GEOTECHNICAL INVESTIGATION

PROPOSED SEWAGE LAGOON EXPANSION
PARCEL MU1, PLAN 102434419, EXT. 0
SW 21-40-10-W3M
RADISSON, SASKATCHEWAN
PMEL FILE NO. 22595
AUGUST 13, 2025

PREPARED FOR:
Town of Radisson

ATTENTION: Norma Stumborg, Administrator

P.MACHIBRODA ENGINEERING LTD.

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1 INTRODUCTION

1.1 GENERAL

The following report presents the results of a geotechnical investigation, conducted by P. Machibroda Engineering Ltd. (PMEL), for the property (i.e., site) legally described as:

- Parcel MU-1, Plan 102434419, Ext. 0, Rural Municipality (RM) of Great Bend No. 405, Saskatchewan.

The Terms of Reference for this investigation were presented in PMEL Proposal No. 22595 REV2, dated July 22, 2025. Written authorization to proceed with this investigation was provided via the signed consulting agreement between PMEL and Town of Radisson, dated July 23, 2025. Initial authorization to proceed with the investigation was provided via email by Norma Stumborg, Administrator, from Town of Radisson on March 23, 2025.

The field investigation, which included drilling of boreholes, soil sampling, installation of monitoring wells and piezocone penetration testing (CPTu), was conducted on May 16, 2025. Groundwater monitoring and sampling were conducted on June 25, 2025.

1.2 PREVIOUS REPORT

The results of a previous geotechnical investigation, completed by PMEL at the site, were presented in the following report:

- Geotechnical Investigation Proposed Sewage Lagoon Expansion and Sewage Lift Station, Radisson, Saskatchewan. PMEL Report No. S09-6987, dated October 30, 2009. Prepared for Town of Radisson. (PMEL, 2009).

The relevant test hole (i.e., borehole) logs from this investigation are included in Appendix B.

2 OBJECTIVES AND SCOPE OF WORK

The objective of this investigation was to assess the suitability of the site, on a geotechnical basis, for construction of a sewage lagoon. The scope of work for this investigation included the following:

1. Provide a description of the site and surrounding area including characterization of the regional topography, geology and hydrogeology.

2. Conduct a field-testing program including borehole drilling and monitoring well installation.

3. Assess soil conditions and conduct laboratory testing to determine if the soils at the site are suitable for liner construction.

4. Record groundwater levels in the monitoring wells installed at the site.

5. Provide geotechnical design recommendations for construction of a sewage lagoon including specifications for an appropriate liner to meet Water Security Agency (WSA, 2012) requirements.

6. Provide an assessment of the existing berm integrity. Groundwater sampling and chemical analysis was conducted as part of the berm integrity assessment.

3 SITE CHARACTERIZATION

3.1 SITE DESCRIPTION, LOCATION AND SURROUNDING LAND USE

The location of the proposed lagoon expansion has been shown on the Site Plan, Drawing No. 22595-1. Select photographs of the site are presented in Appendix C. The site, which is comprised of an irregular shaped 9.098 hectare (22.48 acre) parcel, is located adjacent to the existing lagoon, approximately 400 m south of the southern edge of the Town of Radisson. At the time of this investigation, the area of the proposed lagoon expansion had been stripped of topsoil and had standing water throughout. A Sasktel communication tower was located on the adjacent parcel to the north of the site. The remaining surrounding land use at the site was predominately cultivated agricultural land.

The south dyke (refer to Photograph Nos. 1 and 2) of the existing lagoon appeared to be approximately 2 m in height and had a sideslope of approximately 4H:1V (horizontal:vertical) or flatter. The south dyke did not have any signs of instability (i.e., erosion, slumping or tension cracks). However, standing water was present at the toe of the exterior dyke and there were areas of thicker and darker green vegetation on the dyke exterior sideslope suggestive of seepage through the dyke.

The east dyke (refer to Photograph Nos. 3, 4 and 5) of the existing lagoon appeared to be approximately 2.5 m in height and had a sideslope of approximately 4H:1V. The toe of the exterior dyke was partially cut and there was standing water along portions of the toe of the exterior dyke and the appearance of salt staining (on May 15, 2025). Apparent salt staining was not evident on June 25, 2025.

3.2 SITE TOPOGRAPHY

Review of published topographic information (Google Earth, 2025) revealed the following:

1. The land surface elevation of the site ranges from approximately 522 meters sea level (masl).

2. Regionally the ground surface slopes gradually downward towards North Saskatchewan River (443 masl) which is located, at its nearest point, approximately 9 km southwest.

3. Several small sloughs were located proximate to the site.

3.3 PHYSIOGRAPHY AND REGIONAL GEOLOGY

A review of published physiography and regional geology information (Acton et al., 1960 and Christiansen, 1979) revealed the following:

1. The proposed lagoon site lies in the physiographic region known as the Saskatchewan Rivers Plain.

2. The topography of this region is characterized as undulating to rolling.

3. The landforms of this region consist of glacial lacustrine-alluvial plains (dunes) and till plains.

4. The regional surficial soil conditions in this area consist of approximately 70 m of glacial till and stratified drift (sand, silt and clay) overlying the silty clay shale of the Lea Park Formation – Upper Colorado Croup.

3.4 REGIONAL HYDROGEOLOGY

An examination of hydrogeological data (MDH, 2011) for this region revealed the following observations:

1. The site overlies surficial stratified deposits that appear to extend to from grade to less than 10 m below grade.

2. The site overlies Lower and Upper Dundurn Formation aquifers. These aquifers appear to be located at a depth greater than 40 m.

3. A Warman Formation aquifer is located approximately 1 km to the southwest of the site.

4. A Battleford Formation aquifer is located approximately 1 km to the northwest of the site.

5. There are no Lower Floral Formation Aquifers, Upper Floral Formation Aquifers, Empress Group Aquifers or Mennon Formation Aquifers located within 1 km of the site.

3.5 WATER WELL RECORDS

A search of the Saskatchewan Water Security Agency (WSA) Water Well Database (WSA, 2025) was conducted for an approximately 1.6 km radius of the lagoon site. Results of the search are presented in Appendix D and summarized in Table I.

Review of the results presented in Table I revealed the following:

1. A total of fourteen (14) registered water wells are located within an approximately 1.6 km radius of the site.

2. These wells were completed at depths ranging from approximately 6 to 152 m below grade.

3. The recommended pumping rates for Well Nos. 57217 and 35696 were 4 and 22 litres per minute, respectively. Pumping rates were not provided for the remaining wells.

4. The majority of the wells were registered as domestic or municipal withdrawal wells.

TABLE I SUMMARY OF GROUNDWATER WELL RECORDS

Well Record No.	Completion Date	LSD	Well Name	Borehole Depth		Diameter		Rec. Pumping Rate		Water Use	Well Use
				ft	m	in	mm	IGPM	L/M		
35693	1947-09-01	20-40-10-3	Glen	60	18	NR	NR	NR	NR	Domestic	Withdrawal
35694	1960-06-13	20-40-10-3	Hamilton	20	6	36	914	NR	NR	Domestic	Withdrawal
35695	1960-04-29	20-40-10-3	Agro Eqiupment	60	18	24	610	NR	NR	Domestic	Water Test Hole
35696	1960-06-30	20-40-10-3	Swain	146	45	5	114	5	22	Domestic	Withdrawal
35697	1960-11-18	20-40-10-3	Radisson	180	55	NR	NR	NR	NR	Municipal	Water Test Hole
35698	1960-04-23	20-40-10-3	Radisson Motors	32	10	30	762	NR	NR	Domestic	Withdrawal
35699	1961-11-03	20-40-10-3	Stott	36	11	24	610	NR	NR	Domestic	Withdrawal
35700	1962-11-26	NE-20-40-10-3	Radisson	500	152	5	127	NR	NR	Municipal	Water Test Hole
35701	1960-04-12	NE-20-40-10-3	Racine	18	5	30	762	NR	NR	Domestic	Withdrawal
35703	1960-11-17	NW-21-40-10-3	Radisson	250	76	NR	NR	NR	NR	Municipal	Water Test Hole
57217	1979-03-15	NE-21-40-10-3	Kindt	54	16	42	1067	1	4	Domestic	Withdrawal
57372	1978-10-07	NE-21-40-10-3	Kindt	202	62	5	119	NR	NR	Domestic	Water Test Hole
231576	1997-07-30	07-SE-21-40-10-3	Saskatchewan Research Council	360	110	NR	NR	NR	NR	NR	NR
231577	1997-07-30	07-SE-21-40-10-3	Saskatchewan Research Council	160	49	NR	NR	NR	NR	NR	NR

IGPM - Imperial gallons per minute

L/M - Litres per minute

NR - Not reported

4 FIELD INVESTIGATION

4.1 FIELD DRILLING PROGRAM

On May 16, 2025, a total of six (6) boreholes were drilled at the locations shown on the Site Plan, Drawing No. 22595-1. The location of boreholes drilled at the site in 2009 (PMEL, 2009) are also presented on the Site Plan, Drawing No. 22595-1. Each borehole was approximately 150 mm in diameter and drilled using PMEL's owned and operated track-mounted continuous flight auger drilling rig. Borehole logs were compiled during the field investigation to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered. Disturbed samples of soils, collected during the field investigation, were sealed in plastic bags to minimize moisture loss and taken to PMEL's materials testing laboratory for analysis.

Monitoring wells (i.e., piezometers) were installed in Borehole Nos. 25-1, 25-5 and 25-5A. Each monitoring well consisted of a 50 mm diameter, Schedule 40, PVC machine slotted screen with a solid riser pipe. The annular space around each slotted screen was filled with silica sand and a bentonite seal was placed around each solid riser pipe.

For the remainder of this document, boreholes and boreholes completed with monitoring wells will be referenced by the borehole number. For example, Borehole 25-5 and the monitoring well installed in Borehole 25-5 will be referenced as 25-5.

The ground surface elevation at each borehole location was referenced to the rim of a manhole cover and the top of a found iron pin (FIP), located approximately as shown on Site Plan, Drawing No. 22595-1. A geodetic elevation of 523.75 m was provided for the FIP (as per label adjacent to the FIP).

4.2 PIEZOCONE PENETRATION TESTING

On May 16, 2025, a total of three (3) CPTu's, were conducted at the site at the locations shown on the Site Plan, Drawing No. 22995-1. The CPTu's extended to depths ranging from approximately 9.0 to 9.2 m below the existing ground surface. Each CPTu consisted of pushing a cone, on the end of a series of rods, into the ground at a constant rate while near continuous measurements (q_t)were recorded at the cone tip. Local side friction resistance measurements (f_s) were recorded on a friction sleeve located directly behind the cone tip. Pore-water pressure response (u) generated from the advancement of the cone into the soil was measured via a pore pressure filter located between the cone tip and friction sleeve. The piezocone tip had an apex angle of 60° and a 15 cm^2 base area. The friction sleeve had a perimeter area of 225 cm^2. The equipment and procedures for conducting the CPTu were undertaken in accordance with ASTM D-5778, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Testing of Soils".

The test plots, recorded during the cone soundings, have been presented in Appendix E.

5 SOIL AND GROUNDWATER CONDITIONS

5.1 SOIL CONDITIONS

Detailed descriptions of the soil profile encountered during drilling were provided on the Borehole Logs, Drawing Nos. 22595-2 to 7, inclusive and on the CPTu plots presented in Appendix E. A stratigraphic section across the proposed lagoon expansion has been shown on Drawing No. 22595-8.

Review of the drill logs and the stratigraphic section the revealed the following:

1. Within the proposed lagoon expansion (25-5 and 25-5A), the soil profile consisted of highly plastic clay with intermittent silt layers/seams to a depth of approximately 4.8 m below existing grade. The above deposits were underlain by glacial till, which extended to depth of at least 10.5 m below existing grade. An intertill sand layer was encountered between the depths of 8.5 to 9.3 m below existing grade. The soil conditions were similar to what was reported in the 2009 investigation (PMEL, 2009).

2. Along the existing lagoon dyke (25-2, 25-3 and 25-4), the soil profile consisted of fill material (to depths of approximately 1.8 and 4 m below existing grade), overlying predominantly clay with intermittent silt layers/seams (to depths of approximately 6.6 and 8.2 m below existing grade. The above deposits were underlain by glacial till, which extend to a depth of at least 9 m below existing grade. A sand layer was encountered between the depths of 1.8 and 2.2 m below existing grade in 25-4.

5.2 GROUNDWATER CONDITIONS, SLOUGHING

Groundwater seepage and sloughing conditions were encountered during test drilling. The depths at which groundwater seepage conditions were encountered are shown on the Borehole Logs, Drawing Nos. 22595-2 to 7, inclusive.

A summary of the groundwater levels recorded in the monitoring wells on June 25, 2025, have been presented in Table II.

TABLE II GROUNDWATER MONITORING RESULTS – MAY 20, 2025

Borehole No.	Monitoring Well Rim Elevation (m)	Monitoring Well Bottom Elevation	Ground Surface Elevation (m)	Groundwater Depth below existing grade (m)	Groundwater Elevation (m)
25-1	523.7	516.7	522.7	0.4	522.3
25-5	522.3	512.2	521.2	0.9	520.3
25-5A	522.1	516.7	521.2	0.4	520.8

Review of the groundwater monitoring results, presented in Table II, revealed the following:

1. The depth to groundwater in the monitoring wells ranged from approximately 0.4 to 0.9 m below existing grade.

2. A downward vertical gradient of 0.089 (screen mid-point) was measured in the nested monitoring wells (i.e., 25-5/25-5A).

Higher groundwater levels should be expected during and/or following spring snowmelt and/or extended periods of precipitation. The direction of groundwater flow can change.

5.3 COBBLESTONES AND BOULDERS

Cobblestones and/or boulders were encountered during test drilling at the site. Glacial till consists of a heterogeneous mixture of gravel, sand, silt and clay-sized particles. Glacial till inherently contains sorted deposits of the above particle sizes as well as a random distribution of larger particle sizes in the cobblestone range (60 to 200 mm) and boulder-sized range (larger than 200 mm). Inter/intra till deposits of cobblestones, boulders, boulder pavements and isolated deposits of saturated sand or gravel should be anticipated. The statistical probability of encountering cobbles/boulders in the small diameter boreholes drilled at this site was low. The frequency of encountering such deposits will increase proportionately with the volume of soil excavated at the site.

6 LABORATORY ANALYSIS

6.1 INDEX TEST RESULTS

The soil classification and index tests performed during this investigation consisted of a visual classification of the soil, moisture contents and Atterberg limits. The results of these tests conducted on representative samples of soil have been plotted on the boreholes alongside the corresponding depths at which the samples were recovered, as shown on Drawing Nos. 22595-2 to 7, inclusive.

The results of the Atterberg limit testing and grain size distribution analyses have been shown in Appendix F and summarized in Table III.

The results of the standard Proctor moisture-density analyses, conducted on bulk samples of glacial till, are presented in Appendix G.

TABLE III SUMMARY OF SOIL INDEX TEST RESULTS

Borehole No.	Sample No.	Depth (m)	Soil Type	Grain Size Distribution Analyses (percent)			Atterberg Limits	
				Sand & Gravel	Silt	Clay	Plasticity Index (PI)	Liquid Limit (LL)
25-2	20	1.0	Clay Fill	26	46	28	20	37
25-3	31	1.5	Silt Fill	44	27	29	15	29
25-3	34	4.5	Clay	8	37	55	39	58
25-4	1.0	1.0	Silt Fill	40	35	25	19	33
25-5	8	0.5	Clay	--	--	--	32	49
25-5	10	1.5	Silt	--	--	--	23	41

A soil can be expected to have a hydraulic conductivity of 1 x 10^{-9} m/s or less if it has the following properties:

- Particle Size Range (by weight)
  - Percent fines (i.e., silt and clay) ≥ 50%
  - Clay Content ≥ 20%
  - Sand Content ≤ 45%
- Atterberg Limits
  - Plasticity Index (PI): PI ≥ 20
  - Liquid Limit (LL): LL ≥ 30

Review of the results of the grain size analyses and Atterberg Limits presented in Table III revealed the following:

1. The clay fill (25-2) and clay (25-3) meet the above index properties. As such it is expected that these soils would have a hydraulic conductivity of 1 x 10^{-9} m/s or less.

2. The silt fill/silt soils did not meet the criteria and will thus it is considered likely that these soils will have a hydraulic conductivity that exceeds 1 x 10^{-9} m/s.

It is recommended that laboratory hydraulic conductivity testing (ASTM D5084) be conducted if onsite soils are considered for use as a liner material.

6.2 LABORATORY HYDRAULIC CONDUCTIVITY TEST

Bulk samples of clay soils were collected from the site at depths ranging from grade to approximately 3.0 m below grade. As detailed in Appendix G, the bulk samples were compacted to a density of 98 percent of standard Proctor density at optimum moisture content (ASTM D698). Following compaction, the laboratory hydraulic conductivity of each compacted sample was determined as per ASTM D5084.

The results of the laboratory hydraulic conductivity are summarized in Table IV while detailed results are presented in Appendix H.

As per WSA Sewage Works Design Standard (WSA, 2012), the laboratory hydraulic conductivity should be increased by an order of magnitude to account for a number of factors (e.g., variations in materials, macro-structure, testing errors, etc.). The WSA requires that seepage losses from a compacted clay liner (CCL) be less than 150 mm per year. This means that the laboratory hydraulic conductivity (ASTM D5084) of a soil sample recovered from a 1 m thick CCL, with an effluent head of 2 m, must be 1.5×10^{-10} m/s or less.

In consideration of the above, the test results summarized in Table IV suggest that the hydraulic conductivity of the clay soils at the site soil would be less than maximum allowable laboratory hydraulic conductivity value of 1.5×10^{-10} m/s. In other words, the clay soils would be suitable for use as a CCL.

TABLE IV SUMMARY OF LABORATORY HYDRAULIC CONDUCTIVITY TEST RESULTS

Borehole No.	Depth (m)	Soil Type	Laboratory Hydraulic Conductivity (m/s)
25-5	0 – 3.0	Clay	6×10^{-11}

6.3 RESULTS OF GROUNDWATER SAMPLING

Groundwater sampling was conducted as part of the berm integrity assessment to aid in determining whether the existing lagoon is leaking.

6.3.1 GROUNDWATER SAMPLING

Following measurement of the groundwater levels on June 25, 2025, groundwater samples were recovered from 25-1, 25-5 and 25-5A. Prior to sampling, the monitoring wells were either purged dry or bailed, to remove the equivalent of at least three well volumes of groundwater, using a dedicated disposable bailer. Following bailing, groundwater samples were collected from the monitoring wells for routine water analyses. The collected groundwater samples were placed in laboratory supplied bottles with appropriate preservatives. To prevent cross contamination, all groundwater samples were collected using the same dedicated disposable bailer used to purge each well and new nitrile gloves were worn at each new monitoring well.

The collected groundwater samples were stored on ice in a cooler and submitted to ALS Canada Ltd. (ALS), a Canadian Association for Laboratory Accreditation Inc. (CALA) laboratory, in Saskatoon, Saskatchewan for laboratory analysis.

6.3.2 RESULTS OF GROUNDWATER CHEMICAL ANALYSIS RESULTS

The results of the laboratory chemical analysis for routine groundwater parameters are summarized in Table V along with the Saskatchewan Ministry of Environment (SKMoE, 2025) Saskatchewan Environmental Quality Guidelines (SEQG) Tier 1 Natural Area Endpoints. Detailed laboratory reports, including a listing of the analysis methods, are included in Appendix I. The 2023 routine groundwater analysis results (Pinter, 2024) for the existing lagoon are also presented in Table V.

Review of the results presented in Table V revealed the following:

1. The concentrations of the following chemical constituents, exceeded the SEQG Tier 1 Natural Area Endpoints:

   - Chloride (25-1, 25-5, 25-5A, Lagoon)
   - TDS (25-1, 25-5, 25-5A, Lagoon)
   - Sodium (25-1, 25-5, Lagoon)

2. The concentrations of the remaining chemical constituents, measured in the water samples analysed, were below the SEQG Tier 1 Natural Area Endpoints.

TABLE V SUMMARY OF ROUTINE GROUNDWATER CHEMISTRY RESULTS

Monitoring Well No.	25-1		25-5	25-5A	Lagoon	SEQG Tier 1 Natural Area Endpoints
Sample No.	25-1	22595-1*	25-5	25-5A	LAG1	
Subsurface Vapour (ppm)	145		25	85	-	
Sample Date	25-Jun-2025		25-Jun-2025	25-Jun-2025	7-Jul-2023	
Parameter						
Field Measured Parameters						
Conductivity [µS/cm]	4820		5600	5240	-	No Endpoint
pH [unitless]	7.27		7.31	7.58	-	6.5-9
Temperature [°c]	14.2		12.1	11.7	-	No Endpoint
Laboratory Analysis						
Conductivity [µS/cm]	4350	4290	4900	4480	3030	No Endpoint
pH [unitless]	7.77	7.6	7.51	7.82	8.42	6.5-8.5
Alkalinity, Total (as CaCO3)	890	878	677	533	-	No Endpoint
Bicarbonate (HCO3)	1080	1070	826	650	552	No Endpoint
Carbonate (CO3)	<0.6	<0.6	<0.6	<0.6	9.50	No Endpoint
Chloride (Cl)	**626**	**625**	**155**	**357**	**449**	120
Hardness (as CaCO3)	1800	1800	2850	3060	-	No Endpoint
Hydroxide (OH)	<0.3	<0.3	<0.3	<0.3	-	No Endpoint
Iron (Fe)	<0.050	<0.050	<0.050	<0.050	<0.4	3
Nitrate (as N)	<0.4	<0.4	<0.4	<0.4	<0.4	3
Nitrite (as N)	<0.2	<0.2	<0.2	<0.2	<0.2	VARIES[1]
TDS (Calculated)	**3010**	**3000**	**4620**	**4160**	**1980**	500
Sulfate (SO4)	859	861	2700	2310	600	VARIES[2]
Calcium (Ca)-Dissolved	296	277	528	586	154	No Endpoint
Magnesium (Mg)-Dissolved	257	268	371	387	149	No Endpoint
Potassium (K)-Dissolved	13	13.2	20	8.84	21.3	No Endpoint
Sodium (Na)-Dissolved	**392**	**395**	**402**	158	**288**	200
Fluoride (F)-Dissolved	<0.4	<0.4	<0.4	<0.4	-	-

Results expressed as mg/L (ppm) except where noted in [ ]
< Result is below the laboratory detection limit (LDL)
[1]Endpoint varies with chloride concentration
[2]Endpoint varies with hardness concentration
[3]Endpoint varies with temperature and pH
*Duplicate Sample

6.3.3 RESULTS OF GROUNDWATER CHEMICAL ANALYSIS RESULTS

The routine groundwater results are plotted on the Trilinear (Piper) diagram presented in Figure No. 1. Trilinear diagrams express the relative abundance of cations and anions, were used to describe the composition of groundwater. Discussion on the construction and interpretation of these diagrams are presented by Piper (1944) and Hem (1989). In general terms, the average composition of groundwater from each aquifer is plotted as a unique point in the diamond-shaped field of the trilinear plot. The variations in the composition of the groundwater displayed in the trilinear plots reflect differences in the lithology of the aquifers as well as differences in the lithology of the flow paths that the water traveled enroute to the aquifer.

A review of central diamond shown in Figure No. 1 revealed the following:

1. The groundwater chemistry in 25-1 is relatively similar to the water chemistry of the 2023 lagoon sample appear to be of similar origin which suggests that the lagoon is leaking.

2. The groundwater in 25-5 appears to be comprised of a mixture of the lagoon water and 25-5A.

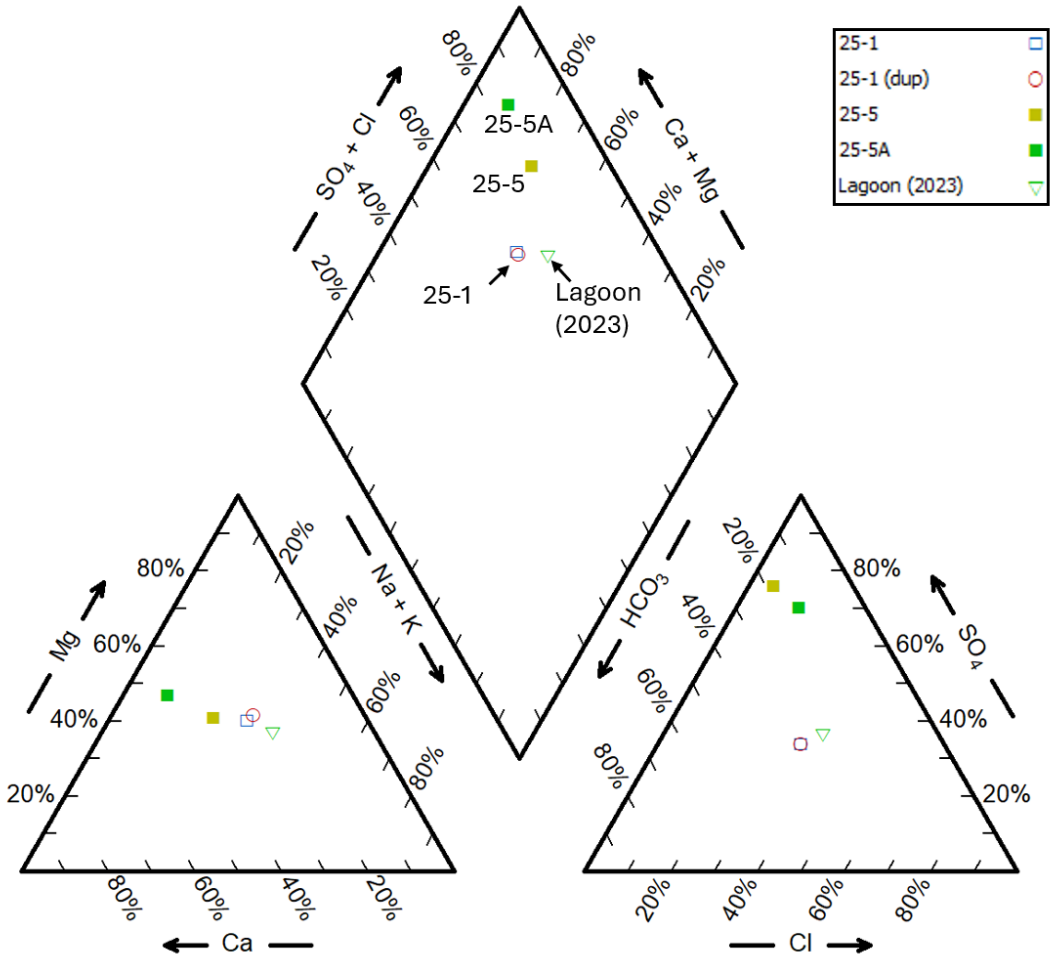

FIGURE 1 TRILINEAR (PIPER) PLOT

7 LAGOON EXPANSION DESIGN RECOMMENDATIONS

7.1 DESIGN CONSIDERATIONS

It is understood that a lagoon expansion is proposed to be constructed along the east side of the existing lagoon. The subgrade soil conditions at the site consisted predominantly of clay with variable silt layers/seams overlying glacial till. The groundwater at the site was measured at a depth of approximately 0.4 m below existing grade.

Based on the field investigation and laboratory hydraulic conductivity test results, a CCL appears to be an option at the site. However, due to the presence of silt and a high groundwater table a CCL is not considered the preferred option. The mixing of silt in the CCL would result in a higher hydraulic conductivity than what would be allowable. Further, the relatively high groundwater table would make compaction of the CCL difficult. Inconsideration of the above, a synthetic or geosynthetic clay liner is recommended for this site.

Significant construction difficulties should be anticipated during construction of the lagoon expansion due to the presence of a high groundwater table and soft subgrade soil conditions. The upper clayey silts and silty clays encountered at the subject site are soft, compressible and will be easily disturbed by construction traffic. Dynamic action of construction equipment may consolidate and saturate the area.

Excavation of the subgrade soils will not be practical with rubber-tired (earth movers, loaders, trucks, etc) where the static water level rises to within one metre of the excavation level. It is expected that track-mounted hydraulic excavators will be required to complete the excavation. Traffic must not be permitted on the excavated surface prior to subgrade preparation. Fill placement must be performed using low ground pressure (wide pad) track-mounted equipment, as well as drier borrow for area grading. A temporary perimeter sub-surface dewatering system and winter construction would likely be required. A sub-surface drainage system is recommended beneath a synthetic or geosynthetic clay liner.

Recommendations for the design and construction of the lagoon expansion have been presented below.

7.2 SITE PREPARATION

All organic soil, loose fill and deleterious materials should be removed from the proposed construction footprints. The general intent of initial site preparation is to make the subgrade suitably stable for construction activities. It is recommended that the subgrade soils within the development footprints are compacted to the following densities:

Sewage Lagoon: 96 percent standard Proctor density at optimum (to ±2%) moisture content;
Landscape: 90 percent standard Proctor density at optimum (to ±2%) moisture content.

Soils which meet the required compaction level should be stable to support construction activities. It is anticipated that conventional site preparation (scarifying, moisture conditioning and re-compacting the soils) will suffice at this site. Soils which fail to achieve the required compaction may require over-excavation and replacement and/or geosynthetic stabilization. The need for additional treatment should be reviewed by the Geotechnical Consultant during field construction with respect to the actual conditions and project requirements.

Subgrade fill, where required, should consist of suitable soils, placed in thin lifts (maximum 150 mm loose) and uniformly compacted to the above-mentioned densities. Fill will be susceptible to settlement, the magnitude of which will be directly related to the level of compaction and fill thickness. Well compacted fills will settle a small percentage of the fill thickness whereas poorly compacted fills can settle appreciably, particularly if frozen soils are utilized/incorporated in the fill.

In areas with variable subgrade soils (i.e., density testing results are unreliable), proof rolling may be acceptable in lieu of density testing and should be reviewed by the Geotechnical Consultant.

The site should be graded to provide positive site drainage away from all work areas and structures prior to, during and following construction.

7.3 EXCAVATIONS AND DEWATERING

Temporary excavations should be designed and excavated in accordance with current Saskatchewan Occupational Health and Safety Regulations. The Contractor is solely responsible for protecting the excavation by shoring, sloping, benching and/or other means as required to maintain the stability of both the excavation sides and the bottom.

On June 25, 2025, the near surface groundwater, encountered at the site was located approximately 0.4 m below existing grade. Groundwater levels should be expected to fluctuate seasonally with the highest groundwater level in the spring and/or during/following spring thaw and/or periods of precipitation. It is recommended that groundwater levels be measured prior to finalizing the design.

Sideslopes should be no steeper than 1H:1V in clay and/or silt. Slope flattening will be required if unstable conditions are encountered during excavation. Continuous visual monitoring of the sideslopes should be undertaken to assess whether flatter sideslopes are required to maintain stability.

Excavation below the groundwater table will cause extensive construction difficulties associated with groundwater seepage and sloughing conditions as the saturated sand and silts may flow into the excavation. De-watering should be conducted over the time-period for which the excavations are left open. A sump (or multiple sumps, if required) should be set up at the deepest excavation points and the floor of the excavation sloped to the sump(s) to handle groundwater seepage and precipitation runoff. A self-actuated sump pump(s) should be operated on a continuous basis and should be discharged well away from the excavations. If conventional dewatering methods are ineffective, dewatering wells will be required.

The stability of the excavation will be affected by wetting and drying of the exposed excavation walls, the length of time that the excavation remains open and the consistency and structure of the subgrade soils.

Excavated soil should be stockpiled away from the crest of the excavation to minimize potential sloughing of the excavation walls due to the soil surcharge loading. Similarly, equipment and construction materials should also be placed away from the crest of the excavation.

7.4 SUB-SURFACE DRAINAGE SYSTEM

A subsurface drainage system should be installed to facilitate the construction and to maintain groundwater levels for the protection of the lagoon liner. The sub-surface drainage system should consist of perforated drainage pipe with the invert placed at least 350 mm below the underside of the proposed liner.

The perforated drainage pipe drains should be at least 100 mm in diameter and placed at a maximum spacing of 4 m on centre on naturally deposited, undisturbed soil or free-draining sand as may be required for levelling. The perforated drainage pipe should be covered with a minimum of 200 mm (above invert) of clean, drainage aggregate meeting the gradation requirements presented in Table VI.

TABLE VI CLEAN, DRAINAGE AGGREGATE

Grain Size (mm)	Percent Passing
25.9	100
9.5	50 – 95
5.0	35 – 70
2.0	20 – 45
0.425	0 – 20
0.150	0 – 8
0.071	0 – 3

The drainage pipe and clean drainage aggregate should be fully encapsulated in non-woven geotextile capable of transmitting a flow of not less than 50 litres per second per square metre (ASTM D-4491). The sub-surface drainage system should be positively drained to sump pits equipped with automatic sump pumps and discharged in accordance with local regulations. A backup power supply for the sump pump(s) is recommended in the event of a power outage.

7.5 BUOYANCY FORCES

On June 25, 2025, the depth to the near surface groundwater at the site was ranged from approximately 0.4 m below existing grade. Additional groundwater monitoring should be conducted to confirm the groundwater elevations. Higher groundwater levels could be encountered during or following spring snowmelt and/or extended periods of precipitation.

If a subsurface drainage system is not installed and the sewage lagoon cells are constructed below the groundwater table, they should be designed to resist uplift forces due to buoyancy. The uplift hydrostatic pressure acting on the base of the structure would be equal to the depth of the structure extending below the groundwater table multiplied by the unit weight of water (9.81 kN/m^3).

7.6 LAGOON LINER

7.6.1 SYNTHETIC LINER

A synthetic liner is considered suitable as a liner material. This liner (referred to as a geomembrane), is comprised of high-density polyethylene (HDPE). An earthen subgrade or a subgrade cover may be required beneath the HDPE liner since granular material may contain unacceptable void space and may be unstable.

Subgrade soils should be scarified, levelled and compacted to a minimum of 96 percent of standard Proctor density within two (2) percent of optimum moisture content prior to placing the HDPE liner. In areas with variable subgrade soils (i.e., density testing results are unreliable), proof rolling may be acceptable in lieu of density testing and should be reviewed by the Geotechnical Consultant.

The subgrade soils should be inorganic, free of rocks, stones, sticks and debris and the subgrade surface should be firm, unyielding and free of voids and cracks. It should also be machine smoothed to ensure that there are no ruts, abrupt grade changes, voids or protrusions greater than 12 mm.

If the subgrade cover beneath the liner does not meet the subgrade requirements, a minimum 200 gm/m^2 of a nonwoven geotextile should be installed, and the liner should be placed directly on the geotextile. The finished subgrade surface should be approved by the Geotechnical Consultant.

The HDPE liner should be deployed at least 1 m above the groundwater table to ensure that the subgrade soils can be prepared as per the project specification. If the HDPE liner is deployed below the groundwater table, dewatering systems should be employed to facilitate the construction and to control the buoyancy forces.

The HDPE liner should be installed in accordance with the following recommendations:

1. Prepare the site in accordance with Section 7.2, Site Preparation.

2. Once the subgrade is prepared, the subgrade should be protected against desiccation and freeze/thaw.

3. The slopes and base of the lagoon should be scarified to a minimum depth of 150 mm, levelled and compacted to a minimum of 96 percent of standard Proctor density within two (2) percent of optimum moisture content.

4. The subgrade should be free of standing water, wet/saturated soils, snow or excessive moisture during installation of the liner. If the subgrade is soft and wet, it should be over-excavated and replaced with suitable fine-grained soils. A combination of geotextile and geogrid may be required prior to placement of the fine-grained soils.

5. Fill, required to bring the subgrade soil to the design elevation in the construction area should be placed in thin lifts (maximum 150 mm loose) and compacted to a minimum of 96 percent of standard Proctor density within two (2) percent of optimum moisture content.

6. The HDPE liner should have smooth contact with the subgrade soils. It should be laid smooth with no wrinkles or folds, properly restrained without excessive tension and the exposed edges of the liner should be kept clean.

7. The HDPE liner should be provided with suitable anchorage (typically 300 mm by 300 mm perimeter trenches) and installed in accordance with the liner manufacturer's recommendations with particular emphasis on liner seaming.

8. The HDPE liner panels should be placed individually and seamed immediately after their placement. All seaming of the liner panels should be performed in accordance with the liner manufacturer's recommendations. The final product of the seaming should be capable of producing a continuous homogeneous bond.

9. The seams are constructed by overlapping adjacent panel edges and ends. Edge-roll and end-roll overlaps should be a minimum of 150 mm and 600 mm, respectively. The overlaps should be placed in the downslope direction to facilitate drainage.

10. The HDPE liner should have a minimum thickness of 60 mils (approximately 1.5 mm). The floor of the liner should be covered with a minimum thickness of 300 mm of onsite fine-grained soils (i.e., glacial till) to prevent liner damage. These soils should be inorganic, free of rocks, stones, sticks and debris.

11. Vehicles should not be allowed to drive directly on the exposed liner. Construction personnel who are working on the liner, should not smoke and perform any activities that could damage the liner. All workers should wear soft-soled shoes.

12. A gas vent system should be installed as per manufacturer's recommendations beneath the liner to allow for venting of gas trapped under the liner.

13. Qualified geotechnical personnel should monitor the construction activities and perform quality control testing (i.e., compaction, proof roll, etc.) on a full-time basis. A post-construction report should be prepared as part of the quality control program.

7.6.2 GEOSYNTHETIC CLAY LINER (GCL)

A geosynthetic clay liner (GCL) can also be considered as an alternative liner material. The GCL consists of a layer of sodium bentonite clay encased by two layers of geotextiles and/or geomembranes which are held together by needling, stitching or adhesives. When the sodium bentonite clay is hydrated with water, the GCL creates a hydraulic barrier, typically providing a hydraulic conductivity of approximately 1×10^{-10} to 1×10^{-12} m/s.

An earthen subgrade or a subgrade cover may be required beneath the GCL since granular material may contain unacceptable void space and may be unstable. Subgrade soils should be scarified, levelled and compacted prior to placing GCL. This soil should be inorganic, free of rocks, stones, sticks and debris.

The finished subgrade surface should be firm, unyielding, free of voids, cracks, ice and/or standing water. It should be machine smoothed to ensure that there are no ruts, abrupt grade changes, voids or protrusions greater than 12 mm.

Subgrade soils should be compacted to a minimum of 96 percent of standard Proctor density within two (2) percent of optimum moisture content. In areas with variable subgrade soils (i.e., density testing results are unreliable), proof rolling may be acceptable in lieu of density testing and should be reviewed by the Geotechnical Consultant. The finished subgrade surface should be approved by qualified geotechnical personnel.

The GCL should be deployed at least 1 m above the groundwater table to ensure that the subgrade soils can be prepared as per the project specification. If the GCL is deployed below the groundwater table, dewatering systems should be employed to facilitate the construction and to control the buoyancy forces.

The GCL should be installed in accordance with the following recommendations:

1. Prepare the site in accordance with Section 7.2, Site Preparation.

2. Once the subgrade is prepared, the subgrade should be protected against desiccation and freeze/thaw.

3. The slopes and base of the lagoon should be scarified to a minimum depth of 150 mm, levelled and compacted to a minimum of 96 percent of standard Proctor density within two (2) percent of optimum moisture content. If rutting occurs during subgrade preparation, the subgrade should be compacted to 96 percent of standard Proctor density within two (2) percent of optimum moisture content.

4. Fill, required to bring the subgrade soil to the design elevation in the construction area should be placed in thin lifts (maximum 150 mm loose) and compacted to a minimum of 96 percent of standard Proctor density within two (2) percent of optimum moisture content.

5. The subgrade should be free of standing water, wet/saturated soils, snow or excessive moisture during installation of the GCL. If the subgrade is soft and wet, it should be over-excavated and replaced with suitable fine-grained soils. A combination of geotextile and geogrid may be required prior to placement of the fine-grained soils.

6. Prior to deployment of the GCL, testing should be conducted to assess the chemical compatibility of the GCL to the effluent and groundwater.

7. The GCL should have smooth contact with the subgrade soils. It should be laid smooth with no wrinkles or folds, properly restrained without excessive tension and the exposed edges of the GCL should be kept clean.

8. The seams should be constructed by overlapping adjacent panel edges and ends, as per the GCL manufacturer's recommendations. The longitudinal and butt seams should be overlapped a minimum of 150 mm and 600 mm, respectively. Care should be taken so that overlap areas are free from soils or debris. The overlaps should be placed in the downslope direction to facilitate drainage and bentonite enhancement is required for both longitudinal and butt seams. The longitudinal seams of the GCL should be parallel to the direction of the slope.

9. The GCL should be covered with a minimum 300 mm thick layer of fine-grained soils (i.e., glacial till) at the end of each working day to prevent liner damage, and the soils should be inorganic, free of rocks, stones, sticks and debris. The soil cover should be placed towards the up-slope direction and care should be taken so that the soil or debris does not enter into the seams.

10. Vehicles should not be allowed to drive directly on the exposed GCL. Construction personnel who are working on the GCL, should not smoke and perform any activities that could damage the GCL. All workers should wear soft-soled shoes.

11. A gas vent system should be installed as per manufacturer's recommendations beneath the GCL to allow for venting of gas trapped under the GCL.

12. Qualified geotechnical personnel should monitor the construction activities and perform quality control testing (i.e., soil cover and/or subgrade review, compaction, etc.) on a fulltime basis. A post-construction report should be prepared as part of the quality control program.

7.7 DYKE CONSTRUCTION

All existing organic soils, loose fills and/or deleterious material should be stripped from the surface of the proposed development area. The topsoil should be stockpiled and replaced on the exterior surface of the perimeter dykes following construction of the proposed sewage lagoon. The excavated surfaces should then be inspected by a representative of the Geotechnical Consultant to ensure that all soil, considered not suitable, has been removed prior to further construction.

The first lift may have to be increased in thickness to allow passage of the construction equipment on the soft, sensitive subgrade soils. If the thickness of the first lift is increased, it should be reviewed by the Geotechnical Consultant. The dykes should then be constructed in thin lifts, not exceeding 150 mm in thickness (loose) and compacted to 96 percent of standard Proctor density (ASTM D-698) within two (2) percent of optimum moisture content. The uppermost 500 mm of soils on the dykes should consist of low permeable soils (i.e., clay/glacial till).

In areas with variable subgrade soils (i.e., density testing results are unreliable), proof rolling may be acceptable in lieu of density testing and should be reviewed by the Geotechnical Consultant.

The dykes should be constructed in accordance with the following recommendations:

1. Prepare the site in accordance with Section 7.2, Site Preparation.
2. The dykes should be constructed with a crest width of 4 m. Slopes of 4:1 to 5:1 (horizontal to vertical) for the outside of the berm and 4:1 for the inside of the berm, are recommended.
3. The dykes should be designed and constructed to control surface water runoff to the proposed sewage lagoon. A minimum dyke height of 0.5 m above exterior grades is recommended, but it should be adjusted accordingly based on local design flood levels.

7.7.1 Slope Protection

The interior surface of the dykes (i.e., liner) should be protected against surface erosion both above and below the design full supply level. Slope protection could consist of riprap or manufactured erosion protection such as geotextiles or erosion control blankets.

Topsoil dressing should be applied to the outer and inner dyke faces where it is not possible to achieve submergence for extended periods of time. The exterior surface of the dykes should be covered with organic topsoil and hydro-seeded to provide slope protection from surface runoff erosion.

7.7.2 Control Structures and Level Control Monitors

Control structures may be required on the dykes where settlement of the dyke soil and underlying subgrade is anticipated. The design of control structures should accommodate differential movement of approximately 100 mm. Riprap should be placed around the openings of the control structures to minimize the potential for surface erosion.

Level control monitors should be installed to prevent overtopping of the dykes. The elevation of the level control monitors should reflect the minimum design freeboard of 1 m.

7.7.3 Site Drainage

A collector ditch should be excavated adjacent to the toe of the perimeter dykes for collection and controlled discharge of surface runoff. The collector ditch should be connected to the local natural surface drainage system.

7.7.4 Traffic Accommodation

The top of the dykes should be of sufficient width (minimum 4 m) to accommodate service vehicle access and practical construction equipment. The top surface of the dykes should have a crown with a minimum cross-slope of 3 percent. It is recommended that the crest of each dyke be capped with 100 mm of Base Coarse (MHI Type 31), presented in Table VII to permit all season vehicular traffic.

TABLE VII SPECIFICATION FOR TYPE 31 BASE COURSE

Sieve Designation	Percent by Weight Passing (Canadian Metric Sieve Series)
31.5 mm	100
18.0 mm	75 – 90
12.5 mm	65 – 83
5.0 mm	40 – 69
2.0 mm	26 – 47
900 µm	17 – 32
400 µm	12 – 22
160 µm	7 – 14
71 µm	6 – 11
Plasticity Index (PI), %	0 – 7
Fractured Face (Min), %	50
Lightweight Pieces (Max), %	5
CBR (Min)	65

7.8 SHRINKAGE FACTOR

A shrinkage factor of 25 percent is recommended for common borrow. The above shrinkage factor assumes that the organic topsoil will be removed and will not be included in volume calculations to which the shrinkage factor will be applied.

7.9 QUALITY CONTROL TESTING

Quality control testing should be performed on a continuous basis during construction to monitor compliance with the placement and compaction requirements outlined in previous sections of this report.

7.10 MONITORING WELLS

The existing monitoring wells, located outside of the footprint of the proposed sewage lagoon, should be preserved and maintained for use in post-construction monitoring. It is recommended that the monitoring wells be encased in lockable protective steel casings to maintain long-term performance. If the monitoring wells installed at this site are located within the lagoon footprint, they should be decommissioned prior to construction of lagoon.

If the monitoring wells are lost (damaged and/or destroyed) during construction, new monitoring wells should be installed where required. Long term monitoring wells should be located close to the toe of the perimeter berms. The monitoring well screens should intersect the groundwater table.

Monitoring wells located within the lagoon footprint and/or not required for long term monitoring should be decommissioned. Decommissioning of the monitoring wells should consist of drilling out the PVC casings/screens and the monitoring well backfill and replacing these materials with hydrated bentonite.

8 EXISTING LAGOON DYKES INTEGRITY

It is understood that there are concerns with the existing lagoon dykes on the east and south sides. The visual review of the exterior sides of the south and east dykes did not reveal any signs of instability (i.e., erosion, tension cracks, slumping). However, potential signs of seepage through the dykes were observed, as evidenced by the presence of thicker and darker green vegetation on the sideslope in areas, ponded water at the toe of the south dyke and apparent salt staining at the toe of the east dyke.

The dyke fill material consisted of variable low and medium plastic silt and/or clay. Sand and silt were present directly underlying the dyke. The presence of higher permeable sand and silt material could possibly form preferential pathways for seepage through and under the dykes. In addition, the fill material encountered along the south dyke (25-3 and 25-4) was predominantly silt, soft to firm in consistency and moist to wet. The groundwater sampling suggests that the lagoon water is mixing with the groundwater in 25-1 (installed on the exterior sideslope of the south dyke).

Based on the above investigation, the south and east dykes appear stable in their present condition. However, the lagoon is leaking and there are potential signs of seepage through the and/or under the dykes. Seepage through the dykes could create preferential flow paths and cause internal erosion through the dykes (i.e., piping) and potential failure. The risk of catastrophic failure is likely low considering the relatively low dyke heights and gradient of the exterior sideslopes.

It is recommended that the dykes are monitored annually for signs of instability (i.e., slumping, tension cracks, piping, etc.).

9 LIMITATIONS

The presentation of the summary of the borehole logs and design recommendations has been completed as authorized. Six (6), 150 mm diameter boreholes were dry drilled using our track-mounted, continuous flight auger drill rig. The borehole logs were compiled during test drilling which, we believe, were representative of the subsurface conditions at the borehole locations, at the time of test drilling.

Three (3) piezocone penetration tests were conducted during the field investigation. The inferred subsoil stratigraphy has been shown on the attached CPTu plots.

Variations in the subsurface conditions from that shown on the borehole logs and CPTu plots at locations other than the exact test locations should be anticipated. If conditions should differ from those reported here, then we should be notified immediately in order that we may examine the conditions in the field and reassess our recommendations in the light of any new findings.

No detectable evidence of environmentally sensitive materials such as chemical odours were apparent during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional boreholes should be drilled, and samples recovered for chemical analysis.

The subsurface investigation necessitated the drilling of deep boreholes. The boreholes were backfilled at the completion of test drilling. Please be advised that some settlement of the backfill materials will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each test location is maintained level with the existing grade.

It is recommended that all monitoring wells should be decommissioned once they are no longer needed. PMEL will not accept any future liability associated with inadequate decommissioning of monitoring wells. Costs for decommissioning monitoring wells can be provided by PMEL upon request.

This report has been prepared for the exclusive use of Town of Radisson and their agents for specific application to the proposed sewage lagoon expansion to be constructed Parcel MU1, Plan 102434419 Ext. 0, RM of Great Bend No. 405, near Radisson, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

The report should be referenced in its entirety, in order to properly understand the suggestions, design considerations and recommendations provided in this report. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Party. Governing Agencies such as municipal, provincial, or federal agencies having jurisdictions with respect to this development and/or construction of the facilities described herein have full jurisdiction with respect to the described development.

Any other unspecified subsequent development would be considered Third Party and would, therefore, require prior review by PMEL. No responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report will be accepted by PMEL.

Prior to completion of the final design drawings/specifications, PMEL should be retained to review the geotechnical aspects of the project plans and documents to confirm that they are consistent with the intent of this report.

The acceptance of responsibility for the design/construction recommendations presented in this report are contingent on PMEL providing field documentation and review services at the time of construction. Field reviews are necessary for PMEL to provide letters of assurance in accordance with requirements of local regulatory authorities. PMEL will not accept any responsibility on this project for any unsatisfactory performance if adequate and/or full-time inspection is not performed by a representative of PMEL.

If this report has been transmitted electronically, it has been digitally signed and secured with personal passwords to lock the document. Due to the possibility of digital modification, only those reports sent directly by PMEL can be relied upon without fault.

We trust that this report fulfils your requirements for this project. Should you require additional information, please contact us.

P. MACHIBRODA ENGINEERING LTD.

Association of Professional Engineers & Geoscientists of Saskatchewan
CERTIFICATE OF AUTHORIZATION
P. MACHIBRODA ENGINEERING LTD.
Number 172
Permission to Consult held by:

Discipline	SK. Reg. No.	Signature
Geoenvironmental	6687	

2025-08-13

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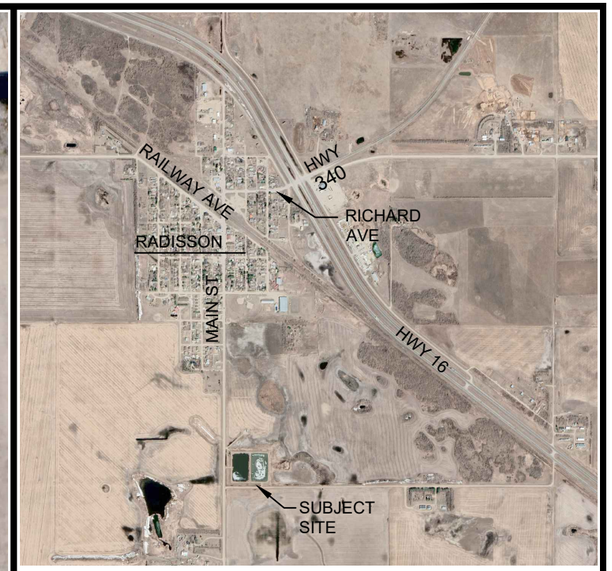
DRAWINGS



KEY PLAN
NOT TO SCALE

NOTE:
1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
2. THIS DRAWING WAS COMPILED FROM GOOGLE EARTH PRO ©2025, IMAGE ©2025 AIRBUS, (IMAGERY DATE: 04/15/21).
3. THIS DRAWING WAS COMPILED USING HANDHELD GPS EQUIPMENT (TRIMBLE 7 Geo7x).
4. BENCHMARK 1: RIM OF MANHOLE: GEODETIC ELEVATION 523.705 m.
5. BENCHMARK 2: FOUND IRON PIN. GEODETIC ELEVATION = 523.00 m.

LEGEND

- PMEL BOREHOLE MONITORING WELL INSTALLED
- FORMER PMEL BOREHOLE MONITORING WELL INSTALLED (S09–6887)
- PMEL BOREHOLE
- FORMER PMEL BOREHOLE (S09–6887)
- PMEL PIEZOCONE PENETRATION TEST
- BENCHMARK

P. MACHIBRODA ENGINEERING LTD.

CONSULTING
GEOENVIRONMENTAL
GEOTECHNICAL
ENGINEERS

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DRAWING TITLE:
SITE PLAN
BOREHOLE AND PIEZOCONE LOCATIONS

PROJECT:
PROPOSED LAGOON EXPANSION
SW 21-40-10 W3M, RADISSON, SK

APPROVED BY:	DRAWN BY:
GB	BS
DATE: MARCH, 2025	DRAWING NUMBER: 22595-1
SCALE: AS SHOWN	

P.MACHIBRODA ENGINEERING LTD.

BOREHOLE 25-1

DRAWING NUMBER: 22595-2

PROJECT: PROPOSED LAGOON EXPANSION

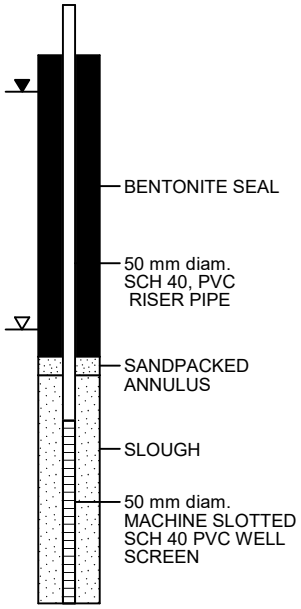
LOCATION: SW 21-40-10 W3M, RADISSON, SK

NORTHING (m): 5813729 **EASTING (m):** 337383 **ELEVATION (m):** 522.7 **DATE DRILLED:** MAY 16/25

SAMPLE TYPE: ☐ CUTTINGS ☒ SPLIT SPOON ■ SHELBY TUBE

WATER LEVELS
- ▼ After Drilling
- ▽ During Drilling

DEPTH (m)	STRATIGRAPHY	DESCRIPTION	SAMPLE TYPE	SPT (N) BLOWS/ 300 mm	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNIT WEIGHT (kN/m³)	% FINES	POCKET PEN. (kg/cm²)
0		TOPSOIL, organic, moist, black, rootlets.			24.8					0.25
1		FILL, clay, some silt, firm to stiff, highly plastic, moist, brown.			27.3					0.25
		silty, soft to firm, medium to highly plastic, moist to wet below 0.7 m.			26.3					0.5
2		trace organics, mottled black and brown below 1.1 m.			22.8					1.75
		CLAY, silty, firm, medium to highly plastic, moist to wet, brown.								
3		trace sand, stiff, moist below 1.6 m.			30.8					
		SILT, some clay, trace sand, firm, low to medium plastic, wet, brown, seepage, sloughing.								
4		CLAY, some silt, stiff, highly plastic, moist, brown.			36.2					2.0
		stiff to very stiff below 4.0 m.								
5		silty, stiff, oxide stained below 4.7 m.								
6					35.0					1.25
7										
8										
9										
10										
11										
12										



NOTE:
1. Borehole sloughed to 3.5 m with water level at 3.0 m Immediately After Drilling.
2. Monitoring well water level is 0.4 m below existing grade on June 25, 2025.

P.MACHIBRODA ENGINEERING LTD.

BOREHOLE 25-2

DRAWING NUMBER: 22595-3

PROJECT: PROPOSED LAGOON EXPANSION

LOCATION: SW 21-40-10-W3M, RADISSON, SK

NORTHING (m): 5813798 **EASTING (m):** 337436 **ELEVATION (m):** 523.9 **DATE DRILLED:** MAY 16/25

SAMPLE TYPE: ☐ CUTTINGS ☒ SPLIT SPOON ■ SHELBY TUBE

WATER LEVELS
▼ After Drilling
▽ During Drilling

DEPTH (m)	STRATIGRAPHY	DESCRIPTION	SAMPLE TYPE	SPT (N) BLOWS/300 mm	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNIT WEIGHT (kN/m³)	COMPRESSIVE STRENGTH (kPa)	POCKET PEN. (kg/cm²)	DEPTH (m)
0		TOPSOIL, organic, moist, black, rootlets.									0
		FILL, clay, silty, firm, medium plastic, moist to wet, brown.			24.9					0.5	
1		mottled brown and dark brown below 0.6 m.			33.5	37	17				1
		frozen 0.7 to 1.2 m.									
		brown below 1.3 m.			24.3					0.25	
2		mottled grey with traces of black below 1.8 m.			26.5					1.75	2
		stiff below 1.9 m.									
		stiff to very stiff below 2.4 m.									
3		greyish brown below 2.9 m.			26.3					2.0	3
					26.2					2.25	
4		SILT, some clay, soft to firm, medium plastic, wet, brown, seepage, sloughing.			41.4						4
		CLAY, silty, stiff, highly plastic, moist, brown.									
5		silt layer, wet, seepage, sloughing 5.4 to 6.0 m.									5
6					33.0						6
		GLACIAL TILL, clay, silty, some sand, trace gravel, firm to stiff, medium plastic, moist to wet, brown.									
7					22.3					0.5	7
		stiff below 7.8 m.									
8											8
9					14.2					1.25	9
10											10
11											11
12											12

NOTES:
1. Borehole sloughed to 6.5 m with water level at 4.5 m Immediately After Drilling.

P.MACHIBRODA ENGINEERING LTD.

BOREHOLE 25-3

DRAWING NUMBER: 22595-4

PROJECT: PROPOSED LAGOON EXPANSION

LOCATION: SW 21-40-10-W3M, RADISSON, SK

NORTHING (m): 5813736 **EASTING (m):** 337382 **ELEVATION (m):** 523.8 **DATE DRILLED:** MAY 16/25

SAMPLE TYPE: CUTTINGS SPLIT SPOON SHELBY TUBE

WATER LEVELS
After Drilling
During Drilling

DEPTH (m)	STRATIGRAPHY	DESCRIPTION	SAMPLE TYPE	SPT (N) BLOWS/300 mm	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNIT WEIGHT (kN/m³)	COMPRESSIVE STRENGTH (kPa)	POCKET PEN. (kg/cm²)	DEPTH (m)
0		TOPSOIL, organic, moist, black, rootlets.									0
		FILL, clay, silty, trace sand, firm, medium plastic, moist to wet, brown.			18.2						
1		FILL, silt, sandy, trace clay, soft to firm, low plastic, wet, brown, seepage, sloughing.			22.4	29	14				1
					26.6						
2		some clay, trace sand, medium plastic, moist, mottled black and grey below 1.6 m.			20.4						2
		CLAY, some silt, stiff, highly plastic, moist, brown, oxide stained. very stiff below 3.2 m.			23.3					1.75	
3											3
4					27.5	58	19			2.5	4
5											5
6		silt seam, firm, moist to wet 5.5 to 6.0 m. silty, firm to stiff below 6.0 m.			32.7					0.25	6
7					33.9					0.5	7
8		GLACIAL TILL, clay, silty, some sand, trace gravel, stiff, medium plastic, moist, brown.									8
9					24.6					1.25	9
10											10
11											11
12											12

NOTES:
1. Borehole sloughed to 1.9 m with water level at 1.9 m Immediately After Drilling.

P.MACHIBRODA ENGINEERING LTD.

BOREHOLE 25-4

DRAWING NUMBER: 22595-5

PROJECT: PROPOSED LAGOON EXPANSION

LOCATION: SW 21-40-10-W3M, RADISSON, SK

NORTHING (m): 5813739 **EASTING (m):** 337291 **ELEVATION (m):** 523.8 **DATE DRILLED:** MAY 16/25

SAMPLE TYPE: CUTTINGS SPLIT SPOON SHELBY TUBE

WATER LEVELS
After Drilling
During Drilling

DEPTH (m)	DESCRIPTION	SAMPLE TYPE	SPT (N) BLOWS/300 mm	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNIT WEIGHT (kN/m³)	COMPRESSIVE STRENGTH (kPa)	POCKET PEN. (kg/cm²)
0	TOPSOIL, organic, moist, black, rootlets.								
0.3	FILL, silt, some sand, trace clay, firm, low to medium plastic, moist to wet, brown.			21.2					0.25
1	some clay, trace sand below 0.7 m.			25.1	33	14			0.5
1.2	clayey, medium plastic below 1.2 m.			24.5					0.25
2	SAND, silty, trace clay, loose, poorly graded, fine grained, wet, grey.			22.3					
2.4	SILT, clayey, trace sand, firm to stiff, medium plastic, moist, grey.			22.8					1.0
3	CLAY, some silt, stiff, highly plastic, moist, brown.								
4				25.4					1.75
5									
5.6	silt seam, moist to wet 5.6 to 6.1 m.			28.8					
6									
7									
7.4	silt lense, wet, seepage, sloughing 7.4 to 7.5 m.			28.8					1.25
8									
8.4	GLACIAL TILL, clay, silty, some sand, trace gravel, stiff, medium plastic, moist, brown.			16.9					1.5
9									
10									
11									
12									

NOTES:
1. Borehole sloughed to 3.5 m with water level at 2.4 m Immediately After Drilling.

P.MACHIBRODA ENGINEERING LTD.

BOREHOLE 25-5

DRAWING NUMBER: 22595-6

PROJECT: PROPOSED LAGOON EXPANSION

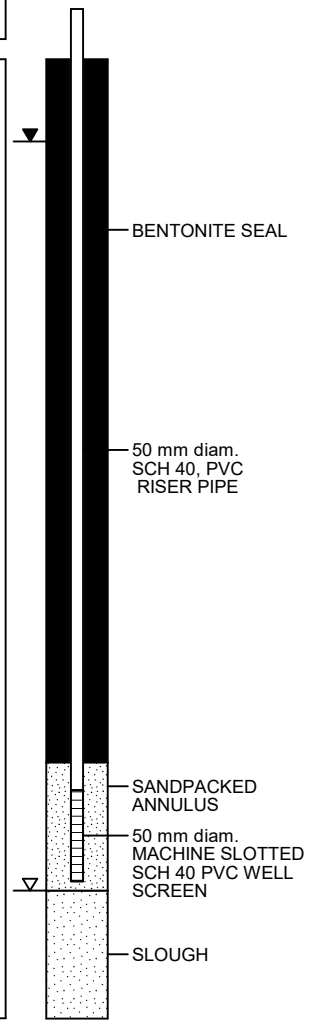
LOCATION: SW 21-40-10 W3M, RADISSON, SK

NORTHING (m): 5813762 **EASTING (m):** 337538 **ELEVATION (m):** 521.2 **DATE DRILLED:** MAY 16/25

SAMPLE TYPE: CUTTINGS SPLIT SPOON SHELBY TUBE

WATER LEVELS
After Drilling
During Drilling

DEPTH (m)	DESCRIPTION	SAMPLE TYPE	SPT (N) BLOWS/ 300 mm	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNIT WEIGHT (kN/m³)	% FINES	POCKET PEN. (kg/cm²)
0	CLAY, some silt, firm to stiff, medium to highly plastic, moist, brown.			30.1	49	17			0.5
1				32.5					0.5
1	SILT, some clay, trace sand, soft, medium plastic, moist to wet, brown, trace seepage, trace sloughing.			35.5	41	18			
2				34.9					1.75
2	CLAY, some silt, stiff, highly plastic, moist, brown.								
3				39.6					1.75
3	silty, firm below 3.2 m.								
3	silt seam, wet, seepage, sloughing 3.5 to 3.9 m.								
4									
4				35.5					1.75
5	GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown, oxide stained.								
6				20.5					1.75
6	very stiff below 6.8 m.								
7				15.2					3.75
8									
8	sand layer, wet, seepage, sloughing 8.5 to 9.3 m.								
9				19.4					
9	hard below 9.3 m.								
10				13.6					4.5
11									
12									



NOTES:
1. Borehole sloughed to 9.1 m with water level at 9.1 m Immediately After Drilling.
2. Monitoring well water level is 0.9 m below existing grade on June 25, 2025.

P.MACHIBRODA ENGINEERING LTD.

BOREHOLE 25-5A

DRAWING NUMBER: 22595-7

PROJECT: PROPOSED LAGOON EXPANSION

LOCATION: SW 21-40-10 W3M, RADISSON, SK

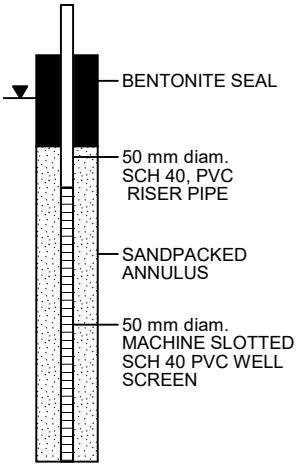
NORTHING (m): 5813763 **EASTING (m):** 337537 **ELEVATION (m):** 521.2 **DATE DRILLED:** MAY 16/25

SAMPLE TYPE: ☐ CUTTINGS ☒ SPLIT SPOON ■ SHELBY TUBE

WATER LEVELS
▼ After Drilling
▽ During Drilling

DEPTH (m)	STRATIGRAPHY	DESCRIPTION	SAMPLE TYPE	SPT (N) BLOWS/ 300 mm	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNIT WEIGHT (kN/m³)	% FINES	POCKET PEN. (kg/cm²)
0		CLAY, some silt, firm to stiff, highly plastic, moist, brown.								
1		SILT, some clay, trace sand, soft, medium plastic, moist to wet, brown, trace seepage, trace sloughing.								
2		CLAY, some silt, stiff, highly plastic, moist, brown.								
3		silty, firm below 3.2 m.								
4		silt seam, wet, seepage, sloughing 3.5 to 3.9 m.								

MONITORING WELL: BH25-5A
ELEV.: 522.1 m

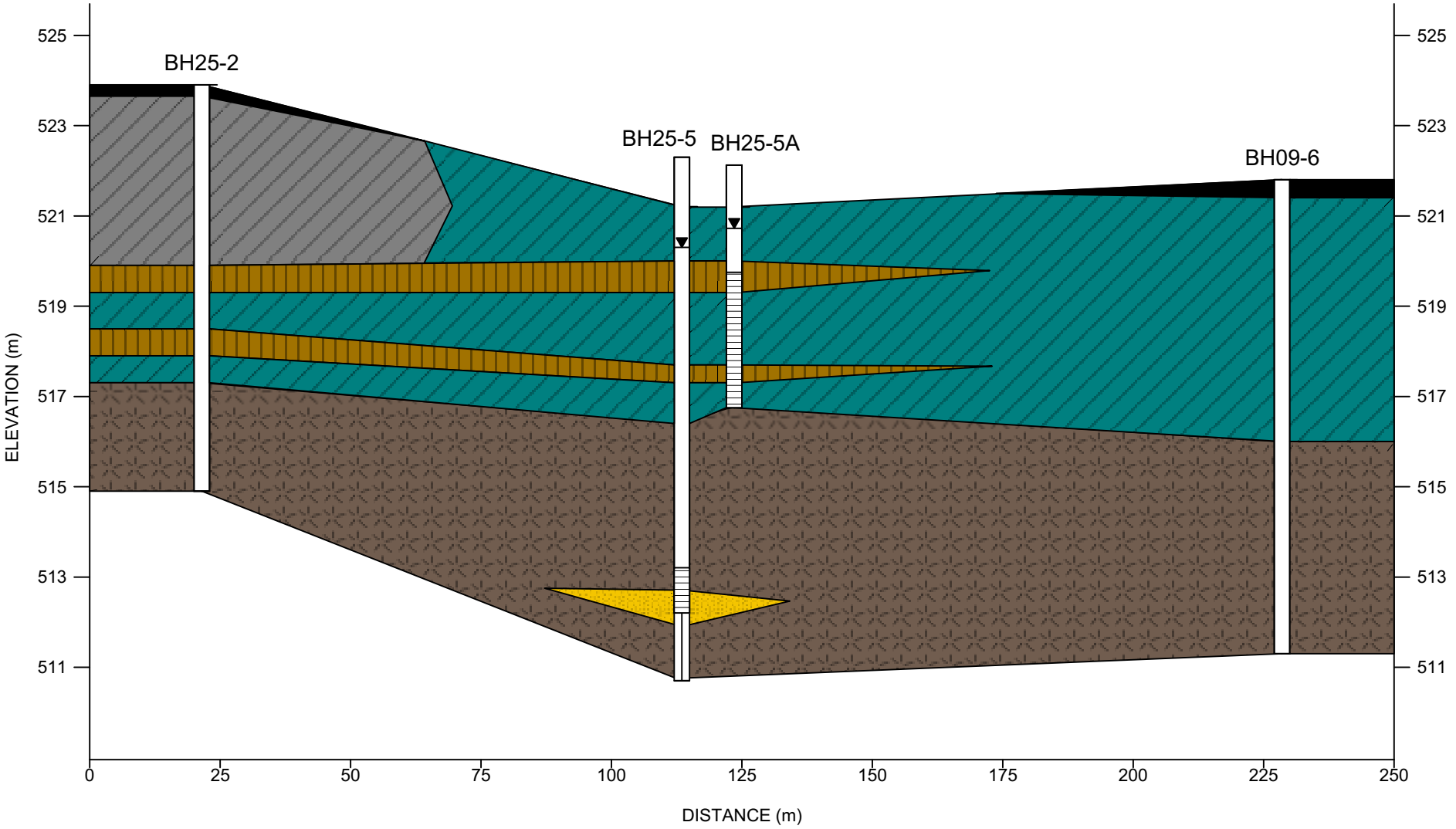


DEPTH (m)

NOTES:
1. Borehole open with trace water Immediately After Drilling.
2. Monitoring well water level is 0.4 m below existing grade on June 25, 2025.

SHEET 1 OF 1

08-13-2025 Y:\2025 Projects\22595 - Radisson Lagoon\Drafting\Dwg\BH5A-22595.bor



CONSULTING GEOENVIRONMENTAL GEOTECHNICAL ENGINEERS

806 - 48th Street East,
Saskatoon, SK, S7Y 3Y4

P.MACHIBRODA ENGINEERING LTD.

DRAWING NUMBER: 22595-8

APPROVED BY: GB
DRAWN BY: TP
SCALE: AS SHOWN
DATE: AUGUST, 2025

LEGEND

- TOPSOIL
- CLAY
- SILT
- SAND
- FILL, CLAY
- GLACIAL TILL

DRAWING TITLE:
STRATIGRAPHIC SECTION
A-A'

PROJECT:
PROPOSED LAGOON EXPANSION
SW 21-40-10-W3M, RADISSON, SK

08-07-2025 Y:\2025 Projects\22595 - Radisson Lagoon\Drafting\Dwg\STRAT A-A.cro

APPENDIX A

Explanation of Terms on
Borehole Logs

CLASSIFICATION OF SOILS

Coarse-Grained Soils: Soils containing particles that are visible to the naked eye. They include gravels and sands and are generally referred to as cohesionless or non-cohesive soils. Coarse-grained soils are soils having more than 50 percent of the dry weight larger than particle size 0.080 mm.

Fine-Grained Soils: Soils containing particles that are not visible to the naked eye. They include silts and clays. Fine-grained soils are soils having more than 50 percent of the dry weight smaller than particle size 0.080 mm.

Organic Soils: Soils containing a high natural organic content.

Soil Classification By Particle Size

Soil Type	Particles of Size
Clay	< 0.002 mm
Silt	0.002 – 0.060 mm
Sand	0.06 – 2.0 mm
Gravel	2.0 – 60 mm
Cobbles	60 – 200 mm
Boulders	>200 mm

TERMS DESCRIBING CONSISTENCY OR CONDITION

Coarse-grained soils: Described in terms of compactness condition and are often interpreted from the results of a Standard Penetration Test (SPT). The standard penetration test is described as the number of blows, N, required to drive a 51 mm outside diameter (O.D.) split barrel sampler into the soil a distance of 0.3 m (from 0.15 m to 0.45 m) with a 63.5 kg weight having a free fall of 0.76 m.

Compactness Condition	SPT N-Index (blows per 0.3 m)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	Over 50

Fine-Grained Soils: Classified in relation to undrained shear strength.

Consistency	Undrained Shear Strength (kPa)	N Value (Approximate)	Field Identification
Very Soft	<12	0-2	Easily penetrated several centimetres by the fist.
Soft	12-25	2-4	Easily penetrated several centimetres by the thumb.
Firm	25-50	4-8	Can be penetrated several centimetres by the thumb with moderate effort.
Stiff	50-100	8-15	Readily indented by the thumb, but penetrated only with great effort.
Very Stiff	100-200	15-30	Readily indented by the thumb nail.
Hard	>200	>30	Indented with difficulty by the thumbnail.

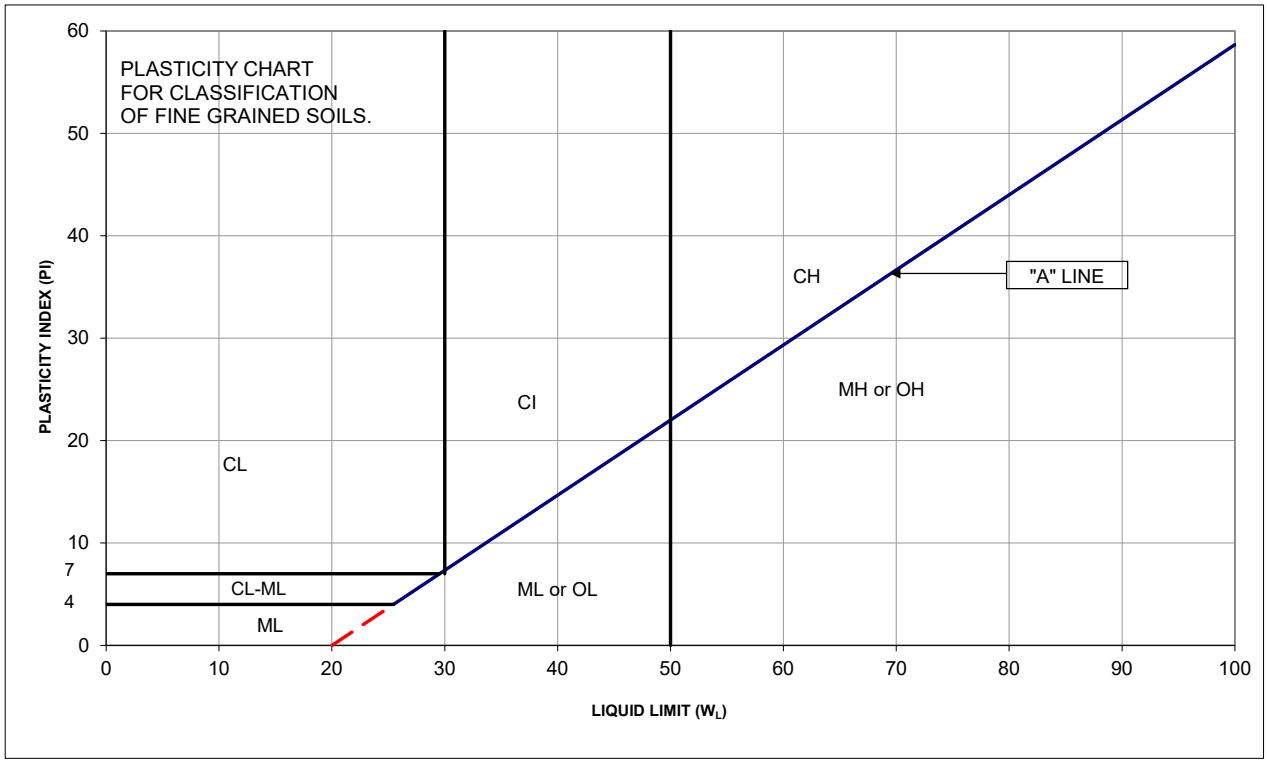
Organic Soils: Readily identified by colour, odour, spongy feel and frequently by fibrous texture.

DESCRIPTIVE TERMS COMMONLY USED TO CHARACTERIZE SOILS

Poorly Graded - predominance of particles of one grain size.
Well Graded - having no excess of particles in any size range with no intermediate sizes lacking.
Mottled - marked with different coloured spots.
Nuggety - structure consisting of small prismatic cubes.
Laminated - structure consisting of thin layers of varying colour and texture.
Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks.
Fractured - broken by randomly oriented interconnecting cracks in all 3 dimensions

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR AND OFTEN FIBROUS TEXTURE
COARSE-GRAINED SOILS(MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS More than half coarse fraction larger than No. 4 sieve size	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 4 \quad C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1 \text{ to } 3$
			GP	POORLY-GRADED GRAVELS AND GRAVEL-SAND MIXTURES <5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS FOR GW
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR PI < 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH PI > 7
	SANDS More than half coarse fraction smaller than No. 4 sieve size	CLEAN SANDS	SW	WELL-GRADED SANDS, GRAVELLY SANDS MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 6 \quad C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1 \text{ to } 3$
			SP	POORLY-GRADED SANDS OR GRAVELLY SANDS <5% FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR SW
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR PI < 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH PI >7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSING NO. 200 SIEVE SIZE)	SILTS Below "A" line on plasticity chart; negligible organic content		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$
	CLAYS Above 'A" line on plasticity chart; negligible organic content		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	$W_L > 30 < 50$
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$
	ORGANIC SILTS & ORGANIC CLAYS Below "A" line on plasticity chart		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$
			OH	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$

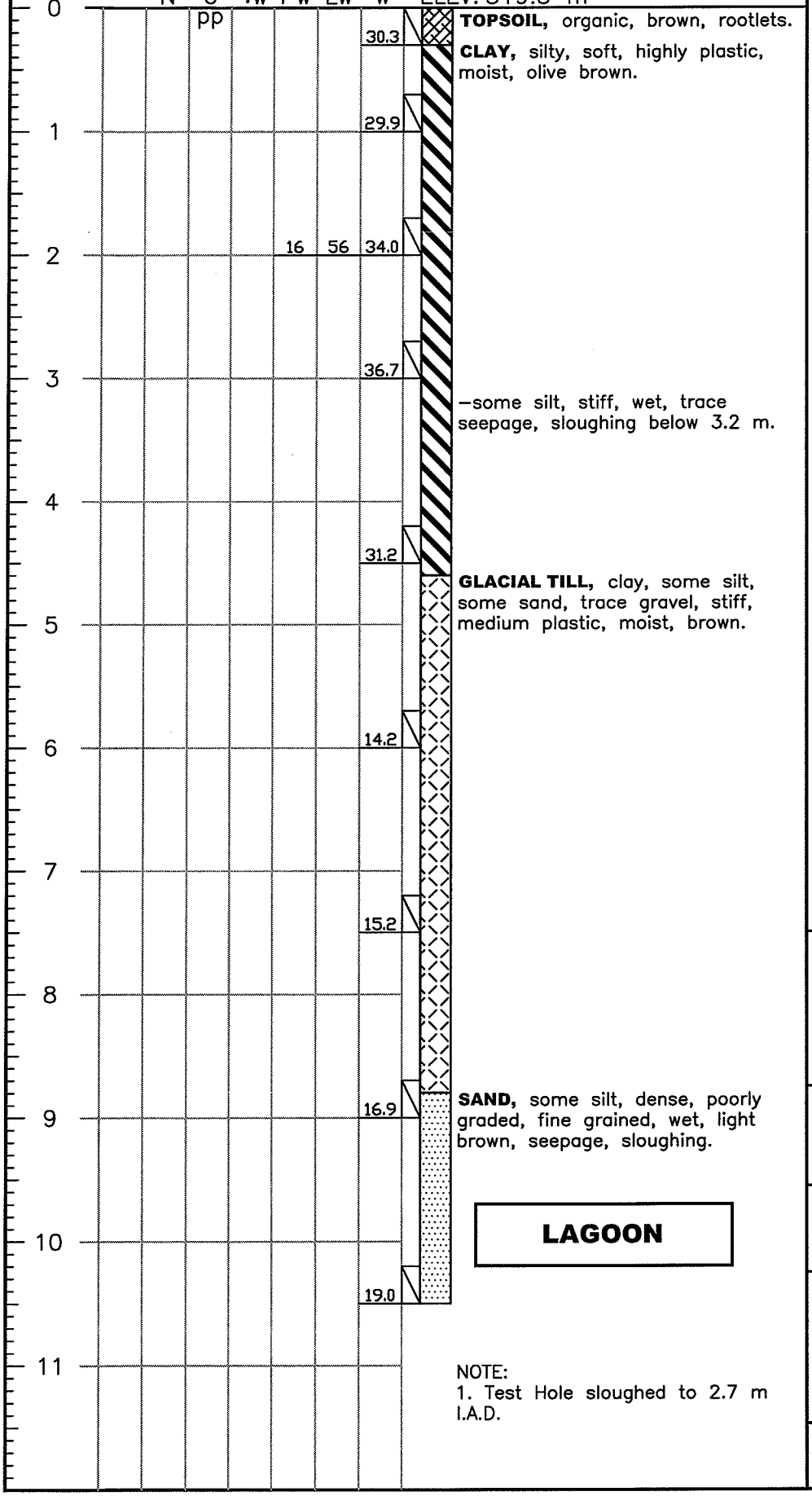


P.MACHIBRODA ENGINEERING LTD.

APPENDIX B

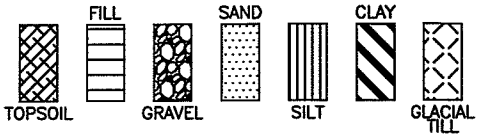
PMEL Report No. S09-6987
Test Hole Logs

TEST HOLE 09-1



NOTE:
1. Test Hole sloughed to 2.7 m I.A.D.

LEGEND:



w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (ROPE–CATHEAD & DONUT HAMMER) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:

SEWAGE LAGOON EXPANSION

LOCATION:

RADISSON, SK

NORTHING: **EASTING:**

DATE DRILLED:	**DRAWING NUMBER:**
SEPT 17/09	S09-6987-2

PIEZO. ELEV.= 520.4 m

TEST HOLE 09-2

ELEV: 519.4 m

DEPTH (m)	N	U	γ_w	Pw	Lw	w	
0				pp			99.6 m OCT 21/09
						37.8	**TOPSOIL,** organic, brown, rootlets.
							BENTONITE SEAL
							CLAY, silty, soft, medium plastic, very moist, brown.
						29.1	
1							–firm, moist, mottled brown/grey, oxide stained below 1.0 m.
							50 mm diam. SCH 40, PVC RISER PIPE
							–some silt, highly plastic, stiff, brown below 1.6 m.
							CUTTINGS
2						36.4	
							–silty, medium plastic, firm below 2.3 m.
							SAND PACKED ANNULUS
3	18	43				36.1	
							50 mm diam. MACHINE SLOTTED SCH 40 PVC WELL SCREEN
							–some silt, firm to stiff below 3.5 m.
4							SLOUGH
						32.2	
5							
6							
7							
8							
9							
10							
11							

NOTE:
1. Test Hole sloughed to 3.0 m I.A.D.

LAGOON

LEGEND:

FILL, SAND, CLAY

TOPSOIL, GRAVEL, SILT, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (ROPE–CATHEAD & DONUT HAMMER) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE, SPLIT SPOON, CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:

SEWAGE LAGOON EXPANSION

LOCATION:

RADISSON, SK

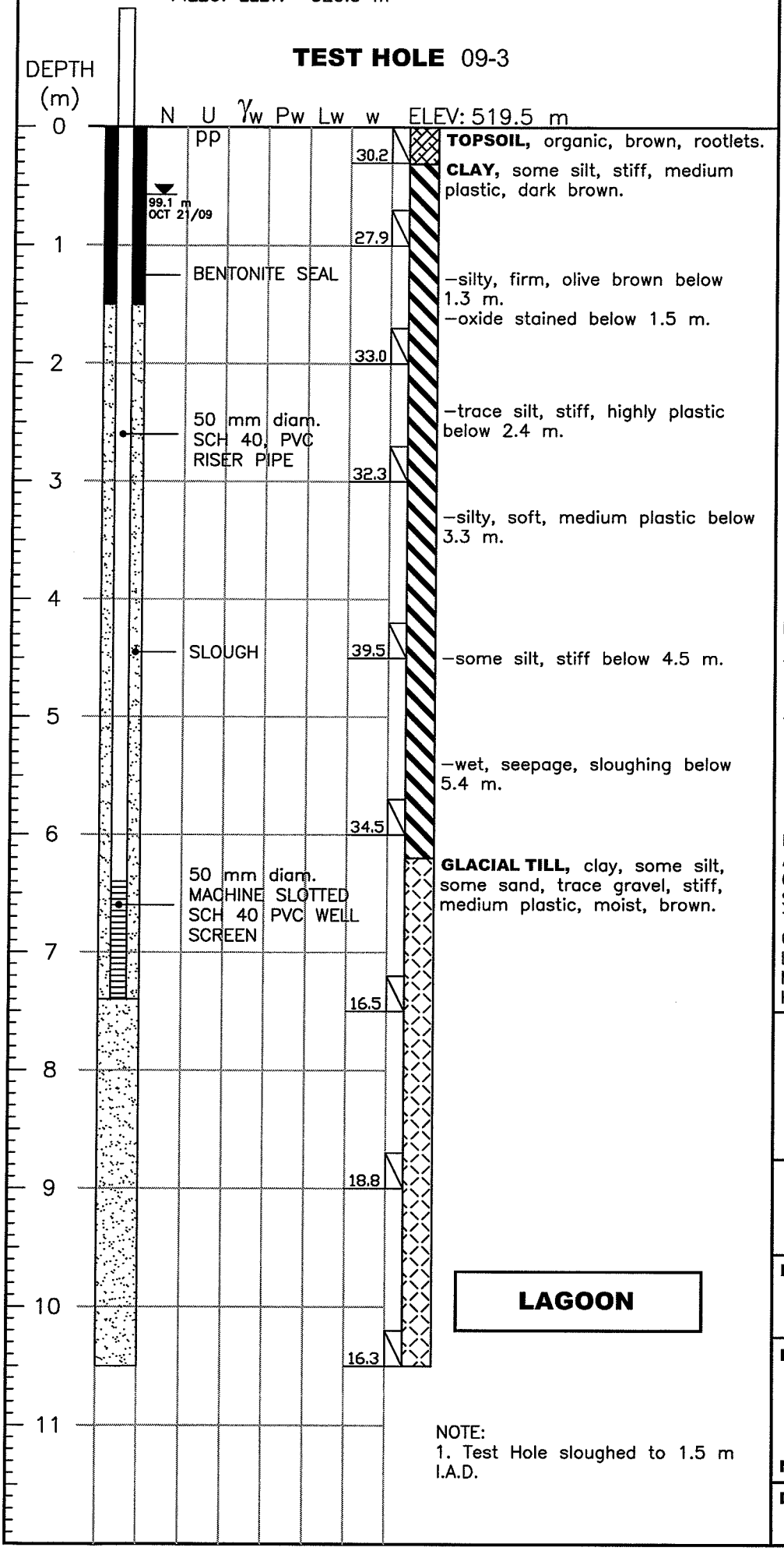
NORTHING: **EASTING:**

DATE DRILLED:	**DRAWING NUMBER:**
JULY 29/09	S09-6987-3

PIEZO. ELEV.= 520.5 m

TEST HOLE 09-3

DEPTH (m) | N | U | γ_w | Pw | Lw | w | ELEV: 519.5 m



TOPSOIL, organic, brown, rootlets.

CLAY, some silt, stiff, medium plastic, dark brown.

–silty, firm, olive brown below 1.3 m.
–oxide stained below 1.5 m.

–trace silt, stiff, highly plastic below 2.4 m.

–silty, soft, medium plastic below 3.3 m.

–some silt, stiff below 4.5 m.

–wet, seepage, sloughing below 5.4 m.

GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown.

LAGOON

NOTE:
1. Test Hole sloughed to 1.5 m I.A.D.

LEGEND:

FILL, SAND, CLAY
TOPSOIL, GRAVEL, SILT, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (ROPE–CATHEAD & DONUT HAMMER) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE, SPLIT SPOON, CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

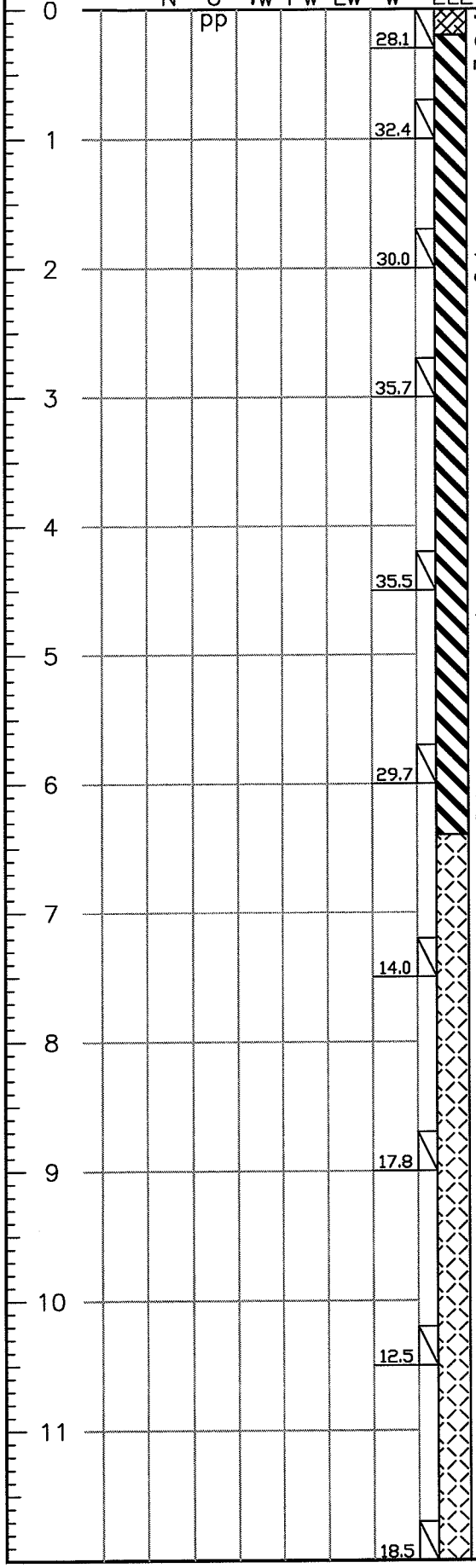
PROJECT:
SEWAGE LAGOON EXPANSION

LOCATION:
RADISSON, SK

NORTHING: **EASTING:**

DATE DRILLED:	**DRAWING NUMBER:**
SEPT 17/09	S09-6987-4

TEST HOLE 09-4



TOPSOIL, organic, brown, rootlets.
CLAY, silty, firm, medium plastic, moist, olive brown.

–trace silt, stiff, highly plastic, gypsum crystals below 1.9 m.

–some silt, firm below 4.7 m.

–wet, seepage, sloughing below 6.1 m.

GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown, oxide stained.

–grey below 8.2 m.

LAGOON

NOTE:
1. Test Hole sloughed to 3.2 m I.A.D.

LEGEND:

FILL, SAND, CLAY, TOPSOIL, GRAVEL, SILT, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (ROPE–CATHEAD & DONUT HAMMER) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE, SPLIT SPOON, CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
SEWAGE LAGOON EXPANSION

LOCATION:
RADISSON, SK

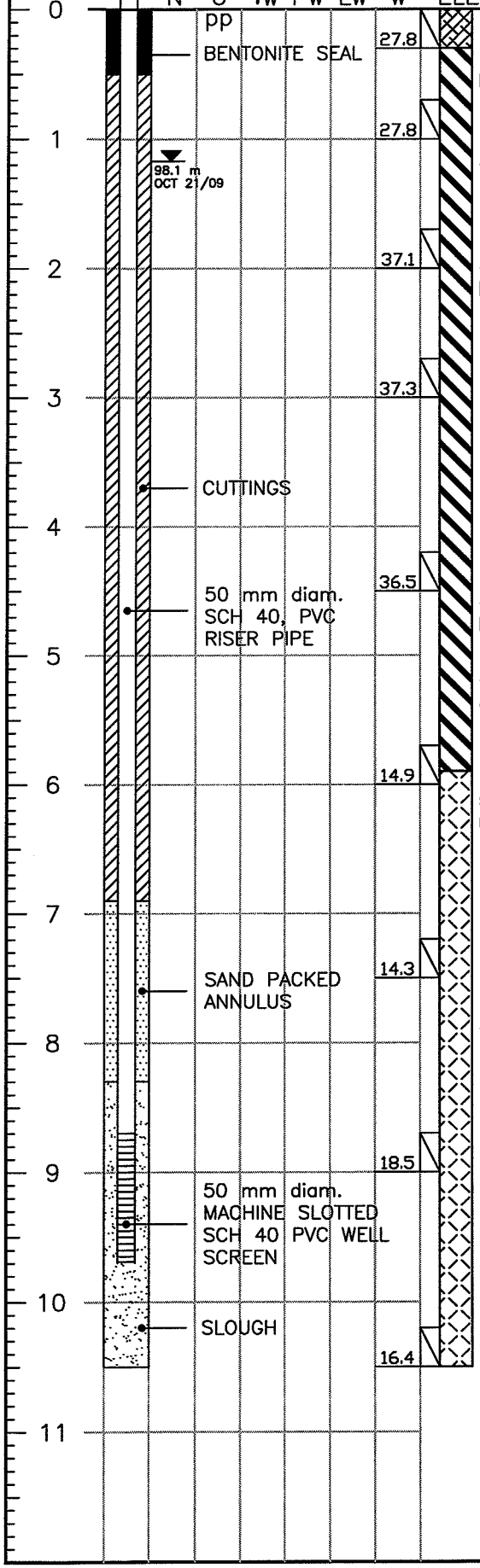
NORTHING: **EASTING:**

DATE DRILLED:	**DRAWING NUMBER:**
SEPT 17/09	S09-6987-5

PIEZO. ELEV.= 520.1 m

TEST HOLE 09-5

ELEV: 519.1 m



TOPSOIL, organic, brown, rootlets.

CLAY, some silt, stiff, medium plastic, moist, olive brown.

–silty, firm below 1.2 m.

–trace silt, stiff, highly plastic below 2.0 m.

–some silt, firm, medium plastic below 4.6 m.

–wet, seepage, sloughing below 5.2 m.

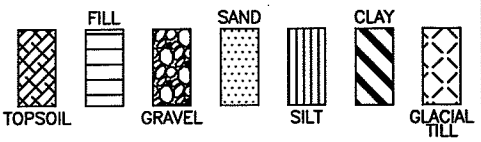
GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown.

–grey below 7.9 m.

LAGOON

NOTE:
1. Test Hole sloughed to 8.3 m I.A.D.

LEGEND:



w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (ROPE–CATHEAD & DONUT HAMMER) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:

SEWAGE LAGOON EXPANSION

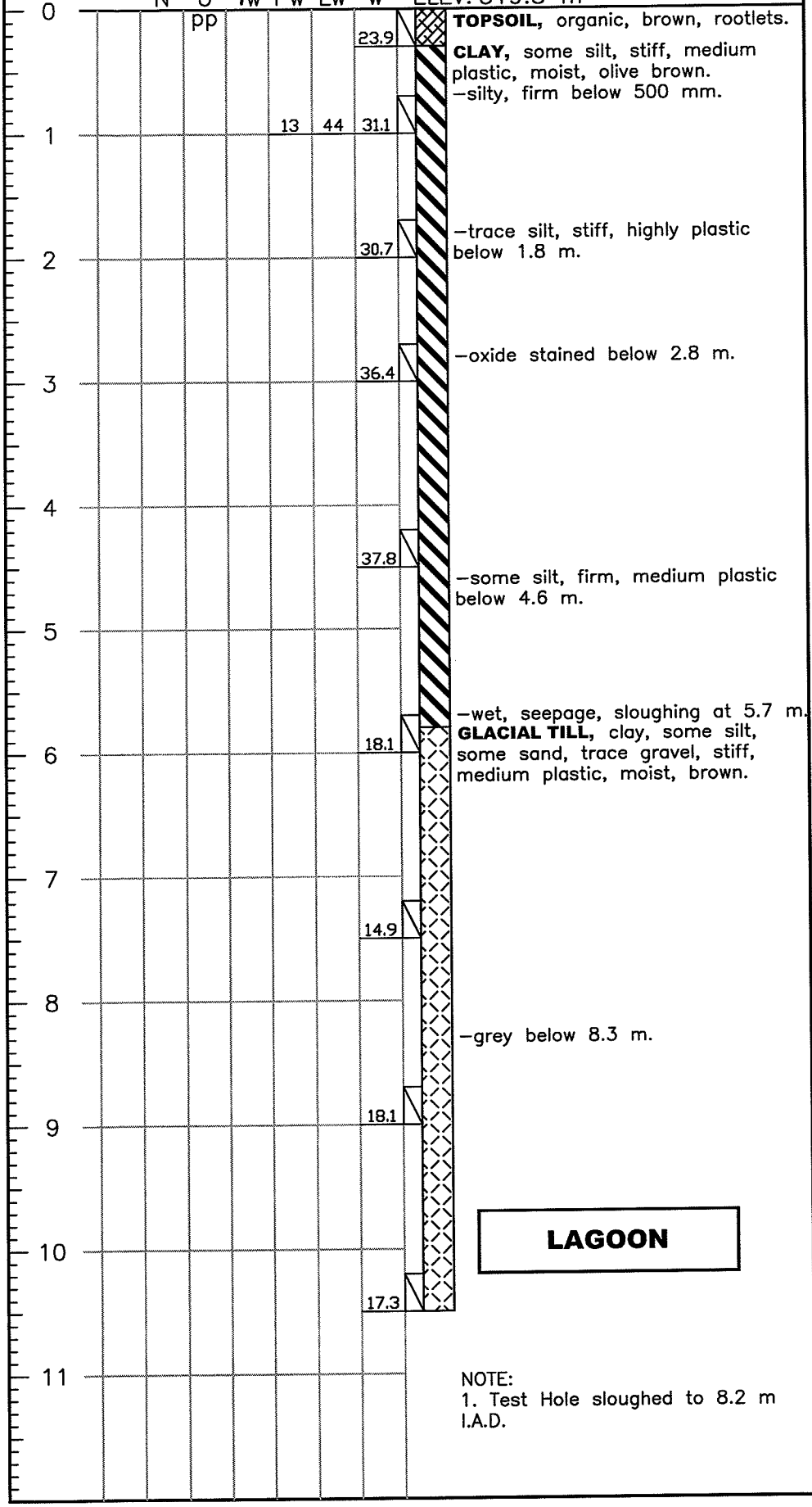
LOCATION:

RADISSON, SK

NORTHING: **EASTING:**

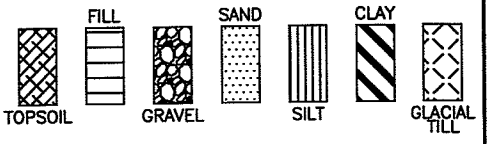
DATE DRILLED:	**DRAWING NUMBER:**
SEPT 17/09	S09-6987-6

TEST HOLE 09-6



NOTE:
1. Test Hole sloughed to 8.2 m I.A.D.

LEGEND:



w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (ROPE–CATHEAD & DONUT HAMMER) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4.....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT:
SEWAGE LAGOON EXPANSION

LOCATION:
RADISSON, SK

NORTHING: **EASTING:**

DATE DRILLED:	**DRAWING NUMBER:**
SEPT 17/09	S09-6987-7

APPENDIX C

Photographs

PHOTOGRAPH NO. 22595-01:
Looking west along toe of south dyke from access road located near the southeast corner of existing lagoon. Brighter green areas on dyke exterior sideslope (circled in yellow) may be an indication of seepage through dyke (May 15, 2025).

PHOTOGRAPH NO. 22595-02:
Looking west along top of south dyke from southeast corner of existing lagoon. (May 15, 2025)

PHOTOGRAPH NO. 22595-03:
Looking east across proposed lagoon expansion area, from east side of existing lagoon. Appearance of salt staining just off toe east dyke of existing lagoon (between yellow lines). (May 15, 2025)

PHOTOGRAPH NO. 22595-04:
Looking east across proposed lagoon expansion area from southeast corner of existing lagoon. Salt staining does not appear to be present along toe of east dyke. (June 25, 2025).

APPENDIX D

Water Well Records

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Glen** WWDR #: **35693**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer **10**

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **Unknown Client 031**
Completion Date **1947.09.01**
Hole #
Install Method **Unknown**
Borehole Depth (ft) **60**
Bit Dia (in) **0**
Water Level **25**
Flowing Head **0**
Water Use **Domestic**
Well Use **Withdrawal**
Completion Method **Curbed**
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
0	**0**	**0**	**Wood**

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
60	Sand & Gravel	Unknown	Clayey

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Hamilton** WWDR #: **35694**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **L. Funk**
Completion Date **1960.06.13**
Hole #
Install Method **Bored**
Borehole Depth (ft) **20**
Bit Dia (in) **36**
Water Level **7**
Flowing Head **0**
Water Use **Domestic**
Well Use **Withdrawal**
Completion Method **Curbed**
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
0	**20**	**36**	**Wood**

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
7	Clay	Black	Unknown
8	Sand	Unknown	Unknown
20	Clay	Yellow	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Agro Equipment** WWDR #: **35695**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **L. Funk**
Completion Date **1960.04.29**
Hole # **002**
Install Method **Bored**
Borehole Depth (ft) **60**
Bit Dia (in) **24**
Water Level **0**
Flowing Head **0**
Water Use **Domestic**
Well Use **Water Test Hole**
Completion Method
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
10	Sand	Unknown	Unknown
60	Clay	Unknown	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Swain** WWDR #: **35696**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **Heron Water Well Drilling Ltd.**
Completion Date **1960.06.30**
Hole #
Install Method **Drilled**
Borehole Depth (ft) **146**
Bit Dia (in) **4.5**
Water Level **20**
Flowing Head **0**
Water Use **Domestic**
Well Use **Withdrawal**
Completion Method **Open Hole**
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
0	**146**	**4.5**	**Steel**

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**15**	ft
Duration	**48**	hrs
Pumping Rate	**5**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
10	Gravel	Unknown	Unknown
60	Clay	Brown	Unknown
120	Clay	Blue	Unknown
146	Sand & Gravel	Unknown	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Radisson** WWDR #: **35697**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **Heron Water Well Drilling Ltd.**
Completion Date **1960.11.18**
Hole # **002**
Install Method **Unknown**
Borehole Depth (ft) **180**
Bit Dia (in) **0**
Water Level **0**
Flowing Head **0**
Water Use **Municipal**
Well Use **Water Test Hole**
Completion Method
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
3	Gravel	Unknown	Unknown
25	Gravelly Clay	Brown	Unknown
180	Clay	Yellow	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Radisson Motors** WWDR #: **35698**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **L. Funk**
Completion Date **1960.04.23**
Hole #
Install Method **Bored**
Borehole Depth (ft) **32**
Bit Dia (in) **30**
Water Level **0**
Flowing Head **0**
Water Use **Domestic**
Well Use **Withdrawal**
Completion Method **Curbed**
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
0	**32**	**30**	**Unknown**

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
10	Sand	Unknown	Unknown
22	Clay	Unknown	Unknown
32	Clay	Blue	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Stott** WWDR #: **35699**

Well Location

Land Location **20-40-10-3**
LSD
Reserve
RM:
NTS Map:
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
14 ft from N/S Boundary **S**
25 ft from E/W Boundary **E**

Major Basin:
SubBasin: **29**

Well Information

Driller **E. Caplette**
Completion Date **1961.11.03**
Hole #
Install Method **Bored**
Borehole Depth (ft) **36**
Bit Dia (in) **24**
Water Level **16**
Flowing Head **0**
Water Use **Domestic**
Well Use **Withdrawal**
Completion Method **Curbed**
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
0	**34**	**24**	**Wood**

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
2	Topsoil	Unknown	Unknown
17	Clay	Yellow	Unknown
22	Clay	Brown	Unknown
24	Gravel	Unknown	Unknown
34	Clay	Brown	Unknown
36	Gravel	Unknown	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Radisson** WWDR #: **35700**

Well Location

Land Location **NE-20-40-10-3**
LSD
Reserve
RM:
NTS Map: **73B06**
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **International Water Supply Ltd.**
Completion Date **1962.11.26**
Hole #
Install Method **Drilled**
Borehole Depth (ft) **500**
Bit Dia (in) **5**
Water Level **0**
Flowing Head **0**
Water Use **Municipal**
Well Use **Water Test Hole**
Completion Method
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

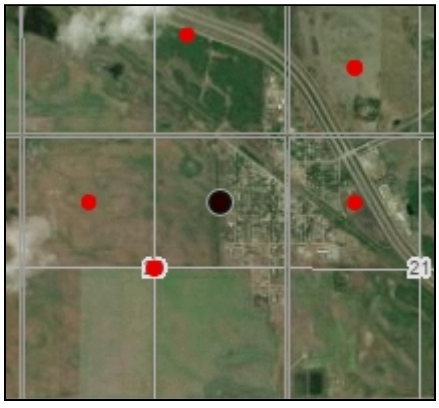
Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
2	Topsoil	Unknown	Unknown
17	Silty Clay	Brown	Unknown
22	Clay	Unknown	Stoney
37	Clay	Brown	Stoney
74	Clay	Grey	Sand-gravel Streaks
112	Clay	Grey	Boulders
114	Sand	Grey	Silty
156	Clay	Grey	Hard
225	Clay	Grey	Hard
302	Clay	Unknown	Shale Streaks
365	Shale	Unknown	Clayey
375	Shale	Unknown	Stoney
397	Shale	Unknown	Sandy
500	Shale	Unknown	Hard



Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Racine** WWDR #: **35701**

Well Location

Land Location **NE-20-40-10-3**
LSD
Reserve
RM:
NTS Map: **73B06**
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
ft from N/S Boundary
ft from E/W Boundary
Major Basin:
SubBasin: **29**

Well Information

Driller **L. Funk**
Completion Date **1960.04.12**
Hole #
Install Method **Bored**
Borehole Depth (ft) **18**
Bit Dia (in) **30**
Water Level **14**
Flowing Head **0**
Water Use **Domestic**
Well Use **Withdrawal**
Completion Method **Curbed**
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
0	**18**	**30**	**Wood**

Well Screens

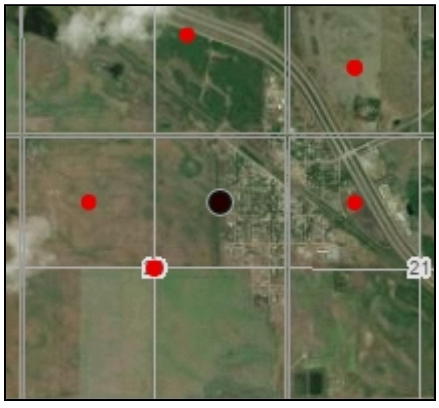
Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
8	Sand	Unknown	Unknown
18	Clay	Unknown	Unknown



Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Radisson** WWDR #: **35703**

Well Location

Land Location **NW-21-40-10-3**
LSD
Reserve
RM:
NTS Map: **73B06**
Elevation (ft) **1715**
Aquifer

Location of Well (in Quarter)
400 ft from N/S Boundary **S**
40 ft from E/W Boundary **E**
Major Basin:
SubBasin: **29**

Well Information

Driller **Heron Water Well Drilling Ltd.**
Completion Date **1960.11.17**
Hole # **001**
Install Method **Unknown**
Borehole Depth (ft) **250**
Bit Dia (in) **0**
Water Level **0**
Flowing Head **0**
Water Use **Municipal**
Well Use **Water Test Hole**
Completion Method
E-Log **None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
3	Topsoil	Unknown	Unknown
40	Clay	Brown	Unknown
110	Clay	Blue	Unknown
250	Sandy Clay	Blue	Unknown

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Kindt** WWDR #: **57217**

Well Location

Land Location	**NE-21-40-10-3**	Location of Well (in Quarter)	
LSD		ft from N/S Boundary	
Reserve		ft from E/W Boundary	
RM:	**405**		
NTS Map:	**73B06**	Major Basin:	
Elevation (ft)	**1700**	SubBasin:	**29**
Aquifer			

Well Information

Driller	**Tweidt Wellboring Servicing Ltd.**
Completion Date	**1979.03.15**
Hole #	
Install Method	**Bored**
Borehole Depth (ft)	**54**
Bit Dia (in)	**42**
Water Level	**0**
Flowing Head	**0**
Water Use	**Domestic**
Well Use	**Withdrawal**
Completion Method	**Curbed**
E-Log	**None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material
56	**54**	**30**	**Galvanized Iron**

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**1**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
1	Topsoil	Unknown	Unknown
5	Clay	Yellow	Unknown
13	Sandy Clay	Unknown	Dry
20	Sandy Clay	Unknown	Wet
42	Till	Unknown	Unknown
48	Clay	Unknown	Fractured
54	Clay	Blue	Stoney

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Kindt** WWDR #: **57372**

Well Location

Land Location	**NE-21-40-10-3**	Location of Well (in Quarter)	
LSD		ft from N/S Boundary	
Reserve		ft from E/W Boundary	
RM:	**405**		
NTS Map:	**73B06**	Major Basin:	
Elevation (ft)	**1700**	SubBasin:	**29**
Aquifer			

Well Information

Driller	**Elk Point Drilling Corp.**
Completion Date	**1978.10.07**
Hole #	
Install Method	**Drilled**
Borehole Depth (ft)	**202**
Bit Dia (in)	**4.7**
Water Level	**0**
Flowing Head	**0**
Water Use	**Domestic**
Well Use	**Water Test Hole**
Completion Method	
E-Log	**Recd**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
18	Clay	Brown	Soft
22	Clay	Brown	Soft
47	Till	Brown	Clayey
70	Till	Grey	Unknown
74	Till	Unknown	Unknown
93	Till	Grey	Unknown
95	Sand	Unknown	Unknown
186	Till	Grey	Unknown
202	Clay	Grey	Noncalcareous

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Saskatchewan Research Council** WWDR #: **231576**

Well Location

Land Location	**07-SE-21-40-10-3**	Location of Well (in Quarter)	
LSD	**07**	ft from N/S Boundary	
Reserve		ft from E/W Boundary	
RM:	**405**		
NTS Map:	**73B06**	Major Basin:	
Elevation (ft)	**1709**	SubBasin:	**29**
Aquifer			

Well Information

Driller	**Saskatchewan Ministry of Highways and In**
Completion Date	**1997.07.30**
Hole #	**00000010**
Install Method	
Borehole Depth (ft)	**360**
Bit Dia (in)	**0**
Water Level	**0**
Flowing Head	**0**
Water Use	
Well Use	
Completion Method	
E-Log	**None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

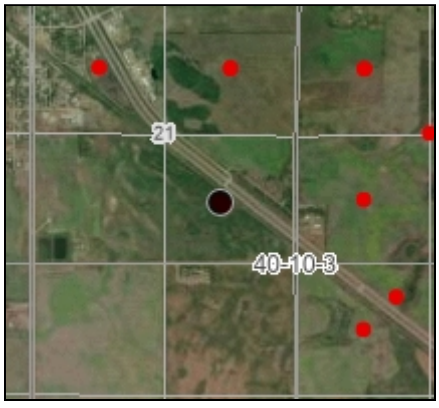
Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
7	Silt	Grey	Clayey
8	Sand	Grey	Fine-medium
13	Silt	Yellow	Calcareous
31	Till	Grey	Sandy
41	Till	Grey	Sandy
89	Till	Grey	Calcareous
98	Silt	Grey	Clayey
102	Sand	Grey	Silty
105	Silt	Grey	Clayey
110	Sand	Grey	Silty
112	Silt	Grey	Clayey
118	Sand	Grey	Silty
120	Silt	Grey	Noncalcareous
174	Till	Grey	Calcareous



266	Clay	Grey	Silty
272	Silt	Grey	Sandy
292	Clay	Grey	Silty
299	Silt	Grey	Sandy
308	Clay	Grey	Noncalcareous
312	Sand	Grey	Unknown
318	Silt	Grey	Sandy
322	Limestone	Unknown	Unknown
360	Clay	Grey	Silty

Water Well Driller's Report

6-Aug-2025
WSaskWWDR01

Well Name: **Saskatchewan Research Council** WWDR #: **231577**

Well Location

Land Location	**07-SE-21-40-10-3**	Location of Well (in Quarter)	
LSD	**07**	ft from N/S Boundary	
Reserve		ft from E/W Boundary	
RM:	**405**		
NTS Map:	**73B06**	Major Basin:	
Elevation (ft)	**1709**	SubBasin:	**29**
Aquifer			

Well Information

Driller	**Saskatchewan Ministry of Highways and In**
Completion Date	**1997.07.30**
Hole #	**0000010A**
Install Method	
Borehole Depth (ft)	**160**
Bit Dia (in)	**0**
Water Level	**0**
Flowing Head	**0**
Water Use	
Well Use	
Completion Method	
E-Log	**None**

Well Casings

Length (ft)	Btm (ft)	Dia (in)	Material

Well Screens

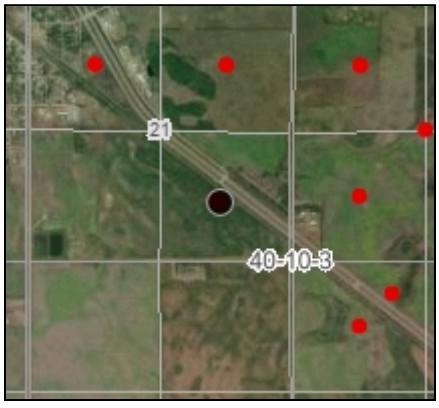
Length (ft)	Bottom (ft)	Dia (in)	Slot (in)	Material

Pump Test

Draw Down	**0**	ft
Duration	**0**	hrs
Pumping Rate	**0**	igpm
Temperature		deg. F
Rec. Pumping Rate	**0**	igpm

Lithology List

Depth (ft):	Material	Colour	Description
7	Sand	Grey	Fine
10	Silt	Grey	Calcareous
13	Clay	Brown	Silty
23	Clay	Brown	Silt
30	Silt	Grey	Unknown
41	Till	Grey	Sandy
43	Sand	Grey	Fine-medium
68	Till	Grey	Calcareous
88	Till	Grey	Firm
98	Till	Olive	Calcareous
136	Till	Grey	Calcareous
141	Sand	Grey	Medium-coarse
160	Till	Grey	Calcareous



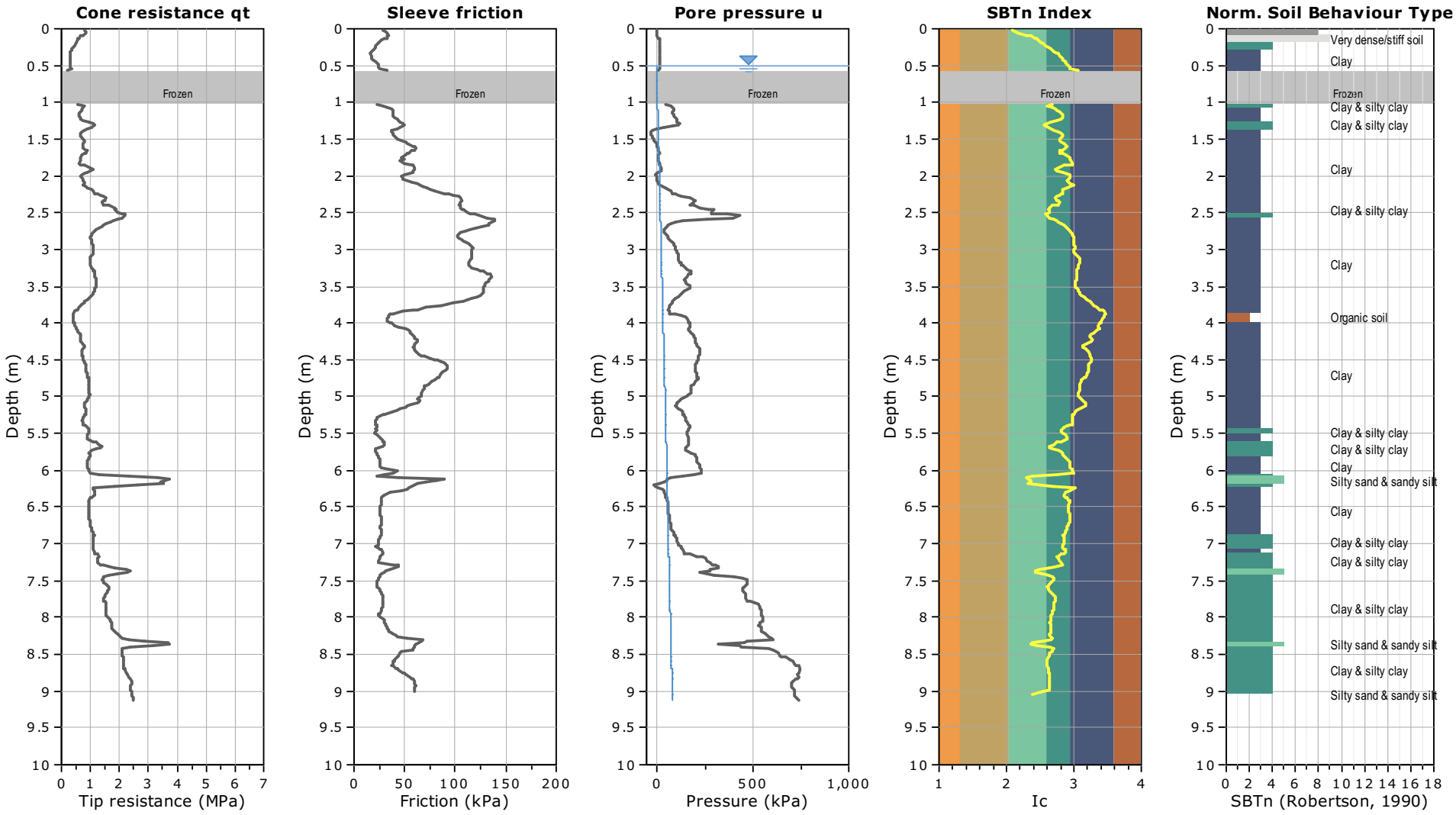
APPENDIX E

CPTu Plots

P.Machibroda Engineering Ltd.
806 - 48th Street East
Saskatoon, Saskatchewan
http://www.machibroda.com

CPTu: 25-2
Total depth: 9.12 m, Date: 2025-05-15
Surface Elevation: 523.90 m
Cone Type: 15 cm^2
Cone Operator: PMEL

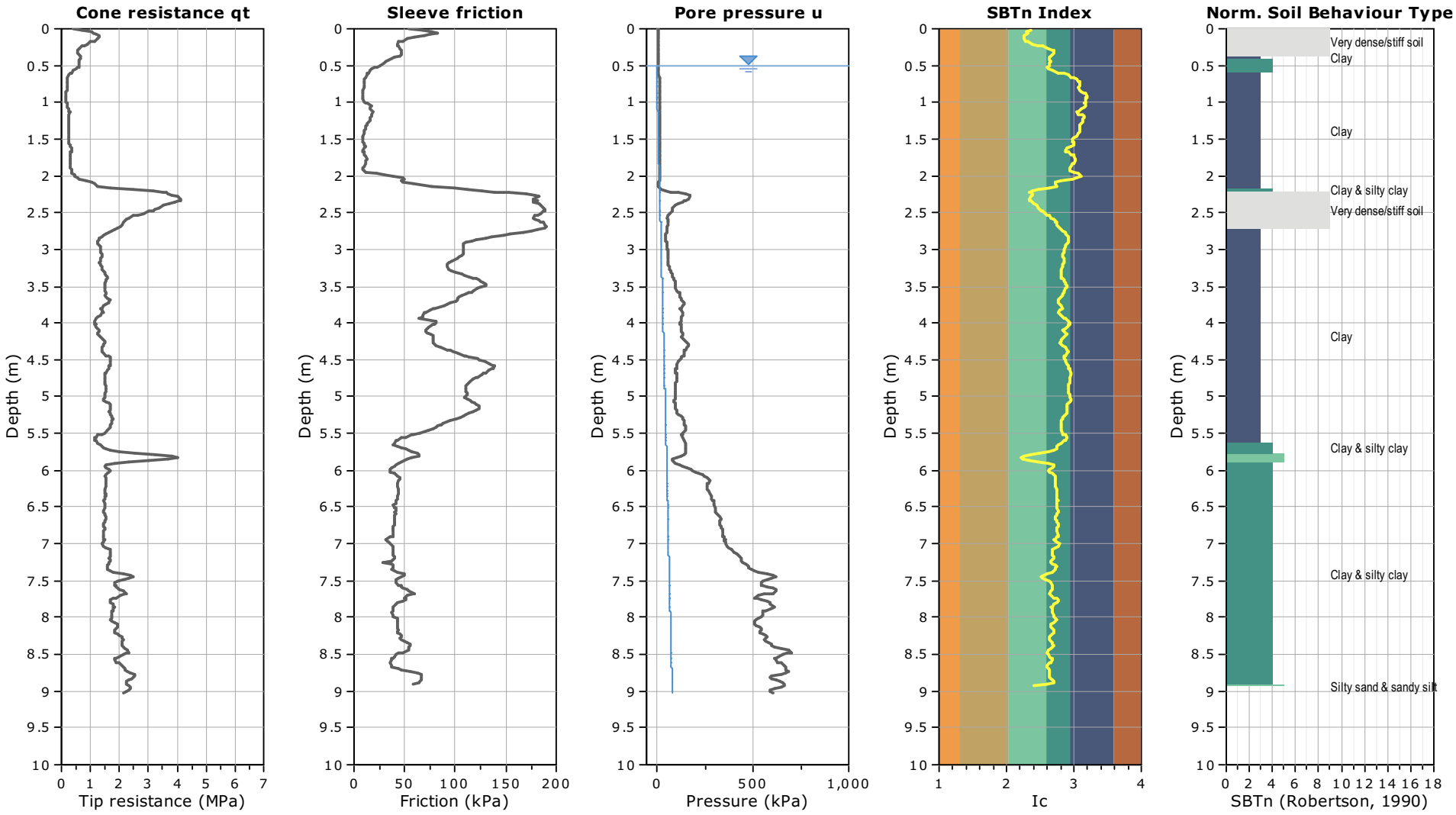
Project: **Proposed Lagoon Expansion**
Location: **SW 21-40-10 W3M, Radisson, SK**



P.MACHIBRODA ENGINEERING LTD.
P.Machibroda Engineering Ltd.
806 - 48th Street East
Saskatoon, Saskatchewan
http://www.machibroda.com

CPTu: 25-3
Total depth: 9.03 m, Date: 2025-05-15
Surface Elevation: 523.80 m
Cone Type: 15 cm^2
Cone Operator: PMEL

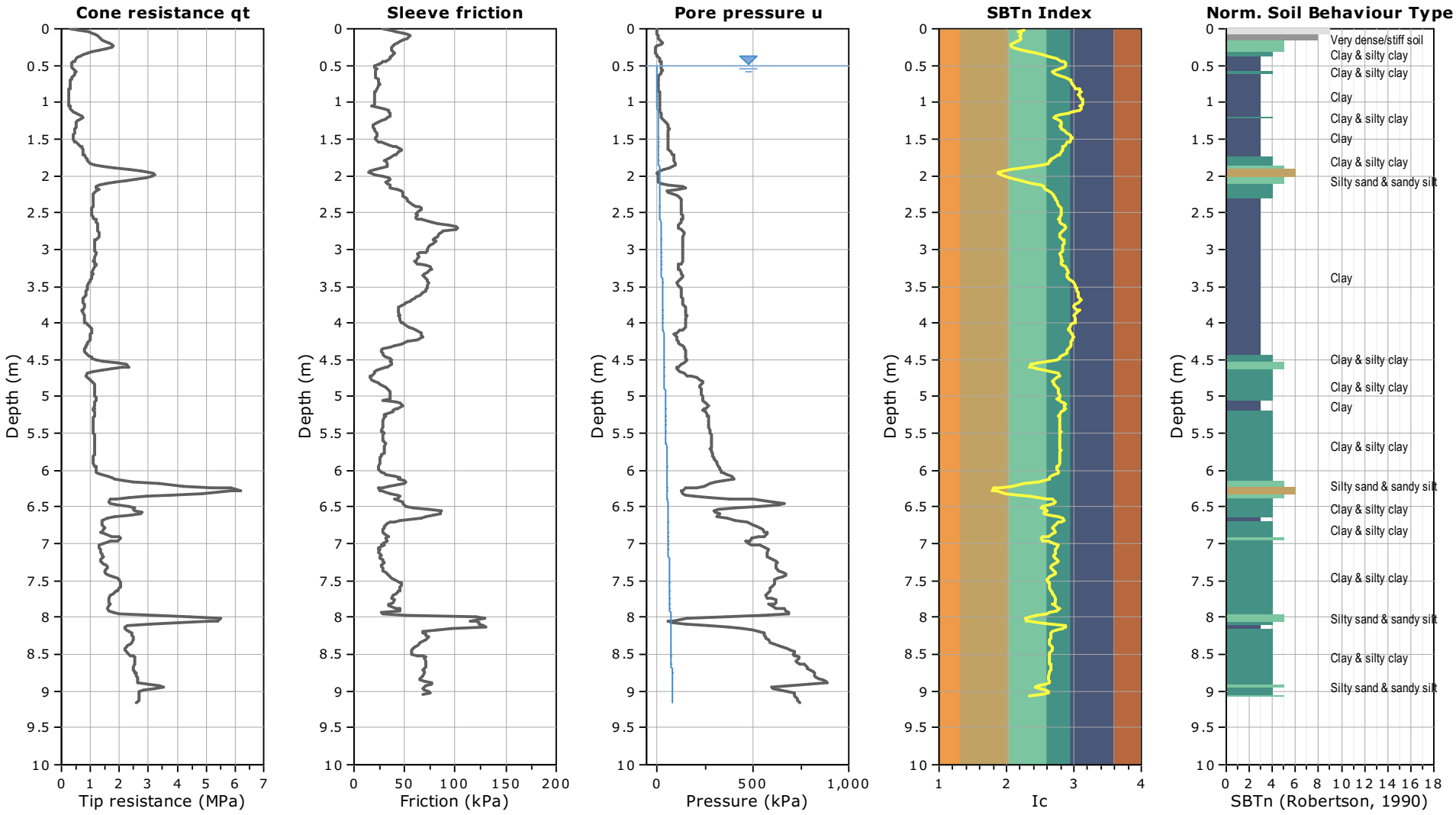
Project: **Proposed Lagoon Expansion**
Location: **SW 21-40-10 W3M, Radisson, SK**



P.MACHIBRODA ENGINEERING LTD.
P.Machibroda Engineering Ltd.
806 - 48th Street East
Saskatoon, Saskatchewan
http://www.machibroda.com

CPTu: 25-4
Total depth: 9.16 m, Date: 2025-05-15
Surface Elevation: 523.80 m
Cone Type: 15 cm^2
Cone Operator: PMEL

Project: **Proposed Lagoon Expansion**
Location: **SW 21-40-10 W3M, Radisson, SK**



APPENDIX F

Atterberg Limits &
Grain Size Analysis Results

ASTM D4318: LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX

P.MACHIBRODA ENGINEERING LTD.

806 48TH STREET EAST, SASKATOON, SK S7K 3Y4

PROJECT INFORMATION

PROJECT NUMBER:	**22595**
PROJECT NAME:	**Proposed Lagoon Expansion**
PROJECT LOCATION:	**SW-21-40-10-W3M, Radisson, Saskatchewan**
DATE:	**June 4, 2025**

SAMPLE INFORMATION

TEST HOLE: **25-2**

SAMPLE NUMBER: **20**

DEPTH: **1.0**

TESTING METHOD AND EQUIPMENT

METHOD OF PREPARATION: **Oven Dried**

METHOD OF REMOVING PARTICLES LARGER THAN THE 425-µm: **Sieve**

METHOD OF ROLLING: **Hand Rolled**

LIQUID LIMIT DEVICE: **Manual**

GROOVING TOOL: **Plastic**

TESTING METHOD: **Method A (Multipoint Liquid Limit)**

LABORATORY TEST RESULTS

LIQUID LIMIT

Test No.	1	2	3
Moisture Content (%)	35.7	37.7	38.4
No. of Blows	34	22	16

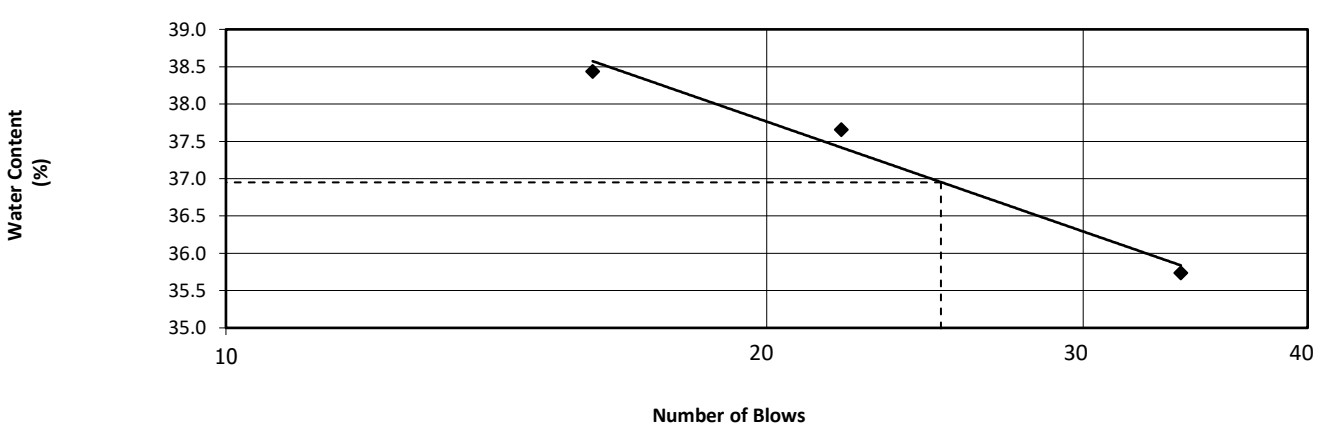
PLASTIC LIMIT

Test No.	1	2
Moisture Content (%)	17.1	16.3

TEST RESULTS

Liquid Limit	**37**
Plastic Limit	**17**
Plasticity Index	**20**

FLOW CURVE GRAPH



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WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCEWITH ASTM D4318 STANDARD

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ASTM D4318: LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX

P.MACHIBRODA ENGINEERING LTD.

806 48TH STREET EAST, SASKATOON, SK S7K 3Y4

PROJECT INFORMATION

PROJECT NUMBER:	**22595**
PROJECT NAME:	**Proposed Lagoon Expansion**
PROJECT LOCATION:	**SW-21-40-10-W3M, Radisson, Saskatchewan**
DATE:	**June 2, 2025**

SAMPLE INFORMATION

TEST HOLE: **25-3**

SAMPLE NUMBER: **31**

DEPTH: **1.5**

TESTING METHOD AND EQUIPMENT

METHOD OF PREPARATION: **Oven Dried**

METHOD OF REMOVING PARTICLES LARGER THAN THE 425-µm: **Sieve**

METHOD OF ROLLING: **Hand Rolled**

LIQUID LIMIT DEVICE: **Manual**

GROOVING TOOL: **Plastic**

TESTING METHOD: **Method A (Multipoint Liquid Limit)**

LABORATORY TEST RESULTS

LIQUID LIMIT

Test No.	1	2	3
Moisture Content (%)	27.2	29.4	31.8
No. of Blows	34	25	18

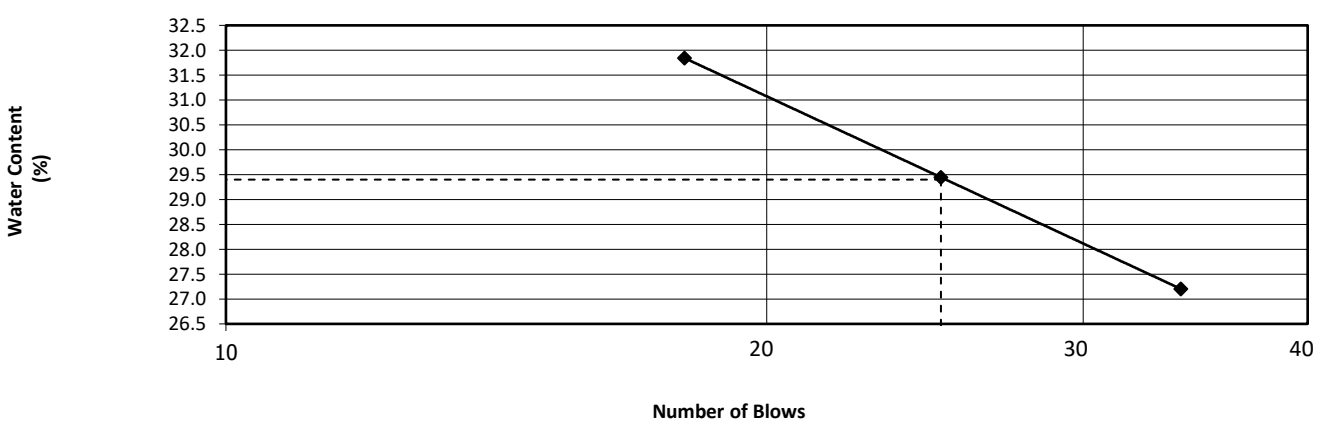
PLASTIC LIMIT

Test No.	1	2
Moisture Content (%)	14.0	13.7

TEST RESULTS

Liquid Limit	**29**
Plastic Limit	**14**
Plasticity Index	**16**

FLOW CURVE GRAPH



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ASTM D4318: LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX

P.MACHIBRODA ENGINEERING LTD.

806 48TH STREET EAST, SASKATOON, SK S7K 3Y4

PROJECT INFORMATION

PROJECT NUMBER:	**22595**
PROJECT NAME:	**Proposed Lagoon Expansion**
PROJECT LOCATION:	**SW-21-40-10-W3M, Radisson, Saskatchewan**
DATE:	**June 4, 2025**

SAMPLE INFORMATION

TEST HOLE: **25-3**

SAMPLE NUMBER: **34**

DEPTH: **4.5**

TESTING METHOD AND EQUIPMENT

METHOD OF PREPARATION: **Oven Dried**

METHOD OF REMOVING PARTICLES LARGER THAN THE 425-µm: **Sieve**

METHOD OF ROLLING: **Hand Rolled**

LIQUID LIMIT DEVICE: **Manual**

GROOVING TOOL: **Plastic**

TESTING METHOD: **Method A (Multipoint Liquid Limit)**

LABORATORY TEST RESULTS

LIQUID LIMIT

Test No.	1	2	3
Moisture Content (%)	55.5	57.0	59.8
No. of Blows	35	27	22

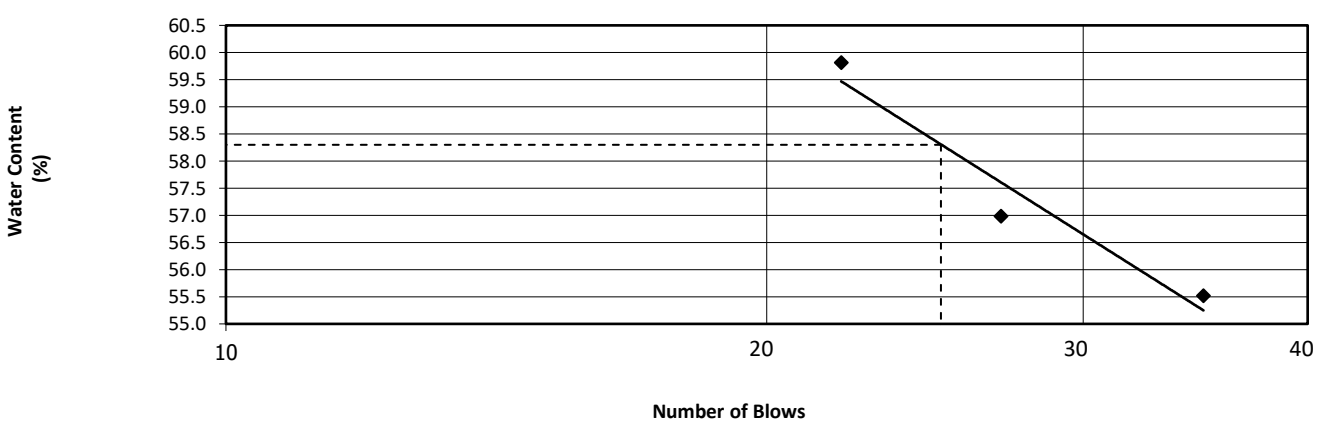
PLASTIC LIMIT

Test No.	1	2
Moisture Content (%)	18.9	18.2

TEST RESULTS

Liquid Limit	**58**
Plastic Limit	**19**
Plasticity Index	**40**

FLOW CURVE GRAPH



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806 48TH STREET EAST, SASKATOON, SK S7K 3Y4

PROJECT INFORMATION

PROJECT NUMBER:	**22595**
PROJECT NAME:	**Proposed Lagoon Expansion**
PROJECT LOCATION:	**SW-21-40-10-W3M, Radisson, Saskatchewan**
DATE:	**June 3, 2025**

SAMPLE INFORMATION

TEST HOLE: **25-4**

SAMPLE NUMBER: **39**

DEPTH: **1.0**

TESTING METHOD AND EQUIPMENT

METHOD OF PREPARATION: **Oven Dried**

METHOD OF REMOVING PARTICLES LARGER THAN THE 425-µm: **Sieve**

METHOD OF ROLLING: **Hand Rolled**

LIQUID LIMIT DEVICE: **Manual**

GROOVING TOOL: **Plastic**

TESTING METHOD: **Method A (Multipoint Liquid Limit)**

LABORATORY TEST RESULTS

LIQUID LIMIT

Test No.	1	2	3
Moisture Content (%)	31.0	32.8	34.0
No. of Blows	33	25	19

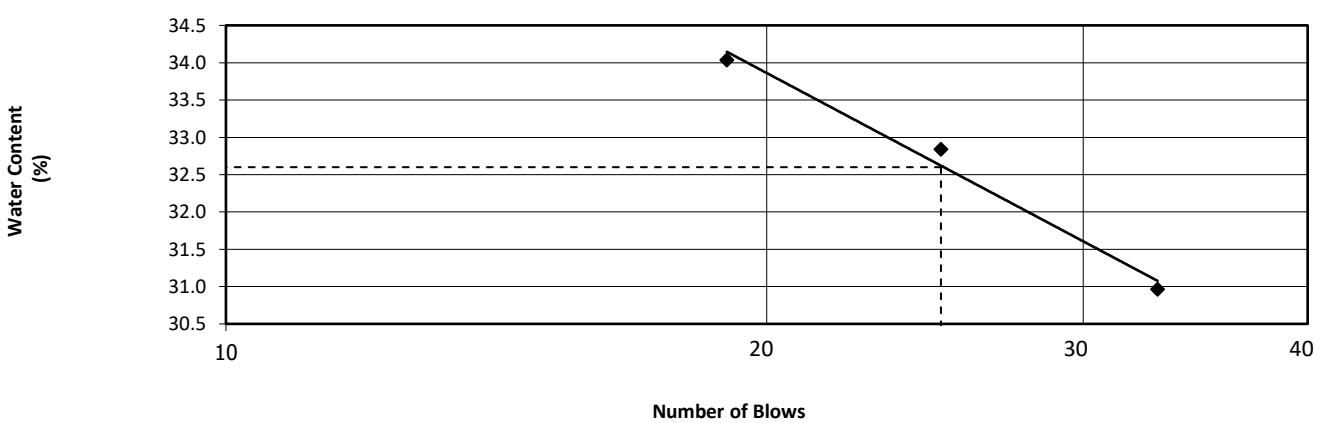
PLASTIC LIMIT

Test No.	1	2
Moisture Content (%)	14.6	14.1

TEST RESULTS

Liquid Limit	**33**
Plastic Limit	**14**
Plasticity Index	**18**

FLOW CURVE GRAPH



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806 48TH STREET EAST, SASKATOON, SK S7K 3Y4

PROJECT INFORMATION

PROJECT NUMBER:	**22595**
PROJECT NAME:	**Proposed Lagoon Expansion**
PROJECT LOCATION:	**SW-21-40-10-W3M, Radisson, Saskatchewan**
DATE:	**June 2, 2025**

SAMPLE INFORMATION

TEST HOLE:	**25-5A**
SAMPLE NUMBER:	**8**
DEPTH:	**0.5**

TESTING METHOD AND EQUIPMENT

METHOD OF PREPARATION:	**Oven Dried**
METHOD OF REMOVING PARTICLES LARGER THAN THE 425-µm:	**Sieve**
METHOD OF ROLLING:	**Hand Rolled**
LIQUID LIMIT DEVICE:	**Manual**
GROOVING TOOL:	**Plastic**
TESTING METHOD:	**Method A (Multipoint Liquid Limit)**

LABORATORY TEST RESULTS

LIQUID LIMIT

Test No.	1	2	3
Moisture Content (%)	48.4	49.4	50.2
No. of Blows	29	23	18

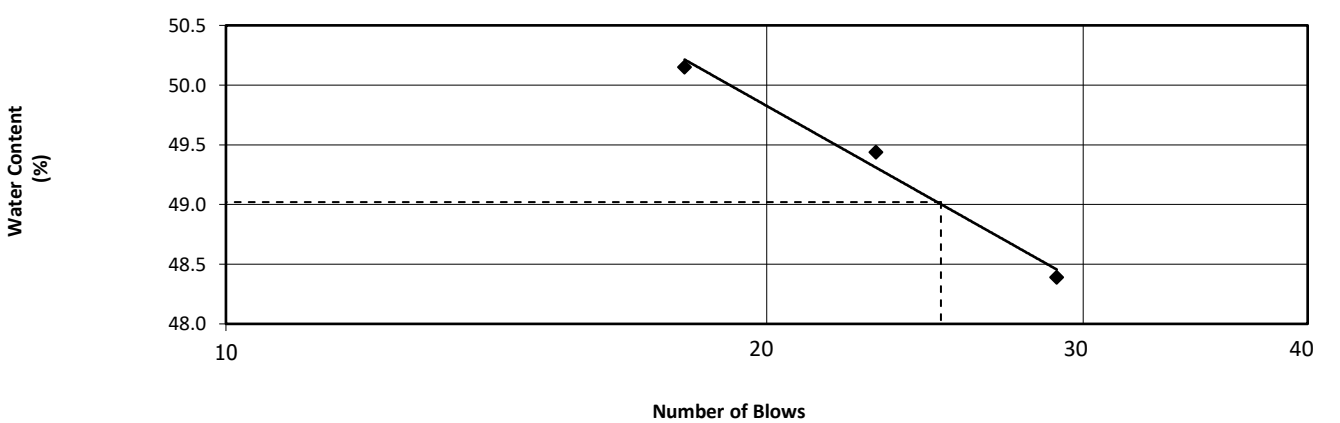
PLASTIC LIMIT

Test No.	1	2
Moisture Content (%)	16.2	16.9

TEST RESULTS

Liquid Limit	**49**
Plastic Limit	**17**
Plasticity Index	**32**

FLOW CURVE GRAPH



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806 48TH STREET EAST, SASKATOON, SK S7K 3Y4

PROJECT INFORMATION

PROJECT NUMBER:	**22595**
PROJECT NAME:	**Proposed Lagoon Expansion**
PROJECT LOCATION:	**SW-21-40-10-W3M, Radisson, Saskatchewan**
DATE:	**June 6, 2025**

SAMPLE INFORMATION

TEST HOLE:	**25-5A**
SAMPLE NUMBER:	**10**
DEPTH:	**1.5**

TESTING METHOD AND EQUIPMENT

METHOD OF PREPARATION:	**Oven Dried**
METHOD OF REMOVING PARTICLES LARGER THAN THE 425-µm:	**Sieve**
METHOD OF ROLLING:	**Hand Rolled**
LIQUID LIMIT DEVICE:	**Manual**
GROOVING TOOL:	**Plastic**
TESTING METHOD:	**Method A (Multipoint Liquid Limit)**

LABORATORY TEST RESULTS

LIQUID LIMIT

Test No.	1	2	3
Moisture Content (%)	39.5	43.0	45.9
No. of Blows	27	21	16

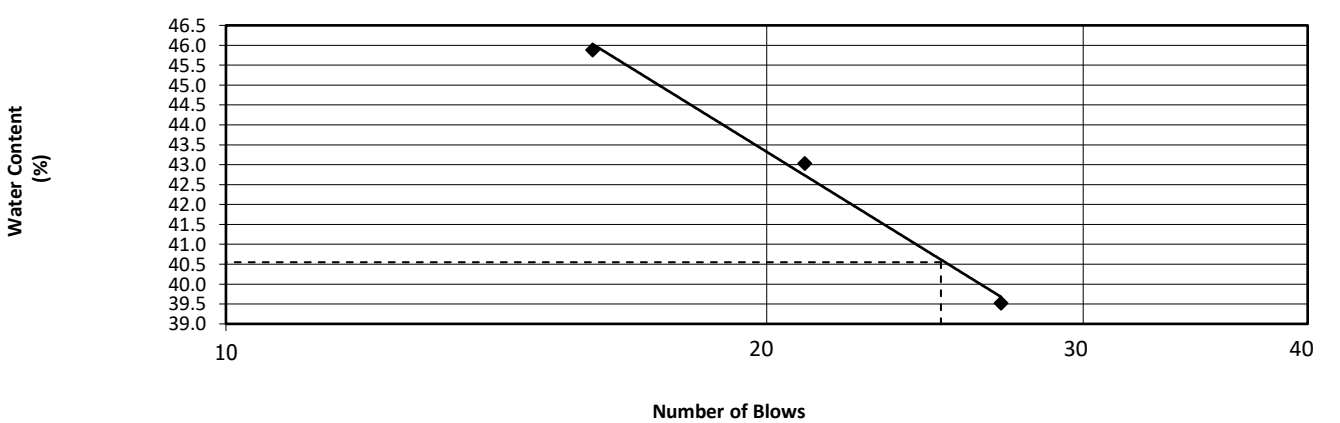
PLASTIC LIMIT

Test No.	1	2
Moisture Content (%)	18.4	18.1

TEST RESULTS

Liquid Limit	**41**
Plastic Limit	**18**
Plasticity Index	**22**

FLOW CURVE GRAPH



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P.MACHIBRODA ENGINEERING LTD.

AASHTO T 88: PARTICLE SIZE ANALYSIS OF SOILS

Project: Proposed Lagoon Expansion

Location: Radisson, SK

Project No.: 22595

Date Tested: May 28, 2025

Borehole No.: 25-2

Sample No.: 20

Depth (m): 1.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.100	100
1"	25.400	100
3/4"	19.100	100
1/2"	12.700	100
3/8"	9.500	100
# 4	4.750	100
# 10	2.000	100
# 20	0.850	100
# 40	0.425	99.4
#60	0.250	97.1
# 100	0.150	89.3
# 200	0.075	74.0

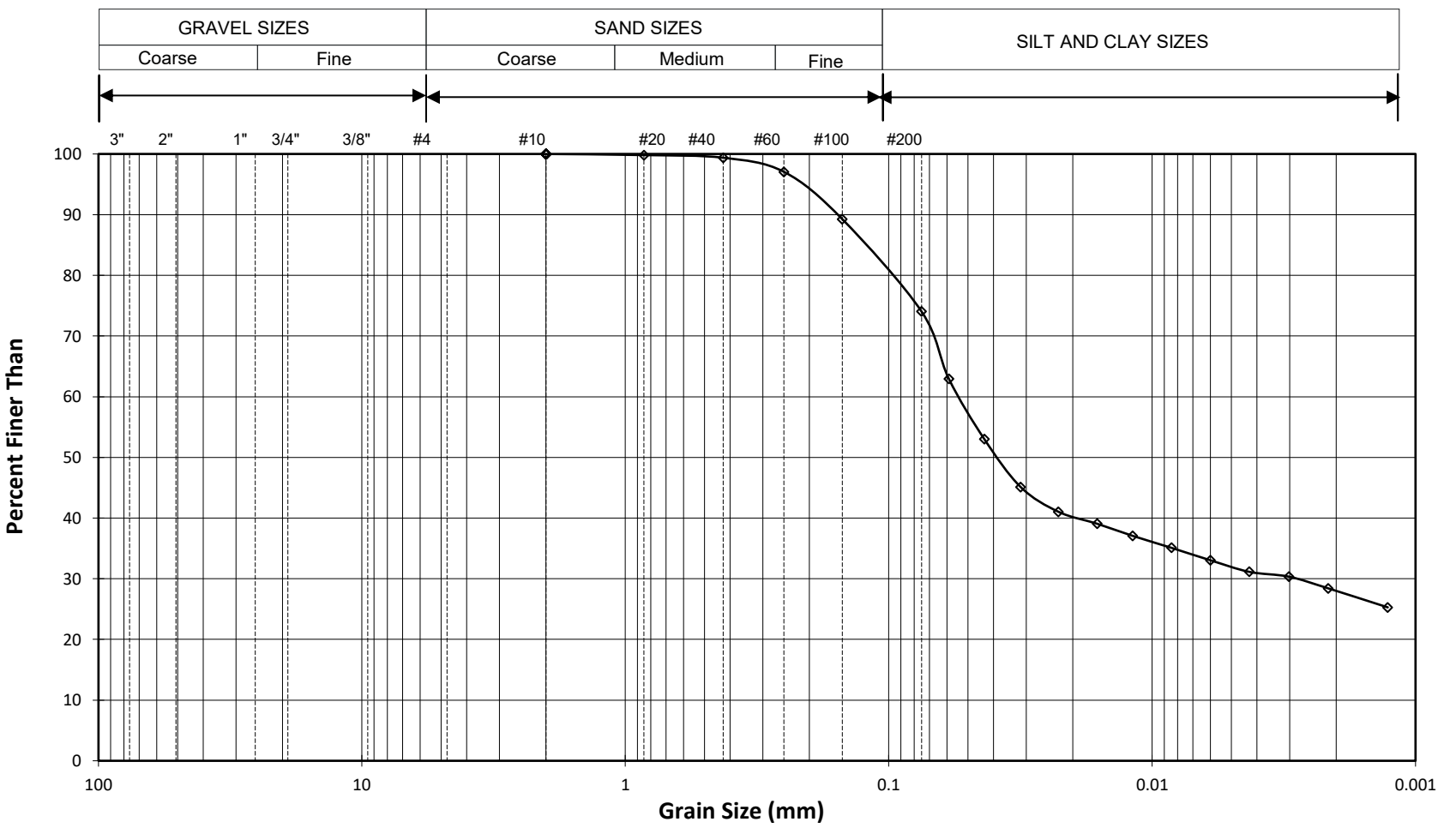
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0591	62.9
Sodium Hexametaphosphate	0.0434	53.0
	0.0316	45.1
	0.0227	41.0
	0.0161	39.1
	0.0119	37.1
	0.0084	35.1
	0.0060	33.1
	0.0043	31.1
	0.0030	30.3
	0.0021	28.4
	0.0013	25.3

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	26	46	28

Remarks:



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P.MACHIBRODA ENGINEERING LTD.

AASHTO T 88: PARTICLE SIZE ANALYSIS OF SOILS

Project: Proposed Lagoon Expansion

Location: Radisson, SK

Project No.: 22595

Date Tested: May 28, 2025

Borehole No.: 25-3

Sample No.: 31

Depth (m): 1.5

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.100	100
1"	25.400	100
3/4"	19.100	100
1/2"	12.700	100
3/8"	9.500	100
# 4	4.750	100
# 10	2.000	100
# 20	0.850	100
# 40	0.425	99.1
#60	0.250	92.5
# 100	0.150	75.8
# 200	0.075	55.6

Hydrometer Analysis:

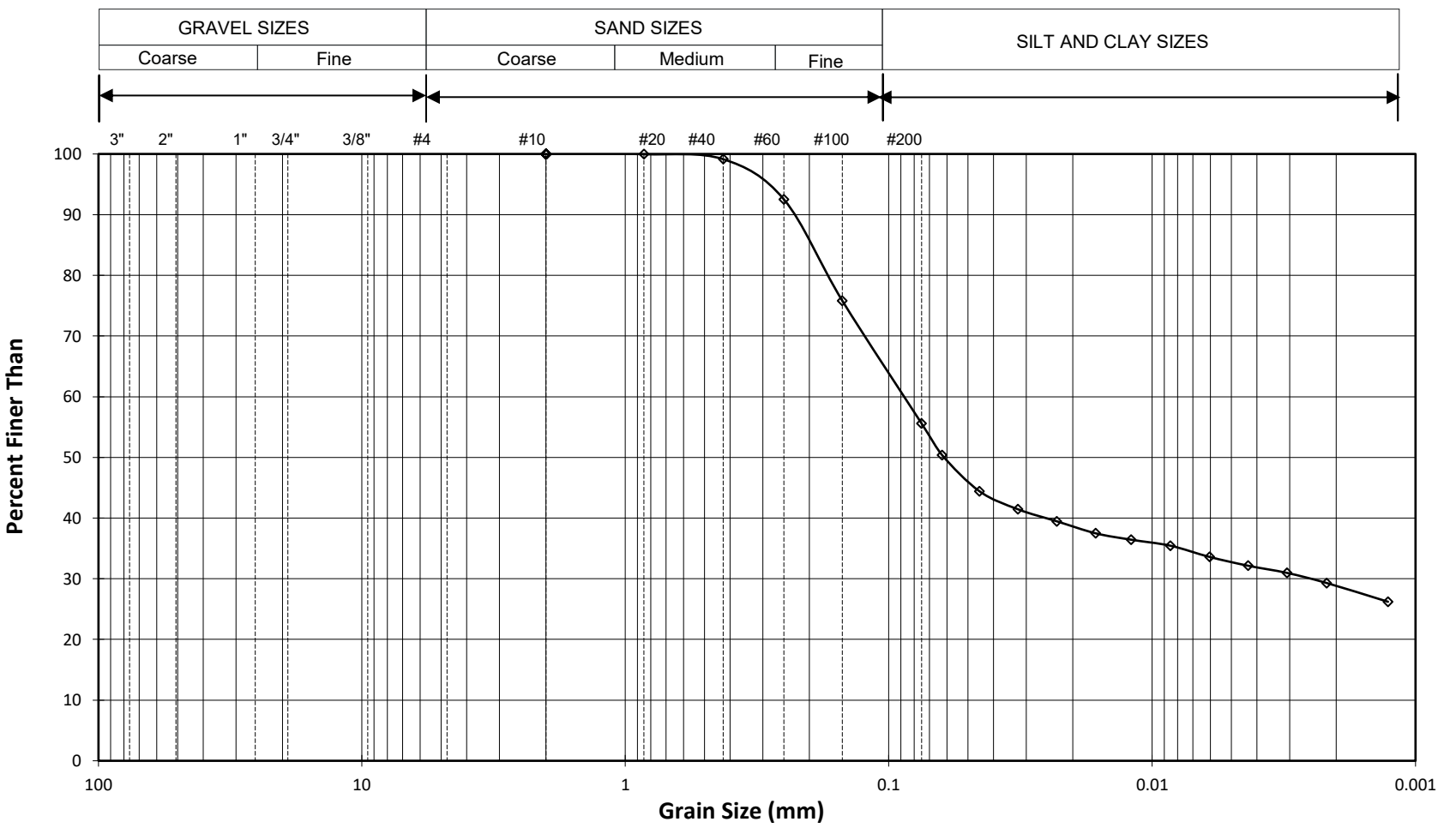
Dispersing Agent: *Sodium Hexametaphosphate*

Diameter mm	% Finer
0.0626	50.4
0.0452	44.4
0.0323	41.4
0.0230	39.5
0.0164	37.5
0.0120	36.4
0.0085	35.4
0.0060	33.6
0.0043	32.1
0.0031	31.0
0.0022	29.3
0.0013	26.2

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	44	27	29

Remarks:



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P. MACHIBRODA ENGINEERING LTD.

PER _____

P.MACHIBRODA ENGINEERING LTD.

AASHTO T 88: PARTICLE SIZE ANALYSIS OF SOILS

Project: Proposed Lagoon Expansion

Location: Radisson, SK

Project No.: 22595

Date Tested: May 28, 2025

Borehole No.: 25-3

Sample No.: 34

Depth (m): 4.5

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.100	100
1"	25.400	100
3/4"	19.100	100
1/2"	12.700	100
3/8"	9.500	100
# 4	4.750	100
# 10	2.000	100
# 20	0.850	100
# 40	0.425	99.7
#60	0.250	99.1
# 100	0.150	97.4
# 200	0.075	92.3

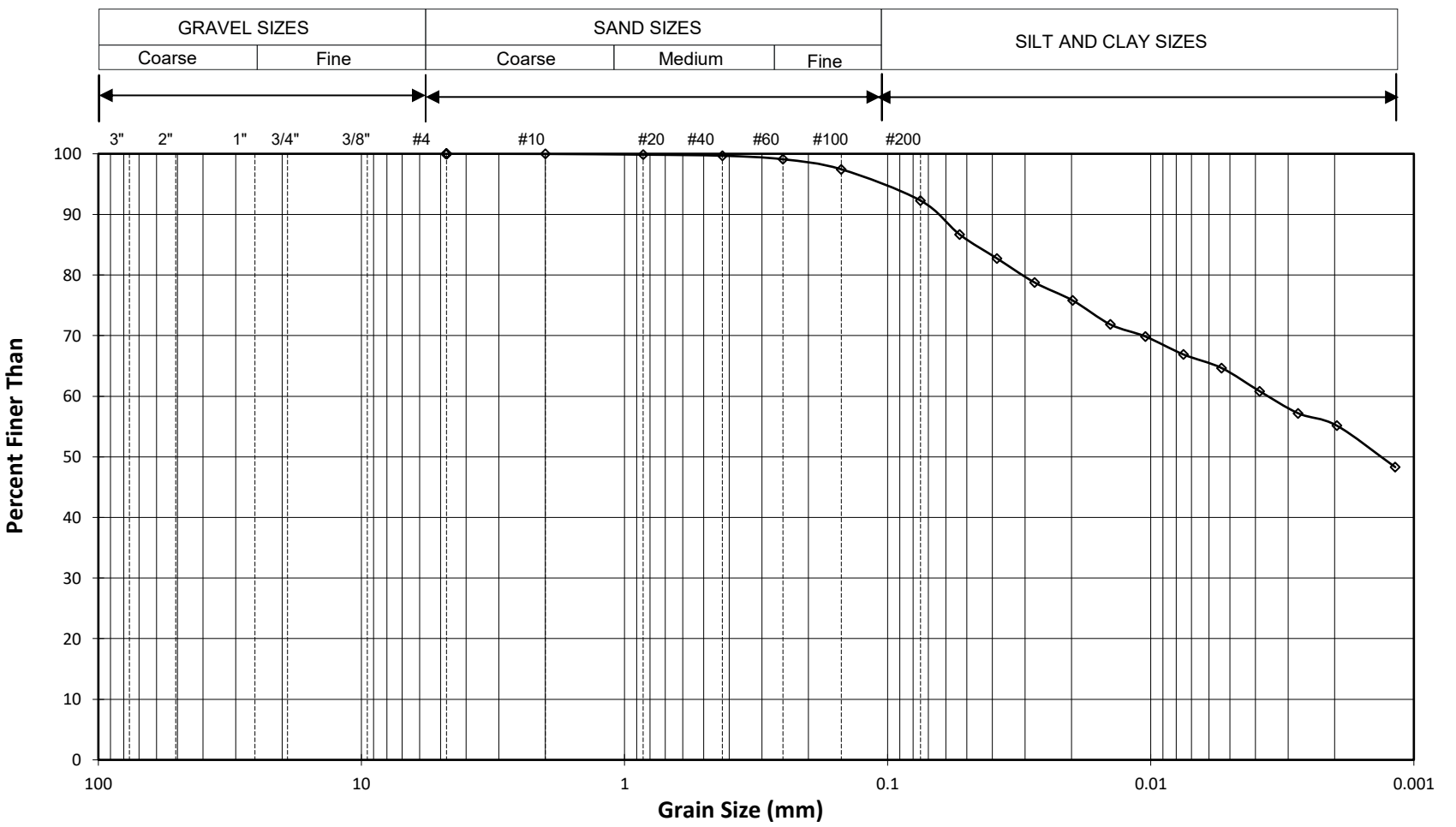
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0533	86.7
Sodium Hexametaphosphate	0.0384	82.7
	0.0276	78.8
	0.0198	75.8
	0.0142	71.8
	0.0105	69.9
	0.0075	66.9
	0.0054	64.7
	0.0039	60.8
	0.0028	57.2
	0.0020	55.1
	0.0012	48.3

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	8	37	55

Remarks:



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AASHTO T 88: PARTICLE SIZE ANALYSIS OF SOILS

Project: Proposed Lagoon Expansion

Location: Radisson, SK

Project No.: 22595

Date Tested: May 28, 2025

Borehole No.: 25-4

Sample No.: 39

Depth (m): 1.0

Sieve Analysis:

Sieve	Diameter mm	% Finer
1.5"	38.100	100
1"	25.400	100
3/4"	19.100	100
1/2"	12.700	100
3/8"	9.500	100
# 4	4.750	100
# 10	2.000	100
# 20	0.850	100
# 40	0.425	99.2
#60	0.250	93.9
# 100	0.150	79.8
# 200	0.075	60.3

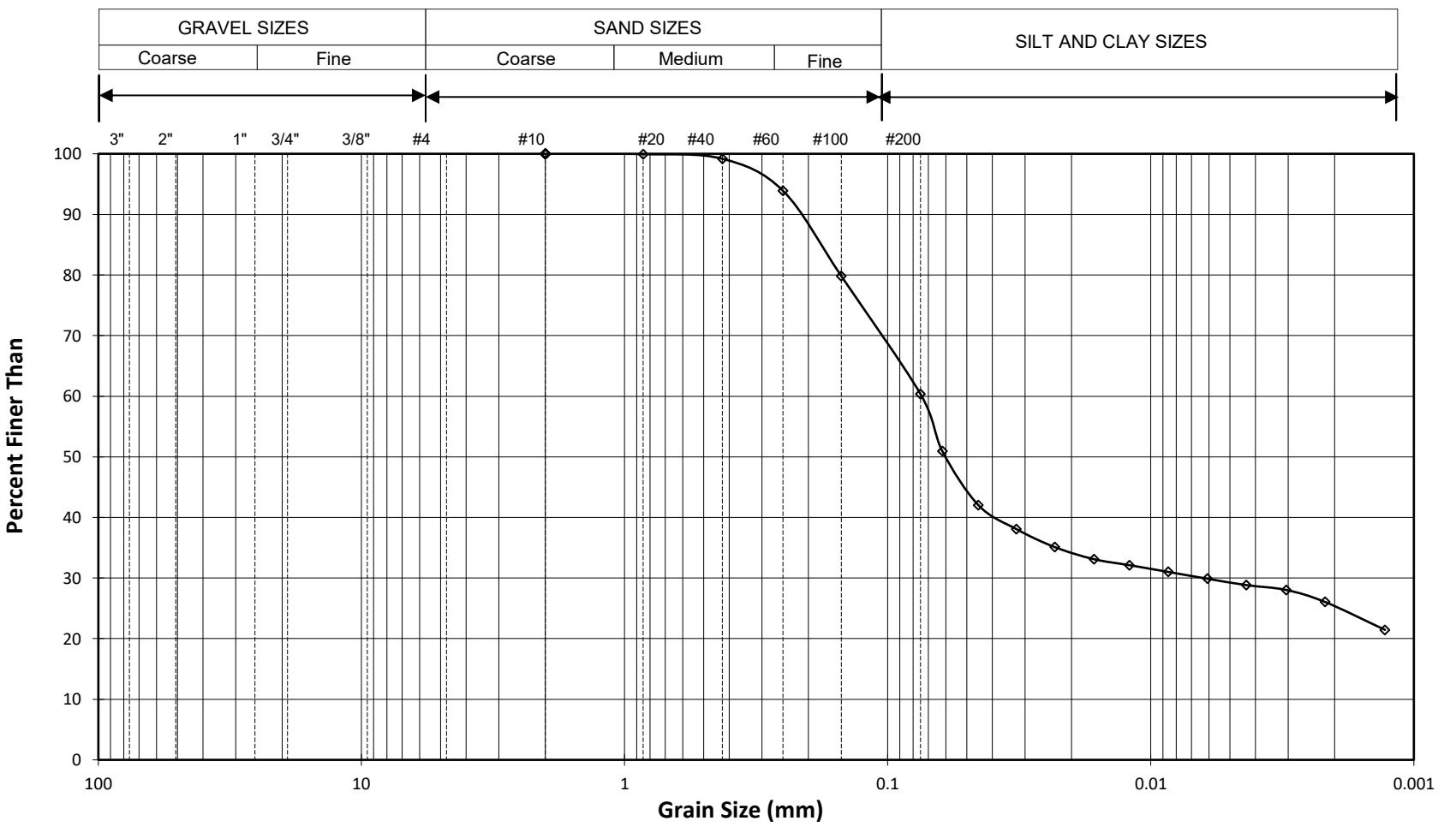
Hydrometer Analysis:

	Diameter mm	% Finer
Dispersing Agent:	0.0620	50.9
Sodium Hexametaphosphate	0.0452	42.0
	0.0324	38.1
	0.0231	35.1
	0.0165	33.1
	0.0121	32.1
	0.0086	31.0
	0.0061	29.9
	0.0043	28.8
	0.0031	28.0
	0.0022	26.1
	0.0013	21.5

Material Description:

% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	40	35	25

Remarks:



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Drawing No.

WE CERTIFY TESTING PROCEDURES ARE IN ACCORDANCE WITH AASHTO T 88 STANDARD

P. MACHIBRODA ENGINEERING LTD.

PER _____

APPENDIX G

Standard Proctor Moisture-Density
Analysis Results

STANDARD PROCTOR MOISTURE-DENSITY RELATIONSHIP TEST REPORT

ASTM Designation D698: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

P.MACHIBRODA ENGINEERING LTD.

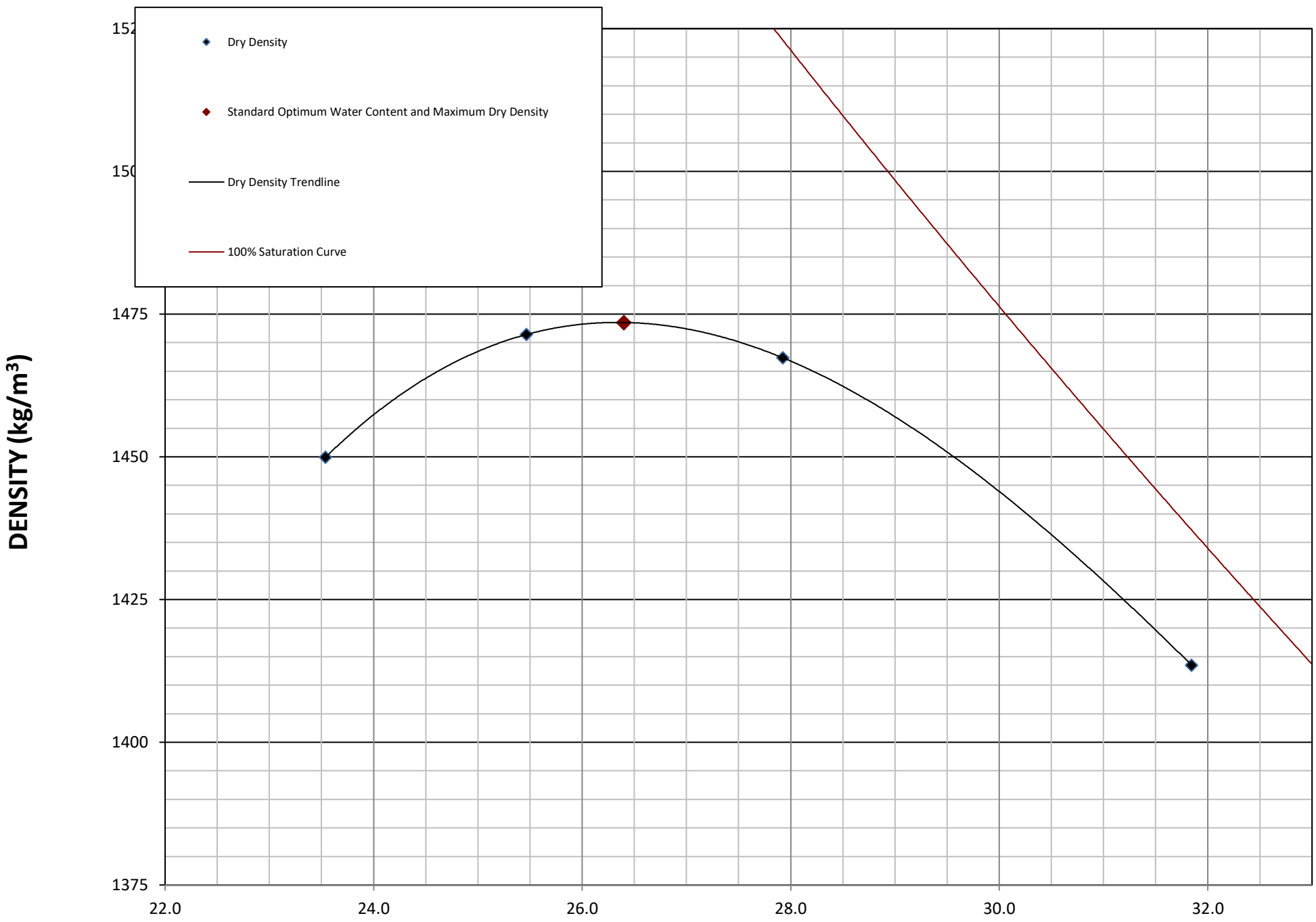
806 48th Street East, Saskatoon, Saskatchewan S7K 3Y4

Phone: 306-665-8444

Email: lab.sk@machibroda.com

PROJECT NO.:	22595	CLIENT:	
PROJECT:	Proposed Lagoon Expansion	SAMPLE NUMBER:	18
LOCATION:	SW-21-40-10-W3M, Raddison, SK	SAMPLED BY:	
DATE TESTED:	July 4, 2025	DATE SAMPLED:	
TECHNICIAN:	O. Senko	DATE RECEIVED:	
SOURCE:	BH25-5A, Depth 0 -3.0m		

TRIAL NUMBER	1	2	3	4	5
DRY DENSITY (kg/m^3)	1450	1471	1467	1413	
WATER CONTENT (%)	23.5	25.5	27.9	31.8	



SAMPLE DESCRIPTION:	**Clay**	METHOD OF COMPACTION:	METHOD A
		PREPARATION METHOD:	DRY
STANDARD OPTIMUM WATER CONTENT (%):	**26.4**	AS RECEIVED WATER CONTENT (%):	13.2
		STANDARD MAXIMUM UNIT WEIGHT (Kn/m^3):	14.45
STANDARD MAXIMUM DRY DENSITY (kg/m^3):	**1474**	TYPE OF RAMMER:	Manual
		MATERIAL RETAINED ON 4.75-mm SIEVE (%)(P_C):	0.0
CORRECTED STANDARD OPTIMUM WATER CONTENT (%):	N/A	MATERIAL PASSING THE 4.75-mm SIEVE (%)(P_F):	100.0
		SPECIFIC GRAVITY (assumed):	2.65
CORRECTED STANDARD MAXIMUM DRY DENSITY (kg/m^3):	N/A	REMARKS:	

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

REVIEWED BY: Preston Schergevitch

Preston Schergevitch, P.Tech.

APPENDIX H

Laboratory Hydraulic
Conductivity Test Results

ASTM D5084: Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall

Project Name:	Proposed Lagoon Expansion
Project No:	22595
Location:	SW-21-40-10-W3M, Radisson, Saskatchewan
Borehole No.	25-5A
Sample No.	18
Depth:	0 - 3.0 m
Sample Type:	Clay
Date:	July 10, 2025

Sample Preparation: Remolded Standard Proctor

Testing Summary:

Cell Pressure = 237 kPa Head across sample = 70 cm Hydraulic gradient = 18.5

Back pressure = 207 kPa

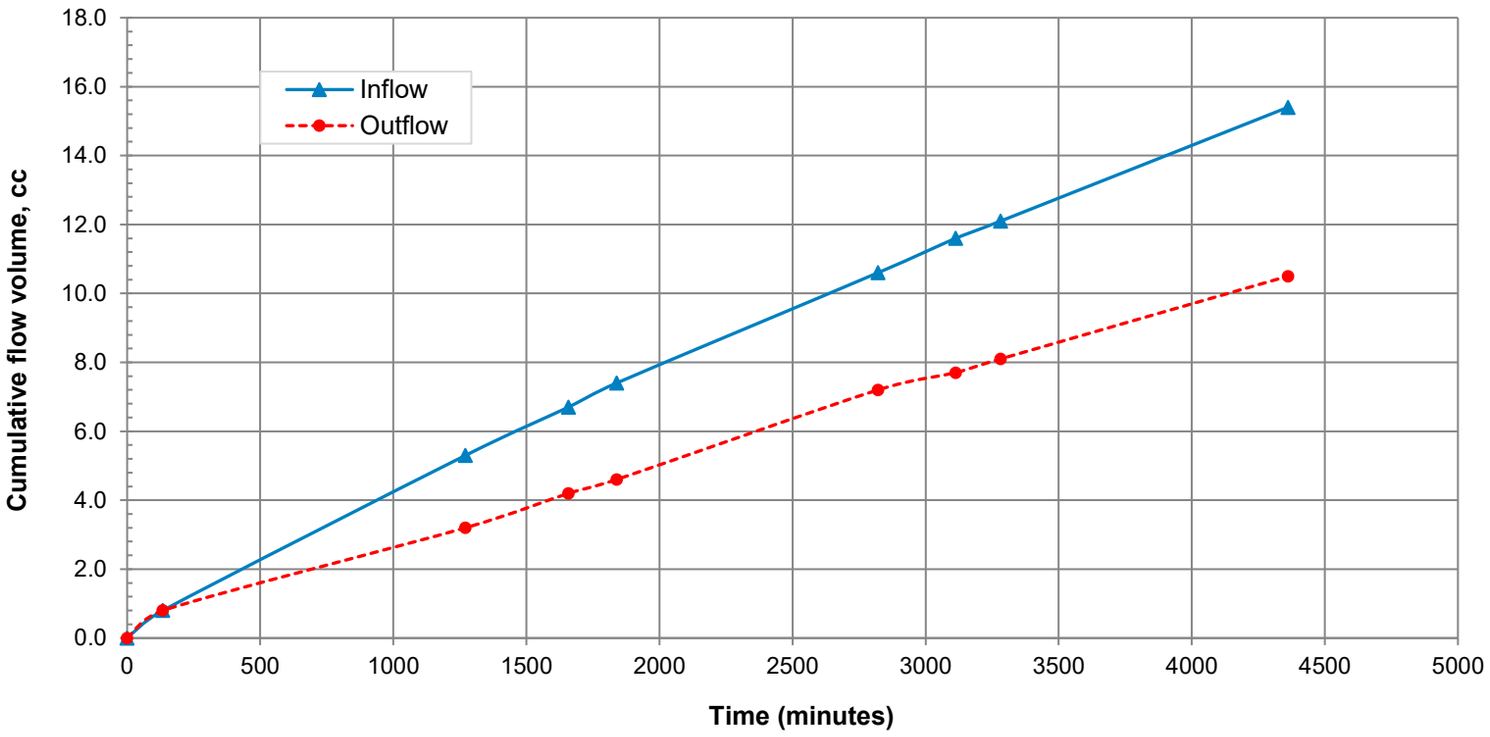
Initial Conditions		Final Conditions	
Initial sample diameter =	70.32 mm	Final water content =	28.3 %
Initial sample height =	37.74 mm	Final wet density =	1917 kg/m^3
Initial sample volume =	146.6 cc	Final dry density (measured) =	1495 kg/m^3
Initial water content =	27.3 %	Wet unit weight =	18.8 KN/m^3
Initial dry density (calculated) =	1448 kg/m^3	Final degree of saturation =	100 %

Inflow Rate = 0.00030 cc/min

Outflow Rate = 0.00020 cc/min

Hydraulic Conductivity = 5.8E-11 m/s

Comment: **Test was conducted at +1% above the optimum water content and remolded to 98.1% of the Standard Proctor maximum dry densisty.**



P.MACHIBRODA ENGINEERING LTD.

Reviewed By: Preston Schergevitch

Preston Schergevitch, P.Tech.

APPENDIX I

Groundwater Chemical
Analysis Results

ALS Canada Ltd.

right solutions.
right partner.

CERTIFICATE OF ANALYSIS

Work Order	: **SK2503503**	Page	: 1 of 6
Client	: **P. Machibroda Engineering Ltd.**	Laboratory	: ALS Environmental - Saskatoon
Contact	: Graham Baxter	Account Manager	: Kimberley Head
Address	: 806-48th STREET EAST Saskatoon SK Canada S7K 3Y4	Address	: 819 58 Street East Saskatoon SK Canada S7K 6X5
Telephone	: 780 733 6575	Telephone	: +1 306 668 8370
Project	: 22595	Date Samples Received	: 26-Jun-2025 11:00
PO	: ----	Date Analysis Commenced	: 26-Jun-2025
C-O-C number	: ----	Issue Date	: 03-Jul-2025 21:05
Sampler	: PMEL		
Site	: ----		
Quote number	: SK Pricing		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Colby Bingham	Laboratory Supervisor	Inorganics, Saskatoon, Saskatchewan
Colby Bingham	Laboratory Supervisor	Metals, Saskatoon, Saskatchewan
Kimberly Hanson	Laboratory Analyst	Metals, Saskatoon, Saskatchewan
Maria Painchaud	Laboratory Assistant	Metals, Saskatoon, Saskatchewan
Milad Khani	Laboratory Analyst	Inorganics, Saskatoon, Saskatchewan

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.
Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).
Measurement Uncertainty: The reported uncertainties in this report are expanded uncertainties calculated using a coverage factor of 2, which gives a level of confidence of approximately 95%.
Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Unit	*Description*
-	no units
%	percent
µS/cm	microsiemens per centimetre
meq/L	milliequivalents per litre
mg/L	milligrams per litre
pH units	pH units

>: greater than.
<: less than.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Accreditation

Accreditation	*Description*	*Laboratory*	*Address*
A	CALA ISO/IEC 17025:2017	SK ALS Environmental - Saskatoon	819 58 Street East, Saskatoon, SK

Applicable accreditations are indicated in the Method/Lab column as superscripts.

Qualifiers

Qualifier	*Description*
DLDS	*Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.*
SFP	*Sample was filtered and preserved at the laboratory.*

Analytical Results

SK2503503-001

Sub-Matrix: **Water** (Matrix: **Water**)

Client sample ID: 25-1

Client sampling date / time: 25-Jun-2025 12:00

Analyte	CAS Number	Result	Measurement Uncertainty	LOR	Unit	Method/Lab	Prep Date	Analysis Date	QCLot
Physical Tests									
Hardness (as CaCO3), dissolved	----	1800	-	0.50	mg/L	EC100/SK	-	03-Jul-2025	-
Conductivity	----	4350	± 88.1	2.0	µS/cm	E100/SK A	27-Jun-2025	27-Jun-2025	2079338
pH	----	7.77	± 0.04	0.10	pH units	E108/SK A	27-Jun-2025	27-Jun-2025	2079337
Alkalinity, bicarbonate (as HCO3)	71-52-3	1080	-	1.2	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, carbonate (as CO3)	3812-32-6	<0.6	-	0.6	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, hydroxide (as OH)	14280-30-9	<0.3	-	0.3	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, total (as CaCO3)	----	890	± 28.8	2.0	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Solids, total dissolved [TDS], calculated	----	3010	-	1.0	mg/L	EC103/SK	-	27-Jun-2025	-
Anions and Nutrients									
Chloride	16887-00-6	626	± 37.4	10.0	mg/L	E235.Cl/SK A	26-Jun-2025	26-Jun-2025	2077429
Fluoride	16984-48-8	<0.400 DLDS	-	0.400	mg/L	E235.F/SK A	26-Jun-2025	26-Jun-2025	2077426
Nitrate (as N)	14797-55-8	<0.400 DLDS	-	0.400	mg/L	E235.NO3/SK A	26-Jun-2025	26-Jun-2025	2077427
Nitrite (as N)	14797-65-0	<0.200 DLDS	-	0.200	mg/L	E235.NO2/SK A	26-Jun-2025	26-Jun-2025	2077430
Sulfate (as SO4)	14808-79-8	859	± 46.1	6.00	mg/L	E235.SO4/SK A	26-Jun-2025	26-Jun-2025	2077428
Nitrate + Nitrite (as N)	----	<0.447	-	0.447	mg/L	EC235.N+N/SK	-	27-Jun-2025	-
Ion Balance									
Anion sum	----	53.3	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Cation sum	----	53.5	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Ion balance (APHA)	----	0.19	-	0.01	%	EC101/SK	-	27-Jun-2025	-
Ion balance (cations/anions)	----	100	-	0.010	%	EC101/SK	-	27-Jun-2025	-
Dissolved Metals									
Calcium, dissolved	7440-70-2	296	± 21.1	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Iron, dissolved	7439-89-6	<0.050 DLDS	-	0.050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Magnesium, dissolved	7439-95-4	257	± 20.8	0.0250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Manganese, dissolved	7439-96-5	7.05	± 0.518	0.00050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Potassium, dissolved	7440-09-7	13.0	± 0.997	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Sodium, dissolved	7440-23-5	392	± 32.9	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Dissolved metals filtration location	----	Laboratory SFP	-	-	-	EP421/SK	-	02-Jul-2025	2081869

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Analytical Results

SK2503503-002

Sub-Matrix: **Water** (Matrix: **Water**)

Client sample ID: 25-5

Client sampling date / time: 26-Jun-2025 09:00

Analyte	CAS Number	Result	Measurement Uncertainty	LOR	Unit	Method/Lab	Prep Date	Analysis Date	QCLot
Physical Tests									
Hardness (as CaCO3), dissolved	----	2850	-	0.50	mg/L	EC100/SK	-	03-Jul-2025	-
Conductivity	----	4900	± 99.1	2.0	µS/cm	E100/SK A	27-Jun-2025	27-Jun-2025	2079338
pH	----	7.51	± 0.04	0.10	pH units	E108/SK A	27-Jun-2025	27-Jun-2025	2079337
Alkalinity, bicarbonate (as HCO3)	71-52-3	826	-	1.2	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, carbonate (as CO3)	3812-32-6	<0.6	-	0.6	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, hydroxide (as OH)	14280-30-9	<0.3	-	0.3	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, total (as CaCO3)	----	677	± 22.0	2.0	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Solids, total dissolved [TDS], calculated	----	4620	-	1.0	mg/L	EC103/SK	-	27-Jun-2025	-
Anions and Nutrients									
Chloride	16887-00-6	155	± 9.26	10.0	mg/L	E235.Cl/SK A	26-Jun-2025	26-Jun-2025	2077429
Fluoride	16984-48-8	<0.400 DLDS	-	0.400	mg/L	E235.F/SK A	26-Jun-2025	26-Jun-2025	2077426
Nitrate (as N)	14797-55-8	<0.400 DLDS	-	0.400	mg/L	E235.NO3/SK A	26-Jun-2025	26-Jun-2025	2077427
Nitrite (as N)	14797-65-0	<0.200 DLDS	-	0.200	mg/L	E235.NO2/SK A	26-Jun-2025	26-Jun-2025	2077430
Sulfate (as SO4)	14808-79-8	2700	± 145	6.00	mg/L	E235.SO4/SK A	26-Jun-2025	26-Jun-2025	2077428
Nitrate + Nitrite (as N)	----	<0.447	-	0.447	mg/L	EC235.N+N/SK	-	27-Jun-2025	-
Ion Balance									
Anion sum	----	74.1	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Cation sum	----	75.0	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Ion balance (APHA)	----	0.60	-	0.01	%	EC101/SK	-	27-Jun-2025	-
Ion balance (cations/anions)	----	101	-	0.010	%	EC101/SK	-	27-Jun-2025	-
Dissolved Metals									
Calcium, dissolved	7440-70-2	528	± 37.6	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Iron, dissolved	7439-89-6	<0.050 DLDS	-	0.050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Magnesium, dissolved	7439-95-4	371	± 30.0	0.0250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Manganese, dissolved	7439-96-5	4.34	± 0.318	0.00050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Potassium, dissolved	7440-09-7	20.0	± 1.53	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Sodium, dissolved	7440-23-5	402	± 33.8	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Dissolved metals filtration location	----	Laboratory SFP	-	-	-	EP421/SK	-	02-Jul-2025	2081869

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Analytical Results

SK2503503-003

Sub-Matrix: **Water** (Matrix: **Water**)

Client sample ID: 25-5A

Client sampling date / time: 26-Jun-2025 09:00

Analyte	CAS Number	Result	Measurement Uncertainty	LOR	Unit	Method/Lab	Prep Date	Analysis Date	QCLot
Physical Tests									
Hardness (as CaCO3), dissolved	----	3060	-	0.50	mg/L	EC100/SK	-	03-Jul-2025	-
Conductivity	----	4480	± 90.7	2.0	µS/cm	E100/SK A	27-Jun-2025	27-Jun-2025	2079338
pH	----	7.82	± 0.04	0.10	pH units	E108/SK A	27-Jun-2025	27-Jun-2025	2079337
Alkalinity, bicarbonate (as HCO3)	71-52-3	650	-	1.2	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, carbonate (as CO3)	3812-32-6	<0.6	-	0.6	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, hydroxide (as OH)	14280-30-9	<0.3	-	0.3	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, total (as CaCO3)	----	533	± 17.4	2.0	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Solids, total dissolved [TDS], calculated	----	4160	-	1.0	mg/L	EC103/SK	-	27-Jun-2025	-
Anions and Nutrients									
Chloride	16887-00-6	357	± 21.3	10.0	mg/L	E235.Cl/SK A	26-Jun-2025	26-Jun-2025	2077429
Fluoride	16984-48-8	<0.400 DLDS	-	0.400	mg/L	E235.F/SK A	26-Jun-2025	26-Jun-2025	2077426
Nitrate (as N)	14797-55-8	<0.400 DLDS	-	0.400	mg/L	E235.NO3/SK A	26-Jun-2025	26-Jun-2025	2077427
Nitrite (as N)	14797-65-0	<0.200 DLDS	-	0.200	mg/L	E235.NO2/SK A	26-Jun-2025	26-Jun-2025	2077430
Sulfate (as SO4)	14808-79-8	2310	± 124	6.00	mg/L	E235.SO4/SK A	26-Jun-2025	26-Jun-2025	2077428
Nitrate + Nitrite (as N)	----	<0.447	-	0.447	mg/L	EC235.N+N/SK	-	27-Jun-2025	-
Ion Balance									
Anion sum	----	68.8	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Cation sum	----	68.2	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Ion balance (APHA)	----	-0.44	-	0.01	%	EC101/SK	-	27-Jun-2025	-
Ion balance (cations/anions)	----	99.1	-	0.010	%	EC101/SK	-	27-Jun-2025	-
Dissolved Metals									
Calcium, dissolved	7440-70-2	586	± 41.7	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Iron, dissolved	7439-89-6	<0.050 DLDS	-	0.050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Magnesium, dissolved	7439-95-4	387	± 31.3	0.0250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Manganese, dissolved	7439-96-5	0.0500	± 0.00367	0.00050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Potassium, dissolved	7440-09-7	8.84	± 0.677	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Sodium, dissolved	7440-23-5	158	± 13.3	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Dissolved metals filtration location	----	Laboratory SFP	-	-	-	EP421/SK	-	02-Jul-2025	2081869

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Analytical Results

SK2503503-004

Sub-Matrix: **Water** (Matrix: **Water**)

Client sample ID: 22595-1

Client sampling date / time: 25-Jun-2025 12:00

Analyte	CAS Number	Result	Measurement Uncertainty	LOR	Unit	Method/Lab	Prep Date	Analysis Date	QCLot
Physical Tests									
Hardness (as CaCO3), dissolved	----	1800	-	0.50	mg/L	EC100/SK	-	03-Jul-2025	-
Conductivity	----	4290	± 86.9	2.0	µS/cm	E100/SK A	27-Jun-2025	27-Jun-2025	2079338
pH	----	7.60	± 0.04	0.10	pH units	E108/SK A	27-Jun-2025	27-Jun-2025	2079337
Alkalinity, bicarbonate (as HCO3)	71-52-3	1070	-	1.2	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, carbonate (as CO3)	3812-32-6	<0.6	-	0.6	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, hydroxide (as OH)	14280-30-9	<0.3	-	0.3	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Alkalinity, total (as CaCO3)	----	878	± 28.4	2.0	mg/L	E290/SK A	27-Jun-2025	27-Jun-2025	2079339
Solids, total dissolved [TDS], calculated	----	3000	-	1.0	mg/L	EC103/SK	-	27-Jun-2025	-
Anions and Nutrients									
Chloride	16887-00-6	625	± 37.3	10.0	mg/L	E235.Cl/SK A	26-Jun-2025	26-Jun-2025	2077429
Fluoride	16984-48-8	<0.400 DLDS	-	0.400	mg/L	E235.F/SK A	26-Jun-2025	26-Jun-2025	2077426
Nitrate (as N)	14797-55-8	<0.400 DLDS	-	0.400	mg/L	E235.NO3/SK A	26-Jun-2025	26-Jun-2025	2077427
Nitrite (as N)	14797-65-0	<0.200 DLDS	-	0.200	mg/L	E235.NO2/SK A	26-Jun-2025	26-Jun-2025	2077430
Sulfate (as SO4)	14808-79-8	861	± 46.2	6.00	mg/L	E235.SO4/SK A	26-Jun-2025	26-Jun-2025	2077428
Nitrate + Nitrite (as N)	----	<0.447	-	0.447	mg/L	EC235.N+N/SK	-	27-Jun-2025	-
Ion Balance									
Anion sum	----	53.1	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Cation sum	----	53.6	-	0.10	meq/L	EC101/SK	-	27-Jun-2025	-
Ion balance (APHA)	----	0.47	-	0.01	%	EC101/SK	-	27-Jun-2025	-
Ion balance (cations/anions)	----	101	-	0.010	%	EC101/SK	-	27-Jun-2025	-
Dissolved Metals									
Calcium, dissolved	7440-70-2	277	± 19.7	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Iron, dissolved	7439-89-6	<0.050 DLDS	-	0.050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Magnesium, dissolved	7439-95-4	268	± 21.6	0.0250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Manganese, dissolved	7439-96-5	6.90	± 0.506	0.00050	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Potassium, dissolved	7440-09-7	13.2	± 1.01	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Sodium, dissolved	7440-23-5	395	± 33.2	0.250	mg/L	E421/SK A	02-Jul-2025	02-Jul-2025	2081869
Dissolved metals filtration location	----	Laboratory SFP	-	-	-	EP421/SK	-	02-Jul-2025	2081869

Please refer to the General Comments section for an explanation of any result qualifiers detected.

QUALITY CONTROL REPORT

Work Order	: **SK2503503**	Page	: 1 of 6
Client	: P. Machibroda Engineering Ltd.	Laboratory	: ALS Environmental - Saskatoon
Contact	: Graham Baxter	Account Manager	: Kimberley Head
Address	: 806-48th STREET EAST Saskatoon SK Canada S7K 3Y4	Address	: 819 58 Street East Saskatoon, Saskatchewan Canada S7K 6X5
Telephone	: 780 733 6575	Telephone	: +1 306 668 8370
Project	: 22595	Date Samples Received	: 26-Jun-2025 11:00
PO	: ----	Date Analysis Commenced	: 26-Jun-2025
C-O-C number	: ----	Issue Date	: 03-Jul-2025 21:05
Sampler	: PMEL		
Site	: ----		
Quote number	: SK Pricing		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Matrix Spike (MS) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Colby Bingham	Laboratory Supervisor	Saskatoon Inorganics, Saskatoon, Saskatchewan
Colby Bingham	Laboratory Supervisor	Saskatoon Metals, Saskatoon, Saskatchewan
Kimberly Hanson	Laboratory Analyst	Saskatoon Metals, Saskatoon, Saskatchewan
Maria Painchaud	Laboratory Assistant	Saskatoon Metals, Saskatoon, Saskatchewan
Milad Khani	Laboratory Analyst	Saskatoon Inorganics, Saskatoon, Saskatchewan

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Physical Tests (QC Lot: 2079337)											
RG2500783-001	Anonymous	pH	----	E108	0.10	pH units	8.40	8.42	0.238%	3%	----
Physical Tests (QC Lot: 2079338)											
RG2500783-001	Anonymous	Conductivity	----	E100	2.0	µS/cm	879	874	0.570%	10%	----
Physical Tests (QC Lot: 2079339)											
RG2500783-001	Anonymous	Alkalinity, total (as CaCO3)	----	E290	2.0	mg/L	203	204	0.216%	20%	----
Anions and Nutrients (QC Lot: 2077426)											
SK2503498-001	Anonymous	Fluoride	16984-48-8	E235.F	0.020	mg/L	0.062	0.061	0.0010	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 2077427)											
SK2503498-001	Anonymous	Nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	<0.020	<0.020	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 2077428)											
SK2503498-001	Anonymous	Sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L	0.71	0.70	0.01	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 2077429)											
SK2503498-001	Anonymous	Chloride	16887-00-6	E235.Cl	0.50	mg/L	<0.50	<0.50	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 2077430)											
SK2503498-001	Anonymous	Nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
Dissolved Metals (QC Lot: 2081869)											
SK2503485-010	Anonymous	Calcium, dissolved	7440-70-2	E421	0.050	mg/L	131	124	5.26%	20%	----
		Iron, dissolved	7439-89-6	E421	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
		Magnesium, dissolved	7439-95-4	E421	0.0050	mg/L	139	137	1.55%	20%	----
		Manganese, dissolved	7439-96-5	E421	0.00010	mg/L	0.00140	0.00136	3.33%	20%	----
		Potassium, dissolved	7440-09-7	E421	0.050	mg/L	8.24	7.92	4.01%	20%	----
		Sodium, dissolved	7440-23-5	E421	0.050	mg/L	17.6	17.2	1.94%	20%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 2079338)						
Conductivity	----	E100	1	µS/cm	<1.0	----
Physical Tests (QCLot: 2079339)						
Alkalinity, total (as CaCO3)	----	E290	1	mg/L	<1.0	----
Anions and Nutrients (QCLot: 2077426)						
Fluoride	16984-48-8	E235.F	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 2077427)						
Nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 2077428)						
Sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	<0.30	----
Anions and Nutrients (QCLot: 2077429)						
Chloride	16887-00-6	E235.Cl	0.5	mg/L	<0.50	----
Anions and Nutrients (QCLot: 2077430)						
Nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Dissolved Metals (QCLot: 2081869)						
Calcium, dissolved	7440-70-2	E421	0.05	mg/L	<0.050	----
Iron, dissolved	7439-89-6	E421	0.01	mg/L	<0.010	----
Magnesium, dissolved	7439-95-4	E421	0.005	mg/L	<0.0050	----
Manganese, dissolved	7439-96-5	E421	0.0001	mg/L	<0.00010	----
Potassium, dissolved	7440-09-7	E421	0.05	mg/L	<0.050	----
Sodium, dissolved	7440-23-5	E421	0.05	mg/L	<0.050	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 2079337)									
pH	----	E108	----	pH units	7 pH units	100	98.6	101	----
Physical Tests (QCLot: 2079338)									
Conductivity	----	E100	1	µS/cm	1000 µS/cm	103	90.0	110	----
Physical Tests (QCLot: 2079339)									
Alkalinity, total (as CaCO3)	----	E290	1	mg/L	500 mg/L	105	85.0	115	----
Anions and Nutrients (QCLot: 2077426)									
Fluoride	16984-48-8	E235.F	0.02	mg/L	1 mg/L	97.2	90.0	110	----
Anions and Nutrients (QCLot: 2077427)									
Nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	100	90.0	110	----
Anions and Nutrients (QCLot: 2077428)									
Sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	100 mg/L	100	90.0	110	----
Anions and Nutrients (QCLot: 2077429)									
Chloride	16887-00-6	E235.Cl	0.5	mg/L	100 mg/L	99.9	90.0	110	----
Anions and Nutrients (QCLot: 2077430)									
Nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	99.6	90.0	110	----
Dissolved Metals (QCLot: 2081869)									
Calcium, dissolved	7440-70-2	E421	0.05	mg/L	50 mg/L	102	80.0	120	----
Iron, dissolved	7439-89-6	E421	0.01	mg/L	1 mg/L	98.9	80.0	120	----
Magnesium, dissolved	7439-95-4	E421	0.005	mg/L	50 mg/L	99.6	80.0	120	----
Manganese, dissolved	7439-96-5	E421	0.0001	mg/L	0.25 mg/L	104	80.0	120	----
Potassium, dissolved	7440-09-7	E421	0.05	mg/L	50 mg/L	104	80.0	120	----
Sodium, dissolved	7440-23-5	E421	0.05	mg/L	50 mg/L	107	80.0	120	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 2077426)										
SK2503498-001	Anonymous	Fluoride	16984-48-8	E235.F	0.995 mg/L	1 mg/L	99.5	75.0	125	----
Anions and Nutrients (QCLot: 2077427)										
SK2503498-001	Anonymous	Nitrate (as N)	14797-55-8	E235.NO3	2.49 mg/L	2.5 mg/L	99.8	75.0	125	----
Anions and Nutrients (QCLot: 2077428)										
SK2503498-001	Anonymous	Sulfate (as SO4)	14808-79-8	E235.SO4	100 mg/L	100 mg/L	100	75.0	125	----
Anions and Nutrients (QCLot: 2077429)										
SK2503498-001	Anonymous	Chloride	16887-00-6	E235.Cl	99.5 mg/L	100 mg/L	99.5	75.0	125	----
Anions and Nutrients (QCLot: 2077430)										
SK2503498-001	Anonymous	Nitrite (as N)	14797-65-0	E235.NO2	0.497 mg/L	0.5 mg/L	99.5	75.0	125	----
Dissolved Metals (QCLot: 2081869)										
SK2503485-011	Anonymous	Calcium, dissolved	7440-70-2	E421	ND mg/L	----	ND	70.0	130	----
		Iron, dissolved	7439-89-6	E421	2.12 mg/L	2 mg/L	106	70.0	130	----
		Magnesium, dissolved	7439-95-4	E421	ND mg/L	----	ND	70.0	130	----
		Manganese, dissolved	7439-96-5	E421	ND mg/L	----	ND	70.0	130	----
		Potassium, dissolved	7440-09-7	E421	ND mg/L	----	ND	70.0	130	----
		Sodium, dissolved	7440-23-5	E421	ND mg/L	----	ND	70.0	130	----

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QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **SK2503503**	Page	: 1 of 10
Client	: **P. Machibroda Engineering Ltd.**	Laboratory	: ALS Environmental - Saskatoon
Contact	: Graham Baxter	Account Manager	: Kimberley Head
Address	: 806-48th STREET EAST Saskatoon SK Canada S7K 3Y4	Address	: 819 58 Street East Saskatoon, Saskatchewan Canada S7K 6X5
Telephone	: 780 733 6575	Telephone	: +1 306 668 8370
Project	: 22595	Date Samples Received	: 26-Jun-2025 11:00
PO	: ----	Issue Date	: 03-Jul-2025 21:05
C-O-C number	: ----		
Sampler	: PMEL		
Site	: ----		
Quote number	: SK Pricing		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Chloride in Water by IC										
HDPE 25-5	E235.Cl	26-Jun-2025	26-Jun-2025	28 days	0 days	✓	26-Jun-2025	28 days	0 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE 25-5A	E235.Cl	26-Jun-2025	26-Jun-2025	28 days	0 days	✓	26-Jun-2025	28 days	0 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE 22595-1	E235.Cl	25-Jun-2025	26-Jun-2025	28 days	1 days	✓	26-Jun-2025	28 days	1 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE 25-1	E235.Cl	25-Jun-2025	26-Jun-2025	28 days	1 days	✓	26-Jun-2025	28 days	1 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE 25-5	E235.F	26-Jun-2025	26-Jun-2025	28 days	0 days	✓	26-Jun-2025	28 days	0 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE 25-5A	E235.F	26-Jun-2025	26-Jun-2025	28 days	0 days	✓	26-Jun-2025	28 days	0 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE 22595-1	E235.F	25-Jun-2025	26-Jun-2025	28 days	1 days	✓	26-Jun-2025	28 days	1 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Fluoride in Water by IC										
HDPE 25-1	E235.F	25-Jun-2025	26-Jun-2025	28 days	1 days	✓	26-Jun-2025	28 days	1 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE 25-5	E235.NO3	26-Jun-2025	26-Jun-2025	3 days	0 days	✓	26-Jun-2025	3 days	0 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE 25-5A	E235.NO3	26-Jun-2025	26-Jun-2025	3 days	0 days	✓	26-Jun-2025	3 days	0 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE 22595-1	E235.NO3	25-Jun-2025	26-Jun-2025	3 days	1 days	✓	26-Jun-2025	3 days	1 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE 25-1	E235.NO3	25-Jun-2025	26-Jun-2025	3 days	1 days	✓	26-Jun-2025	3 days	1 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE 25-5	E235.NO2	26-Jun-2025	26-Jun-2025	3 days	0 days	✓	26-Jun-2025	3 days	0 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE 25-5A	E235.NO2	26-Jun-2025	26-Jun-2025	3 days	0 days	✓	26-Jun-2025	3 days	0 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE 22595-1	E235.NO2	25-Jun-2025	26-Jun-2025	3 days	1 days	✓	26-Jun-2025	3 days	1 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE 25-1	E235.NO2	25-Jun-2025	26-Jun-2025	3 days	1 days	✓	26-Jun-2025	3 days	1 days	✓

Matrix: **Water**

Evaluation: ✗ = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	*Method*	*Sampling Date*	*Extraction / Preparation*				*Analysis*			
			Preparation Date	*Holding Times* Rec	*Holding Times* Actual	*Eval*	*Analysis Date*	*Holding Times* Rec	*Holding Times* Actual	*Eval*
Anions and Nutrients : Sulfate in Water by IC										
HDPE 25-5	E235.SO4	26-Jun-2025	26-Jun-2025	28 days	0 days	✓	26-Jun-2025	28 days	0 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE 25-5A	E235.SO4	26-Jun-2025	26-Jun-2025	28 days	0 days	✓	26-Jun-2025	28 days	0 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE 22595-1	E235.SO4	25-Jun-2025	26-Jun-2025	28 days	1 days	✓	26-Jun-2025	28 days	1 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE 25-1	E235.SO4	25-Jun-2025	26-Jun-2025	28 days	1 days	✓	26-Jun-2025	28 days	1 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE 25-5	E421	26-Jun-2025	02-Jul-2025	0 hrs	148 hrs	✗ UCP	02-Jul-2025	0 hrs	148 hrs	✗ UCP
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE 25-5A	E421	26-Jun-2025	02-Jul-2025	0 hrs	148 hrs	✗ UCP	02-Jul-2025	0 hrs	148 hrs	✗ UCP
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE 22595-1	E421	25-Jun-2025	02-Jul-2025	0 hrs	169 hrs	✗ UCP	02-Jul-2025	0 hrs	169 hrs	✗ UCP
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE 25-1	E421	25-Jun-2025	02-Jul-2025	0 hrs	169 hrs	✗ UCP	02-Jul-2025	0 hrs	169 hrs	✗ UCP
Physical Tests : Alkalinity Species by Titration										
HDPE 25-5	E290	26-Jun-2025	27-Jun-2025	14 days	1 days	✓	27-Jun-2025	14 days	1 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	*Method*	*Sampling Date*	*Extraction / Preparation*				*Analysis*			
			Preparation Date	*Holding Times* Rec	*Holding Times* Actual	*Eval*	*Analysis Date*	*Holding Times* Rec	*Holding Times* Actual	*Eval*
Physical Tests : Alkalinity Species by Titration										
HDPE 25-5A	E290	26-Jun-2025	27-Jun-2025	14 days	1 days	✓	27-Jun-2025	14 days	1 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE 22595-1	E290	25-Jun-2025	27-Jun-2025	14 days	2 days	✓	27-Jun-2025	14 days	2 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE 25-1	E290	25-Jun-2025	27-Jun-2025	14 days	2 days	✓	27-Jun-2025	14 days	2 days	✓
Physical Tests : Conductivity in Water										
HDPE 25-5	E100	26-Jun-2025	27-Jun-2025	28 days	1 days	✓	27-Jun-2025	28 days	1 days	✓
Physical Tests : Conductivity in Water										
HDPE 25-5A	E100	26-Jun-2025	27-Jun-2025	28 days	1 days	✓	27-Jun-2025	28 days	1 days	✓
Physical Tests : Conductivity in Water										
HDPE 22595-1	E100	25-Jun-2025	27-Jun-2025	28 days	2 days	✓	27-Jun-2025	28 days	2 days	✓
Physical Tests : Conductivity in Water										
HDPE 25-1	E100	25-Jun-2025	27-Jun-2025	28 days	2 days	✓	27-Jun-2025	28 days	2 days	✓
Physical Tests : pH by Meter										
HDPE 25-5	E108	26-Jun-2025	27-Jun-2025	0.25 hrs	27 hrs	× EHTR-FM	27-Jun-2025	0.25 hrs	27 hrs	× EHTR-FM
Physical Tests : pH by Meter										
HDPE 25-5A	E108	26-Jun-2025	27-Jun-2025	0.25 hrs	27 hrs	× EHTR-FM	27-Jun-2025	0.25 hrs	27 hrs	× EHTR-FM

Matrix: **Water**

Evaluation: ✗ = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : pH by Meter										
HDPE										
22595-1	E108	25-Jun-2025	27-Jun-2025	0.25 hrs	48 hrs	✗ EHTR-FM	27-Jun-2025	0.25 hrs	48 hrs	✗ EHTR-FM
Physical Tests : pH by Meter										
HDPE										
25-1	E108	25-Jun-2025	27-Jun-2025	0.25 hrs	48 hrs	✗ EHTR-FM	27-Jun-2025	0.25 hrs	48 hrs	✗ EHTR-FM

Legend & Qualifier Definitions

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended

Rec. HT: ALS recommended hold time (see units).

UCP: Unsuitable Container and/or Preservative used (invalidates standard hold time). Maximum hold time of zero applied. Test results may be biased low / unreliable, and may not meet regulatory requirements.

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = QC frequency outside specification; ✓ = QC frequency within specification.

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Conductivity in Water	E100	2079338	1	20	5.0	5.0	✓
pH by Meter	E108	2079337	1	20	5.0	5.0	✓
Chloride in Water by IC	E235.Cl	2077429	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	2077426	1	18	5.5	5.0	✓
Nitrite in Water by IC	E235.NO2	2077430	1	20	5.0	5.0	✓
Nitrate in Water by IC	E235.NO3	2077427	1	20	5.0	5.0	✓
Sulfate in Water by IC	E235.SO4	2077428	1	18	5.5	5.0	✓
Alkalinity Species by Titration	E290	2079339	1	20	5.0	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	2081869	1	20	5.0	5.0	✓
Laboratory Control Samples (LCS)							
Conductivity in Water	E100	2079338	1	20	5.0	5.0	✓
pH by Meter	E108	2079337	1	20	5.0	5.0	✓
Chloride in Water by IC	E235.Cl	2077429	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	2077426	1	18	5.5	5.0	✓
Nitrite in Water by IC	E235.NO2	2077430	1	20	5.0	5.0	✓
Nitrate in Water by IC	E235.NO3	2077427	1	20	5.0	5.0	✓
Sulfate in Water by IC	E235.SO4	2077428	1	18	5.5	5.0	✓
Alkalinity Species by Titration	E290	2079339	1	20	5.0	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	2081869	1	20	5.0	5.0	✓
Method Blanks (MB)							
Conductivity in Water	E100	2079338	1	20	5.0	5.0	✓
Chloride in Water by IC	E235.Cl	2077429	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	2077426	1	18	5.5	5.0	✓
Nitrite in Water by IC	E235.NO2	2077430	1	20	5.0	5.0	✓
Nitrate in Water by IC	E235.NO3	2077427	1	20	5.0	5.0	✓
Sulfate in Water by IC	E235.SO4	2077428	1	18	5.5	5.0	✓
Alkalinity Species by Titration	E290	2079339	1	20	5.0	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	2081869	1	20	5.0	5.0	✓
Matrix Spikes (MS)							
Chloride in Water by IC	E235.Cl	2077429	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	2077426	1	18	5.5	5.0	✓
Nitrite in Water by IC	E235.NO2	2077430	1	20	5.0	5.0	✓
Nitrate in Water by IC	E235.NO3	2077427	1	20	5.0	5.0	✓
Sulfate in Water by IC	E235.SO4	2077428	1	18	5.5	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	2081869	1	20	5.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Water	E100 ALS Environmental - Saskatoon	Water	APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25°C.
pH by Meter	E108 ALS Environmental - Saskatoon	Water	APHA 4500-H (mod)	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C). For high accuracy test results, pH should be measured in the field within the recommended 15 minute hold time.
Chloride in Water by IC	E235.Cl ALS Environmental - Saskatoon	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Fluoride in Water by IC	E235.F ALS Environmental - Saskatoon	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrite in Water by IC	E235.NO2 ALS Environmental - Saskatoon	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrate in Water by IC	E235.NO3 ALS Environmental - Saskatoon	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Sulfate in Water by IC	E235.SO4 ALS Environmental - Saskatoon	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Alkalinity Species by Titration	E290 ALS Environmental - Saskatoon	Water	APHA 2320 B (mod)	Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.
Dissolved Metals in Water by CRC ICPMS	E421 ALS Environmental - Saskatoon	Water	APHA 3030B/EPA 6020B (mod)	Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by Collision/Reaction Cell ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dissolved Hardness (Calculated)	EC100 ALS Environmental - Saskatoon	Water	APHA 2340B	"Hardness (as CaCO3), dissolved" is calculated from the sum of dissolved Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. "Total Hardness" refers to the sum of Calcium and Magnesium Hardness. Hardness is normally or preferentially calculated from dissolved Calcium and Magnesium concentrations, because it is a property of water due to dissolved divalent cations.
Ion Balance using Dissolved Metals	EC101 ALS Environmental - Saskatoon	Water	APHA 1030E	Cation Sum, Anion Sum, and Ion Balance are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Dissolved species are used where available. Minor ions are included where data is present. Ion Balance cannot be calculated accurately for waters with very low electrical conductivity (EC).
TDS in Water (Calculation)	EC103 ALS Environmental - Saskatoon	Water	APHA 1030E (mod)	Total Dissolved Solids is calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Dissolved species are used where available. Minor ions are included where data is present.
Nitrate and Nitrite (as N) (Calculation)	EC235.N+N ALS Environmental - Saskatoon	Water	EPA 300.0	Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dissolved Metals Water Filtration	EP421 ALS Environmental - Saskatoon	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HNO3.

Chain of Custody (COC) / Analytical Request Form

COC Number: 21 -

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www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Environmental Division Saskatoon

Work Order Reference

SK2503503

Telephone : +1 306 668 8370

Report To	Contact and company name below will appear on the final report
Company:	P. Machibroda Engineering Ltd.
Contact:	Graham Baxter
Phone:	306.665.8444
	Company address below will appear on the final report
Street:	806-48th Street East
City/Province:	Saskatoon, SK
Postal Code:	S7K 3Y4
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	P. Machibroda Engineering Ltd.
Contact:	

Reports / Recipients

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☑ YES ☐ NO ☐ N/A

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax : g.baxter@machibroda.com

Email 2 l.gillan@machibroda.com

Email 3 pmel.sk@machibroda.com

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax accounting@machibroda.com

Email 2

Turnaround Time (TAT) Requeste

☑ Routine [R] if received by 3pm M-F - no surcharges a

☐ 4 day [P4] if received by 3pm M-F - 20% rush surcha

☐ 3 day [P3] if received by 3pm M-F - 25% rush surcha

☐ 2 day [P2] if received by 3pm M-F - 50% rush surcha

☐ 1 day [E] if received by 3pm M-F - 100% rush surcha

☐ Same day [E2] if received by 10am M-S - 200% rush

Additional fees may apply to rush requests on

Date and Time Required for all E&P TATs:

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information

ALS Account # / Quote #:	
Job #:	22595
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (ALS use only):

ALS Contact: K. Head **Sampler:** PMEL

Analysis Request

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ROU-SK (routine)		SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	25-1	25-Jun-25		Water	1	R	R			
	25-5	26-Jun-25		Water	1	R	R			
	25-5A	27-Jun-25		Water	1	R	R			
	22595-1	25-Jun-25		Water	1	R	R			

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human consumption/ use? ☐ YES ☑ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

Saskatchewan Environmental Quality Guidelines (SEQG) (Build 7.0, 2016)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☑ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☑ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☑ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
2				2.0			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by:	Date: June 26/25	Time:	Received by:	Date: 26/6/25	Time: 11:00	Received by: ME3	Date: 26 June 25	Time: 11:[illegible]

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRO

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.