

AGENDA
COUNCIL COMMITTEE MEETING
MUNICIPAL DISTRICT OF PINCHER CREEK
JANUARY 9, 2018
9:00 AM

1. Approval of Agenda
2. Meeting with Alberta Transportation
 - Is Council still wishing to meet with Regional Director Darren Davidson?
3. Spring AAMDC Convention
 - Which Councillors plan to attend this event?
4. FCM Convention – Halifax
 - Which Councillors are wishing to attend?
5. Council Picture
 - Decision on Council Picture for Official Purposes required
6. Regional Water and Wastewater Discussion Paper – Town / MD
 - Dated December 11, 2017
7. Beaver Mines Water and Wastewater Project 9:30 am
 - Representatives from MPE will be attending the meeting
8. Beaver Mines Wastewater Treatment Report Update
 - Report from Director of Operations, dated January 3, 2018

Regional Water and Wastewater Discussion Paper

December 11, 2017

The intent of this discussion paper is to stimulate discussion between the Town of Pincher Creek (Town) and Municipal District of Pincher Creek No. 9 (MD) Councils. Potable water and wastewater services in the region east of the Castle River are exclusively provided by the Town. The MD is looking at how to best provide water and wastewater utility services to the Hamlet of Pincher Station (Hamlet) and at the Pincher Creek Airport (Airport).

Although there have been only a few requests for water and wastewater services in the Hamlet or at the Airport in recent memory, it is felt that there are opportunities for growth that are not possible without the water and wastewater utility services. The Hamlet is situated along the CP Rail line that includes a siding and spur line that could accommodate heavy industrial development, and the Airport, Alberta's seventh longest runway, is the most under-utilized piece of public infrastructure in the region.

There are benefits to both municipalities of providing water and wastewater services to the Hamlet and Airport including attracting and retaining commercial and industrial companies in the region, jobs, tax revenue, and more.

The MD's regional water system, west of the Castle River, is nearing capacity with the recent addition of Beaver Mines and Castle Servicing expansions. Given the Castle River crossing that would be required to service areas in the MD to the east, it is prudent to look at more cost effective options.

By engaging the Town in this initiative, the Town may have the ability to benefit in a more significant way, should additional industrial/commercial companies locate in the region. Although there are a few homes located in the Hamlet, it is felt workers for most significant developments would establish themselves in the Town rather than the Hamlet or MD. Additionally, increases to Airport activity or commercial development, will bring new development, jobs, revenue, including taxes to the region.

Being able to market the region as having water and wastewater services, along the rail line or at the Airport, in the setting of the Crown of the Continent will undoubtedly, attract businesses in the short to mid-term.

- How can the Town and the MD work together to enable water and wastewater services to be expanded into the east Castle River region of the MD?
- Could the Town operate a utility service within the MD?
- What grants are available for this type of project?
- How could new MD tax revenues be shared to recognize the Town's contribution?
- Does the Town water and wastewater systems have the ability to provide for the increased capacity?

Questions for Leo and MPE for Council Committee Meeting Tuesday January 9 –

Discrepancies in Numbers Presented to Date

Some numbers presented in MPE's letter of November 24th and Leo's Memo of Dec 11th don't add up and/or appear to contradict numbers previously provided. Please correct/explain the following discrepancies:

- A. MD portion of the "Beaver Mines Servicing project for pipeline and mechanical components" of \$910,769" (Dec 11 memo) vs. MD's portion of the "Potable Water Transmission Pipeline and Storage" of \$741,029 (Sept 6 memo)
- B. \$3.7 million dollars for the Wastewater Treatment project (Dec 11 memo) vs. updated cost estimate of \$4.9M (Oct 4 email)
- C. Budget Breakdown of \$1.8M for Raw Water Intake (MPE letter Table 1) vs. Projected Cost Breakdown and Funding Breakdowns of \$2.7M each in the same table.
- D. Projected Cost Breakdown of \$6.1M for Regional Supply System (MPE letter Table 2) vs. Budget Breakdown and Funding Breakdown of \$7.6M each in same table.
- E. Cost for Contract 1 – Pipeline Construction of \$2.270M for Regional Supply System (MPE letter Table 2) vs. L.W. Dennis low bid of \$2.384M (MPE letter of Sept 1)
- F. Cost for Contract 2 – Mechanical (MPE letter sum of both tables) of \$4.587M vs. DMT Mechanical low bid of \$4.816M

Budget and Schedule

I believe Council needs a clearer picture on where we stand with the Project in terms of budget and schedule. Breaking it into 5 subprojects (Leo's Jan 2 memo) is a good start. Thank you for that. Please come to Tuesday's meeting prepared to discuss the following:

1. Projected costs including:
 - a. Current vs. original estimates - total and by subproject
 - b. Breakdown of each funder's share including how the Provinces share of costs for Castle Water Plan upgrades to the original Project were determined
 - c. An understanding of the accuracy of estimates of various kinds (e.g. "opinions of probable costs" vs. "engineering estimates" vs. "tendered amounts" etc.), since we have a mix
2. A detailed schedule including key milestones/decision points
3. Checks and balances to ensure successful completion of Project on time and on budget
4. Identification of any significant issues or risks which might impact cost or schedule and what are we doing to manage these
5. Capacity of system and what additional costs MD will need to incur once that capacity is reached and when that might be expected to occur
6. Whatever information you can provide on operating costs - I'm not sure we've ever discussed this
7. What can we do to improve reporting to Council to ensure we can monitor the progress of the Project going forward

Granting Process

I believe Council would benefit from better understanding of the granting process and how that impacts the MD's portion of the project. In particular:

8. What exactly are each of the provincial and federal agencies funding within each of the 5 projects (further to Leo's Jan 2 email)
9. When do each of these grants expire?
10. How and when do we get the provincial/federal dollars?
11. How likely is it that we will get 90% of costs covered from Community Resilience Grant for the \$800K overrun for the water intake project? (Dec 11th memo)
12. What are the remaining amounts of the \$9M Federal/Provincial Building Canada Fund Small Communities Fund and how likely is it that these can be used to offset other components of the project (Dec 11th memo)?
13. When will we apply for the above and when will we find out?
14. When do we apply for grant for wastewater treatment system and when will we find out?
15. Do you believe there is still a need for an additional debenture at this time to in light of the answers to the above?

Please ensure Leo/MPE bring all documentation needed to answer the questions above and others that may come up, from myself or other councillors including as a minimum:

- Beaver Mines Water and Sanitary Service Study Nov 2014
- Castle Area Servicing Study Aug 2017
- Beaver Mines Wastewater Options Study Nov 2016
- All information provided by Leo to Council since Sept 1 2017
- MPE Contract
- L.W. Dennis Contract
- DMT Mechanical Contract

JANUARY 3, 2018

TO: Wendy Kay, CAO
FROM: Leo Reedyk, Director of Operations
SUBJECT: Beaver Mines Wastewater Treatment Report Update

1. Origin:

At their September 26, 2017 meeting, Council initiated the Beaver Mines Wastewater Treatment project detailed design work.

2. Background:

MPE Engineering initiated two studies to assist in determining the viability of the proposed site in the SE 19-6-1-W5M, a Historical Resource Impact Assessment and a Phase 1 Geotechnical Evaluation.

The Historical Resource Impact Assessment work done by Arrow Archeology Limited included a site walk about with local land owners and onsite inspection during geotechnical evaluation bore hole and test pit development.

Tetra Tech Canada Inc. performed the Phase 1 Geotechnical Evaluation for the project and provided the attached report for use in the project design. Tetra Tech Canada Inc. has been requested to provide comment on the suitability of a geosynthetic liner given the reported soil conditions; their comments on a liner have not yet been received.

Within their report, Section 5.0, Tetra Tech Canada Inc. indicates that “the site suitability for the proposed sanitary sewage lagoon development is considered low and relocation is highly recommended.”

Options for consideration and discussion moving forward include:

- Enter into discussions with the Village of Cowley or the Town of Pincher Creek for use of their lagoon systems;
- Open a request for proposal process for land owners looking to sell suitable land for wastewater treatment in a lagoon and wetland system in close proximity to Beaver Mines;

As previously presented to Council, the *Environmental Protection and Enhancement Act, Potable Water Regulation* requires that:

“(3) No person shall commence

(a) the extension of a water distribution system...

Where...

(e) the water distribution system will service a portion of a city, town, specialized municipality, village, summer village, settlement area as defined in the Metis Settlements Act, hamlet, privately owned development, municipal development or industrial development that is not serviced by a wastewater system in respect of which a current approval or registration has been issued under the Act.”

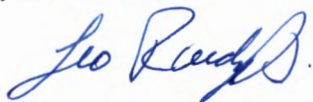
The site at the SE 19-6-1-W5M has been determined to be non-viable, as such, once a decision on the path forward has been made, Alberta Transportation should be notified of the change in the location for Beaver Mines wastewater treatment in the Municipal Districts application with the Alberta Municipal Water Wastewater Partnership grant program.

Following a decision on the path forward, Council is requested to provide direction to Administration.

3. Discussion:

That Council Committee discuss options for Beaver Mines Wastewater Treatment and provide direction to Administration through a resolution in Council.

Respectfully Submitted,



Leo Reedyk

Attachments

Reviewed by: Wendy Kay, Chief Administrative Officer



Date:

January 4, 2018



December 13, 2017

MPE Engineering Ltd.
Suite 300, 714 – 5 Avenue South
Lethbridge, Alberta T1J 0V1

ISSUED FOR USE
FILE: ENG.LGEO03598-01
Via Email: lschoening@mpe.ca

Attention: Mr. Luke Schoening, P.Eng. – Project Manager

Subject: Phase I – Geotechnical Evaluation
Sanitary Sewage Lagoon Development
Beaver Mines, Alberta

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation, conducted by Tetra Tech Canada Inc. (Tetra Tech), for the proposed sanitary sewage lagoon development to be located near the town of Beaver Mines, Alberta. The site is adjacent to the confluence of the Castle River and Milk Creek at the legal site description of 02-19-06-01 W5M.

The scope of work for this evaluation was outlined in an email proposal issued to Mr. Luke Schoening, of MPE Engineering Ltd. (MPE), on October 26, 2017. The objective of this work was to determine the general subsurface and groundwater conditions, and to provide a site suitability assessment for the proposed sanitary sewage lagoon development.

Authorization to proceed with the work was provided by MPE through a signed Subconsultant Agreement on November 2, 2017.

2.0 SCOPE OF WORK

The scope of work comprised the completion of nine (9) geotechnical boreholes and three (3) testpits across the proposed site. The evaluation also included a laboratory program to assist in classifying the subsurface soils and a summary of soil findings with suitability assessment results.

3.0 GEOTECHNICAL AND LABORATORY WORK

The geotechnical drilling fieldwork for this evaluation was carried out on November 7, 2017, using a track-mounted drill rig contracted from Earth Drilling Ltd. of Calgary, Alberta. The rig was equipped with 150 mm diameter hollow stem augers. The geotechnical testpits were excavated on November 28, 2017. Tetra Tech's field representative for both programs was Mr. Stuart Smith.

Nine (9) boreholes (referenced as 17BH001 through 17BH009) were drilled to depths between 0.9 m and 2.2 m below existing ground level. It should be noted that due to auger refusal, all boreholes were terminated early and efforts, including relocating some boreholes (i.e., 17BH001, 17BH005, 17BH006, and 17BH007), were made to achieve the design borehole depths. From the boreholes, disturbed grab samples were obtained at select locations. In addition, Standard Penetration Tests (SPTs) were performed in select boreholes. Three (3) testpits (referenced as 17TP001, 17TP002, and 17TP003) were excavated to depths between 4.6 m and 5.3 m below ground level. All soil samples were visually classified in the field and the individual soil strata and the interfaces between them were noted. The borehole and testpit logs are presented in Appendix B. An explanation of the terms and symbols used on the logs is also included in Appendix B.

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442 - 10 Street N.
Lethbridge, AB T1H 2C7 CANADA
Tel 403.329.9000 Fax 403.328.8817

Slotted 25 mm diameter PVC standpipes were installed in the three testpit locations to monitor groundwater levels. The testpits were backfilled around the standpipes and the boreholes were backfilled with cuttings.

Classification tests, including grain size distribution, were performed in a laboratory on samples collected from the boreholes and testpits to aid in the determination of engineering properties. The results of the laboratory tests are presented in Appendix C, as well as included on the logs in Appendix B.

4.0 SUBSURFACE SOIL CONDITIONS

4.1 Soil Conditions

The general subsurface stratigraphy for the site comprised a surficial layer of topsoil, overlying sand or clay, overlying gravel, in turn underlain by bedrock.

Surficial topsoil was encountered at all borehole and testpit locations with thicknesses less than 300 mm. Sand, bordering on low to medium plastic clay, was present below the topsoil in 17TP002, 17TP003, and 17BH002; and extended to depths of between 0.9 m and 1.4 m below ground surface. The sand was described as silty, trace to some clay, trace to some gravel, damp, compact, and brown. The clay was described as silty, some sand to sandy, some gravel, damp, very stiff, low to medium plastic, and brown.

Gravel was encountered below the topsoil and/or sand and extended to depths of between 3.7 m and 4.9 m below ground surface. The gravel was described as sandy, some silt, trace clay, subrounded, well graded, sizes up to 400 mm, very dense, brown. The sand and gravel are considered alluvial in origin.

Bedrock was encountered below the gravel layer and extended to the termination depths of the testpits (due to excavator refusal). The bedrock was comprised of extremely weak to very weak conglomerate, sandstone, and siltstone.

4.2 Groundwater Conditions

At the time of drilling, no seepage was observed in any of the nine borehole locations and sloughing was only encountered in 17BH002. No seepage was observed in any of the testpit locations; however, sloughing of the granular material was generally encountered. All 25 mm PVC monitoring wells installed within the testpits were measured dry 7 days after drilling (December 5, 2017). It is expected that groundwater may be seasonal and may be directly related to the water elevations of the Castle River and Mill Creek.

5.0 SITE SUITABILITY ASSESSMENT

As discussed in Section 4.1, bedrock, including completely or highly weathered sandstone, siltstone, and conglomerate, was encountered at shallow depths ranging between 4.3 m and 5.1 m below the existing ground surface. The manual of *“Design and Construction of Liners for Municipal Wastewater Stabilization Ponds”* (by Alberta Environment and Sustainable Resource Development) can be used as a guideline for siting wastewater ponds, and is referenced in the *“Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems”* (by the Alberta Government). In accordance with the requirement of Table 2.2 *“Physical Site Criteria”* in the manual it is noted that the bedrock encountered on this site does not meet the requirement that *“A minimum depth of 10 m is recommended when the upper bedrock formation include coal seams, highly fractured or weathered rock, and other deposits with relatively high permeability.”*

According to Table 2.3 "*Rating Chart for Physical Environmental Suitability of Site*" in the manual, the suitability of this site was rated "*low*" for a lagoon development with the following facts:

- Completely to highly weathered sandstone bedrock is present with less than 10 m of overlying surficial sediments. – Low Suitability
- Alluvial sand and gravel are present as surficial sediments. – Low Suitability
- Average topography of the area is unknown, but expected to be around 1%, with areas up to 5%. – Medium Suitability

In addition, based on test results and Tetra Tech's experience of local soils, the low to medium plastic clay, only encountered at one borehole location, is not considered suitable as clay liner materials to meet seepage control criterion required by Alberta Environment and Sustainable Resource Development.

In conclusion, the site suitability for the proposed sanitary sewage lagoon development is considered low and site relocation is highly recommended. The geology, topography, and geomorphology of the site and surrounding area provide little assistance in mitigating environmental impacts of the proposed sanitary sewage lagoon.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of MPE Engineering Ltd. and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than MPE Engineering Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in Appendix A or Contractual Terms and Conditions executed by both parties.

7.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.




Dec. 13. 2017.

Prepared by:
Chris McRae, B.Sc., E.I.T.
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/tlp

Attachments: Appendix A: Limitations on Use of This Document
Appendix B: Borehole and Testpit Logs
Appendix C: Laboratory Test Results

PERMIT TO PRACTICE	
TETRA TECH CANADA INC.	
Signature	
Date	<i>December 13, 2017</i>
PERMIT NUMBER: P13774	
The Association of Professional Engineers and Geoscientists of Alberta	

APPENDIX A

LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

APPENDIX B

BOREHOLE AND TESTPIT LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.

Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.

Laminated - composed of thin layers of varying colour and texture.

Interbedded - composed of alternate layers of different soil types.

Calcareous - containing appreciable quantities of calcium carbonate.;

Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.

Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA			
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = D_{60} / D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for GW		
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines			
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = D_{60} / D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for SW		
			SP	Poorly graded sands and gravelly sands, little or no fines			
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
						Classification on basis of percentage of fines GW, GP, SW, SP GM, GC, SM, SC Borderline Classification requiring use of dual symbols	
						Less than 5% Pass 75 µm sieve More than 12% Pass 75 µm sieve 5% to 12% Pass 75 µm sieve	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS Liquid limit	<50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity	For classification of fine-grained soils and fine fraction of coarse-grained soils. <div style="text-align: center;"> PLASTICITY CHART </div>		
		>50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above "A" line on plasticity chart negligible organic content Liquid limit	<30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		30-50	CI	Inorganic clays of medium plasticity, silty clays			
		>50	CH	Inorganic clays of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS Liquid limit	<50	OL	Organic silts and organic silty clays of low plasticity			
		>50	OH	Organic clays of medium to high plasticity			
	HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils		*Based on the material passing the 75 µm sieve Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA	
	SOIL COMPONENTS					OVERSIZE MATERIAL	
	FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS		Rounded or subrounded COBBLES 75 mm to 300 mm BOULDERS > 300 mm	
PASSING		RETAINED	PERCENTAGE	DESCRIPTDR			
GRAVEL	coarse	75 mm	19 mm	>35 %	Not rounded ROCK FRAGMENTS >75 mm ROCKS > 0.76 cubic metre in volume		
	fine	19 mm	4.75 mm	21 to 35 %			
SAND	coarse	4.75 mm	2.00 mm	10 to 20 %			
	medium	2.00 mm	425 µm	>0 to 10 %			
	fine	425 µm	75 µm	"and" "y-adjective" "some" "trace"			
SILT (non plastic) or CLAY (plastic)		75 µm		as above but by behavior			

TL_Modified Unified Soil Classification.cdr

BOREHOLE KEYSHEET










Water Level Measurement

 Measured in standpipe, piezometer or well
  Inferred




















Sample Types

 A-Casing	 Core	 Disturbed, Bag, Grab	 HQ Core	 Jar
 Jar and Bag	 NQ Core	 No Recovery	 Split Spoon/SPT	 Tube

Backfill Materials

 Asphalt	 Bentonite	 Cement/Grout	 Drill Cuttings	 Grout
 Gravel	 Sand	 Slough	 Topsoil Backfill	

Lithology - Graphical Legend¹

 Asphalt	 Bedrock	 Cobbles/Boulders	 Clay	 Coal
 Concrete	 Fill	 Gravel	 Limestone	 Mudstone
 Organics	 Peat	 Sand	 Sandstone	 Shale
 Silt	 Siltstone	 Till	 Topsoil	

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

MPE ENGINEERING LTD.

Borehole No: 17BH001A

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB I N: 5485004, E: 708546

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Moisture Content (%)	Depth (ft)
0			Plastic Limit Moisture Content Liquid Limit 20 40 ● 60 80	0
	Hollow Stem Auger	TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics		
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense to very dense, brown		
1		... sizes to >150 mm, very dense, auger refusal End of Borehole @ 0.9 m		
		No Seepage or Sloughing Upon Completion No Standpipe Installed		



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.91 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

Page 1 of 1

MPE ENGINEERING LTD.	Borehole No: 17BH001B	
	Project: BEAVER MINES SANITARY LAGOON	Project No: ENG.LGEO03598-01
	Location: LSD 2-19-6-1 W5M	
NEAR BEAVER MINES, AB N: 5485005, E: 708543		PROJECT ENGINEER: CHRIS MCRAE

	Depth (m)	Method	Soil Description	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
	0				20	40 ● 60	80	0
			TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics		⋮	⋮	⋮	1
			GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense to very dense, brown		⋮	⋮	⋮	2
			.. sizes to >150 mm, very dense, auger refusal End of Borehole @ 0.9 m		⋮	⋮	⋮	3
			No Seepage or Sloughing Upon Completion No Standpipe Installed		⋮	⋮	⋮	4
					⋮	⋮	⋮	5
					⋮	⋮	⋮	6
					⋮	⋮	⋮	7
					⋮	⋮	⋮	8
					⋮	⋮	⋮	9
					⋮	⋮	⋮	10

	Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 0.91 m
	Drilling Rig Type: 150mm HOLLOW STEM AUGER	Start Date: 2017 November 07
	Logged By: SS	Completion Date: 2017 November 07
	Reviewed By: JZ	Page 1 of 1

MPE ENGINEERING LTD.

Borehole No: 17BH001C

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB 1 N: 5485005, E: 709540

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics							0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense to very dense, brown							1
				B1					2
1		... sizes to >150 mm, very dense, auger refusal End of Borehole @ 0.9 m							3
		No Seepage or Sloughing Upon Completion No Standpipe Installed							4
									5
									6
									7
									8
									9
3									



TETRA TECH

Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.91 m

Drilling Rig Type: 150mm SOLID STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH002

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485119, E: 708622

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	DCPT (N)	SPT (N)	Moisture Content (%)	Plastic Limit 20 40 60 80	Moisture Content ● 40 60 80	Liquid Limit 20 40 60 80	◆ DCPT (N) ◆	Depth (ft)
											20 40 60 80	
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics CLAY - silty, some sand to sandy, some gravel, damp, very stiff, low to medium plastic, brown, roots										0
1												1
2		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 50 mm, damp, dense, brown		D1		47					■	2
3		sizes to > 100 mm, auger refusal End of Borehole @ 2.2 m				50					◆	3
4		No Seepage, Sloughing to 0.9 m Upon Completion No Standpipe Installed										4



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 2.21 m

Drilling Rig Type: 150mm SOLID STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

Page 1 of 1

MPE ENGINEERING LTD.	<h1>Borehole No: 17BH003</h1>	
	Project: BEAVER MINES SANITARY LAGOON	Project No: ENG.LGEO03598-01
	Location: LSD 2-19-6-1 W5M	
NEAR BEAVER MINES, AB N: 5485009, E: 708597		PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	SPT (N)	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics					20	40	60	80	0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp to moist, dense, brown									1
											2
											3
1											4
		very dense, auger refusal End of Borehole @ 1.2 m		D1	50					>100	4
		No Seepage or Sloughing Upon Completion No Standpipe Installed									5
											6
											7
											8
											9
3											



Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 1.23 m
Drilling Rig Type: 150mm HOLLOW STEM AUGER	Start Date: 2017 November 07
Logged By: SS	Completion Date: 2017 November 07
Reviewed By: JZ	Page 1 of 1

MPE ENGINEERING LTD.	Borehole No: 17BH004	
	Project: BEAVER MINES SANITARY LAGOON	Project No: ENG.LGEO03598-01
	Location: LSD 2-19-6-1 W5M	
NEAR BEAVER MINES, AB N: 5485094, E: 708528		PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	SPT (N)	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics							0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense, brown							1
		... 100 mm very moist pocket, gravel sizes to 100 mm, very dense							2
		... moist							3
1									4
		... auger refusal							5
		End of Borehole @ 1.9 m	D1	54					6
2									7
		No Seepage or Sloughing Upon Completion No Standpipe Installed							8
									9
3									



Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 1.9 m
Drilling Rig Type: 150mm HOLLOW STEM AUGER	Start Date: 2017 November 07
Logged By: SS	Completion Date: 2017 November 07
Reviewed By: JZ	Page 1 of 1

MPE ENGINEERING LTD.

Borehole No: 17BH005A

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485148, E: 708542

PROJECT ENGINEER: CHRIS MCPRAE

Depth (m)	Method	Soil Description	Moisture Content (%)	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics	<div style="text-align: center;"> Plastic Limit: 20 Moisture Content: 40 ● 60 Liquid Limit: 80 </div>	0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense, brown		
		... sizes to > 150 mm, auger refusal End of Borehole @ 0.3 m		1
		No Seepage or Sloughing Upon Completion No Standpipe Installed		2
1				3
				4
				5
				6
2				7
				8
				9
3				



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.3 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH005B

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485150, E: 708538

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plasticity Chart			SPT (N)	Depth (ft)	
							Plastic Limit	Moisture Content	Liquid Limit			
0							20	40	60	80	0	
0 - 0.5		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics										0 - 0.5
0.5 - 1.4		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense, brown ... sizes to > 100 mm, very dense										0.5 - 1.4
1.4		... auger refusal End of Borehole @ 1.4 m		D1	77							1.4
1.4 - 3.0		No Seepage or Sloughing Upon Completion No Standpipe Installed										1.4 - 3.0



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 1.4 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH006A

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485141, E: 709472

PROJECT ENGINEER: CHRIS MCPRAE

Depth (m)	Method	Soil Description	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics					0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense, brown					
		.. sizes to > 100 mm, auger refusal End of Borehole @ 0.3 m					1
		No Seepage or Sloughing Upon Completion No Standpipe Installed					2
1							3
							4
							5
							6
2							7
							8
							9
3							



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.3 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH006B

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB I N: 5485144, E: 709474

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit 20	Moisture Content 40	Liquid Limit 80	SPT (N)		Depth (ft)
										20	40	
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics										0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 75 mm, damp, dense, brown										1
		... sizes to > 100 mm, dense to very dense										2
												3
1												4
		... auger refusal End of Borehole @ 1.4 m		D1	49							5
		No Seepage or Sloughing Upon Completion No Standpipe Installed										6
												7
												8
												9
3												



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 1.4 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH007A

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485239, E: 708469

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Moisture Content (%)	Depth (ft)
0			Plastic Limit: 20 Moisture Content: 40 ● 60 Liquid Limit: 80	0
		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics		
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 150 mm, moist, very dense, brown		
		... auger refusal End of Borehole @ 0.3 m		1
		No Seepage or Sloughing Upon Completion No Standpipe Installed		2
1				3
2				4
				5
				6
				7
				8
				9
3				



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.3 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH007B

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485234, E: 708469

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit 20	Moisture Content 40	Liquid Limit 80	SPT (N)				Depth (ft)
										20	40	60	80	
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics												0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 150 mm, moist, very dense, brown												1
		auger refusal End of Borehole @ 0.6 m	D1	50	50								>100	2
1		No Seepage or Sloughing Upon Completion No Standpipe Installed												3
2														4
														5
														6
														7
														8
														9
3														



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.6 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH008

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB I N: 5485281, E: 708562

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit 20	Moisture Content 40	Liquid Limit 80	SPT (N)				Depth (ft)
										20	40	60	80	
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics												0
		GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 100 mm, moist, very dense, brown												1
				B1										2
		sizes to > 100 mm, auger refusal End of Borehole @ 0.9 m		D1	50								>100	3
		No Seepage or Sloughing Upon Completion, No Standpipe Installed												4
														5
														6
														7
														8
														9
3														



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 0.92 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.

Borehole No: 17BH009

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB I N: 5485036, E: 708442

PROJECT ENGINEER: CHRIS MCPRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	DCPT (N)	SPT (N)	Moisture Content (%)	Plastic Limit 20	Moisture Content 40	Liquid Limit 80	DCPT (N)		SPT (N)		Depth (ft)	
											20	40	60	80		20
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics GRAVEL - sandy, silty, trace clay, sub rounded, well graded, sizes to 50 mm, damp to moist, dense, brown														0
1		... sizes to 75 mm, moist, very dense														1
		... sizes to > 100 mm, auger refusal														2
																3
																4
				D1										41		5
																6
		... dense			34											7
					16											8
2					15											9
		End of Borehole @ 2.1 m														10
		No Seepage or Sloughing Upon Completion. No Standpipe Installed														11



Contractor: CHILAKO DRILLING SERVICES LTD.

Completion Depth: 2.1 m

Drilling Rig Type: 150mm HOLLOW STEM AUGER

Start Date: 2017 November 07

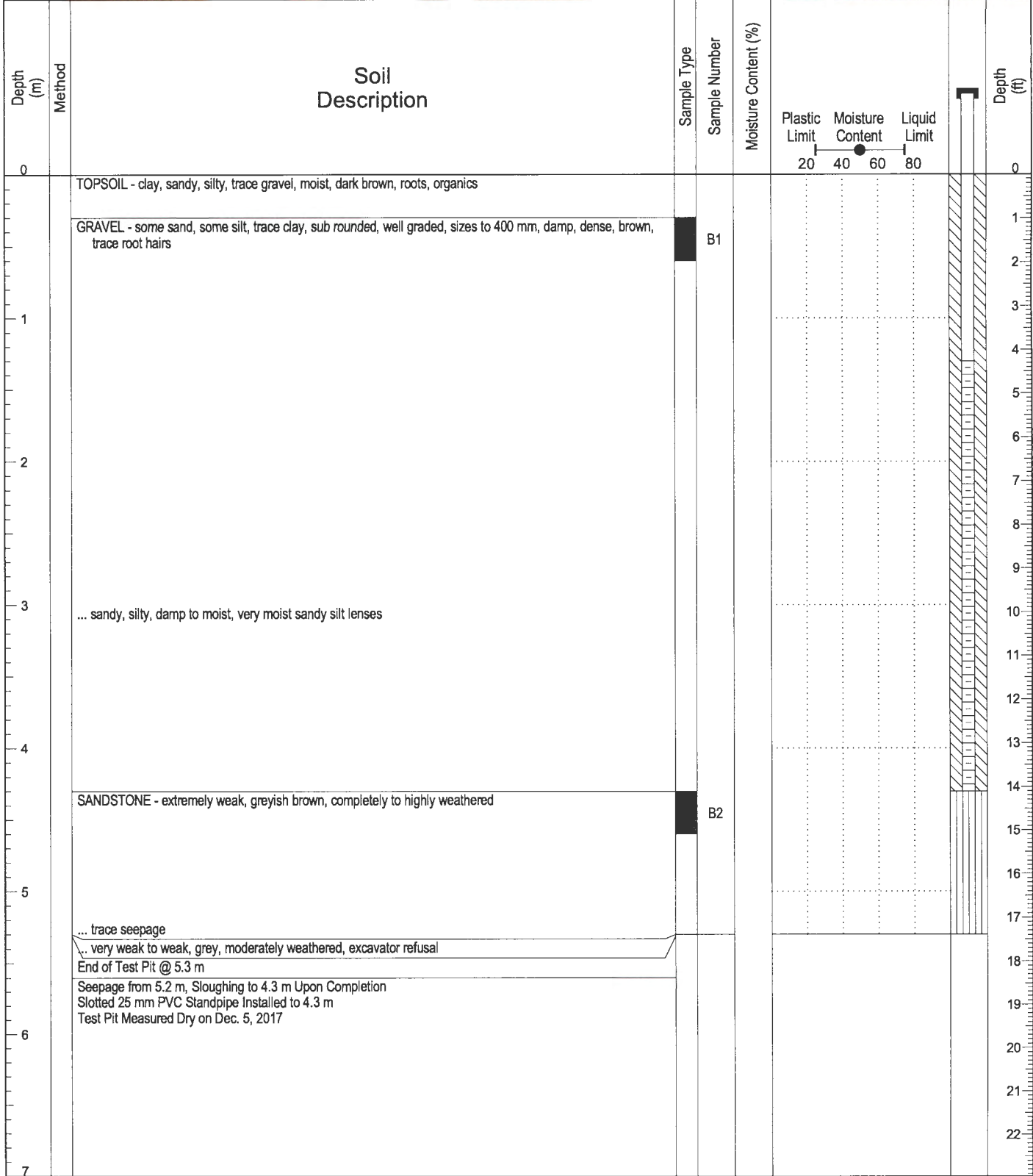
Logged By: SS

Completion Date: 2017 November 07

Reviewed By: JZ

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MPE ENGINEERING LTD.	Borehole No: 17TP001	
	Project: BEAVER MINES SANITARY LAGOON	Project No: ENG.LGEO03598-01
	Location: LSD 2-19-6-1 W5M	
	NEAR BEAVER MINES, AB I N: 5485003, E: 708554	PROJECT ENGINEER: CHRIS MCRAE



TETRA TECH	Contractor: PAT DWYER	Completion Depth: 5.3 m
	Drilling Rig Type: EXCAVATOR	Start Date: 2017 November 28
	Logged By: SS	Completion Date: 2017 November 28
	Reviewed By: JZ	Page 1 of 1

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics					0
0.5		SAND - silty, trace to some clay, damp, compact, brown, roots		B1			1
1.5		GRAVEL - some sand, some silt, trace clay, sub rounded, well graded, sizes to 200 mm, damp, very dense, brown		B2			4
2.5		... sandy, silty, damp to moist					7
3.5		CONGLOMERATE - extremely weak, brown, completely to highly weathered		B3			12
4.5		SANDSTONE - extremely weak to very weak, grey, highly weathered					15
4.6		End of Test Pit @ 4.6 m					15
5.0		No Seepage, Sloughing to 3.7 m Upon Completion Slotted 25 mm PVC Standpipe Installed to 3.7 m Test Pit Measured Dry on Dec. 5, 2017					16
6.0							20
7.0							22

MPE ENGINEERING LTD.

Borehole No: 17TP003

Project: BEAVER MINES SANITARY LAGOON

Project No: ENG.LGEO03598-01

Location: LSD 2-19-6-1 W5M

NEAR BEAVER MINES, AB | N: 5485101, E: 708520

PROJECT ENGINEER: CHRIS MCRAE

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		TOPSOIL - clay, sandy, silty, trace gravel, moist, dark brown, roots, organics				20	40	80	0
		SAND - silty, trace to some clay, trace to some gravel, damp, compact, brown, root hairs							1
									2
1		GRAVEL - some sand, some silt, sub rounded, well graded, sizes to 300 mm, damp, very dense, brown		B1					3
									4
									5
									6
									7
		... sandy							8
									9
									10
									11
									12
									13
									14
5		SAND - silty, trace clay, trace gravel, fine grained, well graded, very moist, very dense, brown, trace coal specks, trace clay lenses to 10 mm		B2					16
		SILTSTONE - extremely weak, brown, completely weathered, claystone inclusions		B3					17
		.. very weak to weak, dark blueish grey, moderately to highly weathered, excavator refusal							18
		End of Test Pit @ 5.3 m							19
		No Seepage, Sloughing to 4.3 m Upon Completion Slotted 25 mm PVC Standpipe Installed to 4.3 m Test Pit Measured Dry on Dec. 5, 2017							20
									21
									22



Contractor: PAT DWYER

Completion Depth: 5.5 m

Drilling Rig Type: EXCAVATOR

Start Date: 2017 November 28

Logged By: SS

Completion Date: 2017 November 28

Reviewed By: JZ

Page 1 of 1

APPENDIX C

LABORATORY TEST RESULTS

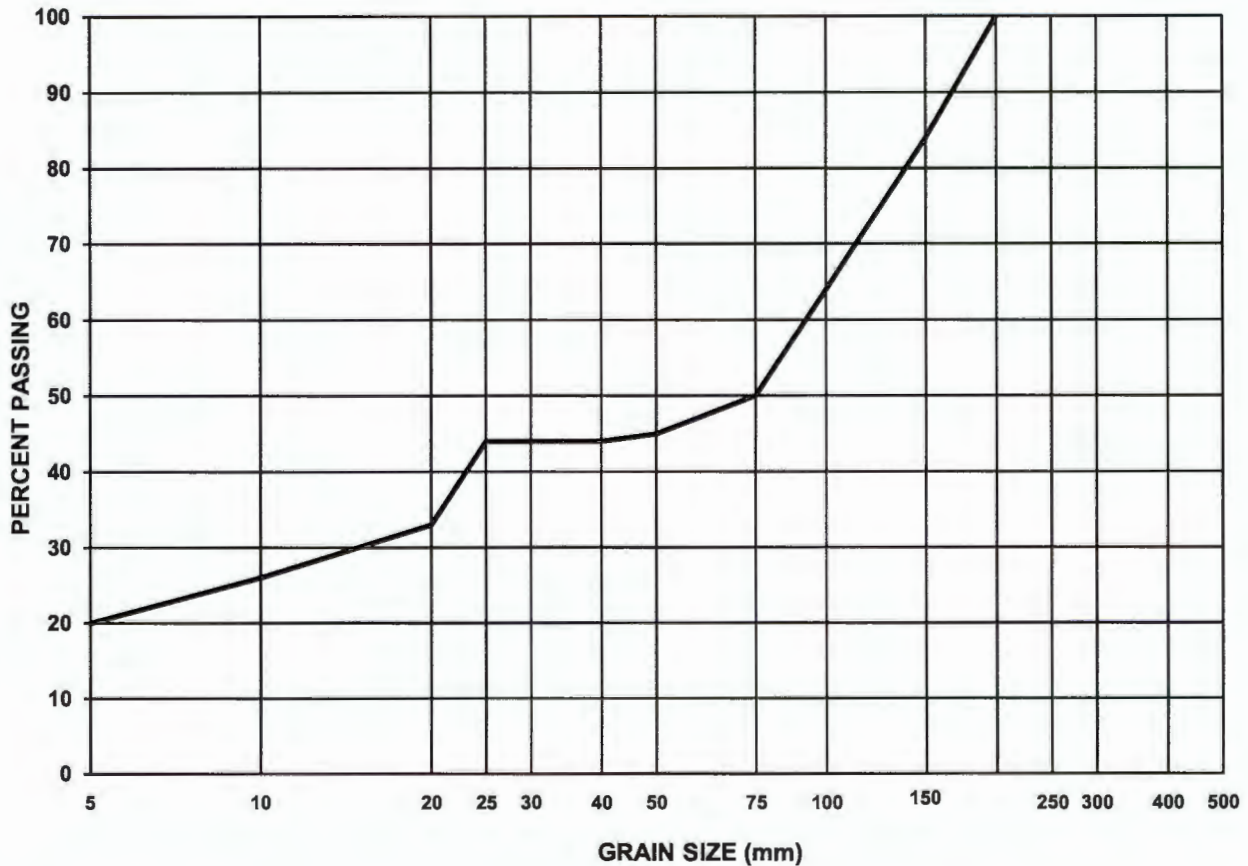
AGGREGATE ANALYSIS REPORT

PROJECT:	Beaver Mines Sanitary Lagoon	SAMPLE NUMBER:	17TP001
PROJECT NUMBER:	ENG.LGEO03598	DATE SAMPLED:	11-Dec-17
CLIENT:	MPE Engineering Ltd.	BY:	TT
ATTENTION:		TIME:	N/A
DESCRIPTION:	TWO OR MORE FRACTURED FACES:		N/A
LOCATION:	MOISTURE CONTENT:		N/A

PERCENT PASSING SIEVE SIZE

SIEVE SIZE (mm)	500	400	300	250	200	150	100	75	50	40	30	25	20	10	5
UPPER LIMIT															
LOWER LIMIT															
TEST RESULT					100	84	64	50	45	44	44	44.0	33.0	26.0	20.0

REMARKS: Sample Size: 32.46 kg
Sample above 5 mm, See corresponding grain size distribution for REVIEWED BY: _____ C.E.T.
passing 5 mm.



Data presented hereon is for the sole use of the stipulated client. Tetra Tech EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech EBA. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech EBA



PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Beaver Mines Sanitary Lagoon

Project Number: ENG.LGEO03598-01

Date Tested: December 11, 2017

Borehole Number: 17TP001

Depth: 0.3 m

Soil Description: _____

Cu: _____

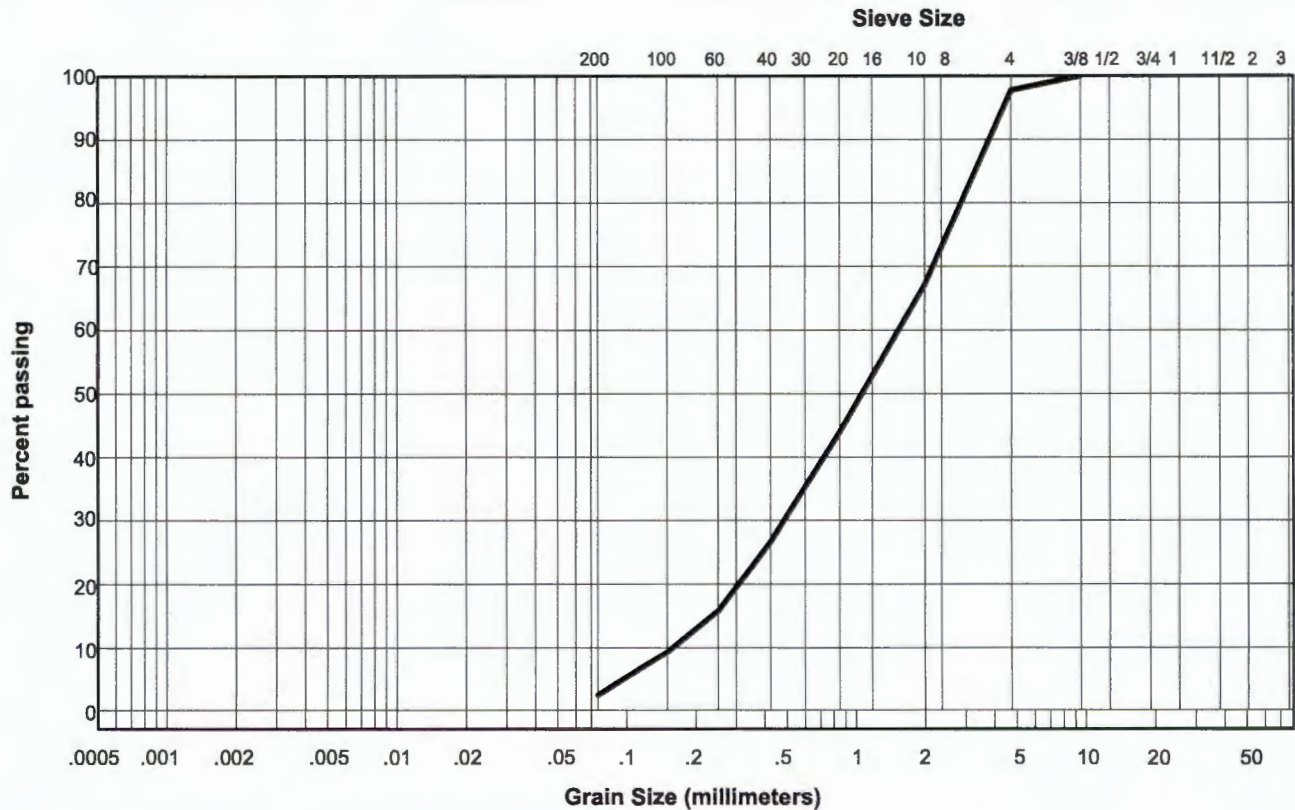
Cc: _____

Natural Moisture Content: Not done

Remarks: See corresponding sample for for sample larger than 5 mm.

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	#N/A
19.000	#N/A
12.500	#N/A
9.500	100
4.750	98
2.000	67
0.850	44
0.425	27
0.250	16
0.150	9
0.075	2.4

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: _____ C.E.T.

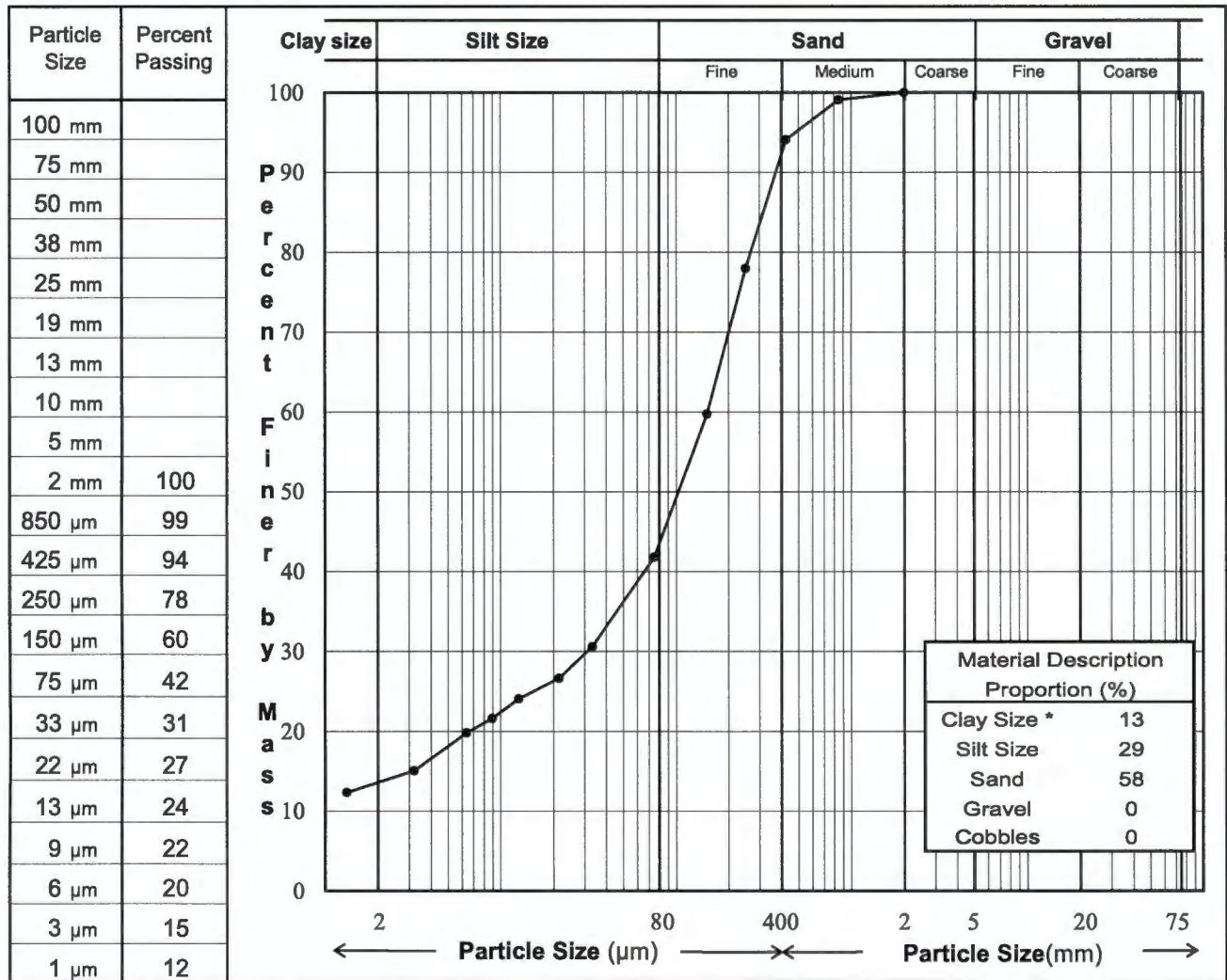
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PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Beaver Mines Sanitary Lagoon	Sample No.:	N/A
Client:	MPE Engineering	Borehole/ TP:	17TP002
Project No.:	704-ENG.LGEO03598	Depth:	0.3 m
Location:		Date Tested	December 11, 2017
Description **:	SAND - Silty, some clay	Tested By:	PL



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.
 ** The description is behaviour based & subject to EBA description protocols.

Reviewed By: _____ P.Eng.

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