Appendix N
Environmental and Geosciences Assessment for Tongue Creek Option

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This appendix was prepared by a team consisting of several professionals. The professionals responsible for this appendix are as follows:

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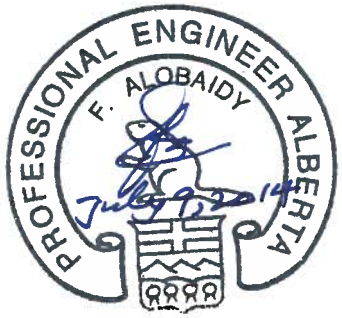
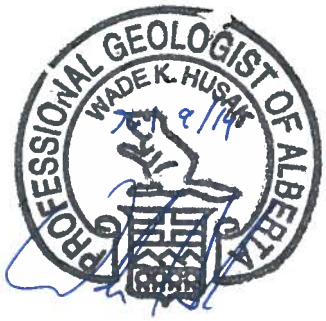
1 Introduction **3 Review of Existing Information Geosciences** **4 Subsurface Conditions** **5 Preliminary Geotechnical Considerations** **6 Hydrogeological Assessment**	 Faris Alobaidy, P.Eng. Geotechnical Engineer, Edmonton, Alberta  Wade Husak, P.Geol. Hydrogeologist, Edmonton, Alberta
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1. Introduction

1.1 General

This report presents the results of a preliminary assessment carried out by AECOM Canada Ltd. (AECOM) for the proposed Tongue Creek flood by-pass. The proposed by-pass channel is located within the Foothills Municipal District in Alberta, as shown on Figure N1-1 in Appendix N1.

The purpose of this desk study was to assess the anticipated environmental, subsurface soil, bedrock, and groundwater conditions along the proposed by-pass channel alignment and to identify major issues that may impact the design and construction of the by-pass channel. It will also provide preliminary recommendations to assist in preparing preliminary design and feasibility of the proposed channel alignment.

The recommendations presented in this report are based on the review of data obtained from the previous investigations near the proposed channel by-pass alignment. A site specific investigation has not been conducted. The subsurface soil/bedrock/groundwater conditions and recommendations provided in this report are preliminary and are subject to review and confirmation during detailed design phase and after completion of site specific investigations.

1.2 Site Description

Tongue Creek originates in the Foothills region between Longview and Turner Valley in southern Alberta and flows in the easterly direction to the Highwood River; north of High River. Approximately 21% of the basin consists of forested areas and the remaining 79% is prairie. The proposed Tongue Creek bypass channel is located west of the Town of High River, with a total length of 3893 metres (m). The preliminary channel design has 4H:1V side slopes with a 60 m wide base. The Tongue Creek by-pass alignment is shown on Figure N1-2 in Appendix N1.

Based on the information provided during preparation of this report, the channel will be constructed in cut and fill sections which will require the construction of the berms. A summary of the available channel information is provided below:

- Channel length – approximately – 3893 m
- Channel depth – generally varies from approximately 4 m to 20 m
- Berm height – varies from approximately 1 m to 2 m, depending on the original ground elevation
- Depth of cut – varies from approximately 2 m to 20 m
- Channel base width – 60 m
- Channel side slopes – 4H:1V

The channel will have one drop structure along the proposed alignment.

1.3 Scope of Work

The scope of work for this desktop study is:

- Review available information including publically available ecological databases and reports, geological maps, water well logs, and previous geotechnical reports to assess the anticipated conditions at the proposed by-pass channel location
- Develop preliminary recommendations to support preliminary design and feasibility of the proposed by-pass channel

- Prepare a preliminary report documenting the findings of the review, providing a summary of the anticipated conditions, and providing preliminary recommendations to support preliminary design and feasibility of the proposed by-pass channel

2. Environmental Assessment

2.1 Overview

AECOM conducted an environmental overview desktop review for the proposed Tongue Creek bypass option around High River, Alberta. The purpose was to compile information on existing conditions and to provide recommendations for future works associated with the bypass options. The desktop review consisted of examining a variety of publically available ecological databases and reports. However, this desktop review does not follow the format of an Environmental Impact Assessment (EIA) due to the limited engineering, hydrological, geotechnical, hydrogeological, and geological information available for the scheme and/or site location. Socioeconomic, First Nations, human health, noise, odour, and/or cost benefit analyses are not discussed in this section due to their inclusion in the triple bottom line appendix and limited available information. Instead, this is considered an environmental overview desktop report and is intended as a general guidance document outlining some of the major environmental concerns and regulatory issues associated with the bypass project and area.

The Tongue Creek Project Area (Figure N2-1 in Appendix N1) included the area covered by a 1% (100-year) flood and consists of a 100 m buffer around the scheme and included every quarter section that was intercepted. Within the Tongue Creek Project Area, various sensitive species, protected areas, and historical resource listings were identified. A summary of identified environmental issues, the dataset they were identified from, and impacted species/impacted areas, applicable legislation, and restricted activities are provided in Table 2-1.

Recommendations are supported by AECOM ecologists with a variety of specializations including, but not limited to, soils, terrestrial vegetation, wildlife, fish and fish habitat, wetlands, and environmental permitting. To date, no field investigations have been conducted. As such, there is potential for permitting requirements to change, once field conditions are confirmed and detailed engineering information is provided.

Table 2-1: Summary of Environmental Issues Associated with the Tongue Creek Project Area

Dataset	Environmental Issues	Impacted Species / Impacted Areas	Applicable Legislation	Restricted
Alberta Conservation Information Management System (ACIMS)- Non-Sensitive EOS	Rare species (as determined by ANPC) that are not protected have been identified within the search radius	Rough-stalked Feather moss (*Brachythecium rutabulum*), low yellow evening-primrose (*Oenothera flava*)	Alberta Wildlife Act, Species at Risk Act	A rare plant survey will be required prior to construction activities commencing. If rare plants are found, mitigation will be required (i.e. transplanting, taking seeds, etc.).
Key Range Layers	Sensitive raptor and sharp tailed grouse key ranges occur within the Project Area	Sensitive raptors and Sharp-tailed Grouse	Alberta Wildlife Act	Limited work during March 15th to June 15th (Sharp-tailed Grouse survey)
Key Wildlife and Biodiversity Zone	Key wildlife zone exists within the Project Area	N/A	Alberta Wildlife Act	All areas identified as Key Wildlife and Biodiversity zones. No construction December 15th to April 30th
Listing of Historical Resource	Historical Resource Values of 4 and 5 within the Project Area	HRV 4: contains a historic resource that may require avoidance HRV 5: believed to contain a historic resource	Historical Resources Act	May have restricted activities if historical resources are found
Wetlands	Permanent wetlands existing in Project Area	274.2 ha of marsh and 36.4 ha of open water	Water Act	Impacts to wetlands will need compensation
Wildlife	Migratory birds and important wildlife habitat occur in the area; Species at Risk may occur at the project site	See Table 2-2	Alberta Wildlife Act, Species at Risk Act, Migratory Birds Convention Act	A variety of wildlife surveys will be required prior to construction commencing (breeding bird, amphibian, bat, winter tracking, remote wildlife camera, and/or ungulate). Depending on the species found on site, a variety of mitigation measures may be required.
Fisheries	Important sport fish and Species at Risk may occur in the area	Bull Trout and West Slope Cutthroat Trout	Alberta Wildlife Act, Species at Risk Act	Impacts to the Highwood River will result in possible destruction of fish habitat, important migration routes, and access to spawning habitat. Habitat compensation and mitigation will be required.

2.2 Environmental Concerns

Environmental concerns associated with the proposed Tongue Creek Project Area are described below in the following sections.

2.2.1 First Nations

No First Nations reservations or lands were identified within the Tongue Creek Project Area. However, the Alberta Government requires that all projects on Public Lands undergo a First Nations Consultation assessment request through Alberta Environment and Sustainable Resource Development (AESRD), as required by *Alberta's First Nations Consultation Policy and Guidelines on Land Management and Resource Development* at the start of the project to determine consultation needs and requirements. First Nations consultation would be required for this project due to the regulatory requirements.

2.2.2 Historical Resources

A Statement of Justification for *Historical Resources Act* clearance was conducted for the bypass option D3/E and was used for the Tongue Creek analysis. This is required by Alberta Culture to provide detailed and accurate information about the relationship between project impacts and historic resources (both known and potential) in the area and to determine if a Historical Resources Impact Assessment (HRIA) will be required as the next step. Six

previously recorded Historic Resource sites were recorded within the Tongue Creek project area (Figure N2-2 in Appendix N1).

Additionally, a database search of the *Listing of Historic Resources (Current to March 2014)*, issued by the Government of Alberta (ACCS 2014) was performed and revealed Historic Resource Values (HRVs) of 4 and 5 within the Tongue Creek Project Area. An HRV of 4 means that a site, or sites, have not been fully assessed and require a HRIA, while an HRV of 5 means that there is a high potential for the presence of historical resources sites (archaeological, historic, and/or paleontological) in the area and an HRIA will likely be required. HRIAs are required when an activity will, or will likely, result in the alteration, damage, or destruction of a historic resource. Mitigation must be provided and depending on the value of the resource, projects may be required to change or move to avoid disturbing the historical resource.

Most of the Historical Resources sites found in the project vicinity are located along or near the Highwood River and on its floodplain or by other hydrologic features. Since one end of the proposed bypass will intersect the Highwood River, there is high potential for the presence of undisturbed Historical Resource sites in that area. Much of the rest of the Tongue Creek Project Area has been disturbed by agriculture or road construction. These areas are considered to have low to medium potential depending on sedimentation depth in areas where the plough zone may not have impacted more deeply buried cultural deposits.

Parts of the Tongue Creek Project Area are considered to have high Historical Resources potential and as a result, an HRIA is recommended.

2.2.3 Protected Areas

2.2.3.1 Wildlife Layers

2.2.3.1.1 Key Wildlife and Biodiversity Zones

Key Wildlife and Biodiversity Zones are intended to prevent: (1) loss and fragmentation of habitat, (2) short and long-term all-weather public vehicle access, sensory disturbance during periods of thermal or nutritional stress on wildlife, and (3) the development of barriers to wildlife corridors (e.g. stream crossings). Typically, Key Wildlife and Biodiversity Zones are established along major river valleys. Such landforms have the topographic variation and site productivity conditions that yield high levels of biodiversity and good winter browse conditions with adequate cover (AESRD 2010).

Key Wildlife and Biodiversity Zones were identified west of Highway 2 within the Tongue Creek project area (Figure N2-3 in Appendix N1). As per the recommended wildlife land use guidelines (AESRD 2010), timing restrictions of no construction between December 15th and April 30th would be enforced due to the impacts on wildlife.

2.2.3.2 Key Range Layers

The project area falls within several key range/wildlife layers developed by AESRD. These wildlife feature layers provide industry, government, and the public with the best information available on the range of wildlife sensitivities in the Province (AESRD 2013a). Specific operating procedures apply to industrial activities in these zones in order to reduce impacts to habitat and wildlife populations (AESRD 2013a). Range layers are based on the extent of known, or partially known, ranges of a species within Alberta, and can assist when deciding where to conduct surveys or where mitigation strategies should be applied (AESRD 2013a).

The Tongue Creek Project Area occurs within two Key Range Layers: the Sensitve Raptor Range and the Sharp-tailed Grouse Range (Figure N2-4 in Appendix N1). The Sharp-tailed Grouse range requires limited work allowance during the March 15th to June 15th lekking (breeding) season.

2.2.3.3 Environmentally Significant Areas

Environmentally Significant Areas (ESAs) represent places in Alberta that are important to the long-term maintenance of biological diversity, soil, water, or other natural processes, at multiple spatial scales (Government of Alberta 2009). They are identified as areas containing rare or unique elements in the province or areas that include elements that may require special management consideration due to their conservation needs. ESAs do not represent government policy and are not necessarily areas that require legal protection, but instead are intended to be an information tool to help inform land use planning and policy at local, regional, and provincial scales.

Although no ESAs were identified within the Tongue Creek Project Area, it is bordered to the south by an area of concern within Grassland 236 (Table 2-1). ESA 236 has a Provincial Significance rating, contains important wildlife habitat, and intact riparian areas. Proposed projects in ESAs may meet greater opposition because of the known high value of these areas with regards to biotic and abiotic resources. The extent of the ESAs are illustrated in Figure N2-4 in Appendix N1.

2.2.3.4 Land Use

The Tongue Creek Project Area is within the Municipal District of Foothills No. 31 and the Intermunicipal Development Plan area. The Town of High River is a rapidly growing municipality and developing in this area creates challenges to ensure cohesion between both current land uses and future land use objectives. Dillon Consulting Limited (2009) provided future growth recommendations to The Town of High River based on: existing land uses and man-made features, protection from natural processes, and ensuring the natural environment and water quality are not negatively impacted. Using maps from Dillon Consulting Limited (2009), the current and future land use within the project area was assessed.

The land impacted within the Tongue Creek Project Area is primarily agricultural, but industrial, residential, and municipal reserve areas are also affected. The Tongue Creek Project Area overlaps the proposed Highway 2A Industrial Area Structure Plan (H2AIASP) to the north of High River. This area has importance as a gateway into and out of the town, and any development in this area is subject to the “Enhanced Design Guidelines” provided in the appendices of H2AIASP (Town of High River and MD of Foothills 2012).

2.2.4 Ecological Factors

2.2.4.1 Vegetation and Rare Plants

The proposed project is in the Foothills Fescue Ecoregion of Alberta’s Grassland Natural Region, which is characterized by hummocky and rolling to undulating mainly morainal terrain with significant lacustrine deposits. Native grasslands are Mountain Rough Fescue on moister sites, and western wheatgrass on drier sites. Wet areas are often shrubby. Much of the Project Area has been disturbed by residential development, agriculture, and/or road construction.

A search of the Alberta Conservation Information Management System (ACIMS) Non-Sensitive Element Occurrences, identified Rough-stalked Feather Moss (*Brachythecium rutabulum*), Low Yellow Evening-Primrose (*Oenothera flava*) and Californian Amaranth as potentially impacted rare species within the Tongue Creek Project Area (Figure N2-4 in Appendix N1; Alberta Tourism, Parks and Recreation 2012).

It is possible that other rare plant species may exist and as such, rare plant surveys will be required prior to construction. The presence of rare plants can cause delays to construction if the plants have to be relocated or may require modifications to construction methodologies and/or location if the rare plants species are listed as Species at Risk.

2.2.4.2 Soils

The Tongue Creek area is characterized as valley's, with terraces of low relief. Weakly developed Orthic Regosol soils will be found within the fluvial terraces and adjacent side slopes of the Tongue Creek channel, and Orthic Black Chernozems will be associated with the crest of the terraces (Figure N2-5 in Appendix N1). The landscape of the surrounding area is characterized as an undulating landform of low relief, with select locations demonstrating high relief. Moderately fine textured Orthic Black Chernozemic soils are the dominant soil subgroup associated with this landscape. Soils in the project area will not be a limiting factor.

2.2.4.3 Wildlife and Species at Risk

A search of the Fisheries and Wildlife Management Information System (FWMIS) was conducted for the Tongue Creek Project Area. Data of recorded wildlife observations was provided by AESRD. The dataset included bird, mammal, amphibian, and reptilian sightings (AESRD2013b; Figure N2-3in Appendix N1). A 20 kilometre (km) buffer was used to search for Species at Risk. A wider range was used for the Species at Risk search as many wildlife species have large home ranges. Results of these two searches are presented in Table 2-2.

Wildlife species were also included in Table 2-2 based on known range distributions that have the potential to occur within the Tongue Creek Project Area. This was determined by a combination of FWMIS data (provided by AESRD), and from species ranges obtained from the following resources: the Birds of North America online database (Poole 2005), the North American Mammals online database (Smithsonian 2014), the New Stokes Field Guide to Birds Western Region (Stokes and Stokes 2013), the Sibley Field Guide to Birds of Western North America (Sibley 2011), Western Reptiles and Amphibians (Stebbins 2003), Mammals of North America (Reid 2006), and Mammals of Alberta (Pattie and Fisher 1999).

In the Tongue Creek Project Area, seven species are listed by AESRD as "At Risk". The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists 12 species as "Special Concern" and five species as "Threatened". The *Species at Risk* Act (SARA) lists five species as "Special Concern" and five species as "Threatened". Piping Plover (*Charadrius melodus*) and Burrowing Owl (*Athene cunicularia*) are listed as "Endangered" by COSEWIC and SARA. All wildlife species identified within the Tongue Creek Project Area, Species at Risk noted within the 20 km buffer, and species with the potential to occur within the Tongue Creek Project Area are listed in Table 2-2. Project delays and/or project related modifications may arise should any Species at Risk occur within the Tongue Creek Project Area. Specific mitigation is required for Species at Risk which include restricted timing windows, disturbance free zones, and the inability to destroy or alter specific habitat features (e.g. dens, nests, hibernacula, etc.). Similarly, migratory birds are, and their nests are, protected under the federal *Migratory Birds Convention Act*. Figure N2-3 in Appendix N1 shows the location of all wildlife species recorded within the Tongue Creek project area.

Table 2-2: Wildlife Species Likely to Occur within the Tongue Creek Project Area

Common Name	Scientific Name	AESRD[1]	COSEWIC[2]	SARA[3]	Schedule
Birds					
American Avocet[4]	*Recurvirostra americana*	Secure	Not Listed	Not Listed	N/A
American Bittern[6]	*Botaurus lentiginosus*	Sensitive	Not Listed	Not Listed	N/A
American Coot[4]	*Fulica americana*	Secure	Not At Risk	Not Listed	N/A
American Dipper[4]	*Cinclus mexicanus*	Secure	Not Listed	Not Listed	N/A
American Kestrel[5]	*Falco sparverius*	Sensitive	Not Listed	Not Listed	N/A
American Robin[4]	*Turdus migratorius*	Secure	Not Listed	Not Listed	N/A
American White Pelican[5]	*Pelecanus erythrorhynchos*	Sensitive	Not at Risk	Not Listed	N/A
American Wigeon[4]	*Anas americana*	Secure	Not Listed	Not Listed	N/A
Baird's Sparrow[5]	*Ammodramus bairdii*	Sensitive	Special Concern	Not Listed	No Schedule
Bald Eagle[4/5]	*Haliaeetus leucocephalus*	Sensitive	Not At Risk	Not Listed	N/A
Baltimore Oriole[5]	*Icterus galbula*	Sensitive	Not At Risk	Not Listed	N/A
Barn Swallow[5]	*Hirundo rustica*	Sensitive	Threatened	Not Listed	No Schedule
Barred Owl[6]	*Strix varia*	Sensitive	Not At Risk	Not Listed	N/A
Black-backed Woodpecker[6]	*Picoides arcticus*	Sensitive	Not At Risk	Not Listed	N/A
Black-billed Magpie[4]	*Pica hudsonia*	Secure	Not Listed	Not Listed	N/A
Black-crowned Night-heron[5]	*Nycticorax nycticorax*	Sensitive	Not Listed	Not Listed	N/A
Black-necked Stilt[5]	*Himantopus mexicanus*	Sensitive	Not Listed	Not Listed	N/A
Black Tern[5]	*Chlidonias niger*	Sensitive	Not at Risk	Not Listed	N/A
Broad-winged Hawk[6]	*Buteo platypterus*	Sensitive	Not At Risk	Not Listed	N/A
Brown Creeper[6]	*Certhia americana*	Sensitive	Not At Risk	Not Listed	N/A
Burrowing Owl[5]	*Athene cunicularia*	At Risk	Endangered	Endangered	Schedule 1
Common Nighthawk[6]	*Chordeiles minor*	Sensitive	Threatened	Threatened	Schedule 1
Common Raven[4]	*Corvus corax*	Secure	Not Listed	Not Listed	N/A
Common Yellowthroat[6]	*Geothlypis trichas*	Sensitive	Not Listed	Not Listed	N/A
Ferruginous Hawk[5]	*Buteo regalis*	At Risk	Threatened	Threatened	Schedule 1
Forster's Tern[5]	*Sterna forsteri*	Sensitive	Not Listed	Not Listed	N/A
Gadwall[4]	*Anas strepera*	Secure	Not Listed	Not Listed	N/A
Golden Eagle[6]	*Aquila chrysaetos*	Sensitive	Not at Risk	Not Listed	N/A
Great Blue Heron[4]	*Ardea herodias*	Sensitive	Not Listed	Not Listed	N/A
Great Gray Owl[6]	*Strix nebulosa*	Sensitive	Not at Risk	Not Listed	N/A
Great Horned Owl[4]	*Bubo virginianus*	Secure	Not Listed	Not Listed	N/A
Green-winged Teal[5]	*Anas crecca*	Sensitive	Not Listed	Not Listed	N/A
Harlequin Duck[6]	*Histrionicus histrionicus*	Sensitive	Not Listed	Not Listed	N/A
Horned Grebe[5]	*Podiceps auritus*	Sensitive	Special Concern	Not Listed	No Schedule
Horned Lark[4]	*Eremophila alpestris*	Secure	Not Listed	Not Listed	N/A
Killdeer[4]	*Charadrius vociferous*	Secure	Not Listed	Not Listed	N/A
Least Flycatcher[6]	*Empidonax minimus*	Sensitive	Not Listed	Not Listed	N/A

Common Name	Scientific Name	AESRD[1]	COSEWIC[2]	SARA[3]	Schedule
Lesser Scaup[5]	*Aythya affinis*	Sensitive	Not Listed	Not Listed	N/A
Loggerhead Shrike[5]	*Lanius ludovicianus excubitorides*	Sensitive	Not Listed	Threatened	Schedule 1
Long-billed Curlew[5]	*Numenius americanus*	Sensitive	Special Concern	Special Concern	Schedule 1
Mallard[4]	*Anas platyrhynchos*	Secure	Not Listed	Not Listed	N/A
Northern Goshawk[6]	*Accipiter gentilis*	Sensitive	Not at Risk	Not Listed	N/A
Northern Harrier[4]	*Circus cyaneus*	Sensitive	Not At Risk	Not Listed	N/A
Northern Pintail[5]	*Anas acuta*	Sensitive	Not Listed	Not Listed	N/A
Northern Pygmy-owl[6]	*Glaucidium gnoma*	Sensitive	Not Listed	Not Listed	N/A
Northern Shoveler[4]	*Anas clypeata*	Secure	Not Listed	Not Listed	N/A
Olive-sided Flycatcher[6]	*Contopus cooperi*	May Be At Risk	Threatened	Threatened	Schedule 1
Osprey[5]	*Pandion haliaetus*	Sensitive	Not Listed	Not Listed	N/A
Peregrine Falcon[5]	*Falco peregrinus*	At Risk	Special Concern	Special Concern	Schedule 1
Pied-billed Grebe[5]	*Podilymbus podiceps*	Sensitive	Not Listed	Not Listed	N/A
Pileated Woodpecker[6]	*Dryocopus pileatus*	Sensitive	Not Listed	Not Listed	N/A
Piping Plover[5]	*Charadrius melodus*	At Risk	Endangered	Endangered	Schedule 1
Prairie Falcon[5]	*Falco mexicanus*	Sensitive	Not at Risk	Not Listed	N/A
Purple Martin[6]	*Progne subis*	Sensitive	Not Listed	Not Listed	N/A
Red-tailed Hawk[4]	*Buteo jamaicensis*	Secure	Not At Risk	Not Listed	N/A
Rusty Blackbird[4]	*Euphagus carolinus*	Sensitive	Special Concern	Special Concern	Schedule 1
Sandhill Crane[6]	*Grus canadensis*	Sensitive	Not Listed	Not Listed	N/A
Sharp-tailed Grouse[5]	*Tympanuchus phasianellus*	Sensitive	Not Listed	Not Listed	N/A
Short-eared Owl[5]	*Asio flammeus*	May Be At Risk	Special Concern	Special Concern	Schedule 1
Sora[4]	*Porzana carolina*	Sensitive	Not Listed	Not Listed	N/A
Sprague's Pipit[5]	*Anthus spragueii*	Sensitive	Threatened	Threatened	Schedule 1
Swainson's Hawk[5]	*Buteo swainsoni*	Sensitive	Not Listed	Not Listed	N/A
Trumpeter Swan[5]	*Cygnus buccinator*	At Risk	Not at Risk	Not Listed	N/A
Upland Sandpiper[6]	*Bartramia longicauda*	Sensitive	Not Listed	Not Listed	N/A
Western Grebe[5]	*Aechmophorus occidentalis*	Sensitive	Not Listed	Not Listed	N/A
Western Meadowlark[4]	*Sturnella neglecta*	Secure	Not Listed	Not Listed	N/A
Western Tanager[6]	*Piranga ludoviciana*	Sensitive	Not Listed	Not Listed	N/A
Western Wood-pewee[6]	*Contopus sordidulus*	Sensitive	Not Listed	Not Listed	N/A
White-faced Ibis[5]	*Plegadis chihi*	Sensitive	Not Listed	Not Listed	N/A
Mammals					
American Badger[6]	*Taxidea taxus*	Sensitive	Special Concern	Not Listed	No Schedule
Bobcat[6]	*Lynx rufus*	Sensitive	Not Listed	Not Listed	N/A
Canada Lynx[6]	*Lynx canadensis*	Sensitive	Not at Risk	Not Listed	N/A
Deer Mouse[4]	*Peromyscus maniculatus*	Secure	Not Listed	Not Listed	N/A
Grizzly Bear[5]	*Ursus arctos*	At Risk	Special Concern	Not Listed	No Schedule
Hoary Bat[6]	*Lasiurus cinereus*	Sensitive	Not Listed	Not Listed	N/A
Little Brown Bat[6]	*Myotis lucifugus*	Secure	Endangered	Not Listed	No Schedule

Common Name	Scientific Name	AESRD[1]	COSEWIC[2]	SARA[3]	Schedule
Long-tailed Weasel[5]	*Mustela frenata longicauda*	May Be At Risk	Not At Risk	Not Listed	N/A
Meadow Vole[4]	*Microtus pennsylvanicus*	Secure	Not Listed	Not Listed	N/A
Muskrat[4]	*Ondatra zibethicus*	Secure	Not Listed	Not Listed	N/A
Northern Grasshopper Mouse[4]	*Onychomys leucogaster*	Secure	Not Listed	Not Listed	N/A
Northern Pocket Gopher[4]	*Thomomys talpoides*	Secure	Not Listed	Not Listed	N/A
Prairie Vole[4]	*Microtus ochrogaster*	Secure	Not Listed	Not Listed	N/A
Red Bat[6]	*Lasiurus borealis*	Sensitive	Not Listed	Not Listed	N/A
Silver-haired Bat[6]	*Lasionycteris noctivagans*	Sensitive	Not Listed	Not Listed	N/A
Water Vole[6]	*Microtus richardsoni*	Sensitive	Not Listed	Not Listed	N/A
Wolverine[6]	*Gulo gulo*	May Be At Risk	Special Concern	No Status	No Schedule
Amphibians					
Boreal Chorus Frog[4]	*Pseudacris maculata*	Secure	Not Listed	Not Listed	N/A
Columbia Spotted Frog[5]	*Rana luteiventris*	Sensitive	Not at Risk	Not Listed	N/A
Long-toed Salamander[6]	*Ambystoma macrodactylum*	Sensitive	Not at Risk	Not Listed	N/A
Northern Leopard Frog[5]	*Lithobates pipiens*	At Risk	Special Concern	Special Concern	Schedule 1
Plains Spadefoot[6]	*Spea bombifrons*	May Be At Risk	Not at Risk	Not Listed	N/A
Western Tiger Salamander[6]	*Ambystoma mavortium*	Secure	Special Concern	Not Listed	No Schedule
Western Toad[6]	*Anaxyrus boreas*	Sensitive	Special Concern	Special Concern	Schedule 1
Reptiles					
Plains Garter Snake[5]	*Thamnophis radix*	Sensitive	Not Listed	Not Listed	N/A
Prairie Rattlesnake[5]	*Crotalus viridis*	May Be At Risk	Not Listed	Not Listed	N/A
Red-sided Garter Snake[5]	*Thamnophis sirtalis*	Sensitive	Not Listed	Not Listed	N/A
Wandering Garter Snake[5]	*Thamnophis elegans*	Sensitive	Not Listed	Not Listed	N/A

Notes: 1 = AESRD 2011 , 2 = COSEWIC 2013, 3 = Species at Risk Public Registry (Government of Canada 2012), 4 = Documented species within the Northern Diversion Project Location, 5 = Species at Risk recorded within a 20 km buffer of the Northern Diversion Project Location, 6 = Species with the Potential to Occur within the Northern Diversion Project Location.

The project could potentially impact 73 Species at Risk, multiple species sensitive to anthropogenic disturbance, and many migratory bird species. The presence of such species within the Tongue Creek Project Area can have ecological ramifications, which may result in project relocation and/or delays. Mitigation efforts would be required that may include, but are not limited to, abiding to migratory bird and sensitive species restricted timing windows, modifications to construction methodologies and/or schedule, and designing for wildlife passage/use during detailed design.

2.2.4.4 Aquatic Resources

2.2.4.4.1 Fisheries

The Tongue Creek Project Area includes Tongue Creek and the Highwood River. The Highwood River at High River is a Mapped Class C Water Body with dual Restricted Activity Periods (RAPs) of May 1st to July 15th and September 16th to April 15th. According to the AESRD FWMIS database, 16 species of fish have been captured that have the potential to transit between these two water bodies representing sportfish (trout, whitefish, burbot, and pike), minnows, suckers, trout-perch, and sculpins (Table 2-3). Tongue Creek is designated as a Class D except for

the first 2 km upgradient of its confluence with the Highwood River, which takes on the class of the receiving water body (Class C). The RAPs for this area will be concurrent with the Highwood River.

Table 2-3: Fish Species that May Occur Near the Tongue Creek Project Area

Common Name	Scientific Name	Spawning Season	Provincial Status[1]	COSEWIC[2]	SARA[3]
SPORTIFISH					
Brook Trout	*Salvelinus fontinalis*	Fall	Exotic / Alien	Not Listed	Not Listed
Brown Trout[4]	*Salmo trutta*	Fall	Exotic / Alien	Not Listed	Not Listed
Burbot[4]	*Lota lota*	Winter	Secure	Not Listed	Not Listed
Bull Trout[4]	*Salvelinus confluentus*	Fall	Special Concern	Threatened	Not Listed
Cutthroat Trout[4]	*Oncorhynchus clarki*	Spring	At Risk	Threatened	Threatened
Mountain Whitefish[4]	*Prosopium williamsoni*	Fall	Secure	Not Listed	Not Listed
Northern Pike[4]	*Esox lucius*	Spring	Secure	Not Listed	Not Listed
Rainbow Trout	*Oncorhynchus mykiss*	Spring-Summer	Secure	Not Listed	Not Listed
NON-SPORTFISH					
Flathead Chub	*Platygobio gracilis*	Spring	Secure	Not Listed	Not Listed
Lake Chub	*Couesius plumbeus*	Spring	Secure	Not Listed	Not Listed
Pearl Dace[4]	*Margariscus margarita*	Spring-Summer	Undetermined	Not Listed	Not Listed
Longnose Dace[5]	*Rhinichthys cataractae*	Spring-Summer	Secure	Not Listed	Not Listed
Longnose Sucker	*Catostomus catostomus*	Spring	Secure	Not Listed	Not Listed
White Sucker	*Catostomus commersoni*	Spring	Secure	Not Listed	Not Listed
Spottail Shiner[5]	*Notropis hudsonius*	Spring	Secure	Not Listed	Not Listed
Trout-perch	*Percopsis omiscomaycus*	Spring-Summer	Secure	Not Listed	Not Listed
Spoonhead Sculpin	*Cottus ricei*	Spring	May Be at Risk	Not Listed	Not Listed

Notes1 = AESRD 2011, 2 = COSEWIC 2013, 3 = Species at Risk Public Registry (Government of Canada 2012), 4 = Not documented in Tongue Creek project area, 5 = Not documented in D3 or E project area

Cutthroat Trout and Bull Trout are listed as “Threatened” by COSEWIC, which indicates that the species is facing imminent extirpation or extinction. Cutthroat Trout are also listed under SARA as “Threatened”, which means a formal, legal review has been conducted and they are protected under the Act.

Bull Trout are listed provincially as “Special Concern” and “Sensitive” by AESRD (2011). Sensitive species are not at risk of extinction, but may require special attention or protection. Overharvesting and habitat loss have led to the decline in the population. Some stocking has occurred historically.

Cutthroat Trout are listed at “At Risk” by AESRD (2011). Species listed as “At Risk” have undergone a formal detailed status assessment and are legally identified as “Threatened” or “Endangered” in the *Wildlife Act*. The native Cutthroat Trout populations are threatened by stocking of Cutthroat Trout and Rainbow Trout. These two species have hybridized, which is leading to a decline in the Cutthroat Trout population.

Brook Trout and Brown Trout are listed as “Exotic/Alien” by AESRD (2011). “Exotic/Alien” ranked species have been introduced as a result of human activities. Brown Trout are native from Iceland to the White Sea area and Morocco through Algeria to Turkey; Caspian and Aral seas (Nelson and Paetz 1992). Brook Trout are native to northern Manitoba, the Ungava Bay area, Newfoundland and south to the Carolinas and some Mississippi headwaters (Nelson and Paetz 1992). Brook Trout and Brown Trout have been successfully introduced throughout western Alberta, including the Bow River system.

As Bull Trout and Cutthroat Trout are protected species, project limitations such as timing windows and habitat replacement are anticipated within the Tongue Creek Project Area. The Highwood River is also a very important fishery in southern Alberta and any disruption to migration, spawning, and water quality could have detrimental impacts. In particular, any structures that block upstream migration of fish and impede downstream movement are the primary concern. Both factors could have implications on whether or not the bypass project could go ahead due to the protected nature of Bull and Cutthroat Trout.

The Highwood River and associated tributaries support a predominantly coldwater salmonid fishery with Rainbow Trout, Brook Trout, Bull Trout, Cutthroat Trout, and Mountain Whitefish. The Highwood River Basin provides very successful spawning, rearing, and wintering habitat that supports the fish within the Highwood River and Bow River systems (Golder 1995). Water management and water quality are of great importance for fish, wildlife, and human use of the Highwood River and its tributaries. Severe weather events in recent years have severely affected aquatic, terrestrial, and human environments in the Highwood River Basin. The full extent of the impact of events such as these on fish communities and fish habitat is unknown.

The following potential impacts may occur as a result of the proposed Tongue Creek Project and may warrant further study and will potentially require a request for review from the minister of Fisheries and Oceans and an Application for Authorization:

- An increase in flow in Tongue Creek at or exceeding the flow capacity of the system is likely to result in increased bank erosion, increased sedimentation and damage to riparian vegetation.
- Diverted water and increased flows are likely to cause fish habitat loss, fish mortality, as well as alteration or increased competition caused by the introduction of invasive species and non-native species.
- Water quality concerns caused by increased nutrient loading, sediment loading, and or contaminant flux.
- Water quality concerns caused by the mixing of groundwater seeping from the diversion channel and freshwater from the creek and/or river.
- Fish movement may be impeded or severely impacted forcing fish to go where they would not have naturally gone.
- It is unclear if the flow volumes in Tongue Creek would be capable of flushing fish species from Tongue Creek to the Highwood River, where different quality of habitats exist that would not support certain species or certain life stages. The effects of this transfer of fish warrants further assessment and will potentially require a request for review by the Minister of Fisheries and Oceans and an Application for Authorization.

2.2.4.4.2 Wetlands

A review of existing site information was conducted using the Alberta Canadian Wetland Classification System (CWCS) Merged Wetland Inventory (AESRD 2012). Within the proposed Tongue Creek Project Area, 67 marshes and four open water wetlands have been identified, with marshes covering an area of 274.18 ha and open water bodies covering 36.42 ha (Figure N2-2 in Appendix N1). The majority of all of these wetlands are located in the northern half of the Project Area. As per the *Water Act* (Government of Alberta 2013c), all wetlands that fall within the white zone are protected and any impacts to a wetland as a result of the proposed Project will require compensation. It is important to note that this wetland dataset does not include ephemeral wetlands (Class I to III) and as such, a wetland inventory must be completed.

2.2.4.4.3 Potential Project Impacts

Proposed projects in the basin have the potential to impact areas well beyond the basin. Downstream habitats can be greatly affected by a change in flow rates and as a result, species adapted to this area can be harmed. To address these potential impacts, the river system should be addressed at an ecosystem level, rather than looking at specific habitat areas. The Natural Flow Paradigm is a system that takes into account that the "natural variability of flow in terms of magnitude, duration, frequency and timing is beneficial to the ecosystem" (TWG 2002).

The Highwood and Sheep River Basin is the only unobstructed major tributary to the Bow River and is considered an important spawning and rearing area for both local stocks and the Bow River. Periodic flooding of this area maintains the riparian forests along the Bow River, and certain species, like cottonwood forests, have adapted to these flood events and utilize them for recruitment. Ecosystem function relies on natural variability within the flow regime in all rivers. Therefore, to assess potential impacts of projects to these rivers, an appropriate system to use is the Natural Flow Paradigm (TWG 2002).

The Natural Flow Paradigm aims to conserve the native biodiversity and ecosystem integrity of all rivers by taking into account the pattern of natural flow. Flow components have specific functions within a river system and maintaining the connectivity amongst all components ensures both habitat and species diversity (TWG 2002). Over many years, species have adapted to take advantage of these dynamic systems and a change to flow patterns could impact these species and their habitat areas.

Studies have concluded that in order to set ecosystem objectives, the hydrology, geomorphology, biology, water quality, and connectivity should all be considered, rather than single-flow recommendations, to better succeed in protecting the integrity of aquatic ecosystems (TWG 2002). As any projects in the basin have the potential to impact areas outside of the basin, these components should be incorporated in to any plans to ensure minimal disturbance to downstream ecosystems.

2.2.5 Regulatory Setting

Below is a non-comprehensive list of regulatory agencies, regulations, and acts that will have to be consulted and considered once more detailed project information is known. A summary of other potential environmental legislation that may be required can be found in Alberta Transportation (2013). Information regarding regulatory requirements and timing was obtained directly from the regulatory agencies. Project descriptions and maps were provided to the agencies in order to gain assistance in determining which regulatory approvals would be required and the approximate timelines that each approval would follow. Until detailed project descriptions are provided to each regulatory agency, required regulatory approvals and timelines are not definite and are subject to change based on alterations to the extent or scope of the project. There may be various other minor Federal, Provincial, Municipal approvals or permits required for the project (e.g. burning permits, noise-bylaws). These should be determined and looked at in further detail when the scope of the project is narrowed.

2.2.6 Federal Legislation and Requirements

Works associated with the Tongue Creek Project Area may involve the following federal legislation depending on the final engineering design and reservoir capacity of the dam: *Canadian Environmental Assessment Act* (CEAA) *Fisheries Act, Navigable Waters Protection Act* (NWPA)*, Migratory Birds Convention Act* (MBCA), and *Species at Risk Act* (SARA).

2.2.6.1 Canadian Environmental Assessment Act

The Canadian Environmental Assessment Agency (CEAA) establishes a process to assess the environmental effects of projects requiring federal actions or decisions, and requires that the environmental effects of projects be considered early in their planning stages. As per the *Regulations Designating Physical Activities* (SOR/2012-147; Government of Canada 2013a) under the *Canadian Environmental Assessment Act* (S.C. 2012, c. 19, s.52; Government of Canada 2013b), Tongue Creek will be subject to an environmental assessment. The proposed Tongue Creek by-pass channel would involve diverting more than 10,000,000 m^3 per year of water from the Highwood River to Tongue Creek and back into the Highwood River during a 1% flood event. This will be subject to the need for an environmental assessment under CEAA, activity 6: "The construction, operation, decommissioning and abandonment of a new structure for the diversion of 10 000 000 m^3/yr or more of water from a natural water body into another natural water body". As a provincial Environmental Impact Assessment would be required (Section 8.3.2.1), the *Canada-Alberta Agreement for Environmental Assessment* Cooperation would allow for the assessment and review process to be coordinated and combined. A detailed project description for all diversion options can be sent to CEAA for confirmation once more design information is available.

2.2.6.2 Fisheries Act

The *Fisheries Act* (R.S.C. 1985, c. F-14) applies to all Canadian fisheries waters and Fisheries and Oceans Canada (DFO) has the responsibility to administer and enforce the conservation and protection of fish habitat on private property, as well as on provincial and federal lands (Government of Canada 2013c). Section 36(3) of the *Fisheries Act* prohibits the discharge of deleterious substances into a water body; Section 20(1) requires that any works conducted in and around a water body accommodate fish passage; and Section 35(1) prohibits serious harm to fish, which includes fish and fish habitat that are part of or support commercial, recreational, or Aboriginal fisheries. Serious harm is defined in the *Fisheries Act* as the death of fish, a permanent alteration to fish habitat, and/or the destruction of fish habitat.

DFO has established a self-assessment tool outlining project activities and criteria that do not require DFO review. DFO also provides *Measures to Avoid Harm to Fish and Fish Habitat* which are designed to avoid causing harm and comply with the *Fisheries Act.* If a project does not meet the criteria established by DFO to avoid serious harm to fish and effects cannot be mitigated, a Request for Review must be submitted for consideration by the Minister of Fisheries and Oceans. If activities are determined to cause serious harm to fish, an Application for Authorization will be required that will include a fish and fish habitat report, available design information, a description of effects on fish and fish habitat, a description of measures and standards to avoid or mitigate serious harm to fish and an offsetting plan. The Application for Authorization must also include a letter of credit (from the proponent) to ensure that, if conditions of authorization are not completed, DFO can access funds to implement all remaining elements of the mitigation plan. The amount of the letter of credit should be sufficient to complete the offsetting plan and any required monitoring program.

Design information for the Tongue Creek Project Area has not yet been developed, which prevents specific comment on the potential impacts of a channel. Impacts to fish and fish habitat might include fish passage issues, sedimentation, erosion, habitat loss, habitat alteration, and water quality issues (mixing of ground water and fresh water). Collaboration with DFO officials will be integral in developing the design of the bypass channel, diversion structure, and outfall structures to minimize the risk to fish and fish habitat. The DFO approval process will take approximately one and a half years, depending on whether or not fish habitat destruction will occur.

The Tongue Creek project will result in serious harm to fish and fish habitat, including fish passage and access to spawning habitat. As such, the requirements discussed above will need to be followed, fish and fish habitat studies will need to be completed, and a letter of credit will have to be drafted. The process will take approximately one and a half years.

2.2.6.3 Navigable Waters Protection Act

The Transport Canada Navigable Waters Protection Program supports the regulation of works constructed or placed in, on, over, under, through, or across, navigable waters in Canada in accordance with the *Navigable Waters Protection Act* (NWPA, R.S.C., 1985, c. N-22, Government of Canada 2009). As part of the Federal Government's 2012 Bill C-45, amendments were made to the NWPA including implementation of a schedule listing major waterways for which regulatory approval is required. The project is projected to commence construction after April 2014, when the amendments come into force, therefore, review will not be required by Transport Canada as the Highwood River is not included in the Schedule of the Act. The amendment to the act still allows proponents of works in non-scheduled waters to opt-in and seek approval of their proposed works. It is recommended that the proponent consult with Transport Canada and seek approval on these proposed works as they would significantly impact navigability.

2.2.6.4 Migratory Birds Convention Act

The *Migratory Birds Convention Act* [1994, amended in 2010, c.22] (MBCA) and Migratory Birds Regulation [2005, amended in 2009, c1035] are administered by Environment Canada (Government of Canada 2010). Under the MBCA, CWS has jurisdictional interest with respect to the management of migratory birds and migratory bird populations, protecting nationally significant nesting habitats, and regulating the hunting of migratory game birds such as ducks and geese. Section 6(a) of the General Prohibitions of the Migratory Birds Regulations C.R.C., c. 1035, states that it is an offence to "disturb, destroy or take a nest, egg, or nest shelter" of a migratory bird. Additionally, Section 35(1) stipulates that "no person shall deposit or permit to be deposited oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds".

The MBCA and its' associated regulation specify that efforts should be made to preserve and protect habitat necessary for the conservation of migratory birds. This includes nesting and wintering grounds, migratory bird corridors, and encompasses such activities as tree clearing, wetland consolidation, and temporary and permanent disturbances occurring in proximity to migratory bird habitat.

In the southern Parkland and Boreal ecozones of Alberta, Environment Canada advises that habitat destruction activities (e.g. vegetation clearing, flooding, draining, construction, etc.) in upland areas attractive to migratory birds are prohibited between May 1st and August 20th. In wetland areas attractive to migratory birds, the window is between April 15th and August 20th (Paul Gregoire, Environment Canada, personal communication). Migratory birds will be encountered at the project site; therefore, mitigation to avoid construction (e.g. tree clearing and/or potential nest habitat destruction) during migratory bird restricted timing windows will be required.

2.2.6.5 Species at Risk Act

The *Species at Risk Act* [2002, c.29] (SARA) provides protection for Canadian indigenous species, subspecies, and distinct populations and their critical habitats on federal lands, but does not apply to lands held by the Province of Alberta or its private citizens unless "the laws of Alberta do not effectively protect the species or the residences of its individuals" (Government of Canada 2013d). The Minister may issue an order in council to protect federally listed species that occur on provincial or private lands, but this has not occurred.

2.2.7 Provincial Legislation

2.2.7.1 Alberta Environmental Protection and Enhancement Act

The Ministry of Environment and Sustainable Resource Development is responsible for evaluating the impacts that a project may have on the environment and for the administration of Alberta's laws governing Environmental Assessments and Environmental Impact Assessments. The *Environmental Assessment Regulation and the Environmental Assessment (Mandatory and Exempted Activities) Regulation* provides direction on matters related to the administration of the environmental assessment process. The purpose of *Environmental Protection and Enhancement Act* (EPEA) (R.S.A. 2000, c. E-12; Government of Alberta 2013e) is to support and promote the protection, enhancement and wise use of the environment.

The proposed Tongue Creek scheme will be subject to an Environmental Impact Assessment (EIA) through the following activities under the *Environmental Assessment (Mandatory and Exempted Activities) Regulations:*

- "The construction, operation or reclamation of a water diversion structure and canals with a capacity greater than 15 cubic metres per second"

As the project is considered a mandatory activity by the EPEA director (personal communication), an Environmental Impact Assessment (EIA) will be subject to and cannot be overridden by any government authority or process. The EIA process will start by submitting a detailed project description to EPEA to determine if an EIA is required. Once that is confirmed, a Terms of Reference (TOR) will be submitted to EPEA and Public Notice will occur (this takes 30 to 45 days). Modifications are made to the TOR depending on the level of public comment (time frame ranging from one month to many months) and an EIA is commenced. The EIA involves field work, analyses, and reporting and generally takes 72 weeks until the TOR is met. The next step is to refer the EIA to the Public Interest Board where the Natural Resources Conservation Board (NRCB) determines if they need more information or if a hearing is required. During the 72 week EIA process, an integrated application can be submitted to all regulatory agencies (EPEA, Water Act, Public Lands, DFO, Transport Canada, CEAA, etc.), but NRCB has to consider a decision before all other approvals are issued. An EIA cannot be submitted until a First Nations Consultation Plan has been approved. From start to finish (meeting the requirements of the TOR), the EIA process takes 2 to 3 years.

When both federal and provincial environmental assessments are required for a project, the two governments act together to minimize overlap and increase efficiency so the assessment will not take any additional time. This process is laid out in the *Canada-Alberta Agreement for Environmental Assessment Cooperation* (Government of Canada 2013e).

2.2.7.2 Natural Resources Conservation Board Act

The NRCB, established in 1991, is an agency independent from the Government of Alberta that reviews proposed non-energy natural resource projects (NRCB 2014). The NRCB, under the *Natural Resources Conservation Board Act*, considers social, environmental, and economic effects when reviewing resource projects before approval is granted to the Proponent (Government of Alberta 2013f). The *Environment Protection and Enhancement Act* sets which projects require EIAs, and of those projects, EPEA determines which will also require a review by the NRCB (NRCB 2007). Reviewable projects include forest industry projects, recreational or tourist projects, metallic or industrial mineral projects, water management projects, and any other type of project prescribed in the regulations (Government of Alberta 2013f). If a water management project requires an EIA under EPEA, it automatically becomes an NRCB reviewed project as described in the *Act.* By definition, a "water management project" means:

i) A project to construct a dam, reservoir or barrier to store water or water containing any other substance for which an environmental impact assessment report has been ordered, or

ii) A project to construct a water diversion structure, or canal capable of conducting water or water containing any other substance for which an environmental impact assessment report has been ordered.

Once an EIA meets its TOR, it is referred to the NRCB to determine if the NRCB requires more information or if a hearing is required. This process can take an additional 1 to 2 years above the EIA timeline of 2 to 3 years.

2.2.7.3 Water Act

All water resources located within the province of Alberta are owned by the Provincial Government. AESRD administers the Alberta *Water Act,* which is the primary legislation governing the use and management of Alberta's water resources, including wetlands. Alberta's *Water Act* (R.S.A. 2000, c. W-3; Government of Alberta 2013c) requires approval and/or attainment of a license before undertaking construction in a surface water body or activities related to a water body which have the potential to impact the aquatic environment. Dams and water diversions require *Water Act* Applications, and diversions also require a *Water Act* Licence. Section 36 of the Act stipulates that an approval is required for all activities that may impact water and the aquatic environment.

The *Approved Water Management Plan for the South Saskatchewan River Basin* (Alberta Environment 2006) recommends that Alberta Environment no longer accept applications for water allocations in both the Bow, and Oldman Sub-basins until the Minister of Environment specifies, through a Crown Reservation, how water currently unallocated is to be used (Alberta Environment 2006). Water allocated to a Crown Reservation within these sub-basins can only be used for:

- Water conservation objectives.
- Storage of peak flows to mitigate impacts on the aquatic environment and to support existing licenses. (Alberta Environment will assist the Watershed Planning and Advisory Councils in evaluations of the potential for on-stream and off-stream storage).
- Licenses and registrations that may be issued for applications and registrations pending at the date of the Crown Reservation (this does not necessarily imply approval; but the pending applications and registration will be reviewed).
- First Nations Reserves.

The Tongue Creek by-pass channel may be considered an accepted use under one or more of the above depending on the final design.

Also, under Section 16(1) of the *Water Act*, the Director may not issue or amend an approval, preliminary certificate, or licence or approve a transfer of an allocation of water under a licence if the Director is of the opinion an EA or EIA is required. Should an EIA process be required, all *Water Act* Approvals and Licences will occur simultaneously with the EIA approval process. A *Water Act* approval will be required for this project. Depending on the final design of the diversion, it is possible that a licence under the *Water Act* may be required. All timelines listed in Table 2-5 were provided by the *Water Act* Approvals group within AESRD.

2.2.7.4 Alberta's Wetland Policy

AESRD released Alberta's new Wetland Policy in September 2013 (Government of Alberta 2013b). This policy will be phased in in the summer of 2014. Until then, the "Wetlands Management in the Settled Area of Alberta – an Interim Policy" (1993) provides a framework to conserve wetlands within Alberta (Alberta Water Resources Commission 1993). In addition to conserving wetlands, this document also introduces the mitigation of wetland impacts as well as the enhancement, restoration, or creation of ephemeral wetlands. In 2007, the Alberta

Government released the revised edition of the Provincial Wetland Restoration/Compensation Guide, which provides recommendations to achieve the policy's goals, intent, objectives, and mitigation requirements. This will occur in conjunction with the EIA process.

The new wetland policy will apply to all wetlands in the province (no discrimination between wetlands located in the green vs. white zone of Alberta) and will focus on conserving and minimizing wetland losses. Impacted wetlands will need to be evaluated by a Qualified Wetland Aquatic Environment Specialist (QWAES) using a standardized tool to determine Wetland Value. The score determined from the tool will be used in the decision making process in order to avoid, mitigate, or replace wetland losses. Wetland Value will also be used to determine wetland replacement/compensation ratios (Government of Alberta 2013b).

2.2.7.5 Historical Resources Act

The *Historical Resources Act* (R.S.A. 2000, c. H-9) protects historic resources in Alberta, including paleontological, prehistoric, historic, archaeological, and certain cultural or natural objects, sites, or structures (Government of Alberta 2013a). Pursuant to the Act, a Historical Resource Clearance is needed for projects where effects on known and unknown historical resources could occur. The recommendation for this project is that a Historical Resources Impact Assessment be conducted, which will occur concurrently with the EIA process.

2.2.7.6 Public Lands Act

All Public Lands, including the bed and shores of all permanent watercourses and water bodies, are considered Alberta Public Lands unless they are owned by the Government of Canada. As such, approvals under the *Public Lands Act* [R.S.A. 2000, c. P-40] (Government of Alberta 2013d) are required for any activity on Public Lands or the bed or shore of Crown owned rivers, streams, or lakes. Any activity that alters or occupies Public Lands or the bed and shore of a water body requires written approval. As all diversions occur on a water body and on terrestrial Public Lands, multiple Public Lands dispositions will be required. This process would occur concurrently with the EIA application.

2.2.7.7 Wildlife Act

On private land and Alberta's Public Lands, the Alberta Government has the responsibility for all wildlife, including Species at Risk, as established by the *Natural Resources Transfer Act* of 1930. Alberta's *Wildlife Act* (R.S.A. 2000, c. W-10) designated endangered and threatened species, and provincially listed species potentially influenced by the Project (Government of Alberta 2013g). Alberta's *Wildlife Act* protects the residences of wildlife on private and public lands. More specifically, a person must not wilfully molest, disturb or destroy a house, nest or den of certain species. Section 96 of the *Wildlife Regulation* (Government of Alberta 2013h) outlines the wildlife species, areas, and time of year when the Act applies. All endangered wildlife, upland game birds, some migratory birds, snake and bat dens, and beavers (in some instances) are covered under Section 36 of the Act. For most wildlife, disturbing the habitat of these animals is prohibited year-round throughout Alberta. AESRD staff may recommend timing restrictions on activities to minimize disturbance to the nests/dens/hibernaculum of breeding wildlife and birds. The *Wildlife Act* also protects endangered plant species (both vascular and non-vascular) listed in the *Wildlife Regulation*. Project delays and/or project related modifications may arise should any provincially listed Species at Risk occur within the Tongue Creek Project Area. Mitigation measures, set back distances, and restricted timing windows will be required.

2.2.7.8 Summary of Regulatory Requirements

A summary of regulatory requirements applicable to this project is provided in Table 2-4.

Table 2-4: Summary of Regulatory Requirements

Legislation, Policy, or Guidelines	Responsible Authority	Description	Required Action
Federal Legislation			
Canadian Environmental Assessment Act	Canadian Environmental Assessment Agency	To assess the environmental effects of projects requiring federal actions or decisions, and ensure that the environmental effects of projects be considered early in their planning stages.	Submission of a Project Description to determine if an Environmental Assessment under CEAA is required. As the project stands, an EA will likely be required for the Tongue Creek by-pass channel.
Fisheries Act	Fisheries and Oceans Canada	Prohibits any harmful alteration, disruption, or destruction of fish habitat.	*Fisheries Act* Authorization or Letter of Advice following Fish and Fish Habitat Assessment Report. DFO Authorization will be required.
Navigable Waters Protection Act	Transport Canada	Protects the public right to navigate all navigable waterways within Canada.	Due to the recent changes to NWPA, an application is not required for this water body. However, a voluntary application should be submitted due to the scope of this project.
Migratory Birds Convention Act	Canadian Wildlife Service	Prohibits the killing, capturing, injuring, taking, or disturbing of migratory birds. Prohibits the damaging, destroying, removing, or disturbing of all migratory bird nests	Vegetation clearing restricted from May 1st to August 20th. Disturbance of wetlands attractive to migratory birds restricted from April 15th to August 20th.
Species at Risk Act	Environment Canada	Prohibits the killing or harming or harassing of listed species, the damage and destruction of their residences, and the destruction of critical habitat.	Activities must acknowledge species-specific Protection and Recovery Plans.
Provincial Legislation			
Environment Protection and Enhancement Act	Alberta Environment and Sustainable Resource Development	Support and promote the protection, enhancement, and wise use of the environment.	Environmental Impact Assessment due to the mandatory activity designation.
Natural Resources Conservation Board Act	Natural Resources Conservation Board	Reviews projects for social, environmental, and economic factors before granting approvals	The Environmental Impact Assessment will be reviewed by the Natural Resources Conservation Board.
Water Act	Alberta Environment and Sustainable Resource Development	The *Water Act* focuses on managing and protecting *Alberta's* water, while streamlining administrative processes.	*Water Act* application for any impacts to a waterbody will be required.
Alberta's Wetland Policy	Alberta Environment and Sustainable Resource Development	Manages the enhancement, restoration, or creation of permanent wetlands.	Wetland conservation and creation according to the wetland policy. Will be required if wetlands are impacted.
Alberta Historical Resources Act	Alberta Culture and Community Spirit (ACCS) and the Royal Tyrrell Museum of Palaeontology	Provides a framework for Historical Resource Impact Assessments (HRIA).	HRIA and clearance letter required

Legislation, Policy, or Guidelines	Responsible Authority	Description	Required Action
Public Lands Act	Alberta Environment and Sustainable Resource Development	Any activity that alters or occupies the bed and shore of a waterbody requires written approval.	Public Lands Disposition will be required for any structures on Crown-owned watercourses and/or land. A Temporary Field Authorization will be required for any temporary access on public land.
Alberta Wildlife Act	Alberta Environment and Sustainable Resource Development	Prohibits the harm of residences of species at risk. Provides restricted timing windows and disturbance setback distances for species at risk.	Consult with AESRD if species at risk are present. Vegetation clearing restricted from March 1st to August 31st for sensitive species, year-round for others.

There may be various other minor Federal, Provincial, Municipal approvals or permits required for the project (e.g. burning permits, noise-bylaws, wildlife research permits, etc.). These can be determined once potential projects and locations are known.

2.2.7.8.1 Required Authorizations and Permits

A summary of required authorizations and permits applicable to this project, as well as their timelines is provided in Table 2-5. However, the EIA process allows for the concurrent submission of all applications and approvals as a single process. During the 72 week EIA process, an integrated application can be submitted to all regulatory agencies (EPEA, Water Act, Public Lands, DFO, Transport Canada, CEAA, etc.), but NRCB has to consider a decision before all other approvals are issued. If a water management project requires an EIA under EPEA, it automatically becomes an NRCB approved project. If NRCB does not require more information or a hearing, the EIA process can take 2 to 3 years. If NRCB requires more information or a public hearing, the EIA process can take an additional 1 to 2 years for a total of 3 to 5 years. All timelines were obtained from the respective regulatory agencies.

Table 2-5: Timeline of Required Authorizations and Permits

Regulatory Agency	Approvals	Timeline
Department of Fisheries and Oceans	Fisheries Act Authorization	1 year if there is no HADD and 1.5 years if there is HADD (occurs concurrently with EIA process)
Alberta Environment and Sustainable Resource Development (AESRD)	Temporary Field Authorization (TFA)	2 days to 2 weeks
	EPEA Environmental Impact Assessment Approval	2 to 3 years
	First Nations Consultation Request (FNC)	Less than 2 weeks
	Water Act Approval	2 to 3 months (occurs concurrently with EIA process)
	Dispositions	3 months to a year
Alberta Wildlife Act	Wildlife Research and Collection Licence	AECOM has a blanket permit for the entire province so there is no wait time
	Fish Research Licence	1 week
Alberta Culture	Statement of Justification (SoJ)	1 to 2 months (occurs concurrently with EIA process)
	Clearance Letter resulting from a Historical Resources Impact Assessment (HRIA)	2 months to a year (occurs concurrently with EIA process)
Canadian Environmental Assessment Agency	Advice to Federal Government Departments resulting from an Environmental Assessment	2 to 3 years (if required; occurs concurrently with EIA process and is followed by the NRCB Approval). Depending on the scheme, an Environmental Assessment under CEAA will most likely not be required based on the current design information
Environment Canada	Species at Risk Act	6 months
Transportation Canada	Navigable Water Protection Act Application	N/A
Natural Resources Conservation Board	NRCB Approval	1 to 2 years (if required)

2.3 Conclusions and Recommendations

The desktop review for the Tongue Creek Project Area identified several environmental concerns:

- The Highwood River at High River is a Mapped Class C Water Body with dual Restricted Activity Periods (RAPs) of May 1st to July 15th and September 16th to April 15th.
- Tongue Creek is designated as a Class D except for the first 2 km upgradient of its confluence with the Highwood River, which takes on the class of the receiving water body (Class C). The RAPs for this area will be concurrent with the Highwood River.
- Bull Trout and Cutthroat Trout have the potential to occur in the area. Cutthroat Trout and Bull Trout are listed as “Threatened” by COSEWIC, which indicates that the species is facing imminent extirpation or extinction. Cutthroat Trout are also listed under SARA as “Threatened”, which means a formal, legal review has been conducted and they are protected under the Act.

The Tongue Creek Project Area occurs within Sensitive Raptor and Sharp-tailed Grouse Key Ranges, Key Wildlife and Biodiversity Zones, , and a variety of land use areas. Timing restrictions of no construction between December 15th and April 30th are mandatory for the Key Wildlife and Biodiversity Zone.

A total of 73 wildlife Species at Risk have been identified with the potential to occur within the Northern Diversions Project Area with general status AESRD listings ranging from 'Sensitive' to 'At Risk'. Environment Canada restricts activities that cause habitat destruction (e.g. vegetation clearing, flooding, draining, construction, etc.) in upland areas attractive to migratory birds between May 1st and August 20th and in wetland areas the restriction occurs between April 15th and August 20th.

Within the proposed Tongue Creek Project Area, 67 marshes and four open water wetlands have been identified, with marshes covering an area of 274.2 ha and open water bodies covering 36.4 ha (Figure N2-2 in Appendix N1). The majority of all of these wetlands are located in the northern half of the Project Area.

If the proposed Tongue Creek by-pass scheme is approved, a full suite of field surveys for the Environmental Impact Assessment will be required. The following is a list of recommended environmental surveys and assessments that must be completed for approval prior to the commencement of any construction activities:

- Aquatic surveys
- Wetland assessments
- Vegetation inventories
- Rare plant surveys
- Soil and terrain surveys
- Wildlife and wildlife habitat surveys
- Species at risk surveys
- Fish and fish habitat assessment
- Historical resources impact assessment
- All associated surveys required for an environmental impact assessment (geological, hydrogeological, socioeconomic, air, hydrological, etc.).

Clearing activities associated with the Tongue Creek Project Area have the potential to impact local wildlife populations and vegetation. Clearing will need to adhere to timing restrictions described in Table 2-4. Field surveys, as mentioned above, will be required to determine if sensitive, protected, or rare species occur in this area. An HRIA will also be required for all areas where Historical Resources have high potential to occur along this alignment.

It is important to note that the presence of protected birds, amphibians, mammals and/or plant species may restrict construction activities in the proposed Project area at certain times of year.

Based on current project design, Tongue Creek would be the most environmentally detrimental of all options examined to date due to the destruction of a natural fish bearing water course, unnatural flooding of riparian ecosystems, and mixing of groundwater with fresh water.

3. Review of Existing Information Geosciences

3.1 Review of Existing Information

The following information was reviewed as part of this desk study report:

- Surficial and bedrock geology maps of the High River area from published literature and Alberta Geology Survey
- Review of previous geotechnical investigation reports near the Tongue Creek alignment
- Groundwater conditions from AESRD's Groundwater Information System
- Existing water well testhole logs taken from AESRD's Groundwater Information Centre

The main objective of the review was to gather information on the surficial geology and depth of bedrock along the channel alignment and to assess the anticipated subsurface conditions along the by-pass channel.

3.2 Surficial and Bedrock Geology

The surficial geology and bedrock maps for the High River Area were reviewed to gather information on overburden and bedrock lithologies. The referenced maps and the channel alignment superimposed on the geological maps are shown on Figures N3-1 and N3-2 in Appendix N1. A brief description of the surficial lithology and bedrock anticipated at the site is provided below.

- Pleistocene and Holocene deposits, Undivided:
  - Glaciolacustrine Deposits - fine sediment; (silt and clay; flat to gently undulating surface).
  - Fluvial Deposits - coarse sediment; (gravel and sand, minor silt beds).
  - Fluvial Deposits - fine sediment; (fine sand, silt and clay, minor gravel beds).
- Pleistocene:
  - Draped moraine - till of even thickness, with minor amounts of water sorted material and local bedrock exposures; up to 5 m thick: includes local areas of undifferentiated subglacially molded deposit with streamlined features; flat to undulating surface reflecting topography of underlying bedrock and other deposits.
  - Stagnation moraine - till of uneven thickness, local water sorted material of up to 30 m thick, undulating to hummocky topography reflecting variations in till thickness. Undulating topography, generally with relief less than 3 m.

The bedrock geology within the area of the proposed channel alignment is shown on Figure N3-2 in Appendix N1. A brief description to expected bedrock along channel alignment is provided below:

- Willow Creek Formation - Grey, green, and pink mudstone with calcareous concretions and friable pale grey, generally fine-grained sandstone, thick bedded and coarse grained in upper part, non marine.
- Porcupine Hills Formation - Olive brown mudstone inter-bedded with fine to coarse grained brownish-grey, cross stratified sandstone and siltstone, non marine.

3.3 Regional Groundwater Conditions

Historical groundwater information was collected using an online search of existing water wells within the project area. The search was conducted using AESRD's Water Well Information database. The database contains records of individual water well drilling reports, stratigraphy, and pump test information. Seven well locations which offset approximately 5 m to 800 m from the proposed diversion channel alignment were selected for compilation of groundwater data. The well locations are presented on Figure N1-2 in Appendix N1. A summary of the compiled groundwater data in the vicinity of the diversion channel is provided in Table 3-1.

Table 3-1: Summary of Groundwater Depths Compiled from Water Wells

Well ID	Measured Date (MM/DD/YYY)	Location		Completion Zone Depth (mBGS)/Lithology	Static Water Level (mBGS)	Approximate Distance from Channel Centre Line (m)
		Latitude	Longitude			
128253	05/11/1979	50.590251	-113.945663	24.4 – 44.5 / Bedrock	13.41	200
166443	06/03/1992	50.575766	-113.957392	29.0 – 44.8 / Bedrock	0.3	800
241765	10/10/1994	50.575766	-113.957392	22.9 – 32.0 / Bedrock	5.55	600
244960	10/19/1994	50.597483	-113.945665	13.4 / 16.8 / Bedrock	4.82	5
264545	09/21/1995	50.597483	-113.945665	6.7 – 7.9 / Gravel	2.41	5
285090	06/19/1996	50.597483	-113.945665	60.3 – 65.5 / Bedrock	21.03	350
1555287	11/21/2002	50.590200	-113.946000	5.8 – 13.4 / Sand & Gravel	3.05	100

Groundwater depths were also obtained from previous testholes drilled near the outlet structure. Table 3-2 provides a summary of testhole information, including date conducted, northing and easting co-ordinates, and depth below ground surface.

Table 3-2: Summary of Groundwater Depths Compiled from Testholes Drilled in the Area

Testhole No.	Drilling Method	Date Drilled (MM/DD/YYY)	Location		Groundwater Depth (mBGS)	Approximate Distance from Channel Centre Line (m)
			Northing	Easting		
01-A1	Auger	06/01/2001	5610750	291680	3.6	1100
01-A2	Auger	06/01/2001	5610539	291719	3.2	850
01-A4	Auger	07/04/2001	5609672	290575	1.6	1050
TH14-01	Auger/ Coring	01/23/2014	5605847.3	291197.2	3.52	0
TH14-02	Auger/ Coring	01/22/2014	5606036.4	291214.8	3.48	0
TH14-03	Auger/ Coring	01/15/2014	5606384.8	291591.5	3.15	350

The available information indicates that aquifers in the region occur within two general types of deposits:

- Sand and gravel deposits inter-bedded in the surficial deposits above the bedrock
- Sandstone, fractured shale or coal seam deposits in near surface bedrock

Regional groundwater flow is generally westward from the mountains towards the Highwood River.

4. Subsurface Conditions

4.1 Subsurface Stratigraphy

The subsurface stratigraphy along the channel alignment is expected to be variable consisting of silt, sand, gravel, clay, clay till and bedrock. Description of the subsurface conditions from boreholes along the first 1000 m of the proposed Tongue Creek alignment is provided on the testhole logs in Appendix N2.

Figures N4-1 and N4-2 show the channel bottom elevation and the existing ground elevation along the proposed channel alignment. It should be noted that the interpreted stratigraphy between testhole locations (Station 0+000 and Station 0+1000) is provided for illustrative purposes only, and the actual stratigraphy may vary from that noted on the figures.

The channel alignment has been divided into two sections for ease of description of the subsurface conditions. These two sections are denoted by station with overall length being taken from the profile of the Tongue Creek channel. The first section is from Station 0+000 to Station 1+000 and the second section runs from Station 1+000 to Station 3+893.

4.1.1 Station 0+000 to Station 1+000

According to the available data, the subsurface stratigraphy near the inlet structure consists of 50 millimetres (mm) to 150 mm thick topsoil, overlying gravel of thicknesses varying from 14.5 to 21 m, followed by bedrock. Bedrock in this region consists of clayshale with interbedded sandstone. Bedrock strength may vary from extremely weak to moderately strong.

Testholes TH14-01 and TH14-02 were drilled close to the inlet structures with existing ground at elevations 1061.5 m and 1061.2 m, respectively. The subsurface stratigraphy near the inlet structure (TH14-01 and TH14-02) consisted of 75 mm thick topsoil, overlying gravel of varying thickness from 14.9 to 21 m, followed by bedrock. In TH14-01 bedrock was encountered at 14.9 metres below ground surface (mBGS) and consisted of clayshale with interbedded sandstone. Bedrock strength varied from extremely weak to moderately strong. The testhole was terminated in clayshale at 45.5 mBGS. The core recovery was 100%, and the Rock-Quality Designation (RQD) varied from 63% to 97%. TH14-02 was a shallow testhole terminating in gravel.

Moving further away from the inlet, the topsoil encountered may have thickness ranging from 100 mm to 400 mm. Topsoil is likely to be underlain by clay which is described as silty with trace of sand, medium plastic, stiff, moist and oxidized. Clay was also encountered underlying clay till.

As the chainage increases, silt and fine grained sand may be encountered underlying the clay. Also the gravel content should decrease as the alignment moves away from the Highwood River.

Clay till may be encountered at 1.5 mBGS to 2.5 mBGS underlying the clay, silt or sand layers. The clay till was described as low plastic and very stiff to very hard. The clay till may be moist, oxidized and might have coal inclusions.

The bedrock should be encountered at depths of 5.0 mBGS to 11.0 mBGS. It consisted of alternating layers of generally weak clayshale, siltstone, and sandstone.

Atterberg Limits were estimated for two bedrock samples. A summary of the Atterberg Limits is provided in Table 4-1.

Table 4-1: Summary of Atterberg Limits Test Results (Station 0+000 to Station 1+000)

Testhole	Sample	Soil Unit	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
TH14-03	8	Clayshale	26.8	18.7	8.1
TH14-03	C4	Clayshale/Siltstone	23.8	19.3	4.5

Grain size analysis tests (hydrometer and sieve analysis) were conducted on three samples. A summary of the test results is provided in Table 4-2.

Table 4-2: Summary of Grain Size Analysis Test Results (Station 0+000 to Station 1+000)

Testhole	Sample	Soil Unit	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TH14-03	5	Gravel and Sand	52	31	17	
TH14-04	3	Gravel	60	25	15	
TH14-04	9	Silt	4.7	20.3	59.3	15.7

The unconfined compressive strengths varied from 228 kPa and 38,300 kPa indicating that the bedrock is extremely weak to medium strong. A summary of the test results is provided in Table 4-3.

Table 4-3: Summary of Unconfined Compressive Strength Results (Station 0+000 to 1+000)

Testhole	Sample	Bedrock Unit	Unconfined Compressive Strength (q_u) (kPa)
TH14-01	C1	Clayshale	402
TH14-01	C3	Clayshale	228
TH14-01	C6	Siltstone	38,300

Electrochemical tests were conducted on six samples to determine water soluble sulphate content, water soluble chloride content, pH and resistivity. A summary of the test results, expected degree of corrosion, and the potential for sulphate attack of the subsurface soils on concrete are presented in Table 4-4.

Table 4-4: Summary of Soil Electrochemical Testing Results (Station 0+000 to Station 1+000)

Testhole	Sample	Soil Unit	pH	Sulphate Content (mg/L)	Resistivity (ohm-cm)	Chloride Content (mg/L)	Degree of Corrosiveness	Potential for Sulphate Attack
TH14-01	C1	Clayshale	7.98	64	3420	13	Corrosive	Low
TH14-01	C3	Clayshale	8.37	54	1690	16	Highly Corrosive	Low
TH14-02	3	Gravel	7.61	160	840	28	Extremely Corrosive	Low
TH14-02	11	Gravel	7.79	120	1210	33	Highly Corrosive	Low
TH14-02	18	Gravel	8.47	150	1490	8.7	Highly Corrosive	Low
TH14-02	19	Gravel	8.01	145	1150	32.5	Highly Corrosive	Low

4.1.2 Station 1+000 to Station 3+893

The subsurface stratigraphy was obtained from the water well records along the diversion channel Stations 1+000 to 3+893 consisted of the following soil deposits in descending order:

- *Topsoil* – topsoil was encountered at ground surface at the borehole locations. Thickness of topsoil varied from approximately 0 to 0.6 m.
- *Silty Clay/ Sandy Clay/ Clay Till* – clay and/or clay till was encountered at surface or below the topsoil. Based on the well records, the thickness of this soil deposit varied from 2.5 m to 16 m.
- *Sand/Gravel* – sand and gravel was encountered below the clay/clay till. Based on the well records, the thickness of this deposit varied from 6.5 to 11 m.
- *Bedrock* – bedrock was encountered below the gravel and sand layer. Based on the well records, the bedrock consisted of interbedded clayshale and sandstone. The bedrock was reported at depths varying from 7 mBGS to 21 mBGS.

The subsurface stratigraphy was also obtained from testholes west of the outlet structure. Testhole 01-A4 (UMA 2001) drilled close to the study area shows 0.9 m of organic topsoil overlying 0.6 m of clayey gravel, overlying 1.8 m of soft to firm silty, sandy clay, overlying 3.5 m of sandy gravel, over siltstone bedrock.

Testholes 01-A1, 01-A2, 01-A3-A, 01-A3-B, 01-A5 and 01-A6 are located 500 to 1000 m north of the outlet structure. Testholes 01-A1, 01-A2 and 01-A5 (UMA 2001) encountered approximately 100 mm of topsoil overlying 4.6 m to 5.0 m of interbedded sand and clay. Claystone bedrock was encountered at 5.0 m depth in testhole 01-A2. The interbedded sand and clay was found to overlie 5.6 m of sandy gravel, in turn overlying siltstone and sandstone bedrock in testhole 01-A1. Clay till was encountered to the base of the testhole in 01-A5.

Testholes 01-A3-A, 01-A3-B and 01-A6 encountered approximately 100 mm of topsoil was encountered overlying silt and clay layers of clay and silt layers, in testholes 01-A3-A and 01-A3-B. In testhole 01-A3-A, silt was found to overlie sand with cobbles which extended to the end of hole at 5.2 mBGS. In testhole 01-A6, a 0.6 m thick boulder layer or occasional rafted bedrock was encountered at the depth of 4.6 mBGS. This was found to overlie clay till with cobbles to 15.2 m depth, which in turn overlies very weak to strong interbedded claystone, siltstone and sandstone bedrock.

4.2 Groundwater Conditions

Standpipe piezometers, consisting of 50 mm diameter slotted PVC pipe were installed in testholes 01-A1, 01-A2 and 01-A4 in 2001 (UMA 2001). The piezometers consisted of a 1.5 m to 3 m long slotted sections installed in a sand, gravel or clay and sand layer. A 1 m bentonite seal was placed at the surface and at the top of the slotted section. Groundwater depths were measured on July 9 and 27, 2001. A summary of piezometer installation details and groundwater conditions are given in Tables 4-5 and 4-6.

Table 4-5: Groundwater Monitoring Results (July 2001)

Piezometer	Lithology	Standpipe Screen Depth (mBGS)		Water Level (mBGS)
		Top	Base	
01-A1	Sandy Gravel	4.6	6.1	3.5
01-A2	Clayey Sand with some gravel	3.1	4.6	3.1
01-A4	Silty clay with sand layers and gravel	1.6	4.6	1.7

Table 4-6: Groundwater Monitoring Results

Piezometer	Ground Elevation (masl)	Standpipe Screen Depth (mBGS)	Date	Water Level (mBGS)	Groundwater Elevation (masl)
TH14-01	1061.488	13.3 – 15.0	2014-Feb-24	3.52	1057.97
TH14-02	1061.181	3.7 - 5.2	2014-Feb-22	3.48	1057.70
TH14-03	1059.338	3.6 - 5.3	2014-Feb-22	3.15	1056.19

Groundwater depths may vary seasonally and as a result of precipitation and may be at different depths during construction.

5. Preliminary Geotechnical Considerations

5.1 General

Geotechnical considerations related to the design and construction of the proposed by-pass channel are discussed in this section. Based on the testhole logs present along the proposed alignment of the channel and projected from the testholes drilled along the D3/E alignment, geological maps and water well drilling information, the ground conditions are highly variable. Therefore, based on the soil stratigraphy, the channel alignment has been divided into two sections (Station 0+000 to Station 1+000 and Station 1+000 to Station 3+893). The sections of the channel alignment are summarized below:

- **Station 0+000 to Station 1+000:** Based on testholes TH14-01 and TH14-04, this section is dominated by coarse grained gravel and sand layers; overlying bedrock, which consisted of alternating layers of clayshale, siltstone, and sandstone. Silt or clay is likely to be encountered near the end of the chainage.
- **Station 1+000 to Station 3+893:** Based on the water well records, this section of the alignment consists of topsoil underlain by silty clay/sandy clay/clay till which extends up to 16 m depth. Sand and gravel is below the clay and clay till followed by clayshale and sandstone bedrock.

5.2 Geotechnical Concerns

The major geotechnical concerns for the proposed diversion channel alignment are:

- Presence of sand and gravel layers at the surface and extended to depths of 15 m and 21 m: - These soils are susceptible to excessive seepage erosion, scouring and piping. Soil erodibility primarily depends on the texture of the soil, especially sand having a grain size between 100 to 200 microns and silt having a grain size between 2 to 100 microns, as well as the water velocity in the channel and permeability of the soil, To protect the channel against seepage, erosion and scouring, channel lining may be required. At locations where heavy erosion is expected, it is recommended to use riprap. Where utilized, riprap should be placed on a medium weight, non-woven geotextile. Non-woven geotextiles typically provide protection against upward migration of fine grained sediments (silt or clay).
- Drop structure: – The drop structure should be designed to minimize the potential for failure due to piping, erosion, scouring and uplift pressure forces. Erosion and scour protection such as cut-off walls (or sheet pile walls) on the upstream and downstream sides, as well as at intermediate points along the structure, may be required. Seepage analysis will be required during detailed design to evaluate the need for cut-off walls.
- Bedrock excavation: – Bedrock may be intersected within the channel at several locations. The bedrock strength information is not available but the sandstone is expected to be medium strong to strong and the shale is expected to be weak to medium strong. Dozer equipment with a ripper or break hammer may be required to excavate the bedrock.
- Groundwater: – The groundwater elevation is expected to fluctuate seasonally and in response to precipitation and may be high during construction. Dewatering of the excavation may be required during construction of the channel.

5.3 Channel Excavation

Construction of the channel will require extensive excavation along the proposed alignment. Based on the available testhole information, the types of subsurface soils that are likely to be encountered within the channel excavation are gravel, clay, sand, silt, and clayshale, siltstone and sandstone bedrock. Exposed channel side slopes will be in the order of 20 m, which may require benching and provision of surface drainage ditches to minimize surface erosion.

Stability of these deep excavation slopes should be investigated during the design phase and side slopes adjusted to obtain long term stability.

Groundwater should be anticipated during excavation operations. The groundwater should be controlled to prevent sloughing of the excavation slopes, and to reduce adverse impacts on the progress of construction. Silt, sand and gravel soils are expected to be encountered during excavation, therefore, lining of the channel base and side slopes may be required in those areas. Conventional excavation equipment should be capable of excavating the overburden soil and clayshale bedrock.

Excavation will encounter a variable thickness of overburden soil and extremely weak rock over medium strong rock. Excavation ease, or rippability, of the rock will be assessed by using seismic velocity, point load strength index or unconfined compressive strength test results along with visual inspection during the detailed design stage.

5.4 Fill Material

Fill materials required for construction of the channel berms to design grade can be obtained from on-site excavations or from approved borrow areas. Locally available low to medium plastic clay soils from excavations can be used as a general engineered fill for building the channel berms. The engineered fill should be placed in 150 mm compacted lifts and compacted to 98% of Standard Proctor Maximum Dry Density (SPMDD) within ±2% of the optimum moisture content (OMC). Fill placement should be undertaken during frost free seasons since the required degree of compaction cannot be achieved during freezing temperatures. If the fills are to be constructed during the winter months, considerable attention to fill quality, moisture content, and placement and compaction practices will be required. Suitable winter earthwork techniques would need to be developed if earthwork construction is planned to occur in winter.

5.5 Dewatering

High groundwater levels could potentially result in various difficulties during construction, including reduced traffic-ability for heavy equipment, unstable excavation in sand zones, and difficulties with placement and compaction of fill. To facilitate excavations and earthworks, construction should be carried out under relatively dry conditions. Therefore, grading and surface drainage should be undertaken during construction.

In excavations through clay, groundwater yields are expected to be low. In excavations into the sand or gravel, higher rates of seepage will be encountered. In sand and gravel, a network of perimeter drainage ditches would likely provide effective dewatering.

5.6 Subgrade Preparation

All unsuitable soils (soft, loose, organic, frozen) exposed at the channel base should be removed to expose competent soils. The exposed subgrade should be scarified to a minimum depth of 200 mm and compacted to 98% of SPMDD. At the fill sections, engineered fill should be used to raise the subgrade to the design grade and to build the thermal embankment. General engineered fill should comprise low to medium plastic clay/clay till. Locally excavated low to medium plastic clay soil may be used as general engineered fill provided these soils do not contain deleterious material such as organics, roots, debris, etc. The general engineered fill must not contain high plastic clays. The general engineered fill should be placed at acceptable moisture content (within ±2 % of the OMC) and compacted to 98% of SPMDD.

The fill material must not be placed on frozen subgrade or in freezing conditions. The exposed subgrade should be inspected by a qualified geotechnical engineer prior to construction to confirm that the subgrade is prepared in accordance with recommendations provided in this report.

The subgrade should be proof rolled by two passes of a dual-wheel truck with 80 kN axle load and a minimum gross weight of 24,000 kilograms (kg). The subgrade soils which display rutting or appreciable deflections upon proof rolling should be over-excavated to expose the underlying competent soils and backfilled with general engineered fill compacted to at least 98% of the SPMDD.

5.7 Foundations for Inlet Structure

One inlet location for the channel has been proposed for Tongue Creek alignment. Two testholes TH14-01 and TH14-02 were drilled near the proposed inlet structure. A gravel layer was encountered at the surface and extended to depths of 15 mBGS (EL 1046.5 m) and 21.35 mBGS (EL1049.8 m). Based on the preliminary inlet structure drawings, the base elevation of the inlet will be at 1054.5 m indicating that the foundation for inlet structure will be placed on relatively deep pervious gravel deposits. Such soil conditions can provide a suitable foundation for the structure; however, issues related to controlling seepage through the gravel layer may be encountered. Excessive seepage, piping of the foundation soils, scour, and high uplift pressures may cause instability of the foundation soils at the inlet structure.

In order to control the seepage flow, impermeable cutoff walls that penetrate through the pervious strata and tie into a relatively impermeable stratum below the gravel layer should be provided. The cutoff walls may consist of sheet pile wall, concrete wall, or jet grouting and cement-bentonite slurry wall. Impermeable blankets of impervious material extending upstream from the structure along with vertical cutoffs and drains may also be used as another option to control the seepage rate below the foundation base. Concrete or riprap should also be considered at the upstream and downstream of the structure to reduce scour, erosion and piping.

5.8 Foundations for Drop Structures

One drop structure is provided in Tongue Creek alignment. The drop has an average height of about 3.9 m. The subsoil and groundwater conditions at this location should be investigated during the detailed design stage to provide recommendations for the design and construction of the drop structure.

5.9 Foundations for Outlet Structure

A slope stability analysis and seepage analysis should be carried out during the detailed design stage to confirm the long term factor of safety and determine the seepage rate through foundation soils, uplifts pressures beneath the outlet structure, and possible erosion and scour. Impermeable cutoff walls and/or impermeable blankets of impervious material extending upstream from the structure and drains may be used if the seepage rate is found to be excessive.

One outlet location has been selected for the proposed Tongue Creek channel alignment. Testholes 01-A1, 01-A3-A, 01-A3-B, and 01-A6 were found in the study to be approximately 500 m (or more) north of the outlet structure location. Based on the preliminary structure drawings, the base elevation of the outlet will be at 1050.34 m. If soft soils are encountered below the outlet foundation base, then this soil should be removed and replaced with low to medium plastic clay/clay till compacted to 98% of the SPMDD.

It should be noted that testhole elevations were not available on the testhole logs. The testholes were also drilled about 500 m to 1200 m north of the outlet structure. For the purpose of this desktop evaluation, these testholes were used to assess the subsurface conditions for the area near the outlet structure. A site specific site investigation should be conducted to determine the subsurface conditions along the alignment.

5.10 Cut/Fill Slope Stability

The proposed channel is 60 m wide at the base, and will be constructed mainly in cut sections. The depth of cut will range from 4 to 20 m.

A preliminary slope stability analysis of the side slopes near the inlet and outlet structure was performed to evaluate the long term factors of safety against slope failure. A limit equilibrium method (Morgenstern-Price Method) was used in the analyses. The soil stratigraphy was inferred from testhole information and the typical cross sections of the channel near the outlet structures. The analyses were carried out using cross sections from Figure N5-1 in Appendix N1 and a 4H:1V slope angle. The soil strength parameters used for this preliminary analysis were obtained from published literature and correlations with material index properties. A summary of the soil properties is presented in Table 5-1. The water level was assumed to be at the base of the channel at the respective cross-section and at 1 m above the base within the slope. The results of the stability analysis are presented in Appendix N4 and summarized in Table 5-2.

Table 5-1: Soil Properties Used in Slope Stability Analysis for Inlet and Outlet Structures

Structure	Soil Description	Unit weight, γ (kN/m^3)	Cohesion, c' (kPa)	Friction Angle, ϕ (°)	Comments
Outlet	Silt with trace sand and trace clay	19	0	28	Based on Published Literature
Outlet	Compact Sand, medium to fine grained	18	0	30	Based on Published Literature
Outlet	Silty sand with trace gravel, very dense	18	0	32	Based on Published Literature
Outlet	Clay till with some silt and trace gravel, medium plasticity	19	5	28	Based on Published Literature
Outlet	Clay	19	3	25	Based on Published Literature

For the inlet and outlet side slopes stability, two sections were carried out using a maximum slope height of 10 m. The soil stratigraphy was obtained from the nearest testholes TH14-01, TH14-03 and 01-A6 to the proposed section location.

Table 5-2: Summary of Slope Stability Analysis Results

Chainage	Structure	Height (m)	Slope (H:V)	Long Term Factor of Safety
0+000	Outlet	21	4:1	2.015
0+100	Channel	15	4:1	2.164

Further stability analyses, coupled with seepage analyses should be carried out during the detailed design stage. The stability analyses should include sudden drawdown from the highest water level and steady seepage conditions.

5.11 Erosion

Native sand, silt and gravel soils in cut and fill slopes, inlet and outlet structures are susceptible to erosion. Therefore, exposed soils should be protected against erosion. Erosion protection in the form of topsoil and seeding with a native seed mixture and/or erosion control mats should be considered. Permanent turf reinforcement mats (P300 or equivalent), should be used and installed as per manufacturer recommendations to protect the slopes within the site. The use of riprap can also be provided near the inlet, outlet and the outfall structures where heavy scour may be expected. All riprap should be placed on a medium weight non woven geotextile.

5.12 Utility Crossings

Based on the information provided, it is understood that the channel will cross utilities at various locations along the proposed channel alignment. Utility details are provided in Table 5-3. In order for the channel to cross over the utilities without damaging them, some form of protection or mitigation measures will be required. Typical measures may include: installing the utilities at greater depth to provide an adequate soil cover; or realignment of the utilities to avoid intersection with the proposed channel route.

Hydrovaccing should be carried out along the existing utility alignments to identify the depths, locations, and conditions of the utilities to assist in determining suitable protective or mitigation measures. Therefore, details and recommendations regarding utility crossing cannot be provided at this time.

Table 5-3: List of Utilities Within Proposed Diversion Channel Alignments

Utility	Utility Owner	Size	Station
Rural Gas Distribution Pipeline	ATCO Gas	-	2+250 and 3+850
Telephone Trench	Telus	-	2+250 and 3+850
Sour Natural Gas Pipeline	MFC Energy Corporation	168.3 mm	0+600

5.13 Future Geotechnical Work

A detailed geotechnical investigation will be required during detailed design stage to determine the site specific subsurface soil, bedrock and groundwater conditions along the proposed channel alignment. The geotechnical investigation should consist of, but not limited to, the following:

- Drilling testholes along the channel at an approximate 250 m spacing. The testhole depths may vary depending on the final depth of the channel.
- Install standpipe piezometers in the testholes to measure depth to groundwater.
- Conduct hydraulic conductivity tests in the piezometers.
- Perform laboratory testing on soil and bedrock samples for soil classification purposes and determination of engineering properties of soils/bedrock.
- Perform slope stability and seepage analyses using engineering properties obtained from the laboratory testing.
- Prepare a geotechnical evaluation report providing recommendations to support design and construction of channel, drop structures, and other geotechnical elements of the project.

6. Hydrogeological Assessment

The purpose of this hydrogeological assessment was to estimate the amount of groundwater discharge that will enter the Tongue Creek by-pass channel. Preliminary design of the by-pass channel calls for significant excavation into the existing ground. The preliminary geological assessment identified coarse sediment in the area of the by-pass channel. Intersecting these sediments with the channel could lead to a continual groundwater discharge; effectively a new stream will be created. In addition, groundwater chemistry is usually different than freshwater river chemistry. This could affect the chemistry of Tongue Creek where the by-pass channel empties into the creek. A major chemical change in the creek could affect the aquatic biota in that region.

The scope of this report consists of projecting the subsurface geology from the geotechnical investigation of Options D3/E by-pass to the Tongue Creek by-pass, estimation of groundwater conditions, an estimate of the groundwater discharge into the channel and Tongue Creek, and an assessment of any chemical differences between the groundwater and the water in the Tongue Creek.

6.1 Subsurface Conditions

6.1.1 Regional Geology

The regional geology and hydrogeology are described in Sections 3.2 and 3.3, respectively.

6.1.2 Local Geology

The channel alignment has been divided into three sections for ease of description of the subsurface conditions. These three areas are denoted by station with overall length being taken from the profile of the by-pass channel. The first section is from Station 0+000 to Station 1+140, the second section is from Station 1+140 to Station 1+500 and the third section runs from Station 1+500 to Station 3+893

- **Station 0+000 to Station 1+140:** this section is dominated by coarse grained surficial deposits, such as gravel and sand; overlaying bedrock, which consist of alternating layers of clayshale, siltstone, and sandstone.
- **Station 1+140 to Station 1+500:** silty clay till overlying a thin gravel bed is the surficial deposits. The bedrock is generally interbedded clayshale and siltstone.
- **Station 1+500 to Station 3+893:** surficial deposits consisting of clay till, occasionally underlain by silt, underlain by bedrock. The bedrock consisted of interbedded clayshale/claystone.

6.1.3 Local Groundwater Conditions

The groundwater elevations are expected to be similar to those seen in the monitoring wells installed in the geotechnical evaluation of the Option D3/E by-pass channel. In general, from Station 0+000 to Station 1+140 the groundwater is expected to be approximately 3.2 mBGS while from Station 1+140 to the end of the channel the groundwater is expected to be approximately 4 mBGS.

6.2 Hydrogeological Assessment

6.2.1 Groundwater Flow into the Channel

The hydraulic conductivity testing performed on the monitoring wells installed in the geotechnical investigation of the High River by-pass channel can be used to estimate the hydraulic conductivities of the saturated sediments that will

be exposed in the Tongue Creek by-pass channel. The gravels observed in wells along the southern portion of the High River by-pass channel have an approximate hydraulic conductivity of $1.6x10^{-4}$ metres per second (m/s). The weathered bedrock observed along proposed diversion has hydraulic conductivities on the order of 10^{-7} m/s. The sands observed in the more northern portion have an approximate hydraulic conductivity of $2.1x10^{-5}$ m/s.

On the basis of the projected geology interpreted for the Tongue Creek by-pass channel, the cross sectional area of the coarse sediments (gravel and sand) was calculated and the appropriate hydraulic conductivity assigned depending on the location of the sediment (i.e., in the south near the Highwood River or on the northerly portion of the channel). This allowed a determination of the amount of groundwater flow into the channel. This was found to be approximately 0.20 cubic metres per second (m^3/s).

Flow measurements for Tongue Creek only exist from the 1920's and 1930's. In the summer the average flow in Tongue Creek ranged from 0.12 m^3/s to 0.50 m^3/s. If the present day flow rate of Tongue Creek is within this historical average, the by-pass channel will increase the flow within the creek by 50 to 100%.

Note although the by-pass channel will lead to a lowering of the groundwater table for an undetermined distance away from the channel, it is not expected to have an impact to users (human or ecological). This is due to no water wells are installed in the shallow sediments that would be affected by the lowered water table and there are no surface water features, other than Tongue Creek, that are groundwater fed in the near vicinity of the proposed by-pass channel.

6.2.2 Groundwater Chemistry

Groundwater samples were collected from the monitoring wells installed during the geotechnical investigation along the Option D3/E by-pass alignment. As the main aquifers seen in those wells are expected to be the same seen along the Tongue Creek bypass, the results can be used in this assessment. The geochemical results show that the groundwater is generally sodium bicarbonate type; with the exception of two wells near the Highwood River that are a calcium-sodium bicarbonate type. Table 6-1 presents the average concentrations for sodium, chloride, sulphate, total dissolved solids, alkalinity, and nitrate as nitrogen by lithology in the monitoring wells.

Table 6-1: Average Parameter Concentration by Lithology (mg/L)

Lithology	Average Na	Average Cl	Average SO_4	Average TDS	Average Alkalinity	Average Nitrate-N
Gravel	130	26	154	564	282	1.64
Sand/Silt	255	48	241	917	478	1.48
Weathered Bedrock	217	51	110	693	425	1.36

6.2.3 Groundwater Impact Assessment

The hydrogeological assessment indicates that a permanent groundwater discharge to the by-pass channel will occur creating a creek. This creek will have a flow that is roughly equal or greater than that currently seen in Tongue Creek. This may lead to erosion, scouring or flooding issues downstream of the outfall and unlike during a flood event this increased flow will be permanent.

Table 6.2 presents the surface water chemistry of Tongue Creek for a monitoring station located at 50.62111^{o}N and 113.8747^{o}W. This station is located approximately 5.4 kilometre from the proposed by-pass channel discharge point. The concentrations reported in Table 6-2 are from a sample collected in 1991 (most recent available).

Table 6-2: Surface Water Chemistry – Station AB05BL0350 (mg/L)

Station	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	TDS	Alkalinity	Nitrate-N
AB05BL0350	82	36	46	6.4	446	85.2	10	65	468	371	0.003

The majority of groundwater discharge into the by-pass channel will come from the gravels. Of the major parameters, the sodium and nitrate concentrations seen in Tongue Creek are the most divergent. Research into sodium effects on freshwater aquatic animals and plants indicates that concentrations need to be over 200 milligrams per litre (mg/L) before toxicity effects are observed to plants. Toxicity effects to aquatic animals at concentrations over 400 mg/L.

The nitrate concentrations are three orders of magnitude higher in the groundwater than in the surface water in Tongue Creek. The likely nitrate sources are fertilizer application on tilled fields and animal waste (stockyards etc.). The nitrate concentration seen in the groundwater is approximately one half the guideline concentration for the protection of aquatic life (the guideline is based on the effects of nitrate on lake trout). As such, direct harmful effects, especially given the dilution of the concentration as it enters the creek, are not likely to occur. Nitrate, however, serves as the primary source of nitrogen for aquatic plants in well oxygenated systems, and as nitrate levels increase, there is an increasing risk of algal blooms and eutrophication in surface waters. Common ecological changes to aquatic systems undergoing nutrient enrichment may include an increase in algal and macrophyte production resulting undesirable blooms, a decrease in water clarity, a loss of cold water fisheries, shortened food chains and changes in species composition (NRC 1978).

As such, the discharge from the by-pass channel may have an impact on the aquatic biota in Tongue creek due to the nutrient enrichment.

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Appendix N1

Figures

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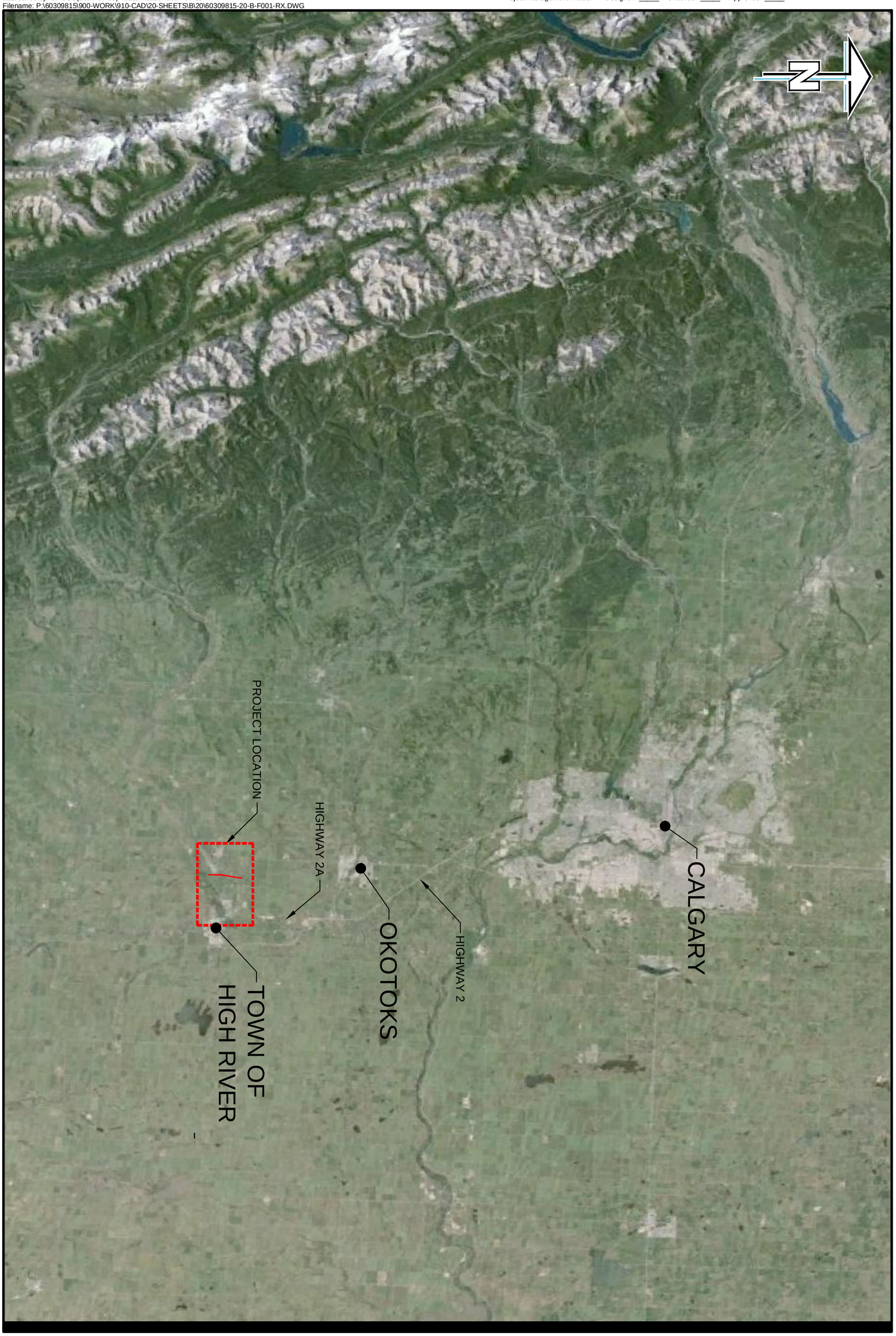

Southern Alberta Flood Mitigation Feasibility Study
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Tongue Creek By-pass
Project Location Plan

AECOM

Figure: N1-1

AECOM

Figure: N1-2

Tongue Creek By-pass
Testholes Location Plan

Southern Alberta Flood Mitigation
Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

01-A5
01-A1
01-A2
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01-A3-A
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1610520
285090
286205
OUTLET
3+910.200
264545
3+500
147389
244960
3+000
128246
128247
1556089
1555287
TONGUE CREEK OPTION
128253
2+500
128250
TOWNSHIP ROAD 191
2+000
291409
1+500
241765
1+000
166443
0+500
TH14-02
TH14-01
INLET
0+000
127721
TH14-27
TH14-26
SUBSTATION
TH14-15
TH14-17
TH14-16
TH14-18
TH14-19
RV STORAGE LOT
TH14-14
RACE TRACK
TH14-13
TH14-12
TH14-11
TH14-10
TH14-09
TH14-06
TH14-05
TH14-08
TH14-07
TH14-04
TH14-03
HIGHWAY 2A
TH14-23
TH14-22
TH14-20
TH14-21
SECONDARY ROAD 543
TOWN OF HIGH RIVER
HIGHWOOD
RIVER
1325 m

LEGEND:

- 2014 TESTHOLE LOCATIONS
- CANCELLED TESTHOLE
- WATER WELL

0 250 500 750 m SCALE 1:25000

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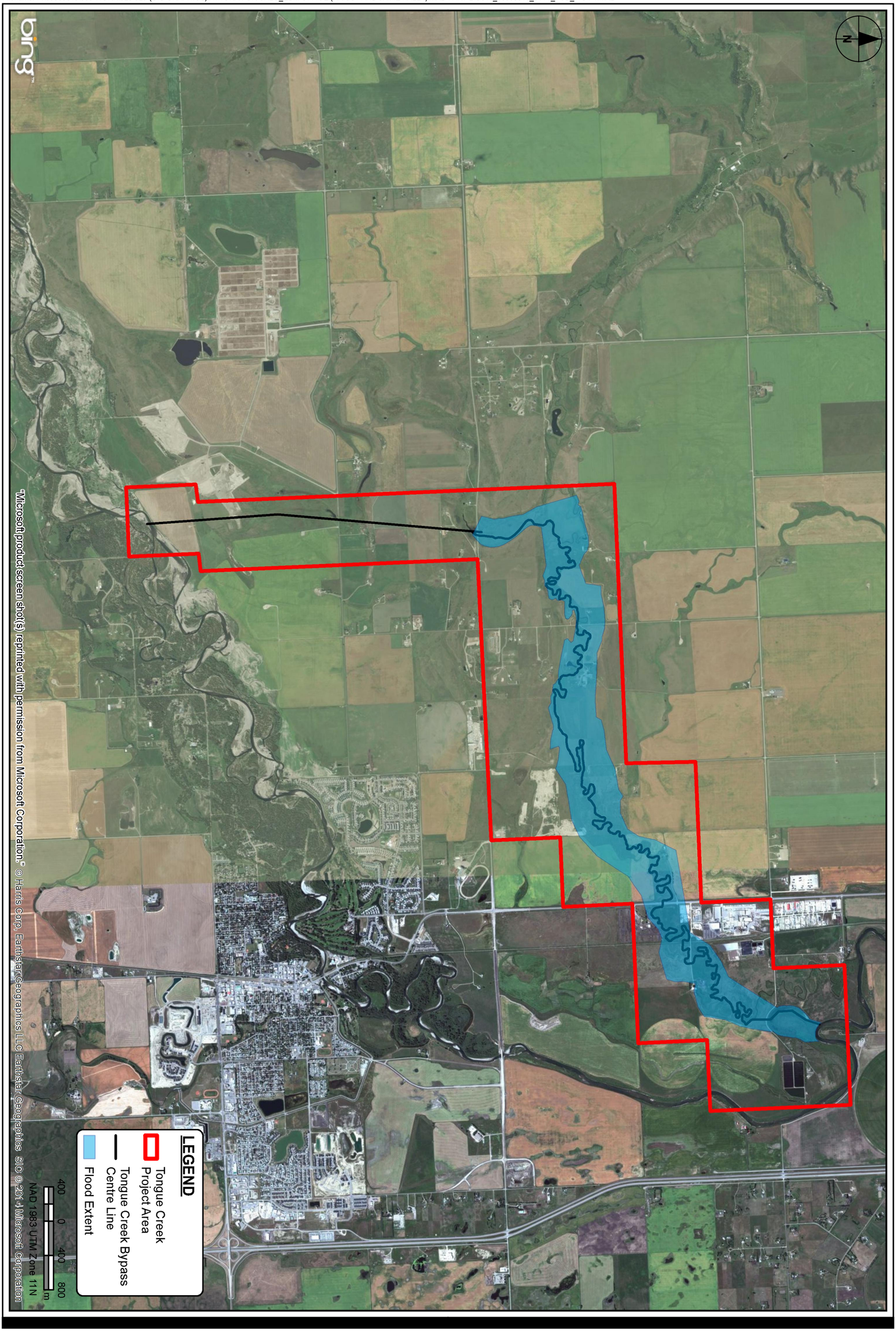

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Proposed Alignment of Tongue Creek with Flood Extent

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Figure: N2-1

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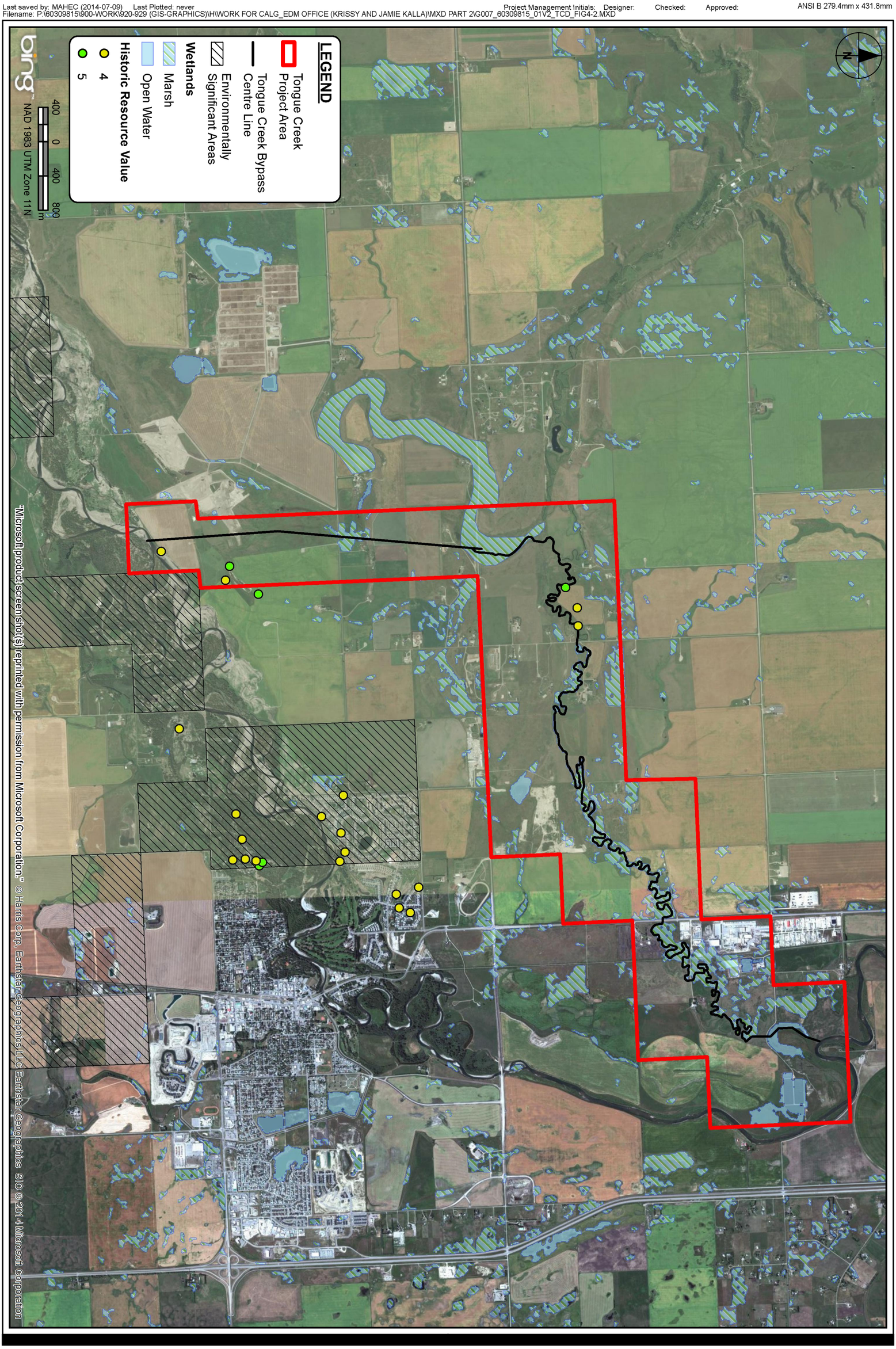

Southern Alberta Flood Mitigation Feasibility Study
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Wetlands, Environmentally Significant Areas, and Historical Resources in the Proposed Tongue Creek Project Area

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Figure: N2-2

SPECIES CODE	SPECIES NAME
AMAV	American Avocet
AMCO	American Coot
AMCR	American Crow
AMDI	American Dipper
AMRO	American Robin
AMWI	American Wigeon
BAEA	Bald Eagle
BBMA	Black-billed Magpie
BCCH	Black-capped Chickadee
BCFR	Boreal Chorus Frog
BLJA	Blue Jay
BOTO	Boreal Toad
BOWA	Bohemian Waxwing
BUFF	Bufflehead
CAGO	Canada Goose
CANV	Canvasback
COGO	Common Goldeneye
CORA	Common Raven
DEMO	Deer Mouse
EUST	European Starling
GADW	Gadwall
GBLH	Great Blue Heron
GHOW	Great Horned Owl
GRSQ	Gray Squirrel
GWTE	Green-winged Teal
HOLA	Horned Lark
KILL	Killdeer
MALL	Mallard
MERL	Merlin
MEVO	Meadow Vole
MUSK	Muskrat
NGMO	Northern Grasshopper Mouse
NLFR	Northen Leopard Frog
NOHA	Northern Harrier
NOPI	Northern Pintail
NOSV	Northern Shoveler
NPGO	Northen Pocket Gopher
OSPR	Osprey
PRFA	Prairie Falcon
PRVO	Prairie Vole
RBNU	Red-breasted Nuthatch
REFO	Red Fox
RLHA	Rough-Legged Hawk
RTHA	Red-tailled Hawk
RUBL	Rusty Blackbird
SEOW	Short-eared Owl
SORA	Sora
SPFR	Columbia Spotted Frog
SWHA	Swainson's Hawk
WEME	Western Meadowlark
WILL	Willet

LEGEND

- Tongue Creek Project Area
- Tongue Creek Bypass Centre Line
- FWMIS Observations
- Colonial Nesting Birds (Great Blue Heron)
- Key Wildlife and Biodiversity Zones

400 0 400 800 m

NAD 1983 UTM Zone 11N

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Figure: N2-3

Key Wildlife Layers, and Historical Wildlife Observations in the Proposed Tongue Creek Project Area

Southern Alberta Flood Mitigation Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

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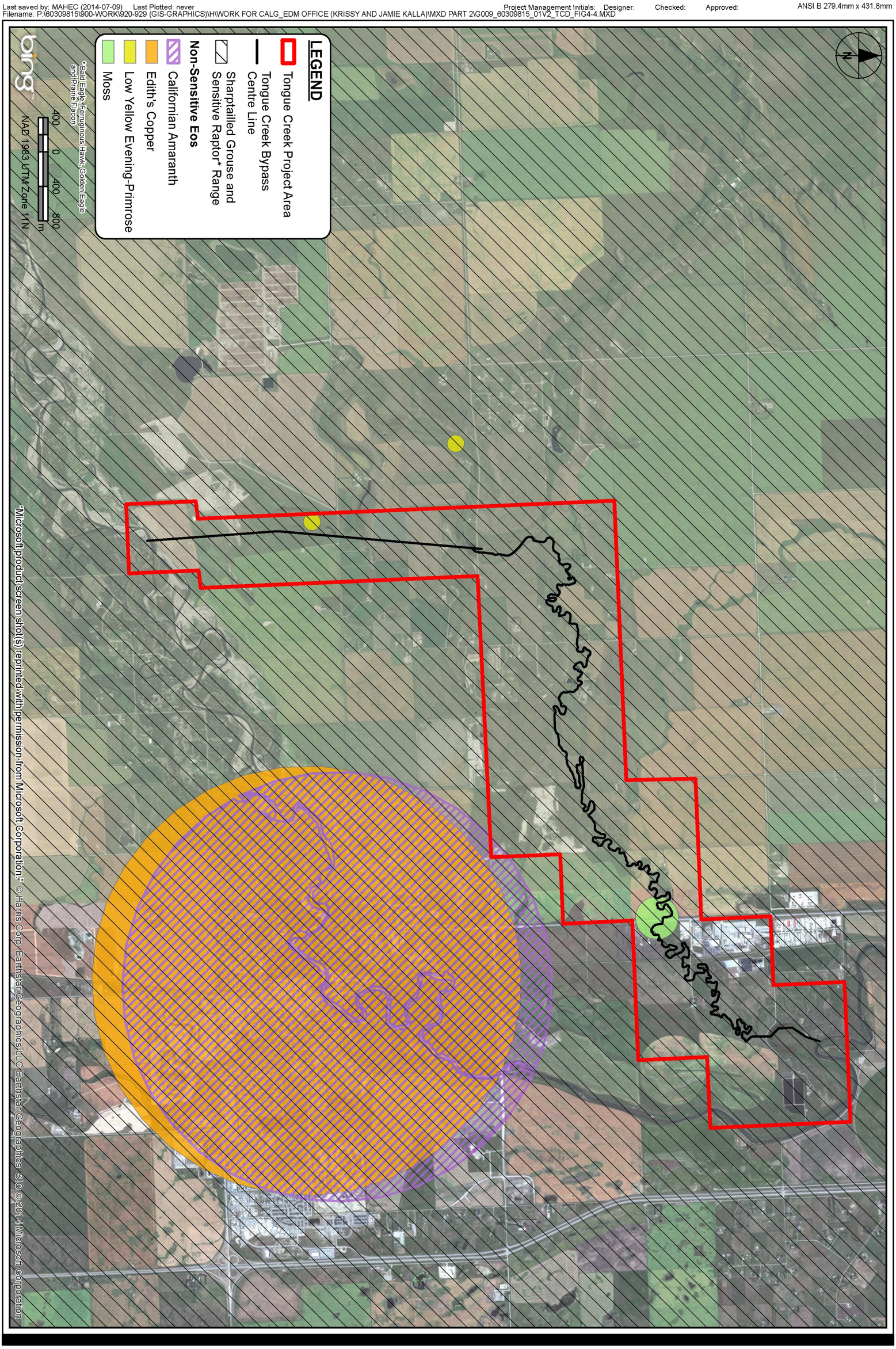

Southern Alberta Flood Mitigation Feasibility Study
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Key Range Layers and Non-sensitive Element Occurrences in the Proposed Tongue Creek Project Area

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Figure: N2-4

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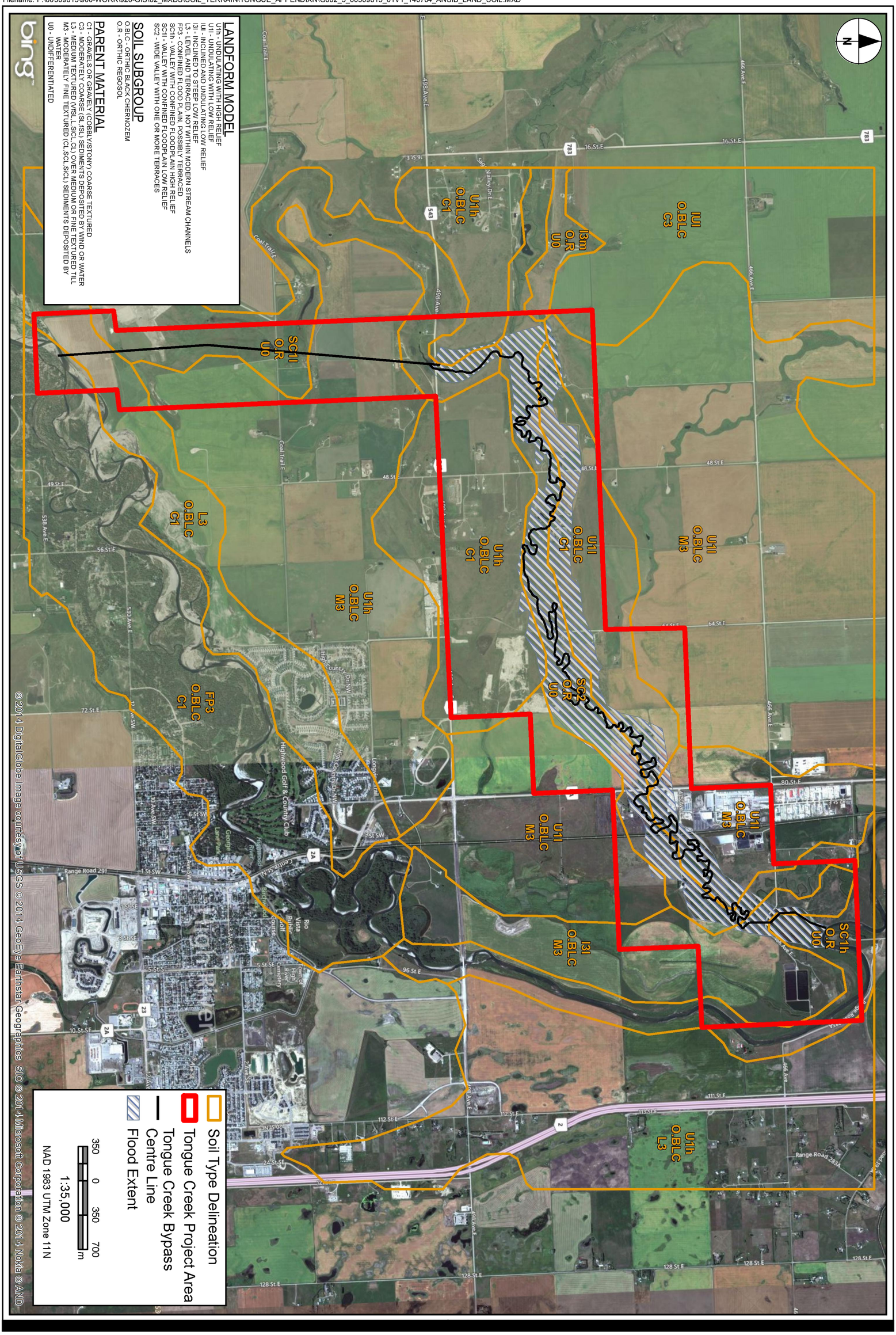

Southern Alberta Flood Mitigation Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

Assessment of the Tongue Creek Project Area
Preliminary Soil Map

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Figure: N2-5

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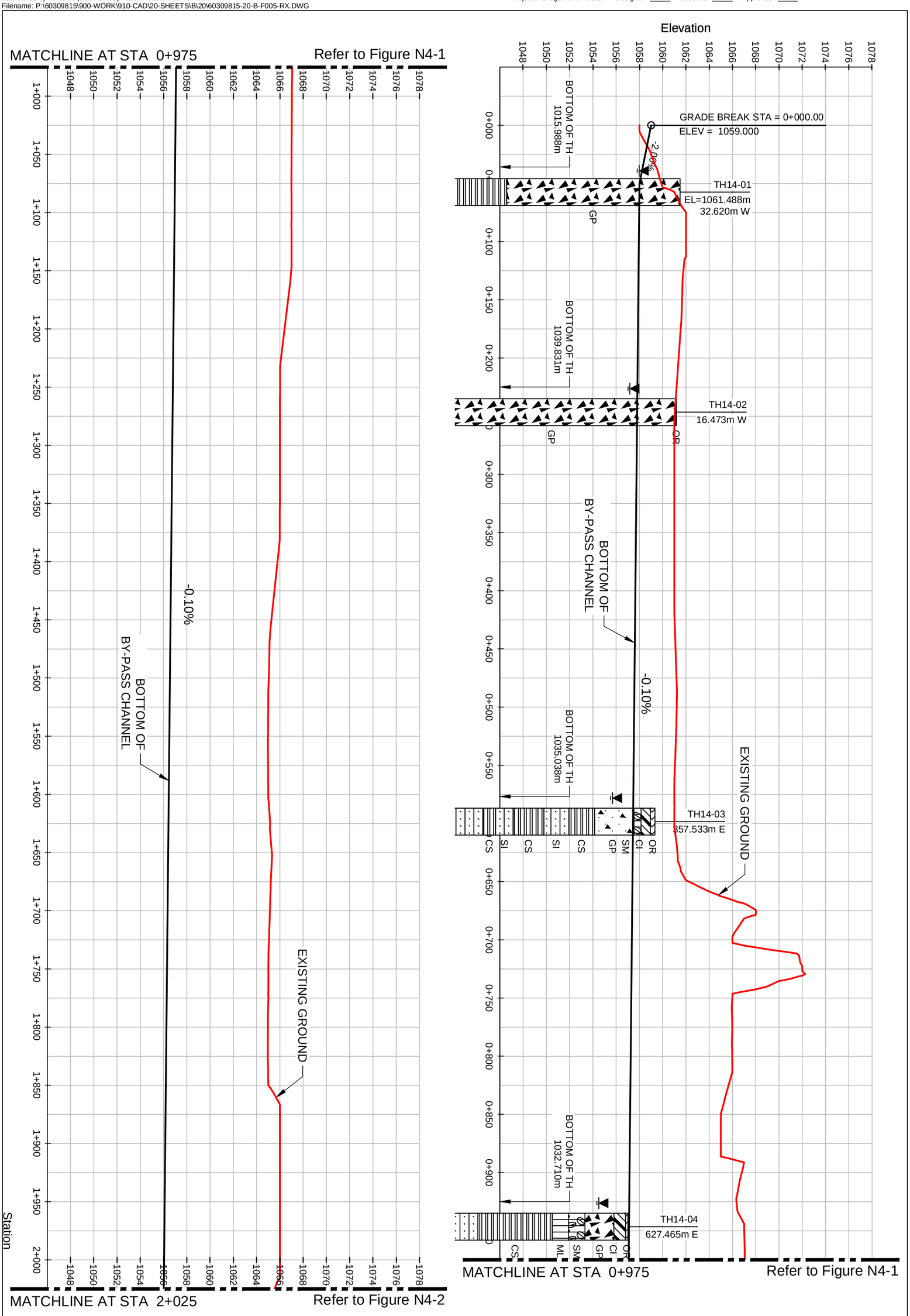
Project Management Initials: Designer: _____ Checked: _____ Approved: _____ ANSI B 279.4mm x 431.8mm

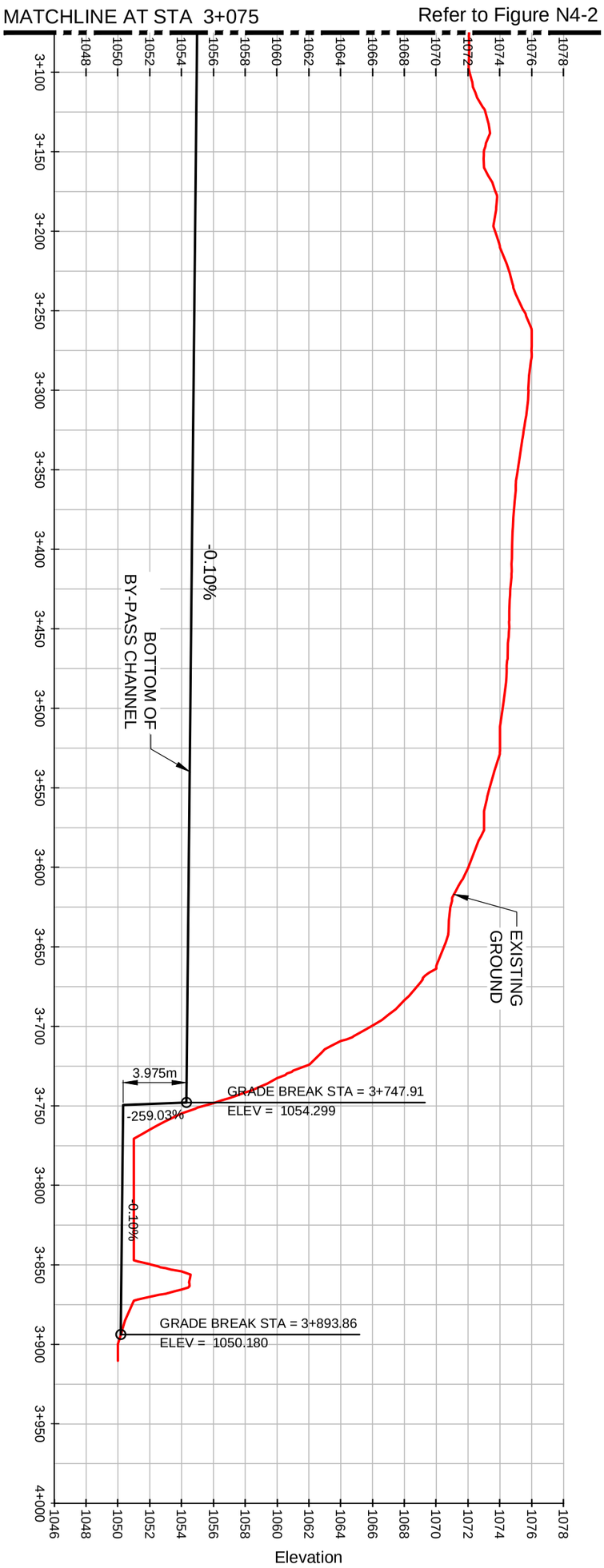


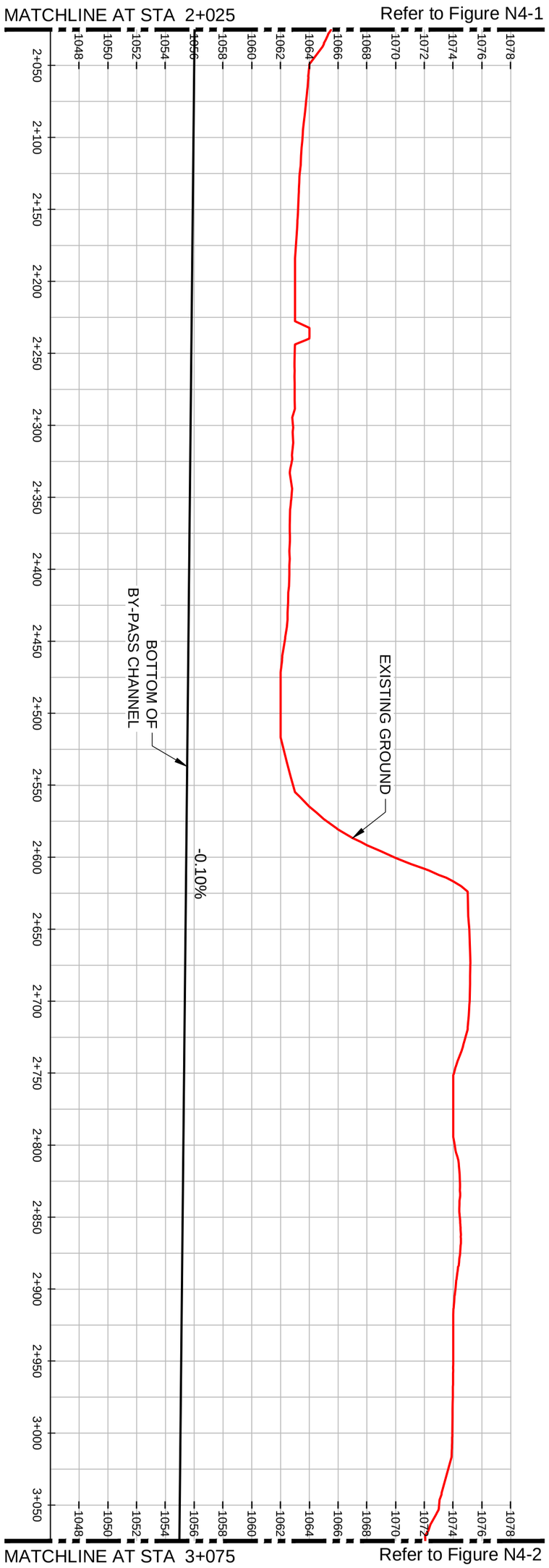
Southern Alberta Flood Mitigation Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

Tongue Creek By-pass
Bottom of Channel Profile and Existing Ground Profile
Page 1 of 2

AECOM

Figure: N4-1



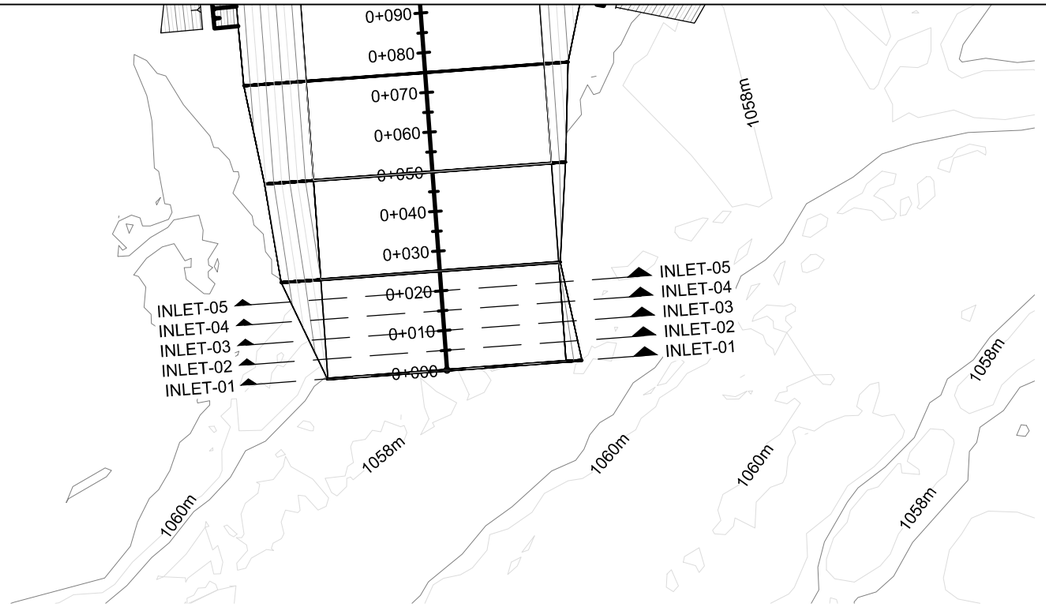


Southern Alberta Flood Mitigation Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

Tongue Creek By-pass
Bottom of Channel Profile and Existing Ground Profile
Page 2 of 2

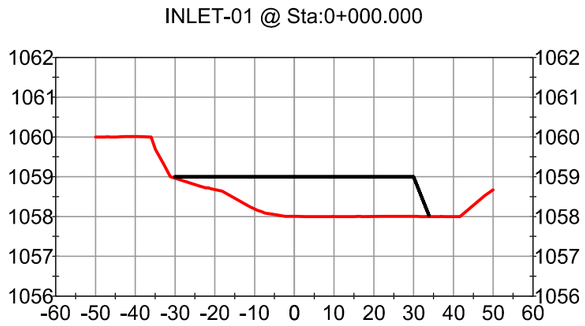
AECOM

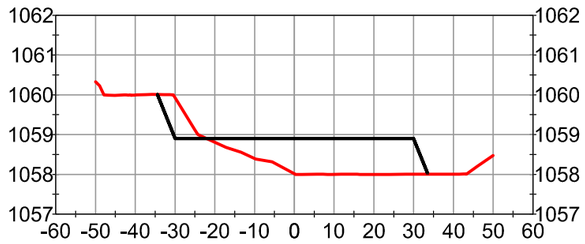
Figure: N4-2

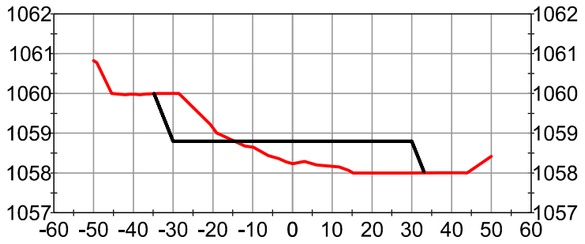


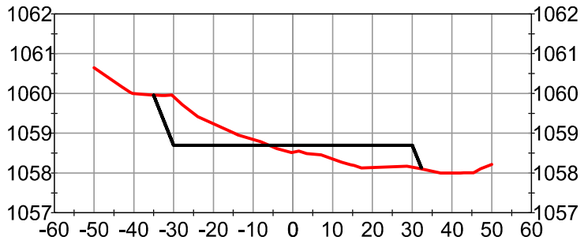
INLET PLAN

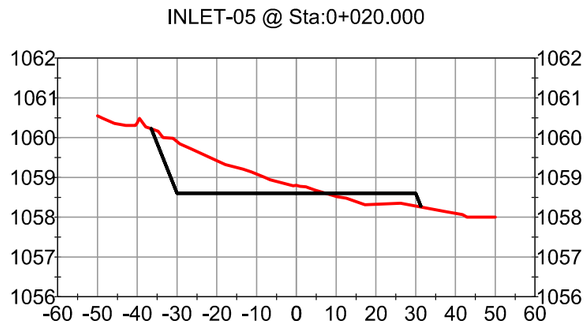
0 15 30 45 m SCALE 1:1500











LEGEND:

EXISTING GROUND

PROPOSED BY-PASS BOTTOM

AECOM

Figure: N5-1

Tongue Creek By-pass
Inlet Sections

Southern Alberta Flood Mitigation
Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ANSI B 279.4mm x 431.8mm

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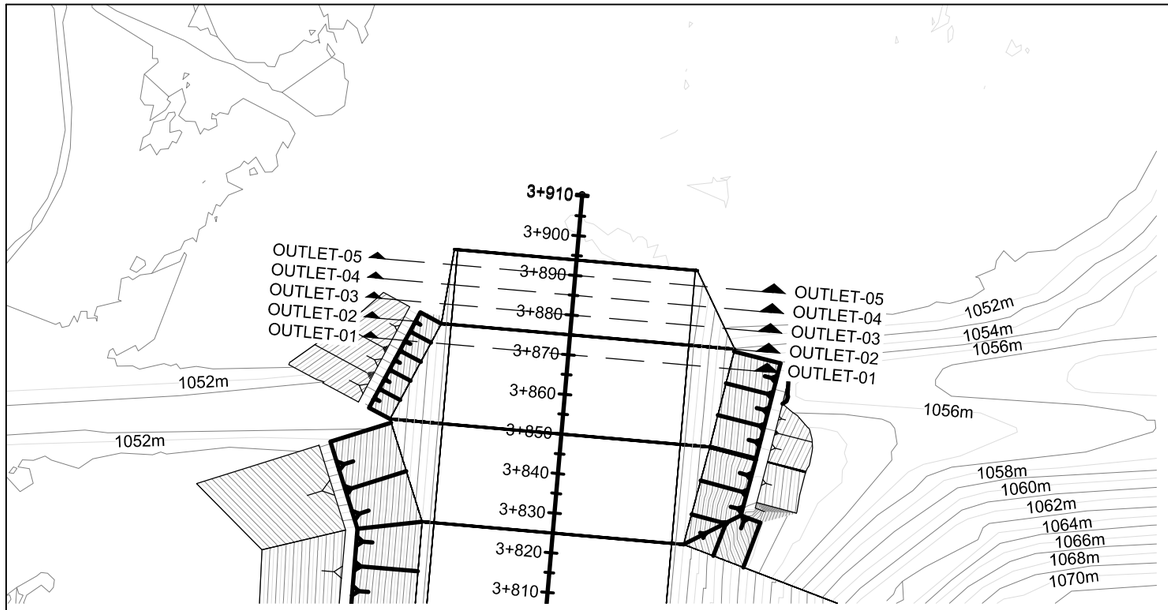
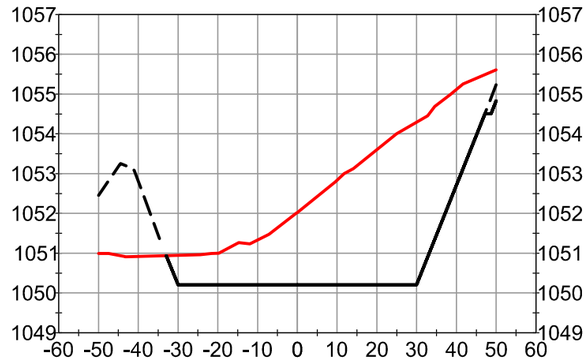


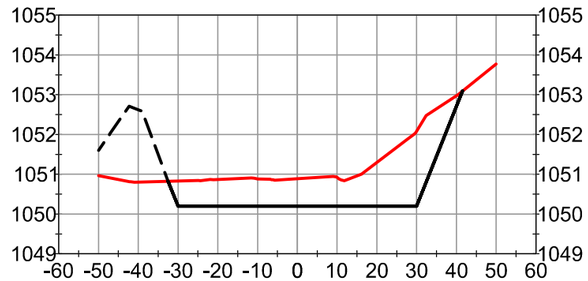
OUTLET PLAN

0 15 30 45 m SCALE 1:1500

OUTLET-01 @ Sta:3+870.000



OUTLET-02 @ Sta:3+875.000



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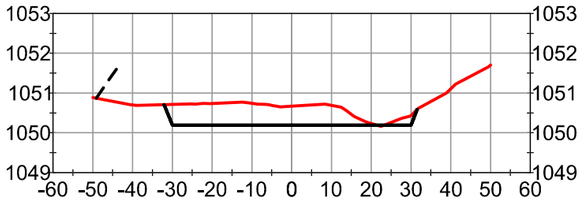
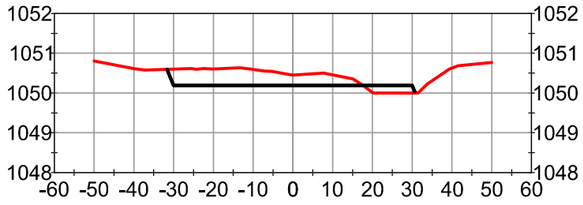
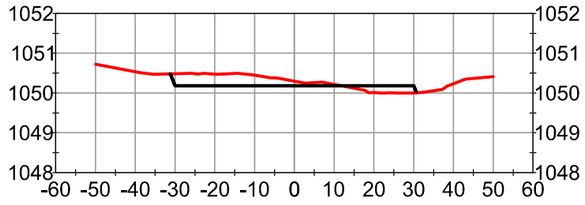


OUTLET-04 @ Sta:3+885.000



OUTLET-05 @ Sta:3+890.000



LEGEND:

EXISTING GROUND

PROPOSED BY-PASS BOTTOM

AECOM

Figure: N5-2

Tongue Creek By-pass
Outlet Sections

Southern Alberta Flood Mitigation
Feasibility Study
Alberta Flood Recovery Task Force
Project No.: 60309815

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ANSI B 279.4mm x 431.8mm

Last saved by: EROSC (2014-07-09) Last Plotted: 2014-07-09
Filename: P:\60309815\900-WORK\910-CAD\20-SHEETS\B\20160309815-20-B-F008-RX.DWG

Appendix N2

Testhole Logs
Modified Unified Classification System for Soils
Explanation of Field and Laboratory Test Data
Normal Variability of Subsurface Conditions

On DVD in Appendix R

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-01**
LOCATION:	COORDINATES: UTM N 5605847.29 E 291197.159	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Wet Rotary	ELEVATION (m): 1061.488

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC / M.C. / LIQUID (25 / 50 / 75)	COMMENTS	ELEVATION (m)
0			GRAVEL - No Samples were collected due to sloughing. Hole was carried out using wet rotary.					1061
1								1060
2								1059
3								1058
4								1057
5	GP							1056
6								1055
7								1054
8								1053
9								1052
10								

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 45.50 m
REVIEWED BY: FA	COMPLETION DATE: 1/23/2014
PROJECT ENGINEER: Stuart Bell	Page 1 of 5

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-01**
LOCATION:	COORDINATES: UTM N 5605847.29 E 291197.159	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Wet Rotary	ELEVATION (m): 1061.488

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC / M.C. / LIQUID (25 / 50 / 75)	COMMENTS	ELEVATION (m)
10								1051
11								1050
12	GP							1049
13								1048
14								1047
15			CLAYSHALE - Silty, trace fine sand, moderately weathered, moderately strong, laminated, some silt/ mudstone layers, medium plastic, damp, dark grey.				Res: 34.2 ohm-m SO4: 64 mg/L Cl: 13 mg/L pH: 7.98	1046
16			- extremely weak				Su = 201 kPa	1045
17	CS				C1 6.5		Recovery = 100 % RQD = 82 %	1044
18								1043
19								1042
20					C2 9.1		Recovery = 100 % RQD = 87 %	

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 45.50 m
REVIEWED BY: FA	COMPLETION DATE: 1/23/2014
PROJECT ENGINEER: Stuart Bell	Page 2 of 5

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-01**
LOCATION:	COORDINATES: UTM N 5605847.29 E 291197.159	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Wet Rotary	ELEVATION (m): 1061.488

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC / M.C. / LIQUID (25 / 50 / 75)	COMMENTS	ELEVATION (m)
20								1041
21							Res: 16.9 ohm-m SO4: 54 mg/L Cl: 16mg/L pH: 8.37	1040
22			- highly weathered, Extremely weak				Su = 114 kPa	1039
23					C3	10.4	Recovery = 100 % RQD = 68 %	1038
24								1037
25	CS							1036
26					C4		Recovery = 86 % RQD = 68 %	1035
27								1034
28								1033
29					C5		Recovery = 100 % RQD = 77 %	1032
30								

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 45.50 m
REVIEWED BY: FA	COMPLETION DATE: 1/23/2014
PROJECT ENGINEER: Stuart Bell	Page 3 of 5

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-01**
LOCATION:	COORDINATES: UTM N 5605847.29 E 291197.159	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Wet Rotary	ELEVATION (m): 1061.488

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC / M.C. / LIQUID (25 / 50 / 75)	COMMENTS	ELEVATION (m)
30								1031
31			- some sandstone layering (fine grained)					1030
32	CS		- medium strong		C6		Recovery = 100 % RQD = 63 % Su = 19.15 MPa	1029
33								1028
34			SANDSTONE - fine grained, fresh jointed, very thinly bedded, silty, damp, grey.					1027
35	SS				C7		Recovery = 100 % RQD = 97 %	1026
36			CLAYSHALE - Silty, trace fine sand, moderately weathered, moderately weak, very thinly bedded, slightly practured, grey, damp.					1025
37								1024
38	CS				C8		Recovery = 100 % RQD = 94 %	1023
39								1022
40								

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 45.50 m
REVIEWED BY: FA	COMPLETION DATE: 1/23/2014
PROJECT ENGINEER: Stuart Bell	Page 4 of 5

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-01**
LOCATION:	COORDINATES: UTM N 5605847.29 E 291197.159	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Wet Rotary	ELEVATION (m): 1061.488

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC / M.C. / LIQUID (25 / 50 / 75)	COMMENTS	ELEVATION (m)
40								1021
41					C9		Recovery = 100 % RQD = 85 %	1020
42								1019
43	CS							1018
44					C10		Recovery = 100 % RQD = 95 %	1017
45								1016
46			END OF TESTHOLE at 45.5 mBGS - Water level at 3.5 mBGS at completion - 50 mm stand pipe installed to 15.0 m - Backfilled with bentonite chips - Water level 3.52 mBGS in standpipe on Feb 24, 2014 - Decommissioned on April 22nd at client's request					1015
47								1014
48								1013
49								1012
50								

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 45.50 m
REVIEWED BY: FA	COMPLETION DATE: 1/23/2014
PROJECT ENGINEER: Stuart Bell	Page 5 of 5

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-02**
LOCATION:	COORDINATES: UTM N 5606036.403 E 291214.829	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1061.181

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75	COMMENTS	ELEVATION (m)
0	OR		TOPSOIL (75mm) - Organic, rootlets, fiberous, silty, damp, black. GRAVEL - Sandy, Silty, Trace clay, trace to some cobbles, occasional boulder, rounded, compact to dense, damp, some sand layering, brown.		1				1061
1					2				1060
2					3	30		Res: 8.40 ohm-m SO4: 160 mg/L Cl: 28 mg/L pH: 7.61	1059
3					4				1058
4			- Slight increase in clay content		5	57			1057
5	GP		- Satuarted, hole sloughing		6				1056
6					7				1055
7					8				1054
8					9	60/ 150mm	>>		1053
9					10			Res: 12.1 ohm-m SO4: 120 mg/L Cl: 33 mg/L pH: 7.79	1052
10					11				
					12				
					13	50/ 125mm	>>		
					14				

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 21.35 m
REVIEWED BY: FA	COMPLETION DATE: 1/22/2014
PROJECT ENGINEER: Stuart Bell	Page 1 of 3

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-02**
LOCATION:	COORDINATES: UTM N 5606036.403 E 291214.829	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1061.181

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 25 50 75	COMMENTS	ELEVATION (m)
10									1051
11					15				1050
12					16				1049
13					17	50/ 100mm	>>		1048
14								Res: 14.9 ohm-m SO4: 150 mg/L Cl: 8.7 mg/L pH: 8.47	1047
15	GP				18				1046
16								Res: 11.5 ohm-m SO4: 145 mg/L Cl: 32.5 mg/L pH: 8.01	1045
17					19	50/ 100mm	>>		1044
18									1043
19					20				1042
20									

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 21.35 m
REVIEWED BY: FA	COMPLETION DATE: 1/22/2014
PROJECT ENGINEER: Stuart Bell	Page 2 of 3

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-02**
LOCATION:	COORDINATES: UTM N 5606036.403 E 291214.829	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1061.181

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 25 50 75	COMMENTS	ELEVATION (m)
20	GP								1041
21					21				1040
22			END OF TESTHOLE at 21.35 mBGS - Water and slough @ 4 mBGS upon completion - 50 mm stand pipe installed to 5.2 m - Water level 3.48 mBGS in standpipe on Feb 24, 2014 - Decommissioned on April 22nd at client's request						1039
23									1038
24									1037
25									1036
26									1035
27									1034
28									1033
29									1032
30									

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 21.35 m
REVIEWED BY: FA	COMPLETION DATE: 1/22/2014
PROJECT ENGINEER: Stuart Bell	Page 3 of 3

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-03**
LOCATION:	COORDINATES: UTM N 5606384.788 E 291591.545	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1059.338

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	WELL INSTALLATION	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 / PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
0		OR		TOPSOIL - Trace Clay, rootlets, silty, organics, damp, layering, Black.						1059
				CLAY - Silty, sandy, medium plastic, stiff, moist, sand laminations, oxidized.		1		34.9		
1		CI				2		27.4		1058
				SAND - Fine grained, silty, trace clay.						
		SM				3	21	15.6		1057
2				GRAVEL - Sandy, silty, some clay, trace cobbles, compact, poorly graded, moist, dark brown.						
						4		11.2		
3									Gravel : 52%	
						5	18	9.1	Sand : 31%	1056
		GP							Silt and Clay : 17%	
4						6		9		1055
				- Saturated		7	91	10.6		
5				CLAYSHALE - Silty, trace fine sand, very hard, trace sandstone layering, some coal laminations, damp, mottled grey/Dark grey/ Black (coal).						1054
						8		13.2	LL : 26.8	
									PL : 18.7	
6									PI : 8.1	
				- clayshale, blue grey, weak		9	115	15.7 >>		1053
		CS		- oxidized @ 7.2 to 7.4m		C1		15.6		
7										
				SILTSTONE - light brown, strong					Recovery = 100 %	1052
									RQD = 67 %	
8						C2		8.6		
		SI		- weak claystone					Recovery = 100 %	1051
									RQD = 65 %	
9				- siltstone, weak, weathered						1050
				CLAYSHALE - medium strong, light grey						
10		CS								

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 24.30 m
REVIEWED BY: FA	COMPLETION DATE: 1/15/2014
PROJECT ENGINEER: Stuart Bell	Page 1 of 3

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-03**
LOCATION:	COORDINATES: UTM N 5606384.788 E 291591.545	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1059.338

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	WELL INSTALLATION	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 / PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
10										1049
				- siltstone, medium strong, slightly weathered		C3		10.6	Recovery = 100 % RQD = 58 %	
11		CS								1048
				- medium strong to weak, dark blue grey clay shale, weathered.						
12				SILTSTONE - fresh joints, olive to dark grey						1047
									LL : 23.8 PL : 19.3 PI : 4.5	
13		SI								1046
						C4		5.8 H	Recovery = 100 % RQD = 77 %	
14				CLAYSHALE - medium strong, dark grey						
		CS		- siltstone @ 14.0-14.6m						1045
15				SILTSTONE - medium strong, fractured, dark grey						
										1044
16				- sandstone, fine grained						
				- claystone/clayshale, weak, olive grey						1043
17						C5			Recovery = 100 % RQD = 83 %	
		SI								1042
18										
				- claystone, highly weathered						1041
19										
										1040
20						C6			Recovery = 100 %	

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 24.30 m
REVIEWED BY: FA	COMPLETION DATE: 1/15/2014
PROJECT ENGINEER: Stuart Bell	Page 2 of 3

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-03**
LOCATION:	COORDINATES: UTM N 5606384.788 E 291591.545	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1059.338

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	WELL INSTALLATION	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 25 50 75 / PLASTIC M.C. LIQUID / 25 50 75	COMMENTS	ELEVATION (m)
20									RQD = 78 %	1039
21		SI		- weak, dark grey, clayshale - fresh joints						1038
22										1037
23		CS		CLAYSHALE - weak		C7			Recovery = 100 % RQD = 87 %	1036
24										1035
25				END OF HOLE at 21.35 mBGS - hole backfilled with bentonite chips to 5.3 m - 50 mm MW installed to 5.2 m - Water level 3.15 mBGS in standpipe on Feb 24, 2014 - Decommissioned on April 22nd at client's request						1034
26										1033
27										1032
28										1031
29										1030
30										

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 24.30 m
REVIEWED BY: FA	COMPLETION DATE: 1/15/2014
PROJECT ENGINEER: Stuart Bell	Page 3 of 3

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-04**
LOCATION:	COORDINATES: UTM N 5606731.206 E 291864.093	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1057.01

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
0	OR		TOPSOIL - Organic, rootlets, fiberous, some silt, moist, black.						
	CI		CLAY - Sandy, some silt, medium plastic, firm, moist, trace sand laminations, oxidized, brown.		1		20.3		
					2		23.4		
1									1056
			GRAVEL - Sandy, some clay, some silt, trace cobbles, dense to very dense, wet, brown.					Gravel : 60 % Sand : 25 % Silt and Clay : 15 %	
					3	50	8.5		
2									1055
	GP		- Saturate/free water, dense		4		12.3		
3									1054
					5	31	10.7		
			SAND - Fine grained, silty, trace clay, occasional silt laminations, trace gravel, wet, oxidized, brown.		6		15.2		
4									1053
	SM				7	50/ 125mm	14.3	>>	
5									1052
			SILT - Some fine sand, trace clay, very dense, damp, brown.		8		12.8		
	ML								
6					9	50/ 75mm	15.5	>>	1051
								Gravel : 4.7% Sand : 20.3% Silt : 59.3% Clay : 15.7%	
			CLAYSHALE - olive grey to dark grey, weak to medium strong, weathered		10		13.5		
7									1050
					11	50/ 50mm	16.5	>>	
8					C1		12.8		1049
	CS							Recovery = 86 % RQD = 52 %	
9									1048
			- olive grey to dark grey, weak						
			- moderate to highly weathered from 9.15 to 10.7m						
10			- 10.7m to 12.2m- medium strong						

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 24.30 m
REVIEWED BY: FA	COMPLETION DATE: 1/25/2014
PROJECT ENGINEER: Stuart Bell	Page 1 of 3

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-04**
LOCATION:	COORDINATES: UTM N 5606731.206 E 291864.093	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1057.01

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
10								
				C2		11.4	Recovery = 100 % RQD = 55 %	
11	CS							1046
12		- clayshale, highly weathered						1045
13		SILTSTONE						1044
		- weak claystone						
				C3		6.7	Recovery = 98 % RQD = 61 %	
14		- fresh joints						1043
15								1042
		- Olive grey, weak siltstone						
	SI	- weak, olive grey, clayshale						
16								1041
		- weak, fresh joints, siltstone, olive to dark grey, siltstone						
				C4			Recovery = 100 % RQD = 69 %	
17								1040
18								1039
		- medium strong siltstone, slighly weathered						
		CLAYSHALE- weathered, weak, clayshale/claystone						
19	CS							1038
				C5			Recovery = 98 % RQD = 77 %	
20	SI	SILTSTONE - weak to medium strong siltstone						

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

LOGGED BY: PE	COMPLETION DEPTH: 24.30 m
REVIEWED BY: FA	COMPLETION DATE: 1/25/2014
PROJECT ENGINEER: Stuart Bell	Page 2 of 3

PROJECT: South Alberta Flood Mitigation Feasibility Study	CLIENT: Alberta Flood Recovery Task Force	TESTHOLE NO.: **TH14-04**
LOCATION:	COORDINATES: UTM N 5606731.206 E 291864.093	PROJECT NO.: 60309815
CONTRACTOR: Garrity & Baker Drilling	METHOD: Auger/Wet Rotary	ELEVATION (m): 1057.01

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 / PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
20	SI		CLAYSHALE - weathered, weak, clayshale/claystone, olive grey						
21	CS								1036
			SILTSTONE						
	SI								
22			CLAYSHALE - weak, olive grey						1035
	CS				C6			Recovery = 100 % RQD = 84 %	
23									1034
			SILTSTONE - medium strong, siltstone						
	SI								
24									1033
			END OF TESTHOLE at 24.3 mBGS - Water level 2.5 mBGS at testhole completion - 50 mm stand pipe intalled to 2.3 mBGS - Water level 2.69 mBGS in standpipe on Feb 24, 2014 - Decommissioned on April 22nd at client's request						
25									1032
26									1031
27									1030
28									1029
29									1028
30									

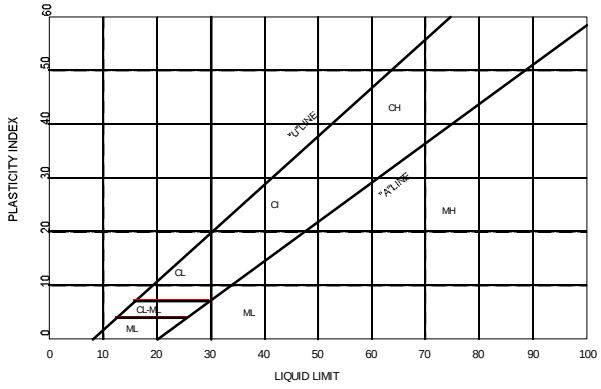
AECOM

LOGGED BY: PE	COMPLETION DEPTH: 24.30 m
REVIEWED BY: FA	COMPLETION DATE: 1/25/2014
PROJECT ENGINEER: Stuart Bell	Page 3 of 3

LOG OF TESTHOLE SAFM2.GPJ UMA_COC.GDT PRINT: 7/10/14 By:

AECOM

MAJOR DIVISION			LOG SYMBOLS	USC	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS	GRAVELS (MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
				GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
	SANDS (MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
				SP	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		SANDS WITH FINES		SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
FINE GRAINED SOILS	SILTS (BELOW 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 50$		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50$		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS		
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER 'F'. E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$30 < W_L < 50$		CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50$		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (BELOW 'A' LINE)	$W_L < 50$		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50$		OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS				Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE	
BEDROCK				BR	SEE REPORT DESCRIPTION		



SOIL COMPONENTS

FRACTION		SIEVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	IDENTIFIER
GRAVEL	COARSE	75	19	50 - 35	AND
	FINE	19	4.75		
SAND	COARSE	4.75	2.00	35 – 20	_____Y
	MEDIUM	2.00	0.425		
	FINE	0.425	0.080	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.080		10 - 1	TRACE
OVERSIZE MATERIALS					
ROUNDED OR SUB-ROUNDED COBBLES 75 mm TO 200 mm BOULDERS >200 mm		ANGULAR ROCK FRAGMENTS ROCKS > 0.75 m3 IN VOLUME			

NOTE :
1. BOUNDARY CLASSIFICATION POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%

MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

APRIL 2012

1. Explanation of Field and Laboratory Test Data

The field and laboratory test results, as shown on the logs, are briefly described below.

1.1 Natural Moisture Content and Atterberg Limits

The relationship between the natural moisture content and depth is significant in determining the subsurface moisture conditions. The Atterberg Limits for a sample should be compared to the natural moisture content and should be on the Plasticity Chart in order to determine their classification.

1.2 Soil Profile and Description

Each soil stratum is classified and described noting any special conditions. The Modified Unified Soils Classification System (MUSCS) is used. The soil profile refers to the existing ground level. When available, the existing ground elevation is shown. The soil symbols used are shown in detail on the soil classification chart.

1.3 Tests on Soil Samples

Laboratory and field tests on the logs are identified by the following:

N (Standard Penetration Test (SPT) Blow Count) - The SPT is conducted in the field to assess the in situ consistency of cohesive soils and the relative density of non-cohesive soils. The N value recorded is the number of blows from a 63.5 kg hammer dropped 760 mm which is required to drive a 51 mm split spoon sampler 300 mm into the soil.

SO_4 (Water Soluble Sulphate Content) - Conducted primarily to determine requirements for the use of sulphate resistant cement. Further details on the water soluble sulphate content are given in Section 1.6.

γ_D (Dry Unit Weight) kN/m^3 and γ_T (Total Unit Weight) kN/m^3.

Q_U (Unconfined Compressive Strength) kPa - May be used in determining allowable bearing capacity of the soil.

C_U (Undrained Shear Strength) kPa - This value is determined by an unconfined compression test and may also be used in determining the allowable bearing capacity of the soil.

C_{PEN} (Pocket Penetrometer Reading) kPa - Estimate of the undrained shear strength as determined by a pocket penetrometer.

The following tests may also be performed on selected soil samples and the results are given on the borehole logs: Grain Size Analysis; Standard or Modified Proctor Compaction Test; California Bearing Ratio; Unconfined Compression Test; Permeability Test; Consolidation Test; Triaxial Test

1.4 Soil Density and Consistency

Table 1.1 Cohesive Soils		
N	**Consistency**	**C_U (kPa) (approx.)**
0 - 1	Very Soft	<10
1 - 4	Soft	10 - 25
4 - 8	Firm	25 - 50
8 - 15	Stiff	50 - 100
15 - 30	Very Stiff	100 - 200
30 - 60	Hard	200 - 300
>60	Very Hard	>300

The SPT test described above may be used to estimate the consistency of cohesive soils and the density of cohesionless soils. These approximate relationships are summarized in the following tables:

Table 1.2 Cohesionless Soils	
N	**Density**
0 - 5	Very Loose
5 - 10	Loose
10 - 30	Compact
30 - 50	Dense
>50	Very Dense

1.5 Sample Condition and Type

The depth, type, and condition of samples are indicated on the borehole logs by the following symbols:

■	Grab Sample	▤	A-Casing
⧄	Shelby Tube	▥	No Recovery
⊠	SPT Sample	◧	Core Sample

1.6 Water Soluble Sulphate Concentration

The following table from CSA Standard A23.1-94 indicates the requirements for concrete subjected to sulphate attack based upon the percentage of water soluble sulphate as presented on the borehole logs. CSA Standard A23.1-94 should be read in conjunction with the table.

Table 1.3
Requirements for Concrete Subjected to Sulphate Attack

Class of Exposure	Degree of Exposure	Water-Soluble Sulphate (SO_4) in Soil Sample %	Sulphate (SO_4) in Groundwater Samples mg/L	Minimum Specified 28 d Compressive Strength MPa†	Maximum Water/ Cementing Materials Ratio†	Portland Cement to be Used‡
S-1	Very severe	over 2.0	over 10,000	35	0.40	50
S-2	Severe	0.20 - 2.0	1,500 - 10,000	32	0.45	50
S-3	Moderate	0.10 - 0.20	150 - 1,500	30	0.50	20§,40, or 50

* For sea water exposure see Clause 15.4
† See Clause 15.1.4
‡ See Clause 15.1.5
§ Type 20 cement with moderate sulphate resistance (see Clause 3.1.2)

1.7 Groundwater Table

The groundwater table is indicated by the equilibrium level of standing water in a standpipe installed in a borehole. This level is generally taken at least 24 hours after installation of the standpipe. The groundwater level is subject to seasonal variations and its highest level usually occurs in spring. The symbol on the borehole logs indicating the groundwater level is an inverted solid triangle (▼).

AECOM Canada Ltd.

General Statement; Normal Variability Of Subsurface Conditions

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability of the site for the proposed project. This report has been prepared to aid in the general evaluation of the site and to assist the design engineer in the conceptual design for the area. The description of the project presented in this report represents the understanding by the geotechnical engineer of the significant aspects of the project relevant to the design and construction of the subdivision, infrastructure and similar. In the event of any changes in the basic design or location of the structures, as outlined in this report or plan, AECOM should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations represented in this report are based on the data obtained from the test holes drilled at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere on the site are not significantly different from those encountered at the test locations. However, variations in soil conditions may exist between the test holes and, also, general groundwater levels and condition may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions, different from those encountered in the test holes are observed or encountered during construction or appear to be present beneath or beyond the excavation, AECOM should be advised at once so that the conditions can be observed and reviewed and the recommendations reconsidered where necessary.

Since it is possible for conditions to vary from those identified at the test locations and from those assumed in the analysis and preparation of recommendations, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modifications of the design and construction procedures.

APPENDIX A

Soil Logs

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE
Boulders	Greater than 200 mm
Cobbles	75 mm to 200 mm
Gravel	5 mm to 75 mm
Sand	Not visible to 5 mm
Silt	Non-Plastic particles, not visible to the naked eye
Clay	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH	
Very Soft	Less than 10 kPa	
Soft	10 - 25 kPa	
Firm	25 - 50 kPa	
Stiff	50 - 100 kPa	
Very Stiff	100 - 200 kPa	} Modified from National Building Code
Hard	200 - 300 kPa	
Very Hard	Greater than 300 kPa	

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from
Dense	30 - 50	} National Building
Very Dense	Over 50	Code

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE


Shelby Tube


SPT


No Recovery


A-Casing


Grab


Core


MC - Moisture Content (% by weight) as determined by sample.

Water Level

CPen - Shear Strength determined by pocket penetrometer

CVane - Shear Strength determined by pocket vane.

Cu - Undrained Shear Strength determined by unconfined compression test.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP; More than 12% GM, GC, SM, SC; 5% to 12% Borderline cases requiring use of dual symbols
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)
		$w_L > 50\%$	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 30\%$	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	
		$30\% < w_L < 50\%$	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS	
		$w_L > 50\%$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$w_L < 50\%$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY	
		$w_L > 50\%$	OH		ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS	
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE

Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP; More than 12% GM, GC, SM, SC; 5% to 12% Borderline cases requiring use of dual symbols

$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$

NOT MEETING ALL GRADATION REQUIREMENTS FOR GW

ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4

ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7

Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols

$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$

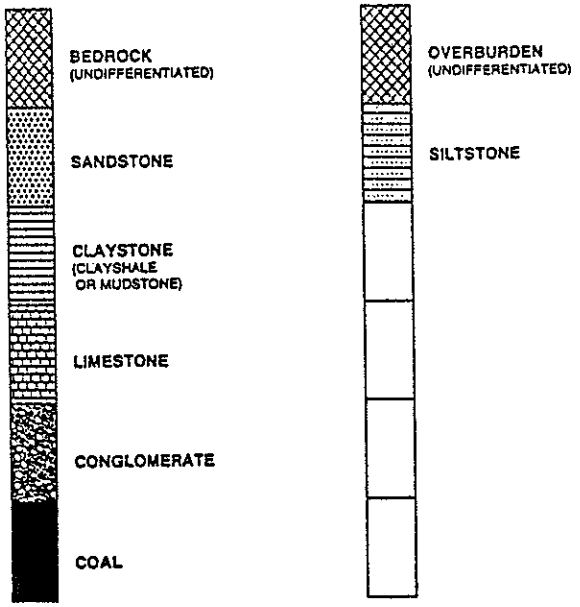
NOT MEETING ALL GRADATION REQUIREMENTS FOR SW

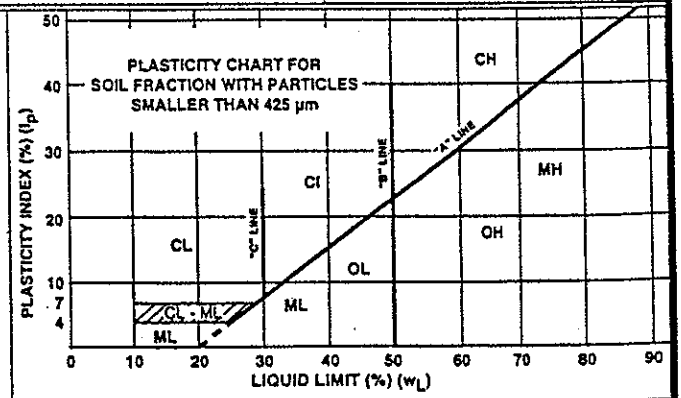
ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4

ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7

Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols

SPECIAL SYMBOLS





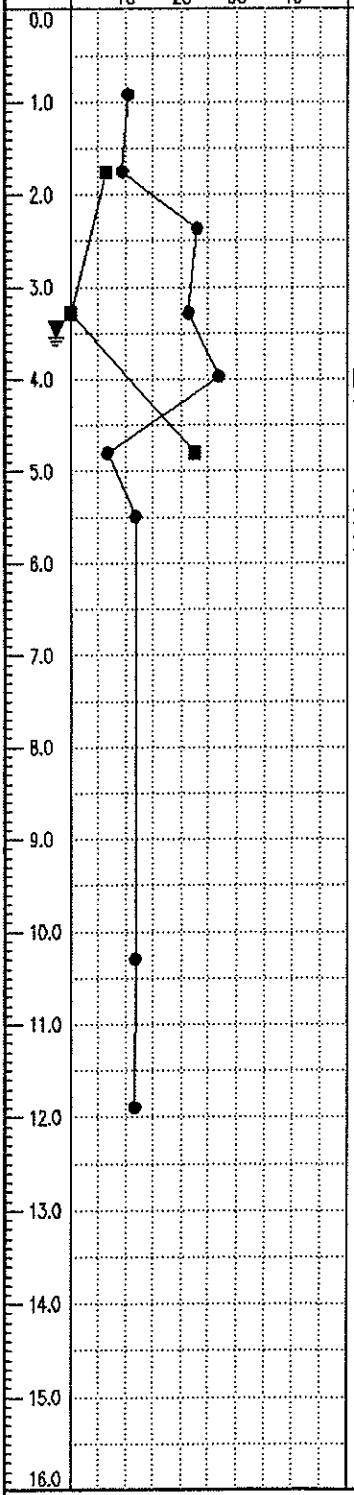
THURBER

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

Highwood River Offstream Storage	Driller: Beck Drilling	BOREHOLE NO: 01-A1
UMA	Rig Type: Solid Stem Auger	PROJECT NO: 17-550-126
N 5610750 E 291680	Inspector: K. Shelestynsky	ELEVATION:

SAMPLE TYPE: SHELBY TUBE | GRAB SAMPLE | NO RECOVERY | A-CASING | SPLIT SPOON | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



REMARKS

Permeability for unit – 4.6 to 6.1 m is 5x10-3 cm/sec

49% Gravel
28% Sand
23% Silt and Clay

SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION(m)
		OR		TOPSOIL, trace rootlets	0.0
		CL-CI		CLAY, sandy, silty, brown, dry, trace sulfides, firm to stiff	-1.0
	13	SC		SAND, clayey, brown, damp, compact	-2.0
		CL-OL		CLAY, some sand, moist, dark brown, some organics, firm	-3.0
	0	SC		SAND, clayey, brown, wet, very loose	-4.0
		CL-ML		CLAY, sandy, silty, brown, wet, firm to stiff	-5.0
	45	GP		GRAVEL, sandy, some silt, trace clay, saturated, brown, dense	-6.0
				-becoming grey at 9.8 m	-10.0
		SS-SI		SILTSTONE/SANDSTONE (weathered), grey, damp	-11.0
				END OF HOLE AT 12.2 metres Auger refusal at 12.2 m Installed 50 mm monitoring well to 6.1 m Screen from 4.6 to 6.1 m Sand from 4.4 to 4.9 m Bentonite from 3.7 to 4.4 m Drill cuttings from 0.6 to 3.7 m Bentonite from 0.2 to 0.6 m Slough from 4.9 to 12.2 m Water Level on July 27, 2001 at 3.5 m	-12.0

SLOTTED PIEZOMETER

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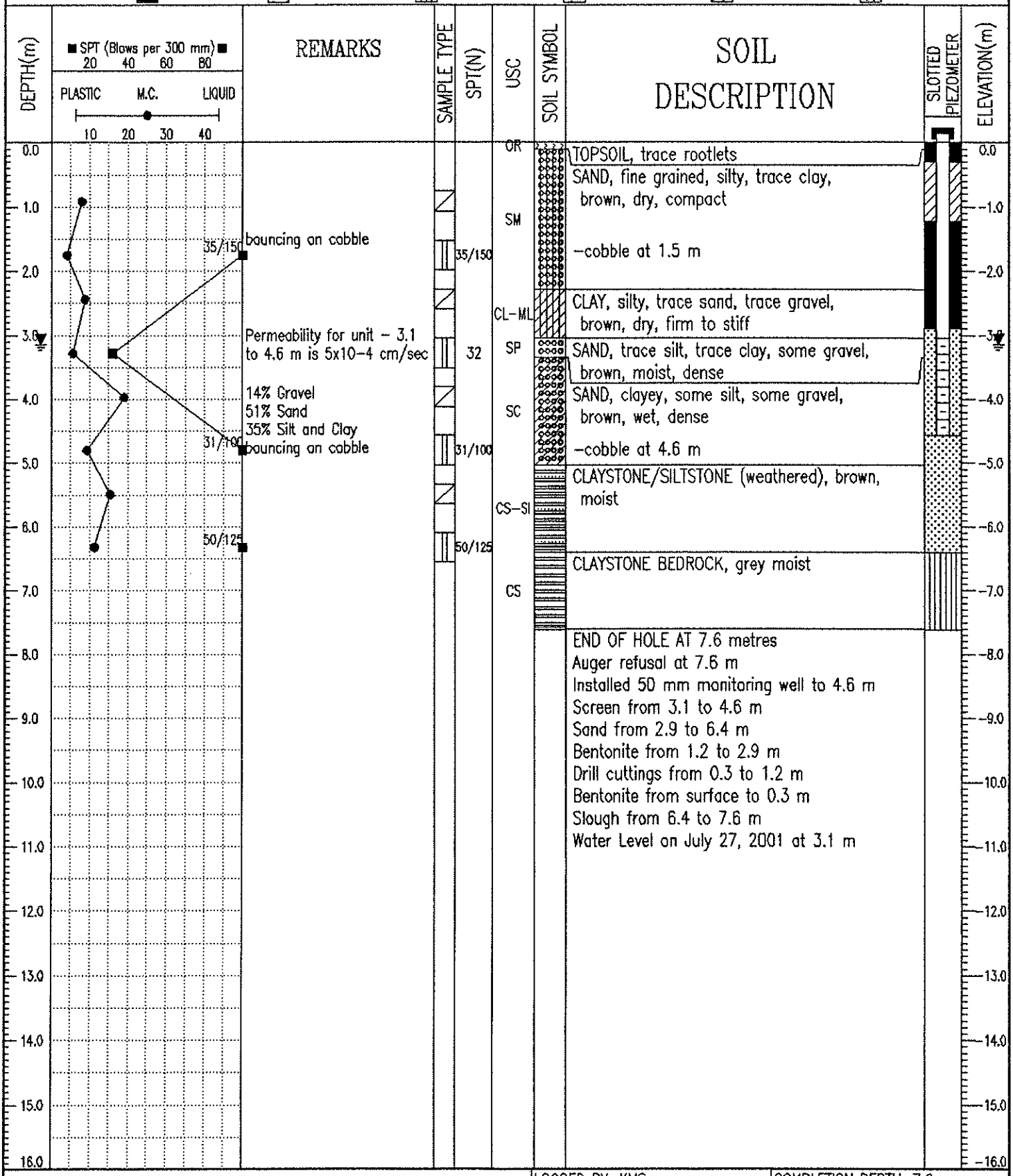
LOGGED BY: KMS	COMPLETION DEPTH: 12.2 m
REVIEWED BY: JCS	COMPLETE: 01/06/01
Fig. No:	Page 1 of 1

01/09/12 01:08PM (17550126)

Highwood River Offstream Storage	Driller: Beck Drilling	BOREHOLE NO: 01-A2
UMA	Rig Type: Solid Stem Auger	PROJECT NO: 17-550-126
N 5610539 E 291719	Inspector: K. Shelestynsky	ELEVATION:

SAMPLE TYPE: SHELBY TUBE | GRAB SAMPLE | NO RECOVERY | A-CASING | SPLIT SPOON | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



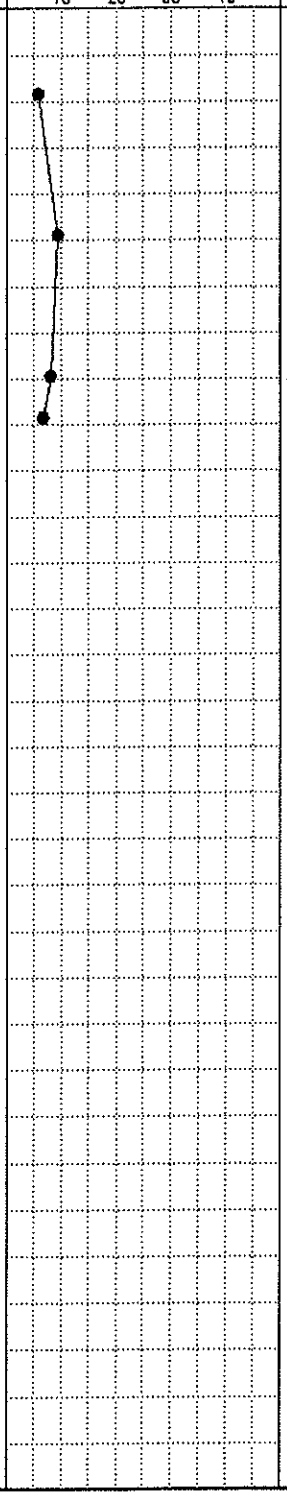
Thurber Engineering Ltd. Calgary, Alberta	LOGGED BY: KMS
	REVIEWED BY: JCS
	Fig. No:
	COMPLETION DEPTH: 7.6 m
	COMPLETE: 01/06/01
	Page 1 of 1

01/09/12 01:38PM (17550126)

Highwood River Offstream Storage	Driller: Beck Drilling	BOREHOLE NO: 01-A3-A
UMA	Rig Type: Solid Stem Auger	PROJECT NO: 17-550-126
N 5610232 E 291755	Inspector: K. Shelestynsky	ELEVATION:

SAMPLE TYPE: SHELBY TUBE | GRAB SAMPLE | NO RECOVERY | A-CASING | SPLIT SPOON | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



DEPTH(m)	REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	ELEVATION(m)
0.0				OR		TOPSOIL, trace rootlets		0.0
1.0	-auger grinding gravel			ML		SILT, gravelly, sandy, trace clay, dry, brown, compact		-1.0
2.0								-2.0
3.0						SAND, trace gravel, some silt, trace clay, damp, brown, compact		-3.0
4.0	-auger grinding cobbles			SW-SM		-cobbles from 4.0 to 5.2 m		-4.0
5.0								-5.0
6.0						END OF HOLE AT 5.2 metres Auger refusal at 5.2 m Slough to 4.4 m Backfilled with bentonite chips Dry upon completion		-6.0
7.0								-7.0
8.0								-8.0
9.0								-9.0
10.0								-10.0
11.0								-11.0
12.0								-12.0
13.0								-13.0
14.0								-14.0
15.0								-15.0
16.0								-16.0

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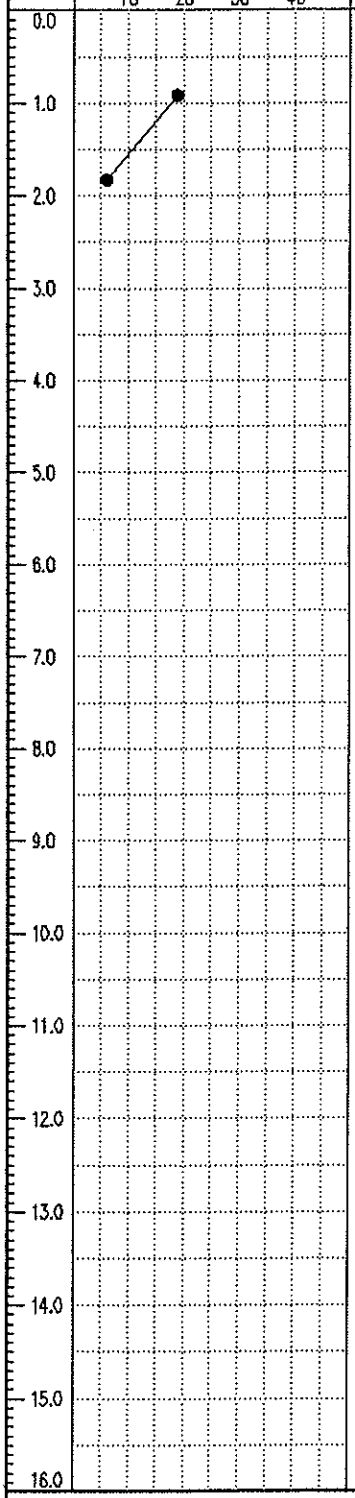
LOGGED BY: KMS	COMPLETION DEPTH: 5.2 m
REVIEWED BY: JCS	COMPLETE: 01/06/01
Fig. No:	Page 1 of 1

01/09/06 03:03PM (17550126)

Highwood River Offstream Storage	Driller: Beck Drilling	BOREHOLE NO: 01-A3-B
UMA	Rig Type: Solid Stem Auger	PROJECT NO: 17-550-126
N 5610239 E 291753	Inspector: K. Shelestynsky	ELEVATION:

SAMPLE TYPE: SHELBY TUBE | GRAB SAMPLE | NO RECOVERY | A-CASING | SPLIT SPOON | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	ELEVATION(m)
			OR		TOPSOIL, trace rootlets		0.0
			CL		CLAY, trace silt, sandy, trace gravel, damp, brown, firm to stiff		-1.0
25% Gravel 25% Sand 50% Silt and Clay -auger grinding cobbles			ML		SILT, gravelly, sandy, trace clay, damp, brown, compact -cobbles at 2.0 m END OF HOLE AT 2.1 metres Auger refusal at 2.1 m Slough to 1.5 m Backfilled with bentonite chips Dry upon completion		-2.0 -3.0 -4.0 -5.0 -6.0 -7.0 -8.0 -9.0 -10.0 -11.0 -12.0 -13.0 -14.0 -15.0 -16.0

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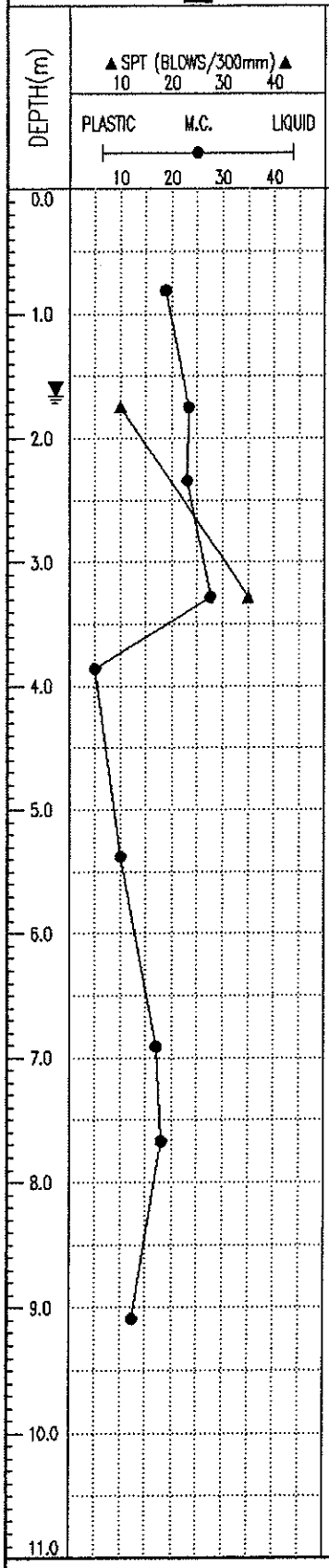
LOGGED BY: KMS	COMPLETION DEPTH: 2.1 m
REVIEWED BY: JCS	COMPLETE: 01/06/01
Fig. No:	Page 1 of 1

01/09/06 03:02PM (17550126)

Highwood River Offstream Storage	Drilling Co.: Beck Drilling	TEST HOLE NO: 01-A4
UMA	Drilling Method: Solid Stem Auger	PROJECT NO: 17-550-126
N 5609672 E 290575	Inspector: T. Safruk	ELEVATION:

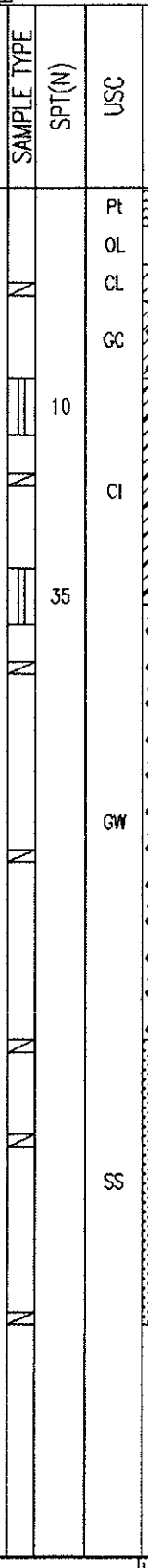
SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

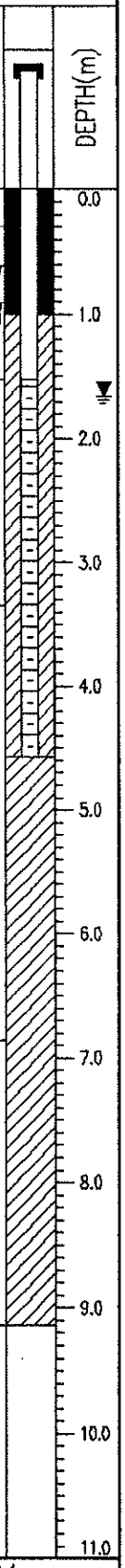


REMARKS

Cpen= 50KPa



SOIL DESCRIPTION



TOPSOIL, organic, rootlets, black

CLAY, organic, silty, medium plastic, dark brown, moist, firm

CLAY, silty, some sand, low to medium plastic, brown, moist, stiff

GRAVEL, clayey, brown, moist, compact

CLAY, silty, some sand, medium plastic, stiff, grey/brown, moist
-sandy layers

GRAVEL, sandy, grey, wet, dense
-cobbles

SILTSTONE BEDROCK, hard, brown, damp

End of hole at 9.1m. Practical refusal.
Seepage and sloughing evident.
Standpipe installed to 4.6m.
Backfilled with cuttings.
Water level 2.1m upon completion.
Water level 1.7m July 9/01.

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LOGGED BY: TS	COMPLETION DEPTH: 9.1 m
REVIEWED BY: JCS	COMPLETE: 07/04/01
Fig. No:	Page 1 of 1

01/09/12 01:41PM (V)

Highwood River Offstream Storage	Drilling Co.: Layne Christensen Ltd.	TEST HOLE NO: 01-A5
UMA	Drilling Method: Wet Rotary/Coring	PROJECT NO: 17-550-126
N 5610947 E 291629	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube; GRAB; NO RECOVERY; A-CASING; SPT; CORE

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH(m)	▲SPT (BLOWS/300mm)▲ 10 20 30 40 PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
0.0		Wet Rotary to 10.36m					CLAY TILL, silty, some sand, trace gravel, medium plastic, very stiff to hard, brown, moist		0.0
1.0									1.0
2.0									2.0
3.0									3.0
4.0									4.0
5.0					CI		-gravelly, occasional cobbles		5.0
6.0									6.0
7.0									7.0
8.0									8.0
9.0									9.0
10.0		Begin coring at 10.36m Run #1 10.36-11.28m 100% REC, 28% RQD			SI		SILTSTONE, slightly to moderately weathered, R0-R1, brown -iron staining on fractures		10.0
11.0									11.0

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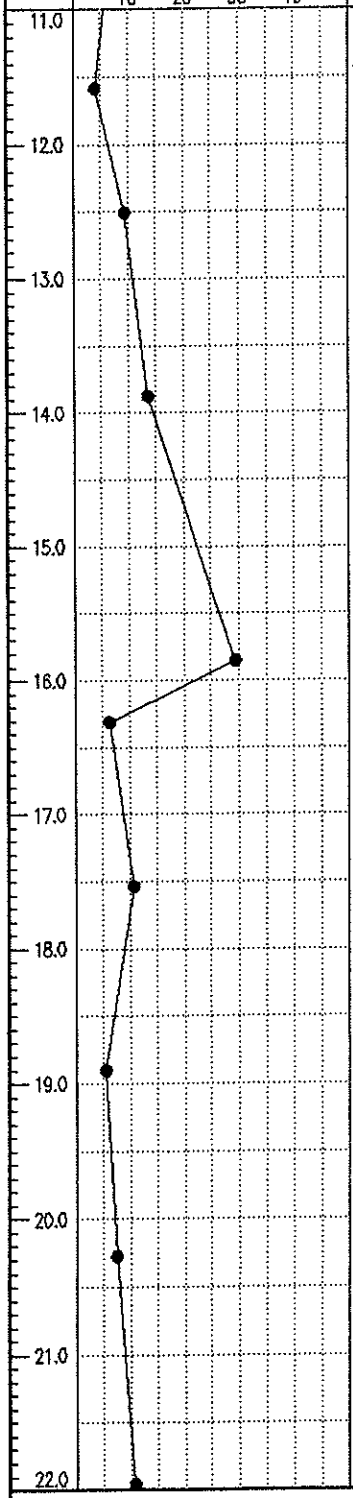
LOGGED BY: TS	COMPLETION DEPTH: 25.6 m
REVIEWED BY: JCS	COMPLETE: 07/06/01
Fig. No:	Page 1 of 3

01/09/12 01:51PM (Y)

Highwood River Offstream Storage	Drilling Co.: Layne Christensen Ltd.	TEST HOLE NO: 01-A5
UMA	Drilling Method: Wet Rotary/Coring	PROJECT NO: 17-550-126
N 5610947 E 291629	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



DEPTH(m)	REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
11.0	Run #2 11.28–13.72m 79% REC, 40% RQD			SI SA		SANDSTONE, slightly weathered to fresh, R5 brown		11.0
12.0	Packer test 12.2–13.7m No flow with 2psi					CLAYSTONE, highly to completely waethered, R0–R1, grey –becoming slightly weathered with bands of siltstone		12.0
13.0				CS				13.0
14.0	Run #3 13.72–16.46m 100% REC, 83% RQD Packer test 13.7–15.2m No flow with 3–7psi					–thin black layer at 14.0m		14.0
15.0	Packer test 15.2–16.8m No flow with 4psi			SA		SANDSTONE, fresh, R1, grey		15.0
16.0	Run #4 16.46–19.51m 100% REC, 54% RQD Packer test 16.8–18.3m No flow with 5psi			CS		CLAYSTONE, moderately weathered, R0–R1, grey –slightly weathered		16.0
17.0						–siltstone bands –thin black layer at 17.4m		17.0
18.0	Packer Test 18.3–19.8m No flow with 6psi			SI–SA		SILTSTONE and SANDSTONE, fresh, R1–R5, grey		18.0
19.0	Run #5 19.51–22.56m 83% REC, 46% RQD					CLAYSTONE, slightly weathered, R0–R1, grey		19.0
20.0	Packer Test 19.8–21.3m No flow with 7psi			CS		Cont'd CLAYSTONE, slightly weathered, R0–R1, grey		20.0
21.0						–thin black layer at 20.7m		21.0
22.0				SA CS		SANDSTONE, fresh, R5, grey CLAYSTONE, slightly weathered, R0–R1, grey		22.0

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LOGGED BY: TS	COMPLETION DEPTH: 25.6 m
REVIEWED BY: JCS	COMPLETE: 07/06/01
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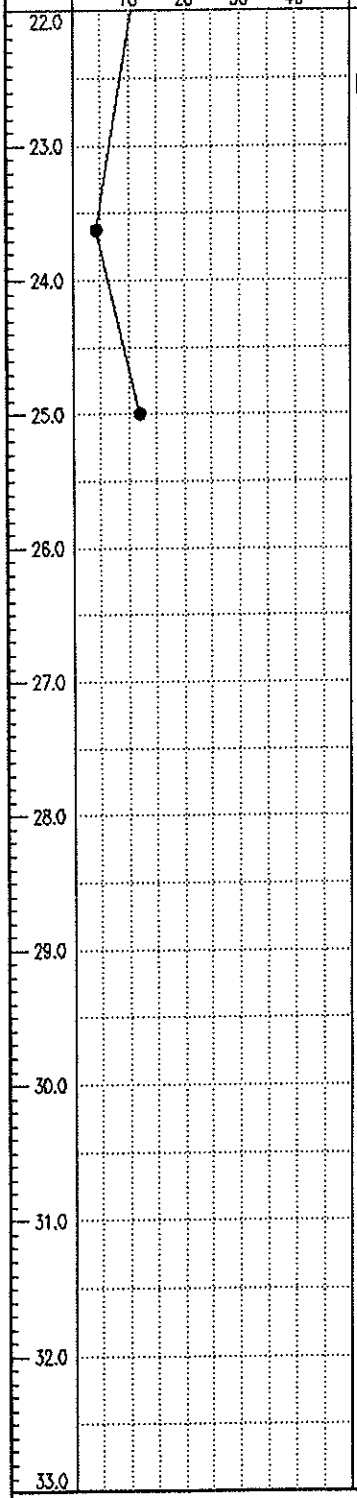
01/08/12 01:51PM (1)

Highwood River Offstream Storage	Drilling Co.: Layne Christensen Ltd.	TEST HOLE NO: 01-A5
UMA	Drilling Method: Wet Rotary/Coring	PROJECT NO: 17-550-126
N 5610947 E 291629	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
Run #6 22.56-25.60m 100% REC, 58% RQD			CS		CLAYSTONE, slightly weathered, R0-R1, grey		22.0
					-fresh, R0-R4		
			SA		SANDSTONE, fresh, R5, grey		23.0
			CS		CLAYSTONE, slightly weathered to fresh, R1-R2, grey		24.0
					END OF HOLE AT 25.6m. Backfilled with cuttings. Bentonite seal at surface.		25.0
							26.0
							27.0
							28.0
							29.0
							30.0
							31.0
							32.0
							33.0

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LOGGED BY: TS	COMPLETION DEPTH: 25.6 m
REVIEWED BY: JCS	COMPLETE: 07/06/01
Fig. No:	Page 3 of 3

01/09/12 01:51PM (1)

Highwood River Offstream Storage	Drilling Co.: Layne Christensen Ltd.	TEST HOLE NO: 01-A6
UMA	Drilling Method: Wet Rotary/Coring	PROJECT NO: 17-550-126
N 5610239 E 291753	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	▲SPT (BLOWS/300mm)▲ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
0.0		Wet Rotary to 4.57m					See TH 01-A3 for 0-4.5m stratigraphy		0.0
1.0									1.0
2.0									2.0
3.0									3.0
4.0		Begin coring at 4.57m							4.0
5.0		Run #1 4.57-5.18m 50% REC, 25% RQD Set casing to 4.9m after Run #1			SA		SANDSTONE, rafted, fresh, R5, grey		5.0
6.0		Run #2 5.49-6.10m 50% REC, 0% RQD Run #3 6.10-7.62m 60% REC, 27% RQD Cpen> 215KPa					CLAY TILL, silty, some sand, trace gravel, low plastic, very stiff to hard, brown, moist		6.0
7.0									7.0
8.0		Run #4 7.62-9.75m 62% REC, 0% RQD Cpen> 215KPa			CI		-medium plastic, occasional cobbles		8.0
9.0									9.0
10.0		Run #5 9.75-11.89m 46% REC, 14% RQD							10.0

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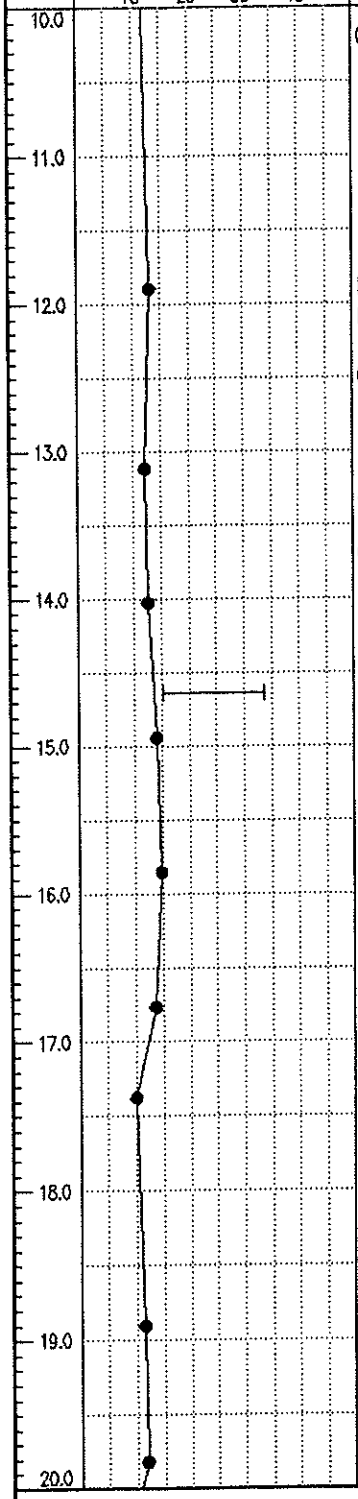
LOGGED BY: TS	COMPLETION DEPTH: 25.0 m
REVIEWED BY: JCS	COMPLETE: 07/05/01
Fig. No:	Page 1 of 3

01/07/25 04:41PM (AUG10)

Highwood River Offstream Storage	Drilling Co.: Layne Christensen Ltd.	TEST HOLE NO: 01-A6
UMA	Drilling Method: Wet Rotary/Coring	PROJECT NO: 17-550-126
N 5610239 E 291753	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



DEPTH(m)	REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
10.0	Cpen> 215KPa					Cont'd CLAY TILL, silty, some sand, trace gravel, medium plastic, very stiff to hard, brown, moist		10.0
11.0								11.0
12.0	Run #6 11.89-13.11m 65% REC, 0% RQD					-grey		12.0
	Cpen> 215KPa			CI				
13.0	Run #7 13.11-14.63m 42% REC, 37% RQD							13.0
	Cpen> 215KPa							
14.0								14.0
	Run #8 14.63-16.15m 90% REC, 67% RQD							
15.0								15.0
						CLAYSTONE, completely weathered, R0, grey		
16.0	Run #9 16.15-19.20m 90% REC, 75% RQD			CS		-thin black layer at 16.3m -highly weathered		16.0
17.0								17.0
	Packer Test 16.8-18.3m No flow with 5psi			SI		SILTSTONE, slightly weathered, R4-R5, grey CLAYSTONE, slightly to highly weathered, R0-R4, grey		
18.0								18.0
				CS		-thin black layer at 18.75m		
19.0								19.0
	Run #10 19.20-22.25m 100% REC, 41% RQD							
20.0								20.0

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LOGGED BY: TS	COMPLETION DEPTH: 25.0 m
REVIEWED BY: JCS	COMPLETE: 07/05/01
Fig. No:	Page 2 of 3

01/07/25 04:41PM (AUG10)

Highwood River Offstream Storage	Drilling Co.: Layne Christensen Ltd.	TEST HOLE NO: 01-A6
UMA	Drilling Method: Wet Rotary/Coring	PROJECT NO: 17-550-126
N 5610239 E 291753	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	▲SPT (BLOWS/300mm)▲ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
20.0		Packer Test 19.8–21.3m No flow with 7psi					Cont'd CLAYSTONE, slightly to highly weathered, R0–R4, grey		20.0
					CS		–siltstone bands, slightly to completely weathered, R1–R4, grey		
21.0									21.0
							SANDSTONE, fresh, R5, grey		
					SA				
22.0		Run #11 22.25–24.99m 100% REC, 78% RQD					CLAYSTONE, highly to completely weathered, R0, brown		22.0
					CS		–grey, slightly weathered –thin black layer at 22.6m		
23.0									23.0
					SI		SILTSTONE, fresh, R1, grey		
					CS		CLAYSTONE, slightly weathered, R0, grey		
							SANDSTONE, fresh, R5, grey		
24.0					SA				24.0
					CS		CLAYSTONE, slightly weathered, R0, grey		
					SA		SANDSTONE, slightly weathered to fresh, R5		
25.0					CS		CLAYSTONE, completely weathered, R0, grey		25.0
							END OF HOLE AT 25m. Backfilled with cuttings. Bentonite seal at surface.		
26.0									26.0
27.0									27.0
28.0									28.0
29.0									29.0
30.0									30.0

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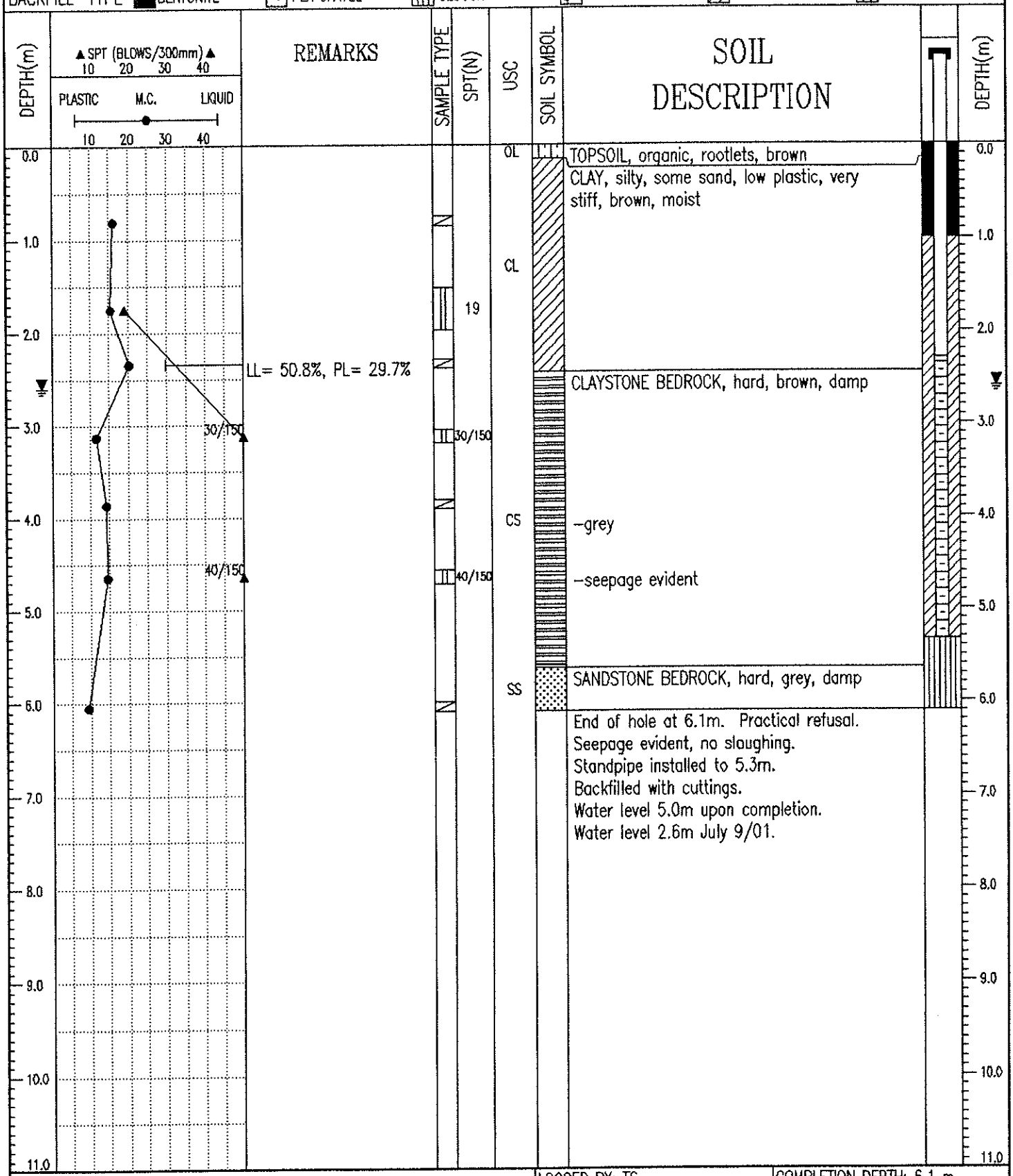
LOGGED BY: TS	COMPLETION DEPTH: 25.0 m
REVIEWED BY: JCS	COMPLETE: 07/05/01
Fig. No:	Page 3 of 3

01/07/25 04:41PM (AUG10)

Highwood River Offstream Storage	Drilling Co.: Beck Drilling	TEST HOLE NO: 01-B1
UMA	Drilling Method: Solid Stem Auger	PROJECT NO: 17-550-126
N 5610342 E 293856	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



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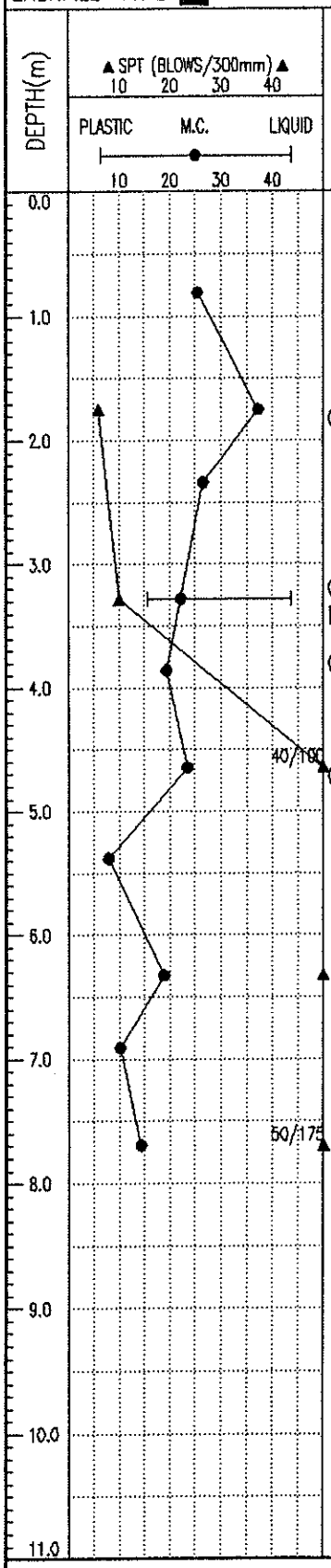
LOGGED BY: TS	COMPLETION DEPTH: 6.1 m
REVIEWED BY: JCS	COMPLETE: 07/04/01
Fig. No:	Page 1 of 1

01/07/25 04:42PM (AUG11)

Highwood River Offstream Storage	Drilling Co.: Beck Drilling	TEST HOLE NO: 01-B2
UMA	Drilling Method: Solid Stem Auger	PROJECT NO: 17-550-126
N 5609983 E 294308	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



REMARKS

Cpen= 15KPa

Cpen= 40KPa
LL= 43.6%, PL= 15.7%

Cpen= 75KPa

Cpen= 100KPa

SAMPLE TYPE	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	INSTRUMENTATION DATA	DEPTH(m)
		OL		TOPSOIL, organic, rootlets, brown		0.0
N				CLAY, silty, some sand, medium to high plastic, firm to stiff, brown, moist		
				-alternating medium and high plastic layers		1.0
N	6	CI-CH		-seepage evident, wet		2.0
						3.0
N	10					4.0
	40/100					
N		SS		SANDSTONE BEDROCK, hard, grey, damp		5.0
				CLAYSTONE BEDROCK, hard, grey, damp		6.0
N	63	CS				
				SANDSTONE BEDROCK, hard, grey, damp		7.0
N		SS				
	50/175					
				End of hole at 7.9m. Practical refusal.		8.0
				Seepage evident, no sloughing.		
				Water level 2.0m upon completion.		9.0
				Backfilled with cuttings.		
						10.0
						11.0

Thurber Engineering Ltd.
Calgary, Alberta

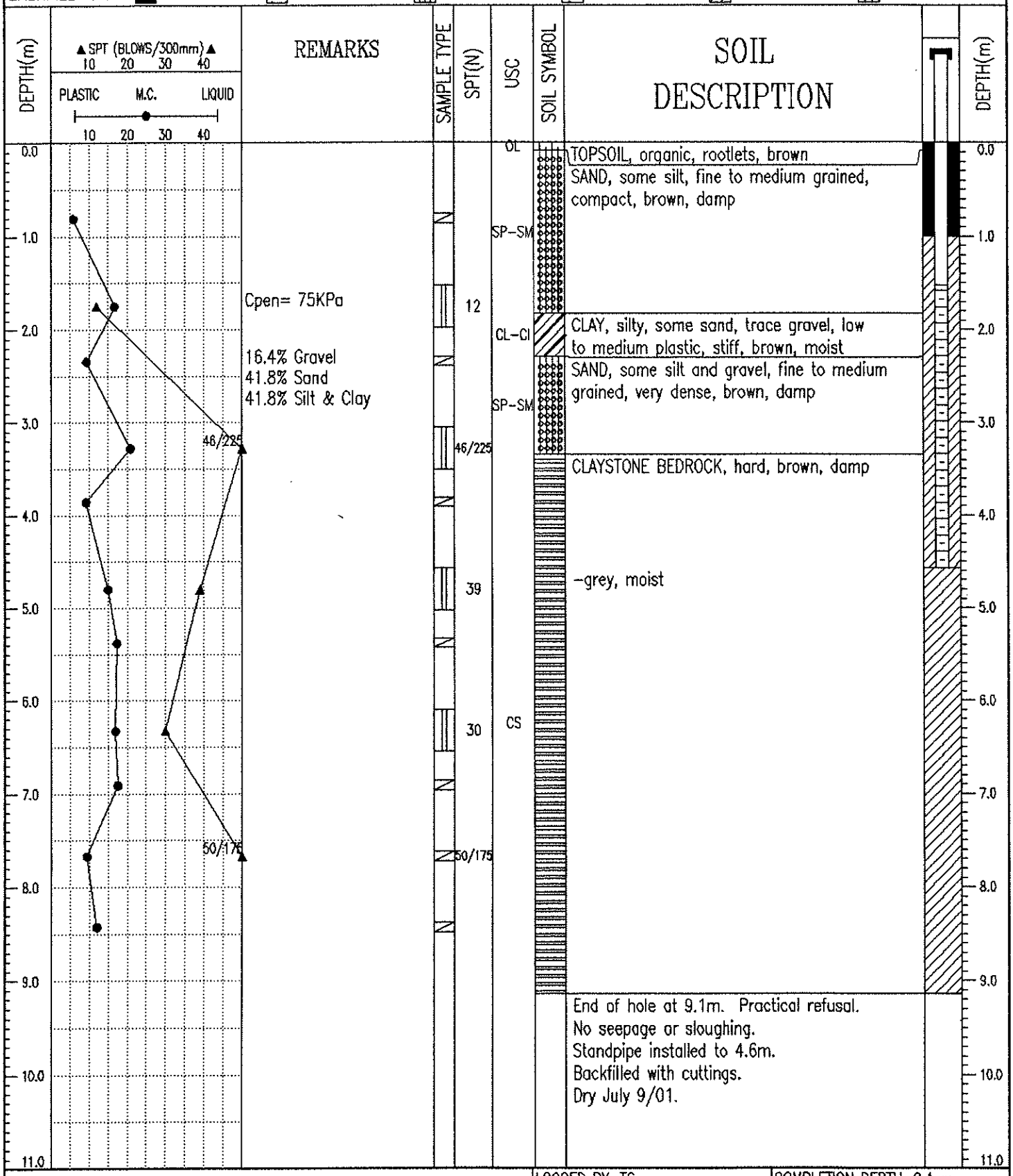
LOGGED BY: TS | COMPLETION DEPTH: 7.8 m
REVIEWED BY: JCS | COMPLETE: 07/04/01
Fig. No: | Page 1 of 1

01/07/25 04:42PM (AUG11)

Highwood River Offstream Storage	Drilling Co.: Beck Drilling	TEST HOLE NO: 01-B3
UMA	Drilling Method: Solid Stem Auger	PROJECT NO: 17-550-126
N 5608882 E 294379	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



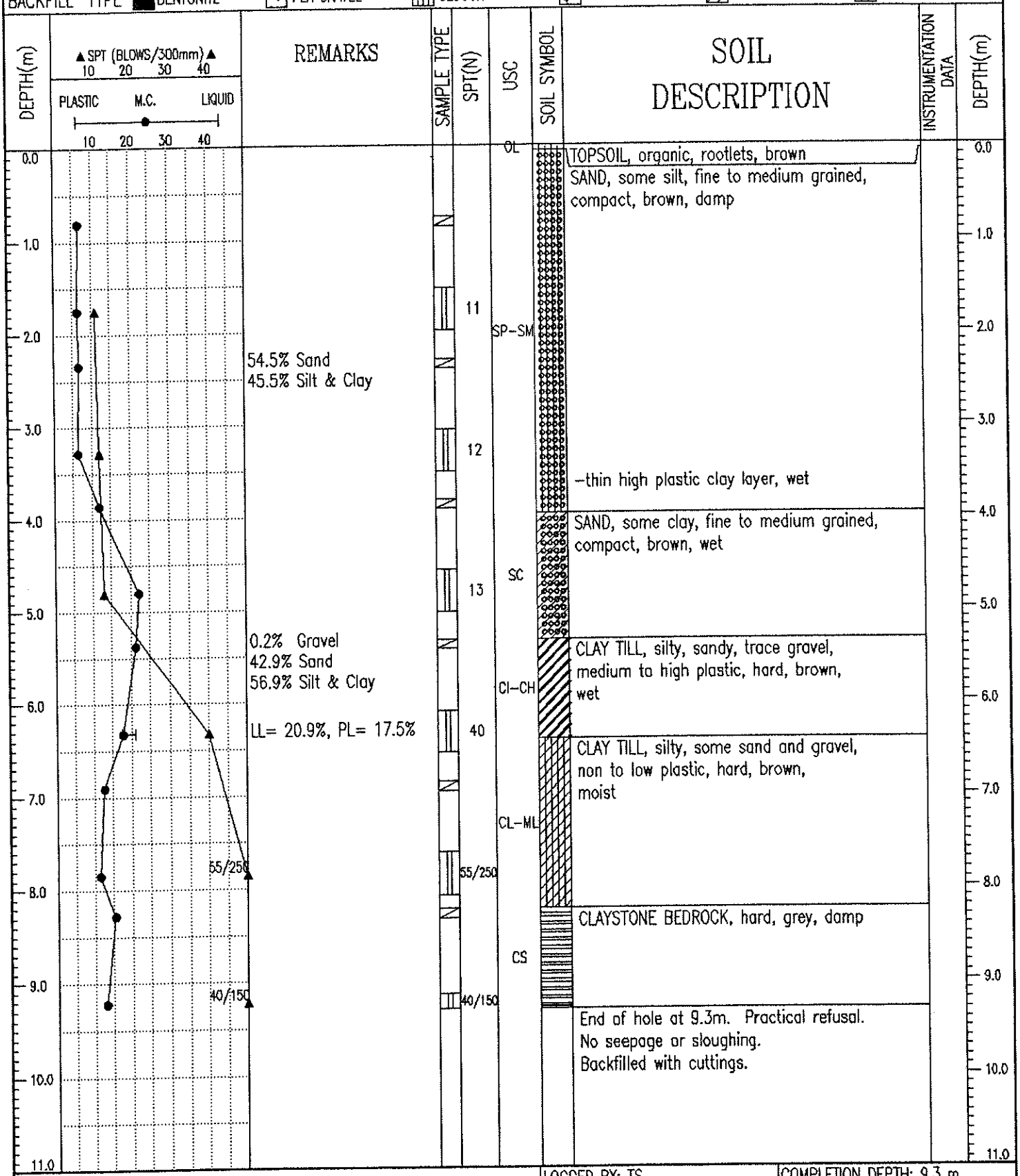
Thurber Engineering Ltd. Calgary, Alberta	LOGGED BY: TS
	REVIEWED BY: JCS
	Fig. No:
	COMPLETION DEPTH: 9.1 m
	COMPLETE: 07/04/01
	Page 1 of 1

01/09/12 01:40PM (AUG11)

Highwood River Offstream Storage	Drilling Co.: Beck Drilling	TEST HOLE NO: 01-B4
UMA	Drilling Method: Solid Stem Auger	PROJECT NO: 17-550-126
N 5607905 E 294335	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



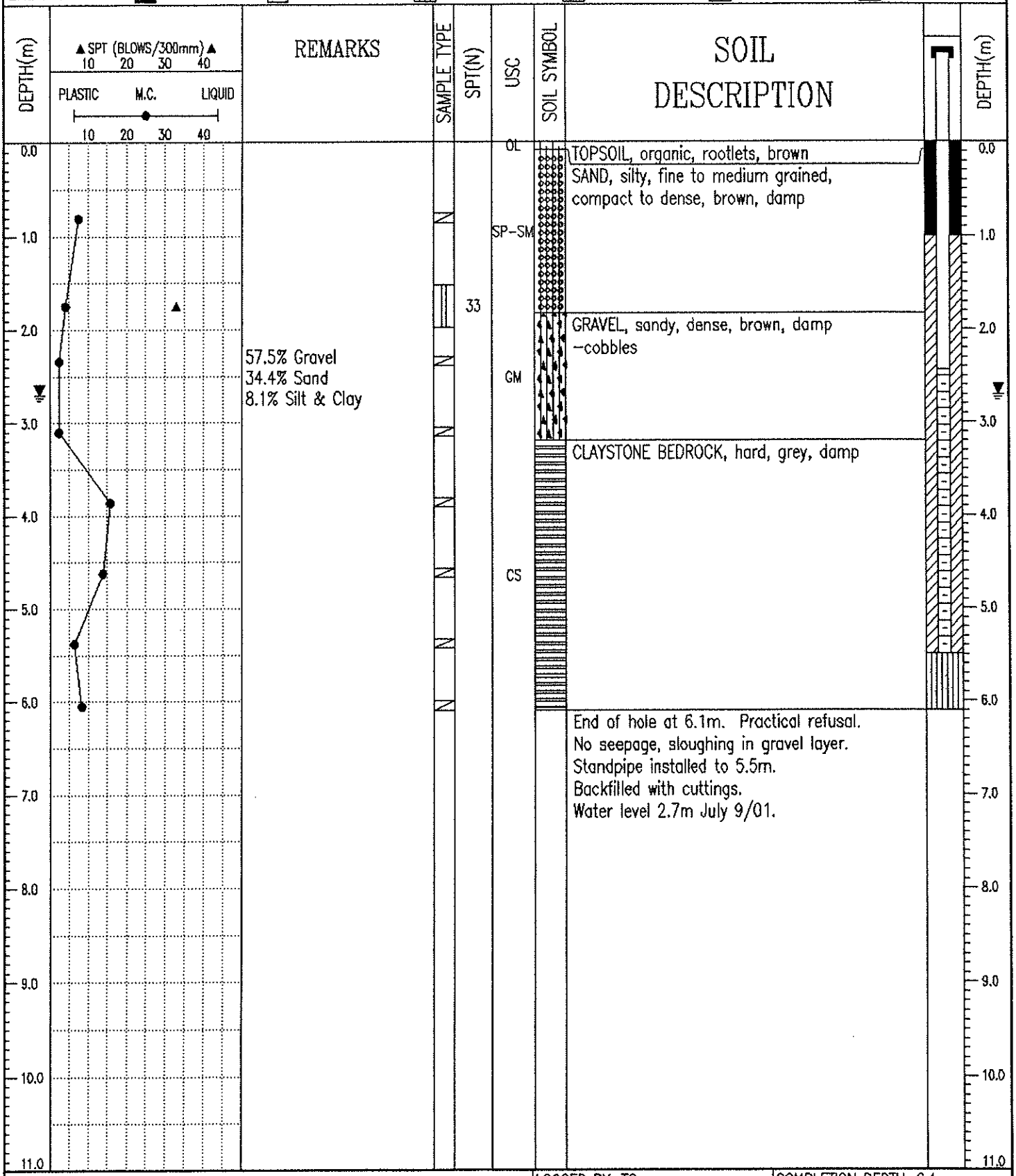
Thurber Engineering Ltd. Calgary, Alberta	LOGGED BY: TS	COMPLETION DEPTH: 9.3 m
	REVIEWED BY: JCS	COMPLETE: 07/04/01
	Fig. No:	Page 1 of 1

01/09/12 01:41PM (Y)

Highwood River Offstream Storage	Drilling Co.: Beck Drilling	TEST HOLE NO: 01-B5
UMA	Drilling Method: Solid Stem Auger	PROJECT NO: 17-550-126
N 5607492 E 294326	Inspector: T. Safruk	ELEVATION:

SAMPLE TYPE: Shelby Tube | GRAB | NO RECOVERY | A-CASING | SPT | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



Thurber Engineering Ltd. Calgary, Alberta	LOGGED BY: TS
	REVIEWED BY: JCS
	Fig. No:
	COMPLETION DEPTH: 6.1 m
	COMPLETE: 07/04/01
	Page 1 of 1

01/09/10 12:06PM (AUS11)

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 128253
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1979/12/27

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
O'HANLON, HARRY	P.O. BOX 158 HIGH RIVER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.590251 Longitude -113.945663
How Location Obtained: Map

Elevation 1066.80 m
How Elevation Obtained: Estimated

Drilling Information

Method of Drilling: Cable Tool

Proposed Well Use: Domestic

Type of Work: New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.96		Gray Till
11.28		Brown Till
16.46		Gray Till
25.30		Gray Shale
27.74	Yes	Light Gray Water Bearing Sandstone
29.87		Gray Shale
30.78		Light Gray Sandstone
38.40		Gray Shale
39.01		Dark Gray Sandstone
40.84		Gray Shale
45.72		Light Gray Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/05/11	11.37	13.41

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
45.72 m		1979/05/04	1979/05/11

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	45.72

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 14.63 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 45.72 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
24.38	44.50	0.000		0.00

Perforated by: Torch

Annular Seal: Driven
Placed from 0.00 m to 14.63 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Certification No: 1
Company Name: DEL'S DRILLING
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 128253
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1979/12/27

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
O'HANLON, HARRY	P.O. BOX 158 HIGH RIVER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.590251 Longitude -113.945663
How Location Obtained: Map

Elevation 1066.80 m
How Elevation Obtained: Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level: cm
Is Artesian Flow:
Rate: L/min
Is Flow Control Installed:
Describe:

Recommended Pump Rate: 0.00 L/min
Recommended Pump Intake Depth (From TOC): 0.00 m
Pump Installed:
Depth: m
Type:
Make:
H.P.:
Model (Output Rating):

Did you Encounter Saline Water (>4000 ppm TDS):
Depth: m
Gas:
Depth: m
Well Disinfected Upon Completion:
Geophysical Log Taken:
Submitted to ESRD:

Sample Collected for Potability:
Submitted to ESRD: Yes (Excel)

Additional Comments on Well

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1979/05/11	12:00 AM	13.41 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type: Bailer
Removal Rate: 11.37 L/min
Depth Withdrawn From: 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Certification No: 1
Company Name: DEL'S DRILLING
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 166443
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/06/18

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
TUMBLE WEED SPRINGS FARM LTD	HIGH RIVER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	04	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.575766 Longitude -113.957392
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.74		Sandy Clay & Rocks
7.32		Clay & Rocks
10.67		Sandy Rocks
12.80		Clay & Rocks
16.15		Sandy Clay & Rocks
19.81		Clay & Rocks
29.26		Shale
31.09		Sandstone
32.00		Shale
36.88		Sandstone
39.32		Shale
43.59		Sandstone
56.39		Shale & Sandstone Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 18.18 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1992/06/03	22.73	0.30

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
56.39 m		1992/06/02	1992/06/03

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	56.39

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 20.42 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 18.29 m
Bottom at : 55.47 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
28.96	48.77	0.318		25.40

Perforated by Saw

Annular Seal Driven
Placed from 0.00 m to 15.24 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 166443
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/06/18

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
TUMBLE WEED SPRINGS FARM LTD	HIGH RIVER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	04	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.575766 Longitude -113.957392
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 18.18 L/min
Recommended Pump Intake Depth (From TOC) 51.82 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1992/06/03	12:00 AM	0.30 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 22.73 L/min
Depth Withdrawn From 55.47 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 241765
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1994/10/17

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MCGROGAN, STEVE	612 6 ST SE, HIGH RIVER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	04	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.575766 Longitude -113.957392
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.52		Sandy Clay
12.80		Clay & Rocks
20.73		Sandy Clay
27.13		Thin Shale & Sandstone Ledges
32.61		Shale
33.22		Sandstone
37.49		Shale & Sandstone Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 45.46 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1994/10/10	63.65	5.55

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
37.49 m		1994/09/28	1994/09/29

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	37.49

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 20.73 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 18.90 m
Bottom at : 37.49 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
22.86	32.00	0.318		15.24

Perforated by Saw

Annular Seal Driven
Placed from 18.29 m to 20.73 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 241765
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1994/10/17

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MCGROGAN, STEVE	612 6 ST SE, HIGH RIVER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	04	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.575766 Longitude -113.957392
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 45.46 L/min
Recommended Pump Intake Depth (From TOC) 33.53 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORT AIR TESTED 50 GPM.

Yield Test

Taken From Ground Level
Depth to water level

Measurement in Metric

Test Date	Start Time	Static Water Level
1994/10/10	12:00 AM	5.55 m

Method of Water Removal

Type Pump
Removal Rate 63.65 L/min
Depth Withdrawn From 35.05 m

If water removal period was < 2 hours, explain why

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
3.18	1:00	5.13
3.26	2:00	5.08
3.31	3:00	5.04
3.37	4:00	5.00
3.40	5:00	4.96
3.43	6:00	4.90
3.47	7:00	4.84
3.50	8:00	4.78
3.52	9:00	4.72
3.56	10:00	4.68
3.61	12:00	4.60
3.63	14:00	4.55
3.67	16:00	4.50
3.79	20:00	4.40
3.96	25:00	4.37
4.03	30:00	4.34
4.13	35:00	4.31
4.26	40:00	4.28
4.41	50:00	4.20
4.55	60:00	4.12
4.76	75:00	4.04
4.96	90:00	3.92
5.12	105:00	3.81
5.27	120:00	3.72
5.55	150:00	3.56
5.77	180:00	3.41
5.95	210:00	3.28
6.09	240:00	3.17

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 244960
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1995/01/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
THIESSEN, LARRY	P.O. BOX 5325 HIGH RIVER				T1V 1M5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
2.74		Brown Silty Clay & Sand
6.71		Gravel
7.32		Clay & Rocks
13.11		Gray Shale
14.02		Gray Sandstone
14.63		Gray Shale
15.85	Yes	Gray Water Bearing Sandstone
18.59		Gray Shale
19.20		Gray Sandstone
22.25		Gray Shale
24.08	Yes	Gray Water Bearing Sandstone
26.52		Gray Shale
27.13		Gray Sandstone
35.05		Gray Shale
40.84	Yes	Gray Water Bearing Sandstone
48.77		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 18.18 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1994/10/19	25.00	4.82
1994/10/19	18.18	4.82

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
48.77 m		1994/10/18	1994/10/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	48.77

Surface Casing (if applicable)
Plastic
Size OD : 15.24 cm
Wall Thickness : 0.940 cm
Bottom at : 7.92 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.602 cm
Top at : 5.79 m
Bottom at : 48.77 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
13.41	16.76	0.318		17.78
21.34	27.43	0.000		0.00
35.05	42.67	0.000		0.00

Perforated by Saw

Annular Seal Driven & Bentonite
Placed from 6.10 m to 7.92 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 244960
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1995/01/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
THIESSEN, LARRY	P.O. BOX 5325 HIGH RIVER				T1V 1M5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 18.18 L/min
Recommended Pump Intake Depth (From TOC) 42.67 m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 15".

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 244960
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1995/01/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
THIESSEN, LARRY	P.O. BOX 5325 HIGH RIVER				T1V 1M5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Yield Test

Taken From Ground Level
Depth to water level
Measurement in Metric

Test Date	Start Time	Static Water Level
1994/10/19	12:00 AM	4.82 m

Method of Water Removal

Type Air
Removal Rate 25.00 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Yield Test

Taken From Ground Level
Depth to water level
Measurement in Metric

Test Date	Start Time	Static Water Level
1994/10/19	12:00 AM	4.82 m

Method of Water Removal

Type Pump
Removal Rate 18.18 L/min
Depth Withdrawn From 33.53 m

If water removal period was < 2 hours, explain why

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
4.82	0:00	10.62
6.10	1:00	10.01
7.21	2:00	9.53
7.72	3:00	9.09
8.04	4:00	8.71
8.33	5:00	8.31
8.53	6:00	7.98
8.71	7:00	7.72
8.86	8:00	7.52
8.99	9:00	7.37
9.12	10:00	7.24
9.27	12:00	7.05
9.40	14:00	6.88
9.50	16:00	6.73
9.65	20:00	6.50
9.83	25:00	6.31
9.96	30:00	6.15
10.03	35:00	6.01
10.10	40:00	5.87
10.20	50:00	5.68
10.27	60:00	5.49
10.36	75:00	5.33
10.44	90:00	5.21
10.50	105:00	5.11
10.56	120:00	5.03

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 264545
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1995/11/10

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ANL RANCH	716 38 AVE SW, CALGARY			CANADA	T2T 2H7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	19	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling: Rotary

Proposed Well Use: Domestic

Type of Work: New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.83		Sandy Clay
5.18		Clay & Boulders
5.79		Clay & Sand
7.01		Fine Grained Gravel
8.84		Clay & Rocks
9.45		Clay
19.81		Gray Shale
20.12		Gray Sandstone
32.92		Gray Shale
34.14		Gray Sandstone
35.97		Gray Shale
38.10		Gray Sandstone
40.23		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 40.91 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1995/09/21	72.74	2.41
1995/09/21	40.91	2.41

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
40.23 m		1995/09/20	1995/09/21

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	40.23

Surface Casing (if applicable)
Plastic
Size OD : 15.24 cm
Wall Thickness : 0.940 cm
Bottom at : 9.75 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.602 cm
Top at : 6.71 m
Bottom at : 40.23 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
6.71	7.92	0.318		17.78
32.31	38.10	0.000		0.00

Perforated by: Saw

Annular Seal: Bentonite Chips/Tablets
Placed from 3.05 m to 6.10 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Certification No: 1
Company Name: PETER NIEMANS WATER WELL DRILLING
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 264545
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1995/11/10

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ANL RANCH	716 38 AVE SW, CALGARY			CANADA	T2T 2H7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	19	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 85.00 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 40.91 L/min
Recommended Pump Intake Depth (From TOC) 18.29 m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Top of Casing
Depth to water level
Measurement in Metric

Test Date	Start Time	Static Water Level
1995/09/21	1:00 PM	2.41 m

Method of Water Removal

Type Air
Removal Rate 72.74 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

BLEW WITH AIR FOR 2.5 HRS. NO RECOVERY MEASUREMENTS REPORTED.

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Yield Test

Taken From Top of Casing
Depth to water level
Measurement in Metric

Test Date	Start Time	Static Water Level
1995/09/21	4:00 PM	2.41 m

Method of Water Removal

Type Pump
Removal Rate 40.91 L/min
Depth Withdrawn From 29.87 m

If water removal period was < 2 hours, explain why

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
2.43	0:00	2.61
2.50	1:00	2.50
5.52	2:00	2.46
5.53	3:00	2.45
5.54	4:00	
	5:00	2.44
2.55	6:00	
2.56	10:00	2.43
2.57	20:00	
2.58	35:00	
2.59	50:00	
2.60	75:00	
2.61	120:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 285090
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1996/09/30

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HOLBROOK, GARY	716 38 AVE SW, CALGARY				T2T 2H7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling: Rotary

Proposed Well Use: Domestic

Type of Work: New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.35		Brown Sandy Clay & Rocks
3.96		Sand
15.85		Brown Sandy Clay & Rocks
17.07		Soft Shale
57.91		Gray Shale & Sandstone
64.62	Yes	Gray Water Bearing Sandstone
66.45		Gray Shale
68.88		Gray Sandstone
71.63		Gray Shale
76.50		Gray Sandstone
78.94		Gray Shale
81.38		Gray Sandstone
86.26		Gray Shale
88.39		Gray Sandstone
91.14		Gray Shale
99.06	Yes	Gray Water Bearing Sandstone
100.58		Gray Shale
101.80		Gray Sandstone
103.02		Gray Shale
104.55		Gray Sandstone
109.12		Gray Shale
110.03		Gray Sandstone
121.92		Shale & Sandstone Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 9.09 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1996/06/19	13.64	21.03
1996/06/19	9.09	21.03

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
121.92 m		1996/06/13	1996/06/17

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	121.92

Surface Casing (if applicable)
Plastic
Size OD : 15.24 cm
Wall Thickness : 0.940 cm
Bottom at : 17.98 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.602 cm
Top at : 10.67 m
Bottom at : 114.30 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
60.35	65.53	0.318		17.78
96.01	102.11	0.000		0.00

Perforated by: Saw

Annular Seal: Driven & Bentonite
Placed from 15.24 m to 17.98 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Certification No: 1
Company Name: PETER NIEMANS WATER WELL DRILLING
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 285090
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1996/09/30

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HOLBROOK, GARY	716 38 AVE SW, CALGARY				T2T 2H7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 9.09 L/min
Recommended Pump Intake Depth (From TOC) 109.73 m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: .50 M.

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 285090
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1996/09/30

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HOLBROOK, GARY	716 38 AVE SW, CALGARY				T2T 2H7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.597483 Longitude -113.945665
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date 1996/06/19
Start Time 12:00 AM
Static Water Level 21.03 m

Method of Water Removal
Type Air
Removal Rate 13.64 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date 1996/06/19
Start Time 12:00 AM
Static Water Level 21.03 m

Method of Water Removal
Type Pump
Removal Rate 9.09 L/min
Depth Withdrawn From 109.73 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
21.05	0:00	57.15
22.21	1:00	55.34
23.13	2:00	53.90
23.87	3:00	53.07
24.36	4:00	52.48
24.86	5:00	52.00
52.32	6:00	51.53
25.76	7:00	51.10
26.16	8:00	50.70
26.51	9:00	50.33
26.83	10:00	49.97
27.52	12:00	49.27
28.15	14:00	48.61
29.12	16:00	47.98
31.00	20:00	46.75
32.95	25:00	45.27
34.81	30:00	44.06
36.60	35:00	43.12
38.35	40:00	42.26
41.32	50:00	40.55
43.97	60:00	38.89
47.05	75:00	36.21
49.52	90:00	33.94
51.70	105:00	32.10
52.55	120:00	30.55
56.00	150:00	
57.15	165:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 291409
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1999/01/27

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
WESTERN FEEDLOTS LTD	P.O. BOX 5279 HIGH RIVER				T1V 1M4

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	03	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.582999 Longitude -113.934272
How Location Obtained: Map

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.40		Brown Clay
9.14		Brown Sandy Clay & Rocks
10.06		Gray Shale
15.54		Gray Wet Sandstone
25.91		Gray Shale & Sandstone Ledges
30.48		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 40.91 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1998/10/24	39.55	5.70

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m		1998/10/21	1998/10/21

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	30.48

Surface Casing (if applicable)
Plastic
Size OD : 15.24 cm
Wall Thickness : 0.940 cm
Bottom at : 9.75 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.602 cm
Top at : 6.10 m
Bottom at : 30.48 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
10.36	17.37	0.318		17.78

Perforated by: Saw

Annular Seal Bentonite Chips/Tablets
Placed from 1.52 m to 9.75 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

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GIC Well ID 291409
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1999/01/27

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
WESTERN FEEDLOTS LTD	P.O. BOX 5279 HIGH RIVER				T1V 1M4

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	03	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.582999 Longitude -113.934272
How Location Obtained: Map

Elevation m
How Elevation Obtained: Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 40.91 L/min
Recommended Pump Intake Depth (From TOC) 27.43 m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

DRILER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 0.5 M.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1998/10/24	12:00 AM	5.70 m

Method of Water Removal

Type Pump
Removal Rate 39.55 L/min
Depth Withdrawn From 27.43 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
5.70	0:00	7.84
6.02	1:00	7.30
6.13	2:00	7.27
6.20	4:00	7.23
6.26	6:00	7.20
6.30	8:00	7.16
6.33	10:00	7.13
6.40	14:00	7.10
6.48	20:00	7.07
6.60	30:00	7.03
6.75	40:00	6.99
7.07	60:00	6.93
7.46	90:00	6.84
7.84	120:00	6.76

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PETER NIEMANS WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 1555287
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MARKERT, GAVIN	P.O. BOX 5301	HIGH RIVER	AB	CA	TIV IM5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.590200 Longitude -113.946000
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling: Rotary

Proposed Well Use: Domestic

Type of Work: New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.61		Topsoil
2.44		Clay & Rocks
3.05		Sand
7.01		Fine Grained Sand & Gravel
25.60		Gray Shale
29.87		Gray Shale & Sandstone Ledges
38.10		Gray Sandstone
60.96		Gray Shale & Sandstone Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 45.46 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2002/11/21	84.10	3.05

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
15.24 m		2002/11/21	2002/11/21

Borehole

Diameter (cm)	From (m)	To (m)
15.24	0.00	15.24

Surface Casing (if applicable): Steel
Size OD : 16.83 cm
Wall Thickness : 0.478 cm
Bottom at : 5.49 m

Well Casing/Liner: Plastic
Size OD : 12.70 cm
Wall Thickness : 0.630 cm
Top at : 4.57 m
Bottom at : 15.24 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
5.79	13.41	0.318		15.24

Perforated by: Saw

Annular Seal: Driven & Bentonite
Placed from 0.00 m to m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type Unknown
Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: CHAD NIEMANS

Certification No: 46340A

Company Name: NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 1555287
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MARKERT, GAVIN	P.O. BOX 5301	HIGH RIVER	AB	CA	TIV IM5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	10	019	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.590200 Longitude -113.946000
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 60.96 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 45.46 L/min
Recommended Pump Intake Depth (From TOC) 10.67 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
BOREHOLE DIAMETER 6" & 5.25"

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2002/11/21	12:00 AM	3.05 m

Method of Water Removal

Type Pump
Removal Rate 84.10 L/min
Depth Withdrawn From 13.72 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
3.05	0:00	
3.11	1:00	3.10
3.11	2:00	3.09
3.11	3:00	3.08
3.11	4:00	3.07
3.12	5:00	3.05
3.13	6:00	
3.13	7:00	
3.13	8:00	
3.13	9:00	
3.13	10:00	
3.13	12:00	
3.13	14:00	
3.13	16:00	
3.13	20:00	
3.13	25:00	
3.13	30:00	
3.13	35:00	
3.13	40:00	
3.13	50:00	
3.13	60:00	
3.13	75:00	
3.13	90:00	
3.13	105:00	
3.13	120:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner

Date approval holder signed

Appendix N3

Laboratory Test Results

On DVD in Appendix R

Maxxam

Success Through Science®

Your Project #: AB GOVERNMENT-SAFM-60309815.04
Site Location: HIGH RIVER
Your C.O.C. #: A004266, A004267

Attention:RICHARD DAGG

AECOM
200 - 6807 RAILWAY STREET SE
CALGARY, AB
CANADA T2H2V6

Report Date: 2014/02/23
Report #: R1521089
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B411666
Received: 2014/02/13, 15:30

Sample Matrix: Soil
Samples Received: 15

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (Soluble)	15	2014/02/20	2014/02/21	AB SOP-00020	SM 4500 Cl-G
Resistivity	4	N/A	2014/02/20		
Resistivity	11	N/A	2014/02/21		
Conductivity @25C (Soluble)	4	2014/02/20	2014/02/20	AB SOP-00004	SSMA 15.3
Conductivity @25C (Soluble)	11	2014/02/21	2014/02/21	AB SOP-00004	SSMA 15.3
pH @25C (Soluble)	4	2014/02/20	2014/02/20	AB SOP-00006	SSMA 16.2
pH @25C (Soluble)	11	2014/02/20	2014/02/21	AB SOP-00006	SSMA 16.2
Ca,Mg,Na,K,SO4 (Soluble)	4	2014/02/20	2014/02/21	AB SOP-00042	EPA 200.7
Ca,Mg,Na,K,SO4 (Soluble)	11	2014/02/21	2014/02/21	AB SOP-00042	EPA 200.7
Soluble Paste	4	2014/02/20	2014/02/20	AB SOP-00033	SSMA 15.2
Soluble Paste	11	2014/02/20	2014/02/21	AB SOP-00033	SSMA 15.2

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Wendy Sears, Project manager
Email: WSears@maxxam.ca
Phone# (403) 291-3077
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Calgary: 2021 - 41st Avenue N.E. T2E 6P2 Telephone (403) 291-3077 Fax (403) 291-9468

Maxxam Job #: B411666
Report Date: 2014/02/23

AECOM
Client Project #: AB GOVERNMENT-SAFM-60309815.04
Site Location: HIGH RIVER

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		IR9655	IR9656	IR9657	IR9658		
Sampling Date		2014/02/13	2014/02/13	2014/02/13	2014/02/13		
COC Number		A004266	A004266	A004266	A004266		
	Units	SAFM TH14-01 C1 @ 15.2M	SAFM TH14-01 C3 @ 21.2M	SAFM TH14-02 #3 @ 1.5M	SAFM TH14-02 #11 @ 7.6M	RDL	QC Batch
Calculated Parameters							
Resistivity @ 25° C	ohm-m	34.2	16.9	8.40	12.1	0.05	7383151
Soluble Parameters							
Soluble Chloride (Cl)	mg/L	13	16	28	33	5.0	7390645
Soluble Conductivity	dS/m	0.29	0.59	1.2	0.83	0.020	7390059
Soluble pH	pH	7.98	8.37	7.61	7.79	N/A	7389717
Saturation %	%	41	30	31	27	N/A	7389156
Soluble Sulphate (SO4)	mg/L	64	54	160	120	5.0	7390164

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam ID		IR9659	IR9659	IR9660	IR9661	IR9662		
Sampling Date		2014/02/13	2014/02/13	2014/02/13	2014/02/13	2014/02/13		
COC Number		A004266	A004266	A004266	A004266	A004266		
	Units	SAFM TH14-02 #19 @ 15.4M	SAFM TH14-02 #19 @ 15.4M Lab-Dup	SAFM TH14-07 #5 @ 3.85M	SAFM TH14-07 C1 @ 9.2M	SAFM TH14-02 C2 @ 13.4M	RDL	QC Batch
Calculated Parameters								
Resistivity @ 25° C	ohm-m	11.5	N/A	10.4	12.7	14.9	0.05	7383151
Soluble Parameters								
Soluble Chloride (Cl)	mg/L	32	33	20	9.5	8.7	5.0	7390195
Soluble Conductivity	dS/m	0.87	0.88	0.96	0.79	0.67	0.020	7389221
Soluble pH	pH	7.99	8.04	7.86	8.14	8.47	N/A	7389158
Saturation %	%	25	25	43	47	51	N/A	7388980
Soluble Sulphate (SO4)	mg/L	150	140	170	140	150	5.0	7389668

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

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Maxxam Job #: B411666
Report Date: 2014/02/23

AECOM
Client Project #: AB GOVERNMENT-SAFM-60309815.04
Site Location: HIGH RIVER

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		IR9746	IR9746	IR9747	IR9748	IR9749		
Sampling Date		2014/02/13	2014/02/13	2014/02/13	2014/02/13	2014/02/13		
COC Number		A004267	A004267	A004267	A004267	A004267		
	Units	SAFM TH14-25 #3 @ 1.5M	SAFM TH14-25 #3 @ 1.5M Lab-Dup	SAFM TH14-25 #6 @ 3.85M	SAFM TH14-25 #10 @ 6.85M	SAFM TH14-25 #24 @ 17.4M	RDL	QC Batch
Calculated Parameters								
Resistivity @ 25° C	ohm-m	4.10	N/A	10.6	6.70	6.50	0.05	7383151
Soluble Parameters								
Soluble Chloride (Cl)	mg/L	50	45	62	14	30	5.0	7390645
Soluble Conductivity	dS/m	2.5	2.3	0.94	1.5	1.5	0.020	7390059
Soluble pH	pH	7.70	7.73	7.92	7.66	8.13	N/A	7389717
Saturation %	%	51	51	57	40	33	N/A	7389156
Soluble Sulphate (SO4)	mg/L	880	790	140	500	430	5.0	7390164

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam ID		IR9750	IR9751	IR9752		
Sampling Date		2014/02/13	2014/02/13	2014/02/13		
COC Number		A004267	A004267	A004267		
	Units	SAFM TH14-25 C1@ 18.3M	SAFM TH14-24 #8 @ 5.35M	SAFM TH14-24 #16 @ 11.35M	RDL	QC Batch
Calculated Parameters						
Resistivity @ 25° C	ohm-m	4.40	9.10	10.9	0.05	7383151
Soluble Parameters						
Soluble Chloride (Cl)	mg/L	31	54	18	5.0	7390645
Soluble Conductivity	dS/m	2.2	1.1	0.92	0.020	7390059
Soluble pH	pH	8.12	8.04	8.08	N/A	7389717
Saturation %	%	38	29	26	N/A	7389156
Soluble Sulphate (SO4)	mg/L	860	540	350	5.0	7390164

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B411666
Report Date: 2014/02/23

AECOM
Client Project #: AB GOVERNMENT-SAFM-60309815.04
Site Location: HIGH RIVER

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	18.3°C

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics Calgary: 2021 - 41st Avenue N.E. T2E 6P2 Telephone (403) 291-3077 Fax (403) 291-9468

Maxxam Job #: B411666
Report Date: 2014/02/23

AECOM
Client Project #: AB GOVERNMENT-SAFM-60309815.04
Site Location: HIGH RIVER

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7388980	LZ0	QC Standard	Saturation %	2014/02/20		100	%	75 - 125
7388980	LZ0	RPD [IR9659-01]	Saturation %	2014/02/20	1.1		%	12
7389156	IK0	QC Standard	Saturation %	2014/02/21		99	%	75 - 125
7389156	IK0	RPD [IR9746-01]	Saturation %	2014/02/21	0.8		%	12
7389158	BL7	QC Standard	Soluble pH	2014/02/20		100	%	98 - 102
7389158	BL7	Spiked Blank	Soluble pH	2014/02/20		100	%	97 - 103
7389158	BL7	RPD [IR9659-01]	Soluble pH	2014/02/20	0.6		%	5
7389221	BL7	QC Standard	Soluble Conductivity	2014/02/20		103	%	75 - 125
7389221	BL7	Spiked Blank	Soluble Conductivity	2014/02/20		99	%	90 - 110
7389221	BL7	Method Blank	Soluble Conductivity	2014/02/20	<0.020		dS/m	
7389221	BL7	RPD [IR9659-01]	Soluble Conductivity	2014/02/20	1.1		%	35
7389668	STI	QC Standard	Soluble Sulphate (SO4)	2014/02/21		106	%	75 - 125
7389668	STI	Method Blank	Soluble Sulphate (SO4)	2014/02/21	<5.0		mg/L	
7389668	STI	RPD [IR9659-01]	Soluble Sulphate (SO4)	2014/02/21	8.8		%	35
7389717	MN0	QC Standard	Soluble pH	2014/02/21		99	%	98 - 102
7389717	MN0	Spiked Blank	Soluble pH	2014/02/21		99	%	97 - 103
7389717	MN0	RPD [IR9746-01]	Soluble pH	2014/02/21	0.4		%	5
7390059	BL7	QC Standard	Soluble Conductivity	2014/02/21		103	%	75 - 125
7390059	BL7	Spiked Blank	Soluble Conductivity	2014/02/21		102	%	90 - 110
7390059	BL7	Method Blank	Soluble Conductivity	2014/02/21	<0.020		dS/m	
7390059	BL7	RPD [IR9746-01]	Soluble Conductivity	2014/02/21	7.0		%	35
7390164	JBA	QC Standard	Soluble Sulphate (SO4)	2014/02/21		106	%	75 - 125
7390164	JBA	Method Blank	Soluble Sulphate (SO4)	2014/02/21	<5.0		mg/L	
7390164	JBA	RPD [IR9746-01]	Soluble Sulphate (SO4)	2014/02/21	10.8		%	35
7390195	ZI	Matrix Spike [IR9659-01]	Soluble Chloride (Cl)	2014/02/21		99	%	75 - 125
7390195	ZI	QC Standard	Soluble Chloride (Cl)	2014/02/21		86	%	75 - 125
7390195	ZI	Spiked Blank	Soluble Chloride (Cl)	2014/02/21		97	%	75 - 125
7390195	ZI	Method Blank	Soluble Chloride (Cl)	2014/02/21	<5.0		mg/L	
7390195	ZI	RPD [IR9659-01]	Soluble Chloride (Cl)	2014/02/21	2.4		%	35
7390645	ZI	Matrix Spike [IR9746-01]	Soluble Chloride (Cl)	2014/02/21		105	%	75 - 125
7390645	ZI	QC Standard	Soluble Chloride (Cl)	2014/02/21		102	%	75 - 125
7390645	ZI	Spiked Blank	Soluble Chloride (Cl)	2014/02/21		102	%	75 - 125
7390645	ZI	Method Blank	Soluble Chloride (Cl)	2014/02/21	<5.0		mg/L	
7390645	ZI	RPD [IR9746-01]	Soluble Chloride (Cl)	2014/02/21	8.9		%	35

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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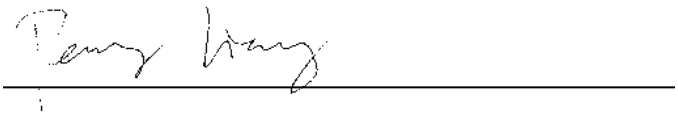
Maxxam Job #: B411666
Report Date: 2014/02/23

AECOM
Client Project #: AB GOVERNMENT-SAFM-60309815.04
Site Location: HIGH RIVER

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Peng Liang, Analyst II

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WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 10, 2014					TECHNICAN :	CK/GU	
HOLE No.	14-03	14-16	14-16	14-20	14-15	14-15	14-19	14-19
DEPTH	14.3m	8.0m	17.5m	8.2m	8.0m	23.0m	8.2m	14.3m
SAMPLE No.	C3	C1	C4	C1	C1	C6	C1	C3
TARE No.								
WT. SAMPLE WET + TARE	317.4	452.7	524.6	494.0	584.0	597.2	519.0	788.2
WT. SAMPLE DRY + TARE	301.8	405.2	463.2	451.6	504.5	528.5	474.3	745.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.4%**	**12.1%**	**13.7%**	**9.7%**	**16.2%**	**13.3%**	**9.7%**	**5.8%**
HOLE No.	14-21	14-08	14-07	14-01	14-01	14-25		
DEPTH	13.0m	10.2m	9.2m	15.2m	21.2m	18.3m		
SAMPLE No.	C2	C2	C1	C1	C3	C1		
TARE No.								
WT. SAMPLE WET + TARE	676.1	439.2	540.9	716.7	678.3	670.4		
WT. SAMPLE DRY + TARE	625.0	388.3	475.2	673.6	648.3	607.6		
WT. TARE	13.5	13.0	13.3	13.3	13.3	13.3		
WATER CONTENT W%	**8.4%**	**13.6%**	**14.2%**	**6.5%**	**4.7%**	**10.6%**		
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 10, 2014					TECHNICAN :	CK/GU	
HOLE No.	14-03	14-16	14-16	14-20	14-15	14-15	14-19	14-19
DEPTH	14.3m	8.0m	17.5m	8.2m	8.0m	23.0m	8.2m	14.3m
SAMPLE No.	C3	C1	C4	C1	C1	C6	C1	C3
TARE No.								
WT. SAMPLE WET + TARE	317.4	452.7	524.6	494.0	584.0	597.2	519.0	788.2
WT. SAMPLE DRY + TARE	301.8	405.2	463.2	451.6	504.5	528.5	474.3	745.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.4%**	**12.1%**	**13.7%**	**9.7%**	**16.2%**	**13.3%**	**9.7%**	**5.8%**
HOLE No.	14-21							
DEPTH	13.0m							
SAMPLE No.	C2							
TARE No.								
WT. SAMPLE WET + TARE	676.1							
WT. SAMPLE DRY + TARE	625.0							
WT. TARE	13.5							
WATER CONTENT W%	**8.4%**							
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 10, 2014					TECHNICAN :	CK/GU	
HOLE No.	14-03	14-16	14-16	14-20	14-15	14-15	14-19	14-19
DEPTH	14.3m	8.0m	17.5m	8.2m	8.0m	23.0m	8.2m	14.3m
SAMPLE No.	C3	C1	C4	C1	C1	C6	C1	C3
TARE No.								
WT. SAMPLE WET + TARE	317.4	452.7	524.6	494.0	584.0	597.2	519.0	788.2
WT. SAMPLE DRY + TARE	301.8	405.2	463.2	451.6	504.5	528.5	474.3	745.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.4%**	**12.1%**	**13.7%**	**9.7%**	**16.2%**	**13.3%**	**9.7%**	**5.8%**
HOLE No.	14-21	14-08	14-07	14-01	14-01	14-25		
DEPTH	13.0m	10.2m	9.2m	15.2m	21.2m	18.3m		
SAMPLE No.	C2	C2	C1	C1	C3	C1		
TARE No.								
WT. SAMPLE WET + TARE	676.1	439.2	540.9	716.7	678.3	670.4		
WT. SAMPLE DRY + TARE	625.0	388.3	475.2	673.6	648.3	607.6		
WT. TARE	13.5	13.0	13.3	13.3	13.3	13.3		
WATER CONTENT W%	**8.4%**	**13.6%**	**14.2%**	**6.5%**	**4.7%**	**10.6%**		
HOLE No.	14-26		14-13		14-27		14-10	
DEPTH	7.5m	8.7m	6.8m	8.3m	6.6m	8.7m	7.2m	8.8m
SAMPLE No.	C1	C1	C1	C1	C1	C1	C1	C1
TARE No.								
WT. SAMPLE WET + TARE	596.9	404.5	380.6	417.2	651.1	368.5	509.1	566.0
WT. SAMPLE DRY + TARE	514.0	362.7	353.7	389.7	575.6	321.1	477.8	535.3
WT. TARE	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
WATER CONTENT W%	**16.6%**	**12.0%**	**8.0%**	**7.4%**	**13.5%**	**15.5%**	**6.8%**	**5.9%**
HOLE No.	TH14-11							
DEPTH	9.3m	11.4m						
SAMPLE No.	C2	C2						
TARE No.								
WT. SAMPLE WET + TARE	511.0	403.0						
WT. SAMPLE DRY + TARE	475.1	362.2						
WT. TARE	15.8	15.8						
WATER CONTENT W%	**7.8%**	**11.8%**						

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 26, 2014					TECHNICAN :	CK/GU	
HOLE No.	14-10			14-13			TH-26	
DEPTH	6.2m	6.6	7.8m	6.5m	7.7m	9m	7.8m	8m
SAMPLE No.	R1	R1	R1	R1	R1	R1	R1	R1
TARE No.								
WT. SAMPLE WET + TARE	507.1	474.7	350.0	386.3	413.4	642.8	360.7	344.6
WT. SAMPLE DRY + TARE	454.7	407.9	325.2	355.4	351.4	611.3	335.0	320.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.9%**	**16.9%**	**8.0%**	**9.0%**	**18.3%**	**5.3%**	**8.0%**	**8.0%**
HOLE No.	TH14-26	14-27			14-11			
DEPTH	9m	7.5m	8.4m	9m	9.1m	9.6m	9.8	
SAMPLE No.	R1	R1	R1	R1	R2	R2	R2	
TARE No.								
WT. SAMPLE WET + TARE	481.3	361.7	311.9	462.1	468.7	518.7	686.0	
WT. SAMPLE DRY + TARE	433.2	319.1	270.0	414.3	457.9	477.8	631.7	
WT. TARE	13.5	13.0	13.3	13.3	13.3	13.3	13.3	
WATER CONTENT W%	**11.5%**	**13.9%**	**16.3%**	**11.9%**	**2.4%**	**8.8%**	**8.8%**	
HOLE No.	TH14-01				TH14-03			
DEPTH	18.6m	21.2m	22.8m	23.0m	6.2m	8.8m	9.6m	12.0m
SAMPLE No.	R2	R2	R3	R3	R1	R1	R2	R2
TARE No.								
WT. SAMPLE WET + TARE	517.6	307.9	465.0	573.6	290.2	529.6	539.1	726.8
WT. SAMPLE DRY + TARE	475.5	283.2	420.4	523.5	252.9	488.6	474.2	679.7
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**9.1%**	**9.2%**	**11.0%**	**9.8%**	**15.6%**	**8.6%**	**14.1%**	**7.1%**
HOLE No.	TH14-03	TH14-04					TH14-05	
DEPTH	15.0m	8.2m	8.9m	9.6m	11.8m	15.0m	12.3m	14.9m
SAMPLE No.	R3	R1	R1	R2	R2	R3	R1	R1
TARE No.								
WT. SAMPLE WET + TARE	1106.6	403.8	666.1	570.6	451.8	357.8	627.4	423.0
WT. SAMPLE DRY + TARE	1046.8	347.8	612.8	490.0	427.4	336.1	598.5	397.5
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**5.8%**	**16.7%**	**8.9%**	**16.9%**	**5.9%**	**6.7%**	**4.9%**	**6.6%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	March 3, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-05			TH14-08				
DEPTH	15.2m	16.6m	17.8m	6.1m	8.1m	9.2m	10.1m	14.3m
SAMPLE No.	R2	R2	R2	R1	R1	R2	R2	R3
TARE No.								
WT. SAMPLE WET + TARE	741.5	272.8	1054.3	452.0	328.0	664.5	903.4	166.2
WT. SAMPLE DRY + TARE	707.6	239.9	1002.5	421.7	306.7	620.3	798.8	147.6
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**4.9%**	**14.5%**	**5.2%**	**7.4%**	**7.3%**	**7.3%**	**13.3%**	**13.9%**
HOLE No.	TH14-15					TH14-16		
DEPTH	9.4m	10.7m	12.2m	12.9m	14.3m	7.1m	8.0m	12.4m
SAMPLE No.	R2	R2	R2	R3	R3	R1	R1	R3
TARE No.								
WT. SAMPLE WET + TARE	599.4	516.7	831.7	437.6	904.1	481.5	795.3	581.4
WT. SAMPLE DRY + TARE	552.2	470.9	812.1	386.3	824.3	453.7	706.1	542.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**8.8%**	**10.0%**	**2.5%**	**13.8%**	**9.8%**	**6.3%**	**12.9%**	**7.5%**
HOLE No.	TH14-16		TH14-17					TH14-19
DEPTH	13.6m	15.2m	6.3m	8.6m	12.2m	13.6m	15.3m	6.3m
SAMPLE No.	R3	R3	R1	R1	R3	R3	R4	R1
TARE No.								
WT. SAMPLE WET + TARE	657.2	696.1	669.4	739.0	753.3	637.1	470.7	517.0
WT. SAMPLE DRY + TARE	592.4	622.6	605.8	696.3	706.0	564.5	451.0	455.0
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**11.2%**	**12.1%**	**10.7%**	**6.3%**	**6.8%**	**13.2%**	**4.5%**	**14.0%**
HOLE No.	TH14-19				TH14-20			
DEPTH	10.1m	11.1m	12.4m	14.7m	7.1m	9.4m	11.9m	12.6m
SAMPLE No.	R2	R2	R3	R3	R1	R2	R2	R3
TARE No.								
WT. SAMPLE WET + TARE	858.7	226.9	718.8	792.5	883.0	399.4	469.6	1021.5
WT. SAMPLE DRY + TARE	794.2	214.5	628.7	742.1	864.7	355.2	419.4	982.4
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**8.3%**	**6.2%**	**14.6%**	**6.9%**	**2.1%**	**12.9%**	**12.4%**	**4.0%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	March 3, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-20	TH14-21					TH14-06	
DEPTH	14.8m	9.6m	12.4m	13.4m	13.6m	15.0m	6.8m	7.7m
SAMPLE No.	R3	R1&R2	R1&R2	R1&R2	R3	R3	R1	R1
TARE No.								
WT. SAMPLE WET + TARE	730.1	710.2	527.0	895.6	449.1	609.7	593.7	477.1
WT. SAMPLE DRY + TARE	655.1	701.7	495.0	834.4	402.1	587.0	525.2	435.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.7%**	**1.2%**	**6.6%**	**7.5%**	**12.1%**	**4.0%**	**13.4%**	**9.9%**
HOLE No.	TH14-06			TH14-07				
DEPTH	8.5m	9.5m	12.0m	9.3m	10.1m	12.2m	13.2m	15.0m
SAMPLE No.	R1	R2	R2	R1	R1	R1	R2	R2
TARE No.								
WT. SAMPLE WET + TARE	981.9	517.8	335.3	465.2	599.4	393.4	427.5	427.5
WT. SAMPLE DRY + TARE	928.6	476.2	294.4	414.2	560.0	350.8	383.3	388.8
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.8%**	**9.0%**	**14.6%**	**12.7%**	**7.2%**	**12.6%**	**12.0%**	**10.3%**
HOLE No.	TH14-12					TH14-14		
DEPTH	8.5m	6.8m	10.4m	11.1m	14.0m	7.3m	7.8m	9.0m
SAMPLE No.	R1	R1	R2	R2	R3	R1	R1	R1
TARE No.								
WT. SAMPLE WET + TARE	496.0	475.0	349.9	554.1	579.3	514.9	418.6	729.3
WT. SAMPLE DRY + TARE	428.0	443.6	331.8	501.8	542.6	468.1	357.3	691.4
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**16.4%**	**7.3%**	**5.7%**	**10.7%**	**6.9%**	**10.3%**	**17.8%**	**5.6%**
HOLE No.	TH14-14		TH14-18					TH14-25
DEPTH	10.0m	11.5m	9.4m	12.3m	14.7m	16.1m	17.0m	18.4m
SAMPLE No.	R2	R2	R1	R2	R2	R3	R3	R1
TARE No.								
WT. SAMPLE WET + TARE	634.0	467.9	562.6	426.4	458.0	572.5	641.3	591.9
WT. SAMPLE DRY + TARE	560.3	432.8	489.6	395.8	410.1	543.9	596.6	547.4
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**13.5%**	**8.4%**	**15.3%**	**8.0%**	**12.1%**	**5.4%**	**7.7%**	**8.3%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	March 3, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-25							
DEPTH	21.0m	22.0m	23.5m	25.6m				
SAMPLE No.	R1	R2	R2	R3				
TARE No.								
WT. SAMPLE WET + TARE	482.8	479.6	705.5	490.8				
WT. SAMPLE DRY + TARE	445.3	448.4	661.5	418.7				
WT. TARE	13.5	13.5	13.5	13.5				
WATER CONTENT W%	**8.7%**	**7.2%**	**6.8%**	**17.8%**				
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 26, 2014					TECHNICAN :	CK/GU	
HOLE No.	14-10			14-13			TH-26	
DEPTH	6.2m	6.6	7.8m	6.5m	7.7m	9m	7.8m	8m
SAMPLE No.	R1	R1	R1	R1	R1	R1	R1	R1
TARE No.								
WT. SAMPLE WET + TARE	507.1	474.7	350.0	386.3	413.4	642.8	360.7	344.6
WT. SAMPLE DRY + TARE	454.7	407.9	325.2	355.4	351.4	611.3	335.0	320.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.9%**	**16.9%**	**8.0%**	**9.0%**	**18.3%**	**5.3%**	**8.0%**	**8.0%**
HOLE No.	TH14-26	14-27			14-11			
DEPTH	9m	7.5m	8.4m	9m	9.1m	9.6m	9.8	
SAMPLE No.	R1	R1	R1	R1	R2	R2	R2	
TARE No.								
WT. SAMPLE WET + TARE	481.3	361.7	311.9	462.1	468.7	518.7	686.0	
WT. SAMPLE DRY + TARE	433.2	319.1	270.0	414.3	457.9	477.8	631.7	
WT. TARE	13.5	13.0	13.3	13.3	13.3	13.3	13.3	
WATER CONTENT W%	**11.5%**	**13.9%**	**16.3%**	**11.9%**	**2.4%**	**8.8%**	**8.8%**	
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-02							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	633.4	584.5	389.7	580.2	512.9	607.7	442.3	553.5
WT. SAMPLE DRY + TARE	507.6	543.6	370.8	544.2	487.2	579.2	424.2	524.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**25.5%**	**7.7%**	**5.3%**	**6.8%**	**5.4%**	**5.0%**	**4.4%**	**5.7%**
HOLE No.	TH14-02							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	606.1	768.1	794.0	749.6	784.0	735.1	658.6	732.9
WT. SAMPLE DRY + TARE	573.2	716.3	739.7	707.5	732.5	691.6	606.6	673.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.9%**	**7.4%**	**7.5%**	**6.1%**	**7.2%**	**6.4%**	**8.8%**	**9.0%**
HOLE No.	TH14-02					TH14-03		
DEPTH								
SAMPLE No.	17	18	19	20	21	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	725.5	656.5	494.5	626.8	798.6	389.3	470.7	408.8
WT. SAMPLE DRY + TARE	676.4	515.4	469.1	583.2	731.1	292.0	372.4	355.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**7.4%**	**28.1%**	**5.6%**	**7.7%**	**9.4%**	**34.9%**	**27.4%**	**15.6%**
HOLE No.	TH14-03						TH14-04	
DEPTH								
SAMPLE No.	4	5	6	7	8	9	1	2
TARE No.								
WT. SAMPLE WET + TARE	645.4	757.2	578.0	192.8	794.1	421.8	517.9	469.3
WT. SAMPLE DRY + TARE	581.6	695.3	531.6	175.6	702.9	366.5	432.8	382.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.2%**	**9.1%**	**9.0%**	**10.6%**	**13.2%**	**15.7%**	**20.3%**	**23.4%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH04-04							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	10
TARE No.								
WT. SAMPLE WET + TARE	370.3	576.5	563.2	454.9	197.7	481.1	228.6	550.2
WT. SAMPLE DRY + TARE	358.4	514.7	510.2	396.7	174.7	428.2	199.7	486.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**3.5%**	**12.3%**	**10.7%**	**15.2%**	**14.3%**	**12.8%**	**15.5%**	**13.5%**
HOLE No.	TH14-04	TH14-05						
DEPTH								
SAMPLE No.	11	1	2	3	4	5	6	7
TARE No.								
WT. SAMPLE WET + TARE	310.0	538.6	522.7	314.8	627.0	380.5	615.8	504.0
WT. SAMPLE DRY + TARE	268.1	490.3	475.6	282.5	523.8	323.6	533.0	433.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**16.5%**	**10.1%**	**10.2%**	**12.0%**	**20.2%**	**18.3%**	**15.9%**	**16.9%**
HOLE No.	TH14-05							
DEPTH								
SAMPLE No.	8	9	10	11	12	13	14	15
TARE No.								
WT. SAMPLE WET + TARE	712.7	461.5	509.8	580.8	526.2	660.6	546.7	558.0
WT. SAMPLE DRY + TARE	612.5	383.5	432.7	498.7	432.6	589.1	407.8	469.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**16.7%**	**21.1%**	**18.4%**	**16.9%**	**22.3%**	**12.4%**	**35.2%**	**19.4%**
HOLE No.	TH14-05		TH14-06					
DEPTH								
SAMPLE No.	16	17	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	586.9	274.4	639.4	538.9	595.2	657.6	591.5	585.9
WT. SAMPLE DRY + TARE	524.0	241.2	548.3	472.3	508.3	565.4	498.6	507.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.3%**	**14.6%**	**17.0%**	**14.5%**	**17.6%**	**16.7%**	**19.2%**	**15.9%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-06					TH14-07		
DEPTH								
SAMPLE No.	7	8	9	10	11	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	534.6	632.6	507.9	537.6	78.1	680.9	647.9	257.4
WT. SAMPLE DRY + TARE	472.8	560.6	444.7	487.4	73.9	506.0	465.3	236.1
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.5%**	**13.2%**	**14.7%**	**10.6%**	**7.0%**	**35.5%**	**40.4%**	**9.6%**
HOLE No.	TH14-07							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	741.7	656.7	421.0	804.1	780.8	417.0	580.3	580.7
WT. SAMPLE DRY + TARE	645.8	588.0	362.1	711.3	692.1	383.2	528.3	477.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.2%**	**12.0%**	**16.9%**	**13.3%**	**13.1%**	**9.1%**	**10.1%**	**22.4%**
HOLE No.	TH14-07	TH14-08						
DEPTH								
SAMPLE No.	12	1	2	3	4	5	6	7
TARE No.								
WT. SAMPLE WET + TARE	589.1	607.7	599.9	480.0	659.3	523.0	726.1	549.1
WT. SAMPLE DRY + TARE	487.5	498.8	503.0	453.7	614.4	477.7	643.5	497.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**21.4%**	**22.4%**	**19.8%**	**6.0%**	**7.5%**	**9.8%**	**13.1%**	**10.7%**
HOLE No.	TH14-08		TH14-14					
DEPTH								
SAMPLE No.	8	9	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	401.9	615.3	637.7	569.8	630.7	612.6	591.6	605.1
WT. SAMPLE DRY + TARE	366.2	572.9	545.6	469.1	545.5	522.0	515.2	530.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**10.1%**	**7.6%**	**17.3%**	**22.1%**	**16.0%**	**17.8%**	**15.2%**	**14.3%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-14			TH14-15				
DEPTH								
SAMPLE No.	7	9	10	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	447.2	492.8	553.0	489.4	622.5	269.3	458.9	505.9
WT. SAMPLE DRY + TARE	390.4	412.0	463.6	425.0	589.4	254.0	393.9	447.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.1%**	**20.3%**	**19.9%**	**15.7%**	**5.7%**	**6.4%**	**17.1%**	**13.5%**
HOLE No.	TH14-15				TH14-16			
DEPTH								
SAMPLE No.	6	7	8	9	1	2	3	4
TARE No.								
WT. SAMPLE WET + TARE	521.1	202.5	507.0	189.1	721.0	576.6	1618.9	700.7
WT. SAMPLE DRY + TARE	455.0	181.1	458.8	164.4	692.0	525.5	1519.4	614.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	252.3	13.5
WATER CONTENT W%	**15.0%**	**12.8%**	**10.8%**	**16.4%**	**4.3%**	**10.0%**	**7.9%**	**14.3%**
HOLE No.	TH14-16					TH14-17		
DEPTH								
SAMPLE No.	5	6	7	8	9	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	539.4	517.1	572.0	600.5	135.2	670.0	678.7	548.4
WT. SAMPLE DRY + TARE	477.1	457.1	505.0	559.7	127.7	618.6	625.1	477.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.4%**	**13.5%**	**13.6%**	**7.5%**	**6.6%**	**8.5%**	**8.8%**	**15.2%**
HOLE No.	TH14-17						TH14-18	
DEPTH								
SAMPLE No.	4	5	6	7	8	9	1	2
TARE No.								
WT. SAMPLE WET + TARE	616.8	640.7	534.6	447.1	701.1	205.4	642.9	641.0
WT. SAMPLE DRY + TARE	520.5	560.6	454.1	398.3	581.5	189.0	618.3	610.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**19.0%**	**14.6%**	**18.3%**	**12.7%**	**21.1%**	**9.3%**	**4.1%**	**5.1%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-18							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	10
TARE No.								
WT. SAMPLE WET + TARE	403.3	572.2	364.9	588.5	585.7	476.3	595.5	582.2
WT. SAMPLE DRY + TARE	355.1	542.6	326.4	546.5	518.0	427.3	521.5	506.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**14.1%**	**5.6%**	**12.3%**	**7.9%**	**13.4%**	**11.8%**	**14.6%**	**15.5%**
HOLE No.	TH14-18			TH14-19				
DEPTH								
SAMPLE No.	11	12	13	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	571.5	628.9	427.4	388.1	673.1	502.5	663.2	515.6
WT. SAMPLE DRY + TARE	500.1	560.9	367.2	288.7	543.8	414.1	537.6	445.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**14.7%**	**12.4%**	**17.0%**	**36.1%**	**24.4%**	**22.1%**	**24.0%**	**16.3%**
HOLE No.	TH14-19				TH14-20			
DEPTH								
SAMPLE No.	6	7	8	9	1	2	3	4
TARE No.								
WT. SAMPLE WET + TARE	549.7	475.2	539.3	319.1	421.9	435.0	382.4	544.3
WT. SAMPLE DRY + TARE	477.9	420.9	474.7	275.9	333.2	336.9	308.4	446.1
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.5%**	**13.3%**	**14.0%**	**16.5%**	**27.7%**	**30.3%**	**25.1%**	**22.7%**
HOLE No.	TH14-20					TH14-21		
DEPTH								
SAMPLE No.	5	6	7	8	9	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	538.7	625.1	339.0	411.7	280.0	549.0	377.1	376.7
WT. SAMPLE DRY + TARE	491.7	531.1	303.1	359.9	248.1	447.1	303.7	296.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**9.8%**	**18.2%**	**12.4%**	**15.0%**	**13.6%**	**23.5%**	**25.3%**	**28.6%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-21							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	438.1	561.6	660.7	464.1	523.6	400.3	371.5	285.0
WT. SAMPLE DRY + TARE	342.3	459.3	551.9	387.5	461.0	335.9	314.2	249.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**29.1%**	**22.9%**	**20.2%**	**20.5%**	**14.0%**	**20.0%**	**19.1%**	**14.9%**
HOLE No.	TH14-21							
DEPTH								
SAMPLE No.	12	13						
TARE No.								
WT. SAMPLE WET + TARE	443.6	268.1						
WT. SAMPLE DRY + TARE	369.9	235.6						
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**20.7%**	**14.6%**						
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 18, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-10							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	459.7	615.5	514.2	501.2	564.5	642.8	549.2	604.4
WT. SAMPLE DRY + TARE	405.9	538.8	441.0	423.7	488.5	568.9	483.5	522.8
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**13.7%**	**14.6%**	**17.1%**	**18.9%**	**16.0%**	**13.3%**	**14.0%**	**16.0%**
HOLE No.	TH14-10			TH14-11				
DEPTH								
SAMPLE No.	9	10	11	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	561.4	594.7	322.3	426.5	418.4	323.0	558.0	449.0
WT. SAMPLE DRY + TARE	514.5	556.8	298.2	401.5	393.0	299.3	516.9	410.3
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**9.4%**	**7.0%**	**8.5%**	**6.4%**	**6.7%**	**8.3%**	**8.2%**	**9.8%**
HOLE No.	TH14-11						TH14-13	
DEPTH								
SAMPLE No.	6	7	8	9	10	11	1	2
TARE No.								
WT. SAMPLE WET + TARE	641.3	473.3	538.4	408.4	599.3	472.2	576.0	555.4
WT. SAMPLE DRY + TARE	582.0	389.7	449.0	357.5	536.5	421.8	509.4	492.1
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**10.4%**	**22.2%**	**20.5%**	**14.8%**	**12.0%**	**12.3%**	**13.4%**	**13.2%**
HOLE No.	TH14-13							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	
TARE No.								
WT. SAMPLE WET + TARE	471.9	626.1	444.6	544.2	613.6	480.1	443.8	
WT. SAMPLE DRY + TARE	385.7	536.0	380.0	469.4	521.5	420.4	388.5	
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	
WATER CONTENT W%	**23.2%**	**17.2%**	**17.6%**	**16.4%**	**18.1%**	**14.7%**	**14.7%**	

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 18, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-26							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	521.7	645.0	504.9	545.5	562.5	587.5	335.8	635.9
WT. SAMPLE DRY + TARE	499.9	626.6	487.0	520.5	492.9	482.8	299.2	517.7
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**4.5%**	**3.0%**	**3.8%**	**4.9%**	**14.5%**	**22.3%**	**12.8%**	**23.4%**
HOLE No.	TH14-26			TH14-27				
DEPTH								
SAMPLE No.	9	10	11	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	567.9	560.9	342.5	510.8	573.5	366.3	482.2	562.3
WT. SAMPLE DRY + TARE	487.6	494.7	304.1	485.1	547.0	322.3	423.7	510.1
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
WATER CONTENT W%	**16.9%**	**13.8%**	**13.2%**	**5.4%**	**5.0%**	**14.2%**	**14.3%**	**10.5%**
HOLE No.	TH14-27							
DEPTH								
SAMPLE No.	6	7	8	9	10	11		
TARE No.								
WT. SAMPLE WET + TARE	509.4	483.1	577.6	521.8	510.8	469.8		
WT. SAMPLE DRY + TARE	434.0	413.5	501.4	464.6	466.9	409.5		
WT. TARE	13.4	13.4	13.4	13.4	13.4	13.4		
WATER CONTENT W%	**17.9%**	**17.4%**	**15.6%**	**12.7%**	**9.7%**	**15.2%**		
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-02							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	633.4	584.5	389.7	580.2	512.9	607.7	442.3	553.5
WT. SAMPLE DRY + TARE	507.6	543.6	370.8	544.2	487.2	579.2	424.2	524.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**25.5%**	**7.7%**	**5.3%**	**6.8%**	**5.4%**	**5.0%**	**4.4%**	**5.7%**
HOLE No.	TH14-02							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	606.1	768.1	794.0	749.6	784.0	735.1	658.6	732.9
WT. SAMPLE DRY + TARE	573.2	716.3	739.7	707.5	732.5	691.6	606.6	673.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.9%**	**7.4%**	**7.5%**	**6.1%**	**7.2%**	**6.4%**	**8.8%**	**9.0%**
HOLE No.	TH14-02					TH14-03		
DEPTH								
SAMPLE No.	17	18	19	20	21	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	725.5	656.5	494.5	626.8	798.6	389.3	470.7	408.8
WT. SAMPLE DRY + TARE	676.4	515.4	469.1	583.2	731.1	292.0	372.4	355.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**7.4%**	**28.1%**	**5.6%**	**7.7%**	**9.4%**	**34.9%**	**27.4%**	**15.6%**
HOLE No.	TH14-03						TH14-04	
DEPTH								
SAMPLE No.	4	5	6	7	8	9	1	2
TARE No.								
WT. SAMPLE WET + TARE	645.4	757.2	578.0	192.8	794.1	421.8	517.9	469.3
WT. SAMPLE DRY + TARE	581.6	695.3	531.6	175.6	702.9	366.5	432.8	382.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.2%**	**9.1%**	**9.0%**	**10.6%**	**13.2%**	**15.7%**	**20.3%**	**23.4%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH04-04							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	10
TARE No.								
WT. SAMPLE WET + TARE	370.3	576.5	563.2	454.9	197.7	481.1	228.6	550.2
WT. SAMPLE DRY + TARE	358.4	514.7	510.2	396.7	174.7	428.2	199.7	486.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**3.5%**	**12.3%**	**10.7%**	**15.2%**	**14.3%**	**12.8%**	**15.5%**	**13.5%**
HOLE No.	TH14-04	TH14-05						
DEPTH								
SAMPLE No.	11	1	2	3	4	5	6	7
TARE No.								
WT. SAMPLE WET + TARE	310.0	538.6	522.7	314.8	627.0	380.5	615.8	504.0
WT. SAMPLE DRY + TARE	268.1	490.3	475.6	282.5	523.8	323.6	533.0	433.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**16.5%**	**10.1%**	**10.2%**	**12.0%**	**20.2%**	**18.3%**	**15.9%**	**16.9%**
HOLE No.	TH14-05							
DEPTH								
SAMPLE No.	8	9	10	11	12	13	14	15
TARE No.								
WT. SAMPLE WET + TARE	712.7	461.5	509.8	580.8	526.2	660.6	546.7	558.0
WT. SAMPLE DRY + TARE	612.5	383.5	432.7	498.7	432.6	589.1	407.8	469.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**16.7%**	**21.1%**	**18.4%**	**16.9%**	**22.3%**	**12.4%**	**35.2%**	**19.4%**
HOLE No.	TH14-05		TH14-06					
DEPTH								
SAMPLE No.	16	17	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	586.9	274.4	639.4	538.9	595.2	657.6	591.5	585.9
WT. SAMPLE DRY + TARE	524.0	241.2	548.3	472.3	508.3	565.4	498.6	507.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.3%**	**14.6%**	**17.0%**	**14.5%**	**17.6%**	**16.7%**	**19.2%**	**15.9%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-06					TH14-07		
DEPTH								
SAMPLE No.	7	8	9	10	11	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	534.6	632.6	507.9	537.6	78.1	680.9	647.9	257.4
WT. SAMPLE DRY + TARE	472.8	560.6	444.7	487.4	73.9	506.0	465.3	236.1
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.5%**	**13.2%**	**14.7%**	**10.6%**	**7.0%**	**35.5%**	**40.4%**	**9.6%**
HOLE No.	TH14-07							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	741.7	656.7	421.0	804.1	780.8	417.0	580.3	580.7
WT. SAMPLE DRY + TARE	645.8	588.0	362.1	711.3	692.1	383.2	528.3	477.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.2%**	**12.0%**	**16.9%**	**13.3%**	**13.1%**	**9.1%**	**10.1%**	**22.4%**
HOLE No.	TH14-07	TH14-08						
DEPTH								
SAMPLE No.	12	1	2	3	4	5	6	7
TARE No.								
WT. SAMPLE WET + TARE	589.1	607.7	599.9	480.0	659.3	523.0	726.1	549.1
WT. SAMPLE DRY + TARE	487.5	498.8	503.0	453.7	614.4	477.7	643.5	497.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**21.4%**	**22.4%**	**19.8%**	**6.0%**	**7.5%**	**9.8%**	**13.1%**	**10.7%**
HOLE No.	TH14-08		TH14-14					
DEPTH								
SAMPLE No.	8	9	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	401.9	615.3	637.7	569.8	630.7	612.6	591.6	605.1
WT. SAMPLE DRY + TARE	366.2	572.9	545.6	469.1	545.5	522.0	515.2	530.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**10.1%**	**7.6%**	**17.3%**	**22.1%**	**16.0%**	**17.8%**	**15.2%**	**14.3%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-14			TH14-15				
DEPTH								
SAMPLE No.	7	9	10	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	447.2	492.8	553.0	489.4	622.5	269.3	458.9	505.9
WT. SAMPLE DRY + TARE	390.4	412.0	463.6	425.0	589.4	254.0	393.9	447.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.1%**	**20.3%**	**19.9%**	**15.7%**	**5.7%**	**6.4%**	**17.1%**	**13.5%**
HOLE No.	TH14-15				TH14-16			
DEPTH								
SAMPLE No.	6	7	8	9	1	2	3	4
TARE No.								
WT. SAMPLE WET + TARE	521.1	202.5	507.0	189.1	721.0	576.6	1618.9	700.7
WT. SAMPLE DRY + TARE	455.0	181.1	458.8	164.4	692.0	525.5	1519.4	614.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	252.3	13.5
WATER CONTENT W%	**15.0%**	**12.8%**	**10.8%**	**16.4%**	**4.3%**	**10.0%**	**7.9%**	**14.3%**
HOLE No.	TH14-16					TH14-17		
DEPTH								
SAMPLE No.	5	6	7	8	9	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	539.4	517.1	572.0	600.5	135.2	670.0	678.7	548.4
WT. SAMPLE DRY + TARE	477.1	457.1	505.0	559.7	127.7	618.6	625.1	477.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.4%**	**13.5%**	**13.6%**	**7.5%**	**6.6%**	**8.5%**	**8.8%**	**15.2%**
HOLE No.	TH14-17						TH14-18	
DEPTH								
SAMPLE No.	4	5	6	7	8	9	1	2
TARE No.								
WT. SAMPLE WET + TARE	616.8	640.7	534.6	447.1	701.1	205.4	642.9	641.0
WT. SAMPLE DRY + TARE	520.5	560.6	454.1	398.3	581.5	189.0	618.3	610.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**19.0%**	**14.6%**	**18.3%**	**12.7%**	**21.1%**	**9.3%**	**4.1%**	**5.1%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-18							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	10
TARE No.								
WT. SAMPLE WET + TARE	403.3	572.2	364.9	588.5	585.7	476.3	595.5	582.2
WT. SAMPLE DRY + TARE	355.1	542.6	326.4	546.5	518.0	427.3	521.5	506.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**14.1%**	**5.6%**	**12.3%**	**7.9%**	**13.4%**	**11.8%**	**14.6%**	**15.5%**
HOLE No.	TH14-18			TH14-19				
DEPTH								
SAMPLE No.	11	12	13	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	571.5	628.9	427.4	388.1	673.1	502.5	663.2	515.6
WT. SAMPLE DRY + TARE	500.1	560.9	367.2	288.7	543.8	414.1	537.6	445.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**14.7%**	**12.4%**	**17.0%**	**36.1%**	**24.4%**	**22.1%**	**24.0%**	**16.3%**
HOLE No.	TH14-19				TH14-20			
DEPTH								
SAMPLE No.	6	7	8	9	1	2	3	4
TARE No.								
WT. SAMPLE WET + TARE	549.7	475.2	539.3	319.1	421.9	435.0	382.4	544.3
WT. SAMPLE DRY + TARE	477.9	420.9	474.7	275.9	333.2	336.9	308.4	446.1
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.5%**	**13.3%**	**14.0%**	**16.5%**	**27.7%**	**30.3%**	**25.1%**	**22.7%**
HOLE No.	TH14-20					TH14-21		
DEPTH								
SAMPLE No.	5	6	7	8	9	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	538.7	625.1	339.0	411.7	280.0	549.0	377.1	376.7
WT. SAMPLE DRY + TARE	491.7	531.1	303.1	359.9	248.1	447.1	303.7	296.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**9.8%**	**18.2%**	**12.4%**	**15.0%**	**13.6%**	**23.5%**	**25.3%**	**28.6%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 4, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-21							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	438.1	561.6	660.7	464.1	523.6	400.3	371.5	285.0
WT. SAMPLE DRY + TARE	342.3	459.3	551.9	387.5	461.0	335.9	314.2	249.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**29.1%**	**22.9%**	**20.2%**	**20.5%**	**14.0%**	**20.0%**	**19.1%**	**14.9%**
HOLE No.	TH14-21		TH14-12					
DEPTH								
SAMPLE No.	12	13	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	443.6	268.1	480.0	471.2	361.8	637.8	445.1	664.0
WT. SAMPLE DRY + TARE	369.9	235.6	452.5	435.9	335.0	521.9	361.0	538.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**20.7%**	**14.6%**	**6.3%**	**8.4%**	**8.3%**	**22.8%**	**24.2%**	**23.9%**
HOLE No.	TH14-12					TH14-24		
DEPTH								
SAMPLE No.	7	8	9	10	11	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	539.2	378.7	288.1	581.5	198.3	375.0	508.3	296.6
WT. SAMPLE DRY + TARE	444.2	314.2	257.6	489.6	171.5	356.8	464.7	282.6
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**22.1%**	**21.4%**	**12.5%**	**19.3%**	**17.0%**	**5.3%**	**9.7%**	**5.2%**
HOLE No.	TH14-24							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	535.3	366.5	515.7	568.1	535.4	433.9	479.9	356.4
WT. SAMPLE DRY + TARE	478.7	317.9	458.0	509.6	468.3	385.9	402.0	302.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.2%**	**16.0%**	**13.0%**	**11.8%**	**14.8%**	**12.9%**	**20.1%**	**18.7%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 4, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-24							
DEPTH								
SAMPLE No.	12	13	14	15	16	18	19	20
TARE No.								
WT. SAMPLE WET + TARE	560.7	556.0	564.5	254.1	560.2	520.0	449.1	550.2
WT. SAMPLE DRY + TARE	447.0	448.0	459.3	217.4	457.4	444.8	378.2	454.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**26.2%**	**24.9%**	**23.6%**	**18.0%**	**23.2%**	**17.4%**	**19.4%**	**21.6%**
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	371.1	509.0	358.8	417.2	326.8	537.6	611.7	609.1
WT. SAMPLE DRY + TARE	331.5	460.3	297.6	333.6	263.5	439.8	518.5	484.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.5%**	**10.9%**	**21.5%**	**26.1%**	**25.3%**	**22.9%**	**18.5%**	**26.6%**
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	520.3	565.8	432.2	528.5	394.8	563.8	498.8	553.0
WT. SAMPLE DRY + TARE	423.7	471.7	363.2	446.8	351.4	498.5	451.4	483.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**23.5%**	**20.5%**	**19.7%**	**18.9%**	**12.8%**	**13.5%**	**10.8%**	**14.7%**
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	17	18	19	20	21	22	23	24
TARE No.								
WT. SAMPLE WET + TARE	485.0	528.5	356.0	493.1	425.9	635.5	362.5	601.2
WT. SAMPLE DRY + TARE	429.4	474.9	317.9	432.9	381.7	574.6	322.5	518.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.4%**	**11.6%**	**12.5%**	**14.4%**	**12.0%**	**10.9%**	**12.9%**	**16.4%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 4, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	25							
TARE No.								
WT. SAMPLE WET + TARE	251.0							
WT. SAMPLE DRY + TARE	225.8							
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.9%**							
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-02							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	633.4	584.5	389.7	580.2	512.9	607.7	442.3	553.5
WT. SAMPLE DRY + TARE	507.6	543.6	370.8	544.2	487.2	579.2	424.2	524.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**25.5%**	**7.7%**	**5.3%**	**6.8%**	**5.4%**	**5.0%**	**4.4%**	**5.7%**
HOLE No.	TH14-02							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	606.1	768.1	794.0	749.6	784.0	735.1	658.6	732.9
WT. SAMPLE DRY + TARE	573.2	716.3	739.7	707.5	732.5	691.6	606.6	673.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**5.9%**	**7.4%**	**7.5%**	**6.1%**	**7.2%**	**6.4%**	**8.8%**	**9.0%**
HOLE No.	TH14-02					TH14-03		
DEPTH								
SAMPLE No.	17	18	19	20	21	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	725.5	656.5	494.5	626.8	798.6	389.3	470.7	408.8
WT. SAMPLE DRY + TARE	676.4	515.4	469.1	583.2	731.1	292.0	372.4	355.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**7.4%**	**28.1%**	**5.6%**	**7.7%**	**9.4%**	**34.9%**	**27.4%**	**15.6%**
HOLE No.	TH14-03						TH14-04	
DEPTH								
SAMPLE No.	4	5	6	7	8	9	1	2
TARE No.								
WT. SAMPLE WET + TARE	645.4	757.2	578.0	192.8	794.1	421.8	517.9	469.3
WT. SAMPLE DRY + TARE	581.6	695.3	531.6	175.6	702.9	366.5	432.8	382.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.2%**	**9.1%**	**9.0%**	**10.6%**	**13.2%**	**15.7%**	**20.3%**	**23.4%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH04-04							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	10
TARE No.								
WT. SAMPLE WET + TARE	370.3	576.5	563.2	454.9	197.7	481.1	228.6	550.2
WT. SAMPLE DRY + TARE	358.4	514.7	510.2	396.7	174.7	428.2	199.7	486.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**3.5%**	**12.3%**	**10.7%**	**15.2%**	**14.3%**	**12.8%**	**15.5%**	**13.5%**
HOLE No.	TH14-04	TH14-05						
DEPTH								
SAMPLE No.	11	1	2	3	4	5	6	7
TARE No.								
WT. SAMPLE WET + TARE	310.0	538.6	522.7	314.8	627.0	380.5	615.8	504.0
WT. SAMPLE DRY + TARE	268.1	490.3	475.6	282.5	523.8	323.6	533.0	433.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**16.5%**	**10.1%**	**10.2%**	**12.0%**	**20.2%**	**18.3%**	**15.9%**	**16.9%**
HOLE No.	TH14-05							
DEPTH								
SAMPLE No.	8	9	10	11	12	13	14	15
TARE No.								
WT. SAMPLE WET + TARE	712.7	461.5	509.8	580.8	526.2	660.6	546.7	558.0
WT. SAMPLE DRY + TARE	612.5	383.5	432.7	498.7	432.6	589.1	407.8	469.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**16.7%**	**21.1%**	**18.4%**	**16.9%**	**22.3%**	**12.4%**	**35.2%**	**19.4%**
HOLE No.	TH14-05		TH14-06					
DEPTH								
SAMPLE No.	16	17	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	586.9	274.4	639.4	538.9	595.2	657.6	591.5	585.9
WT. SAMPLE DRY + TARE	524.0	241.2	548.3	472.3	508.3	565.4	498.6	507.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.3%**	**14.6%**	**17.0%**	**14.5%**	**17.6%**	**16.7%**	**19.2%**	**15.9%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-06					TH14-07		
DEPTH								
SAMPLE No.	7	8	9	10	11	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	534.6	632.6	507.9	537.6	78.1	680.9	647.9	257.4
WT. SAMPLE DRY + TARE	472.8	560.6	444.7	487.4	73.9	506.0	465.3	236.1
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.5%**	**13.2%**	**14.7%**	**10.6%**	**7.0%**	**35.5%**	**40.4%**	**9.6%**
HOLE No.	TH14-07							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	741.7	656.7	421.0	804.1	780.8	417.0	580.3	580.7
WT. SAMPLE DRY + TARE	645.8	588.0	362.1	711.3	692.1	383.2	528.3	477.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.2%**	**12.0%**	**16.9%**	**13.3%**	**13.1%**	**9.1%**	**10.1%**	**22.4%**
HOLE No.	TH14-07	TH14-08						
DEPTH								
SAMPLE No.	12	1	2	3	4	5	6	7
TARE No.								
WT. SAMPLE WET + TARE	589.1	607.7	599.9	480.0	659.3	523.0	726.1	549.1
WT. SAMPLE DRY + TARE	487.5	498.8	503.0	453.7	614.4	477.7	643.5	497.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**21.4%**	**22.4%**	**19.8%**	**6.0%**	**7.5%**	**9.8%**	**13.1%**	**10.7%**
HOLE No.	TH14-08		TH14-14					
DEPTH								
SAMPLE No.	8	9	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	401.9	615.3	637.7	569.8	630.7	612.6	591.6	605.1
WT. SAMPLE DRY + TARE	366.2	572.9	545.6	469.1	545.5	522.0	515.2	530.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**10.1%**	**7.6%**	**17.3%**	**22.1%**	**16.0%**	**17.8%**	**15.2%**	**14.3%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-14			TH14-15				
DEPTH								
SAMPLE No.	7	9	10	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	447.2	492.8	553.0	489.4	622.5	269.3	458.9	505.9
WT. SAMPLE DRY + TARE	390.4	412.0	463.6	425.0	589.4	254.0	393.9	447.2
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.1%**	**20.3%**	**19.9%**	**15.7%**	**5.7%**	**6.4%**	**17.1%**	**13.5%**
HOLE No.	TH14-15				TH14-16			
DEPTH								
SAMPLE No.	6	7	8	9	1	2	3	4
TARE No.								
WT. SAMPLE WET + TARE	521.1	202.5	507.0	189.1	721.0	576.6	1618.9	700.7
WT. SAMPLE DRY + TARE	455.0	181.1	458.8	164.4	692.0	525.5	1519.4	614.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	252.3	13.5
WATER CONTENT W%	**15.0%**	**12.8%**	**10.8%**	**16.4%**	**4.3%**	**10.0%**	**7.9%**	**14.3%**
HOLE No.	TH14-16					TH14-17		
DEPTH								
SAMPLE No.	5	6	7	8	9	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	539.4	517.1	572.0	600.5	135.2	670.0	678.7	548.4
WT. SAMPLE DRY + TARE	477.1	457.1	505.0	559.7	127.7	618.6	625.1	477.9
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.4%**	**13.5%**	**13.6%**	**7.5%**	**6.6%**	**8.5%**	**8.8%**	**15.2%**
HOLE No.	TH14-17						TH14-18	
DEPTH								
SAMPLE No.	4	5	6	7	8	9	1	2
TARE No.								
WT. SAMPLE WET + TARE	616.8	640.7	534.6	447.1	701.1	205.4	642.9	641.0
WT. SAMPLE DRY + TARE	520.5	560.6	454.1	398.3	581.5	189.0	618.3	610.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**19.0%**	**14.6%**	**18.3%**	**12.7%**	**21.1%**	**9.3%**	**4.1%**	**5.1%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	January 30, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-18							
DEPTH								
SAMPLE No.	3	4	5	6	7	8	9	10
TARE No.								
WT. SAMPLE WET + TARE	403.3	572.2	364.9	588.5	585.7	476.3	595.5	582.2
WT. SAMPLE DRY + TARE	355.1	542.6	326.4	546.5	518.0	427.3	521.5	506.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**14.1%**	**5.6%**	**12.3%**	**7.9%**	**13.4%**	**11.8%**	**14.6%**	**15.5%**
HOLE No.	TH14-18			TH14-19				
DEPTH								
SAMPLE No.	11	12	13	1	2	3	4	5
TARE No.								
WT. SAMPLE WET + TARE	571.5	628.9	427.4	388.1	673.1	502.5	663.2	515.6
WT. SAMPLE DRY + TARE	500.1	560.9	367.2	288.7	543.8	414.1	537.6	445.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**14.7%**	**12.4%**	**17.0%**	**36.1%**	**24.4%**	**22.1%**	**24.0%**	**16.3%**
HOLE No.	TH14-19				TH14-20			
DEPTH								
SAMPLE No.	6	7	8	9	1	2	3	4
TARE No.								
WT. SAMPLE WET + TARE	549.7	475.2	539.3	319.1	421.9	435.0	382.4	544.3
WT. SAMPLE DRY + TARE	477.9	420.9	474.7	275.9	333.2	336.9	308.4	446.1
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**15.5%**	**13.3%**	**14.0%**	**16.5%**	**27.7%**	**30.3%**	**25.1%**	**22.7%**
HOLE No.	TH14-20					TH14-21		
DEPTH								
SAMPLE No.	5	6	7	8	9	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	538.7	625.1	339.0	411.7	280.0	549.0	377.1	376.7
WT. SAMPLE DRY + TARE	491.7	531.1	303.1	359.9	248.1	447.1	303.7	296.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**9.8%**	**18.2%**	**12.4%**	**15.0%**	**13.6%**	**23.5%**	**25.3%**	**28.6%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 4, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-21							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	438.1	561.6	660.7	464.1	523.6	400.3	371.5	285.0
WT. SAMPLE DRY + TARE	342.3	459.3	551.9	387.5	461.0	335.9	314.2	249.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**29.1%**	**22.9%**	**20.2%**	**20.5%**	**14.0%**	**20.0%**	**19.1%**	**14.9%**
HOLE No.	TH14-21		TH14-12					
DEPTH								
SAMPLE No.	12	13	1	2	3	4	5	6
TARE No.								
WT. SAMPLE WET + TARE	443.6	268.1	480.0	471.2	361.8	637.8	445.1	664.0
WT. SAMPLE DRY + TARE	369.9	235.6	452.5	435.9	335.0	521.9	361.0	538.4
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**20.7%**	**14.6%**	**6.3%**	**8.4%**	**8.3%**	**22.8%**	**24.2%**	**23.9%**
HOLE No.	TH14-12					TH14-24		
DEPTH								
SAMPLE No.	7	8	9	10	11	1	2	3
TARE No.								
WT. SAMPLE WET + TARE	539.2	378.7	288.1	581.5	198.3	375.0	508.3	296.6
WT. SAMPLE DRY + TARE	444.2	314.2	257.6	489.6	171.5	356.8	464.7	282.6
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**22.1%**	**21.4%**	**12.5%**	**19.3%**	**17.0%**	**5.3%**	**9.7%**	**5.2%**
HOLE No.	TH14-24							
DEPTH								
SAMPLE No.	4	5	6	7	8	9	10	11
TARE No.								
WT. SAMPLE WET + TARE	535.3	366.5	515.7	568.1	535.4	433.9	479.9	356.4
WT. SAMPLE DRY + TARE	478.7	317.9	458.0	509.6	468.3	385.9	402.0	302.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.2%**	**16.0%**	**13.0%**	**11.8%**	**14.8%**	**12.9%**	**20.1%**	**18.7%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 4, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-24							
DEPTH								
SAMPLE No.	12	13	14	15	16	18	19	20
TARE No.								
WT. SAMPLE WET + TARE	560.7	556.0	564.5	254.1	560.2	520.0	449.1	550.2
WT. SAMPLE DRY + TARE	447.0	448.0	459.3	217.4	457.4	444.8	378.2	454.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**26.2%**	**24.9%**	**23.6%**	**18.0%**	**23.2%**	**17.4%**	**19.4%**	**21.6%**
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	371.1	509.0	358.8	417.2	326.8	537.6	611.7	609.1
WT. SAMPLE DRY + TARE	331.5	460.3	297.6	333.6	263.5	439.8	518.5	484.0
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**12.5%**	**10.9%**	**21.5%**	**26.1%**	**25.3%**	**22.9%**	**18.5%**	**26.6%**
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	520.3	565.8	432.2	528.5	394.8	563.8	498.8	553.0
WT. SAMPLE DRY + TARE	423.7	471.7	363.2	446.8	351.4	498.5	451.4	483.7
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**23.5%**	**20.5%**	**19.7%**	**18.9%**	**12.8%**	**13.5%**	**10.8%**	**14.7%**
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	17	18	19	20	21	22	23	24
TARE No.								
WT. SAMPLE WET + TARE	485.0	528.5	356.0	493.1	425.9	635.5	362.5	601.2
WT. SAMPLE DRY + TARE	429.4	474.9	317.9	432.9	381.7	574.6	322.5	518.5
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**13.4%**	**11.6%**	**12.5%**	**14.4%**	**12.0%**	**10.9%**	**12.9%**	**16.4%**

WATER CONTENT

AECOM

CLIENT:	Government of Alberta							
PROJECT:	SAFM - High River							
JOB No.:	60309815.04							
DATE :	February 4, 2014					TECHNICAN :	CK/GU	
HOLE No.	TH14-25							
DEPTH								
SAMPLE No.	25							
TARE No.								
WT. SAMPLE WET + TARE	251.0							
WT. SAMPLE DRY + TARE	225.8							
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%	**11.9%**							
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WATER CONTENT W%								

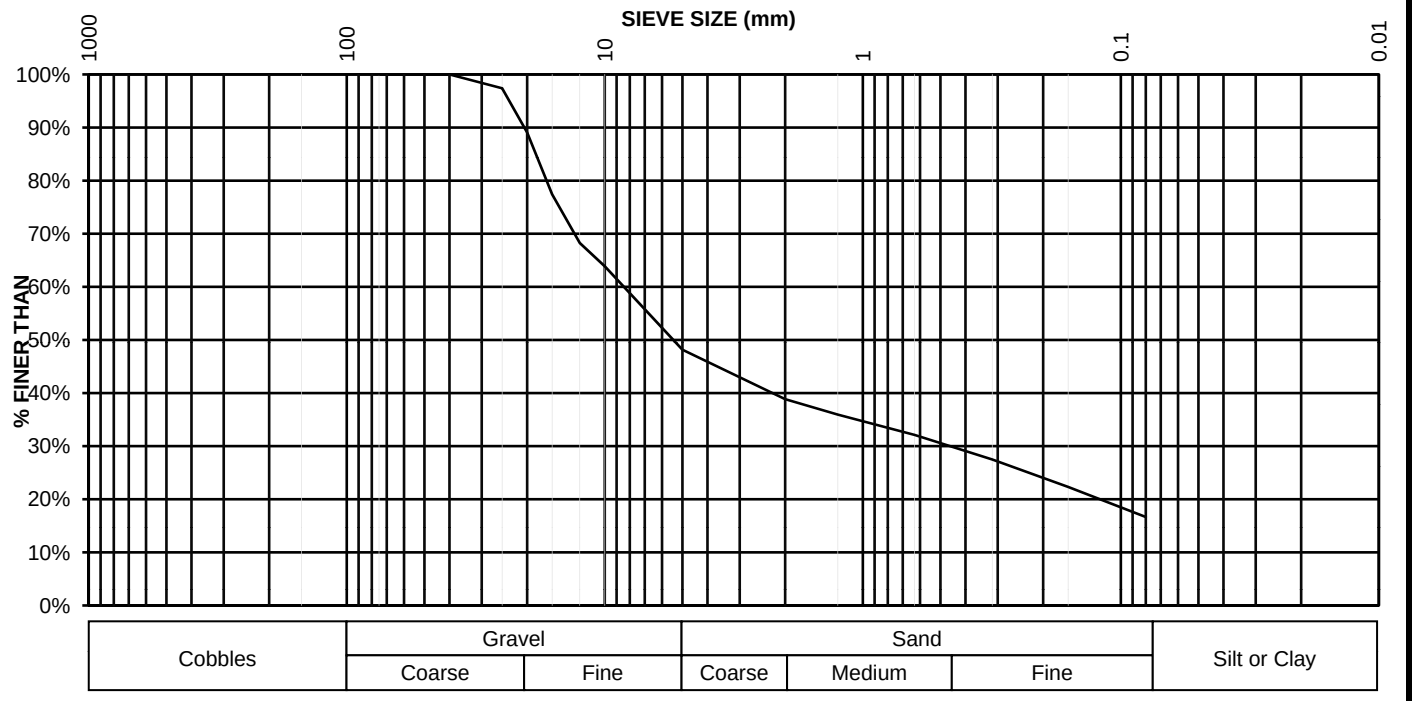
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE :	14-03	DEPTH :	3.3m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	949.9	50000	2	50.0			100%		
Tare	265.2	40000	1 1/2	40.0			100%		
Wt. Dry	684.7	25000	1	25.0	17.9	3%	97%		
Moisture Content		20000	3/4	20.0	74.9	11%	89%		
Wet + Tare		16000	5/8	16.0	154.5	23%	77%		
Dry+Tare		12500	1/2	12.5	217.3	32%	68%		
Tare		10000	3/8	10.0	247.4	36%	64%		
MC (%)		5000	0.185	5.0	354.9	52%	48%		
	Passing								
After Washing		2000	0.0937	2.0	418.7	61%	39%		
Wt. Dry+Tare	841.7	1250	0.0469	1.25	438.6	64%	36%		
Tare	265.2	630	0.0234	0.630	464.8	68%	32%		
Wt. Dry	576.5	315	0.0116	0.315	496.5	73%	27%		
Tare No.		160	0.0059	0.160	531.8	78%	22%		
		80	0.0029	0.080	570.6	83%	17%		
		PAN			574.8				

Classification:	GM or GC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-03 #5 Sieve.xls
DATE: 2/4/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	8
BOREHOLE:	TH14-03	DEPTH :	5.4m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	24					
Container Number						
Wt. Sample (wet+tare)(g)	45.10					
Wt. Sample (dry+tare)(g)	38.01					
Wt. Tare (g)	11.70					
Wt. Dry Soil (g)	26.3					
Wt. Water (g)	7.1					
Water Content (%)	26.9%					

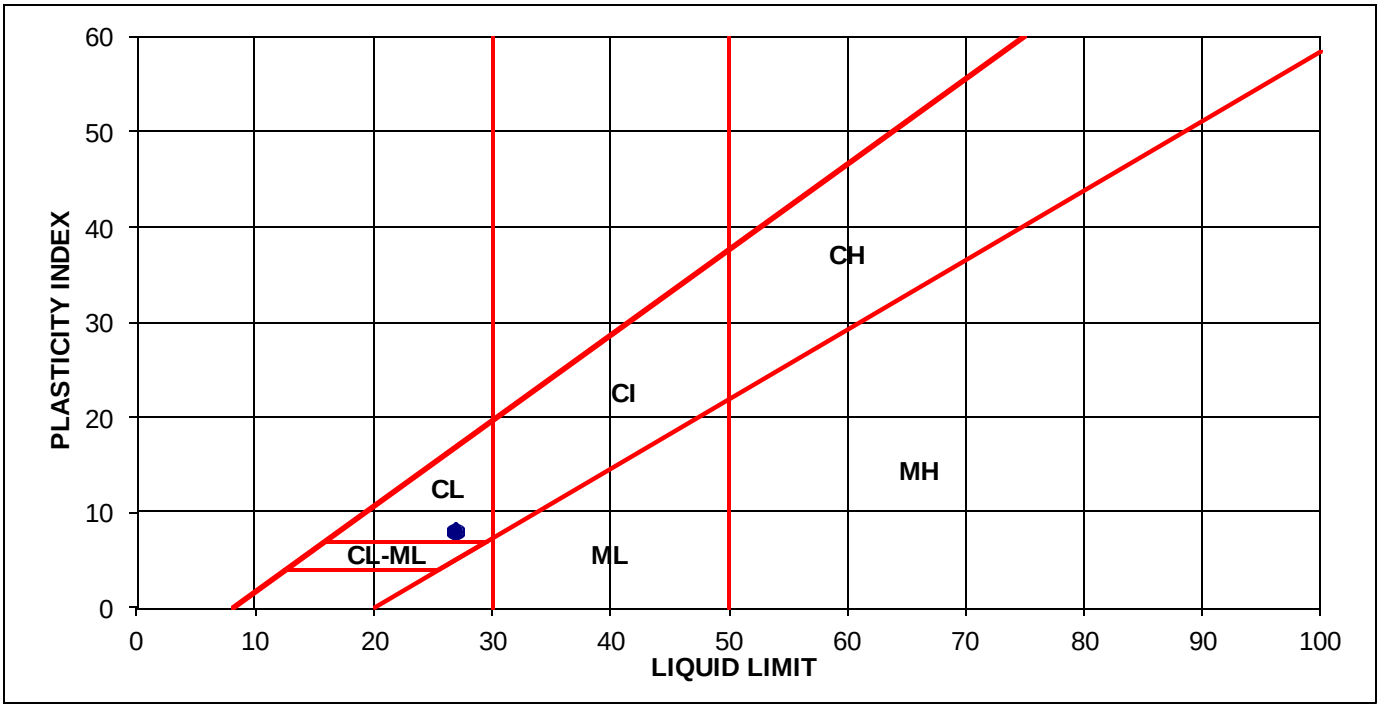
AVERAGE VALUES	
Liquid Limit	26.8
Plastic Limit	18.7
Plasticity Index	8.1

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.65		
Wt. Sample (dry+tare)(g)	29.20		
Wt. Tare (g)	16.09		
Wt. Dry Soil (g)	13.1		
Wt. Water (g)	2.5		
Water Content (%)	18.7%		



FORM: SAFM TH14-03#8 Att.xlsx
DATE: 2/5/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C3
BOREHOLE:	TH14-03	DEPTH :	14.3m
DATE :	February 10, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	19					
Container Number						
Wt. Sample (wet+tare)(g)	50.78					
Wt. Sample (dry+tare)(g)	43.07					
Wt. Tare (g)	11.73					
Wt. Dry Soil (g)	31.3					
Wt. Water (g)	7.7					
Water Content (%)	24.6%					

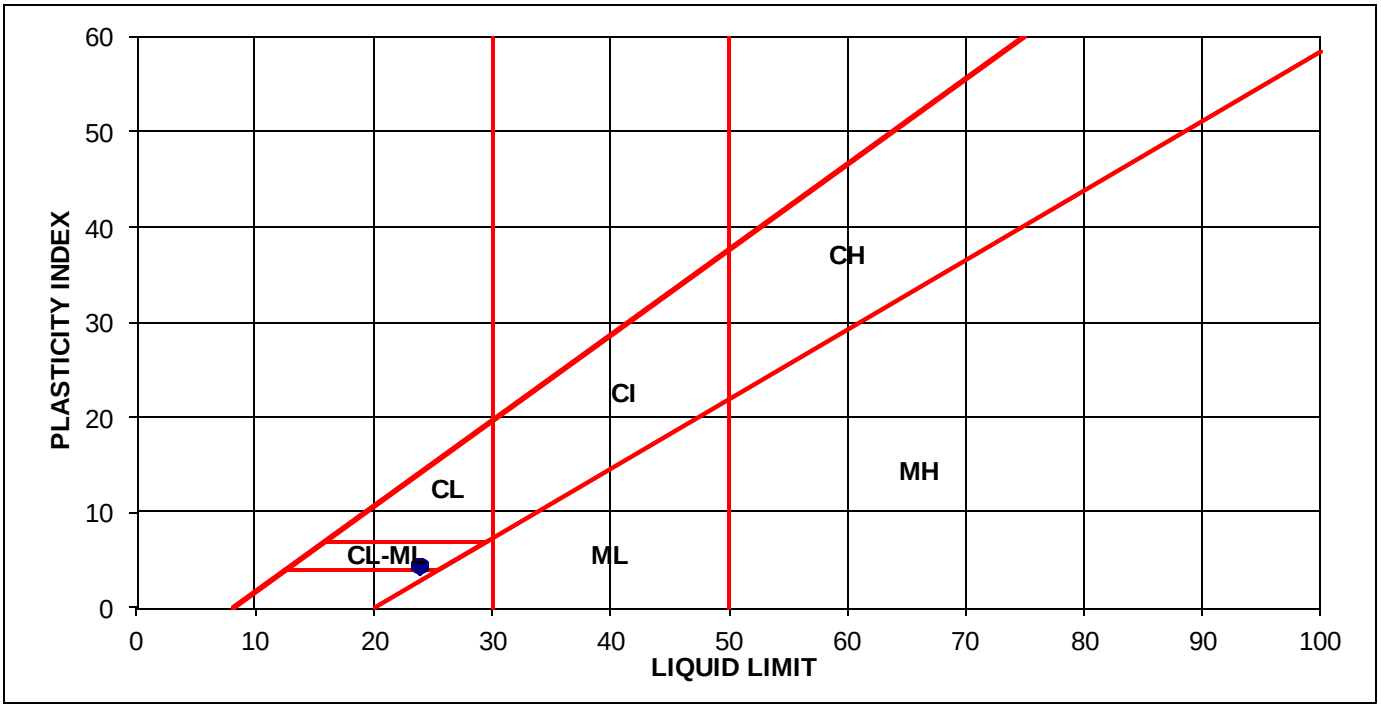
AVERAGE VALUES	
Liquid Limit	23.8
Plastic Limit	19.3
Plasticity Index	4.5

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	34.17		
Wt. Sample (dry+tare)(g)	31.25		
Wt. Tare (g)	16.10		
Wt. Dry Soil (g)	15.2		
Wt. Water (g)	2.9		
Water Content (%)	19.3%		



FORM: SAFM TH14-03#C3 Att.xlsx
DATE: 2/11/2014

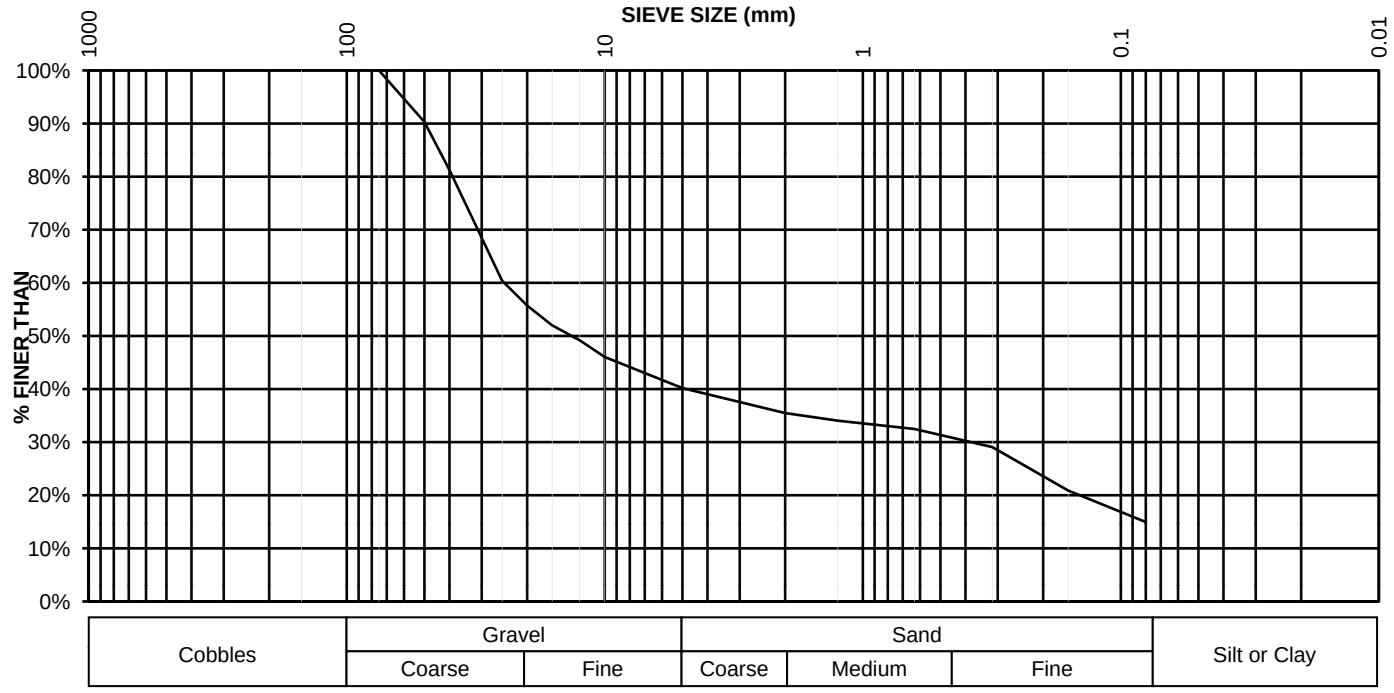
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
TESTHOLE :	14-04	DEPTH :	1.7m
DATE :	February 6, 2014	TECHNICIAN :	CK

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	3884.3	50000	2	50.0	335.0	10%	90%		
Tare	433.7	40000	1 1/2	40.0	647.4	19%	81%		
Wt. Dry	3450.6	25000	1	25.0	1366.8	40%	60%		
Moisture Content		20000	3/4	20.0	1527.9	44%	56%		
Wet + Tare		16000	5/8	16.0	1656.2	48%	52%		
Dry+Tare		12500	1/2	12.5	1753.9	51%	49%		
Tare		10000	3/8	10.0	1862.3	54%	46%		
MC (%)		5000	0.185	5.0	2064.3	60%	40%		
	Passing								
After Washing		2000	0.0937	2.0	2226.4	65%	35%		
Wt. Dry+Tare	3395.5	1250	0.0469	1.25	2276.0	66%	34%		
Tare	433.6	630	0.0234	0.630	2329.7	68%	32%		
Wt. Dry	2961.9	315	0.0116	0.315	2447.2	71%	29%		
Tare No.		160	0.0059	0.160	2729.7	79%	21%		
		80	0.0029	0.080	2934.3	85%	15%		
		PAN			2960.6				

Classification:	GM or GC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-04 #3 Sieve.xls
DATE: 2/7/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	9
TESTHOLE:	14-04	DEPTH :	6.3
DATE :	February 7, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	354.1	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	254.1	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0	4.1	2%	98.4%	
MC (%)		5,000	0.185	5.0	11.9	5%	95.3%	
	Passing							
After Washing		2,000	0.0937	2.0	16.5	6%	93.5%	
Wt. Dry+Tare		1,250	0.0469	1.25	21.3	8%	91.6%	
Tare		630	0.0234	0.63	24.1	9%	90.5%	
Wt. Dry		315	0.0116	0.315	27.9	11%	89.0%	
Tare No.		160	0.0059	0.160	34.6	14%	86.4%	
		75	0.00295	0.075	63.5	25%	75.0%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	354.1	40	0.5	0.059	20	36	65.7%	
Wt Tare	100.0	34	1	0.044	20	30	54.6%	
Wt Dry	254.1	29	2	0.032	20	25	45.4%	
Sample Size :	50	24	5	0.021	20	20	36.1%	
Wt Retained 2 mm:	16.5	20	15	0.013	20	16	28.7%	
% Passing 2 mm:	93.5%	18	30	0.009	20	14	25.0%	
Specific Gravity :	2.70	16	60	0.006	20	12	21.3%	
Hydrometer No.:	43-9856	14	120	0.005	20	10	17.6%	
Solution (g/L) :	40	13	240	0.003	20	9	15.7%	
		11	1440	0.001	20	7	12.0%	
		10	2880	0.001	20	6	10.2%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	9
TESTHOLE:	14-04	DEPTH :	6.3
DATE :	February 7, 2014	TECHNICIAN :	GU

FORM: SAFM TH14-04#9 Hydro.xls
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	17
BOREHOLE:	TH14-05	DEPTH :	12.5m
DATE :	February 6, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	27					
Container Number						
Wt. Sample (wet+tare)(g)	40.96					
Wt. Sample (dry+tare)(g)	32.65					
Wt. Tare (g)	11.79					
Wt. Dry Soil (g)	20.9					
Wt. Water (g)	8.3					
Water Content (%)	39.8%					

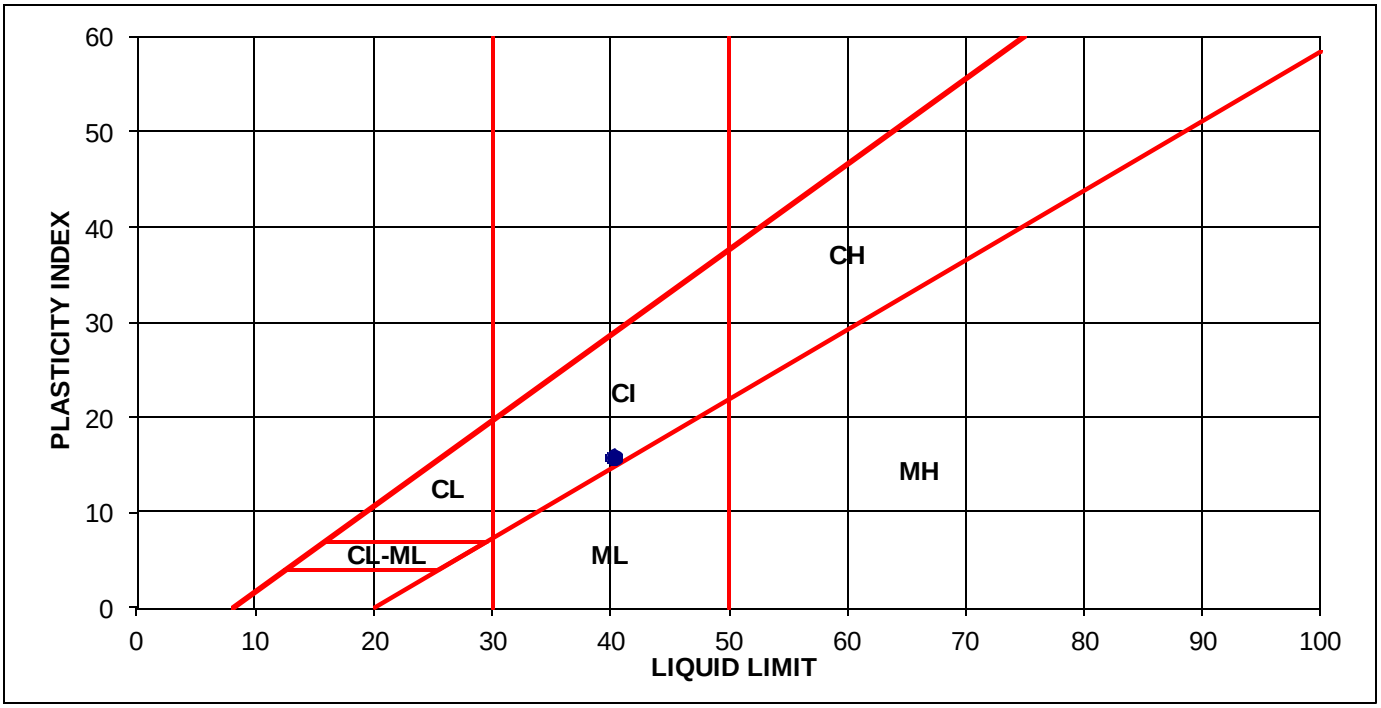
AVERAGE VALUES	
Liquid Limit	40.2
Plastic Limit	24.3
Plasticity Index	15.9

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	30.51		
Wt. Sample (dry+tare)(g)	27.68		
Wt. Tare (g)	16.05		
Wt. Dry Soil (g)	11.6		
Wt. Water (g)	2.8		
Water Content (%)	24.3%		



FORM: SAFM TH14-05 #17 Att.xlsx
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

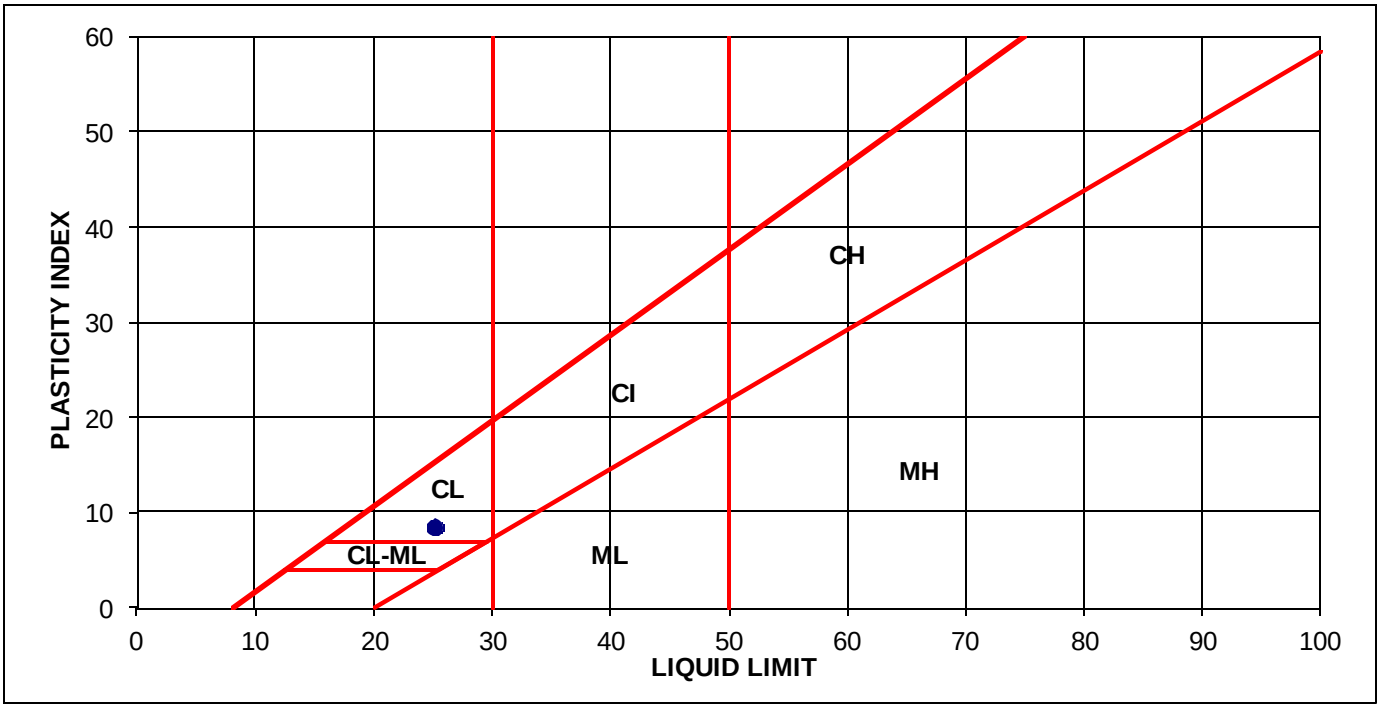
CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
BOREHOLE:	TH14-05	DEPTH :	3.9m
DATE :	February 6, 2014	TECHNICIAN :	CK

LIQUID LIMIT						
Trial No.	1					
Number of Blows	21					
Container Number						
Wt. Sample (wet+tare)(g)	43.21					
Wt. Sample (dry+tare)(g)	36.85					
Wt. Tare (g)	12.05					
Wt. Dry Soil (g)	24.8					
Wt. Water (g)	6.4					
Water Content (%)	25.6%					

AVERAGE VALUES	
Liquid Limit	25.1
Plastic Limit	16.6
Plasticity Index	8.5

SAMPLE DESCRIPTION	
Classification:	**CL**

PLASTIC LIMIT			
Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	33.36		
Wt. Sample (dry+tare)(g)	30.96		
Wt. Tare (g)	16.47		
Wt. Dry Soil (g)	14.5		
Wt. Water (g)	2.4		
Water Content (%)	16.6%		



FORM: SAFM TH14-05 #6 Att.xlsx
DATE: 2/7/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
TESTHOLE:	14-05	DEPTH :	1.7
DATE :	February 7, 2014	TECHNICIAN :	GU

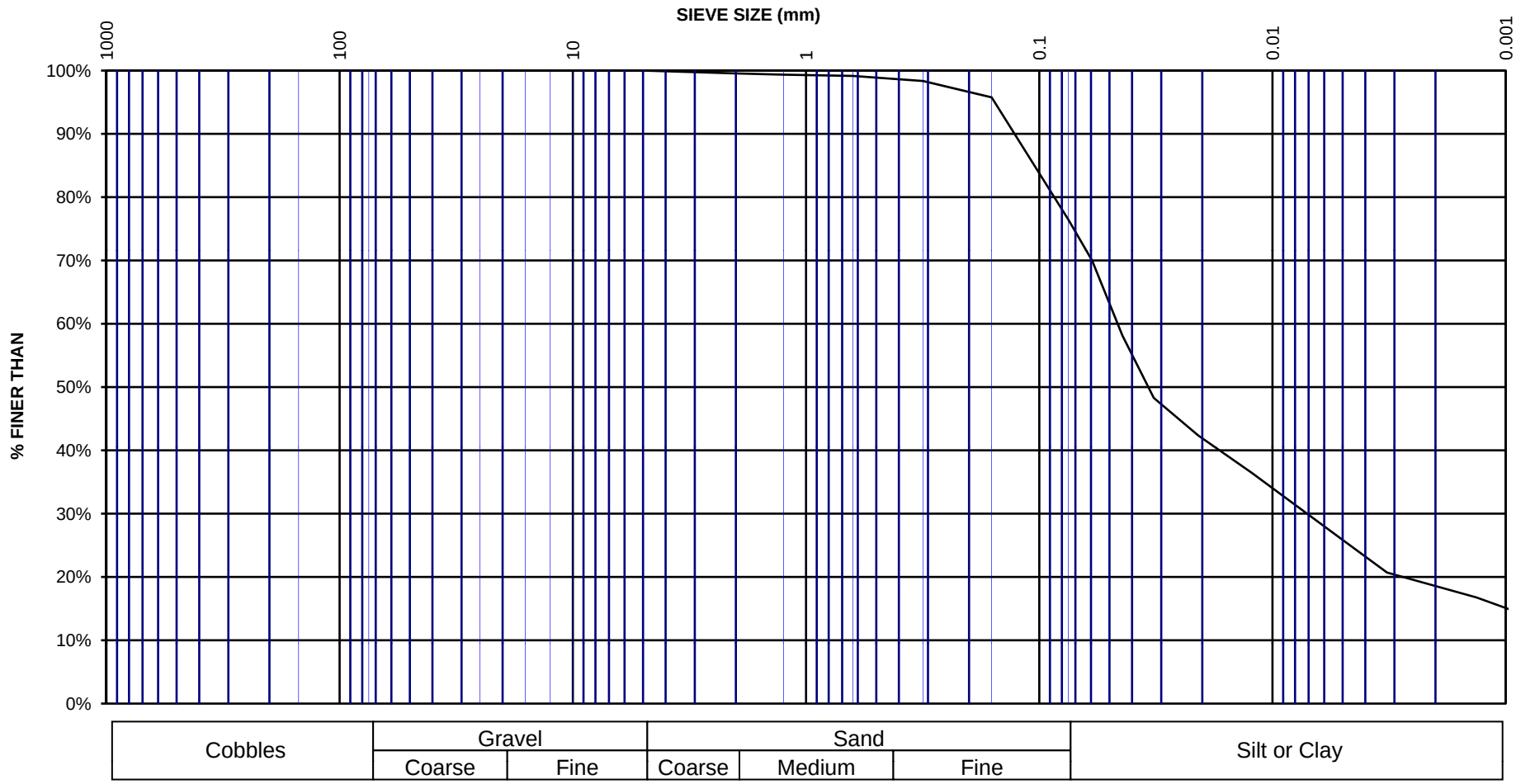
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	209.7	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	109.7	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0		0%	100.0%	
MC (%)		5,000	0.185	5.0		0%	100.0%	
	Passing							
After Washing		2,000	0.0937	2.0	0.5	0%	99.5%	
Wt. Dry+Tare		1,250	0.0469	1.25	0.7	1%	99.3%	
Tare		630	0.0234	0.63	0.9	1%	99.1%	
Wt. Dry		315	0.0116	0.315	1.8	2%	98.3%	
Tare No.		160	0.0059	0.160	4.6	4%	95.8%	
		75	0.00295	0.075	25.8	24%	76.4%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	209.7	40	0.5	0.059	20	36	70.0%	
Wt Tare	100.0	34	1	0.044	20	30	58.1%	
Wt Dry	109.7	29	2	0.032	20	25	48.3%	
Sample Size :	50	26	5	0.021	20	22	42.4%	
Wt Retained 2 mm:	0.5	23	15	0.012	20	19	36.5%	
% Passing 2 mm:	99.5%	21	30	0.009	20	17	32.5%	
Specific Gravity :	2.70	19	60	0.006	20	15	28.6%	
Hydrometer No.:	43-9856	17	120	0.005	20	13	24.6%	
Solution (g/L) :	40	15	240	0.003	20	11	20.7%	
		13	1440	0.001	20	9	16.8%	
		12	2880	0.001	20	8	14.8%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
TESTHOLE:	14-05	DEPTH :	1.7
DATE :	February 7, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-05#3 Hydro.xls
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
BOREHOLE:	TH14-06	DEPTH :	2.3m
DATE :	February 6, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	28					
Container Number						
Wt. Sample (wet+tare)(g)	42.44					
Wt. Sample (dry+tare)(g)	36.01					
Wt. Tare (g)	11.71					
Wt. Dry Soil (g)	24.3					
Wt. Water (g)	6.4					
Water Content (%)	26.5%					

AVERAGE VALUES

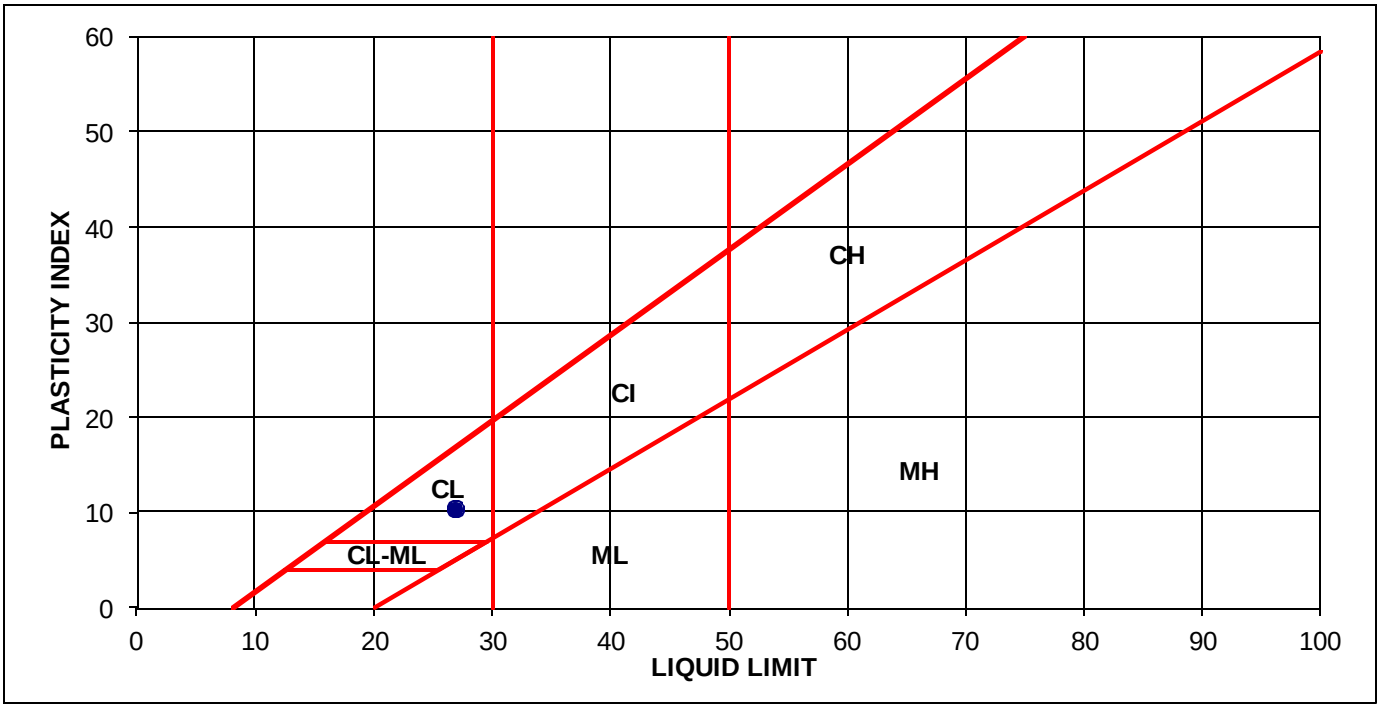
Liquid Limit	26.8
Plastic Limit	16.3
Plasticity Index	10.5

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.19		
Wt. Sample (dry+tare)(g)	29.07		
Wt. Tare (g)	16.09		
Wt. Dry Soil (g)	13.0		
Wt. Water (g)	2.1		
Water Content (%)	16.3%		



FORM: SAFM TH14-06 #4 Att.xlsx
DATE: 2/7/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE:	14-06	DEPTH :	2.3m
DATE :	February 7, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	650.7	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	550.7	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0	5.4	1%	99.0%	
MC (%)		5,000	0.185	5.0	8.4	2%	98.5%	
	Passing							
After Washing		2,000	0.0937	2.0	9.6	2%	98.3%	
Wt. Dry+Tare		1,250	0.0469	1.25	11.8	2%	97.9%	
Tare		630	0.0234	0.63	15.0	3%	97.3%	
Wt. Dry		315	0.0116	0.315	24.8	4%	95.5%	
Tare No.		160	0.0059	0.160	47.5	9%	91.4%	
		75	0.00295	0.075	97.3	18%	82.3%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	650.7	45	0.5	0.057	20	41	78.8%	
Wt Tare	100.0	42	1	0.041	20	38	73.0%	
Wt Dry	550.7	39	2	0.030	20	35	67.1%	
Sample Size :	50	36	5	0.019	20	32	61.3%	
Wt Retained 2 mm:	9.6	32	15	0.012	20	28	53.5%	
% Passing 2 mm:	98.3%	30	30	0.008	20	26	49.6%	
Specific Gravity :	2.70	27	60	0.006	20	23	43.8%	
Hydrometer No.:	43-9856	24	120	0.004	20	20	37.9%	
Solution (g/L) :	40	21	240	0.003	20	17	32.1%	
		18	1440	0.001	20	14	26.3%	
		17	2880	0.001	20	13	24.3%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE:	14-06	DEPTH :	2.3m
DATE :	February 7, 2014	TECHNICIAN :	GU

FORM: SAFM TH14-06#4 Hydro.xls
DATE: 2/7/2014

SIEVE ANALYSIS

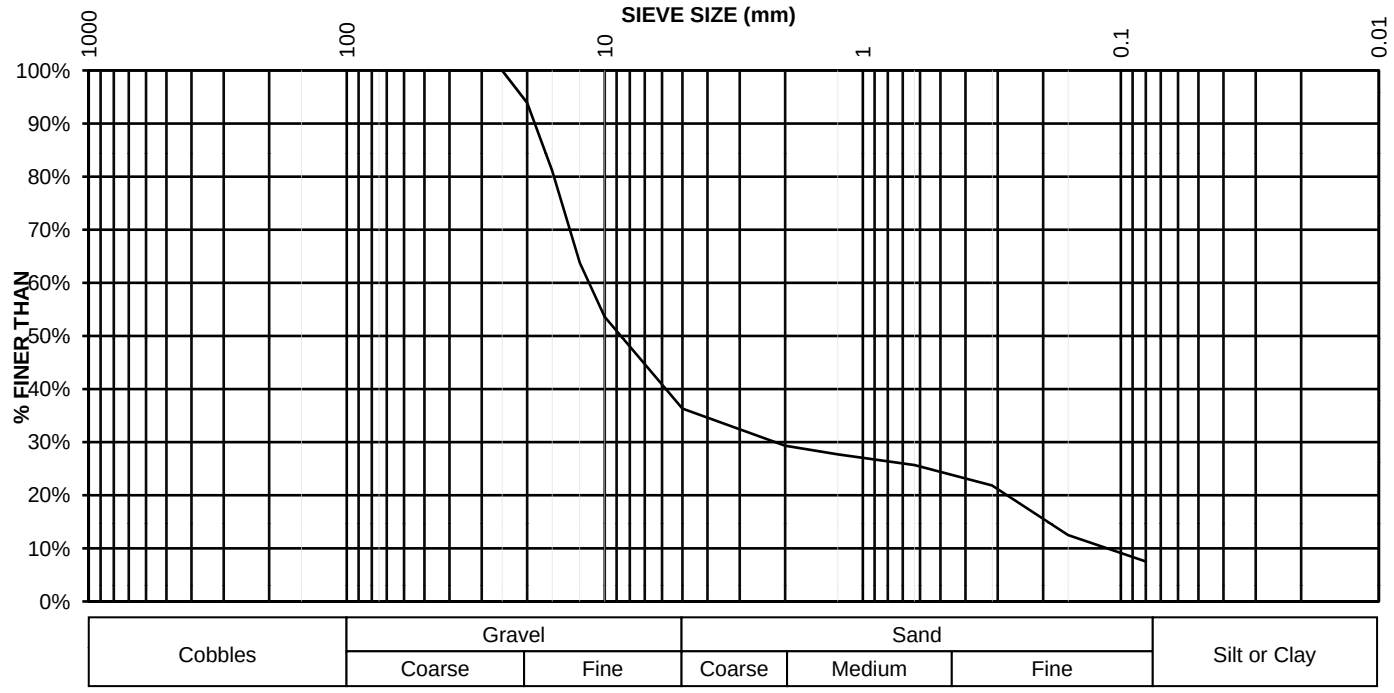
AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE :	14-08	DEPTH :	2.3m
DATE :	February 6, 2014	TECHNICIAN :	CK

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	833.6	50000	2	50.0			100%		
Tare	231.2	40000	1 1/2	40.0			100%		
Wt. Dry	602.4	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0	36.8	6%	94%		
Wet + Tare		16000	5/8	16.0	113.5	19%	81%		
Dry+Tare		12500	1/2	12.5	218.2	36%	64%		
Tare		10000	3/8	10.0	279.6	46%	54%		
MC (%)		5000	0.185	5.0	383.6	64%	36%		
	Passing								
After Washing		2000	0.0937	2.0	425.7	71%	29%		
Wt. Dry+Tare	792.3	1250	0.0469	1.25	435.5	72%	28%		
Tare	231.2	630	0.0234	0.630	447.7	74%	26%		
Wt. Dry	561.1	315	0.0116	0.315	470.9	78%	22%		
Tare No.		160	0.0059	0.160	527.1	88%	13%		
		80	0.0029	0.080	557.0	92%	8%		
		PAN			560.4				

Classification:	GP
Cc	3.8
Cu	97

Description and Remarks:



FORM: SAFM TH14-08 #4 Sieve.xls
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	9
BOREHOLE:	TH14-08	DEPTH :	6.3m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	22					
Container Number						
Wt. Sample (wet+tare)(g)	46.18					
Wt. Sample (dry+tare)(g)	39.33					
Wt. Tare (g)	11.55					
Wt. Dry Soil (g)	27.8					
Wt. Water (g)	6.9					
Water Content (%)	24.7%					

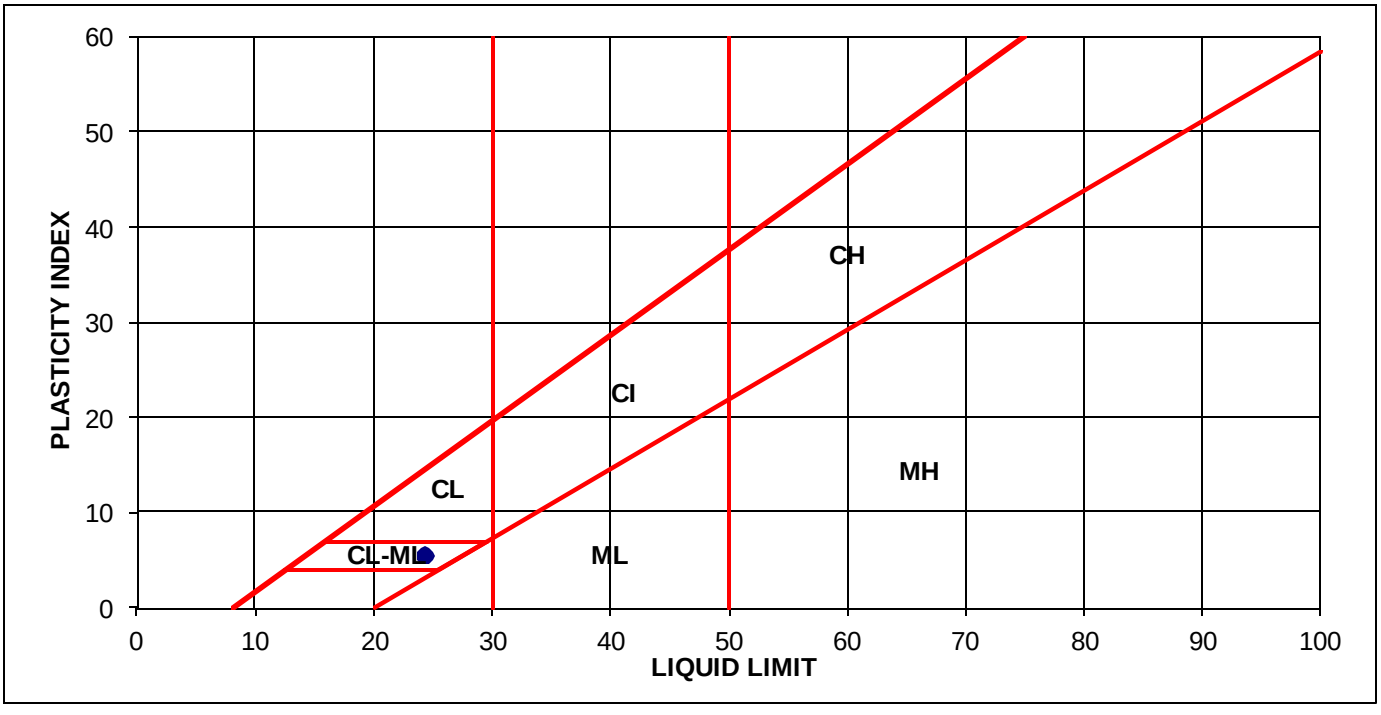
AVERAGE VALUES	
Liquid Limit	24.2
Plastic Limit	18.6
Plasticity Index	5.6

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.96		
Wt. Sample (dry+tare)(g)	27.20		
Wt. Tare (g)	12.36		
Wt. Dry Soil (g)	14.8		
Wt. Water (g)	2.8		
Water Content (%)	18.6%		



FORM: SAFM TH14-08 #9 Att.xlsx
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C2
BOREHOLE:	TH14-08	DEPTH :	10.2m
DATE :	February 12, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	19					
Container Number						
Wt. Sample (wet+tare)(g)	44.18					
Wt. Sample (dry+tare)(g)	35.06					
Wt. Tare (g)	12.10					
Wt. Dry Soil (g)	23.0					
Wt. Water (g)	9.1					
Water Content (%)	39.7%					

AVERAGE VALUES

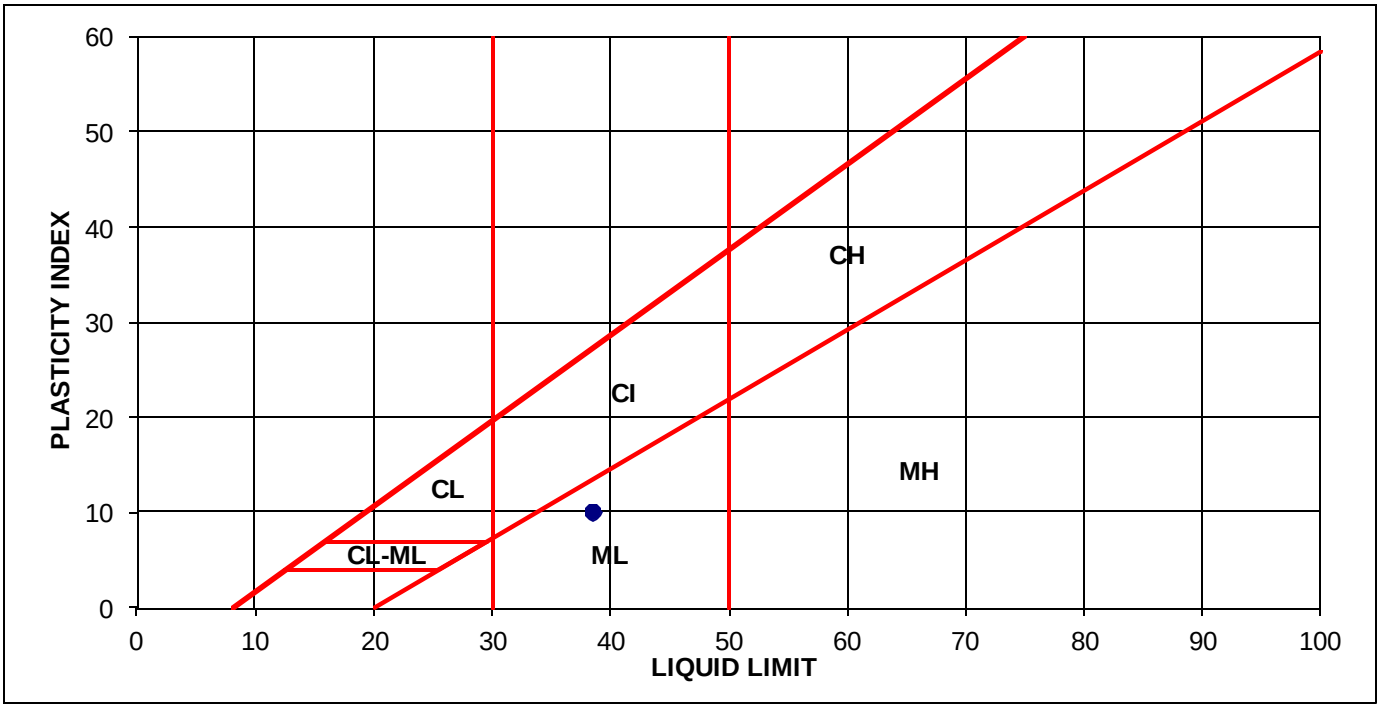
Liquid Limit	38.4
Plastic Limit	28.3
Plasticity Index	10.1

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.23		
Wt. Sample (dry+tare)(g)	26.23		
Wt. Tare (g)	15.62		
Wt. Dry Soil (g)	10.6		
Wt. Water (g)	3.0		
Water Content (%)	28.3%		



FORM: SAFM TH14-08 C2 Att.xlsx
DATE: 2/13/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
BOREHOLE:	TH14-10	DEPTH :	3.05m
DATE :	February 25, 2014	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	24					
Container Number						
Wt. Sample (wet+tare)(g)	59.30					
Wt. Sample (dry+tare)(g)	50.19					
Wt. Tare (g)	16.45					
Wt. Dry Soil (g)	33.7					
Wt. Water (g)	9.1					
Water Content (%)	27.0%					

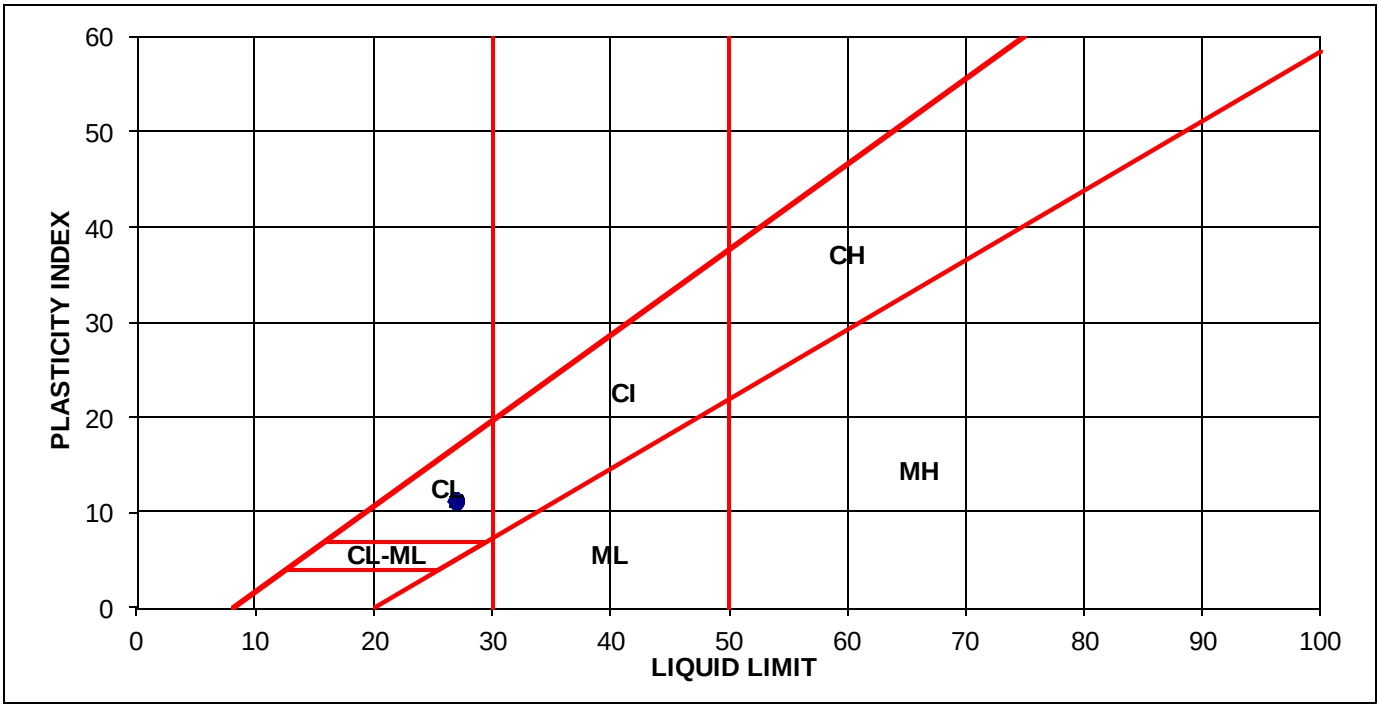
AVERAGE VALUES	
Liquid Limit	26.9
Plastic Limit	15.5
Plasticity Index	11.3

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	38.59		
Wt. Sample (dry+tare)(g)	35.02		
Wt. Tare (g)	12.06		
Wt. Dry Soil (g)	23.0		
Wt. Water (g)	3.6		
Water Content (%)	15.5%		



FORM: SAFM TH14-10 #5 Att.xlsx
DATE: 2/26/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE:	14-10	DEPTH :	3.05m
DATE :	February 25, 2014	TECHNICIAN :	GU

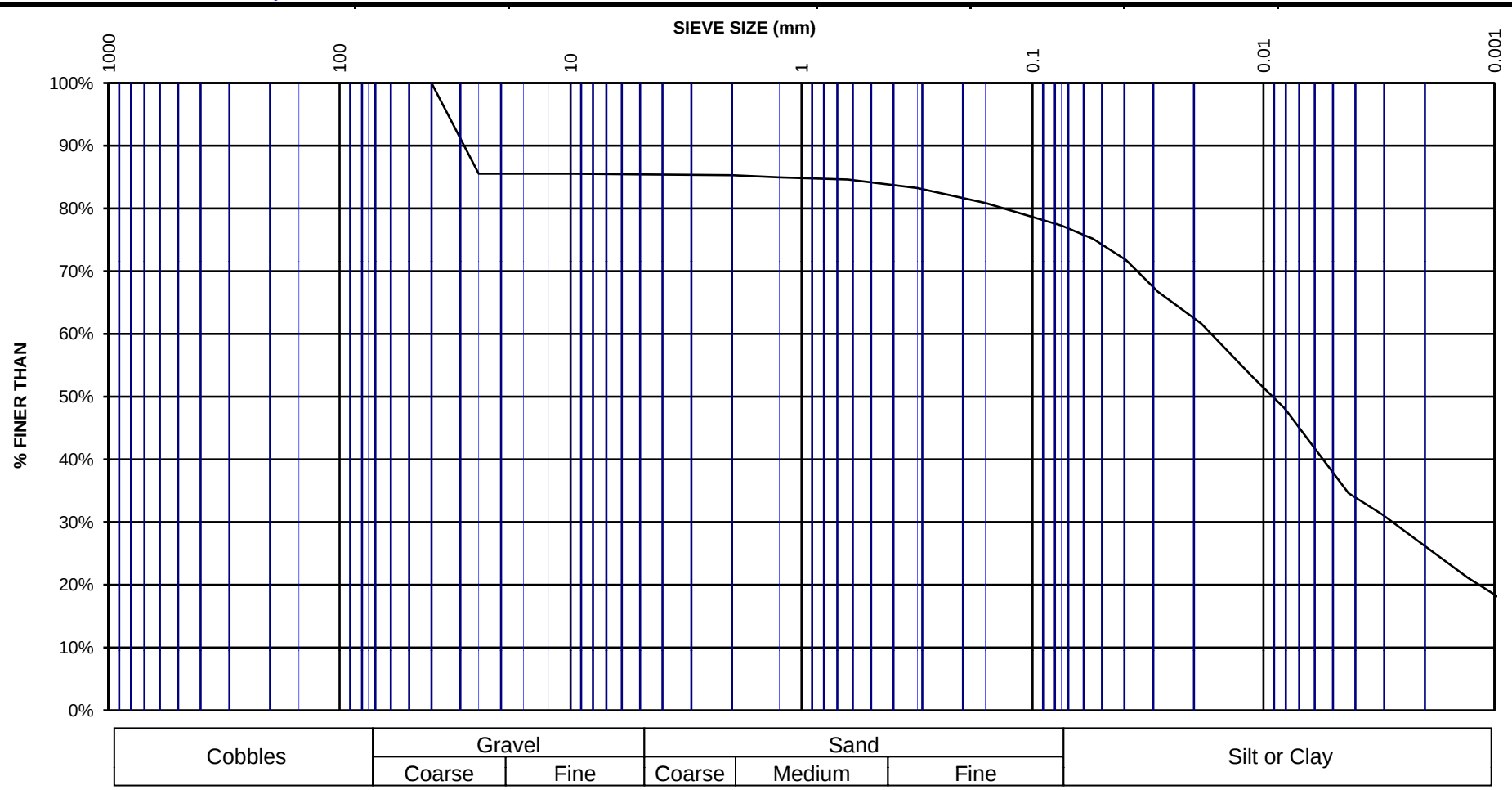
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	265.3	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	165.3	25,000	1	25.0	23.9	14%	86%	
Moisture Content		20,000	3/4	20.0	23.9	14%	86%	
Wet + Tare		16,000	5/8	16.0	23.9	14%	86%	
Dry+Tare		12,500	1/2	12.5	23.9	14%	86%	
Tare		10,000	3/8	10.0	23.9	14%	85.5%	
MC (%)		5,000	0.185	5.0	24.1	15%	85.4%	
	Passing							
After Washing		2,000	0.0937	2.0	24.3	15%	85.3%	
Wt. Dry+Tare		1,250	0.0469	1.25	24.9	15%	85.0%	
Tare		630	0.0234	0.63	25.4	15%	84.6%	
Wt. Dry		315	0.0116	0.315	27.7	17%	83.3%	
Tare No.		160	0.0059	0.160	31.6	19%	80.9%	
		75	0.00295	0.075	37.6	23%	77.3%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	265.3	49	0.5	0.055	20	45	75.2%	
Wt Tare	100.0	47	1	0.039	20	43	71.8%	
Wt Dry	165.3	44	2	0.029	20	40	66.7%	
Sample Size :	50	41	5	0.019	20	37	61.6%	
Wt Retained 2 mm:	24.3	36	15	0.011	20	32	53.2%	
% Passing 2 mm:	85.3%	33	30	0.008	20	29	48.1%	
Specific Gravity :	2.70	29	60	0.006	20	25	41.4%	
Hydrometer No.:	43-9856	25	120	0.004	20	21	34.6%	
Solution (g/L) :	40	23	240	0.003	20	19	31.2%	
		17	1440	0.001	20	13	21.1%	
		15	2880	0.001	20	11	17.7%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE:	14-10	DEPTH :	3.05m
DATE :	February 25, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-10#5 Hydro.xls
DATE: 2/26/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C1
BOREHOLE:	TH14-10	DEPTH :	6.5m
DATE :	March 3, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	29					
Container Number						
Wt. Sample (wet+tare)(g)	42.59					
Wt. Sample (dry+tare)(g)	34.25					
Wt. Tare (g)	12.08					
Wt. Dry Soil (g)	22.2					
Wt. Water (g)	8.3					
Water Content (%)	37.6%					

AVERAGE VALUES

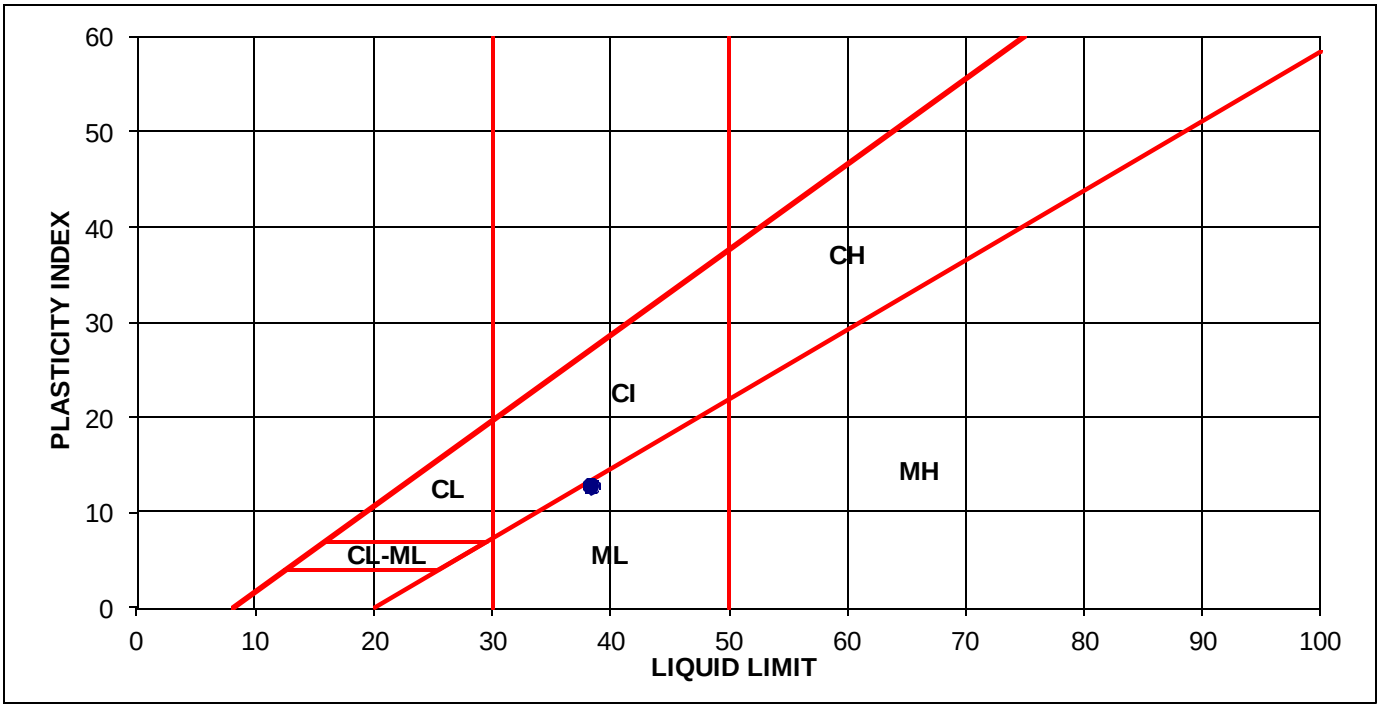
Liquid Limit	38.3
Plastic Limit	25.4
Plasticity Index	12.9

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.98		
Wt. Sample (dry+tare)(g)	28.83		
Wt. Tare (g)	16.44		
Wt. Dry Soil (g)	12.4		
Wt. Water (g)	3.2		
Water Content (%)	25.4%		



FORM: SAFM TH14-10#C1 Att.xlsx
DATE: 3/4/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C3
BOREHOLE:	TH14-10	DEPTH :	13.1m
DATE :	March 3, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	17					
Container Number						
Wt. Sample (wet+tare)(g)	48.82					
Wt. Sample (dry+tare)(g)	40.72					
Wt. Tare (g)	11.54					
Wt. Dry Soil (g)	29.2					
Wt. Water (g)	8.1					
Water Content (%)	27.8%					

AVERAGE VALUES

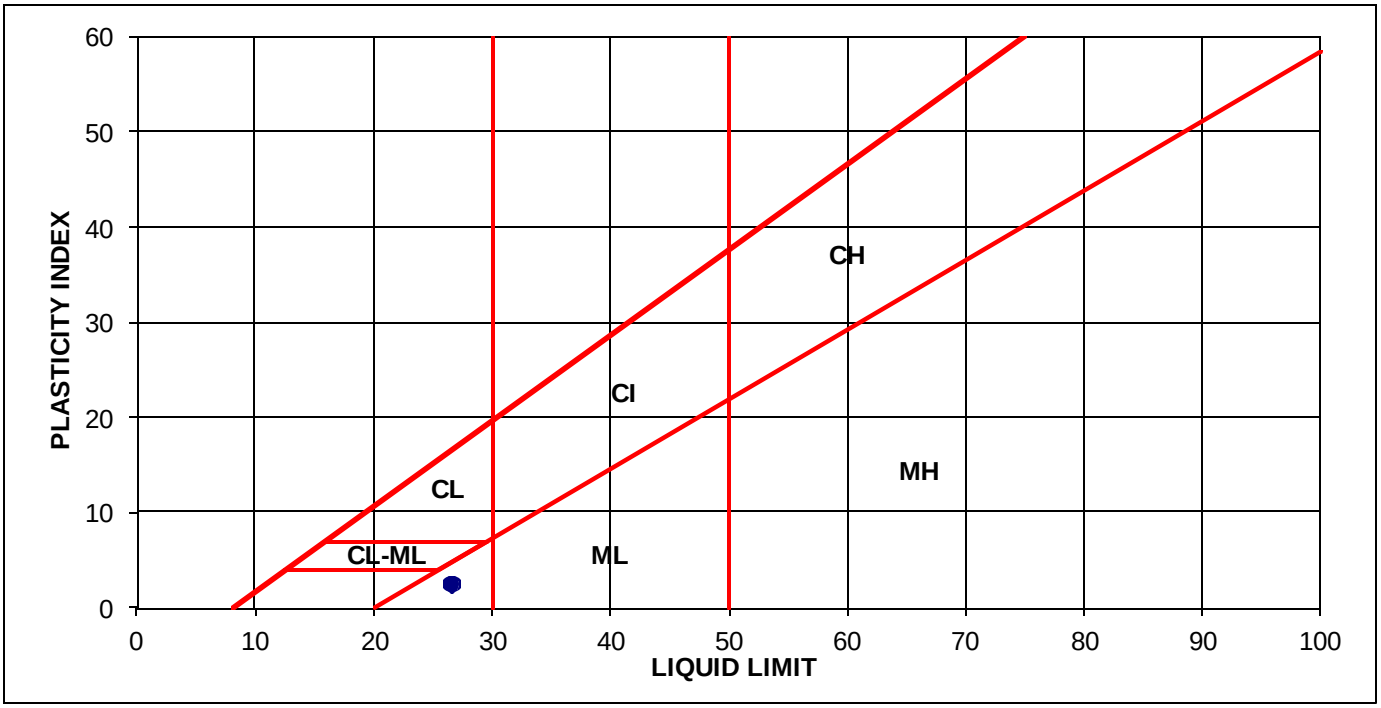
Liquid Limit	26.5
Plastic Limit	23.9
Plasticity Index	2.6

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.17		
Wt. Sample (dry+tare)(g)	26.16		
Wt. Tare (g)	13.55		
Wt. Dry Soil (g)	12.6		
Wt. Water (g)	3.0		
Water Content (%)	23.9%		



FORM: SAFM TH14-10#C3 Att.xlsx
DATE: 3/4/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	10
BOREHOLE:	TH14-11	DEPTH :	6.85m
DATE :	February 25, 2014	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	20					
Container Number						
Wt. Sample (wet+tare)(g)	56.01					
Wt. Sample (dry+tare)(g)	48.26					
Wt. Tare (g)	13.54					
Wt. Dry Soil (g)	34.7					
Wt. Water (g)	7.8					
Water Content (%)	22.3%					

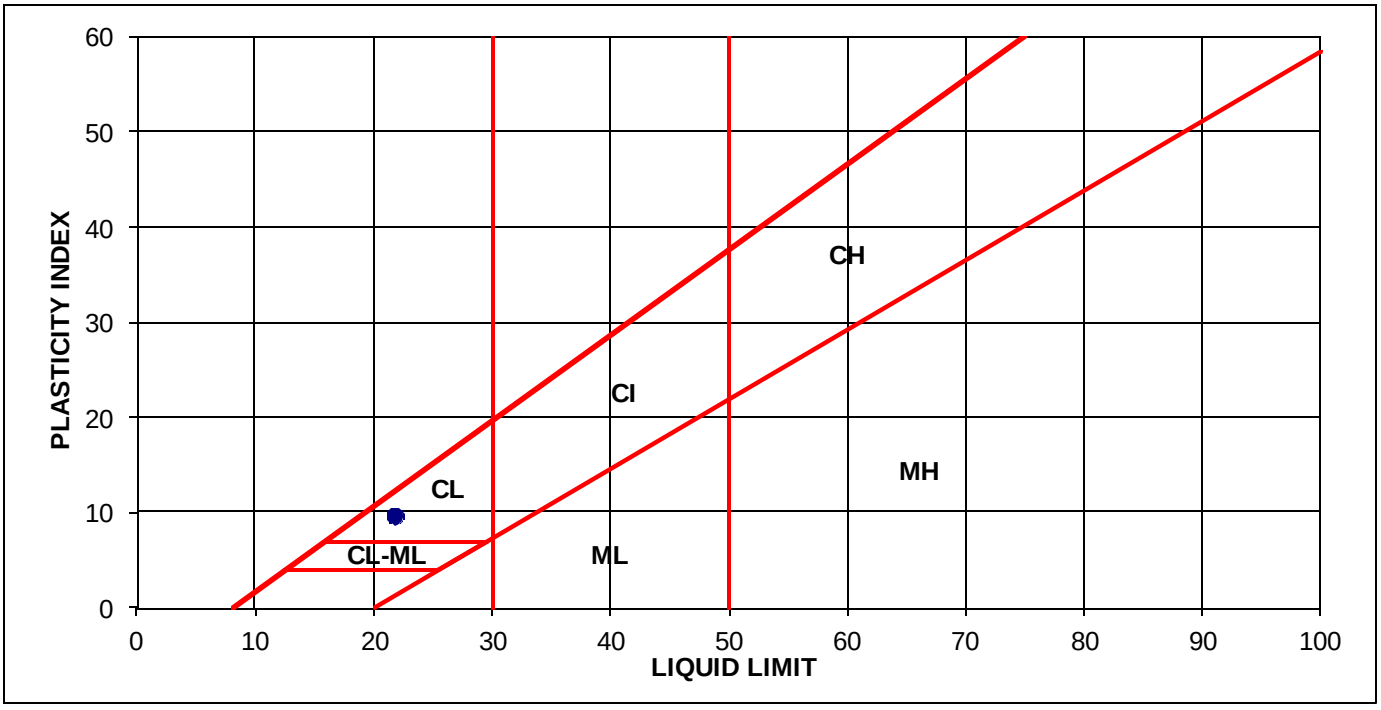
AVERAGE VALUES	
Liquid Limit	21.7
Plastic Limit	12.0
Plasticity Index	9.7

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	36.44		
Wt. Sample (dry+tare)(g)	33.83		
Wt. Tare (g)	12.09		
Wt. Dry Soil (g)	21.7		
Wt. Water (g)	2.6		
Water Content (%)	12.0%		



FORM: SAFM TH14-11 #10 Att.xlsx
DATE: 2/26/2014

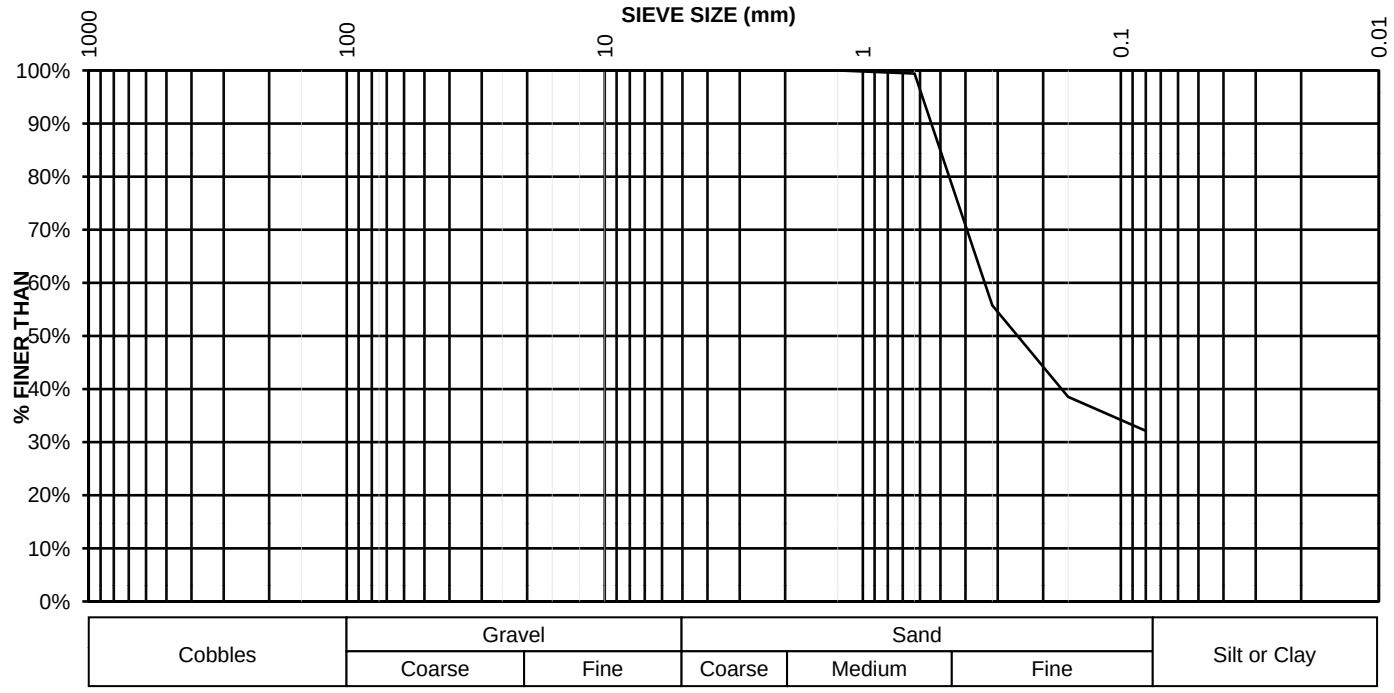
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE :	14-11	DEPTH :	2.5m
DATE :	February 25, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	770.6	50000	2	50.0			100%		
Tare	261.2	40000	1 1/2	40.0			100%		
Wt. Dry	509.4	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0			100%		
MC (%)		5000	0.185	5.0			100%		
	Passing								
After Washing		2000	0.0937	2.0			100%		
Wt. Dry+Tare	610.4	1250	0.0469	1.25			100%		
Tare	261.2	630	0.0234	0.630	3.0	1%	99%		
Wt. Dry	349.2	315	0.0116	0.315	225.3	44%	56%		
Tare No.		160	0.0059	0.160	313.1	61%	39%		
		80	0.0029	0.080	345.7	68%	32%		
		PAN			249.2				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-11 #4 Sieve.xls
DATE: 2/26/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	10
TESTHOLE:	14-11	DEPTH :	6.85m
DATE :	February 25, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	276.0	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	176.0	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0	1.3	1%	99.3%	
MC (%)		5,000	0.185	5.0	6.3	4%	96.4%	
	Passing							
After Washing		2,000	0.0937	2.0	7.3	4%	95.9%	
Wt. Dry+Tare		1,250	0.0469	1.25	9.7	5%	94.5%	
Tare		630	0.0234	0.63	13.0	7%	92.6%	
Wt. Dry		315	0.0116	0.315	19.1	11%	89.1%	
Tare No.		160	0.0059	0.160	30.6	17%	82.6%	
		75	0.00295	0.075	51.8	29%	70.5%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	276.0	39	0.5	0.060	20	35	65.5%	
Wt Tare	100.0	36	1	0.043	20	32	59.8%	
Wt Dry	176.0	32	2	0.032	20	28	52.2%	
Sample Size :	50	28	5	0.021	20	24	44.6%	
Wt Retained 2 mm:	7.3	23	15	0.012	20	19	35.1%	
% Passing 2 mm:	95.9%	20	30	0.009	20	16	29.4%	
Specific Gravity :	2.70	18	60	0.006	20	14	25.6%	
Hydrometer No.:	43-9856	16	120	0.005	20	12	21.8%	
Solution (g/L) :	40	14	240	0.003	20	10	18.0%	
		12	1440	0.001	20	8	14.2%	
		11	2880	0.001	20	7	12.3%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	10
TESTHOLE:	14-11	DEPTH :	6.85m
DATE :	February 25, 2014	TECHNICIAN :	GU

FORM: SAFM TH14-11#10 Hydro.xls
DATE: 2/26/2014

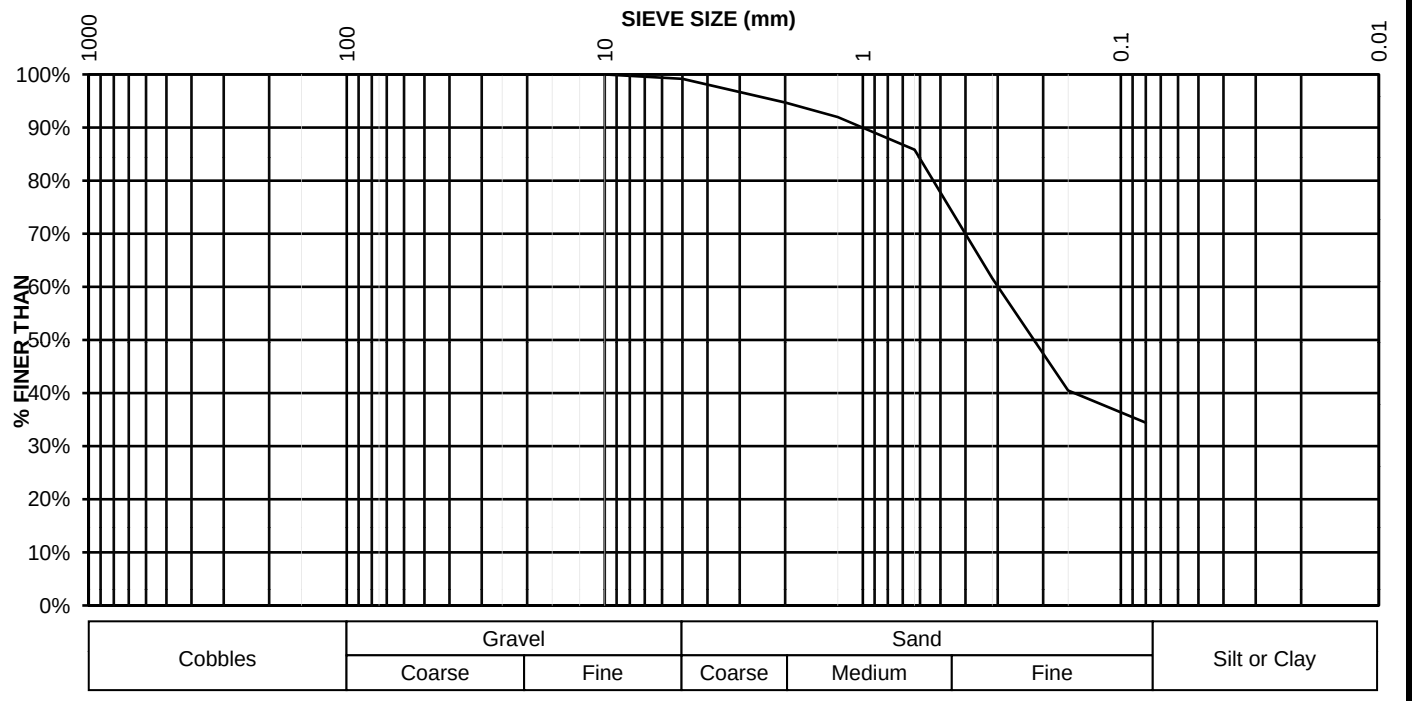
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	2
TESTHOLE :	14-12	DEPTH :	0.75m
DATE :	February 18, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	557.2	50000	2	50.0			100%		
Tare	233.6	40000	1 1/2	40.0			100%		
Wt. Dry	323.6	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0			100%		
MC (%)		5000	0.185	5.0	2.7	1%	99%		
	Passing								
After Washing		2000	0.0937	2.0	17.1	5%	95%		
Wt. Dry+Tare	446.1	1250	0.0469	1.25	26.0	8%	92%		
Tare	233.6	630	0.0234	0.630	45.9	14%	86%		
Wt. Dry	212.5	315	0.0116	0.315	124.2	38%	62%		
Tare No.		160	0.0059	0.160	192.6	60%	40%		
		80	0.0029	0.080	212.2	66%	34%		
		PAN			212.4				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-12#2 Sieve.xls
DATE: 2/19/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
BOREHOLE:	TH14-12	DEPTH :	3.05m
DATE :	February 18, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	29					
Container Number						
Wt. Sample (wet+tare)(g)	38.01					
Wt. Sample (dry+tare)(g)	31.84					
Wt. Tare (g)	12.07					
Wt. Dry Soil (g)	19.8					
Wt. Water (g)	6.2					
Water Content (%)	31.2%					

AVERAGE VALUES

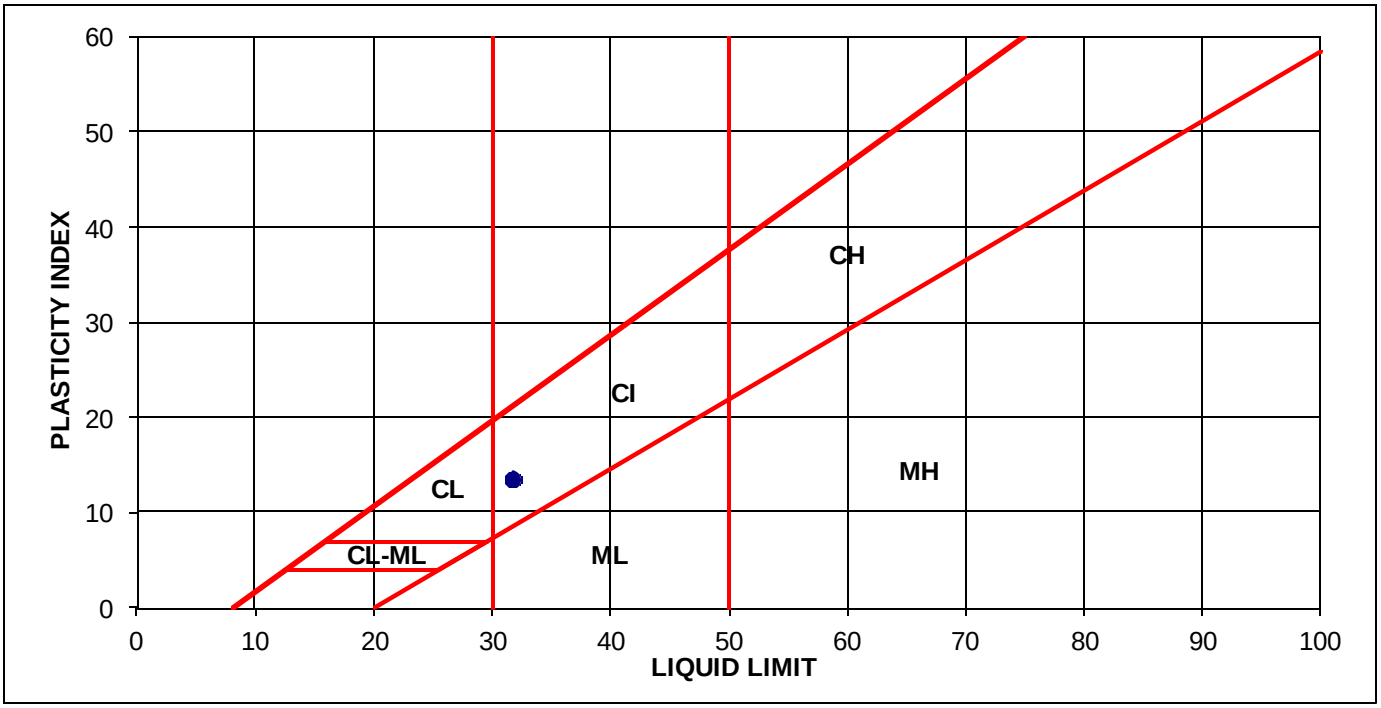
Liquid Limit	31.7
Plastic Limit	18.1
Plasticity Index	13.6

SAMPLE DESCRIPTION

Classification: **CI-CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	34.28		
Wt. Sample (dry+tare)(g)	31.54		
Wt. Tare (g)	16.44		
Wt. Dry Soil (g)	15.1		
Wt. Water (g)	2.7		
Water Content (%)	18.1%		



FORM: SAFM TH14-12#5 Att.xlsx
DATE: 2/19/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	9
BOREHOLE:	TH14-12	DEPTH :	6.05m
DATE :	February 18, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	19					
Container Number						
Wt. Sample (wet+tare)(g)	38.28					
Wt. Sample (dry+tare)(g)	32.09					
Wt. Tare (g)	11.54					
Wt. Dry Soil (g)	20.6					
Wt. Water (g)	6.2					
Water Content (%)	30.1%					

AVERAGE VALUES

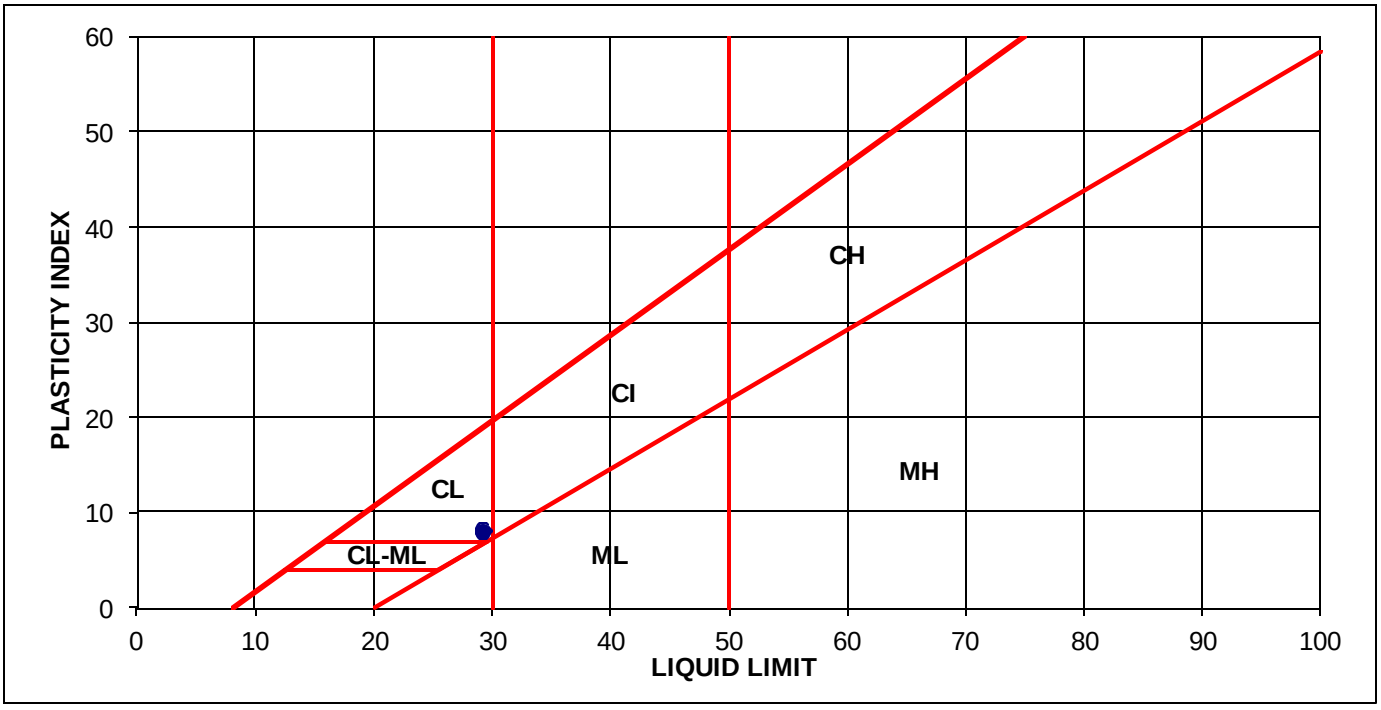
Liquid Limit	29.1
Plastic Limit	21.0
Plasticity Index	8.2

SAMPLE DESCRIPTION

Classification: **CL-CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	33.52		
Wt. Sample (dry+tare)(g)	30.50		
Wt. Tare (g)	16.09		
Wt. Dry Soil (g)	14.4		
Wt. Water (g)	3.0		
Water Content (%)	21.0%		



FORM: SAFM TH14-12#9 Att.xlsx
DATE: 2/19/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
BOREHOLE:	TH14-13	DEPTH :	2.5m
DATE :	February 25, 2014	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	24					
Container Number						
Wt. Sample (wet+tare)(g)	65.16					
Wt. Sample (dry+tare)(g)	57.06					
Wt. Tare (g)	16.33					
Wt. Dry Soil (g)	40.7					
Wt. Water (g)	8.1					
Water Content (%)	19.9%					

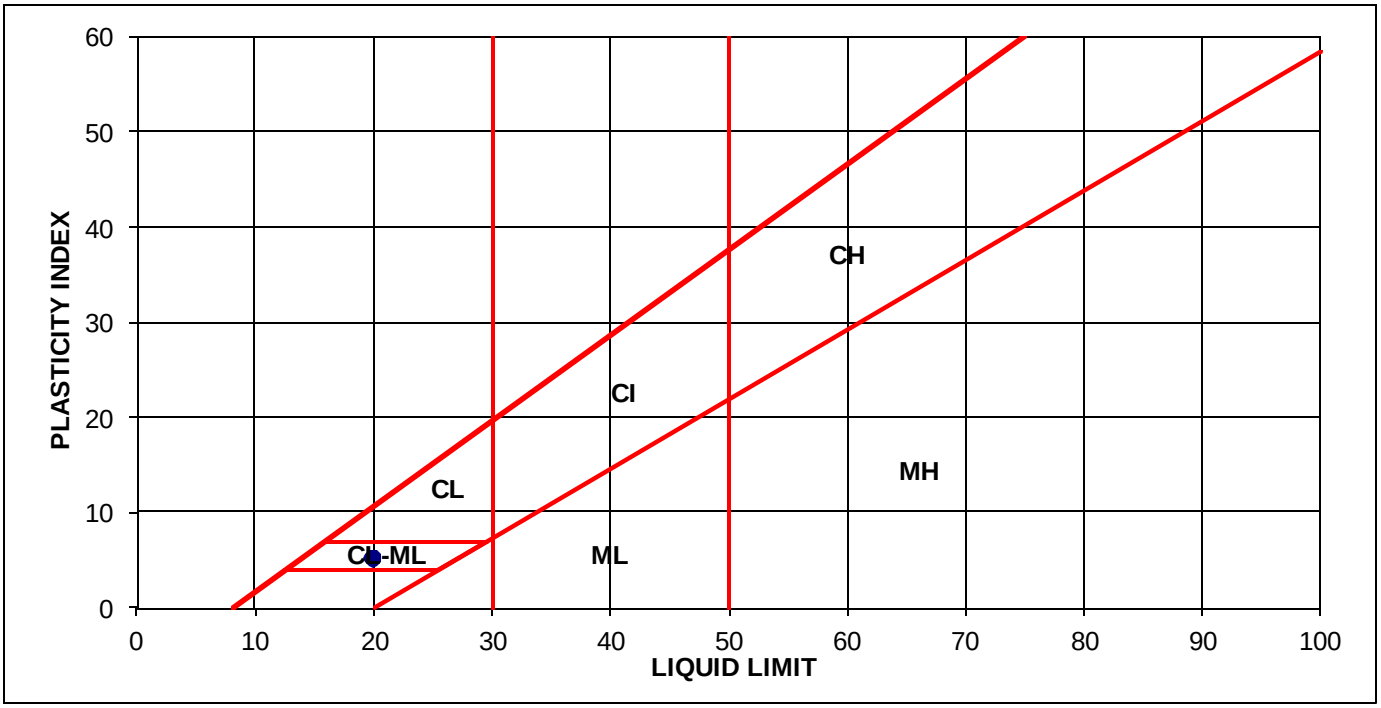
AVERAGE VALUES	
Liquid Limit	19.8
Plastic Limit	14.5
Plasticity Index	5.3

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	27.98		
Wt. Sample (dry+tare)(g)	25.93		
Wt. Tare (g)	11.75		
Wt. Dry Soil (g)	14.2		
Wt. Water (g)	2.1		
Water Content (%)	14.5%		



FORM: SAFM TH14-13 #4 Att.xlsx
DATE: 2/26/2014

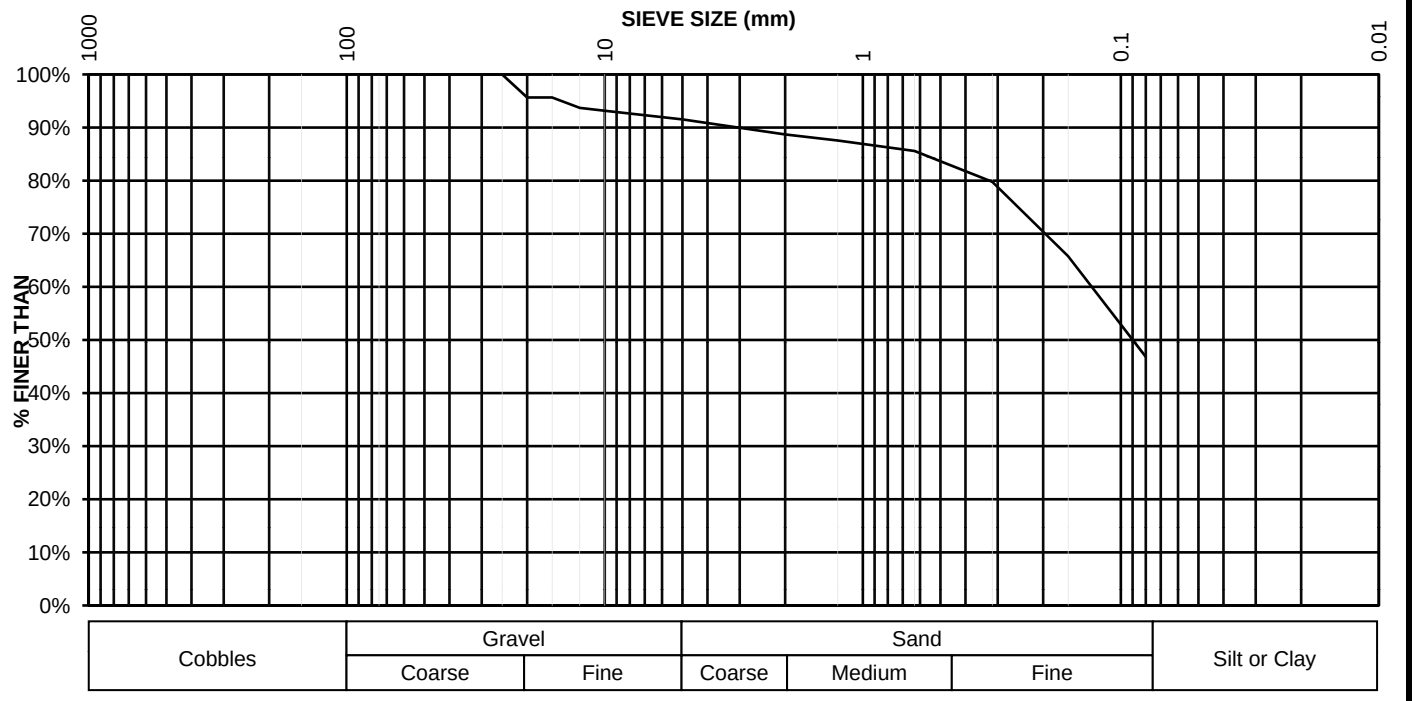
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
TESTHOLE :	14-13	DEPTH :	3.85m
DATE :	February 25, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	710.6	50000	2	50.0			100%		
Tare	252.0	40000	1 1/2	40.0			100%		
Wt. Dry	458.6	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0	19.9	4%	96%		
Wet + Tare		16000	5/8	16.0	19.9	4%	96%		
Dry+Tare		12500	1/2	12.5	28.9	6%	94%		
Tare		10000	3/8	10.0	31.4	7%	93%		
MC (%)		5000	0.185	5.0	38.8	8%	92%		
	Passing								
After Washing		2000	0.0937	2.0	51.8	11%	89%		
Wt. Dry+Tare	513.8	1250	0.0469	1.25	57.1	12%	88%		
Tare	252.0	630	0.0234	0.630	66.1	14%	86%		
Wt. Dry	261.8	315	0.0116	0.315	92.7	20%	80%		
Tare No.		160	0.0059	0.160	157.0	34%	66%		
		80	0.0029	0.080	243.9	53%	47%		
		PAN			261.6				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-13 #6 Sieve.xls
DATE: 2/26/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	8
BOREHOLE:	TH14-13	DEPTH :	5.3m
DATE :	February 25, 2014	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	26					
Container Number						
Wt. Sample (wet+tare)(g)	57.39					
Wt. Sample (dry+tare)(g)	47.70					
Wt. Tare (g)	16.09					
Wt. Dry Soil (g)	31.6					
Wt. Water (g)	9.7					
Water Content (%)	30.7%					

AVERAGE VALUES

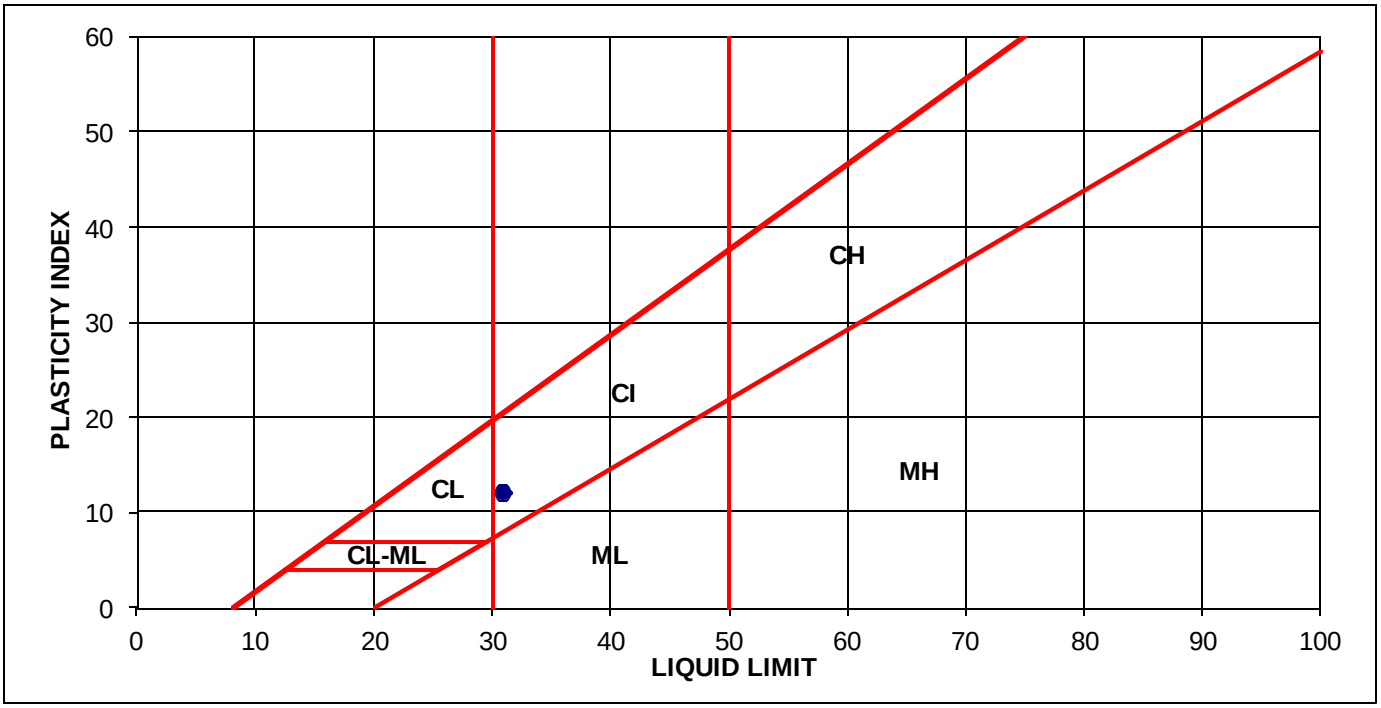
Liquid Limit	30.8
Plastic Limit	18.6
Plasticity Index	12.2

SAMPLE DESCRIPTION

Classification: **CI-CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.78		
Wt. Sample (dry+tare)(g)	26.92		
Wt. Tare (g)	11.54		
Wt. Dry Soil (g)	15.4		
Wt. Water (g)	2.9		
Water Content (%)	18.6%		



FORM: SAFM TH14-13 #8 Att.xlsx
DATE: 2/26/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
BOREHOLE:	TH14-14	DEPTH :	1.7m
DATE :	February 6, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	32					
Container Number						
Wt. Sample (wet+tare)(g)	47.15					
Wt. Sample (dry+tare)(g)	41.18					
Wt. Tare (g)	12.11					
Wt. Dry Soil (g)	29.1					
Wt. Water (g)	6.0					
Water Content (%)	20.5%					

AVERAGE VALUES

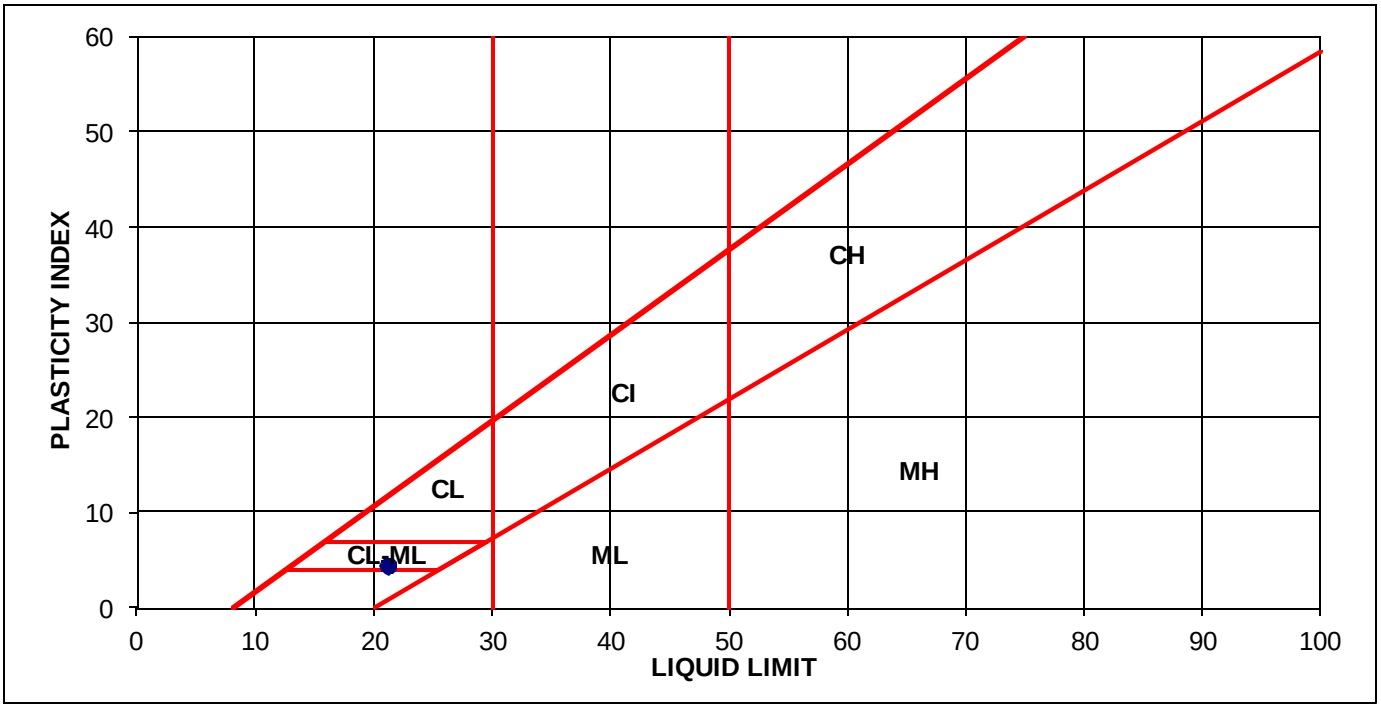
Liquid Limit	21.1
Plastic Limit	16.6
Plasticity Index	4.5

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	35.84		
Wt. Sample (dry+tare)(g)	32.96		
Wt. Tare (g)	15.64		
Wt. Dry Soil (g)	17.3		
Wt. Water (g)	2.9		
Water Content (%)	16.6%		



FORM: SAFM TH14-14 #3 Att.xlsx
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
BOREHOLE:	TH14-14	DEPTH :	3.9m
DATE :	February 6, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	20					
Container Number						
Wt. Sample (wet+tare)(g)	44.66					
Wt. Sample (dry+tare)(g)	39.01					
Wt. Tare (g)	12.06					
Wt. Dry Soil (g)	27.0					
Wt. Water (g)	5.7					
Water Content (%)	21.0%					

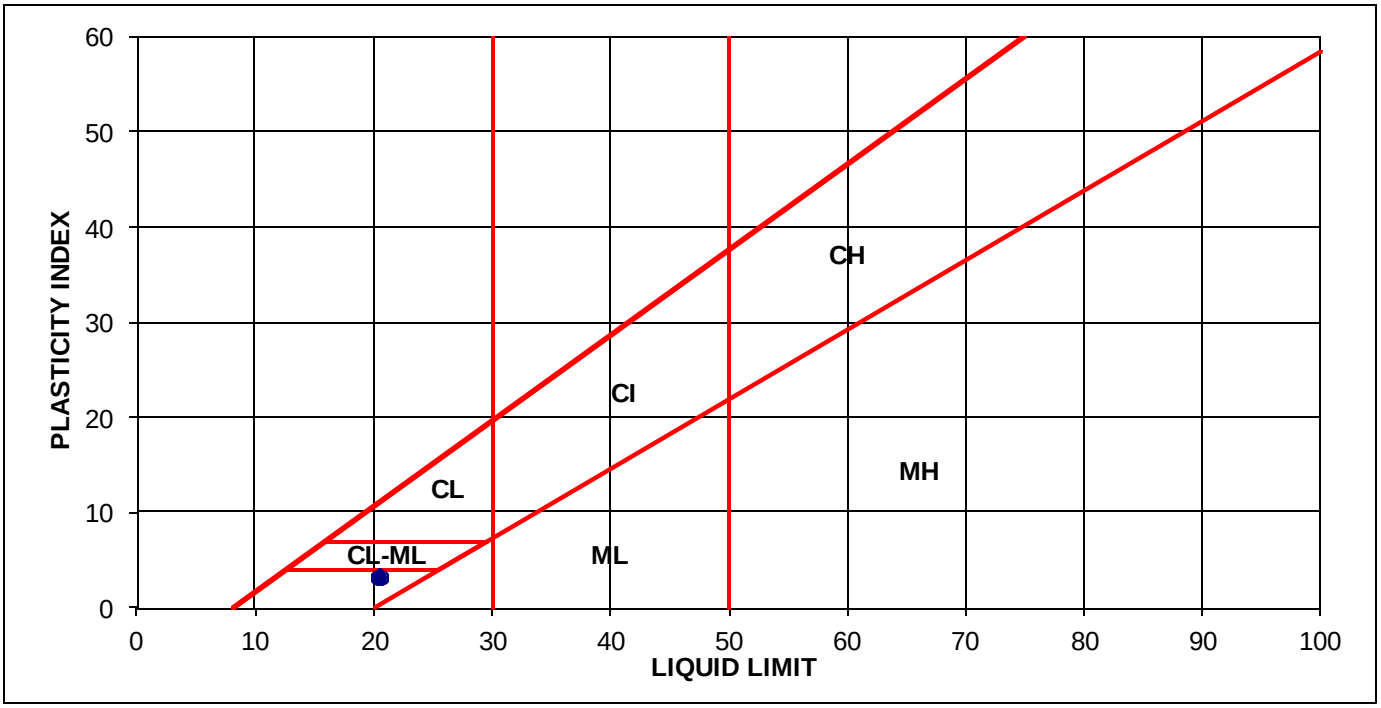
AVERAGE VALUES	
Liquid Limit	20.4
Plastic Limit	17.1
Plasticity Index	3.3

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	32.40		
Wt. Sample (dry+tare)(g)	30.06		
Wt. Tare (g)	16.37		
Wt. Dry Soil (g)	13.7		
Wt. Water (g)	2.3		
Water Content (%)	17.1%		



FORM: SAFM TH14-14 #6 Att.xlsx
DATE: 2/7/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
TESTHOLE:	14-14	DEPTH :	3.9
DATE :	February 7, 2014	TECHNICIAN :	GU

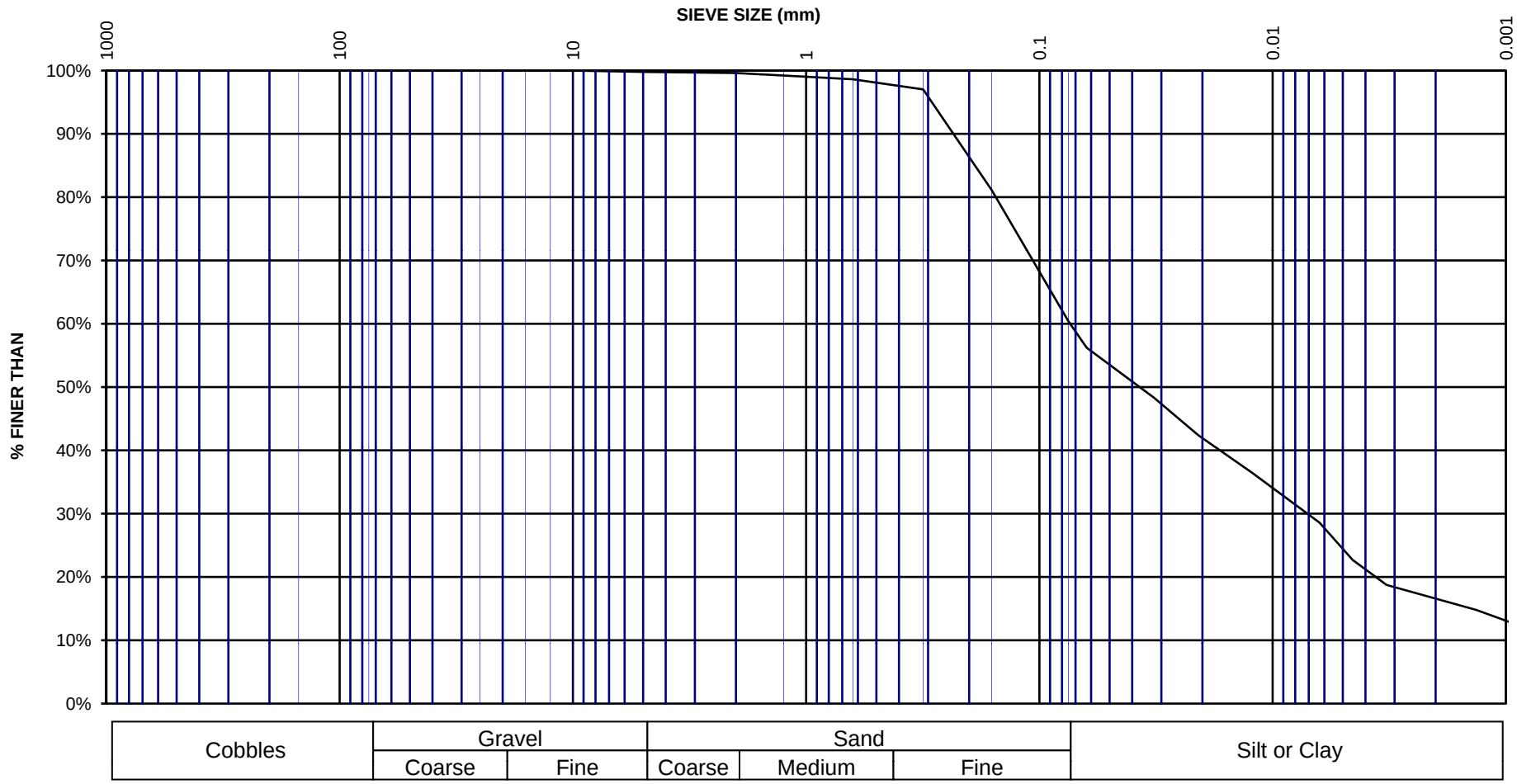
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	618.5	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	518.5	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0		0%	100.0%	
MC (%)		5,000	0.185	5.0	1.1	0%	99.8%	
	Passing							
After Washing		2,000	0.0937	2.0	2.0	0%	99.6%	
Wt. Dry+Tare		1,250	0.0469	1.25	4.1	1%	99.2%	
Tare		630	0.0234	0.63	7.2	1%	98.6%	
Wt. Dry		315	0.0116	0.315	15.4	3%	97.0%	
Tare No.		160	0.0059	0.160	98.1	19%	81.1%	
		75	0.00295	0.075	205.5	40%	60.4%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	618.5	33	0.5	0.063	20	29	56.2%	
Wt Tare	100.0	31	1	0.045	20	27	52.3%	
Wt Dry	518.5	29	2	0.032	20	25	48.3%	
Sample Size :	50	26	5	0.021	20	22	42.4%	
Wt Retained 2 mm:	2	23	15	0.012	20	19	36.5%	
% Passing 2 mm:	99.6%	21	30	0.009	20	17	32.5%	
Specific Gravity :	2.70	19	60	0.006	20	15	28.6%	
Hydrometer No.:	43-9856	16	120	0.005	20	12	22.7%	
Solution (g/L) :	40	14	240	0.003	20	10	18.7%	
		12	1440	0.001	20	8	14.8%	
		11	2880	0.001	20	7	12.8%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
TESTHOLE:	14-14	DEPTH :	3.9
DATE :	February 7, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-04#9 Hydro.xls
DATE: 2/7/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE:	14-15	DEPTH :	2.3m
DATE :	February 6, 2014	TECHNICIAN :	GU

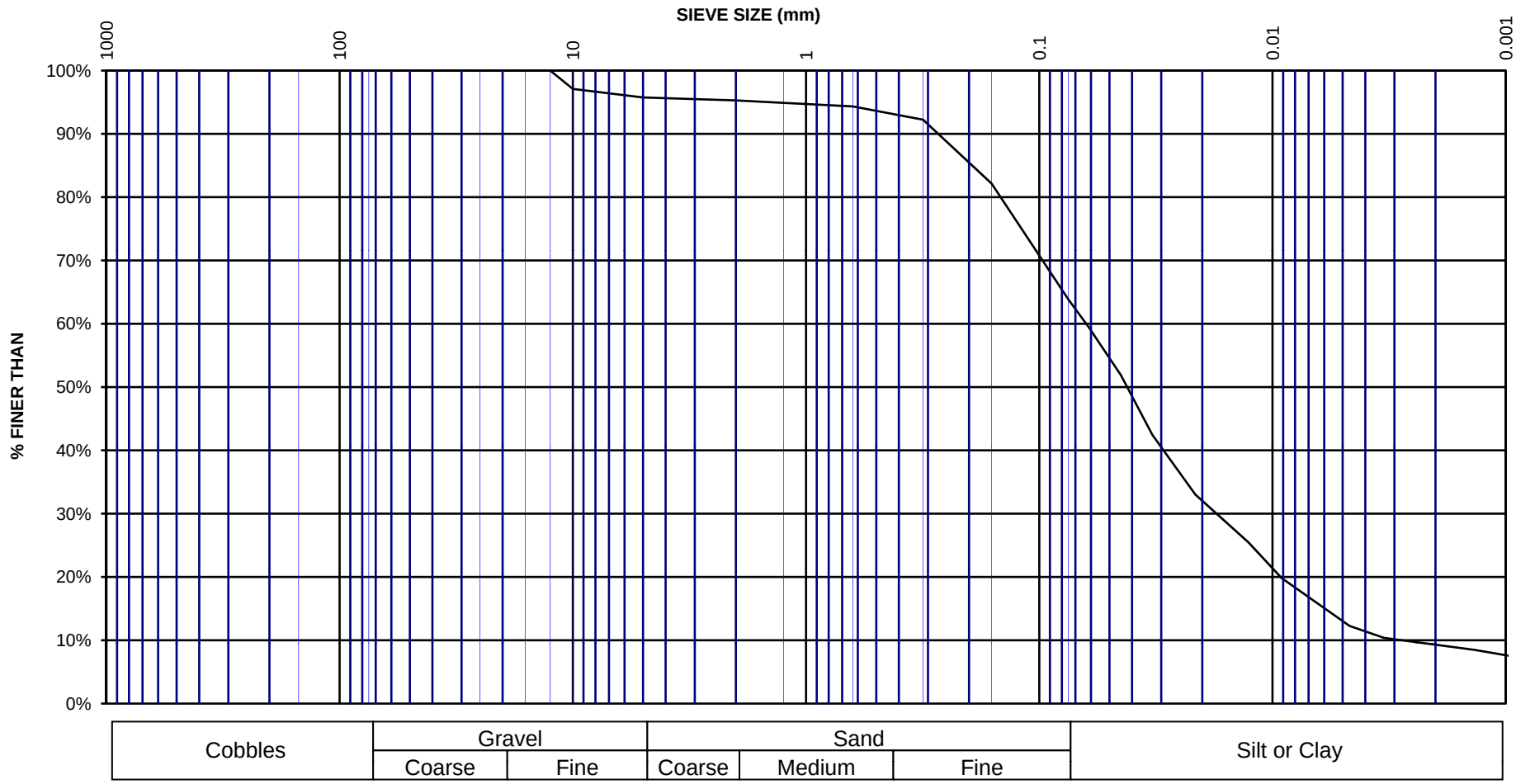
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	479.3	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	379.3	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0	11.0	3%	97.1%	
MC (%)		5,000	0.185	5.0	16.1	4%	95.8%	
	Passing							
After Washing		2,000	0.0937	2.0	17.9	5%	95.3%	
Wt. Dry+Tare		1,250	0.0469	1.25	19.3	5%	94.9%	
Tare		630	0.0234	0.63	21.5	6%	94.3%	
Wt. Dry		315	0.0116	0.315	29.5	8%	92.2%	
Tare No.		160	0.0059	0.160	67.8	18%	82.1%	
		75	0.00295	0.075	137.2	36%	63.8%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	479.3	36	0.5	0.061	20	32	59.4%	
Wt Tare	100.0	32	1	0.045	20	28	51.9%	
Wt Dry	379.3	27	2	0.033	20	23	42.4%	
Sample Size :	50	22	5	0.021	20	18	33.0%	
Wt Retained 2 mm:	17.9	18	15	0.013	20	14	25.5%	
% Passing 2 mm:	95.3%	15	30	0.009	20	11	19.8%	
Specific Gravity :	2.70	13	60	0.007	20	9	16.0%	
Hydrometer No.:	43-9856	11	120	0.005	20	7	12.3%	
Solution (g/L) :	40	10	240	0.003	20	6	10.4%	
		9	1440	0.001	20	5	8.5%	
		9	2880	0.001	20	4	7.5%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE:	14-15	DEPTH :	2.3m
DATE :	February 6, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-15#4 Hydro.xls
DATE: 2/6/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
BOREHOLE:	TH14-15	DEPTH :	3.3m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	17					
Container Number						
Wt. Sample (wet+tare)(g)	48.21					
Wt. Sample (dry+tare)(g)	42.21					
Wt. Tare (g)	11.72					
Wt. Dry Soil (g)	30.5					
Wt. Water (g)	6.0					
Water Content (%)	19.7%					

AVERAGE VALUES

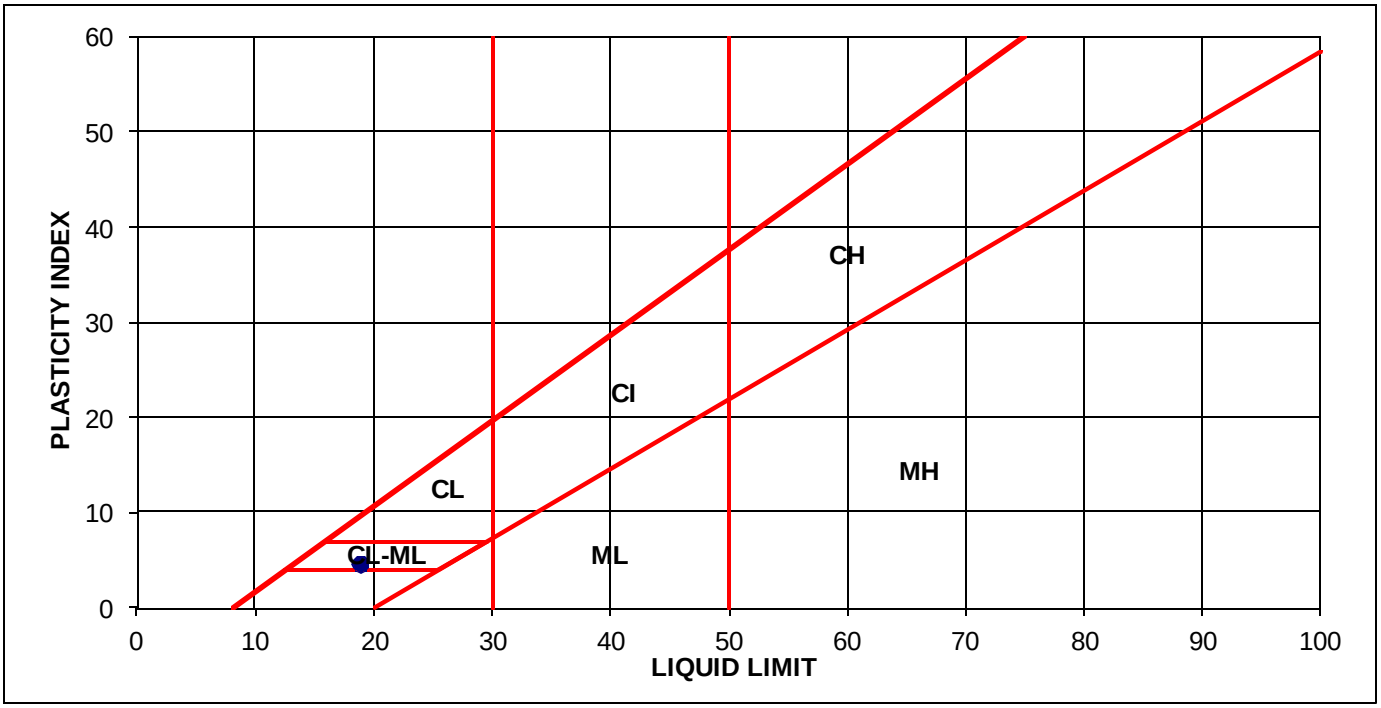
Liquid Limit	18.8
Plastic Limit	14.1
Plasticity Index	4.7

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	30.44		
Wt. Sample (dry+tare)(g)	28.36		
Wt. Tare (g)	13.61		
Wt. Dry Soil (g)	14.8		
Wt. Water (g)	2.1		
Water Content (%)	14.1%		



FORM: SAFM TH14-15#5 Att.xlsx
DATE: 2/5/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	7
BOREHOLE:	TH14-15	DEPTH :	4.8m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	33					
Container Number						
Wt. Sample (wet+tare)(g)	40.40					
Wt. Sample (dry+tare)(g)	33.68					
Wt. Tare (g)	12.05					
Wt. Dry Soil (g)	21.6					
Wt. Water (g)	6.7					
Water Content (%)	31.1%					

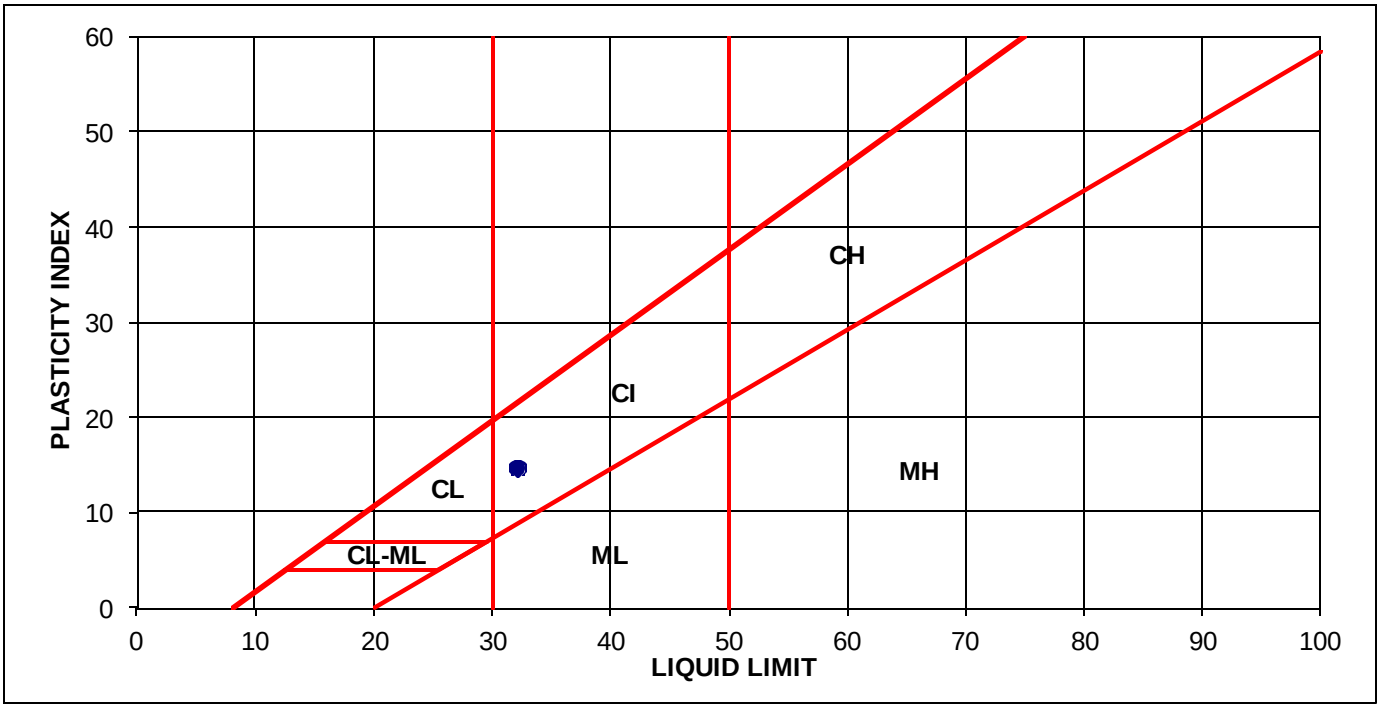
AVERAGE VALUES	
Liquid Limit	32.1
Plastic Limit	17.3
Plasticity Index	14.8

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.28		
Wt. Sample (dry+tare)(g)	29.08		
Wt. Tare (g)	16.37		
Wt. Dry Soil (g)	12.7		
Wt. Water (g)	2.2		
Water Content (%)	17.3%		



FORM: SAFM TH14-15#7 Att.xlsx
DATE: 2/5/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C1
BOREHOLE:	TH14-15	DEPTH :	8.0m
DATE :	February 11, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	17					
Container Number						
Wt. Sample (wet+tare)(g)	41.52					
Wt. Sample (dry+tare)(g)	33.49					
Wt. Tare (g)	11.71					
Wt. Dry Soil (g)	21.8					
Wt. Water (g)	8.0					
Water Content (%)	36.9%					

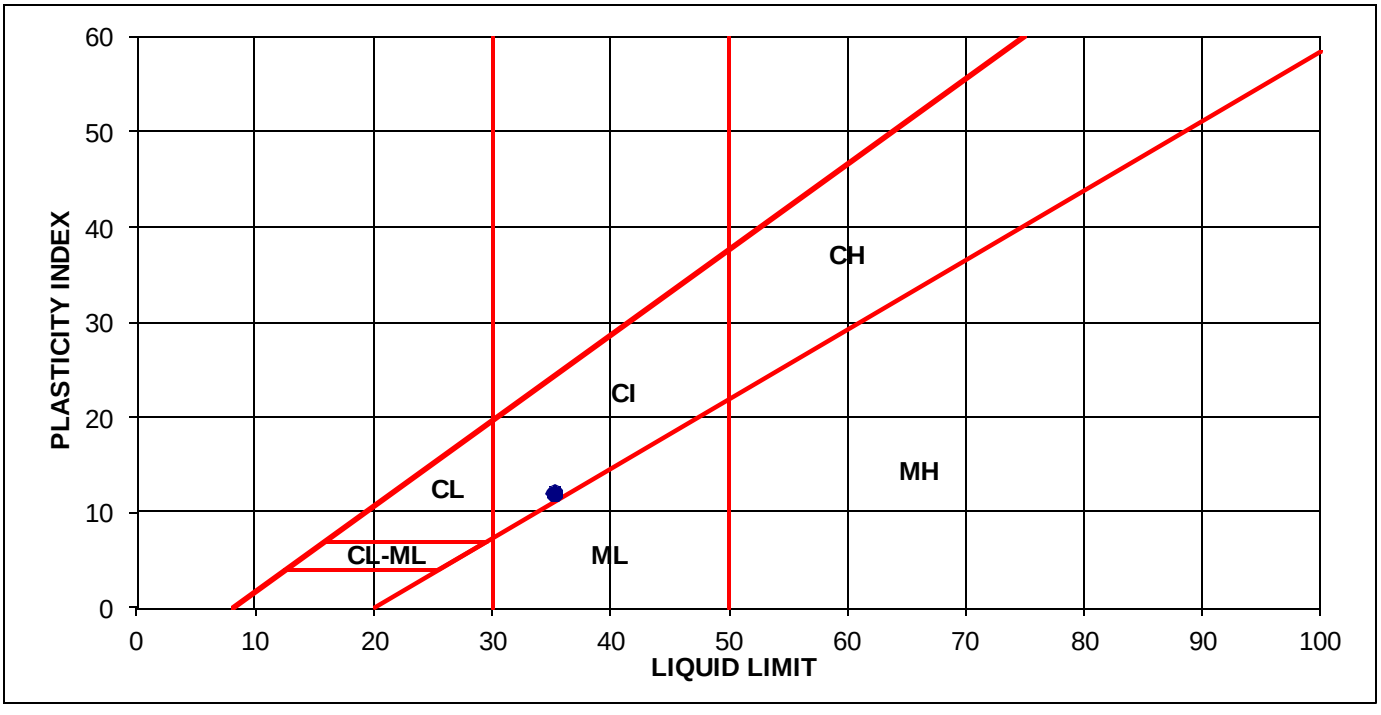
AVERAGE VALUES	
Liquid Limit	35.2
Plastic Limit	23.0
Plasticity Index	12.1

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1			
Container Number				
Wt. Sample (wet+tare)(g)	29.86			
Wt. Sample (dry+tare)(g)	27.33			
Wt. Tare (g)	16.35			
Wt. Dry Soil (g)	11.0			
Wt. Water (g)	2.5			
Water Content (%)	23.0%			



FORM: SAFM TH14-15#C1 Att.xlsx
DATE: 2/12/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C6
BOREHOLE:	TH14-15	DEPTH :	23.0m
DATE :	February 12, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	25					
Container Number						
Wt. Sample (wet+tare)(g)	40.23					
Wt. Sample (dry+tare)(g)	31.47					
Wt. Tare (g)	12.05					
Wt. Dry Soil (g)	19.4					
Wt. Water (g)	8.8					
Water Content (%)	45.1%					

AVERAGE VALUES

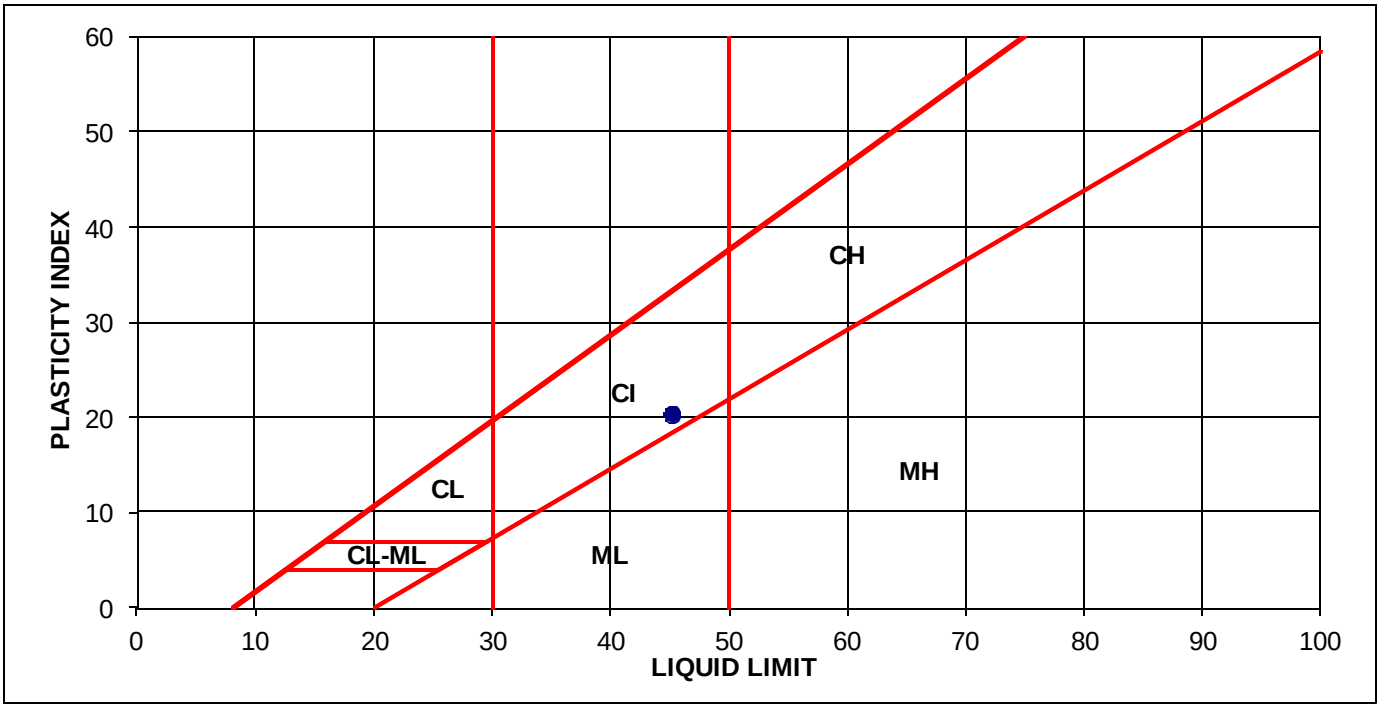
Liquid Limit	45.1
Plastic Limit	24.7
Plasticity Index	20.4

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	26.48		
Wt. Sample (dry+tare)(g)	23.68		
Wt. Tare (g)	12.35		
Wt. Dry Soil (g)	11.3		
Wt. Water (g)	2.8		
Water Content (%)	24.7%		



FORM: SAFM TH14-15#C6 Att.xlsx
DATE: 2/13/2014

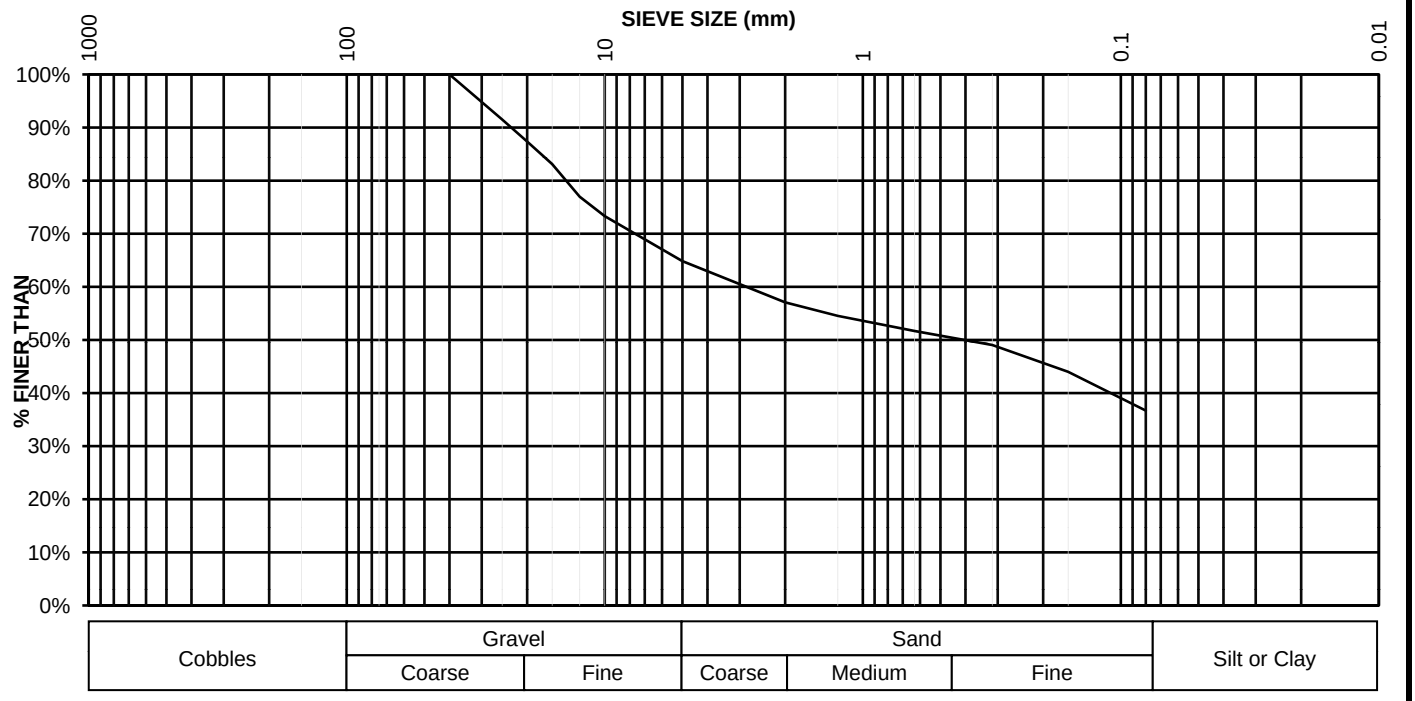
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
TESTHOLE :	14-16	DEPTH :	1.8m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	1520.1	50000	2	50.0			100%		
Tare	252.3	40000	1 1/2	40.0			100%		
Wt. Dry	1267.8	25000	1	25.0	107.6	8%	92%		
Moisture Content		20000	3/4	20.0	160.3	13%	87%		
Wet + Tare		16000	5/8	16.0	214.0	17%	83%		
Dry+Tare		12500	1/2	12.5	292.3	23%	77%		
Tare		10000	3/8	10.0	338.5	27%	73%		
MC (%)		5000	0.185	5.0	445.7	35%	65%		
	Passing								
After Washing		2000	0.0937	2.0	544.1	43%	57%		
Wt. Dry+Tare	1064.1	1250	0.0469	1.25	576.4	45%	55%		
Tare	252.3	630	0.0234	0.630	612.6	48%	52%		
Wt. Dry	811.8	315	0.0116	0.315	646.0	51%	49%		
Tare No.		160	0.0059	0.160	710.0	56%	44%		
		80	0.0029	0.080	802.6	63%	37%		
		PAN			811.1				

Classification:	GM or GC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-16 #3 Sieve.xls
DATE: 2/4/2014

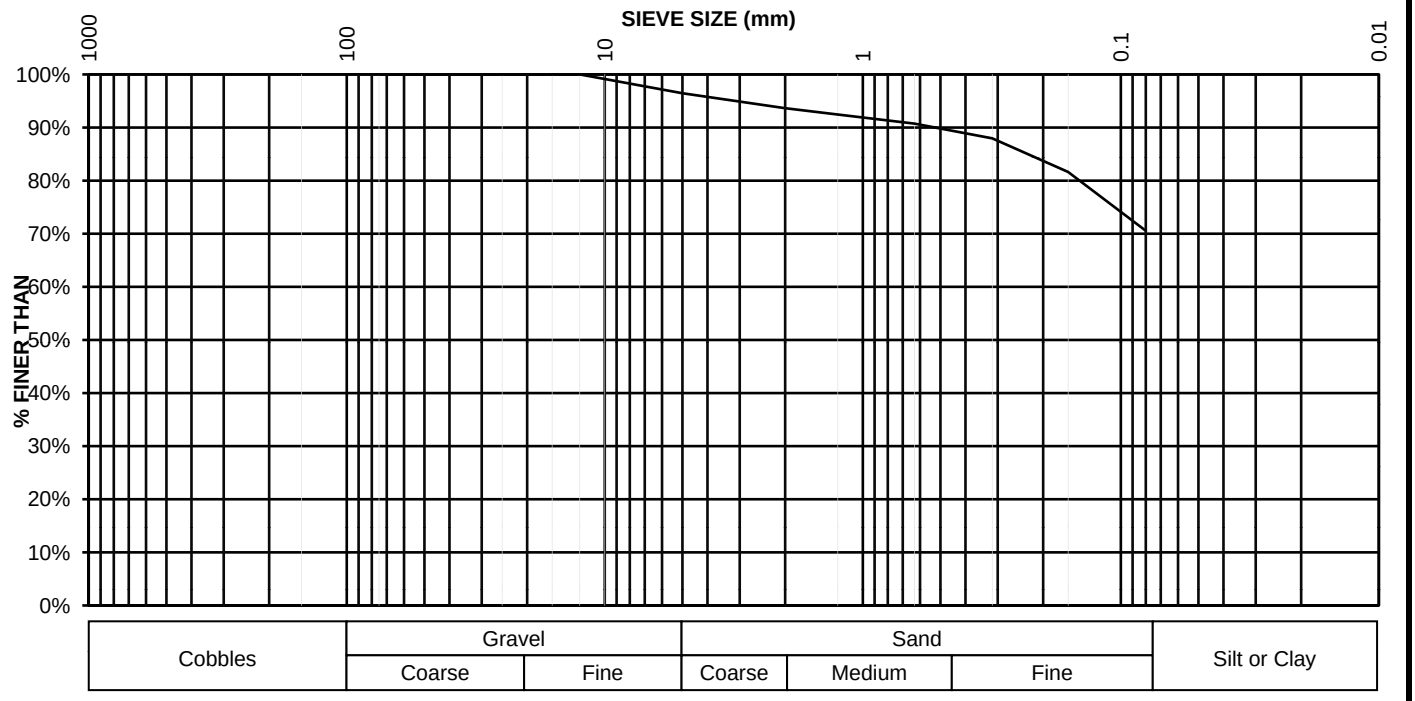
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
TESTHOLE :	14-16	DEPTH :	3.9m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	707.8	50000	2	50.0			100%		
Tare	264.1	40000	1 1/2	40.0			100%		
Wt. Dry	443.7	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0	3.8	1%	99%		
MC (%)		5000	0.185	5.0	15.7	4%	96%		
	Passing								
After Washing		2000	0.0937	2.0	28.2	6%	94%		
Wt. Dry+Tare	397.4	1250	0.0469	1.25	33.5	8%	92%		
Tare	264.1	630	0.0234	0.630	41.1	9%	91%		
Wt. Dry	133.3	315	0.0116	0.315	53.4	12%	88%		
Tare No.		160	0.0059	0.160	81.5	18%	82%		
		80	0.0029	0.080	130.6	29%	71%		
		PAN			133.2				

Classification:	SILT or CLAY	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-16 #6 Sieve.xls
DATE: 2/4/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C1
BOREHOLE:	TH14-16	DEPTH :	8.0m
DATE :	February 10, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	18					
Container Number						
Wt. Sample (wet+tare)(g)	45.21					
Wt. Sample (dry+tare)(g)	36.78					
Wt. Tare (g)	12.06					
Wt. Dry Soil (g)	24.7					
Wt. Water (g)	8.4					
Water Content (%)	34.1%					

AVERAGE VALUES

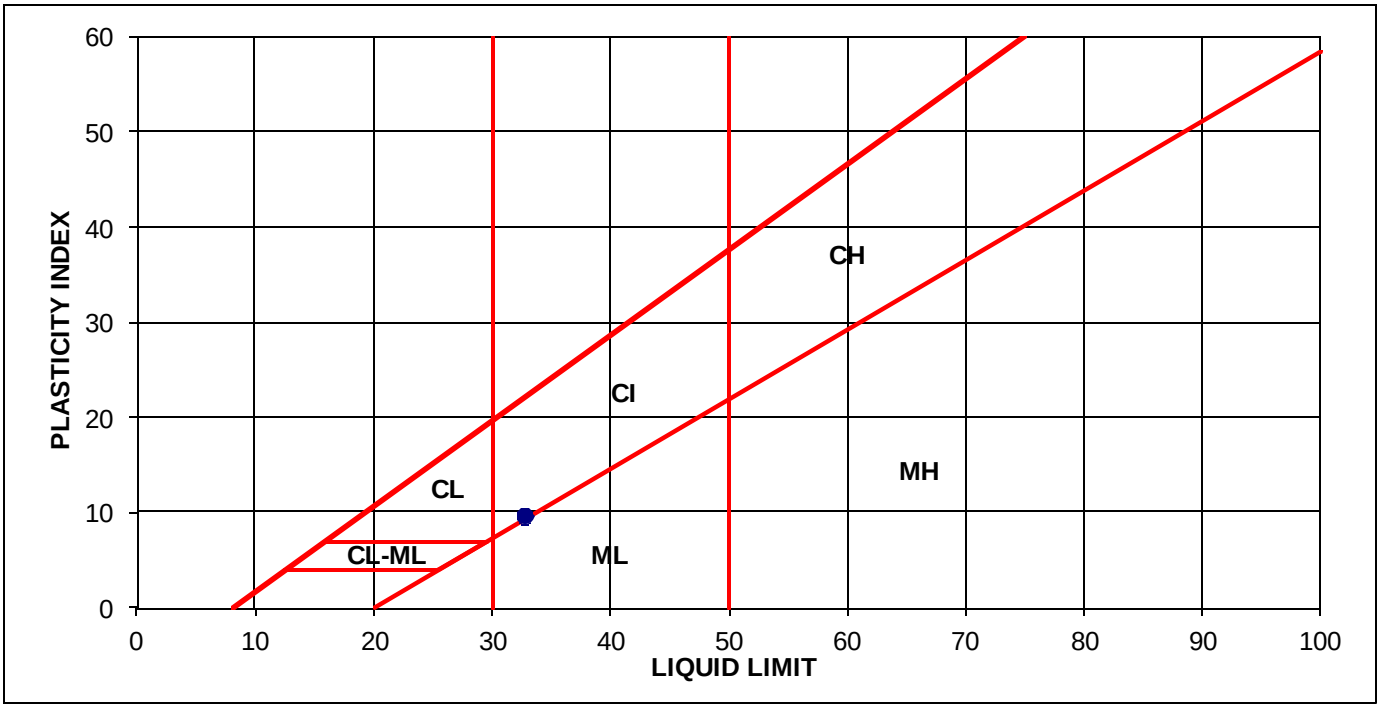
Liquid Limit	32.7
Plastic Limit	23.0
Plasticity Index	9.7

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.15		
Wt. Sample (dry+tare)(g)	28.39		
Wt. Tare (g)	16.37		
Wt. Dry Soil (g)	12.0		
Wt. Water (g)	2.8		
Water Content (%)	23.0%		



FORM: SAFM TH14-16#C1 Att.xlsx
DATE: 2/11/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C4
BOREHOLE:	TH14-16	DEPTH :	17.5m
DATE :	February 10, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	18					
Container Number						
Wt. Sample (wet+tare)(g)	40.72					
Wt. Sample (dry+tare)(g)	30.57					
Wt. Tare (g)	11.54					
Wt. Dry Soil (g)	19.0					
Wt. Water (g)	10.2					
Water Content (%)	53.3%					

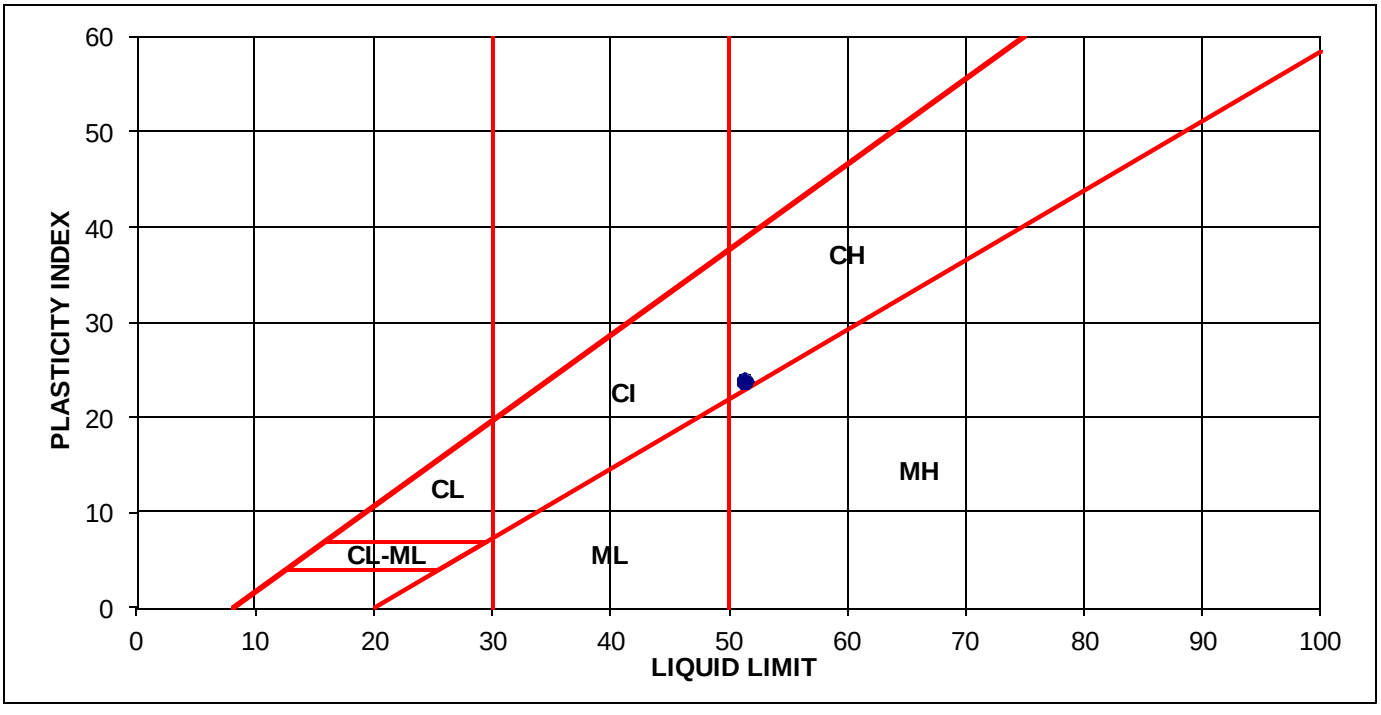
AVERAGE VALUES	
Liquid Limit	51.3
Plastic Limit	27.4
Plasticity Index	23.9

SAMPLE DESCRIPTION

Classification: **CH-CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	25.72		
Wt. Sample (dry+tare)(g)	22.85		
Wt. Tare (g)	12.36		
Wt. Dry Soil (g)	10.5		
Wt. Water (g)	2.9		
Water Content (%)	27.4%		



FORM: SAFM TH14-16#C4 Att.xlsx
DATE: 2/11/2014

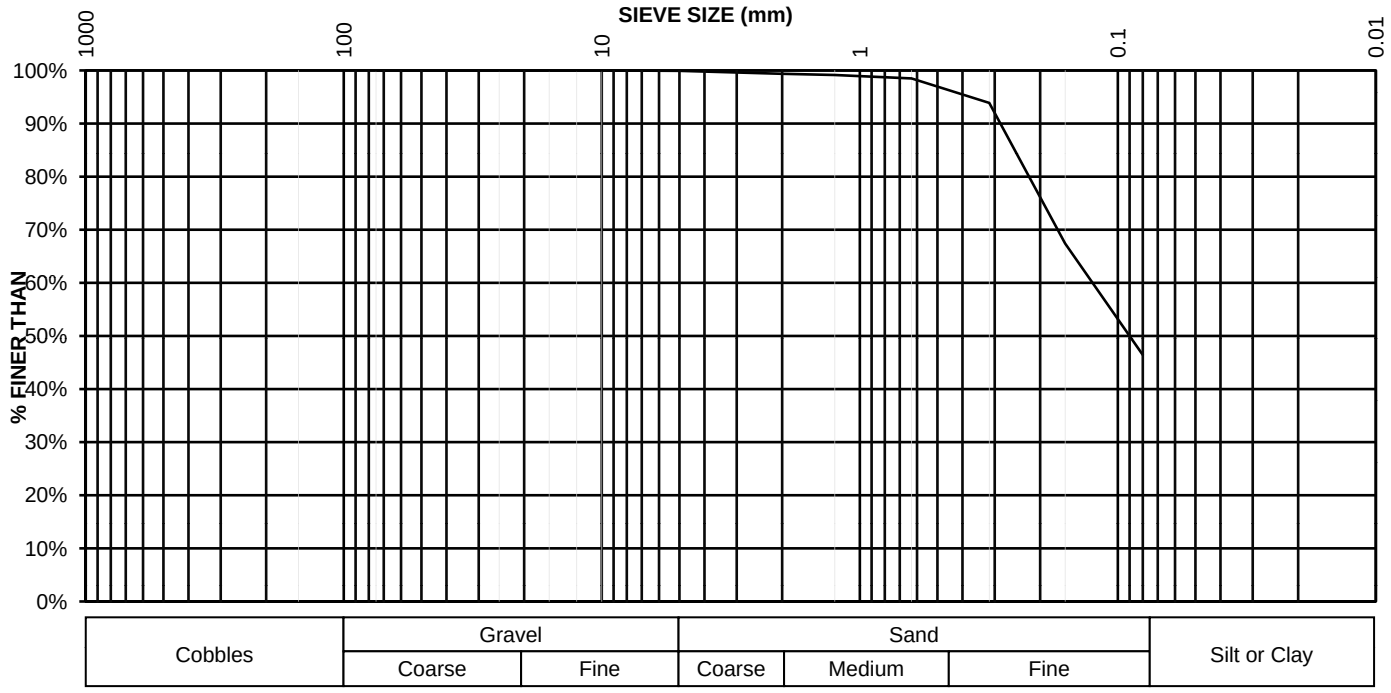
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE :	14-17	DEPTH :	2.3m
DATE :	February 6, 2014	TECHNICIAN :	CK

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	762.7	50000	2	50.0			100%		
Tare	254.4	40000	1 1/2	40.0			100%		
Wt. Dry	508.3	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0			100%		
MC (%)		5000	0.185	5.0	0.4	0%	100%		
	Passing								
After Washing		2000	0.0937	2.0	3.2	1%	99%		
Wt. Dry+Tare	544.9	1250	0.0469	1.25	4.4	1%	99%		
Tare	254.4	630	0.0234	0.630	7.7	2%	98%		
Wt. Dry	290.5	315	0.0116	0.315	31.1	6%	94%		
Tare No.		160	0.0059	0.160	165.6	33%	67%		
		80	0.0029	0.080	272.3	54%	46%		
		PAN			290.6				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-17 #4 Sieve.xls
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	10
BOREHOLE:	TH14-18	DEPTH :	7.0m
DATE :	February 6, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	18					
Container Number						
Wt. Sample (wet+tare)(g)	41.64					
Wt. Sample (dry+tare)(g)	34.61					
Wt. Tare (g)	11.72					
Wt. Dry Soil (g)	22.9					
Wt. Water (g)	7.0					
Water Content (%)	30.7%					

AVERAGE VALUES

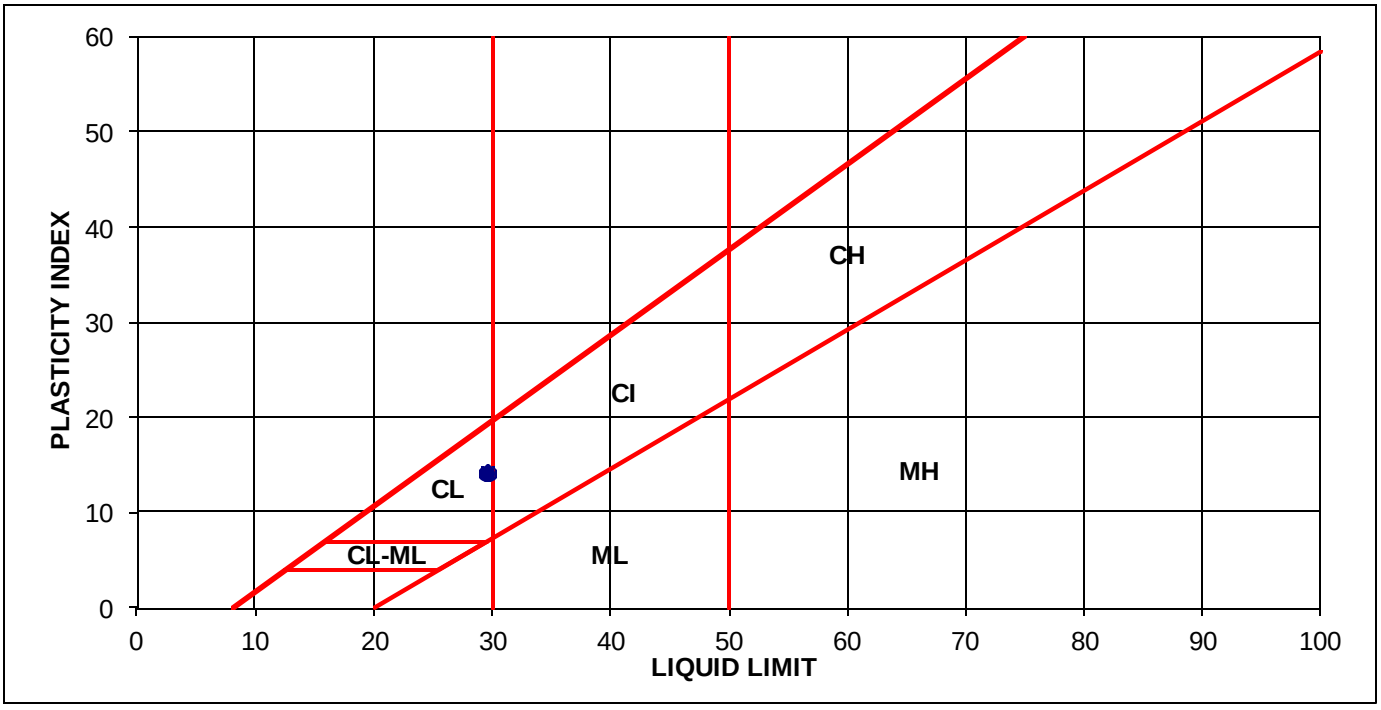
Liquid Limit	29.5
Plastic Limit	15.3
Plasticity Index	14.2

SAMPLE DESCRIPTION

Classification: **CL-CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.57		
Wt. Sample (dry+tare)(g)	29.55		
Wt. Tare (g)	16.32		
Wt. Dry Soil (g)	13.2		
Wt. Water (g)	2.0		
Water Content (%)	15.3%		



FORM: SAFM TH14-18 #10 Att.xlsx
DATE: 2/7/2014

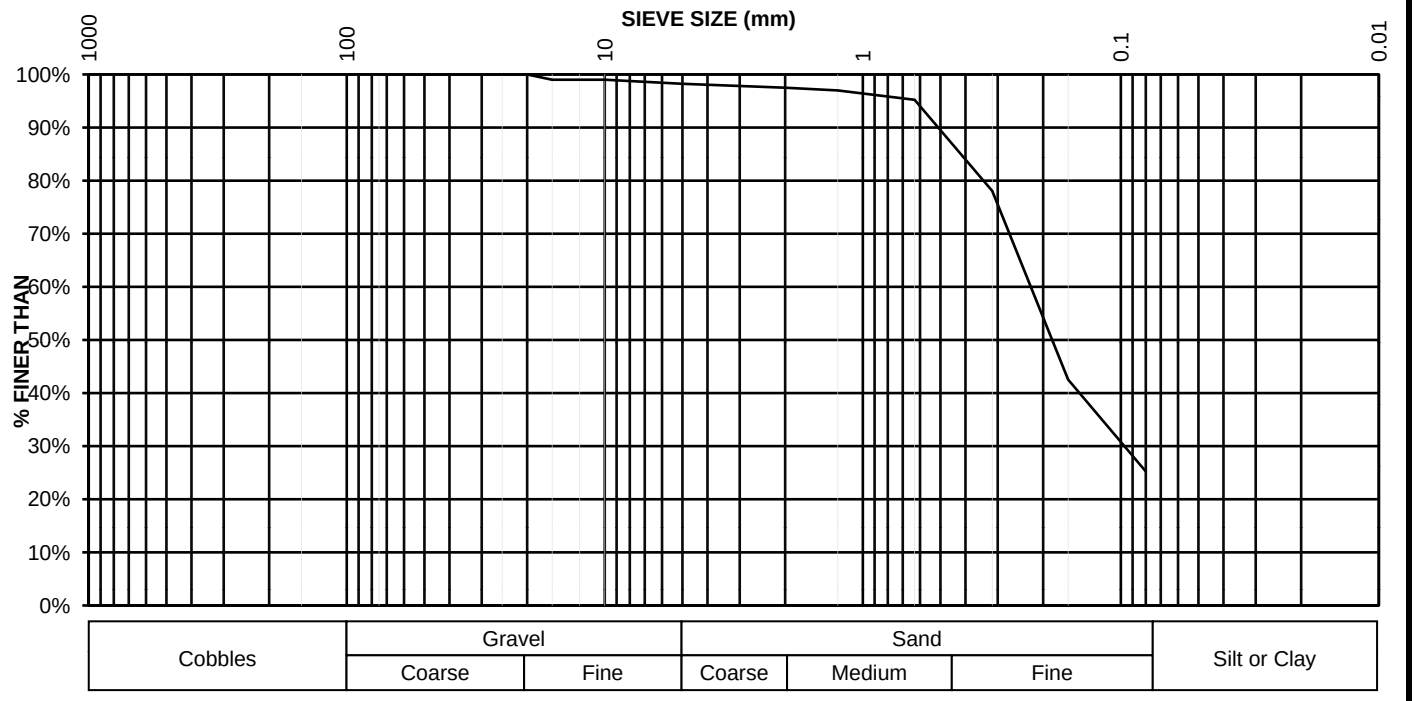
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	2
TESTHOLE :	14-18	DEPTH :	0.8m
DATE :	February 6, 2014	TECHNICIAN :	CK

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	863.6	50000	2	50.0			100%		
Tare	264.1	40000	1 1/2	40.0			100%		
Wt. Dry	599.5	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0	6.0	1%	99%		
Dry+Tare		12500	1/2	12.5	6.0	1%	99%		
Tare		10000	3/8	10.0	6.0	1%	99%		
MC (%)		5000	0.185	5.0	10.6	2%	98%		
	Passing								
After Washing		2000	0.0937	2.0	15.0	3%	97%		
Wt. Dry+Tare	720.4	1250	0.0469	1.25	18.1	3%	97%		
Tare	264.1	630	0.0234	0.630	28.6	5%	95%		
Wt. Dry	456.3	315	0.0116	0.315	131.6	22%	78%		
Tare No.		160	0.0059	0.160	344.5	57%	43%		
		80	0.0029	0.080	448.2	75%	25%		
		PAN			456.3				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-18 #2 Sieve.xls
DATE: 2/7/2014

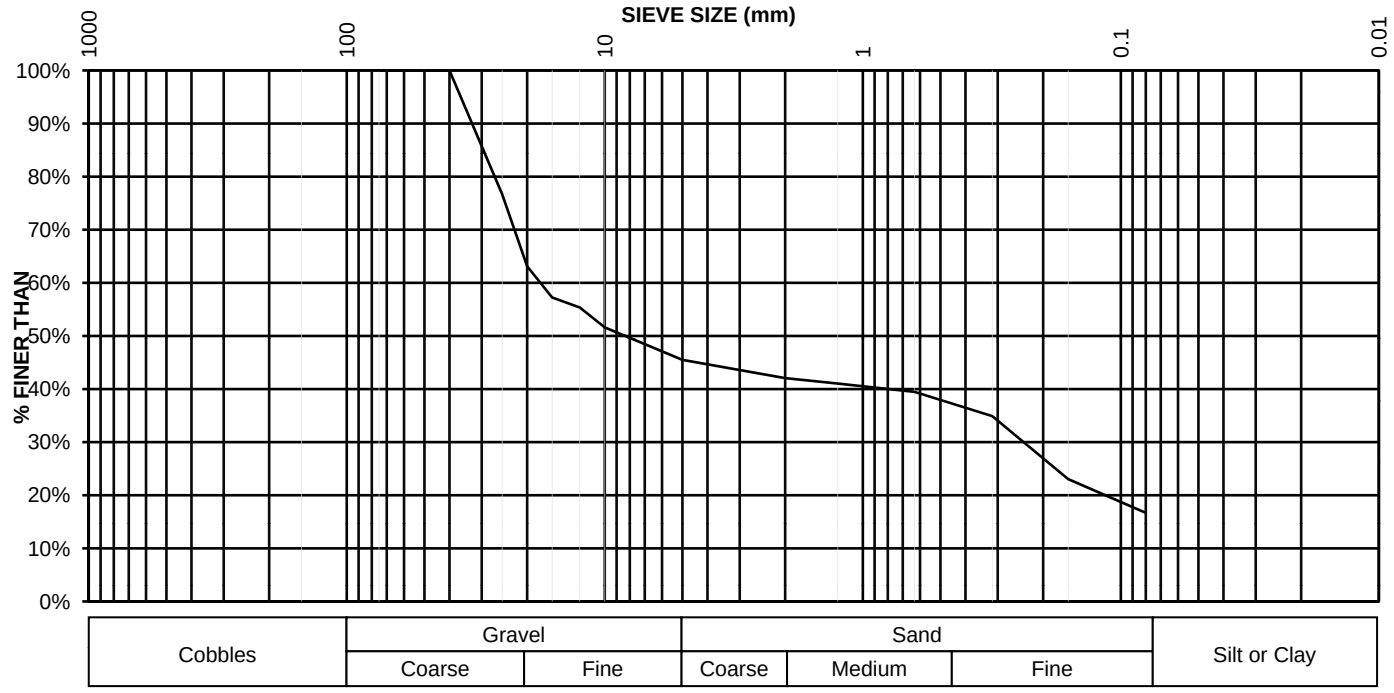
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE :	14-18	DEPTH :	2.3m
DATE :	February 6, 2014	TECHNICIAN :	CK

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	781.7	50000	2	50.0			100%		
Tare	250.6	40000	1 1/2	40.0			100%		
Wt. Dry	531.1	25000	1	25.0	123.7	23%	77%		
Moisture Content		20000	3/4	20.0	195.9	37%	63%		
Wet + Tare		16000	5/8	16.0	227.1	43%	57%		
Dry+Tare		12500	1/2	12.5	237.1	45%	55%		
Tare		10000	3/8	10.0	257.0	48%	52%		
MC (%)		5000	0.185	5.0	289.5	55%	45%		
	Passing								
After Washing		2000	0.0937	2.0	307.7	58%	42%		
Wt. Dry+Tare	699.8	1250	0.0469	1.25	313.2	59%	41%		
Tare	250.6	630	0.0234	0.630	321.5	61%	39%		
Wt. Dry	449.2	315	0.0116	0.315	345.7	65%	35%		
Tare No.		160	0.0059	0.160	408.7	77%	23%		
		80	0.0029	0.080	442.5	83%	17%		
		PAN			448.6				

Classification:	GM or GC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-18 #4 Sieve.xls
DATE: 2/7/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
BOREHOLE:	TH14-19	DEPTH :	1.8m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	27					
Container Number						
Wt. Sample (wet+tare)(g)	40.44					
Wt. Sample (dry+tare)(g)	34.54					
Wt. Tare (g)	11.54					
Wt. Dry Soil (g)	23.0					
Wt. Water (g)	5.9					
Water Content (%)	25.7%					

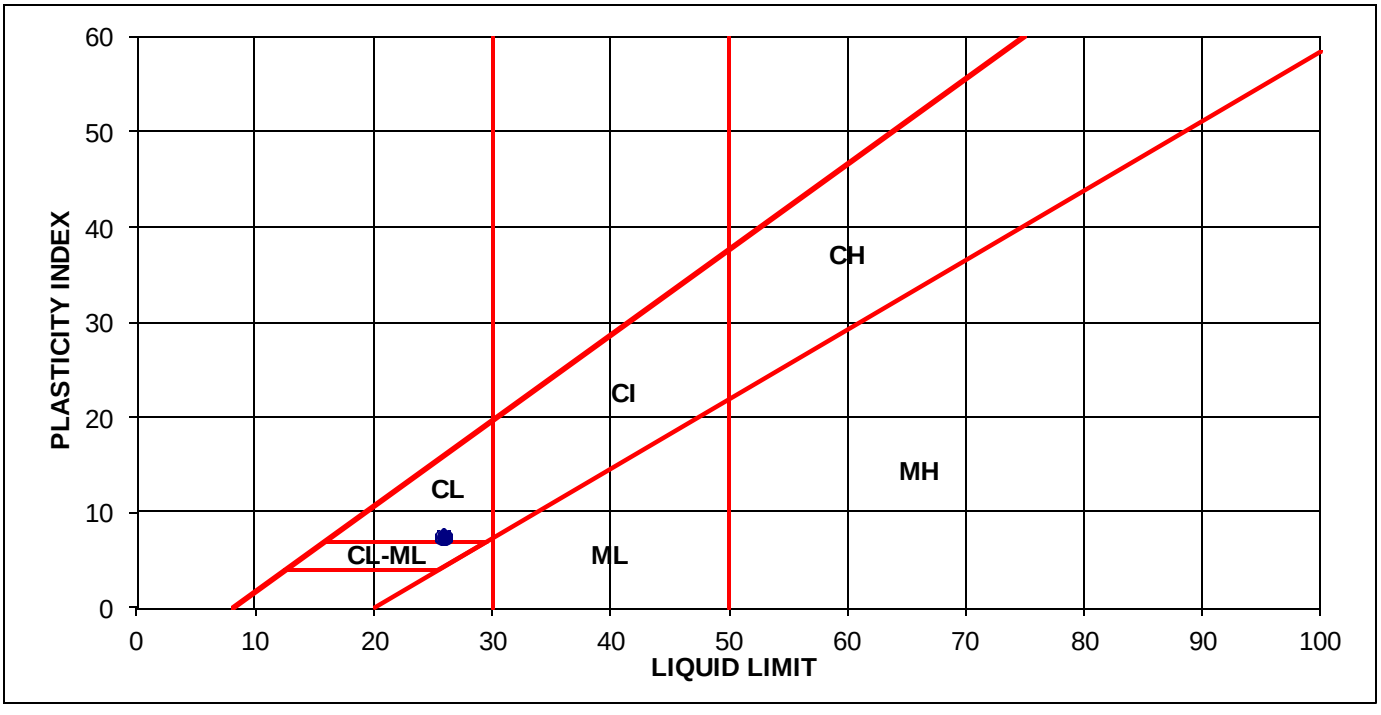
AVERAGE VALUES	
Liquid Limit	25.8
Plastic Limit	18.3
Plasticity Index	7.5

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	28.41		
Wt. Sample (dry+tare)(g)	25.93		
Wt. Tare (g)	12.38		
Wt. Dry Soil (g)	13.6		
Wt. Water (g)	2.5		
Water Content (%)	18.3%		



FORM: SAFM TH14-19#3 Att.xlsx
DATE: 2/5/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE:	14-19	DEPTH :	2.4m
DATE :	February 6, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	621.5	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	521.5	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0	3.2	1%	99.4%	
MC (%)		5,000	0.185	5.0	4.2	1%	99.2%	
	Passing							
After Washing		2,000	0.0937	2.0	6.3	1%	98.8%	
Wt. Dry+Tare		1,250	0.0469	1.25	8.4	2%	98.4%	
Tare		630	0.0234	0.63	12.5	2%	97.6%	
Wt. Dry		315	0.0116	0.315	24.8	5%	95.2%	
Tare No.		160	0.0059	0.160	47.5	9%	90.9%	
		75	0.00295	0.075	85.6	16%	83.6%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	621.5	46	0.5	0.056	20	42	81.2%	
Wt Tare	100.0	44	1	0.040	20	40	77.3%	
Wt Dry	521.5	40	2	0.030	20	36	69.4%	
Sample Size :	50	35	5	0.020	20	31	59.7%	
Wt Retained 2 mm:	6.3	27	15	0.012	20	23	44.0%	
% Passing 2 mm:	98.8%	22	30	0.009	20	18	34.2%	
Specific Gravity :	2.70	19	60	0.006	20	15	28.4%	
Hydrometer No.:	43-9856	16	120	0.005	20	12	22.5%	
Solution (g/L) :	40	14	240	0.003	20	10	18.6%	
		12	1440	0.001	20	8	14.7%	
		11	2880	0.001	20	7	12.7%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE:	14-19	DEPTH :	2.4m
DATE :	February 6, 2014	TECHNICIAN :	GU

FORM: SAFM TH14-19#4 Hydro.xls
DATE: 2/6/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	7
BOREHOLE:	TH14-19	DEPTH :	4.8m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	23					
Container Number						
Wt. Sample (wet+tare)(g)	36.49					
Wt. Sample (dry+tare)(g)	30.02					
Wt. Tare (g)	11.80					
Wt. Dry Soil (g)	18.2					
Wt. Water (g)	6.5					
Water Content (%)	35.5%					

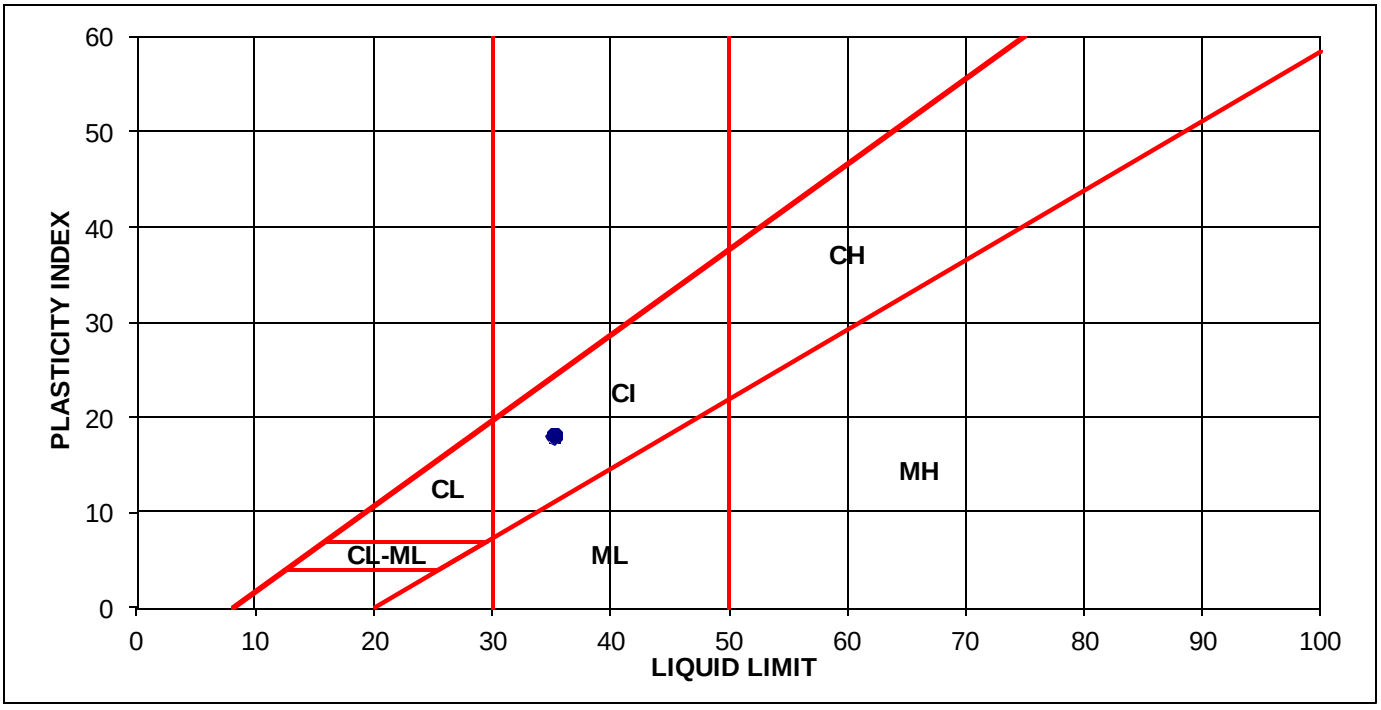
AVERAGE VALUES	
Liquid Limit	35.2
Plastic Limit	17.0
Plasticity Index	18.1

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.59		
Wt. Sample (dry+tare)(g)	29.33		
Wt. Tare (g)	16.06		
Wt. Dry Soil (g)	13.3		
Wt. Water (g)	2.3		
Water Content (%)	17.0%		



FORM: SAFM TH14-19#7 Att.xlsx
DATE: 2/5/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C1
BOREHOLE:	TH14-19	DEPTH :	8.2m
DATE :	February 12, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	21					
Container Number						
Wt. Sample (wet+tare)(g)	46.21					
Wt. Sample (dry+tare)(g)	38.84					
Wt. Tare (g)	11.74					
Wt. Dry Soil (g)	27.1					
Wt. Water (g)	7.4					
Water Content (%)	27.2%					

AVERAGE VALUES

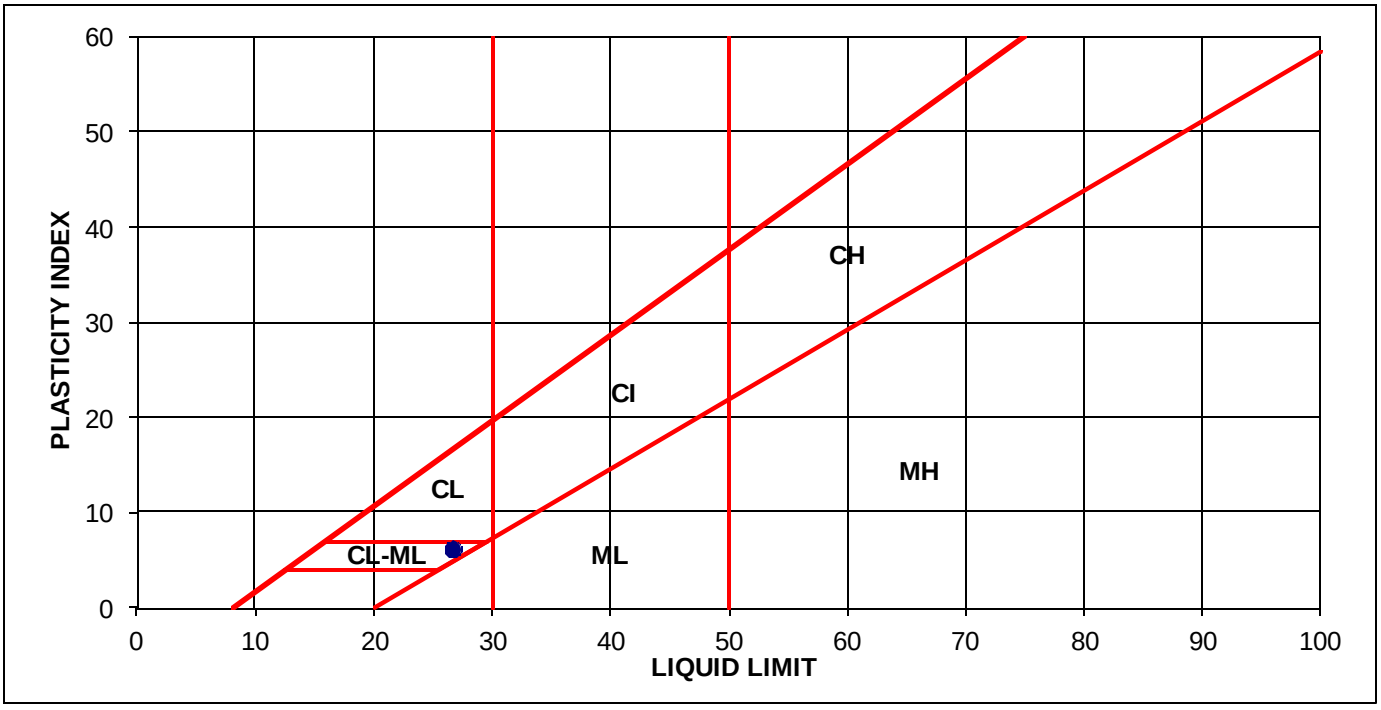
Liquid Limit	26.6
Plastic Limit	20.4
Plasticity Index	6.3

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	30.98		
Wt. Sample (dry+tare)(g)	28.50		
Wt. Tare (g)	16.32		
Wt. Dry Soil (g)	12.2		
Wt. Water (g)	2.5		
Water Content (%)	20.4%		



FORM: SAFM TH14-19#C1 Att.xlsx
DATE: 2/13/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C3
BOREHOLE:	TH14-19	DEPTH :	14.3m
DATE :	February 12, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	20					
Container Number						
Wt. Sample (wet+tare)(g)	45.61					
Wt. Sample (dry+tare)(g)	38.20					
Wt. Tare (g)	12.25					
Wt. Dry Soil (g)	26.0					
Wt. Water (g)	7.4					
Water Content (%)	28.6%					

AVERAGE VALUES

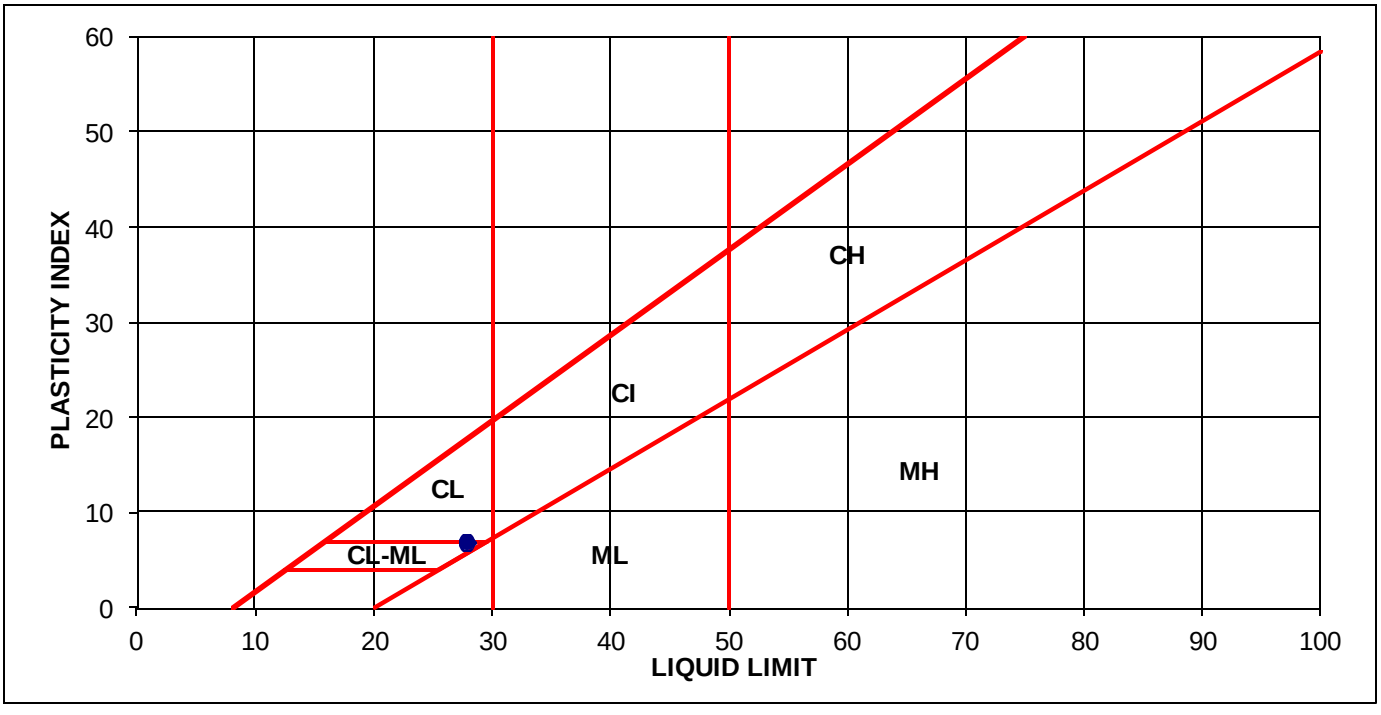
Liquid Limit	27.8
Plastic Limit	20.8
Plasticity Index	7.0

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	32.89		
Wt. Sample (dry+tare)(g)	30.03		
Wt. Tare (g)	16.30		
Wt. Dry Soil (g)	13.7		
Wt. Water (g)	2.9		
Water Content (%)	20.8%		



FORM: SAFM TH14-19#C3 Att.xlsx
DATE: 2/13/2014

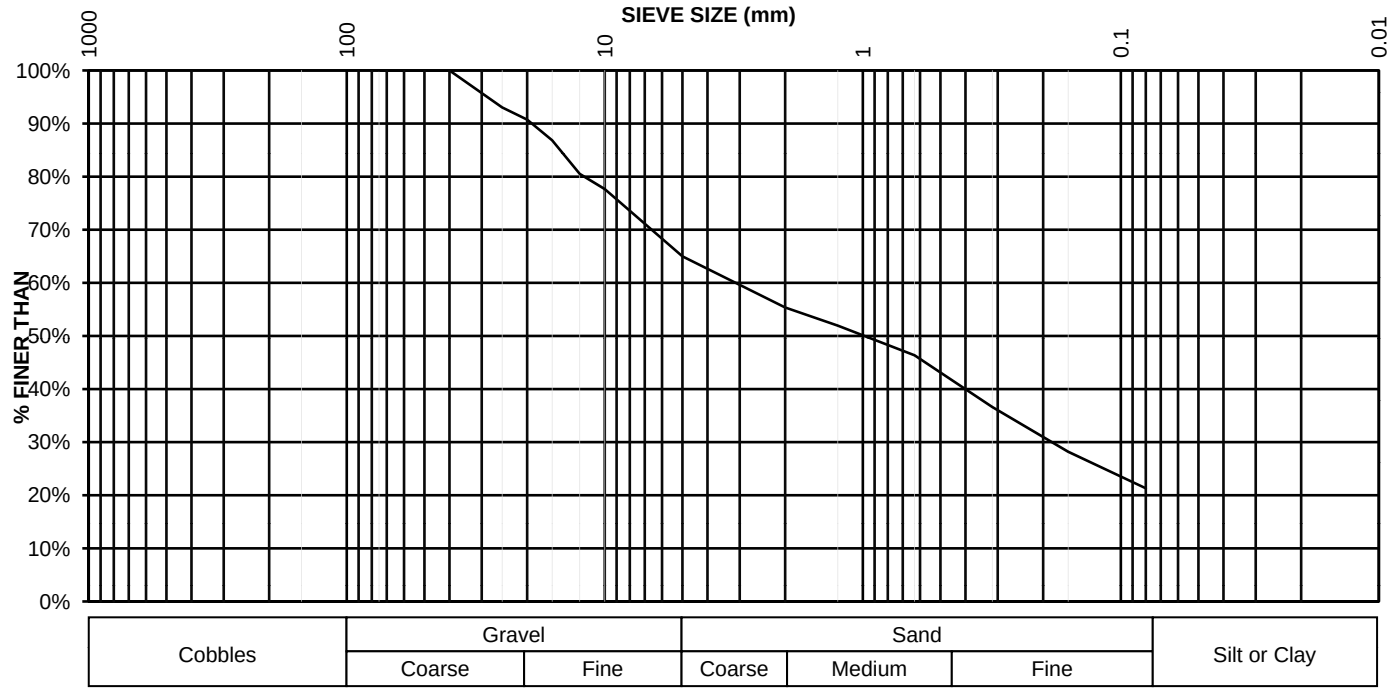
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE :	14-20	DEPTH :	3.3m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	720.2	50000	2	50.0			100%		
Tare	242.1	40000	1 1/2	40.0			100%		
Wt. Dry	478.1	25000	1	25.0	33.3	7%	93%		
Moisture Content		20000	3/4	20.0	44.3	9%	91%		
Wet + Tare		16000	5/8	16.0	62.9	13%	87%		
Dry+Tare		12500	1/2	12.5	93.2	19%	81%		
Tare		10000	3/8	10.0	106.8	22%	78%		
MC (%)		5000	0.185	5.0	167.4	35%	65%		
	Passing								
After Washing		2000	0.0937	2.0	213.4	45%	55%		
Wt. Dry+Tare	621.4	1250	0.0469	1.25	229.8	48%	52%		
Tare	242.1	630	0.0234	0.630	256.5	54%	46%		
Wt. Dry	379.3	315	0.0116	0.315	303.0	63%	37%		
Tare No.		160	0.0059	0.160	343.3	72%	28%		
		80	0.0029	0.080	376.2	79%	21%		
		PAN			378.9				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-20 #5 Sieve.xls
DATE: 2/4/2014

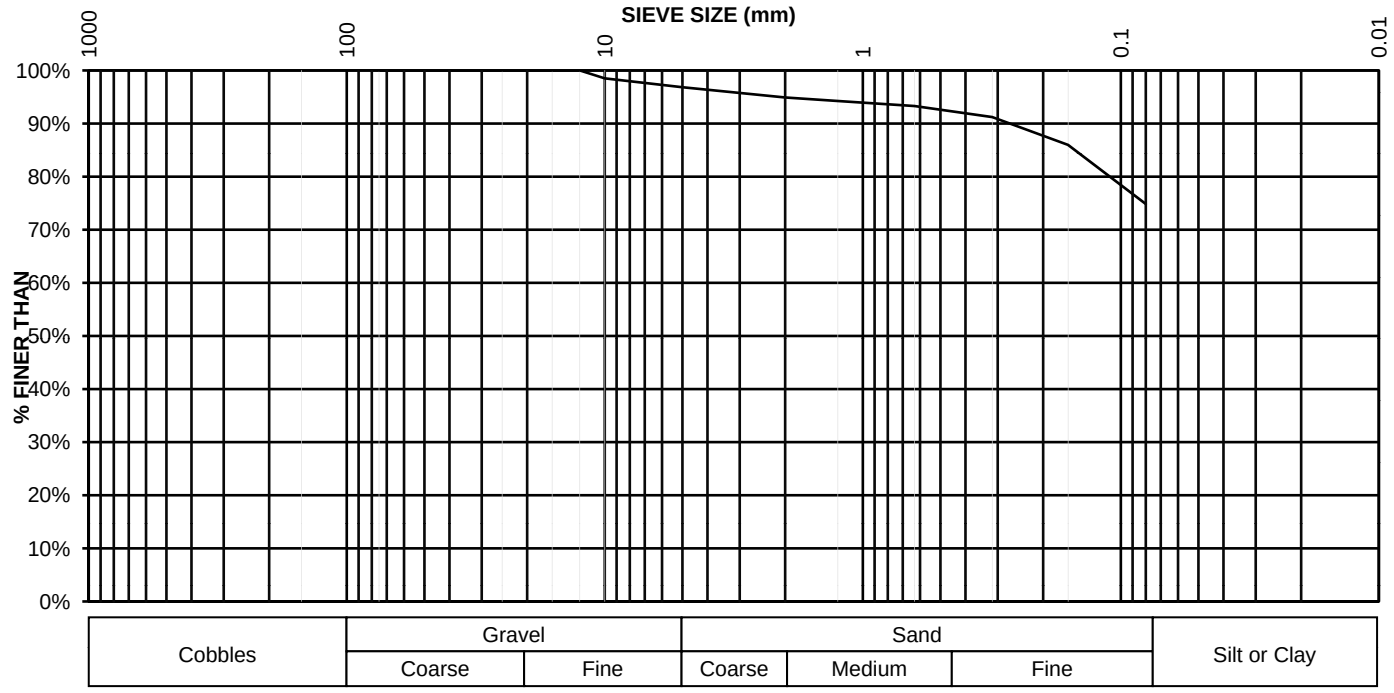
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	8
TESTHOLE :	14-20	DEPTH :	5.4m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	608.4	50000	2	50.0			100%		
Tare	261.2	40000	1 1/2	40.0			100%		
Wt. Dry	347.2	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0	5.2	1%	99%		
MC (%)		5000	0.185	5.0	11.0	3%	97%		
	Passing								
After Washing		2000	0.0937	2.0	17.7	5%	95%		
Wt. Dry+Tare	351.1	1250	0.0469	1.25	20.0	6%	94%		
Tare	261.2	630	0.0234	0.630	23.3	7%	93%		
Wt. Dry	89.9	315	0.0116	0.315	30.5	9%	91%		
Tare No.		160	0.0059	0.160	48.7	14%	86%		
		80	0.0029	0.080	87.3	25%	75%		
		PAN			89.7				

Classification:	SILT or CLAY	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-20 #8 Sieve.xls
DATE: 2/4/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	6
BOREHOLE:	TH14-20	DEPTH :	3.9m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	26					
Container Number						
Wt. Sample (wet+tare)(g)	44.17					
Wt. Sample (dry+tare)(g)	38.44					
Wt. Tare (g)	12.09					
Wt. Dry Soil (g)	26.4					
Wt. Water (g)	5.7					
Water Content (%)	21.7%					

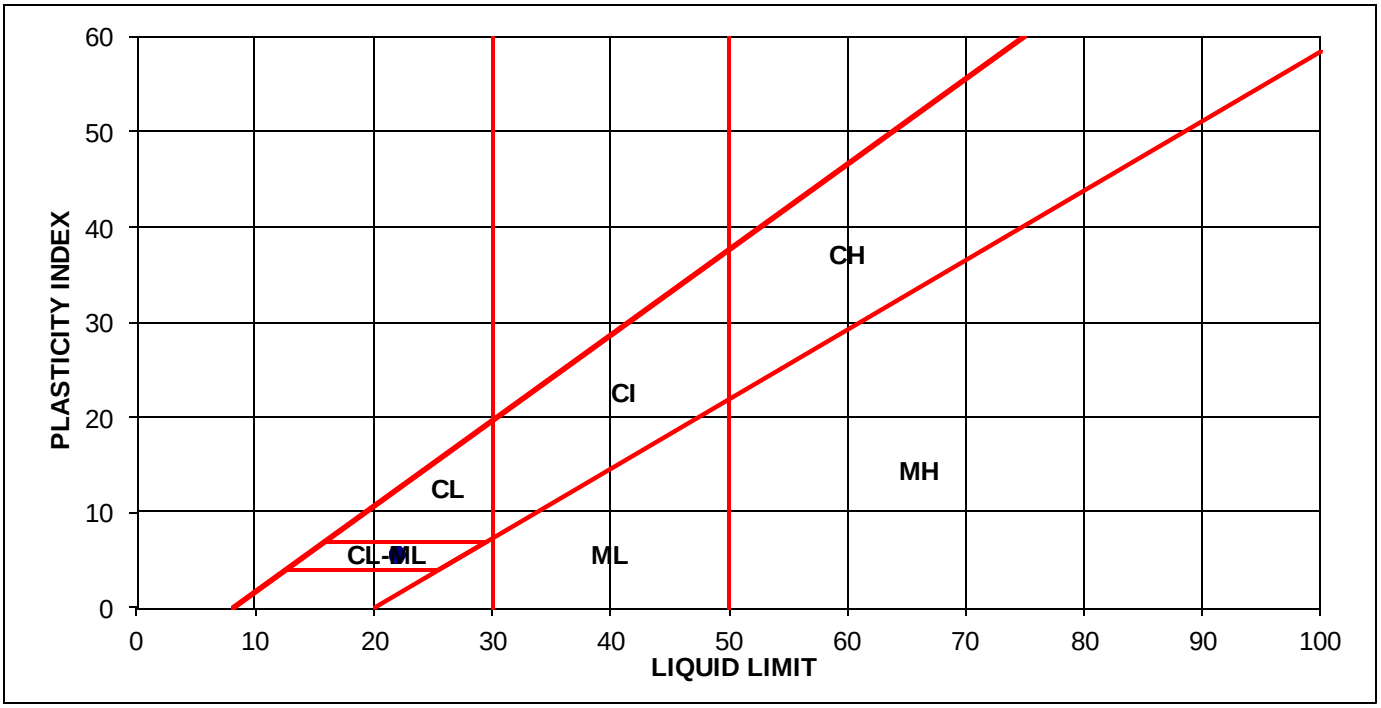
AVERAGE VALUES	
Liquid Limit	21.8
Plastic Limit	16.2
Plasticity Index	5.7

SAMPLE DESCRIPTION

Classification: **CL-ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.30		
Wt. Sample (dry+tare)(g)	27.11		
Wt. Tare (g)	13.55		
Wt. Dry Soil (g)	13.6		
Wt. Water (g)	2.2		
Water Content (%)	16.2%		



FORM: SAFM TH14-20#6 Att.xlsx
DATE: 2/5/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C1
BOREHOLE:	TH14-20	DEPTH :	8.2m
DATE :	February 10, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	18					
Container Number						
Wt. Sample (wet+tare)(g)	38.47					
Wt. Sample (dry+tare)(g)	31.91					
Wt. Tare (g)	11.82					
Wt. Dry Soil (g)	20.1					
Wt. Water (g)	6.6					
Water Content (%)	32.7%					

AVERAGE VALUES

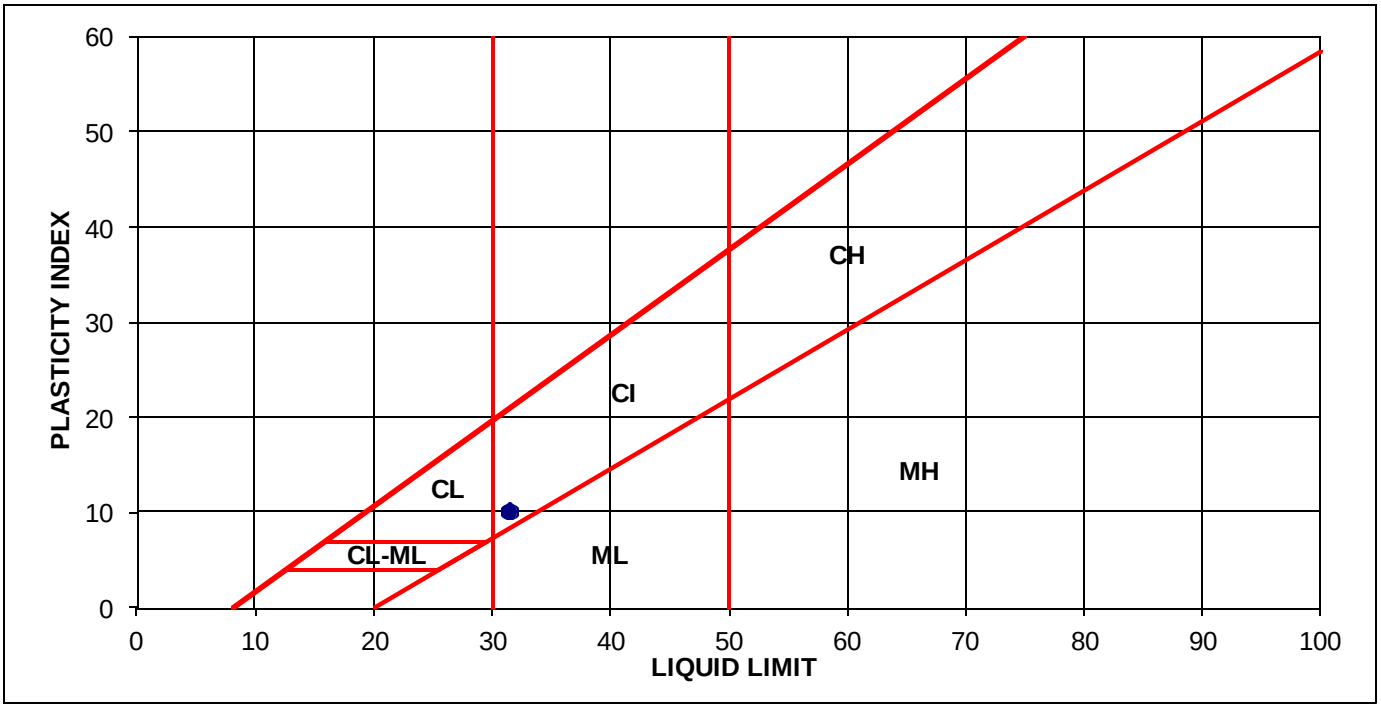
Liquid Limit	31.4
Plastic Limit	21.2
Plasticity Index	10.2

SAMPLE DESCRIPTION

Classification: **CI-CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.85		
Wt. Sample (dry+tare)(g)	27.44		
Wt. Tare (g)	16.06		
Wt. Dry Soil (g)	11.4		
Wt. Water (g)	2.4		
Water Content (%)	21.2%		



FORM: SAFM TH14-20#C1 Att.xlsx
DATE: 2/11/2014

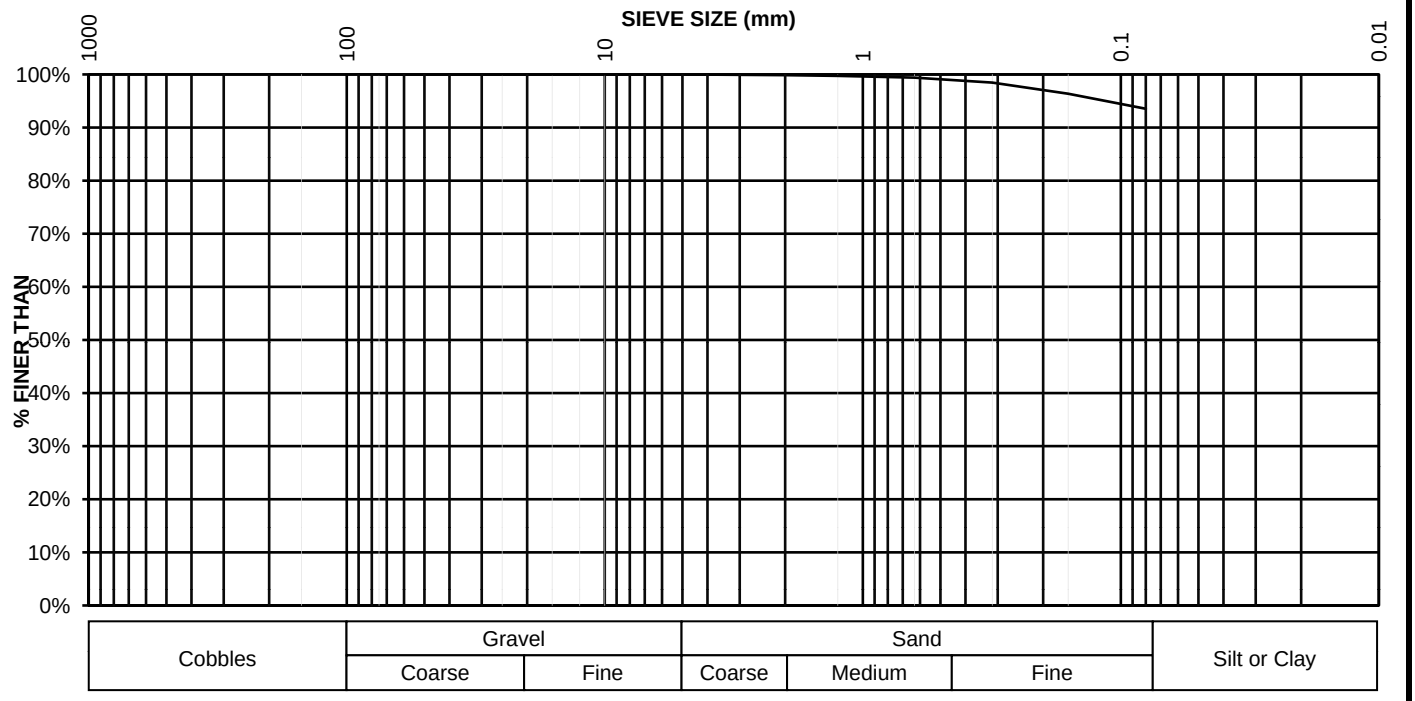
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	10
TESTHOLE :	14-21	DEPTH :	6.9m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	554.7	50000	2	50.0			100%		
Tare	254.4	40000	1 1/2	40.0			100%		
Wt. Dry	300.3	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0			100%		
MC (%)		5000	0.185	5.0			100%		
	Passing								
After Washing		2000	0.0937	2.0	0.4	0%	100%		
Wt. Dry+Tare	275.1	1250	0.0469	1.25	0.8	0%	100%		
Tare	254.5	630	0.0234	0.630	1.8	1%	99%		
Wt. Dry	20.6	315	0.0116	0.315	4.6	2%	98%		
Tare No.		160	0.0059	0.160	10.9	4%	96%		
		80	0.0029	0.080	19.4	6%	94%		
		PAN			20.5				

Classification:	SILT or CLAY	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-21 #10 Sieve.xls
DATE: 2/4/2014

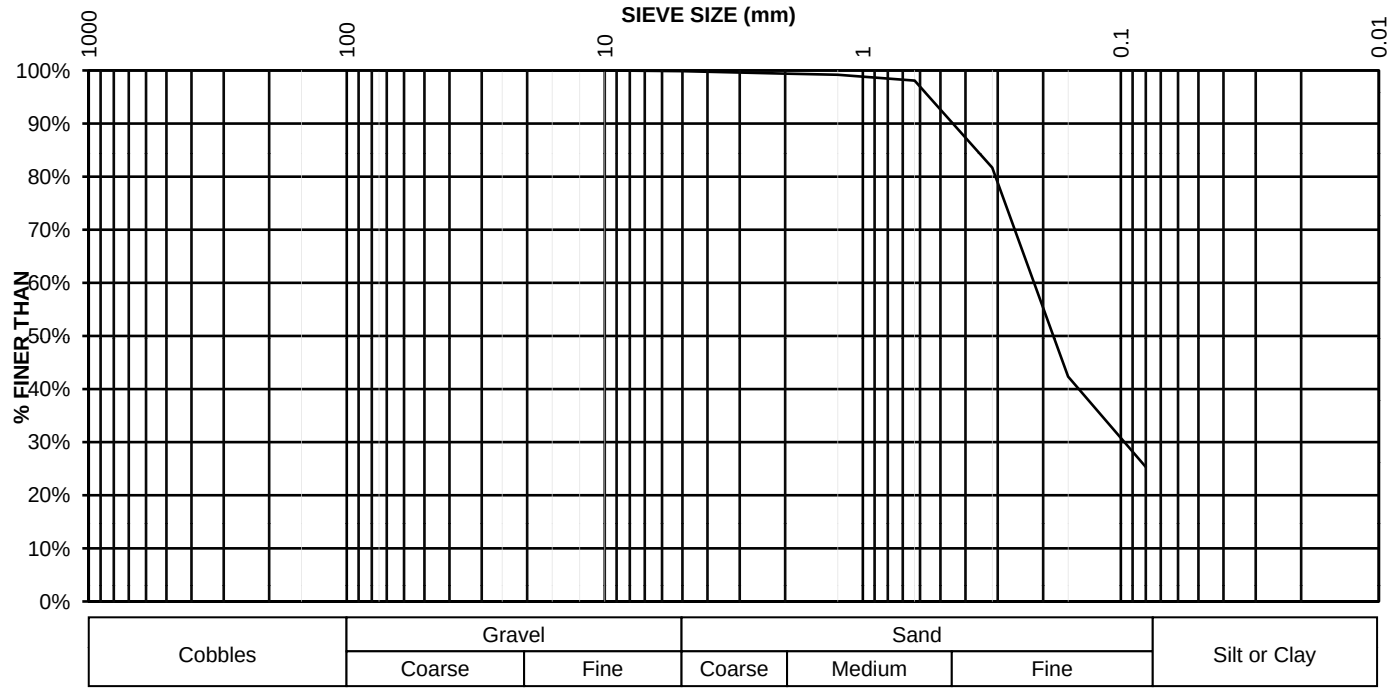
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE :	14-21	DEPTH :	3.3m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	695.3	50000	2	50.0			100%		
Tare	250.6	40000	1 1/2	40.0			100%		
Wt. Dry	444.7	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0			100%		
MC (%)		5000	0.185	5.0	0.6	0%	100%		
	Passing								
After Washing		2000	0.0937	2.0	2.7	1%	99%		
Wt. Dry+Tare	586.6	1250	0.0469	1.25	3.6	1%	99%		
Tare	250.6	630	0.0234	0.630	8.5	2%	98%		
Wt. Dry	336.0	315	0.0116	0.315	81.5	18%	82%		
Tare No.		160	0.0059	0.160	256.4	58%	42%		
		80	0.0029	0.080	332.1	75%	25%		
		PAN			336.0				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-21 #5 Sieve.xls
DATE: 2/4/2014

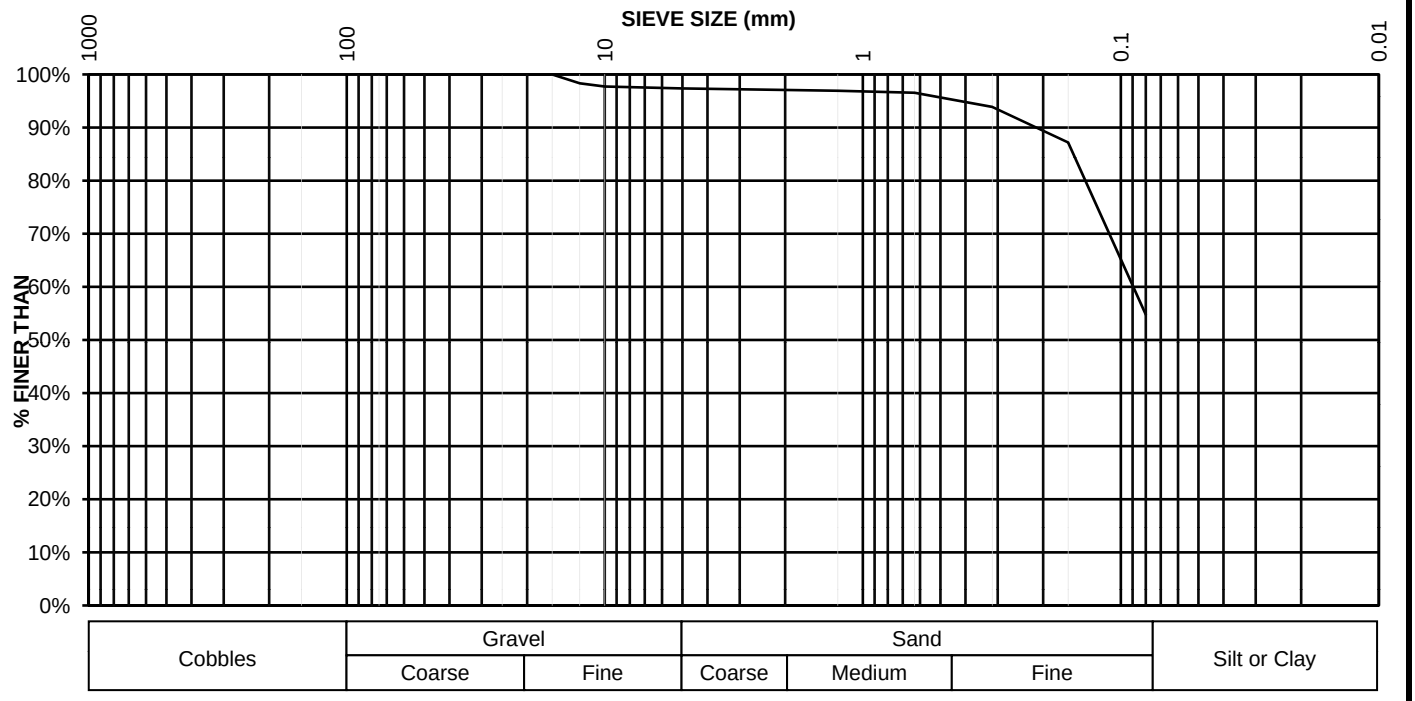
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	9
TESTHOLE :	14-21	DEPTH :	6.3m
DATE :	February 3, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	556.7	50000	2	50.0			100%		
Tare	235.0	40000	1 1/2	40.0			100%		
Wt. Dry	321.7	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5	5.4	2%	98%		
Tare		10000	3/8	10.0	7.3	2%	98%		
MC (%)		5000	0.185	5.0	8.5	3%	97%		
	Passing								
After Washing		2000	0.0937	2.0	9.4	3%	97%		
Wt. Dry+Tare	395.5	1250	0.0469	1.25	9.9	3%	97%		
Tare	235.0	630	0.0234	0.630	11.1	3%	97%		
Wt. Dry	160.5	315	0.0116	0.315	19.7	6%	94%		
Tare No.		160	0.0059	0.160	41.2	13%	87%		
		80	0.0029	0.080	145.5	45%	55%		
		PAN			160.5				

Classification:	SILT or CLAY	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-21 #9 Sieve.xls
DATE: 2/4/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Alberta Government		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	11
BOREHOLE:	TH14-21	DEPTH :	7.8m
DATE :	February 4, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	24					
Container Number						
Wt. Sample (wet+tare)(g)	38.35					
Wt. Sample (dry+tare)(g)	32.27					
Wt. Tare (g)	12.09					
Wt. Dry Soil (g)	20.2					
Wt. Water (g)	6.1					
Water Content (%)	30.1%					

AVERAGE VALUES

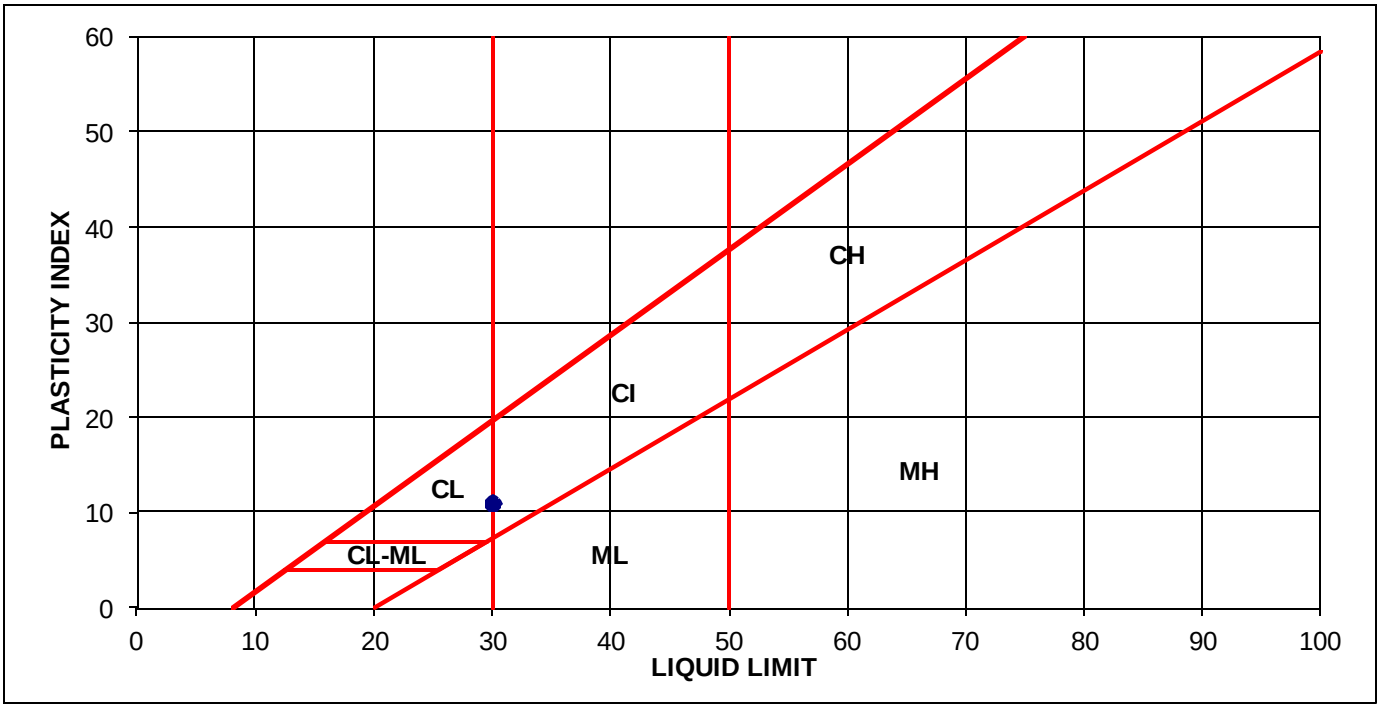
Liquid Limit	30.0
Plastic Limit	18.9
Plasticity Index	11.1

SAMPLE DESCRIPTION

Classification: **CL-CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.22		
Wt. Sample (dry+tare)(g)	28.74		
Wt. Tare (g)	15.62		
Wt. Dry Soil (g)	13.1		
Wt. Water (g)	2.5		
Water Content (%)	18.9%		



FORM: SAFM TH14-21#11 Att.xlsx
DATE: 2/5/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C2
BOREHOLE:	TH14-21	DEPTH :	13.0m
DATE :	February 12, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	30					
Container Number						
Wt. Sample (wet+tare)(g)	45.60					
Wt. Sample (dry+tare)(g)	37.32					
Wt. Tare (g)	12.06					
Wt. Dry Soil (g)	25.3					
Wt. Water (g)	8.3					
Water Content (%)	32.8%					

AVERAGE VALUES

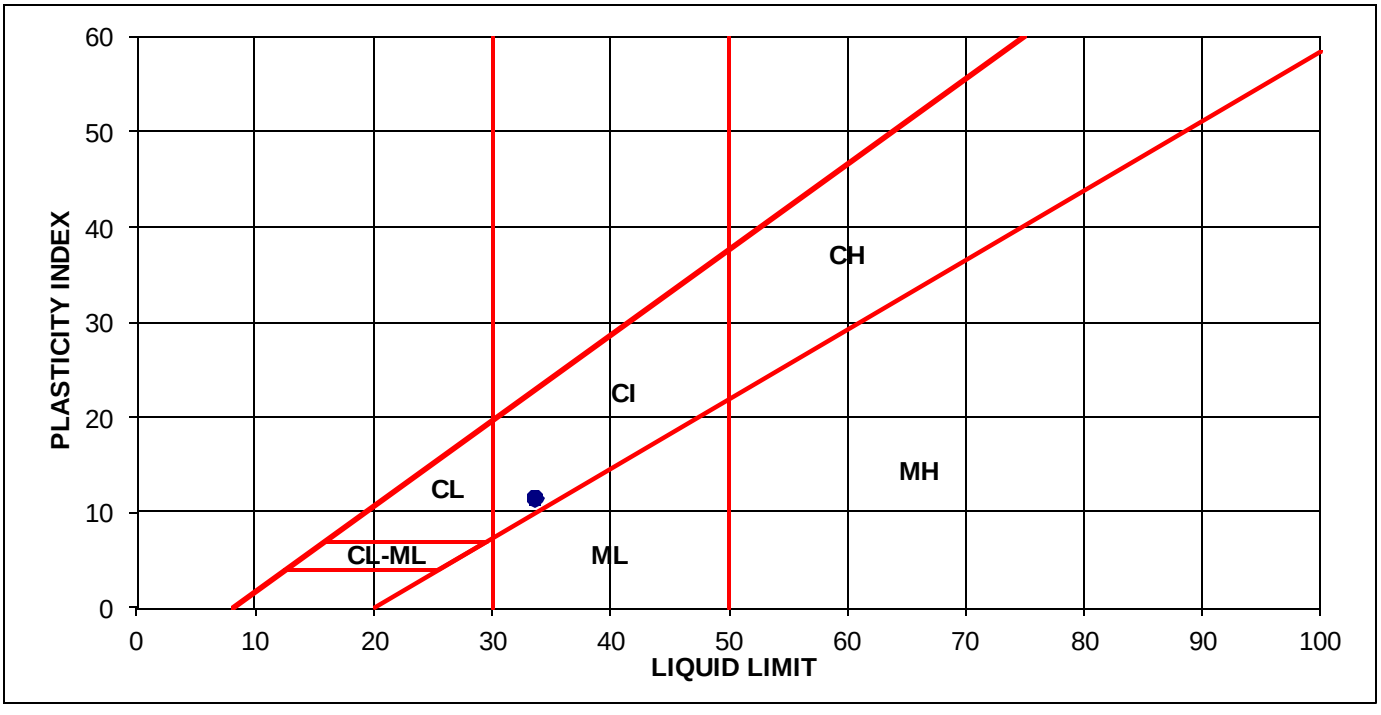
Liquid Limit	33.5
Plastic Limit	21.9
Plasticity Index	11.6

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	32.04		
Wt. Sample (dry+tare)(g)	29.24		
Wt. Tare (g)	16.45		
Wt. Dry Soil (g)	12.8		
Wt. Water (g)	2.8		
Water Content (%)	21.9%		



FORM: SAFM TH14-21#C2 Att.xlsx
DATE: 2/13/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	12
BOREHOLE:	TH14-24	DEPTH :	8.35m
DATE :	February 18, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.						
Number of Blows						
Container Number						
Wt. Sample (wet+tare)(g)						
Wt. Sample (dry+tare)(g)						
Wt. Tare (g)						
Wt. Dry Soil (g)						
Wt. Water (g)						
Water Content (%)						

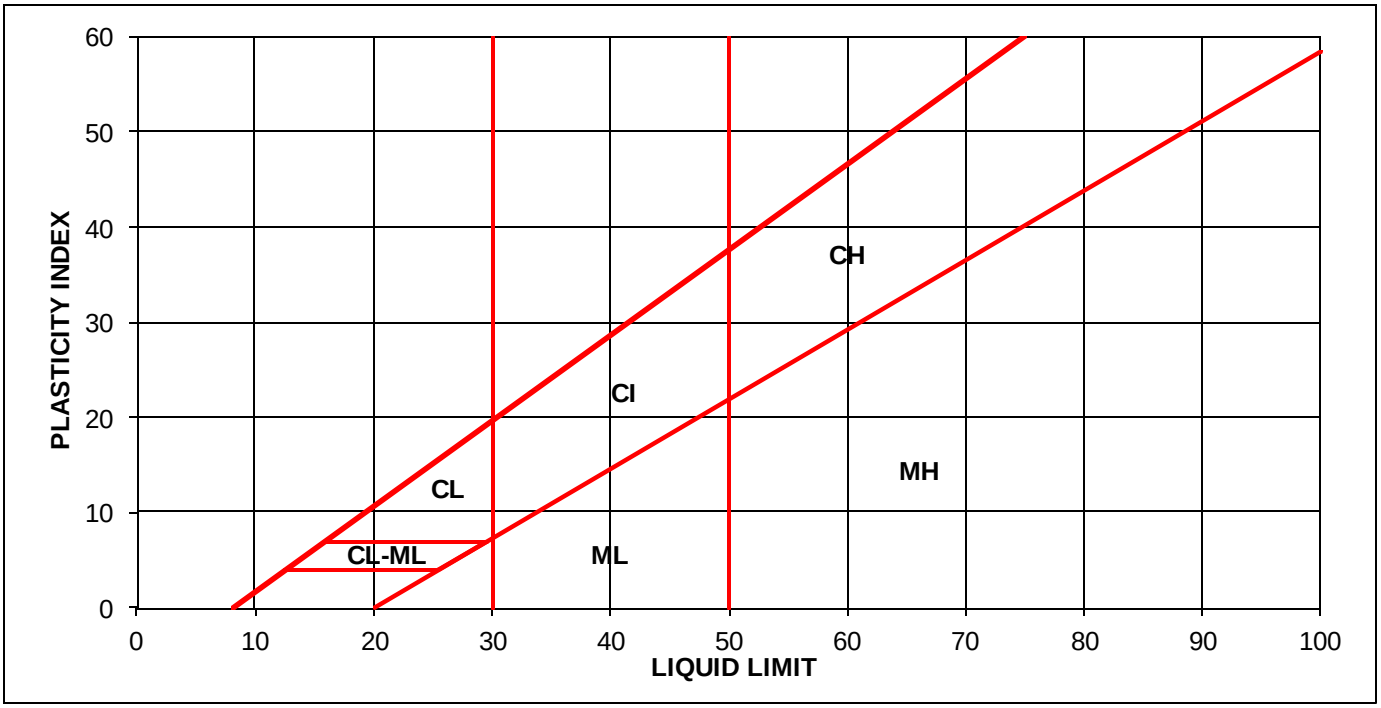
AVERAGE VALUES	
Liquid Limit	
Plastic Limit	
Plasticity Index	

SAMPLE DESCRIPTION

Classification: **NON-PLASTIC**

PLASTIC LIMIT

Trial No.			
Container Number			
Wt. Sample (wet+tare)(g)			
Wt. Sample (dry+tare)(g)			
Wt. Tare (g)			
Wt. Dry Soil (g)			
Wt. Water (g)			
Water Content (%)			



FORM: SAFM TH14-24#12 Att.xlsx
DATE: 2/19/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	12
TESTHOLE:	14-24	DEPTH :	8.35m
DATE :	February 17, 2014	TECHNICIAN :	GU

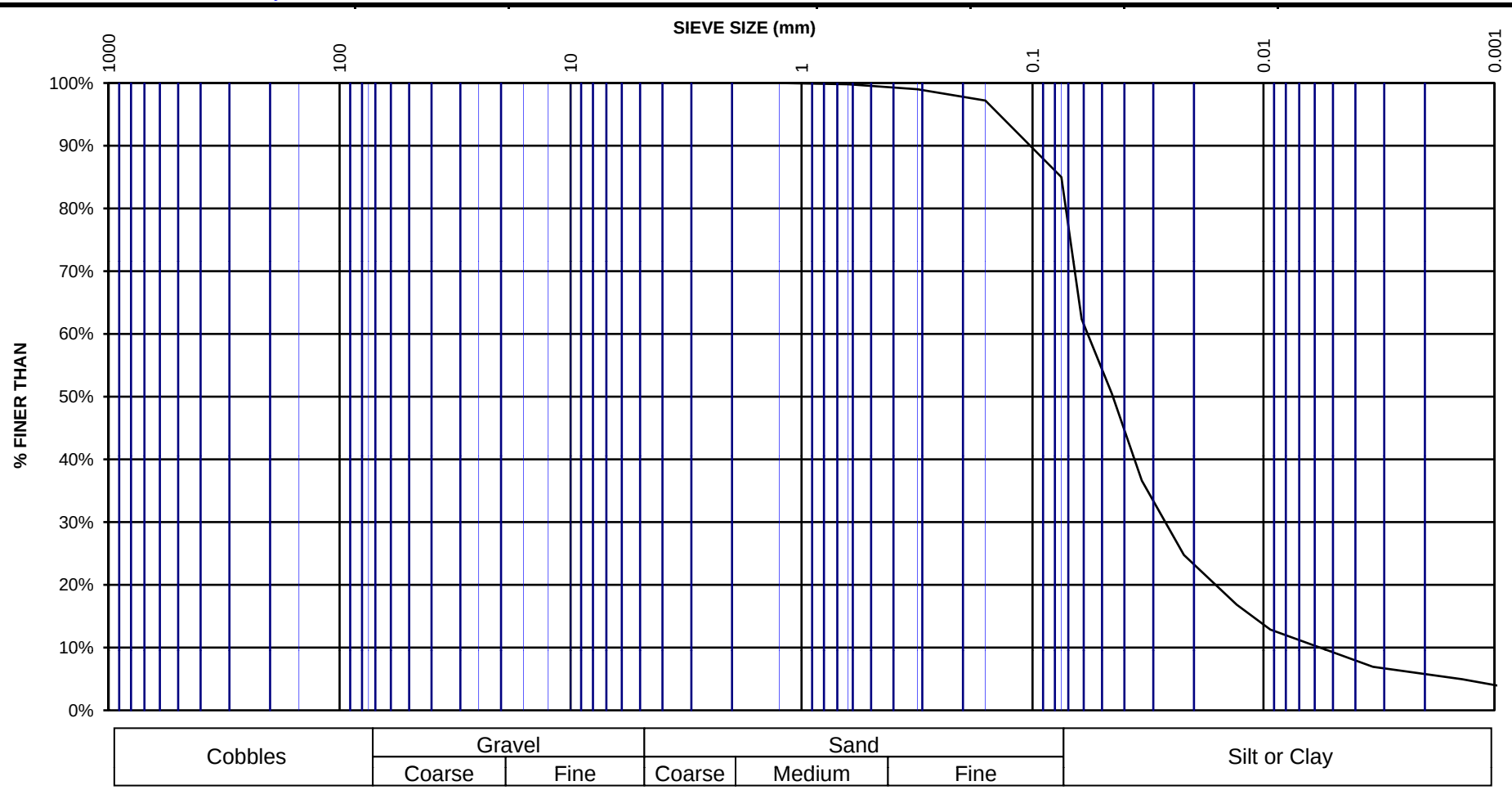
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	397.0	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	297.0	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0		0%	100%	
MC (%)		5,000	0.185	5.0		0%	100%	
	Passing							
After Washing		2,000	0.0937	2.0		0%	100%	
Wt. Dry+Tare		1,250	0.0469	1.25	0.0	0%	100.0%	
Tare		630	0.0234	0.63	0.6	0%	99.8%	
Wt. Dry		315	0.0116	0.315	3.0	1%	99.0%	
Tare No.		160	0.0059	0.160	8.3	3%	97.2%	
		75	0.00295	0.075	44.6	15%	85.0%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	397.0	36	0.5	0.061	20	32	62.4%	
Wt Tare	100.0	30	1	0.045	20	26	50.5%	
Wt Dry	297.0	23	2	0.034	20	19	36.6%	
Sample Size :	50	17	5	0.022	20	13	24.8%	
Wt Retained 2 mm:	0	13	15	0.013	20	9	16.8%	
% Passing 2 mm:	100.0%	11	30	0.009	20	7	12.9%	
Specific Gravity :	2.70	10	60	0.007	20	6	10.9%	
Hydrometer No.:	43-9856	9	120	0.005	20	5	8.9%	
Solution (g/L) :	40	8	240	0.003	20	4	6.9%	
		7	1440	0.001	20	3	5.0%	
		7	2880	0.001	20	2	4.0%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	12
TESTHOLE:	14-24	DEPTH :	8.35m
DATE :	February 17, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-24#12 Hydro.xls
DATE: 2/19/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	19
BOREHOLE:	TH14-24	DEPTH :	13.7m
DATE :	February 18, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	21					
Container Number						
Wt. Sample (wet+tare)(g)	42.65					
Wt. Sample (dry+tare)(g)	34.84					
Wt. Tare (g)	12.25					
Wt. Dry Soil (g)	22.6					
Wt. Water (g)	7.8					
Water Content (%)	34.6%					

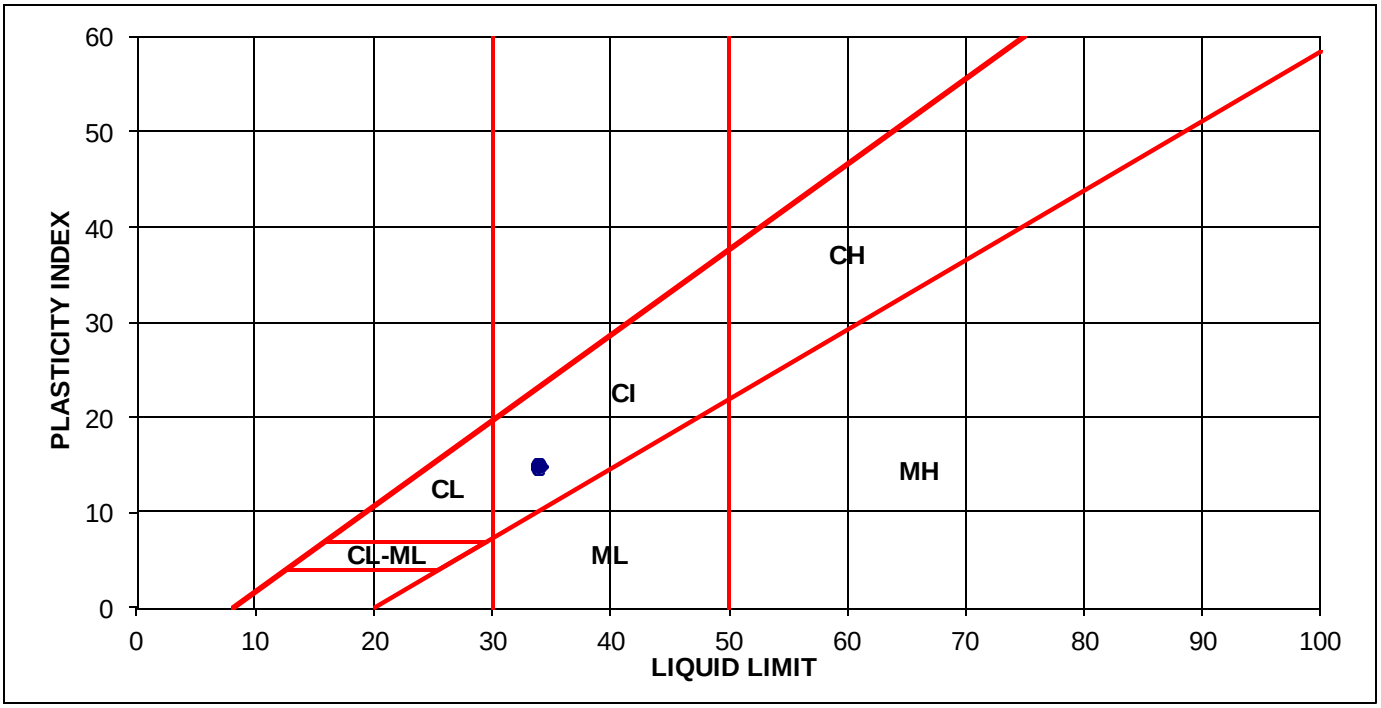
AVERAGE VALUES	
Liquid Limit	33.9
Plastic Limit	18.9
Plasticity Index	14.9

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	29.51		
Wt. Sample (dry+tare)(g)	26.98		
Wt. Tare (g)	13.60		
Wt. Dry Soil (g)	13.4		
Wt. Water (g)	2.5		
Water Content (%)	18.9%		



FORM: SAFM TH14-24#19 Att.xlsx
DATE: 2/19/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	2
BOREHOLE:	TH14-24	DEPTH :	0.75m
DATE :	February 18, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	15					
Container Number						
Wt. Sample (wet+tare)(g)	50.42					
Wt. Sample (dry+tare)(g)	41.20					
Wt. Tare (g)	12.09					
Wt. Dry Soil (g)	29.1					
Wt. Water (g)	9.2					
Water Content (%)	31.7%					

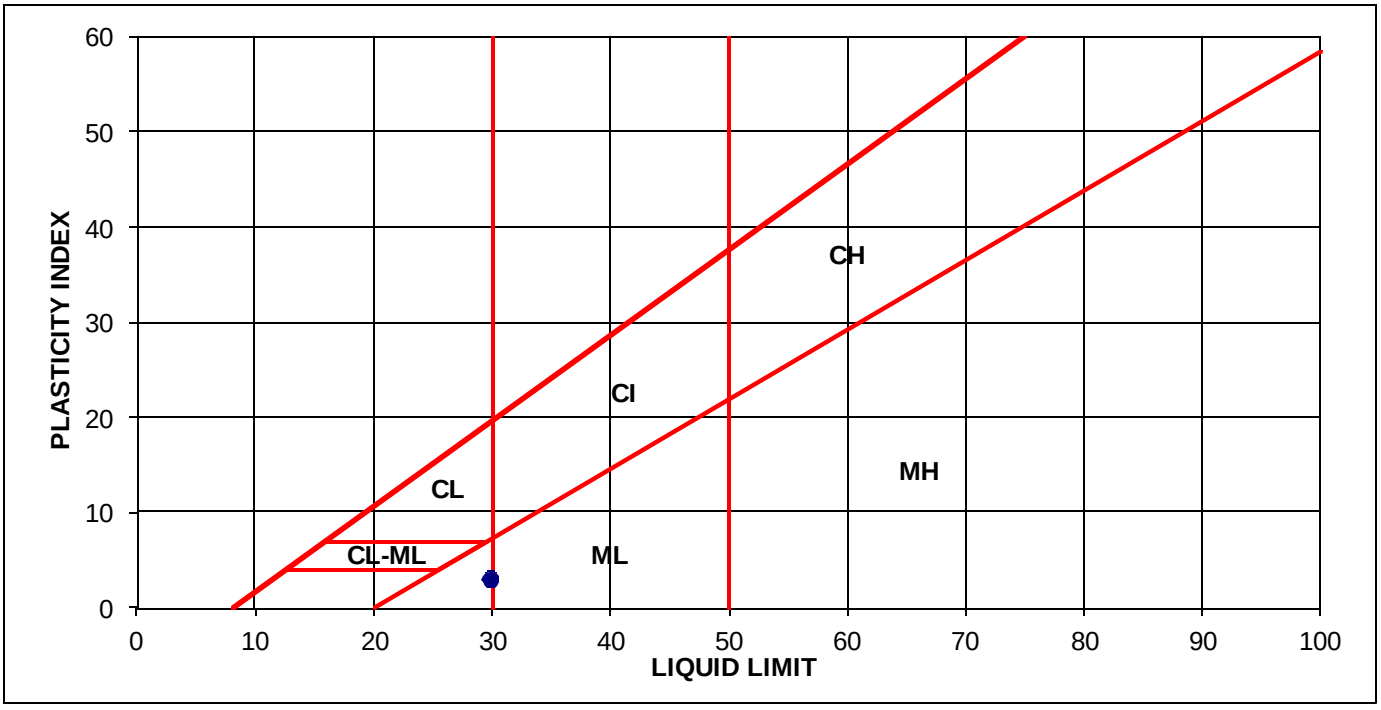
AVERAGE VALUES	
Liquid Limit	29.8
Plastic Limit	26.7
Plasticity Index	3.1

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	36.90		
Wt. Sample (dry+tare)(g)	32.42		
Wt. Tare (g)	15.61		
Wt. Dry Soil (g)	16.8		
Wt. Water (g)	4.5		
Water Content (%)	26.7%		



FORM: SAFM TH14-24#2 Att.xlsx
DATE: 2/19/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	2
TESTHOLE:	14-24	DEPTH :	0.75m
DATE :	February 17, 2014	TECHNICIAN :	GU

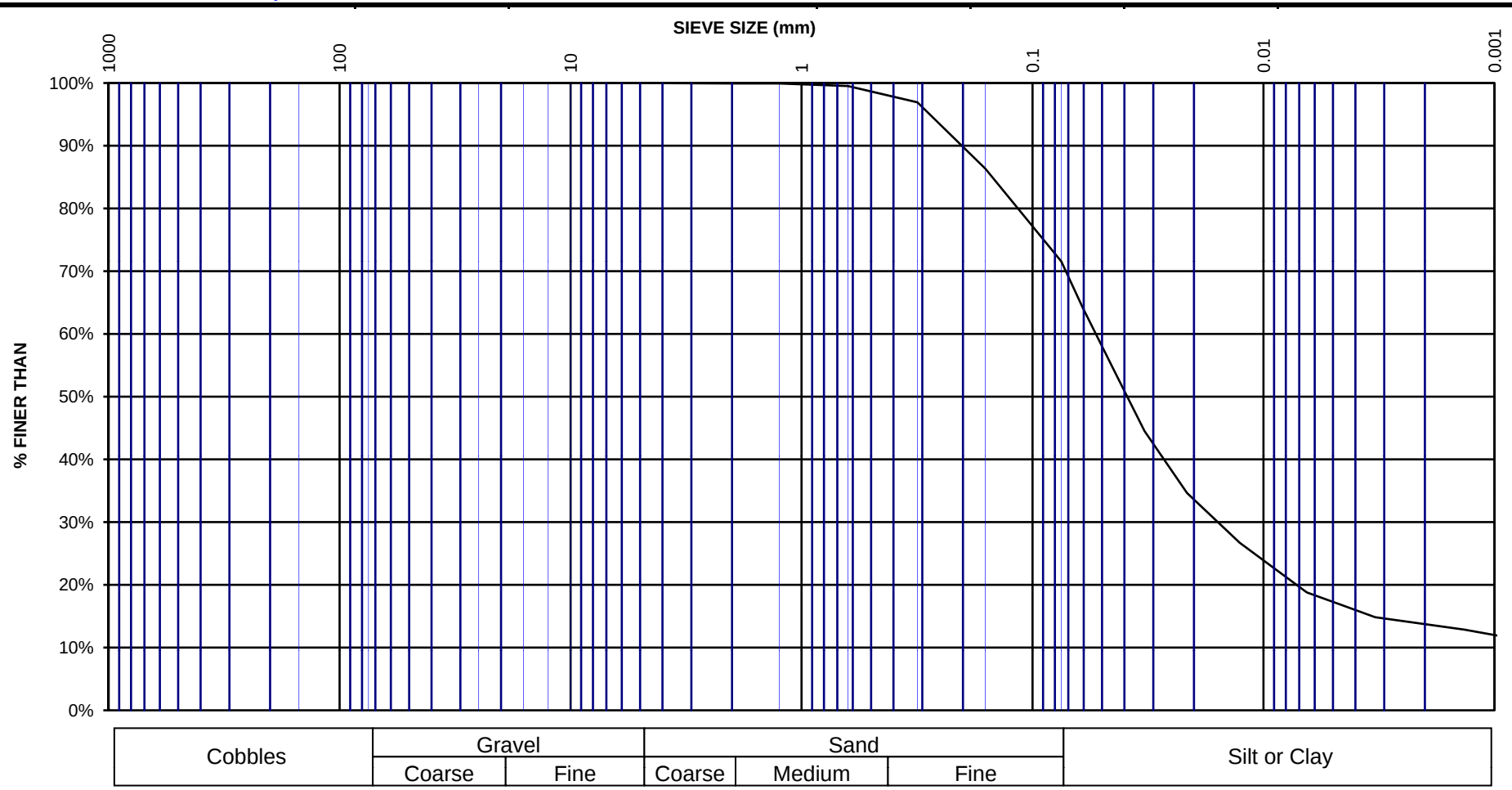
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	342.1	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	242.1	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0		0%	100%	
MC (%)		5,000	0.185	5.0		0%	100%	
	Passing							
After Washing		2,000	0.0937	2.0	0.2	0%	99.9%	
Wt. Dry+Tare		1,250	0.0469	1.25	0.2	0%	99.9%	
Tare		630	0.0234	0.63	1.2	0%	99.5%	
Wt. Dry		315	0.0116	0.315	7.5	3%	96.9%	
Tare No.		160	0.0059	0.160	33.1	14%	86.3%	
		75	0.00295	0.075	68.9	28%	71.5%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	342.1	37	0.5	0.061	20	33	64.3%	
Wt Tare	100.0	32	1	0.045	20	28	54.4%	
Wt Dry	242.1	27	2	0.033	20	23	44.5%	
Sample Size :	50	22	5	0.021	20	18	34.6%	
Wt Retained 2 mm:	0.2	18	15	0.013	20	14	26.7%	
% Passing 2 mm:	99.9%	16	30	0.009	20	12	22.8%	
Specific Gravity :	2.70	14	60	0.006	20	10	18.8%	
Hydrometer No.:	43-9856	13	120	0.005	20	9	16.8%	
Solution (g/L) :	40	12	240	0.003	20	8	14.8%	
		11	1440	0.001	20	7	12.9%	
		11	2880	0.001	20	6	11.9%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	2
TESTHOLE:	14-24	DEPTH :	0.75m
DATE :	February 17, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-24#2 Hydro.xls
DATE: 2/19/2014

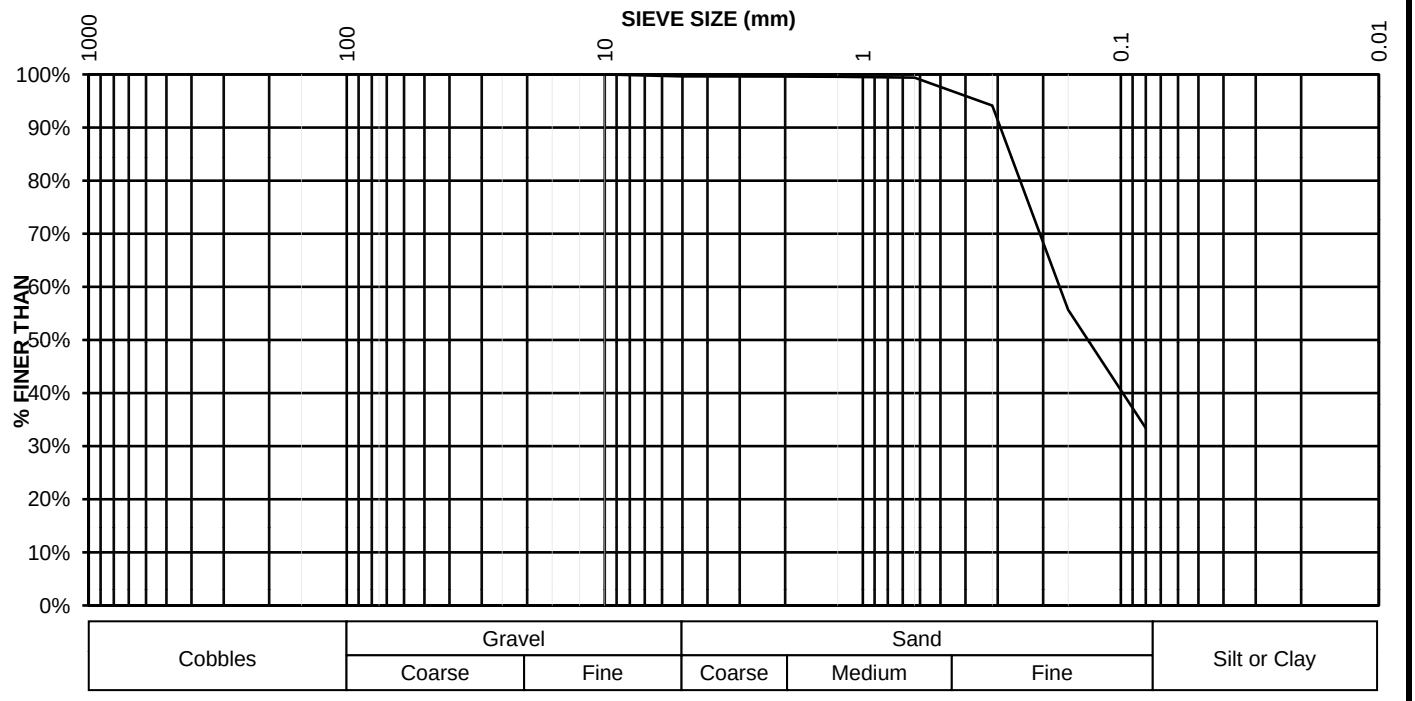
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	4
TESTHOLE :	14-24	DEPTH :	2.3m
DATE :	February 18, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	536.8	50000	2	50.0			100%		
Tare	235.0	40000	1 1/2	40.0			100%		
Wt. Dry	301.8	25000	1	25.0			100%		
Moisture Content		20000	3/4	20.0			100%		
Wet + Tare		16000	5/8	16.0			100%		
Dry+Tare		12500	1/2	12.5			100%		
Tare		10000	3/8	10.0			100%		
MC (%)		5000	0.185	5.0	1.1	0%	100%		
	Passing								
After Washing		2000	0.0937	2.0	1.2	0%	100%		
Wt. Dry+Tare	442.6	1250	0.0469	1.25	1.3	0%	100%		
Tare	235.0	630	0.0234	0.630	1.8	1%	99%		
Wt. Dry	207.6	315	0.0116	0.315	17.7	6%	94%		
Tare No.		160	0.0059	0.160	133.7	44%	56%		
		80	0.0029	0.080	201.0	67%	33%		
		PAN			207.5				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-24#4 Sieve.xls
DATE: 2/19/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	7
BOREHOLE:	TH14-24	DEPTH :	4.55m
DATE :	February 18, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	28					
Container Number						
Wt. Sample (wet+tare)(g)	46.08					
Wt. Sample (dry+tare)(g)	40.78					
Wt. Tare (g)	11.81					
Wt. Dry Soil (g)	29.0					
Wt. Water (g)	5.3					
Water Content (%)	18.3%					

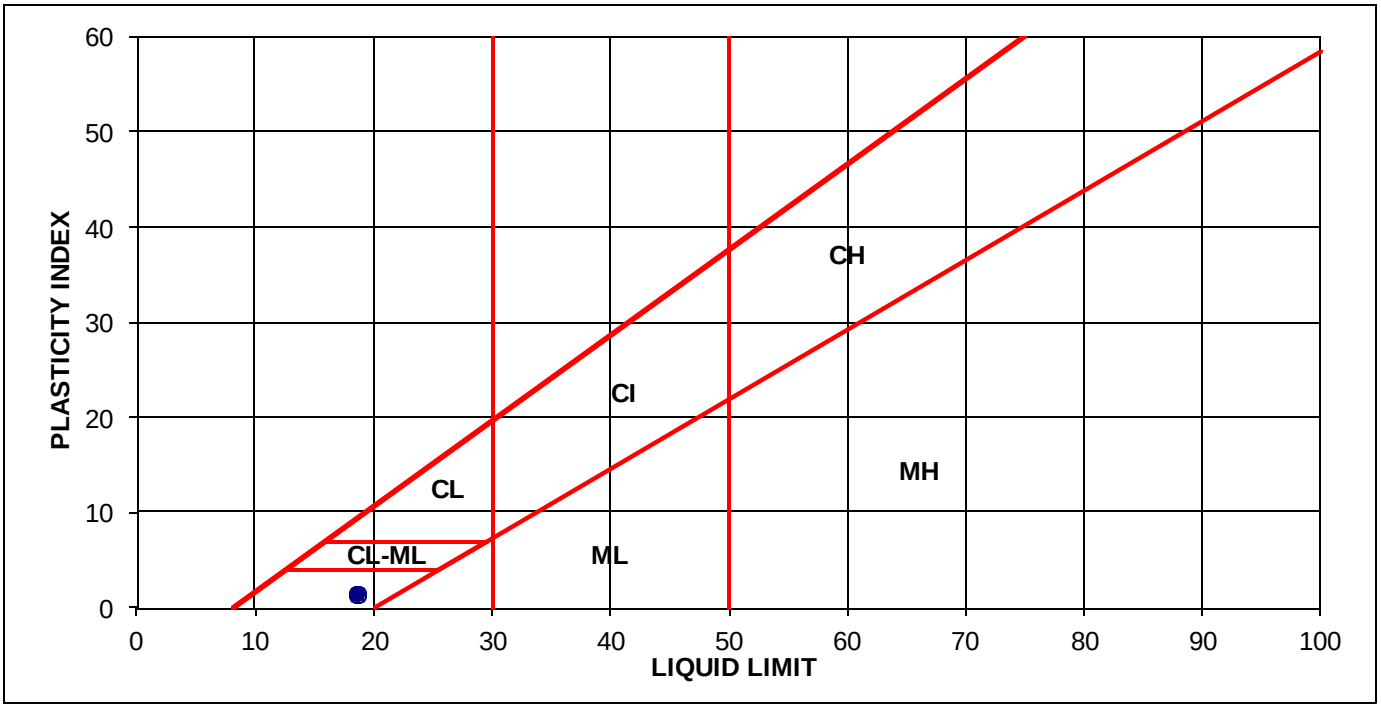
AVERAGE VALUES	
Liquid Limit	18.5
Plastic Limit	17.0
Plasticity Index	1.5

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	39.26		
Wt. Sample (dry+tare)(g)	35.88		
Wt. Tare (g)	16.05		
Wt. Dry Soil (g)	19.8		
Wt. Water (g)	3.4		
Water Content (%)	17.0%		



FORM: SAFM TH14-24#7 Att.xlsx
DATE: 2/19/2014

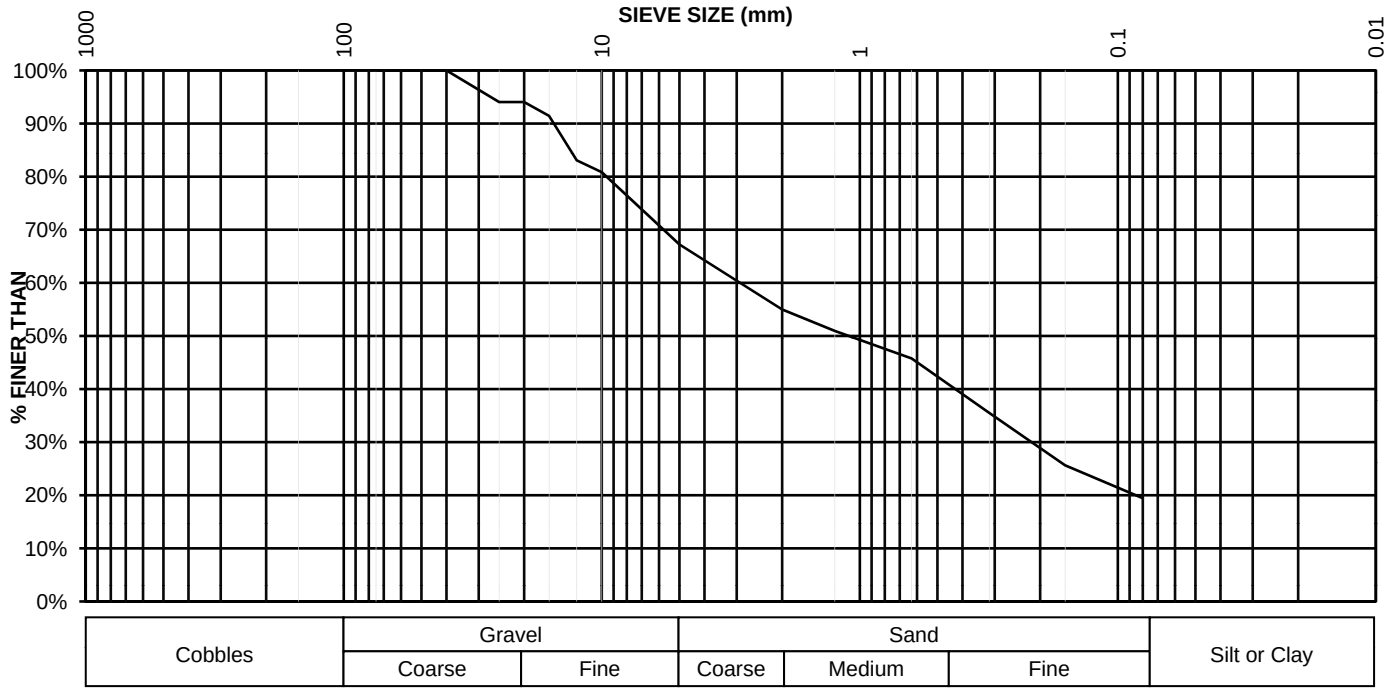
SIEVE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	3
TESTHOLE :	14-26	DEPTH :	2m
DATE :	February 25, 2014	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	SPECIFICATION LOWER	SPECIFICATION UPPER
Before Washing		150000	6	150.0			100%		
Wet + Tare		75000	3	75.0			100%		
Dry+Tare	725.8	50000	2	50.0			100%		
Tare	250.6	40000	1 1/2	40.0			100%		
Wt. Dry	475.2	25000	1	25.0	28.3	6%	94%		
Moisture Content		20000	3/4	20.0	28.3	6%	94%		
Wet + Tare		16000	5/8	16.0	40.7	9%	91%		
Dry+Tare		12500	1/2	12.5	80.5	17%	83%		
Tare		10000	3/8	10.0	91.1	19%	81%		
MC (%)		5000	0.185	5.0	155.7	33%	67%		
	Passing								
After Washing		2000	0.0937	2.0	213.9	45%	55%		
Wt. Dry+Tare	635.9	1250	0.0469	1.25	233.1	49%	51%		
Tare	250.6	630	0.0234	0.630	257.7	54%	46%		
Wt. Dry	385.3	315	0.0116	0.315	306.5	64%	36%		
Tare No.		160	0.0059	0.160	353.4	74%	26%		
		80	0.0029	0.080	382.8	81%	19%		
		PAN			385.3				

Classification:	SM or SC	Description and Remarks:
Cc	#N/A	
Cu	#N/A	



FORM: SAFM TH14-26 #3 Sieve.xls
DATE: 2/26/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	7
BOREHOLE:	TH14-26	DEPTH :	4.6m
DATE :	February 25, 2014	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	21					
Container Number						
Wt. Sample (wet+tare)(g)	56.73					
Wt. Sample (dry+tare)(g)	49.84					
Wt. Tare (g)	16.06					
Wt. Dry Soil (g)	33.8					
Wt. Water (g)	6.9					
Water Content (%)	20.4%					

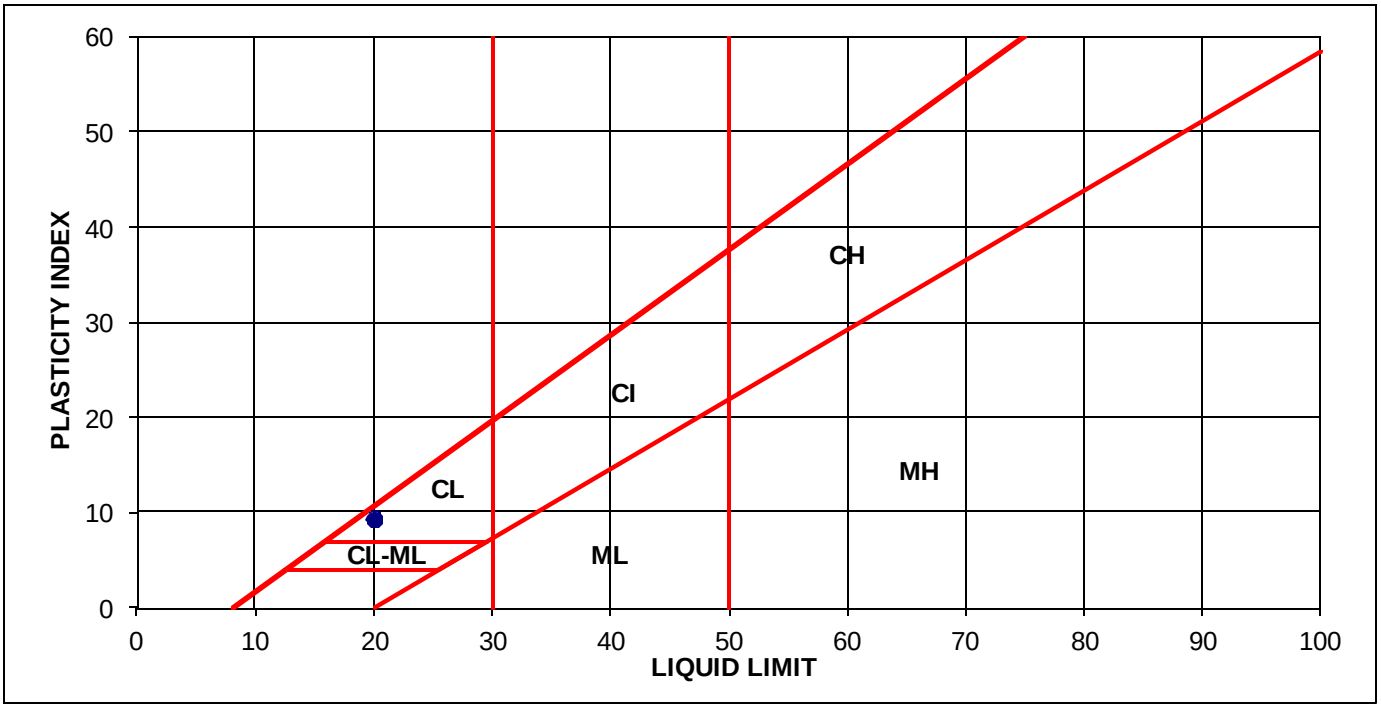
AVERAGE VALUES	
Liquid Limit	20.0
Plastic Limit	10.5
Plasticity Index	9.4

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1				
Container Number					
Wt. Sample (wet+tare)(g)	34.05				
Wt. Sample (dry+tare)(g)	31.93				
Wt. Tare (g)	11.81				
Wt. Dry Soil (g)	20.1				
Wt. Water (g)	2.1				
Water Content (%)	10.5%				



FORM: SAFM TH14-26 #7 Att.xlsx
DATE: 2/26/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	7
TESTHOLE:	14-26	DEPTH :	4.6m
DATE :	February 25, 2014	TECHNICIAN :	GU

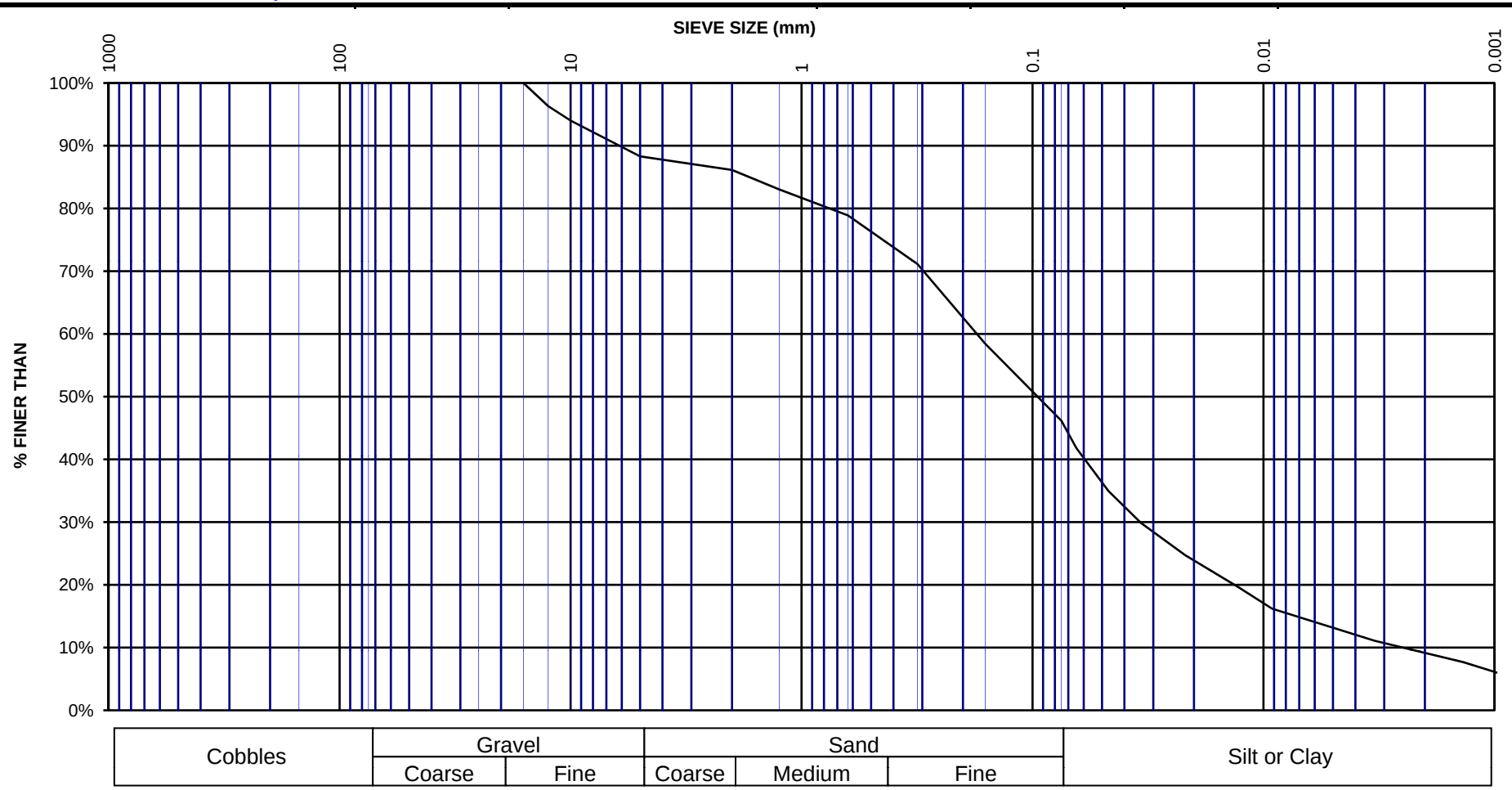
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	238.5	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	138.5	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5	5.1	4%	96%	
Tare		10,000	3/8	10.0	8.3	6%	94.0%	
MC (%)		5,000	0.185	5.0	16.2	12%	88.3%	
	Passing							
After Washing		2,000	0.0937	2.0	19.2	14%	86.1%	
Wt. Dry+Tare		1,250	0.0469	1.25	23.5	17%	83.0%	
Tare		630	0.0234	0.63	29.2	21%	78.9%	
Wt. Dry		315	0.0116	0.315	40.0	29%	71.1%	
Tare No.		160	0.0059	0.160	57.6	42%	58.4%	
		75	0.00295	0.075	74.6	54%	46.2%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	238.5	29	0.5	0.065	20	25	41.8%	
Wt Tare	100.0	25	1	0.047	20	21	35.0%	
Wt Dry	138.5	22	2	0.034	20	18	29.8%	
Sample Size :	50	19	5	0.022	20	15	24.7%	
Wt Retained 2 mm:	19.2	16	15	0.013	20	12	19.6%	
% Passing 2 mm:	86.1%	14	30	0.009	20	10	16.2%	
Specific Gravity :	2.70	13	60	0.007	20	9	14.5%	
Hydrometer No.:	43-9856	12	120	0.005	20	8	12.8%	
Solution (g/L) :	40	11	240	0.003	20	7	11.1%	
		9	1440	0.001	20	5	7.7%	
		8	2880	0.001	20	4	6.0%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	7
TESTHOLE:	14-26	DEPTH :	4.6m
DATE :	February 25, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-26#7 Hydro.xls
DATE: 2/26/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
BOREHOLE:	TH14-27	DEPTH :	4.6m
DATE :	February 25, 2014	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	22					
Container Number						
Wt. Sample (wet+tare)(g)	59.60					
Wt. Sample (dry+tare)(g)	50.51					
Wt. Tare (g)	15.62					
Wt. Dry Soil (g)	34.9					
Wt. Water (g)	9.1					
Water Content (%)	26.1%					

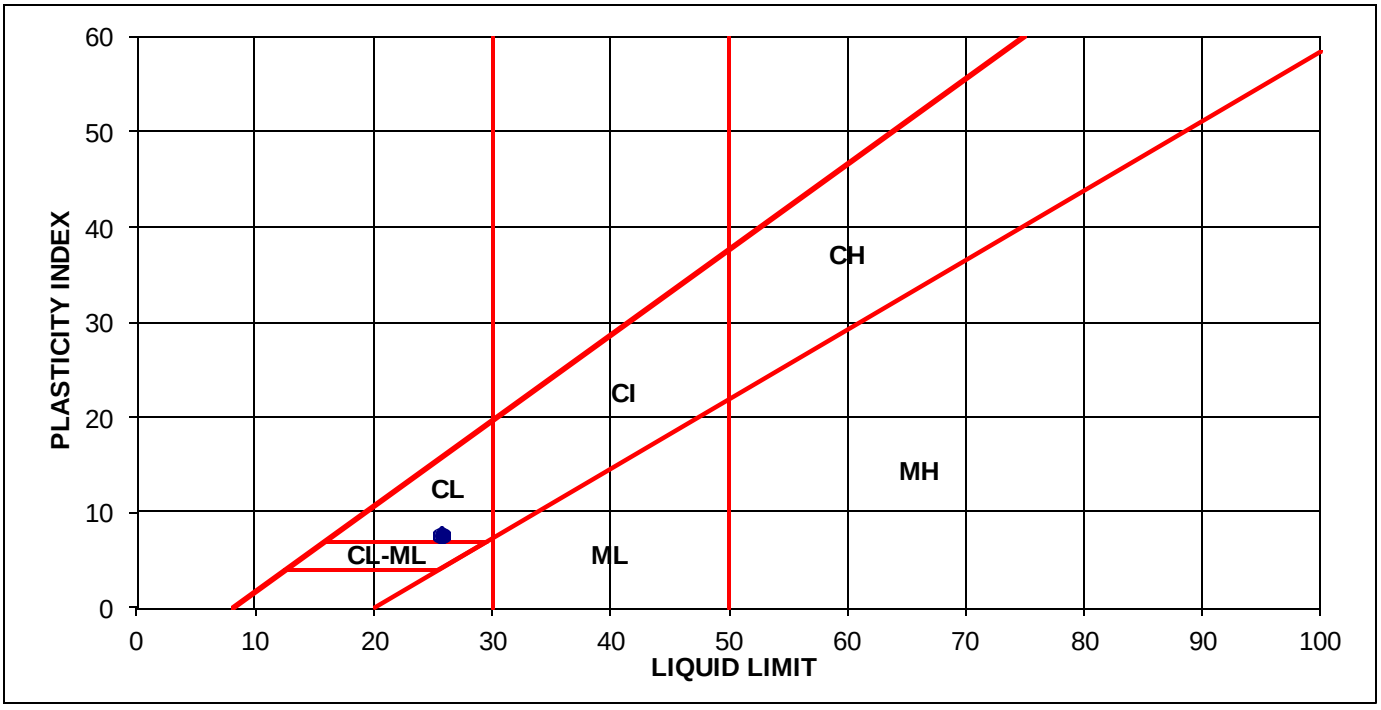
AVERAGE VALUES	
Liquid Limit	25.7
Plastic Limit	17.9
Plasticity Index	7.7

SAMPLE DESCRIPTION

Classification: **CL**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	33.00		
Wt. Sample (dry+tare)(g)	29.82		
Wt. Tare (g)	12.10		
Wt. Dry Soil (g)	17.7		
Wt. Water (g)	3.2		
Water Content (%)	17.9%		



FORM: SAFM TH14-27#5 Att.xlsx
DATE: 2/26/2014

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE:	14-27	DEPTH :	3.2m
DATE :	February 25, 2014	TECHNICIAN :	GU

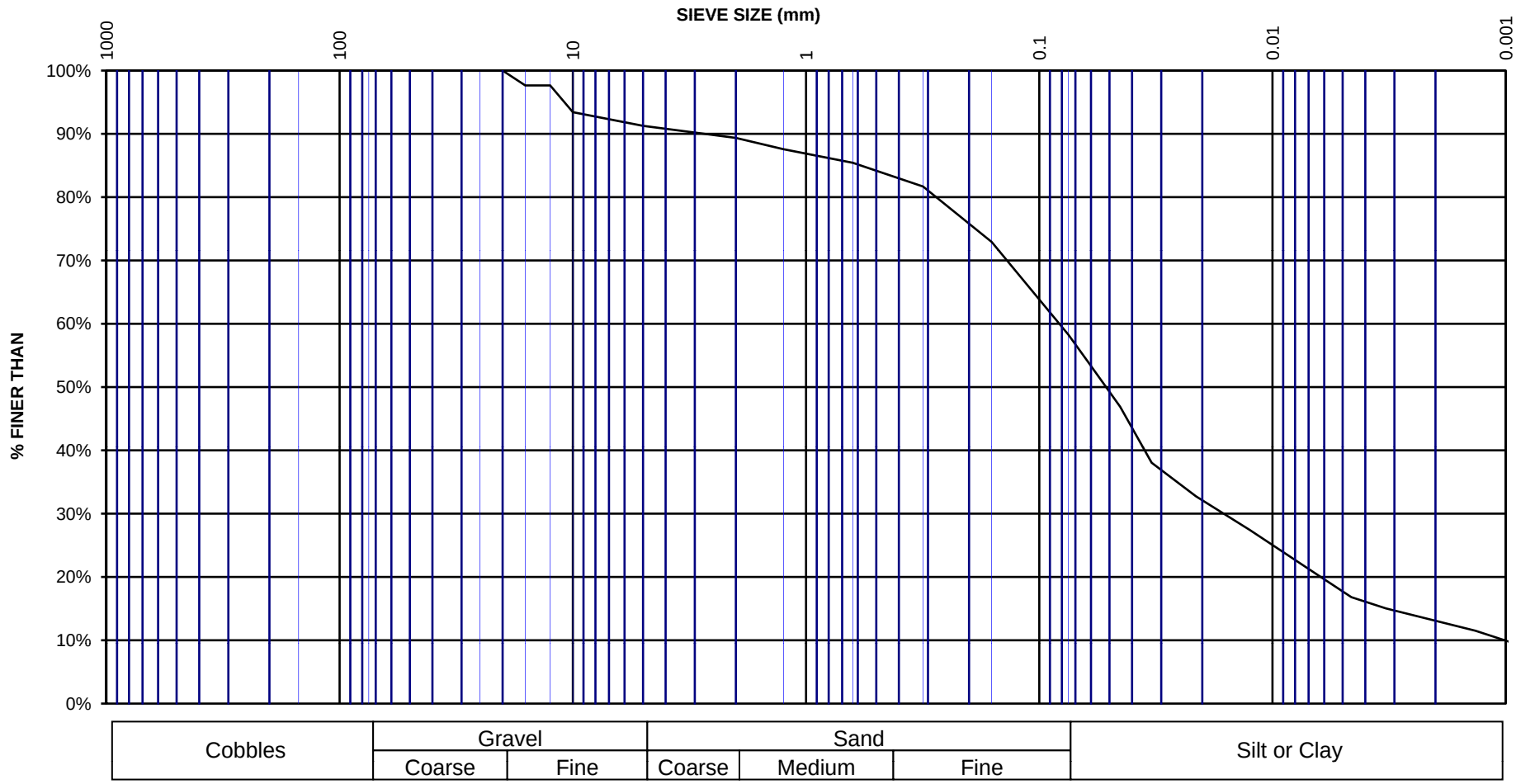
TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	346.3	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	246.3	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0	5.8	2%	98%	
Dry+Tare		12,500	1/2	12.5	5.8	2%	98%	
Tare		10,000	3/8	10.0	16.2	7%	93.4%	
MC (%)		5,000	0.185	5.0	21.5	9%	91.3%	
	Passing							
After Washing		2,000	0.0937	2.0	26.2	11%	89.4%	
Wt. Dry+Tare		1,250	0.0469	1.25	30.6	12%	87.6%	
Tare		630	0.0234	0.63	35.9	15%	85.4%	
Wt. Dry		315	0.0116	0.315	45.1	18%	81.7%	
Tare No.		160	0.0059	0.160	66.7	27%	72.9%	
		75	0.00295	0.075	102.8	42%	58.3%	
		PAN						

HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	346.3	35	0.5	0.062	20	31	54.0%	
Wt Tare	100.0	31	1	0.045	20	27	46.9%	
Wt Dry	246.3	26	2	0.033	20	22	38.0%	
Sample Size :	50	23	5	0.021	20	19	32.7%	
Wt Retained 2 mm:	26.2	20	15	0.013	20	16	27.4%	
% Passing 2 mm:	89.4%	18	30	0.009	20	14	23.9%	
Specific Gravity :	2.70	16	60	0.006	20	12	20.3%	
Hydrometer No.:	43-9856	14	120	0.005	20	10	16.8%	
Solution (g/L) :	40	13	240	0.003	20	9	15.0%	
		11	1440	0.001	20	7	11.5%	
		10	2880	0.001	20	6	9.7%	

GRAIN SIZE ANALYSIS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	5
TESTHOLE:	14-27	DEPTH :	3.2m
DATE :	February 25, 2014	TECHNICIAN :	GU



FORM: SAFM TH14-27#5 Hydro.xls
DATE: 2/26/2014

ATTERBERG LIMITS

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C2
BOREHOLE:	TH14-27	DEPTH :	10.5m
DATE :	March 3, 2014	TECHNICIAN :	CK

LIQUID LIMIT

Trial No.	1					
Number of Blows	16					
Container Number						
Wt. Sample (wet+tare)(g)	46.52					
Wt. Sample (dry+tare)(g)	38.66					
Wt. Tare (g)	11.75					
Wt. Dry Soil (g)	26.9					
Wt. Water (g)	7.9					
Water Content (%)	29.2%					

AVERAGE VALUES

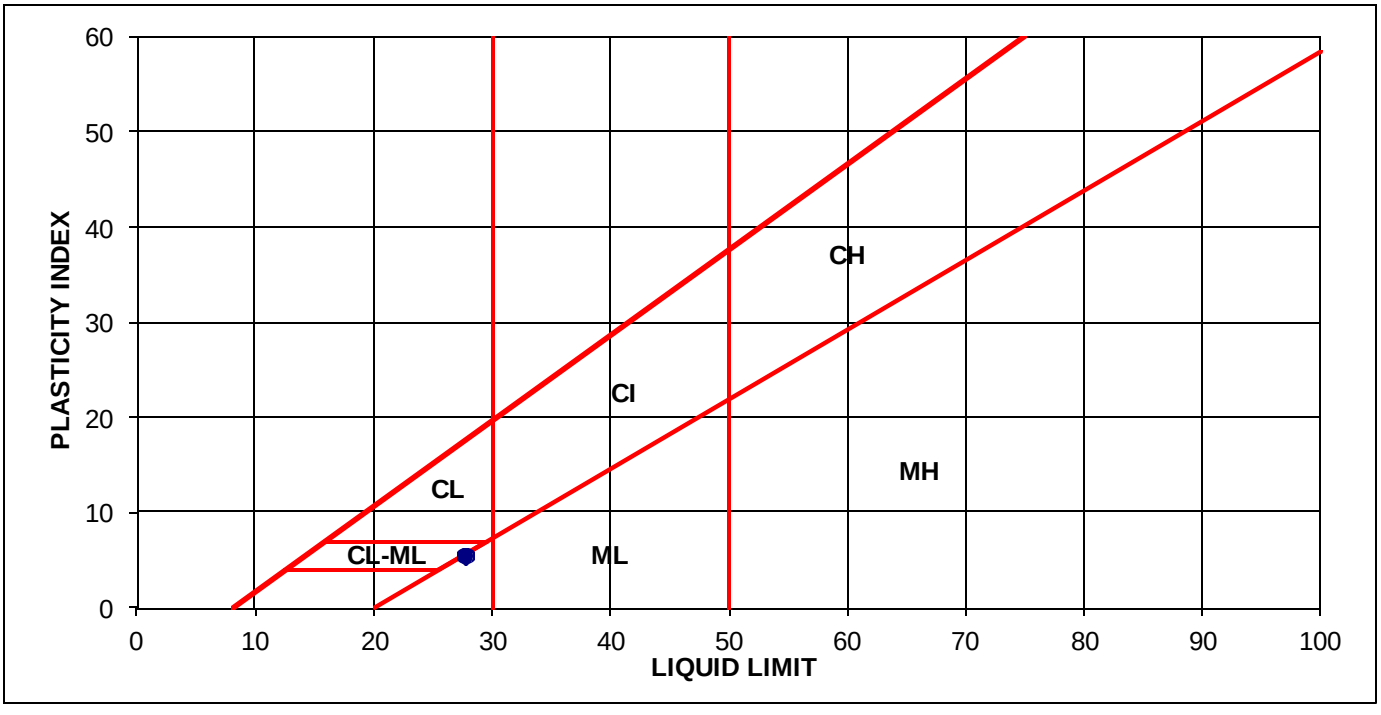
Liquid Limit	27.7
Plastic Limit	22.1
Plasticity Index	5.6

SAMPLE DESCRIPTION

Classification: **ML**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	31.56		
Wt. Sample (dry+tare)(g)	28.76		
Wt. Tare (g)	16.09		
Wt. Dry Soil (g)	12.7		
Wt. Water (g)	2.8		
Water Content (%)	22.1%		



FORM: SAFM TH14-27#C2 Att.xlsx
DATE: 3/4/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-1	DEPTH :	6m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1581.6	Tare Number		Olive grey clayshale, mod strong, very blocky
Initial Length (mm)	159.8	Wt. Sample (wet+tare) (g)	1672.2	
Initial Diameter (mm)	75.0	Wt. Sample (dry+tare)(g)	1529.6	
Wet Unit Weight (kN/m³)	22.0	Wt. Tare (g)	158.3	
Dry Unit Weight (kN/m³)	19.9	Water Content (%)	10.4%	

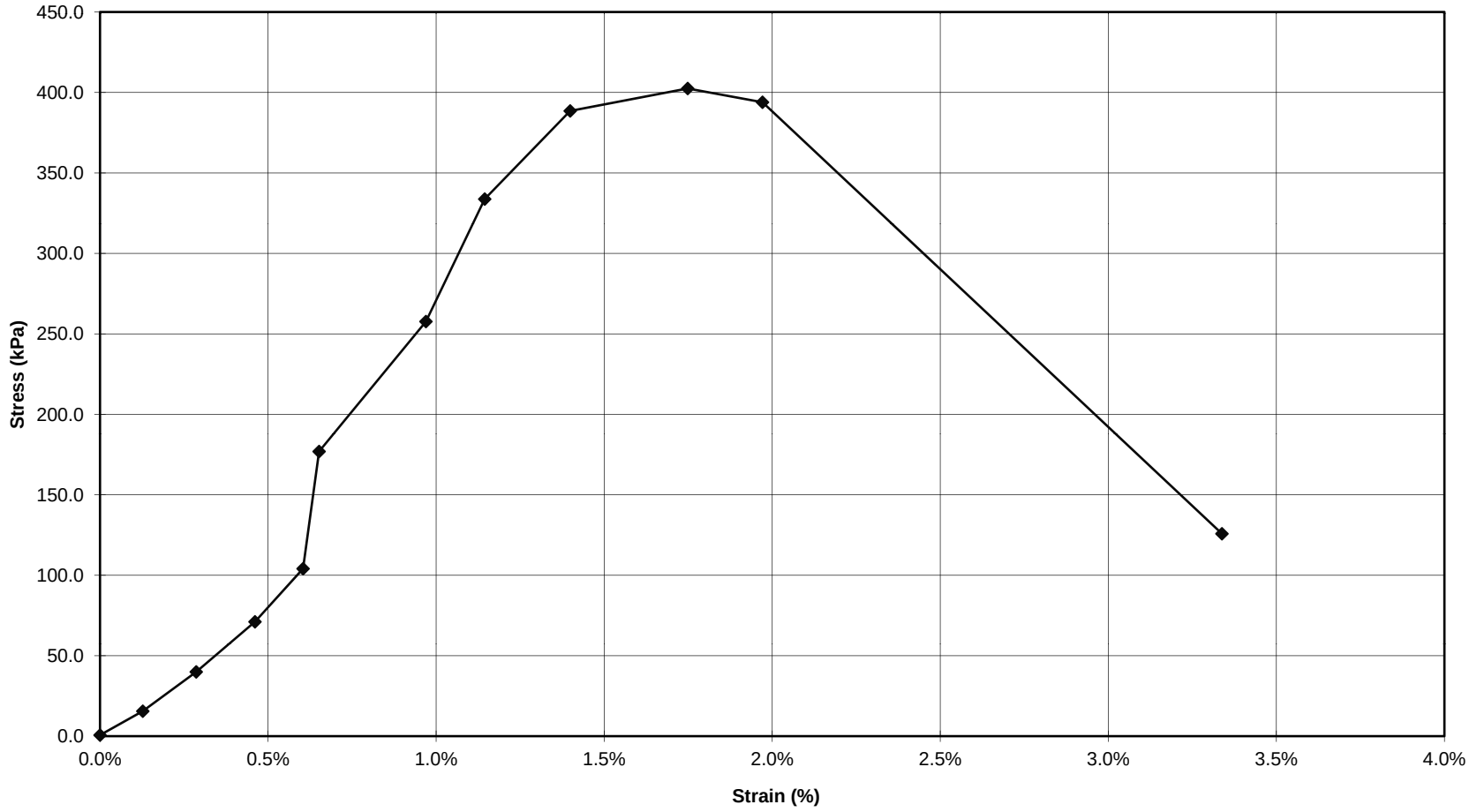
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	1810	bottom crushing along horizontal failure plane
Gears Used		% Strain :	1.7%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	402	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4418	0.7	
0.25	25	69	992	0.1%	4423	15.5	
0.5	65	177	982	0.3%	4431	40.0	
0.75	117	316	971	0.5%	4438	71.1	
1	172	463	962	0.6%	4445	104.1	
1.5	293	787	959	0.7%	4447	176.9	
2	429	1149	939	1.0%	4461	257.7	
2.5	558	1492	928	1.1%	4469	333.8	
3	652	1741	912	1.4%	4481	388.5	
3.25	678	1810	890	1.7%	4496	402.5	
3	665	1775	876	2.0%	4507	393.9	
3.5	214	575	790	3.3%	4570	125.8	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-1	DEPTH :	6m
DATE :	2-Mar-14	TECH. :	RGD



FORM : Unconf SAFM 14-1 1.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-1	DEPTH :	22m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1692.0	Tare Number		Olive grey clayshale, mod strong
Initial Length (mm)	168.8	Wt. Sample (wet+tare) (g)	1945.2	
Initial Diameter (mm)	76.2	Wt. Sample (dry+tare)(g)	1726.7	
Wet Unit Weight (kN/m³)	21.6	Wt. Tare (g)	255.7	
Dry Unit Weight (kN/m³)	18.8	Water Content (%)	14.9%	

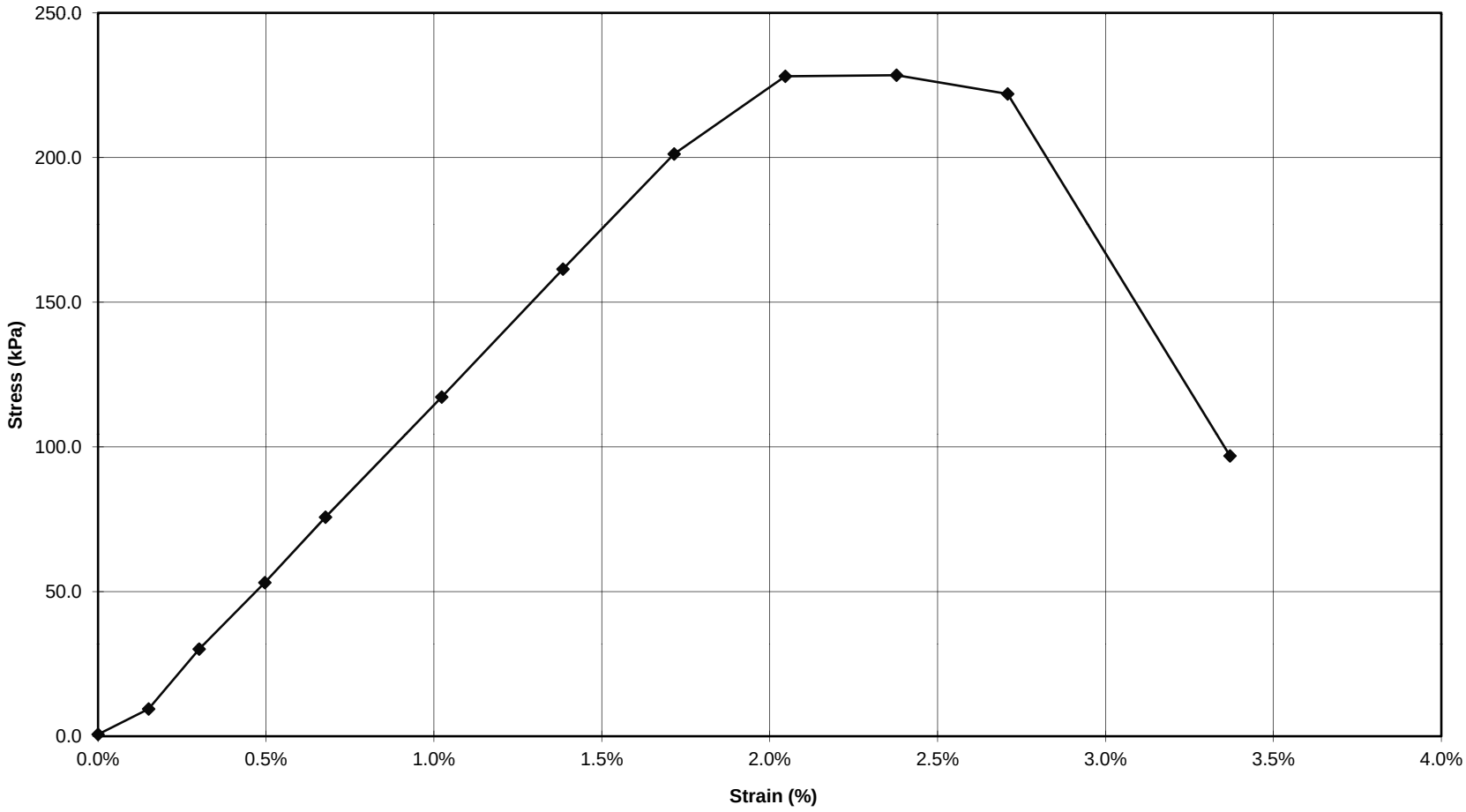
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	1067	Crack starting at top centre angling down to exit approx 100m from top.
Gears Used		% Strain :	2.4%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	228	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4560	0.7	
0.25	15	43	990	0.2%	4567	9.4	
0.5	50	138	980	0.3%	4574	30.1	
0.75	90	243	967	0.5%	4583	53.1	
1	129	348	955	0.7%	4591	75.7	
1.5	201	540	932	1.0%	4608	117.2	
2	278	747	908	1.4%	4624	161.4	
2.5	348	934	886	1.7%	4640	201.2	
3	396	1062	864	2.0%	4656	228.1	
3.5	398	1067	842	2.4%	4671	228.5	
4	388	1041	820	2.7%	4687	222.0	
4.5	170	457	776	3.4%	4719	96.9	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-1	DEPTH :	22m
DATE :	2-Mar-14	TECH. :	RGD



FORM : Unconf SAFM 14-1 3.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 6
BOREHOLE:	TH14-1	DEPTH :	31.9m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1744.4	Tare Number		Siltstone, very strong
Initial Length (mm)	161.3	Wt. Sample (wet+tare) (g)	1809.3	
Initial Diameter (mm)	75.4	Wt. Sample (dry+tare)(g)	1732.8	
Wet Unit Weight (kN/m³)	23.8	Wt. Tare (g)	154.1	
Dry Unit Weight (kN/m³)	22.7	Water Content (%)	4.8%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	17416	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	38.3	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4465.1		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 17416 kg.

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-10	DEPTH :	6.5m
DATE :	February 27, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1880.9	Tare Number		Olive grey clayshale
Initial Length (mm)	178.3	Wt. Sample (wet+tare) (g)	2055.6	
Initial Diameter (mm)	77.4	Wt. Sample (dry+tare)(g)	1861.8	
Wet Unit Weight (kN/m³)	22.0	Wt. Tare (g)	202.4	
Dry Unit Weight (kN/m³)	19.7	Water Content (%)	11.7%	

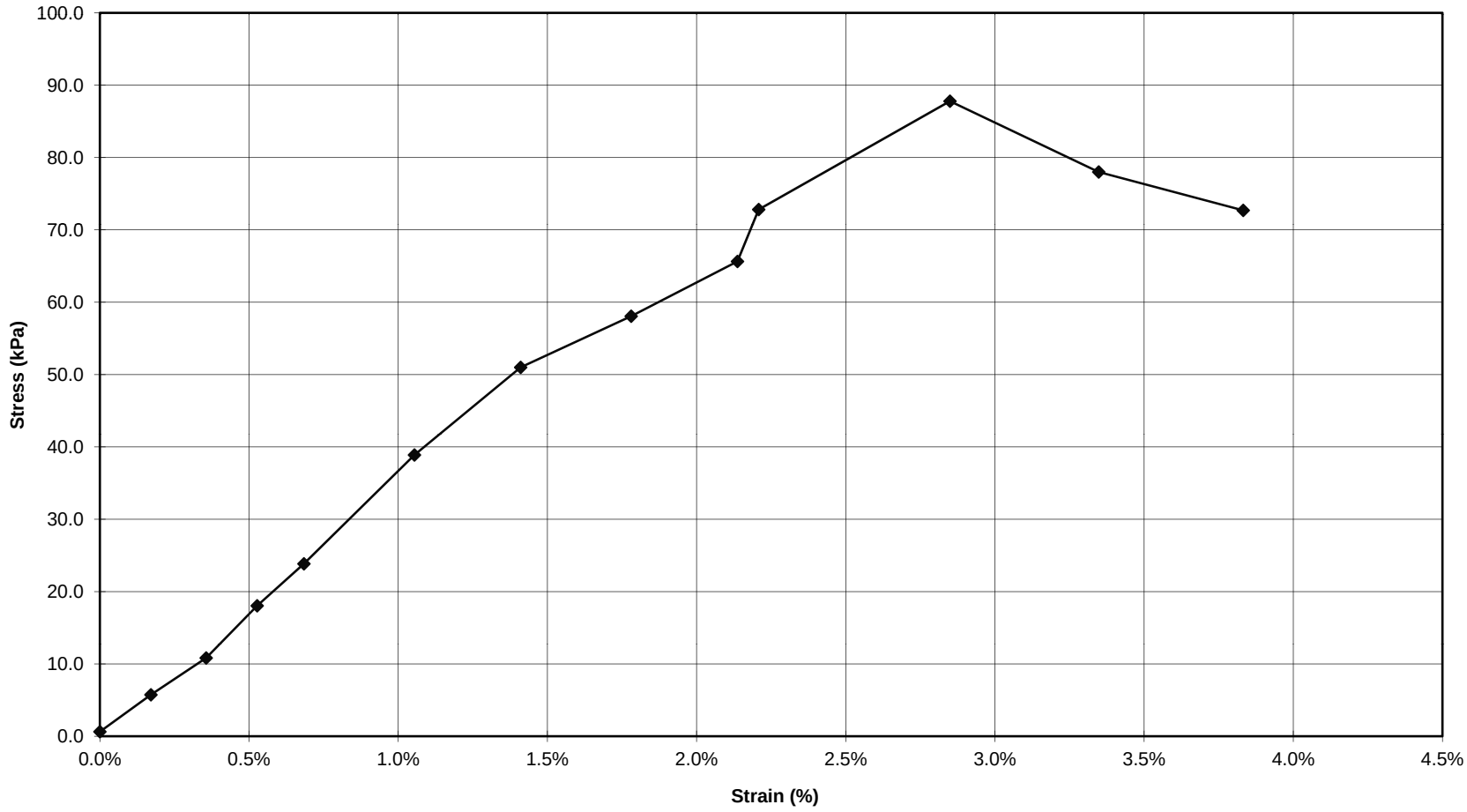
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	425	
Gears Used		% Strain :	2.8%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	88	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4705	0.6	
0.25	9	27	988	0.2%	4713	5.7	
0.5	18	51	975	0.4%	4722	10.8	
0.75	31	85	963	0.5%	4730	18.0	
1	41	113	952	0.7%	4738	23.8	
1.5	68	185	926	1.1%	4755	38.9	
2	90	243	901	1.4%	4772	51.0	
2.5	103	278	875	1.8%	4790	58.1	
3	117	316	850	2.1%	4808	65.6	
3.5	130	350	845	2.2%	4811	72.8	
4	158	425	800	2.8%	4843	87.8	
4.5	141	380	765	3.3%	4868	78.0	
5	132	356	731	3.8%	4893	72.7	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-10	DEPTH :	6.5m
DATE :	27-Feb-14	TECH. :	RGD



FORM : Unconf SAFM 14-10 1.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C3
BOREHOLE:	TH14-10	DEPTH :	13.1m
DATE :	February 21, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1772.3	Tare Number		Siltstone, very strong
Initial Length (mm)	157.1	Wt. Sample (wet+tare) (g)	1714.5	
Initial Diameter (mm)	75.5	Wt. Sample (dry+tare)(g)	1651.4	
Wet Unit Weight (kN/m³)	24.7	Wt. Tare (g)	158.2	
Dry Unit Weight (kN/m³)	23.7	Water Content (%)	4.2%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	14267.0	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	31.3	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4477		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 14267 kg.

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C2
BOREHOLE:	TH14-11	DEPTH :	10.7m
DATE :	February 21, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1758.6	Tare Number		Olive grey clayshale, mod weak to mod strong
Initial Length (mm)	172.0	Wt. Sample (wet+tare) (g)	1857.4	
Initial Diameter (mm)	77.4	Wt. Sample (dry+tare)(g)	1650.6	
Wet Unit Weight (kN/m³)	21.3	Wt. Tare (g)	156.8	
Dry Unit Weight (kN/m³)	18.7	Water Content (%)	13.8%	

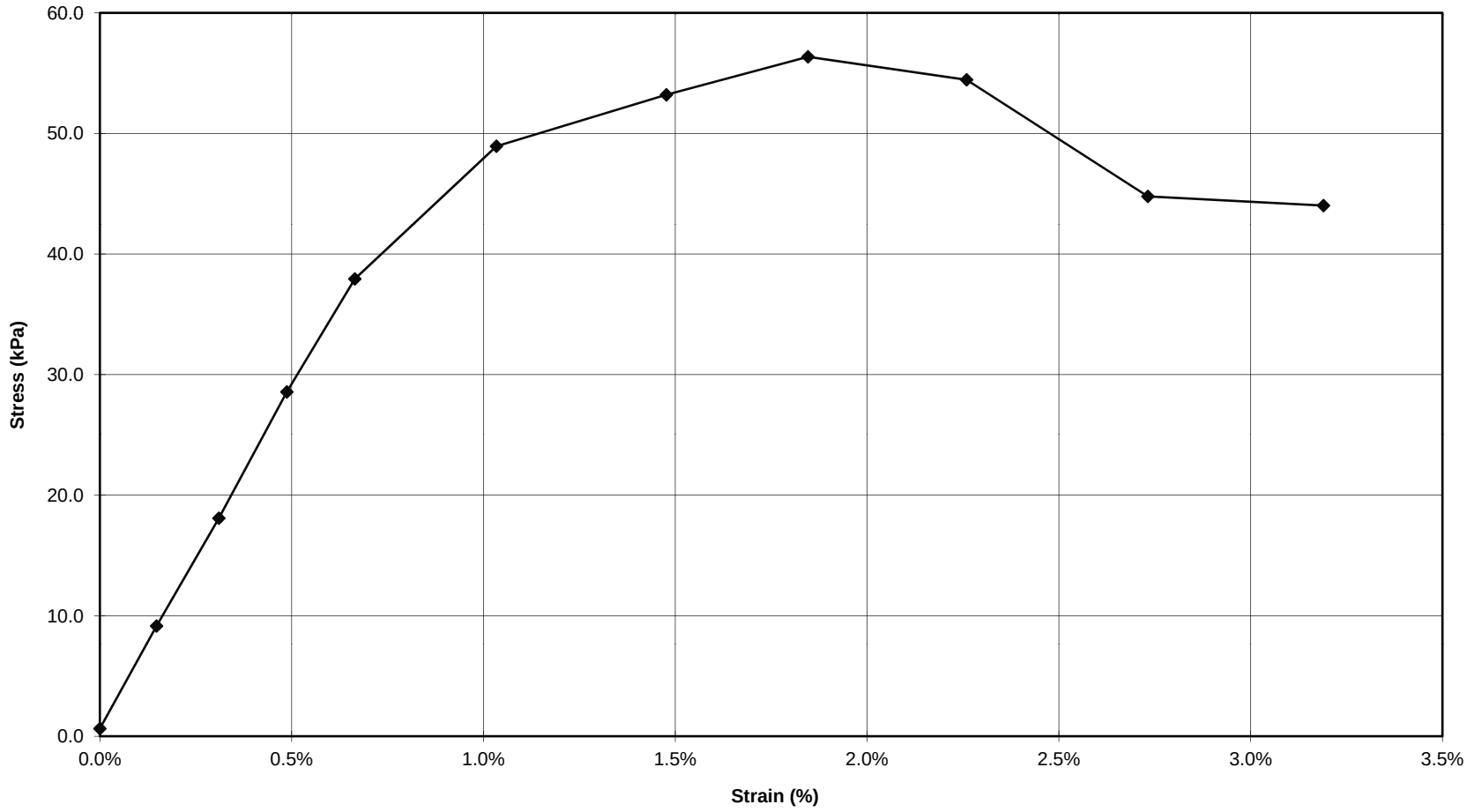
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	270	Wedge shaped starting at bottom
Gears Used		% Strain :	1.8%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	56	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4705	0.6	
0.25	15	43	990	0.1%	4712	9.1	
0.5	31	85	979	0.3%	4720	18.1	
0.75	49	135	967	0.5%	4728	28.6	
1	66	180	955	0.7%	4737	37.9	
1.5	86	233	930	1.0%	4754	48.9	
2	94	254	900	1.5%	4776	53.2	
2.5	100	270	875	1.8%	4794	56.4	
3	97	262	847	2.3%	4814	54.5	
3.5	80	217	815	2.7%	4837	44.8	
4	79	214	784	3.2%	4860	44.0	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C2
BOREHOLE:	TH14-11	DEPTH :	10.7m
DATE :	21-Feb-14	TECH. :	RGD



FORM : Unconf SAFM 14-11 2.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C4
BOREHOLE:	TH14-11	DEPTH :	16.0m
DATE :	February 21, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1663.5	Tare Number		Clayshale/Siltstone, very strong
Initial Length (mm)	152.1	Wt. Sample (wet+tare) (g)	1462.3	
Initial Diameter (mm)	75.6	Wt. Sample (dry+tare)(g)	1386.3	
Wet Unit Weight (kN/m³)	23.9	Wt. Tare (g)	160	
Dry Unit Weight (kN/m³)	22.5	Water Content (%)	6.2%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	12265.0	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	26.8	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4489		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 12265 kg.

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C1
BOREHOLE:	TH14-13	DEPTH :	8.6m
DATE :	February 21, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1692.0	Tare Number		Clayshale/Siltstone, very strong
Initial Length (mm)	151.7	Wt. Sample (wet+tare) (g)	1860.6	
Initial Diameter (mm)	75.7	Wt. Sample (dry+tare)(g)	1786.5	
Wet Unit Weight (kN/m³)	24.3	Wt. Tare (g)	233.1	
Dry Unit Weight (kN/m³)	23.2	Water Content (%)	4.8%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	12388	Edge to opposite edge top to bottom shear
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	27.0	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4501		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 12388 kg.

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-13	DEPTH :	13m
DATE :	February 27, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1351.9	Tare Number		Olive grey clayshale, mod weak to mod strong
Initial Length (mm)	143.0	Wt. Sample (wet+tare) (g)	1457.2	
Initial Diameter (mm)	73.6	Wt. Sample (dry+tare)(g)	1294.4	
Wet Unit Weight (kN/m³)	21.8	Wt. Tare (g)	164.5	
Dry Unit Weight (kN/m³)	19.0	Water Content (%)	14.4%	

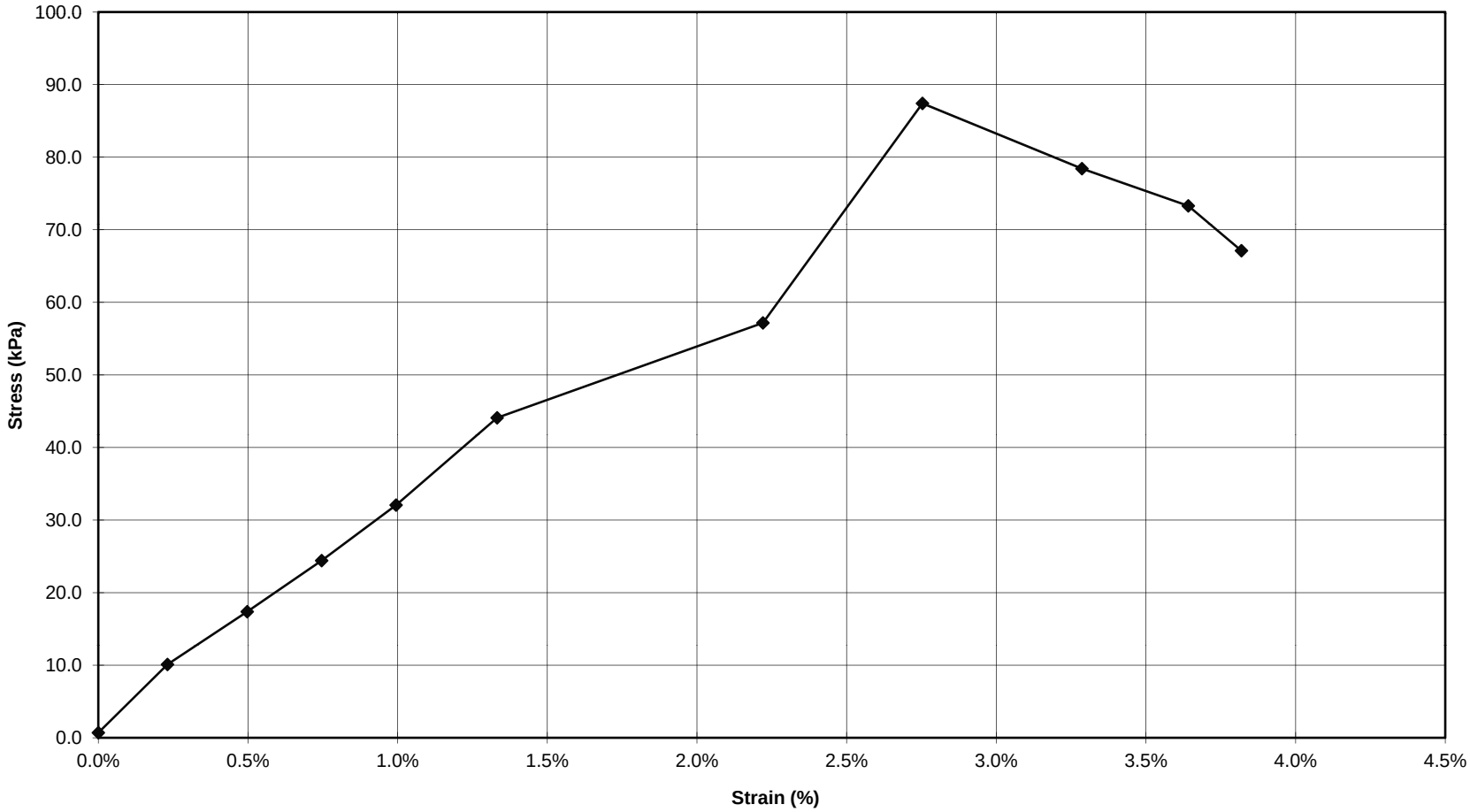
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	382	45^0 Starting at top edge
Gears Used		% Strain :	2.8%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	87	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4254	0.7	
0.25	15	43	987	0.2%	4264	10.1	
0.5	27	74	972	0.5%	4276	17.4	
0.75	38	105	958	0.7%	4286	24.4	
1	50	138	944	1.0%	4297	32.1	
1.5	70	190	925	1.3%	4312	44.1	
2	92	249	875	2.2%	4351	57.2	
2.5	142	382	845	2.8%	4375	87.4	
3	128	345	815	3.3%	4399	78.4	
3.5	120	324	795	3.6%	4415	73.3	
4	110	297	785	3.8%	4423	67.1	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-13	DEPTH :	13m
DATE :	27-Feb-14	TECH. :	RGD



FORM : Unconf SAFM 14-13. 3.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-25	DEPTH :	19m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1407.3	Tare Number		Clayshale/claystone, olive grey, mod strong to strong, very blocky
Initial Length (mm)	134.5	Wt. Sample (wet+tare) (g)	1546.6	
Initial Diameter (mm)	76.1	Wt. Sample (dry+tare)(g)	1429.2	
Wet Unit Weight (kN/m³)	22.6	Wt. Tare (g)	207.7	
Dry Unit Weight (kN/m³)	20.6	Water Content (%)	9.6%	

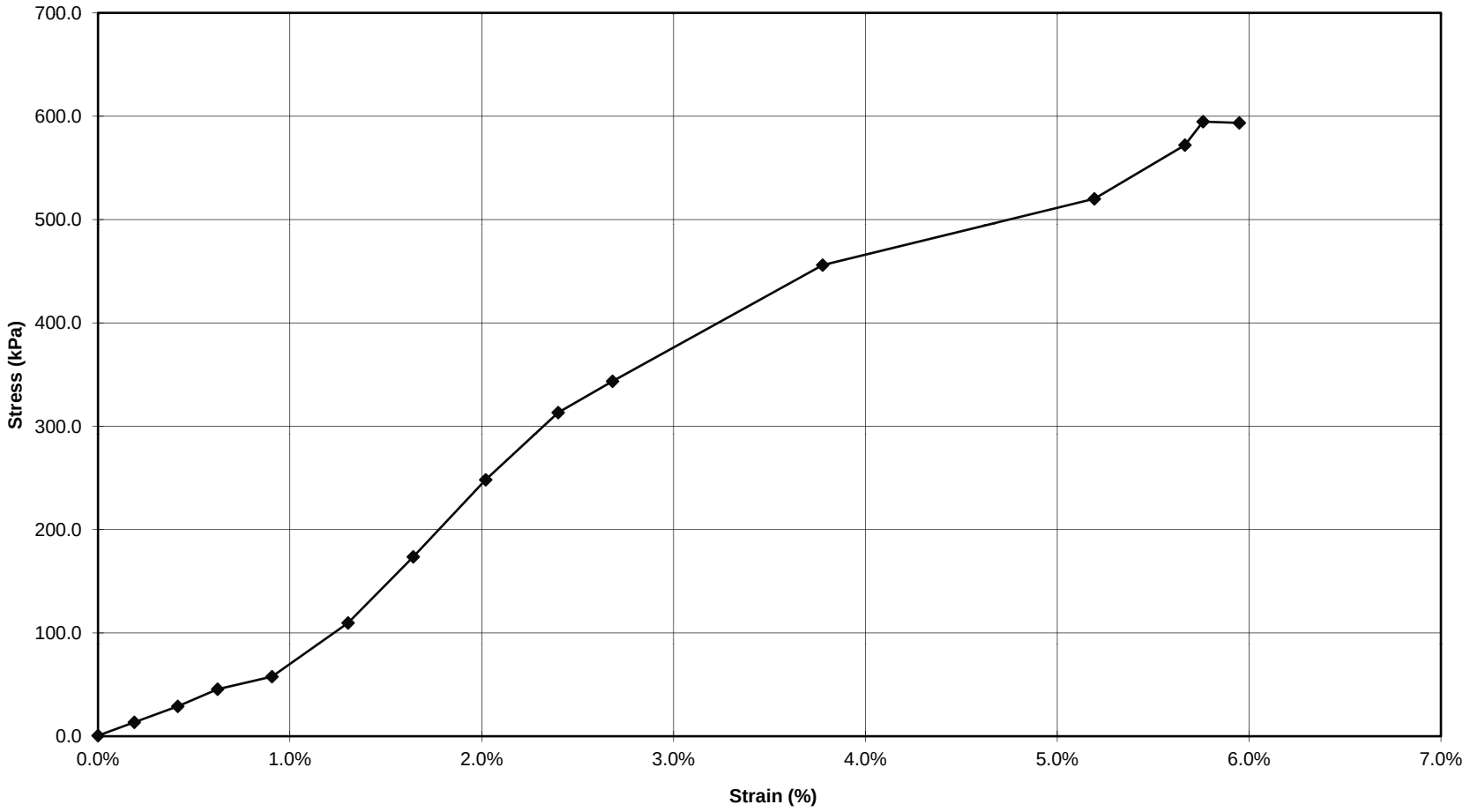
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	2870	Vertical cracking
Gears Used		% Strain :	5.8%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	585	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4548	0.7	
0.25	22	62	990	0.2%	4557	13.6	
0.5	48	132	978	0.4%	4567	29.0	
0.75	77	209	967	0.6%	4577	45.6	
1	98	265	952	0.9%	4590	57.7	
1.5	188	505	931	1.3%	4608	109.7	
2	299	803	913	1.6%	4624	173.6	
2.5	430	1152	893	2.0%	4642	248.2	
3	546	1460	873	2.4%	4660	313.2	
3.5	601	1606	858	2.7%	4674	343.5	
4	810	2155	800	3.8%	4727	455.9	
4.5	940	2495	725	5.2%	4798	520.1	
5	1043	2758	700	5.7%	4822	572.1	
5.5	1088	2870	695	5.8%	4826	594.7	
5.8	1088	2870	685	5.9%	4836	593.5	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-25	DEPTH :	19m
DATE :	2-Mar-14	TECH. :	RGD



FORM : Unconf SAFM 14-25 1.xls
DATE: 3/4/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-25	DEPTH :	26.8m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1734.9	Tare Number		Olive grey, clayshale, strong
Initial Length (mm)	155.2	Wt. Sample (wet+tare) (g)	1664.1	
Initial Diameter (mm)	75.9	Wt. Sample (dry+tare)(g)	1595.3	
Wet Unit Weight (kN/m³)	24.2	Wt. Tare (g)	223	
Dry Unit Weight (kN/m³)	23.1	Water Content (%)	5.0%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	6117	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	13.3	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4524.5		
	Due to high strength of sample core was capped and broken in concrete breaker.						
	Core failed at	6117kg					

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 6
BOREHOLE:	TH14-25	DEPTH :	34m
DATE :	March 2, 2014	TECHNICIAN :	CK/GU

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1645.2	Tare Number		Claystone/clayshale - top half, siltstone-bottom, grey, mod strong to strong
Initial Length (mm)	156.5	Wt. Sample (wet+tare) (g)	1669.8	
Initial Diameter (mm)	75.7	Wt. Sample (dry+tare)(g)	1560.8	
Wet Unit Weight (kN/m³)	22.9	Wt. Tare (g)	207.7	
Dry Unit Weight (kN/m³)	21.2	Water Content (%)	8.1%	

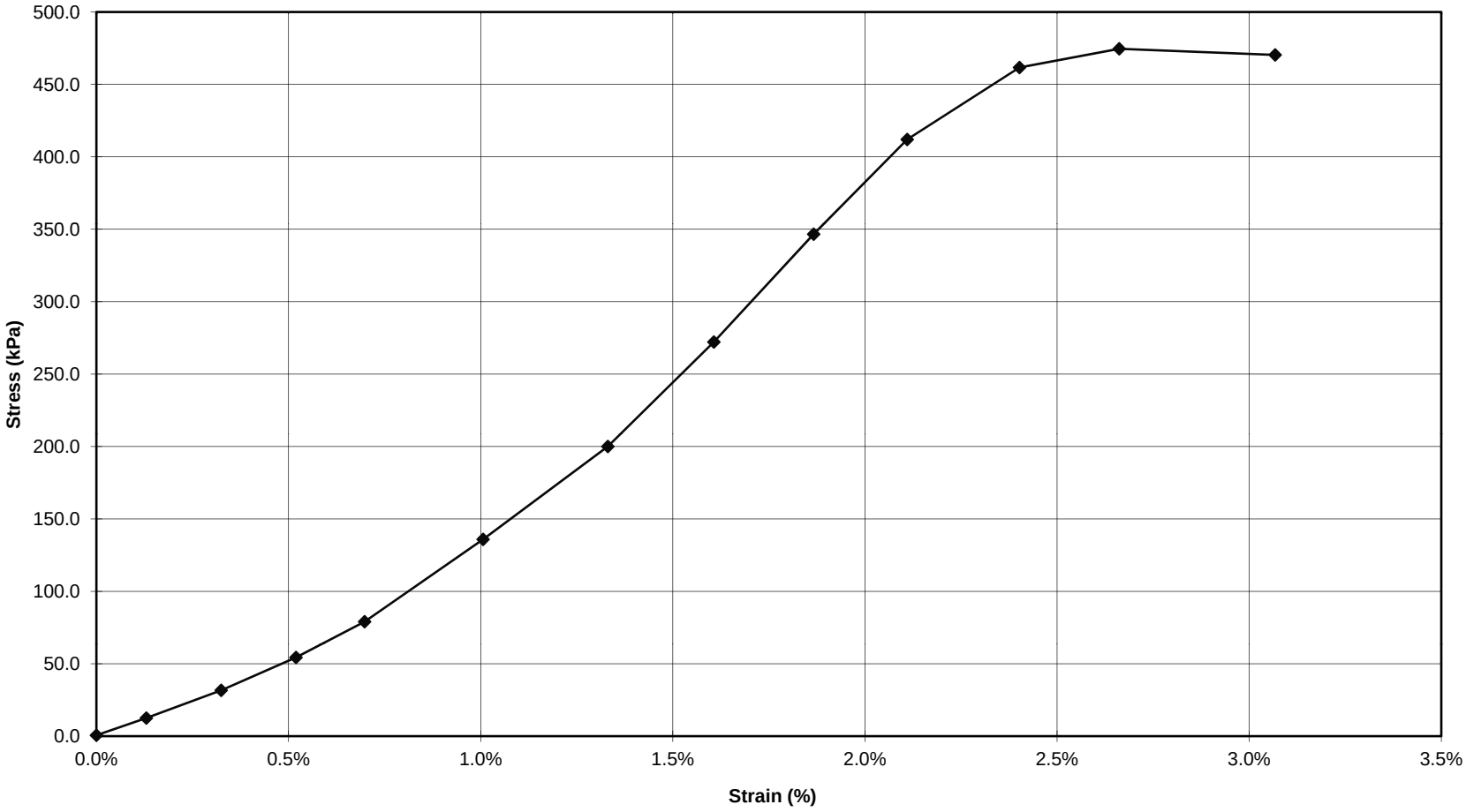
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	2195	Vertical cracking, horizontal crack between types of material
Gears Used		% Strain :	2.7%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	475	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4501	0.7	
0.25	20	56	992	0.1%	4507	12.5	
0.5	52	143	980	0.3%	4515	31.7	
0.75	91	246	968	0.5%	4524	54.4	
1	133	358	957	0.7%	4532	79.1	
1.5	230	618	938	1.0%	4546	135.9	
2	340	912	918	1.3%	4561	200.0	
2.5	465	1245	901	1.6%	4574	272.2	
3	595	1590	885	1.9%	4586	346.6	
3.5	710	1894	870	2.1%	4598	412.0	
4	800	2129	852	2.4%	4611	461.7	
4.5	825	2195	836	2.7%	4624	474.6	
5	821	2184	811	3.1%	4643	470.4	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 6
BOREHOLE:	TH14-25	DEPTH :	34m
DATE :	2-Mar-14	TECH. :	CK/GU



FORM : Unconf SAFM 14-25 6.xls
DATE: 3/4/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-26	DEPTH :	8.5m
DATE :	February 27, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1554.9	Tare Number		Olive Gray Clay shale, very weak
Initial Length (mm)	152.7	Wt. Sample (wet+tare) (g)	1796.3	
Initial Diameter (mm)	76.4	Wt. Sample (dry+tare)(g)	1589.7	
Wet Unit Weight (kN/m³)	21.8	Wt. Tare (g)	250.8	
Dry Unit Weight (kN/m³)	18.9	Water Content (%)	15.4%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	395	Vertical Cracks
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	0.84	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4584		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 395 kg.

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-26	DEPTH :	13m
DATE :	February 27, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1510.0	Tare Number		Blocky Olive grey clayshale/Claystone, mod strong
Initial Length (mm)	148.6	Wt. Sample (wet+tare) (g)	1476.2	
Initial Diameter (mm)	77.2	Wt. Sample (dry+tare)(g)	1325.7	
Wet Unit Weight (kN/m³)	21.3	Wt. Tare (g)	156.7	
Dry Unit Weight (kN/m³)	18.9	Water Content (%)	12.9%	

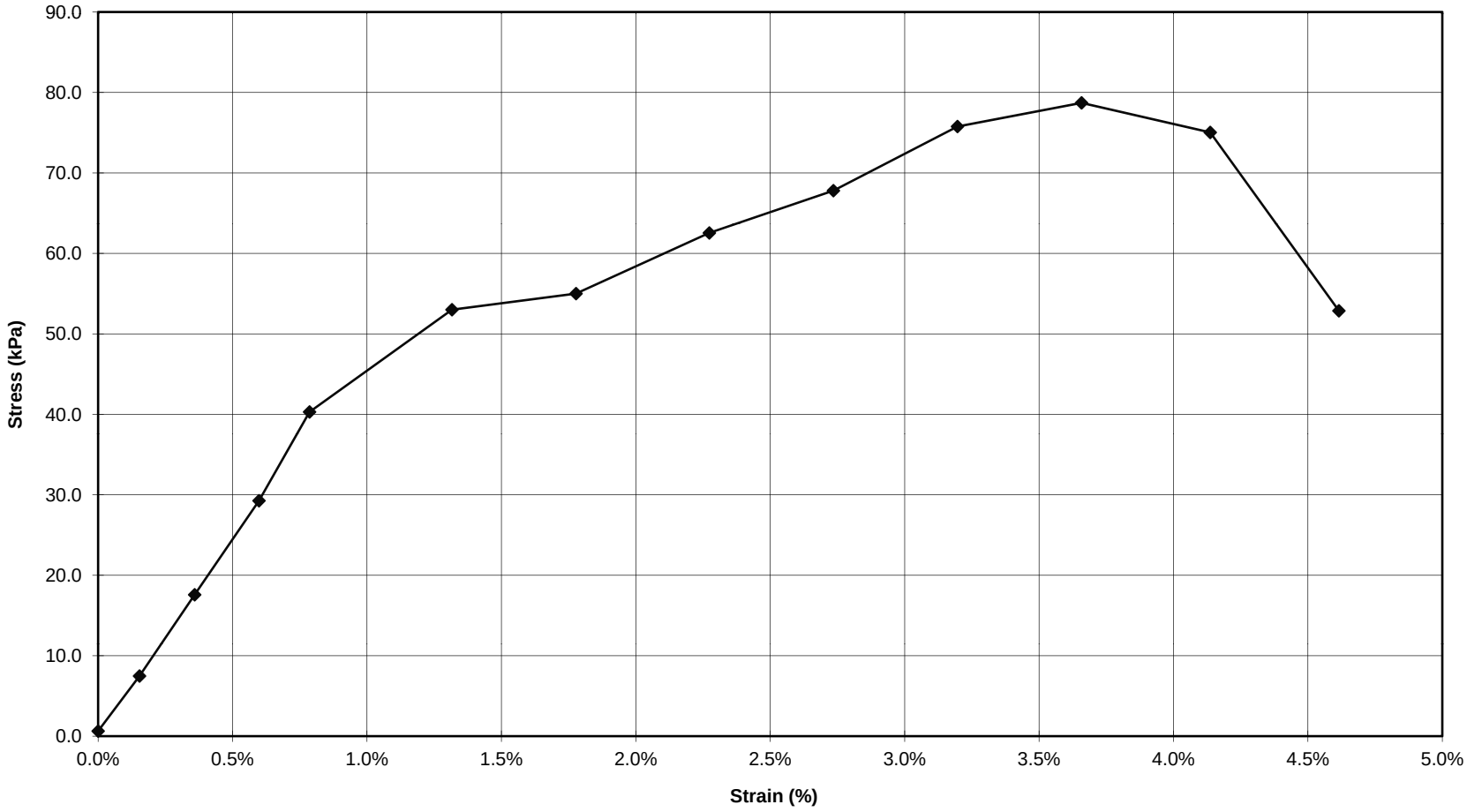
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	382	Cracking on top so badly
Gears Used		% Strain :	3.7%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	78	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4681	0.6	
0.25	12	35	991	0.2%	4688	7.5	
0.5	30	83	979	0.4%	4698	17.6	
0.75	50	138	965	0.6%	4709	29.3	
1	70	190	954	0.8%	4718	40.3	
1.5	93	251	923	1.3%	4743	53.0	
2	97	262	896	1.8%	4766	55.0	
2.5	111	300	867	2.3%	4790	62.5	
3	121	326	840	2.7%	4812	67.8	
3.5	136	366	813	3.2%	4835	75.8	
4	142	382	786	3.7%	4859	78.7	
4.5	136	366	758	4.1%	4883	75.0	
5	96	259	730	4.6%	4907	52.9	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-26	DEPTH :	13m
DATE :	27-Feb-14	TECH. :	RGD



FORM : Unconf SAFM 14-26. 3.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-27	DEPTH :	6.2m
DATE :	February 27, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1675.8	Tare Number		Olive grey clayshale/Claystone, med strong
Initial Length (mm)	165.5	Wt. Sample (wet+tare) (g)	1828.8	
Initial Diameter (mm)	77.4	Wt. Sample (dry+tare)(g)	1594	
Wet Unit Weight (kN/m³)	21.1	Wt. Tare (g)	156.7	
Dry Unit Weight (kN/m³)	18.1	Water Content (%)	16.3%	

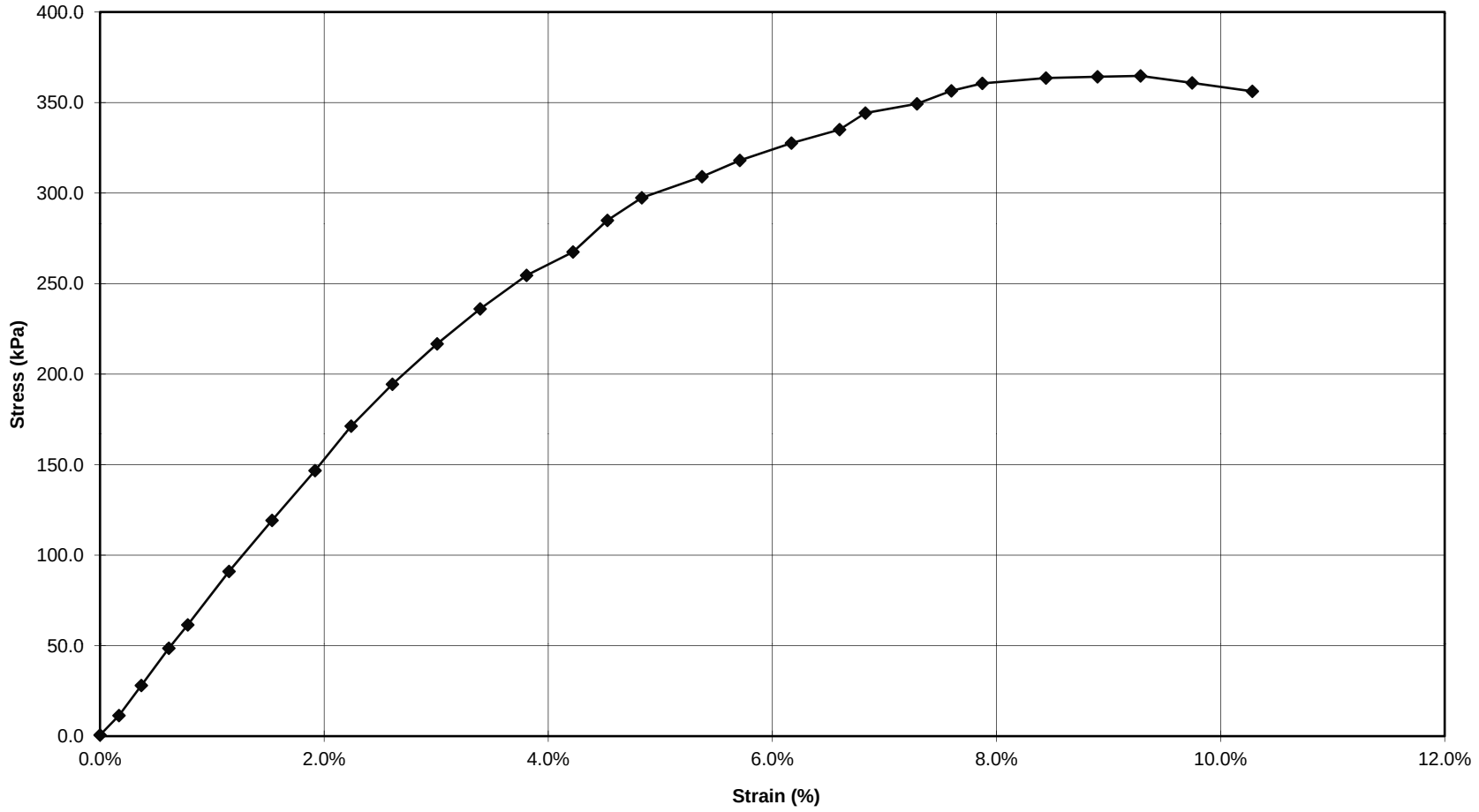
LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #	3491	Load (N)	1892	45^0 Starting at centre of bottom
Gears Used		% Strain :	9.3%	
Loading Rate	.055"/min	Corrected Q_U (kPa)	365	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
0	0	3	1000	0.0%	4705	0.6	
0.25	19	54	989	0.2%	4713	11.4	
0.5	48	132	976	0.4%	4723	28.0	
0.75	85	230	960	0.6%	4734	48.6	
1	108	292	949	0.8%	4742	61.5	
1.5	161	433	925	1.2%	4760	91.0	
2	212	570	900	1.5%	4778	119.2	
2.5	262	704	875	1.9%	4797	146.7	
3	307	824	854	2.2%	4813	171.3	
3.5	350	939	830	2.6%	4831	194.4	
4	392	1051	804	3.0%	4851	216.7	
4.5	429	1149	779	3.4%	4870	236.0	
5	465	1245	752	3.8%	4891	254.5	
5.5	491	1314	725	4.2%	4912	267.5	
6	525	1404	705	4.5%	4928	284.9	
6.5	550	1470	685	4.8%	4944	297.4	
7	575	1537	650	5.4%	4972	309.0	
7.5	594	1587	628	5.7%	4990	318.0	
8	615	1643	598	6.2%	5015	327.6	
8.5	632	1688	570	6.6%	5038	335.0	
9	651	1738	555	6.8%	5050	344.2	
9.5	664	1773	525	7.3%	5075	349.3	
10	680	1815	505	7.6%	5092	356.5	
10.5	690	1842	487	7.9%	5107	360.6	
11	700	1868	450	8.4%	5139	363.5	
11.5	705	1881	420	8.9%	5165	364.2	
12	709	1892	395	9.3%	5187	364.7	
12.5	705	1881	365	9.7%	5213	360.9	
13	700	1868	330	10.3%	5244	356.2	

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-27	DEPTH :	6.2m
DATE :	27-Feb-14	TECH. :	RGD



FORM : Unconf SAFM 14-27 1.xls
DATE: 3/3/2014

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	C2
BOREHOLE:	TH14-27	DEPTH :	10.5m
DATE :	February 26, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1706.4	Tare Number		Clayshale/claystone, very strong
Initial Length (mm)	154.5	Wt. Sample (wet+tare) (g)	1797.9	
Initial Diameter (mm)	76.3	Wt. Sample (dry+tare)(g)	1718.2	
Wet Unit Weight (kN/m³)	23.7	Wt. Tare (g)	251.9	
Dry Unit Weight (kN/m³)	22.5	Water Content (%)	5.4%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	4619	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	9.9	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4572.3		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 4619 kg.

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 1
BOREHOLE:	TH14-07	DEPTH :	9.4m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1321.1	Tare Number		Clayshale/claystone, strong
Initial Length (mm)	125.0	Wt. Sample (wet+tare) (g)	1394.2	
Initial Diameter (mm)	75.5	Wt. Sample (dry+tare)(g)	1334.1	
Wet Unit Weight (kN/m³)	23.2	Wt. Tare (g)	156.7	
Dry Unit Weight (kN/m³)	22.0	Water Content (%)	5.1%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	2602	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	5.7	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4477.0		

Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 2602kg

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 3
BOREHOLE:	TH14-7	DEPTH :	16m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1758.9	Tare Number		Olive to med grey clayshale/claystone, very strong
Initial Length (mm)	156.0	Wt. Sample (wet+tare) (g)	1695.3	
Initial Diameter (mm)	75.8	Wt. Sample (dry+tare)(g)	1635.8	
Wet Unit Weight (kN/m³)	24.5	Wt. Tare (g)	159.1	
Dry Unit Weight (kN/m³)	23.6	Water Content (%)	4.0%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	4415	
Gears Used		% Strain :	0.0%	
Loading Rate		Corrected (MPa)	9.6	

Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4512.6		
	Due to high strength of sample core was capped and broken in concrete breaker.						
	Core failed at	4415kg					

UNCONFINED COMPRESSION TEST

AECOM

CLIENT :	Government of Alberta		
PROJECT :	SAFM		
JOB No. :	60309815.04		
LOCATION :		SAMPLE:	Run 6
BOREHOLE:	TH14-7	DEPTH :	25m
DATE :	March 2, 2014	TECHNICIAN :	RGD

DENSITY DETERMINATION		WATER CONTENT		SAMPLE DESCRIPTION
Wt. Sample (g)	1498.5	Tare Number		Siltstone, very strong
Initial Length (mm)	137.1	Wt. Sample (wet+tare) (g)	1536.2	
Initial Diameter (mm)	75.2	Wt. Sample (dry+tare)(g)	1478	
Wet Unit Weight (kN/m³)	24.1	Wt. Tare (g)	155.5	
Dry Unit Weight (kN/m³)	23.1	Water Content (%)	4.4%	

LOAD DATA		FAILURE DATA		FAILURE MODE
Ring #		Load (Kg)	14053	
Gears Used		% Strain :	N/A	
Loading Rate		Corrected (MPa)	30.7	

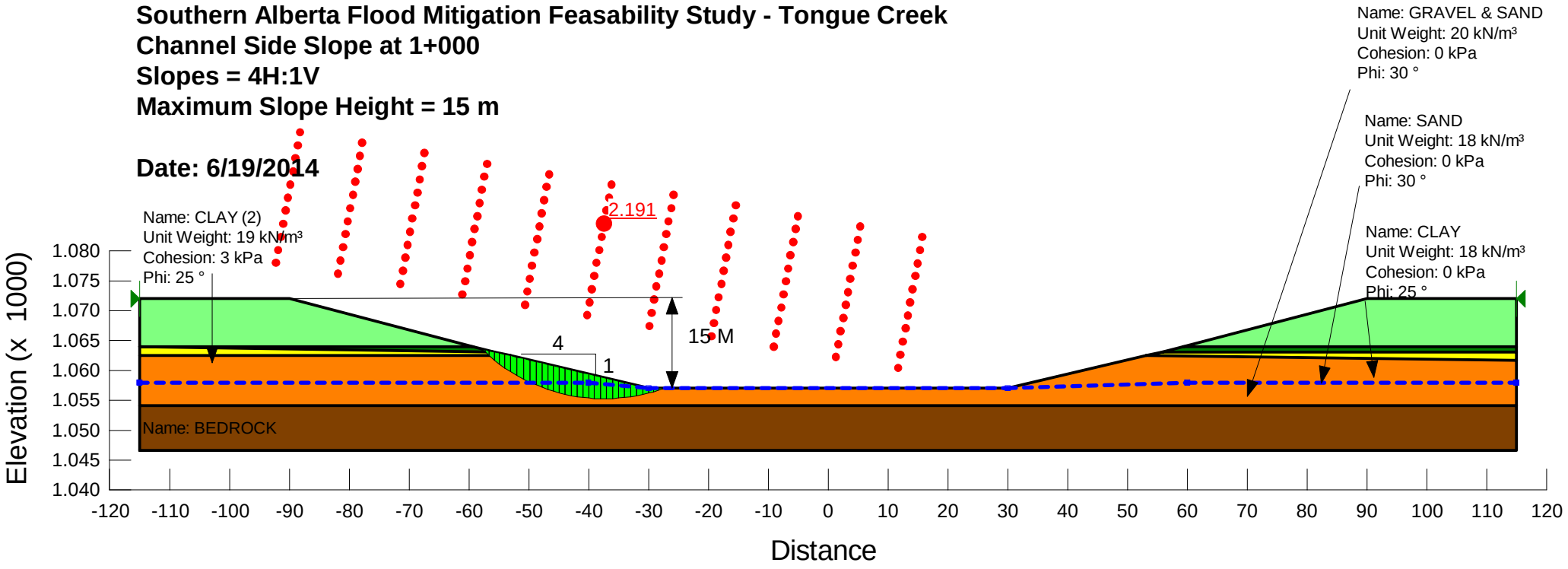
Time (min)	Load Dial (0.0001")	Load (N)	Strain Dial (0.001")	Strain (%)	Area (mm²)	Q_U (kPa)	Comments
					4441.5		

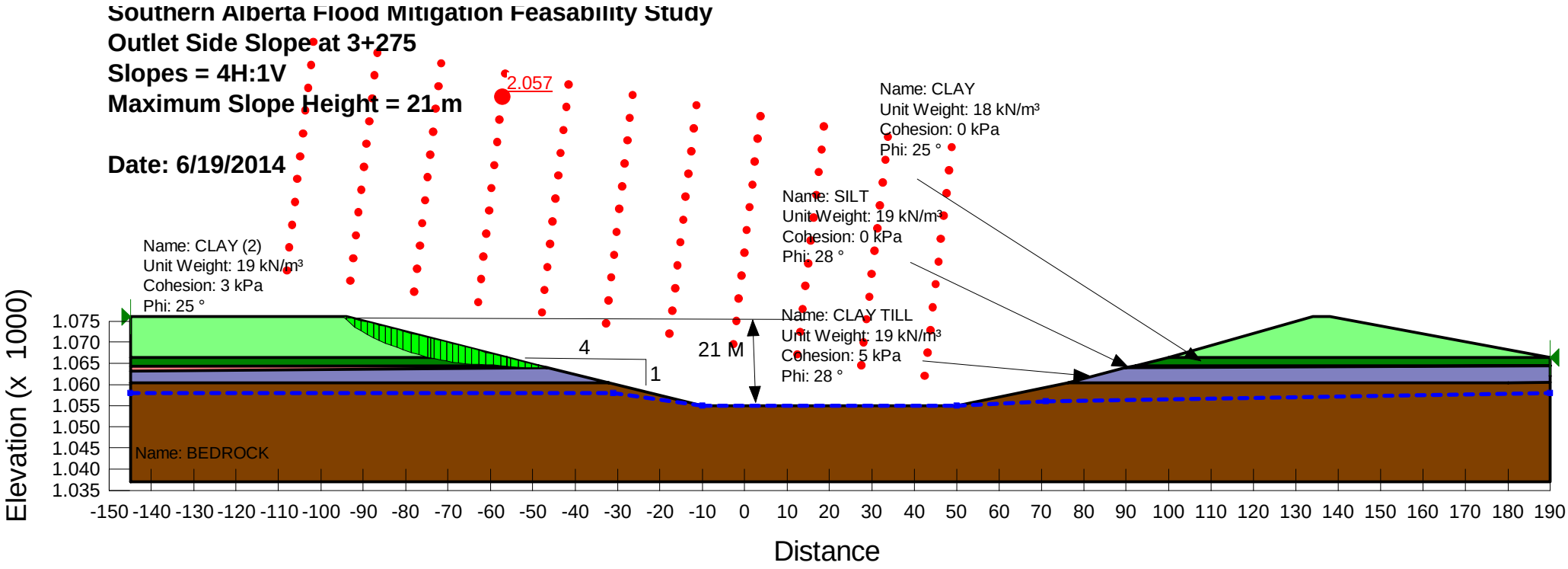
Due to high strength of sample core was capped and broken in concrete breaker.

Core failed at 14053 kg.

Appendix N4

Slope Stability Analysis Results


Southern Alberta Flood Mitigation Feasability Study - Tongue Creek
Channel Side Slope at 1+000
Slopes = 4H:1V
Maximum Slope Height = 15 m
Date: 6/19/2014
Name: CLAY (2)
Unit Weight: 19 kN/m³
Cohesion: 3 kPa
Phi: 25 °
2.191
15 M
4
1
Name: BEDROCK
Name: GRAVEL & SAND
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Name: SAND
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °
Name: CLAY
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 25 °
Elevation (x 1000)
1.080
1.075
1.070
1.065
1.060
1.055
1.050
1.045
1.040
-120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120
Distance


Southern Alberta Flood Mitigation Feasability Study
Outlet Side Slope at 3+275
Slopes = 4H:1V
Maximum Slope Height = 21 m
Date: 6/19/2014
2.057
Name: CLAY
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 25 °
Name: SILT
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 28 °
Name: CLAY (2)
Unit Weight: 19 kN/m³
Cohesion: 3 kPa
Phi: 25 °
Name: CLAY TILL
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 28 °
4
1
21 M
Name: BEDROCK
Elevation (x 1000)
1.075
1.070
1.065
1.060
1.055
1.050
1.045
1.040
1.035
-150 -140 -130 -120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Distance