	S
	32-33	SiS	S	27.7	F	7.13	F	G	0.51	G	<0.1	G	<0.8	G	F(1,5)	S
	34-40	SH/SS	S	29.9	F	8.02	P	F	0.53	G	<0.1	G	12.1	F	P(1)	S
	41-50	SH	LS	23.9	F	8.03	P	F	0.74	G	<0.1	G	4.68	F	P(1)	S
	52-57	MS/CO	LS	25.6	F	7.70	P	F	0.82	G	<0.1	G	<0.8	G	P(1)	S
	81-84	SH	LS	20.7	F	7.96	P	F	0.91	G	<0.1	G	3.38	F	P(1)	S
	102-109	CS/SH	S	27.2	F	7.86	P	F	0.73	G	<0.1	G	2.76	F	P(1)	S
	112, 116- 127	CS/SS/Si S/SH	S	25.3	F	8.17	P	F	0.36	G	0.12	G	6.72	F	P(1)	S
	136-137	CO/CS	S	24.6	F	8.15	P	F	0.31	G	0.2	G	14.3	F	P(1)	S
	143-144	SS	S	24.4	F	7.92	P	F	1.05	G	<0.1	G	4.64	F	P(1)	S

* - Only samples tested for all required parameters presented.

¹ Material (used for bedrock materials): CS = claystone SS = sandstone SiS = siltstone MS = mudstone CN = conglomerate SH = shale CO = coal seam

² Texture (used for surficial materials): S = sand LS = loamy sand SL = sandy loam SiL = silt loam L = loam SCL = sandy clay loam SiCL = silty clay loam CL = clay loam C = clay

³ Ratings and Limitations for eastern slopes rooting zone material (SQCWG 1987)

G – Good

1 – pH

F – Fair

2 – EC

P – Poor

3 – SAR

U – Unsuitable

4 – CaCO₃ (Calcium carbonate)

S – Suitable

5 – Saturation percentage

*no calc. – The SAR value was incalculable due to non-detect calcium or magnesium values.

The data summarized in [Table 5.3-1](#) was evaluated on pH, EC, SAR, saturation percentage, and CCE parameters. General lithology and soil texture was used as a guide in determining potential reclamation limitations to samples that were not initially limited by pH, EC, SAR, saturation percentage and/or CCE. Textures were not rated as the samples were mainly composed of bedrock material. Limited information was available on overburden consistence.

The process of overburden handling during mining will affect the expected coarse fragment content. Blasting and handling of the sandstone, siltstone and mudstone will determine the size and distribution of coarse fragments within the displaced overburden material. Sandstone materials are likely to produce the most persistent coarse fragment materials during mining. Coarse fragment content of the bedrock overburden materials is not expected to be a limiting factor for reclamation suitability.

The main limiting parameters of overburden/bedrock material based on the sample chemistry are pH and SAR as compared to the *Soil quality criteria relative to disturbance and reclamation guidelines*, as specified for the eastern slopes region of Alberta (SQCWG, 1987). For the data evaluated: 13% of the overburden samples (surficial and bedrock) rated as unsuitable material as root zone material according to the SQCWG (1987), dominant limitations were alkaline pH and SAR values. None of the surficial samples rated as unsuitable. The bedrock samples that were rated as unsuitable were found at one location (drill hole RGOH3001) from the depths of 88 m to 135 m. Ninety percent of the overburden samples were rated as poor reclamation media due to alkaline pH values according to the SQCWG (1987).

5.3.1 Salinity (EC and SAR) & Saturation Percentage

SAR is a measurement of soil sodicity. Sodicity is a term used to describe the relationship of soluble sodium to soluble calcium and magnesium in the soil solution (Hausenbuiller, 1985). Sodic materials have a relatively high concentration of sodium ions in comparison to calcium and magnesium. In surficial soil materials, high SAR results in poor soil structure and reduces water uptake by vegetation, thus lowering overall productivity. SAR values ranged from <0.1 – 1.03 (excluding one sample with SAR of 18.7). Only one sample exceeded the SAR criteria, from drill hole RGOH3001 at 129 to 135 m, and was deemed unsuitable. The three samples above this one (from 88 to 113 m) had incalculable SAR values due to non-detectable calcium or magnesium values and had high pH values so were also rated as unsuitable.

The concentration of soluble salts in soil is measured as electrical conductivity on a soil paste extract. EC values >4 dS/m indicate elevated soluble salts, and hence a saline soil. EC values ranged from 0.31 – 2.85 dS/m with an average of 0.84 dS/m for all overburden data (surficial and bedrock) reviewed. No distinct patterns or trends were displayed spatially for EC values. The average EC

value of 0.84 dS/m indicates that the overburden material is generally non-saline. Saturation percentage values ranged from 20.7 – 30.3% with an average of 26.2% for all overburden data (surficial and bedrock) reviewed. Saturation percentage was not considered a limiting factor for reclamation suitability of overburden material.

5.3.2 Soil Reaction (pH)

Reaction of the overburden material ranged from strongly acidic (pH 3.69) to strongly alkaline (pH 9.07), with an average pH of 7.12.

No distinct patterns or trends were displayed spatially for pH values. Soil pH was the most limiting factor for the majority of the samples; the resultant reclamation suitability rating was mainly poor. Three samples from drill hole RGOH3001 at depths of 88 to 113 m were rated as unsuitable.

Soil pH can influence availability of plant nutrients, thus potentially affecting plant growth. It is anticipated that the alkaline pH recorded in the overburden material will not result in effects on vegetation, as the overburden material will not form a significant portion of the reclaimed rooting zone. Studies have shown that stockpiled / exposed overburden material can display a decrease in pH when carbonate-rich overburden material oxidizes, forming weak carbonic acid (Chernipeski, 2008). It is expected that overburden material excavated during the mining process will be exposed to weathering elements and the potential for a decrease in pH of this material does exist.

5.3.3 Calcium Carbonate (Lime) Content

Calcium carbonate equivalent (percent) expresses the lime content in soil. The lime (CaCO_3) content (measured as calcium carbonate equivalency (CCE)) of overburden material ranged from <0.8 – 22.6% in all the reviewed data. These values do not present limitations for reclamation suitability.

5.3.4 Overburden Physical Characteristics

Overburden materials comprised of sandstone may result in coarser textured material, particularly after materials handling whereas overburden material comprised of mudstone, or siltstone will likely produce medium textured spoil. Blasting and handling of sandstone, siltstone and mudstones will result in mixing of materials during development and produces overburden fines (<2 mm in size) of variable texture that are expected to range from medium to moderately coarse in texture. Texture (of the resultant fines) is not expected to be a limiting factor for reclamation suitability of the bedrock overburden.

Core samples collected do not represent the rock / coarse fragment content of spoil material produced by the process of overburden removal and handling; laboratory analysis cannot predict resultant physical properties of the spoil material post excavation (Chernipeski, 2008). Overburden

characteristics as relating to coarse fragments are, to some degree, a result of materials handling as well as material composition. Stones (rock fragments ranging from 2 mm to 80 mm in size) were generally not a limiting factor for reclamation suitability in the overburden materials, and not anticipated to be of concern in the mine permit boundary for reclamation. Coarse fragment content of the bedrock overburden materials is not expected to be a limiting factor for reclamation suitability.

5.4 Acid Rock Drainage

Acidic drainage from the replaced overburden can be an issue at surface mines. Oxidation of sulfide minerals in the overburden will cause sulfuric acid to form, and high concentrations of trace elements may become dissolved in solution resulting in acid rock drainage. Acidity within the exposed overburden may be partially or completely neutralized in the presence of naturally occurring carbonates, either mineralized or in solution.

A detailed assessment of the overburden material for acid rock drainage (ARD) potential was completed and the results are presented in Geochemical Characterization Progress Report (SRK, 2015).

Results indicate:

- ARD potential is associated with the Cadomin Formation (particularly the conglomerate), and the Mutz, Adanac, and Moose Mountain Members of the Kootenay Formation.
- Near-surface legacy spoil appears to have low ARD potential with all samples containing less than 0.1% sulphide sulphur.

Layers with higher ARD potential are relatively thin and usually surrounded by material with high neutralization potential. The acidity is completely neutralized by carbonate minerals by assuming that acid-generating materials are thoroughly mixed with acid-consuming materials.

5.5 Trace Elements

A total of 16 trace elements were analyzed from samples collected to identify baseline concentrations in the overburden material. A total of 176 samples were analyzed for trace metals in accordance with the Canadian Council of Ministers of the Environment (CCME, 2011) guidelines. Sample collection varied from 0.6 – 170.9 m in depth, with the bulk of samples originating from bedrock units. Mean trace metal concentrations were compared to published data in Canadian Soil Quality Guidelines (CCME, 2011). A summary of analytical results for baseline trace metals by depth increment is provided in [Table 5.5-1](#).

Table 5.5-1 Trace Element Analysis Results for the Overburden Samples (mg/kg)

Depth (m) (sample size)	Metals	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Cobalt (Co)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Lead (Pb)	Selenium (Se)	Thallium (Tl)	Vanadium (V)	Zinc (Zn)
0-5 (n=1)	Min	1.28	3.15	185	<1	1.34	9.2	11.0	29.0	0.114	2.1	30.5	13.7	1.22	<0.5	40.0	161
	Max	1.28	3.15	185	<1	1.34	9.2	11.0	29.0	0.114	2.1	30.5	13.7	1.22	<0.5	40.0	161
	Mean	1.28	3.15	185	<1	1.34	9.2	11.0	29.0	0.114	2.1	30.5	13.7	1.22	<0.5	40.0	161
5-10 (n=2)	Min	0.79	2.32	220	<1	1.38	6.9	5.40	21.3	0.075	1.4	30.2	9.0	0.70	<0.5	17.4	133
	Max	0.98	4.57	242	<1	1.54	7.6	6.58	32.8	0.163	2.1	35.4	11.5	1.14	<0.5	26.3	164
	Mean	1.16	3.45	231	<1	1.46	7.3	5.99	27.1	0.12	1.8	32.8	10.3	0.92	<0.5	21.9	149
10-50 (n=39)	Min	0.27	1.92	22	<1	0.33	3.9	3.42	6.70	0.01	1.20	11.60	7.00	0.10	0.04	12.1	29.0
	Max	1.92	17.50	699	<1	2.04	13.9	206.1	55.71	0.44	9.88	60.9	24.6	2.90	0.16	42.8	251.7
	Mean	0.73	7.61	181	<1	1.13	8.2	23.03	23.48	0.09	2.61	28.5	12.3	1.00	0.10	26.8	103.7
50-90 (n=51)	Min	0.08	0.90	28	<1	0.04	2.4	2.28	4.80	0.01	0.40	8.6	6.1	0.20	0.03	5.0	18.0
	Max	1.79	18.30	500	<1	4.42	13.4	84.8	81.03	0.84	5.46	68.8	46.1	4.80	0.29	61.0	395.8
	Mean	0.64	5.11	237	<1	1.56	8.6	12.05	28.98	0.14	2.05*	31.0	13.7	1.43	0.09	28.9	143.2
90-130 (n=45)	Min	0.10	0.40	123	<1	0.35	0.6	3.02	14.55	0.04	0.48	3.3	7.4	0.30	0.03	9.0	23.3
	Max	1.28	9.90	694	<1	2.60	18.8	100.6	77.56	0.25	4.72	50.2	29.9	2.30	0.10	57.0	335.0
	Mean	0.40	3.44	381	<1	1.50	8.3	15.9	31.06	0.13	1.69	25.7	13.4	1.19	0.07	26.6	137.5
130-170 (n=40)	Min	0.10	0.20	16	<1	0.09	0.5	2.1	5.80	0.01	0.23	2.3	1.4	0.40	0.02	3.0	4.5
	Max	0.52	26.70	591	<1	2.10	16.4	181.5	61.77	1.19	8.17	57.5	20.0	3.40	0.24	37.0	205.5
	Mean	0.26	4.71	336	<1	1.07	7.6	16.80	27.81	0.14	1.80	22.1	14.3	1.12	0.07	18.0	101.9
CCME Guidelines ¹	-	20	12	500	4	10	50	64	63	6.6	10	50	140	1	1	130	200

¹ Canadian Council of Ministers of the Environment (CCME). Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health – Parkland Land Use Summary Tables December 2011

*For calculating mean, samples that were below the detectable limit were given a value equal to the detectable limit.

BOLD – Analytical result is above the screening guidelines.

Mean values of the 16 trace metals are generally within Canadian Soil Quality Guidelines for parkland soils (CCME, 2011). Selenium (Se) is the only element to have concentrations above the conservative CCME guidelines with any regularity. The vertical distribution of the elevated Selenium results was as follows:

- 0 – 5 m – 1 sample;
- 5 – 10 m – 1 samples;
- 10 – 50 m – 14 samples;
- 50 – 90 m – 29 samples;
- 90 – 130 m – 21 samples; and
- 130-170 m – 19 samples.

Selenium concentrations observed indicated that selenium leaching is a consideration for the project based on experience at other coal projects in British Columbia and Alberta.

5.6 Overburden Summary

The overburden assessment relied on analytical results from the geotechnical and hydrogeological investigations. Sample data was available from near surface (1 m) to a maximum depth of 170.9 m. Evaluation of the overburden chemistry included data for SAR, EC, pH, calcium carbonate equivalent (CCE), ARD data and trace metals. Reclamation suitability of the overburden materials was assessed using the *Soil quality criteria relative to disturbance and reclamation* guidelines as specified for root zone materials in the eastern slopes region of Alberta (SQCWG, 1987).

A majority of the bedrock overburden material is rated suitable as reclamation material. With respect to the bedrock overburden material (consolidated material), the ratings were consistent and independent of material type or depth. Bedrock overburden sample depths ranged from 1 to 170.9 m. pH values of the bedrock overburden were predominantly poor.

The suitability rating of overburden material throughout the depth of the investigation was limited by pH and SAR. In instances where the pH and SAR values were not a limiting factor, suitability ratings were typically fair. It is expected that pH values of exposed overburden materials will likely decrease with exposure to rain water and oxygen. Overburden analysis at various mines indicates that decrease in pH of the exposed overburden was noted after only a few months of exposure (Chernipeski 2008, Knapik and Rosentreter, 1999).

Physical characteristics (consistence and coarse fragment content) were evaluated based on test hole information and a review of reference material relating to the handling and consolidated overburden

materials during mining. Coarse fragment content and material consistence are not expected to be limiting factors for reclamation suitability for surface or bedrock overburden materials.

The results of the acid rock drainage assessment show that acid rock drainage will not occur assuming acid-generating materials are thoroughly mixed with acid-consuming materials.

Trace metals data were reviewed; the majority of results met applicable CCME (2011) trace metal guidelines. However, Selenium (Se) concentrations slightly exceeded the CCME (2011) guidelines for parkland soils at a total of 92 samples. The depths of the exceedances ranged from 0 – 170 m with majority of the elevated results recorded between 50-90 m. Se concentrations observed indicated that selenium leaching is a consideration for the project based on experience at other coal projects in British Columbia and Alberta.

6.0 IMPACT ASSESSMENT

6.1 Assessment Scenarios

Three assessment cases were considered for evaluating potential environmental effects on soil and terrain as valued components (VCs):

- Baseline Case: includes existing environmental conditions and existing and approved projects or activities within the LSA.
- Application Case: includes the Baseline Case plus the Project.
- Planned Development (Cumulative Effects) Case: Baseline Case; the Application Case; and reasonably foreseeable projects (those that have been disclosed).

For the purposes of defining assessment scenarios, “approved” means approved by any federal, provincial or municipal regulatory authority, and “planned” means any project or activity that has been publicly disclosed up to six months prior to the submission of the Project Application and EIA report.

Baseline soil information is presented in [Sections 3 and 4](#). The baseline information and interpretations collected and mapped for the LSA and RSA and immediately adjacent lands provides the current conditions within the soil and terrain RSA. This is considered the Baseline Case.

The Application Case focuses on the soil resource within the LSA that will be directly affected by development of the Project and non-mining (recreational) area as identified in [Table 2.1-1](#). Environmental impacts discussed in [Section 7](#) focus on the description of potential environmental effects, mitigation, and residual effects that relate directly to the development, operation, and reclamation of the Project.

The Planned Development Case focuses on the cumulative effects. No planned industrial developments were identified; therefore, Cumulative Case is identical to the Application Case. It is expected that the impact assessment detailed for the Application Case is the same as for the Planned Development Case. As such, the two cases are discussed in concert and summarized in [Table 7.5-1](#).

6.2 Potential Impacts

Mitigative measures and monitoring activities have been developed to minimize the potential effects of the Project on soil and terrain. These activities are summarized in this assessment and detailed in the Conservation and Reclamation Plan provided in [Part F](#) of the Project Application.

Mitigation including final reclamation and closure of the replacement golf course and helipad areas are not included as the responsibility to each component is intended to extend beyond the operational and closure plan life of the Project's mining activities therefore they remain as disturbed areas in all post-baseline assessment cases.

Mitigation and monitoring activities provided relate to the Project activities and address potential impacts associated with the Project. With respect to soil and terrain no specific mitigation is proposed to address potential cumulative impacts occurring within the RSA outside of Project related disturbances or activities. It is assumed that for existing, planned, or approved future activities located within the RSA regulatory requirements and activities similar to what is described for the Project would be completed to properly mitigate any adverse impacts to soils and terrain.

The potential for residual effects following the implementation of mitigative measures exists. The level of potential impact on the soil resource following mitigative measures was predicted using criteria for assessing the degree of environmental impact as defined in [Part D](#) (EIA Methodology) of the Project Application. The evaluation criteria include:

- Magnitude of the impact (nil, low, moderate or high).
- Geographic extent of impact (local, regional, provincial, national, or global).
- Duration of impact (short, long, extended or residual).
- Frequency (continuous, isolated, periodic or occasional).
- Ability for recovery (reversible in short term, long term, or irreversible – rare).
- Project contribution (neutral, positive or negative).
- Confidence rating (low, moderate or high).
- Probability of occurrence (low, medium or high).

- Determination of significance (significant or not significant). The determination of the significance of the residual effects of the project is determined for each activity that may affect the VCs over the life of the Project (both Project based and cumulatively).

Activities that may impact the soil resource and associated terrain as a result of the Project for the Application and Planned Development Cases include:

- Soil salvage and handling – salvage of all required soil materials in the proposed disturbance areas may result in effects to soil quality.
- Soil stockpiling – stockpiling of salvaged soil materials during the construction of the Project, both short term and long term, results in potential for soil erosion issues and effects to soil productivity.
- Development of Project infrastructure – includes creation of roads, and all related Project Infrastructures, may result in environmental effects to soil quality and terrain.
- Mining process – extraction of the coal will require removal of all soil – landscape patterns within the proposed mining pit as well as all overburden materials. Replacement of overburden materials at reclamation will result in terrain units different from baseline conditions and the potential for introduction of unsuitable overburden materials into the reclaimed soil profile.
- Operational activities – day to day operations that may result in effects to soil through accidental releases.
- Progressive reclamation – activities including recontouring, soil handling and replacement may result in effects to the reclaimed soil profiles and terrain.

Environmental effects, implementation of mitigative measures, potential residual effects, and evaluation of potential impacts for each VC are discussed in the following sections and summarized in [Table 7.5-1](#).

6.3 Evaluation Process – VC Selection

Identification of appropriate VCs related to the disturbance of existing soil and terrain patterns and evaluation of potential environmental impacts associated with Project development included the following:

- completion of a baseline soil and terrain inventory of the LSA and RSA and assessment of current baseline conditions relating: soil – landscape patterns, available soil materials, suitability of soil material for reclamation, erosion potential of soils associated with various landscapes, a terrain inventory, and identification of lands where soil and terrain has been already impacted by development (based on the map production scale);

- review the LSA and gain an understanding of the mine development and operations process of the various components of the Project;
- conduct an assessment of the overburden materials for the Project and determine the limitations of the overburden material as relating to the reclamation of the Project;
- determine potential environmental effects to soil and terrain based on the development of the Project;
- review the C&R Plan and evaluate the effectiveness of the proposed C&R Plan to minimize / reduce and mitigate impacts to the soil resource and terrain that is expected to be disturbed as a result of Project development;
- analyze potential adverse effects of the Project on soil and terrain within the development area; and
- evaluate cumulative effects (including acidifying emissions) related to the Project in conjunction with existing and planned future activities.

Steps 1 through 3 have been discussed on the preceding sections and steps 4 through 7 utilize all baseline and Project related information to provide the impact assessment of the Project on the soil and terrain VCs.

The following VCs were identified for the Project:

- soil quality (includes impacts related to soil disturbance, erosion, soil burial, and accidental releases);
- soil biodiversity;
- alteration of terrain; and
- landscape capability (impact to potential capability of reclaimed soil and landscapes in comparison to baseline conditions).

7.0 IMPACT ASSESSMENT

The impact assessment considered each VC and assessed the impacts for the Application (Project only) and the Planned Development Case (Cumulative Effects).

For each activity that has the potential to impact, the VC's mitigation is proposed to minimize the impacts of the activities on soil and terrain within the LSA and RSA. Monitoring is proposed to evaluate the predictions that were made in the application. For each VC a rating of environmental impact has been determined, after mitigation is applied.

7.1 Soil Quality

Within the proposed mine development disturbance (Project Footprint) the available reclamation materials, (based on assumptions in [Section 4.1](#)) are estimated as follows:

- Upland surface soil – 3,019,660 m³; and
- Deep organic material – 330,047 m³.

The total reclamation material that is available for salvage within the project footprint is 3,349,707 m³. Replacement golf course and helipad access areas are not included into reclamation material volumes assessment. Available volume of upland surface soils within the replacement golf course and helipad access areas is approximately 167,053 m³. The analysis of soil quality considers changes that may occur in soil physical, chemical and biological properties and soil quantity due to soil profile disturbance, erosion and accidental releases.

7.1.1 Application Case

7.1.1.1 Soil Profile Disturbance

Disturbance of the soil profile during development of Project infrastructure, mining of the coal resource, and reclamation has the potential to impact soil quality. During the life of the Project potential impacts to the soil resource will be limited to the proposed areas of disturbance excluding reclamation material stockpile areas that are not considered in the soil disturbance area. This is as only vegetation will be disturbed during the construction of reclamation material stockpiles. For clarification, please note that the total Project footprint is 1,481.0 ha and non-mining (replacement golf course and helipad access) area is 39.7 ha; however, when excluding reclamation material storage of 37.9 ha the total disturbed area is 1,482.8 ha. Soil salvage, handling, storage (long term and short term stockpiles) and replacement may impact soil quality. Soil material salvaged from disturbance areas may be chemically and physically impacted through the removal, handling and storage, and replacement during reclamation. Potential physical and /or chemical alterations may impact the quality of the soil resource. This removal and subsequent replacement of the soil resource may initially reduce soil quality of the reclaimed soil profiles. As reclaimed soil profiles develop, a similar level of capability to pre-disturbance conditions will be achieved over an extended period of time (*e.g.*, decades).

Upland surface soil thickness in the proposed disturbance area is variable and dependent on terrain types and more specifically landscape positions within discrete terrain types. The vast majority of soils within the proposed disturbance area are usually juvenile with little or no profile development. The upland areas have thin leaf litter and A horizons (if any); therefore, salvage of a part or all of the B horizon is recommended to meet the reclamation materials balance requirements. This plan also minimizes the risk of degrading the quality of the reclamation material via incorporation of marginal

substrates from greater depths. Soil quality within the A horizons (includes surface litter layer) and B horizons is similar (as displayed in [Table 4.1-2](#)) and the blending of all or portions of these layers is not expected to be detrimental, and in some instances increase soil quality depending on layer textures and nutrient levels.

The organic deposits within the proposed disturbance areas will be excavated and will form part of the soil balance salvaged for use in the reclamation program.

Based on the terrain classification for the LSA, it is estimated that approximately 379.7 ha (25.6%) of the proposed soil disturbance area will not have soil materials salvaged due to equipment limitations resulting from the steep terrain. Also approximately 185.2 ha of land was previously disturbed by legacy mining operations in the area; no soil resources available to be salvaged in these areas. It will be extremely important to salvage the upland surface soil resource in all available areas to ensure there is enough material to complete the proposed reclamation.

Soil compaction as a result of soil salvage, handling and replacement activities may also negatively impact soil quality during disturbance activities. Compaction can reduce soil permeability, reduce water infiltration into the soil profile and decrease soil porosity (Naeth *et al.*, 1991). Compaction is of particular concern during direct replacement activities when large equipment is traversing reclaimed profiles during progressive reclamation. Appropriate soil replacement strategies (*e.g.*, limiting heavy traffic to certain areas) and soil de-compaction activities post-reclamation (*e.g.*, rough mounding, tillage, deep ripping) will minimize impacts potentially associated with soil compaction.

Implementation of appropriate soil salvage techniques, in addition to field guidance by experienced professionals and pre-disturbance soil survey information will result in minimal soil losses due to conventional salvage and handling methods and minimize impacts to soil quality. As reclaimed profiles evolve in the reconstructed landscape, it is expected that the soil profiles and resultant mine landscapes will support the required end land uses objectives.

Benga is expecting that proper soil salvage, handling, storage and replacement techniques will be utilized for non-mining (replacement golf course and helipad access) construction that is not performed by Benga.

With proper soil salvage, handling, storage and replacement the effects of soil profile disturbance for the Application case are rated as a low impact.

7.1.1.2 Erosion

The potential for impacts resulting from wind and water erosion on soil quality exists throughout the life of the Project. There is potential for loss of soil via erosion during soil salvage, soil storage, and

after soil replacement. The risk of erosion to surface soils is greatest during the soil salvage (construction phase) and soil replacement (reclamation phase). The potential impacts to soil quality via erosion are discussed separately for soil stockpiles and soil handling during reclamation.

7.1.1.2.1 Reclamation Material Stockpiles

Erosion of stockpiled soil may occur by wind and water. Salvaged soil material will be stored in stockpiles. The stockpiles will be stabilized, and vegetated to minimize erosion. It is anticipated that the length of time over which stockpiled soil material will be at risk to soil erosion due to lack of vegetative cover will be brief and not significant with respect to the life of the Project.

7.1.1.2.2 Soil Replacement at Reclamation

Reclamation materials replaced during reclamation are at risk of erosion by wind and/or water during soil handling activities and immediately after replacement. The reclaimed landscapes over which the reclamation material will be replaced are estimated to be similar to pre-disturbance conditions with respect to slopes and slope lengths. There will be a slight reduction in the maximum slopes that will exist in the reclaimed landscape, as all slopes will be reclaimed to a maximum slope angle of 23°, except the portions of highwall that will remain after reclamation. [Section 4.3.1](#) provided baseline and estimated water erosion risk ratings of reclaimed lands with and without implementation of mitigation.

Within the LSA, approximately 42.1% (640.5 ha) of the area has a high risk of wind erosion and 77.9% (1,185.0 ha) of the area has a severe risk of water erosion (assuming no mitigation) prior to vegetation establishment. With appropriate revegetation and erosion control activities during the Project, it is expected that the soil loss due to erosion will be minimal and have a low effect on the soil resource.

7.1.1.3 Accidental Releases

Impacts to soil quality caused by accidental releases and operational incidents within the proposed disturbance area have the potential to alter chemical and physical attributes of soils. This can include equipment failures, line failures, tank releases, and surface releases from operations activities. Accidental releases may occur as one time releases, or as cumulative releases that occur over longer periods of time. With the appropriate environmental management plans in place, accidental releases will result in a low effect on soil quality.

7.1.2 Planned Development Case (PDC)

For the PDC it is assumed that within the RSA, an estimated 33.4% (1,520.7 ha) will be disturbed based on the Project. An estimated 8.2% (372.6 ha) is currently disturbed within the RSA.

It is expected that existing and potential future developments within the RSA that disturb the soil resource as a part of the development will be required to conserve soil and complete reclamation as per current regulatory and operating requirements. Compliance with regulatory requirements for planning, construction, and reclamation of developments will minimize any impacts to soil quality and quantity (productivity) by ensuring appropriate conservation and reclamation planning is in place that addresses soil handling, storage, replacement, and mitigation and monitoring post reclamation.

With effective soil salvage and handling, reclamation, and mitigation and monitoring, the impacts to the RSA as a result of development of the Project and existing current and future developments are expected to be low impact with respect to reclaimed soil profiles in the reclaimed landscapes. It is expected that desired end land uses and appropriate capability will be achieved.

7.1.2.1 Erosion

The resultant environmental effects pertaining to soil erosion for the PDC are anticipated to be equivalent to the Application Case. It is anticipated that similar mitigative measures and monitoring described to minimize erosion for the Application Case are currently being used for existing disturbances within the RSA and will be used in potential future projects (as required to ensure soil conservation). Minimization and mitigation of soil erosion is a regulatory requirement to ensure soil conservation and to protect water bodies. The resultant residual effects to the soil resource due to potential soil erosion for the PDC are anticipated to be low.

7.1.2.2 Accidental Releases

It is anticipated that type, frequency, severity, and potential methods of accidental releases for existing developments currently within the RSA are in some instances similar to the Application case. Forestry developments pose similar risks related to accidental releases; refuelling, equipment breakdowns, material transfers, and waste generation are all potential sources that are common to development activities related to the Project. With the appropriate environmental management plans in place, compliance with appropriate regulatory requirements related to project development, and materials containment accidental releases and subsequent cleanup will result in a low impact on soil quality.

The assessment of impacts to the soil resource as a result of accidental releases for the PDC is anticipated to be low.

7.1.3 Mitigation and Monitoring

Mitigation and monitoring processes provided will minimize impacts to the soil resource throughout the life of the Project. Recommendations are generalized with more detailed information related to

soil conservation and reclamation procedures being provided in the C&R Plan for the Project (Section F) in Sections F.2.1.5 Terrain and Soils, F.3.4 Soil Conservation Program, F.3.6 Mine Reclamation and F.4.2 Soil Management .

Benga recommends mitigation processes described below also to be utilized where applicable for non-mining (replacement golf course and helipad access) construction that is not performed by Benga.

7.1.3.1 Soil Profile Disturbance

The soil baseline work completed for the Project LSA provides information on reclamation suitability, baseline soil thickness, erosion potential. Utilizing this information to develop appropriate soil salvage plans will reduce potential impacts to the soil resource. Impact management and mitigation objectives aim to reduce the extent and severity of surface disturbance during construction and operations. General mitigation and monitoring measures are summarized below.

Mitigation

- Upland surface soil and organic materials (reclamation material) will be salvaged using best management practices. Supervision of salvage operations, stockpiling, and placement of materials during reclamation (including direct placement) by qualified individuals is recommended.
- Soil handling activities should be suspended under wet or windy conditions when the degradation of soil quality is a potential.
- Organic soil material will be salvaged for later use in reclamation.
- Placement of reclamation material will require that it is stored in a manner to minimize material loss or degradation of quality and located in areas that are accessible and retrievable.
- Varying thicknesses of reclamation material will be replaced, with a target of 20 cm average thickness, to assist in creating diversity in the reclaimed landscapes.
- Decompaction of the replaced materials will be done to reduce potential compaction as a result of soil replacement.
- All reclaimed lands will be initially vegetated using a cover crop upon completion of soil placement to minimize soil loss via erosion (wind and water); target vegetation establishment will occur through natural regeneration and through seeding or planting of desired understory and tree species.

Monitoring

A monitoring program will be developed and implemented to assess the success of reclamation with respect to soil quality. Success will be measured as compared to applicable reclamation criteria and the requirements set by regulatory approvals. Monitoring activities will include the following:

- direct supervision of salvage and replacement activities by a qualified individual;
- erosion of stockpiled or recently replaced soil material as well as effectiveness of erosion control activities;
- ensure reclamation material replacement coverage and depths meet required standards;
- quality of overburden material through a sampling program in order to determine material replacement requirements; and
- assessment of vegetation communities to determine if the seral communities established are appropriate for the target local common forest ecosystems and desired end land uses.

Mitigation and monitoring measures are detailed in the C&R Plan provided in [Section F](#) in Sections [F.2.2 Reclamation Schedule](#), [F.2.3 Adaptive Management for Reclamation](#), [F.3.6 Mine Reclamation](#) and [F.3.9 Research and Monitoring](#) to ensure soil quality is maintained throughout the life of the Project.

7.1.3.2 Erosion

Mitigation

Soil erosion control measures will be implemented to minimize loss of soil materials via wind or water erosion during activities associated with soil salvage, storage and reclamation. General mitigation activities to reduce wind or water erosion potential include the following:

- When stockpiling reclamation material, piles will be placed in strategic locations, to minimize exposure to wind or water.
- Stockpiles will be seeded with a non-invasive and weed free seed mix that establishes quickly.
- Erosion control materials (mats, netting, mulches, straw) will be used to reduce soil surface exposure, as required.
- Reclaimed landscapes will be reseeded with a quick establishing; non-invasive cover crop to minimize the length of time bare soil is exposed to potential wind and water erosion. In addition, reclaimed landscapes that have a moderate to high water erosion risk (*i.e.*, steep side slopes) will have soil stabilizers or other measures implemented (where necessary) to minimize the potential of erosion (*i.e.*, rough mounding, check bales, silt fences, tackifiers, and/or mulch).

Monitoring

- monitoring of stockpiled soils and reclaimed areas to ensure erosion is minimized;
- develop and implement an erosion control plan as required; and
- based on monitoring results of reclaimed landscapes, adaptive management will be incorporated by Benga in order to allow for continual improvement of erosion control processes.

7.1.3.3 Accidental Releases

To mitigate and/or minimize the potential for accidental releases of operational-related chemicals, liquids, or solids, proper handling and containment of these substances will be implemented. Containment and waste storage facilities and processes will be based on regulatory requirements and a spill response plan implemented by Benga to address the various operating processes required for the Project. In the [Project Application, Section C.7](#), detailed spill response, pollution prevention and waste disposal plans for the Project are provided.

7.1.4 Residual Effects

7.1.4.1 Soil Profile Disturbance

Residual effects on the soil quality and quantity for the Project, including construction, operation and reclamation (Application and PDC Effects) are discussed in the following section.

Geographic Extent – The extent is limited to the areas of soil disturbance is 1,482.8 ha, approximately 32.6% of the RSA. Within the RSA, approximately 372.6 ha of land are estimated to be disturbed currently, which equates to 8.2% of the RSA. The geographic extent is considered to be local in nature.

Duration – The duration of potential impacts to soil quality (soil capability) as a result of disturbance to the soil profile is extended. Over time, as reclaimed soil profiles develop, it is expected that reclaimed soil profiles will achieve soil quality similar to pre-disturbance soil quality. Processes such as freeze - thaw cycles, organic inputs, soil water movement through the profile, and biotic activity will allow for reclaimed soil profiles to function similarly to pre-disturbance soils. Cumulatively, duration is also expected to be extended as reclaimed soil and landscapes of various other disturbances will require time to develop to provide equivalent capability (as relating to soil quality).

Frequency – The frequency of impacts to soil quality as a result of disturbance is continuous through the life of the Project and other developments (regionally) during which soil disturbance and reclamation are active. Decreased soil quality will diminish over time upon reclamation as the reclaimed profiles develop in the re-contoured landscape. Cumulatively, frequency is also expected

to be continuous as reclaimed soil and landscapes of various other disturbances will require time to develop to provide equivalent capability (as relating to soil quality)

Reversibility – Soil quality of the reclaimed soil profiles is expected to be reversible in the long term. Implementation of appropriate soil conservation and reclamation practices (landscape, soil and vegetation) will allow for the reclaimed soil profiles to evolve over time and support the desired end land uses.

Magnitude – The magnitude of residual impacts to soil quality and as a result of soil profile disturbance is considered to be moderate. The removal of the soil profile from the landscape and eventual replacement is a disturbance that is considered above normal background conditions, and for the Application case a majority of the area disturbed by the Project will cause a detectable change in ecological parameters beyond the range of natural variability. In addition, some soil materials may not be salvaged (slope steepness), and as such some soil material will be lost as a result of development. Additional suitable soil material will be salvaged to ensure sufficient material is available at reclamation.

Project Contribution – A net negative contribution is expected immediately following reclamation; however, as the reclaimed profiles develop over time, it is expected that the capability of the reclaimed soil profiles will provide capability to meet positive end land uses. Therefore, the impact is expected to be neutral. The estimated contribution of the Project cumulatively is expected to be the same as for the Application case.

Confidence Rating – The confidence rating of the prediction of residual effects on soil quality as a result of soil profile disturbance is high. The baseline information and C&R Plan provide a good understanding of current soil- landscape conditions. The utilization of this information in the C&R Plan will allow for effective soil salvage, storage, and replacement at reclamation and reducing the impact on soil quality. The estimated confidence rating cumulatively is expected to be moderate, regulatory requirements and best management practices will reduce potential impacts to soil disturbance within the RSA; however, regulatory requirements may be unique for different activities within the RSA.

Probability of Occurrence – It is expected that there will be some impact to soil quality as a result of soil salvage, stockpiling, and replacement at reclamation throughout the life of the Project, the probability is considered to be high. In the short term (during soil disturbance and immediately following reclamation), residual effects may impact the reclaimed soil profile. Over the long term, the residual effects on soil quality will decrease as the reclaimed profile evolves within the reclaimed minescape to provide similar function to that of baseline landscape patterns. Cumulatively the

probability of impacts to soil quality is high; there will be impacts to soil profiles and hence soil quality within the RSA.

Determination of Significance – The residual environmental effect of the Project on soil quality as a result of complete disturbance of the soil profile through soil salvage, storage and replacement at reclamation throughout the development is rated as low impact. Soil salvage, handling, progressive reclamation, and monitoring and mitigation efforts will allow for reclaimed soil profiles to evolve over time to provide land capability suitable to meet the desired end land uses. From a PDC case, the residual impacts are predicted to be not significant.

7.1.4.2 Erosion

Residual effects of wind and/or water erosion will be localized to the proposed disturbance area and are of concern in areas where the vegetation has been removed and the soil profile disturbed and/or stockpiled. Appropriate soils handling and implementation of erosion control and monitoring of areas (both pre-disturbance and reclaimed landscapes) that are considered to have a moderate to high erosion potential via wind or water (after implementation of appropriate mitigation) throughout the life of the Project will minimize the potential impacts of erosion. Residual effects on the soil quality and quantity for the Project are discussed below and are inclusive of the Application and PDC cases. Residual effects of erosion on soil and the evaluation of impacts are provided.

Geographic Extent – The extent is limited to areas of soil disturbance, corresponding to the proposed disturbance area (excluding reclamation material stockpiles), and more specifically to areas co-dominated with coarse soil that may be at a high risk of wind erosion (640.5 ha or 42.1% of the footprint) and soils on steep slopes that may be at severe risk of water erosion (1,185.0 ha or 77.9% of the footprint). These represent 14.1% and 26.0% of the RSA, respectively. Within the RSA, coarse textured soil map units and soil map units located on steep slopes are considered to be at risk for soil loss via erosion (wind and/or water). These equate to approximately 2,045.5 ha (45.0%) and 3,749.5 ha (82.4%) of the RSA, respectively. The geographic extent is considered to be local in nature for the Application and PDC cases.

Duration – The duration of the impact to soils via erosion is expected to be short for both the Application and PDC cases. For the Application Case, mitigative measures will be implemented to reduce the length of time soil materials are void of vegetative cover and/or addressed through a suitable erosion control method. Revegetation is dependent on weather that is unpredictable; therefore, there is a degree of uncertainty in the duration of the potential impact.

Frequency – The frequency of impacts to soil by erosion is considered as an occasional (unplanned) event that is dependent on both vegetation establishment and weather.

Reversibility – Loss of soil material by wind or water erosion is irreversible.

Magnitude – For the Application and PDC case, the magnitude of soil loss by erosion is expected to be moderate after soil disturbances and prior to vegetation establishment and/or implementation of other erosion control methods. The magnitude is anticipated to be low once stockpiles have established a suitable vegetation cover and reclaimed landscapes have developed sufficient self-sustaining vegetation to reduce erosion risk.

Project Contribution – A net negative contribution is expected, as some soil material will be lost throughout the life of the Project as a result of water erosion, the extent of soil loss by wind erosion is expected to be negligible upon the implementation of erosion control methods. However, the amount of upland surface soil and subsoil material lost as a result of Project development and subsequent reclamation is expected to be minimal and not impact the capability of the reclaimed soil profiles. Some positive effect of the Project development is expected due to proper reclamation of abandoned legacy mining operations sites within the Project. Currently those sites are highly susceptible to soil erosion due to sparse vegetative cover and low quality of rooting zone. Proper reclamation of abandoned legacy mining sites within the Project will reduce erosion and increase aquatic resources protection by avoidance of soil or coal waste rock deposition into receiving watercourses. The estimated contribution of the Project cumulatively is expected to be neutral as it is expected the soil loss via erosion will not be significant after appropriate mitigation and monitoring with respect to the RSA.

Confidence Rating – The confidence in the prediction of Project and cumulative effects of erosion is moderate. Conventional and timely mitigation and monitoring measures are proven to prevent and minimize erosion of soil; however, weather conditions have the potential to accelerate potential erosion prior to vegetative establishment or delay vegetation establishment.

Probability of Occurrence – The probability of erosion occurring following mitigation in areas susceptible to erosion is potentially high during the initial stages of soil stockpiling or materials placement during direct placement reclamation (prior to vegetation establishment). After vegetation establishment and/or implementation of erosion control measures, the probability of erosion occurring is low, and monitoring of reclaimed lands will address any issues related to erosion that arise through the life of the Project. The PDC case is expected to be the same as for the Application case.

Determination of Significance – Appropriate soil handling, storage, and implementation of mitigative measures during soil salvage and replacement activities to reduce potential erosion will result in a residual environmental effect that is not significant. The PDC Case will result in a residual environmental effect that is not significant.

7.1.4.3 Accidental Releases

Residual effects to the soil resource as a result of accidental releases will occur if releases are not addressed, identified, or remediated effectively. Residual effects of accidental releases on soil and the evaluation of impacts are provided.

Geographic Extent – The extent is generally limited to the areas of disturbance, corresponding to the proposed disturbance area (including reclamation material stockpiles), which is 1,520.7 ha in size and represents 33.4% of the RSA. Within the RSA, approximately 372.6 ha of the land are estimated to be disturbed, and this equates to 8.2% of the RSA. Benga is assuming that the potential for accidental release does exist in all lands mapped as disturbed. The geographic extent is considered to be local in nature.

Duration – The duration of the impact of accidental releases on soils is expected to last throughout the life of the Project (23 years) and is considered to be long in duration. Upon completion of decommissioning and reclamation, accidental releases are not expected within the reclaimed lands. Cumulatively the duration of the potential impact is expected to be extended.

Frequency – The frequency of accidental releases on the soil resource is considered to be occasional (unplanned) for both Application and PDC cases.

Reversibility – Impacts to the soil resource as a result of accidental release are expected to be reversible in the short term for both the Application and PDC cases. Appropriate spill response and subsequent remedial activities will ensure all affected areas meet applicable regulatory guidelines.

Magnitude – The magnitude of residual impacts to soil as a result of accidental releases for both the Application and PDC cases is expected to be low. Implementation of regulatory requirements for containment, facility design and required spill response plans will ensure that impacts or releases are minimized or prevented. In addition, adherence to applicable regulatory requirements relating to soil remediation will ensure any impacted materials are remediated to meet applicable regulations in place.

Project Contribution – A net neutral contribution is expected for both the Application and PDC cases. Any releases will be remediated to meet regulatory guidelines. No net loss of soil material is expected.

Confidence Rating – The confidence rating of the prediction of residual effects of accidental releases within the LSA is high. Regulatory requirements for facility design and containment provide good protection of the soil resource from releases. In addition, remediation techniques and strategies for dealing with chemicals and processes related to the Project are well documented in Alberta.

Cumulatively, similar regulatory requirements related to current and future developments will also ensure potential contamination of the soil resource is identified and addressed. However, the confidence rating is considered moderate for the PDC due to the wide range of various activities within the RSA and the increased likelihood (in comparison to the Project) for potential releases from various activities.

Probability of Occurrence – The probability of a residual impact as a result of an accidental release occurring throughout the life of the Project that impacts the soil resource is considered medium to low. In locations where containment is provided, the likelihood of a release impacting the soil resource is low. However, in areas where secondary containment of spill prevention infrastructure is not provided, the likelihood of an accidental release occurring over the life of the Project is medium (*i.e.*, equipment release on an access road). Based on the type of existing and planned future developments within the RSA the probability of current impacts to soil and future releases is estimated as medium to high.

Determination of Significance – The residual environmental effect of potential soil impacts via accidental releases will result in a residual environmental effect that is not significant as all containment, spill response, and applicable regulatory guidelines will ensure that any accidental releases are prevented and/or contained and remediated.

7.2 Soil Biodiversity and Ecological Integrity

7.2.1 Application Case

The potential effect to soil biodiversity and resulting ecological integrity of vegetation communities will be discussed in terms of the effects of the Project on the spatial distribution of soil patterns and potential changes in soil diversity and ecological integrity post disturbance.

Common soils in the LSA and RSA include Brunisols, Regosols, Luvisols and Chernozems in upland and mid slope positions, Gleysols in transitional areas, and shallow to deep Organics in the poorly drained level landscapes. Based on soil information for the LSA and RSA, there were no uncommon soil profiles or patterns in the proposed disturbance area in the LSA and RSA.

Ecological integrity with respect to soil and landscapes is related to the vegetation communities and resultant habitats that are formed as a result of the relationship between soil and landscape patterns and corresponding moisture and nutrient regimes. The natural variability associated with the soil and landscape patterns will be removed at the time of soil salvage and handling. Reclaimed soil - landscape patterns will be more homogenous than baseline conditions because reconstruction of the inherent variability associated with natural soil profiles is not possible.

Establishment of reclaimed soil and landscape patterns that are conducive to the formation of a range of desired vegetation communities will allow for the eventual formation of suitable reclaimed habitats that meets desired end land use objectives, conforms to adjacent undisturbed soil and landscape patterns, and is self-sustaining.

No change in soil diversity or ecological integrity with respect to soil types and landscape patterns is expected from a regional perspective, and the Project is expected to have a low impact.

7.2.2 Planned Development Case

The soil types and distribution of soil and landscapes within the RSA are similar to that of the LSA as shown on the baseline RSA and LSA soil maps ([Figures 3.3-2 to 3.3-5](#)). The assessment of impacts to soil biodiversity for the PDC is anticipated to be equivalent to the Application Case.

7.2.3 Mitigation and Monitoring

Final re-contouring of depleted mine blocks and appropriate soil replacement will create soil landscape patterns appropriate for the desired end land uses. The landscapes will provide surface water drainage to ensure water movement across disturbed lands, provide surface runoff for constructed wetlands and end pit lakes, as well as establishment of ecosystem patterns appropriate for desired end land uses. Monitoring (as stated in [Section 7.1.3](#)) will be completed throughout the life of the Project to ensure appropriate site contouring, soil placement, and vegetation establishment. Monitoring of reclaimed sites will be continued post reclamation to ensure that the desired vegetation communities are establishing to meet the target end land uses.

7.2.4 Residual and Cumulative Effects

Soil diversity and ecological integrity may be decreased as a result of development (both for the Project and within the RSA) but appropriate reclamation will allow for increased reclaimed soil profile diversity over time in the reclaimed landscapes. Residual effects for the Application and PDC cases on soil diversity and the impact rating are provided.

Geographic Extent – The extent is limited to the areas of soil disturbance, corresponding to the proposed disturbance area (excluding reclamation material stockpiles), 1,482.8 ha or 32.6% of the RSA. Currently within the RSA, approximately 372.6 ha of land are estimated to be previously disturbed, this equates to 8.2% of the RSA. Benga is assuming that the potential for impacts to soil biodiversity does exist in all lands mapped as disturbed.

Duration – The impact on soil biodiversity and ecological integrity is expected to be extended but diminish with time for both the Application and PDC cases. Over time, as reclaimed soil profiles

develop, it is expected that soil and landscape biodiversity will increase as reclaimed profiles develop relative to landscape position, aspect, and slope.

Frequency – For the Application and PDC cases, the frequency of decreased soil biodiversity and impacts to ecological integrity on developed and subsequently reclaimed lands is expected to be continuous and diminish with time post reclamation.

Reversibility – For both the Application and PDC cases, decrease in soil biodiversity and effects to ecological integrity is partially reversible in the long term. Creating soil profile diversity similar to baseline conditions is not possible. Re-creation of reclaimed soil patterns in the reclaimed landscape that display similar patterns to pre-disturbance conditions is possible (*i.e.*, increasing surface soil thickness and wetter moisture regime in lower slope positions).

Magnitude – The magnitude of residual impacts to soil biodiversity and ecological integrity for both the Application and PDC cases is considered to be low. All of the soil-landscape patterns recorded within the proposed development footprint is common within the RSA with respect to distribution and occurrence.

Project Contribution – A net negative contribution is expected. Soil biodiversity of the reclaimed landscape will be less diverse than the baseline conditions. However, as the reclaimed profiles develop, it is expected that the diversity of the reclaimed profiles will increase over time.

Confidence Rating – The confidence rating of the prediction of residual effects within the LSA and RSA is high. The recreation of the variability recorded in pre disturbance conditions is not possible. However, appropriate re-contouring, soil replacement and revegetation will allow for reclaimed soil and landscape patterns that will provide increased diversity over time.

Probability of Occurrence – The probability of decreased soil biodiversity and initial impacts to ecological integrity as a result of development within the LSA and RSA (in comparison to pre disturbance conditions) is initially high as the natural soil profiles and associated landscape and vegetation communities will be removed. Over time it is expected that diversity will increase as soils develop in the reclaimed landscapes.

Determination of Significance – The residual environmental effect of the Project on soil diversity and ecological integrity is predicted to not be significant. Soil salvage, handling, progressive reclamation, and monitoring and mitigation efforts will allow for reclaimed soil profiles, reclaimed landscapes and revegetated lands to evolve over time to provide equivalent capability with a level of biodiversity appropriate for the end land uses. From a PDC case, the residual environmental effect of the Project on soil diversity and ecological integrity is predicted to not be significant. Regulatory requirements

related to soil conservation and reclamation will ensure appropriate processes are completed to allow for development of diversity in lands reclaimed within the RSA.

7.3 Alteration of Terrain

7.3.1 Application Case

Development of the Project results in disturbances to the terrain types within the LSA. Various terrain types will be removed as a result of Project development. Terrain types expected to be removed over the life of the Project include:

- Upland terrain – typically includes hummocky, ridged, terraced, inclined and steep landforms. These landforms account for 1,265.6 ha of the proposed disturbance area and represent terrain disturbances equivalent to 83.2% of the LSA.
- Organic terrain – include nearly level to level, basin and sloped organic landforms with >40 cm of surface peat. Organic landforms account for 18.8 ha of the proposed disturbance area and represent terrain disturbances equivalent to 1.2% of the LSA.

After mining and reclamation of Project infrastructure there will be a permanent loss of organic landforms and the extreme slopes in the upland terrain will be reduced to a maximum slope angle of 23°. The natural variability and complexity of the existing terrain within the LSA will not be duplicated by creation of re-contoured landscapes. The reclaimed landscape will be more homogenous than current conditions. However, the reclaimed landscapes will contain characteristics similar to the existing upland terrain. Similar aspects and slope lengths will exist and will include ridges, benches (plateaus) separated by terraces, valleys, and steep single slope inclines. A variety of wetland complexes and an end pit lake will also be created during the reclamation of the Project. It is expected that the creation of a range of terrain types, during contouring and reclamation will provide a reclaimed terrain that will tie into adjacent undisturbed lands, provide suitable landscapes for the development of a range of reclaimed soil types and functioning vegetation communities. The development of the project is expected to have a low impact on terrain.

7.3.2 Planned Development Case

The soil and landscape patterns within the region, the RSA and LSA are similar. The expected impacts to terrain types disturbed by existing and future Projects in the RSA are negligible. Compliance with regulatory requirements for planning, construction, and reclamation of developments will minimize the impacts to terrain types in the RSA. The evaluation of the impact to altered terrain types is the same as for the Application Case.

7.3.3 Mitigation and Monitoring

Impacts to terrain will be mitigated through appropriate re-contouring of reclaimed landscapes to; provide topography and surface forms that provide appropriate surface drainage, blend with the adjacent undisturbed terrain (*i.e.*, drainage, aspect), remain stable, provide suitable habitat for the formation of diverse reclaimed soil and vegetation patterns in the reclaimed landscape, and meet the desired end land use objectives. In instances where the reclaimed landscape is expected to differ from the original terrain type (*i.e.*, end pit lake or wetland), the landscape will be designed to ensure that end land use objectives are met. The reclamation plan for the Project will also include the development of various ecosystem features (wetlands, surface drain ways (swales), and end pit lakes that will function as wetlands) to ensure that a range of diverse terrain and terrain features are created post development.

Monitoring of post reclamation landscapes for stability, drainage, and the interaction of the vegetation communities in the reclaimed landscapes will be completed after reclamation and revegetation. Areas of concern would be addressed as necessary to mitigate terrain conditions undesirable for end land use and reclaimed vegetation communities. Monitoring will allow for adaptive management of the re-contouring, soil placement and re-vegetation activities throughout the life of the Project.

7.3.4 Residual and Cumulative Effects

Residual effects on terrain, as a result of development, including development of Project infrastructure, mining of the coal resource, and reclamation are discussed below and are inclusive of the Application and PDC cases. Residual effects on reclaimed terrain types are provided.

Geographic Extent – The extent is local and limited to the areas of soil disturbance, corresponding to the proposed disturbance area (excluding reclamation material stockpiles), 1,482.8 ha, approximately 32.6% of the RSA. Within the RSA approximately 372.6 ha of land is estimated to be currently disturbed, this equates to 8.2% of the RSA. Benga is assuming that the potential for impacts to terrain does exist in all lands mapped as disturbed.

Duration – The duration of the impact of reclaimed terrain types is expected to be residual for both Application and PDC cases. Reclaimed terrain types will allow for soil and vegetation communities appropriate for the reclaimed terrain type, and not resemble the pre-disturbance conditions.

Frequency – The frequency of altered terrain is expected to be continuous for both the Application and PDC cases.

Reversibility – Altered terrain created for both the Application and PDC cases are considered to be irreversible.

Magnitude – The magnitude of altered terrain is moderate. The anticipated changes to terrain types as a result of the Project as well as existing and planned activities will result in reclaimed landscapes that are less complex than pre-disturbance conditions. It is expected that reclaimed terrain will provide appropriate ecological function to meet the objectives of the desired end land uses.

Project Contribution – A net neutral contribution is expected for both Application and PDC cases. Although various terrain types are expected to be removed as a result of development, it is expected that reclaimed landscape units will be designed to ensure a similar level of functionality is created to allow for land capability to be returned to disturbed lands.

Confidence Rating – The confidence rating of the prediction of residual effects of altered terrain is high for both Application and PDC cases. Development of the Project will result in the creation of reclaimed landscapes that are less diverse than the pre-disturbance conditions. Existing and planned future activities within the RSA and regional area will result in creation of reclaimed landscapes more homogenous than baseline conditions, and in some instances reclaimed terrain may not provide the exact same function as baseline conditions but will provide a function suitable for the desired end land use objectives.

Probability of Occurrence – The probability of alteration of various terrain aspects is considered high for both Application and Cumulative cases. Development within the LSA and RSA will result in some landscape changes that will create terrain types different from pre-disturbance conditions.

Determination of Significance – The residual environmental effect of altered terrain types is predicted to not be significant for both Application and PDC cases, as appropriate reclamation activities will create reclaimed terrain types similar to pre-disturbance conditions. In other cases, reclamation activities will create terrain types acceptable/desirable to end land use objectives.

7.4 Land Capability Effects

Proper soil conservation, soil replacement, mine backfilling and re-contouring, soil placement and revegetation are all key to ensuring that the reclaimed landscape inclusive of reclaimed soil profiles and vegetation communities provide equivalent land capability. Reclamation success for the Project will be measured by the ability of the reclaimed landscape to achieve land capability equivalent to pre-disturbance conditions and meet the desired end land use objectives with normal land management practices. It is expected that land capability and end land uses post disturbance will not be exactly as the land capability distribution (spatially) that currently exists but the overall reclaimed landscape will provide similar ecological function as the pre-disturbance conditions. The analysis of equivalent capability is assessed by evaluation of soil and overburden materials comprising the root zone, pre-disturbance and post-reclamation land capability, comparison of the reclaimed and baseline

land capability class distribution, loss of various land capabilities due to disturbance, and delay in achieving equivalent land capability post reclamation.

7.4.1 Application Case

Reclaimed Overburden Materials

Overburden material will be used to backfill and re-contour completed mine blocks. The overburden material will be recontoured to a maximum slope angle of 23° and will then have reclamation material replaced, followed with vegetation establishment. Reclaimed soil profiles will provide the rooting zone in the re-constructed landscapes.

In the overburden assessment ([Section 5.0](#)), the majority of the bedrock overburden is considered suitable as a rooting medium for reclamation. Benga will ensure that sufficient suitable overburden material is placed over unsuitable overburden (1.0 m of suitable material) if it is present prior to reclamation material replacement.

An overburden sampling program will be conducted prior to soil placement to determine the soil replacement requirements at reclamation. An overburden assessment program coupled with proper soil salvage and prescriptive soil replacement plan will allow for suitable reclaimed soil profiles to be replaced after mining.

Pre-disturbance and Post-reclamation land capability Comparison

The post reclamation land capabilities will be similar or better than ratings determined for the pre-disturbance soil map units ([Table 4.5-5](#)).

[Table 7.4-1](#) presents a comparison of the reclaimed and baseline forest land capability class distribution within the proposed mining soil disturbance.

Table 7.4-1 Comparison of the Pre-Disturbance and Reclaimed Land Capability Ratings for the Proposed Mining Soil Disturbance					
Capability Class	Pre-disturbance Capabilities		Reclaimed Capabilities		Difference (%)
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	
4	26.6	1.8	50.1	3.5	1.7
4-5	121.8	8.4	406.6	28.2	19.8
4-6	27.1	1.9	869.2	60.2	58.3

Table 7.4-1 Comparison of the Pre-Disturbance and Reclaimed Land Capability Ratings for the Proposed Mining Soil Disturbance					
Capability Class	Pre-disturbance Capabilities		Reclaimed Capabilities		Difference (%)
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	
5	1.7	0.1	1.7	0.1	0
5-6	302.4	21.0	61.3	4.2	-16.8
5-7	672.6	46.6	-	-	-46.6
6	3.5	0.2	-	-	-0.2
7	287.5	19.9	35.8	2.5	-17.4
NA*	0.1	<0.1	18.5	1.3	1.2
TOTAL¹	1443.1	100	1443.1	100	-

Dash (-) there are no occurrences of a particular LCCS class or no area of disturbed lands (ZDL).

¹ Due to rounding, total values may not equal the sum of the individual values.

*Open Water, Post-closure lake

Differences in reclaimed and baseline land capability ratings for the Project are associated with the following changes:

- a total of 18.8 ha of organic landscapes that will be reclaimed as upland landscapes;
- the portions of the Project Footprint that were mapped as disturbed lands (ZDL) will be reclaimed to provide a suitable reclaimed landscapes to meet the end land use goals; and
- a post-closure end-pit lake that covers approximately 18.4 ha will be created.

Non-mining (recreational) area is not included in the calculation due to changes in land use. Benga expects that overall post-development changes in recreational land capability of this area will be positive.

Land Capability – Loss and Delays

The reclaimed landscape will contain reclaimed soil profiles, and landforms similar to what existed prior to disturbance. There will also be wetland complexes and various reclaimed drainage patterns reinstated to ensure appropriate surface water drainage post development. These reclaimed features will provide enhanced diversity, and are considered acceptable landscape features for the desired end land use objectives for the Project.

All reclaimed features will require time, some management inputs, and various ecological processes to be initiated to allow for the creation of suitable vegetation communities and habitat that meets end land use objectives and achieves equivalent land capability. Reclamation goals, end land use objectives, and measures of reclamation success will dictate the length of time that the reclaimed landscape requires to reach equivalent land capability. Over time, Benga expects that the reclaimed landscape and vegetation communities will provide equivalent capability to allow for commercial forestry, wildlife habitat, and recreational uses.

7.4.2 Planned Development Case

Reclaimed Overburden Materials

The impact assessment for the PDC case is the same as the Application case.

Land Capability

Effective soil conservation, reclamation, revegetation, and mitigation and monitoring of developments or activities within the RSA will ensure that land capability will be achieved to meet desired end land uses.

The cumulative impacts to the RSA as a result of development of the Project and existing current and future developments are expected to be low impact with respect to impacts to equivalent land capability. The impact assessment for the PDC case is the same as the Application case.

7.4.3 Mitigation and Monitoring

7.4.3.1 Reclaimed Overburden Materials

Mitigation

Implementation of appropriate soil salvage activities will ensure sufficient volumes of reclamation material are salvaged for placement. Sufficient suitable overburden material will be available for placement over unsuitable overburden. Upon backfilling and re-contouring of mine blocks unsuitable overburden will be identified to ensure that sufficient reclamation material is replaced to meet regulatory requirements over all reclaimed lands.

Monitoring

Monitoring activities related to material placement of overburden and soil materials will assess the following:

- quality of overburden after mine backfilling and contouring to determine if overburden material located at surface is suitable or unsuitable as root zone medium;

- quantity of suitable overburden material placed over unsuitable overburden; and
- reclaimed areas for reclamation material quality and quantity (depths) and suitability of overburden materials.

After establishment of desired vegetation communities, vegetation will be monitored for plant composition, vigour, health, cover, density, and height. Assessment of vegetation will allow Benga to evaluate the reclaimed rooting zone by assessing vegetation response.

7.4.3.2 Land Capability

Mitigation

Project disturbance will result in reclaimed landscapes that will provide a range of capabilities that will be spatially unique to pre-disturbance conditions.

Reducing the length of time to achieve equivalent land capability is based largely on the success of reclamation. It is expected that Benga will reclaim disturbed areas to meet all regulatory requirements related to soil salvage, storage and replacement. In addition, Benga will utilize best management practices currently used in the industry as well as adaptive management to ensure that reclamation practices are effective.

Monitoring

Evaluation of equivalent land capability will be primarily a monitoring process upon completion of reclamation and revegetation. Assessment of vegetation health, diversity and community succession in the reclaimed landscapes will allow Benga to evaluate reclaimed capability to ensure that established reclaimed landscapes and vegetation communities are trending towards (or have achieved) equivalent land capability as per the desired end land use objectives.

7.4.4 Residual Effects

7.4.4.1 Reclaimed Overburden Materials

Benga will comply with all regulatory requirements regarding the identification of unsuitable overburden materials and subsequent covering of all unsuitable overburden with 1.0 m of suitable material. Residual effects of unsuitable overburden material impacting the reclaimed soil profiles and the evaluation of impacts are inclusive of the Application and PDC cases. A summary of the impact assessment is provided.

Geographic Extent – The extent is for the Application case is limited to the areas of disturbance, corresponding to the proposed disturbance area (excluding reclamation material stockpiles), 1,482.8 ha which equates to 32.6% of the RSA.

Duration – The duration of the residual effect of unsuitable overburden is expected to be residual. It is estimated that over time, if unsuitable overburden is located in the reclaimed profile a combination of weathering carbonates and net downward movement of soil water in the reclaimed profile will decrease the unfavorable conditions of the root zone.

Frequency – The frequency of the residual impact to the reclaimed profile is expected to be continuous and diminish over time. As with duration, eventual downward movement of the salts in the reclaimed profile will reduce the negative impacts of unsuitable overburden on soil quality and overall equivalent capability.

Reversibility – Effects of overburden material in the reclaimed soil profile is anticipated to be reversible in the long term.

Magnitude – The magnitude of residual impacts of unsuitable overburden material is low. The soil resource will be modified above background conditions, but will remain within accepted scientific thresholds. It is expected that completion of the recommended mitigation and monitoring activities will minimize the potential of unsuitable overburden materials being introduced into the reclaimed soil profile by ensuring appropriate replacement depths and recognition of potential problem areas during, and immediately after, reclamation.

Project Contribution – A net neutral contribution is expected. The likelihood of unsuitable overburden material comprising the root zone or impacting vegetation communities or land capability is low.

Confidence Rating – Confidence in the prediction of potential residual effects to reclaimed soil profiles is high. The confidence rating is high, as compliance with appropriate material placement at reclamation will ensure that unsuitable overburden material does not comprise the reclaimed root zone.

Probability of Occurrence – The probability of residual environmental effects occurring to the reclaimed soil profile is expected to be low. Implementation of mitigation and monitoring activities coupled with regulatory requirements regarding material placement over unsuitable overburden reduces the potential for adverse effects to the reclaimed soil profile.

Determination of Significance - Appropriate soil handling, materials replacement at reclamation and the implementation of mitigative measures throughout the life of the Project will ensure that the impacts of unsuitable overburden material are minimized. The residual environmental effect of the Project on overburden material in the reclaimed soil profiles for the Application and PDC case is not significant.

7.4.4.2 Land Capability

Residual effects on land capability, as a result of development of the Project and existing and proposed disturbances in the RSA are discussed and the assessment of residual effects for both cases is the same. A summary of the residual effects assessment is provided.

Geographic Extent – The extent is for the Application case is limited to the areas of disturbance, corresponding to the proposed disturbance area (excluding reclamation material stockpiles), 1,482.8 ha. Currently within the RSA there is an estimated 372.6 ha (8.2%) of the RSA that is disturbed as a result of other activities.

Duration – The duration of the loss of capability is residual and the duration of the delay in achieving capability is expected to be extended for both Application and PDC cases.

Frequency – The frequency of loss capability is expected to be continuous for both the Application and PDC cases.

Reversibility – Equivalent capability is expected to be achieved over time; initial decreased land capability post reclamation is reversible over the long term as reclaimed landscapes and vegetation communities evolve.

Magnitude – The magnitude is moderate. The anticipated changes to terrain types as a result of the Project as well as existing and planned activities will result in reclaimed landscapes with a unique spatial distribution of land forms different then pre-disturbance but still able to provide equivalent land capability for the desired end land use objectives. The magnitude of delay in achieving land capability is seen as low, over time target capabilities will be met.

Project Contribution – A net neutral contribution is expected for land capability loss. The reclaimed landscapes will provide land capability similar to pre-disturbance through the creation of similar landscapes where possible and provide a range of additional landscape forms. It is expected that land capability in the reclaimed lands will be achieved over time.

Confidence Rating – The confidence rating of the prediction of residual effects on land capability is high for both Application and PDC cases.

Probability of Occurrence – The probability of alteration of land capability distribution in reclaimed lands and the delay of achieving equivalent land capability is high for both Application and PDC cases. Development of the Project and development within the RSA, followed by appropriate reclamation, will result in some landscape changes; however, the reclaimed landscape will over time provide equivalent capability for the end land use objectives.

Determination of Significance – The residual environmental effect on land capability post reclamation for both Application and PDC cases is predicted to not be significant.

7.5 Summary of Residual Effects

[Table 7.5-1](#) summarizes all of the potential impacts anticipated to affect soils and terrain as a valued component (VC) throughout the life of the Project.

Table 7.5-1 Summary of Residual Effects on Valued Components (VCs)											
Nature of Potential Impact or Effect	Mitigation/Protection Plan	Type of Effect	Geographic Extent ¹	Duration ²	Frequency ³	Reversibility ⁴	Magnitude ⁵	Project Contribution ⁶	Confidence Rating ⁷	Probability of Occurrence ⁸	Impact Rating ⁹
1. Soil Quality											
Soil Profile Disturbance											
Impact on soil quality - soil profile disturbance	Appropriate soil salvage, handling, storage, and reclamation	Application	LSA	Extended	Continuous, diminish with time	Reversible – long term	Moderate	Initially – Negative; Over time - Neutral	High	High	Not Significant
Impact on soil quality - soil profile disturbance	Soil salvage, handling, and reclamation as per regulatory requirements for Projects in the RSA	Cumulative Effects (Developments outside the LSA)	RSA	Extended	Continuous, diminish with time	Reversible – long term	Moderate	Initially – Negative; Over time - Neutral	Moderate	High	Not Significant
Erosion											
Impact on soil quality – potential soil loss	Appropriate erosion control measures and monitoring throughout Project	Application	LSA	Short	Occasional (unplanned)	Irreversible	Initially - Moderate, Low - with veg. establishment	Negative	Moderate	High during salvage and replacement at reclamation decreasing to Low after veg. establishment	Not Significant
Impact on soil quality – potential soil loss	Appropriate erosion control measures as per regulatory requirements for all stages of Projects in the RSA	Cumulative Effects	RSA	Short	Occasional (unplanned)	Irreversible	Initially - Moderate, Low - with veg. establishment	Neutral	Moderate	High during salvage and replacement at reclamation decreasing to Low after veg. establishment	Not Significant
Accidental Releases											
Impact on soil quality – soil loss or degradation of soil quality	Appropriate environmental management plans - spill containment and spill response plan	Application	LSA	Long	Occasional (unplanned)	Reversible – short term	Low	Neutral	High	Medium to Low	Not Significant
Impact on soil quality – soil loss or degradation of soil quality	Appropriate spill containment and spill response plan; compliant with regulatory requirements for construction, operation, and reclamation of Projects in the RSA	Cumulative Effects	RSA	Extended	Occasional (unplanned)	Reversible – short term	Low	Neutral	Moderate	Medium to High	Not Significant
2. Soil Biodiversity & Ecological Integrity											
Impact on soil diversity (distribution of soils) and ecological integrity	Appropriate soil salvage, site re-contouring effective soil replacement, revegetation, and monitoring	Application	LSA	Extended – diminish with time	Continuous	Partially Reversible – long term	Low	Negative	High	High	Not Significant
Impact on soil diversity (distribution of soils) and ecological integrity	Implementation of an appropriate C&R plan as per regulatory requirements for existing and planned future Projects in the RSA	Cumulative Effects	RSA	Extended – diminish with time	Continuous	Partially Reversible – long term	Low	Negative	High	High	Not Significant

Table 7.5-1 Summary of Residual Effects on Valued Components (VCs)											
Nature of Potential Impact or Effect	Mitigation/Protection Plan	Type of Effect	Geographic Extent ¹	Duration ²	Frequency ³	Reversibility ⁴	Magnitude ⁵	Project Contribution ⁶	Confidence Rating ⁷	Probability of Occurrence ⁸	Impact Rating ⁹
3. Alteration of Terrain											
Removal of natural terrain and reconstruction of reclaimed terrain post development	Appropriate site construction practices and re-contouring at reclamation to meet end land use objectives	Application	LSA	Residual	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant
Removal of natural terrain and reconstruction of reclaimed terrain post development	Implementation of a C&R plan as per regulatory requirements for existing and planned future Projects in the RSA	Cumulative Effects	RSA	Residual	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant
4. Land Capability Effects											
Reclaimed Overburden Materials											
Achievement of equivalent land capability delayed or hindered through unsuitable overburden in root zone	Ensure 1.0 m of suitable overburden is placed over unsuitable during material replacement	Application	LSA	Residual	Continuous, diminish with time	Reversible – long term	Low	Neutral	High	Low	Not Significant
Achievement of equivalent land capability delayed or hindered through unsuitable overburden in root zone – Planned Vista Phase 2	Compliance with regulatory requirements for materials placement post mining	Cumulative Effects	RSA	Residual	Continuous, diminish with time	Reversible – long term	Low	Neutral	High	Low	Not Significant
Land Capability											
Project Development and subsequent materials placement on altered landscape may causes alteration land capability distribution and delay in achieving equivalent capability	Soil salvage, site re-contouring effective soil replacement, revegetation, and monitoring are designed to meet land use objectives for land capability	Application	LSA	Extended – diminish with time	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant
Existing and planned future development and subsequent materials placement on altered landscape may causes alteration land capability distribution and delay in achieving equivalent capability	Development and reclamation / revegetation of Projects within the RSA to ensure equivalent land capability is attained to meet end land use objectives	Cumulative Effects	RSA	Extended – diminish with time	Continuous	Irreversible	Moderate	Neutral	High	High	Not Significant

1. Local, Regional, Provincial, National, Global

2. Short, Long, Extended, Residual

3. Continuous, Isolated, Periodic, Occasional

4. Reversible in short term, Reversible in long term, Irreversible – rare

5. Nil, Low, Moderate, High

6. Neutral, Positive, Negative

7. Low, Moderate, High

8. Low, Medium, High

9. Significant, Not Significant

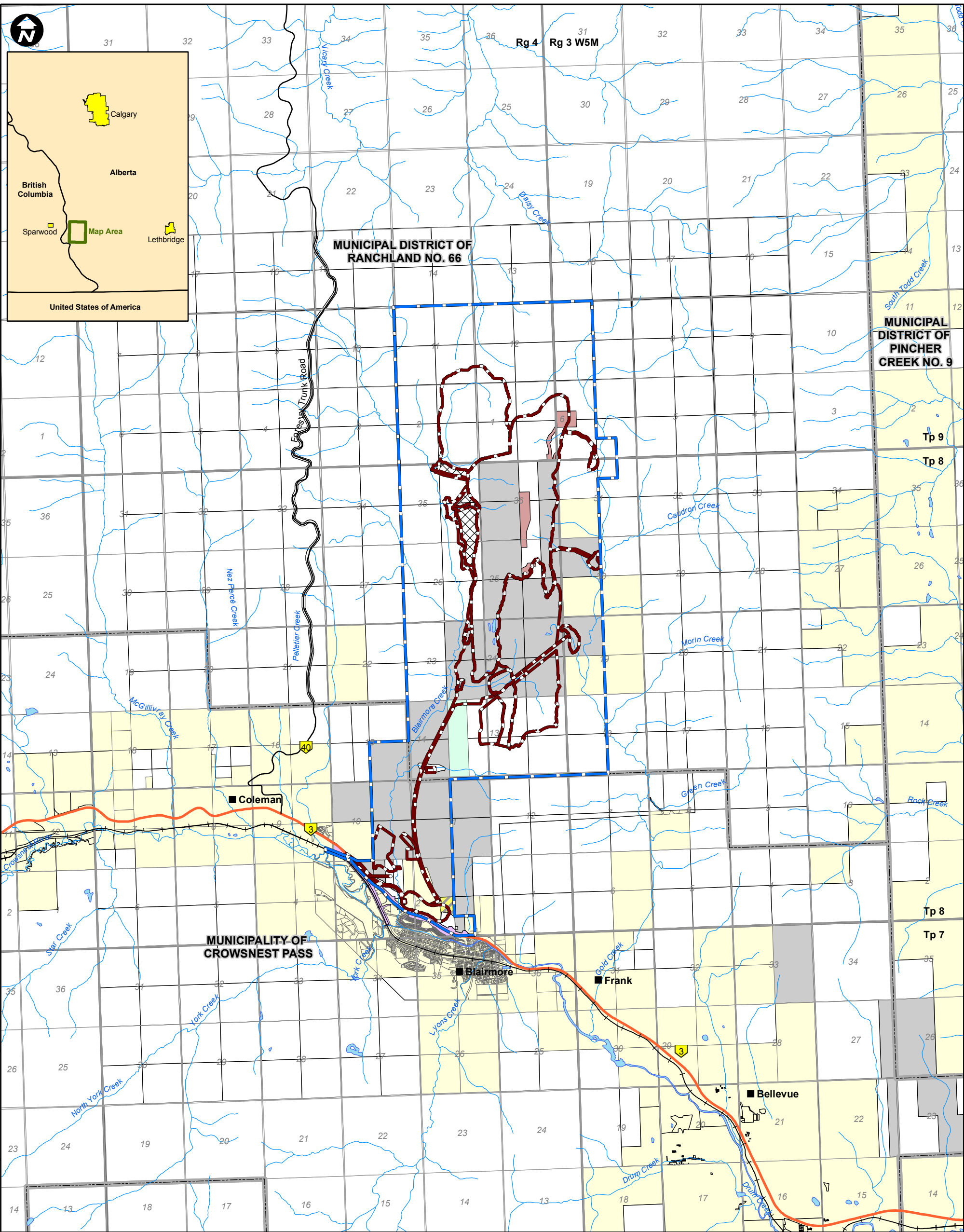
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FIGURES



LEGEND

- Primary Highway

Secondary Highway

Existing Railway

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area
- Land Ownership**

Crown

Crown (ROE Held By Devon)

Crown (MLL Held By Benga)

Freehold - Benga

Freehold - Benga 50%, CNP Golf & Country Club 50%

Freehold - Other

Registered Roadway

PROJECT



RIVERSDALE
RESOURCES

**GRASSY MOUNTAIN
COAL PROJECT**



TITLE

PROJECT LOCATION

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

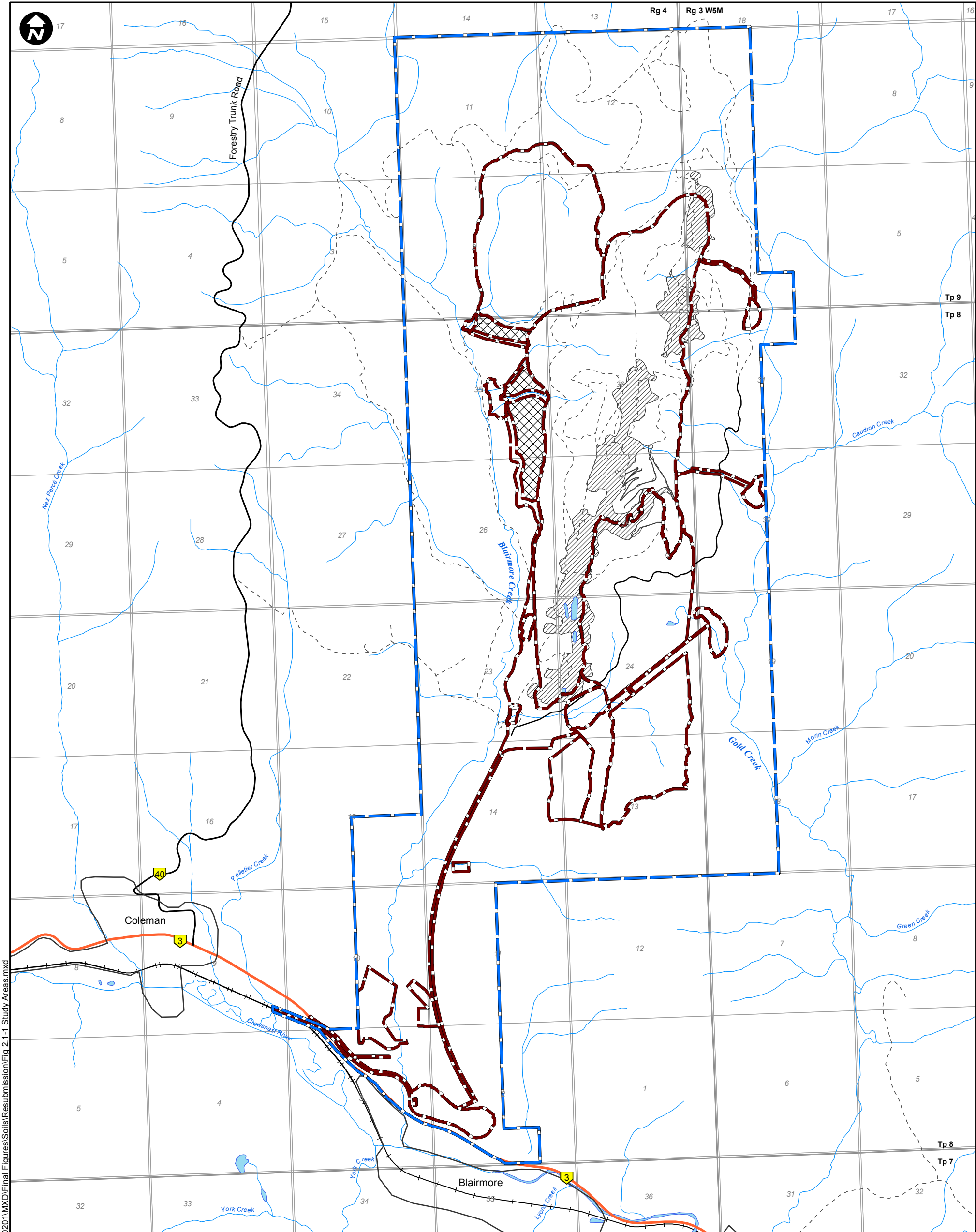
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DATE: JUNE 13, 2016

FIGURE

1.1-1





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LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Trails
- Surface Water Drainage
- Waterbody
- Soils Regional Study Area
- Soils Local Study Area
- Undisturbed Area
- Legacy Mine Disturbance

PROJECT



RIVERSDALE
RESOURCES

GRASSY MOUNTAIN
COAL PROJECT



TITLE

STUDY AREAS

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

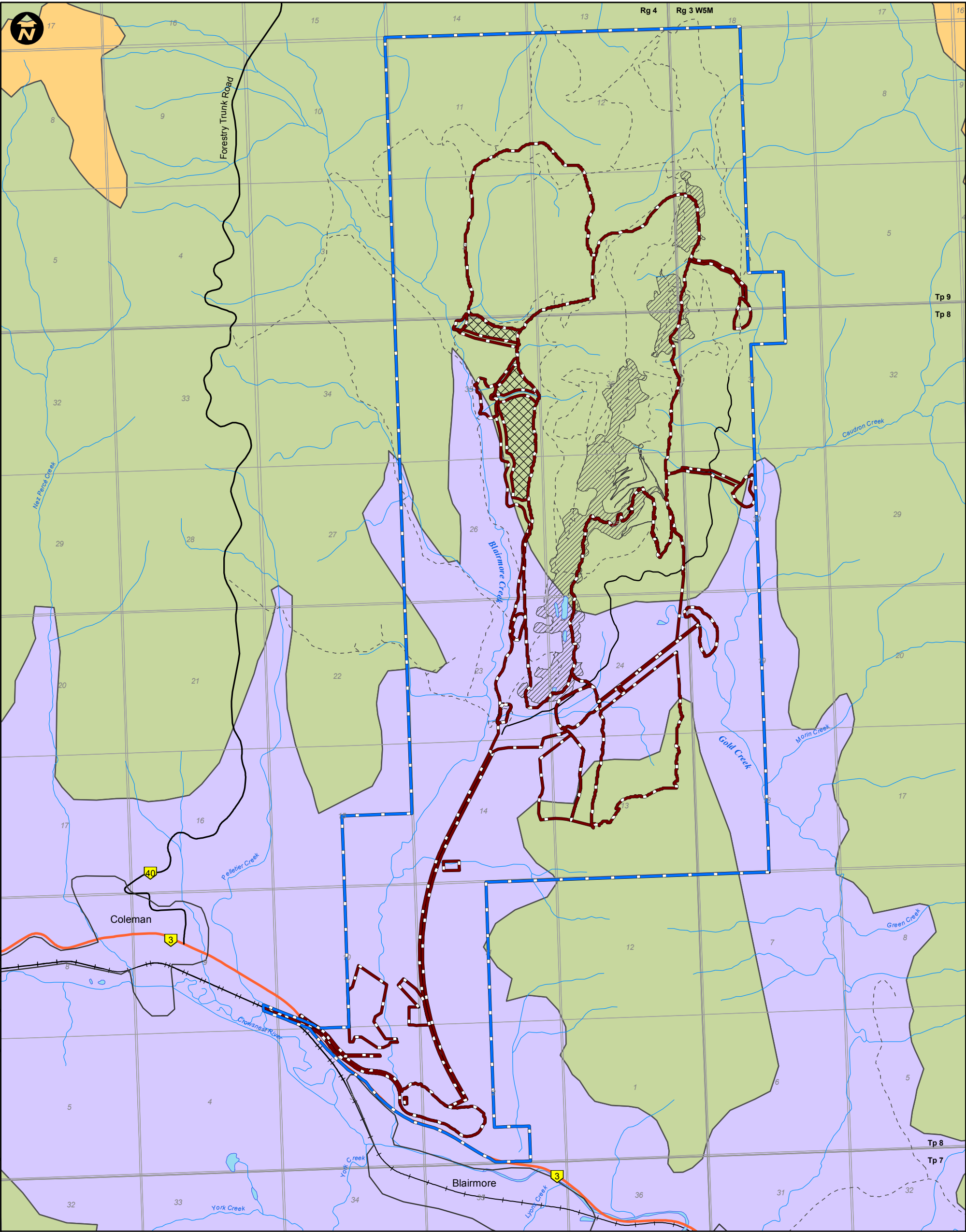
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FIGURE

2.1-1



LEGEND

- Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody
- Soils Regional Study Area

Soils Local Study Area

Undisturbed Area

Legacy Mine Disturbance
- Natural Subregion

Alpine

Montane

Subalpine

Map area is within Soil Correlation Area 16

PROJECT



RIVERSDALE
RESOURCES

GRASSY MOUNTAIN
COAL PROJECT



TITLE

REGIONAL PHYSIOGRAPHY INFORMATION

NOTES

AltaLIS, 2016; Alberta Parks, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

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DATE: JUNE 22, 2016

FIGURE

2.2-1



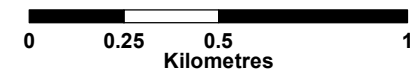
 Soil Inspection Site (Full Profile Sampled)
 Soil Inspection Site (Selected Horizons Sampled)
 Soil Inspection Site (Not Sampled)
 Primary Highway
 Secondary Highway
 Existing Railway
 Existing Trails
 Surface Water Drainage
 Waterbody
 Soils Regional Study Area
 Soils Local Study Area
 Undisturbed Area
 Legacy Mine Disturbance



RIVERSDALE
RESOURCES

SOIL INSPECTION SITES WITHIN THE RSA - MAPSHEET 1

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11



PROJECT: 14-00201
DRAWN BY: SL
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DATE: JUNE 22, 2016

FIGURE

3.1-1

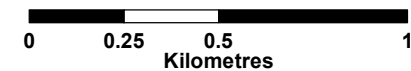
 Soil Inspection Site (Full Profile Sampled)
 Soil Inspection Site (Selected Horizons Sampled)
 Soil Inspection Site (Not Sampled)
 Primary Highway
 Secondary Highway
 Existing Railway
 Existing Trails
 Surface Water Drainage
 Waterbody
 Soils Regional Study Area
 Soils Local Study Area
 Undisturbed Area
 Legacy Mine Disturbance



RIVERSDALE
RESOURCES

SOIL INSPECTION SITES WITHIN THE RSA - MAPSHEET 2

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11



DATE: JUNE 22, 2016

FIGURE

3.1-2

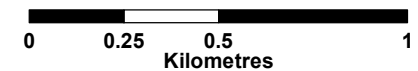
 Soil Inspection Site (Full Profile Sampled)
 Soil Inspection Site (Selected Horizons Sampled)
 Soil Inspection Site (Not Sampled)
 Primary Highway
 Secondary Highway
 Existing Railway
 Existing Trails
 Surface Water Drainage
 Waterbody
 Soils Regional Study Area
 Soils Local Study Area
 Undisturbed Area
 Legacy Mine Disturbance



RIVERSDALE
RESOURCES

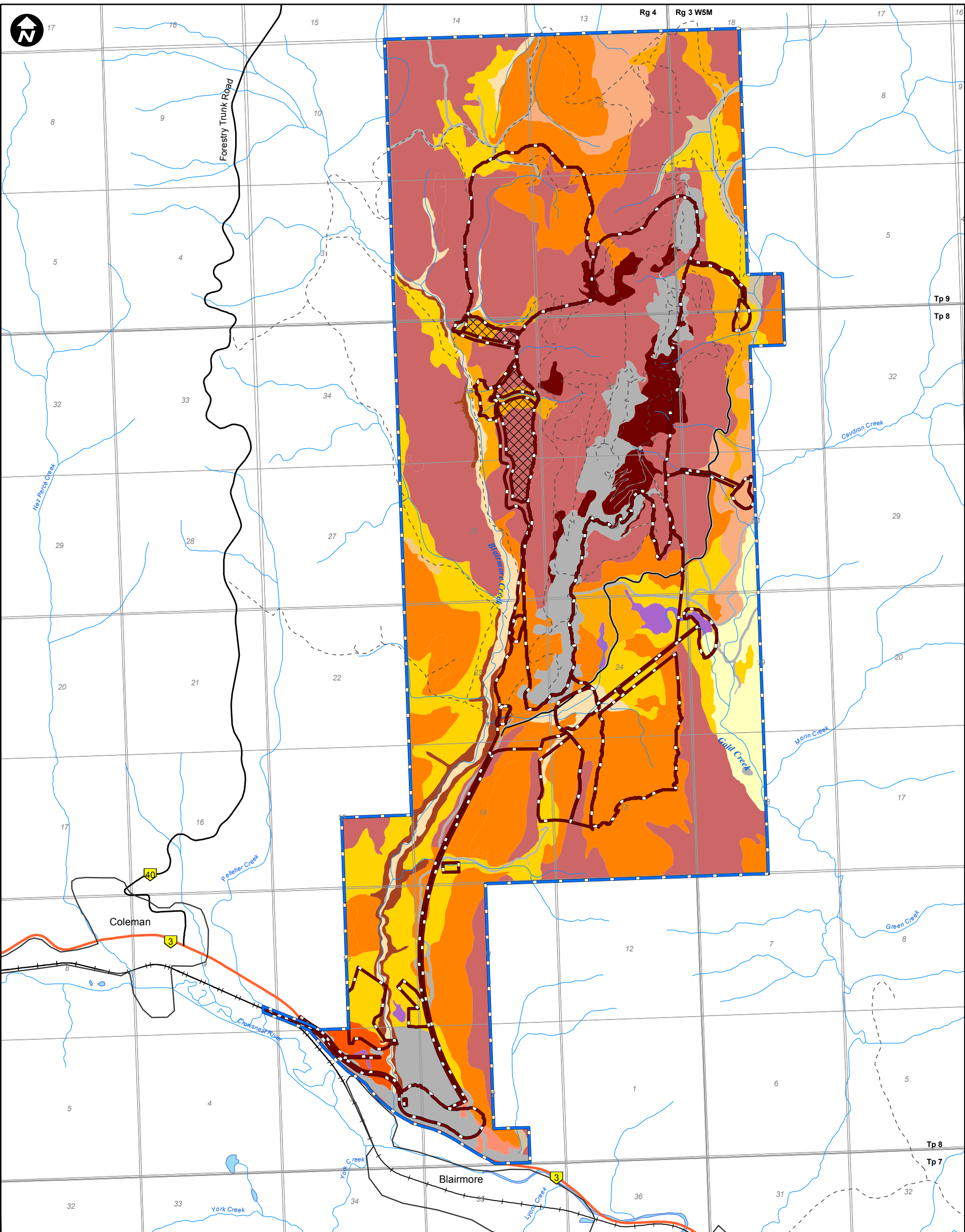
SOIL INSPECTION SITES WITHIN THE RSA - MAPSHEET 3

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11



DATE: JUNE 22, 2016

3.1-3



LEGEND

Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area

Slope Class

1 - 2

1 - 3

3 - 4

3 - 5

4 - 5

4 - 6

4 - 7

5 - 6

5 - 7

6 - 7

6 - 8

7 - 8

7 - 9

8 - 9

Other

Disturbed

Open Water

PROJECT



RIVERSDALE
RESOURCES

**GRASSY MOUNTAIN
COAL PROJECT**



TITLE

SLOPE CLASSES WITHIN THE RSA

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

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DATE: JUNE 13, 2016

FIGURE

3.3-1

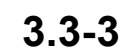


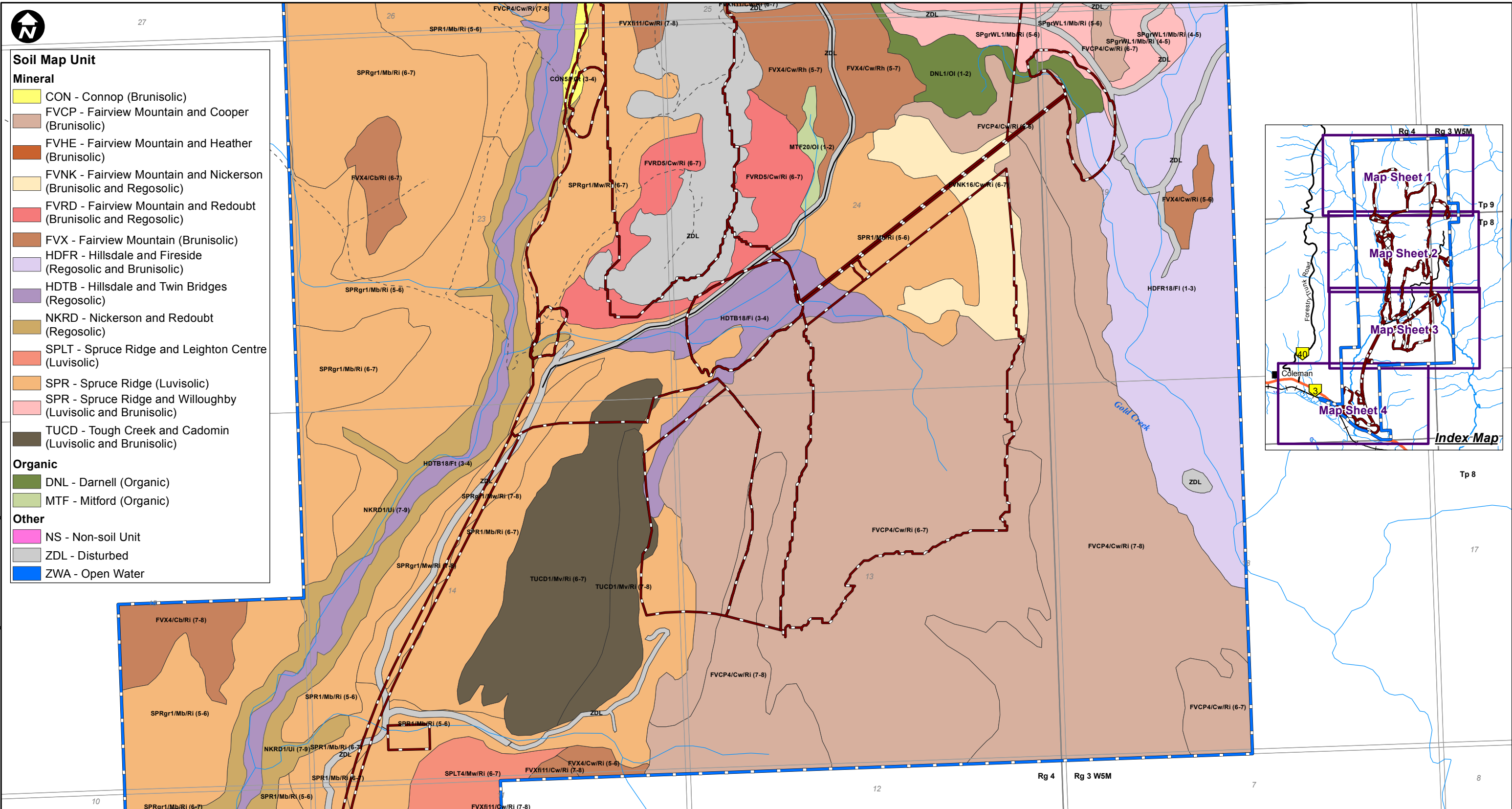
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GRASSY MOUNTAIN COAL PROJECT

BASELINE SOIL AND TERRAIN OF THE RSA - MAPSHEET 2

A horizontal scale bar with a black background. It has white tick marks at 0, 0.25, 0.5, and 1. The word "Kilometres" is written in black text below the bar.

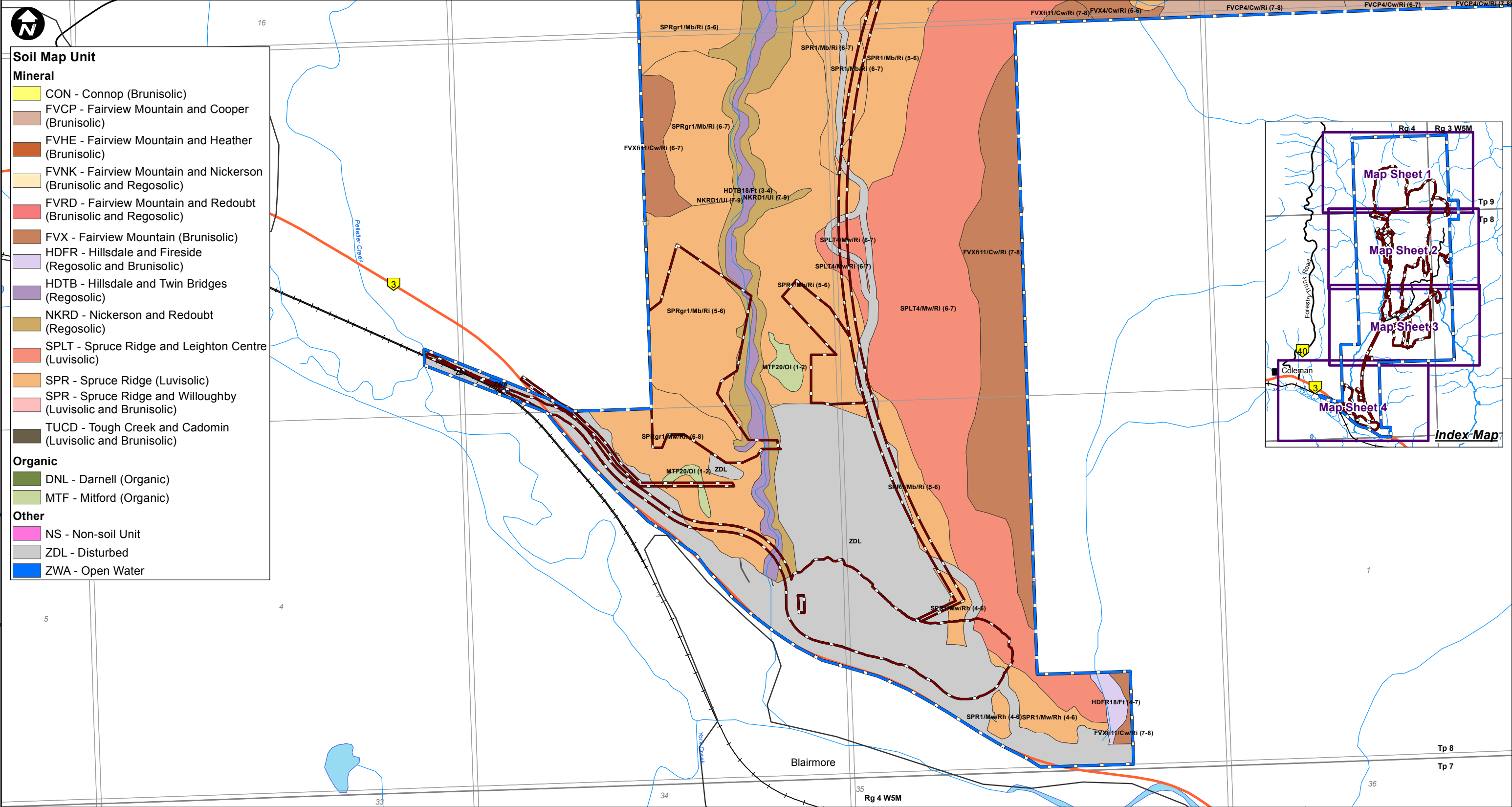




LEGEND

-  Primary Highway
 Secondary Highway
 Existing Railway
 Existing Trails
 Surface Water Drainage
 Waterbody
-  Soils Regional Study Area
 Soils Local Study Area
 Undisturbed Area
- Soil Model ——— Surface Expression
 SPR1/Mb/Rl(5-6)
 Surficial Material ——— Slope Classes

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Soils\Resubmission\Fig 3.3 Baseline Soil and Terrain RSA.mxd



LEGEND

Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area

Soil Model

Surface Expression

Slope Classes

Surficial Material

SPR1/Mb/Ri (5-6)

PROJECT

RIVERSDALE

RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

BASELINE SOIL AND TERRAIN OF THE RSA - MAPSHEET 4

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201

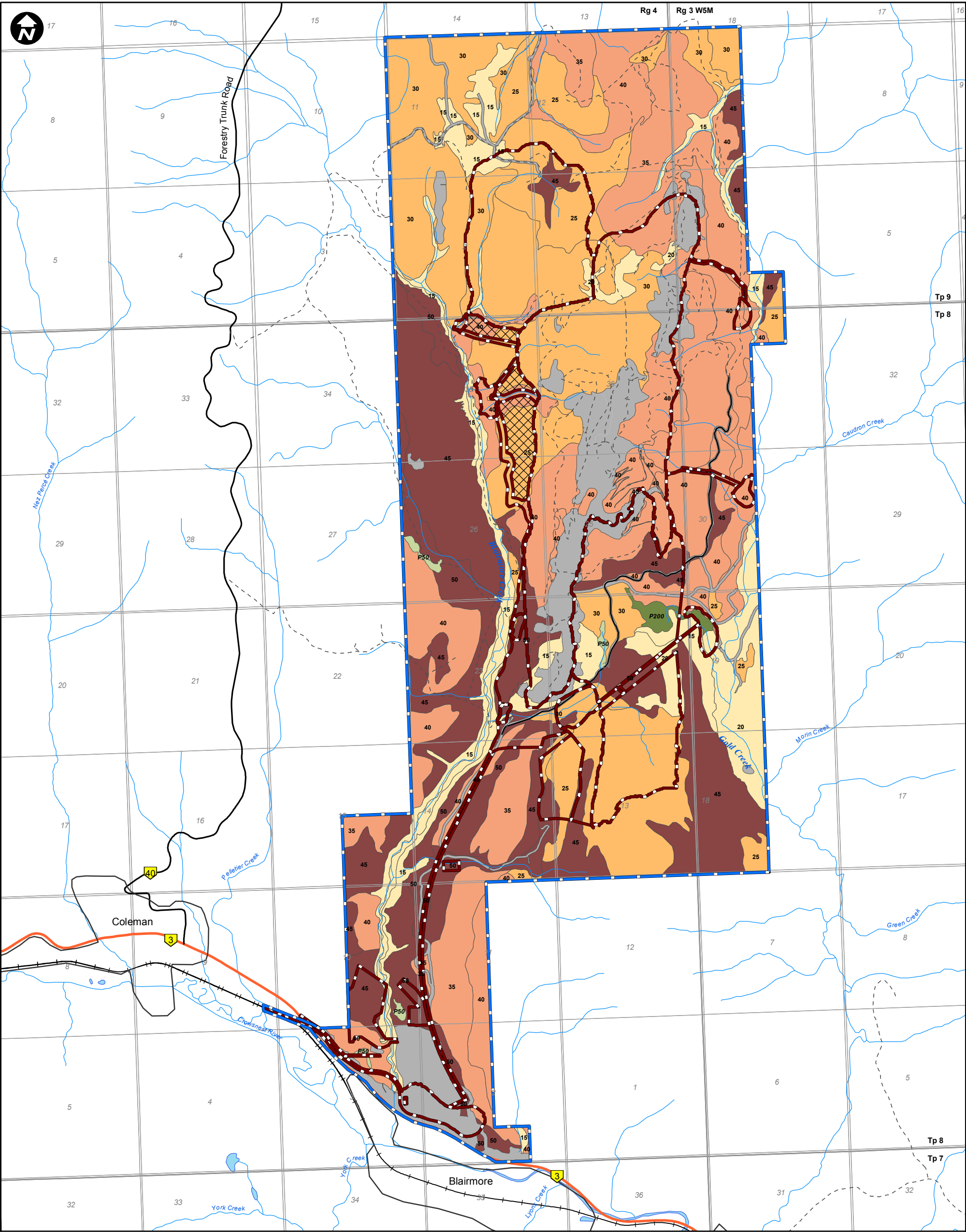
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DATE: JUNE 13, 2016

FIGURE

3.3-5



LEGEND

- Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area
- Upland Surface Soil Thickness (cm)

15 - 20

25 - 30

35 - 40

45 - 50

Deep Organic Thickness (cm)

50

200

Other

Disturbed and Non-soil Units
- 40 Average Upland Surface Soil Thickness (cm)

P200 Average Deep Organic thickness (cm)

PROJECT

 **RIVERSDALE**
RESOURCES

**GRASSY MOUNTAIN
COAL PROJECT**



TITLE

THICKNESSES OF SOIL LAYERS WITHIN THE RSA

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

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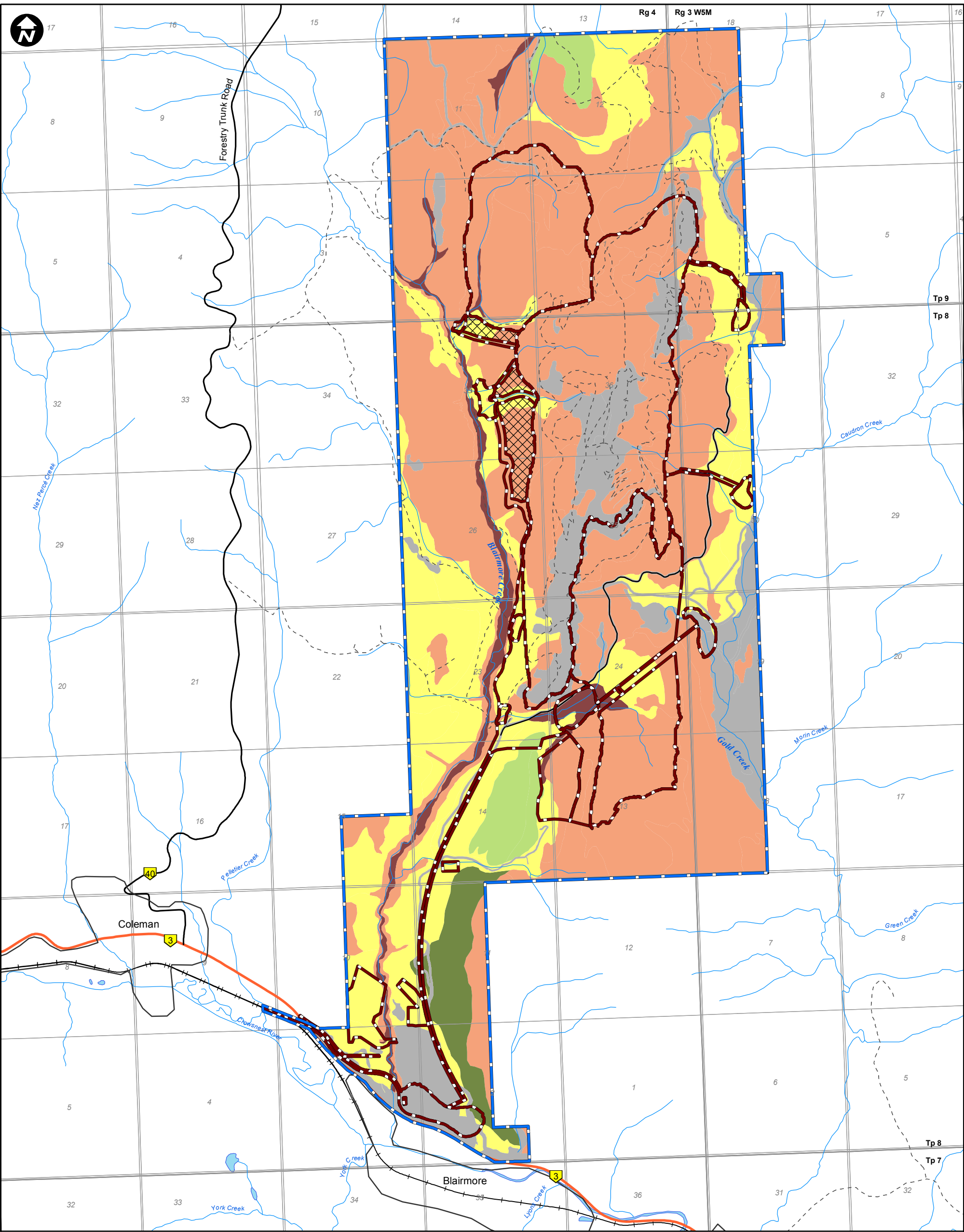
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FIGURE

4.1-1





LEGEND

- Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area
- Reclamation Suitability**

Good to Fair

Good to Unsuitable

Fair

Poor

Unsuitable

Not Rated

PROJECT



RIVERSDALE

RESOURCES

GRASSY MOUNTAIN

COAL PROJECT



TITLE

RECLAMATION SUITABILITY RATING - A HORIZONS

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

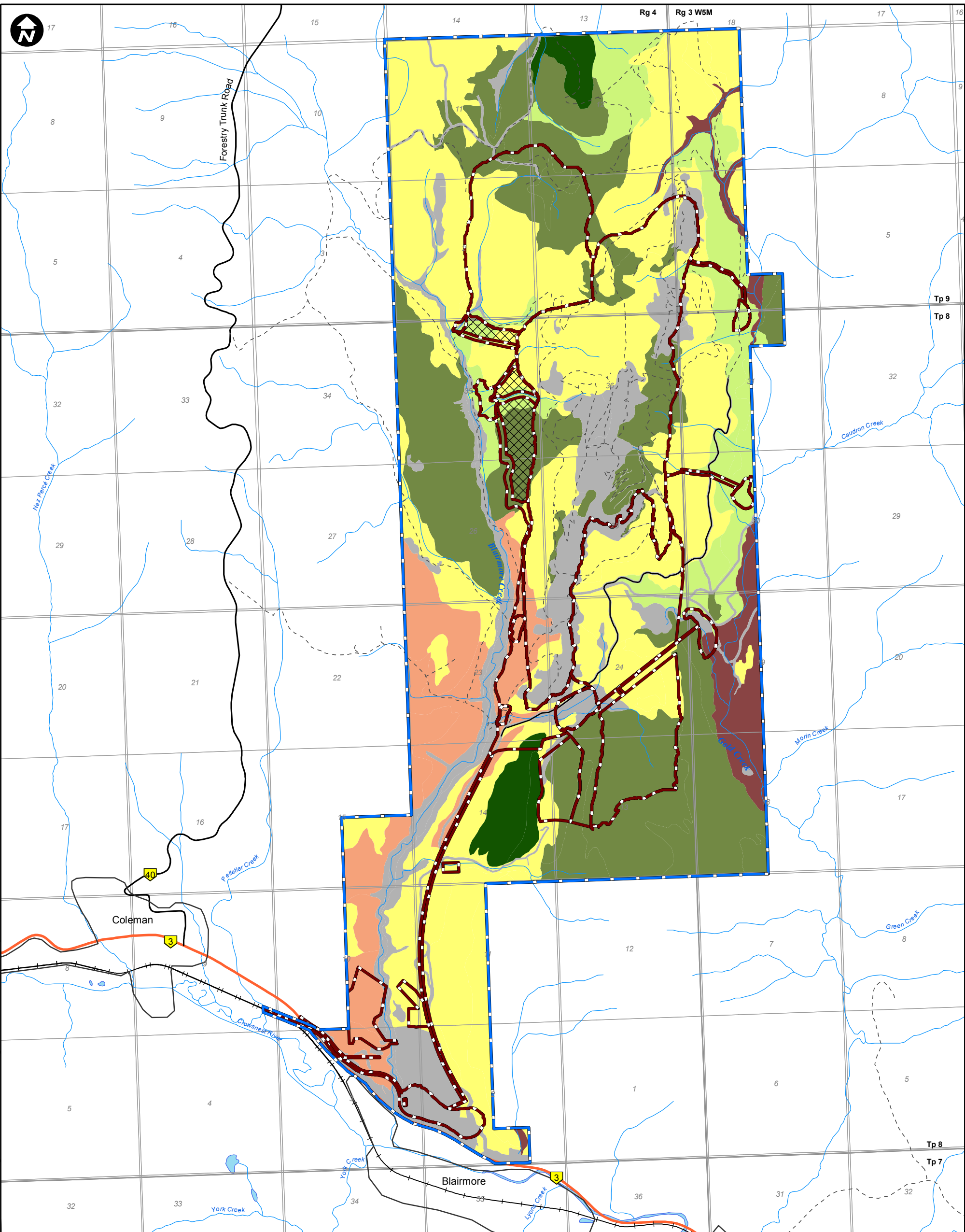
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DATE: JUNE 13, 2016

FIGURE

4.1-2





LEGEND

- Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area
- Reclamation Suitability

Good

Good to Fair

Good to Poor

Fair

Poor

Unsuitable

Not Rated

PROJECT

 **RIVERSDALE**
RESOURCES

**GRASSY MOUNTAIN
COAL PROJECT**



TITLE

RECLAMATION SUITABILITY RATING - B HORIZONS

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

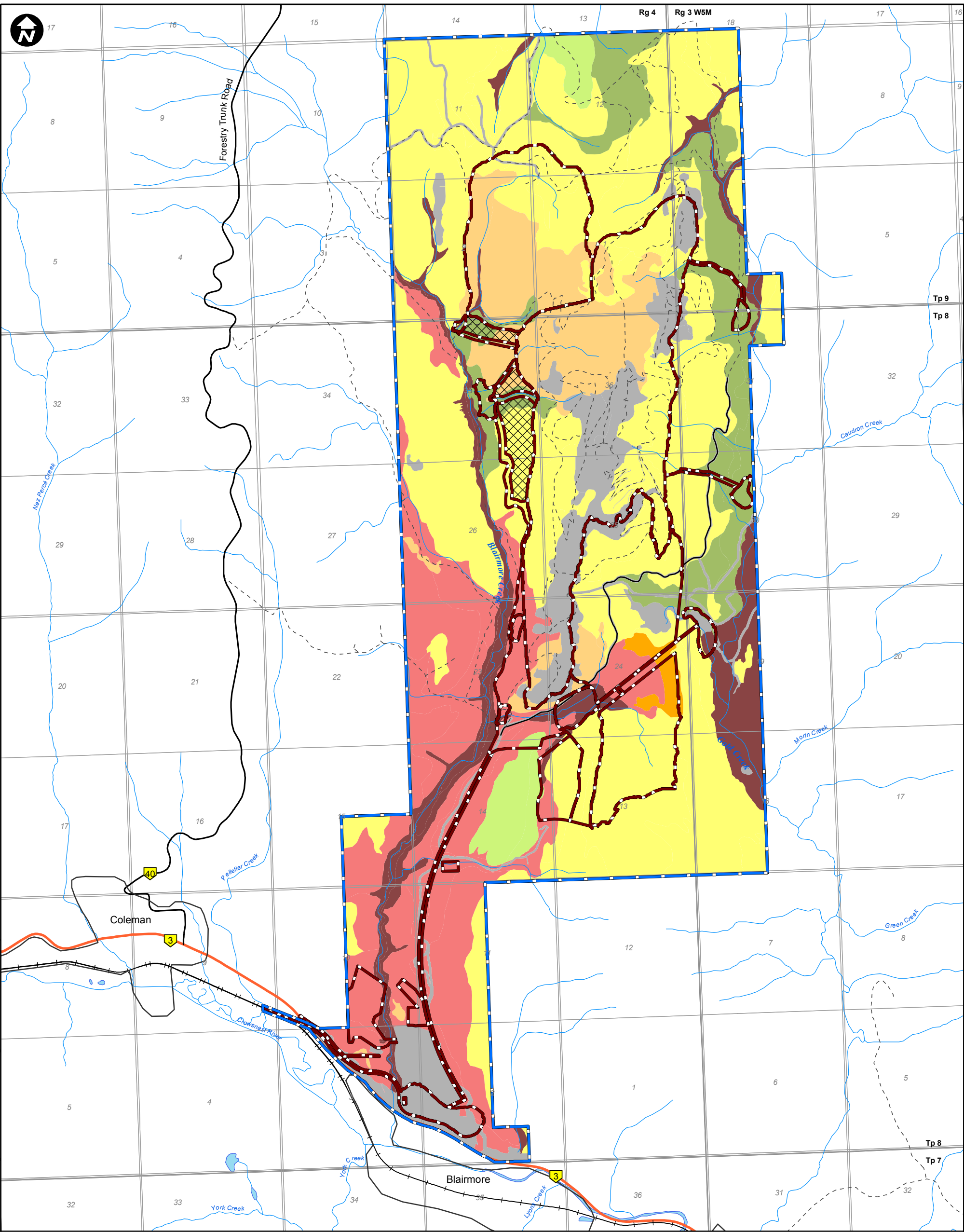
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DATE: JUNE 13, 2016

FIGURE

4.1-3





LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Trails
- Surface Water Drainage
- Waterbody
- Soils Regional Study Area
- Soils Local Study Area
- Undisturbed Area

- Reclamation Suitability
- Good to Poor
 - Good to Unsuitable
 - Fair
 - Fair to Poor
 - Fair to Unsuitable
 - Poor
 - Poor to Unsuitable
 - Not Rated

PROJECT



RIVERSDALE
RESOURCES

GRASSY MOUNTAIN
COAL PROJECT



TITLE

RECLAMATION SUITABILITY RATING - C HORIZONS

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

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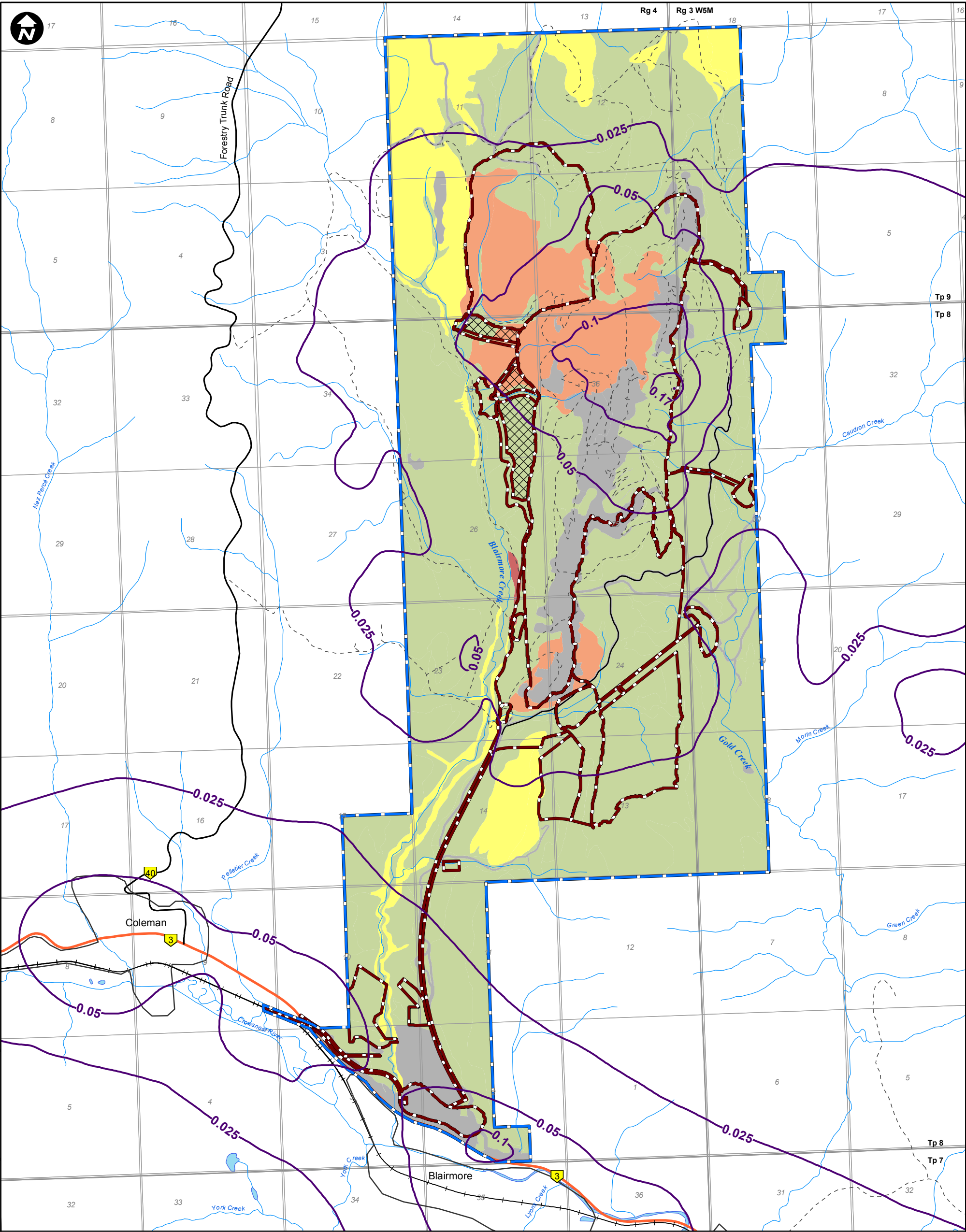
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DATE: JUNE 13, 2016

FIGURE

4.1-4





LEGEND

- Potential Acid Input Concentration Isopleth (keq/ha/yr)

Primary Highway

Secondary Highway

Existing Railway

Existing Trails

Surface Water Drainage

Waterbody

Soils Regional Study Area

Soils Local Study Area

Undisturbed Area
- Low

Low-Medium

Medium

High

Not Rated

PROJECT



RIVERSDALE
RESOURCES

GRASSY MOUNTAIN
COAL PROJECT



TITLE

SOIL ACIDIFICATION SENSITIVITY RATINGS
FOR SOILS IN THE REGIONAL STUDY AREA

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

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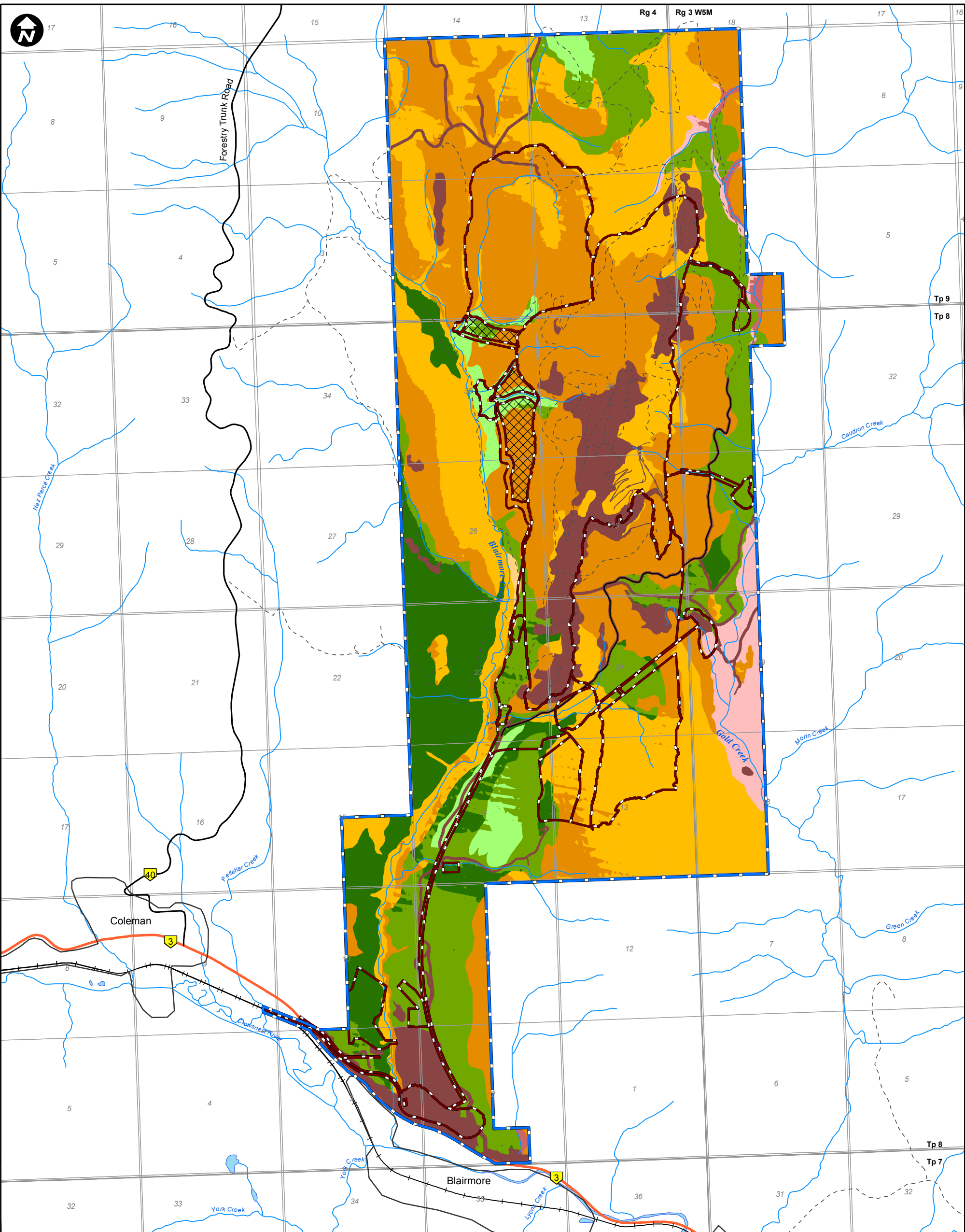
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DATE: JUNE 29, 2016

FIGURE

4.4-1





LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Trails
- Surface Water Drainage
- Waterbody
- Soils Regional Study Area
- Soils Local Study Area
- Undisturbed Area

Baseline Land Capability Class	
4	4
4-5	4-5
4-6	4-6
5	5
5-6	5-6
5-7	5-7
6	6
6-7	6-7
7	7
NA	NA

PROJECT



RIVERSDALE
RESOURCES

GRASSY MOUNTAIN
COAL PROJECT



TITLE

BASELINE LAND CAPABILITY WITHIN THE RSA

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

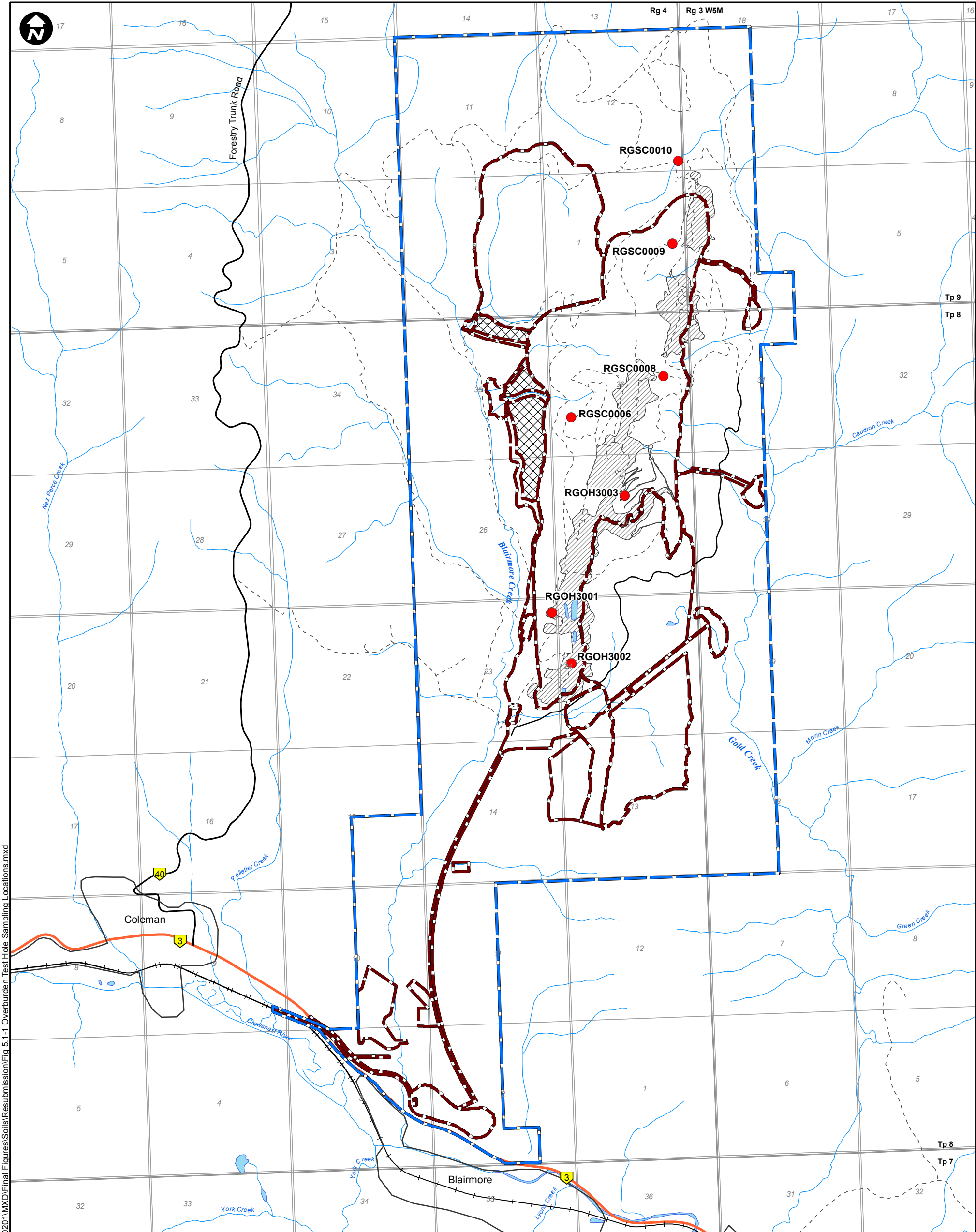
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DATE: JUNE 13, 2016

FIGURE

4.5-1





- LEGEND**
- Overburden Test Hole
 - Primary Highway
 - Secondary Highway
 - Existing Railway
 - - - Existing Trails
 - Surface Water Drainage
 - Waterbody
 - Soils Regional Study Area
 - Soils Local Study Area
 - Undisturbed Area
 - Legacy Mine Disturbance

PROJECT



RIVERSDALE
RESOURCES

**GRASSY MOUNTAIN
COAL PROJECT**



TITLE

OVERBURDEN TEST HOLE SAMPLING LOCATIONS

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01

DRAWN BY: SL

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DATE: JUNE 22, 2016

FIGURE

5.1-1



**APPENDIX A: SOIL SERIES / VARIANT DESCRIPTIONS, AND
DETAILED SITE INSPECTION LIST**

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1.0 INTRODUCTION

Brief tabular descriptions of the dominant and significant soil series and variants found in the Project Area are provided. Soil and site data within or adjacent to the Project Area, including laboratory results, were used to characterise and describe the soils. The summary descriptions below include chemical and physical attributes from representative inspection sites and sampled profiles. These soil physical and chemical attributes were used to calculate reclamation suitability ratings of the soils in the Project Area.

Bellevue-CO (BEVco) Variant

The BEV series is a Chernozemic soil. BEVco soils are developed on moderately coarse textured colluvium or weathered bedrock (residuum) in SCA 16. Variants of modal BEV that occur on coarser textured parent material are classified as Bellevue-CO (BEVco). Some important features of BEVco:

- Subgroup – Orthic Dark Brown Chernozem;
- Parent material – moderately coarse textured colluvium or weathered bedrock (residuum);
- Drainage – rapidly to well drained; and
- Distribution – BEVco soils are significant within the FVCP16 and FVNC16 soil models and accounts for approximately 19.6 ha (0.4%) of the RSA and 12.4 ha (0.8%) of the LSA.

Table A-1 General Description of BEVco Variant			
GM4263PM - BEVzzco			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	2-0	-	-
Ah	0-15	30	Friable
Bm	15-37	30	Friable
C	37-65	30	Friable

Table A-2 Selected Chemical and Physical Attributes of BEVco Variant												
Soil Analytical GM4263PM - BEVzzco*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	2-0	-	-	-	-	-	-	-	-	-	-	-
Ah	0-15	6.6	0.39	7.69	-	0.72	-	-	-	Sandy Loam	<0.1	91
Bm	15-37	6.1	0.14	-	-	-	-	-	-	Sandy Loam	0.1	61
C	37-65	6.2	0.14	-	-	-	-	-	-	Sandy Loam	0.1	47

*Lab data adapted from GM4575DM (PPEaagr), field textures used.

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Beaupre (BPE) Series and Variants

The BPE series is a Brunisolic soil. Modal BPE soils are developed on gravelly and non-gravelly, medium to moderately fine textured till in SCA 16. Variants of modal BPE that have greater gravel content than modal BPE are classified as Beaupre-GR (BPEgr). Variants of modal BPE that have a thick A horizon are classified as Beaupre-TK (BPEtk). Variants of modal BPE that have an atypical subgroup are classified as Beaupre-ZZ (BPEzz). Some important features of BPE include:

- Subgroup – Orthic Eutric Brunisol (BPE), Orthic Melanic Brunisol (BPEtk), and Eluviated Eutric Brunisol (BPEzz).
- Parent material – gravelly and non-gravelly, medium to moderately fine textured till.
- Drainage – well drained.
- Distribution – BPE soils occur sporadically within the FVX4, NKRD1, SPgrWL1, SPLT4, and SPRgr1 soil models.

Table A-3 General Description of BPE Series and Variants			
GM4111VL - BPEtkgr			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
Ah	0-15	5-10	Friable
AB	15-24	30-40	Friable
Bm	24-42	30-40	Friable
Ck	42-110	40-50	Friable

Table A-4 Selected Chemical and Physical Attributes of BPE Series and Variants												
Soil Analytical GM4111VL - BPEtkgr												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
Ah	0-15	7.4	0.99	14.8	-	0.46	58	32	10	Sandy Loam	<0.1	80
AB	15-24	7.5	0.38	2.81	-	-	51	31	18	Loam	<0.1	62
Bm	24-42	7.6	0.38	-	-	-	53	31	16	Sandy Loam	<0.1	53
Ck	42-110	7.9	0.38	-	>25	-	43	36	21	Loam	<0.1	55

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Cadomin-AA (CDMaa) Series and Variants

The CDMaa series is a Brunisolic soil (modal SCA is 15). Modal CDMaa soils are developed on medium textured weathered bedrock (residuum) or medium textured colluvium veneer overlying bedrock in SCA 16. Variants of modal CDMaa that are an atypical subgroup are classified as Cadomin-AA,ZZ (CDMaazz). Some important features of CDMaa:

- Subgroup – Eluviated Dystric Brunisol (CDMaa) and Orthic Dystric Brunisol (CDMaazz);
- Parent material – medium textured weathered bedrock (residuum) or medium textured colluvium veneer overlying bedrock;
- Drainage – rapidly to well drained; and
- Distribution – CDMaa soils are co-dominant within the TUCD1 soil model and accounts for approximately 44.3 ha (1.0%) of the RSA and 1.8 ha (0.1%) of the LSA.

Table A-5 General Description of CDMaa Series and Variants			
GM4176JJ - CDMaa			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFG	2-0	-	-
Ae	0-10	5-10	Friable
Bm	10-38	5-10	Friable
BC	38-61	10-20	Friable
C	61-80	70-80	Firm

Table A-6 Selected Chemical and Physical Attributes of CDMaa Series and Variants												
Soil Analytical GM4176JJ - CDMaa												
Horizon	Depth (cm)	pH	EC	OC	CaCO₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFG	2-0	6.2	-	-	-	-	-	-	-	-	-	-
Ae	0-10	5.4	0.12	-	-	-	39	44	17	Loam	<0.1	53
Bm	10-38	5.0	0.07	-	-	-	43	34	23	Loam	0.2	48
BC	38-61	5.0	0.04	-	-	-	45	33	22	Loam	0.2	39
C	61-80	5.0	0.04	-	-	-	45	37.4	17.6	Loam	0.2	34

pH – measured in saturated paste or water
EC – electrical conductivity (dS/m)
OC – total organic carbon (%)
CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)
PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class
SAR – sodium adsorption ratio
Sat % – saturation percentage

Connop (CON) Series and Variants

The CON series is a Brunisolic soil. Modal CON soils are developed on moderately coarse to very coarse textured glaciofluvial deposits in SCA 16. Some important features of CON:

- Subgroup –Eluviated Eutric Brunisol;
- Parent material – moderately coarse to very coarse textured glaciofluvial deposits;
- Drainage – well drained; and
- Distribution – CON soils are dominant within the CON5 soil model, and accounts for approximately 5.3 ha (0.1%) of the RSA and 1.3 ha (0.1%) of the LSA.

Table A-7 General Description of CON Series and Variants			
GM4494PM – CON			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LF	4-0	-	-
Ae	0-8	15	Loose
Bm	8-20	15	Loose
C	20-60	15	Loose

Table A-8 Selected Chemical and Physical Attributes of CON Series and Variants												
Soil Analytical GM4494PM - CON*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LF	4-0	4.4	-	-	-	-	-	-	-	-	-	-
Ae	0-8	4.9	0.07	-	-	-	-	-	-	Loamy Sand	0.2	52
Bm	8-20	7.0	0.24	-	-	-	-	-	-	Loamy Sand	<0.1	55
C	20-60	7.8	0.28	-	19.1	-	-	-	-	Loamy Sand	<0.1	45

*Lab data adapted from GM4211PM (FRKzzco), field textures used.

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Copper-AA (CPXaa) Series and Variants

The CPXaa series is a Brunisolic soil (modal SCA is 15). Modal CPXaa soils are developed on moderately coarse textured weathered bedrock (residuum) or moderately coarse textured colluvium veneer overlying bedrock in SCA 16. Variants of modal CPXaa that have an atypical subgroup are classified as Copper-AA,ZZ (CPXaazz). Some important features of CPXaa:

- Subgroup – Orthic Dystric Brunisol (CPXaa) and Eluviated Dystric Brunisol (CPXaazz);
- Parent material – moderately coarse textured weathered bedrock (residuum) or moderately coarse textured colluvium veneer overlying bedrock;
- Drainage – rapidly to well drained; and
- Distribution – CPXaa soils are co-dominant within the FVCP16 and FVCP4 soil models, and accounts for approximately 461.7 ha (10.1%) of the RSA and 155.4 ha (10.2%) of the LSA.

Table A-9 General Description of CPXaa Series and Variants			
GM4806PM - CPXaa			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	2-0	-	-
Bm	0-13	5	Friable
BC	13-48	20	Friable
R	48-58	-	-

Table A-10 Selected Chemical and Physical Attributes of CPXaa Series and Variants												
Soil Analytical GM4806PM - CPXaa												
Horizon	Depth (cm)	pH	EC	OC	CaCO₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	2-0	6.3	-	-	-	-	-	-	-	-	-	-
Bm	0-13	5.2	0.09	-	-	-	68	21	11	Sandy Loam	0.1	50
BC	13-48	5.4	0.05	-	-	-	73.4	17.2	9.4	Sandy Loam	0.2	40
R	48-58	-	-	-	-	-	-	-	-	-	-	-

pH – measured in saturated paste or water
EC – electrical conductivity (dS/m)
OC – total organic carbon (%)
CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)
PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class
SAR – sodium adsorption ratio
Sat % – saturation percentage

Darnell (DNL) Series and Variants

The DNL series is an Organic. Modal DNL soils are developed on fen peat (>160 cm) in SCA 16. Some important features of DNL:

- Subgroup – Typic Mesisol;
- Parent material – fen peat (>160 cm);
- Drainage – very poorly drained; and
- Distribution – DNL soils are dominant within the DNL1 soil model, and accounts for approximately 12.9 ha (0.3%) of the RSA and 12.6 ha (0.8%) of the LSA.

Table A-11 General Description of DNL Series and Variants			
GM4102DL - DNL			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
Om	0-220	-	-

Table A-12 Selected Chemical and Physical Attributes of DNL Series and Variants												
Soil Analytical GM4102DL – DNL*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
Om	0-220	7.4	-	-	-	-	-	-	-	-	-	-

*Lab data adapted from GM4130PM (MTF).

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Frank (FRK) Series and Variants

The FRK series is a Brunisolic soil. FRK soils are developed on gravelly to non-gravelly, medium textured colluvial deposit in SCA 16. Variants of modal FRK that have a thick A horizon are classified as Frank-TK (FRKtk). Some important features of FRK include:

- Subgroup – Orthic Eutric Brunisol (FRK) and Orthic Melanic Brunisol (FRKtk);
- Parent material – gravelly to non-gravelly, medium textured colluvial deposit;
- Drainage – rapidly to well drained;
- Distribution – FRK soils occur sporadically within FVCP4, FVRD5, FVX4, FVXfi11, SPgrWL1, and TUCD1 soil models.

Table A-13 General Description of FRK Series and Variants

GM4254DL - FRKtkxl			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
Ah	0-19	20-30	Firm
Bm	19-40	20-30	Firm
R	40	-	-

Table A-14 Selected Chemical and Physical Attributes of FRK Series and Variants

Soil Analytical GM4254DL - FRKtkxl												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
Ah	0-19	6.9	0.41	7.7	-	0.38	31.7	21.7	46.7	Clay	<0.1	134
Bm	19-40	6.8	0.23	-	-	-	39	29	32	Clay Loam	0.1	63
R	40	-	-	-	-	-	-	-	-	-	-	-

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Fireside-AA (FRXaa) Series and Variants

The FRXaa series is a Brunisolic soil (modal SCA is 15). FRXaa soils are developed on stratified (L, SiL, Sl, LS) fluvial deposits commonly overlying medium to moderately fine textured till in SCA 16. Variants of modal FRXaa that occur on finer textured parent material and have till contact within 30-99 cm are classified as Fireside-AA,FI,XT (FRXaafixt). Some important features of FRXaa include:

- Subgroup – Orthic Eutric Brunisol;
- Parent material – stratified (L, SiL, Sl, LS) fluvial deposits commonly overlying medium to moderately fine textured till;
- Drainage –well drained; and
- Distribution – FRXaa soils are co-dominant within the HDFR18 soil model, and accounts for approximately 67.3 ha (1.5%) of the RSA and 1.6 ha (0.1%) of the LSA.

Table A-15 General Description of FRXaa Series and Variants

GM4802JJ - FRXaa			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	6-0	-	-
Bm	0-50	50-70	Loose
C	50-60	70-90	Loose

Table A-16 Selected Chemical and Physical Attributes of FRXaa Series and Variants

Soil Analytical GM4802JJ - FRXaa*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	6-0	-	-	-	-	-	-	-	-	-	-	-
Bm**	0-50	6.5	0.55	-	-	-	-	-	-	Sandy Loam – Loamy Sand	<0.1	66
C	50-60	7.7	0.55	-	-	-	-	-	-	Sandy Loam – Loamy Sand	<0.1	66

*Lab data adapted from GM4394DL (HDXaazzfi), field textures used.

**pH (CaCl₂) used for Bm adapted from GM4428VL (FRXaafixt)

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Fairview Mountain-AA (FVXaa) Series and Variants

The FVXaa series is a Brunisolic soil (modal SCA is 15). Modal FVXaa soils are developed on gravelly, medium to moderately coarse textured colluvial deposits in SCA 16. Variants of modal FVXaa that occur on finer textured parent material are classified as Fairview Mountain-AA,FI (FVXaafi). Variants of modal FVXaa that have an atypical subgroup are classified as Fairview Mountain-AA,ZZ (FVXaazz). Some important features of FVXaa:

- Subgroup – Eluviated Dystric Brunisol (FVXaa) and Orthic Dystric Brunisol (FVXaazz);
- Parent material – gravelly, medium to moderately coarse textured colluvial deposits;
- Drainage – rapidly to well drained; and
- Distribution – FVXaa soils are dominant or co-dominant within the FVCP16, FVCP4, FVHE4, FVKN16, FVRD5, FVX4, and FVXfi11 soil models, and accounts for approximately 1,268.9 ha (27.9%) of the RSA and 491.5 ha (32.3%) of the LSA.

Table A-17 General Description of FVXaa Series and Variants

GM4085RH - FVXaa			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	20-0	-	-
Ae	0-9	30-50	Friable
Bm	9-24	20-30	Friable
C	24-90	10-20	Friable

Table A-18 Selected Chemical and Physical Attributes of General Description of FVXaa Series and Variants

Soil Analytical GM4085RH - FVXaa												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	20-0	5.9	-	-	-	-	-	-	-	-	-	-
Ae	0-9	5.3	0.08	-	-	-	68.6	21.4	10	Sandy Loam	0.2	54
Bm	9-24	5.4	0.08	-	-	-	67.7	20.7	11.7	Sandy Loam	0.2	63
C	24-90	5.2	0.64	-	-	-	58	31.6	10.4	Sandy Loam	0.1	65

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Hillsdale-AA (HDXaa) Series and Variants

The HDXaa series is a Regosolic soil (modal SCA is 15). HDXaa soils are developed on gravelly and non-gravelly, moderately to very coarse textured, stratified (L, SiL, SL, LS) fluvial deposits in SCA 16. Variants of modal HDXaa that are an atypical subgroup and occur on coarser textured parent material are classified as Hillside-AA,ZZ,CO (HDXaazzco). Some important features of HDXaa include:

- Subgroup – Cumulic Regosol (HDXaa) and Orthic Regosol (HDXaazzco);
- Parent material – gravelly and non-gravelly, moderately to very coarse textured, stratified (L, SiL, SL, LS) fluvial deposits;
- Drainage – rapidly to well drained; and
- Distribution – HDXaazzco are co-dominant within the HDFR18 and HDTB18 soil models and account for approximately 123.0 ha (2.7%) of the RSA and 15.1 ha (1.0%) of the LSA.

Table A-19 General Description of HDXaazzco Variant

GM4485VL - HDXaazzco			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LF	3-0	-	-
C1	0-11	0	Loose
C2	11-50	60-70	Loose

Table A-20 Selected Chemical and Physical Attributes of General Description of HDXaazzco Variant

Soil Analytical GM4485VL - HDXaazzco												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LF	3-0	7.6	-	-	-	-	-	-	-	-	-	-
C1	0-11	7.6	0.38	-	-	-	82	13.6	4.4	Loamy Sand	<0.1	46
C2	11-50	7.5	0.47	-	-	-	84	12	4	Loamy Sand	<0.1	45

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Heather-AA (HEXaa) Series and Variants

The HEXaa series is a Brunisolic soil (modal SCA is 15). Modal HEXaa soils are developed on gravelly, medium textured colluvial deposits overlying bedrock in SCA 16. Variants of modal HEXaa that have an atypical subgroup are classified as Heather-AA,ZZ (HEXaazz). Some important features of the HEXaa series include:

- Subgroup – Orthic Dystric Brunisol (HEXaa) and Eluviated Dystric Brunisol (HEXaazz);
- Parent material – gravelly, medium textured colluvial deposits overlying bedrock;
- Drainage – rapidly to well drained; and
- Distribution – HEXaa soils are co-dominant within the FVHE4 soil model, significant component of FVRD5 soil model, and account for approximately 156.6 ha (3.4%) of the RSA and 34.5 ha (2.3%) of the LSA.

Table A-21 General Description of HEXaa Series and Variants

GM4805PM - HEXaa			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	3-0	-	-
Bm	0-16	15	Friable
BC	16-65	30	Friable
R	65-66	-	-

Table A-22 Selected Chemical and Physical Attributes of General Description of HEXaa Series and Variants

Soil Analytical GM4805PM – HEXaa*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	3-0	5.1	-	-	-	-	-	-	-	-	-	-
Bm	0-16	4.8	0.08	-	-	-	-	-	-	Loam	0.2	51
BC	16-65	5.2	0.06	-	-	-	-	-	-	Loam-Sandy Loam	0.2	38
R	65-66	-	-	-	-	-	-	-	-	-	-	-

*Lab data adapted from GM4200PM (CDMaazz), field textures used.

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Leighton Centre (LTC) Series and Variants

The LTC series is a Luvisolic soil. Modal LTC soils are developed on gravelly and non-gravelly, moderately fine textured till in SCA 16. Variants of modal LTC that have greater gravel content than modal LTC are classified as Leighton Centre-GR (LTCgr). Some important features of LTC:

- Subgroup – Dark Gray Luvisol;
- Parent material – gravelly and non-gravelly, moderately fine textured till;
- Drainage – well drained; and
- Distribution – LTC soils are co-dominant within the SPLT4soil model, significant component of SPR1 and SPRgr1 soil models, and account for approximately 106.3 ha (2.3%) of the RSA and 16.5 ha (1.1%) of the LSA.

Table A-23 General Description of the LTC Series and Variants			
GM4439DM – LTC			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	6-0	-	-
Ahe	0-9	1-2	Friable
Bt	9-40	2-5	Firm
Ck	40-80	5-10	Firm

Table A-24 Selected Chemical and Physical Attributes of the LTC Series and Variants												
Soil Analytical GM4439DM – LTC*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	6-0	6.7	-	-	-	-	-	-	-	-	-	-
Ahe	0-9	5.2	0.13	-	-	-	-	-	-	Silt Loam	0.2	57
Bt	9-40	6.6	0.25	-	-	-	-	-	-	Clay Loam	0.1	59
Ck	40-80	7.9	0.35	-	15.7	-	-	-	-	Clay Loam	0.1	50

*Lab data adapted from GM4140VL (SPR), field textures used.

pH – measured in saturated paste or water

EC – electrical conductivity (dS/m)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Mitford (MTF) Series and Variants

The MTF series is an Organic soil. Modal MTF are developed on peat (40-159 cm) overlying moderately fine textured material in SCA 16. Some important features of the MTF series and variants include:

- Subgroup – Terric Mesisol;
- Parent material – peat (40-159 cm) overlying moderately fine textured material;
- Drainage – very poorly drained; and
- Distribution – MTF soils are dominant within the MTF20 soil model, significant within the DNL1 soil model, and account for approximately 12.4 ha (0.3%) of the RSA and 5.8 ha (0.4%) of the LSA.

Table A-25 General Description of the MTF Series and Variants			
GM4130VL – MTF			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
Om	0-42	-	-
C	42-60	<1	Slightly Sticky
Cgj	60-90	5-10	Sticky
R	90-91	-	-

Table A-26 Selected Chemical and Physical Attributes of the MTF Series and Variants												
Soil Analytical GM4130VL – MTF												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	% Sat
							Sand	Silt	Clay			
Om	0-42	7.4	-	-	-	-	-	-	-	-	-	-
C	42-60	7.2	0.30	-	-	-	31.7	43.3	25	Loam	<0.1	90
Cgj	60-90	7.0	0.43	-	-	-	35	39	26	Loam	0.1	79
R	90-91	-	-	-	-	-	-	-	-	-	-	-

pH – measured in saturated paste or water
EC – electrical conductivity (dS/m)
OC – total organic carbon (%)
CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)
PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class
SAR – sodium adsorption ratio
Sat % – saturation percentage

Nickerson-AA (NKNaa) Series and Variants

The NKNaa series is a Regosolic soil (modal SCA is 15). Modal NKNaa are developed on gravelly, medium to moderately fine textured colluvium or weathered bedrock (residuum) in SCA 16. Variants of modal NKNaa that have greater gravel content than modal NKNaa are classified as Nickerson-AA,GR (NKNaagr). Some important features of the NKNaa series and variants include:

- Subgroup – Orthic Humic Regosol;
- Parent material – gravelly, medium to moderately fine textured colluvium or weathered bedrock (residuum);
- Drainage – rapidly to well drained; and
- Distribution – NKNaa soils are co-dominant within the FVVK16 and NKRD1 soil models, significant within the FVRD5 soil model, and account for approximately 85.2 ha (1.9%) of the RSA and 44.1 ha (2.9%) of the LSA.

Table A-27 General Description of the NKNaa Series and Variants			
GM4128VL – NKNaagr			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	5-0	-	-
Ah	0-10	60-70	Friable
C	10-100	70-80	Loose

Table A-28 Selected Chemical and Physical Attributes of the NKNaa Series and Variants												
Soil Analytical GM4128VL – NKNaagr												
Horizon	Depth (cm)	pH	EC	OC	CaCO₃ Equiv.	TN	PSA			Texture Class	SAR	% Sat
							Sand	Silt	Clay			
LFH	5-0	6.5	-	-	-	-	-	-	-	-	-	-
Ah	0-10	6.4	0.48	2.18	-	0.12	49	40.6	10.4	Loam	<0.1	62
C	10-100	5.7	0.09	-	-	-	45	40	15	Loam	0.1	51

pH – measured in saturated paste or water
EC – electrical conductivity (dS/m)
OC – total organic carbon (%)
CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (N, %)
PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class
SAR – sodium adsorption ratio
Sat % – saturation percentage

Porcupine-AA (PPEaa) Series and Variants

The PPEaa series is a Chernozemic soil (modal SCA is 8). Modal PPEaa are developed on gravelly and non-gravelly, medium to moderately coarse textured colluvium in SCA 16. Variants of modal PPEaa that occur on coarser textured parent material are classified as Porcupine-AA,CO (PPEaaco). Some important features of PPEaa:

- Subgroup – Orthic Black Chernozem;
- Parent material – gravelly and non-gravelly, medium to moderately coarse textured colluvium;
- Drainage – well drained; and
- Distribution – PPEaa soils occur sporadically within the FVCP16, FVCP4, and FVNC16 soil models.

Table A-29 General Description of the PPEaa Series and Variants			
GM4575DM – PPEaagr			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
Ah	0-17	10-20	Very Friable
Bm	17-45	30-40	Friable
C	45-100	20-30	Friable

Table A-30 Selected Chemical and Physical Attributes of the PPEaa Series and Variants												
Soil Analytical GM4575DM – PPEaagr												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
Ah	0-17	6.6	0.39	7.69	-	0.72	44	44	12	Loam	<0.1	91
Bm	17-45	6.1	0.14	-	-	-	50	27.6	22.4	Sandy Clay Loam	0.1	61
C	45-100	6.2	0.14	-	-	-	44	31	25	Loam	0.1	47

pH – measured in saturated paste

EC – electrical conductivity (dS m⁻¹)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (%)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Redoubt-AA (RDXaa) Series and Variants

The RDXaa soils are Regosolic soils (modal SCA is 15). Modal RDXaa are developed on gravelly, moderately coarse textured colluvium or weathered bedrock (residuum) in SCA 16. Variants of modal RDXaa that occur on finer textured parent material are classified as Redoubt-AA,FI (RDXaafi). Variants of modal RDXaa that have till contact within 30-99 cm are classified as Redoubt-AA,XL (RDXaaxl). Variants of modal RDXaa with a thick A horizon are classified as Redoubt-AA,ZH (RDXaazh). Some important features of RDXaa:

- Subgroup – Orthic Regosol (RDXaa) and Orthic Humic Regosol (RDXaazh);
- Parent material – gravelly, moderately coarse textured colluvium or weathered bedrock (residuum);
- Drainage – rapidly drained; and
- Distribution – RDXaa soils are co-dominant within the FVRD5 and NKRD1 soil models, significant within the FVCP4, FVHE4, FVX4, FVXfi11, and SPLT4 soil models and accounts for approximately 580.8 ha (12.8%) of the RSA and 241.4 ha (15.9%) of the LSA.

Table A-31 General Description of the RDXaa Series and Variants			
GM4250DL – RDXaafi			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	8-0	-	-
C	0-25	50-70	-
R	25	-	-

Table A-32 Selected Chemical and Physical Attributes of the RDXaa Series and Variants												
Soil Analytical GM4250DL – RDXaafi												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	8-0	4.7	-	-	-	-	-	-	-	-	-	-
C	0-25	4.6	0.06	-	-	-	54.6	25.4	20	Sandy Clay Loam	0.2	57
R	25	-	-	-	-	-	-	-	-	-	-	-

pH – measured in saturated paste

EC – electrical conductivity (dS m⁻¹)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total nitrogen (%)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Spruce Ridge (SPR) Series and Variants

The SPR series is a Luvisolic soil. Modal SPR soils are developed on non-gravelly and gravelly, medium to moderately fine textured till in SCA 16. Variants of modal SPR that have a Brunisolic Bm horizon are classified as Spruce Ridge-ZB (SPRzb). Variants of modal SPR that have greater gravel content than modal SPR are classified as Spruce Ridge-GR (SPRgr). Some important features of SPR are:

- Subgroup – Orthic Gray Luvisol (SPR) and Brunisolic Gray Luvisol (SPRzb);
- Parent material – non-gravelly and gravelly, medium to moderately fine textured till;
- Drainage – well drained; and
- Distribution – SPR soils are dominant or co-dominant within the SPgrWL1, SPLT4, SPR1, and SPRgr1 soil models, significant within the CON5 soil model and accounts for approximately 894.8 ha (19.7%) of the RSA and 176.8 ha (11.6%) of the LSA.

Table A-33 General Description of the SPR Series and Variants

GM4140VL – SPR			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	9-0	-	-
Ae	0-5	30-40	Friable
Bt	5-55	5-10	Firm
Ck	55-90	5-10	Friable

Table A-34 Selected Chemical and Physical Attributes of the SPR Series and Variants

Soil Analytical GM4140VL – SPR												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	9-0	6.7	-	-	-	-	-	-	-	-	-	-
Ae	0-5	5.2	0.13	-	-	-	45	39	16	Loam	0.2	57
Bt	5-55	6.6	0.25	-	-	-	24	40	36	Clay Loam	0.1	59
Ck	55-90	7.9	0.35	-	15.7	-	23	57	20	Silt Loam	0.1	50

pH – measured in saturated paste
EC – electrical conductivity (dS m⁻¹)
OC – total organic carbon (%)
CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total Kjeldahl nitrogen (%)
PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class
SAR – sodium adsorption ratio
Sat % – saturation percentage

Twin Bridges-AA (TBRaa) Series and Variants

The TBRaa series is a Regosolic soil (modal SCA is 8). TBRaa soils are developed on gravelly and non-gravelly, moderately to very coarse textured fluvial deposits in SCA 16. Variants of modal TBRaa that are an atypical subgroup are classified as Twin Bridges-AA, ZZ (TBRaazz). Variants of modal TBRaa that occur on coarser textured parent material are classified as Twin Bridges-AA, CO (TBRaaco). Some important features of TBRaa are:

- Subgroup – Gleyed Humic Regosol (TBRaa and TBRaaco), Cumulic Humic Regosol (TBRaazz), and Orthic Humic Regosol (TBRaazz);
- Parent material – gravelly and non-gravelly, moderately to very coarse textured fluvial deposits;
- Drainage – rapidly to imperfectly drained; and
- Distribution – TBRaa soils are co-dominant within the HDTB18 soil model and accounts for approximately 44.5 ha (1.0%) of the RSA and 10.8 ha (0.7%) of the LSA.

Table A-35 General Description of the TBRaa Series and Variants			
GM4259PM – TBRaaco			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
Ah	0-12	40	Friable
Cgj	12-13	60	Loose

Table A-36 Selected Chemical and Physical Attributes of the TBRaa Series and Variants												
Soil Analytical GM4259PM – TBRaaco*												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
Ah	0-12	6.8	1.47	10.5	-	-	-	-	-	Loamy Sand	<0.1	130
Cgj	12-13	7.7	0.55	-	-	-	-	-	-	Loamy Sand	<0.1	66

*Lab data adapted from GM4394DL (HDXaazzfi), field textures used.

pH – measured in saturated paste

EC – electrical conductivity (dS m⁻¹)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total Kjeldahl nitrogen (%)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Tough Creek (TUC) Series and Variants

The TUC series is a Luvisolic soil. Modal TUC soils are developed on medium textured till overlying bedrock in SCA 16. Some important features of TUC are:

- Subgroup – Orthic Gray Luvisol;
- Parent material – medium textured till overlying bedrock;
- Drainage – well drained; and
- Distribution – TUC soils are dominant within the TUCD1 soil model and account for approximately 66.5 ha (1.5%) of the RSA and 2.6 ha (0.2%) of the LSA.

Table A-37 General Description of the TUC Series and Variants			
GM4402VL – TUC			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	5-0	-	-
Ae	0-10	5-10	Soft
Bt	10-43	5-10	Hard
R	43-62	-	-

Table A-38 Selected Chemical and Physical Attributes of the TUC Series and Variants												
Soil Analytical GM4402VL – TUC												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	5-0	5.5	-	-	-	-	-	-	-	-	-	-
Ae	0-10	5.9	0.35	-	-	-	56.7	26.7	16.7	Sandy Loam	<0.1	123
Bt	10-43	5.4	0.20	-	-	-	41.7	35	23.3	Loam	0.2	69
R	43-62	-	-	-	-	-	-	-	-	-	-	-

pH – measured in saturated paste

EC – electrical conductivity (dS m⁻¹)

OC – total organic carbon (%)

CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total Kjeldahl nitrogen (%)

PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class

SAR – sodium adsorption ratio

Sat % – saturation percentage

Willoughby (WLB) Series and Variants

The WLB series are a Brunisolic soil. Modal WLB soils are developed on gravelly and non-gravelly, medium to moderately fine textured till in SCA 16. Variants of modal WLB that are an atypical subgroup are classified as Willoughby-ZZ (WLBzz). Some important features of the WLB series include:

- Subgroup – Eluviated Dystric Brunisol (WLB) and Orthic Dystric Brunisol (WLBzz);
- Parent material – gravelly and non-gravelly, medium to moderately fine textured till;
- Drainage – well drained; and
- Distribution – WLB soils are co-dominant within the SPgrWL1 soil model and account for approximately 151.5 ha (3.3%) of the RSA and 23.0 ha (1.5%) of the LSA.

Table A-39 General Description of the WLB Series and Variants			
GM4406DL - WLB			
Horizon	Depth (cm)	Coarse Fragments (%)	Consistence
LFH	4-0	-	-
Ae	0-2	2	Very Friable
Btj	2-38	10	Friable
BC	38-67	5-7	Friable
C	67-90	5-7	Firm

Table A-40 Selected Chemical and Physical Attributes of the WLB Series and Variants												
Soil Analytical GM4406DL - WLB												
Horizon	Depth (cm)	pH	EC	OC	CaCO ₃ Equiv.	TN	PSA			Texture Class	SAR	Sat. %
							Sand	Silt	Clay			
LFH	4-0	6.1	-	-	-	-	-	-	-	-	-	-
Ae	0-2	5.3	0.14	-	-	-	36	48	16	Loam	0.1	73
Btj	2-38	5.7	0.07	-	-	-	41	41	18	Loam	0.2	57
BC	38-67	6.0	0.08	-	-	-	40.6	38.4	21	Loam	0.2	40
C	67-90	6.1	0.09	-	-	-	49	33	18	Loam	0.2	38

pH – measured in saturated paste
EC – electrical conductivity (dS m⁻¹)
OC – total organic carbon (%)
CaCO₃ Equiv. – calcium carbonate equivalent (%)

TN – total Kjeldahl nitrogen (%)
PSA – particle size analysis (% sand, silt, and clay separates) by the hydrometer method, with texture class
SAR – sodium adsorption ratio
Sat % – saturation percentage

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4028DL	28-Jul-14	686362	5508977	L7	Inclined	R	Regosolic	O.R	RDXaaxl	Ah	0-5	L	VFr
										AC	5-30	SL	Fr
										R	30+	-	-
GM4041DL	27-Jul-14	686284	5508256	C6	Inclined	R	Regosolic	O.R	RDXaazz	LFH	5-0	-	-
										AC	0-30	FSL	Fr
GM4042DL	27-Jul-14	686330	5508177	L8	Inclined	R	Brunisolic	O.MB	FRKxptk	LFH	5-0	-	-
										Ah	0-14	L	Fr
										Bm	14-41	L	Fr
										IIC	41-70	L	Fr
GM4043DL	27-Jul-14	686262	5507919	L19	Inclined	VR	Regosolic	O.R	RDXaaxlgr	LFH	6-0	-	-
										AC	0-30	L	-
										R	30-36	-	-
GM4044DL	27-Jul-14	686611	5508055	L19	Inclined	R	Brunisolic	E.DYB	HEXaazz	LFH	4-0	-	-
										Ae	0-15	L	VFr
										Bm	15-41	L	Fr
										IIC	41-55	VFSL	Fr
GM4045DL	27-Jul-14	686480	5507950	L7	Inclined	R	Regosolic	O.R	RDXaaxl	AC	0-13	L	Fr
										C	13-35	FSL	Fr
										R	35-45	-	-
GM4046DL	27-Jul-14	686469	5507821	L19	Inclined	R	Brunisolic	O.DYB	HEXaa	Ah	0-8	L	Fr
										Bm	8-32	L	Fr
										R	32-42	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4047DL	27-Jul-14	686511	5507693	M5	Inclined	R	Brunisolic	E.DYB	CDMaa	LFH	5-0	-	-
										Ae	0-4	L	VFr
										Bm	4-28	L	VFr
										R	28-38	-	-
GM4048DL	27-Jul-14	686585	5507638	M5	Inclined	VR	Brunisolic	O.DYB	CDMaazz	LFH	2-0	-	-
										Bm	0-29	L	Fr
										R	29-35	-	-
GM4049DL	27-Jul-14	686709	5507610	L7	Inclined	R	Brunisolic	E.DYB	CPXaazz	LFH	6-0	-	-
										Ae	0-8	SL	VFr
										Bm	8-38	SL	Fr
										C	38-60	L	Fr
										R	60+	-	-
GM4054DL	27-Jul-14	686649	5507668	L19	Inclined	R	Brunisolic	E.DYB	HEXaazz	LFH	1-0	-	-
										Ae	0-17	L	VFr
										Bm	17-90	L	VFr
										R	90-91	-	-
GM4055DL	27-Jul-14	686305	5507797	L7	Inclined	VR	Regosolic	O.R	RDXaaxl	AC	0-65	FSL	-
										R	65-70	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4056DL	27-Jul-14	686344	5508023	L19	Inclined	R	Brunisolic	O.DYB	HEXaa	LFH	8-0	-	-
										Ahj	0-9	L	VFr
										Bm	9-32	L	VFr
										C	32-65	L	Fr
										R	65+	-	-
GM4057RH	30-Jul-14	687484	5507089	L7	Inclined	R	Brunisolic	O.DYB	CPXaa	Ah	0-8	FSL	Fr
										Bm	8-35	SL	Fr
										R	35+	-	-
GM4058RH	30-Jul-14	687328	5506955	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	3-0	-	-
										Ae	0-10	FSL	VFr
										Bt	10-33	L	Fr
										C	33-80	SCL	Fi
GM4059DL	30-Jul-14	687177	5507065	-	Inclined	-	-	-	-	disturbed	-	-	-
GM4060DL	30-Jul-14	687071	5507077	C1	Inclined	W	Brunisolic	O.DYB	FVXaazz	LFH	11-0	-	-
										Ahj	0-15	L	Fr
										Bm	15-55	SL	Fi
										C	55-90	SCL	Fi
GM4061DL	30-Jul-14	687327	5507168	C6	Inclined	R	Regosolic	O.HR	RDXaazh	Ah	0-12	FSL	VFr
										C	12-19	FSL	Fr
										R	19-20	-	-
GM4062DL	30-Jul-14	687242	5507181	L19	Inclined	R	Brunisolic	O.DYB	HEXaa	LFH	3-0	-	-
										Bm	0-23	VFSL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
										C	23-50	VFSL	Fr
										R	50-51	-	-
GM4063DL	30-Jul-14	687156	5507132	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	6-0	-	-
										Bm	0-26	FSL	-
										C1	26-54	FSL	-
										C2	54-100	FSL	-
GM4064DL	30-Jul-14	687064	5507156	C1	Inclined	R	Brunisolic	O.SB	FVXaazztk	LFH	8-0	-	-
										Ah	0-10	SL	VFr
										Bm	10-38	SL	VFr
										C	38-80	SL	Fr
GM4065RH	24-Jul-14	686516	5506779	C1	Inclined	R	Regosolic	O.HR	RDXaazh	FH/Ah	0-13	LS	Fr
										C	13-60	LS	Fr
GM4075DL	30-Jul-14	686984	5507141	M5	Inclined	R	Regosolic	O.HR	RDXaacoZh	Ah	0-13	L	Fr
										AC	13-27	SCL	Fi
GM4084JJ	24-Jul-14	686464	5506666	M1	Steep	R	Regosolic	O.R	RDXaafi	LFH	5-0	-	-
										Ah	0-4	L	Fr
										C	4-22	L	Fr
GM4085RH	24-Jul-14	686516	5506538	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	LFH	20-0	-	-
										Ae	0-9	SL	Fr
										Bm	9-24	SL	Fr
										C	24-90	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4086RH	24-Jul-14	686594	5506662	M1	Inclined	R	Brunisolic	O.DYB	FVXaazzfi	LFH	4-0	-	-
										Ah	0-5	L	Fr
										Bm	5-35	L	Fr
										C	35-85	L	Fr
GM4087RH	26-Jul-14	686673	5506523	L7	Inclined	R	Brunisolic	O.DYB	CPXaa	LFH	9-0	-	-
										Bm1	0-17	SL	Fr
										Bm2	17-50	SL	Fr
										C	50-70	L	Fr
										R	70-90	-	Fr
GM4088JJ	26-Jul-14	686513	5506393	L8	Inclined	R	Regosolic	O.HR	NKNaaxl	Ah	0-15	L	Fr
										AC	15-35	L	Fr
										R	35-40	-	-
GM4089JJ	24-Jul-14	686704	5505984	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	8-0	-	-
										Ae	0-20	L	Fr
										Bm	20-55	L	Fr
GM4090RH	23-Jul-14	686675	5506065	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	Ah	0-5	L	Fr
										Bm	5-45	L	Fr
										C1	45-75	L	Fr
										C2	75-90	CL	Fr
GM4091JJ	23-Jul-14	686662	5506177	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	Ah	0-6	L	Fr
										Bm	6-24	L	Fr
										C	24-50	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4092RH	23-Jul-14	686651	5506271	M1	Inclined	W	Brunisolic	O.MB	FRKtk	Ah	0-11	L	Fr
										Bm	11-51	SL	Fr
										C	51-115	L-CL	Fr
GM4093JJ	24-Jul-14	686682	5506662	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	Ah	0-7	L	Fr
										Ae	7-22	L	Fr
										Bm	22-43	L-FSL	Fr
										C	43-85	CL	Fi
GM4096RH	24-Jul-14	686968	5506073	C6	-	R	Brunisolic	O.DYB	CPXaa	Ah	0-12	SL	Fr
										Bm	12-22	SL	Fr
										R	22-23	-	-
GM4097JJ	24-Jul-14	686872	5506023	M1	Inclined	R	Brunisolic	E.DYB	FVXaafi	LFH	2-0	-	-
										Ah	0-5	L	Fr
										Ae	5-22	L	Fr
										Bm	22-50	L-SL	Fr
GM4098RH	24-Jul-14	686798	5506010	M1	Inclined	W	Brunisolic	O.MB	FRKtk	Ah	0-24	L	Fr
										Bm	24-39	L	Fr
										BC	39-60	FSL	Fr
GM4099DL	26-Jul-14	686604	5505090	M2	Inclined	W	Regosolic	O.HR	NKNaa	LFH	5-0	-	-
										Ah1	0-7	SL	VFr
										Ah2	7-14	SiL	VFr
										AC	14-45	SCL	Fr
										C	45-46	SCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4100JJ	23-Jul-14	686122	5505509	C3	Hummocky	W	Regosolic	O.HR	RDXaazh	Ah	0-10	L	Fr
										AC	10-50	FSL	Fr
										C	50-110	FSL	Fr
GM4101DL	26-Jul-14	686886	5505072	M4	Inclined	R	Brunisolic	O.DYB	WLBzz	LFH	5-0	-	-
										Bm	0-50	SL	Fr
										BC	50-73	SCL	Fr
										C	73-75	CL	Fi
GM4102DL	26-Jul-14	686673	5504934	P2	Level	VP	Organic	TY.M	DNL	Om	0-220	-	-
GM4103DL	26-Jul-14	686836	5504907	M5	Inclined	W	Brunisolic	E.DYB	CDMaa	LFH	4-0	-	-
										Ae	0-4	SL	-
										Bm	4-9	L	-
										BC	9-20	L	-
										R	20-21	-	-
GM4104DL	26-Jul-14	686739	5504797	P2	Level	VP	Organic	TY.M	DNL	Om	0-115	-	-
										Oh	115-180	-	-
										Cg	180-181	SiC	-
GM4105DL	25-Jul-14	686912	5504493	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	FH	6-0	-	-
										Aej	0-8	SL	VFr
										Bm	8-44	SL	Lo

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4106DL	26-Jul-14	686903	5504692	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	Ah1	0-4	L	VFr
										Ah2	4-8	L	VFr
										Ae	8-11	CL	VFr
										Bm	11-17	CL	Fr
										C	17-35	SL	Lo
GM4107JJ	28-Jul-14	685032	5503654	-	Hummocky	W	Brunisolic	O.EB	CONfixtzz	Ah	0-9	L	Fr
										AB	9-23	SiL	Fr
										Bm	23-36	SiL	Fr
										R	36-50	-	-
GM4108JJ	28-Jul-14	684976	5503721	L19	Hummocky	W	Regosolic	O.R	RDXaafixl	LFH	5-0	-	-
										Ah	0-8	L	Fr
										ACk	8-17	L	Fr
										Ck	17-50	L	Fr
										R	50-53	-	-
GM4109VL	23-Jul-14	685227	5503654	M4	Inclined	W	Luvisolic	D.GL	LTC	LFH	13-0	-	-
										Ahe	0-10	L	Fr
										Bt	10-32	L-CL	Fr
										Ck	32-100	CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4110VL	23-Jul-14	685348	5503735	M4	Inclined	P	Gleysolic	O.HG	POTaacozz	Ah	0-22	L	Fr
										ABgj	22-34	L	Fr
										Bg	34-52	L	Fr
										BCg	52-90	L	Fr
										Ckg	90-110	CL	ST
GM4111VL	23-Jul-14	685326	5503784	M6	Inclined	W	Brunisolic	O.MB	BPETkgr	Ah	0-15	SL	Fr
										AB	15-24	L	Fr
										Bm	24-42	SL	Fr
										Ck	42-110	L	Fr
GM4112VL	23-Jul-14	685133	5503808	M0	Inclined	W	Regosolic	CU.HR	NKNaacu	LF	2-0	-	-
										Ah	0-11	L	VFr
										Ahb1	11-21	L	VFr
										Ahb2	21-33	L	VFr
										Ahb3	33-42	L	VFr
										Ahb4	42-54	L	VFr
										Ahb5	54-120	L	VFr
GM4113VL	24-Jul-14	685127	5503887	C6	Inclined	R	Regosolic	O.R	RDXaazz	LFH	5-0	-	-
										Bm	0-4	FSL	VFr
										C	4-46	FSL	Lo

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4114VL	28-Jul-14	685315	5503640	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	7-0	-	-
										Ae	0-9	L	Fr
										AB	9-20	L	Fr
										Bt	20-50	CL	Fr
										BC	50-90	L	VFr
GM4115VL	24-Jul-14	685169	5504167	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-13	FSL	Fr
										Bt	13-44	CL	Fi
										Ck	44-70	L	Fr
GM4116VL	24-Jul-14	685231	5504225	M1	Inclined	R	Regosolic	O.R	RDXaafi	Ah	0-9	L	Fr
										C	9-40	L	Lo
GM4117VL	24-Jul-14	685463	5503895	L19	Inclined	W	Brunisolic	O.EB	FRKzzxl	LF	2-0	-	-
										Ah	0-8	L	Fr
										AB	8-16	L	Fr
										Bm	16-29	L	Fr
										Ck	29-51	L	Lo
										R	51-65	-	-
GM4118DL	26-Jul-14	685629	5503958	C1	Inclined	R	Regosolic	O.R	RDXaa	LFH	4-0	-	-
										Ah	0-5	SL	Fr
										C	5-40	LS	Lo

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4119VL	24-Jul-14	685200	5504309	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-11	FSL	VFr
										Bt	11-43	SCL	Fi
										Ck	43-52	L	Fr
GM4120VL	24-Jul-14	685374	5504443	M1	Inclined	R	Brunisolic	O.DYB	FVXaazzfi	Ah	0-9	L	Fr
										AB	9-17	L	Fr
										Bm	17-30	L	Fr
										C	30-45	L	Fr
GM4121VL	24-Jul-14	685206	5504464	M4	Undulating	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-10	FSL	Fr
										Bt	10-55	SCL	Fi
										Ck	55-70	SCL	Fi
GM4122VL	24-Jul-14	685333	5504655	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-15	FSL	Fr
										AB	15-32	L-FSL	Fr
										Bt	32-65	CL	Fi
										Ck	65-75	L	Fr
GM4123VL	24-Jul-14	685254	5504588	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-20	FSL	VFr
										Bt	20-60	CL	Fi
										Ck	60-75	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4124VL	24-Jul-14	685130	5504454	L6	Inclined	W	Luvisolic	O.GL	TUC	Ahe	0-4	L	Fr
										Ae	4-18	L	Fr
										BA	18-29	L	Fr
										Bt	29-41	CL	Fi
										R	41-42	-	-
GM4125VL	24-Jul-14	685009	5504322	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LF	2-0	-	-
										Ae	0-7	L	VFr
										BA	7-15	L	Fr
										Bt	15-35	CL	Fi
										Ck	35-75	L	Fr
GM4126VL	24-Jul-14	685525	5504673	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	11-0	-	-
										Ae	0-5	SL	Fr
										Bt	5-45	SCL	Fr
										BC	45-52	L	Fr
GM4127VL	25-Jul-14	685462	5504841	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-10	SL	VFr
										Bt	10-44	SCL	Fi
										BC	44-65	SCL	Fi
GM4128VL	25-Jul-14	685402	5505138	M1	Inclined	R	Regosolic	O.HR	NKNaagr	LFH	5-0	-	-
										Ah	0-10	L	Fr
										C	10-100	L	Lo
GM4129VL	25-Jul-14	685688	5504887	-	Inclined	-	-	-	ZDL	C	0-38	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4130RH	24-Jul-14	685698	5505123	L3	Hummocky	W	Brunisolic	E.EB	FRKfizzxt	LFH	7-0	-	-
										Ae	0-5	L	Fr
										Bm	5-55	L	Fr
										IIC	55-95	CL	Fi
GM4130VL	25-Jul-14	685700	5505124	L12	Level	VP	Organic	T.M	MTF	Om	0-42	-	-
										C	42-60	L	SS
										Cgj	60-90	L	ST
										R	90-91	-	-
GM4131RH	23-Jul-14	685667	5505238	M1	Inclined	W	Regosolic	O.HR	NKNaagr	Ah	0-18	L	Fr
										C	18-25	L	Hd
GM4132VL	23-Jul-14	685723	5505226	M5	Inclined	W	Regosolic	O.HR	NKNaagrzz	LF	2-0	-	-
										Ah	0-14	SiL	VFr
										AC	14-27	SiL	VFr
										R	27-42	-	-
GM4211PM	27-Jul-14	685495	5507936	C1	Inclined	R	Brunisolic	E.EB	FRKzzco	LFH	5-0	-	-
										Ae	0-21	SL	Fr
										Bm	21-34	SCL	Fr
										Ck	34-100	SL	Fr
GM4210PM	27-Jul-14	685393	-	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	1-0	-	-
										Ae	0-4	LS	Lo
										Bm	4-24	LS	Lo
										C	24-105	LS	Lo

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4209PM	27-Jul-14	685323	5507712	L6	Inclined	R	Luvisolic	O.GL	TUC	LFH	3-0	-	-
										Ae	0-42	SL	Fr
										Bt	42-51	CL	Fr
										IIBt	51-62	L	Fi
										IIR	62-90	VFSL	Fi
GM4142PM	24-Jul-14	685000	5505731	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-13	L	Fr
										Bt	13-33	CL	Fi
										Ck	33-75	CL	Fi
GM4143PM	24-Jul-14	684939	5505760	M6	Inclined	W	Brunisolic	E.EB	BPEzzgr	LF	2-0	-	-
										Aej	0-10	SL-L	Fr
										Btj	10-21	L-CL	Fr
										Ck	21-55	L-CL	Fr
GM4191PM	27-Jul-14	685700	5507228	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	2-0	-	-
										Ae	0-16	FSL	Fr
										Bm	16-35	FSL	Fr
										C	35-60	FSL	Fr
GM4196PM	27-Jul-14	685366	5507020	L7	Inclined	R	Brunisolic	E.DYB	CPXaazz	LF	1-0	-	-
										Ahe	0-8	VFSL	VFr
										Ae	8-33	VFSL	VFr
										Bm	33-41	VFSL	VFr
										R	41-42	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4193PM	27-Jul-14	685425	5507220	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	2-0	-	-
										Ae	0-48	VFSL	VFr
										Bt	48-100	CL	VFi
GM4195PM	27-Jul-14	685405	5507477	L7	Inclined	R	Brunisolic	O.DYB	CPXaa	LF	4-0	-	-
										Bm	0-30	VFSL	VFr
										C	30-53	VFSL	VFr
										R	53-100	VFSL	-
GM4208PM	27-Jul-14	685342	5507613	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	1-0	-	-
										Ae	0-34	VFSL	VFr
										Bm	34-62	VFSL	VFr
										C	62-100	VFSL	VFr
GM4154PM	24-Jul-14	684987	5506193	C6	Inclined	W	Chernozemic	O.DBC	BEVcoer	Ah	0-8	SL	VFr
										Bm	8-15	SL	VFr
										R	15-16	SL	-
GM4204PM	29-Jul-14	684678	5507151	M6	Terraced	W	Luvisolic	BR.GL	SPRgrzb	LF	2-0	-	-
										Ae	0-11	SL	Fr
										Bm	11-41	L	Fr
										Bt	41-95	CL	VFi
										Ck	95-110	-	VFi
GM4155PM	24-Jul-14	684956	5506130	C6	Ridged	R	Brunisolic	O.DYB	CPXaa	Bm	0-9	SL	VFr
										R	9-10	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4261PM	28-Jul-14	684708	5508570	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LF	2-0	-	-
										Bfj	0-26	LS-SL	Fr
										Bm	26-48	SL	So
										BC	48-72	LS	Lo
GM4260PM	28-Jul-14	684676	5508547	C1	Inclined	R	Brunisolic	O.EB	MGVzz	LF	1-0	-	-
										Bm	0-26	LS	Lo
										C1	26-54	LS	Lo
										C2	54-75	LS	Lo
GM4259PM	28-Jul-14	684634	5508431	C2	Terraced	I	Regosolic	GL.HR	TBRaaco	Ah	0-12	LS	Fr
										Cgj	12-13	LS	Lo
GM4233PM	28-Jul-14	684830	5507972	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	5-0	-	-
										Ae	0-5	SL	VFr
										Bm	5-20	SL	VFr
										C	20-50	SL	VFr
GM4200PM	26-Jul-14	684990	5507235	L8	Inclined	R	Brunisolic	O.DYB	CDMaazz	LFH	4-0	-	-
										Bm	0-16	L	VFr
										BC	16-33	L	VFr
										R	33-67	SL	VFr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4199PM	26-Jul-14	685099	5507212	L7	Inclined	R	Brunisolic	E.DYB	CPXaazz	LF	3-0	-	-
										Ae	0-5	SL	Fr
										Bm	5-25	SL	Fr
										C	25-55	SL	Fr
										R	55-70	SL	Fr
GM4198PM	26-Jul-14	685197	5507315	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-1	SL	Fr
										Bt	1-26	CL	VFi
										BC	26-62	L-CL	VFi
GM4197PM	26-Jul-14	685298	5507215	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	2-0	-	-
										Ae	0-2	SL	Fr
										Bm	2-20	SL	Fr
										C	20-55	SL	Fr
GM4202PM	26-Jul-14	684841	5507262	M4	Inclined	W	Brunisolic	O.DYB	WLBzz	LFH	6-0	-	-
										Bm	0-23	L	Fr
										BC	23-48	L	Fr
GM4203PM	26-Jul-14	684775	5507302	M4	Inclined	W	Brunisolic	O.EB	BPE	LFH	6-0	-	-
										Bmk	0-12	SL	Fr
										Ck	12-57	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4168PM	25-Jul-14	685478	5506351	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	2-0	-	-
										Ae	0-4	SL	VFr
										Bm	4-21	SL	VFr
										C	21-47	SL	VFr
GM4201PM	26-Jul-14	684851	5507201	M6	Inclined	MW	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Aej	0-18	L	Fr
										Btj	18-52	L-CL	Fr
										BCgj	52-70	L-CL	Fr
GM4148PM	24-Jul-14	685184	5506498	L7	Inclined	R	Brunisolic	O.DYB	CPXaa	LF	2-0	-	-
										Bm	0-12	SL-L	Fr
										BC	12-43	SL-L	Fr
										R	43-44	-	-
GM4144PM	23-Jul-14	684850	5505850	C3	Terraced	I	Regosolic	GLCU.R	TBRaazz	C1	0-20	LS	Lo
										C2	20-40	SL	Fr
GM4145PM	23-Jul-14	684749	5506110	C3	Terraced	W	Brunisolic	E.EB	CON	LF	2-0	-	-
										Aej	0-18	SL	Fr
										Btj	18-42	L	Fr
										C	42-66	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4149PM	24-Jul-14	685137	5506442	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	2-0	-	-
										Ah	0-4	SL	VFr
										Ae	4-28	SL	Lo
										Bm	28-44	SL	Lo
										BC	44-53	SL	Fr
GM4150PM	24-Jul-14	685114	5506366	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	2-0	-	-
										Ahe	0-6	SL-L	VFr
										Ae	6-24	SL-L	VFr
										Bm	24-37	SL-L	VFr
GM4151PM	24-Jul-14	685079	5506325	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LF	2-0	-	-
										Bm	0-28	SL	Fr
										C	28-45	SL	Fr
GM4153PM	24-Jul-14	685099	5506181	M1	Inclined	R	Brunisolic	E.EB	FRKzz	Bm	14-28	SL-L	VFr
										C	28-40	SL-L	VFr
										LFH	5-0	-	-
										Ae	0-14	SL-L	VFr
GM4156PM	24-Jul-14	684949	5506035	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LF	2-0	-	-
										Ae	0-28	SL	Fr
										Bt	28-75	CL	Fi
GM4157PM	24-Jul-14	684870	5505997	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-32	SL	Fr
										Bt	32-52	L-CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4561PM	29-Jul-14	685378	5509127	C6	Ridged	R	Brunisolic	O.DYB	CPXaa	Ah	0-1	SL	Fr
										Bm	1-6	SL	Fr
										R	6-7	-	-
GM4573JJ	29-Jul-14	685328	5509131	L7	Inclined	R	Brunisolic	E.DYB	CPXaazz	LFH	5-0	-	-
										Ae	0-3	FSL	Fr
										Bm	3-30	SL	Fr
										IIC	30-60	VFSL	Fr
GM4266PM	29-Jul-14	685086	5508795	C1	Inclined	R	Brunisolic	E.DYB	FVXaacu	LFH	5-0	-	-
										Ae	0-5	SL	Fr
										LFHb	5-8	SL	-
										Aeb	8-11	SL	Fr
										Bmb	11-22	SL	Fr
										C	22-45	SL	Fr
GM4269PM	29-Jul-14	684929	5508873	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	4-0	-	-
										Ae	0-15	SL	Fr
										Bm	15-36	SL	Fr
										C	36-55	SL	Fr
GM4263PM	29-Jul-14	684796	5508737	M1	Inclined	R	Chernozemic	O.DBC	BEVzzco	LFH	2-0	-	-
										Ah	0-15	SL	Fr
										Bm	15-37	SL	Fr
										C	37-65	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4158PM	23-Jul-14	684799	5505922	C3	Terraced	R	Regosolic	CU.R	PPXaa	Ahj	0-16	SL	Fr
										C1	16-35	LS	Lo
										C2	35-80	SL	Fr
GM4212PM	27-Jul-14	685545	5507982	C1	Steep	W	Regosolic	O.R	RDXaa	C	0-25	SL-L	-
GM4227PM	28-Jul-14	685019	5508051	C6	Ridged	VR	Regosolic	O.R	RDXaazz	C	0-8	LS	Lo
										R	8-9	-	-
GM4152PM	24-Jul-14	685084	5506256	C6	Ridged	R	Chernozemic	R.DBC	BEVzrco	Ah	0-9	SL	VFr
										C	9-24	SL	VFr
										R	24-25	-	-
GM4264JJ	29-Jul-14	684846	5508786	M1	Inclined	R	Regosolic	O.HR	NKNaagr	LFH	4-0	-	-
										Ah	0-25	L-CL	Fr
										Cgj	25-40	CL	Fr
GM4499JJ	29-Jul-14	684520	5507144	M1	Steep	R	Regosolic	O.R	RDXaafi	Ck	0-55	L-CL	Fr
GM4194PM	27-Jul-14	685509	5507309	M6	Inclined	P	Gleysolic	O.G	CVXaazz	LFH	2-0	-	-
										Bg	0-22	CL	Fi
										Cg	22-45	L-CL	Fi
GM4268JJ	29-Jul-14	684802	5508649	L19	Inclined	R	Brunisolic	O.DYB	HEXaa	Ae	0-12	L	Fr
										Bm	12-40	L	Fr
										R	40-48	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4270JJ	29-Jul-14	685174	5508863	L19	Inclined	W	Brunisolic	E.DYB	HEXaazz	LFH	5-0	-	-
										Aej	0-6	L	Fr
										Bm	6-31	L	Fr
										C	31-39	L	-
										R	39-125	L-CL	Fr
GM4572JJ	29-Jul-14	-	5509202	L19	Inclined	R	Brunisolic	E.DYB	HEXaazz	LFH	2-0	-	-
										Ae	0-4	SL	Fr
										Bm	4-30	SL	Fr
										BC	30-70	VFSL	Fr
										R	70-71	-	-
GM4507JJ	29-Jul-14	684583	5508549	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	3-0	-	-
										Ae	0-11	SL	Fr
										Bm	11-50	SL	Fr
										BC	50-90	SL	Fr
										C	90-105	SL	Fr
GM4265JJ	29-Jul-14	685013	5508840	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	6-0	-	-
										Ae	0-14	FSL	Fr
										Bm	14-34	SL	Fr
GM4239PM	28-Jul-14	684815	5508170	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LF	2-0	-	-
										Ae	0-47	SL	Fr
										Bt	47-60	CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4228PM	28-Jul-14	684913	5507931	C1	Inclined	R	Chernozemic	O.BLC	MSBco	Ah	0-10	SL-L	Fr
										Bm	10-38	SL	Fr
										BC	38-66	SL	Fr
GM4620PM	25-Jul-14	684957	5505235	C3	Terraced	P	Gleysolic	R.HG	HCXaazh	LF	1-0	-	-
										Ah	0-12	L	Fr
										C	12-40	SL	Fr
										Cg	40-90	SL	NS
GM4452JJ	30-Jul-14	687884	5506523	C1	Terraced	R	Regosolic	CU.HR	TBRaazz	LFH	18-0	-	-
										Ck	0-8	FSL	Fr
										Ahkb	8-12	FSL	Fr
										Ck	12-80	SL	Fr
GM4445PM	30-Jul-14	688278	5506705	C3	Inclined	I	Regosolic	CU.R	PPXaa	LFH	3-0	-	-
										Ah	0-6	SL	VFr
										AC	6-16	SL	VFr
										Ahb	16-29	SL	VFr
										ACK	29-40	SL	VFr
										Ahkb	40-56	SL	VFr
GM4450PM	30-Jul-14	688059	5507450	C1	Inclined	R	Brunisolic	O.EB	MGVzz	Ck	56-70	SL	VFr
										LFH	3-0	-	-
										Bmk	0-20	SL	Fr
										BCK	20-45	SL-L	Fr
GM4450PM	30-Jul-14	688059	5507450	C1	Inclined	R	Brunisolic	O.EB	MGVzz	Ck	45-100	SL-L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4434PM	30-Jul-14	688370	5507055	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	2-0	-	-
										Ae	0-20	SL	Fr
										Bt	20-45	CL	VFi
GM4908PM	06-Sep-14	686537	5506874	C1	Inclined	W	Brunisolic	O.SB	FVXaazztk	LF	5-0	-	-
										Ah	0-14	SL-L	Fr
										Bm	14-55	SL-L	Fr
										C	55-100	SL	Fr
GM4901PM	06-Sep-14	686849	5507714	L7	Inclined	R	Brunisolic	E.DYB	CPXaazz	LF	2-0	-	-
										Ae	0-2	SL	Fr
										Bm	2-20	SL-L	Fr
										C	20-45	SL	Fr
										R	45-100	-	-
GM4896PM	06-Sep-14	686743	5507957	C0	Inclined	R	-	-	ZDL	C	0-100	SL	Lo
GM4893PM	06-Sep-14	686947	5508317	C1	Inclined	W	Brunisolic	O.DYB	FVXaazz	Bm	9-34	SL-L	Fr
										C	34-70	SL-L	Fr
										LF	3-0	-	-
										Ah	0-9	SL-L	Fr
GM4889PM	06-Sep-14	686860	5508717	-	Hummocky	R	Regosolic	O.R	ZDL	C	0-100	variable	Fr
GM4879PM	06-Sep-14	686997	5508969	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LF	1-0	-	-
										Ae	0-9	SL	Fr
										Bm	9-47	SL	Fr
										C	47-100	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4905PM	06-Sep-14	686554	5507250	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	Bm	7-40	SL	Fr
										C	40-150	SL	Fr
										R	150-151	-	-
										LFH	6-0	-	-
										Ah	0-7	SL	Fr
GM4814RH	07-Sep-14	687454	5510663	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	1-0	-	-
										Bm	0-52	LS	Lo
										BC	52-86	SL	Fr
										C	86-100	SL	Fr
GM4830PM	07-Sep-14	687756	5510262	M4	Inclined	MW	Chernozemic	R.BLC	DVGaazr	Ah	0-39	L	Fr
										AC	39-70	L	Fr
										Cgj	70-100	L	Fr
GM4878PM	07-Sep-14	687789	5508995	C1	Terraced	R	Regosolic	O.R	TBRaazz	LFH	3-0	-	-
										C1	0-11	LS	Lo
										C2	11-45	LS	Lo
GM4897PM	07-Sep-14	687604	5508018	C5	Inclined	R	Brunisolic	O.DYB	MLXaazz	LFH	2-0	-	-
										Bm	0-20	SL	Fr
										C	20-100	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4873PM	07-Sep-14	687179	5509307	L6	Inclined	W	Brunisolic	E.EB	BPEzzxt	LFH	2-0	-	-
										Ae	0-9	SL	Fr
										Bm	9-24	SL	Fr
										Btj	24-45	CL	Fr
										R	45-46	-	-
GM4870PM	07-Sep-14	687017	5509485	-	Inclined	R	Regosolic	O.R	ZDL	C	0-100	LS	Lo
GM4883PM	07-Sep-14	686795	5508974	M1	Inclined	-	Chernozemic	R.BLC	PPEaazr	Ah	0-43	L	Fr
										C	43-100	L	Fr
GM4915PM	08-Sep-14	684181	5503923	L3	Terraced	I	Gleysolic	O.HG	POTcoxt	Ah	0-28	L	Fr
										Btj	28-45	CL	Fr
										IIBCg	45-75	CL	Fi
										IICgj	75-110	CL	Fi
GM4805PM	08-Sep-14	684201	5511169	L19	Inclined	R	Brunisolic	O.DYB	HEXaa	LFH	3-0	-	-
										Bm	0-16	L	Fr
										BC	16-65	L-SL	Fr
										R	65-66	-	-
GM4806PM	08-Sep-14	684474	5510977	L7	Inclined	R	Brunisolic	O.DYB	CPXaa	LFH	2-0	-	-
										Bm	0-13	SL	Fr
										BC	13-48	SL	Fr
										R	48-58	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4850PM	08-Sep-14	685379	5509893	M1	Inclined	W	Brunisolic	O.EB	MGVzz	LFH	3-0	-	-
										Bm	0-8	SL-L	Fr
										Btj	8-45	L	Fr
										C	45-90	L	Fr
GM4861PM	08-Sep-14	682390	5508294	L6	Inclined	W	Luvisolic	BR.GL	TUCzb	LFH	3-0	-	-
										Bm	0-25	SL	-
										Bt	25-60	CL	-
										R	60-61	-	-
GM4864PM	08-Sep-14	682259	5507496	C1	Terraced	R	Brunisolic	E.EB	MGV	LFH	5-0	-	-
										Ahjej	0-12	L	Fr
										Btj	12-27	SL-SCL	Fr
										C	27-45	SL-SCL	Fr
GM4860PM	08-Sep-14	682880	5508348	M4	Inclined	I	Luvisolic	GLD.GL	LTCgl	LFH	6-0	-	-
										Ahe	0-23	L-CL	Fr
										Bt	23-39	CL-C	Fi
										Cgj	39-100	FSCL	Fi
GM4865PM	08-Sep-14	683132	5507581	L2	Inclined	R	Brunisolic	E.EB	CONxt	LFH	5-0	-	-
										Ae	0-7	SL	Fr
										Bm	7-17	SL	Fr
										C	17-85	SL	Fr
										IIC	85-100	SCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4867PM	08-Sep-14	683579	5506812	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	2-0	-	-
										Ah	0-4	SL-L	Fr
										Ae	4-17	SL-L	Fr
										Bt	17-30	CL	Fr
										BC	30-80	SCL	Fr
										Ck	80-100	SCL	Fr
GM4916PM	08-Sep-14	684120	5504016	M4	Inclined	W	Luvisolic	D.GL	LTC	Ah	0-8	SL-L	Fr
										Ae	8-17	SL-L	Fr
										Bt	17-30	CL	Fi
										Ck	30-100	CL	Fi
GM4133VL	25-Jul-14	685419	5505244	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ahe	0-4	L	Fr
										Ae	4-19	L	VFr
										Bt	19-43	CL	Fi
										Ck	43-89	L	Fr
GM4134VL	25-Jul-14	685390	5505480	L5	Terraced	W	Brunisolic	O.EB	-	LFH	12-0	-	-
										Ah	0-8	FSL	Fr
										Bm	8-44	L	Fr
										IIBC	44-85	L	Fr
GM4135JJ	25-Jul-14	685495	5505628	M1	Inclined	W	Brunisolic	O.MB	FRKtk	Ah	0-11	L	Fr
										Bm	11-55	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4136JJ	25-Jul-14	685516	5505756	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	11-0	-	-
										Ae	0-14	L	Fr
										Bm	14-33	L	Fr
										C	33-100	L	Fr
GM4137RH	25-Jul-14	685486	5505905	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	1-0	-	-
										Ae	0-5	L	Fr
										Bm	5-50	L	Fr
GM4138VL	25-Jul-14	685500	5505389	M5	Inclined	R	Brunisolic	O.DYB	CDMaazz	LFH	5-0	-	-
										Ah	0-5	L	Fr
										Bm	5-25	L	Fr
										R	25-28	-	-
GM4139VL	25-Jul-14	585074	5505074	M4	Inclined	W	Luvisolic	O.GL	SPRer	LFH	10-0	-	-
										Bt	0-45	CL	Fi
										BC	45-80	CL	Fi
										C	80-100	CL	Fi
GM4140VL	25-Jul-14	684917	5505880	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	9-0	-	-
										Ae	0-5	L	Fr
										Bt	5-55	CL	Fi
										Ck	55-90	SiL	Fr
GM4141VL	25-Jul-14	685434	5505390	M5	Inclined	R	Regosolic	O.HR	RDXaazhfi	Ah	0-12	L	VFr
										R	12-130	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4160JJ	25-Jul-14	685490	5505998	M1	Inclined	R	Brunisolic	E.DYB	FVXaafi	LFH	2-0	-	-
										Ae	0-5	L	Fr
										Bm	5-31	L	Fr
										C	31-80	L	Fr
GM4161JJ	25-Jul-14	685535	5506090	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	6-0	-	-
										Ae	0-8	L	Fr
										Bm	8-80	L	Fr
GM4162RH	26-Jul-14	685732	5506203	M1	Steep	W	Regosolic	O.R	RDXaafi	LF	2-0	-	-
										C1	0-24	SL	Fr
										C2	24-105	SCL	Fr
										Ck	105-200	SCL	Fr
GM4163JJ	26-Jul-14	685730	5506290	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	6-0	-	-
										Ae	0-13	FSL	Fr
										Bm	13-55	VFSL	Fr
GM4164RH	26-Jul-14	685751	5506399	-	Inclined	VR	-	-	-	R	-	-	-
GM4165JJ	26-Jul-14	685725	5506522	M1	Inclined	R	Brunisolic	O.DYB	FVXaazzfi	LFH	11-0	-	-
										Bm	0-50	VFSL	Fr
										C	50-60	VFSL	Fr
GM4166RH	25-Jul-14	685529	5506469	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	LFH	8-0	-	-
										Ah	0-9	L	Fr
										Bm	9-55	L	Fr
										C	55-65	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4167JJ	25-Jul-14	685483	5506441	M1	Inclined	R	Brunisolic	E.DYB	FVXaafi	Ah	0-8	L	Fr
										Ae	8-24	L	Fr
										Bm	24-75	L-SL	Fr
GM4169JJ	25-Jul-14	685455	5506224	M1	Inclined	R	Brunisolic	E.DYB	FVXaafi	LFH	5-0	-	-
										Ae	0-19	L	Fr
										Bm	19-50	L	Fr
GM4170JJ	25-Jul-14	685421	5506594	M0	Inclined	R	Brunisolic	O.DYB	FVXaazzfi	LFH	6-0	-	-
										Ah	0-6	L	Fr
										Bm	6-16	L-SL	Fr
										C	16-60	L	Fr
GM4171RH	25-Jul-14	685562	5506669	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	LFH	9-0	-	-
										Ahj	0-12	L	Fr
										Bm	12-62	L	Fr
										C	62-80	L	Fr
GM4172JJ	25-Jul-14	685624	5506629	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	7-0	-	-
										Ah	0-8	L	Fr
										Ae	8-22	FSL	Fr
										Bm	22-45	FSL	Fr
GM4173RH	25-Jul-14	685626	5506708	M1	Inclined	R	Brunisolic	E.DYB	FVXaafi	Ah	0-4	L	Fr
										Ae	4-20	L	Fr
										Bm	20-60	L	Fr
										C	60-80	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4174RH	25-Jul-14	685469	5506105	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	2-0	-	-
										Ae	0-26	L	Fr
										Bm	26-47	L	Fr
										C	47-90	L	Fr
GM4175RH	25-Jul-14	685520	5506281	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	8-0	-	-
										Ae	0-8	L	Fr
										Bm	8-40	SL	Fr
										C	40-95	SL	Fr
GM4176JJ	27-Jul-14	685724	5506971	M5	Inclined	R	Brunisolic	E.DYB	CDMaa	LFH	2-0	-	-
										Ae	0-10	L	Fr
										Bm	10-38	L	Fr
										BC	38-61	L	Fr
										C	61-80	L	Fi
GM4177JJ	27-Jul-14	685507	5506962	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	7-0	-	-
										Bm	0-25	L	VFr
										C	25-75	SL	Lo
GM4178JJ	27-Jul-14	685876	5506826	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	5-0	-	-
										Bm	0-9	FSL	Lo
										C	9-100	FSL	Lo
GM4179RH	26-Jul-14	685897	5506867	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	10-0	-	-
										Bm	0-35	SL	Fr
										C	35-60	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4180JJ	26-Jul-14	685984	5506936	-	Inclined	-	-	-	-	R	-	-	-
GM4181JJ	-	686046	5507038	-	-	-	-	-	-	R	-	-	-
GM4182RH	26-Jul-14	685935	5506992	-	Inclined	R	-	-	-	R	-	-	-
GM4183RH	26-Jul-14	685953	5507100	-	Inclined	-	-	-	-	R	-	-	-
GM4184RH	26-Jul-14	686074	5507204	-	Inclined	R	-	-	-	R	-	-	-
GM4185VL	27-Jul-14	686079	5507280	C1	Undulating	R	Brunisolic	O.DYB	FVXaazz	LFH	9-0	-	-
										Bm	0-43	VFSL	Lo
GM4186JJ	27-Jul-14	486175	5507449	-	Hummocky	R	-	-	ZDL	Min	0-50	L	Lo
GM4187JJ	27-Jul-14	685953	5507840	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	4-0	-	-
										Bm	0-12	FSL	VFr
										C	12-80	FSL	Lo
GM4188VL	27-Jul-14	685901	5507184	-	Inclined	-	-	-	-	R	0-100	-	-
GM4212DL	29-Jul-14	685505	5508017	-	Steep	VR	-	-	-	R	-	-	-
GM4213DL	29-Jul-14	685414	5508054	L19	Steep	VR	Regosolic	O.DYB	HEXaa	LFH	7-0	-	-
										Bm	0-29	VFSL	Fr
										R	-	-	-
GM4214DL	29-Jul-14	685371	5508201	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	7-0	-	-
										Ae	0-11	FSL	VFr
										Bm	11-38	FSL	VFr
										C	38-100	FSL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4215DL	29-Jul-14	685384	5508302	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	Ah	0-9	L	Fr
										Bm	9-31	VFSL	Fr
										C	31-80	FSL	Fr
GM4216DL	28-Jul-14	685550	5508275	-	Inclined	R	-	-	-	R	-	-	-
GM4217DL	28-Jul-14	685629	5508272	L19	Inclined	R	Brunisolic	E.DYB	HEXaa	LFH	2-0	-	-
										Ae	0-8	L	VFr
										Btj	8-30	VFSL	Fr
										R	30-31	-	-
GM4219VL	27-Jul-14	606140	5507596	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	5-0	-	-
										Ae	0-4	SiL	VFr
										Bm	4-26	FSL	Lo
										C	26-80	FSL	Lo
GM4220JJ	27-Jul-14	686000	5507656	C0	Inclined	R	Regosolic	O.R	RDXaazz	Ah	0-8	FSL	VFr
										R	8-30	-	-
GM4221VL	27-Jul-14	686048	5507680	L7	Inclined	R	Brunisolic	E.DYB	-	LFH	6-0	-	-
										Ae	0-4	L	VFr
										AB	4-9	FSL	VFr
										Bm	9-39	SL	VFr
										BC	39-75	SL	Lo
										IIC	75-90	SCL	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4222JJ	27-Jul-14	685826	5507743	L7	Inclined	R	Brunisolic	E.DYB	CPXaazz	LFH	5-0	-	-
										Ae	0-9	FSL	Fr
										Bm	9-49	FSL	Fr
										IIC	49-85	L	Lo
GM4223VL	27-Jul-14	685637	5507641	C0	Hummocky	R	Brunisolic	O.DYB	CPXaa	LFH	11-0	-	-
										Bm	0-15	FSL	VFr
										C	15-40	FSL	Lo
GM4240RH	29-Jul-14	684992	5508296	-	Inclined	VR	-	-	-	R	-	-	-
GM4241RH	29-Jul-14	685099	5508261	M6	Inclined	R	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-8	VFSL	VFr
										Bt	8-22	FSCl	Fr
										C	22-50	SCL	Fr
GM4242DL	28-Jul-14	685826	5508424	C6	Inclined	R	Regosolic	O.R	RDXaazz	Ah	0-1	SL	Fr
										C	1-6	SL	-
										R	6-10	-	-
GM4243DL	28-Jul-14	685932	5508452	L19	Inclined	R	Regosolic	O.R	RDXaafixl	C	0-50	VFSL	-
										R	50+	-	-
GM4244DL	28-Jul-14	685906	5508549	C1	Inclined	R	Regosolic	O.R	RDXaa	LFH	2-0	-	-
										Ah	0-5	SL	-
										C	5-65	SL	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4245DL	28-Jul-14	685999	5508593	C6	Steep	R	Brunisolic	O.DYB	CPXaa	Ah	0-3	SL	VFr
										Bm	3-5	SL	Fr
										R	5+	-	-
GM4246DL	28-Jul-14	685993	5508750	C6	Inclined	W	Regosolic	O.HR	RDXaazh	Ah	0-23	SL	VFr
										R	23+	-	-
GM4247DL	28-Jul-14	685963	5508816	C1	Inclined	R	Regosolic	O.R	RDXaa	LFH	4-0	-	-
										C	0-80	SL	Lo
GM4248DL	28-Jul-14	685590	5508399	L19	Inclined	R	Brunisolic	E.DYB	HEXaazz	LFH	10-0	-	-
										Ae	0-4	L	Fr
										Bm	4-16	FSL	Fr
										C	16-38	VFSL	Fr
										R	38+	-	-
GM4249DL	28-Jul-14	685647	5508567	C6	Inclined	R	Brunisolic	O.DYB	CPXaa	Ah	0-7	L	Fr
										Bm	7-24	FSL	Fr
										R	24+	-	-
GM4250DL	28-Jul-14	685553	5508576	M5	Inclined	W	Regosolic	O.R	RDXaazzfi	LFH	8-0	-	-
										C	0-25	SCL	-
										R	25+	-	-
GM4251DL	29-Jul-14	685417	5508481	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	8-0	-	-
										Ae	0-7	L	VFr
										Bm	7-29	VFSL	Fr
										C	29-70	FSL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4252DL	29-Jul-14	685391	5508663	C6	Inclined	R	Brunisolic	E.DYB	CPXaazz	LFH	2-0	-	-
										Ah	0-2	FSL	VFr
										Ae	2-7	FSL	VFr
										Bm	7-32	FSL	Fr
										C	32-65	FSL	Fr
										R	65+	-	-
GM4253DL	29-Jul-14	685512	5508656	C1	Steep	W	Brunisolic	E.DYB	FVXaa	LFH	8-0	-	-
										Ae	0-5	L	Fr
										Bm	5-31	FSL	Fr
										C	31-100	FSL	Fr
GM4254DL	29-Jul-14	685331	5508556	L19	Inclined	W	Brunisolic	O.MB	FRKtkxl	Ah	0-19	C	Fi
										Bm	19-40	CL	Fi
										R	40+	-	-
GM4255RH	29-Jul-14	685211	5508343	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-8	FSL	VFr
										Bt	8-20	SCL	Fr
										C	20-50	SCL	Fi
GM4256DL	29-Jul-14	685276	5508419	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-10	FSL	VFr
										Bt	10-30	FSCL	Fi
										C	30-70	CL	VFi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4257DL	29-Jul-14	685235	5508491	M4	Inclined	W	Brunisolic	O.DYB	WLBzz	Ah	0-7	L	Fr
										Bm	7-41	L	Fr
										C	41-75	CL	Fi
GM4377RH	30-Jul-14	687477	5506975	C6	-	R	Brunisolic	O.DYB	CPXaa	LFH	6-0	-	-
										Bm	0-5	SL	Fr
										R	5+	-	-
GM4379JJ	30-Jul-14	687672	5506276	L2	-	-	Luvisolic	O.GL	KKYaazlxt	LF	1-0	-	-
										Ae1	0-8	SL	Fr
										Ae2	8-32	SL	Fr
										IIBt	32-45	L	Fr
										IIC1	45-100	SL-L	Fr
										IIC2	100-120	SL-L	Fr
GM4382JJ	25-Jul-14	686393	5505338	M4	Inclined	W	Brunisolic	E.DYB	WLB	LFH	6-0	-	-
										Ae	0-21	L	Fr
										Bm	21-40	L	Fr
										C	40-100	L	Fr
GM4383JJ	26-Jul-14	686400	5505632	L7	Inclined	R	Regosolic	O.HR	RDXaaxtzb	Ah	0-11	L	Fr
										C	11-31	FSL	Fr
										R	31-40	-	-
GM4384JJ	24-Jul-14	686621	5505929	M1	Steep	W	Brunisolic	O.DYB	FVXaazzfi	Ah	0-7	L	Fr
										Bm	7-28	L	Fr
										C	28-46	L-SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4385JJ	25-Jul-14	686916	5505424	M1	Inclined	W	Brunisolic	O.SB	FVXaatkfi	Ah	0-10	L	Fr
										Bm	10-40	L	Fr
										C	40-60	L	Fr
GM4386RH	25-Jul-14	686859	5505395	L3	Inclined	W	Brunisolic	O.DYB	FVXfizzxt	Ah	0-8	L	Fr
										Bm	8-41	L	Fr
										IIC	41-70	CL	Fi
GM4388DL	26-Jul-14	687309	5504938	L7	Inclined	R	Brunisolic	O.DYB	CPXaa	Ah	0-7	LS	VFr
										Bm	7-40	LS	Lo
										R	40-41	-	-
GM4389DL	26-Jul-14	687086	5504752	M5	Hummocky	W	Brunisolic	O.DYB	CDMaazz	Ah	0-3	SiL	VFr
										Bm	3-12	SiL	VFr
										R	12-13	-	-
GM4390DL	24-Jul-14	687510	5504888	M6	Inclined	R	Brunisolic	E.DYB	WLB	LF	4-0	-	-
										Ae	0-5	FSL	VFr
										Bm	5-38	L	Fr
GM4391DL	26-Jul-14	687499	5504769	L2	Level	W	Brunisolic	O.EB	FRXaaxt	LFH	10-0	-	-
										Bm	0-22	FSL	VFr
										BCK	22-48	FSL	VFr
										IICk	48-80	SCL	Fi
GM4392DL	25-Jul-14	687169	5504334	C6	Inclined	R	Regosolic	O.R	RDXaazz	Ah	0-8	SL	VFr
										C1	8-21	SL	Lo
										C2	21-35	SL	Lo

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4393DL	24-Jul-14	687599	5504278	M1	Inclined	W	Regosolic	O.HR	NKNaagr	LFH	4-0	-	-
										Ah1	0-3	SL	VFr
										Ah2	3-12	SL	VFr
										C	12-40	SCL	Fi
GM4394DL	25-Jul-14	687514	5503665	M2	Level	R	Regosolic	O.R	PPXaazzfi	Ah	0-8	L	VFr
										C	8-90	L	Lo
GM4395DL	26-Jul-14	687509	5504433	L2	Level	W	Brunisolic	O.EB	FRXaaxt	LFH	3-0	-	-
										Ah	0-6	SiL	-
										Bm	6-27	L	-
										BCk	27-60	SL	-
										Ck	60-100	SCL	-
GM4396DL	25-Jul-14	687368	5504173	C2	Level	R	Regosolic	O.R	HDXaazz	Ah	0-7	LS	VFr
										Ck	7-30	LS	Lo
GM4397DL	25-Jul-14	687214	5503625	C1	Inclined	R	Brunisolic	E.DYB	CPXaazz	LFH	8-0	-	-
										Aej	0-5	SL	VFr
										Bm	5-30	SL	Fr
GM4398VL	29-Jul-14	685187	5501911	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	4-0	-	-
										Ae	0-7	SL	Fr
										Bm	7-22	FSL	Fr
										C	22-60	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4399VL	29-Jul-14	685386	5502023	M5	Inclined	W	Brunisolic	O.DYB	CDMaazz	LFH	4-0	-	-
										Bm1	0-8	SL	So
										Bm2	8-35	L	So
										BC	35-60	L	SHd
										C	60-75	L	SHd
GM4400VL	29-Jul-14	685436	5502518	M4	Hummocky	W	Luvisolic	O.GL	SPR	LFH	6-0	-	-
										Ae	0-13	L	So
										Bt	13-55	CL	Hd
										BC	55-70	SCL	Hd
GM4401VL	29-Jul-14	685223	5502553	L6	Inclined	W	Luvisolic	O.GL	TUC	LFH	5-0	-	-
										Ae	0-13	FSL	So
										Bt	13-51	SCL	Hd
										BC	51-75	SCL	Hd
										R	75-100	-	-
GM4402VL	29-Jul-14	685095	5502618	L6	Inclined	W	Luvisolic	O.GL	TUC	LFH	5-0	-	-
										Ae	0-10	SL	So
										Bt	10-43	L	Hd
										R	43-62	-	-
GM4404DL	23-Jul-14	686568	5503776	M6	Inclined	W	Luvisolic	D.GL	LTCgr	LFH	2-0	-	-
										Ahe	0-6	L	VFr
										Bt	6-50	CL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4405DL	24-Jul-14	686517	5504410	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	9-0	-	-
										Ae	0-6	FSL	VFr
										Bt	6-32	CL	Fi
										C	32-90	CL	Fi
GM4406DL	24-Jul-14	686684	5504273	M4	Inclined	W	Brunisolic	E.DYB	WLB	LFH	4-0	-	-
										Ae	0-2	L	VFr
										Btj	2-38	L	Fr
										BC	38-67	L	Fr
										C	67-90	L	Fi
GM4407DL	25-Jul-14	686288	5504881	C1	Hummocky	W	Brunisolic	O.EB	MGVzz	Ah	0-8	SL	VFr
										Bm	8-20	SL	VFr
										BC	20-30	SiL	Fr
GM4408DL	24-Jul-14	686267	5504675	L18	Inclined	MW	Chernozemic	GL.BLC	-	FH	2-0	-	-
										Ah	0-10	SiL	VFr
										AB	10-21	SiCL	Fr
										Bm	21-32	SCL	Fr
										BCgj	32-43	SCL	Fr
										IICkg	43-100	SL	SS
GM4410DL	27-Jul-14	686505	5505098	M4	Inclined	W	Brunisolic	E.EB	BPEzz	LFH	1-0	-	-
										Ae	0-18	VFSL	VFr
										Bm	18-48	L	Fr
										Ck	48-65	SCL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4411RH	25-Jul-14	686044	5505146	M1	-	W	Brunisolic	E.DYB	FVXaafi	Ah	0-5	L	Fr
										Ae	5-26	L	Fr
										Bm	26-50	L	Fr
GM4412DL	28-Jul-14	686198	5508940	L7	Inclined	W	Brunisolic	O.DYB	CPXaa	LFH	4-0	-	-
										Bm	0-9	SL	Fr
										C	9-45	SL	Fr
										R	45-50	-	-
GM4413DL	28-Jul-14	686151	5509119	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	3-0	-	-
										Ae	0-4	L	Fr
										Bm	4-20	L	Fr
										C	20-70	L	Fr
GM4414DL	28-Jul-14	686276	5509210	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	7-0	-	-
										Ae	0-4	L	Fr
										Bm	4-35	SL	Fr
										C	35-70	SL	Fr
GM4415DL	28-Jul-14	686439	5509185	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	3-0	-	-
										Bm	0-40	SL	Fr
										BC	40-75	SL	Fr
GM4420RH	25-Jul-14	686618	5505420	M5	Inclined	W	Brunisolic	O.EB	SKLzzfi	Ah	0-6	L	Fr
										Bm	6-22	L	Fr
										R	22+	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4421JJ	25-Jul-14	686670	5505330	M2	Hummocky	W	Brunisolic	E.DYB	FVXazzfi	LFH	4-0	-	-
										Ae	0-19	L	Fr
										Bm	19-85	L	Fr
										C	85-100	L	Fr
GM4422JJ	25-Jul-14	686786	5505288	M1	Inclined	W	Brunisolic	E.DYB	FVXazzfi	LFH	6-0	-	-
										Ae	0-20	L	Fr
										Bm	20-25	L	Fr
GM4424DL	25-Jul-14	685705	5503547	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	4-0	-	-
										Ae	0-2	CL	VFr
										Bt1	2-11	CL	Fr
										Bt2	11-45	SCL	Fi
										C	45-90	CL	Fi
GM4425DL	25-Jul-14	685497	5503611	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-6	SL	VFr
										Bt1	6-24	L	Fr
										Bt2	24-46	C	Fi
										C	46-100	CL	Fi
GM4426DL	24-Jul-14	686220	5504104	M4	Inclined	MW	Luvisolic	D.GL	LTC	LFH	2-0	-	-
										Ah	0-5	SiL	VFr
										Ahe	5-15	SiL	VFr
										Bt	15-44	SiCL	Fr
										Ckgj	44-80	SiCL	SS

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4427DL	24-Jul-14	686066	5503938	L12	Level	VP	Gleysolic	R.G	VLXaapt	Oh	0-30	-	-
										Cg	30-100	SiL	NS
GM4428VL	28-Jul-14	585491	5503388	L3	Undulating	W	Brunisolic	O.EB	FRXaafi	LFH	7-0	-	-
										Bm1	0-6	L	Fr
										Bm2	6-31	L	Fr
										BC	31-37	L	Fr
										IIBC	37-85	CL	Fi
										IICk	85-100	CL	Fi
GM4429VL	24-Jul-14	684294	5502121	M6	Inclined	W	Luvisolic	O.GL	SPRgrcr	LFH	3-0	-	-
										Aek	0-9	FSL	VFr
										Btk	9-41	CL	Fi
										Ck	41-49	L	Fr
GM4430VL	28-Jul-14	685270	5503298	L3	Inclined	W	Luvisolic	O.GL	ORCaaxter	LFH	5-0	-	-
										AB	0-16	SL	Fr
										Bt	16-42	L	Fr
										IIBC	42-70	L	Fr
GM4431VL	28-Jul-14	685087	5503073	M5	Inclined	R	Brunisolic	O.DYB	CDMaazz	LFH	6-0	-	-
										Bm	0-17	L	Fr
										R	17-30	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4432JJ	28-Jul-14	684679	5503134	M4	Inclined	R	Luvisolic	O.GL	SPR	LFH	9-0	-	-
										Ae	0-10	L	Fr
										Bt	10-52	SCL	Fi
										BC	52-70	SCL	VFi
GM4433JJ	30-Jul-14	687996	5506977	L6	Hummocky	W	Luvisolic	O.GL	TUC	LFH	9-0	-	-
										Ae	0-30	FSL	Fr
										Bt	30-40	CL	Fi
										R	40-41	-	-
GM4435DM	30-Jul-14	684653	5499928	M1	Inclined	R	Brunisolic	O.MB	FRKtk	Ah	0-20	L	Fr
										Bm	20-50	FSCL	Fr
										Ck	50-60	CL	Fr
GM4436DM	30-Jul-14	684654	5500121	C6	Inclined	R	Regosolic	O.R	RDXaazz	LF	1-0	-	-
										Ahj	0-15	FSL	Fr
										R	15-20	-	-
GM4437DM	30-Jul-14	684496	5500263	L6	Inclined	W	Luvisolic	D.GL	CCR	LFH	3-0	-	-
										Ahe	0-15	FSL	Fr
										Bt	15-40	CL	Fi
										R	40-41	-	-
GM4438DM	30-Jul-14	684525	5500418	M4	Inclined	R	Brunisolic	O.MB	BPEtk	Ah	0-15	L	Fr
										Bm	15-50	FSCL	Fr
										Ck	50-60	FSCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4439DM	29-Jul-14	684423	5500543	M4	Inclined	W	Luvisolic	D.GL	LTC	LF	6-0	-	-
										Ahe	0-9	SiL	Fr
										Bt	9-40	CL	Fi
										Ck	40-80	CL	Fi
GM4440DM	29-Jul-14	684117	5500401	M5	Inclined	R	Regosolic	O.HR	RDXaazhfi	Ah	0-27	L	VFr
										R	27-34	-	-
GM4441DM	29-Jul-14	684095	5500543	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	1-0	-	-
										Ae	0-11	SL	Fr
										Bt	11-35	SCL	Fr
										Ck	35-55	SCL	Fr
GM4442DM	30-Jul-14	684449	5499522	M5	Inclined	W	Brunisolic	O.DYB	CDMaazz	LF	1-0	-	-
										Ah	0-8	L	Fr
										Bm	8-23	SCL	Fr
										R	23-30	-	-
GM4443DM	30-Jul-14	684642	5499664	M6	Inclined	W	Brunisolic	E.DYB	WLB	LFH	1-0	-	-
										Ae	0-12	FSL	Fr
										Btj	12-50	SCL	Fi
										BC	50-75	SCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4444DM	30-Jul-14	684648	5499430	M4	Inclined	W	Luvisolic	O.GL	SPRcu	LF	1-0	-	-
										C	0-25	-	-
										Aeb	25-45	SL	Fr
										Btb	45-65	SCL	Fi
										Ck	65-85	SCL	Fi
GM4446PM	30-Jul-14	688161	5506478	C6	Inclined	W	Brunisolic	O.DYB	CPXaa	Ah	0-2	SL	Fr
										Bm	2-14	SL	Fr
										R	14-20	-	-
GM4447PM	30-Jul-14	688424	5506671	M6	Inclined	R	Luvisolic	O.GL	SPRgr	LFH	2-0	-	-
										Ae	0-36	SL	Fr
										Bt	36-64	CL	VFi
										BC	64-90	L-CL	VFi
GM4449JJ	30-Jul-14	688270	5507361	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	Ae	0-30	SL	VFr
										Bm	30-35	SL	VFr
GM4453DM	30-Jul-14	684656	5498796	C3	Inclined	R	Brunisolic	O.EB	CONzz	LF	1-0	-	-
										Ah	0-7	L	Fr
										Bm	7-45	FSL	Fr
GM4454DM	30-Jul-14	684716	5498998	M6	Inclined	W	Luvisolic	D.GL	LTCgr	LFH	1-0	-	-
										Ahe	0-8	L	Fr
										Bm	8-17	SL	Fr
										Bt	17-50	SCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4455DM	30-Jul-14	684581	5499148	C1	Inclined	W	Regosolic	O.HR	RDXaazh	LF	1-0	-	-
										Ah	0-25	SL	Fr
										Ck	25-45	SL	Fr
GM4461DM	29-Jul-14	683713	5500372	L12	Level	VP	Organic	T.M	MTF	Om	0-50	-	-
										Cg1	50-75	LFS	SS
										Cg2	75-100	CL	SS
GM4462VL	30-Jul-14	683097	5500841	M5	Hummocky	R	Brunisolic	O.DYB	CDMaazz	LFH	2-0	-	-
										Ah	0-3	L	Fr
										Bm	3-8	L	Fr
										R	8-30	-	-
GM4460DM	29-Jul-14	683551	5500644	C6	Inclined	R	Regosolic	O.R	RDXaazz	FH	1-0	-	-
										C	0-9	FSL	Fr
										R	9-20	-	-
GM4463VL	30-Jul-14	683040	5500495	M6	Hummocky	W	Luvisolic	O.GL	SPRgr	LFH	2-0	-	-
										Ae	0-12	FSL	Fr
										Bt	12-33	SCL	Fr
										BC	33-55	SCL	Fr
GM4464DM	29-Jul-14	683916	5500882	C6	Inclined	R	Regosolic	O.R	RDXaazz	LF	1-0	-	-
										C	0-17	FSL	Fr
										R	17-18	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4465DM	29-Jul-14	683729	5501560	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	4-0	-	-
										Ae	0-7	SiL	VFr
										Bt	7-30	CL	Fi
										Ck	30-70	SCL	Fi
GM4466DM	29-Jul-14	683649	5501410	M4	Inclined	W	Luvisolic	O.GL	SPR	LF	7-0	-	-
										Ae	0-30	SiL	Fr
										Bt	30-60	CL	Fi
										BC	60-100	CL	Fi
GM4467DL	23-Jul-14	686907	5503869	C3	Inclined	W	Chernozemic	R.BLC	PPEaaco	Ah	0-38	SL	VFr
										AC	38-100	SL	VFr
GM4468VL	30-Jul-14	683294	5501107	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	3-0	-	-
										Ae	0-8	FSL	Fr
										Bt	8-40	CL	Fi
										Ck	40-48	CL	Fi
GM4469DM	29-Jul-14	683867	5501250	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	2-0	-	-
										Ae	0-10	SL	VFr
										Bt	10-45	SCL	Fr
										Ck	45-65	FSCL	Fr
GM4470DM	29-Jul-14	684092	5501107	M6	Inclined	W	Regosolic	O.HR	GTXaazh	LFH	4-0	-	-
										Ahk	0-15	L	Fr
										Ck	15-50	SCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4471DM	29-Jul-14	684213	5501444	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-7	FSL	Fr
										Bt	7-40	CL	Fi
										Ck	40-55	FSCL	Fr
GM4472DM	29-Jul-14	684011	5501597	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LF	2-0	-	-
										Ae	0-10	SL	Fr
										Bt	10-30	SCL	Fr
										Ck	30-40	FSL	Lo
GM4473DM	29-Jul-14	684632	5501752	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-18	SiL	VFr
										Bt	18-40	CL	Fi
										Ck	40-80	CL	Fr
GM4474VL	29-Jul-14	685065	5502117	L8	Inclined	R	Brunisolic	O.EB	FRKcox1	LFH	7-0	-	-
										Ah	0-6	LS	VFr
										Bm	6-32	LS	VFr
										BC1	32-48	LS	Lo
										BC2	48-69	L	Fr
										R	69-80	-	-
GM4476VL	29-Jul-14	684606	5502148	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	3-0	-	-
										Ae	0-12	L	So
										Bt	12-65	SCL	Hd
										BC	65-100	CL	Hd

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4477JJ	28-Jul-14	684214	5502345	C6	Inclined	R	Brunisolic	O.DYB	CPXaa	LFH	2-0	-	-
										Ah	0-4	FSL	VFr
										AB	4-12	FSL	Fr
										Bm	12-22	FSL	Fr
										R	22-25	-	-
GM4478VL	28-Jul-14	684297	5502536	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-4	FSL	Fr
										Bt	4-26	CL	Fi
										Ck	26-75	L	Fr
GM4475VL	28-Jul-14	684339	5502066	C6	Inclined	-	Regosolic	O.HR	RDXaazh	Ahk	0-20	FSL	EHd
										R	20-21	-	-
GM4479JJ	28-Jul-14	684424	5502726	M6	Inclined	R	Brunisolic	O.EB	BPEgr	LFH	2-0	-	-
										Ahk	0-5	L	Fr
										Bmk	5-20	FSL	Fr
										Ck	20-40	L	Fr
GM4480VL	28-Jul-14	684477	5502866	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	10-0	-	-
										Ae	0-4	SL	Fr
										Bt	4-27	L	Fr
										Ck	27-85	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4481VL	28-Jul-14	684498	5503032	M4	Inclined	W	Luvisolic	BR.GL	SPRzb	LFH	4-0	-	-
										Ae	0-16	SL	So
										Bm	16-40	FSL	SHd
										Bt	40-80	CL	Fi
										Ck	80-100	CL	Fi
GM4482VL	30-Jul-14	684007	5503220	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-9	FSL	Fr
										Bt	9-26	SCL	Fi
										Ck	26-40	SCL	Fi
GM4483VL	28-Jul-14	684831	5503347	M5	Inclined	W	Regosolic	O.HR	RDXaazhfi	LFH	10-0	-	-
										Ah	0-10	L	Fr
GM4484VL	26-Jul-14	684238	5504339	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	4-0	-	-
										Bm	0-31	FSL	Fr
										C	31-52	FSL	Lo
GM4485VL	24-Jul-14	684944	5504840	C1	Level	-	Regosolic	O.R	HDXaazzco	LF	3-0	-	-
										C1	0-11	LS	Lo
										C2	11-50	LS	Lo
GM4486VL	25-Jul-14	684773	5505003	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	3-0	-	-
										Ae	0-8	SL-LS	VFr
										Bt	8-50	CL	Fi
										Ck	50-85	SCL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4487VL	24-Jul-14	684874	5504294	M6	Inclined	W	Brunisolic	O.MB	BPETkgr	LF	3-0	-	-
										Ah	0-17	CL	Fr
										AB	17-32	L	Fr
										Bm	32-55	L	Fr
										BC	55-65	L	Fr
GM4488VL	25-Jul-14	684189	5505506	L12	Inclined	VP	Organic	T.M	MTF	Om	0-45	-	-
										C	45-55	CL	SS
										Ckgj	55-100	CL	ST
GM4489VL	25-Jul-14	684303	5505480	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-7	SL	Fr
										Bt	7-55	SCL	Fi
										BC	55-100	SCL	Fi
GM4490VL	25-Jul-14	684630	5505171	M4	Steep	W	Luvisolic	O.GL	SPR	LFH	11-0	-	-
										Ae	0-10	SL	Fr
										Bt	10-60	CL	Fr
										BC	60-75	CL	Fr
GM4491VL	25-Jul-14	684454	5505346	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-22	SL	VFr
										Bt	22-60	SCL	Fr
										BC	60-100	CL	Fi
GM4492VL	25-Jul-14	684065	5505450	L12	Inclined	VP	Organic	T.M	MTF	Om	0-50	-	-
										Cg	50-100	CL	ST

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4520JJ	24-Jul-14	686705	5505838	M1	Inclined	R	Brunisolic	O.DYB	FVXaazzfi	LFH	5-0	-	-
										Bm	0-10	L	Fr
										C	10-100	L	Fr
GM4522RH	25-Jul-14	686746	5505405	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	Ah	0-3	L	Fr
										Ae	3-19	L	Fr
										Bm	19-44	L	Fr
GM4523DL	26-Jul-14	686819	5505145	M4	Terraced	W	Luvisolic	O.GL	SPR	LFH	4-0	-	-
										Ae	0-5	L	VFr
										Btj	5-17	CL	Fr
										BC	17-37	SCL	Fr
										C	37-75	SCL	Fi
GM4544RH	24-Jul-14	686642	5505866	C1	-	R	Brunisolic	E.DYB	FVXaa	LFH	7-0	-	-
										Ah	0-4	L	Fr
										Ae	4-14	SL	Fr
										Bm	14-45	SL	Fr
										C	45-85	SL	Fr
GM4553DM	28-Jul-14	682286	5506037	M4	Inclined	W	Brunisolic	O.EB	BPE	LFH	4-0	-	-
										Bm	0-40	CL	Fi
										BC	40-65	CL	Fi
										Ck	65-100	CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4554DM	28-Jul-14	682223	5505830	L3	Inclined	P	Gleysolic	HU.LG	WDCxt	LFH	6-0	-	-
										Ahg	0-18	L	Fr
										Btg	18-46	CL	Fr
										IICkg	46-100	CL	Fi
GM4558DM	28-Jul-14	682232	5505358	M6	Inclined	R	Gleysolic	O.G	CVXaazz	LF	27-20	-	-
										Oh	20-0	-	-
										Bm	0-10	SL	Fi
										Ckg	10-60	CL	Fi
GM4559DM	28-Jul-14	682257	5505584	M4	Inclined	W	Brunisolic	O.EB	BPE	LFH	5-0	-	-
										Bm	0-25	CL	Fi
										Ck	25-100	CL	Fi
GM4569DM	28-Jul-14	682363	5504878	L3	Level	P	Gleysolic	R.HG	WDCzrpt	LF	32-25	-	-
										Om	25-0	-	-
										Ah	0-50	CL	Fi
										IICg	50-95	CL	ST
GM4570DM	28-Jul-14	682228	5504880	M6	Inclined	-	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Bt	0-25	CL	Fi
										Ck1	25-45	SCL	Fr
										Ck2	45-100	SCL	Fi
GM4570JJ	27-Jul-14	685982	5507568	M5	Inclined	R	Brunisolic	O.DYB	CDMaazz	Ah	0-6	L	VFr
										Bm	6-24	L	VFr
										R	24-135	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4571DM	27-Jul-14	682642	5504680	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-12	FSL	Fr
										Bt	12-35	CL	Fi
										Ck	35-95	CL	Fi
GM4572DM	28-Jul-14	682821	5504698	M1	Inclined	R	Regosolic	O.HR	NKNaagr	Ah	0-21	L	VFr
										Ck	21-70	SCL	Fr
GM4573DM	27-Jul-14	683199	5504434	M4	Inclined	P	Gleysolic	O.HG	CVXaazh	Om	30-0	-	-
										Ahg	0-15	CL	ST
										Cg	15-90	SCL	ST
GM4574DM	27-Jul-14	682919	5504400	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	8-0	-	-
										Ae	0-13	L	Fr
										Bt	13-50	CL	Fi
										Ck	50-95	CL	Fi
GM4575DM	28-Jul-14	683180	5504877	M1	Inclined	W	Chernozemic	O.BLC	PPEaagr	Ah	0-17	L	VFr
										Bm	17-45	SCL	Fr
										C	45-100	L	Fr
GM4576DM	28-Jul-14	683328	5504633	C6	Inclined	-	Regosolic	O.R	RDXaazz	LFH	4-0	-	-
										C	0-6	FSL	VFr
										R	6-36	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4577DM	28-Jul-14	683562	5504729	M6	Inclined	-	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-16	FSL	Fr
										Bt	16-45	SCL	Fr
										BC	45-100	L	Fr
GM4578DM	27-Jul-14	683653	5503645	C6	Hummocky	R	Brunisolic	E.DYB	CPXaazz	LFH	6-0	-	-
										Ae	0-13	FSL	Fr
										Bm	13-25	FSL	Fr
										R	25-40	-	-
GM4579DM	27-Jul-14	683331	5503747	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	3-0	-	-
										Ae	0-11	FSL	Fr
										Bt	11-45	CL	Fi
										Ck	45-70	CL	Fi
GM4580DM	27-Jul-14	683450	5503666	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-7	FSL	Fr
										Bt	7-40	SCL	Fi
										Ck	40-100	SCL	Fi
GM4581DM	27-Jul-14	683759	5504260	M4	Inclined	R	Brunisolic	E.EB	BPEzz	LFH	4-0	-	-
										Ae	0-12	SiL	Fr
										Bm	12-50	FSL	Fr
										BC	50-95	SCL	Fi
										Ck	95-105	SCL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4582DM	27-Jul-14	684611	5503795	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	5-0	-	-
										Ae	0-12	SiL	Fr
										Bt	12-40	CL	Fi
										Ck	40-75	CL	Fi
GM4583DM	27-Jul-14	684173	5503730	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-13	FSL	Fr
										Bt	13-40	CL	Fi
										Ck	40-55	CL	Fi
GM4584DM	27-Jul-14	683897	5503726	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	6-0	-	-
										Ae	0-15	FSL	Fr
										Bt	15-45	CL	Fi
										Ck	45-85	SCL	Fi
GM4584VL	26-Jul-14	684293	5504537	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-16	SL	Fr
										Bt	16-40	SCL	Fr
										BC	40-85	SCL	Fi
GM4586VL	30-Jul-14	683855	5502487	M1	Inclined	W	Regosolic	O.HR	NKNaagr	Ahk	0-17	CL	Fr
										ACk	17-29	CL	Fi
										Ck	29-42	CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4587VL	30-Jul-14	684267	5503032	M5	Inclined	R	Brunisolic	O.DYB	CDMaazz	Ah	0-6	L	So
										Bm	6-25	L	So
										C	25-36	L	SHd
										R	36-41	-	-
GM4589DM	30-Jul-14	683176	5503070	M5	Inclined	R	Regosolic	O.HR	NKNaazhxl	Ah	0-25	L	VFr
										R	25-30	-	-
GM4591VL	30-Jul-14	684204	5505419	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	6-0	-	-
										Ae	0-6	L	Fr
										Bt	6-39	CL	Fi
										Ck	39-100	SCL	Fi
GM4595DM	27-Jul-14	684359	5503712	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-17	FSL	VFr
										Bt	17-40	CL	Fi
										Ck	40-50	CL	Fi
GM4596VL	26-Jul-14	684029	5504151	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	3-0	-	-
										Ae	0-14	LS	Fr
										Bt	14-47	SCL	Fi
										Ck	47-57	CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4597DM	27-Jul-14	684262	5503938	M4	Inclined	W	Chernozemic	O.BLC	DVGaa	LFH	6-0	-	-
										Ah	0-27	L	Fr
										Bt	27-50	CL	Fr
										BC	50-90	CL	Fi
										Ck	90-95	CL	Fi
GM4600VL	29-Jul-14	683805	5502155	M1	Inclined	W	Regosolic	O.R	NKNaagrt	Ahk	0-9	CL	Fr
										Ck	9-70	CL	Fr
GM4601DL	23-Jul-14	686556	5503960	M5	Inclined	W	Regosolic	O.HR	RDXaazhfi	LFH	2-0	-	-
										Ah	0-18	SiL	VFr
										R	18-22	-	-
GM4608VL	30-Jul-14	683407	5501755	M6	Undulating	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-5	FSL	Fr
										Bt	5-20	CL	Fi
										Ck	20-40	SCL	Fr
GM4616JJ	23-Jul-14	686417	5506043	M1	Inclined	R	Regosolic	O.BLC	PPEaaxg	Ah	0-55	L	Fr
										Bm	55-65	L	Fr
GM4609VL	30-Jul-14	683366	5501378	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-22	FSL	So
										Bt	22-46	CL	Hd
										Ck	46-55	CL	VHd

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4610VL	30-Jul-14	683521	5501974	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-12	FSL	VFr
										AB	12-25	SL-SCL	Fr
										Bt	25-55	CL	Fi
										Ck	55-60	CL	Fi
GM4611VL	29-Jul-14	683863	5502117	M4	Inclined	W	Luvisolic	O.GL	SPR	Ae	0-15	SL	SHd
										Bt	15-50	CL	VHd
										Ck	50-100	CL	Hd
GM4612VL	29-Jul-14	683757	5502185	L4	Terraced	R	Brunisolic	E.DYB	ERRaacoxxg	LFH	4-0	-	-
										Ae	0-5	SiL	So
										Bm	5-19	SL	So
										C	19-30	SL	Lo
										IIC	30-60	LS	Lo
GM4617RH	26-Jul-14	686223	5506461	L19	Inclined	R	Regosolic	O.HR	NKNaagrxl	Ah	0-14	L	Fr
										C	14-55	VFSL	Fr
										IIC	55-80	L	Fr
										IIR	80-110	-	-
GM4650VL	26-Jul-14	686267	5506558	L7	Inclined	R	Brunisolic	O.BLC	MSBcogr	Ah	0-24	SL	VFr
										AB	24-40	SL	VFr
										IIBm	40-58	SL	Fr
										IIC	58-75	SL	Fr
										IIIC	75-110	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4651VL	26-Jul-14	684727	5504733	M4	Inclined	W	Luvisolic	O.GL	SPR	LFH	2-0	-	-
										Ae	0-6	SiL	Fr
										Bt	6-25	CL	Fr
										BC	25-65	CL	Fi
										Ck	65-95	CL	Fi
GM4652VL	26-Jul-14	684625	5504581	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										AB	0-10	L	Fr
										Bt	10-40	SCL	Fi
										BC	40-50	CL	Fi
GM4653VL	26-Jul-14	684604	5504196	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	4-0	-	-
										Ae	0-10	L	Fr
										Bt	10-45	L	Fi
										Ck	45-100	L	Fi
GM4654DM	27-Jul-14	684620	5503600	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	7-0	-	-
										Ae	0-10	FSL	Fr
										Bt	10-25	SCL	Fr
										Ck	25-60	SCL	Fr
GM4655DM	29-Jul-14	684109	5501089	M6	Inclined	W	Luvisolic	D.GL	LTCgr	LFH	5-0	-	-
										Ahe	0-13	L	Fr
										Bt	13-30	SCL	Fr
										Ck	30-40	SCL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4660DM	29-Jul-14	683551	5500644	C6	Inclined	R	Regosolic	O.R	RDXaazz	LF	1-0	-	-
										C	0-9	FSL	Fr
										R	9-20	-	-
GM4668VL	30-Jul-14	683863	5502780	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-10	SL	VFr
										Bt	10-32	CL	Fi
										Ck	32-63	SCL	Fi
GM4669VL	30-Jul-14	683873	5503033	M6	Inclined	W	Luvisolic	O.GL	SPRgr	LFH	5-0	-	-
										Ae	0-9	FSL	Fr
										Bt	9-27	CL	Fi
										Ck	27-42	SCL	Fi
GM4271PM	29-Jul-14	685142	5508903	L7	Inclined	R	Chernozemic	O.DGC	-	Ahe	0-17	FSL	Fr
										Bm	17-34	FSL	Fr
										R	34-45	-	-
GM4494PM	24-Jul-14	685042	5505369	C2	Ridged	-	Brunisolic	E.EB	CON	LFH	4-0	-	-
										Ae	0-8	LS	Lo
										Bm	8-20	LS	Lo
										C	20-60	LS	Lo
GM4262PM	29-Jul-14	684630	5508545	C1	Terraced	R	Brunisolic	O.EB	MGVzz	LFH	3-0	-	-
										Bm	0-15	SL	Fr
										BC	15-34	SL	Fr
GM4190PM	27-Jul-14	685750	5507307	-	Inclined	VR	-	-	-	R	0-100	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4189PM	27-Jul-14	685808	5507378	-	Inclined	VR	-	-	-	R	0-100	-	-
GM4874JJ	06-Sep-14	686846	5509363	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	8-0	-	-
										Ae	0-8	L	Fr
										Bm	8-34	L	Fr
										BC	34-60	L-CL	Fr
GM4844JJ	06-Sep-14	686933	5509794	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	LFH	5-0	-	-
										Ae	0-10	L	Fr
										Bm	10-41	L	Fr
										BC	41-75	L	Fr
GM4832JJ	06-Sep-14	687198	5510143	L3	Inclined	MW	Brunisolic	O.MB	FRKtkxt	Ah	0-50	L	Fr
										Bm	50-70	L	Fr
										IIBC	70-85	CL	Fi
GM4839JJ	06-Sep-14	686766	5509937	M1	Inclined	W	Brunisolic	E.DYB	FVXaafi	Ae	0-22	L-CL	Fr
										Btj	22-40	CL	Fi
										BC	40-80	CL	Fi
GM4833JJ	06-Sep-14	687114	5510122	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	Bm	0-26	L	Fr
										C1	26-60	L	Fr
										C2	60-100	L	Fr
GM4835JJ	06-Sep-14	686972	5510156	L6	Inclined	W	Luvisolic	D.GL	CCR	Ah	0-35	L-CL	Fr
										Bt	35-80	CL	Fi
										IIC	80-100	L	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4843JJ	06-Sep-14	687036	5509885	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	Ah	0-9	L	Fr
										Bm	9-30	SL	Fr
										C	30-75	SL	Fr
GM4845JJ	06-Sep-14	686867	5509763	-	Inclined	-	-	-	-	R	0-100	-	-
GM4875JJ	06-Sep-14	686826	5509242	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	Bm	0-22	L	Fr
										C	22-70	L	Fr
GM4849JJ	06-Sep-14	686744	5509636	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	Bm	0-39	L-SL	Fr
										C	39-80	L-SL	Fr
GM4809JJ	07-Sep-14	686464	5511304	L7	Inclined	W	Regosolic	O.R	RDXaaxl	LFH	7-0	-	-
										Ae	0-3	SL	Fr
										Bm	3-7	SL	Fr
										C	7-30	SL	Fr
										R	30-35	-	-
GM4815JJ	07-Sep-14	686358	5510693	M6	Hummocky	MW	Brunisolic	E.DYB	WLB	LFH	3-0	-	-
										Ae	0-4	L	Fr
										Bm	4-13	L	Fr
										C	13-40	L-CL	Fr
GM4827JJ	07-Sep-14	686133	5510348	L3	Inclined	P	Gleysolic	R.HG	VLXaazhxt	Ah	0-25	L-CL	SS
										Cg	25-60	CL	ST
										IICg	60-100	CL	ST

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4882JJ	07-Sep-14	686514	5508995	L19	Inclined	R	Chernozemic	O.BLC	MSBgr	Ah	0-15	L	Fr
										Bm	15-43	L	Fr
										C	43-79	CL	Fr
										R	79-85	-	-
GM4838JJ	07-Sep-14	686691	5510070	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LFH	3-0	-	-
										Bm	0-9	L	Fr
										C	9-70	SL	Fr
GM4828JJ	07-Sep-14	686367	5510397	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	Bm	0-15	SL	Fr
										C	15-50	L-SL	Fr
GM4811JJ	07-Sep-14	687199	5511440	L19	Inclined	R	Brunisolic	O.DYB	HEXaa	Bm	0-28	L	Fr
										C	28-90	L	Fr
										R	90-100	-	-
GM4881JJ	07-Sep-14	686718	5509151	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	Bm	0-13	SL	Fr
										C	13-90	SL	Fr
GM4821JJ	08-Sep-14	688977	5510495	C6	Hummocky	R	Regosolic	O.R	RDXaazz	LFH	4-0	-	-
										C	0-5	SL	Fr
										R	5-100	-	-
GM4912JJ	08-Sep-14	684535	5503689	M6	Hummocky	W	Luvisolic	D.GL	LTCgr	Ah	0-7	L	Fr
										Ae	7-10	L	Fr
										Bt	10-27	CL	Fi
										C	27-50	L-SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4911JJ	08-Sep-14	684473	5503859	M6	Hummocky	W	Luvisolic	D.GL	LTCgr	LFH	2-0	-	-
										Ah	0-5	L	Fr
										Bt	5-29	CL	Fr
										BC	29-42	CL	Fr
										Ck	42-60	L	Fr
GM4825JJ	08-Sep-14	683435	5510095	L7	Inclined	VR	Brunisolic	E.DYB	CPXaazz	LFH	3-0	-	-
										Ae	0-5	SL	Fr
										Bm	5-13	LS	Fr
										BC	13-20	SL	Fr
										C	20-34	SL	Fr
										R	34-100	-	-
GM4823JJ	08-Sep-14	682844	5510247	L18	Inclined	W	Luvisolic	D.GL	LTCgrxs	LFH	6-0	-	-
										Ahe	0-8	L	Fr
										Bt	8-34	CL	Fi
										IIC	34-70	SL	Fr
GM4856JJ	08-Sep-14	683329	5509068	C1	Inclined	R	Brunisolic	E.EB	MGV	LFH	3-0	-	-
										Ae	0-4	L	Fr
										Bm	4-38	SL	Fr
										C	38-100	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4824JJ	08-Sep-14	682931	5509860	C1	-	W	Regosolic	O.R	PPXgr	LFH	5-0	-	-
										Ahj	0-12	L	Fr
										C1	12-27	SL	Fr
										C2	27-50	SL	Fr
GM4802JJ	08-Sep-14	682542	5510689	C1	Terraced	W	Brunisolic	O.EB	FRXaa	LFH	6-0	-	-
										Bm	0-50	SL-LS	Lo
										C	50-60	SL-LS	Lo
GM4854JJ	08-Sep-14	682883	5509469	L3	Hummocky	P	Gleysolic	O.LG	SKYaa	LFH	1-0	-	-
										Btg	0-40	CL	ST
										BCg	40-63	CL	ST
										IICg	63-105	L-CL	SS
GM4880RH	07-Sep-14	686921	5509073	C1	Inclined	R	Regosolic	O.HR	RDXaazh	LFH	1-0	-	-
										Ah	0-24	SL	Fr
										C	24-65	SL	Fr
GM4902RH	06-Sep-14	686777	5507619	L7	Ridged	W	Brunisolic	E.DYB	CPXaazz	LFH	1-0	-	-
										Ae	0-3	SL	Fr
										Bm	3-31	SL	Fr
										IIC	31-67	-	Fr
										R	67-100	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4886RH	06-Sep-14	687104	5508851	M4	Inclined	-	Luvisolic	O.GL	SPRcu	LF	1-0	-	-
										Ae	0-14	SL	Fr
										LFHb	14-18	-	-
										Aeb	18-37	L	Fr
										Btb	37-64	SCL	Fr
										C	64-90	SCL	Fr
GM4888RH	06-Sep-14	687030	5508644	C1	Inclined	R	Brunisolic	O.DYB	TZXaazz	LFH	2-0	-	-
										Bm	0-36	SL	Fr
										C	36-55	SL	Fr
GM4890RH	06-Sep-14	686773	5508596	C1	Inclined	W	Brunisolic	O.DYB	FVXaazz	LFH	3-0	-	-
										Bm	0-47	SL	Fr
										C	47-85	SL	Fr
GM4891RH	06-Sep-14	686819	5508416	-	Inclined	VR	-	-	-	coal	0-60	-	-
										waste	60+	-	-
GM4892RH	06-Sep-14	686789	5508285	-	Inclined	R	-	-	-	coal	0-60	-	-
										waste	60+	-	-
GM4895RH	06-Sep-14	686785	5508155	-	Steep	VR	-	-	-	coal	0-60	-	-
										waste	60+	-	-
GM4899RH	06-Sep-14	686680	5507809	L7	Inclined	R	Brunisolic	O.DYB	CPXaazz	LFH	1-0	-	-
										Ah	0-4	VFSL	Fr
										Bm	4-54	L-SL	Fr
										IIC	54-95	SL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4900RH	06-Sep-14	686754	5507737	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	LFH	1-0	-	-
										Ae	0-20	SL	Fr
										Bm	20-45	SL	Fr
										C	45-100	SL	Fr
GM4903RH	06-Sep-14	686810	5507502	L19	Inclined	W	Chernozemic	R.BLC	MSBzrgr	LFH	2-0	-	-
										Ah	0-17	L	Fr
										AC	17-52	SL-L	Fr
										R	52+	-	-
GM4904RH	06-Sep-14	686650	5507396	C1	Inclined	R	Brunisolic	O.DYB	FVXaazz	LF	3-0	-	-
										Ah	0-4	SL	Fr
										Bm	4-34	SL	Fr
										C	34-60	SL	Fr
GM4906RH	06-Sep-14	686581	5507039	C1	Inclined	W	Brunisolic	O.SB	FVXaazztk	LFH	9-0	-	-
										Ah	0-13	L	Fr
										Bm	13-42	SL	Fr
										C	42-80	SL	Fr
GM4907RH	06-Sep-14	686684	5506921	M5	Inclined	R	Regosolic	O.HR	NKNaagr	Ah	0-11	L	Fr
										R	11-45	-	-
GM4819RH	08-Sep-14	684481	5510515	L7	Inclined	W	Brunisolic	O.DYB	CPXaa	LFH	1-0	-	-
										Bm	0-17	SL	Fr
										C	17-57	FSL	Fr
										R	57-70	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4820RH	08-Sep-14	684223	5510623	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	LFH	4-0	-	-
										Ae	0-13	SL	Fr
										Bm	13-25	SL	Fr
GM4818RH	08-Sep-14	684948	5510554	L7	Inclined	W	Brunisolic	E.DYB	CPXaazz	LFH	1-0	-	-
										Ahe	0-3	SL	Fr
										Bm1	3-18	SL	Fr
										Bm2	18-35	SL	Fr
										R	35-45	-	-
GM4826RH	08-Sep-14	684896	5510168	C6	Inclined	R	Brunisolic	O.DYB	CPXaa	LFH	1-0	-	-
										Bm1	0-9	SL	Fr
										Bm2	9-14	SL	Fr
										R	14-25	-	-
GM4851RH	08-Sep-14	684814	5509954	L7	Inclined	R	Regosolic	O.HR	RDXaazhxl	Ah	0-19	SL	Fr
										C	19-50	SL	Fr
										R	50-60	-	-
GM4855RH	08-Sep-14	682683	5508802	L12	Hummocky	P	Organic	T.H	MTFzz	LFH	5-0	-	-
										Oh	0-60	-	-
										Cg	60-80	SiCL	SS
GM4862RH	08-Sep-14	682425	5507943	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	LFH	6-0	-	-
										Ae	0-4	VFSL	Fr
										Bm	4-21	VFSL	Fr
										C	21-70	SL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4866RH	08-Sep-14	683427	5507141	C1	Hummocky	W	Brunisolic	E.EB	MGV	LFH	3-0	-	-
										Ae	0-3	L	Fr
										Bm	3-16	VFSL	Fr
										BC	16-32	VFSL	Fr
										C	32-65	VFSL	Fr
GM4868RH	08-Sep-14	683645	5506332	M6	Inclined	W	Brunisolic	O.DYB	WLBzz	LFH	6-0	-	-
										Bm	0-21	CL	Fr
										Btj	21-31	CL	Fr
										C	31-60	CL	Fr
GM4909RH	08-Sep-14	684563	5504127	M6	Inclined	W	Luvisolic	BR.GL	SPRzbgr	LFH	3-0	-	-
										Ahe	0-4	L	Fr
										Bm	4-44	SL	Fr
										Bt	44-60	SCL	Fi
GM4829RH	07-Sep-14	687376	5510356	M6	Steep	W	Chernozemic	R.BLC	DVGaazrgr	LFH	4-0	-	-
										Ah	0-40	CL	Fr
										C	40-70	CL	Fr
GM4831RH	07-Sep-14	687507	5509958	C2	Terraced	W	Regosolic	O.HR	TBRaaccozz	LFH	4-0	-	-
										Ah	0-29	LS	Lo
										Ck	29-55	LS	Lo
GM4872RH	07-Sep-14	687615	5509247	M6	Inclined	W	Brunisolic	O.DYB	WLBzz	LFH	7-0	-	-
										Bm	0-19	CL	Fr
										C	19-60	CL	Fr

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4887RH	07-Sep-14	687594	5508539	M6	Inclined	W	Brunisolic	O.DYB	WLBzz	LFH	5-0	-	-
										Bm	0-35	SCL	Fr
GM4863RH	08-Sep-14	683139	5507960	C6	Inclined	R	Brunisolic	E.DYB	CPXaazz	LF	4-0	-	-
										Ae	0-6	SL	Fr
										Bm	6-27	SL	Fr
										R	27-40	-	-
GM4898RH	07-Sep-14	687757	5507831	M6	Inclined	W	Brunisolic	O.EB	BPEgrca	LFH	4-0	-	-
										Bmk	0-45	L	Fr
										Ck	45-100	CL	Fr
GM4894RH	07-Sep-14	687362	5508262	L6	Inclined	R	Luvisolic	BR.GL	TUCzb	LFH	2-0	-	-
										Bm	0-29	SL	Fr
										Bt	29-74	CL	Fr
										R	74-100	-	-
GM4871RH	07-Sep-14	687156	5509496	-	Inclined	VR	-	-	ZDL	C	0-60	-	-
GM4877RH	07-Sep-14	687168	5509120	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	1-0	-	-
										Ae	0-2	L	Fr
										Bm	2-41	L	Fr
										C	41-100	SL	Fr
GM4876RH	07-Sep-14	686990	5509228	-	Undulating	VR	-	-	ZDL	C	0-60	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4885RH	07-Sep-14	686709	5508819	M2	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	LFH	2-0	-	-
										Ah	0-9	L	Fr
										Bm	9-38	L-CL	Fr
										C	38-100	L	Fi
GM4910RH	08-Sep-14	684505	5504007	M4	Inclined	W	Luvisolic	BR.GL	SPRzb	LFH	3-0	-	-
										Ahe	0-4	L	Fr
										Bm	4-28	SL	Fr
										Bt	28-50	SCL	Fr
GM4834DL	06-Sep-14	687095	5510198	M4	Inclined	W	Luvisolic	BR.GL	SPRzb	LFH	6-0	-	-
										Bm	0-15	L	Fr
										Ae	15-27	SiL	Fr
										Bt	27-53	SiCL	Fi
										BCgj	53-100	SiC	VFi
GM4840DL	06-Sep-14	606807	5509931	C1	Inclined	W	Brunisolic	E.DYB	FVXaa	LFH	8-0	-	-
										Ae	0-5	FSL	VFr
										Btj	5-12	FSCL	Fr
										BC	12-32	SL	-
GM4836DL	06-Sep-14	686977	5510031	C1	Inclined	R	Brunisolic	E.DYB	FVXaa	LFH	7-0	-	-
										Ae	0-13	SL	VFr
										Bm	13-38	SL	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4841DL	06-Sep-14	686927	5509863	C6	Inclined	W	Regosolic	O.HR	RDXaazh	LFH	5-0	-	-
										Ah	0-12	SL	Fr
										AC	12-22	SL	-
GM4846DL	06-Sep-14	686808	5509697	-	Inclined	VR	-	-	-	R	-	-	-
GM4848DL	06-Sep-14	686922	5509665	L6	Inclined	W	Brunisolic	E.DYB	CPXaazz	LFH	8-0	-	-
										Ae	0-4	FSL	Fr
										Bm	4-25	SL	Fr
										C	25-40	L	Fi
										R	40-41	-	-
GM4869DL	06-Sep-14	686908	5509562	L7	Level	W	Brunisolic	E.DYB	CPXaazz	LFH	3-0	-	-
										Ae	0-4	FSL	VFr
										Bm	4-24	SL	Fr
										C	24-45	L	Fi
										R	45-46	-	-
GM4842DL	06-Sep-14	686974	5509857	C1	Inclined	W	Brunisolic	O.SB	FVXaazztk	LFH	4-0	-	-
										Ah	0-16	FSL	Fr
										Bm	16-30	FSL	Fr
GM4822DL	08-Sep-14	683624	5510276	L19	Inclined	R	Brunisolic	E.DYB	HEXaazz	LFH	2-0	-	-
										Ae	0-5	SL	Fr
										Bm	5-21	CL	Fr
										BC	21-60	CL	Fr
										R	60-70	-	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4804DL	08-Sep-14	683226	5510447	C1	Inclined	-	Chernozemic	O.BLC	PPEaaco	Ah	0-18	SL	Fr
										Bm	18-60	SL	Fr
										C	60-80	SCL	Fr
GM4801DL	08-Sep-14	682418	5511096	M4	Inclined	W	Brunisolic	E.DYB	WLB	LFH	4-0	-	-
										Ae	0-8	SL	Fr
										Bm	8-21	SL	Fr
										C	21-75	CL	Fi
GM4803DL	08-Sep-14	682716	5510516	M6	Inclined	W	Brunisolic	E.DYB	WLB	LFH	3-0	-	-
										Ae	0-7	SL	Fr
										Bm	7-21	SL	Fr
										C	21-45	CL	Fr
GM4853DL	08-Sep-14	683629	5509435	M4	Inclined	W	Luvisolic	D.GL	LTCxg	LFH	10-0	-	-
										Ahe	0-25	SiC	Fi
										Bt	25-35	SiC	Fi
										C1	35-70	CL	Fi
										C2	70-80	CL	Fi
GM4857DL	08-Sep-14	683548	5508833	M4	Inclined	MW	Brunisolic	O.MB	BPEtk	LFH	3-0	-	-
										Ah	0-14	C	Fr
										Btj	14-38	L	Fi
										Cgj	38-100	CL	Fi

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4913DL	08-Sep-14	684255	5503693	M4	Inclined	W	Luvisolic	BR.GL	SPRzb	LFH	6-0	-	-
										Bm	0-20	SL	Fr
										Bt	20-35	SCL	Fr
										C	35-100	CL	Fi
GM4914DL	08-Sep-14	684066	5503695	M6	Inclined	W	Luvisolic	BR.GL	SPRzbgr	LFH	8-0	-	-
										Bm	0-12	SL	Fr
										Bt	12-32	SCL	Fr
										C	32-75	CL	Fr
GM4813DL	07-Sep-14	687494	5510900	C1	Inclined	R	Regosolic	O.R	PPXaazzgr	C	0-45	LS	Fr
GM4812DL	07-Sep-14	687396	5511097	M1	Inclined	W	Brunisolic	O.DYB	FVXaazzfi	LFH	7-0	-	-
										Bm1	0-17	L	Fr
										Bm2	17-42	-	Fr
										C	42-100	CL	Fr
GM4810DL	07-Sep-14	686828	5511545	L19	Inclined	W	Brunisolic	E.DYB	HEXaazz	LFH	4-0	-	-
										Ae	0-2	FSL	Fr
										Bm	2-25	L	Fr
										C	25-50	CL	Fr
										R	50-60	-	-
GM4816DL	07-Sep-14	686000	5510929	C6	Inclined	W	Brunisolic	O.DYB	CPXaa	LFH	3-0	-	-
										Bm	0-10	L	Fr
										R	10-35	FS	-

Table A-41 Site Inspection List for All Sites Collected within the Project Area for 2014

Site	Date	Easting	Northing	PM Group	Surface Expression	Drainage	Order	Subgroup	Series	Horizon	Depth	Texture	Consistence
GM4808DL	07-Sep-14	685685	5511346	L6	Inclined	W	Brunisolic	E.DYB	WLBxl	LFH	3-0	-	-
										Ae	0-2	FSL	VFr
										Bm	2-25	L	Fr
										C	25-48	CL	Fr
										R	48-75	-	-
GM4817DL	07-Sep-14	685231	5510658	M4	Inclined	MW	Luvisolic	D.GL	LTC	LFH	5-0	-	-
										Ahe	0-12	CL	Fr
										Bt	12-36	SiC	Fi
										C	36-80	CL-C	Fi
GM4837DL	07-Sep-14	686780	5510118	C1	-	R	Regosolic	O.R	PPXaacozz	C	0-30	SCL	Lo
GM4884DL	07-Sep-14	686442	5508883	C3	Steep	W	Chernozemic	O.BLC	PPEaaco	LFH	3-0	-	-
										Ah	0-11	SL	Fr
										AB	11-23	SL	Fr
										Bm	23-45	SL	Fr
										C	45-100	L	Fi
GM4847DL	07-Sep-14	687016	5509767	-	Inclined	W	-	-	ZDL	C	0-17	-	-
										R	17-25	-	-

APPENDIX B: SOIL MAP UNIT DESCRIPTIONS

1.0 INTRODUCTION – SOIL MAP UNITS

The soil map unit symbols used to describe the soil and terrain for the Project include a numerator and a denominator. The numerator describes the soil patterns; the patterns are based on the AGRASID Soil Model (ASIC 2013). The denominator describes the terrain in terms of surficial material, landform surface shape and topography. The terrain is composed of a group of letters and numbers, that provide information about the type of the surficial material (upper-case letters), surface expression (lower-case letters), and topographic slope class range given in brackets (*e.g. Ft (2-3)*). If one surficial material overlies another slash symbol was used (*e.g. Mv/Ri*).

The Soil Model is created by using one or two soil series symbols (*e.g., SPR and LTC*, displayed as SPLT) that are considered dominant (>50% coverage) or co-dominant in a polygon (>30% coverage). Additionally, a numbering system is applied (*e.g., FVX4*) that identifies patterns of significant soils (10-30% coverage) within a polygon. The following Soil Model numbers are used in the baseline mapping of the study area (adapted from ASIC, 2013):

- 1 soil map unit features significant soils that are either not identified in polygon or not strongly contrasting from dominant or co-dominant soils.
- 4 soil map unit feature significant soils that have Rego profiles are calcareous or eroded.
- 5 soil map unit feature significant finer textured soils than the dominant soil or co-dominant soils.
- 11 soil map unit features significant soils that have Rego profiles and significant soils that contain coarser textured profiles than the dominant or co-dominant soils.
- 16 soil map unit feature significant Chernozemic soils.
- 18 soil map unit features significant poorly drained soils and significant soils that contain finer textured profiles than the dominant or co-dominant soils.
- 20 soil map unit features significant¹ freely or imperfectly drained soils where the dominant or co-dominant soil types are poorly drained.

In this appendix, the 18 soil models (SMs) developed to describe the soil and terrain patterns of the Project area are summarized.

CON5 Soil Model Summary

Dominant Soil (> 60%)	Eluviated Eutric Brunisol – Connop (CON)
Significant Soils (10-30% ea.)	Orthic Gray Luvisol – Spruce Ridge-GR (SPRgr)
Common Surficial (Parent) Materials	Moderately coarse to very coarse textured glaciofluvial deposits; Gravelly, medium to moderately fine textured till
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 10 cm
Reclamation Suitability	Topsoil: P Upper subsoil: P
Terrain: Landform Model (Slope %)	Terraces made up of glaciofluvial deposits (2-9%)

CON5 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
CON5 FGt(3-4)	6.6	0.1	1.7	0.1
Totals	6.6	0.1	1.7	0.1

DNL1 Soil Model

Dominant Soil (> 60%)	Typic Mesisol – Darnell (DNL)
Significant Soils (10-30% ea.)	Terric Mesisol – Mitford (MTF)
Common Surficial (Parent) Materials	Fen peat >160 cm thick; Peat (40-159 cm) overlying moderately fine textured material
Estimated Soil Profile Thicknesses	Deep organics: 200 cm
Reclamation Suitability	Topsoil: O (F) Upper Subsoil: O
Terrain: Landform Model (Slope %)	Level, flat peatland (0-2%)

DNL1 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>DNL1</u> Ol(1-2)	16.2	0.4	15.8	1.0
Totals	16.2	0.4	15.8	1.0

FVCP16 Soil Model

Co-dominant Soil (> 30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa); Orthic Dystric Brunisol – Copper-AA (CPXaa)
Significant Soils (10-30% ea.)	Orthic Dark Brown Chernozem – Bellevue-CO (BEVco)
Common Surficial (Parent) Materials	Gravelly, moderately coarse textured, colluvial deposits; Moderately coarse textured weathered bedrock (residuum) or moderately coarse textured colluvium veneer overlying bedrock
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 0 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 15 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: G-F
Terrain: Landform Model (Slope %)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (30-100%)

FVCP16 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVCP16</u> Cw/Ri(7-8)	79.3	1.7	36.0	2.4
<u>FVCP16</u> Cw/Ri(8-9)	22.7	0.5	22.7	1.5
Totals	102.0	2.2	58.7	3.9

FVCP4 Soil Model

Co-dominant Soil (> 30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa); Orthic Dystric Brunisol – Copper-AA (CPXaa)
Significant Soils (10-30% ea.)	Orthic Regosol – Redoubt-AA (RDXaa)
Common Surficial (Parent) Materials	Gravelly, moderately coarse textured, colluvial deposits; Moderately coarse textured weathered bedrock (residuum) or moderately coarse textured colluvium veneer overlying bedrock; Gravelly moderately coarse to medium textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 25 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: G-F
Terrain: Landform Model (Slope %)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (9-100%)

FVCP4 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVCP4</u> Cw/Ri(5-6)	85.5	1.9	36.0	2.4
<u>FVCP4</u> Cw/Ri(6-7)	466.3	9.2	22.7	1.5
<u>FVCP4</u> Cw/Ri(7-8)	415	9.1	14.6	1.0
<u>FVCP4</u> Cw/Ri(8-9)	85.5	1.9	214.9	14.1
Totals	1,052.4	23.1	329.8	21.7

FVHE4 Soil Model

Co-dominant Soil (> 30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa); Orthic Dystric Brunisol – Heather-AA (HEXaa)
Significant Soils (10-30% ea.)	Orthic Regosol – Redoubt-AA (RDXaa)
Common Surficial (Parent) Materials	Gravelly, moderately coarse textured colluvial deposits; Gravelly, medium textured colluvial deposits overlying bedrock; Gravelly, moderately coarse to medium textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 5 cm Upper subsoil (B horizon): 20 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: F
Terrain: Landform Model (Slope %)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (9-70%)

FVHE4 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVHE4</u> Cw/Ri(5-7)	27.6	0.6	0	0
<u>FVHE4</u> Cw/Ri(7-8)	269.4	5.9	0.3	<0.1
Totals	297.0	6.6	0.3	<0.1

FVNK16 Soil Model

Co-dominant Soil (> 30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa); Orthic Humic Regosol – Nickerson-AA (NKNaa)
Significant Soils (10-30% ea.)	Orthic Dark Brown Chernozem – Bellevue-CO (BEVco)
Common Surficial (Parent) Materials	Gravelly, moderately coarse textured colluvial; Gravelly, medium to moderately fine textured colluvium or weathered bedrock (residuum); Moderately coarse textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 0 cm Topsoil (A horizon): 20 cm Upper subsoil (B horizon): 0 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: F
Terrain: Landform Model (Slope %)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (15-45%)

FVNK16 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVNK16</u> Cw/Ri(6-7)	28.9	0.6	24.1	1.6
Totals	28.9	0.6	24.1	1.6

FVRD5 Soil Model

Co-dominant Soil (> 30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa); Orthic Regosol – Redoubt-AA (RDXaa)
Significant Soils (10-30% ea.)	Orthic Dystric Brunisol – Heather-AA (HEXaa); Orthic Humic Regosol – Nickerson-AA (NKNaa)
Common Surficial (Parent) Materials	Gravelly, moderately coarse textured colluvial deposits; Gravelly, moderately coarse to medium texture colluvium or weathered bedrock (residuum); Gravelly, medium textured colluvial deposits overlying bedrock; Gravelly, medium to moderately fine textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 15 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: F
Terrain: Landform Model (Slope %)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (15-70%)

FVRD5 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVRD5</u> Cw/Ri(6-7)	32.0	0.7	32.0	2.1
<u>FVRD5</u> Cw/Ri(7-8)	346.0	7.6	311.8	20.5
Totals	378.0	8.3	343.8	22.6

FVX4 Soil Model

Dominant Soil (> 60%)	Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa)
Significant Soils (10-30% ea.)	Orthic Regosol – Redoubt-AA (RDXaa)
Common Surficial (Parent) Materials	Gravelly, moderately coarse textured colluvial deposits; Gravelly, moderately coarse to medium textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 5 cm Upper subsoil (B horizon): 25 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: F
Terrain: Landform Model (Slope %)	Colluvium blanket overlying bedrock (bedrock-controlled topography) (15-70%); Colluvium mantle of variable thickness over hummocky bedrock; bedrock outcrop may occur (9-45%); Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (9-30%)

FVX4 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVX4</u> Cb/Ri(6-7)	20.2	0.4	0	0
<u>FVX4</u> Cb/Ri(7-8)	186.4	4.1	32.1	2.1
<u>FVX4</u> Cw/Rh(5-7)	33.8	0.7	33.8	2.2
<u>FVX4</u> Cw/Ri(5-6)	7.7	0.2	0	0
Totals	248.1	5.4	65.9	4.3

FVXfi11 Soil Model

Dominant Soil (> 60%)	Eluviated Dystric Brunisol – Fairview Mountain-AA,FI (FVXaafi)
Significant Soils (10-30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA(FVXaa); Orthic Regosol – Redoubt-AA (RDXaa)
Common Surficial (Parent) Materials	Gravelly, medium textured colluvial deposits; Gravelly, moderately coarse textured colluvial deposits; Gravelly, moderately coarse to medium textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 25 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: F
Terrain: Landform Model (Slope %)	Colluvium mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrop may occur (15-70%)

FVXfi11 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>FVXfi11</u> Cw/Ri(6-7)	58.8	1.3	31.3	2.1
<u>FVXfi11</u> Cw/Ri(7-8)	316.8	7.0	122.6	8.1
Totals	375.6	8.3	153.9	10.2

HDFR18 Soil Model

Co-dominant Soil (> 30% ea.)	Cumulic Regosol – Hillsdale-AA (HDXaa); Eluviated Dystric Brunisol – Fairview Mountain-AA (FVXaa)
Significant Soils (10-30% ea.)	Eluviated Dystric Brunisol – Fairview Mountain-AA,FI (FVXaafi); Miscellaneous Gleysols
Common Surficial (Parent) Materials	Gravelly and non-gravelly, moderately to very coarse textured, stratified (L, SiL, SL, LS) fluvial deposits; Gravelly, moderately coarse textured colluvial deposits; Gravelly, medium textured colluvial deposits
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 0 cm Topsoil (A horizon): 5 cm Upper subsoil (B horizon): 5 cm
Reclamation Suitability	Topsoil: NA Upper Subsoil: U
Terrain: Landform Model (Slope %)	Fluvial plain (floodplain) (0-5%); Terraces made up of fluvial deposits (5-45%)

HDFR18 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>HDFR18</u> Fl(1-3)	114.6	2.5	3.5	0.2
<u>HDFR18</u> Ft(4-7)	34.9	0.8	0	0
Totals	149.5	3.3	3.5	0.2

HDTB18 Soil Model

Co-dominant Soil (> 30% ea.)	Cumulic Regosol – Hillsdale-AA (HDXaa); Gleyed Humic Regosol – Twin Bridges-AA (TBRaa)
Significant Soils (10-30% ea.)	Miscellaneous Gleysols
Common Surficial (Parent) Materials	Gravelly and non-gravelly, moderately to very coarse textured, stratified (L, SiL, SL, LS) fluvial deposits
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 0 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 10 cm
Reclamation Suitability	Topsoil: U Upper Subsoil: NA
Terrain: Landform Model (Slope %)	Fluvial deposits on slope (2-9%); Terraces made up of fluvial deposits (2-9%)

HDTB18 Soil Map Unit Distribution

Soil Map Unit	Extent of Project Area		Extent of Proposed Disturbance Area	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>HDTB18</u> Fi(3-4)	33.4	0.7	22.8	1.5
<u>HDTB18</u> Ft(3-4)	77.9	1.7	4.2	0.3
Totals	111.3	2.5	27.0	1.8

MTF20 Soil Model

Dominant Soil (> 60%)	Terric Mesisol – Mitford (MTF)
Significant Soils (10-30% ea.)	Miscellaneous Gleysols
Common Surficial (Parent) Materials	Peat overlying moderately fine textured material
Estimated Soil Profile Thicknesses	Deep organics: 50 cm
Reclamation Suitability	Topsoil: O (F) Upper Subsoil: NA
Terrain: Landform Model (Slope %)	Level, flat peatland (0-2%); Organic veneer over sloping morainal deposits of unknown thickness (more likely overlying bedrock) (2-15%)

MTF20 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>MTF20</u> Ol(1-2)	6.4	0.1	3.1	0.2
<u>MTF20</u> Ov/Mi(3-5)	4.4	0.1	0	0
Totals	10.8	0.2	3.1	0.2

NKRD1 Soil Model

Co-dominant Soil (> 30% ea.)	Orthic Humic Regosol – Nickerson-AA (NKNaa); Orthic Regosol – Redoubt-AA (RDXaa)
Common Surficial (Parent) Materials	Gravelly, medium to moderately fine textured colluvium or weathered bedrock (residuum); Gravelly, moderately coarse to medium textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 0 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 5 cm
Reclamation Suitability	Topsoil: P Upper Subsoil: NA
Terrain: Landform Model (Slope %)	Undifferentiated material (till, colluvium, or bedrock material) outcropping on a steep creek bank escarpment (30-100%)

NKRD1 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>NKRD1</u> Ui(7-9)	74.7	1.6	2.5	0.2
Totals	74.7	1.6	2.5	0.2

SPgrWL1 Soil Model

Co-dominant Soil (> 30% ea.)	Orthic Gray Luvisol – Spruce Ridge-GR (SPRgr); Eluviated Dystric Brunisol – Willoughby (WLB)
Common Surficial (Parent) Materials	Gravelly, medium to moderately fine textured till
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 25 cm
Reclamation Suitability	Topsoil: F Upper Subsoil: G-P
Terrain: Landform Model (Slope %)	Till blanket overlying bedrock (bedrock-controlled topography) (5-30%); Till mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrops may occur (9-45%)

SPgrWL1 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>SPgrWL1</u> Mb/Ri(4-5)	144.8	3.2	6.9	0.5
<u>SPgrWL1</u> Mb/Ri(5-6)	39.9	0.9	15.7	1
<u>SPgrWL1</u> Mw/Ri(5-6)	75.8	1.7	3.6	0.2
<u>SPgrWL1</u> Mw/Ri(5-7)	118.3	2.6	31.4	2.1
Totals	378.8	8.4	57.6	3.8

SPLT4 Soil Model

Co-dominant Soil (> 30% ea.)	Orthic Gray Luvisol – Spruce Ridge (SPR) Dark Gray Luvisol – Leighton Centre (LTC)
Significant Soils (10-30% ea.)	Orthic Regosol – Redoubt-AA (RDXaa)
Common Surficial (Parent) Materials	Medium to moderately fine textured till; Gravelly and non-gravelly, moderately fine textured till; Gravelly, moderately coarse to medium textured colluvium or weathered bedrock (residuum)
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 15 cm Upper subsoil (B horizon): 15 cm
Reclamation Suitability	Topsoil: G-F Upper Subsoil: F
Terrain: Landform Model (Slope %)	Till mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrops may occur (15-45%)

SPLT4 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>SPLT4</u> Mw/Ri(6-7)	109.5	2.4	2.4	0.2
Totals	109.5	2.4	2.4	0.2

SPR1 Soil Model

Dominant Soil (> 60%)	Orthic Gray Luvisol – Spruce Ridge (SPR)
Significant Soils (10-30% ea.)	Dark Gray Luvisol – Leighton Centre (LTC)
Common Surficial (Parent) Materials	Medium to moderately fine textured till; Gravelly and non-gravelly, moderately fine textured till
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 35 cm
Reclamation Suitability	Topsoil: F Upper Subsoil: F
Terrain: Landform Model (Slope %)	Till blanket overlying bedrock (bedrock-controlled topography) (9-45%); Till mantle of variable thickness over hummocky bedrock; bedrock outcrops may occur (5-30%)

SPR1 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>SPR1</u> Mb/Ri(5-6)	246.1	5.4	55	3.6
<u>SPR1</u> Mb/Ri(6-7)	60.4	1.3	16.1	1.1
<u>SPR1</u> Mw/Rh(4-6)	9.9	0.2	1.7	0.1
Totals	316.4	7.0	72.8	4.8

SPRgr1 Soil Model

Dominant Soil (> 60%)	Orthic Gray Luvisol – Spruce Ridge-GR (SPRgr)
Significant Soils (10-30% ea.)	Dark Gray Luvisol – Leighton Centre-GR (LTCgr)
Common Surficial (Parent) Materials	Gravelly, medium to moderately fine textured till; Gravelly and non-gravelly, moderately fine textured till
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 15 cm Upper subsoil (B horizon): 30 cm
Reclamation Suitability	Topsoil: F Upper Subsoil: P
Terrain: Landform Model (Slope %)	Till blanket overlying bedrock (bedrock-controlled topography) (9-45%); Till mantle of variable thickness over hummocky bedrock; bedrock outcrops may occur (15-70%); Till mantle of variable thickness over bedrock (bedrock-controlled topography); bedrock outcrops may occur (15-70%)

SPRgr1 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>SPRgr1</u> Mb/Ri(5-6)	135.7	3.0	21.4	1.4
<u>SPRgr1</u> Mb/Ri(6-7)	124.5	2.7	0	0
<u>SPRgr1</u> Mw/Rh(6-8)	26.9	0.6	8.6	0.6
<u>SPRgr1</u> Mw/Ri(6-7)	58.2	1.3	47.5	3.1
<u>SPRgr1</u> Mw/Ri(7-8)	17.8	0.4	6.1	0.4
Totals	363.1	8.0	83.6	5.5

TUCD1 Soil Model

Co-dominant Soil (> 30% ea.)	Orthic Gray Luvisol – Tough Creek (TUC); Eluviated Dystric Brunisol – Cadomin-AA (CDMaa)
Common Surficial (Parent) Materials	Medium textured till overlying bedrock; Medium textured weathered bedrock (residuum) or medium textured colluvium veneer overlying bedrock
Estimated Soil Profile Thicknesses	Surface litter/shallow organics: 5 cm Topsoil (A horizon): 10 cm Upper subsoil (B horizon): 25 cm
Reclamation Suitability	Topsoil: G-U Upper Subsoil: G
Terrain: Landform Model (Slope %)	Till veneer overlying bedrock (bedrock-controlled topography); bedrock outcrop are common (15-70%)

TUCD1 Soil Map Unit Distribution

Soil Map Unit	Extent of RSA		Extent of LSA	
	Extent (ha)	Percent (%)	Extent (ha)	Percent (%)
<u>TUCD1</u> Mv/Ri(6-7)	93.7	2.1	3.8	0.3
<u>TUCD1</u> Mv/Ri(7-8)	17.2	0.4	0.6	<0.1
Totals	110.8	2.4	4.4	0.3

APPENDIX C: RECLAMATION SUITABILITY SUMMARY INFORMATION

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Soil Quality Criteria Relative to Disturbance and Reclamation – Detailed Methodology and Assumptions

This assessment followed the *Soil Quality Criteria Relative to Disturbance and Reclamation Guidelines* as specified for the Eastern Slopes Region of Alberta (SQCWG 1987). The A, B, and C horizons of sampled profiles were assessed for all applicable parameters as provide in Table 10 of the SQCWG (1987). The materials have been rated for the suitability as root zone material for the eastern slopes region. Ratings categories of mineral soils included:

Good (G)	No or slight limitations that affect use as a plant growth medium.
Fair (F)	Moderate limitations that affect use but can be overcome by proper planning and good management.
Poor (P)	Severe limitations that make use questionable. This does not mean the material cannot be used, but rather careful planning and very good management is required; and
Unsuitable (U)	Chemical or physical properties are so severe reclamation would not be economically feasible or in some cases impossible (<i>i.e.</i> , special reclamation strategies must be implemented and land use may be severely restricted).

Each particular soil map unit within the Project Area was rated based on typical soil series and variants found within each map unit. Ratings were determined based on the following process:

1. Each series/variant within a map unit was rated using the aforementioned information sources and the proportion of occurrence in the map unit accounted for (co-dominant *vs.* significant).
2. The most limiting parameter for each soil series/variant identified the overall rating for that soil entity.
3. Map unit ratings were determined by selecting the dominant ratings class for all series/variants within each map unit. If two ratings classes appeared co-dominant, the overall rating for the map unit was displayed as a range of the two co-dominant ratings (*i.e.*, F-P).

The rating criteria used in this assessment is presented in [Table C-1](#). [Table C-1](#) is extracted from Table 10 in the SCWG (1987) document. [Table C-2](#) displays the ratings for all sampled profiles collected within the Project area, including organic profiles. Organic profiles were assessed through a review of pH, when available. “Organic soils should be considered for salvage and use as a soil conditioner. Origin, degree of decomposition and reaction will determine the suitability of these materials” (SQCWG 1987).

[Table C-2](#) serves as a complete list of profiles submitted for analytical, therefore, some of the organic profiles, although not rated were submitted for various other analysis.

Table C-1 Criteria for Evaluating the Suitability of Rootzone Material in the Eastern Slopes Region				
Rating Parameter	Good (G)	Fair (F)	Poor (P)	Unsuitable (U)
Reaction (pH) ¹	5.0-6.5	4.0-5.0 & 6.5-7.5	3.5-4.0 & 7.5-9.0	<3.5 and >9.0
Salinity (E.C.) ² (dS/m)	<2	2-4	4-8	>8
Sodicity (SAR) ²	<4	4-8	8-12	>12 ³
Saturation (%) ²	30-60	20-30, 60-80	15-20, 80-100	<15 and >100
Coarse Fragments ⁴ (% / Vol)	<30 ⁵ / <15 ⁶	30-50 ⁵ / 15-30 ⁶	50-70 ⁵ / 30-50 ⁶	>70 ⁵ / >50 ⁶
Texture	L, SiCL, SCL, SL, FSL	CL, SiC, VFSL, SC, SiC	S, LS, Si, C, HC	Bedrock
Moist Consistence	Very friable, Friable	Loose, Firm	Very firm	Extremely firm
CaCO ₃ Equivalent (%)	<2	5-20	20-70	>70

Table adapted from the *Soil Quality Criteria Relative to Disturbance and Reclamation Guidelines* as specified for the northern forest region of Alberta (SQCWG 1987).

¹pH values presented are most appropriate for trees, primarily conifers. Where reclamation objective is for other end land uses, such as erosion control, and where other plant species may be more important refer to the topsoil table of the Plains region.

²Limits may vary depending on plant species to be used

³Materials characterized by an SAR of 12 to 20 may be rated as Poor if texture is sandy loam or coarser and saturation % is less than 100.

⁴0.2 to 25 cm diameter fragments in the soil material.

⁵Matrix texture (modal) finer than sandy loam.

⁶Matrix texture (modal) sandy loam and coarser.

Table C-2 Soil Quality Working Group (1987) Soil Suitability Ratings for Sampled Soil Horizons within the Project Area

Site #	Soil Series	Horizon	Depth (cm)	pH	EC ¹ (dS/m)	SAR ²	Saturation (%)	Coarse Fragments (%vol.)	Texture	Reclamation Suitability Rating and Limitations ³
GM4085RH	FVXaa	LFH	20-0	5.9	-	-	-	-	-	GOOD
		Ae	0-9	5.3	0.08	0.2	54	30-50	Sandy Loam	POOR-6
		Bm	9-24	5.4	0.08	0.2	63	20-30	Sandy Loam	FAIR-4,6
		C	24-90	5.2	0.08	0.1	65	10-20	Sandy Loam	FAIR-4,6
GM4107JJ	CONfixlzz	Ah	0-9	6.8	0.64	<0.1	130	0	Loam	UNSUITABLE-4
		AB	9-23	7.1	0.23	0.1	104	0	Silt Loam	UNSUITABLE-4
		Bm	23-36	7.1	0.22	0.1	101	0	Silt Loam	UNSUITABLE-4
		R	36-50	-	-	-	-	-	Bedrock	UNSUITABLE-5
GM4111VL	BPEtkgr	Ah	0-15	7.4	0.99	<0.1	80	5-10	Sandy Loam	POOR-4
		AB	15-24	7.5	0.38	<0.1	62	30-40	Loam	POOR-1
		Bm	24-42	7.6	0.38	<0.1	53	30-40	Sandy Loam	POOR-1,6
		Ck	42-110	7.9	0.38	<0.1	55	40-50	Loam	POOR-1
GM4128VL	NKNaagr	LFH	5-0	6.5	-	-	-	-	-	GOOD
		Ah	0-10	6.4	0.48	<0.1	62	60-70	Loam	POOR-6
		C	10-100	5.7	0.09	0.1	51	70-80	Loam	UNSUITABLE-6
GM4130VL	MTF	Om	0-42	7.4	-	-	-	-	-	FAIR-1
		C	42-60	7.2	0.30	<0.1	90	<1	Loam	POOR-4
		Cg	60-90	7.0	0.43	0.1	79	5-10	Loam	FAIR-1,4,7
		R	90-91	-	-	-	-	-	Bedrock	UNSUITABLE-5

Table C-2 Soil Quality Working Group (1987) Soil Suitability Ratings for Sampled Soil Horizons within the Project Area

Site #	Soil Series	Horizon	Depth (cm)	pH	EC ¹ (dS/m)	SAR ²	Saturation (%)	Coarse Fragments (%vol.)	Texture	Reclamation Suitability Rating and Limitations ³
GM4140VL	SPR	LFH	9-0	6.7	-	-	-	-	-	FAIR-1
		Ae	0-5	5.2	0.13	0.2	57	30-40	Loam	FAIR-6
		Bt	5-55	6.6	0.25	0.1	59	5-10	Clay Loam	FAIR-1,5,7
		Ck	55-90	7.9	0.35	0.1	50	5-10	Silt Loam	POOR-1
GM4176JJ	CDMaa	LFH	2-0	6.2	-	-	-	-	-	GOOD
		Ae	0-10	5.4	0.12	<0.1	53	5-10	Loam	GOOD
		Bm	10-38	5.0	0.07	0.2	48	5-10	Loam	GOOD
		BC	38-61	5.0	0.04	0.2	39	10-20	Loam	GOOD
		C	61-80	5.0	0.04	0.2	34	70-80	Loam	UNSUITABLE-6
GM4177JJ	FVXaazz	LFH	7-0	5.6	-	-	-	50-60	-	POOR-6
		Bm	0-25	5.6	0.14	<0.1	65	60-70	Loam	POOR-6
		C	25-75	5.6	0.14	0.1	42	70-80	Sandy Loam	UNSUITABLE-6
GM4200PM	CDMaazz	LFH	4-0	5.1	-	-	-	-	-	GOOD
		Bm	0-16	4.8	0.08	0.2	51	30	Loam	FAIR-1,6
		BC	16-33	5.2	0.06	0.2	38	40	Loam	FAIR-6
		R	33-67	-	-	-	-	90	Bedrock	UNSUITABLE-5,6
GM4211PM	FRKzzco	LFH	5-0	4.4	-	-	-	-	-	FAIR-1
		Ae	0-21	4.9	0.07	0.2	52	50	Sandy Loam	POOR-6
		Bm	21-34	7.0	0.24	<0.1	55	50	Sandy Clay Loam	POOR-6
		Ck	34-100	7.8	0.28	<0.1	45	50	Sandy Loam	POOR-1,6

Table C-2 Soil Quality Working Group (1987) Soil Suitability Ratings for Sampled Soil Horizons within the Project Area

Site #	Soil Series	Horizon	Depth (cm)	pH	EC ¹ (dS/m)	SAR ²	Saturation (%)	Coarse Fragments (%vol.)	Texture	Reclamation Suitability Rating and Limitations ³
GM4250DL	RDXaafi	LFH	8-0	4.7	-	-	-	-	-	FAIR-1
		C	0-25	4.6	0.06	0.2	57	50-70	Sandy Clay Loam	POOR-6
		R	25+	-	-	-	-	-	Bedrock	UNSUITABLE-5
GM4254DL	FRKtkxl	Ah	0-19	6.9	0.41	<0.1	134	20-30	Clay	UNSUITABLE-4
		Bm	19-40	6.8	0.23	0.1	63	20-30	Clay Loam	FAIR-1,4,5,7
		R	40+	-	-	-	-	-	Bedrock	UNSUITABLE-5
GM4394DL	HDXaazzfi	Ah	0-8	6.8	1.47	<0.1	130	0	Loam	UNSUITABLE-4
		C	8-90	7.7	0.55	<0.1	66	0	Loam	POOR-1
GM4402VL	TUC	LFH	5-0	5.5	-	-	-	-	-	GOOD
		Ae	0-10	5.9	0.35	<0.1	123	5-10	Sandy Loam	UNSUITABLE-4
		Bt	10-43	5.4	0.2	0.2	69	5-10	Loam	FAIR-4,7
		R	43-62	-	-	-	-	-	Bedrock	UNSUITABLE-5
GM4406DL	WLB	LFH	4-0	6.1	-	-	-	-	-	GOOD
		Ae	0-2	5.3	0.14	0.1	73	2	Sandy Loam	FAIR-4
		Btj	2-38	5.7	0.07	0.2	57	10	Loam	GOOD
		BC	38-67	6.0	0.08	0.2	40	5-7	Loam	GOOD
		C	67-90	6.1	0.09	0.2	38	5-7	Loam	GOOD

Table C-2 Soil Quality Working Group (1987) Soil Suitability Ratings for Sampled Soil Horizons within the Project Area

Site #	Soil Series	Horizon	Depth (cm)	pH	EC ¹ (dS/m)	SAR ²	Saturation (%)	Coarse Fragments (%vol.)	Texture	Reclamation Suitability Rating and Limitations ³
GM4455DM	RDXaazh	LF	1-0	7.0	-	-	-	-	-	FAIR-1
		Ah	0-25	7.4	0.52	<0.1	72	20-30	Sandy Loam	FAIR-1,4,6
		Ck	25-45	7.8	0.48	<0.1	63	30-40	Sandy Loam	POOR-1,6,8
GM4467DM	PPEaazrco	Ah	0-38	6.4	0.30	<0.1	64	7	Sandy Loam	FAIR-4
		AC	38-100	6.6	0.29	<0.1	58	7	Sandy Loam	FAIR-1
GM4485VL	HDXaazzco	LF	3-0	7.6	-	-	-	-	-	POOR-1
		C1	0-11	7.6	0.38	<0.1	46	0	Loamy Sand	POOR-1,5
		C2	11-50	7.5	0.47	<0.1	45	60-70	Loamy Sand	UNSUITABLE-6
GM4575DM	PPEaagr	Ah	0-17	6.6	0.39	<0.1	91	10-20	Loam	POOR-4
		Bm	17-45	6.1	0.14	0.1	61	30-40	Sandy Clay Loam	FAIR-4,6
		C	45-100	6.2	0.14	0.1	47	20-30	Loam	GOOD
GM4612VL	ERRaacoxy	LFH	4-0	5.9	-	-	-	-	-	GOOD
		Ae	0-5	5.2	0.21	0.1	71	<1	Silt Loam	FAIR-4,5
		Bm	5-19	6.0	0.09	0.2	51	<1	Sandy Loam	GOOD
		C	19-30	6.1	0.07	0.2	36	<1	Sandy Loam	FAIR-7
		IIC	30-60	6.1	0.06	0.3	37	50-60	Loamy Sand	UNSUITABLE-6

Table C-2 Soil Quality Working Group (1987) Soil Suitability Ratings for Sampled Soil Horizons within the Project Area

Site #	Soil Series	Horizon	Depth (cm)	pH	EC ¹ (dS/m)	SAR ²	Saturation (%)	Coarse Fragments (%vol.)	Texture	Reclamation Suitability Rating and Limitations ³
GM4620PM	VLXaazhco	LF	1-0	-	-	-	-	-	-	GOOD
		Ah	0-12	7.3	0.51	<0.1	90	0	Loam	POOR-4
		C	12-40	7.4	0.88	0.1	48	10	Sandy Loam	FAIR-1
		Cg	40-90	7.5	0.26	0.2	50	5	Sandy Loam	POOR-1
GM4650VL	MSBcogr	Ah	0-24	5.1	0.63	<0.1	70	<1	Sandy Loam	FAIR-4
		AB	24-40	5.4	0.15	<0.1	61	1-2	Sandy Loam	FAIR-4
		IIbM	40-58	5.6	0.09	0.2	45	40-50	Sandy Loam	POOR-6
		IIC	58-75	5.6	0.13	0.1	48	40-50	Sandy Loam	POOR-6
		IIIC	75-110	6.3	0.11	0.2	47	80-90	Sandy Loam	UNSUITABLE-6
GM4653VL	SPRgr	LFH	4-0	6.8	-	-	-	-	-	FAIR-1
		Ae	0-10	6.7	0.30	<0.1	60	10-20	Loam	FAIR-1
		Bt	10-45	7.6	0.31	<0.1	51	30-40	Loam	POOR-1
		Ck	45-100	7.9	0.38	0.1	49	30-40	Loam	POOR-1
GM4806PM	CPXaa	LFH	2-0	6.3	-	-	-	-	-	GOOD
		Bm	0-13	5.2	0.09	0.1	50	5	Sandy Loam	GOOD
		BC	13-48	5.4	0.05	0.2	40	20	Sandy Loam	FAIR-6
		R	48-58	-	-	-	-	100	Bedrock	UNSUITABLE-5,6

Table C-2 Soil Quality Working Group (1987) Soil Suitability Ratings for Sampled Soil Horizons within the Project Area

Site #	Soil Series	Horizon	Depth (cm)	pH	EC ¹ (dS/m)	SAR ²	Saturation (%)	Coarse Fragments (%vol.)	Texture	Reclamation Suitability Rating and Limitations ³
GM4857DL	BPetk	LFH	3-0	6.8	-	-	-	-	-	FAIR-1
		Ah	0-14	6.2	0.22	0.3	153	5-10	Clay	UNSUITABLE-4
		Btj	14-38	6.4	0.15	0.3	56	10-20	Loam	FAIR-7
		Cgj	38-100	6.4	0.08	0.3	53	10-20	Clay Loam	FAIR-5,7
GM4897PM	MLXaazz	LFH	2-0	-	-	-	-	-	-	GOOD
		Bm	0-20	5.1	0.05	0.2	59	5-10	Sandy Loam	GOOD
		C	20-100	5.5	0.04	0.3	42	5-10	Sandy Loam	GOOD

¹ Electrical Conductivity

² Sodium Adsorption Ratio

³ Limitations: 1 - pH, 2 - EC, 3 - SAR, 4 - Sat %, 5 - Texture, 6 - Coarse fragment content (based on field data for each sampled profile), 7 - Consistence, 8 - CCE

* Organic horizons are assumed to be suitable reclamation material, however pH values were reviewed, if available, and a rating was applied accordingly.

APPENDIX D: SOIL AND OVERBURDEN ORIGINAL LABORATORY RESULTS



Millennium EMS Solutions Ltd.
ATTN: DANNY LAJOIE / KYLA WALKER
305-1925 18 Ave NE
Suite 325
Calgary AB T2E 7T8

Date Received: 28-MAR-14
Report Date: 22-APR-14 12:55 (MT)
Version: FINAL

Client Phone: 403-270-4709

Certificate of Analysis

Lab Work Order #: L1437868
Project P.O. #: NOT SUBMITTED
Job Reference: 12-00328-01
C of C Numbers: 0328
Legal Site Desc:

<Original signed by>

Maureen Olinek
Senior Account Manager

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ADDRESS: 9936-67 Avenue, Edmonton, AB T6E 0P5 Canada | Phone: +1 780 413 5227 | Fax: +1 780 437 2311
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-1 RGOH3003 4-14M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL Total Organic Carbon -Inorg & Total C Inorganic and Organic Carbon Inorganic Carbon0.420.10%07-APR-1407-APR-14R2817715 Total Organic Carbon1.270.10%07-APR-1407-APR-14R2817715 CaCO3 Equivalent3.510.80%07-APR-1407-APR-14R2817715 Total Carbon by combustion method Total Carbon by Combustion1.70.1%04-APR-1404-APR-14R2817727 Metals in Soil by ICPMS (CCME) Metals in Soil by CRC ICPMS Antimony (Sb)0.790.20mg/kg03-APR-1403-APR-14R2815764 Arsenic (As)2.320.20mg/kg03-APR-1403-APR-14R2815764 Barium (Ba)2205.0mg/kg03-APR-1403-APR-14R2815764 Beryllium (Be)<1.01.0mg/kg03-APR-1403-APR-14R2815764 Cadmium (Cd)1.540.50mg/kg03-APR-1403-APR-14R2815764 Chromium (Cr)5.400.50mg/kg03-APR-1403-APR-14R2815764 Cobalt (Co)7.61.0mg/kg03-APR-1403-APR-14R2815764 Copper (Cu)21.32.0mg/kg03-APR-1403-APR-14R2815764 Lead (Pb)9.05.0mg/kg03-APR-1403-APR-14R2815764 Molybdenum (Mo)1.41.0mg/kg03-APR-1403-APR-14R2815764 Nickel (Ni)35.42.0mg/kg03-APR-1403-APR-14R2815764 Selenium (Se)0.700.50mg/kg03-APR-1403-APR-14R2815764 Silver (Ag)<1.01.0mg/kg03-APR-1403-APR-14R2815764 Thallium (Tl)<0.500.50mg/kg03-APR-1403-APR-14R2815764 Tin (Sn)<5.05.0mg/kg03-APR-1403-APR-14R2815764 Uranium (U)<2.02.0mg/kg03-APR-1403-APR-14R2815764 Vanadium (V)17.41.0mg/kg03-APR-1403-APR-14R2815764 Zinc (Zn)16410mg/kg03-APR-1403-APR-14R2815764 Miscellaneous Parameters Fragments > 2mm55.61.0%04-APR-14R2815784 Mercury (Hg)0.0750.050mg/kg03-APR-1404-APR-14R2816177 Special RequestSee Attached1.022-APR-14R2825326 Particle Size % Sand86.41.0%04-APR-14R2816147 % Silt9.61.0%04-APR-14R2816147 % Clay4.01.0%04-APR-14R2816147 TextureLoamy sand04-APR-14R2816147 Basic Salinity Package Ca, K, Mg, & Na by ICPOES (Sat. Paste) Calcium (Ca)21.15.0mg/L04-APR-14R2815989 Magnesium (Mg)24.63.0mg/L04-APR-14R2815989 Potassium (K)8.62.0mg/L04-APR-14R2815989 Sodium (Na)2.42.0mg/L04-APR-14R2815989 Sodium Adsorption Ratio (Sat. Paste) SAR<0.100.10SAR04-APR-14 pH and EC (Saturated Paste) % Saturation25.51.0%03-APR-14R2815613 pH in Saturated Paste7.750.10pH03-APR-14R2815613 Conductivity Sat. Paste0.4160.010dS m-103-APR-14R2815613							
L1437868-2 RGOH3003 15-25M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL Total Organic Carbon -Inorg & Total C							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-2 RGOH3003 15-25M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.17		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	0.39		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	1.46		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	0.6		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.54		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	5.81		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	87.8		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	3.81		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	6.4		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	7.6		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	7.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	20.7		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	12.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	71		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	40.2		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.073		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	91.0		1.0	%		04-APR-14	R2816147
% Silt	7.0		1.0	%		04-APR-14	R2816147
% Clay	2.0		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	29.4		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	28.7		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	9.4		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	2.5		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	24.0		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	7.78		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.525		0.010	dS m-1		03-APR-14	R2815613
L1437868-3 RGOH3003 26-30M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-3 RGOH3003 26-30M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	<0.10		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	0.96		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	<0.80		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	1.0		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.63		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	15.1		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	64.5		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	5.42		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	6.5		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	6.7		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	7.6		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	24.5		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	12.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	66		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	35.3		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.183		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	94.0		1.0	%		04-APR-14	R2816147
% Silt	4.4		1.0	%		04-APR-14	R2816147
% Clay	1.6		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	18.8		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	28.2		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	6.5		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	<2.0		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10	SAR:DL	0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	23.7		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	7.69		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.449		0.010	dS m-1		03-APR-14	R2815613
L1437868-4 RGOH3003 32-33M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-4 RGOH3003 32-33M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	<0.10		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	11.4		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	<0.80		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	11.4		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	1.92		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	17.5		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	170		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.31		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	3.79		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	3.9		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	26.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	16.2		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	2.3		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	19.7		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.99		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	16.5		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	81		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	34.2		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.444		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	93.6		1.0	%		04-APR-14	R2816147
% Silt	6.0		1.0	%		04-APR-14	R2816147
% Clay	<1.0		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	25.1		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	33.3		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	5.7		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	<2.0		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10	SAR:DL	0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	27.7		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	7.13		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.508		0.010	dS m-1		03-APR-14	R2815613
L1437868-5 RGOH3003 34-40M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-5 RGOH3003 34-40M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	1.45		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	2.48		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	12.1		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	3.9		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	1.00		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	4.09		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	321		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.56		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	8.16		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	7.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	27.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	10.5		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	1.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	29.5		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.26		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	31.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	138		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	40.0		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.118		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	91.0		1.0	%		04-APR-14	R2816147
% Silt	7.0		1.0	%		04-APR-14	R2816147
% Clay	2.0		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	23.4		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	42.6		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	10.3		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	2.5		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	29.9		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	8.02		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.527		0.010	dS m-1		03-APR-14	R2815613
L1437868-6 RGOH3003 41-50M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-6 RGOH3003 41-50M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.56		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	4.49		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	4.68		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	5.1		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	1.17		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	4.94		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	258		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.61		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	8.62		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	8.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	30.1		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	11.6		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	1.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	31.9		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.54		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	33.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	169		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	50.4		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.167		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	88.4		1.0	%		04-APR-14	R2816147
% Silt	9.6		1.0	%		04-APR-14	R2816147
% Clay	2.0		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	23.0		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	63.8		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	7.7		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	2.6		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	23.9		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	8.03		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.738		0.010	dS m-1		03-APR-14	R2815613
L1437868-7 RGOH3003 52-57M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-8 RGOH3003 81-84M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.41		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	0.96		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	3.38		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	1.4		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.45		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	2.74		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	101		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	0.97		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	2.28		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	4.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	18.1		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	10.6		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	10.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	0.55		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	9.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	112		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	21.6		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.063		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	84.0		1.0	%		04-APR-14	R2816147
% Silt	13.6		1.0	%		04-APR-14	R2816147
% Clay	2.4		1.0	%		04-APR-14	R2816147
Texture	Loamy sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	78.0		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	41.8		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	8.3		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	4.1		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	20.7		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	7.96		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.906		0.010	dS m-1		03-APR-14	R2815613
L1437868-9 RGOH3003 102-109M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-11 RGOH3003 136-137M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	1.71		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	17.6		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	14.3		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	19.3		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.52		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	2.41		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	386		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.05		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	2.74		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	7.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	28.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	11.3		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	1.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	19.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.25		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	12.3		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	107		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	34.1		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.083		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	90.0		1.0	%		04-APR-14	R2816147
% Silt	7.2		1.0	%		04-APR-14	R2816147
% Clay	2.8		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	20.5		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	11.6		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	7.9		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	4.6		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.20		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	24.6		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	8.15		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.314		0.010	dS m-1		03-APR-14	R2815613
L1437868-12 RGOH3003 143-144M Sampled By: RIVERSDALE on 14-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters			Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-12	RGOH3003	143-144M							
Sampled By: RIVERSDALE on 14-JAN-14									
Matrix: SOIL									
Inorganic and Organic Carbon									
Inorganic Carbon			0.56		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon			1.87		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent			4.64		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method									
Total Carbon by Combustion			2.4		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)									
Metals in Soil by CRC ICPMS									
Antimony (Sb)			0.27		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)			4.49		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)			180		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)			<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)			2.51		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)			5.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)			8.5		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)			7.3		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)			16.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)			<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)			<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)			<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)			<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)			7.9		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)			70		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters									
Fragments > 2mm			56.7		1.0	%		04-APR-14	R2815784
Mercury (Hg)			0.122		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request			See Attached		1.0			22-APR-14	R2825326
Particle Size									
% Sand			93.6		1.0	%		04-APR-14	R2816147
% Silt			4.8		1.0	%		04-APR-14	R2816147
% Clay			1.6		1.0	%		04-APR-14	R2816147
Texture			Sand					04-APR-14	R2816147
Basic Salinity Package									
Ca, K, Mg, & Na by ICPOES (Sat. Paste)									
Calcium (Ca)			99.6		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)			51.2		3.0	mg/L		04-APR-14	R2815989
Potassium (K)			12.0		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)			4.3		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)									
SAR			<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)									
% Saturation			24.4		1.0	%		03-APR-14	R2815613
pH in Saturated Paste			7.92		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste			1.05		0.010	dS m-1		03-APR-14	R2815613
L1437868-13	RGOH3001	1-12M							
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Total Organic Carbon -Inorg & Total C									
Inorganic and Organic Carbon									

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters			Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-13 RGOH3001 1-12M									
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Inorganic and Organic Carbon									
Inorganic Carbon			0.23		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon			26.7		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent			1.90		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method									
Total Carbon by Combustion			27.0		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)									
Metals in Soil by CRC ICPMS									
Antimony (Sb)			1.16		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)			4.57		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)			242		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)			1.38		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)			6.58		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)			6.9		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)			32.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)			11.5		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)			2.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)			30.2		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)			1.14		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)			<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)			<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)			<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)			26.3		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)			133		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters									
Fragments > 2mm			82.4		1.0	%		04-APR-14	R2815784
Mercury (Hg)			0.163		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request			See Attached		1.0			22-APR-14	R2825326
Particle Size									
% Sand			90.0		1.0	%		04-APR-14	R2816147
% Silt			9.0		1.0	%		04-APR-14	R2816147
% Clay			1.0		1.0	%		04-APR-14	R2816147
Texture			Sand					04-APR-14	R2816147
Basic Salinity Package									
Ca, K, Mg, & Na by ICPOES (Sat. Paste)									
Calcium (Ca)			61.2		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)			38.1		3.0	mg/L		04-APR-14	R2815989
Potassium (K)			3.0		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)			5.5		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)									
SAR			0.14		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)									
% Saturation			29.9		1.0	%		03-APR-14	R2815613
pH in Saturated Paste			7.79		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste			0.717		0.010	dS m-1		03-APR-14	R2815613
L1437868-14 RGOH3001 14-20M									
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Total Organic Carbon -Inorg & Total C									
Inorganic and Organic Carbon									

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-14 RGOH3001 14-20M Sampled By: RIVERSDALE on 10-JAN-14 Matrix: SOIL								
Inorganic and Organic Carbon								
Inorganic Carbon		0.15		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon		1.02		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent		1.29		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method								
Total Carbon by Combustion		1.2		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)								
Metals in Soil by CRC ICPMS								
Antimony (Sb)		1.52		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)		17.5		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)		26.8		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)		<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)		0.94		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)		9.67		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)		7.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)		10.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)		8.9		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)		2.6		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)		24.4		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)		0.62		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)		<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)		<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)		<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)		<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)		31.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)		64		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters								
Fragments > 2mm		69.9		1.0	%		04-APR-14	R2815784
Mercury (Hg)		0.091		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request		See Attached		1.0			22-APR-14	R2825326
Particle Size								
% Sand		92.0		1.0	%		04-APR-14	R2816147
% Silt		7.6		1.0	%		04-APR-14	R2816147
% Clay		<1.0		1.0	%		04-APR-14	R2816147
Texture		Sand					04-APR-14	R2816147
Basic Salinity Package								
Ca, K, Mg, & Na by ICPOES (Sat. Paste)								
Calcium (Ca)		390		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)		145		3.0	mg/L		04-APR-14	R2815989
Potassium (K)		5.6		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)		4.6		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)								
SAR		<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)								
% Saturation		25.5		1.0	%		03-APR-14	R2815613
pH in Saturated Paste		6.72		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste		2.52		0.010	dS m-1		03-APR-14	R2815613
L1437868-15 RGOH3001 21-32M Sampled By: RIVERSDALE on 10-JAN-14 Matrix: SOIL								
Total Organic Carbon -Inorg & Total C								
Inorganic and Organic Carbon								

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-16 RGOH3001 33-39M&44-49M Sampled By: RIVERSDALE on 10-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.51		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	8.70		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	4.26		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	9.2		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.96		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	1.92		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	699		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.09		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	8.48		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	4.6		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	33.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	12.9		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	1.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	16.6		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.65		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	32.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	100		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	32.6		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.080		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	88.0		1.0	%		04-APR-14	R2816147
% Silt	9.6		1.0	%		04-APR-14	R2816147
% Clay	2.4		1.0	%		04-APR-14	R2816147
Texture	Sand					04-APR-14	R2816147
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	75.9		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	37.2		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	10.4		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	6.6		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.15		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	24.5		1.0	%		03-APR-14	R2815613
pH in Saturated Paste	7.86		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste	0.841		0.010	dS m-1		03-APR-14	R2815613
L1437868-17 RGOH3001 53-59M Sampled By: RIVERSDALE on 10-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-18 RGOH3001 60-70M								
Sampled By: RIVERSDALE on 10-JAN-14								
Matrix: SOIL								
Inorganic and Organic Carbon								
Inorganic Carbon		1.09		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon		3.09		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent		9.06		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method								
Total Carbon by Combustion		4.2		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)								
Metals in Soil by CRC ICPMS								
Antimony (Sb)		0.97		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)		3.40		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)		376		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)		<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)		1.78		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)		8.25		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)		6.9		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)		32.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)		10.2		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)		1.6		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)		26.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)		1.67		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)		<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)		<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)		<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)		<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)		31.9		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)		162		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters								
Fragments > 2mm		39.4		1.0	%		04-APR-14	R2815784
Mercury (Hg)		0.166		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request		See Attached		1.0			22-APR-14	R2825326
Particle Size								
% Sand		95.0		1.0	%		04-APR-14	R2816147
% Silt		5.0		1.0	%		04-APR-14	R2816147
% Clay		<1.0		1.0	%		04-APR-14	R2816147
Texture		Sand					04-APR-14	R2816147
Basic Salinity Package								
Ca, K, Mg, & Na by ICPOES (Sat. Paste)								
Calcium (Ca)		21.8		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)		11.2		3.0	mg/L		04-APR-14	R2815989
Potassium (K)		7.5		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)		11.6		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)								
SAR		0.50		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)								
% Saturation		26.7		1.0	%		03-APR-14	R2815613
pH in Saturated Paste		8.30		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste		0.347		0.010	dS m-1		03-APR-14	R2815613
L1437868-19 RGOH3001 71-77M								
Sampled By: RIVERSDALE on 10-JAN-14								
Matrix: SOIL								
Total Organic Carbon -Inorg & Total C								
Inorganic and Organic Carbon								

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-19	RGOH3001 71-77M							
Sampled By: RIVERSDALE on 10-JAN-14								
Matrix: SOIL								
Inorganic and Organic Carbon								
Inorganic Carbon		1.07		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon		3.45		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent		8.89		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method								
Total Carbon by Combustion		4.5		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)								
Metals in Soil by CRC ICPMS								
Antimony (Sb)		1.39		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)		4.57		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)		445		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)		<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)		1.87		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)		9.29		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)		10.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)		35.5		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)		13.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)		2.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)		38.4		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)		2.06		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)		<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)		<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)		<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)		<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)		38.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)		173		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters								
Fragments > 2mm		41.7		1.0	%		04-APR-14	R2815784
Mercury (Hg)		0.197		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request		See Attached		1.0			22-APR-14	R2825326
Particle Size								
% Sand		90.0		1.0	%		04-APR-14	R2816147
% Silt		8.0		1.0	%		04-APR-14	R2816147
% Clay		2.0		1.0	%		04-APR-14	R2816147
Texture		Sand					04-APR-14	R2816147
Basic Salinity Package								
Ca, K, Mg, & Na by ICPOES (Sat. Paste)								
Calcium (Ca)		29.5		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)		13.7		3.0	mg/L		04-APR-14	R2815989
Potassium (K)		6.1		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)		26.9		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)								
SAR		1.03		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)								
% Saturation		26.6		1.0	%		03-APR-14	R2815613
pH in Saturated Paste		8.19		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste		0.466		0.010	dS m-1		03-APR-14	R2815613
L1437868-20	RGOH3001 88-97M							
Sampled By: RIVERSDALE on 10-JAN-14								
Matrix: SOIL								
Total Organic Carbon -Inorg & Total C								
Inorganic and Organic Carbon								

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters			Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-20 RGOH3001 88-97M									
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Inorganic and Organic Carbon									
Inorganic Carbon			1.08		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon			3.01		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent			9.01		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method									
Total Carbon by Combustion			4.1		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)									
Metals in Soil by CRC ICPMS									
Antimony (Sb)			0.56		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)			3.12		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)			308		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)			1.13		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)			3.02		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)			5.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)			22.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)			9.6		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)			14.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)			0.63		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)			<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)			<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)			<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)			11.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)			121		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters									
Fragments > 2mm			49.7		1.0	%		04-APR-14	R2815784
Mercury (Hg)			0.103		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request			See Attached		1.0			22-APR-14	R2825326
Particle Size									
% Sand			89.6		1.0	%		04-APR-14	R2816147
% Silt			10.0		1.0	%		04-APR-14	R2816147
% Clay			<1.0		1.0	%		04-APR-14	R2816147
Texture			Sand					04-APR-14	R2816147
Basic Salinity Package									
Ca, K, Mg, & Na by ICPOES (Sat. Paste)									
Calcium (Ca)			<5.0		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)			<3.0		3.0	mg/L		04-APR-14	R2815989
Potassium (K)			2.6		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)			159		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)									
SAR			Incalculable	SAR:INC	0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)									
% Saturation			25.2		1.0	%		03-APR-14	R2815613
pH in Saturated Paste			9.05		0.10	pH		03-APR-14	R2815613
Conductivity Sat. Paste			0.803		0.010	dS m-1		03-APR-14	R2815613
L1437868-21 RGOH3001 98-105M									
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Total Organic Carbon -Inorg & Total C									
Inorganic and Organic Carbon									

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters			Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-21 RGOH3001 98-105M									
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Inorganic and Organic Carbon									
Inorganic Carbon			0.95		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon			1.47		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent			7.91		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method									
Total Carbon by Combustion			2.4		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)									
Metals in Soil by CRC ICPMS									
Antimony (Sb)			0.66		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)			4.44		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)			263		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)			1.13		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)			3.99		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)			6.6		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)			20.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)			9.6		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)			20.9		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)			0.80		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)			<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)			<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)			<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)			<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)			17.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)			117		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters									
Fragments > 2mm			39.8		1.0	%		04-APR-14	R2815784
Mercury (Hg)			0.099		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request			See Attached		1.0			22-APR-14	R2825326
Particle Size									
% Sand			91.6		1.0	%		04-APR-14	R2816147
% Silt			8.4		1.0	%		04-APR-14	R2816147
% Clay			<1.0		1.0	%		04-APR-14	R2816147
Texture			Sand					04-APR-14	R2816147
Basic Salinity Package									
Ca, K, Mg, & Na by ICPOES (Sat. Paste)									
Calcium (Ca)			<5.0		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)			<3.0		3.0	mg/L		04-APR-14	R2815989
Potassium (K)			2.3		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)			128		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)									
SAR			Incalculable	SAR:INC	0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)									
% Saturation			29.1		1.0	%		03-APR-14	R2815627
pH in Saturated Paste			9.07		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste			0.775		0.010	dS m-1		03-APR-14	R2815627
L1437868-22 RGOH3001 106-113M									
Sampled By: RIVERSDALE on 10-JAN-14									
Matrix: SOIL									
Total Organic Carbon -Inorg & Total C									
Inorganic and Organic Carbon									

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-23 RGOH3001 129-135M Sampled By: RIVERSDALE on 10-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.44		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	0.99		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	3.71		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	1.4		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.23		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	3.26		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	92.9		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	2.14		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	4.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	5.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	6.4		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	13.6		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	7.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	64		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	54.3		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.097		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	92.2		1.0	%		05-APR-14	R2816294
% Silt	5.4		1.0	%		05-APR-14	R2816294
% Clay	2.4		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	20.0		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	5.2		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	6.2		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	362		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	18.7		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	22.9		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	8.47		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	2.04		0.010	dS m-1		03-APR-14	R2815627
L1437868-24 RGOH3002 1-8M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-24 RGOH3002 1-8M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.26		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	3.20		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	2.18		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	3.5		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	1.28		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	3.15		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	185		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.34		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	11.0		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	9.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	29.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	13.7		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	2.1		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	30.5		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.22		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	40.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	161		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	79.5		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.114		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	92.4		1.0	%		05-APR-14	R2816294
% Silt	5.5		1.0	%		05-APR-14	R2816294
% Clay	2.1		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	33.4		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	14.7		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	4.0		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	3.6		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.13		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	27.3		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	7.59		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	0.414		0.010	dS m-1		03-APR-14	R2815627
L1437868-25 RGOH3002 16-25M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-25 RGOH3002 16-25M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	1.89		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	1.59		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	15.7		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	3.5		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	1.34		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	5.43		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	279		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.85		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	11.3		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	8.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	28.2		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	10.5		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	2.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	30.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.62		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	42.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	156		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	39.1		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.158		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	90.0		1.0	%		05-APR-14	R2816294
% Silt	6.5		1.0	%		05-APR-14	R2816294
% Clay	3.5		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	87.4		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	80.9		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	9.8		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	6.1		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.11		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	30.3		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	8.08		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	1.06		0.010	dS m-1		03-APR-14	R2815627
L1437868-26 RGOH3002 25-33M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-27 RGOH3002 34-41M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.90		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	2.27		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	7.46		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	3.2		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	1.32		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	4.39		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	319		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	2.02		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	9.32		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	9.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	32.3		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	11.9		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	2.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	37.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.77		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	38.4		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	164		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	38.3		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.193		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	89.2		1.0	%		05-APR-14	R2816294
% Silt	8.0		1.0	%		05-APR-14	R2816294
% Clay	2.8		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	85.6		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	72.2		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	7.7		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	4.5		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	<0.10		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	25.4		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	7.99		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	1.04		0.010	dS m-1		03-APR-14	R2815627
L1437868-28 RGOH3002 53-61M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-28 RGOH3002 53-61M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.39		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	2.21		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	3.25		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	2.6		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.99		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	5.91		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	353		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.55		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	3.28		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	9.6		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	30.8		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	13.4		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	1.2		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	29.4		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.30		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	14.9		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	162		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	41.4		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.166		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	89.8		1.0	%		05-APR-14	R2816294
% Silt	6.2		1.0	%		05-APR-14	R2816294
% Clay	4.0		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	36.4		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	16.8		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	12.0		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	6.2		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.21		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	25.1		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	8.01		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	0.422		0.010	dS m-1		03-APR-14	R2815627
L1437868-29 RGOH3002 62-70M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-29 RGOH3002 62-70M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	2.11		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	1.58		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	17.6		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	3.7		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.56		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	2.61		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Barium (Ba)	290		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.31		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	6.10		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	7.5		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	24.6		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	11.2		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	21.9		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	0.75		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	22.5		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	125		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	44.9		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.097		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	94.2		1.0	%		05-APR-14	R2816294
% Silt	3.5		1.0	%		05-APR-14	R2816294
% Clay	2.3		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	59.0		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	28.4		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	11.1		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	8.7		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.23		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	27.4		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	8.03		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	0.652		0.010	dS m-1		03-APR-14	R2815627
L1437868-30 RGOH3002 77-93M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1437868-30 RGOH3002 77-93M Sampled By: RIVERSDALE on 11-JAN-14 Matrix: SOIL							
Inorganic and Organic Carbon							
Inorganic Carbon	0.66		0.10	%	07-APR-14	07-APR-14	R2817715
Total Organic Carbon	4.86		0.10	%	07-APR-14	07-APR-14	R2817715
CaCO3 Equivalent	5.52		0.80	%	07-APR-14	07-APR-14	R2817715
Total Carbon by combustion method							
Total Carbon by Combustion	5.5		0.1	%	04-APR-14	04-APR-14	R2817727
Metals in Soil by ICPMS (CCME)							
Metals in Soil by CRC ICPMS							
Antimony (Sb)	0.89		0.20	mg/kg	03-APR-14	03-APR-14	R2815764
Arsenic (As)	4.44		0.20	mg/kg	05-APR-14	05-APR-14	R2816961
Barium (Ba)	195		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Beryllium (Be)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Cadmium (Cd)	1.03		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Chromium (Cr)	2.83		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Cobalt (Co)	7.8		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Copper (Cu)	28.9		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Lead (Pb)	14.3		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Molybdenum (Mo)	1.5		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Nickel (Ni)	23.6		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Selenium (Se)	1.45		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Silver (Ag)	<1.0		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Thallium (Tl)	<0.50		0.50	mg/kg	03-APR-14	03-APR-14	R2815764
Tin (Sn)	<5.0		5.0	mg/kg	03-APR-14	03-APR-14	R2815764
Uranium (U)	<2.0		2.0	mg/kg	03-APR-14	03-APR-14	R2815764
Vanadium (V)	11.7		1.0	mg/kg	03-APR-14	03-APR-14	R2815764
Zinc (Zn)	107		10	mg/kg	03-APR-14	03-APR-14	R2815764
Miscellaneous Parameters							
Fragments > 2mm	36.8		1.0	%		04-APR-14	R2815784
Mercury (Hg)	0.136		0.050	mg/kg	03-APR-14	04-APR-14	R2816177
Special Request	See Attached		1.0			22-APR-14	R2825326
Particle Size							
% Sand	93.8		1.0	%		05-APR-14	R2816294
% Silt	4.3		1.0	%		05-APR-14	R2816294
% Clay	1.9		1.0	%		05-APR-14	R2816294
Texture	Sand					05-APR-14	R2816294
Basic Salinity Package							
Ca, K, Mg, & Na by ICPOES (Sat. Paste)							
Calcium (Ca)	111		5.0	mg/L		04-APR-14	R2815989
Magnesium (Mg)	41.0		3.0	mg/L		04-APR-14	R2815989
Potassium (K)	8.8		2.0	mg/L		04-APR-14	R2815989
Sodium (Na)	6.5		2.0	mg/L		04-APR-14	R2815989
Sodium Adsorption Ratio (Sat. Paste)							
SAR	0.13		0.10	SAR		04-APR-14	
pH and EC (Saturated Paste)							
% Saturation	28.4		1.0	%		03-APR-14	R2815627
pH in Saturated Paste	7.61		0.10	pH		03-APR-14	R2815627
Conductivity Sat. Paste	0.995		0.010	dS m-1		03-APR-14	R2815627

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EXTEMP	18C - Samples Received with temperature >15 Degrees C
EHR	TOC, HG - Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested

Sample Parameter Qualifier Key:

Qualifier	Description
SAR:DL	SAR cannot be calculated due to undetectable Na. Detection Limit represents the maximum possible value.
SAR:INC	SAR is incalculable due to Ca and Mg below detection limit.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-INORG-ORG-SK	Soil	Inorganic and Organic Carbon	SSSA (1996) P455-456
When carbonates are decomposed with acid in an open system, carbon dioxide is released to the atmosphere. The decrease in sample weight resulting from CO2 loss is proportional to the carbonate content of the soil.			
Reference: Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5			
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974
The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.			
HG-200.2-CVAA-ED	Soil	Mercury in Soil by CVAAS	EPA 200.2/245.1
Test method is based on US EPA Method 200.2 "Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements", and meets all requirements of BC CSR Analytical Method 8 "Strong Acid Leachable Metals (SALM) in Soil", BC MOE, June 26, 2001. Soil is dried at <60°C and digested with nitric and hydrochloric acids, prior to analysis for mercury by cold vapour atomic absorption.			
MET-200.2-CCMS-ED	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A
This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.			
MET-PASTE-ICP-ED	Soil	Ca, K, Mg, & Na by ICPOES (Sat. Paste)	CSSS CH15/EPA 6010B
PSA-1-ED	Soil	Particle Size	CSSS 47.3-Hydrometer
PSA-COARSE_FRAGS-ED	Soil	Fragments >2mm (Cobbles and Stones)	CSSS 47.4
SALINITY-INTCHECK-ED	Soil		CSSS 18.4-Calculation
SAR-PASTE-CALC-ED	Soil	Sodium Adsorption Ratio (Sat. Paste)	CSSS 15.4.4-Calculation
SAT/PH/EC-ED	Soil	pH and EC (Saturated Paste)	CSSS 15.2, 15.3
SPECIAL REQUEST-AX	Misc.	Special Request ALS Minerals Vancouver	SEE SUBLET LAB RESULTS

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
0328			

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1437868

Report Date: 01-MAY-14

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Client: Millennium EMS Solutions Ltd.
305-1925 18 Ave NE Suite 325
Calgary AB T2E 7T8

Contact: DANNY LAJOIE / KYLA WALKER

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-INORG-ORG-SK		Soil						
Batch	R2817715							
WG1854191-1	DUP	L1437868-10						
Inorganic Carbon		0.81	0.74		%	8.1	20	07-APR-14
CaCO3 Equivalent		6.72	6.20		%	8.1	25	07-APR-14
WG1854191-5	DUP	L1437868-25						
Inorganic Carbon		1.89	1.83		%	2.7	20	07-APR-14
CaCO3 Equivalent		15.7	15.3		%	2.7	25	07-APR-14
WG1854191-2	IRM	0.1%IC						
Inorganic Carbon			113.8		%		60-140	07-APR-14
CaCO3 Equivalent			114.2		%		60-140	07-APR-14
WG1854191-3	IRM	0.4%IC						
Inorganic Carbon			107.9		%		80-120	07-APR-14
CaCO3 Equivalent			108.1		%		80-120	07-APR-14
WG1854191-6	IRM	0.1%IC						
Inorganic Carbon			119.9		%		60-140	07-APR-14
CaCO3 Equivalent			120.4		%		60-140	07-APR-14
WG1854191-7	IRM	0.4%IC						
Inorganic Carbon			106.5		%		80-120	07-APR-14
CaCO3 Equivalent			106.6		%		80-120	07-APR-14
WG1854191-4	MB							
Inorganic Carbon			<0.10		%		0.1	07-APR-14
CaCO3 Equivalent			<0.80		%		0.8	07-APR-14
WG1854191-8	MB							
Inorganic Carbon			<0.10		%		0.1	07-APR-14
CaCO3 Equivalent			<0.80		%		0.8	07-APR-14
C-TOT-LECO-SK		Soil						
Batch	R2817727							
WG1854189-1	DUP	L1437868-10						
Total Carbon by Combustion		5.1	5.2		%	0.5	20	04-APR-14
WG1854189-4	DUP	L1437868-25						
Total Carbon by Combustion		3.5	3.5		%	0.0	20	04-APR-14
WG1854189-2	IRM	08-109_SOIL						
Total Carbon by Combustion			103.0		%		80-120	04-APR-14
WG1854189-5	IRM	08-109_SOIL						
Total Carbon by Combustion			106.4		%		80-120	04-APR-14
WG1854189-3	MB							
Total Carbon by Combustion			<0.1		%		0.1	04-APR-14
WG1854189-6	MB							
Total Carbon by Combustion			<0.1		%		0.1	04-APR-14

Quality Control Report

Workorder: L1437868

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-200.2-CVAA-ED		Soil						
Batch	R2816177							
WG1853486-3	CRM	TILL-1_SOIL						
Mercury (Hg)			89.5		%		70-130	04-APR-14
WG1853486-4	CRM	TILL-1_SOIL						
Mercury (Hg)			110.7		%		70-130	04-APR-14
WG1853486-5	DUP	L1437868-29						
Mercury (Hg)		0.097	0.087		mg/kg	11	20	04-APR-14
WG1853486-6	DUP	L1437868-30						
Mercury (Hg)		0.136	0.129		mg/kg	5.1	20	04-APR-14
WG1853486-1	MB							
Mercury (Hg)			<0.050		mg/kg		0.05	04-APR-14
WG1853486-2	MB							
Mercury (Hg)			<0.050		mg/kg		0.05	04-APR-14
MET-200.2-CCMS-ED		Soil						
Batch	R2815764							
WG1853486-3	CRM	TILL-1_SOIL						
Antimony (Sb)			97.5		%		70-130	03-APR-14
Arsenic (As)			100.1		%		70-130	03-APR-14
Barium (Ba)			94.4		%		70-130	03-APR-14
Beryllium (Be)			84.5		%		70-130	03-APR-14
Cadmium (Cd)			87.3		%		70-130	03-APR-14
Chromium (Cr)			97.2		%		70-130	03-APR-14
Cobalt (Co)			94.7		%		70-130	03-APR-14
Copper (Cu)			94.2		%		70-130	03-APR-14
Lead (Pb)			86.1		%		70-130	03-APR-14
Molybdenum (Mo)			89.1		%		70-130	03-APR-14
Nickel (Ni)			93.7		%		70-130	03-APR-14
Selenium (Se)			88.4		%		70-130	03-APR-14
Thallium (Tl)			92.9		%		70-130	03-APR-14
Uranium (U)			93.9		%		70-130	03-APR-14
Vanadium (V)			99.1		%		70-130	03-APR-14
Zinc (Zn)			93.9		%		70-130	03-APR-14
WG1853486-4	CRM	TILL-1_SOIL						
Antimony (Sb)			101.8		%		70-130	03-APR-14
Arsenic (As)			106.3		%		70-130	03-APR-14
Barium (Ba)			98.8		%		70-130	03-APR-14
Beryllium (Be)			93.2		%		70-130	03-APR-14

Quality Control Report

Workorder: L1437868

Report Date: 01-MAY-14

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-ED		Soil						
Batch	R2815764							
WG1853486-4	CRM	TILL-1_SOIL						
Cadmium (Cd)			92.7		%		70-130	03-APR-14
Chromium (Cr)			102.8		%		70-130	03-APR-14
Cobalt (Co)			99.5		%		70-130	03-APR-14
Copper (Cu)			97.0		%		70-130	03-APR-14
Lead (Pb)			93.3		%		70-130	03-APR-14
Molybdenum (Mo)			94.3		%		70-130	03-APR-14
Nickel (Ni)			98.4		%		70-130	03-APR-14
Selenium (Se)			99.9		%		70-130	03-APR-14
Thallium (Tl)			98.4		%		70-130	03-APR-14
Uranium (U)			104.3		%		70-130	03-APR-14
Vanadium (V)			103.7		%		70-130	03-APR-14
Zinc (Zn)			97.7		%		70-130	03-APR-14
WG1853486-5	DUP	L1437868-29						
Antimony (Sb)		0.56	0.63		mg/kg	12	25	03-APR-14
Arsenic (As)		2.61	2.89		mg/kg	9.9	30	03-APR-14
Barium (Ba)		290	378		mg/kg	26	40	03-APR-14
Beryllium (Be)		<1.0	<1.0	RPD-NA	mg/kg	N/A	30	03-APR-14
Cadmium (Cd)		1.31	1.17		mg/kg	12	30	03-APR-14
Chromium (Cr)		6.10	6.95		mg/kg	13	30	03-APR-14
Cobalt (Co)		7.5	8.2		mg/kg	9.0	30	03-APR-14
Copper (Cu)		24.6	21.8		mg/kg	12	30	03-APR-14
Lead (Pb)		11.2	10.3		mg/kg	8.2	40	03-APR-14
Molybdenum (Mo)		<1.0	<1.0	RPD-NA	mg/kg	N/A	40	03-APR-14
Nickel (Ni)		21.9	24.2		mg/kg	10	30	03-APR-14
Selenium (Se)		0.75	0.89		mg/kg	17	25	03-APR-14
Silver (Ag)		<1.0	<1.0	RPD-NA	mg/kg	N/A	40	03-APR-14
Thallium (Tl)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	03-APR-14
Tin (Sn)		<5.0	<5.0	RPD-NA	mg/kg	N/A	40	03-APR-14
Uranium (U)		<2.0	<2.0	RPD-NA	mg/kg	N/A	30	03-APR-14
Vanadium (V)		22.5	25.8		mg/kg	13	25	03-APR-14
Zinc (Zn)		125	110		mg/kg	13	30	03-APR-14
WG1853486-6	DUP	L1437868-30						
Antimony (Sb)		0.89	0.70		mg/kg	24	25	03-APR-14
Barium (Ba)		195	263		mg/kg	29	40	03-APR-14
Beryllium (Be)		<1.0	<1.0	RPD-NA	mg/kg	N/A	30	03-APR-14

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-ED		Soil						
Batch	R2815764							
WG1853486-6	DUP	L1437868-30						
Cadmium (Cd)		1.03	1.05		mg/kg	1.8	30	03-APR-14
Chromium (Cr)		2.83	3.04		mg/kg	7.2	30	03-APR-14
Cobalt (Co)		7.8	6.3		mg/kg	21	30	03-APR-14
Copper (Cu)		28.9	25.7		mg/kg	12	30	03-APR-14
Lead (Pb)		14.3	11.3		mg/kg	23	40	03-APR-14
Molybdenum (Mo)		1.5	1.1		mg/kg	29	40	03-APR-14
Nickel (Ni)		23.6	19.2		mg/kg	21	30	03-APR-14
Selenium (Se)		1.45	1.08	J	mg/kg	0.36	1	03-APR-14
Silver (Ag)		<1.0	<1.0	RPD-NA	mg/kg	N/A	40	03-APR-14
Thallium (Tl)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	03-APR-14
Tin (Sn)		<5.0	<5.0	RPD-NA	mg/kg	N/A	40	03-APR-14
Uranium (U)		<2.0	<2.0	RPD-NA	mg/kg	N/A	30	03-APR-14
Vanadium (V)		11.7	12.8		mg/kg	8.5	25	03-APR-14
Zinc (Zn)		107	117		mg/kg	8.4	30	03-APR-14
WG1853486-1	MB							
Antimony (Sb)			<0.10		mg/kg		0.1	03-APR-14
Arsenic (As)			<0.10		mg/kg		0.1	03-APR-14
Barium (Ba)			<0.50		mg/kg		0.5	03-APR-14
Beryllium (Be)			<0.20		mg/kg		0.2	03-APR-14
Cadmium (Cd)			<0.10		mg/kg		0.1	03-APR-14
Chromium (Cr)			<0.50		mg/kg		0.5	03-APR-14
Cobalt (Co)			<0.10		mg/kg		0.1	03-APR-14
Copper (Cu)			<0.50		mg/kg		0.5	03-APR-14
Lead (Pb)			<0.50		mg/kg		0.5	03-APR-14
Molybdenum (Mo)			<0.10		mg/kg		0.1	03-APR-14
Nickel (Ni)			<0.50		mg/kg		0.5	03-APR-14
Selenium (Se)			<0.20		mg/kg		0.2	03-APR-14
Silver (Ag)			<0.20		mg/kg		0.2	03-APR-14
Thallium (Tl)			<0.050		mg/kg		0.05	03-APR-14
Tin (Sn)			<2.0		mg/kg		2	03-APR-14
Uranium (U)			<0.050		mg/kg		0.05	03-APR-14
Vanadium (V)			<0.20		mg/kg		0.2	03-APR-14
Zinc (Zn)			<5.0		mg/kg		5	03-APR-14
WG1853486-2	MB							
Antimony (Sb)			<0.10		mg/kg		0.1	03-APR-14

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-ED		Soil						
Batch R2815764								
WG1853486-2	MB							
Arsenic (As)			<0.10		mg/kg		0.1	03-APR-14
Barium (Ba)			<0.50		mg/kg		0.5	03-APR-14
Beryllium (Be)			<0.20		mg/kg		0.2	03-APR-14
Cadmium (Cd)			<0.10		mg/kg		0.1	03-APR-14
Chromium (Cr)			<0.50		mg/kg		0.5	03-APR-14
Cobalt (Co)			<0.10		mg/kg		0.1	03-APR-14
Copper (Cu)			<0.50		mg/kg		0.5	03-APR-14
Lead (Pb)			<0.50		mg/kg		0.5	03-APR-14
Molybdenum (Mo)			<0.10		mg/kg		0.1	03-APR-14
Nickel (Ni)			<0.50		mg/kg		0.5	03-APR-14
Selenium (Se)			<0.20		mg/kg		0.2	03-APR-14
Silver (Ag)			<0.20		mg/kg		0.2	03-APR-14
Thallium (Tl)			<0.050		mg/kg		0.05	03-APR-14
Tin (Sn)			<2.0		mg/kg		2	03-APR-14
Uranium (U)			<0.050		mg/kg		0.05	03-APR-14
Vanadium (V)			<0.20		mg/kg		0.2	03-APR-14
Zinc (Zn)			<5.0		mg/kg		5	03-APR-14
Batch R2816961								
WG1854456-3	CRM	TILL-1_SOIL						
Arsenic (As)			103.3		%		70-130	05-APR-14
WG1854456-4	CRM	TILL-1_SOIL						
Arsenic (As)			101.6		%		70-130	05-APR-14
WG1853486-6	DUP	L1437868-30						
Arsenic (As)		4.44	4.88		mg/kg	9.4	30	05-APR-14
WG1854456-5	DUP	L1437868-30						
Arsenic (As)		4.44	5.09		mg/kg	14	30	05-APR-14
WG1854456-1	MB							
Arsenic (As)			<0.10		mg/kg		0.1	05-APR-14
WG1854456-2	MB							
Arsenic (As)			<0.10		mg/kg		0.1	05-APR-14
MET-PASTE-ICP-ED		Soil						
Batch R2815989								
WG1853478-3	DUP	L1437868-20						
Calcium (Ca)		<5.0	6.5	RPD-NA	mg/L	N/A	30	04-APR-14
Magnesium (Mg)		<3.0	<3.0	RPD-NA	mg/L	N/A	30	04-APR-14

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-PASTE-ICP-ED		Soil						
Batch	R2815989							
WG1853478-3	DUP	L1437868-20						
Potassium (K)		2.6	2.8		mg/L	8.4	30	04-APR-14
Sodium (Na)		159	163		mg/L	2.2	30	04-APR-14
WG1853509-3	DUP	L1437868-29						
Calcium (Ca)		59.0	54.0		mg/L	8.8	30	04-APR-14
Magnesium (Mg)		28.4	26.1		mg/L	8.4	30	04-APR-14
Potassium (K)		11.1	10.1		mg/L	8.8	30	04-APR-14
Sodium (Na)		8.7	7.9		mg/L	9.7	30	04-APR-14
WG1853478-2	IRM	ED-SAL_NAT1						
Calcium (Ca)			113.2		%		70-130	04-APR-14
Magnesium (Mg)			107.3		%		70-130	04-APR-14
Potassium (K)			125.3		%		70-130	04-APR-14
Sodium (Na)			109.7		%		70-130	04-APR-14
WG1853509-2	IRM	ED-SAL_NAT1						
Calcium (Ca)			111.9		%		70-130	04-APR-14
Magnesium (Mg)			104.4		%		70-130	04-APR-14
Potassium (K)			126.1		%		70-130	04-APR-14
Sodium (Na)			108.0		%		70-130	04-APR-14
WG1853478-1	MB							
Calcium (Ca)			<5.0		mg/L		5	04-APR-14
Magnesium (Mg)			<3.0		mg/L		3	04-APR-14
Potassium (K)			<2.0		mg/L		2	04-APR-14
Sodium (Na)			<2.0		mg/L		2	04-APR-14
WG1853509-1	MB							
Calcium (Ca)			<5.0		mg/L		5	04-APR-14
Magnesium (Mg)			<3.0		mg/L		3	04-APR-14
Potassium (K)			<2.0		mg/L		2	04-APR-14
Sodium (Na)			<2.0		mg/L		2	04-APR-14
PSA-1-ED		Soil						
Batch	R2816147							
WG1853606-3	DUP	L1437868-20						
% Sand		89.6	89.0	J	%	0.6	5	04-APR-14
% Silt		10.0	10.6	J	%	0.6	5	04-APR-14
% Clay		<1.0	<1.0	RPD-NA	%	N/A	5	04-APR-14
WG1853606-2	IRM	ED-SAL_NAT1						
% Sand			52.0		%		51.3-61.3	04-APR-14



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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-1-ED		Soil						
Batch	R2816147							
WG1853606-2	IRM	ED-SAL_NAT1						
% Silt			29.0		%		24.7-34.7	04-APR-14
% Clay			19.0		%		9-19	04-APR-14
WG1853606-1	MB							
% Sand			<1.0		%		1	04-APR-14
% Silt			<1.0		%		1	04-APR-14
% Clay			<1.0		%		1	04-APR-14
Batch	R2816294							
WG1853611-3	DUP	L1437868-29						
% Sand		94.2	93.2	J	%	1.0	5	05-APR-14
% Silt		3.5	4.5	J	%	1.0	5	05-APR-14
% Clay		2.3	2.3	J	%	0.0	5	05-APR-14
WG1853611-2	IRM	ED-SAL_NAT1						
% Sand			57.6		%		51.3-61.3	05-APR-14
% Silt			29.4		%		24.7-34.7	05-APR-14
% Clay			13.1		%		9-19	05-APR-14
WG1853611-1	MB							
% Sand			<1.0		%		1	05-APR-14
% Silt			<1.0		%		1	05-APR-14
% Clay			<1.0		%		1	05-APR-14
SAT/PH/EC-ED		Soil						
Batch	R2815613							
WG1853478-3	DUP	L1437868-20						
% Saturation		25.2	24.2		%	3.8	20	03-APR-14
pH in Saturated Paste		9.05	9.01	J	pH	0.04	0.3	03-APR-14
Conductivity Sat. Paste		0.803	0.808		dS m-1	0.6	20	03-APR-14
WG1853478-2	IRM	ED-SAL_NAT1						
% Saturation			102.4		%		80-120	03-APR-14
pH in Saturated Paste			6.53		pH		6.49-7.09	03-APR-14
Conductivity Sat. Paste			109.1		%		80-120	03-APR-14
WG1853478-4	LCS							
pH in Saturated Paste			4.00		pH		3.7-4.3	03-APR-14
WG1853478-5	LCS							
pH in Saturated Paste			6.93		pH		6.7-7.3	03-APR-14
WG1853478-6	LCS							
pH in Saturated Paste			10.00		pH		9.7-10.3	03-APR-14
WG1853478-7	LCS							

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAT/PH/EC-ED		Soil						
Batch	R2815613							
WG1853478-7	LCS							
Conductivity Sat. Paste			101.9		%		90-110	03-APR-14
WG1853478-8	LCS							
Conductivity Sat. Paste			102.0		%		90-110	03-APR-14
WG1853478-9	LCS							
Conductivity Sat. Paste			104.5		%		80-120	03-APR-14
Batch	R2815627							
WG1853509-3	DUP	L1437868-29						
% Saturation		27.4	25.1		%	9.0	20	03-APR-14
pH in Saturated Paste		8.03	7.97	J	pH	0.06	0.3	03-APR-14
Conductivity Sat. Paste		0.652	0.644		dS m-1	1.2	20	03-APR-14
WG1853509-2	IRM	ED-SAL_NAT1						
% Saturation			100.7		%		80-120	03-APR-14
pH in Saturated Paste			6.51		pH		6.49-7.09	03-APR-14
Conductivity Sat. Paste			111.6		%		80-120	03-APR-14
WG1853509-4	LCS							
pH in Saturated Paste			4.00		pH		3.7-4.3	03-APR-14
WG1853509-5	LCS							
pH in Saturated Paste			6.93		pH		6.7-7.3	03-APR-14
WG1853509-6	LCS							
pH in Saturated Paste			10.00		pH		9.7-10.3	03-APR-14
WG1853509-7	LCS							
Conductivity Sat. Paste			101.9		%		90-110	03-APR-14
WG1853509-8	LCS							
Conductivity Sat. Paste			102.0		%		90-110	03-APR-14
WG1853509-9	LCS							
Conductivity Sat. Paste			104.5		%		80-120	03-APR-14

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Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

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Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Organic / Inorganic Carbon							
Inorganic and Organic Carbon							
	1	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	2	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	3	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	4	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	5	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	6	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	7	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	8	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	9	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	10	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	11	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	12	14-JAN-14	07-APR-14 00:00	28	83	days	EHTR
	13	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	14	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	15	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	16	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	17	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	18	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	19	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	20	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	21	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	22	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	23	10-JAN-14	07-APR-14 00:00	28	87	days	EHTR
	24	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
	25	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
	26	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
	27	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
	28	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
	29	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
	30	11-JAN-14	07-APR-14 00:00	28	86	days	EHTR
Total Carbon by combustion method							
	1	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	2	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	3	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	4	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	5	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	6	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	7	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	8	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	9	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	10	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	11	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	12	14-JAN-14	04-APR-14 00:00	28	80	days	EHTR
	13	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	14	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	15	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	16	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	17	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	18	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	19	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	20	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	21	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	22	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	23	10-JAN-14	04-APR-14 00:00	28	84	days	EHTR
	24	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR
	25	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR
	26	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR

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Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Organic / Inorganic Carbon							
Total Carbon by combustion method							
	27	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR
	28	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR
	29	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR
	30	11-JAN-14	04-APR-14 00:00	28	83	days	EHTR
Metals							
Mercury in Soil by CVAAS							
	1	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	2	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	3	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	4	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	5	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	6	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	7	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	8	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	9	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	10	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	11	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	12	14-JAN-14	03-APR-14 00:00	28	79	days	EHTR
	13	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	14	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	15	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	16	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	17	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	18	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	19	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	20	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	21	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	22	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	23	10-JAN-14	03-APR-14 00:00	28	83	days	EHTR
	24	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR
	25	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR
	26	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR
	27	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR
	28	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR
	29	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR
	30	11-JAN-14	03-APR-14 00:00	28	82	days	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.

Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1437868 were received on 28-MAR-14 13:15.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

Quality Control Report

Workorder: L1437868

Report Date: 01-MAY-14

Page 12 of 12

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: 604 984 0221 Fax: 604 984 0218 www.alsglobal.com

To: **ALS ENVIRONMENTAL - EDMONTON**
9936 67 AVENUE
EDMONTON AB T6E 0P5

Page: 1
Total # Pages: 2 (A)
Plus Appendix Pages
Finalized Date: 21 - APR - 2014
Account: ALSEDM

CERTIFICATE VA14052293

Project: L1437868

P.O. No.: L1437868

This report is for 30 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 4 - APR - 2014.

The following have access to data associated with this certificate:

NICOLE THIBAUT

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI - 21	Received Sample Weight
LOG - 22	Sample login - Rcd w/o BarCode
PUL - 31	Pulverize split to 85% <75 um
PUL - QC	Pulverizing QC Test

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
OA - VOL08	Basic Acid Base Accounting
S - IR08	Total Sulphur (Leco) LECO
OA - ELE07	Paste pH
S - CAL06a	Sulfide Sulfur (calculated*)
S - GRA06a	Sulfate Sulfur (HCl leachable) WST - SEQ

To: **ALS ENVIRONMENTAL - EDMONTON**
ATTN: NICOLE THIBAUT
9936 67 AVENUE
EDMONTON AB T6E 0P5

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Colin Ramshaw, Vancouver Laboratory Manager



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 North Vancouver BC V7H 0A7
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9936 67 AVENUE
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Page: 2 - A
 Total # Pages: 2 (A)
 Plus Appendix Pages
 Finalized Date: 21 - APR - 2014
 Account: ALSED

Project: L1437868

CERTIFICATE OF ANALYSIS VA14052293

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/100 0.3	OA-VOL08 NNP tCaCO3/100 1	OA-VOL08 NP tCaCO3/100 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N) Unity 0.01	S-IR08 S % 0.01	S-CAL06a S % 0.01	S-GRA06a S % 0.01
L1437868-1		0.28	2	1.3	31	32	7.6	25.60	0.04	0.03	0.01
L1437868-2		0.30	1	1.6	8	10	7.7	6.40	0.05	0.03	0.02
L1437868-3		0.20	1	2.2	4	6	7.5	2.74	0.07	0.06	0.01
L1437868-4		0.26	1	8.1	-4	4	7.1	0.49	0.26	0.23	0.03
L1437868-5		0.30	3	2.8	97	100	8.0	35.56	0.09	0.09	<0.01
L1437868-6		0.30	2	2.8	34	37	7.7	13.16	0.09	0.08	0.01
L1437868-7		0.28	1	4.4	2	6	7.3	1.37	0.14	0.13	0.01
L1437868-8		0.30	2	1.6	19	21	7.9	13.44	0.05	0.03	0.02
L1437868-9		0.30	2	4.4	12	16	7.5	3.66	0.14	0.12	0.02
L1437868-10		0.32	2	2.8	47	50	8.0	17.78	0.09	0.08	0.01
L1437868-11		0.22	2	5.3	52	57	8.0	10.73	0.17	0.13	0.04
L1437868-12		0.16	2	13.8	20	34	7.9	2.47	0.44	0.37	0.07
L1437868-13		0.20	1	5.9	9	15	7.5	2.53	0.19	0.16	0.03
L1437868-14		0.28	1	9.7	-1	9	6.8	0.93	0.31	0.29	0.02
L1437868-15		0.28	2	15.6	5	21	6.6	1.34	0.50	0.48	0.02
L1437868-16		0.28	2	5.9	21	27	7.7	4.55	0.19	0.16	0.03
L1437868-17		0.28	2	4.7	54	59	8.1	12.59	0.15	0.13	0.02
L1437868-18		0.30	3	3.4	84	87	8.1	25.31	0.11	0.08	0.03
L1437868-19		0.28	2	3.8	63	67	8.1	17.87	0.12	0.05	0.07
L1437868-20		0.32	2	2.2	60	62	8.6	28.34	0.07	0.03	0.04
L1437868-21		0.30	2	2.5	57	59	8.7	23.60	0.08	0.04	0.04
L1437868-22		0.32	3	1.6	134	136	8.9	87.04	0.05	0.02	0.03
L1437868-23		0.22	2	10.6	15	26	8.4	2.45	0.34	0.31	0.03
L1437868-24		0.18	2	1.9	16	18	7.6	9.60	0.06	0.04	0.02
L1437868-25		0.30	3	3.4	133	136	8.1	39.56	0.11	0.02	0.09
L1437868-26		0.30	1	6.6	9	16	7.5	2.44	0.21	0.14	0.07
L1437868-27		0.30	2	3.8	56	60	7.9	16.00	0.12	0.08	0.04
L1437868-28		0.30	2	3.1	16	19	7.8	6.08	0.10	0.07	0.03
L1437868-29		0.32	3	1.6	151	153	8.2	97.92	0.05	0.04	0.01
L1437868-30		0.30	1	9.4	7	16	7.5	1.71	0.30	0.30	<0.01



ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
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To: **ALS ENVIRONMENTAL - EDMONTON**
9936 67 AVENUE
EDMONTON AB T6E 0P5

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 21-APR-2014
Account: ALSEDM

Project: L1437868

CERTIFICATE OF ANALYSIS VA14052293

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Applies to Method:

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.
LOG-22
PUL-QC
WEI-21

OA-ELE07
S-CAL06a

OA-VOL08
S-GRA06a

PUL-31
S-IR08



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North Vancouver BC V7H 0A7
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Page: 1
Total # Pages: 3 (A)
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Finalized Date: 21 - APR - 2014
Account: ALSEDM

QC CERTIFICATE VA14052293

Project: L1437868

P.O. No.: L1437868

This report is for 30 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 4 - APR - 2014.

The following have access to data associated with this certificate:

NICOLE THIBAUT

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI - 21	Received Sample Weight
LOG - 22	Sample login - Rcd w/o BarCode
PUL - 31	Pulverize split to 85% <75 um
PUL - QC	Pulverizing QC Test

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA - VOL08	Basic Acid Base Accounting	
S - IR08	Total Sulphur (Leco)	LECO
OA - ELE07	Paste pH	
S - CAL06a	Sulfide Sulfur (calculated*)	
S - GRA06a	Sulfate Sulfur (HCl leachable)	WST - SEQ

To: **ALS ENVIRONMENTAL - EDMONTON**
ATTN: NICOLE THIBAUT
9936 67 AVENUE
EDMONTON AB T6E 0P5

<Original signed by>

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Colin Ramshaw, Vancouver Laboratory Manager



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 North Vancouver BC V7H 0A7
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Project: L1437868

QC CERTIFICATE OF ANALYSIS VA14052293

Sample Description	Method Analyte Units LOR	OA-VOL08 FIZZ RAT Unity	OA-VOL08 MPA tCaCO3/100	OA-VOL08 NNP tCaCO3/100	OA-VOL08 NP tCaCO3/100	OA-ELE07 pH Unity	OA-VOL08 Ratio (N) Unity	S-IR08 S %	S-GRA06a S %
		1	0.3	1	1	0.1	0.01	0.01	0.01
STANDARDS									
KZK - 1		2	25.0	37	62		2.48		
KZK - 1		2	25.0	37	62		2.48		
Target Range - Lower Bound			22.9	30	54		2.18		
Upper Bound			27.1	38	64		2.54		
NBM - 1		2	8.8	43	52		5.94		
NBM - 1		2	8.8	43	52		5.94		
Target Range - Lower Bound			7.8	37	45		5.26		
Upper Bound			9.7	47	54		6.08		
RTS - 1								1.28	
Target Range - Lower Bound								1.14	
Upper Bound								1.34	
SILICA						7.4			
SILICA						7.8			
Target Range - Lower Bound						6.6			
Upper Bound						8.3			
UTS - 1								0.89	
Target Range - Lower Bound								0.81	
Upper Bound								0.95	
UTS - 1							1.03		
Target Range - Lower Bound							0.95		
Upper Bound							1.05		
UTS - 2							3.25		
Target Range - Lower Bound							3.11		
Upper Bound							3.35		
BLANKS									
BLANK						6.2			
Target Range - Lower Bound						5.5			
Upper Bound						6.9			
BLANK								<0.01	
Target Range - Lower Bound								<0.01	
Upper Bound								0.02	
BLANK							0.01		
Target Range - Lower Bound							<0.01		
Upper Bound							0.02		



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Page: 3 - A
 Total # Pages: 3 (A)
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 Finalized Date: 21 - APR - 2014
 Account: ALSEDM

Project: L1437868

QC CERTIFICATE OF ANALYSIS VA14052293

Sample Description	Method Analyte Units LOR	OA - VOL08 FIZZ RAT Unity	OA - VOL08 MPA tCaCO3/100	OA - VOL08 NNP tCaCO3/100	OA - VOL08 NP tCaCO3/100	OA - ELE07 pH Unity	OA - VOL08 Ratio (N) Unity	S - IR08 S %	S - GRA06a S %
		1	0.3	1	1	0.1	0.01	0.01	0.01
L1437868-5 DUP Target Range - Lower Bound Upper Bound		DUPLICATES 0.09 0.09 0.08 0.10							
L1437868-8 DUP Target Range - Lower Bound Upper Bound						7.9 7.9 7.4 8.4		0.02 <0.01 <0.01 0.02	
L1437868-10 DUP Target Range - Lower Bound Upper Bound		2 2 <1 3	2.8 2.8 2.4 3.2	47 47 44 50	50 50 47 54		17.78 17.78 16.88 18.68		
L1437868-29 DUP Target Range - Lower Bound Upper Bound		3 3 2 >4	1.6 1.6 1.2 2.0	151 152 143 160	153 154 145 162		97.92 98.56 93.32 103.15		



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Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 21 - APR - 2014
Account: ALSEDM

Project: L1437868

QC CERTIFICATE OF ANALYSIS VA14052293

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Applies to Method:

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.
LOG - 22
PUL - QC
WEI - 21

OA - ELE07
S - CAL06a

OA - VOL08
S - GRA06a

PUL - 31
S - IR08



L1437868-COFC

Request Form
368 8878

COC # 328

Page ____ of ____

7540

Report To		Service Requested (Rush for routine analysis subject to availability)	
Company: Millennium EMS Sol		☒ Regular (Standard Turnaround Times - Business Days)	
Contact: Danny Lejole		☐ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT	
Address: 305-1925, 18th Avenue, NE Calgary, AB, T2E 7T8		☐ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT	
Phone: 403-270-4709 Fax: _____		☐ Same Day or Weekend Emergency - Contact ALS to Confirm TAT	
Email 1: dlejoie@MEMS.ca		Analysis Request	
Email 2: dmccoy@MEMS.ca		Please indicate below Filtered, Preserved or both (F, P, F/P)	
Email 3: kwalker@MEMS.ca			
Invoice To Same as Report? ☒ Yes ☐ No			
Hardcopy of Invoice with Report? ☒ Yes ☐ No			
Company:			
Contact:			
Address:			
Phone: _____ Fax: _____			
Quote #: Q044061			
ALS Contact: Maureen Olinek			
Sampler: Riversdale			
Lab Work Order # _____			
(lab use only)			
Sample #	Sample Identification (This description will appear on the report)	Date (dd-mm-yy)	Time (hh:mm)
Sample Type			
1	RGOH3003 4-14m	14-Jan-14	Soil
2	RGOH3003 15-25m	14-Jan-14	Soil
3	RGOH3003 26-30m	14-Jan-14	Soil
4	RGOH3003 32-33m	14-Jan-14	Soil
5	RGOH3003 34-40m	14-Jan-14	Soil
6	RGOH3003 41-50m	14-Jan-14	Soil
7	RGOH3003 52-57m	14-Jan-14	Soil
8	RGOH3003 61-84m	14-Jan-14	Soil
9	RGOH3003 102-109m	14-Jan-14	Soil
10	RGOH3003 112, 116-127m	14-Jan-14	Soil
11	RGOH3003 136-137m	14-Jan-14	Soil
12	RGOH3003 143-144m	14-Jan-14	Soil
13	RGOH 3001 1-12m	10-Jan-14	Soil
14	RGOH 3001 14-20m	10-Jan-14	Soil
15	RGOH 3001 21-32m	10-Jan-14	Soil
16	RGOH 3001 33-39m & 44-49m	10-Jan-14	Soil
17	RGOH 3001 53-59m	10-Jan-14	Soil
18	RGOH 3001 60-70m	10-Jan-14	Soil
19	RGOH 3001 71-77m	10-Jan-14	Soil
20	RGOH 3001 88-97m	10-Jan-14	Soil
21	RGOH 3001 99-105m	10-Jan-14	Soil
22	RGOH 3001 106-113m	10-Jan-14	Soil
23	RGOH 3001 129-135m	10-Jan-14	Soil
24	RGOH 3002 1-6m	11-Jan-14	Soil
25	RGOH 3002 16-25m	11-Jan-14	Soil
26	RGOH 3002 25-33m	11-Jan-14	Soil
27	RGOH 3002 34-41m	11-Jan-14	Soil
28	RGOH 3002 53-61m	11-Jan-14	Soil
29	RGOH 3002 62-70m	11-Jan-14	Soil
30	RGOH 3002 77-93m	11-Jan-14	Soil
Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details			
Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.			
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.			
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.			
SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)	
Released by:	Date (dd-mm-yy):	Received by:	Date:
Time (hh:mm):	Time (hh:mm):	Temperature:	Verified by:
Date:		Date:	Time:
Time:		Observations:	
Yes / No ?		If Yes add SIF	

<Original signed by>

28 Mar 14 15:50

16 °C

Report Transmission Cover Page

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

Contact & Affiliation	Address	Delivery Commitments
Accounts Payable Millennium EMS Solutions	6111 - 91 Street Edmonton, Alberta T6E 6V6 Phone: (780) 496-9048 Fax: (780) 496-9049 Email: acct@mems.ca	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report
Ryan Muri Millennium EMS Solutions	6111-91 Street Edmonton, Alberta T6E 6V6 Phone: (780) 496-9048 Fax: (780) 496-9049 Email: rmuri@mems.ca	On [Lot Verification] send (COA) by Email - Multiple Reports By Agreement On [Lot Creation] send (COR) by Email - Multiple Reports By Agreement
Lab Data Millennium EMS Solutions	6111-91 Street Edmonton, Alberta T6E 6V6 Phone: (780) 496-9048 Fax: (780) 496-9049 Email: labdata@mems.ca	On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report, COC) by Email - Merge Reports
Vadim Lyzhin Millennium EMS Solutions	6111-91 Street Edmonton, Alberta T6E 6V6 Phone: (587) 987-6802 Fax: (780) 496-9049 Email: vlyzhin@mems.ca	On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report

Notes To Clients:

- Report was issued to include addition of analysis on lot 1017944 requested by Vadim Lyzhin of MEMS on Dec. 3, 2014.

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-1	1017944-2	1017944-8	
		Sample Date	Jul 23, 2014	Jul 23, 2014	Jul 23, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4467DL-Ah / 0-38 / cm Soil	GM4467DL-AB / 38-100 / cm Soil	GM4111VL-Ah / 0-15 / cm Soil	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
C:N Ratio			11		32	
Organic Matter		%	8.49		29.6	0.15
Carbon	Total Organic	% dry weight	4.24	3.14	14.8	0.05
Nitrogen	Total	% dry weight	0.40		0.46	0.02
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	64.0	63.0	58.0	0.1
Silt	2 µm - 50 µm	% by weight	26.4	25.0	32.0	0.1
Clay	<2 µm	% by weight	9.6	12.0	10.0	0.1
Salinity						
pH	Saturated Paste	pH	6.4	6.6	7.4	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.30	0.29	0.99	0.01
SAR	Saturated Paste		<0.1	<0.1	<0.1	
% Saturation		%	64	58	80	
Calcium	Saturated Paste	meq/L	1.40	1.81	8.02	0.01
Calcium	Saturated Paste	mg/kg	17.8	21.1	129	
Magnesium	Saturated Paste	meq/L	0.39	0.43	1.88	0.02
Magnesium	Saturated Paste	mg/kg	3.0	3.1	18.2	
Sodium	Saturated Paste	meq/L	0.07	0.10	0.08	0.04
Sodium	Saturated Paste	mg/kg	1	1	2	
Potassium	Saturated Paste	meq/L	1.15	0.61	0.33	0.03
Potassium	Saturated Paste	mg/kg	29	14	10	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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		Reference Number	1017944-1	1017944-3	1017944-4
		Sample Date	Jul 23, 2014	Jul 24, 2014	Jul 25, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4467DL-Ah / 0-38 / cm	GM4089JJ-Bm / 20-55 / cm	GM4421JJ-Bm / 19-85 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH		5.4	5.3
pH	1:2 Soil:Water	pH	6.8		

Analytical Report

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

		Reference Number	1017944-1	1017944-8	1017944-25	
		Sample Date	Jul 23, 2014	Jul 23, 2014	Jul 24, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4467DL-Ah / 0-38 / cm	GM4111VL-Ah / 0-15 / cm	GM4065RH-Ah / 0-13 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Available Nutrients						
Potassium	Farmsoil	ppm	>600	169	175	25
Base saturation	FS Base Saturation	%	<87.1	100	48.2	
Calcium	FS Base Saturation	%	<70.2	85.1	33.2	
Magnesium	FS Base Saturation	%	<10.5	13.0	13.3	
Sodium	FS Base Saturation	%	<0.5	<0.6	<0.5	
Potassium	FS Base Saturation	%	>7.4	1.9	1.7	
TEC	FS Base Saturation	meq/100g	>24.0	23.0	26.5	
Calcium	FS Macro-nutrients	ppm	3370	3920	1760	30
Magnesium	FS Macro-nutrients	ppm	306	364	427	5
Sodium	FS Macro-nutrients	ppm	<30	<30	<30	30
Lime Requirement						
pH	SMP	pH	6.7	Not Required	5.6	

Analytical Report

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Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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		Reference Number	1017944-5	1017944-6	1017944-7
		Sample Date	Jul 25, 2014	Jul 24, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4386RH-Bm / 8- 41 / cm	GM4093JJ-Bm / 22- 43 / cm	GM4097JJ-Bm / 22- 50 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	5.4	6.2	5.4

Analytical Report

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Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
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		Reference Number	1017944-8	1017944-10	1017944-11
		Sample Date	Jul 23, 2014	Jul 23, 2014	Jul 23, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4111VL-Ah / 0-15	GM4111VL-Bm / 24-	GM4111VL-Ck / 42-
			/ cm	42 / cm	110 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH		7.3	
pH	1:2 Soil:Water	pH	7.6		
CCE	as CaCO3	%			>25.0 0.2

Analytical Report

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6111-91 Street
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T6E 6V6
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Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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		Reference Number	1017944-9	1017944-10	1017944-11	
		Sample Date	Jul 23, 2014	Jul 23, 2014	Jul 23, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4111VL-AB / 15- 24 / cm Soil	GM4111VL-Bm / 24- 42 / cm Soil	GM4111VL-Ck / 42- 110 / cm Soil	
		Matrix				
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Sandy Loam	Loam	
Sand	50 µm - 2 mm	% by weight	51.0	53.0	43.0	0.1
Silt	2 µm - 50 µm	% by weight	31.0	31.0	36.0	0.1
Clay	<2 µm	% by weight	18.0	16.0	21.0	0.1
Salinity						
pH	Saturated Paste	pH	7.5	7.6	7.9	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.38	0.38	0.38	0.01
SAR	Saturated Paste		<0.1	<0.1	<0.1	
% Saturation		%	62	53	55	
Calcium	Saturated Paste	meq/L	3.75	3.48	3.36	0.01
Calcium	Saturated Paste	mg/kg	46.6	36.7	37.2	
Magnesium	Saturated Paste	meq/L	0.72	0.71	0.74	0.02
Magnesium	Saturated Paste	mg/kg	5.4	4.5	5.0	
Sodium	Saturated Paste	meq/L	0.07	0.11	0.13	0.04
Sodium	Saturated Paste	mg/kg	1	1	2	
Potassium	Saturated Paste	meq/L	0.04	0.04	0.03	0.03
Potassium	Saturated Paste	mg/kg	<1	<1	<1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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6111-91 Street
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T6E 6V6
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Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
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P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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Reference Number		1017944-9	1017944-25	1017944-29	
Sample Date		Jul 23, 2014	Jul 24, 2014	Jul 25, 2014	
Sample Time		NA	NA	NA	
Sample Location					
Sample Description		GM4111VL-AB / 15-24 / cm	GM4065RH-Ah / 0-13 / cm	GM4394DL-Ah / 0-8 / cm	
Matrix		Soil	Soil	Soil	
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Classification					
C:N Ratio			68		
Organic Matter	%		55.0		0.15
Carbon	Total Organic	% dry weight	2.81	27.5	10.5
Nitrogen	Total	% dry weight	0.40		0.02

Analytical Report

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Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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		Reference Number	1017944-12	1017944-13	1017944-21
		Sample Date	Jul 24, 2014	Jul 24, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4384JJ-Bm / 7- 28 / cm	GM4485VL-LF / 3-0 / cm	GM4085RH-LFH / 20-0 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:Water	pH		7.6	5.9
pH	1:2 Soil:CaCl2 sol.	pH	4.7		

Analytical Report

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Project:
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Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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		Reference Number	1017944-14	1017944-15	1017944-22
		Sample Date	Jul 24, 2014	Jul 24, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4485VL-C1 / 0-11 / cm	GM4485VL-C2 / 11-50 / cm	GM4085RH-Ae / 0-9 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties					
Texture		Loamy Sand	Loamy Sand	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	82.0	84.0	68.6
Silt	2 µm - 50 µm	% by weight	13.6	12.0	21.4
Clay	<2 µm	% by weight	4.4	4.0	10.0
Salinity					
pH	Saturated Paste	pH	7.6	7.5	5.3
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.38	0.47	0.08
SAR	Saturated Paste		<0.1	<0.1	0.2
% Saturation		%	46	45	54
Calcium	Saturated Paste	meq/L	2.85	3.62	0.39
Calcium	Saturated Paste	mg/kg	26.1	32.4	4.2
Magnesium	Saturated Paste	meq/L	0.48	0.68	0.25
Magnesium	Saturated Paste	mg/kg	2.7	3.7	1.6
Sodium	Saturated Paste	meq/L	0.09	0.08	0.10
Sodium	Saturated Paste	mg/kg	<1	<1	1
Potassium	Saturated Paste	meq/L	0.17	0.15	0.08
Potassium	Saturated Paste	mg/kg	3	3	2
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1

Analytical Report

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6111-91 Street
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T6E 6V6
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Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
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		Reference Number	1017944-23	1017944-24	1017944-25	
		Sample Date	Jul 24, 2014	Jul 24, 2014	Jul 24, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4085RH-Bm / 9- 24 / cm	GM4085RH-C / 24- 90 / cm	GM4065RH-Ah / 0- 13 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Loamy Sand	
Sand	50 µm - 2 mm	% by weight	67.7	58.0	75.0	0.1
Silt	2 µm - 50 µm	% by weight	20.7	31.6	21.0	0.1
Clay	<2 µm	% by weight	11.7	10.4	4.0	0.1
Salinity						
pH	Saturated Paste	pH	5.4	5.2	5.5	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.08	0.08	0.37	0.01
SAR	Saturated Paste		0.2	0.1	<0.1	
% Saturation		%	63	65	55	
Calcium	Saturated Paste	meq/L	0.32	0.32	1.35	0.01
Calcium	Saturated Paste	mg/kg	4.1	4.1	14.8	
Magnesium	Saturated Paste	meq/L	0.18	0.18	1.15	0.02
Magnesium	Saturated Paste	mg/kg	1.4	1.4	7.6	
Sodium	Saturated Paste	meq/L	0.09	0.07	0.08	0.04
Sodium	Saturated Paste	mg/kg	1	1	1	
Potassium	Saturated Paste	meq/L	0.08	0.06	0.26	0.03
Potassium	Saturated Paste	mg/kg	2	1	6	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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T6E 6V6
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Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
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Acct code:

Lot ID: **1017944**
Control Number:
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		Reference Number	1017944-23	1017944-25	1017944-26
		Sample Date	Jul 24, 2014	Jul 24, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4085RH-Bm / 9- 24 / cm	GM4065RH-Ah / 0- 13 / cm	GM4098RH-Bm / 39- 60 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	4.4		5.6
pH	1:2 Soil:Water	pH		5.8	

Analytical Report

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T6E 6V6
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Project:
ID: 14-00201-01
Name: Grassy Mountain
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Lot ID: **1017944**
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		Reference Number	1017944-27	1017944-28	1017944-30
		Sample Date	Jul 25, 2014	Jul 24, 2014	Jul 25, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4420RH-Bm / 6- 22 / cm	GM4130RH-Bm / 5- 55 / cm	GM4394DL-Bm / 8- 90 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	6.4	5.8	7.2

Analytical Report

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6111-91 Street
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T6E 6V6
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Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
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Acct code:

Lot ID: **1017944**
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		Reference Number	1017944-29	1017944-30	1017944-32	
		Sample Date	Jul 25, 2014	Jul 25, 2014	Jul 25, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4394DL-Ah / 0-8	GM4394DL-Bm / 8-	GM4128VL-Ah / 0-10	
			/ cm	90 / cm	/ cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Loam	Loam	
Sand	50 µm - 2 mm	% by weight	48.0	45.0	49.0	0.1
Silt	2 µm - 50 µm	% by weight	40.0	45.0	40.6	0.1
Clay	<2 µm	% by weight	12.0	10.0	10.4	0.1
Salinity						
pH	Saturated Paste	pH	6.8	7.7	6.4	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	1.47	0.55	0.48	0.01
SAR	Saturated Paste		<0.1	<0.1	<0.1	
% Saturation		%	130	66	62	
Calcium	Saturated Paste	meq/L	10.3	4.32	2.91	0.01
Calcium	Saturated Paste	mg/kg	267	56.5	35.8	
Magnesium	Saturated Paste	meq/L	4.63	1.40	1.02	0.02
Magnesium	Saturated Paste	mg/kg	72.7	11.1	7.6	
Sodium	Saturated Paste	meq/L	0.07	0.06	0.06	0.04
Sodium	Saturated Paste	mg/kg	2	<1	<1	
Potassium	Saturated Paste	meq/L	0.17	0.04	0.51	0.03
Potassium	Saturated Paste	mg/kg	9	1	12	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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T6E 6V6
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ID: 14-00201-01
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Lot ID: **1017944**
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Reference Number		1017944-31	1017944-32	1017944-37	
Sample Date		Jul 25, 2014	Jul 25, 2014	Jul 27, 2014	
Sample Time		NA	NA	NA	
Sample Location					
Sample Description		GM4128VL-LFH / 5- 0 / cm	GM4128VL-Ah / 0-10 / cm	GM4211PM-LFH / 5- 0 / cm	
Matrix		Soil	Soil	Soil	
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:Water	pH	6.5		4.4
pH	1:2 Soil:Water	pH		6.9	

Analytical Report

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Project:
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		Reference Number	1017944-32	1017944-34	1017944-49	
		Sample Date	Jul 25, 2014	Jul 25, 2014	Jul 26, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4128VL-Ah / 0-10	GM4620PM-Ah / 0-	GM4650VL-Ah / 0-24	
			/ cm	12 / cm	/ cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
C:N Ratio			18		50	
Organic Matter		%	4.35		40.2	0.15
Carbon	Total Organic	% dry weight	2.18	5.58	20.1	0.05
Nitrogen	Total	% dry weight	0.12		0.40	0.02

Analytical Report

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

		Reference Number	1017944-32	1017944-49	1017944-88	
		Sample Date	Jul 25, 2014	Jul 26, 2014	Jul 28, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4128VL-Ah / 0-10	GM4650VL-Ah / 0-24	GM4575DM-Ah / 0-	
			/ cm	/ cm	17 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Available Nutrients						
Potassium	Farmsoil	ppm	227	370	414	25
Base saturation	FS Base Saturation	%	94.3	49.6	80.7	
Calcium	FS Base Saturation	%	75.5	35.7	67.6	
Magnesium	FS Base Saturation	%	13.2	9.9	8.9	
Sodium	FS Base Saturation	%	<1	<0.5	<0.5	
Potassium	FS Base Saturation	%	5.6	4.0	4.2	
TEC	FS Base Saturation	meq/100g	10.5	24.0	25.4	
Calcium	FS Macro-nutrients	ppm	1580	1720	3440	30
Magnesium	FS Macro-nutrients	ppm	168	288	275	5
Sodium	FS Macro-nutrients	ppm	<30	<30	<30	30
Lime Requirement						
pH	SMP	pH	6.9	5.8	6.5	

Analytical Report

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

		Reference Number	1017944-33	1017944-34	1017944-35	
		Sample Date	Jul 25, 2014	Jul 25, 2014	Jul 25, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4128VL-C / 10-100 / cm	GM4620PM-Ah / 0-12 / cm	GM4620PM-C / 12-40 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	45.0	42.6	62.0	0.1
Silt	2 µm - 50 µm	% by weight	40.0	44.4	26.0	0.1
Clay	<2 µm	% by weight	15.0	13.0	12.0	0.1
Salinity						
pH	Saturated Paste	pH	5.7	7.3	7.4	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.09	0.51	0.88	0.01
SAR	Saturated Paste		0.1	<0.1	0.1	
% Saturation		%	51	90	48	
Calcium	Saturated Paste	meq/L	0.48	4.38	6.54	0.01
Calcium	Saturated Paste	mg/kg	4.8	78.6	62.2	
Magnesium	Saturated Paste	meq/L	0.18	1.64	2.26	0.02
Magnesium	Saturated Paste	mg/kg	1.1	17.8	13.0	
Sodium	Saturated Paste	meq/L	0.09	0.11	0.26	0.04
Sodium	Saturated Paste	mg/kg	1	2	3	
Potassium	Saturated Paste	meq/L	0.10	0.08	0.08	0.03
Potassium	Saturated Paste	mg/kg	2	3	1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
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Acct code:

Lot ID: **1017944**
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		Reference Number	1017944-36	1017944-38	1017944-39	
		Sample Date	Jul 25, 2014	Jul 27, 2014	Jul 27, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4620PM-Cg2 / 40-90 / cm	GM4211PM-Ae / 0-21 / cm	GM4211PM-Bm / 21-34 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Sandy Clay Loam	
Sand	50 µm - 2 mm	% by weight	54.0	55.0	63.0	0.1
Silt	2 µm - 50 µm	% by weight	36.0	34.0	17.0	0.1
Clay	<2 µm	% by weight	10.0	11.0	20.0	0.1
Salinity						
pH	Saturated Paste	pH	7.5	4.9	7.0	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.26	0.07	0.24	0.01
SAR	Saturated Paste		0.2	0.2	<0.1	
% Saturation		%	50	52	55	
Calcium	Saturated Paste	meq/L	2.25	0.39	2.08	0.01
Calcium	Saturated Paste	mg/kg	22.4	4.1	22.8	
Magnesium	Saturated Paste	meq/L	0.61	0.17	0.59	0.02
Magnesium	Saturated Paste	mg/kg	3.7	1.0	3.9	
Sodium	Saturated Paste	meq/L	0.22	0.10	0.08	0.04
Sodium	Saturated Paste	mg/kg	3	1	1	
Potassium	Saturated Paste	meq/L	0.04	0.04	<0.03	0.03
Potassium	Saturated Paste	mg/kg	<1	<1	<1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-39	1017944-40	1017944-41
		Sample Date	Jul 27, 2014	Jul 27, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4211PM-Bm / 21- 34 / cm	GM4211PM-Ck / 34- 100 / cm	GM4544RH-Bm / 14- 45 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	6.4		5.0
CCE	as CaCO3	%		19.1	0.2

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		Reference Number	1017944-40	1017944-47	1017944-48	
		Sample Date	Jul 27, 2014	Jul 25, 2014	Jul 25, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4211PM-Ck / 34- 100 / cm	GM4130VL-C / 42- 60 / cm	GM4130VL-Cgj / 60- 90 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Loam	Loam	
Sand	50 µm - 2 mm	% by weight	71.0	31.7	35.0	0.1
Silt	2 µm - 50 µm	% by weight	19.0	43.3	39.0	0.1
Clay	<2 µm	% by weight	10.0	25.0	26.0	0.1
Salinity						
pH	Saturated Paste	pH	7.8	7.2	7.0	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.28	0.30	0.43	0.01
SAR	Saturated Paste		<0.1	<0.1	0.1	
% Saturation		%	45	90	79	
Calcium	Saturated Paste	meq/L	2.63	1.85	2.03	0.01
Calcium	Saturated Paste	mg/kg	23.5	33.3	32.2	
Magnesium	Saturated Paste	meq/L	0.40	1.45	1.91	0.02
Magnesium	Saturated Paste	mg/kg	2.1	15.8	18.4	
Sodium	Saturated Paste	meq/L	0.08	0.09	0.15	0.04
Sodium	Saturated Paste	mg/kg	<1	2	3	
Potassium	Saturated Paste	meq/L	0.03	0.07	0.08	0.03
Potassium	Saturated Paste	mg/kg	<1	2	3	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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		Reference Number	1017944-44	1017944-45	1017944-46
		Sample Date	Jul 25, 2014	Jul 27, 2014	Jul 25, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4161JJ-Bm / 8- 80 / cm	GM4196PM-Bm / 33- 41 / cm	GM4130VL-Om / 0- 42 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:Water	pH			7.4
pH	1:2 Soil:CaCl2 sol.	pH	5.2	5.1	

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Lot ID: **1017944**
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		Reference Number	1017944-49	1017944-50	1017944-51	
		Sample Date	Jul 26, 2014	Jul 26, 2014	Jul 26, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4650VL-Ah / 0-24 / cm	GM4650VL-AB / 24-40 / cm	GM4650VL-IIBm / 40-58 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	68.0	55.0	64.0	0.1
Silt	2 µm - 50 µm	% by weight	24.0	32.0	25.0	0.1
Clay	<2 µm	% by weight	8.0	13.0	11.0	0.1
Salinity						
pH	Saturated Paste	pH	5.1	5.4	5.6	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.63	0.15	0.09	0.01
SAR	Saturated Paste		<0.1	<0.1	0.2	
% Saturation		%	70	61	45	
Calcium	Saturated Paste	meq/L	2.52	0.90	0.53	0.01
Calcium	Saturated Paste	mg/kg	35.4	11.0	4.9	
Magnesium	Saturated Paste	meq/L	1.50	0.36	0.23	0.02
Magnesium	Saturated Paste	mg/kg	12.7	2.7	1.3	
Sodium	Saturated Paste	meq/L	0.06	0.07	0.11	0.04
Sodium	Saturated Paste	mg/kg	1	<1	1	
Potassium	Saturated Paste	meq/L	1.27	0.14	0.06	0.03
Potassium	Saturated Paste	mg/kg	35	3	1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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		Reference Number	1017944-49	1017944-54	1017944-57
		Sample Date	Jul 26, 2014	Jul 25, 2014	Jul 25, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4650VL-Ah / 0-24	GM4140VL-LFH / 9-	GM4140VL-Ck / 55-
			/ cm	0 / cm	90 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:Water	pH		6.7	
pH	1:2 Soil:Water	pH	5.6		
CCE	as CaCO ₃	%			15.7
					Nominal Detection Limit 0.2

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		Reference Number	1017944-50	1017944-88	1017944-101
		Sample Date	Jul 26, 2014	Jul 28, 2014	Jul 28, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4650VL-AB / 24-40 / cm	GM4575DM-Ah / 0-17 / cm	GM4107JJ-Ah / 0-9 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Classification					
C:N Ratio			11		
Organic Matter	%		15.4		0.15
Carbon	Total Organic	% dry weight	4.46	7.69	0.05
Nitrogen	Total	% dry weight		0.72	0.02

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Lot ID: **1017944**
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		Reference Number	1017944-52	1017944-53	1017944-55
		Sample Date	Jul 26, 2014	Jul 26, 2014	Jul 25, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4650VL-IIc / 58-75 / cm	GM4650VL-IIIC / 75-110 / cm	GM4140VL-Ae / 0-5 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties					
Texture		Sandy Loam	Sandy Loam	Loam	
Sand	50 µm - 2 mm	% by weight	63.4	66.0	45.0
Silt	2 µm - 50 µm	% by weight	24.6	24.0	39.0
Clay	<2 µm	% by weight	12.0	10.0	16.0
Salinity					
pH	Saturated Paste	pH	5.6	6.3	5.2
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.13	0.11	0.13
SAR	Saturated Paste		0.1	0.2	0.2
% Saturation		%	48	47	57
Calcium	Saturated Paste	meq/L	0.80	0.55	0.89
Calcium	Saturated Paste	mg/kg	7.7	5.1	10.2
Magnesium	Saturated Paste	meq/L	0.35	0.29	0.24
Magnesium	Saturated Paste	mg/kg	2.0	1.7	1.7
Sodium	Saturated Paste	meq/L	0.11	0.12	0.18
Sodium	Saturated Paste	mg/kg	1	1	2
Potassium	Saturated Paste	meq/L	0.05	0.06	0.09
Potassium	Saturated Paste	mg/kg	<1	1	2
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1

Analytical Report

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Lot ID: **1017944**
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		Reference Number	1017944-56	1017944-57	1017944-59
		Sample Date	Jul 25, 2014	Jul 25, 2014	Jul 26, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4140VL-Bt / 5-55	GM4140VL-Ck / 55-	GM4200PM-Bm / 0-
			/ cm	90 / cm	16 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties					
Texture		Clay Loam	Silt Loam	Loam	
Sand	50 µm - 2 mm	% by weight	24.0	23.0	48.0
Silt	2 µm - 50 µm	% by weight	40.0	57.0	40.0
Clay	<2 µm	% by weight	36.0	20.0	12.0
Salinity					
pH	Saturated Paste	pH	6.6	7.9	4.8
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.25	0.35	0.08
SAR	Saturated Paste		0.1	0.1	0.2
% Saturation		%	59	50	51
Calcium	Saturated Paste	meq/L	2.04	2.84	0.37
Calcium	Saturated Paste	mg/kg	24.2	28.6	3.8
Magnesium	Saturated Paste	meq/L	0.54	0.54	0.17
Magnesium	Saturated Paste	mg/kg	3.9	3.3	1.1
Sodium	Saturated Paste	meq/L	0.16	0.15	0.09
Sodium	Saturated Paste	mg/kg	2	2	1
Potassium	Saturated Paste	meq/L	0.06	<0.03	0.06
Potassium	Saturated Paste	mg/kg	1	<1	1
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1

Analytical Report

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ID: 14-00201-01
Name: Grassy Mountain
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Lot ID: **1017944**
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Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-58	1017944-59	1017944-67
		Sample Date	Jul 26, 2014	Jul 26, 2014	Jul 26, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4200PM-LFH / 4-	GM4200PM-Bm / 0-	GM4087RH-Bm / 17-
			0 / cm	16 / cm	50 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:Water	pH	5.1		
pH	1:2 Soil:CaCl2 sol.	pH		3.8	4.4

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		Reference Number	1017944-60	1017944-73	1017944-74	
		Sample Date	Jul 26, 2014	Jul 25, 2014	Jul 25, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4200PM-BC / 16-33 / cm	GM4653VL-Ae / 0-10 / cm	GM4653VL-Bt / 10-45 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Loam	Loam	
Sand	50 µm - 2 mm	% by weight	51.0	36.6	48.6	0.1
Silt	2 µm - 50 µm	% by weight	37.0	43.4	31.0	0.1
Clay	<2 µm	% by weight	12.0	20.0	20.4	0.1
Salinity						
pH	Saturated Paste	pH	5.2	6.7	7.6	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.06	0.30	0.31	0.01
SAR	Saturated Paste		0.2	<0.1	<0.1	
% Saturation		%	38	60	51	
Calcium	Saturated Paste	meq/L	0.23	2.31	2.58	0.01
Calcium	Saturated Paste	mg/kg	1.8	27.7	26.3	
Magnesium	Saturated Paste	meq/L	0.13	0.65	0.54	0.02
Magnesium	Saturated Paste	mg/kg	0.6	4.7	3.3	
Sodium	Saturated Paste	meq/L	0.09	0.10	0.11	0.04
Sodium	Saturated Paste	mg/kg	<1	1	1	
Potassium	Saturated Paste	meq/L	0.07	0.24	0.07	0.03
Potassium	Saturated Paste	mg/kg	1	6	1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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		Reference Number	1017944-72	1017944-75	1017944-76
		Sample Date	Jul 25, 2014	Jul 25, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4653VL-LFH / 4- 0 / cm	GM4653VL-Ck / 45- 100 / cm	GM4406DL-LFH / 4- 0 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:Water	pH	6.8		6.1
CCE	as CaCO ₃	%		18.6	0.2

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		Reference Number	1017944-75	1017944-76	1017944-77	
		Sample Date	Jul 25, 2014	Jul 24, 2014	Jul 24, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4653VL-Ck / 45- 100 / cm	GM4406DL-LFH / 4- 0 / cm	GM4406DL-Ae / 0-2 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Sandy Loam	Loam	
Sand	50 µm - 2 mm	% by weight	45.0	47.5	36.0	0.1
Silt	2 µm - 50 µm	% by weight	34.0	45.0	48.0	0.1
Clay	<2 µm	% by weight	21.0	7.5	16.0	0.1

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		Reference Number	1017944-75	1017944-77	1017944-78	
		Sample Date	Jul 25, 2014	Jul 24, 2014	Jul 24, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4653VL-Ck / 45- 100 / cm	GM4406DL-Ae / 0-2 / cm	GM4406DL-Btj / 2-38 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	7.9	5.3	5.7	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.38	0.14	0.07	0.01
SAR	Saturated Paste		0.1	0.1	0.2	
% Saturation		%	49	73	57	
Calcium	Saturated Paste	meq/L	3.01	0.80	0.41	0.01
Calcium	Saturated Paste	mg/kg	29.7	11.5	4.7	
Magnesium	Saturated Paste	meq/L	0.64	0.36	0.19	0.02
Magnesium	Saturated Paste	mg/kg	3.8	3.1	1.3	
Sodium	Saturated Paste	meq/L	0.17	0.08	0.10	0.04
Sodium	Saturated Paste	mg/kg	2	1	1	
Potassium	Saturated Paste	meq/L	0.08	0.24	0.08	0.03
Potassium	Saturated Paste	mg/kg	2	7	2	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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		Reference Number	1017944-78	1017944-79	1017944-80
		Sample Date	Jul 24, 2014	Jul 24, 2014	Jul 24, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4406DL-Btj / 2-38	GM4406DL-BC / 38-	GM4406DL-C / 67-
			/ cm	67 / cm	90 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties					
Texture		Loam	Loam	Loam	
Sand	50 µm - 2 mm	% by weight	41.0	40.6	49.0
Silt	2 µm - 50 µm	% by weight	41.0	38.4	33.0
Clay	<2 µm	% by weight	18.0	21.0	18.0

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Reference Number		1017944-78	1017944-85	1017944-86	
Sample Date		Jul 24, 2014	Jul 27, 2014	Jul 27, 2014	
Sample Time		NA	NA	NA	
Sample Location					
Sample Description		GM4406DL-Btj / 2-38	GM4177JJ-LFH / 7-0	GM4177JJ-Bm / 0-	
		/ cm	/ cm	25 / cm	
Matrix		Soil	Soil	Soil	
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:Water	pH	5.6		
pH	1:2 Soil:CaCl2 sol.	pH	4.6	4.8	

Analytical Report

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6111-91 Street
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T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
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		Reference Number	1017944-79	1017944-80	1017944-86	
		Sample Date	Jul 24, 2014	Jul 24, 2014	Jul 27, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4406DL-BC / 38- 67 / cm	GM4406DL-C / 67- 90 / cm	GM4177JJ-Bm / 0- 25 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	6.0	6.1	5.6	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.08	0.09	0.14	0.01
SAR	Saturated Paste		0.2	0.2	<0.1	
% Saturation		%	40	38	65	
Calcium	Saturated Paste	meq/L	0.56	0.60	0.63	0.01
Calcium	Saturated Paste	mg/kg	4.5	4.5	8.2	
Magnesium	Saturated Paste	meq/L	0.27	0.28	0.33	0.02
Magnesium	Saturated Paste	mg/kg	1.3	1.3	2.6	
Sodium	Saturated Paste	meq/L	0.13	0.14	0.06	0.04
Sodium	Saturated Paste	mg/kg	1	1	<1	
Potassium	Saturated Paste	meq/L	0.08	0.08	0.49	0.03
Potassium	Saturated Paste	mg/kg	1	1	12	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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Lot ID: **1017944**
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		Reference Number	1017944-86	1017944-87	1017944-88	
		Sample Date	Jul 27, 2014	Jul 27, 2014	Jul 28, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4177JJ-Bm / 0-25 / cm	GM4177JJ-C / 25-75 / cm	GM4575DM-Ah / 0-17 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Sandy Loam	Loam	
Sand	50 µm - 2 mm	% by weight	46.0	53.0	44.0	0.1
Silt	2 µm - 50 µm	% by weight	36.0	29.0	44.0	0.1
Clay	<2 µm	% by weight	18.0	18.0	12.0	0.1

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		Reference Number	1017944-87	1017944-88	1017944-89	
		Sample Date	Jul 27, 2014	Jul 28, 2014	Jul 28, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4177JJ-C / 25-75	GM4575DM-Ah / 0-	GM4575DM-Bm /	
			/ cm	17 / cm	17-45 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	5.6	6.6	6.1	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.14	0.39	0.14	0.01
SAR	Saturated Paste		0.1	<0.1	0.1	
% Saturation		%	42	91	61	
Calcium	Saturated Paste	meq/L	0.97	2.70	1.13	0.01
Calcium	Saturated Paste	mg/kg	8.2	49.1	13.9	
Magnesium	Saturated Paste	meq/L	0.28	0.82	0.35	0.02
Magnesium	Saturated Paste	mg/kg	1.4	9.0	2.6	
Sodium	Saturated Paste	meq/L	0.12	0.07	0.10	0.04
Sodium	Saturated Paste	mg/kg	1	1	1	
Potassium	Saturated Paste	meq/L	0.17	0.78	0.16	0.03
Potassium	Saturated Paste	mg/kg	3	28	4	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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		Reference Number	1017944-88	1017944-89	1017944-91
		Sample Date	Jul 28, 2014	Jul 28, 2014	Jul 27, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4575DM-Ah / 0-17 / cm	GM4575DM-Bm / 17-45 / cm	GM4221VL-Bm / 9-39 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH		5.0	3.7
pH	1:2 Soil:Water	pH	6.6		

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		Reference Number	1017944-89	1017944-90	1017944-93	
		Sample Date	Jul 28, 2014	Jul 28, 2014	Jul 27, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4575DM-Bm / 17-45 / cm	GM4575DM-C / 45- 100 / cm	GM4176JJ-Ae / 0-10 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Clay Loam	Loam	Loam	
Sand	50 µm - 2 mm	% by weight	50.0	44.0	39.0	0.1
Silt	2 µm - 50 µm	% by weight	27.6	31.0	44.0	0.1
Clay	<2 µm	% by weight	22.4	25.0	17.0	0.1

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		Reference Number	1017944-90	1017944-93	1017944-94	
		Sample Date	Jul 28, 2014	Jul 27, 2014	Jul 27, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4575DM-C / 45- 100 / cm	GM4176JJ-Ae / 0-10 / cm	GM4176JJ-Bm / 10- 38 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	6.2	5.4	5.0	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.14	0.12	0.07	0.01
SAR	Saturated Paste		0.1	<0.1	0.2	
% Saturation		%	47	53	48	
Calcium	Saturated Paste	meq/L	1.15	0.77	0.31	0.01
Calcium	Saturated Paste	mg/kg	10.9	8.3	3.0	
Magnesium	Saturated Paste	meq/L	0.33	0.29	0.13	0.02
Magnesium	Saturated Paste	mg/kg	1.9	1.9	0.8	
Sodium	Saturated Paste	meq/L	0.12	0.06	0.08	0.04
Sodium	Saturated Paste	mg/kg	1	<1	<1	
Potassium	Saturated Paste	meq/L	0.14	0.19	0.11	0.03
Potassium	Saturated Paste	mg/kg	3	4	2	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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		Reference Number	1017944-92	1017944-94	1017944-103
		Sample Date	Jul 27, 2014	Jul 27, 2014	Jul 28, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4176JJ-LFH / 2-0	GM4176JJ-Bm / 10-	GM4107JJ-Bm / 23-
			/ cm	38 / cm	36 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:Water	pH	6.2		
pH	1:2 Soil:CaCl2 sol.	pH		4.0	6.6

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		Reference Number	1017944-94	1017944-95	1017944-96	
		Sample Date	Jul 27, 2014	Jul 27, 2014	Jul 27, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4176JJ-Bm / 10-38 / cm	GM4176JJ-BC / 38-61 / cm	GM4176JJ-C / 61-80 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Loam	Loam	
Sand	50 µm - 2 mm	% by weight	43.0	45.0	45.0	0.1
Silt	2 µm - 50 µm	% by weight	34.0	33.0	37.4	0.1
Clay	<2 µm	% by weight	23.0	22.0	17.6	0.1

Analytical Report

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		Reference Number	1017944-95	1017944-96	1017944-101	
		Sample Date	Jul 27, 2014	Jul 27, 2014	Jul 28, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4176JJ-BC / 38-61 / cm	GM4176JJ-C / 61-80 / cm	GM4107JJ-Ah / 0-9 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	5.0	5.0	6.8	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.04	0.04	0.64	0.01
SAR	Saturated Paste		0.2	0.2	<0.1	
% Saturation		%	39	34	130	
Calcium	Saturated Paste	meq/L	0.15	0.17	5.10	0.01
Calcium	Saturated Paste	mg/kg	1.2	1.2	132	
Magnesium	Saturated Paste	meq/L	0.09	0.07	1.44	0.02
Magnesium	Saturated Paste	mg/kg	0.4	0.3	22.6	
Sodium	Saturated Paste	meq/L	0.07	0.08	0.15	0.04
Sodium	Saturated Paste	mg/kg	<1	<1	4	
Potassium	Saturated Paste	meq/L	0.04	0.04	0.30	0.03
Potassium	Saturated Paste	mg/kg	<1	<1	15	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

		Reference Number	1017944-101	1017944-102	1017944-103	
		Sample Date	Jul 28, 2014	Jul 28, 2014	Jul 28, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4107JJ-Ah / 0-9 /	GM4107JJ-AB / 9-23	GM4107JJ-Bm / 23-	
			cm	/ cm	36 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Silt Loam	Silt Loam	
Sand	50 µm - 2 mm	% by weight	48.3	33.3	28.3	0.1
Silt	2 µm - 50 µm	% by weight	35.0	53.3	56.7	0.1
Clay	<2 µm	% by weight	16.7	13.3	15.0	0.1

Analytical Report

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		Reference Number	1017944-102	1017944-103	1017944-105	
		Sample Date	Jul 28, 2014	Jul 28, 2014	Jul 28, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4107JJ-AB / 9-23	GM4107JJ-Bm / 23-	GM4250DL-C / 0-25	
		Matrix	/ cm Soil	36 / cm Soil	/ cm Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	7.1	7.1	4.6	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.23	0.22	0.06	0.01
SAR	Saturated Paste		0.1	0.1	0.2	
% Saturation		%	104	101	57	
Calcium	Saturated Paste	meq/L	2.00	1.83	0.23	0.01
Calcium	Saturated Paste	mg/kg	41.7	36.8	2.7	
Magnesium	Saturated Paste	meq/L	0.55	0.55	0.12	0.02
Magnesium	Saturated Paste	mg/kg	7.0	6.7	0.9	
Sodium	Saturated Paste	meq/L	0.16	0.14	0.07	0.04
Sodium	Saturated Paste	mg/kg	4	3	<1	
Potassium	Saturated Paste	meq/L	0.05	<0.03	0.10	0.03
Potassium	Saturated Paste	mg/kg	2	1	2	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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		Reference Number	1017944-102	1017944-119	1017944-130
		Sample Date	Jul 28, 2014	Aug 29, 2014	Jul 30, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4107JJ-AB / 9-23	GM4254DL-Ah / 0-19 / cm	GM4455DM-Ah / 0-25 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Classification					
C:N Ratio			20	28	
Organic Matter	%		15.4	12.8	0.15
Carbon	Total Organic	% dry weight	5.68	7.70	0.05
Nitrogen	Total	% dry weight		0.38	0.02

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		Reference Number	1017944-104	1017944-108	1017944-114
		Sample Date	Jul 28, 2014	Jul 27, 2014	Aug 29, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4250DL-LFH / 8- 0 / cm	GM4049DL-Bm / 8- 38 / cm	GM4612VL-LF / 0-4 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:Water	pH	4.7		5.9
pH	1:2 Soil:CaCl2 sol.	pH		4.5	

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		Reference Number	1017944-105	1017944-115	1017944-116	
		Sample Date	Jul 28, 2014	Aug 29, 2014	Aug 29, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4250DL-C / 0-25	GM4612VL-Ae / 0-5 /	GM4612VL-Bm / 5-	
			/ cm	cm	19 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Clay Loam	Silt Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	54.6	38.0	58.0	0.1
Silt	2 µm - 50 µm	% by weight	25.4	50.0	32.0	0.1
Clay	<2 µm	% by weight	20.0	12.0	10.0	0.1

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		Reference Number	1017944-115	1017944-116	1017944-117	
		Sample Date	Aug 29, 2014	Aug 29, 2014	Aug 29, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4612VL-Ae / 0-5 /	GM4612VL-Bm / 5-	GM4612VL-C / 19-	
			cm	19 / cm	30 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	5.2	6.0	6.1	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.21	0.09	0.07	0.01
SAR	Saturated Paste		0.1	0.2	0.2	
% Saturation		%	71	51	36	
Calcium	Saturated Paste	meq/L	1.46	0.61	0.50	0.01
Calcium	Saturated Paste	mg/kg	20.7	6.2	3.6	
Magnesium	Saturated Paste	meq/L	0.48	0.21	0.17	0.02
Magnesium	Saturated Paste	mg/kg	4.1	1.3	0.7	
Sodium	Saturated Paste	meq/L	0.11	0.15	0.14	0.04
Sodium	Saturated Paste	mg/kg	2	2	1	
Potassium	Saturated Paste	meq/L	0.26	0.09	0.06	0.03
Potassium	Saturated Paste	mg/kg	7	2	<1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

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		Reference Number	1017944-116	1017944-119	1017944-120
		Sample Date	Aug 29, 2014	Aug 29, 2014	Aug 29, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4612VL-Bm / 5-19 / cm	GM4254DL-Ah / 0-19 / cm	GM4254DL-Bm / 17-40 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	5.2		6.0
pH	1:2 Soil:Water	pH		7.2	

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		Reference Number	1017944-117	1017944-118	1017944-119	
		Sample Date	Aug 29, 2014	Aug 29, 2014	Aug 29, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4612VL-C / 19-30 / cm	GM4612VL-IIC / 30-60 / cm	GM4254DL-Ah / 0-19 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Loamy Sand	Clay	
Sand	50 µm - 2 mm	% by weight	69.0	82.0	31.7	0.1
Silt	2 µm - 50 µm	% by weight	25.0	14.0	21.7	0.1
Clay	<2 µm	% by weight	6.0	4.0	46.7	0.1

Analytical Report

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

		Reference Number	1017944-118	1017944-119	1017944-120	
		Sample Date	Aug 29, 2014	Aug 29, 2014	Aug 29, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4612VL-IIC / 30-60 / cm	GM4254DL-Ah / 0-19 / cm	GM4254DL-Bm / 17-40 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	6.1	6.9	6.8	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.06	0.41	0.23	0.01
SAR	Saturated Paste		0.3	<0.1	0.1	
% Saturation		%	37	134	63	
Calcium	Saturated Paste	meq/L	0.32	3.60	1.88	0.01
Calcium	Saturated Paste	mg/kg	2.4	96.1	23.5	
Magnesium	Saturated Paste	meq/L	0.13	1.07	0.57	0.02
Magnesium	Saturated Paste	mg/kg	0.6	17.3	4.3	
Sodium	Saturated Paste	meq/L	0.13	0.13	0.14	0.04
Sodium	Saturated Paste	mg/kg	1	4	2	
Potassium	Saturated Paste	meq/L	0.06	0.08	0.04	0.03
Potassium	Saturated Paste	mg/kg	<1	4	<1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

		Reference Number	1017944-119	1017944-130	
		Sample Date	Aug 29, 2014	Jul 30, 2014	
		Sample Time	NA	NA	
		Sample Location			
		Sample Description	GM4254DL-Ah / 0-19 / cm	GM4455DM-Ah / 0-25 / cm	
		Matrix	Soil	Soil	
Analyte		Units	Results	Results	Nominal Detection Limit
Available Nutrients					
Potassium	Farmsoil	ppm	228	159	25
Base saturation	FS Base Saturation	%	100	100	
Calcium	FS Base Saturation	%	84.6	89.4	
Magnesium	FS Base Saturation	%	13.9	8.9	
Sodium	FS Base Saturation	%	<0.3	<0.5	
Potassium	FS Base Saturation	%	1.6	1.7	
TEC	FS Base Saturation	meq/100g	37.6	24.0	
Calcium	FS Macro-nutrients	ppm	6370	4310	30
Magnesium	FS Macro-nutrients	ppm	635	259	5
Sodium	FS Macro-nutrients	ppm	<30	<30	30
Lime Requirement					
pH	SMP	pH	Not Required	Not Required	

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-120	1017944-130	1017944-131	
		Sample Date	Aug 29, 2014	Jul 30, 2014	Jul 30, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4254DL-Bm / 17-40 / cm	GM4455DM-Ah / 0-25 / cm	GM4455DM-Ck / 25-45 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam	Sandy Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	39.0	56.7	58.3	0.1
Silt	2 µm - 50 µm	% by weight	29.0	26.7	31.7	0.1
Clay	<2 µm	% by weight	32.0	16.7	10.0	0.1

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-129	1017944-130	1017944-131
		Sample Date	Jul 30, 2014	Jul 30, 2014	Jul 30, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4455DM-FH / 1-0	GM4455DM-Ah / 0-	GM4455DM-Ck / 25-
			/ cm	25 / cm	45 / cm
		Matrix	Soil	Soil	Soil
Analyte		Units	Results	Results	Results
Soil Acidity					
pH	1:2 Soil:Water	pH	7.0		
pH	1:2 Soil:Water	pH		7.5	
CCE	as CaCO ₃	%			>25.0
					Nominal Detection Limit 0.2

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-130	1017944-131	1017944-145	
		Sample Date	Jul 30, 2014	Jul 30, 2014	Jul 29, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4455DM-Ah / 0-25 / cm	GM4455DM-Ck / 25-45 / cm	GM4402VL-Ae / 0-10 / cm	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Salinity						
pH	Saturated Paste	pH	7.4	7.8	5.9	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.52	0.48	0.35	0.01
SAR	Saturated Paste		<0.1	<0.1	<0.1	
% Saturation		%	72	63	123	
Calcium	Saturated Paste	meq/L	4.64	4.54	3.31	0.01
Calcium	Saturated Paste	mg/kg	66.8	57.0	81.4	
Magnesium	Saturated Paste	meq/L	1.02	0.80	1.04	0.02
Magnesium	Saturated Paste	mg/kg	8.9	6.1	15.5	
Sodium	Saturated Paste	meq/L	0.12	0.13	0.14	0.04
Sodium	Saturated Paste	mg/kg	2	2	4	
Potassium	Saturated Paste	meq/L	0.17	0.13	0.72	0.03
Potassium	Saturated Paste	mg/kg	5	3	35	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

		Reference Number	1017944-132	1017944-136	1017944-139
		Sample Date	Jul 29, 2014	Jul 28, 2014	Jul 29, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4474VL-Bm / 6-32 / cm	GM4428VL-Bm / 6-31 / cm	GM4204PM-Bm / 11-41 / cm
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	5.7	6.5	6.4

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

Reference Number	1017944-143	1017944-144
Sample Date	Jul 30, 2014	Jul 29, 2014
Sample Time	NA	NA
Sample Location		
Sample Description	GM4057RH-C / 8-35	GM4402VL-LFH / 5-
	/ cm	0 / cm
Matrix	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity						
pH	1:2 Soil:Water	pH		5.5		
pH	1:2 Soil:CaCl2 sol.	pH	5.2			

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

Reference Number	1017944-145	1017944-146
Sample Date	Jul 29, 2014	Jul 29, 2014
Sample Time	NA	NA
Sample Location		
Sample Description	GM4402VL-Ae / 0-10 / cm	GM4402VL-Bt / 10-43 / cm
Matrix	Soil	Soil

Analyte	Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties					
Texture		Sandy Loam	Loam		
Sand	50 µm - 2 mm	% by weight	56.7	41.7	0.1
Silt	2 µm - 50 µm	% by weight	26.7	35.0	0.1
Clay	<2 µm	% by weight	16.7	23.3	0.1

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

Reference Number 1017944-146
Sample Date Jul 29, 2014
Sample Time NA
Sample Location
Sample Description GM4402VL-Bt / 10-
43 / cm
Matrix Soil

Analyte		Units	Results	Results	Nominal Detection Limit
Salinity					
pH	Saturated Paste	pH	5.4		
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.20		0.01
SAR	Saturated Paste		0.2		
% Saturation		%	69		
Calcium	Saturated Paste	meq/L	1.28		0.01
Calcium	Saturated Paste	mg/kg	17.7		
Magnesium	Saturated Paste	meq/L	0.36		0.02
Magnesium	Saturated Paste	mg/kg	3.0		
Sodium	Saturated Paste	meq/L	0.17		0.04
Sodium	Saturated Paste	mg/kg	3		
Potassium	Saturated Paste	meq/L	0.16		0.03
Potassium	Saturated Paste	mg/kg	4		
TGR	Saturated Paste	T/ac	<0.1		

<Original signed by>

Approved by:

Darlene Lintott, MSc
Consulting Scientist

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).

Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.

Methodology and Notes

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1017944
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number:
6111-91 Street	Name: Grassy Mountain	Date Received: Aug 1, 2014
Edmonton, AB, Canada	Location: Blairmore	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974016
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

Method of Analysis

Method Name	Reference	Method	Date Analysis Started	Location
Calcium Carbonate in Soil (Dual pH)	Comm. Soil Sci. Pl. Anal.	* Improvement to Two Routine Methods for CaCO ₃ in Soil, Vol 28, 1997	05-Dec-14	Exova Edmonton
Carbon and Nitrogen in soil (FSJ)	SSSA Book Series 5	* Nitrogen-Total, Ch 37	17-Dec-14	Exova Fort St. John
Carbon and Nitrogen in soil (FSJ)	SSSA Book Series 5	* Total Carbon, Organic Carbon, and Organic Matter, Ch 34	17-Dec-14	Exova Fort St. John
Macronutrients in Farm Soils	McKeague	* Ammonium Acetate Extractable Cations, 4.51	05-Dec-14	Exova Edmonton
Nutrients in Farm Soil	Comm. Soil Sci. Pl. Anal.	* Modified Kelowna Soil Test, Vol 26, 1995	05-Dec-14	Exova Edmonton
Particle Size Analysis - GS	Carter	* Hydrometer Method, 55.3	05-Dec-14	Exova Edmonton
pH and Conductivity in farm soil	McKeague	* 1:2 Soil:Water Ratio, 4.12	05-Dec-14	Exova Edmonton
pH and Conductivity in general soil 1:2	McKeague	* 1:2 Soil:Water Ratio, 4.12	05-Dec-14	Exova Edmonton
pH by CaCl ₂ (1:2 ratio) in soil	McKeague	* pH in 0.01M Calcium Chloride, 3.11	05-Dec-14	Exova Edmonton
Saturated Paste in General Soil	Carter	* Electrical Conductivity and Soluble Ions, Chapter 15	05-Dec-14	Exova Edmonton
SMP Lime Requirements	Carter	* Shoemaker-Mclean-Pratt Single-Buffer Method, 12.2	05-Dec-14	Exova Edmonton

** Reference Method Modified*

References

Carter	Soil Sampling and Methods of Analysis.
Comm. Soil Sci. Pl.	Communications in Soil Science and Plant Analysis
McKeague	Manual on Soil Sampling and Methods of Analysis
SSSA Book Series 5	Methods of Soil Analysis, Part 3

Comments:

- Report was issued to include addition of analysis on lot 1017944 requested by Vadim Lyzhin of MEMS on Dec. 3, 2014.

Methodology and Notes

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location: Blairmore
LSD:
P.O.:
Acct code:

Lot ID: **1017944**
Control Number:
Date Received: Aug 1, 2014
Date Reported: Dec 19, 2014
Report Number: 1974016

Please direct any inquiries regarding this report to our Client Services group.

Results relate only to samples as submitted.

The test report shall not be reproduced except in full, without the written approval of the laboratory.



Billing Information

Company: Millennium EMS Solutions
 Address: 6111 91st ST NW
Edmonton, AB
 Attention: Vadim Lyzhin
 Phone: (780) 496-9048
 Cell: (587) 987-6802
 Fax: (780) 496-9049
 E-mail: vlyzhin@meas.ca
 Agreement ID:
 Copy of report:

Copy of Report To:

Company:
 Address:
 Attention: same as
 Phone: billing
 Cell:
 Fax:
 E-mail:
 Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Project Information

Project ID: 14-0201-01
 Project Name: Gassy Mountain
 Project Location: Blainville
 Legal Location:
 PO/AFE#:
 Proj. Acct. Code:

Attention:
 Phone:
 Cell:
 Fax:
 E-mail:
 Agreement ID:
 Copy of report:

Attention:
 Phone:
 Cell:
 Fax:
 E-mail:
 Copy of invoice:

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

AUG 1 PM 5:42

Report Results ☒ E-mail ☐ Online ☐
☐ Mail ☐ Fax ☒ PDF ☒ Excel

QA/QC Report

Special Instructions/Comments (please include contact information including ph. # if different from above).

Include Regulatory
 Requirements Below:

please hold until further notice

Number of Containers

Sample Identification	Location	Depth IN (CM) M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)										Indicate below any deficiencies in the condition of samples:	
1 GM4467DL-Ah		0-38	July 23, 2014	soil	grab	1											Were Exova supplies used?	
2 GM4467DL-AB		38-100	July 23, 2014	soil	grab	1											Was there any damage to the shipping container?	
3 GM4089JJ-Bm		20-55	July 24, 2014	soil	grab	1											Were the containers packaged well?	
4 GM4421JJ-Bm		19-85	July 25, 2014	soil	grab	1											Were any extra samples received (document below)?	
5 GM4386RH-Bm		8-41	July 25, 2014	soil	grab	1											Are samples within recommended holding times/temp?	
6 GM4093JJ-Bm		22-43	July 24, 2014	soil	grab	1												
7 GM4097JJ-Bm		22-50	July 24, 2014	soil	grab	1												
8 GM4111VL-Ah		0-15	July 23, 2014	soil	grab	1												
9 GM4111VL-AB		15-24	July 23, 2014	soil	grab	1												
10 GM4111VL-Bm		24-42	July 23, 2014	soil	grab	1												
11 GM4111VL-CK		42-110	July 23, 2014	soil	grab	1												
12 GM4384JJ-Bm		7-28	July 24, 2014	soil	grab	1												
13 GM4485VL-LF		3-0	July 24, 2014	soil	grab	1												
14 GM4485VL-C1		0-11	July 24, 2014	soil	grab	1												
15 GM4465VL-C2		11-50	July 24, 2014	soil	grab	1												

Environmental Sample Information Sheet

Indicate lot number or affix lot label here:

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 1 of 10

Control # B03164

1017944

Shipping:

COD Y/N

Cooler temp:

25.62

and size of coolers received:

Delivery Method:

Waybill:

Received by:

<Original signed by>



Billing Information

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Agreement ID:

Copy of report:

Copy of Report To:

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

Project Information

Project ID: 14-00201-01

Project Name: Grassy 1st tail

Project Location: Blairmore

Legal Location:

PO/AFE#:

Proj. Acct. Code:

Report Results



E-mail

Mail

Online

Fax

PDF

Excel

QA/QC Report

Include Regulatory

Requirements Below:

Special Instructions/Comments (please include contact information including ph. # if different from above).

please hold until further notice

Number of Containers

Sample Identification	Location	Depth IN CM M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4110VL-Ah		0-22	July 23, 2014	soil	grab	1		Were Exova supplies used?
2 GM4110VL-ABg		22-34	July 23, 2014	soil	grab	1		
3 GM4110VL-Bg		34-52	July 23, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4110VL-BCg		52-90	July 23, 2014	soil	grab	1		
5 GM4110VL-Cg		90-110	July 23, 2014	soil	grab	1		
6 GM4085RH-LFH		20-0	July 24, 2014	soil	grab	1		Were the containers packaged well?
7 GM4085RH-Ae		0-9	July 24, 2014	soil	grab	1		
8 GM4085RH-Bm		9-24	July 24, 2014	soil	grab	1		
9 GM4085RH-C		24-90	July 24, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4065RH-Ah		0-13	July 24, 2014	soil	grab	1		
11 GM4098RH-Bm		39-60	July 24, 2014	soil	grab	1		
12 GM4420RH-Bm		6-22	July 25, 2014	soil	grab	1		
13 GM4130RH-Bm		5-55	July 24, 2014	soil	grab	1		Are samples within recommended holding times/temp?
14 GM4394DL-Ah		0-8	July 25, 2014	soil	grab	1		
15 GM4314DL-Bm		8-90	July 25, 2014	soil	grab	1		

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:

Billing Information

Company: _____

Address: _____

Attention: _____

Phone: _____

Cell: _____

Fax: _____

E-mail: _____

Agreement ID: _____

Copy of report: _____

Copy of Report To:

Company: _____

Address: _____

Attention: _____

Phone: _____

Cell: _____

Fax: _____

E-mail: _____

Copy of invoice: _____

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Date Required _____

As Indicated _____

All Analysis _____

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature _____

Sample Custody (please print)

Sampled by: _____

Company: _____

I authorize Exova to proceed with the work indicated on this form:

Date: _____

Initial: _____

This section for Lab use only

Date/Time stamp: _____

Project Information

Project ID: 14-00201-01
Project Name: Grossy Mountain
Project Location: Blairstown
Legal Location: _____
PO/AFE#: _____
Proj. Acct. Code: _____

Report Results

☒ E-mail
☐ Mail

☐ Online
☐ Fax

☒ PDF
☐ Excel

QA/QC Report

Include Regulatory
Requirements Below:

Special Instructions/Comments (please include contact information including ph. # if different from above).

please hold until further notice

Number of Containers

Sample Identification	Location	Depth IN CM M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4128VL-LFH		5-0	July 25, 2014	soil	grab	1		Were Exova supplies used?
2 GM4128VL-Ah		0-10	July 25, 2014	soil	grab	1		
3 GM4128VL-C		10-100	July 25, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4620PM-Ah		0-12	July 25, 2014	soil	grab	1		
5 GM4620PM-C		12-40	July 25, 2014	soil	grab	1		
6 GM4620PM-Cg2		40-90	July 25, 2014	soil	grab	1		Were the containers packaged well?
7 GM4211PM-LFH		5-0	July 27, 2014	soil	grab	1		
8 GM4211PM-Ae		0-21	July 27, 2014	soil	grab	1		
9 GM4211PM-Bm		21-34	July 27, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4211PM-CK		34-100	July 27, 2014	soil	grab	1		
11 GM4544RH-Bm		14-45	July 24, 2014	soil	grab	1		
12 GM4161JJ-LFH		6-0	July 25, 2014	soil	grab	1		
13 GM4161JJ-Ae		0-8	July 25, 2014	soil	grab	1		Are samples within recommended holding times/temp?
14 GM4161JJ-Bm		8-80	July 25, 2014	soil	grab	1		
15 GM4195JM-CK		33-41	July 27, 2014	soil	grab	1		

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 3 of 10

Control # **B03166**

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:



Billing Information

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Agreement ID:

Copy of report:

Copy of Report To:

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that
surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default
to a 100% RUSH priority, with pricing and turn
around time to match. Please contact the lab prior
to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated
on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

Project Information

Project ID: 4-00201-01

Project Name: Grassy Mountain

Project Location: Baltimore

Legal Location:

PO/AFE#:

Proj. Acct. Code:

Report Results

E-mail
MailOnline
FaxPDF
Excel

QA/QC Report

Include Regulatory

Requirements Below:

Special Instructions/Comments (please include contact information including ph. # if
different from above).

please hold until further notice

Number of Containers

Sample Identification	Location	Depth IN (CM) M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4261PM-LF		2-0	July 28, 2014	soil	grab	1		Were Exova supplies used?
2 GM4261PM-Bfj		0-26	July 28, 2014	soil	grab	1		
3 GM4261PM-Bm		26-48	July 28, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4261PM-BC		48-72	July 28, 2014	soil	grab	1		
5 GM4087RH-LFH		9-0	July 26, 2014	soil	grab	1		
6 GM4087RH-AB		0-17	July 26, 2014	soil	grab	1		Were the containers packaged well?
7 GM4087RH-Bm		17-50	July 26, 2014	soil	grab	1		
8 GM4087RH-C		50-70	July 26, 2014	soil	grab	1		
9 GM4087RH-R		70-90	July 26, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4088JJ-Ah		0-15	July 26, 2014	soil	grab	1		
11 GM4088JJ-AC		15-35	July 26, 2014	soil	grab	1		
12 GM4653VL-LFH		4-0	July 25, 2014	soil	grab	1		
13 GM4653VL-Ap		0-10	July 25, 2014	soil	grab	1		
14 GM4653VL-Bfj		10-45	July 25, 2014	soil	grab	1		Are samples within recommended holding times/temp?
15 GM4653VL-CK		45-100	July 25, 2014	soil	grab	1		

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 5 of 10

Control # B03168

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:



Billing Information

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Agreement ID:

Copy of report:

Copy of Report To:

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

Project Information

Project ID: 14-00201-01

Project Name: Grassy Mountain

Project Location: Blairmore

Legal Location:

PO/AFE#:

Proj. Acct. Code:

Report Results

☒ E-mail
☐ Mail

☐ Online
☐ Fax

☒ PDF
☒ Excel

QA/QC Report

Special Instructions/Comments (please include contact information including ph. # if different from above).

please hold until further notice

Include Regulatory
Requirements Below:

Number of Containers

Sample Identification	Location	Depth IN CM M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4406DL-LFH		4-0	July 24, 2014	soil	grab	1		Were Exova supplies used?
2 GM4406DL-Ap		0-2	July 24, 2014	soil	grab	1		
3 GM4406DL-BTj		2-38	July 24, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4406DL-BC		38-67	July 24, 2014	soil	grab	1		
5 GM4406DL-C		67-90	July 24, 2014	soil	grab	1		
6 GM4653VL-LFH		4-0	July 25, 2014	soil	grab	1		Were the containers packaged well?
7 GM4653VL-Ae		0-10	July 25, 2014	soil	grab	1		
8 GM4653VL-Bt		10-45	July 25, 2014	soil	grab	1		
9 GM4653VL-CK		45-100	July 25, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM41775J-LFH		7-0	July 27, 2014	soil	grab	1		
11 GM41775J-Bm		0-25	July 27, 2014	soil	grab	1		
12 GM41775J-C		25-75	July 27, 2014	soil	grab	1		
13 GM4575DM-Ah		0-17	July 28, 2014	soil	grab	1		Are samples within recommended holding times/temp?
14 GM4575DM-Bm		17-45	July 28, 2014	soil	grab	1		
15 GM4575DM-C		45-100	July 28, 2014	soil	grab	1		

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 6 of 10

Control # B03169

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:



Billing Information

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Agreement ID:

Copy of report:

Copy of Report To:

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

Project Information

Project ID:

14-00201-01

Project Name:

Grassy Meadow

Project Location:

Plainville

Legal Location:

PO/AFE#:

Proj. Acct. Code:

Report Results

☒ E-mail
☐ Mail

☐ Online
☐ Fax

☒ PDF
☒ Excel

QA/QC Report

Include Regulatory

Requirements Below:

Special Instructions/Comments (please include contact information including ph. # if different from above).

please hold until further notice

Number of Containers

Sample Identification	Location	Depth IN (CM) M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4221VL - Bm		9-39	July 27, 2014	soil	grab	1		Were Exova supplies used?
2 GM4176JS - LFH		2-0	July 27, 2014	soil	grab	1		
3 GM4176JS - Ae		0-10	July 27, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4176JS - Bm		10-38	July 27, 2014	soil	grab	1		
5 GM4176JS - BC		38-61	July 27, 2014	soil	grab	1		
6 GM4176JS - C		61-80	July 27, 2014	soil	grab	1		Were the containers packaged well?
7 GM4580DM - LFH		5-0	July 27, 2014	soil	grab	1		
8 GM4580DM - Ae		0-7	July 27, 2014	soil	grab	1		
9 GM4580DM - Bt		7-40	July 27, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4580DM - Ck		40-100	July 27, 2014	soil	grab	1		
11 GM4107JS - Ah		0-9	July 28, 2014	soil	grab	1		
12 GM4107JS - AB		9-23	July 28, 2014	soil	grab	1		
13 GM4107JS - Bm		23-36	July 28, 2014	soil	grab	1		Are samples within recommended holding times/temp?
14 GM4250DL - LFH		8-0	July 28, 2014	soil	grab	1		
15 GM4250DL - C		0-25	July 28, 2014	soil	grab	1		

Environmental Sample Information Sheet

Indicate lot number or affix lot label here:

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 7 of 10

Control # B03170

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:



Billing Information

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Agreement ID:

Copy of report:

Copy of Report To:

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that
surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default
to a 100% RUSH priority, with pricing and turn
around time to match. Please contact the lab prior
to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated
on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

Project Information

Project ID: 14-00201-01

Project Name: Grassy Mountain

Project Location: Blairmore

Legal Location:

PO/AFE#:

Proj. Acct. Code:

Report Results

☒ E-mail
☐ Mail

☐ Online
☐ Fax

☒ PDF
☐ Excel

QA/QC Report

Special Instructions/Comments (please include contact information including ph. # if
different from above).

please hold until further notice

Include Regulatory
Requirements Below:

Number of Containers

Sample Identification	Location	Depth IN (CM) M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4049DL-LFH		6-0	July 27, 2014	soil	grab	1		Were Exova supplies used?
2 GM4049DL-AC		0-8	July 27, 2014	soil	grab	1		
3 GM4049DL-Bm		8-38	July 27, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4049DL-C		38-60	July 27, 2014	soil	grab	1		
5 GM4668VL-LFH		5-0	July 30, 2014	soil	grab	1		
6 GM4668VL-Ae		0-10	July 30, 2014	soil	grab	1		Were the containers packaged well?
7 GM4668VL-BT		10-32	July 30, 2014	soil	grab	1		
8 GM4668VL-CK		32-63	July 30, 2014	soil	grab	1		
9 GM4612VL-LF		0-4	July 29, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4612VL-Ae		0-5	July 29, 2014	soil	grab	1		
11 GM4612VL-Bm		5-19	July 29, 2014	soil	grab	1		
12 GM4612VL-C		19-30	July 29, 2014	soil	grab	1		
13 GM4612VL-TTC		30-60	July 29, 2014	soil	grab	1		Are samples within recommended holding times/temp?
14 GM4254DL-Ah		0-19	July 29, 2014	soil	grab	1		
15 GM4254DL-Bm		17-40	July 29, 2014	soil	grab	1		

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 8 of 10

Control # B03171

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:



Billing Information

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Agreement ID:

Copy of report:

Copy of Report To:

Company:

Address:

Attention:

Phone:

Cell:

Fax:

E-mail:

Copy of invoice:

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by:

Company:

I authorize Exova to proceed with the work indicated on this form:

Date:

Initial:

This section for Lab use only

Date/Time stamp:

Project Information

Project ID:

Project Name:

Project Location:

Legal Location:

PO/AFE#:

Proj. Acct. Code:

Report Results

☒ E-mail
☐ Mail

☐ Online
☐ Fax

☒ PDF
☐ Excel

QA/QC Report

Special Instructions/Comments (please include contact information including ph. # if different from above).

please hold until further notice

Include Regulatory
Requirements Below:

Number of Containers

Sample Identification	Location	Depth IN CM M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4476VL-LFH		3-0	July 29, 2014	soil	grab	1		Were Exova supplies used?
2 GM4476VL-Ae		0-12	July 29, 2014	soil	grab	1		
3 GM4476VL-Bt		12-65	July 29, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4476VL-BC		65-100	July 29, 2014	soil	grab	1		
5 GM4256DL-LFH		7-0	July 29, 2014	soil	grab	1		
6 GM4256DL-Ae		0-10	July 29, 2014	soil	grab	1		Were the containers packaged well?
7 GM4256DL-Bt		10-30	July 29, 2014	soil	grab	1		
8 GM4256DL-C		30-70	July 29, 2014	soil	grab	1		
9 GM4455DM-FH		1-0	July 30, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4455DM-Ah		0-25	July 30, 2014	soil	grab	1		
11 GM4455DM-CK		25-45	July 30, 2014	soil	grab	1		
12 GM4474VL-Bm		6-32	July 29, 2014	soil	grab	1		
13 GM4433JJ-LFH		9-0	July 29, 2014	soil	grab	1		Are samples within recommended holding times/temp?
14 GM4433JJ-Ae		-30	July 29, 2014	soil	grab	1		
15 GM4433JJ-B		3-4	July 29, 2014	soil	grab	1		

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 9 of 10

Control # B03172

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:



Billing Information

Company: _____

Address: _____

Attention: _____

Phone: _____

Cell: _____

Fax: _____

E-mail: _____

Agreement ID: _____

Copy of report: _____

Copy of Report To:

Company: _____

Address: _____

Attention: _____

Phone: _____

Cell: _____

Fax: _____

E-mail: _____

Copy of invoice: _____

RUSH Priority

Upon filling out this section, client accepts that surcharges will be applied to the analysis

Date Required

As Indicated

All Analysis

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples.

Signature

Sample Custody (please print)

Sampled by: _____

Company: _____

I authorize Exova to proceed with the work indicated on this form:

Date: _____

Initial: _____

This section for Lab use only

Date/Time stamp: _____

Project Information

Project ID: 14-00201-01

Project Name: Grassy Meadow

Project Location: Blue Ridge

Legal Location: _____

PO/AFE#: _____

Proj. Acct. Code: _____

Report Results

☒ E-mail
☐ Mail

☐ Online
☐ Fax

☒ PDF
☒ Excel

QA/QC Report

Special Instructions/Comments (please include contact information including ph. # if different from above).

please hold until further notice

Include Regulatory

Requirements Below:

Number of Containers

Sample Identification	Location	Depth IN CM M	Date/Time sampled	Matrix	Sampling Method	↓	Enter tests above (√ relevant samples below)	Indicate below any deficiencies in the condition of samples:
1 GM4428VL-Bm		6-31	July 28, 2014	soil	grab	1		Were Exova supplies used?
2 GM4204PM-LF		2-0	July 29, 2014	soil	grab	1		
3 GM4204PM-Ae		0-11	July 29, 2014	soil	grab	1		Was there any damage to the shipping container?
4 GM4204PM-Bm		11-41	July 29, 2014	soil	grab	1		
5 GM4204PM-BT		41-95	July 29, 2014	soil	grab	1		
6 GM4204PM-CK		95-110	July 29, 2014	soil	grab	1		Were the containers packaged well?
7 GM4057RH-Ah		0-8	July 30, 2014	soil	grab	1		
8 GM4057RH-C		8-35	July 30, 2014	soil	grab	1		
9 GM4402VL-LFH		5-0	July 29, 2014	soil	grab	1		Were any extra samples received (document below)?
10 GM4402VL-Ae		0-10	July 29, 2014	soil	grab	1		
11 GM4402VL-BT		10-43	July 29, 2014					
12								
13								
14								Are samples within recommended holding times/temp?
15								

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Please indicate any potentially hazardous samples

Page 10 of 10

Control # B03173

Indicate lot number or affix lot label here:

Shipping:

COD Y/N

Cooler temp:

and size of coolers received:

Delivery Method:

Waybill:

Received by:

Report Transmission Cover Page

Bill To:	Millennium EMS Solutions	Project:		Lot ID:	1026631
Report To:	Millennium EMS Solutions	ID:	14-00201-01	Control Number:	A201055
	6111-91 Street	Name:	Grassy Mountain	Date Received:	Sep 16, 2014
	Edmonton, AB, Canada	Location:		Date Reported:	Dec 19, 2014
	T6E 6V6	LSD:		Report Number:	1974612
Attn:	Vadim Lyzhin	P.O.:			
Sampled By:		Acct code:			
Company:					

Contact & Affiliation	Address	Delivery Commitments
Accounts Payable Millennium EMS Solutions	6111 - 91 Street Edmonton, Alberta T6E 6V6 Phone: (780) 496-9048 Fax: (780) 496-9049 Email: acct@mems.ca	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report
Lab Data Millennium EMS Solutions	6111-91 Street Edmonton, Alberta T6E 6V6 Phone: (780) 496-9048 Fax: (780) 496-9049 Email: labdata@mems.ca	On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports
Vadim Lyzhin Millennium EMS Solutions	6111-91 Street Edmonton, Alberta T6E 6V6 Phone: (587) 987-6802 Fax: (780) 496-9049 Email: vlyzhin@mems.ca	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report

Notes To Clients:

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Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

		Reference Number	1026631-7	1026631-9	1026631-11
		Sample Date	Sep 07, 2014	Sep 07, 2014	Sep 08, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4842DL / Bm / 0-16 / CM	GM4897PM / BM / 0-20 / CM	GM4857DL / LFH / 3-0 / CM
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:Water	pH			6.8
pH	1:2 Soil:CaCl2 sol.	pH	5.0	4.2	

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

		Reference Number	1026631-9	1026631-10	1026631-12	
		Sample Date	Sep 07, 2014	Sep 07, 2014	Sep 08, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4897PM / BM / 0-	GM4897PM / C / 20-	GM4857DL / Ahe / 0-	
			20 / CM	100 / CM	14 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Clay	
Sand	50 µm - 2 mm	% by weight	55.4	62.0	30.7	0.1
Silt	2 µm - 50 µm	% by weight	31.6	30.0	27.7	0.1
Clay	<2 µm	% by weight	13.0	8.0	41.7	0.1
Salinity						
pH	Saturated Paste	pH	5.1	5.5	6.2	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.05	0.04	0.22	0.01
SAR	Saturated Paste		0.2	0.3	0.3	
% Saturation		%	59	42	153	
Calcium	Saturated Paste	meq/L	0.20	0.21	1.96	0.01
Calcium	Saturated Paste	mg/kg	2.3	1.7	60.0	
Magnesium	Saturated Paste	meq/L	0.12	0.10	0.44	0.02
Magnesium	Saturated Paste	mg/kg	0.9	0.5	8.1	
Sodium	Saturated Paste	meq/L	0.09	0.11	0.28	0.04
Sodium	Saturated Paste	mg/kg	1	1	10	
Potassium	Saturated Paste	meq/L	0.10	0.07	0.06	0.03
Potassium	Saturated Paste	mg/kg	2	1	4	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

Reference Number 1026631-12
Sample Date Sep 08, 2014
Sample Time NA
Sample Location
Sample Description GM4857DL / Ahe / 0-
14 / CM
Matrix Soil

Analyte	Units	Results	Results	Results	Nominal Detection Limit
Classification					
Carbon	Total Organic	% dry weight	9.66		0.05

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

		Reference Number	1026631-13	1026631-14	1026631-16	
		Sample Date	Sep 08, 2014	Sep 08, 2014	Sep 08, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	GM4857DL / Bt / 14-38 / CM	GM4857DL / C / 38-100 / CM	GM4806PM / Bm / 0-13 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Clay Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	31.4	30.4	68.0	0.1
Silt	2 µm - 50 µm	% by weight	43.2	39.6	21.0	0.1
Clay	<2 µm	% by weight	25.4	30.0	11.0	0.1
Salinity						
pH	Saturated Paste	pH	6.4	6.4	5.2	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.15	0.08	0.09	0.01
SAR	Saturated Paste		0.3	0.3	0.1	
% Saturation		%	56	53	50	
Calcium	Saturated Paste	meq/L	1.19	0.54	0.51	0.01
Calcium	Saturated Paste	mg/kg	13.3	5.8	5.0	
Magnesium	Saturated Paste	meq/L	0.29	0.18	0.29	0.02
Magnesium	Saturated Paste	mg/kg	1.9	1.2	1.7	
Sodium	Saturated Paste	meq/L	0.23	0.21	0.07	0.04
Sodium	Saturated Paste	mg/kg	3	3	<1	
Potassium	Saturated Paste	meq/L	0.07	0.09	0.10	0.03
Potassium	Saturated Paste	mg/kg	1	2	2	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

		Reference Number	1026631-15	1026631-16	1026631-21
		Sample Date	Sep 08, 2014	Sep 08, 2014	Sep 07, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	GM4806PM / LFH / 2-0 / CM	GM4806PM / Bm / 0-13 / CM	GM4808DL / Bm / 2-25 / CM
		Matrix	Soil	Soil	Soil
Analyte	Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:Water	pH	6.3		
pH	1:2 Soil:CaCl2 sol.	pH		4.8	4.8

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

Reference Number 1026631-17
Sample Date Sep 08, 2014
Sample Time NA
Sample Location
Sample Description GM4806PM / C / 13-
48 / CM
Matrix Soil

Analyte	Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties					
Texture			Sandy Loam		
Sand	50 µm - 2 mm	% by weight	73.4		0.1
Silt	2 µm - 50 µm	% by weight	17.2		0.1
Clay	<2 µm	% by weight	9.4		0.1
Salinity					
pH	Saturated Paste	pH	5.4		
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.05		0.01
SAR	Saturated Paste		0.2		
% Saturation		%	40		
Calcium	Saturated Paste	meq/L	0.22		0.01
Calcium	Saturated Paste	mg/kg	1.8		
Magnesium	Saturated Paste	meq/L	0.13		0.02
Magnesium	Saturated Paste	mg/kg	0.6		
Sodium	Saturated Paste	meq/L	0.08		0.04
Sodium	Saturated Paste	mg/kg	<1		
Potassium	Saturated Paste	meq/L	0.05		0.03
Potassium	Saturated Paste	mg/kg	<1		
TGR	Saturated Paste	T/ac	<0.1		

Analytical Report

Bill To: Millennium EMS Solutions
Report To: Millennium EMS Solutions
6111-91 Street
Edmonton, AB, Canada
T6E 6V6
Attn: Vadim Lyzhin
Sampled By:
Company:

Project:
ID: 14-00201-01
Name: Grassy Mountain
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1026631**
Control Number: A201055
Date Received: Sep 16, 2014
Date Reported: Dec 19, 2014
Report Number: 1974612

		Reference Number	1026631-22	1026631-23	
		Sample Date	Jul 24, 2014	Jul 24, 2014	
		Sample Time	NA	NA	
		Sample Location			
		Sample Description	GM4148PM / Bm / 0-12 / CM	GM4149PM / Bm / 28-44 / CM	
		Matrix	Soil	Soil	
Analyte		Units	Results	Results	Nominal Detection Limit
Soil Acidity					
pH	1:2 Soil:CaCl2 sol.	pH	4.5	4.9	

Approved by:

Darlene Lintott, MSc
Consulting Scientist

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).

Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.

Quality Control

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1026631
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number: A201055
6111-91 Street	Name: Grassy Mountain	Date Received: Sep 16, 2014
Edmonton, AB, Canada	Location:	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974612
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

Classification

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Carbon	% dry weight	0.12	0.13	20	1.00	yes
Date Acquired: December 17, 2014						
Control Sample	Units	Measured	Lower Limit	Upper Limit		Passed QC
Carbon	% dry weight	4.88	4.42	5.08		yes
Date Acquired: December 17, 2014						

Physical and Aggregate Properties

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Sand	% by weight	52.4	52.4	10	0.1	yes
Silt	% by weight	40.6	40.6	10	0.1	yes
Clay	% by weight	7.0	7.0	10	0.1	yes
Date Acquired: December 09, 2014						
Control Sample	Units	Measured	Lower Limit	Upper Limit		Passed QC
Sand	% by weight	37.4	29.0	41.0		yes
Silt	% by weight	38.6	34.1	43.3		yes
Clay	% by weight	24.0	18.0	30.0		yes
Date Acquired: December 09, 2014						

Salinity

Blanks	Units	Measured	Lower Limit	Upper Limit		Passed QC
Calcium	mg/L	0.0199	-0.4	0.5		yes
Magnesium	mg/L	0.0089	-0.1	0.1		yes
Sodium	mg/L	0.2753	-0	2		yes
Potassium	mg/L	0.0196	-0.5	0.7		yes
Date Acquired: December 09, 2014						
Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
pH	pH	8.7	8.6	0	0.3	yes
Electrical Conductivity	dS/m at 25 C	2.40	2.49	10	0.01	yes
Calcium	mg/kg	12	13.2	10	0.6	yes
Magnesium	mg/kg	5.6	6.0	10	0.6	yes
Sodium	mg/kg	666	729	10	1	yes
Potassium	mg/kg	<12	<12	10	1	yes
Date Acquired: December 09, 2014						
Control Sample	Units	Measured	Lower Limit	Upper Limit		Passed QC
pH	pH	7.1	6.9	7.4		yes
Electrical Conductivity	dS/m at 25 C	3.17	2.20	4.00		yes
% Saturation	%	65	56	68		yes
Magnesium	mg/L	134	109.8	147.0		yes
Sodium	mg/L	61	47	68		yes
Potassium	mg/L	29	17.6	32.0		yes
Date Acquired: December 09, 2014						

Quality Control

Bill To: Millennium EMS Solutions	Project:	Lot ID: 1026631
Report To: Millennium EMS Solutions	ID: 14-00201-01	Control Number: A201055
6111-91 Street	Name: Grassy Mountain	Date Received: Sep 16, 2014
Edmonton, AB, Canada	Location:	Date Reported: Dec 19, 2014
T6E 6V6	LSD:	Report Number: 1974612
Attn: Vadim Lyzhin	P.O.:	
Sampled By:	Acct code:	
Company:		

Salinity - Continued

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Electrical Conductivity	dS/m at 25 C	31.9	26.80	35.20	yes
Calcium	mg/L	246	226.8	258.0	yes
Magnesium	mg/L	99.7	91.4	103.6	yes
Sodium	mg/L	243	229	269	yes
Potassium	mg/L	245	229.4	265.4	yes
Date Acquired: December 09, 2014					

Soil Acidity

Blanks		Units	Measured	Lower Limit	Upper Limit	Passed QC	
pH		pH	6.45	5.3	7.2	yes	
Date Acquired:		December 09, 2014					
Client Sample Replicates		Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
pH		pH	9.3	9.3	0	0.3	yes
Date Acquired:		December 09, 2014					
Control Sample		Units	Measured	Lower Limit	Upper Limit	Passed QC	
pH		pH	7.3	7.0	7.4	yes	
Date Acquired:		December 09, 2014					

Methodology and Notes

Bill To:	Millennium EMS Solutions	Project:		Lot ID:	1026631
Report To:	Millennium EMS Solutions	ID:	14-00201-01	Control Number:	A201055
	6111-91 Street	Name:	Grassy Mountain	Date Received:	Sep 16, 2014
	Edmonton, AB, Canada	Location:		Date Reported:	Dec 19, 2014
	T6E 6V6	LSD:		Report Number:	1974612
Attn:	Vadim Lyzhin	P.O.:			
Sampled By:		Acct code:			
Company:					

Method of Analysis

Method Name	Reference	Method	Date Analysis Started	Location
Carbon and Nitrogen in soil (FSJ)	SSSA Book Series 5	* Total Carbon, Organic Carbon, and Organic Matter, Ch 34	17-Dec-14	Exova Fort St. John
Particle Size Analysis - GS	Carter	* Hydrometer Method, 55.3	09-Dec-14	Exova Edmonton
pH and Conductivity in general soil 1:2	McKeague	* 1:2 Soil:Water Ratio, 4.12	09-Dec-14	Exova Edmonton
pH by CaCl ₂ (1:2 ratio) in soil	McKeague	* pH in 0.01M Calcium Chloride, 3.11	09-Dec-14	Exova Edmonton
Saturated Paste in General Soil	Carter	* Electrical Conductivity and Soluble Ions, Chapter 15	09-Dec-14	Exova Edmonton

** Reference Method Modified*

References

Carter	Soil Sampling and Methods of Analysis.
McKeague	Manual on Soil Sampling and Methods of Analysis
SSSA Book Series 5	Methods of Soil Analysis, Part 3

Comments:

Please direct any inquiries regarding this report to our Client Services group.

Results relate only to samples as submitted.

The test report shall not be reproduced except in full, without the written approval of the laboratory.

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis
See reverse for your nearest Exova location and proper sampling protocol

www.exova.com

Billing Address:		Copy of Report: ☐	Copy of Report To:		Copy of Invoice: ☐	
Company: Millennium EMS Solutions		QA/QC Report ☐	Company:		Send invoice to this	
Address: 6111-91st Edmonton, AB T6E 6V6			Address:		address for approval ☐	
Attention: Vadim Lyzhin		Report Result:	Same as billing address SEP 15 AM 11:04		Report Result:	
Phone: 780-391-2567		e-mail ☒			Attention:	e-mail ☐
Fax: 780-496-9049		Results Online ☐			Phone:	Results Online ☐
Cell: 780-987-6802		Fax ☐			Fax:	Fax ☐
e-mail: vlyzhin@mems.ca		Mail ☐			Cell:	Mail ☐
			e-mail:			

Information to be included on Report and Invoice

Project ID: 14-00201-01
Project Name: Grassy Mountain.
Project Location:
Legal Location:
PO#:
Proj. Acct. Code:
Agreement ID:

PRIORITY

Please contact laboratory prior to submitting any RUSH samples.

Upon filling out this section, client accepts that surcharges will be applied to this analysis.
If not all samples require RUSH, please indicate in special instructions.

Date Required: _____
Signature: _____

Sample Custody (Please Print)

Sampled by:

Company: _____ Signature: _____

I authorize Exova to proceed with the work indicated on this form:

Date: _____ Initial: _____

Received by:

Waybill #: Roy

Company: HAND

Sample Temp. 17.5

Date

Time

Special Instructions / Comments

Please indicate which regulations you are required to meet:

- ☐ Health Canada Drinking Water Quality
☐ Alberta Tier 1
☐ Other: _____

Sample Identification	Location	Depth	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	Enter tests above (✓ relevant samples below)											
		IN M																
GM4827JJ - Ah		0-25	7-Sep-2014	Soil	grab	1												X
- Bg		25-60																X
- Cg		60-100																X
GM4883PM - Ah		0-43																X
- C		43-100																X
GM4842DL - Ah		4-0																X
- Bm		0-16																X
- C		16-30																X
GM4897PM - Bm		0-20																X
- C		20-100	✓	✓	✓	✓												X
GM4857DL - LFH		3-0	8-Sep-2014	Soil	grab	1												X
- Ahe		0-14																X
- Bt		14-38																X
- C		38-100	✓	✓	✓	✓												X

NOTE: All hazardous samples must be labeled according to WHMIS guidelines.

Page 1 of 2



Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis
See reverse for your nearest Exova location and proper sampling protocol

www.exova.com

Billing Address:		Copy of Report: ☐	Copy of Report To:		Copy of invoice: ☐
Company: Address:		QA/QC Report ☐	Company: Address:		Send invoice to this address for approval ☐
Attention: Phone: Fax: Cell: e-mail:		Report Result: e-mail ☐ Results Online ☐ Fax ☐ Mail ☐	Attention: Phone: Fax: Cell: e-mail:		Report Result: e-mail ☐ Results Online ☐ Fax ☐ Mail ☐

Information to be included on Report and Invoice

Project ID:
Project Name:
Project Location:
Legal Location:
PO#:
Proj. Acct. Code:
Agreement ID:

PRIORITY

Please contact laboratory prior to submitting any RUSH samples.

Upon filling out this section, client accepts that surcharges will be applied to this analysis.
If not all samples require RUSH, please indicate in special instructions.

Date Required: _____
Signature: _____

Sample Custody (Please Print)

Sampled by:

Company _____ Signature _____

I authorize Exova to proceed with the work indicated on this form:

Date: _____ Initial: _____

Received by: _____ Sample Temp. _____

Waybill #: _____ Date _____

Company _____ Time _____

Special Instructions / Comments

Please indicate which regulations you are required to meet:

- ☐ Health Canada Drinking Water Quality
☐ Alberta Tier 1
☐ Other: _____

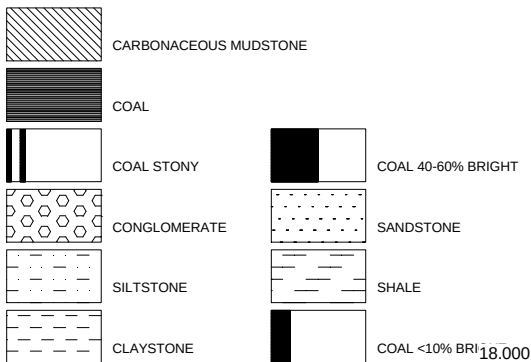
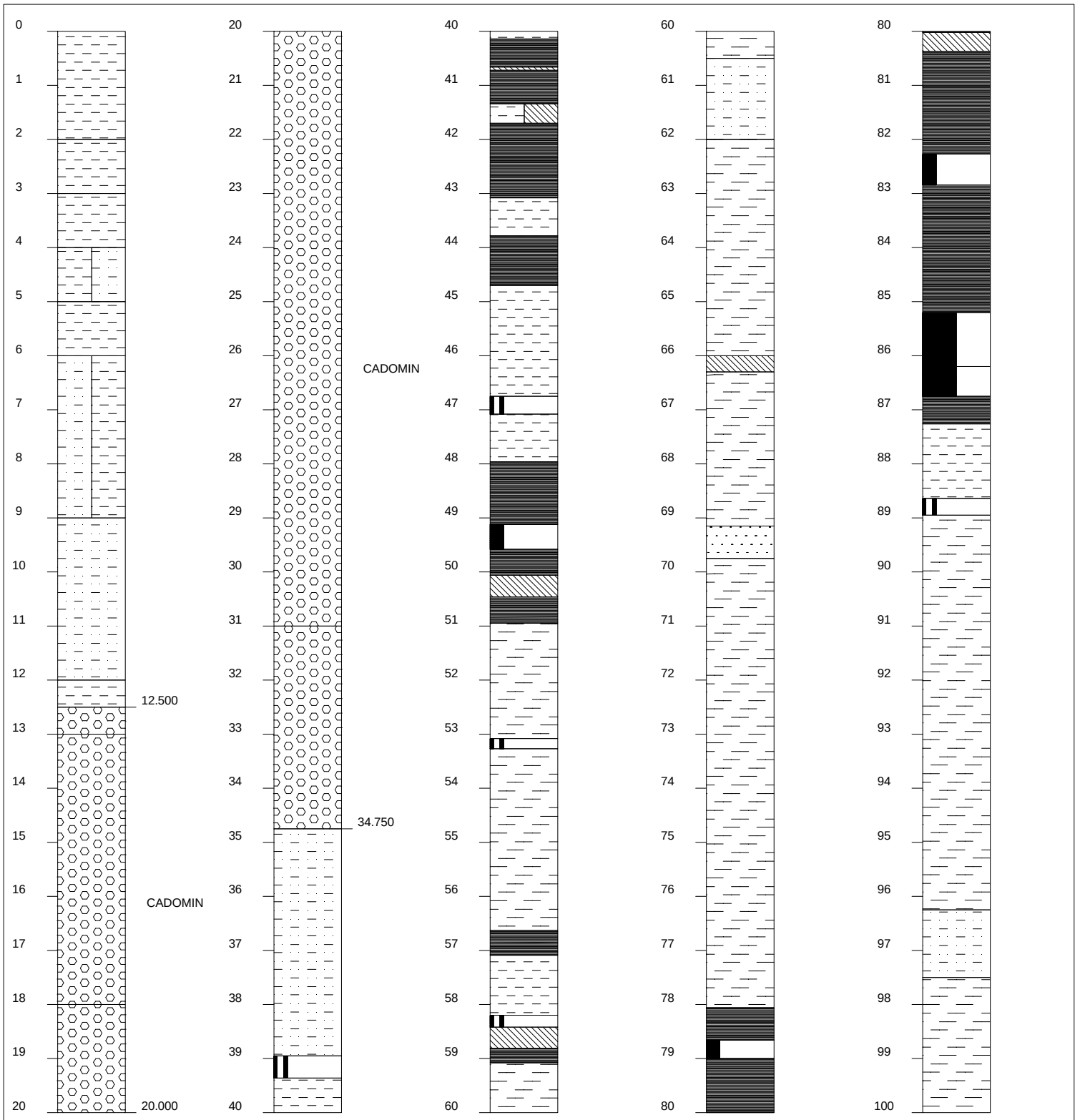
Sample Identification	Location	Depth			Date/Time Sampled	Matrix	Sampling Method	↓	Enter tests above (✓ relevant samples below)											
		IN	CM	M																
GM4808PM-LFH			2-0		8-Sep-2014	Soil	grab	1												X
-Bm			0-13																	X
-C			13-48																	X
GM4855RH-LFH			6-0																	X
-Oh			0-60																	X
-Cg			60-80																	X
GM4808DL-Bm			2-25		7-Sep-2014	Soil	grab	1												X
GM4148BM-Bm			0-12		24-Jul-2014															X
GM4149PM-Bm			28-44																	X

NOTE: All hazardous samples must be labeled according to WHMIS guidelines.

Page 2 of 2

APPENDIX E: OVERBURDEN TEST HOLES LOCATIONS AND LOGS

Table E-1 Test Holes Locations				
Test Hole ID	Drill Hole Type	Sampled	Easting	Northing
RGOH3001	Open Hole	Yes	685357	5504917
RGOH3002	Open Hole	Yes	685581	5504340
RGOH3003	Open Hole	Yes	686194	5506263
RGSC0006	Open Hole	Yes	685577	5507161
RGSC0008	Open Hole	Yes	686638	5507638
RGSC0009	Open Hole	Yes	686742	5509160
RGSC0010	Open Hole	Yes	686807	5510108



BOREHOLE NO: RGOH3001

PROJECT: Grassy Mountain

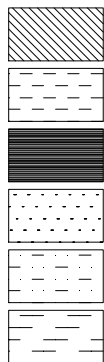
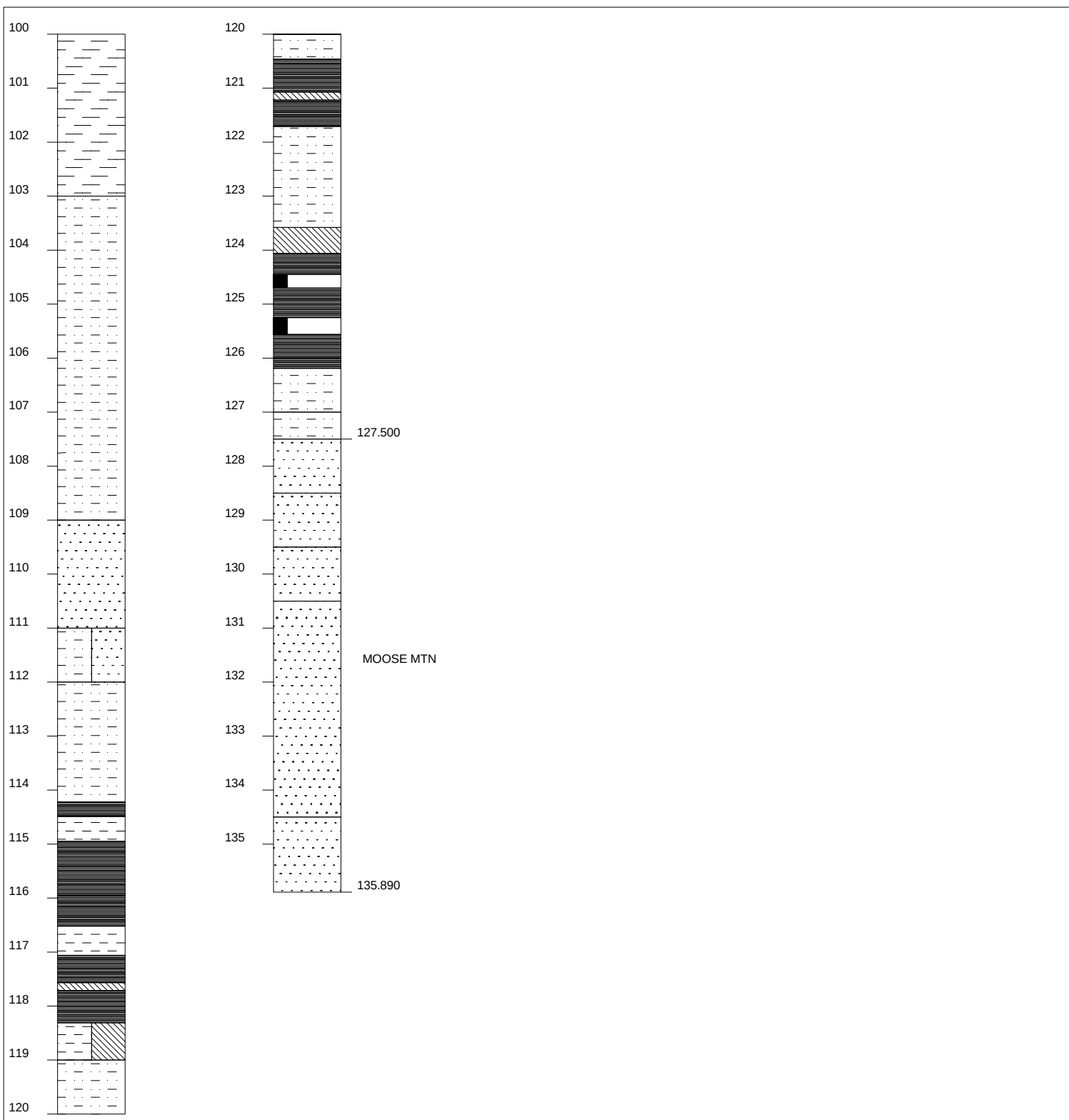
RC-HOLE

DATE DRILLED: Jan 10-11/2014

LOGGED BY: L.BOUT/D.LEF

SCALE: 1:100

PLAN NO: CORRECTED



BOREHOLE NO: RGOH3001

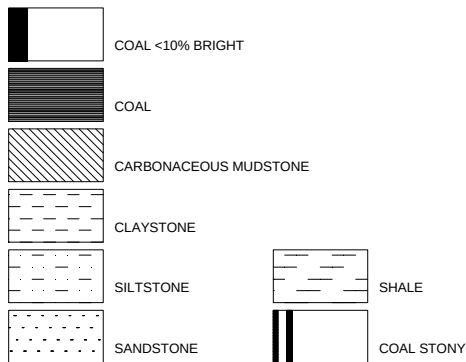
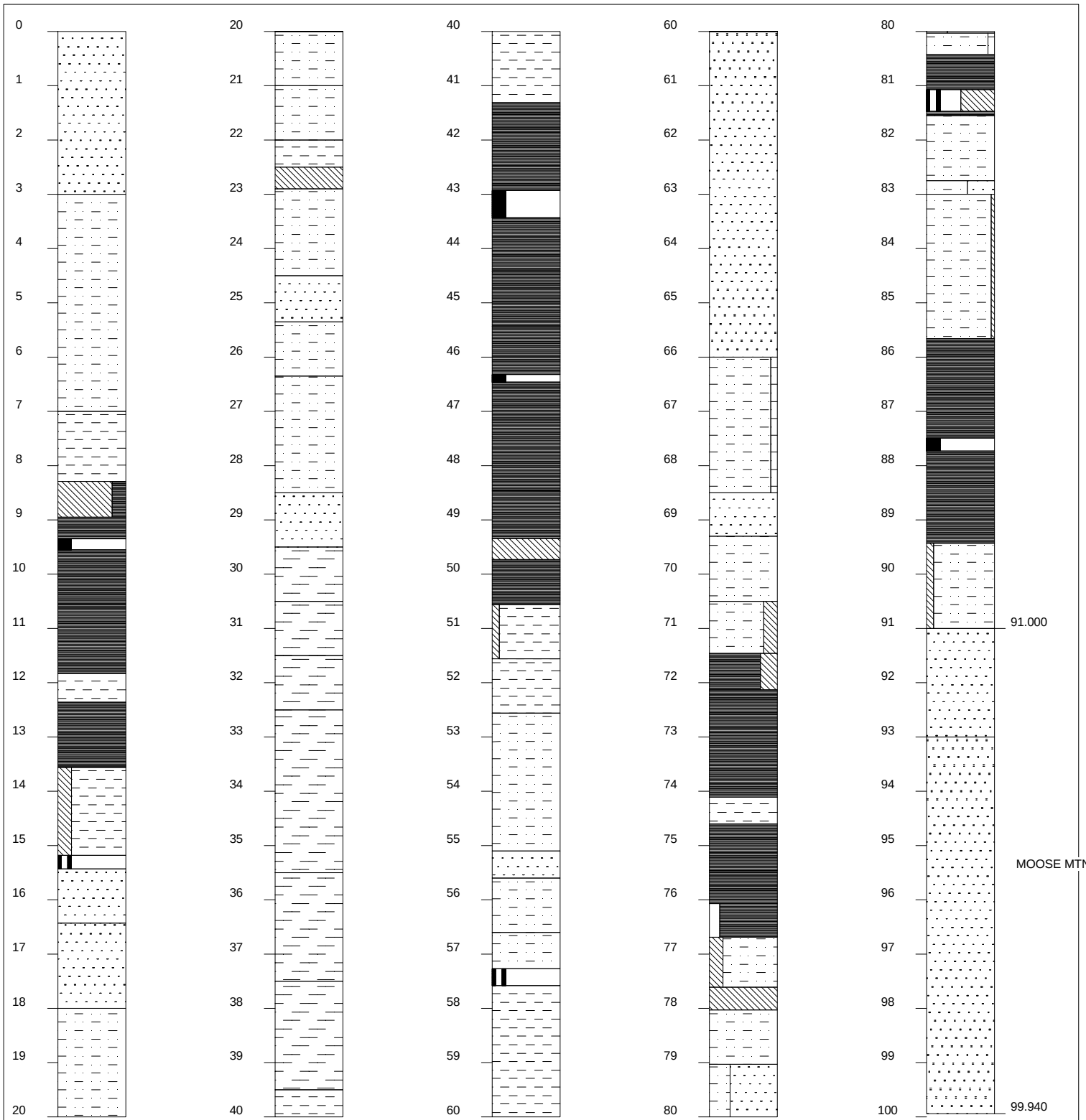
PROJECT: Grassy Mountain

RC-HOLE

DATE DRILLED: Jan 10-11/2014

LOGGED BY: L.BOUT/D.LEF

SCALE: 1:100 PLAN NO: CORRECTED



BOREHOLE NO: RG0H3002

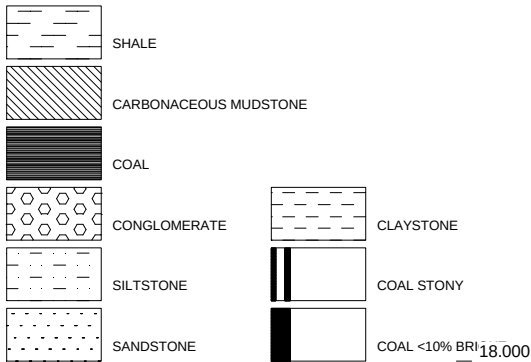
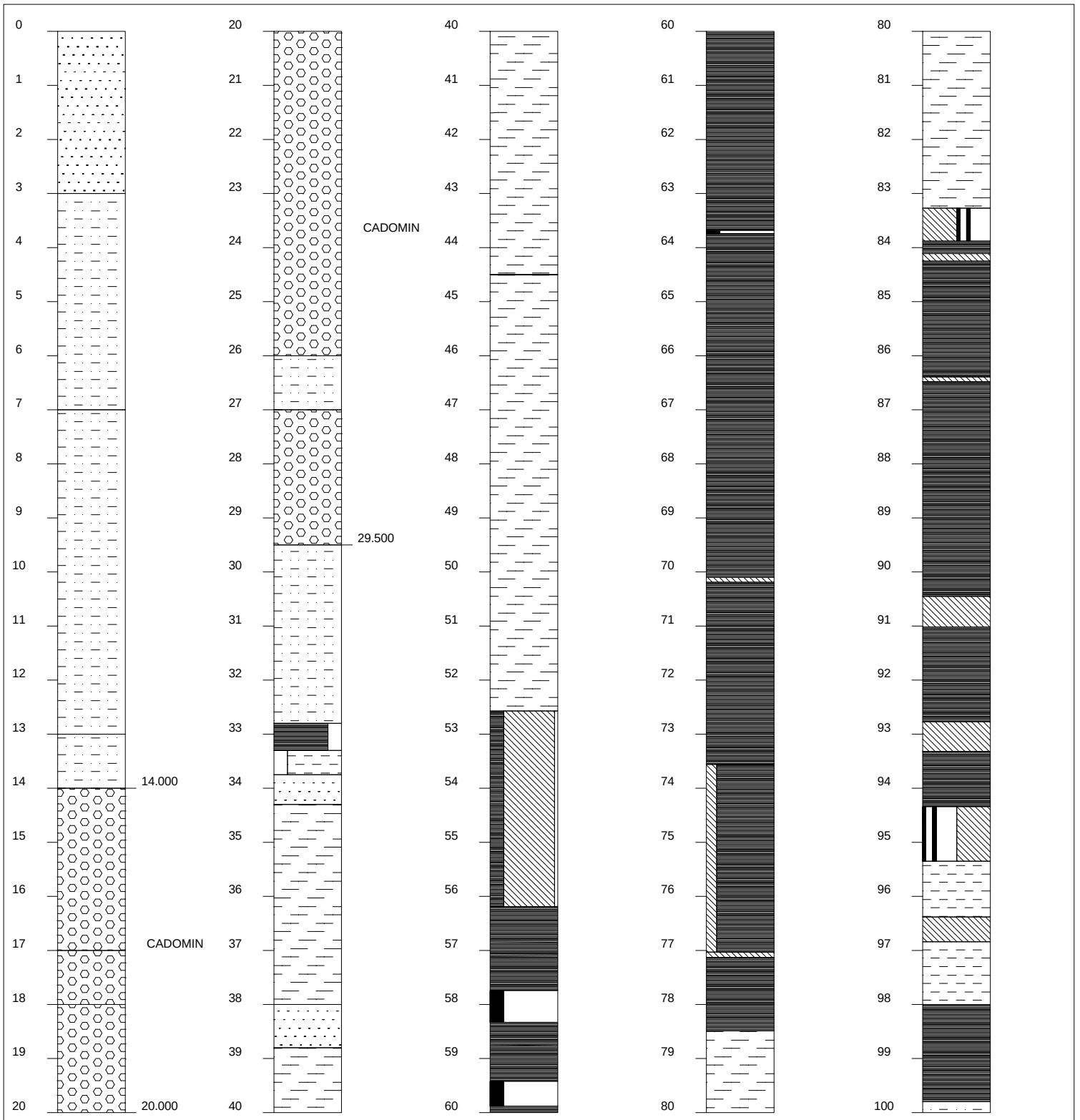
PROJECT: Grassy Mountain

RC-HOLE

DATE DRILLED: 12/JAN/2014

LOGGED BY: L.BOUT; D.LEF

SCALE: 1:100 PLAN NO: CORRECTED



BOREHOLE NO: RGOH3003

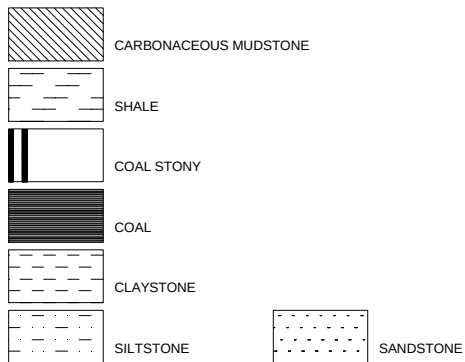
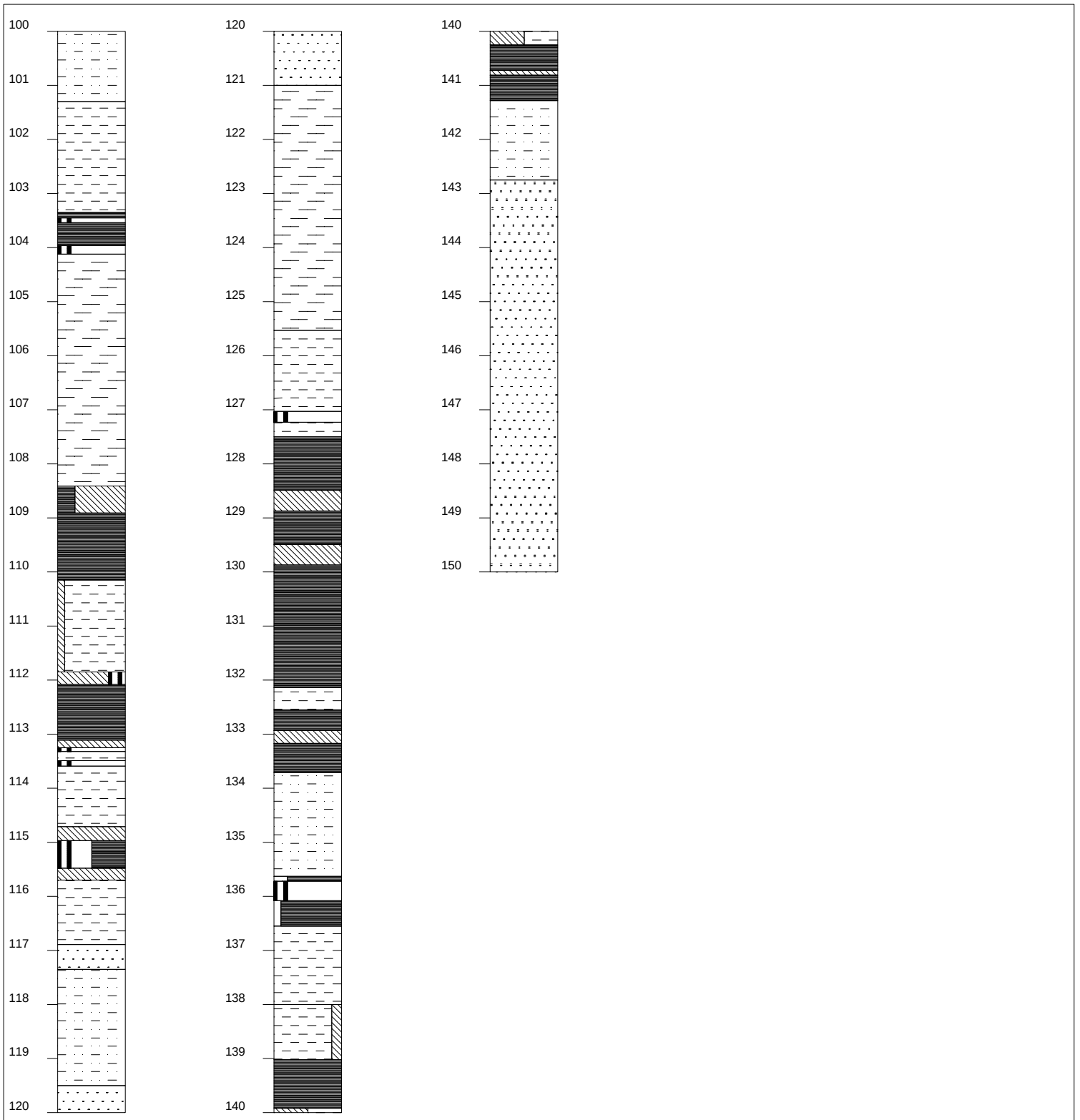
PROJECT: Grassy Mountain

Riversdale Resources

DATE DRILLED: 14/01/2014

LOGGED BY: Century Wireline

SCALE: 1:100 PLAN NO: Corrected



BOREHOLE NO: RG0H3003

PROJECT: Grassy Mountain

Riversdale Resources

DATE DRILLED: 14/01/2014

LOGGED BY: Century Wireline

SCALE: 1:100 PLAN NO: Corrected