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GEOTECHNICAL DUE DILIGENCE INVESTIGATION REPORT

PROPOSED RETAIL FUEL OUTLET

1622 ROGER STEVENS DRIVE

KARS, ONTARIO K0A 2E0

REPORT REF. NO. CB1057.00
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CONTENTS

APPENDICES

1 INTRODUCTION

Alston Associates (**AA**), the geotechnical division of Terrapex Environmental Ltd. (Terrapex) has been retained by Parkland Fuel Corporation (Parkland) to carry out a geotechnical due diligence study for the proposed construction of a retail fuel outlet, septic system and pavement design at 1622 Roger Stevens Drive, Kars, Ontario.

The property is located on the south side of Roger Stevens Drive and measures approximately 6,400 m^2 in size. It is currently occupied by a single-storey building and a two-storey residential dwelling, with the remainder of the site being covered with asphalt, trees and grass. The site slopes gradually from South to North and East to West, with a localized 2.5 m steep elevation change from the west edge of the asphalt and single-storey building down onto the adjacent farmer's field. The site is bounded by a funeral home (Tubman Funeral Homes) to the east, residential lands to the north and south and agricultural land to the west. The location of the site with the proposed development and borehole/monitoring well locations is shown on Terrapex drawing Figure 1, "*Borehole Location Plan*" enclosed in Appendix B.

It is understood that the proposed retail fuel outlet will include a one-storey retail store with no basement level, a gas pump island with an overhead canopy, underground storage tanks, an asphalt-paved parking lot, and a septic system to be installed in the southern section of the site.

The purpose of this study was to characterize the underlying soil and groundwater conditions of the site, to determine the relevant geotechnical properties of encountered soils and to prepare design recommendations pertaining to building foundations, excavation, backfilling considerations, surface support structures and asphaltic concrete pavement.

This report presents the results of the investigation performed in accordance with the general terms of reference outlined above and is intended for the guidance of the client and the design engineers only. It is assumed that the design will be in accordance with the applicable building codes and standards.

2 FIELDWORK

The fieldwork for this study was carried out on February 22 and 23, 2018 by Terrapex and consisted of advancing nine boreholes, denoted as MW101, BH102 through BH105, MW106 through MW108, and BH109, and one sounding by Dynamic Cone Penetration Test (DCPT), denoted as BH110. The geotechnical boreholes were sampled to depths ranging from 1.8 to 6.1 m below ground surface (bgs). The DCPT sounding was advanced without soil sampling to a depth of 10.7 m bgs. The locations of these boreholes are based on the preliminary layout of the gas station that was provided by Parkland and they are shown on Figure 1, "*Borehole Location Plan*", in Appendix B.

A monitoring well was installed within each of the completed boreholes MW101, MW106, MW107 and MW108. All monitoring wells were developed using disposable plastic bailers to ensure groundwater can flow in and out of the well freely. The construction of these wells are shown on the borehole log sheets enclosed in Appendix C. A representative from Terrapex returned to the site on March 15, 2018 to measure the groundwater levels in the monitoring wells.

Standard Penetration Tests (SPT) were carried out in accordance with American Society for Testing and Materials (ASTM) D-1586 in the course of advancing the sampled boreholes to take representative soil samples and to measure the standard penetration index (N-values) to characterize the condition of the various soil materials. The number of blows of the automatic-trip hammer required to drive the split spoon sampler to 0.3 m depth is recorded and these are presented on the logs as N-values. Results of the SPT are shown on the borehole logs enclosed in Appendix C of this report.

During the drilling program, auger refusal was encountered in six of the boreholes by possible large cobbles or boulders. When auger refusal was encountered at shallow depths, the drill rig was repositioned about 1.0 m away from the original location and subsequently augured to our desired depth. Auger refusal was encountered in BH103, BH104, BH105, MW107, MW108 and BH109.

The purpose of performing DCPT was to measure the equivalent penetration index values in the subsoil units in order to determine the penetration resistance of the subsoil at greater depths where soil sampling was not carried out. The DCPT involves advancing a cone with an outside diameter of 50 mm into the ground using standard penetration test (DPSH) energy. The number of blows of the striking hammer required to drive the cone through successive 300 mm depth increments was recorded and these are presented as penetration index values on the borehole BH110 log from 3.1 to 10.7 m bgs, enclosed in Appendix C of this report.

Observations were made of the groundwater conditions occurring in the boreholes, in the course of their advancement.

On September 19, 2018, Terrapex surveyed the positions and elevations (tops of the well standpipes, as well as the ground surfaces) of the newly installed monitoring wells relative to a temporary site benchmark (TBM). A survey nail located on a utility pole at the northeast corner of the Site was selected as the TBM, which had a geodetic elevation of 92.48 m. As documented on the *Topographic Plan of Survey of Part of Lot 21, Concession 1, Geographic Township of North Gower, City of Ottawa*, by Farley, Smith and Denis Surveying Ltd., 2017, the TBM elevation was derived from the vertical benchmark 0011986U011.

The fieldwork for this study was supervised by a field technician from Terrapex who arranged for the locates of buried services; effected the drilling, sampling and in-situ testing; defined strata interface depths; measured groundwater levels; and prepared field borehole log sheets.

3 LABORATORY TESTING

The soil samples recovered from the boreholes were transported to our laboratory for detailed examination, soil classification and laboratory testing. Water content tests were conducted on all soil samples retained from Boreholes MW101, BH102, BH103B and MW106. The results of the classification and water contents are presented on the borehole log sheets attached in Appendix C. It is noted that selected soil samples retrieved from the boreholes were laboratory-tested for environmental purposes. While the environmental sampling locations are noted in the borehole logs, environmental analytical results and discussions are not part of the scope of work of this report and therefore, they are not included herein.

Grain size analysis ASTM D422 (sieve) were carried out on the following three (3) soil samples:

- Borehole MW101 at 5.5 m depth (sample 9).
- Borehole BH103 at 1.5 m depth (sample 2).
- Borehole BH102 at 2.3 m depth (sample 3).

Grain size analysis ASTM D422 (sieve and hydrometer) were carried out on the following two (2) soil samples:

- Borehole BH105 at 2.3 m depth (sample 3).
- Borehole MW107 at 1.5 m depth (sample 2).

The results of the grain size analyses are presented in Appendix D of this report.

Two representative samples of the subsurface soils obtained from the anticipated foundation depth was submitted to Maxxam Analytics for chemical analytical testing (pH and soluble sulphate content); to determine if the subsurface concrete is to be designed for sulphate attack. Chemical analytical test results are presented in Appendix E of this report.

4 SITE AND SUBSURFACE CONDITIONS

The following sections provide a brief description of the site and subsurface soil and groundwater conditions encountered during our field test program.

4.1 Site Description

The property is located at 1622 Roger Stevens Drive, Kars, Ontario, approximately 1.2 km east of Highway 416. It is rectangular in shape and measures approximately 6,400 m^2 in size. The property is currently occupied by a single storey building and a two storey residential dwelling, with the remainder of the site being covered with asphalt, trees and grass. The site is bounded by a funeral home (Tubman Funeral Homes) to the east, residential lands to the north and south and agricultural lands to the west.

The proposed retail store to be located south of the existing one story building with the proposed gasoline pump island located north of the building. In general, the site slopes gradually from South to North and East to west, with a localized 2.5 m steep elevation change from the west edge of the asphalt and single storey building down onto the adjacent farmer's field. The slope extends from the south edge of Roger Stevens Drive approximately 47.0 m and gradually tapers off to the west.

The preliminary layout of the proposed retail fuel outlet and borehole locations are shown on Figure 1, "Borehole Location Plan", as presented in Appendix B herein.

4.2 Subsurface soil conditions

Details of the subsurface conditions contacted in the boreholes are given on the individual borehole logs enclosed in Appendix C. A brief description of the subsoil units and groundwater conditions are given in the following subsections.

It should be noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design, and therefore, should not be construed as exact planes of geological change. Due to the frost penetration we were unable to recover surficial split spoon samples, samples were collected from auger cuttings within the top 0.61-0.76 m of each borehole.

The subsurface stratigraphy as revealed in the boreholes comprises of a surficial layer of topsoil in boreholes located within the grassed areas of the property; the surficial layer of the boreholes located within the paved areas of the site (MW101, BH102 and BH109) comprises of a sand and gravel fill. These surficial layers are underlain by a native silty sand to sand with some to trace organics. The silty sand to sand with some to trace organics deposit is underlain by a native silty sand to sand, some to trace embedded gravel which extends beyond the sampled depth of the boreholes. On March 15, 2018, the groundwater levels were measured in the monitoring wells at depths between 0.08 m bgs (MW107) to 2.80 m bgs (MW108); these groundwater measurements correspond to about elevation 92.38 to 88.59 m.

4.2.1 Topsoil

Topsoil was encountered in boreholes BH103, BH104, BH105, MW106, MW107 and MW108. The thickness of the topsoil in boreholes BH103 and MW108 were measured as 102 mm and 40 mm, respectively. It should be noted that the topsoil thickness will vary between boreholes and may be thicker than that found at the boreholes.

4.2.2 Fill

Sandy gravel with trace silt fill material was found in MW101 at depths between 0.6 to 3.6 m bgs and in BH102 between 0.6 and 1.4 m bgs. BH102 contained a brownish black sand some silt trace organics fill deposit between 1.4 and 2.2 m bgs. Samples of the subbase material from underside of the asphaltic concrete were collected from the augers between the depths of 0.1 and 0.6 m and were classified as a sand and gravel.

4.2.3 Native Silty Sand, some to trace gravel [SM]

Underlying the surficial topsoil layer is natural deposit of a dark brown, brown and grey native silty sand with some to trace gravel. The silty sand with some to trace gravel deposit extends beyond the sampled depth of all the boreholes. Near the surface, in the upper 0.6 to 1.8 m of the deposit, the silty sand is dark brown to brown and contains trace to some organic material at the locations of BH103, BH104, BH105, MW106 and MW108.

The silty sand with some to trace gravel changes from brown to a grey at depths ranging from 4.9 to 5.3 m bgs in MW101m BH102, MW106, and MW108.

Standard penetration test N-values obtained from this layer ranged from 2 to 56 blows per 300 mm of penetration to indicate a compactness condition ranging from loose to dense. The compactness of the soil is variable in this deposit possibly due to the inclusions of cobbles/boulders which were encountered in six (6) locations during the drilling program, resulting in auger refusal and relocating the drill rig 1.0 m away from original location. Auger refusal on possible cobbles or boulders occurred in;

- BH103 at a depth of 4.4 m bgs;

- BH104 at a depth of 1.8 m bgs;
- BH105 at a depth of 3.7 m bgs;
- MW107 at a depth of 3.7 m bgs;
- MW108 at a depth of 2.9 m bgs;
- BH109 at a depth of 3.7 m bgs.

The loose condition is only encountered in the grey saturated silty sand, some to trace gravel deposit in MW106 at a depth of 4.7 m bgs.

Some of the high blow counts recorded are likely the result of encountering larger cobbles or boulders. The balance of the silty sand, some to trace gravel deposit is in a compact condition.

Grain size analyses were carried out on five (5) representative samples of the silty sand, some to trace gravel soil. The material in this layer is classified as SM, in accordance with the Unified Soil Classification System (USCS). The test results are enclosed in Appendix D, and summarized below.

Borehole No.	Sample Number)	Sample Depth (mbgs)	Sample Description	Gravel %	Sand %	Silt %	Clay %	Coefficient of Permeability, k[1] (cm/sec)
BH101	6	3.7 to 4.4	SAND some gravel some silt	15	73	12	-	
BH102	3	2.2 to 2.8	SILTY SAND trace gravel	9	78	22	-	
BH104	2	1.5 to 2.1	SILTY SAND some gravel	14	51	35	-	
BH105	3	2.2 to 2.8	SILTY SAND some gravel	12	57	31	-	10^{-3} to 10^{-5}
MW107	2	1.5 to 2.1	SILTY SAND some gravel	11	49	40	-	10^{-3} to 10^{-5}

Note: (1) References from Terzaghi and Peck “Soil Mechanics in Engineering Practice”. John Wiley and Sons, Inc. (1967)

Water contents measured on samples of the silty sand range from approximately 9 to 16 percent by weight.

4.3 Groundwater

Observations of groundwater conditions were made in the installed monitoring wells on February 23 and March 15, 2018.

Groundwater was encountered in all the monitoring wells. Upon completion of the fieldwork the groundwater was measured at depths ranging from 0.10 to 2.80 m bgs in the monitoring wells. On March 15, 2018, the groundwater levels were measured in the monitoring wells at depths between 0.08 m bgs (MW107) to 2.80 m bgs (MW108); these groundwater measurements correspond to about elevation 92.38 and 88.59.

The silty sand with some to trace gravel has medium to low conductivities and the groundwater yield from these soils is expected to be moderate.

It should be noted that groundwater levels are subject to seasonal fluctuations. A higher groundwater table condition will likely develop in the spring and following significant rainfall events.

4.4 Soundings by Dynamic Cone Penetration Tests (DCPT)

Borehole BH110 was extended beyond the sampled depth by advancing by Dynamic cone penetration tests (DCPT) to a depth of 10.7 m bgs. The DCPT measured equivalent N-values ranging between 10 and 83; more specifically, equivalent N-values of less than 30 were found to extend to a depth of 6.5 m bgs and equivalent N-values of less than 50 were found to extend to a depth of 10.7 m bgs, with N-values of greater than 60 where possible boulders were encountered.

4.5 Chemical Characterization of Sub-Soil

Two soil samples were submitted for chemical testing; one sample was selected from MW102 at a depth of 3.0 m bgs (sample 4) and one sample was selected from BH103 at a depth of 1.5 m bgs (sample 2). The samples were submitted to Maxxam Analytics for determination of pH index and sulphate content.

The test results revealed that the pH index in MW102-4 was 7.85 and 7.93 in BH103-2. The water-soluble sulphate content of the soil sample is 0.0054 % in both samples.

The pH content of the tested sample has a weak alkalinity. The concentration of water-soluble sulphate content of the tested samples is below the CSA standard of 0.1% water-soluble sulphate (Table 12 CSA A23.1, Requirements for Concrete Subjected to Sulphate Attack). Special concrete mixes against sulphate attack is therefore not required for the sub-surface concrete of the proposed buildings.

The test results are included in the Certificate of Analysis provided by Maxxam Analytics; contained in Appendix E of this report.

5 DISCUSSION AND RECOMMENDATIONS

It is understood that the subject property is to be developed as a retail fuel outlet consisting of a one-storey retail store with no basement level, a gas pump island with overhead canopy, underground storage tanks, an asphalt-paved parking lot, and a septic system to be placed in the southern portion of the site. It is anticipated that there will be some modifications in site grading, but this has not been established at the time of the issuance of this report.

This investigation has revealed that below the surficial topsoil layer the site is underlain in general by a moist, brown and grey native silty sand some to trace gravel with occasional boulders. A loose condition is present in the upper 1.5 m of topsoil and native silty sand some organics soil; below this depth the silty sand some to trace gravel soil is generally loose to compact with occasional very dense areas where possible large cobbles or boulders were encountered. Below of the asphaltic concrete is a moist, compact sand and gravel fill which varies in depths up to 3.6 m bgs in MW101; below this depth the silty sand some to trace gravel deposit was encountered.

The groundwater levels were measured on March 15, 2018 in the monitoring wells at depths between 0.08 m bgs (MW107) to 2.80 m bgs (MW108); these groundwater measurements correspond to about elevation 92.38 to 88.59 m. The groundwater flows in a northwesterly direction from the southern end of the site with higher ground elevations towards Roger Stevens Drive. It should be noted that considerable rain and snow melt had occurred during the time of monitoring and may affect the groundwater readings.

The DCPT sounding revealed a compact soil below a depth of 3.2 m bgs.

On the basis of the fieldwork, laboratory tests and other pertinent information supplied by the client, the following comments and recommendations are made.

It should be understood that the comments are to be considered preliminary, and should be reviewed by **AA** when detailed designs are finalized.

5.1 Excavations and Dewatering

Excavation of the soils at this site can be carried out using standard hydraulic excavators. We note that based on our subsurface investigation, numerous cobbles/boulders were encountered within the native silty sand, some to trace gravel layer. Removal of the cobbles/boulders may be required if they are interfering with foundation construction at subgrade level.

All excavations must be carried out in accordance with Occupational Health and Safety Act (OHSA). The sand and gravel fill material and the native silty sand with some to trace gravel above the groundwater table are classified as Type 3 soil and below the groundwater table are classified as Type 4 soil. Slopes of sidewalls in excavations should be cut back at an angle of 1 horizontal to 1 vertical (45 degrees) above the groundwater and at an angle of 3 horizontal to 1 vertical below the groundwater table.

The silty sand some to trace gravel soils positioned below the groundwater table are expected to remain vertical for a short period of time, however if walls are left exposed the soil will begin to crack and splay into the trench. In order to safely and effectively construct an excavation, the groundwater table should be lowered below the proposed base of the excavation.

The groundwater table must be lowered prior to excavating for footing foundations and services.

Based on the results of the grain size analyses, the coefficient of permeability of the silty sand soil is estimated to range between 10^{-3} and 10^{-5} cm/second considered to be of medium to low hydraulic conductivity. The groundwater yield from this deposit is expected to be low to moderate. For shallow localized excavations which extend to depths of up to 0.3 m below the groundwater level, dewatering should not be an issue. Where excavations are required to extend more than 0.3 m below the groundwater table, it may be possible to use deep filtered sumps to provide the required dewatering in order to maintain basal stability as well as dry working conditions. The dewatering system should be designed and installed by specialist dewatering contractor experienced in this field.

Where workers must enter excavations, the excavation must be dry and, the excavation side-walls must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.

In the event that the dewatering quantities will exceed 50,000 litres per day it will be necessary to obtain a Permit to Take Water (PTTW).

5.2 Reuse of On-site Excavated Soils as Compacted Backfill

The existing on-site native silty sand, some to trace gravel soil is considered suitable for reuse as backfill material provided any topsoil, organic or other unsuitable materials are excluded from the backfill, and the backfill materials' water content is within 2 percent of its optimum moisture content as determined by Standard Proctor test.

The water contents of the native silty sand, some to trace gravel soil range between 9 and 16 percent; which is close to the materials' optimum moisture content (about 11 percent). Wet soils should be dried sufficiently in order to achieve the specified degree of compaction. Spreading of the material in a wide area and air drying will be required to achieve the specified compaction of the material. The lift thickness for compaction and the water content of the soils must be properly controlled during the backfilling. The silty sand some to trace gravel soils should be effectively compacted with heavy vibratory smooth drum roller.

It is recommended that service trench excavations may be backfilled with on-site suitable native soils such that at least 95% of Standard Proctor Maximum Dry Density (SPMDD) is obtained in the lower zone of the subgrade and 98% of SPMDD for the upper 1 m of the subgrade.

5.3 Foundation Design

The proposed structures within the fuel outlet are the one-storey retail store with no basement level, a gas pump island with overhead canopy, and underground storage tanks (assuming bottom of the tanks is at about 4 m bgs). The subsurface conditions at these locations are represented by Boreholes BH103 and BH104 for the retail store, BH102 and BH109 for the gas pump island, and MW101 for the underground storage tank. Based on the subsurface investigation results and the proposed structures, shallow foundation system appears to be feasible to support the three structures.

5.3.1 Foundations for the Retail Store and Gas Pump Island

The soil profile at the site consists of a surficial topsoil layer underlain by a native silty sand, some to trace gravel soil. The upper layer (about 0.75 m thick) of the silty sand soil deposit is found to be loose, dark brown and contains some organic material; below this upper organic layer the silty sand some to trace gravel soil is generally loose to compact with occasional boulders positioned at random and unpredictable depths. Groundwater is situated at about 2.80 m bgs (or elevation 88.59 m) below the location of the proposed retail store and gas pump island in the vicinity of borehole MW108.

Conventional spread and strip footings may be used to support the proposed retail store and gas pump island. Refer to Section 5.1 Excavations and Dewatering for recommendations pertaining to foundation excavations and dewatering.

The on-site fill material is considered as unsuitable bearing material for the proposed structure. The proposed foundations must be founded on the loose to compact native silty sand with some to trace gravel. Conventional spread and strip footings may be designed for an allowable bearing resistance at Serviceability Limit States (SLS) of 100 kPa, and a factored geotechnical bearing resistances at Ultimate Limit States (ULS) of 150 kPa. Subgrade preparation should include the removal of topsoil, fill material, any weak, softened and disturbed soils. All exterior footings and footings in unheated areas should be provided with at least 1.8 m of soil cover or equivalent artificial thermal insulation for frost protection purposes.

The total and differential settlements of foundations designed in accordance with the bearing resistance values recommended in the above sub-sections should not exceed the conventional limits of 25 mm and 19 mm, respectively.

Due to variations in the consistency of the founding soils and/or softening caused by excavation disturbance and/or seasonal frost effects, all footing subgrade preparation must be witnessed by the Geotechnical Engineer prior to placing foundation concrete to ensure that the soil exposed at the excavation base is consistent with the design geotechnical bearing resistance. Larger cobbles or boulders encountered within the excavation base must to be removed.

The foundations of the overhead canopy columns of the gas pump island should be designed to resist uplift forces from wind loads. The recommended ultimate bond stress between the canopy column foundation and the soil is 50 kPa.

5.3.2 Slab-on-Grade

The floor slab for the proposed retail store and gas pump island will be supported on the native silty sand some to trace gravel which is adequate to support a slab-on-grade construction. Subgrade preparation should include the removal of topsoil, fill material, any weak, softened and disturbed soils. After removal of all unsuitable materials, the subgrade should then be proof-rolled with heavy rubber tired equipment. The proof-rolling operation should be witnessed by the Geotechnical Engineer. Any soft or wet subgrade areas which deflect significantly should be sub-excavated and replaced with suitable approved earth fill material compacted to at least 98% of SPMDD.

Where new fill is required to raise the grade, excavated native material from the site may be used, provided the material is free from topsoil, organic or deleterious matter. The fill material should not be frozen and should not be too wet for efficient compaction (moisture content at optimum or 2 percent greater than optimum). The fill placement should not be performed during winter months when freezing temperatures occur persistently or intermittently. All fill placed below the slab on grade areas of the buildings must be placed in thin lifts of 150 mm thickness or less.

It is recommended that a combined moisture barrier and a levelling course, having a minimum thickness of 150 mm and comprised of free draining material using Granular A be provided as a base for the slab-on-grade. Granular materials should meet OPSS 1010 specifications. The base material should be compacted to 98 percent of its SPMDD. Alternatively, 19 mm clear stone (OPSS 1004) may be used and compacted by vibration to a dense state, with filter fabric separating the clear stone and the subgrade soils.

Provided the subgrade, under-floor fill and granular base are prepared in accordance with the above recommendations, the Modulus of Subgrade Reaction (Ks) for floor slab design will be 20 MPa/m.

The soils at this site are susceptible to frost effects which would have the potential to deform hard landscaping adjacent to the buildings. At locations where the buildings are expected to have flush entrances, care must be taken in detailing the exterior slabs / sidewalks, providing insulation / drainage / non-frost susceptible backfill to maintain the flush threshold during freezing weather conditions.

Perimeter and under floor drainage will not be required provided that the floor slab of the building is a minimum of 150 mm above the exterior grade.

5.3.3 Foundations for the Underground Storage Tanks

The foundation recommendations for the underground storage tanks are based on the assumption that the bottom of the tanks will be situated at about 4 m bgs. The native sand with some gravel and silt is encountered at this depth and this material is considered as suitable bearing material. A concrete mat foundation appears to be feasible to support the underground storage tanks and to minimize the amount of differential settlement of the foundation. The mat may be designed for an allowable bearing resistance at Serviceability Limit States (SLS) of 200 kPa, and a factored geotechnical bearing resistances at Ultimate Limit States (ULS) of 300 kPa. The Modulus of Subgrade Reaction (Ks) for the mat design will be 20 MPa/m.

5.3.4 Subgrade Protection

The native soils are susceptible to disturbance when wet, so construction scheduling should consider the amount of excavation left exposed to the elements, during foundation preparation.

Rainwater or groundwater seepage entering the foundation excavation must be pumped away (not allowed to pond). The foundation subgrade soils should be protected from freezing, inundation and equipment traffic at all times.

The native soils tend to weather and deteriorate rapidly on exposure to atmosphere or surface water. **AA** recommends that footings placed on the exposed soil should be poured on the same day as they are excavated, after removal of all unsuitable founding materials and approval of the bearing surface. Alternatively, a concrete mud slab could be used to protect a bearing surface where footing construction is to be delayed.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

5.4 Service Trenches

The loose to compact native silty sand some to trace gravel soils would require some improvement in order to provide a suitable support for the pipelines; this may be accomplished by compacting the loose soils to no less than 98 % of SPMDD provided the trench is dry. Alternatively, the granular bedding may be reinforced with a high strength woven geotextile. This should consist of material with a wide width tensile strength of 200kN/m in both directions such as TenCate Geolon® PET 200S or approved equal. The recommended geotextile should fully enclose the bedding, below the invert of the pipeline.

Watermain positioned to rest on the improved native soils should be restrained at the connection points along the pipeline.

The type of bedding depends mainly on the quality of the subgrade immediately below the invert levels and particularly on the shear strength of the subgrade.

Conventional Class ‘B’ bedding is recommended for the underground utilities. Bedding materials can be well graded, granular material such as Granular ‘A’ (sand and gravel) or 19 mm Crusher Run Limestone; all granular materials should meet the OPSS 1010 specifications provided the base of the trench excavation is dry enough to effect compaction. All granular bedding materials must be compacted to at least 98% of SPMDD.

The use of unprotected no-fines material such as “clear stone” or “high performance bedding” for pipe bedding and trench backfill is not recommended for the site. The saturated silty fine sand soils which lie at invert elevation and which will enclose the bedding are expected to invade any no-fines material resulting in subsidence of the adjacent ground.

Pipe bedding and backfill for flexible pipes should be undertaken in accordance with OPSD 802.010. Pipe embedment and cover for rigid pipes should be undertaken in accordance with OPSD 802.030.

Where disturbance of the trench base has occurred, for example as a result of groundwater seepage or construction traffic, the disturbed soils must be sub-excavated and replaced with suitably compacted bedding material.

Sand cover material should be placed as backfill to at least 300 mm above the top of pipe for the full width of the trench excavation. Placement of additional granular material (thickness dictated by the type of compaction equipment) as required or use of smaller compaction equipment for the first few lifts of native material above the pipe will probably be necessary to prevent damage to the pipe during the trench backfill compaction.

The soils used to backfill the utility trenches should be compacted to no less than 95% SPMDD in the lower zone of the subgrade and 98% of SPMDD for the upper 1 m of the subgrade.

In areas of narrow trenches or confined spaces such as around manholes, catchbasins, etc., the use of aggregate fill such as Granular ‘B’ Type I (OPSS 1010) is required if there is to be post-construction grade integrity.

5.5 Pavement Thickness

We understand that the pavement will be used for parking light vehicles and occasional delivery tractor-trailer trucks. The entrances and sections of the pavement should be reconstructed to support these loads.

The condition of the subgrade soils should be improved in order to be considered suitable to support a conventional pavement structure. Given the frost susceptibility and drainage characteristics of the subgrade soils, the following pavement structure designs are recommended for light and heavy duty pavement structures:

Table No. 1. Recommended Asphaltic Concrete Pavement Structure Design

Pavement Layer	**Compaction Requirements**	**Light Duty Pavement Minimum Component Thickness**	**Heavy Duty Pavement Minimum Component Thickness**
Surface Course Asphaltic Concrete	as per OPSS 310	40 mm Hot-Laid HL3	50 mm Hot-Laid HL3
Binder Course Asphaltic Concrete	as per OPSS 310	40 mm Hot-Laid HL8	60 mm Hot-Laid HL8
Granular Base	100% SPMDD*	150 mm Granular 'A' or 19 mm Crusher Run Limestone	150 mm Granular 'A' or 19 mm Crusher Run Limestone
Granular Subbase	100% SPMDD*	200 mm Granular 'B' Type II	400 mm Granular 'B' Type II

* Note: Standard Proctor Maximum Dry Density (ASTM-D698).

The subgrade must be compacted to at least 98% of SPMDD for at least the upper 600 mm and 95% below this level. The granular pavement structure materials should be placed in lifts not exceeding 150 mm thick and be compacted to a minimum of 100% SPMDD. Asphaltic concrete materials should be rolled and compacted as per OPSS 310. The granular and asphaltic concrete pavement materials and their placement should conform to OPSS 310, 501, 1010 and 1150, and the pertinent Municipality specifications. Further, it is recommended that the Municipality's specifications should be referred to for use of higher grades of asphalt cement for asphaltic concrete where applicable, particularly in the areas of expected heavy truck traffic.

The long-term performance of the proposed pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be crowned and sloped (at minimum of 3% for both the pavement surface and the subgrade) to provide effective drainage. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Sub-drains or drainage ditches must be provided to facilitate effective and assured drainage of the pavement structures as required to intercept excess subsurface moisture and minimize subgrade softening. The invert of sub-drains should be maintained at least 0.3 m below subgrade level.

Additional comments on the construction of pavement areas are as follows:

- As part of the subgrade preparation, proposed pavement areas should be stripped of topsoil, unsuitable earth fill, organic soils and other obvious objectionable material. Fill required to raise the grades to design elevations should be free of organic material and at a moisture content which will permit compaction to the specified densities. The subgrade should be properly shaped, crowned, and then proof-rolled. Soft or spongy subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% of SPMDD.

- The most severe loading conditions on pavement areas and the subgrade may occur during construction during wet and un-drained conditions. Consequently, special provisions such as restricted lanes, half-loads during paving etc., may be required, especially if construction is carried out during unfavorable weather.
- Proof-rolling of the subgrade must be carried out and witnessed by **AA** personnel for final recommendations of sub-base thicknesses.

5.6 Septic System

It is our understanding that a septic bed is to be installed in the vicinity of boreholes MW107 and BH105 located within the southern portion of the site. The soil located within the boreholes is native silty sand with trace gravel. Groundwater level is at about 0.3 m bgs; this corresponds to an elevation of about elevation 92.16 m.

To determine the Coefficient of Permeability (k), soil samples were selected for grain size analysis from depths ranging from 2.3-2.9 m bgs in BH 105 (sample 3) and 1.5-1.9 m bgs in MW107 (sample 2). The grain size analysis carried out on BH105 sample 3 and MW107 sample 2 classified the soil samples as SM (Silty sands, silt sand mixtures) based on the Unified Soil Classification; the result of these tests are presented in appendix D as Figure No. F4G and F5G. The grain size analysis was carried out in accordance with ASTM D422.

We were able to calculate an approximate coefficient of permeability k, based on the D_{10} value determined from the grain size analysis. The percolation times are estimated based on the Unified Soil Classification and the empirical charts provided in the Ontario Building Code's *MMAH Supplementary Standard SB-6 Percolation Time and Soil Descriptions*.

The table below provides an approximate coefficient of permeability and estimated percolation time for BH105 sample 3 and MW107 sample 2.

Sample Number	Approximate Coefficient of Permeability (k)	Estimated Percolation Time based on Unified Soil Classification (Percolation Time T-mins/cm)	Comments
BH105-3	K= 10^{-3} to 10^{-5} cm/s	8 to 20	Medium to low permeability
MW107-2	K= 10^{-3} to 10^{-5} cm/s	8 to 20	Medium to low permeability

5.7 Earthquake Design Parameters

The Ontario Building Code (2012) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.18.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

The parameters for determination of the Site Classification for Seismic Site Response are set out in Table 4.1.8.4.A of the Ontario Building Code (2012). The classification is based on the determination of the average shear wave velocity in the top 30 meters of the site stratigraphy, where shear wave velocity (Vs) measurements have been taken. In the absence of such measurements, the classification is estimated on the basis of empirical analysis of undrained shear strength or penetration resistance. The applicable penetration resistance is that which has been corrected to a rod energy efficiency of 60 percent of the theoretical maximum or the (N_{60}) value.

Based on the borehole information and the DCPT sounding, the subsurface stratigraphy generally comprises of a loose to compact native silty sand some to trace gravel becoming dense below a depth of 9.5 m bgs. Based on the above, the site designation for seismic analysis is Class D according to Table 4.1.8.4.A from the quoted code.

The site specific 5 percent damped spectral acceleration coefficients, and the peak ground acceleration factors are provided in the 2012 Ontario Building Code - Supplementary Standard SB-1 (August 15, 2006), Table 1.2, Ottawa, Ontario.

6 LIMITATIONS OF REPORT

The Limitations of Report, as quoted in Appendix 'A', are an integral part of this report.

alston associates

A division of Terrapex Environmental Ltd.

LICENSED PROFESSIONAL ENGINEER
DEC. 13 2018
V. NERSESIAN
3377[illegible]05
PROVINCE OF ONTARIO

Prepared by:
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Vice President, Geotechnical Services

Jeffrey K. Au, P.E.
Project Manager

APPENDIX A

LIMITATIONS OF REPORT

limitations of report

The conclusions and recommendations in this report are based on information determined at the inspection locations. Soil and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made as set out in this report. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

This report was prepared for Parkland Fuel Corporation by Alston Associates. The material in it reflects Alston Associates judgement in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions which the Third Party may make based on it, are the sole responsibility of such Third Parties.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis. We recommend also that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. In cases where these recommendations are not followed, the company’s responsibility is limited to accurately interpreting the conditions encountered at the test holes, only.

The comments given in this report on potential construction problems and possible methods are intended for the guidance of the design engineer, only. The number of inspection locations may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

APPENDIX B

FIGURE 1: BOREHOLE LOCATION PLAN

TERRAPEX

BOREHOLE LOCATIONS PLAN

1622 ROGER STEVENS DRIVE
KARS, ONTARIO

CLIENT

Parkland
FUEL CORPORATION

-This plan has been prepared without a up to date certificate of location.
-The municipal regulations have not been verified.
-The plan can be modified as required.

LEGEND

- 🔴 BOREHOLE LOCATION
- ⊕ MONITORING WELL LOCATION

0 15m 30m
(APPROXIMATE)

SOURCE: PROVIDED BY CLIENT.

PROJECT #	CB1057.00
SCALE	AS SHOWN
DATE	FEBRUARY 2018
DRAWN	GS
CHECKED	GLL
DRAWING #	FIGURE 1

APPENDIX C

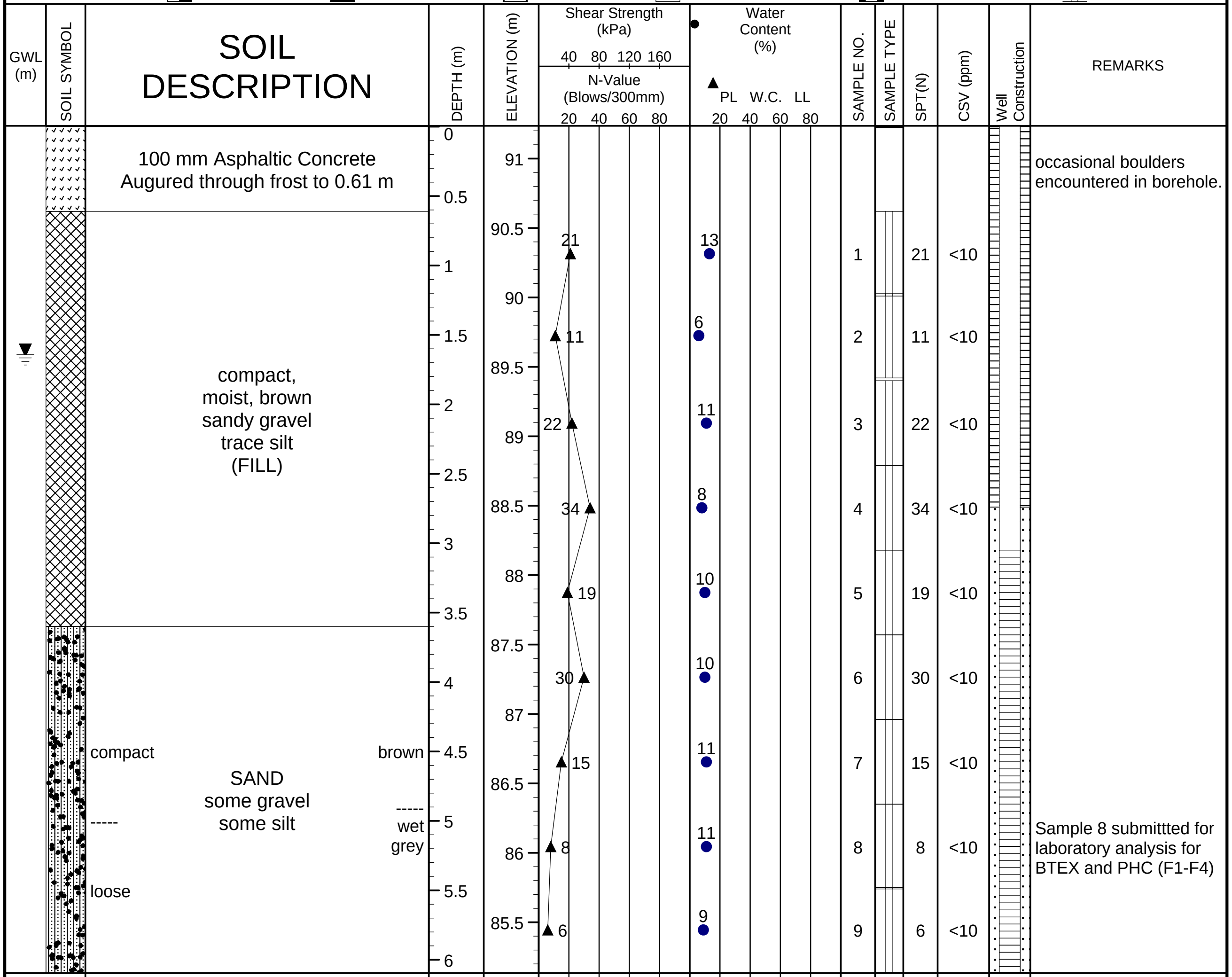
BOREHOLE LOGS AND DYNAMIC CONE PENETRATION TEST RESULTS

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling

BH No.: MW101

PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 91.23
LOCATION: Kars, Ontario
NORTHING: 0448260
EASTING: 5000463
PROJECT NO.: CB1057.00

SAMPLE TYPE ◨ AUGER ◪ DRIVEN ⧗ CORING ⬒ DYNAMIC CONE ▮ SHELBY ⌶ SPLIT SPOON



100 mm Asphaltic Concrete
Augured through frost to 0.61 m

compact,
moist, brown
sandy gravel
trace silt
(FILL)

compact brown
SAND
some gravel
some silt
----- -----
wet
grey
loose

END OF BOREHOLE

SAMPLE NO.	N-Value	Water Content (%)	SPT(N)	CSV (ppm)
1	21	13	21	<10
2	11	6	11	<10
3	22	11	22	<10
4	34	8	34	<10
5	19	10	19	<10
6	30	10	30	<10
7	15	11	15	<10
8	8	11	8	<10
9	6	9	6	<10

REMARKS:

occasional boulders encountered in borehole.

Sample 8 submittted for laboratory analysis for BTEX and PHC (F1-F4)

LOGGED BY: RH
DRILLING DATE: February 26, 2018
REVIEWED BY: VN
Page 1 of 1

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 91.64

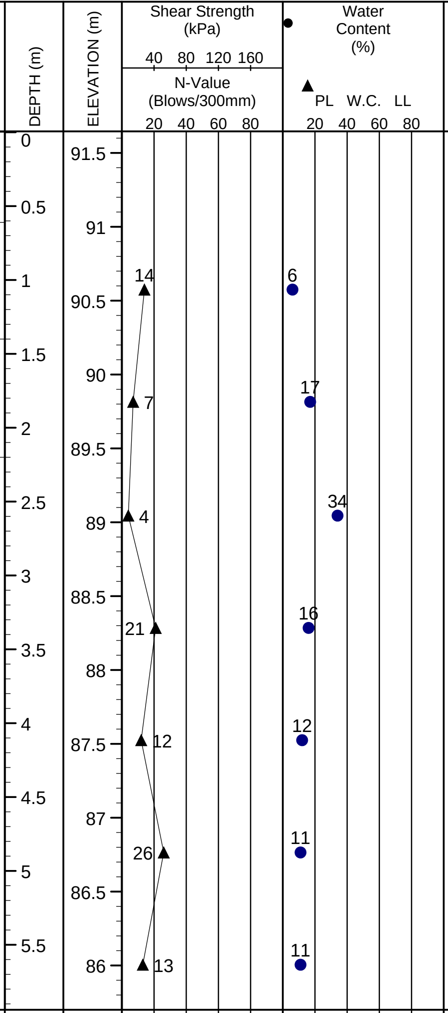
BH No.: BH102

LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

SOIL DESCRIPTION	SAMPLE NO.	SPT(N)	Water Content (%)	CSV (ppm)	REMARKS
50 mm Asphaltic Concrete Augured through frost to 0.60 m					150 mm of Granular material measured underside of pavement occasional boulders encountered in borehole.
compact, very moist, brown sand and gravel (FILL)	1	14	6	<10	
loose, moist, brownish black sand some silt trace organics (FILL)	2	7	17	<10	Sample 2 was submitted for laboratory analysis for pH and Soluable. Sulphate analysis.
loose wet	3	4	34	<10	
----- ----- moist	4	21	16	<10	
compact SILTY SAND trace embedded gravel	5	12	12	<10	Sample 5 was submitted for laboratory analysis for BTEX and PHC's F1-F4
brown -----	6	26	11	<10	
grey	7	13	11	<10	

END OF BOREHOLE



LOGGED BY: RH
DRILLING DATE: February 26, 2018
REVIEWED BY: VN
Page 1 of 1

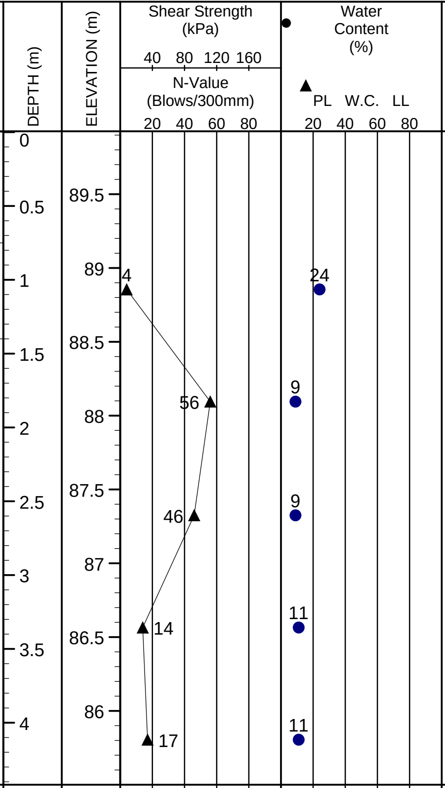
CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 89.92

BH No.: BH103

LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

GWL (m)	SOIL DESCRIPTION
	100 mm Topsoil Augured through frost to 0.75 m
	loose, wet, dark brown SILTY SAND some organics
	moist, brown SILTY SAND some embedded gravel ----- dense ----- compact
	END OF BOREHOLE



SAMPLE NO.	SAMPLE TYPE	SPT(N)	CSV (ppm)	W.C. (%)	Well Construction
1	SPLIT SPOON	4	<10	24	
2	SPLIT SPOON	56	<10	9	
3	SPLIT SPOON	46	<10	9	
4	SPLIT SPOON	14	<10	11	
5	SPLIT SPOON	17	<10	11	

REMARKS

102 mm of Topsoil measured in Borehole

occasional boulders encountered in borehole.

Sample 2 was submitted for laboratory analysis for pH and Soluable. Sulphate analysis.

Sample 4 was submitted for laboratory analysis of BTEX and PHC's (F1-F2).

Auger refusal at 2.9 and 4.42 m on possible boulders.

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Page 1 of 1

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 91.75

BH No.: BH104

LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	● Water Content (%) ▲ PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	CSV (ppm)	Well Construction	REMARKS
		Topsoil at surface Augured through frost to 0.76 m	0 0.5	91.5 91								occasional boulders encountered in borehole.
		loose ----- compact to dense moist, dark brown sand some silt some organics (FILL)	1 1.5	90.5 90	6 ▲ 56 ▲		1 2		6 56	<10 <10		Sample 1 was submitted for laboratory analysis of BTEX, PHC's F1-F2 and pH. Auger refusal at 1.82 m on possible boulders.
		END OF BOREHOLE										

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DRILLING DATE: February 26, 2018
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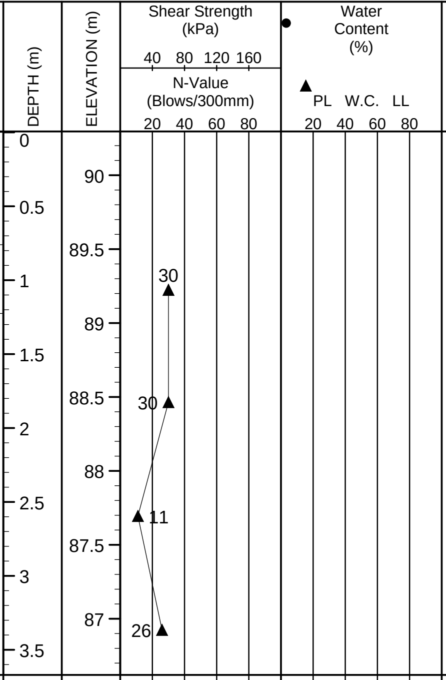
Page 1 of 1

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 90.29
BH No.: BH105
LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SAMPLE NO.	SAMPLE TYPE	SPT(N)	CSV (ppm)	Well Construction	REMARKS
		Topsoil at surface Augured through frost to 0.75 m								occasional boulders encountered in borehole.
		compact, moist, brown SILTY SAND trace organics			1		30	<10		
		compact, moist, brown SILTY SAND some embedded gravel			2		30	<10		
					3		11	<10		Sample 3 was submitted for laboratory analysis for BTEX and PHC's F1-F4.
					4		26	<10		



END OF BOREHOLE

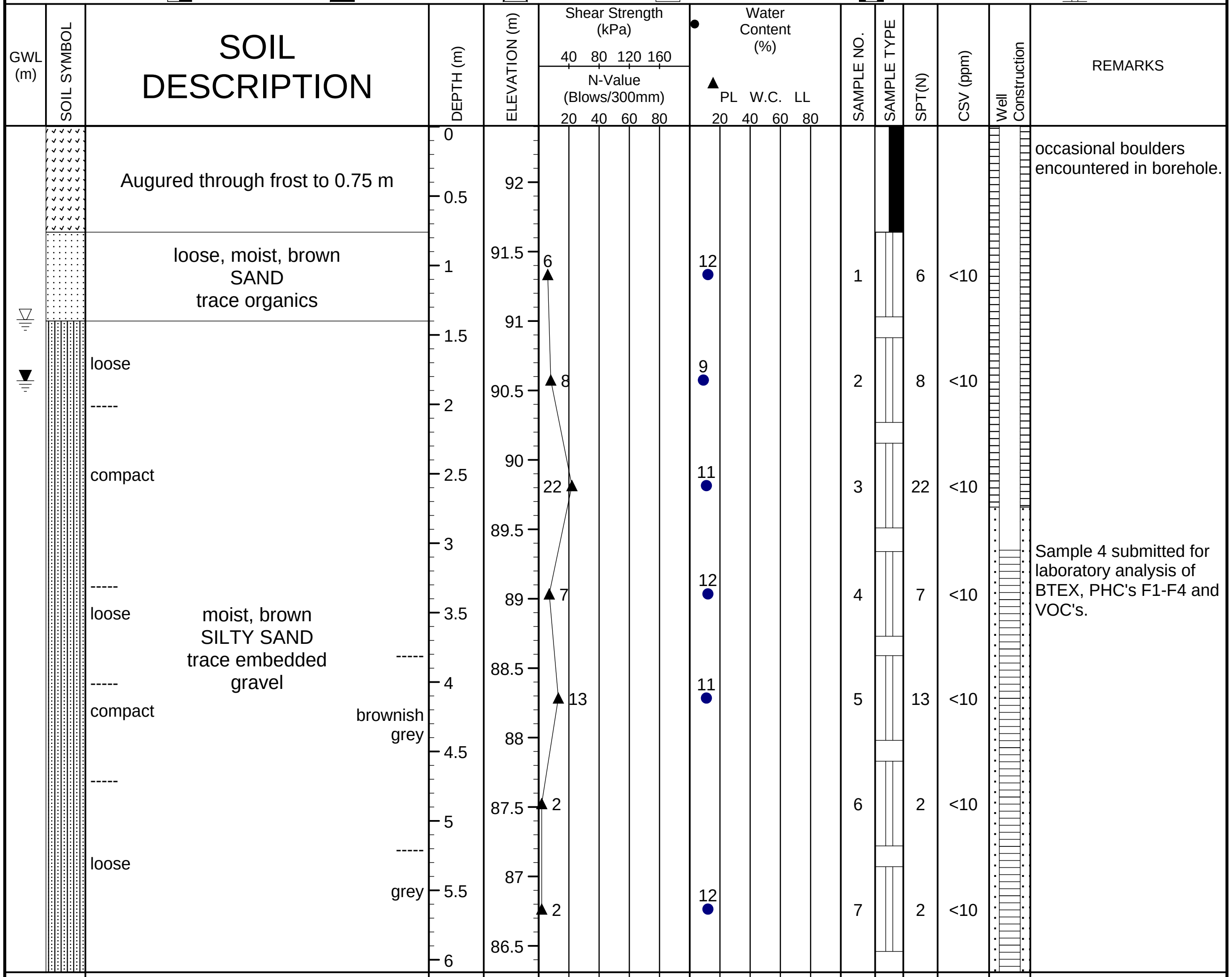
LOGGED BY: RH
DRILLING DATE: February 26, 2018
REVIEWED BY: VN

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 92.40

BH No.: MW106

LOCATION: Kars, Ontario
NORTHING: 0448302
EASTING: 5000442
PROJECT NO.: CB1057.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



Augured through frost to 0.75 m

loose, moist, brown
SAND
trace organics

moist, brown
SILTY SAND
trace embedded
gravel

loose
-----
compact
-----
loose
-----
compact
-----
loose

-----
brownish
grey
-----
grey

SAMPLE NO.	SPT(N)	CSV (ppm)	Water Content (%)
1	6	<10	12
2	8	<10	9
3	22	<10	11
4	7	<10	12
5	13	<10	11
6	2	<10	
7	2	<10	12

REMARKS:

occasional boulders encountered in borehole.

Sample 4 submitted for laboratory analysis of BTEX, PHC's F1-F4 and VOC's.

END OF BOREHOLE

LOGGED BY: RH
DRILLING DATE: February 22, 2018
REVIEWED BY: VN
Page 1 of 1

CLIENT: Parkland Fuel Corporation	METHOD: Split Spoon Sampling		**BH No.: MW107**
PROJECT: 1622 Roger Stevens Drive	PROJECT ENGINEER: Vic	ELEV. (m) 92.46	
LOCATION: Kars, Ontario	NORTHING: 0448315	EASTING: 5000409	PROJECT NO.: CB1057.00

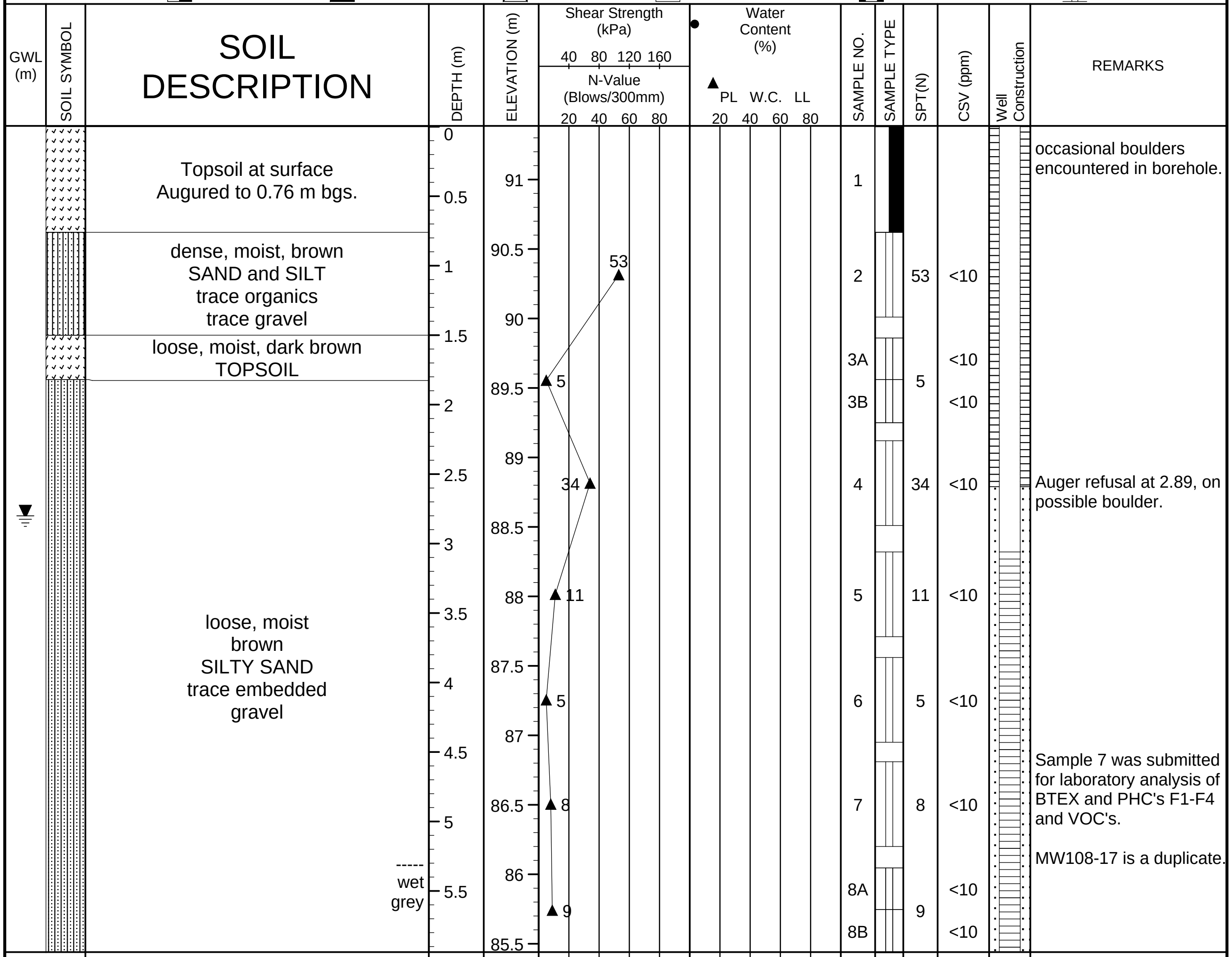
SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) 40 80 120 160 N-Value (Blows/300mm) 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SPT(N)	CSV (ppm)	REMARKS
▽	Topsoil at surface Augured through frost to 0.76 m	0 0.5	92						occasional boulders encountered in borehole.
	dense, moist, brown SILTY SAND some embedded gravel	1	91.5	39		1	39	<10	
		1.5	91	50+		2	50+	<10	
		2 2.5	90.5 90	50+		3	50+	<10	Sample 3 submitted for laboratory analysis of BTEX and PHC's F1-F4.
		3 3.5	89.5 89	50+		4	50+	<10	Auger Refusal at 3.7 m bgs, on possible boulders.
	END OF BOREHOLE								

LOGGED BY: RH	DRILLING DATE: February 22, 2018
REVIEWED BY: VN	Page 1 of 1

CLIENT: Parkland Fuel Corporation	METHOD: Split Spoon Sampling		**BH No.: MW108**
PROJECT: 1622 Roger Stevens Drive	PROJECT ENGINEER: Vic	ELEV. (m) 91.38	
LOCATION: Kars, Ontario	NORTHING: 0448270	EASTING: 5000428	PROJECT NO.: CB1057.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION

SOIL DESCRIPTION	DEPTH (m)
Topsoil at surface Augured to 0.76 m bgs.	0 – 0.76
dense, moist, brown SAND and SILT trace organics trace gravel	0.76 – 1.5
loose, moist, dark brown TOPSOIL	1.5 – 1.8
loose, moist brown SILTY SAND trace embedded gravel ----- wet grey	1.8 – 5.95

END OF BOREHOLE

SAMPLE NO.	SPT(N)	CSV (ppm)
1		
2	53	<10
3A	5	<10
3B		<10
4	34	<10
5	11	<10
6	5	<10
7	8	<10
8A	9	<10
8B		<10

REMARKS

occasional boulders encountered in borehole.

Auger refusal at 2.89, on possible boulder.

Sample 7 was submitted for laboratory analysis of BTEX and PHC's F1-F4 and VOC's.

MW108-17 is a duplicate.

LOGGED BY: RH	DRILLING DATE: February 22, 2018
REVIEWED BY: VN	Page 1 of 1

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 101.051

BH No.: BH109A

LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE ◨ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) 40 80 120 160 ● / N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	CSV (ppm)	Well Construction	REMARKS
		50 mm of Asphaltic Concrete Aurgured through frost to 0.76 m.	0 0.5	101 100.5				◨				occasional boulders encountered in borehole.
		compact, moist, brown sand and gravel (FILL)	1	100	16 ▲		1	⌶	16	<10		Auger Refusal at 1.35 m on possible boulder.
		END OF BOREHOLE										

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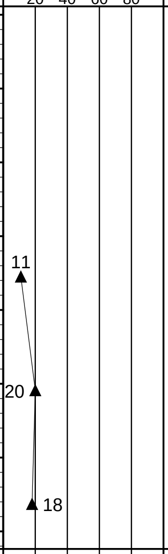
DRILLING DATE: February 26, 2018
REVIEWED BY: VN
Page 1 of 1

CLIENT: Parkland Fuel Corporation
METHOD: Split Spoon Sampling
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m) 101.051

BH No.: BH109B

LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

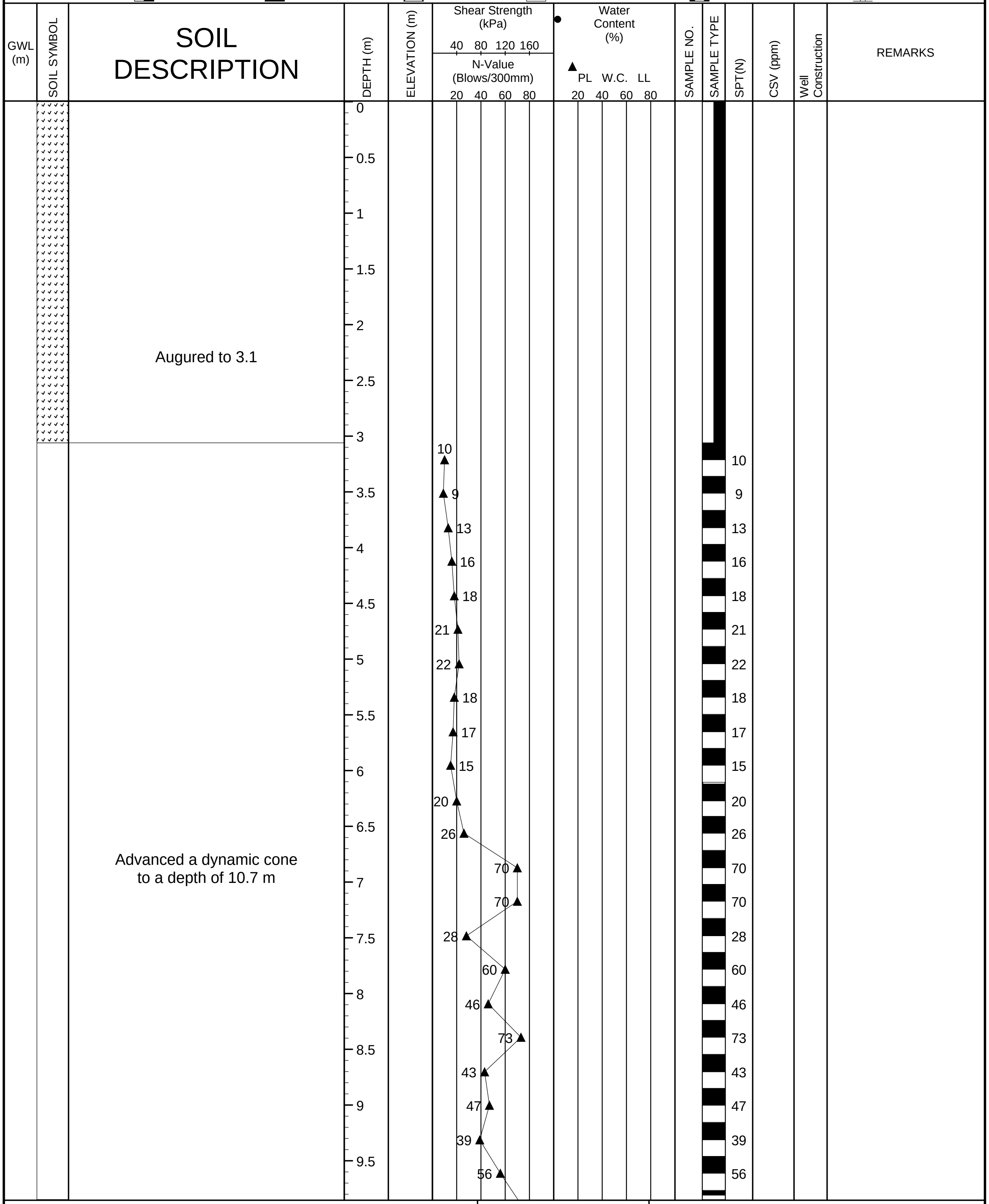


GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	● Water Content (%) ▲ PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	CSV (ppm)	Well Construction	REMARKS
		Asphalt at surface, Augured to 1.5 m	0	101								occasional boulders encountered in borehole.
			0.5	100.5								
			1	100								
		compact, moist brown SILTY SAND trace embedded gravel	1.5	99.5								
					11 ▲		1		11	<10		
			2	99								
			2.5	98.5	20 ▲		2		20	<10		Sample 2 was submitted for laboratory analysis for BTEX and PHC F1-F4. Duplicate was taken.
			3	98								
					▲ 18		3		18	<10		
			3.5	97.5								Auger refusal at 3.7 m on possible boulder.
		END OF BOREHOLE										

LOGGED BY: RH
DRILLING DATE: February 26, 2018
REVIEWED BY: VN
Page 1 of 1

CLIENT: Parkland Fuel Corporation	METHOD: Dynamic Cone Penetration Test		**BH No.: BH110**
PROJECT: 1622 Roger Stevens Drive	PROJECT ENGINEER: Vic	ELEV. (m)	
LOCATION: Kars, Ontario	NORTHING:	EASTING:	PROJECT NO.: CB1057.00

SAMPLE TYPE ◧ AUGER ◪ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



Augured to 3.1

Advanced a dynamic cone to a depth of 10.7 m

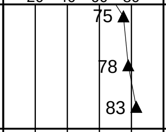
LOGGED BY: RH	DRILLING DATE: February 23, 2018
REVIEWED BY: VN	Page 1 of 2

CLIENT: Parkland Fuel Corporation
METHOD: Dynamic Cone Penetration Test
PROJECT: 1622 Roger Stevens Drive
PROJECT ENGINEER: Vic
ELEV. (m)

BH No.: BH110

LOCATION: Kars, Ontario
NORTHING:
EASTING:
PROJECT NO.: CB1057.00

SAMPLE TYPE ◨ AUGER ◪ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



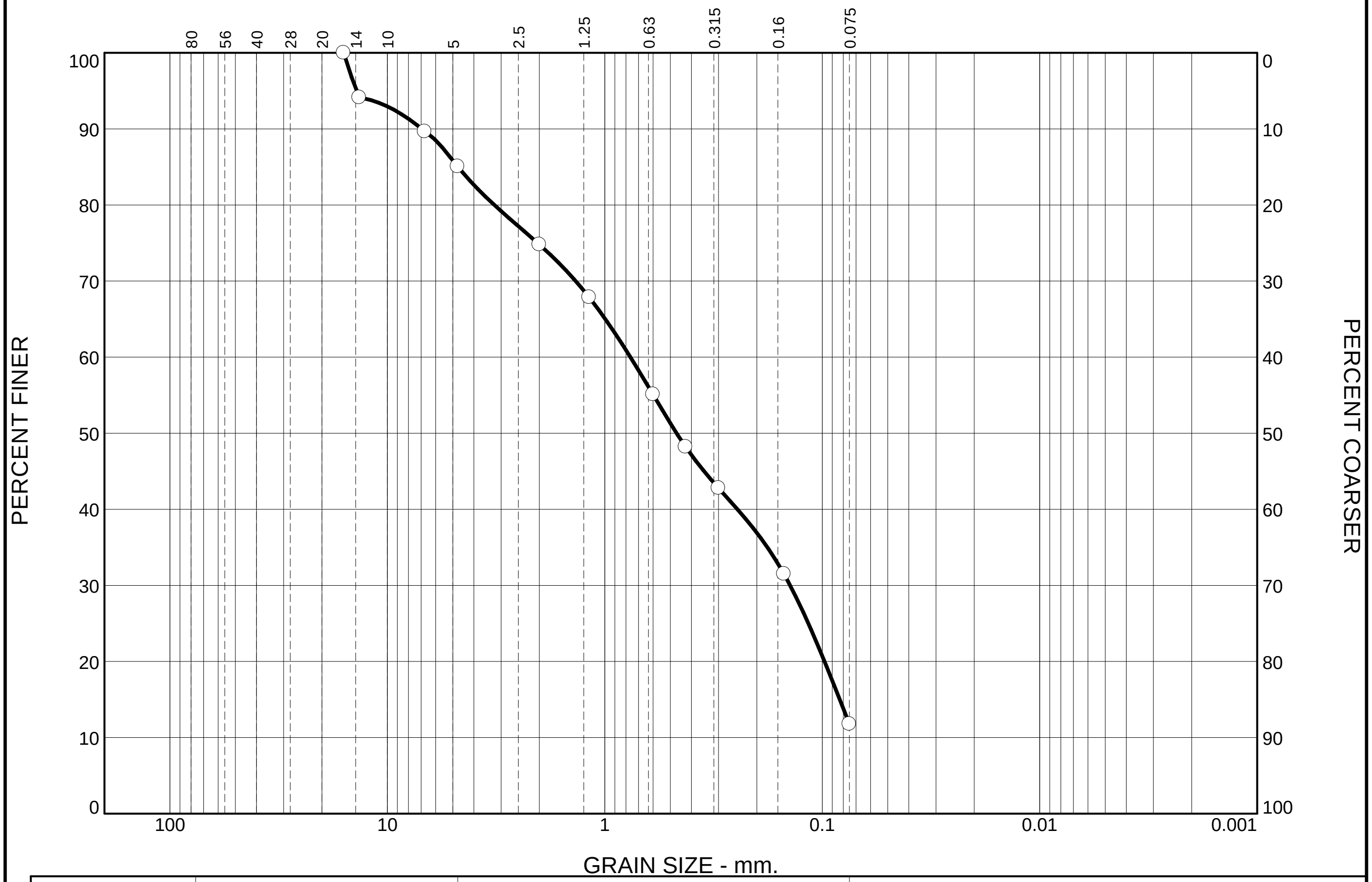
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) 40 80 120 160 N-Value (Blows/300mm) 20 40 60 80	● Water Content (%) ▲ PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	CSV (ppm)	Well Construction	REMARKS
			10		75 ▲			⬒	75			
					78 ▲			⬒	78			
			10.5		83 ▲			⬒	83			
		END OF BOREHOLE										

LOGGED BY: RH
DRILLING DATE: February 23, 2018
REVIEWED BY: VN

APPENDIX D

LABORATORY TEST RESULTS

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	15	10	27	36	12	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			4.7327	0.7632	0.4676	0.1405	0.0831			

Material Description	USCS	AASHTO
○ SAND, some gravel, some silt		

Project No. CB1057 **Client:** Parkland

Project: 1622 Roger Stevens Road

○ **Sample Number:** MW101 sample 9

Remarks:

○Tested on February 27, 2018

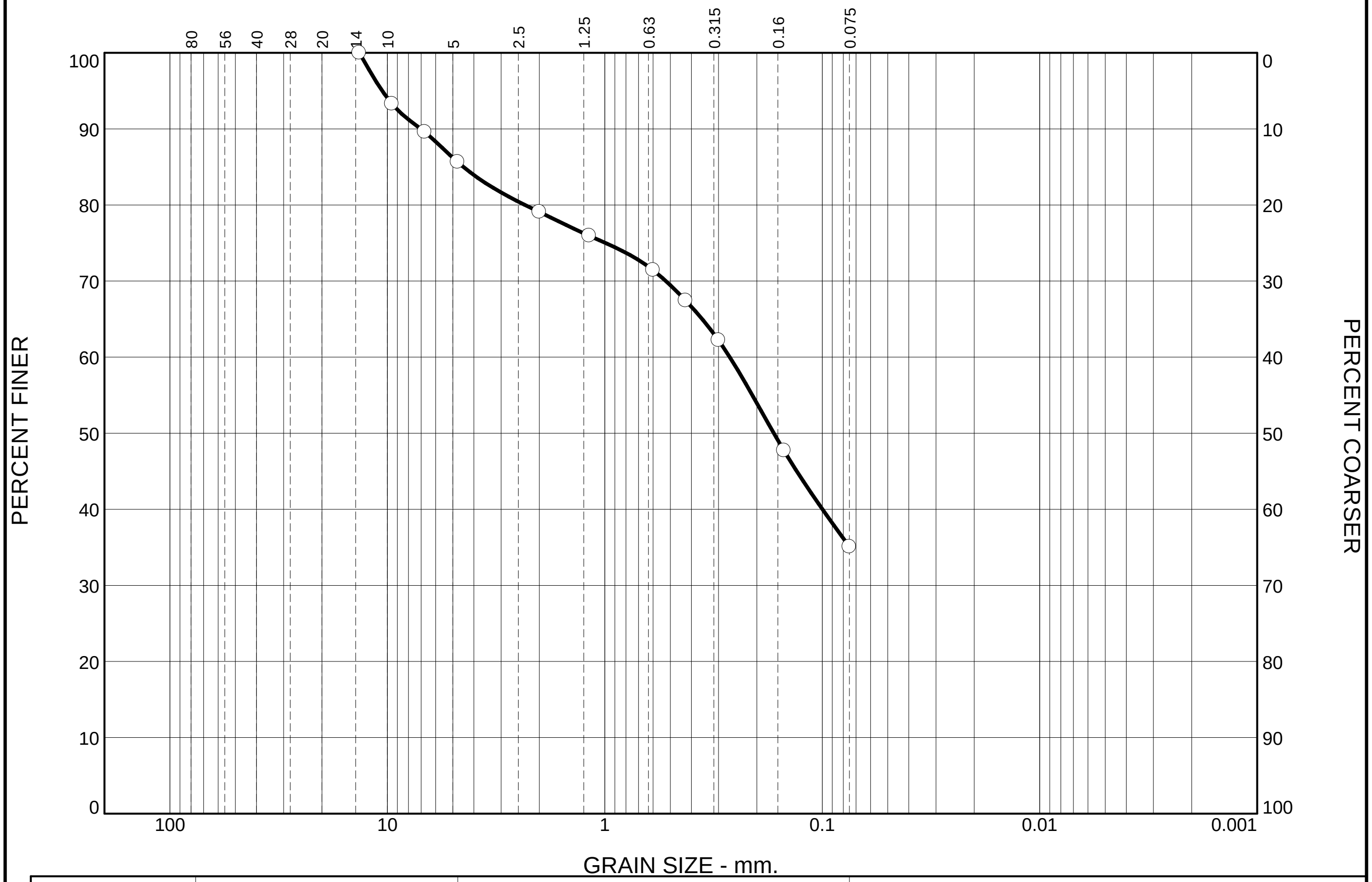
Alston Associates

Geotechnical Division of Terrapex

Figure F1G

Tested By: RH **Checked By:** VN

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	14	7	12	32	35	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			4.4711	0.2664	0.1670					

Material Description	USCS	AASHTO
○ SILTY SAND, some gravel		

Project No. CB1057 **Client:** Parkland

Project: 1622 Roger Stevens Road

○ **Sample Number:** BH104 sample 2

Alston Associates

Geotechnical Division of Terrapex

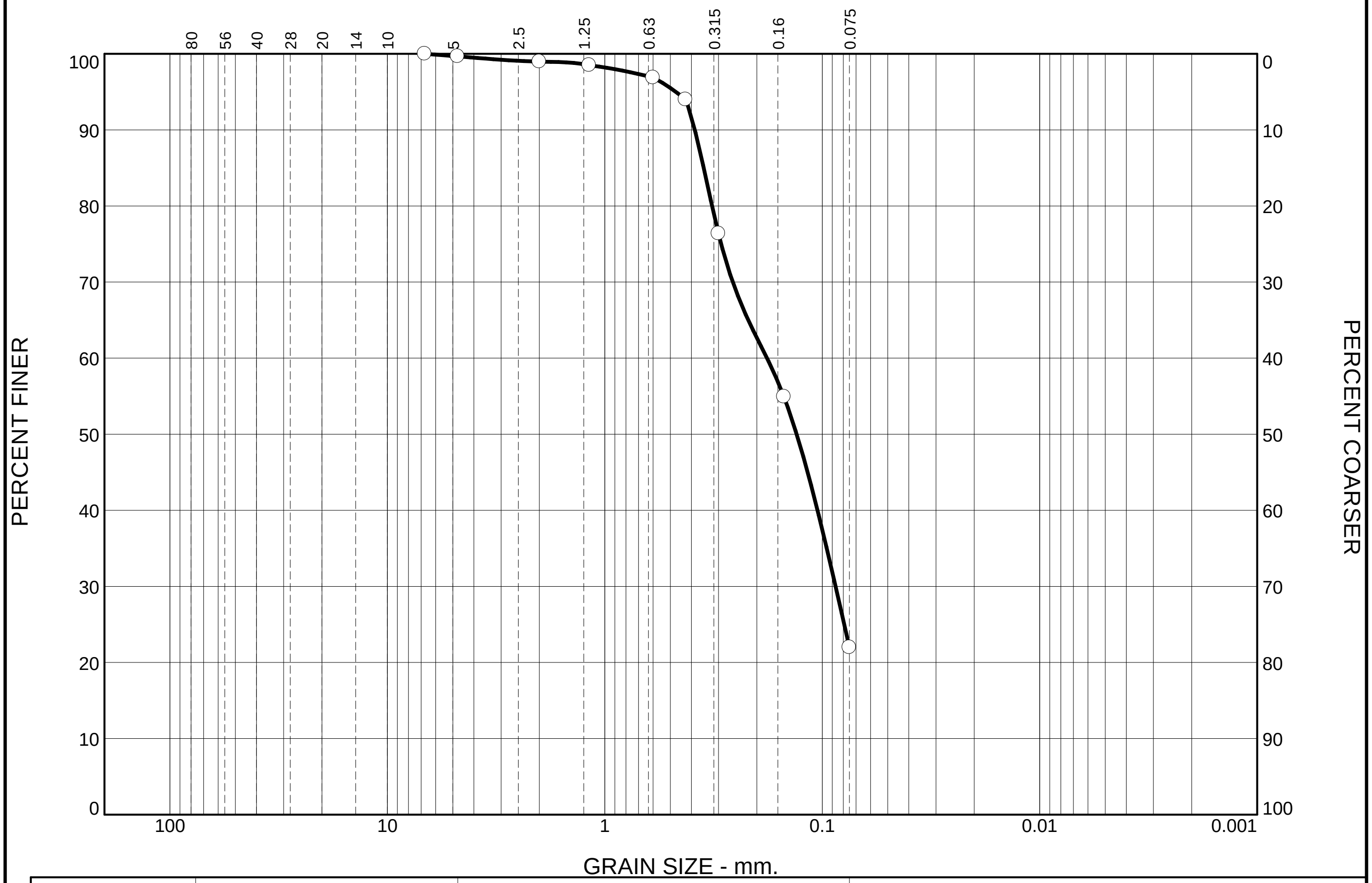
Remarks:

○Tested on February 27, 2018

Figure F2G

Tested By: RH **Checked By:** VN

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	1	5	72	22	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3510	0.1796	0.1312	0.0869				

Material Description	USCS	AASHTO
○ SILTY SAND		

Project No. CB1057 **Client:** Parkland

Project: 1622 Roger Stevens Road

○ **Sample Number:** BH102 sample 3

Remarks:

○Tested on February 27, 2018

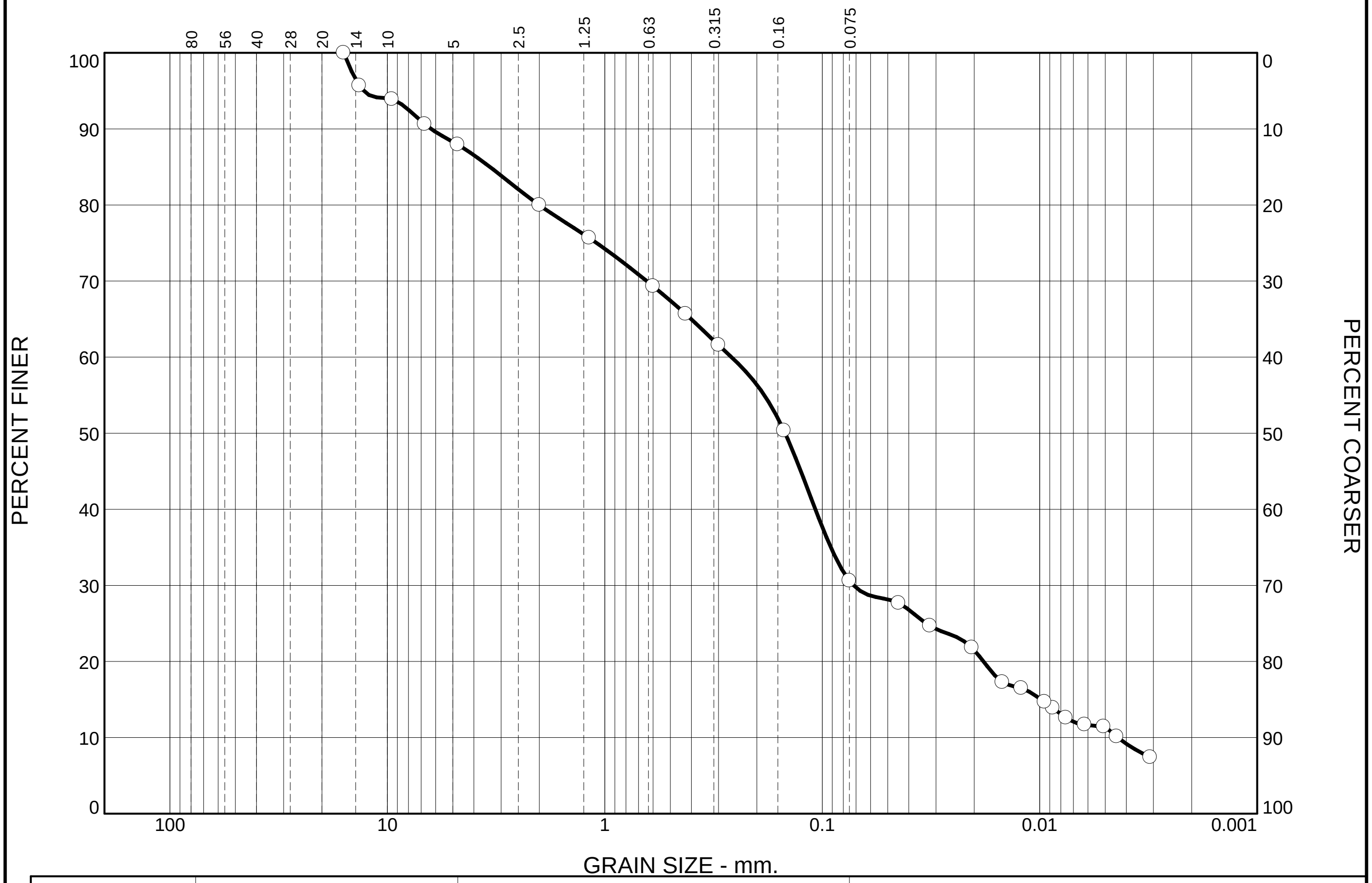
Alston Associates

Geotechnical Division of Terrapex

Figure F3G

Tested By: RH

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	12	8	14	35	31	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			3.3772	0.2615	0.1481	0.0718	0.0098	0.0044	4.52	59.87

Material Description	USCS	AASHTO
○ SILTY SAND some gravel		

Project No. CB1057.00 **Client:** Parkland Fuel Corporation

Project: 1622 Roger Stevens Drive

○ **Sample Number:** BH105 sample 3

Remarks:

○Tested on March 2, 2018

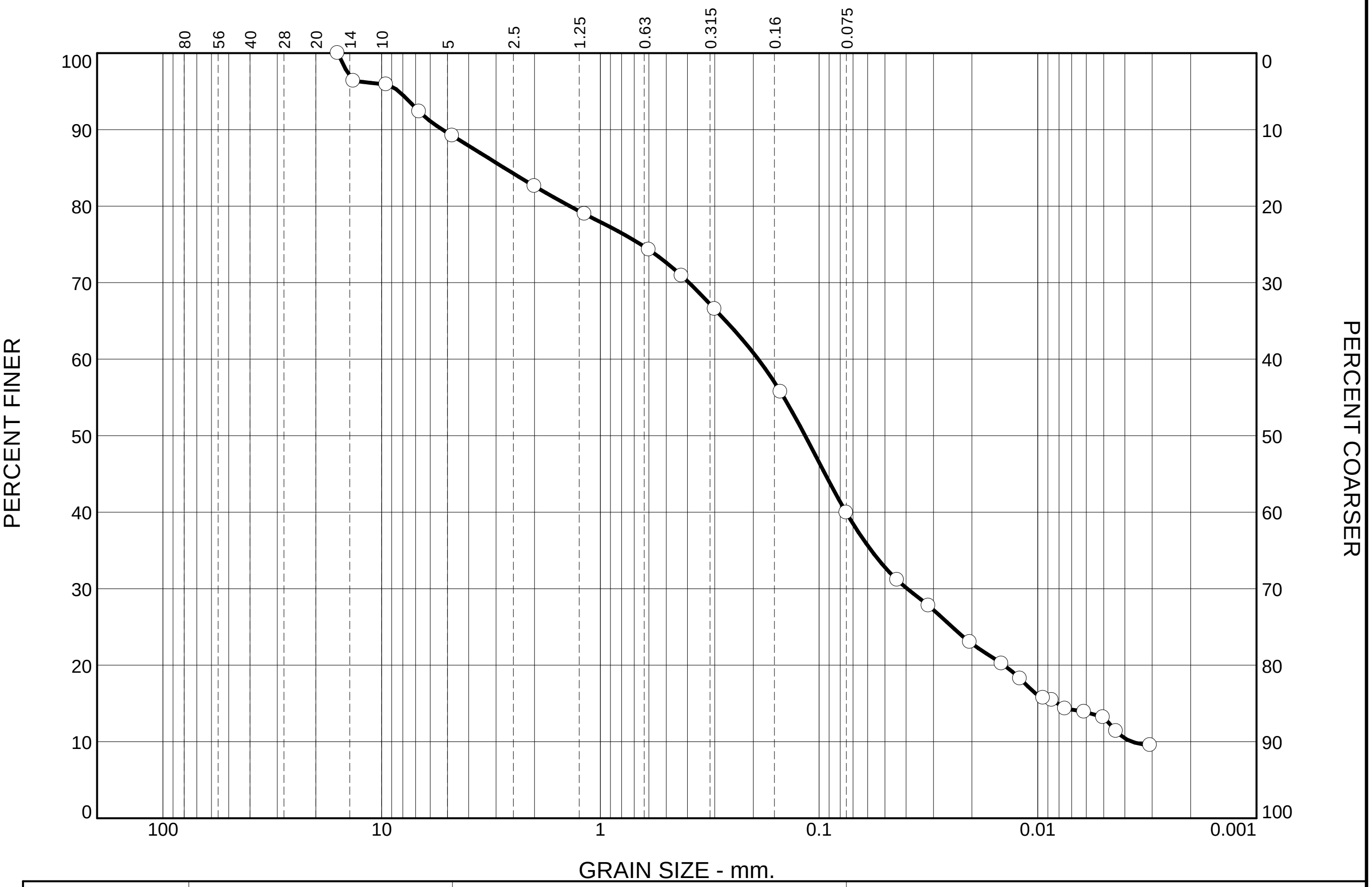
Alston Associates

Geotechnical Division of Terrapex

Figure F4G

Tested By: RH

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	11	6	12	31	40	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.7506	0.1898	0.1159	0.0395	0.0081	0.0037	2.22	51.17

Material Description	USCS	AASHTO
○ SILTY SAND, some gravel		

Project No. CB1057.00 **Client:** Parkland Fuel Corporation

Project: 1622 Roger Stevens Drive

○ **Sample Number:** MW107 sample 2

Remarks:

○Tested on March 2, 2018

Alston Associates

Geotechnical Division of Terrapex

Figure F5G

Tested By: RH

APPENDIX E

CHEMICAL ANALYTICAL SOIL TEST RESULTS

Your P.O. #: PIONEER
Your Project #: CB1057.00
Site Location: 1622 Roger Stevens Drive
Your C.O.C. #: 650870-05-01

Attention: Geoff Lussier

Terrapex Environmental Ltd
920 Brant St.
Suite 16
Burlington, ON
Canada L7R 4J1

Report Date: 2018/03/05
Report #: R5029583
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B842304
Received: 2018/02/23, 15:05

Sample Matrix: Soil
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
pH CaCl2 EXTRACT (1)	2	2018/03/02	2018/03/02	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract) (1)	2	N/A	2018/03/02	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Maxxam Analytics Mississauga

Your P.O. #: PIONEER
Your Project #: CB1057.00
Site Location: 1622 Roger Stevens Drive
Your C.O.C. #: 650870-05-01

Attention: Geoff Lussier

Terrapex Environmental Ltd
920 Brant St.
Suite 16
Burlington, ON
Canada L7R 4J1

Report Date: 2018/03/05
Report #: R5029583
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B842304
Received: 2018/02/23, 15:05

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Augustyna Dobosz, Project Manager
Email: ADobosz@maxxam.ca
Phone# (905)817-5700 Ext:5798
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GDL933	GDL934		GDL934		
Sampling Date		2018/02/21 13:00	2018/02/21 14:00		2018/02/21 14:00		
COC Number		650870-05-01	650870-05-01		650870-05-01		
	UNITS	**MW102 SAMPLE 4**	**BH103 SAMPLE 2**	**QC Batch**	**BH103 SAMPLE 2 Lab-Dup**	**RDL**	**QC Batch**
Inorganics							
Available (CaCl2) pH	pH	7.85	7.93	5422743			
Soluble (20:1) Sulphate (SO4)	ug/g	54	54	5420892	42	20	5420892

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Maxxam ID: GDL933
Sample ID: MW102 SAMPLE 4
Matrix: Soil

Collected: 2018/02/21
Shipped:
Received: 2018/02/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5422743	2018/03/02	2018/03/02	Tahir Anwar
Sulphate (20:1 Extract)	KONE/EC	5420892	N/A	2018/03/02	Alina Dobreanu

Maxxam ID: GDL934
Sample ID: BH103 SAMPLE 2
Matrix: Soil

Collected: 2018/02/21
Shipped:
Received: 2018/02/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5422743	2018/03/02	2018/03/02	Tahir Anwar
Sulphate (20:1 Extract)	KONE/EC	5420892	N/A	2018/03/02	Alina Dobreanu

Maxxam ID: GDL934 Dup
Sample ID: BH103 SAMPLE 2
Matrix: Soil

Collected: 2018/02/21
Shipped:
Received: 2018/02/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	5420892	N/A	2018/03/02	Alina Dobreanu

GENERAL COMMENTS

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

Package 1	0.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5420892	ADB	Matrix Spike [GDL934-01]	Soluble (20:1) Sulphate (SO4)	2018/03/02		NC	%	70 - 130
5420892	ADB	Spiked Blank	Soluble (20:1) Sulphate (SO4)	2018/03/02		103	%	70 - 130
5420892	ADB	Method Blank	Soluble (20:1) Sulphate (SO4)	2018/03/02	<20		ug/g	
5420892	ADB	RPD [GDL934-01]	Soluble (20:1) Sulphate (SO4)	2018/03/02	25		%	35
5422743	TA1	Spiked Blank	Available (CaCl2) pH	2018/03/02		100	%	97 - 103
5422743	TA1	RPD	Available (CaCl2) pH	2018/03/02	0.22		%	N/A

N/A = Not Applicable

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

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

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

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

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

VALIDATION SIGNATURE PAGE

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

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam
A Bureau Veritas Group Company

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name:	#30396 Parkland Industries Ltd	Company Name:	#19684 Terrapex Environmental Ltd	Quotation #:	B75111
Attention:	Retail Invoices	Attention:	Geoff Lussier	P.O. #:	
Address:	4919-59th St Suite 100 Red Deer AB T4N 6C9	Address:	920 Brant St. Suite 16 Burlington ON L7R 4J1	Project:	CB1057.00
Tel:	(403) 357-6400 x Fax: (403) 356-3015 x	Tel:	(905) 632-5939 x228 Fax:	Project Name:	Parkland Kars
Email:	emilie.price@parkland.ca, victoria.pianarosa@parkland.	Email:	g.lussier@terrapex.com	Site #:	1622 Roger Stevens Drive
				Sampled By:	Greg Sabourin

Laboratory Use Only:

Maxxam Job #:	Bottle Order #:
	650870
COC #:	**Project Manager:**
C#650870-05-01	Augustyna Dobosz

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☒ Table 2 ☒ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ___

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558. ☐ Storm Sewer Bylaw
☐ MISA Municipality ________
☐ PWQO
☐ Other ________

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ______

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) ☐
Date Required: ________ Time Required: ________
Rush Confirmation Number: ________ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	~~Petroleum Hydrocarbons CCME F1-4 BTEX~~ pH + Soluble ~~Sulfate~~ Sulphate	Petroleum Hydrocarbons F2-F4	O.Reg 153 ICPMS Metals and Sulphate	Soil Texture (%sand, %silt, %clay)	Moisture	pH CaCl2 EXTRACT	Flashpoint	O.Reg 558 TCLP Inorganics Package	O.Reg 558 TCLP PCBs	O.Reg 558 TCLP Volatile Organics HS	# of Bottles	Comments
1		MW102 Sample 4	February 21, 2018	1:00pm	SOIL	NO	X										1	
2		BH103 Sample 2	February 21, 2018	2:00pm	SOIL	NO	X										1	
3					SOIL													
4					SOIL													
5					SOIL													
6					SOIL													
7					SOIL													
8					SOIL													
9					SOIL													On ice
10					SOIL													

23-Feb-18 15:05
Augustyna Dobosz
B842304
URE ENV-907

RECEIVED IN OTTAWA

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
RH / RACHEL HERZOG	18/02/23	15:10	Mariana Gascon Gascon	2018/02/23	15:05	
				2018/02/24	10:04	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
0,0,0		Present	✓	
		Intact	✓	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

513/3

Maxxam Analytics International Corporation o/a Maxxam Analytics