GEOTECHNICAL INVESTIGATION

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M
LACOMBE COUNTY, ALBERTA

PREPARED FOR

PIDHERNEY'S TRUCKING LTD. C/O STANTEC CONSULTING LTD.

600 – 4808 50 STREET
RED DEER, ALBERTA
T4N 1X5

Stantec

PREPARED BY

PARKLAND GEOTECHNICAL CONSULTING LTD.

RED DEER, ALBERTA

ParklandGEO

POJECT NO. RD4372

MARCH 2013

Environmental Geotechnical and Materials Engineering
Red Deer • Sherwood Park • Grande Prairie • Airdrie • Peace River

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1.0 INTRODUCTION

Pidherney's Trucking Ltd. is proposing a new industrial subdivision in Lacombe County, Alberta. Parkland Geotechnical Consulting Ltd. (ParklandGEO) was requested to conduct a geotechnical investigation of the site for the proposed subdivision. The scope of the work was outlined in ParklandGEO's proposal dated October 12, 2012 (File# PRO2743). Authorization to proceed with this investigation was given by Mr. Brad Currie of Stantec Consulting Ltd. (Stantec), acting on behalf of Pidherney's Trucking Ltd. (Pidherney's). A preliminary report was prepared for the site, dated February 1, 2013 (File# RD4372). This report summarizes the results of the field and laboratory testing programs and presents geotechnical recommendations for general site development.

2.0 SITE AND PROJECT DESCRIPTION

The proposed subdivision site is located west of Blackfalds, Alberta at the legal address, NW 21-39-27 W4M. This quarter section is east of Range Road 274 and to the south of Aspelund Road (Township Road 394), as shown on the Key Plan, Figure 1.

At the time of the investigation, the site was undeveloped farmland. There was an industrial development to the northeast, a development in progress to the east, a storage yard to the southeast, and farmland on all other neighbouring sides. In the northeast part of the site, there was a pre-existing road that served as access for the development to the east. The Site Plan and Aerial Site Plan are provided in Figure 2 and Figure 3 respectively. There was a treed area within a local high spot at the approximately centre of the quarter section, which led in to the low lying area in the south-west portion of the site. The site had a gently rolling topography, which was sloping slightly to the south-east. Various localized low areas. As seen in the Contour Plan, Figure 4, site elevations ranged from 886.5 m on the north side, to 874.0 m on the south side. Surface grades were generally less than five percent.

The site is proposed to be developed as an industrial subdivision. Roadways and connections to existing municipal services in the area will occur as development progresses. A storm water detention pond in the southwest will likely be developed to manage storm water within the subdivision.

3.0 FIELD AND LABORATORY PROGRAMS

On November 15 and 16, 2012, nineteen boreholes were drilled at the approximate locations shown on the Site Plan, Figure 2. All boreholes were drilled to depths between 6.0 to 6.5 m, with one exception. Borehole 19 encountered auger refusal at a depth of 4.4 m below grade. Twenty-one boreholes where planned. However, two borehole locations in the south-west were not completed due to site access issues of the truck-mounted auger rig related to soft ground conditions.

The soil encountered was visually examined during drilling, and logged according to the Modified Unified Soil Classification System. Soil samples were taken at 1.0 m intervals in order to determine the soil/moisture profile. Standard Penetration Tests were taken at selected depth intervals in the boreholes. All soil samples were returned to ParklandGEO's Red Deer soil laboratory for selected testing to determine the soil properties.

Standpipes were installed in all boreholes upon completion of drilling. Groundwater levels were measured upon completion of drilling and on December 5 and 20, 2012. The local ground surface elevations of the borehole locations were surveyed by ParklandGEO using a Trimble GeoXH 2008 Series GPS receiver, and a Trimble Zephyr GPS antenna referenced to a geodetic datum. The elevations are shown on the borehole logs in Appendix A.

4.0 SOIL CONDITIONS

The general soil profile encountered at this site consisted of surficial topsoil overlying variable sand and silt layers. Some sand and gravel deposits were also encountered at the site. The detailed soil conditions encountered at the borehole locations are described on the borehole logs in Appendix A. The soil test results and definitions of the terminology and symbols used on the borehole logs are provided on the explanation sheets also in Appendix A. The following is a brief description of the soil types encountered.

4.1 TOPSOIL

A 50 to 500 mm thick layer of topsoil was encountered at all borehole locations. The topsoil was moderately organic, black and moist. In general, this topsoil is considered to be weak and compressible under load. A topsoil thickness plan is shown on Figure 5.

4.2 SILT AND SAND

Variable layers of silt and sand were encountered at the surface or below the topsoil in all locations drilled except Boreholes 15 and 19; and extended beyond the depths drilled everywhere except Boreholes 09 and 10. The sand was typically fine to medium grained, poorly graded, and loose to compact. The silt was non to low plastic and firm. SPT "N" values were: 2 to 24 for sand, 4 to 50 for silty sand, and 5 to 7 for the silt. The soils generally increased in consistency and density with depth. There were variable amounts of clay and gravel; and occasional rust stains, coal inclusions.

The moisture contents above the groundwater table ranged from 3 to 25 percent, and averaged 11 percent. Moisture contents below the local groundwater table ranged from 9 to 34 percent, and averaged 21.5 percent. One Standard Porctor Maximum Dry Density (SPMDD) test was conducted on a sample of the silty sand from Borehole 5. The sample had a SPMDD value of 1998 kg/m^3 with an Optimum Moisture Content (OMC) of 10.6%. Based on local experience, this soil is considered to be near its OMC above the local groundwater table, and over its OMC below the local groundwater table. One California Bearing Ratio (CBR) test was conducted on the silty sand which indicated a soaked CBR value of 2.8, indicating a relatively low level of subgrade support for these soils.

4.3 SAND AND GRAVEL

Sand and gravel was encountered at the surface of Boreholes 15 and 19, and at a depth of 4.5 m at Borehole 10. The sand and gravel was well graded and loose to compact, with SPT "N" values ranging between 5 and 14 blows per 300 mm of penetration.

4.4 WATER SOLUBLE SULPHATES

Soil samples at a depth of 2 m from ten boreholes were tested for water soluble sulphate. The concentration of sulphate is expressed as a percent of the dry mass of soil. The concentrations of water soluble sulphate range from 0.04 to 0.09 percent as shown on Figure 6. The reported sulphate level indicates a "negligible potential for sulphate attack on buried concrete in direct contact with soil."

5.0 GROUNDWATER LEVELS

The groundwater levels were measured at completion of drilling, and on December 5 and 20, 2012. A summary of the groundwater readings is provided in Table 1 below. Groundwater elevations on December 5 ranged from 879.6 m to 873.7 m. On December 20 they ranged from 879.4 m to less than 873.6 m; Boreholes 10 and 15 were observed as dry, and Borehole 19 was destroyed. As seen on Groundwater Elevation, Figure 7, the groundwater table varied with the topography, and generally flowed toward the south-east side of the site. The average decrease in groundwater elevation between December 5 and December 20 was 0.13 m.

TABLE 1
GROUNDWATER MEASUREMENTS

BH	BH Elevation (m)	Condition Upon Completion	December 5, 2012		December 20, 2012	
			Depth (mbg)	Elevation (m)	Depth (mbg)	Elevation (m)
01	885.18	Dry	5.72	879.46	5.85	879.33
02	886.15	Dry	6.58	879.57	6.74	879.41
03	884.44	Wet	5.13	879.31	5.19	879.25
04	882.49	Wet	4.10	878.39	4.15	878.34
05	883.26	Dry	5.28	877.98	5.45	877.81
06	884.65	Wet	5.40	879.25	5.78	878.87
07	882.95	Wet	4.22	878.73	4.35	878.60
08	881.21	Wet	2.50	878.71	2.61	878.60
09	881.52	Wet	3.15	878.37	3.19	878.33
10	881.34	Dry	6.00	875.34	Dry	< 874.84
11	880.01	Wet	1.47	878.54	1.55	878.46
12	880.77	Dry	2.33	878.44	2.59	878.18
13	880.72	Wet	2.74	877.98	2.85	877.87
14	879.21	Wet	2.75	876.46	2.68	876.53
15	878.81	Dry	5.10	873.71	Dry	< 872.81
16	881.08	Wet	3.22	877.86	3.35	877.73
17	878.80	Dry	1.00	877.80	1.15	877.65
18	878.24	Dry	1.38	876.86	1.53	876.71
19	873.95	Wet	0.95	873.00	Destroyed	-

The groundwater table varied with the topography, and flowed towards the south-east. The static water table at this site was relatively shallow at about 1 to 6 m below grade. This groundwater condition is expected to be typical in the area. Local groundwater is dependent on infiltration of surface water for recharge, and groundwater conditions are expected to be most adverse after snow-melt and periods of heavy or prolonged precipitation. Groundwater seepage is expected for deep excavations at this site. The volumes of groundwater encountered will be dependent on seasonal conditions.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 GEOTECHNICAL EVALUATION

The subsurface conditions at this site are considered to be suitable for the proposed industrial subdivision development. Construction considerations for this site are expected to be typical for this area of Lacombe County. Site grading will be required to level and raise areas to smooth out grades at the site. The main geotechnical issues regarding site development are:

- Most of the subgrade at this site is stable sandy soil which will provide a moderate level of subgrade support for road construction and site prep. The sandy soil gets denser with depth. The silty subsurface soils were relatively loose and possibly sensitive to disturbance when wet. The silter soils provide a low to moderate level of subgrade support.

- The native sandy soil is considered to be a good fill material for trench backfill and general grading. Depending on the initial moisture contents of the excavated soils, moisture adjustments will be necessary to improve compaction characteristics.

- The cleaner sand and gravel is considered to be non to low frost susceptible. The silty sand is considered to be moderately to highly frost susceptible if given access to groundwater or free water within the zone of seasonal frost. In general, the depth to the local groundwater table for much of the site is 2.5 to 4.0 m below grade, which is near the potential depth of frost.

- There are topographically low areas that may need to be raised more than 1.0 m. Placement of fill below footing elevation will need to be carefully addressed and monitored to minimize the potential for foundation problems due to settlement.

- Relatively shallow groundwater conditions may be encountered during service trench installations at this site. Conventional pumping arrangements from collector sumps are expected to be capable of dewatering excavations.

The general foundation conditions at this site are considered to be fair to good. Suitable foundation alternatives include conventional footings and driven pile foundations. The site soil conditions are not well suited to cast-in-place concrete piles due to the potential for sloughing conditions particularly below the shallow groundwater table. Detailed recommendations for foundations are not provided in this report, since it is assumed site specific geotechnical investigations will be performed for individual lots.

6.2 SITE PREPARATION

6.2.1 General Site Preparation

It is recommended that all vegetation and topsoil be stripped from areas to be developed. Topsoil could be stockpiled for future use in landscaping at the site. Ideally, fill used to bring the site up to grade should be well graded select sand or gravel. The native sandy soils are considered to be suitable fill materials, provided they can be compacted to desired density levels. Moisture conditioning of the native soils may be required prior to use as fill in order to achieve specified densities. Granular fill is more compatible with this subgrade. If course gravel is proposed, it is recommended to use gravel with a maximum aggregate size of 100mm. Surface grades should be designed to minimize the depth of fill across building footprints to reduce potential settlements.

The engineered fill placed during site grading at this site should be compacted to at least 95 percent of Standard Proctor Maximum Dry Density (SPMDD). The lift thicknesses should be governed by the ability of the selected compaction equipment to uniformly achieve the recommended density. A maximum lift thickness of 200 mm for granular fill is recommended. Uniformity of compaction is most important. Granular fill is best compacted with large smooth drum vibratory rollers while silt and clay fill is best compacted with large vibratory "padfoot" or "sheepsfoot" rollers. In areas which require higher compaction, it is recommended that granular fill be placed at moisture contents 0 to 2 percent below the OMC and that clay fill be placed at moisture contents about 0 to 2 percent above the OMC. This will help reduce compactive effort and potential risk of subgrade disturbance needed to achieve higher densities.

Special consideration must be given to deep fill areas below the proposed building sites in areas where proposed fills are greater than 1.0 m below final grade. The engineered fill placed below structures should be uniformly compacted to at least 98 percent of SPMDD at a moisture content within 2 percent of OMC for fills up to 1.0 m deep. For deeper fill, the compaction standards should be increased to 100 percent of SPMDD. If these density levels cannot be achieved using common fill during site grading, the footing bearing surfaces should be sub-cut and underlain with select granular fills compacted to at least 98 percent. The depth of sub-cut should be determined at the time of construction and will depend on factors such as: age of fill, initial compaction, depth of fill, water table, footing configuration and loads.

6.2.2 Soft Subgrade Conditions

Initially stripping activities and construction traffic should be monitored to identify soft areas where subgrade failure may be a concern. Soft subgrade conditions may impact slab and foundation performance in building areas and may affect the ability to place fill in parking and yard areas. In building areas, soft subgrade should be sub-excavated and replaced with a suitable fill material. The depth of excavation should be sufficient to remove the soft material to give proper support to floor slab loads. In parking areas, soft subgrade within 1.5 m of final grade should be similarly removed and replaced to support fill compaction, pavement construction, and future traffic.

Soft subgrade conditions are a common problem for silty subgrades in this area. Problems are most often encountered in the spring or during periods of wet weather when the groundwater table is shallowest. In some cases, construction traffic on the fine grained silty subgrade may cause the shallow groundwater to “pump up” into the surface soils due to capillary action. The resulting rise in moisture content substantially disturbs and weakens the subgrade which may result in failure.

Upon identification of soft areas, methods to avoid subgrade failure may include: limiting construction traffic, modification of site preparation procedures (scarification, recompaction, etc.), use of backhoe excavation equipment and fill placement by end dumping and spreading with wide pad crawler equipment. If coarse gravel is used as a granular fill, it is recommended to use select sand or gravel with a maximum aggregate size of 100 mm. In road areas, this extra gravel can be incorporated into the pavement subbase. The gravel should be placed in a single lift on top of filter fabric to keep the subgrade fines from migrating into the gravel. The initial lift of material should be placed and nominally compacted in a manner to minimize disturbance to the sensitive subgrade. The need for special measures and/or gravel fill in soft areas should be subject to review in the field during construction and based on the actual conditions, the required fill thickness, the proposed compaction equipment, and the intended use for the designated area.

6.3 SERVICE TRENCH INSTALLATION

It is expected that buried services will be installed to typical depths within 4.0 m of the final ground surface. It is expected that the service trenches will be based in firm silt and loose to compact sand. Most excavations are expected to extend below the ground water table and groundwater seepage is expected, particularly in areas where relatively permeable sand soils are present below the groundwater table. Trench side slope stability will be a concern where the groundwater table is intercepted.

6.3.1 Service Trench Excavation

The side-slope of conventional unsupported trench excavations is dependent on the local soil conditions at any given location. Conventional trenched excavations with side-slopes of at least 1H:1V or flatter are considered to be feasible for shallow excavations above the groundwater table. Based on local experience with similar soil profiles in the area, side-slopes in the order of 4H:1V, or flatter may be required for excavations into the water table. Steeper cuts may be possible depending on contractor procedures, weather conditions and observed soil conditions in the excavation. The alternative would be to reduce the size of the excavation by many different configurations of braced/slope excavations and dewatering measures.

The degree of stability of excavated trench walls directly decreases with time and therefore, construction should be directed at minimizing the length of time service trenches are left open. Groundwater seepage from the sides of the trenches and from the base of the excavation is to be expected. Dewatering of excavated trenches may be necessary for trenches extending below the depth of the static water table. Base heave and/or boiling of the trench bottom can occur where a significant differential hydrostatic head exists at the bottom of the excavations and soils are not cohesive. Surface grading should be undertaken so that surface water is not allowed to pond adjacent to service trenches. Surcharge loads, including excavation spoil, should be kept back from the crest of the excavation a minimum distance equal to the excavation depth, if not greater, dependent on stability analyses. Monitoring and maintenance of the slopes should be carried out on a regular basis.

Installation of underground services and utilities require an observational approach to be adopted, which should combine past local experience, contractor's experience, and geotechnical input. It would be desirable for the selected excavation contractor to be experienced in similar conditions and/or, alternatively, to excavate test pits in advance of construction to familiarize field personnel with subsurface conditions. Quality workmanship is essential. Once disturbed, it will be very difficult and expensive to rehabilitate deep, wet cohesionless soils.

Notwithstanding any of the above comments, excavations should be carried out in accordance with Alberta Occupational Health and Safety Regulations.

6.3.2 Pipe Bedding

Minor deflections of the trench bedding are expected. Underground utility pipes should be of a type which will maintain a watertight joint (i.e. rubber gasket) after minor shifting has occurred. Bedding requirements are a function of the class of pipe and trench configuration, as well as site specific geotechnical considerations. In general, granular pipe bedding should be relatively well graded sand or sand gravel mixture which can be readily compacted around the pipe to achieve a high frictional strength. Bedding materials must have an appropriate gradation so that migration of natural soils into the granular system is minimized. Uniform or gap-graded sands and gravels should not be used as bedding materials unless adequate provision is made to surround such soils with a filter fabric or graded granular filter compatible with the existing subsoils. Select native materials may be proposed for bedding; however the use of these materials will require a higher level of compaction in order to satisfy the pipe manufacturer's requirements for adequate pipe support (see Figure 8). Native materials consisting of high plastic clay or wet silt and sand that cannot be adequately compacted should not be used for pipe bedding. If granular bedding material is proposed, the following gradation specifications are suggested.

TABLE 2
GRADATION SPECIFICATION – GRANULAR BEDDING MATERIAL

Sieve Size (mm)	Percent Passing By Weight		
	Native Sand	Clean Sand	Drain Rock
50	-	-	100
40	-	-	95 - 100
20	-	-	5 - 10
10	-	100	0 - 5
5	100	90 - 100	0 - 5
2.5	-	80 - 95	-
1.25	66 - 100	55 - 85	-
0.63	52 - 100	30 - 65	-
0.315	35 - 78	10 - 35	-
0.160	18 - 43	2 - 10	-
0.080	2 - 12	0 - 8	-

In the event of significant groundwater seepage or wet base conditions, additional pipe foundation measures may be required. Typically these measures include placement of a working mat of free draining gravel and filter cloth after lowering of the water table and removal of disturbed soils. This layer of gravel is intended to be a safe working base and the thickness required will be based on keeping groundwater below the working surface. The function of the geotextile in pipe bedding applications is to act as a separation barrier between the coarse bedding materials and the native fine grained soils; therefore it needs to be strong enough to withstand construction activity.

6.3.3 Trench Backfill

Soil used for trench backfill should be free of frozen material, organics, and any other undesirable debris. It is expected that native soils will be used at the site for economic reasons. The native soils are typically silt and sand, which are considered suitable for use as trench backfill, but may require adjustment of the natural moisture content to achieve proper compaction. Suitable replacement soils would include local or imported sand borrow materials with an appropriate moisture content relative to the OMC.

To minimize fill settlement under self-weight, it is recommended to use soil with a moisture content within 5 percent of the OMC. When excavated soils are excessively wet, the material should be dried or blended prior to use as a trench backfill. Suitable replacement soils would include local or imported sand borrow materials with an appropriate moisture content relative to the OMC.

Lift thicknesses for backfill should be governed by the ability of the selected compaction equipment to achieve specified density throughout the entire lift. Uniformity is of most importance. The backfill should be placed in thin lifts. The nominal thickness for select granular fill is 200 mm. The backfill should be uniformly compacted to a minimum of 95 percent of the SPMDD to within 1.5 m of the finished ground surface and to a minimum 97 percent of the SPMDD from 1.5 m below ground surface to grade. For road areas, the backfill should be compacted throughout the depth of the fill to a minimum 97 percent of SPMDD.

Some settlement of the compacted backfill in trenches under self-weight is expected. The magnitude and rate of settlement is dependent on the backfill soil type, the moisture condition of the backfill at the time of placement, the depth of the service trench, drainage conditions, and the initial density achieved during compaction. For the compaction recommendations given above it is expected that total settlement in the order of 2.0 to 3.0 percent of the trench depth will occur. For properly moisture conditioned sand backfill the majority of the settlement is expected to occur within 2 to 4 months of backfilling, unless the backfill becomes frozen. Density monitoring of backfill placement is recommended to encourage better attention to quality workmanship in placement.

Fill materials with variable moisture contents recompacted as trench backfill would not be expected to provide uniform roadway subgrades for the support of pavement sections. If trench settlement in road areas is a concern, a deep subgrade preparation across the entire roadway is recommended to help make the subgrade more uniform. (i.e. uniform backfill method). To minimize the effects of potential settlements on completed roadway surfaces, it is recommended that staged asphalt pavement construction be adopted and that placement of final asphalt concrete surfacing materials be delayed as long as possible, subsequent to completion of trench backfilling.

6.3.4 Concrete for Underground Structures

Water-soluble sulphate concentrations of soil samples from the site indicated negligible potential for chemical attack of subsurface concrete in localized areas of the site. Therefore, General Use (Type GU) hydraulic cement is recommended for use in all subsurface concrete in contact with native soil at the site in accordance with CSA Standard CAN3-A23.1-M09. The recommended minimum 28 day compressive strength is 30 MPa with a water cement ratio of 0.5. All concrete exposed to a freezing environment either during or after construction should be air entrained.

6.4 GENERAL FOUNDATIONS

Foundation conditions at this site are considered to be fair due to the presence of stable but loose sand at shallow depths. Feasible foundation options for this site include conventional footings and driven piles. A summary of considerations that should be made during foundation design are:

- The fine grained surficial silty sand subgrade will be easily disturbed, so support of footing foundations on these materials will result in a relatively low bearing capacity of about 100 to 150 kPa. In areas where near surface native compact well graded sand and gravel exists, the allowable bearing capacity of footings will likely be 150 kPa or greater.

- Based on local experience, the depth to high strength bearing soils in most areas is estimated to be over 12 m below grade, so driven steel piles will likely be designed on friction and/or heavily loaded piles will require relatively long shafts before significant bearing can be achieved.

- For heavier foundation loads, the use of dynamically cast-in-place concrete piles would be well suited for the majority of this site. These piles are commonly referred to as "Compacto" or "Franki" piles, and are considered to be a specialty foundation system which is usually designed by the individual piling contractors.

- Short bored cast-in-place piles or piers might also be suitable, but deep piles at or below the groundwater table will encounter significant sloughing conditions and associated installation problems for bored piles. Bored cast-in-place concrete piles are not generally used in the Blackfalds area of Lacombe County.

It is expected that site and project specific geotechnical investigations will be undertaken on each individual lot for foundation design and site development purposes.

6.5 ROADWAY SUBGRADE CONSTRUCTION

The native surficial soils were estimated to have CBR values in the order of 2.5 to 10 depending on the type of subgrade soil (silt, silty sand, or sand and gravel). These estimated CBR values are indicative of a low to moderate level of subgrade support. One CBR test was performed on a silty sample, which was found to have a soaked CBR value of 2.8. In general, the subgrade support from the drier sand and sand and gravel would be greater than areas of silt.

The exposed subgrade surface should be proof-rolled to identify soft areas. Soft areas should be sub-cut and replaced with suitable fill compacted to 95 percent of SPMDD as per section 6.2.2. The recommended type of subgrade fill would be a select granular fill such as relatively clean coarse graded gravel with a maximum aggregate size of 150 mm. If coarse gravel is selected, a proposed gradation specification is provided in the following table:

TABLE 3
150 MM COARSE GRADED GRAVEL

Sieve Size (mm)	Percent Passing By Weight
150	100
75	80 - 100
25	50 - 75
5	25 - 55
0.08	2 - 10

This material is generally placed at the same time as the granular subbase of the pavement section resulting in a thick lift of coarse granular material below the asphalt and base course gravel layers. Based on local experience, the gravel subbase thickness required to establish a stable construction base will be in the order of 200 mm to 500 mm, depending on conditions encountered at the time of construction.

Construction procedures should be designed to minimize disturbance to the subgrade. If the subgrade is failed during construction, it can lead to costly replacement of weakened soils. The need for any special construction procedures is best determined based on observations at the time of construction. Therefore, construction of roads will require careful monitoring by an experienced soils technician to avoid costly construction problems.

6.6 FLEXIBLE PAVEMENT DESIGN

As per Lacombe County's Operation Standards Manual, one flexible pavement design is proposed for this industrial subdivision: a moderate traffic section for the Industrial Subdivision Road Calssification using an assumed Design Traffic of $2x10^6$ Equivalent Single Axle Loads (ESAL's).

This design traffic number is based on a design period of 20 years. The proposed pavement design sections are based on the assumption of a stable subgrade which has a CBR of at least 4.0 in a soaked condition; or a subgrade which has been improved to an equivalent level as described in Section 6.5. The majority of surficial soils across the site are expected to meet this minimum subgrade support condition, with and exception for some localized soft areas. Based on the preceding design assumptions the following flexible pavement sections are proposed:

TABLE 4
FLEXIBLE PAVEMENT DESIGN

Pavement Sections	**Subdivision Road**	
Design traffic (ESAL's)	**2 x 10^6**	
Asphalt Concrete 20 mm Crushed Granular Base Granular Subbase (minimum) 300 mm Subgrade Prep	100 mm 150 mm 300 mm No	125 mm 250 mm - Yes

The performance of the proposed pavement design sections will be, in part, dependent on achieving an adequate level of compaction in subgrade and pavement materials. The recommended levels of compaction for the granular materials in the pavement section should be a minimum of 98 percent of SPMDD. The asphalt concrete should be compacted to a minimum of 97 percent of Marshall density based on a 75 blow laboratory Marshall test. Pavement materials should conform to the Alberta Transportation or Lacombe County specifications. The following asphalt specifications are recommended.

TABLE 5
ASPHALT CONCRETE

Stability (kN minimum)	8.5
Flow (mm)	2 - 4
Air Voids (percent)	3 - 5
VMA (minimum percent)	14.5
Asphalt Cement (penetration grade)	150-200 (A)

Aggregate materials for base and subbase gravel should be composed of sound, hard, durable particles free from organics and other foreign material. It is recommended to use aggregate materials conforming to the following Alberta Transportation specifications.

TABLE 6
RECOMMENDED AGGREGATE SPECIFICATIONS

Pavement Sections	AT Specifications
Asphalt Gravel	Designation 1, Class 16
Crushed Granular Base	Designation 2, Class 20
Granular Subbase	Designation 2, Class 40

A copy of the Alberta Transportation aggregate specification is provided in Appendix A. Based on availability of local materials at the time of tendering or construction, alternate materials could be considered upon review by the geotechnical engineer.

The road surface should be sloped and graded to effectively remove all surface water as rapidly as possible. To minimize the occurrence of surface water ponding in the roadways, finished surface grades and cross slopes in the order of two percent are recommended. Allowing water to pond on the pavement surface will lead to infiltration of water into the subgrade which could result in weakening of the subgrade soils.

No special pre-design considerations are given to thickening the pavement section over backfilled trenches. Unless backfill compaction standards cannot be met, thickening the pavement section will not significantly reduce the problems of long term fill settlement. The settlement of trenches is caused mainly by the long term self-weight of the fill, not the short term live loads from traffic. The road section or the thickness of granular subbase placed in the road bed should be determined by the level of support expected from the subgrade based on field observations. To minimize distress to pavement structures, trench backfill should be compacted to the higher density levels as previously recommended. To minimize the effects of potential settlements on completed roadway surfaces, it is recommended that staged asphalt pavement construction be adopted and that placement of final asphalt concrete surfacing materials be delayed as long as possible subsequent to completion of trench backfilling.

6.7 FROST ACTION

For frost heave to occur, frost susceptible soils, high soil moistures, and/or available free-water within the depth of frost, must be present. If any one of these three conditions is removed, the potential for heave is significantly reduced. The depth of frost is dependent on temperatures of both surface and subgrade conditions which vary from winter to winter. Soil conditions such as moisture content, grain size and latent heat of groundwater also affect frost penetration depths. In general, frost penetration in granular materials (sand and gravel) is greater and faster than in fine grained materials (silt and clay). For soils above the groundwater table, frost penetration depths of 2.0 m for silty clay and 2.5 m for sand are considered to be typical in this area. The potential penetration of frost for a road setting is severe due to the presence of gravel in the profile and lack of snow cover which acts as an insulator to reduce penetration.

The potential for frost heave is dependent on grain size, permeability and thermal properties of the soil which govern the ability to draw water from the surrounding subgrade soils and groundwater table, if available. Unsaturated sands and gravels are non frost susceptible since soil moisture water freezes and expands into the air voids between the aggregate particles resulting in no heave. If the granular soil is saturated, the frozen soil will heave uniformly bout 10 percent. Silty soils have a moderate permeability which allows for the movement of free-water and the formation of ice lenses, so silty soils are considered to be highly susceptible to ice lensing. During a normal winter in this area, frost heave in local soils is typically in the order of 75 to 150 mm.

The local road construction practice requires thick gravel layers in pavements because the frost susceptible subgrade is also a low strength material. Normal pavement construction allows for some replacement of frost susceptible materials with thick gravel. The thick gravel also helps to protect the subgrade after spring thaw as the surface subsides. In areas where the subgrade material is similar the overall heave is uniform, resulting in relatively minor damage to surface development such as sidewalks, curbs and pavements. Uniformity can be provided in fill materials, such as trench backfill, but there is limited control over non-uniformity in undisturbed native soils. In areas with subgrade non-uniformities where the soils change between highly frost susceptible silty soils and non or low frost susceptible soils (eg. imported granular backfill), the differential heave over short distances can almost be equal to the total heave. Other general recommendations to minimize frost related problems for road structure include:

- Setting final road grades well above the water table or provision of sub-drainage system and/or capillary cut-off to restrict groundwater migration into the road subgrade in areas of shallow groundwater table.

- Replacing the frost susceptible soils with less frost susceptible fill such as coarser sand and gravels.

- Removing or smoothing out sand to silt transitions.

Even if thick gravel pavement layers minimize damage to the pavement surface, a severely distorted vertical profile in the winter is still undesirable. In these most severe cases, deep replacement of frost susceptible materials or the use of insulation materials such as rigid insulation or light weight aggregate (ie. granu-lite) are options to minimize heave or restrict frost penetration into frost susceptible soils. Since these options are very costly, it is recommended to try and identify areas which require extraordinary measures prior to subbase construction. It is suggested to closely monitor all service trenches and road beds for signs of sharp sand to clay transitions. It should be understood that the texture of local non frost susceptible sand and frost susceptible silty sand is very similar. Therefore, it will be difficult to distinguish all problem areas prior to construction. Some repair of undetected areas of differential heave should be expected after construction.

6.8 STORM WATER DETENTION POND

Stormwater detention pond area(s) will be feasible to impound storm water during peak flows and ease the demand on storm sewers in this area. Normally for a dry detention pond, the base elevation should be above the typical groundwater elevation so that the pond does not contain water throughout the year. Ponds with bases below the groundwater elevation table are usually designed as wet ponds. The depth of the pond into the water table governs the feasibility and recommended spacing of the drains so costs increase with depth below the water table. The dry pond will be drained shortly after major storm events, normally within 24 hours of filling.

Design considerations for dry detention ponds at this site include, the influence of impounded water on the local groundwater table, shoreline slope stability, shoreline erosion protection and drainage of the pond base.

Impounded water inside a detention pond, above the groundwater table elevation, will have a tendency to raise the local groundwater table through seepage. However, the pond base subgrade is expected to be a silty sand soil of relatively high in-situ permeability suggesting that seepage rates will be relatively high. Since the local subgrade is highly permeable and the detention periods will be very short, the potential for long term impact on the groundwater table will be minimal and will be limited to the areas immediately around the pond. The following recommendations are provided:

1. For preliminary design purposes on a wet detention pond, the maximum side slope should be 5H:1V below the static water level, and 4H:1V for the portion of the slope above the static water level. The side slopes on a dry detention pond should be a maximum of 4H:1V. For stability under normal conditions, the groundwater table at the toe of dry pond slopes should be maintained at least 0.6 m below the final grade. Recommendations for steeper side-slopes may be possible for constructed slope faces upon review of actual soil conditions and groundwater elevations. A review of groundwater levels and slope stability should be performed once the preliminary grades and pond geometry are set.
2. Drainage of dry pond will occur through overland flow to the pond outlet with some seepage through the base if the base is above the water table. The base of the pond should be graded to allow positive drainage towards the pond outlet to minimize seepage. The recommended base slope is at least 1.0 percent. For longer runs, steeper grades may be required or French drains could be provided to direct flow to the outlet.

3. Some restrictions might apply to pond operations, because fast draw-down rates will impact slope stability. For safety reasons, municipal authorities such as City of Edmonton design ponds with volumes to limit surface water rises to less than 1.0 m for a 1:25 year rainfall event and 2.5 m for a crisis event.

4. The pond shoreline should be protected against erosion from wave action, because shoreline erosion may destabilize the pond slopes. Sideslopes should be vegetated as soon as possible after construction.

5. Adjacent development restrictions may be required in relation to design groundwater levels. Seepage from the pond is not expected to significantly impact adjacent structures, however, it is considered prudent to set adjacent foundation elevations above the design high water level in the pond.

6.9 INSPECTION

During construction, it is recommended that on-site construction testing and monitoring be performed to verify that actual site conditions are consistent with assumed conditions and actual conditions meet or exceed design criteria. Based on the Alberta Building Code, adequate levels of inspection for industrial site development are considered to be: full time monitoring of deep foundations; and monitoring and compaction control of engineered fill.

7.0 CLOSURE

This report is based on the findings at the nineteen boreholes at the site. If new information or different subsoil/groundwater conditions are encountered, this office must be notified and recommendations submitted herein will be reviewed and revised as required. This report has been prepared for the exclusive use of **Pidherney's Trucking Ltd.**, **Stantec Consulting Ltd.**, and their approved agents for the specified application to the proposed residential subdivision in NW 21-39-27-W4M, Lacombe County, Alberta. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made. The limitations of this report are specified in the General Terms and Conditions section and should be considered part of this report.

Respectfully submitted,
PARKLAND GEOTECHNICAL CONSULTING LTD.
A.P.E.G.A. Permit #07312

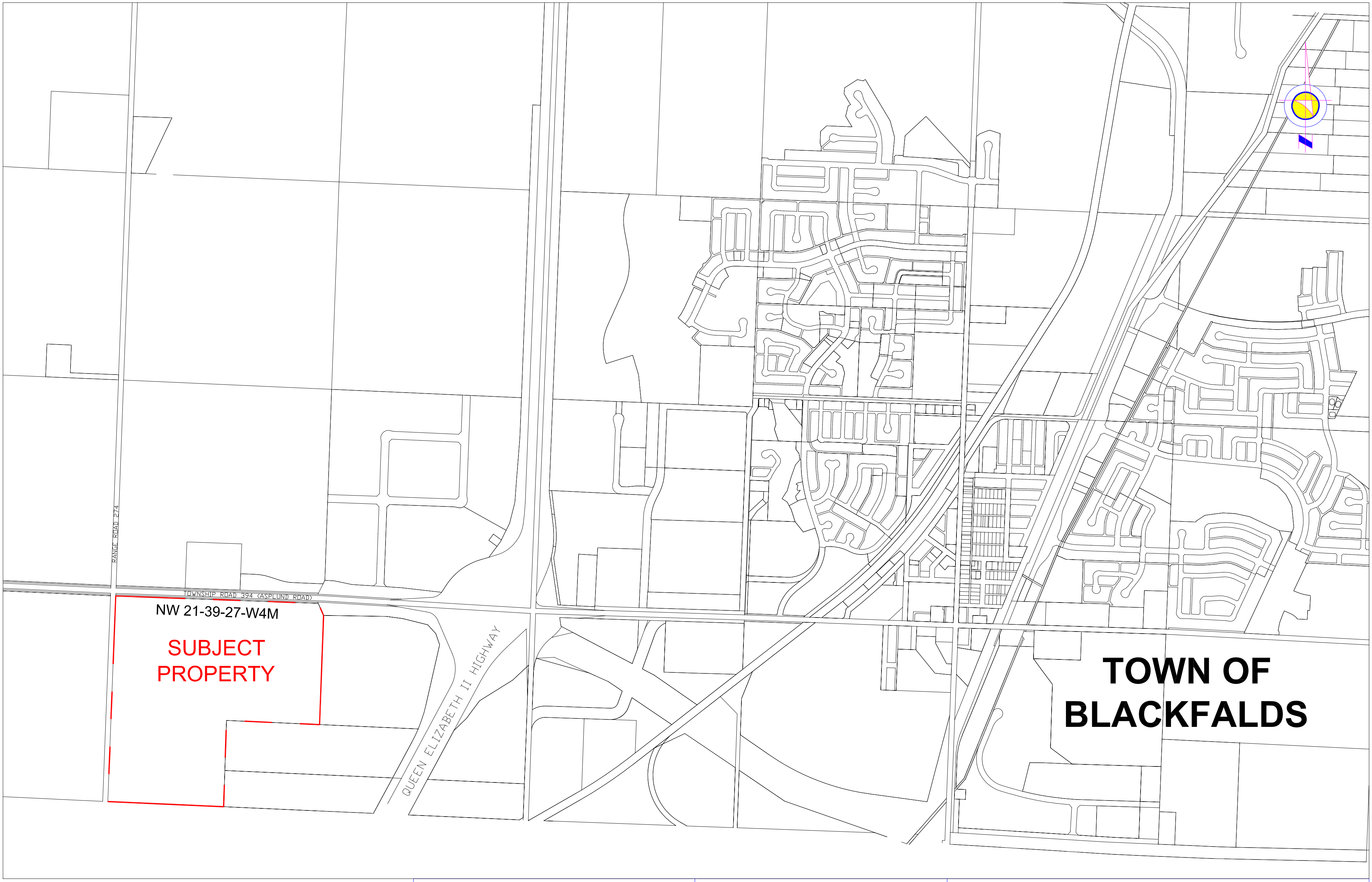
LEE J. BIRN
19 March 2013

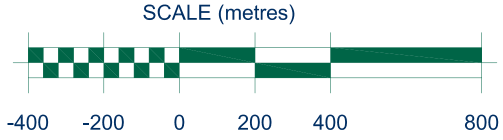
Sachin Patel, E.I.T.
Geotechnical Engineer

Lee Birn, P. Eng.
Geotechnical Manager

Reviewed By:
Mark Brotherton, P. Eng.

FIGURES





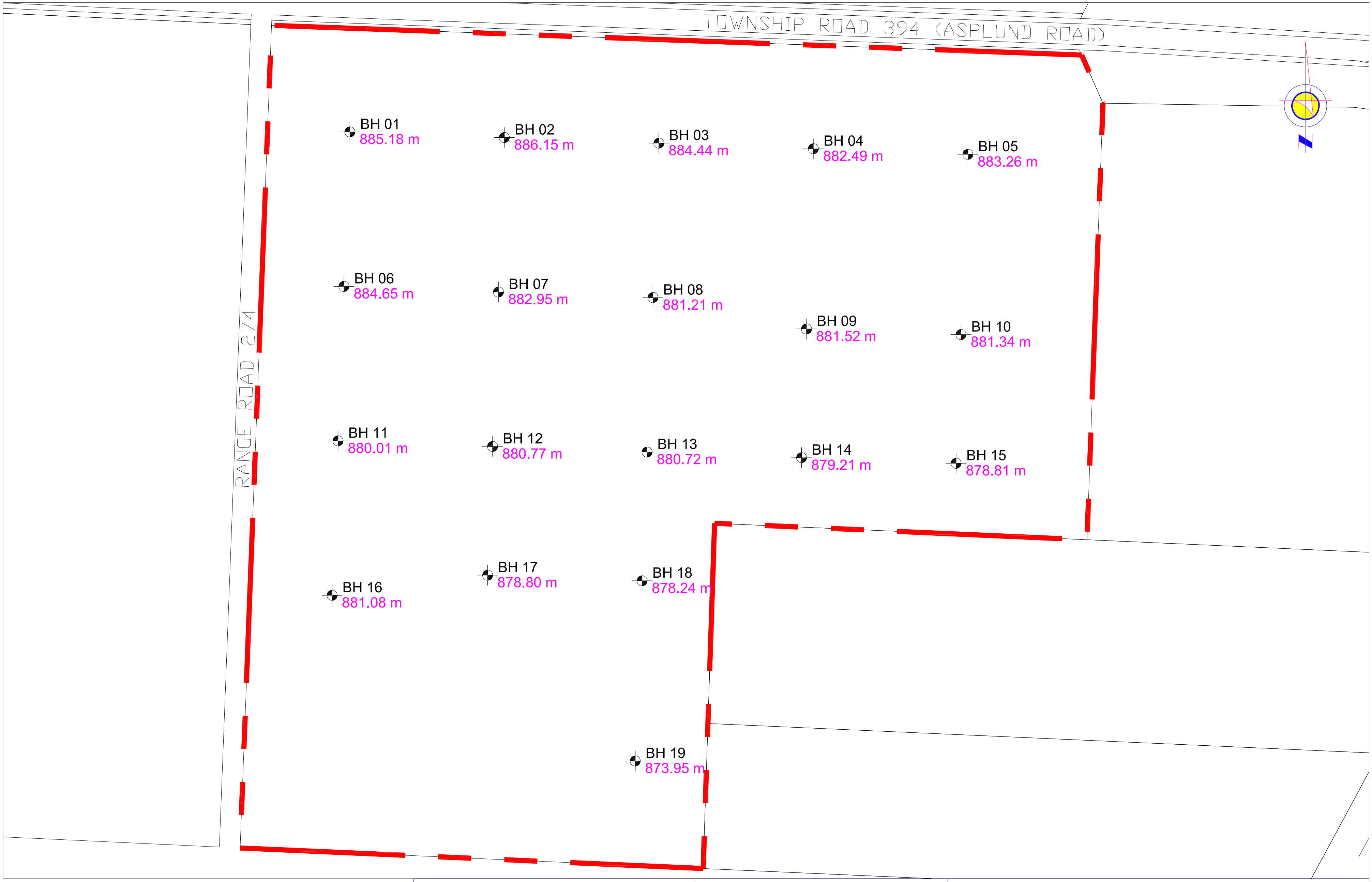
CLIENT:

KEY PLAN

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
SP	JN	1	JANUARY, 2013

SCALE:	JOB NO.	DRAWING NO.
1:20000	RD4372	FIGURE 1



⌖ APPROXIMATE BOREHOLE LOCATION
SURFACE ELEVATION

SCALE (metres)

-100 -50 0 50 100 200

Parkland GEO

CLIENT:

SITE PLAN

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
SP	LB	1	MARCH, 2013

SCALE:	JOB NO.	DRAWING NO.
1:5000	RD4372	FIGURE 2

⌖ APPROXIMATE BOREHOLE LOCATION
SURFACE ELEVATION

SCALE (metres)
-100 -50 0 50 100 200

Parkland GEO

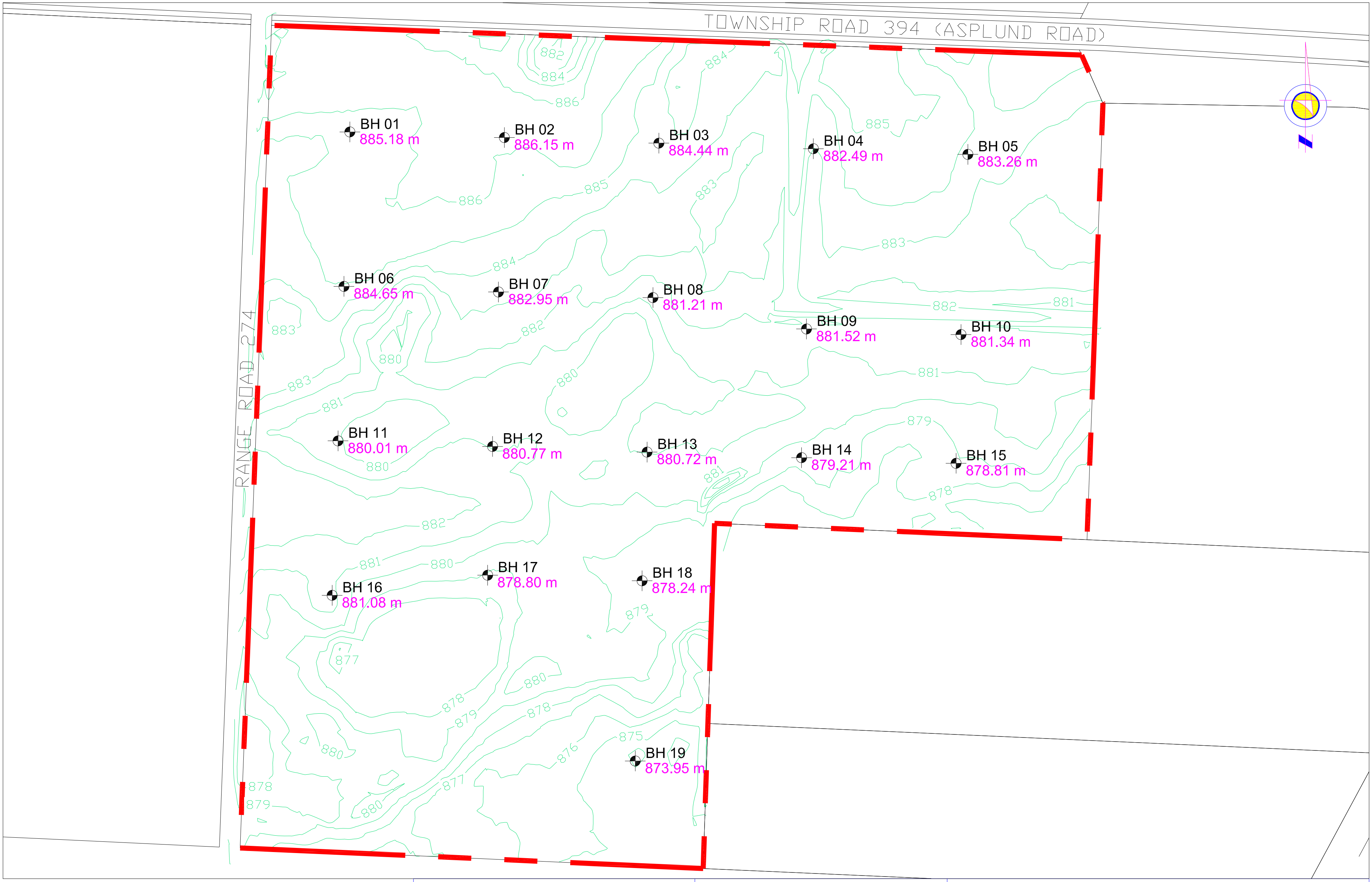
CLIENT:

AERIAL SITE PLAN

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
SP	JN	1	JANUARY, 2012

SCALE:	JOB NO.	DRAWING NO.
1:5000	RD4372	FIGURE 3



⌖ APPROXIMATE BOREHOLE LOCATION
SURFACE ELEVATION

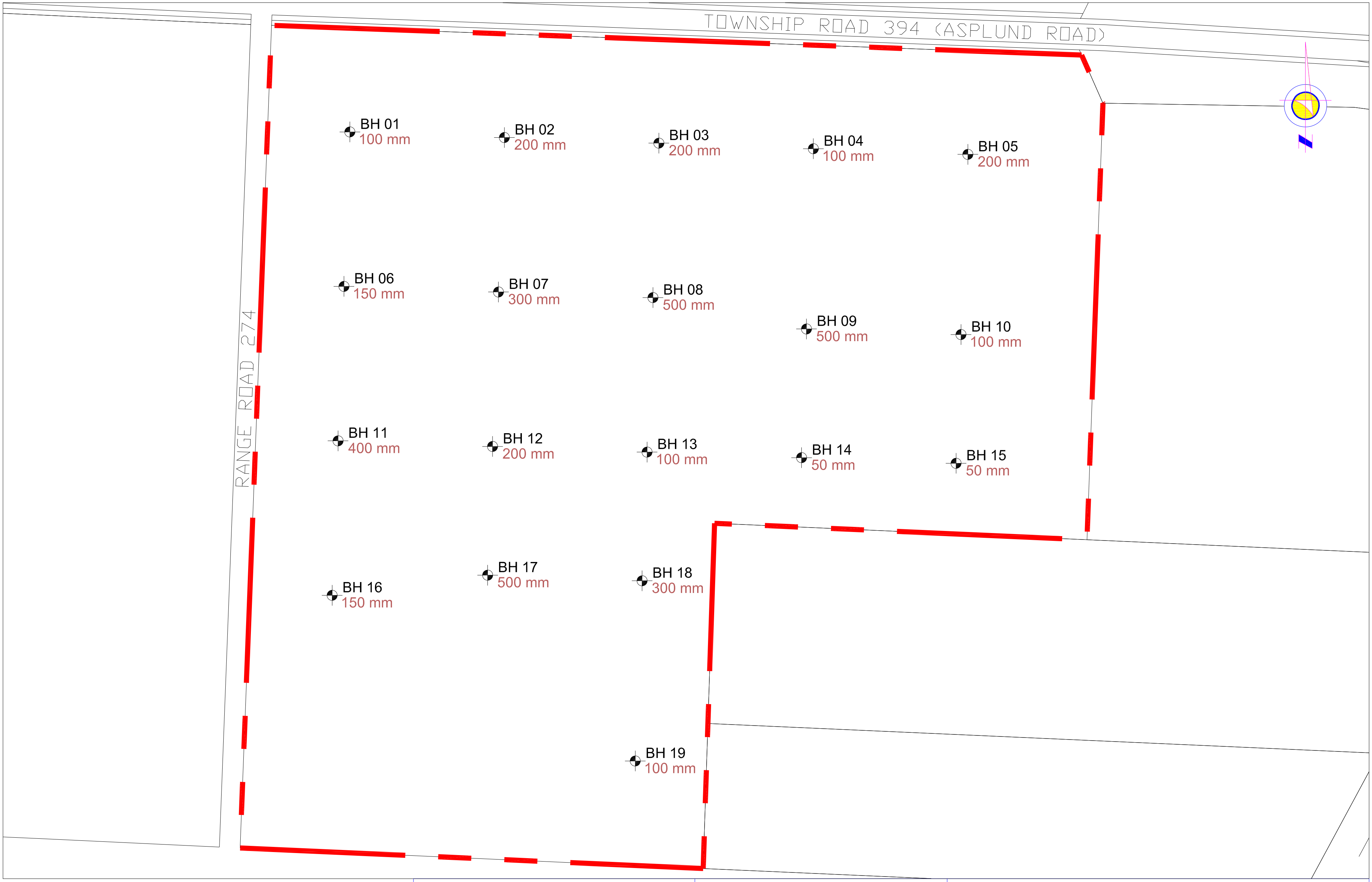
SCALE (metres)
-100 -50 0 50 100 200

CLIENT:

CONTOUR PLAN

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN: SP	CHK'D.: JN	REV #: 1	DATE: FEBRUARY, 2012
SCALE: 1:5000	JOB NO. RD4372		DRAWING NO. FIGURE 4



⊕ APPROXIMATE BOREHOLE LOCATION
TOPSOIL THICKNESS

SCALE (metres)
-100 -50 0 50 100 200

ParklandGEO

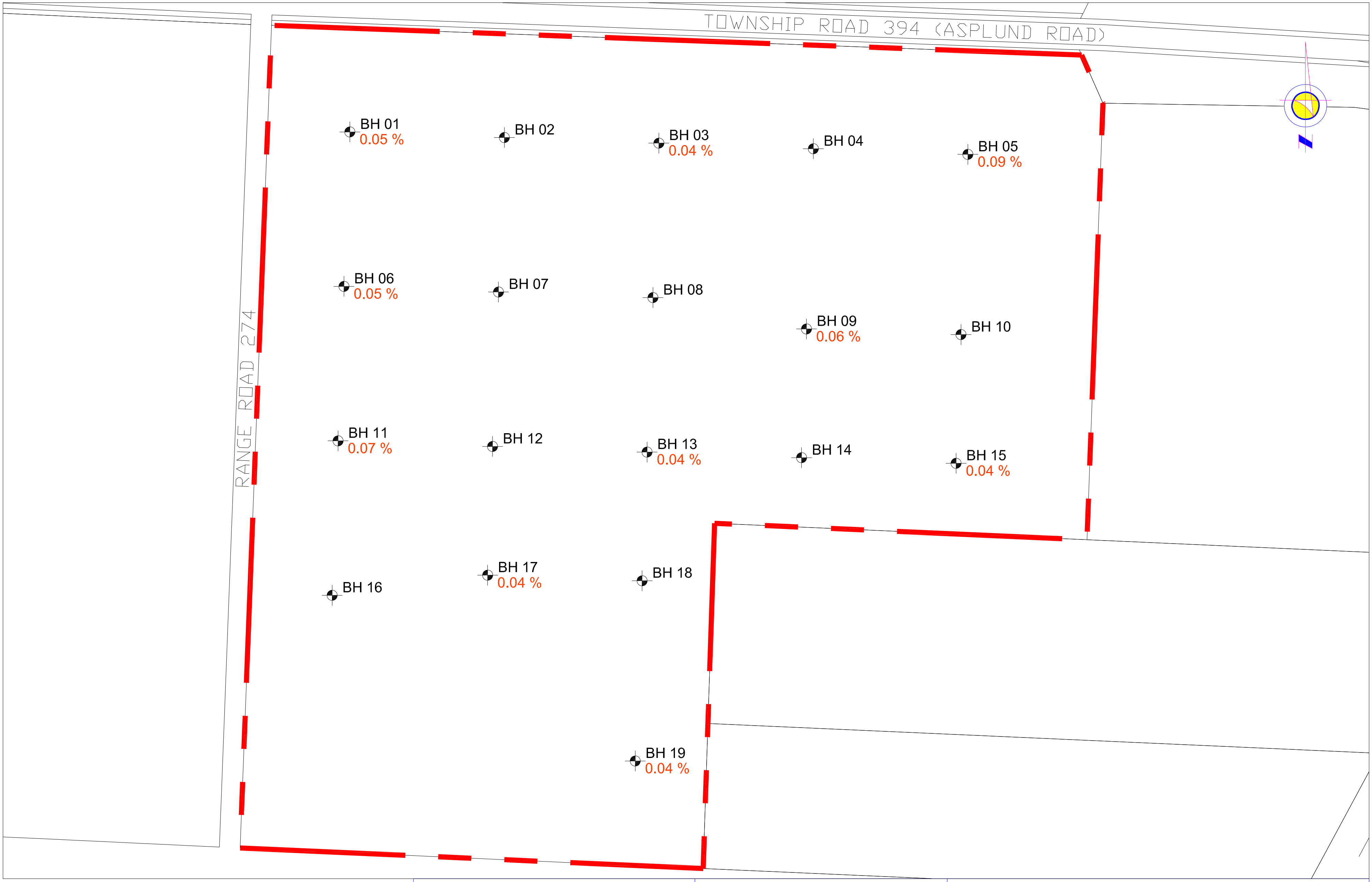
CLIENT:

TOPSOIL THICKNESS

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

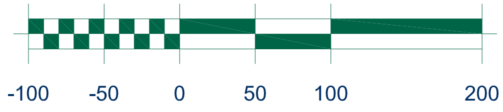
DRAWN:	CHK'D.:	REV #:	DATE:
SP	JN	2	MARCH, 2013

SCALE:	JOB NO.	DRAWING NO.
1:5000	RD4372	FIGURE 5



⌖ APPROXIMATE BOREHOLE LOCATION
SULPHATE CONCENTRATION

SCALE (metres)



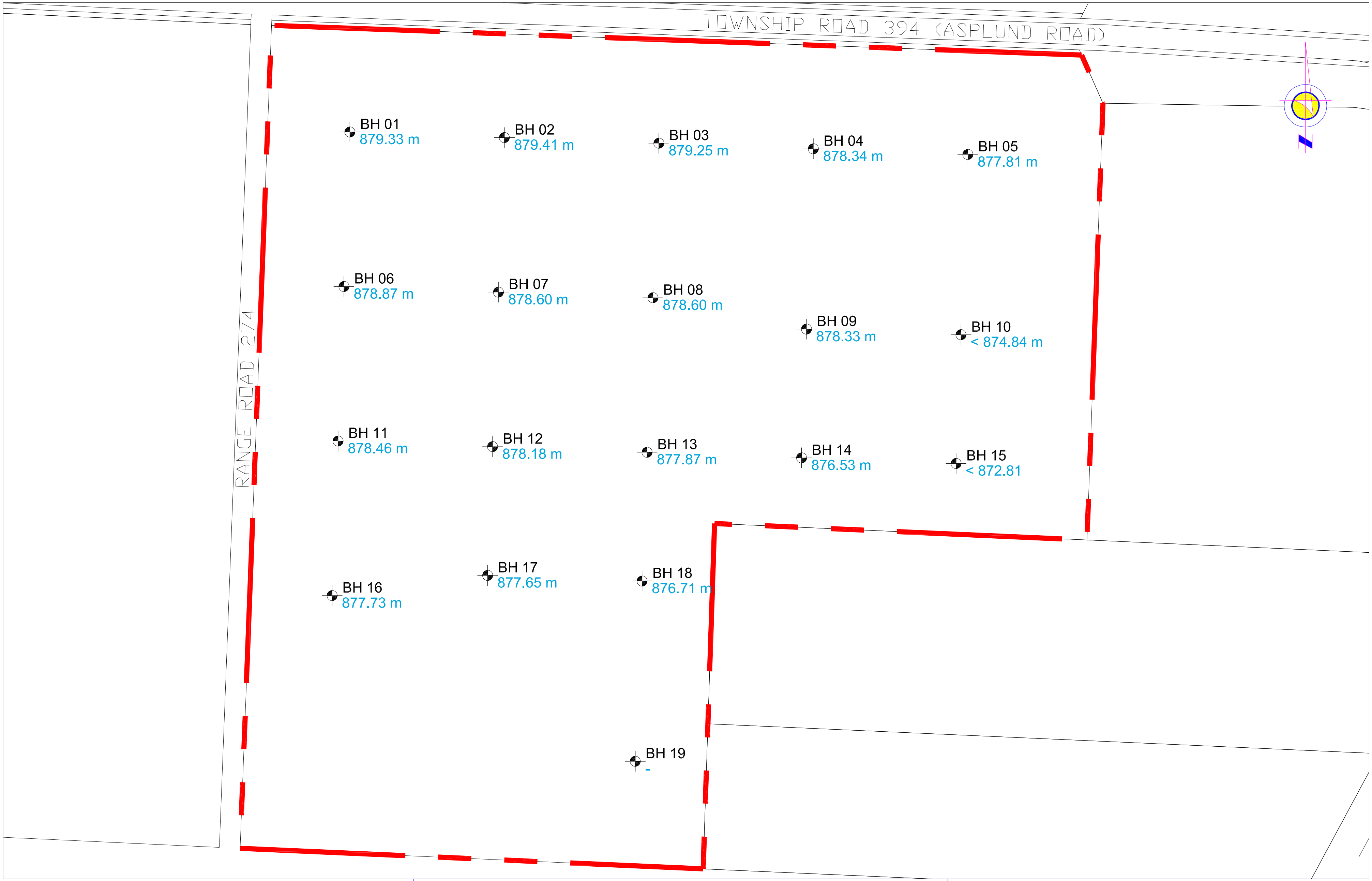
Parkland GEO

CLIENT:

SULPHATE CONCENTRATION

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN: SP	CHK'D.: JN	REV #: 1	DATE: FEBRUARY, 2012
SCALE: 1:5000	JOB NO. RD4372		DRAWING NO. FIGURE 6



⌖ APPROXIMATE BOREHOLE LOCATION
GROUNDWATER ELEVATION

SCALE (metres)

-100 -50 0 50 100 200

ParklandGEO

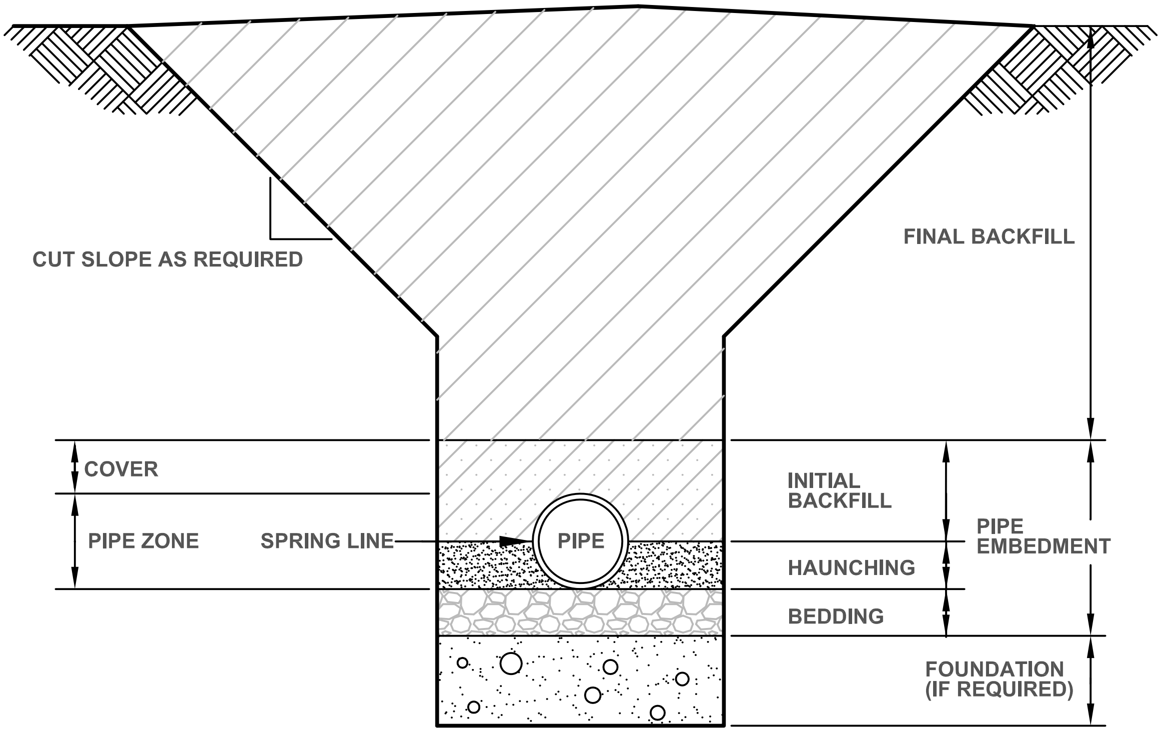
CLIENT:

GROUNDWATER ELEVATION

(DECEMBER 20, 2012)

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN: SP	CHK'D.: LB	REV #: 1	DATE: FEBRUARY, 2012
SCALE: 1:5000	JOB NO. RD4372		DRAWING NO. FIGURE 7



ESTIMATED PIPE DEFLECTION

MODIFIED IOWA FORMULA

$$\text{DEFLECTION} = \frac{0.1\ ((D_L \text{ x } P) + W')\ r^3}{EI + 0.061\ (E')\ r^3}$$

P = PRISM LOAD - Pressure of soil column above the pipe (ie. the Dead Load).
W' = LIVE LOAD - Pressure transmitted from traffic at ground surface.
r = PIPE RADIUS
E = MODULUS OF ELASTICITY FOR THE PIPE
I = TRANSVERSE MOMENT OF INERTIA - per length of individual pipe wall = $t^3 / 12$ where t is wall thickness.
E' = MODULUS OF SOIL REACTION
D_L = DEFLECTION LAG FACTOR (1.0 - 1.5)

NOTES: For preliminary purposes the allowable pipe deflection should be less than 5 % of the pipe diameter. This criteria should be verified with the manufacturer.

REFERENCE: Watkins and Spangler (1958).

TYPICAL VALUES OF MODULUS OF SOIL REACTION, E'

BACKFILL SOIL CLASS	SOIL TYPE (Modified Unified Classification System)	SOIL REACTION MODULUS, E' PSI (MPa) Average value for compaction of Pipe Zone Backfill		
		LOOSE < 85% SPMDD	MODERATE 85 - 95% SPMDD	HIGH > 95% SPMDD
CLASS A	CRUSHED GRAVEL OR ROCK.	1000 (6.89)	3000 (20.68)	3000 (20.68)
CLASS B	COARSE GRAINED SOILS: Soils with little to no fines - less than 12% fines (GW, GP, SW, SP); or borderline materials (GM-GC, GC-SC).	1000 (6.89)	2000 (13.79)	3000 (20.68)
CLASS C	FINE GRAINED SOILS: Non to medium plastic soil with more than 25% coarse particles (CL, ML, ML-CL); COARSE GRAINED SOILS: Soils with more than 12% fines (GM, GC, SM, SC).	NR	1000 (6.89)	2000 (13.79)
CLASS D	FINE GRAINED SOILS: Non to medium plastic soil with less than 25% coarse particles (CL, ML, ML-CL).	NR	400 (2.76)	1000 (6.89)
CLASS E	FINE GRAINED SOILS: High plastic soils (CH, MH, MH-CH);	NR	NR	NR

NOTES: Values in this table are applicable only for fills less than 15 m. The table values do not include any factor of safety. For use in predicting only the initial deflections. Appropriate Deflection Lag Factor must be applied for long term deflections. For borderline soil classifications, select the average E' value between the two categories. SPMDD. For compaction SPMDD denotes Standard Proctor Maximum Dry Density (ASTM D698)

REFERENCE: "Soil Reaction for Buried Flexible Pipe", by Amster Howard, U.S. Bureau of Reclamation, ASCE Journal of Geotechnical Engineering Division, January 1977, pp. 33-43.

ParklandGEO

CLIENT:

TRENCH BACKFILL AND BEDDING

PROPOSED MCLEVIN INDUSTRIAL PARK SUBDIVISION
NW 21-39-27-W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
NN	SP	1	JULY 2011

SCALE:	JOB NO.	DRAWING NO.
NTS	RD4372	FIGURE 8

APPENDIX A

Borehole Logs (19)
Soil Test Results
Aggregate Specifications
Explanation Sheets

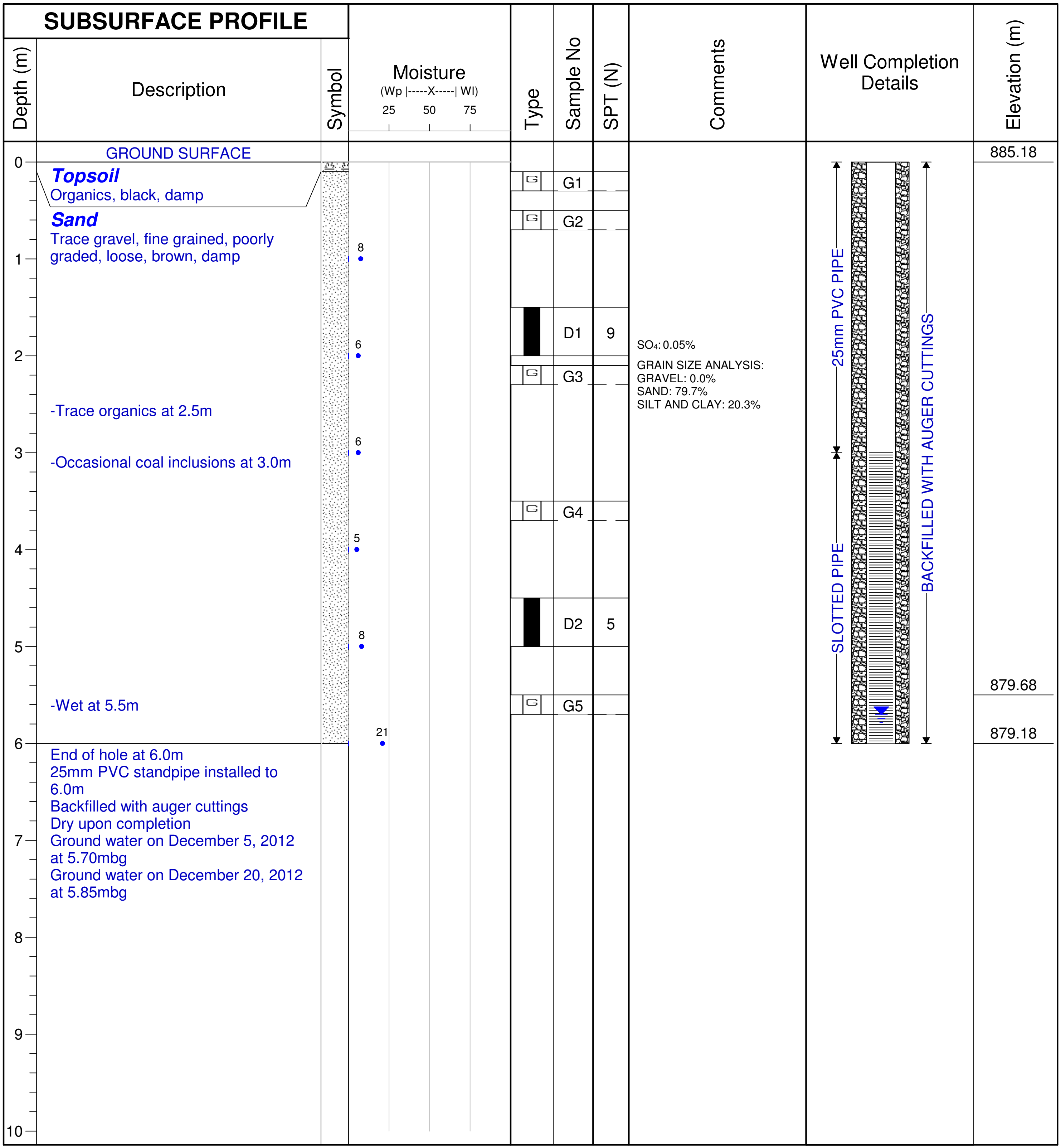
ParklandGEO

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

BOREHOLE NO.: 01

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



GROUND SURFACE

Topsoil
Organics, black, damp

Sand
Trace gravel, fine grained, poorly graded, loose, brown, damp

-Trace organics at 2.5m

-Occasional coal inclusions at 3.0m

-Wet at 5.5m

End of hole at 6.0m
25mm PVC standpipe installed to 6.0m
Backfilled with auger cuttings
Dry upon completion
Ground water on December 5, 2012 at 5.70mbg
Ground water on December 20, 2012 at 5.85mbg

SO_4: 0.05%

GRAIN SIZE ANALYSIS:
GRAVEL: 0.0%
SAND: 79.7%
SILT AND CLAY: 20.3%

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED
RIG/METHOD: Truck rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

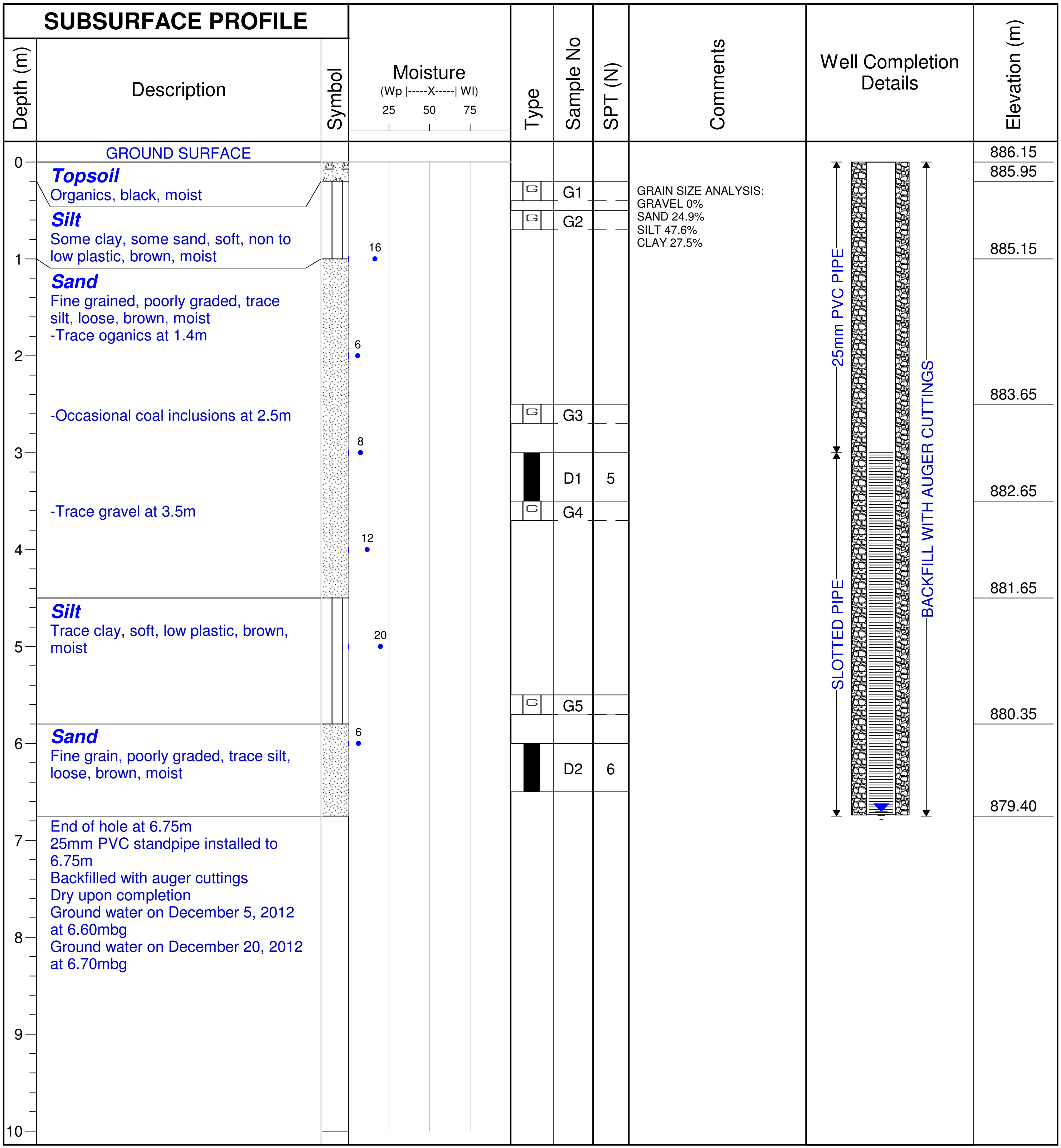
GROUND ELEVATION: 885.18
NORTHING: 5806501.11
EASTING: 306540.98

BOREHOLE NO.: 02

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



Description
GROUND SURFACE
Topsoil Organics, black, moist
Silt Some clay, some sand, soft, non to low plastic, brown, moist
Sand Fine grained, poorly graded, trace silt, loose, brown, moist -Trace oganics at 1.4m -Occasional coal inclusions at 2.5m -Trace gravel at 3.5m
Silt Trace clay, soft, low plastic, brown, moist
Sand Fine grain, poorly graded, trace silt, loose, brown, moist
End of hole at 6.75m 25mm PVC standpipe installed to 6.75m Backfilled with auger cuttings Dry upon completion Ground water on December 5, 2012 at 6.60mbg Ground water on December 20, 2012 at 6.70mbg

Type	Sample No	SPT (N)
G	G1	
G	G2	
G	G3	
■	D1	5
G	G4	
G	G5	
■	D2	6

GRAIN SIZE ANALYSIS:
GRAVEL 0%
SAND 24.9%
SILT 47.6%
CLAY 27.5%

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Envinronmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 19, 2012
CALIBRATION:

GROUND ELEVATION: 886.15
NORTHING: 5806496.39
EASTING: 306690.39

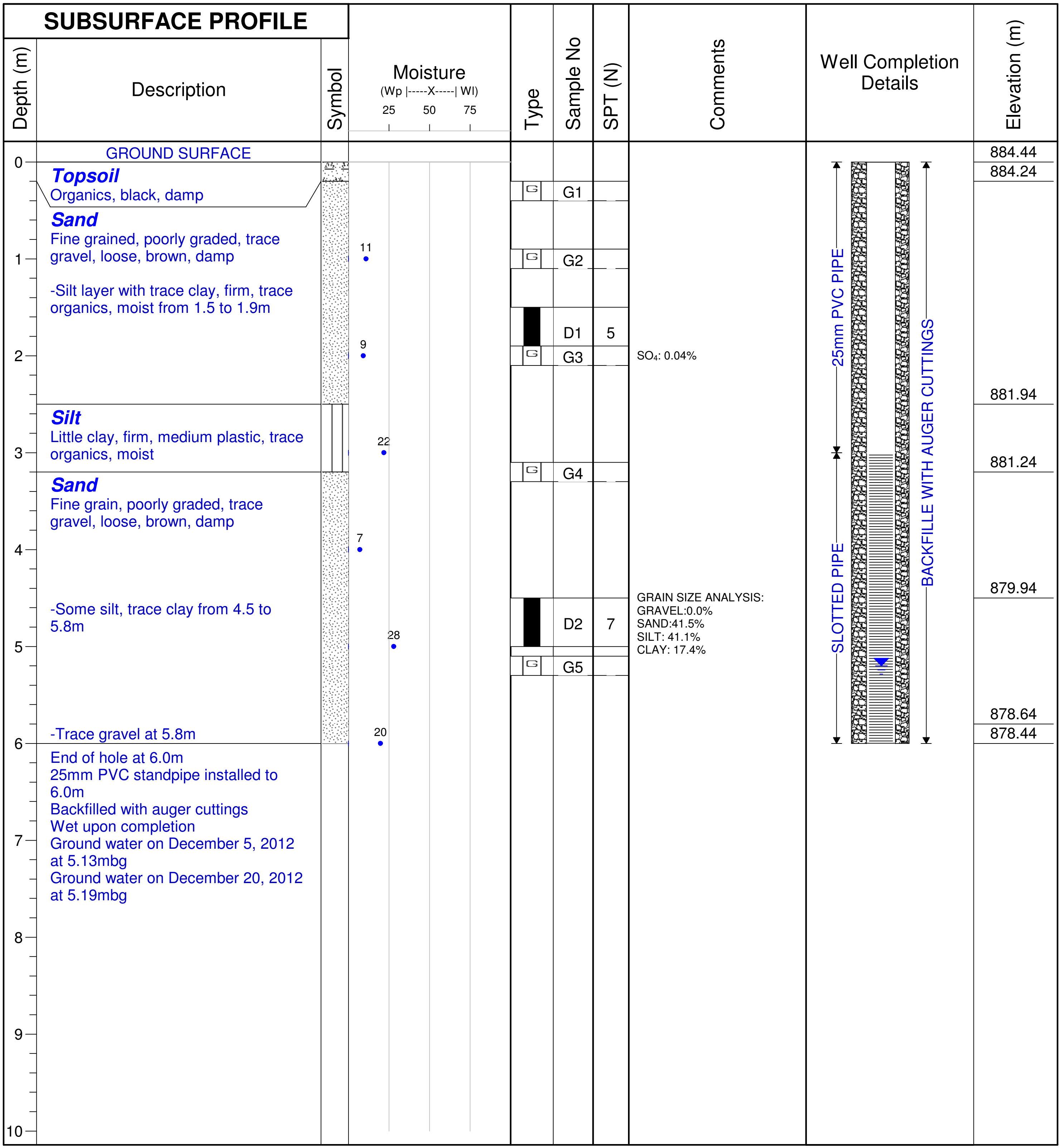
ParklandGEO

CLIENT: Stantec
SITE: McLevin Industial Park Subdivision
NOTES:

BOREHOLE NO.: 03

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



Depth (m)	Description	Moisture	Type	Sample No	SPT (N)	Comments	Elevation (m)
	GROUND SURFACE						884.44
0	**Topsoil** Organics, black, damp		G	G1			884.24
1	**Sand** Fine grained, poorly graded, trace gravel, loose, brown, damp	11	G	G2			
	-Silt layer with trace clay, firm, trace organics, moist from 1.5 to 1.9m		D	D1	5		
2		9	G	G3		SO$_4$: 0.04%	
3	**Silt** Little clay, firm, medium plastic, trace organics, moist	22					881.94
	Sand Fine grain, poorly graded, trace gravel, loose, brown, damp		G	G4			881.24
4		7					
5	-Some silt, trace clay from 4.5 to 5.8m	28	D	D2	7	GRAIN SIZE ANALYSIS: GRAVEL:0.0% SAND:41.5% SILT: 41.1% CLAY: 17.4%	879.94
			G	G5			
6	-Trace gravel at 5.8m	20					878.64 878.44

End of hole at 6.0m
25mm PVC standpipe installed to 6.0m
Backfilled with auger cuttings
Wet upon completion
Ground water on December 5, 2012 at 5.13mbg
Ground water on December 20, 2012 at 5.19mbg

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Envinronmental Ltd
RIG/METHOD: Truck Rig/Solid stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 884.44
NORTHING: 5806490.64
EASTING: 306841.30

ParklandGEO

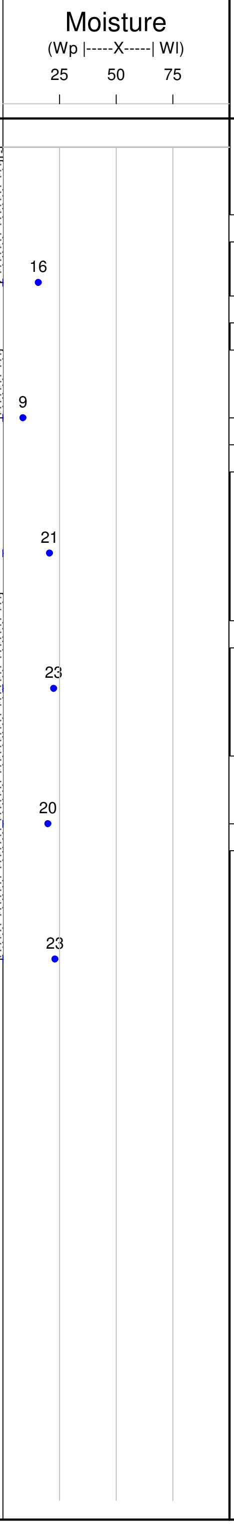
CLIENT: Stantec
SITE: McLevin Industrial Park subdivision
NOTES:

BOREHOLE NO.: 04

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

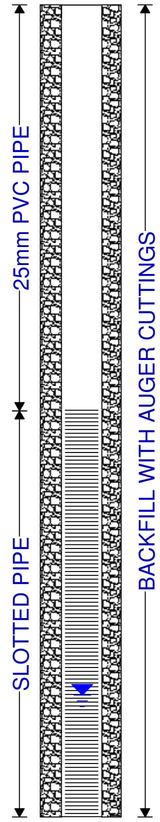
Depth (m)	Description	Elevation (m)
	GROUND SURFACE	882.49
0	**Topsoil**	
	Sand Trace gravel, fine grained, poorly graded, loose, brown, damp	
1	**Silt** Some clay, little sand, soft, medium plastic, brown, damp	881.49
	Sand Little silt, fine grained, poorly graded, loose, brown, moist	880.99
2	**Silt** Some clay, trace sand, soft, medium plastic, brown, moist	880.49
3	**Sand** Little silt, trace gravel, fine to medium grained, loose, brown, wet	879.19
4	-Trace gravel, medium to coarse grained at 4.5m	877.99
6	End of hole at 6.0m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Ground water on December 5, 2012 at 4.10mbg Ground water on December 20, 2012 at 4.15mbg	876.49



Type	Sample No	SPT (N)
G	G1	
G	G2	
■	D1	8
G	G3	
G	G4	
G	G5	
■	D2	8
G	G6	

Comments:
GRAIN SIZE ANALYSIS:
GRAVEL: 0.0%
SAND:35.6%
SILT AND CLAY: 64.4%

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED
RIG/METHOD: Truck Rig/Solid stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 882.49
NORTHING: 5806484.32
EASTING: 306990.38

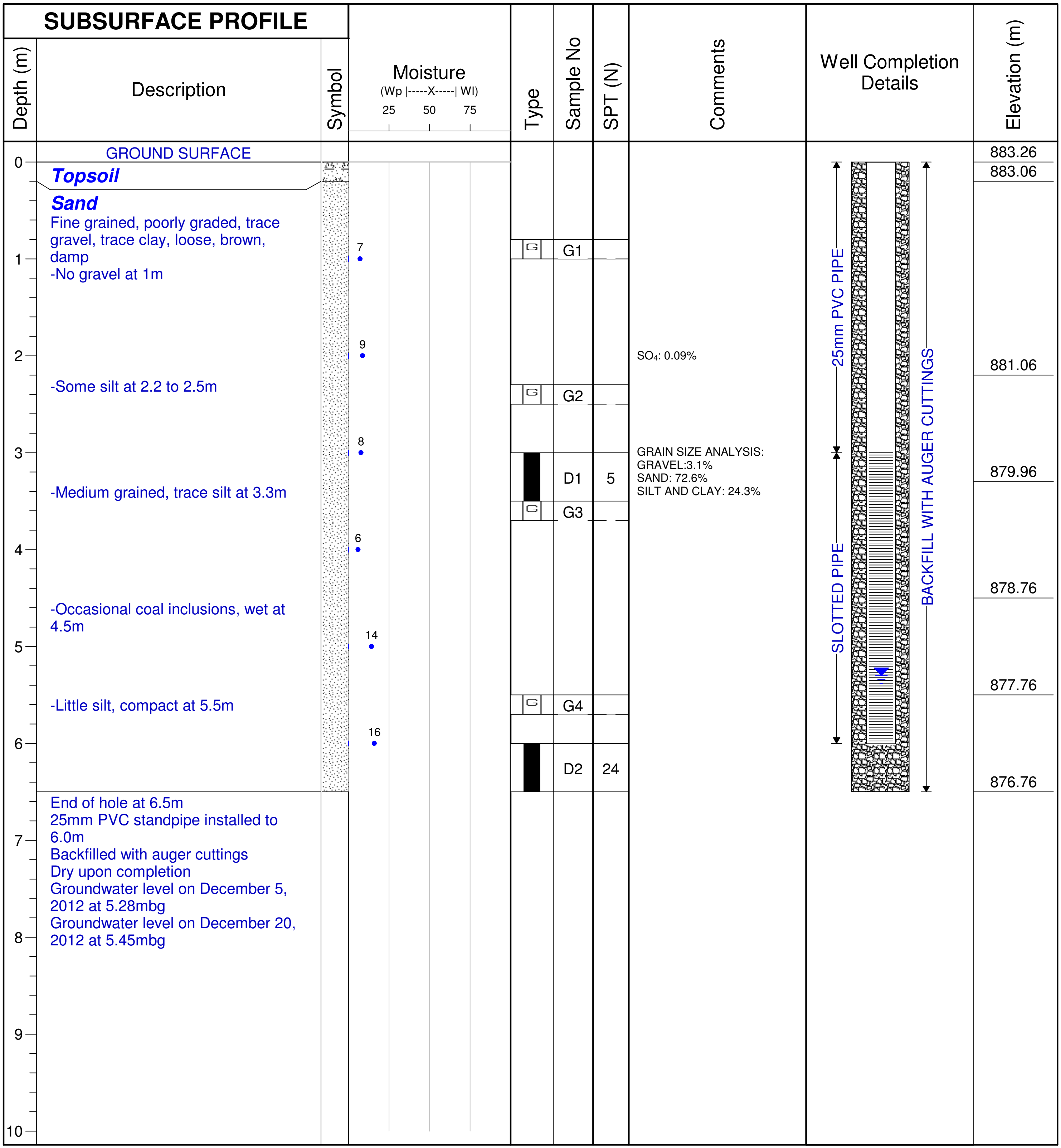
ParklandGEO

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

BOREHOLE NO.: 05

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



Depth (m)	Description	Symbol	Moisture (Wp |-----X-----| Wl) 25 50 75	Type	Sample No	SPT (N)	Comments	Well Completion Details	Elevation (m)
0	GROUND SURFACE								883.26
	Topsoil							25mm PVC PIPE BACKFILL WITH AUGER CUTTINGS	883.06
1	***Sand*** Fine grained, poorly graded, trace gravel, trace clay, loose, brown, damp -No gravel at 1m		7	G	G1				
2			9				SO_4: 0.09%		881.06
	-Some silt at 2.2 to 2.5m			G	G2				
3			8		D1	5	GRAIN SIZE ANALYSIS: GRAVEL:3.1% SAND: 72.6% SILT AND CLAY: 24.3%	SLOTTED PIPE	
	-Medium grained, trace silt at 3.3m			G	G3				879.96
4			6						
	-Occasional coal inclusions, wet at 4.5m								878.76
5			14						
	-Little silt, compact at 5.5m			G	G4				877.76
6			16		D2	24			876.76
	End of hole at 6.5m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Dry upon completion Groundwater level on December 5, 2012 at 5.28mbg Groundwater level on December 20, 2012 at 5.45mbg								
7									
8									
9									
10									

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck rig/Solid Stem
DATE: November 16
CALIBRATION:

GROUND ELEVATION: 883.26
NORTHING: 5806480.63
EASTING: 307140.39

BOREHOLE NO.: 06

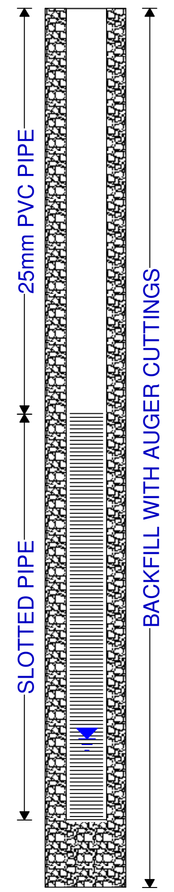
CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description	Moisture (Wp |-----X-----| Wl) 25 50 75	Type	Sample No	SPT (N)	Comments	Elevation (m)
	GROUND SURFACE						884.65
0	***Topsoil***						
	Sand Fine and medium grained, poorly graded, loose, brown, damp -Silt layer from 0.5 to 0.6m		G G	G1 G2			
1		8					
2		7				SO$_4$: 0.05%	
	-Trace organics at 2.5m		G	G3		Organic content: 10.2%	882.15
3		22	■	D1	7		
	-Occasional coal inclusions at 3.5m		G	G4			881.15
4		6					
5		21					
	-Wet at 5.5m		G	G5			879.15
6		20	■	D2	5		878.15
	End of hole at 6.5m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 5.40mbg Groundwater level on December 20, 2012 at 5.78mbg						
7							
8							
9							
10							

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 884.65
NORTHING: 5806351.67
EASTING: 306534.85

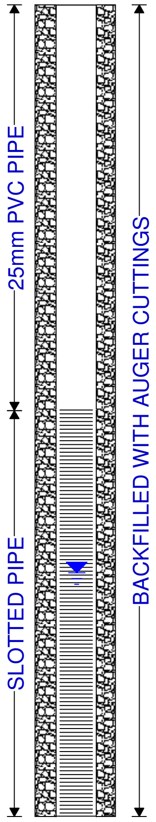
BOREHOLE NO.: 07

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description	Symbol	Moisture (Wp |-----X-----| Wl) 25 50 75	Type	Sample No	SPT (N)	Comments	Well Completion Details	Elevation (m)
	GROUND SURFACE								882.95
0	**Topsoil** Organics, black, damp								882.65
	Sand Trace silt, fine to medium grained, poorly graded, compact, brown, moist			G	G1				
1			6						
				G	G2				
				■	D1	10			
2	-Little silt at 2.0m		9						880.95
	-Some silt at 2.5m			G	G3				880.45
3	-Silt layer, soft, low plastic, brown, moist from 3.0 to 3.4m		9	G	G4				879.95
	-Coarse grained at 3.4m								879.55
4			17						
	Silt Trace clay, trace sand, firm, low plastic, brown, wet			■	D2	7			878.45
5			25						
	Sand Some silt, fine grained, poorly graded, compact, brown, wet			G	G5				877.75
				G	G6				
6	End of hole at 6.0m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 4.22mbg Groundwater level on December 20, 2012 at 4.35mbg		22						876.95
7									
8									
9									
10									



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 882.95
NORTHING: 5806345.76
EASTING: 306685.84

BOREHOLE NO.: 08

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

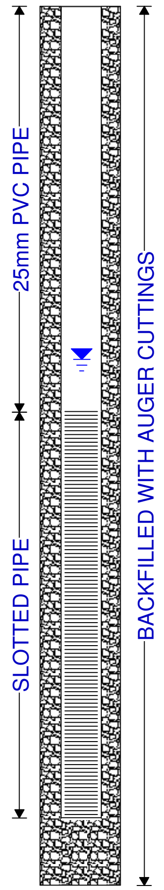
PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Description	Moisture (Wp |-----X-----| Wl)	Type	Sample No	SPT (N)	Comments	Elevation (m)
GROUND SURFACE						881.21
Topsoil Organics, black, moist		G	G1			880.71
Sand Trace gravel, fine grained, poorly graded, loose, brown, moist	12 25	G	G2			878.81
Silt Little clay, trace sand, firm, nonplastic, brown, moist	34	G	G3			878.11
Sand Little silt, fine to medium grained, poorly graded, loose, brown, wet -Grayish brown at 4.5m	23 27 26	■	D1	6		
		G	G4			
		G	G5			
		■	D2	8		874.71

End of hole at 6.5m
25mm PVC standpipe installed to 6.0m
Backfilled with auger cuttings
Wet upon completion
Groundwater level on December 5, 2012 at 2.50mbg
Groundwater level on December 20, 2012 at 2.61mbg

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

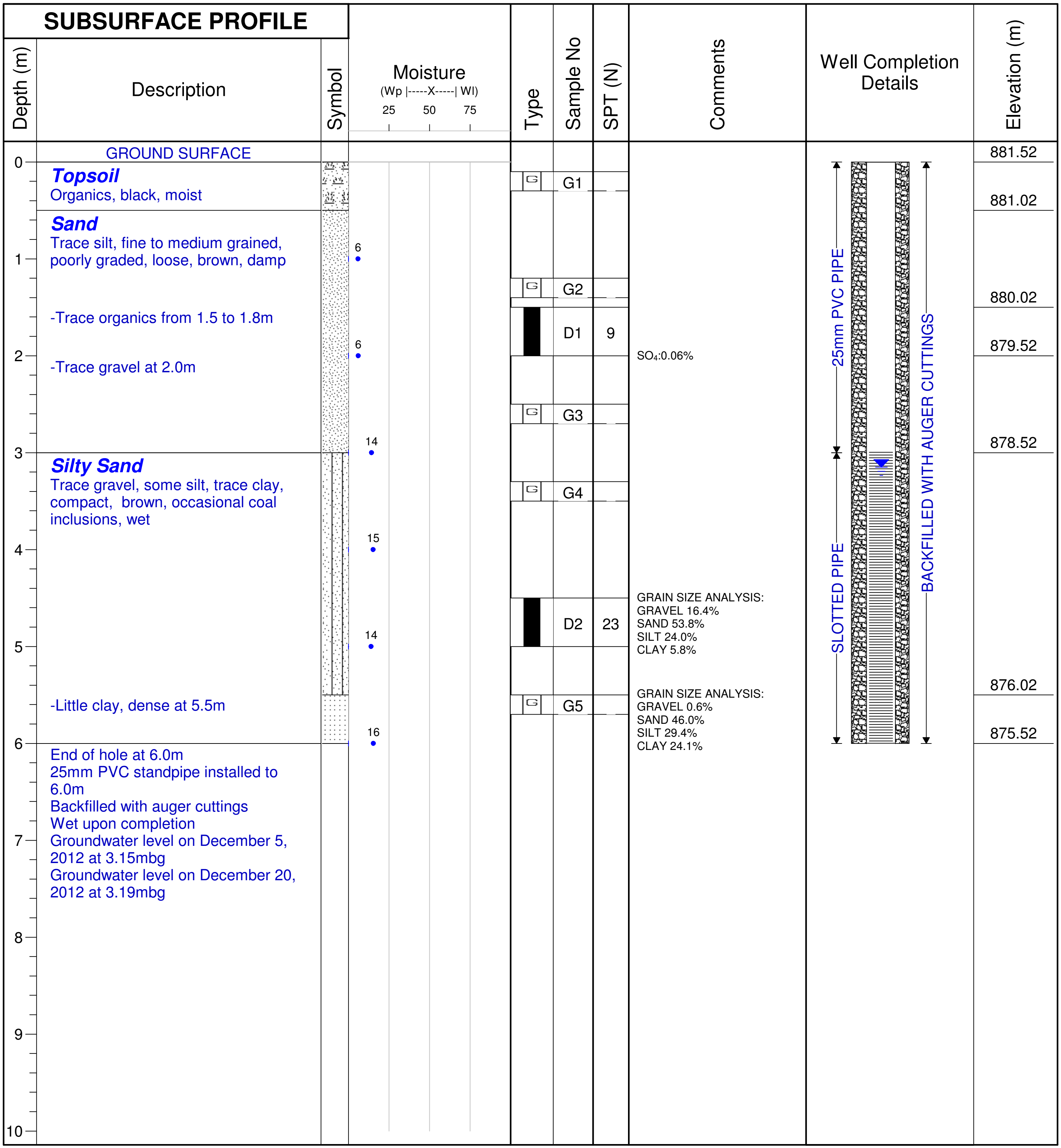
GROUND ELEVATION: 881.21
NORTHING: 5806340.81
EASTING: 306834.71

BOREHOLE NO.: 09

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



Depth (m)	Description	Moisture	Type	Sample No	SPT (N)	Comments	Elevation (m)
	GROUND SURFACE						881.52
0	***Topsoil*** Organics, black, moist		G	G1			881.02
	Sand Trace silt, fine to medium grained, poorly graded, loose, brown, damp						
1		6					
			G	G2			880.02
	-Trace organics from 1.5 to 1.8m			D1	9		
2	-Trace gravel at 2.0m	6				SO_4:0.06%	879.52
			G	G3			
3	***Silty Sand*** Trace gravel, some silt, trace clay, compact, brown, occasional coal inclusions, wet	14					878.52
			G	G4			
4		15					
				D2	23	GRAIN SIZE ANALYSIS: GRAVEL 16.4% SAND 53.8% SILT 24.0% CLAY 5.8%	
5		14					
	-Little clay, dense at 5.5m		G	G5		GRAIN SIZE ANALYSIS: GRAVEL 0.6% SAND 46.0% SILT 29.4% CLAY 24.1%	876.02
6	End of hole at 6.0m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 3.15mbg Groundwater level on December 20, 2012 at 3.19mbg	16					875.52
7							
8							
9							
10							

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

GROUND ELEVATION: 881.52
NORTHING: 5806310.06
EASTING: 306983.92

ParklandGEO

BOREHOLE NO.: 10

CLIENT: Stantec
SITE: Mclevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description
	GROUND SURFACE
0	***Topsoil***
	Sand Trace gravel, fine to medium grained, poorly graded, loose, brown, damp -Fine grained, no gravel from 1.5 to 2.0m -Trace gravel from 2.3 to 2.5m -Compact at 3.0m
	Sand and Gravel Well graded, loose, brown, wet
	End of hole at 6.5m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Dry upon completion Groundwater level on December 5, 2012 at 6.00mbg Dry on December 20, 2012

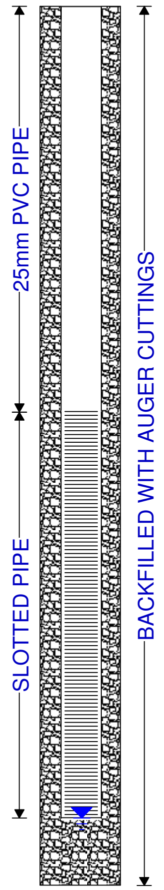
Moisture
(Wp |-----X-----| Wl)
25 50 75

Depth (m)	Moisture
1	7
2	10
3	8
4	5
5	6
6	14

Type	Sample No	SPT (N)
G	G1	
G	G2	
■	D1	14
G	G3	
G	G4	
■	D2	5

Comments

Well Completion Details



Elevation (m)
881.34
879.84
879.04
878.34
876.84
874.84

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

GROUND ELEVATION: 881.34
NORTHING: 5806306.12
EASTING: 307133.73

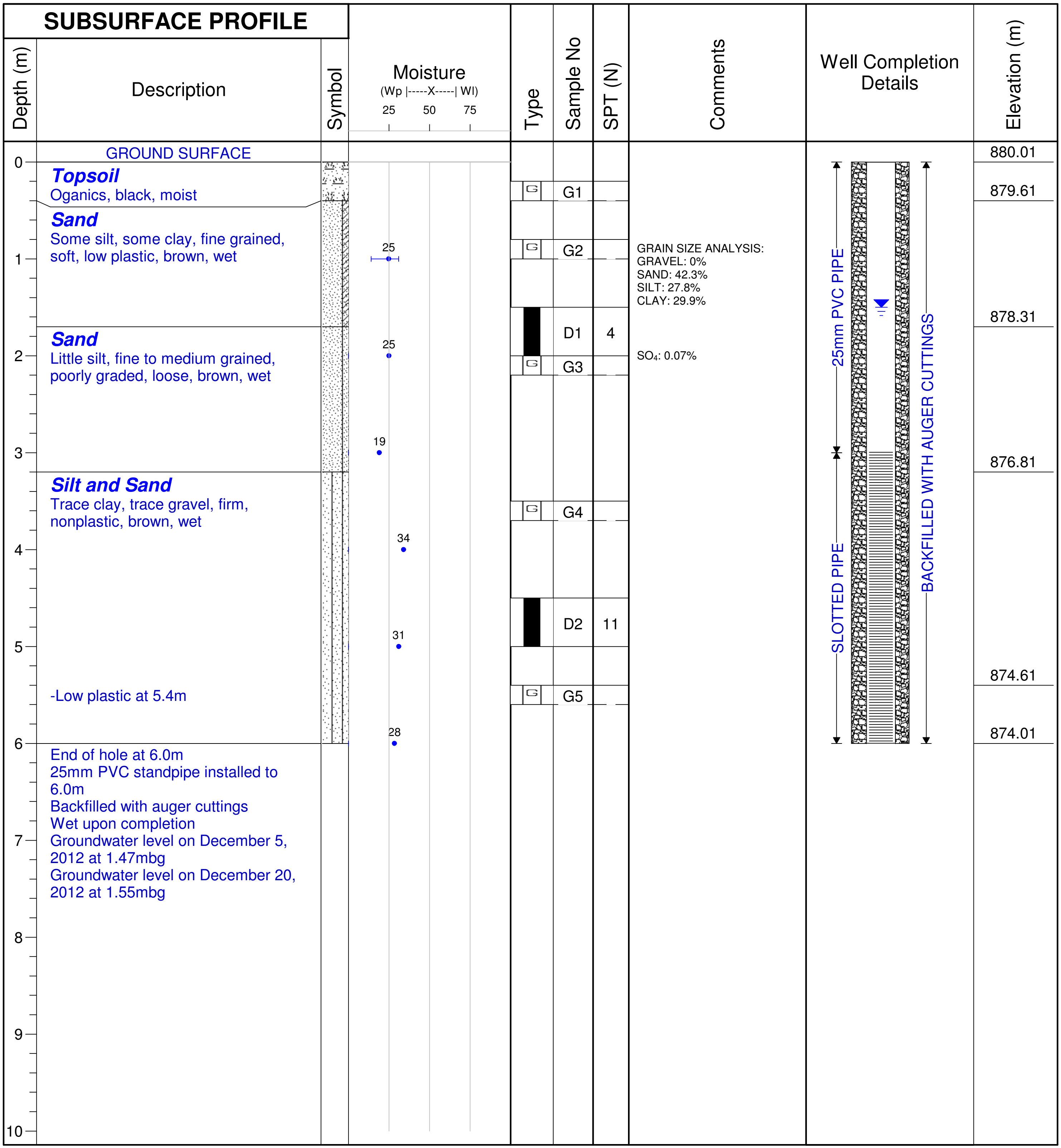
ParklandGEO

BOREHOLE NO.: 11

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



Description	Elevation (m)
GROUND SURFACE	880.01
Topsoil Oganics, black, moist	879.61
Sand Some silt, some clay, fine grained, soft, low plastic, brown, wet	878.31
Sand Little silt, fine to medium grained, poorly graded, loose, brown, wet	876.81
Silt and Sand Trace clay, trace gravel, firm, nonplastic, brown, wet	
-Low plastic at 5.4m	874.61
End of hole at 6.0m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 1.47mbg Groundwater level on December 20, 2012 at 1.55mbg	874.01

Type	Sample No	SPT (N)	Comments
G	G1		
G	G2		GRAIN SIZE ANALYSIS: GRAVEL: 0% SAND: 42.3% SILT: 27.8% CLAY: 29.9%
■	D1	4	
G	G3		SO$_4$: 0.07%
G	G4		
■	D2	11	
G	G5		

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 880.01
NORTHING: 5806201.70
EASTING: 306529.56

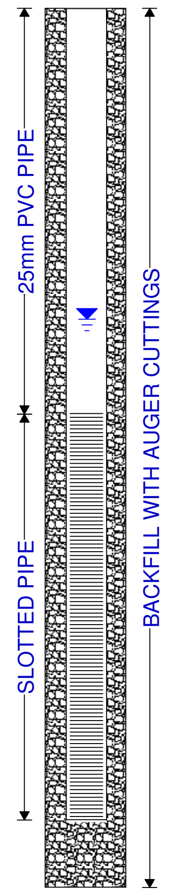
BOREHOLE NO.: 12

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:
PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description	Moisture (Wp |-----X-----| Wl) 25 50 75	Type	Sample No	SPT (N)	Comments	Elevation (m)
	GROUND SURFACE						880.77
0	***Topsoil***						880.57
	Sand Trace gravel, medium grained, poorly graded, loose, brown, damp						
			G	G1			
1		8					
	-Fine grained, no gravel, moist at 1.5m						
2		17					
			G	G2			
3		19	■	D1	5		
	-Wet at 3.0m						
			G	G3			
4		22					
5		31					
			G	G4			
6		23					
			■	D2	9		874.27
7	End of hole at 6.5m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Dry upon completion Groundwater level on December 5, 2012 at 2.33mbg Groundwater level on December 20, 2012 at 2.59mbg						
8							
9							
10							

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

GROUND ELEVATION: 880.77
NORTHING: 5806196.25
EASTING: 306679.35

ParklandGEO

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

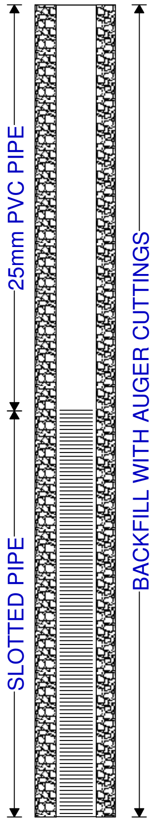
BOREHOLE NO.: 13

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description	Moisture (Wp |-----X-----| Wl)	Type	Sample No	SPT (N)	Comments	Elevation (m)
	GROUND SURFACE						880.72
0	***Topsoil***						
	Sand Trace gravel, medium grained, poorly graded, loose, brown, damp		G	G1			
1		7					
	-Silt layer, soft, low plastic, moist at 1.5 to 1.7m						879.22
			■	D1	5		
2		20				SO$_4$: 0.04%	
			G	G2			
3	- Wet, coarse grained at 3.0m	17					877.72
			G	G3			
4		28					876.62
	Silt Trace sand, trace gravel, soft, low plastic, brown, wet -Sand layer, coarse grained, poorly graded, loose, brown from 4.3 to 4.5m		■	D2	5		
5		27					875.62
	Sand Trace silt, trace gravel, fine grained, poorly graded, loose, brown, damp		G	G4			
6		19					874.72
	End of hole at 6.0m 25mm PVC pipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 2.74mbg Groundwater level on December 20, 2012 at 2.85mbg						
7							
8							
9							
10							

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

GROUND ELEVATION: 880.72
NORTHING: 5806190.97
EASTING: 306829.58

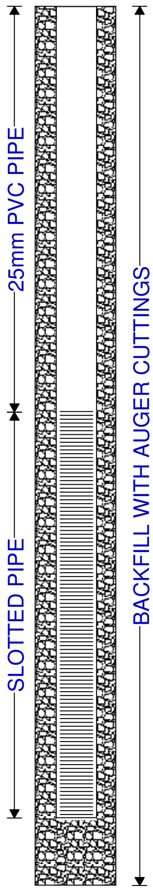
CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

BOREHOLE NO.: 14

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description	Symbol	Moisture (Wp |-----X-----| Wl) 25 50 75	Type	Sample No	SPT (N)	Comments	Well Completion Details	Elevation (m)
	GROUND SURFACE								879.21
0	***Topsoil***								
	Sand Fine grained, poorly graded, loose, brown, damp -Trace gravel, coarse grained, wet at 0.7m			G	G1				
1			3						
2			6						
				G	G2				
3			15	■	D1	2			
	-Trace organics from 3.0 to 4.0m								
				G	G3		Organic content: 7.4%		
4			12						
	Silt and Sand Trace gravel, little clay, dense, non to low plastic, brown, wet								874.71
				G	G4		GRAIN SIZE ANALYSIS: GRAVEL: 0.6% SAND: 46.0% SILT: 37.4% CLAY: 16.0%		
5			16						
6			16						
				■	D2	49			
	End of hole at 6.5m 25mm PVC standpipe istalled to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 2.75mbg Groundwater level on December 20, 2012 at 2.62mbg								872.71
7									
8									
9									
10									



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

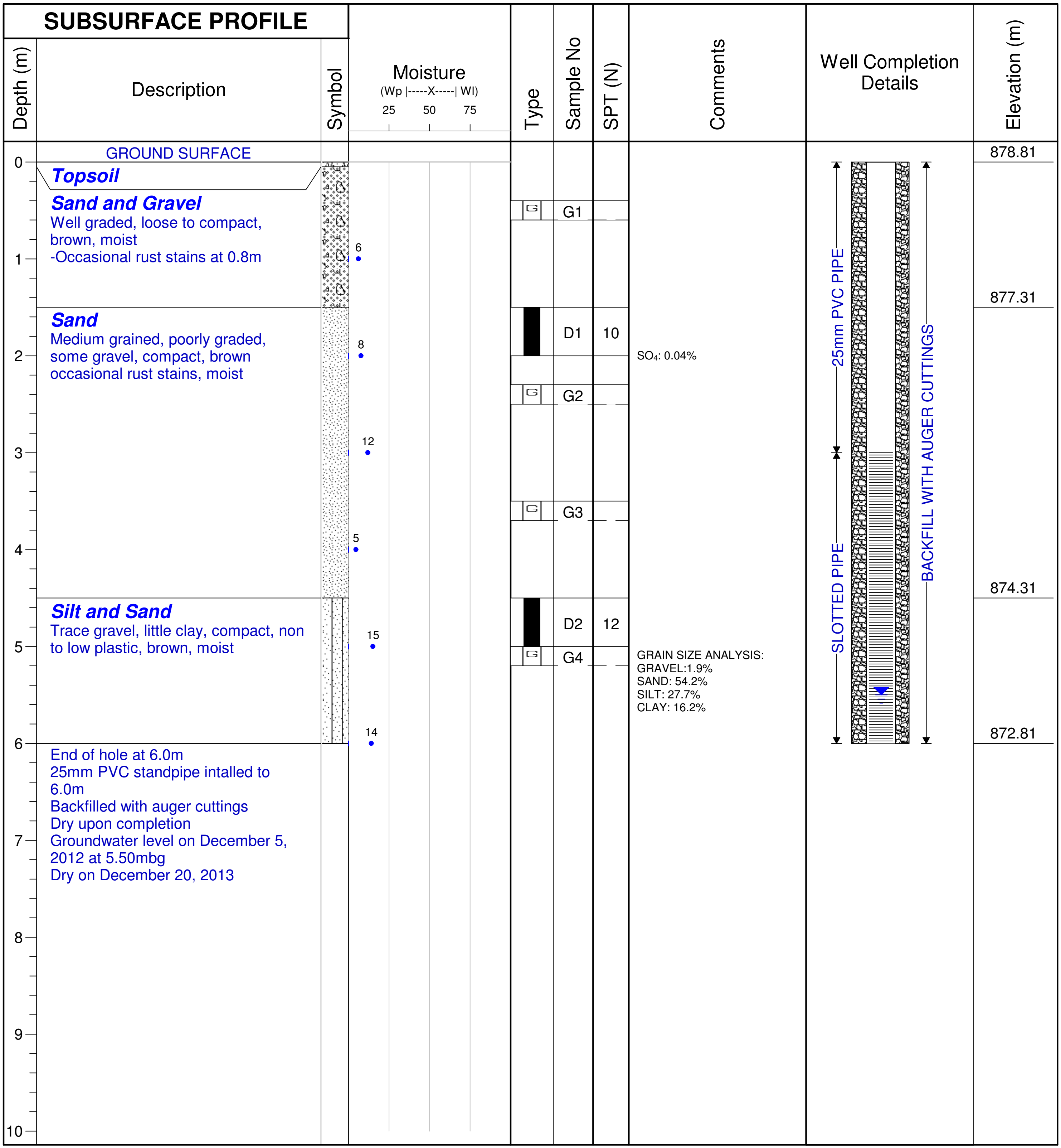
GROUND ELEVATION: 879.21
NORTHING: 5806185.74
EASTING: 306978.24

BOREHOLE NO.: 15

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



Depth (m)	Description	Moisture	Type	Sample No	SPT (N)	Comments	Elevation (m)
0	GROUND SURFACE						878.81
	Topsoil						
	Sand and Gravel Well graded, loose to compact, brown, moist -Occasional rust stains at 0.8m		G	G1			
1		6					877.31
	Sand Medium grained, poorly graded, some gravel, compact, brown occasional rust stains, moist		■	D1	10		
2		8				SO$_4$: 0.04%	
			G	G2			
3		12					
			G	G3			
4		5					874.31
	Silt and Sand Trace gravel, little clay, compact, non to low plastic, brown, moist		■	D2	12		
5		15	G	G4		GRAIN SIZE ANALYSIS: GRAVEL:1.9% SAND: 54.2% SILT: 27.7% CLAY: 16.2%	
6		14					872.81
	End of hole at 6.0m 25mm PVC standpipe intalled to 6.0m Backfilled with auger cuttings Dry upon completion Groundwater level on December 5, 2012 at 5.50mbg Dry on December 20, 2013						
7							
8							
9							
10							

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

GROUND ELEVATION: 878.81
NORTHING: 5806180.02
EASTING: 307128.66

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

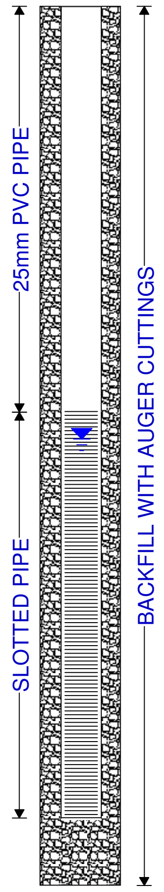
BOREHOLE NO.: 16

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

Depth (m)	Description	Moisture (Wp |-----X-----| Wl)	Type	Sample No	SPT (N)	Comments	Elevation (m)
	GROUND SURFACE						881.08
0	***Topsoil***						
	Silt and Sand Some clay, fine to medium grained, poorly graded, loose, non to low plastic, brown, damp		G	G1		GRAIN SIZE ANALYSIS: GRAVEL: 0.4% SAND: 56.0% SILT AND CLAY:43.6%	
1		8					
2		9					
	-Trace organics from 2.5 to 2.7m		G	G2			878.58
3		17		D1	6		
			G	G3			
4	-Wet at 4.0m	26					877.08
	-Occasional coal inclusioins at 4.5m						876.58
5		22					
	-Trace gravel, compact at 5.5m		G	G4			875.58
6		17		D2	26		874.58
7	End of hole at 6.5m 25mm PVC standpipe installed to 6.0m Backfilled with auger cuttings Wet upon completion Groundwater level on December 5, 2012 at 3.22mbg Groundwater level on December 20, 2012 at 3.35mbg						
8							
9							
10							

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

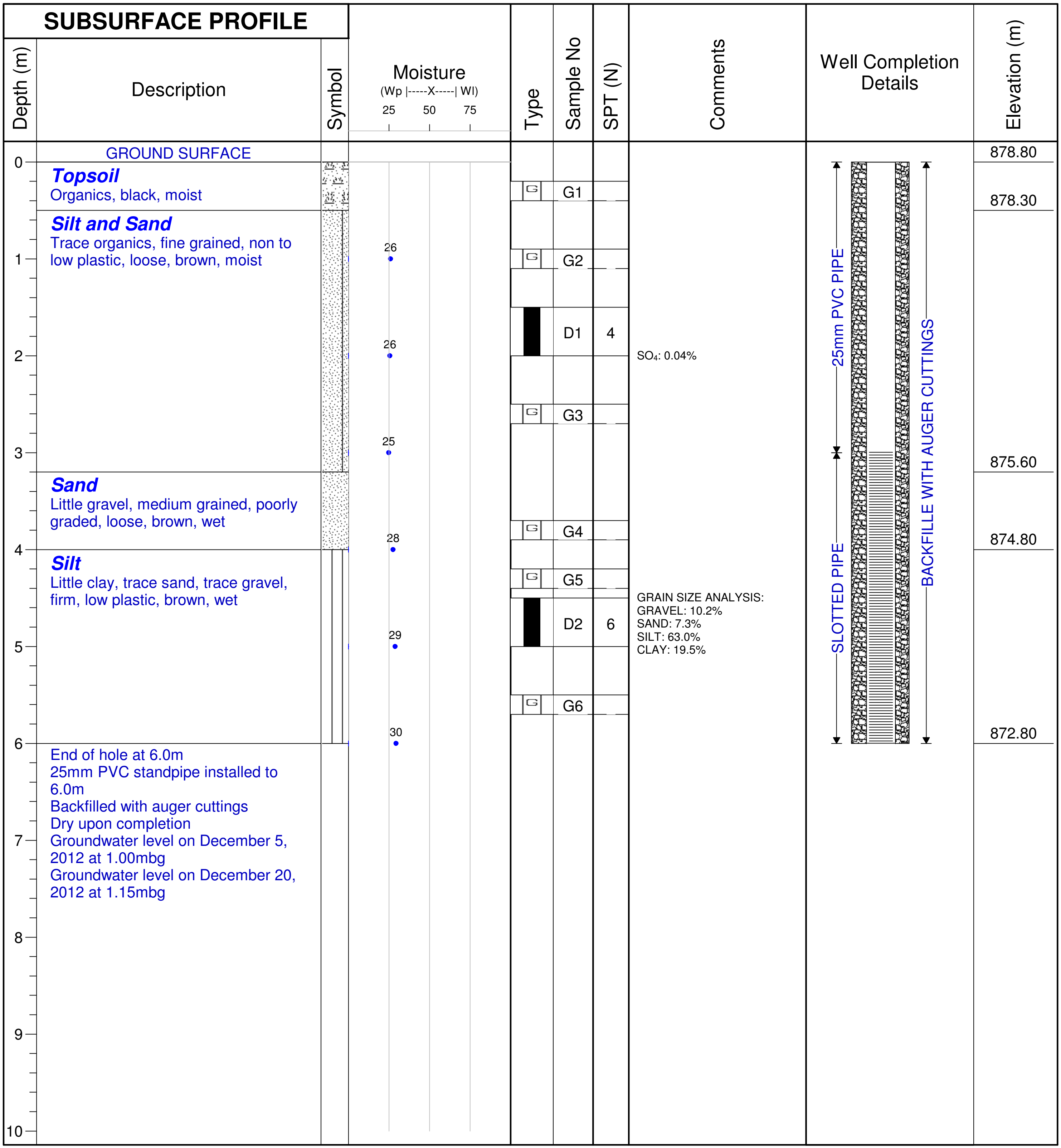
GROUND ELEVATION: 881.08
NORTHING: 5806052.28
EASTING: 306523.62

BOREHOLE NO.: 17

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



GROUND SURFACE

Description	Elevation (m)
	878.80
Topsoil Organics, black, moist	878.30
Silt and Sand Trace organics, fine grained, non to low plastic, loose, brown, moist	875.60
Sand Little gravel, medium grained, poorly graded, loose, brown, wet	874.80
Silt Little clay, trace sand, trace gravel, firm, low plastic, brown, wet	872.80

End of hole at 6.0m
25mm PVC standpipe installed to 6.0m
Backfilled with auger cuttings
Dry upon completion
Groundwater level on December 5, 2012 at 1.00mbg
Groundwater level on December 20, 2012 at 1.15mbg

Sample No	SPT (N)	Comments
G1		
G2		
D1	4	SO$_4$: 0.04%
G3		
G4		
G5		
D2	6	GRAIN SIZE ANALYSIS: GRAVEL: 10.2% SAND: 7.3% SILT: 63.0% CLAY: 19.5%
G6		

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 878.80
NORTHING: 5806072.42
EASTING: 306674.59

ParklandGEO

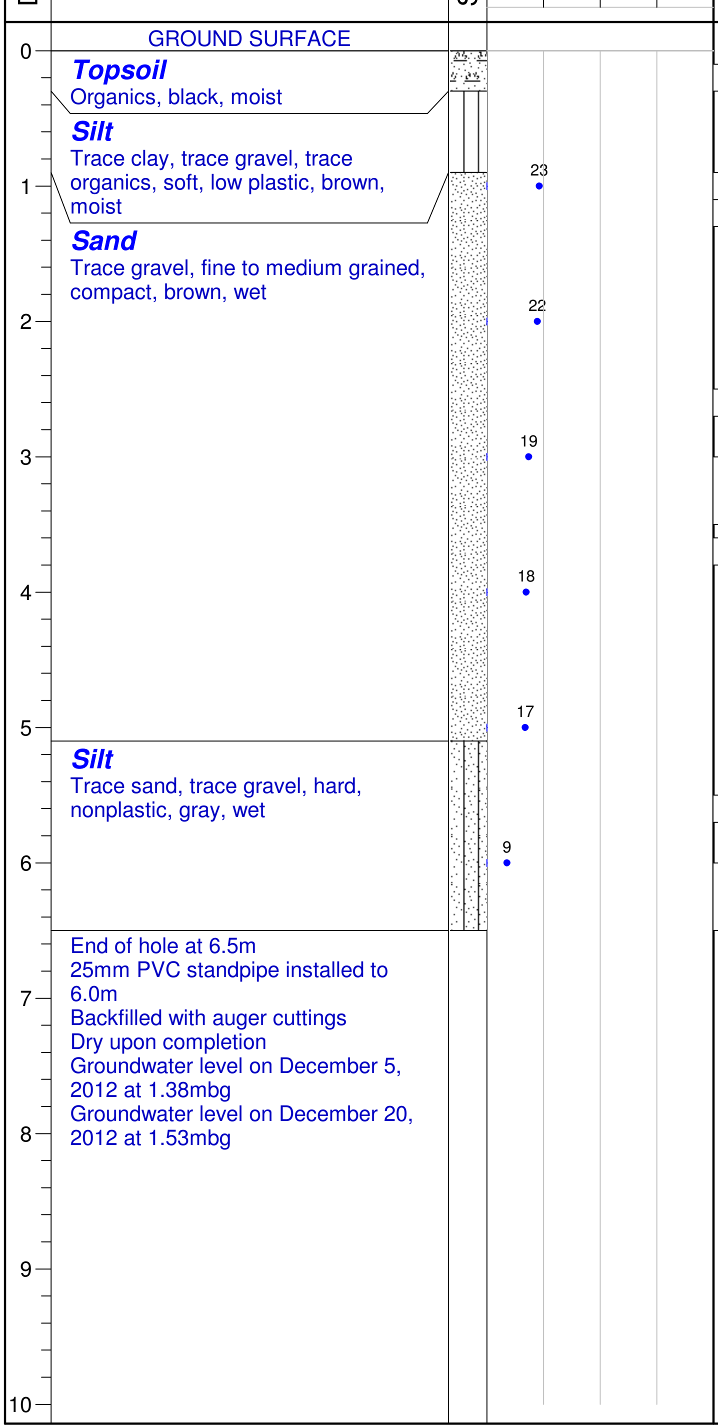
BOREHOLE NO.: 18

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:
PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE

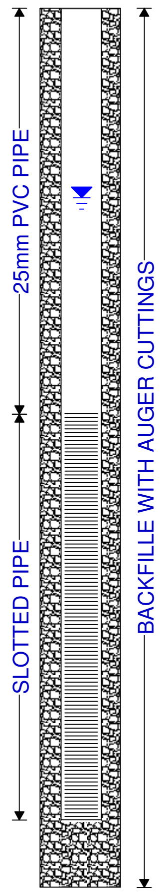
Description	Elevation (m)
GROUND SURFACE	878.24
Topsoil Organics, black, moist	877.94
Silt Trace clay, trace gravel, trace organics, soft, low plastic, brown, moist	877.34
Sand Trace gravel, fine to medium grained, compact, brown, wet	873.14
Silt Trace sand, trace gravel, hard, nonplastic, gray, wet	871.74

End of hole at 6.5m
25mm PVC standpipe installed to 6.0m
Backfilled with auger cuttings
Dry upon completion
Groundwater level on December 5, 2012 at 1.38mbg
Groundwater level on December 20, 2012 at 1.53mbg



Type	Sample No	SPT (N)	Comments
G	G1		
G	G2		
G	G3		
G	G4		
■	D1	13	
G	G5		
G	G6		
■	D2	50	50 blows for 6"

Well Completion Details



LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 15, 2012
CALIBRATION:

GROUND ELEVATION: 878.24
NORTHING: 580606.23
EASTING: 306824.96

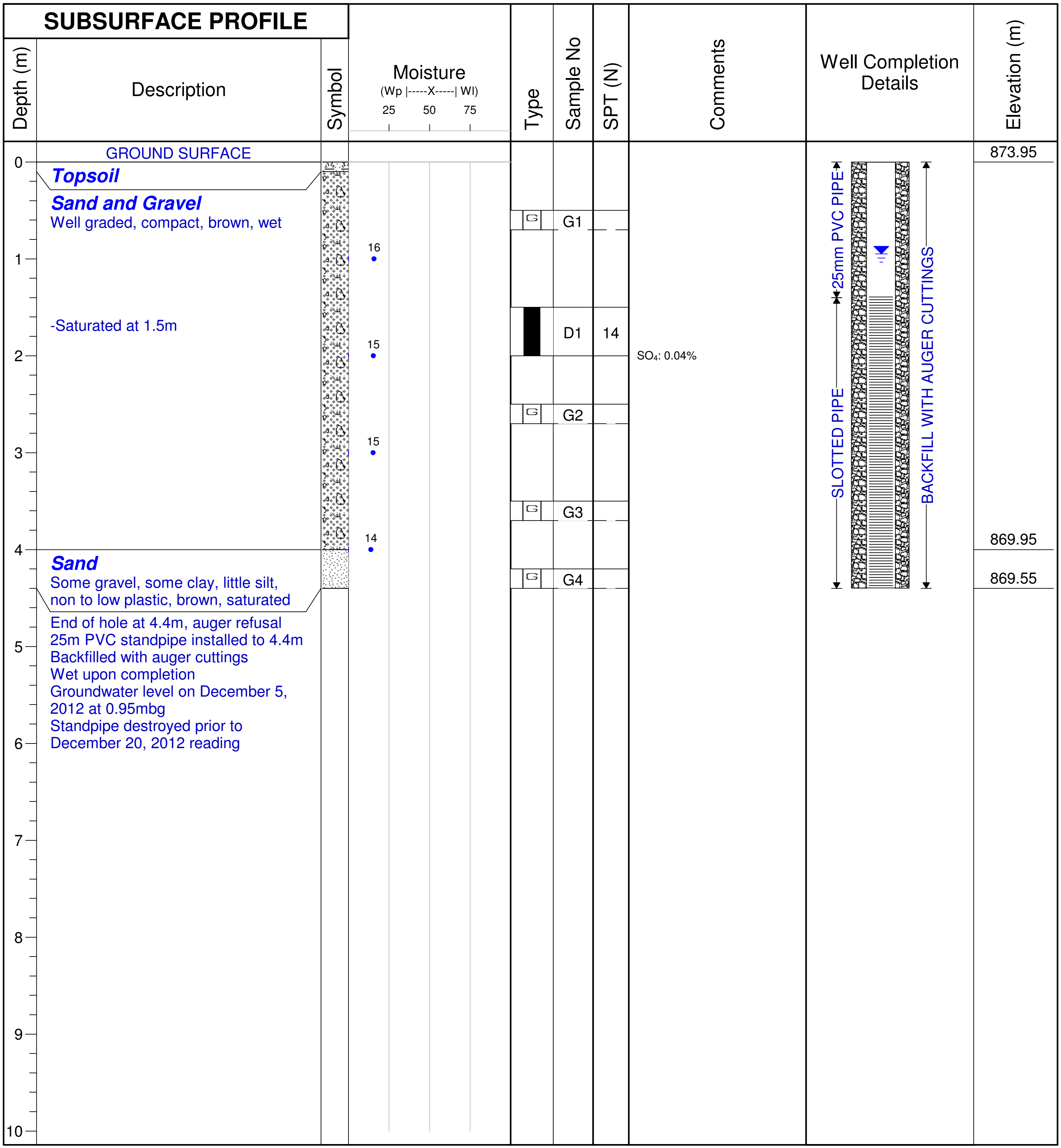
ParklandGEO

CLIENT: Stantec
SITE: McLevin Industrial Park Subdivision
NOTES:

BOREHOLE NO.: 19

PROJECT NO.: RD4372
BH LOCATION:

SUBSURFACE PROFILE



GROUND SURFACE

Topsoil

Sand and Gravel

Well graded, compact, brown, wet

-Saturated at 1.5m

Sand

Some gravel, some clay, little silt, non to low plastic, brown, saturated

End of hole at 4.4m, auger refusal
25m PVC standpipe installed to 4.4m
Backfilled with auger cuttings
Wet upon completion
Groundwater level on December 5, 2012 at 0.95mbg
Standpipe destroyed prior to December 20, 2012 reading

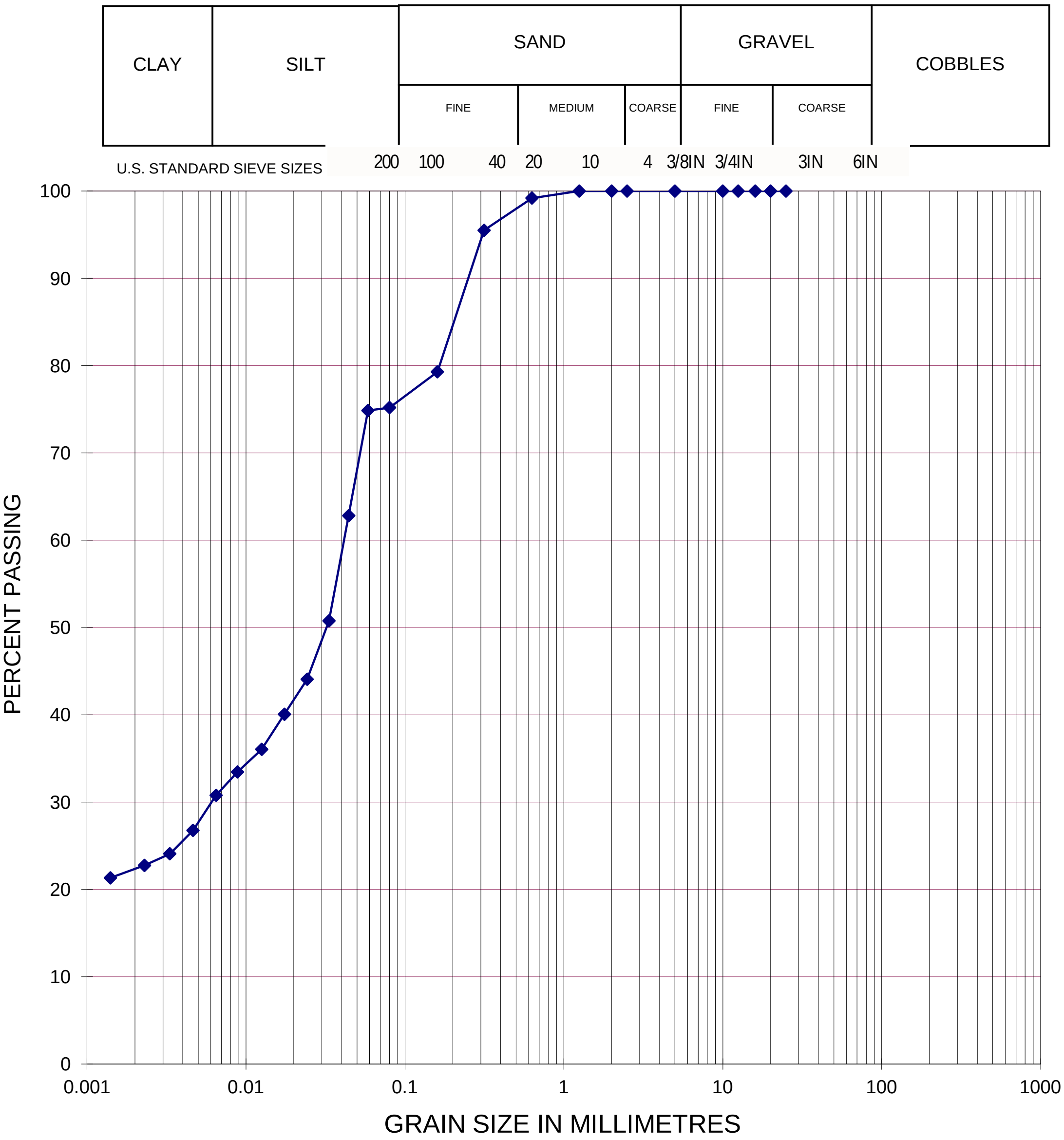
Type	Sample No	SPT (N)	Comments
G	G1		
■	D1	14	SO$_4$: 0.04%
G	G2		
G	G3		
G	G4		

LOGGED BY: Timothy Hoehne
CONTRACTOR: JED Anchors and Environmental Ltd
RIG/METHOD: Truck Rig/Solid Stem
DATE: November 16, 2012
CALIBRATION:

GROUND ELEVATION: 873.95
NORTHING: 5806106.07
EASTING: 307122.35

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 2 **DATE** Dec 17/12
DEPTH 0.5m **TECH** JB
SAMPLE 2G1
LOCATION

GRAIN SIZE DISTRIBUTION



COMMENTS:

% Retained on 2 mm sieve
Soil Type: Silt, some clay, some sand

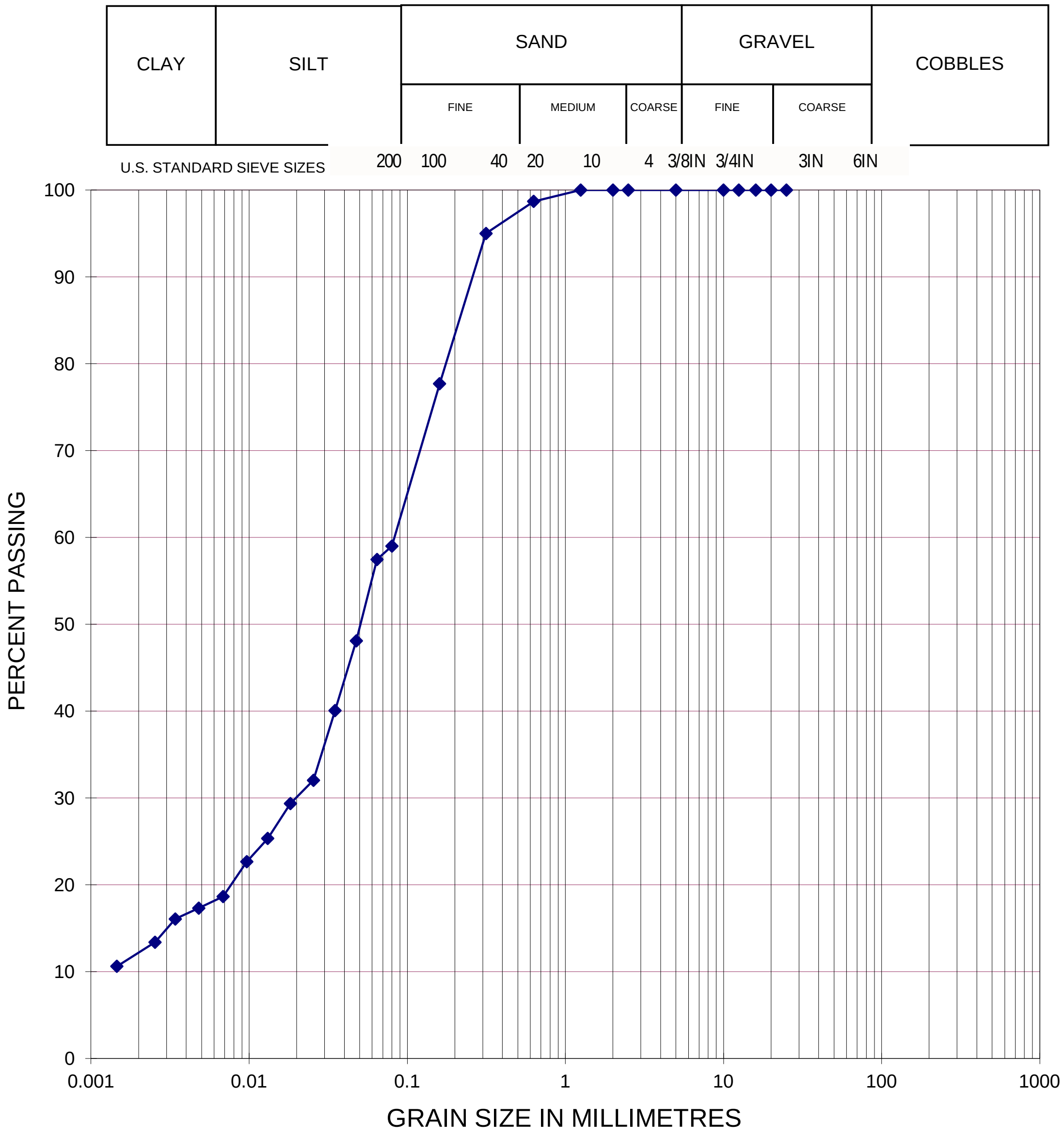
SUMMARY

D10 =		GRAVEL	0.00%
D30 =		SAND	24.88%
D60 =		SILT	47.57%
CU =		CLAY	27.55%
CC =			

ParklandGEO

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 3 **DATE** Dec 13/12
DEPTH 4.5m **TECH** JB
SAMPLE 3D2
LOCATION

GRAIN SIZE DISTRIBUTION



COMMENTS:

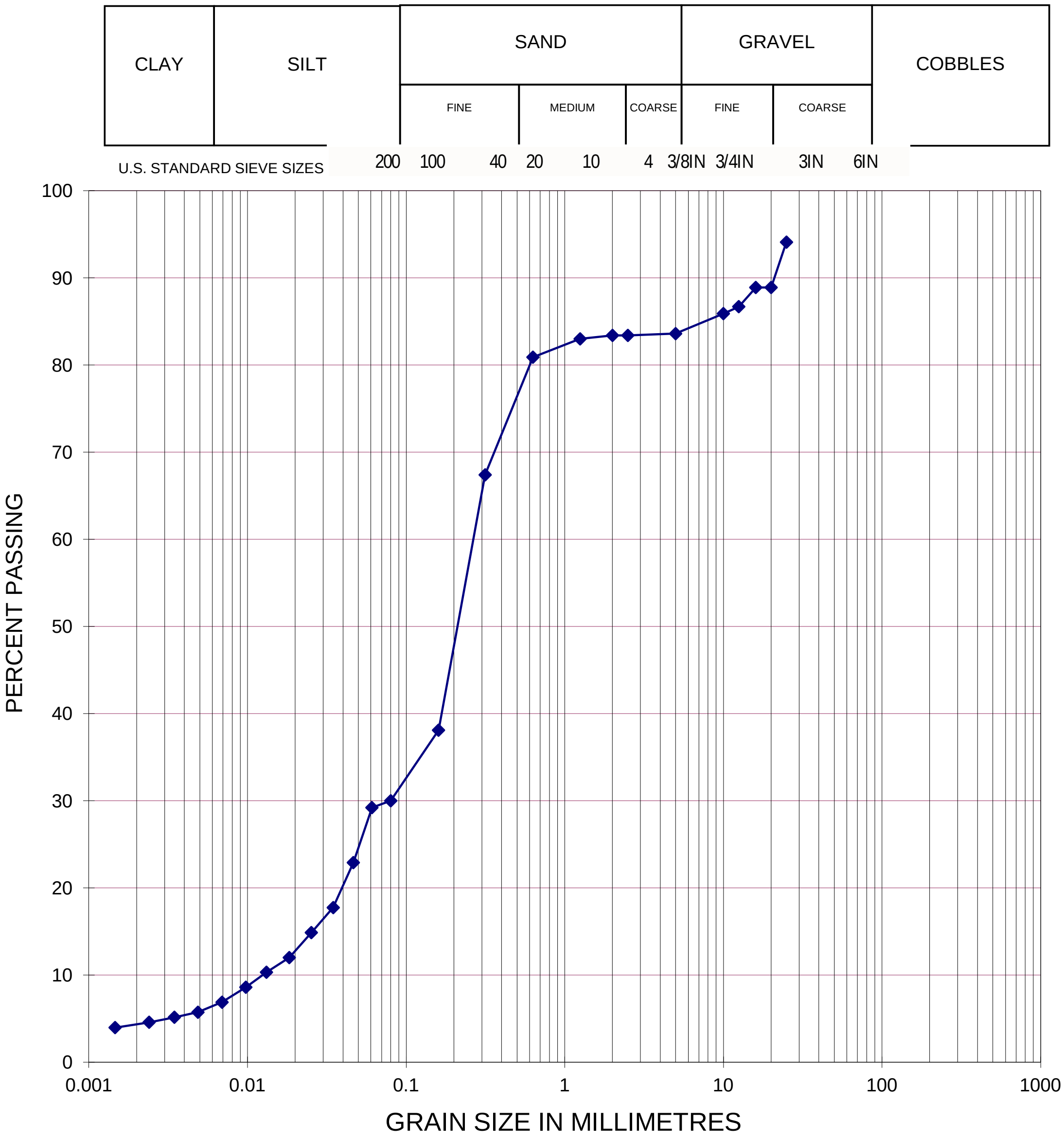
% Retained on 2 mm sieve
Soil Type: Sand, and silt, little clay

SUMMARY

D10 =		GRAVEL	0.00%
D30 =		SAND	41.49%
D60 =		SILT	41.07%
CU =		CLAY	17.44%
CC =			

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 9 **DATE** Dec 17/12
DEPTH 4.5m **TECH** JB
SAMPLE 9D2
LOCATION

GRAIN SIZE DISTRIBUTION



COMMENTS:

% Retained on 2 mm sieve
Soil Type: Sand, some silt, little gravel

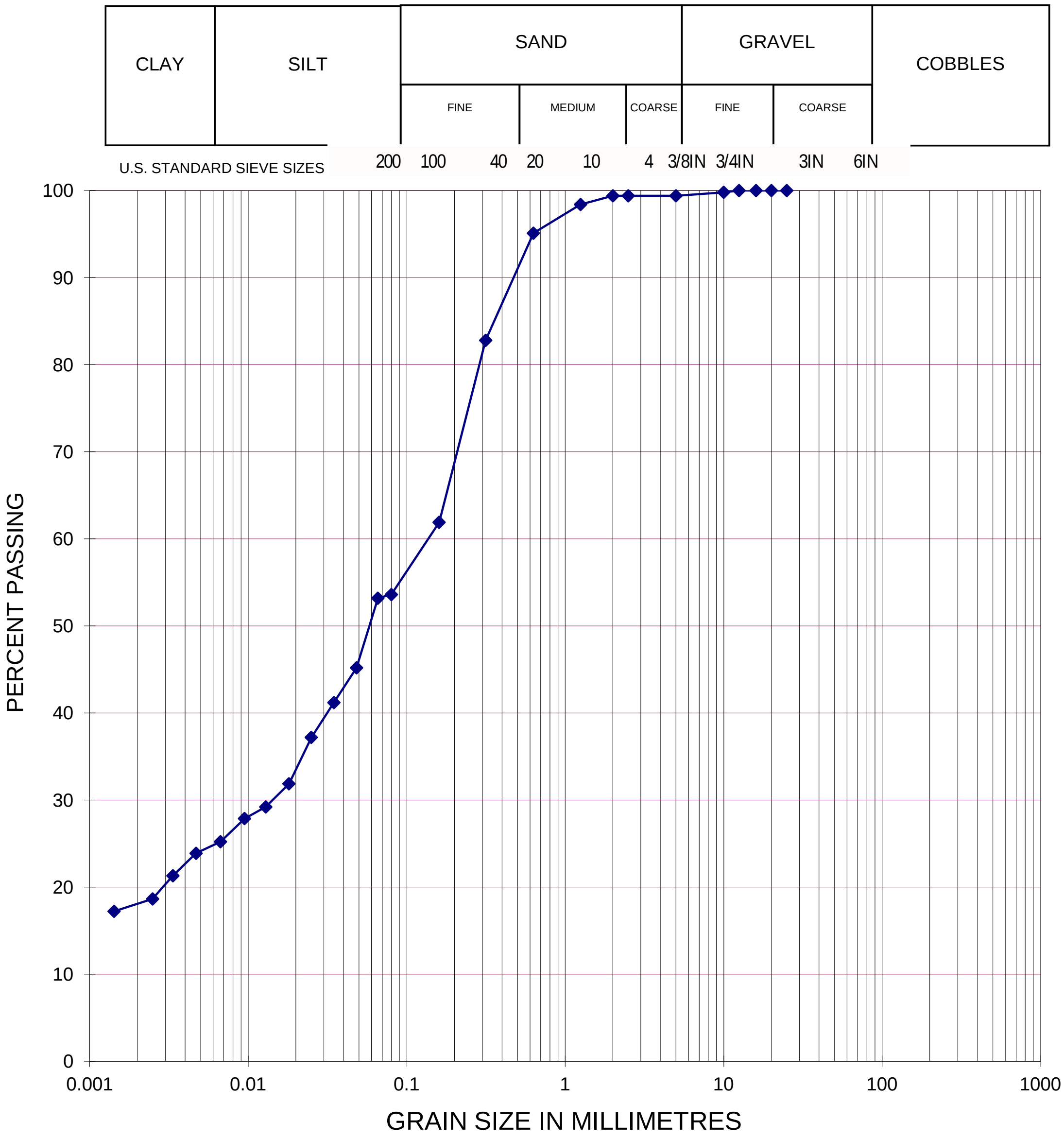
SUMMARY

D10	=	GRAVEL	16.40%
D30	=	SAND	53.80%
D60	=	SILT	23.99%
CU	=	CLAY	5.81%
CC	=		

ParklandGEO

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 9 **DATE** Dec 13/12
DEPTH 5.5m **TECH** JB
SAMPLE 9G5
LOCATION

GRAIN SIZE DISTRIBUTION



COMMENTS:

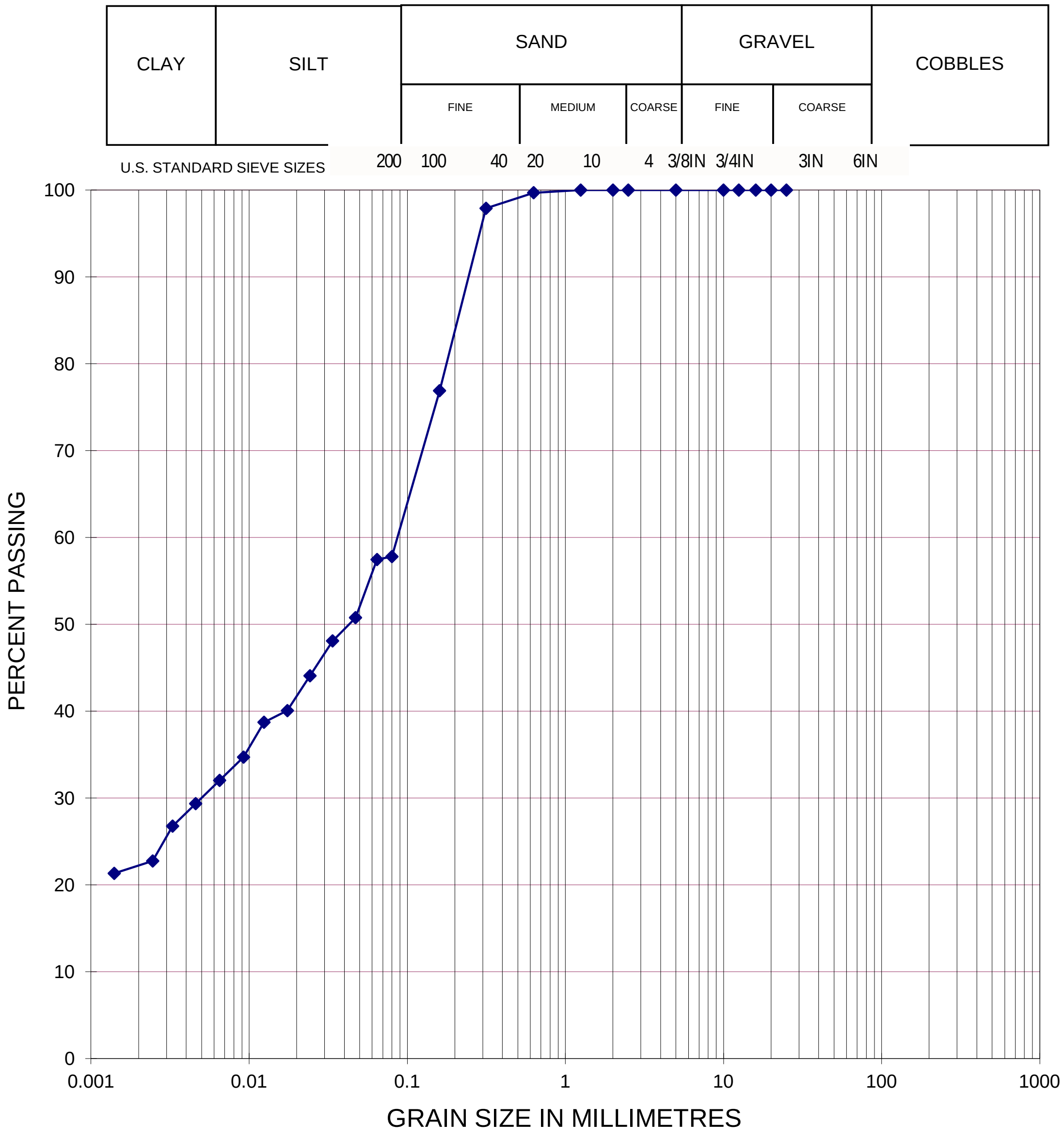
% Retained on 2 mm sieve
Soil Type: Sand, some silt, some clay

SUMMARY

D10	=	GRAVEL	0.60%
D30	=	SAND	45.95%
D60	=	SILT	29.36%
CU	=	CLAY	24.09%
CC	=		

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 11 **DATE** Dec 13/12
DEPTH 0.9m **TECH** JB
SAMPLE 11G2
LOCATION

GRAIN SIZE DISTRIBUTION



COMMENTS:

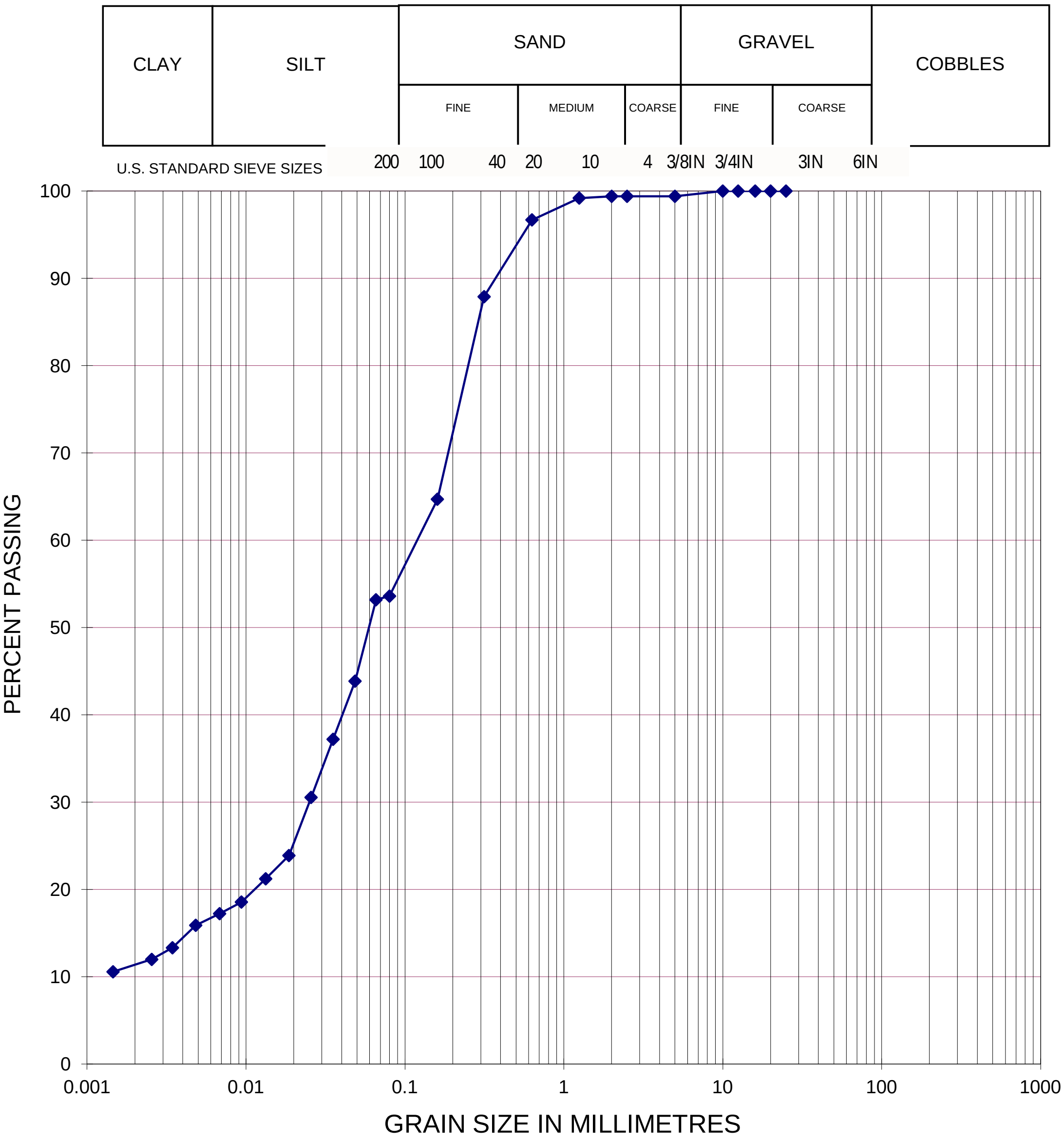
% Retained on 2 mm sieve
Soil Type: Sand, some clay, some silt

SUMMARY

D10	=	GRAVEL	0.00%
D30	=	SAND	42.31%
D60	=	SILT	27.76%
CU	=	CLAY	29.93%
CC	=		

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 14 **DATE** Dec 13/12
DEPTH 4.7m **TECH** JB
SAMPLE 14G4
LOCATION

GRAIN SIZE DISTRIBUTION



COMMENTS:

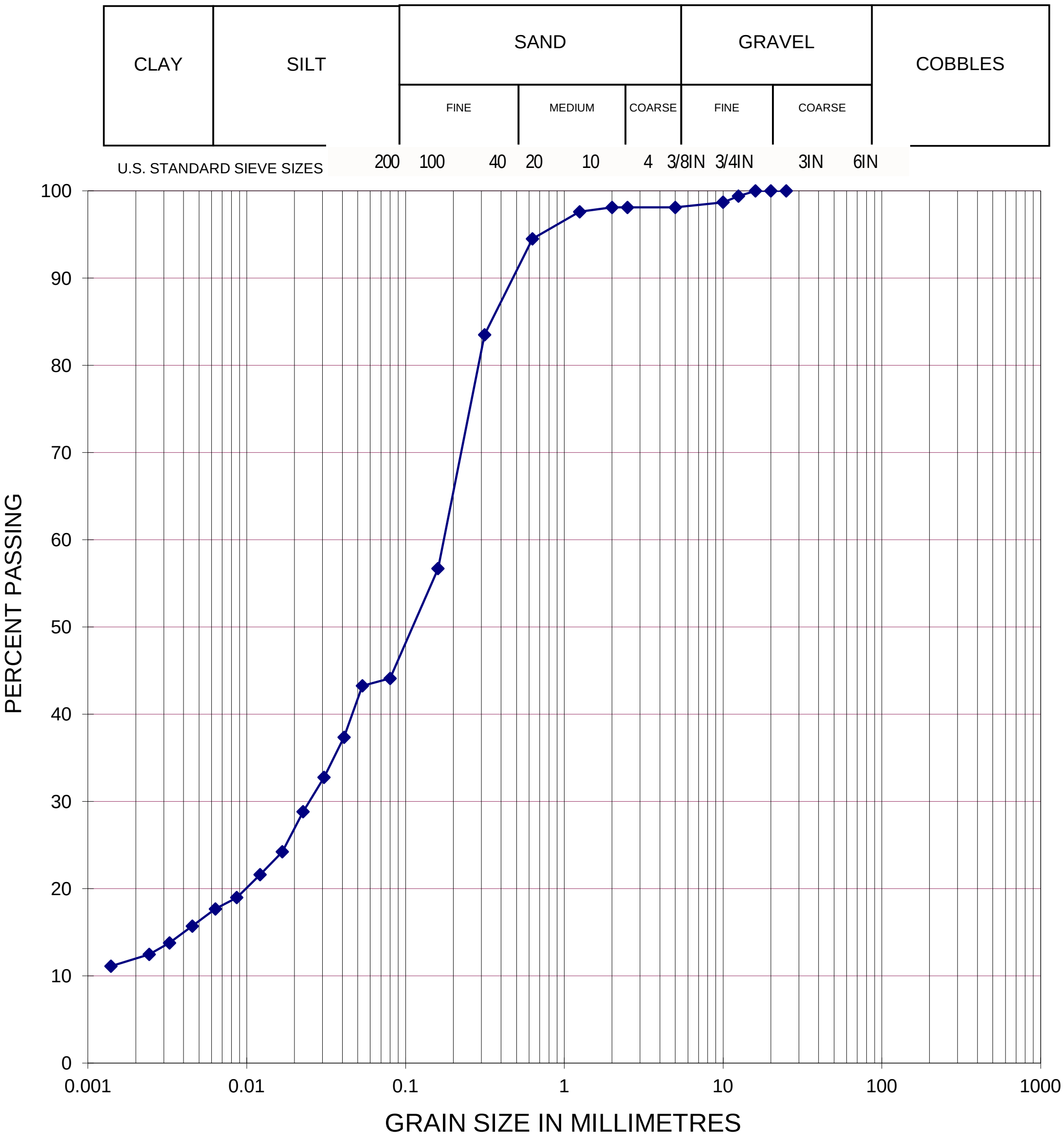
% Retained on 2 mm sieve
Soil Type: Sand, and silt, little clay

SUMMARY

D10	=	GRAVEL	0.60%
D30	=	SAND	45.95%
D60	=	SILT	37.44%
CU	=	CLAY	16.01%
CC	=		

PROJECT	McLevin Industrial Park Subdivision		
PROJECT #	RD4372		
BOREHOLE	15	**DATE** Dec 13/12	
DEPTH	4.8m	**TECH** JB	
SAMPLE	15G4		
LOCATION			

GRAIN SIZE DISTRIBUTION



OMMENTS:

% Retained on 2 mm sieve
Soil Type: Sand, some silt, little clay

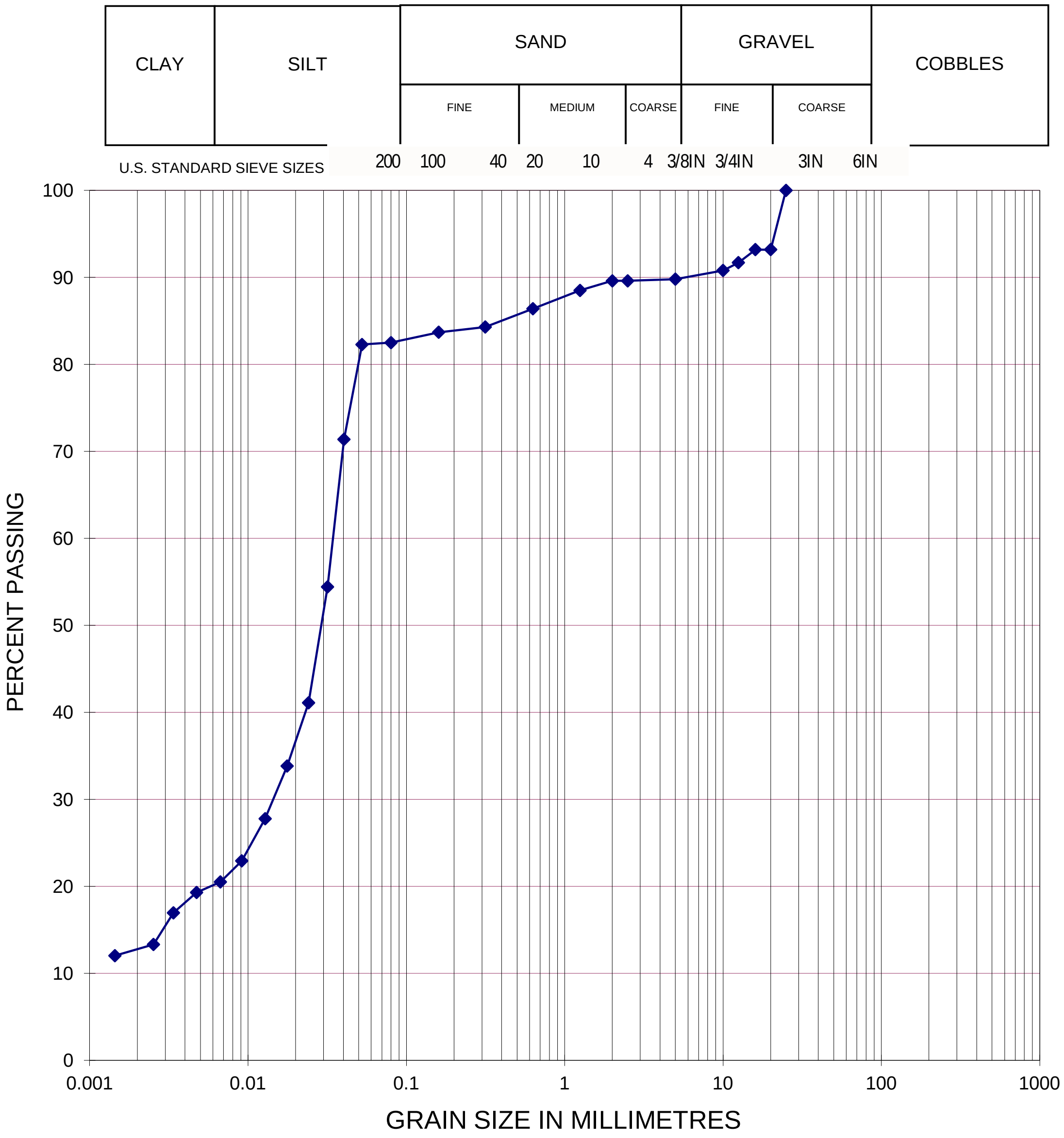
SUMMARY

D10 =		GRAVEL	1.90%
D30 =		SAND	54.16%
D60 =		SILT	27.74%
CU =		CLAY	16.20%
CC =			

ParklandGEO

PROJECT McLevin Industrial Park Subdivision
PROJECT # RD4372
BOREHOLE 17 **DATE** Dec 13/12
DEPTH 4.5m **TECH** JB
SAMPLE 17D2
LOCATION

GRAIN SIZE DISTRIBUTION



OMMENTS:

% Retained on 2 mm sieve
Soil Type: Silt, little clay, trace sand

SUMMARY

D10	=	GRAVEL	10.20%
D30	=	SAND	7.34%
D60	=	SILT	63.00%
CU	=	CLAY	19.46%
CC	=		

ParklandGEO

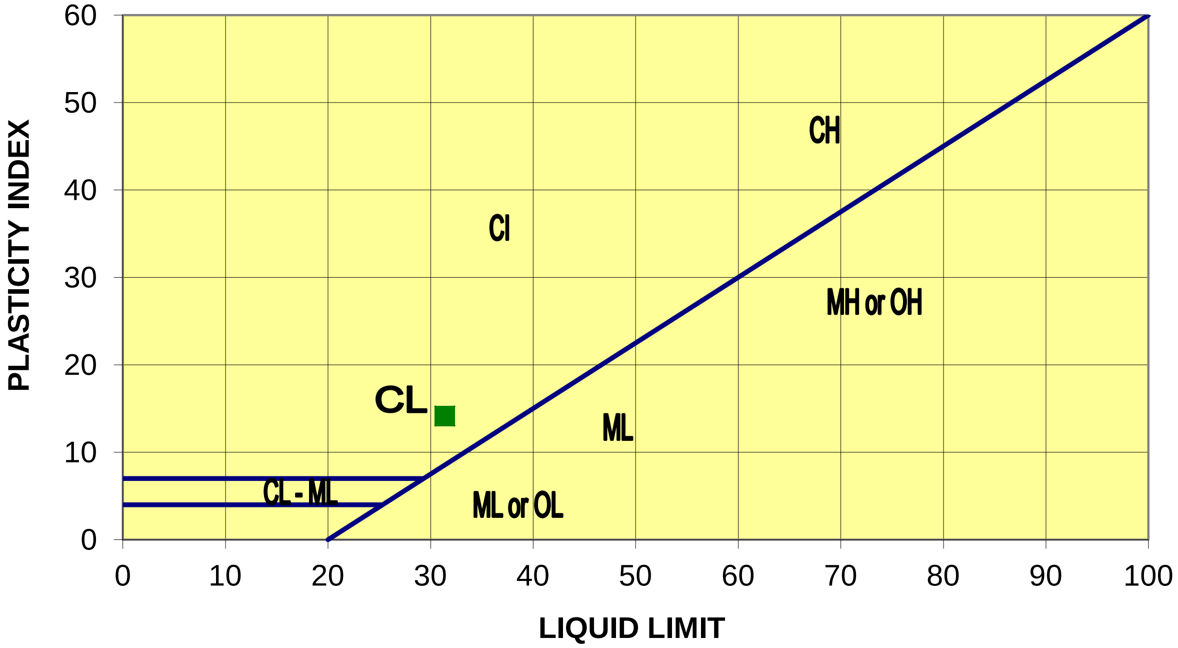
PROJECT# RD4372
PROJECT McLevin Industrial Park Subdivision
BOREHOLE 11
DEPTH 0.9m
SAMPLE # 11G2
DATE Dec 13/12
TECH JB

SOIL PLASTICITY SUMMARY

LIQUID LIMIT (LL)		
Trial No.	1	2
No. Blows	20	21
Wt. Sample Wet + Tare	38.522	40.185
Wt. Sample Dry + Tare	33.005	34.442
Wt. Water	5.517	5.743
Tare Container	16.041	16.379
Wt. Dry Soil	16.964	18.063
Moisture Content	32.522	31.794
Corrected for Blow Count	31.655	31.131
Liquid Limit Average	**31.4**	

PLASTIC LIMIT (PL)			
Trial No.	1	2	3
Wt. Wet Worm + Tare	8.989	8.795	8.945
Wt. Dry Worm + Tare	8.594	8.428	8.556
Wt. Water	0.395	0.367	0.389
Tare Container	6.300	6.310	6.293
Wt. Dry Worm	2.294	2.118	2.263
Moisture Content	17.219	17.328	17.190
Plastic Limit Average		**17.2**	

PLASTICITY INDEX (PI) = LL-PL **14.1**



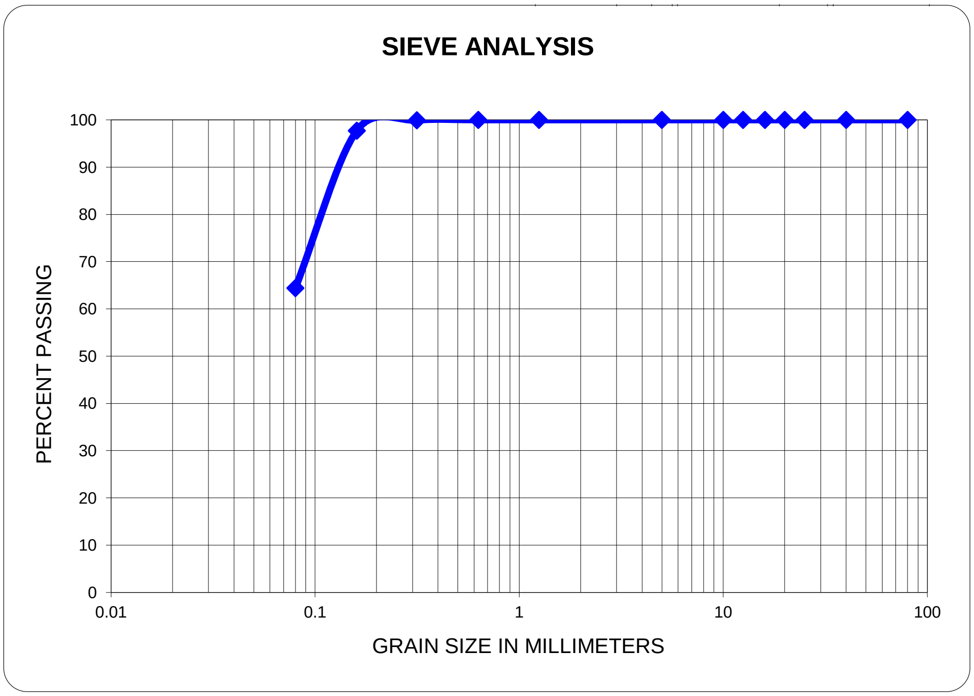
C:\Users\Sachin\Downloads\Lab\Lab\Limit 11G2

PROJECT - McLevin Industrial Park Subdivisic
PROJECT # RD4372 **DATE -** Dec 12/12
SAMPLE SOURCE -
PIT NAME -
TECHNICIAN - JB **SIEVE #** 1

SIEVE NO.	OPENING SIZE (mm)	WEIGHT RETAINED (g)	TOTAL WT. FINER (gms)	PERCENT PASSING	SPECIFICATION Min.	SPECIFICATION Max.
80000	80		511.3	100.0		
40000	40		511.3	100.0		
25000	25		511.3	100.0		
20000	20		511.3	100.0		
16000	16		511.3	100.0		
12500	12.5		511.3	100.0		
10000	10		511.3	100.0		
5000	5		511.3	100.0		
1250	1.25		511.3	100.0		
630	0.63		511.3	100.0		
315	0.315	0.4	510.9	99.9		
160	0.16	11.3	499.6	97.7		
80	0.08	170.3	329.3	64.4		
SIEVE PAN		29.7				

MOISTURE CONTENT SAMPLE		SIEVE ANALYSIS SAMPLE		D.W.W.CALCULATIONS
A-WT. WET SAMPLE + PAN	1285.6	G-WT. OF DRY SAMPLE	511.3	
B-WT. DRY SAMPLE + PAN	1206	H- WASHED DRY +PAN	906.9	
C-WT. OF WATER	79.6	I- WT OF WASHED DRY SA	212.2	
D-WT. OF PAN	694.7	J- WT WASHED FINES	299.1	
E-WT. OF DRY SAMPLE	511.3			
F-MOISTURE CONTENT	15.6			

DESCRIPTION OF SAMPLE/COMMENTS	METHOD OF PREPARATION	WASHED
BH4	TOTAL WEIGHT	510.8
4G4	DRY WT.	511.3
2.2m	DIFFERENCE	-0.5
	% DIFFERENCE	-0.0009779



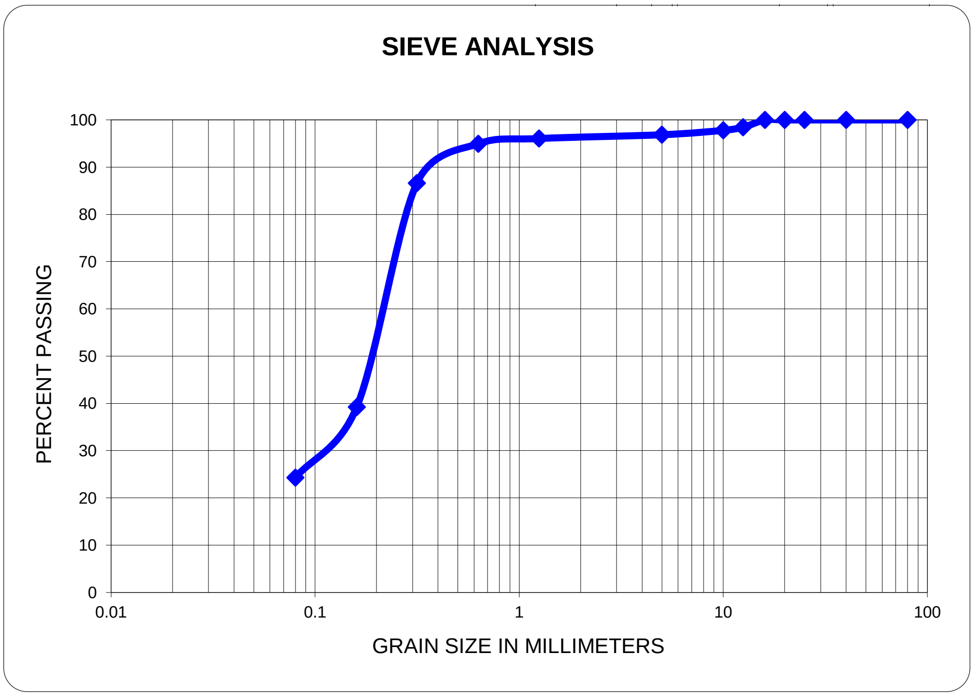
ParklandGEO

PROJECT - McLevin Industrial Park Subdivisic
PROJECT # RD4372 **DATE -** Dec 12/12
SAMPLE SOURCE -
PIT NAME -
TECHNICIAN - JB **SIEVE #** 2

SIEVE NO.	OPENING SIZE (mm)	WEIGHT RETAINED (g)	TOTAL WT. FINER (gms)	PERCENT PASSING	SPECIFICATION Min.	SPECIFICATION Max.
80000	80		587.5	100.0		
40000	40		587.5	100.0		
25000	25		587.5	100.0		
20000	20		587.5	100.0		
16000	16		587.5	100.0		
12500	12.5	9.1	578.4	98.5		
10000	10	3.8	574.6	97.8		
5000	5	5.5	569.1	96.9		
1250	1.25	4.7	564.4	96.1		
630	0.63	6.6	557.8	94.9		
315	0.315	48.9	508.9	86.6		
160	0.16	278.4	230.5	39.2		
80	0.08	87.8	142.7	24.3		
SIEVE PAN		6.7				

MOISTURE CONTENT SAMPLE		SIEVE ANALYSIS SAMPLE		D.W.W.CALCULATIONS
A-WT. WET SAMPLE + PAN	1350.6	G-WT. OF DRY SAMPLE	587.5	
B-WT. DRY SAMPLE + PAN	1277.4	H- WASHED DRY +PAN	1141.6	
C-WT. OF WATER	73.2	I- WT OF WASHED DRY SA	451.7	
D-WT. OF PAN	689.9	J- WT WASHED FINES	135.8	
E-WT. OF DRY SAMPLE	587.5			
F-MOISTURE CONTENT	12.5			

DESCRIPTION OF SAMPLE/COMMENTS	METHOD OF PREPARATION	WASHED
BH5	TOTAL WEIGHT	587.3
5D1	DRY WT.	587.5
3.0m	DIFFERENCE	-0.2
	% DIFFERENCE	-0.0003404



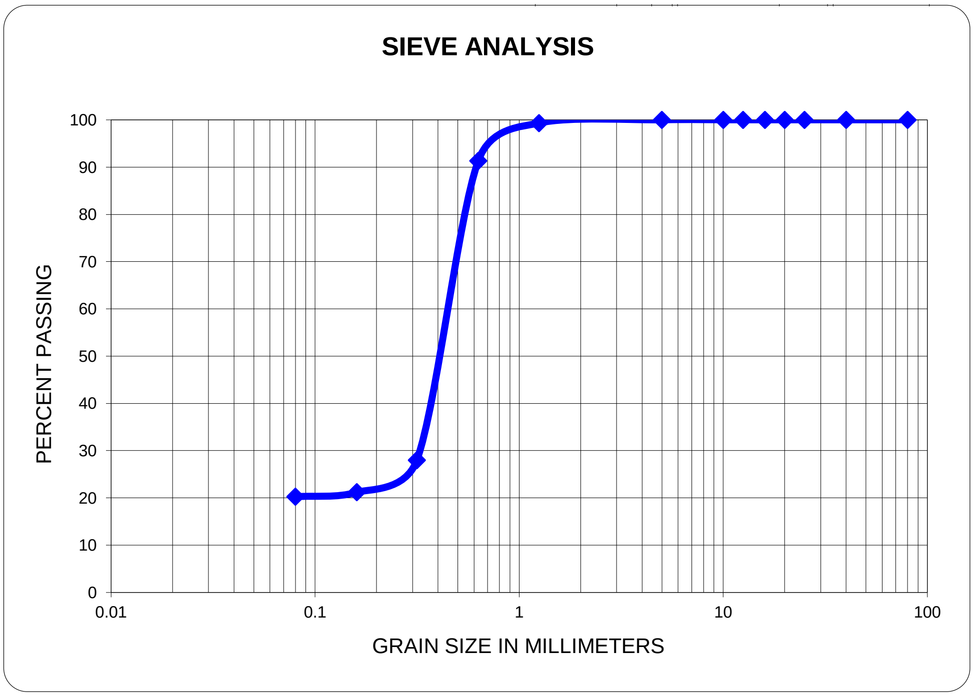
ParklandGEO

PROJECT - McLevin Industrial Park Subdivisio
PROJECT # RD4372 **DATE -** Dec 12/12
SAMPLE SOURCE -
PIT NAME -
TECHNICIAN - JB **SIEVE #** 3

SIEVE NO.	OPENING SIZE (mm)	WEIGHT RETAINED (g)	TOTAL WT. FINER (gms)	PERCENT PASSING	SPECIFICATION Min.	SPECIFICATION Max.
80000	80		511.1	100.0		
40000	40		511.1	100.0		
25000	25		511.1	100.0		
20000	20		511.1	100.0		
16000	16		511.1	100.0		
12500	12.5		511.1	100.0		
10000	10		511.1	100.0		
5000	5		511.1	100.0		
1250	1.25	3.5	507.6	99.3		
630	0.63	40.8	466.8	91.3		
315	0.315	323.8	143	28.0		
160	0.16	34.6	108.4	21.2		
80	0.08	4.9	103.5	20.3		
SIEVE PAN		0.9				

MOISTURE CONTENT SAMPLE		SIEVE ANALYSIS SAMPLE		D.W.W.CALCULATIONS
A-WT. WET SAMPLE + PAN	1231.6	G-WT. OF DRY SAMPLE	511.1	
B-WT. DRY SAMPLE + PAN	1205.4	H- WASHED DRY +PAN	1103.2	
C-WT. OF WATER	26.2	I- WT OF WASHED DRY SA	408.9	
D-WT. OF PAN	694.3	J- WT WASHED FINES	102.2	
E-WT. OF DRY SAMPLE	511.1			
F-MOISTURE CONTENT	5.1			

DESCRIPTION OF SAMPLE/COMMENTS		
BH1	METHOD OF PREPARATION	WASHED
1G3	TOTAL WEIGHT	510.7
2.1m	DRY WT.	511.1
	DIFFERENCE	-0.4
	% DIFFERENCE	-0.0007826



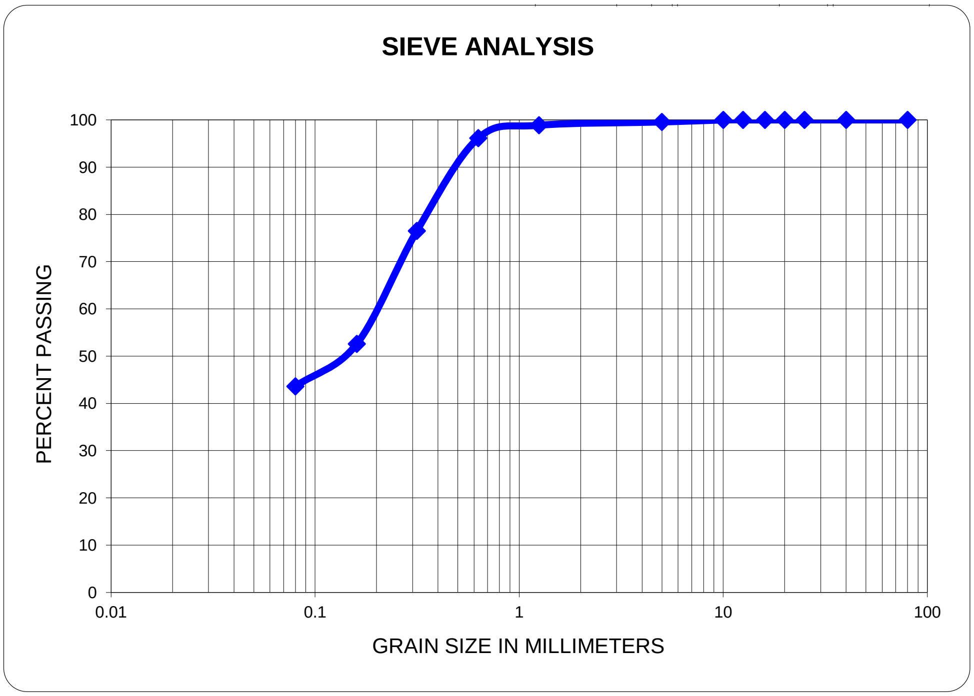
ParklandGEO

PROJECT - McLevin Industrial Park Subdivisic
PROJECT # RD4372 **DATE -** Dec 12/12
SAMPLE SOURCE -
PIT NAME -
TECHNICIAN - JB **SIEVE #** 4

SIEVE NO.	OPENING SIZE (mm)	WEIGHT RETAINED (g)	TOTAL WT. FINER (gms)	PERCENT PASSING	SPECIFICATION Min.	SPECIFICATION Max.
80000	80		578.4	100.0		
40000	40		578.4	100.0		
25000	25		578.4	100.0		
20000	20		578.4	100.0		
16000	16		578.4	100.0		
12500	12.5		578.4	100.0		
10000	10		578.4	100.0		
5000	5	2.5	575.9	99.6		
1250	1.25	4	571.9	98.9		
630	0.63	15.8	556.1	96.1		
315	0.315	113.6	442.5	76.5		
160	0.16	138.3	304.2	52.6		
80	0.08	52	252.2	43.6		
SIEVE PAN		4.8				

MOISTURE CONTENT SAMPLE		SIEVE ANALYSIS SAMPLE		D.W.W.CALCULATIONS
A-WT. WET SAMPLE + PAN	992.9	G-WT. OF DRY SAMPLE	578.4	
B-WT. DRY SAMPLE + PAN	940.2	H- WASHED DRY +PAN	693.8	
C-WT. OF WATER	52.7	I- WT OF WASHED DRY SA	332	
D-WT. OF PAN	361.8	J- WT WASHED FINES	246.4	
E-WT. OF DRY SAMPLE	578.4			
F-MOISTURE CONTENT	9.1			

DESCRIPTION OF SAMPLE/COMMENTS	METHOD OF PREPARATION	WASHED
BH16	TOTAL WEIGHT	577.4
16G1	DRY WT.	578.4
0.4m	DIFFERENCE	-1
	% DIFFERENCE	-0.0017289



ParklandGEO

Project: McLevin Industrial Park Subdivision
Subject: Geotechnical Testing - Soil Sulphate Test Results
Project #: RD4372 **Date:** Dec 14/12

Soil Sulphate Test Results

Laboratory: Parkland Geotechnical

Sample #: MC2 Borehole: 1 Depth: 2.0m Result (% Sulphate): 0.05	Sample #: MC2 Borehole: 11 Depth: 2.0m Result (% Sulphate): 0.07
Sample #: MC2 Borehole: 3 Depth: 2.0m Result (% Sulphate): 0.04	Sample #: MC2 Borehole: 13 Depth: 2.0m Result (% Sulphate): 0.04
Sample #: MC2 Borehole: 5 Depth: 2.0m Result (% Sulphate): 0.09	Sample #: MC2 Borehole: 15 Depth: 2.0m Result (% Sulphate): 0.04
Sample #: MC2 Borehole: 6 Depth: 2.0m Result (% Sulphate): 0.05	Sample #: MC2 Borehole: 17 Depth: 2.0m Result (% Sulphate): 0.04
Sample #: MC2 Borehole: 9 Depth: 2.0m Result (% Sulphate): 0.06	Sample #: MC2 Borehole: 19 Depth: 2.0m Result (% Sulphate): 0.04

Comments:

REQUIREMENTS FOR CONCRETE SUBJECTED TO SULPHATE ATTACK (CAN/CSA-A231-M04)

EXPOSURE CLASSIFICATION	DEGREE OF EXPOSURE	WATER-SOLUBLE SULPHATE(SO4) IN SOIL SAMPLE, %	SULPHATE(SO4) IN GROUND WATER SAMPLES, mg/L	MINIMUM SPECIFIED 56-DAY COMPRESSIVE STRENGTH, MPa	MAXIMUM WATER/CEMENTING MATERIALS RATIO	PORTLAND CEMENT TO BE USED
S-1	Very Severe	over 2.0	over 10,000	35	0.4	HS
S-2	Severe	0.20 to 2.0	1 500 to 10 000	32	0.45	HS
S-3	Moderate	0.10 to 0.20	150 to 1 500	30	0.5	MS or HS

Tech: JB **Chkd:** SP

ParklandGEO

MOISTURE DENSITY RELATIONSHIP WORKSHEET

PROJECT Mclevin Industries Park
CLIENT Stantec
PROJECT # RD4372
DATE 16-Feb-13

DRY DENSITY

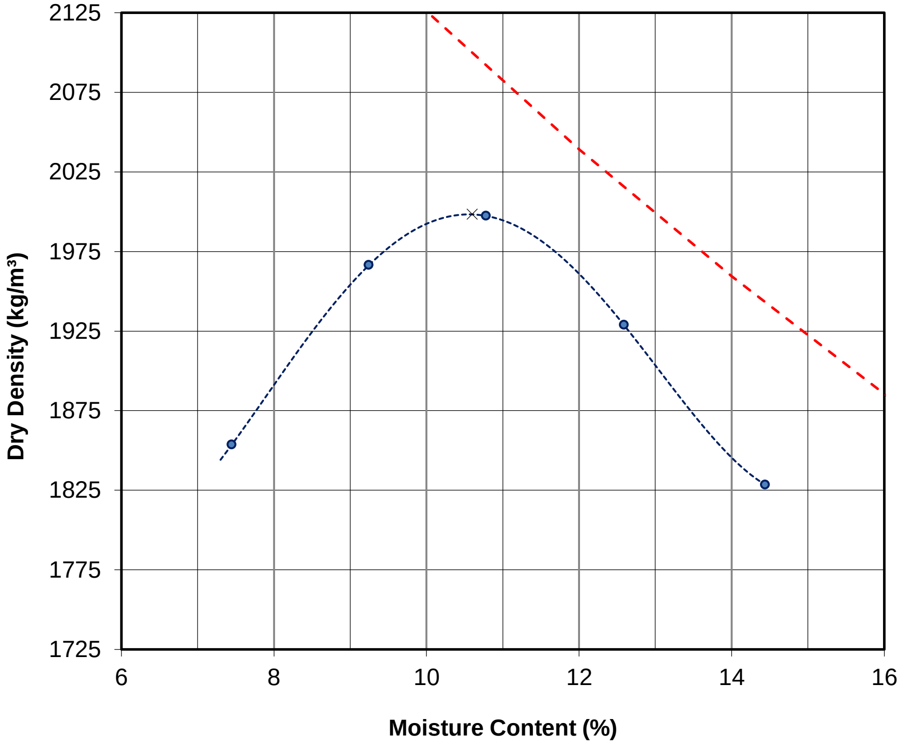
SAMPLE NUMBER	1	2	3	4	5	
Wt. Sample Wet + Mold	6720.6	6867.4	6927.9	6889.3	6815.2	
Wt. Small Mold	4852.4	4852.4	4852.4	4852.4	4852.4	
Wt. Sample Wet	1868.2	2015.0	2075.5	2036.9	1962.8	
Volume Mold, cm³	938	938	938	938	938	
Wet Density, kg/m³	1992	2148	2213	2172	2093	
Dry Density, kg/m³	1854	1966	1997	1929	1828	
Corr. Density, kg/m³						

DATE SAMPLED 21-Feb-13
CONTRACTOR
SOURCE/LOCATION BH 5
SAMPLED BY June
PROCTOR # P13-049

MOISTURE

CONTAINER NUMBER	A	B	C	D	E	
Wt. Sample Wet + Tare	275.4	261.2	300.3	206.2	247.2	
Wt. Sample Dry + Tare	257.6	240.5	272.7	185.2	218.1	
Wt. Water	17.8	20.7	27.6	21.0	29.1	
Tare Container	18.6	16.6	16.7	18.4	16.6	
Wt. Dry Soil	239.0	223.9	256.0	166.8	201.5	
Moisture Content	7.4	9.2	10.8	12.6	14.4	
Corr. Moisture Content						

PREPARATION: ____________
RAMMER TYPE: ____________
COMPACTION STANDARD: ASTM D698



SOIL TYPE: Silty Sand

COMMENTS:

ROCK CORRECTION

% Rock Retained
4.75 mm Sieve ____________
19.0 mm Sieve ____________
% Moisture Content
Tare wt. : ____________
Wet wt.+ Tare : ____________
Dry wt. + Tare : ____________
Wt. of Water : ____________
Moisture Content: ____________

MAXIMUM DRY DENSITY (Corrected) ____________

OPTIMUM MOISTURE CONTENT (Corrected) ____________

MAXIMUM DRY DENSITY (Uncorrected) 1998 kg/m³

OPTIMUM MOISTURE CONTENT (Uncorrected) 10.6 %

TECHNICIAN D.S.

CHECKED S.N-K.

Results are valid for <40 percent retained on 4.75 mm sieve, and <30 percent retained on 19 mm sieve as per ASTM D4718

ParklandGEO

CALIFORNIA BEARING RATIO

ASTM D1883

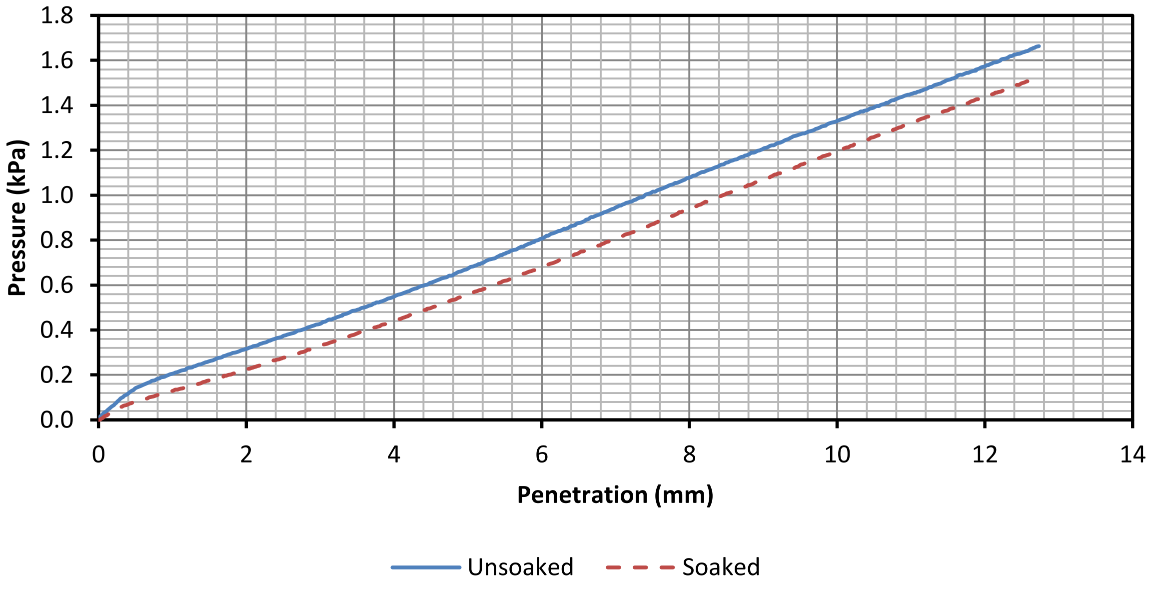
PROJECT: RD4372
PROJECT#: McLevin Industrial Park
CLIENT: Pidherney's Trucking

SAMPLE ID: CBR-2
SAMPLE DATE: November 26, 2012
TEST DATE: February 25, 2012

SOIL DESCRIPTION: Silty Sand

PROCTOR NUMBER: P13-049
MAXIMUM DRY DENSITY: 1998 kg/m³
OPTIMUM MOISTURE CONTENT: 10.6%

		Unsoaked	**Soaked**
DRY DENSITY	Wt. Sample Wet + Mold (g)	8831.5	8800.0
	Wt. Mold (g)	4225.8	4225.8
	Wt. Sample Wet (g)	4605.7	4574.2
	Volume Mold (cm^3)	2128.7	2128.7
	Wet Density (kg/m^3)	2163.7	2148.9
	Dry Density (kg/m^3)	1903.6	1897.6
MOISTURE CONTENT	Wt. Sample Wet + Tare (g)	325.1	379.6
	Wt. Sample Dry + Tare (g)	288.0	337.1
	Wt. Water (g)	37.1	42.5
	Tare Container (g)	16.5	16.1
	Wt. Dry Soil (g)	271.5	321.0
	Moisture Content (%)	13.7%	13.2%
TEST RESULTS	Relative Compaction (%)	95.3%	95.0%
	Relative Moisture Content (%)	3.1%	2.6%
	Surcharge Weight (kg)	4.54	4.54
	Initial Swell Reading (mm)	-	13.9
	Final Swell Reading (mm)	-	14.4
	Swell (%)	-	0.380%
	CBR at 2.54 mm (%)	2.8	2.1
	CBR at 5.08 mm (%)	3.4	2.8



TECH: SP
CHECKED: TA

AGGREGATE GRADATION SPECIFICATIONS

AGGREGATE DESCRIPTIONS

Asphalt Concrete Pavement Aggregate
- 10 mm ACP Aggregate (AIT Des. 1 Class. 10)
- 12.5 mm ACP Aggregate (AIT Des. 1 Class. 12.5)
- 16 mm ACP Aggregate (AIT Des. 1 Class. 16)
- 20 mm ACP Aggregate (CRD Des. 5a)

Granular Base Course (GBC)
- 20 mm GBC Aggregate (AIT Des. 2 Class. 20)
- 25 mm GBC Aggregate (AIT Des. 2 Class. 25)

Granular Subbase - Select Engineered Fill
- 50 mm Select Aggregate (AIT Des. 2 Class. 50)
- 75 mm Select Aggregate (CRD Des. 3a)
- 100 mm Select Aggregate
- 150 mm Select Aggregate (CRD Des. 3b)

General Pit Run Gravel Subgrade Fill
- 80 mm Pit Run Fill (AIT Des. 6 Class. 80)
- 125 mm Pit Run Fill (AIT Des. 6 Class. 125)

Trench Bedding Material/ Drainage Gravel
- 5 mm Native Sand Fill (CRD Des. 1a)
- 5 mm Clean Sand Fill (CRD Des. 1b)
- 40 mm Screened Rock Aggregate (CRD Des. 1c)

Revised May 2007

Aggregate Type		Asphalt Concrete Pavement				Granular Base		Granular Subbase				Pit Run		Bedding Material		
		10 mm	12.5mm	16mm	20mm	20mm	25mm	50mm	80mm	100mm	150mm	80mm	125mm	5mm	5mm	40mm
SIEVE SIZE: Percent Passing Metric Sieve (CGSB 8 - GP 2mm)	150000										100					
	125000												100			
	100000									100						
	80000								100		80 - 100	100				
	50000							100	80 - 100	85 - 100		55 - 100	55 - 100			100
	40000															90 - 100
	25000						100	63 - 90	50 - 75	50 - 80	50 - 85	38 - 100	38 - 100			
	20000				100	100										5 - 10
	16000			100	90 - 100		70 - 94	47 - 79				32 - 85	32 - 85			
	12500		100	80 - 92												
	10000	100	83 - 92	70 - 84	56 - 84	63 - 86	52 - 79	38 - 70								0 - 5
	7500															
	5000	60 - 75	55 - 70	50 - 65	35 - 64	40 - 67	35 - 64	28 - 59	25 - 55	25 - 55	25 - 60	20 - 65	20 - 65	100	90 - 100	0 - 5
	2500				21 - 49										80 - 95	
	1250	30 - 45	30 - 45	30 - 45	11 - 34	20 - 43	18 - 43	16 - 42						66 - 100	55 - 85	
	630	22 - 38	22 - 38	22 - 38	8 - 30	14 - 34	12 - 34	12 - 34						52 - 100		
	315	15 - 30	15 - 30	15 - 30	5 - 21	9 - 26	8 - 26	8 - 26				6 - 30	6 - 30	35 - 78	10 - 35	
	160	9 - 20	9 - 20	9 - 20	3 - 15	5 - 18	5 - 18	5 - 18						18 - 43		
	80 µm	4 - 10	4 - 10	4 - 10	2 - 8	2 - 10	2 - 10	2 - 10	2 - 10	2 - 10	2 - 12	2 - 15	2 - 15	7 - 13	0 - 5	
% Fracture By Weight		60+	60+	60+	60+	60+	60+	40+	30+	30+	25+	N/A	N/A	N/A	N/A	N/A
Plastic Index		0 - 4	0 - 4	0 - 4	0 - 4	0 - 6	0 - 6	0 - 6	0 - 6	0 - 6	0 - 6	0 - 8	0 - 8	N/A	N/A	N/A
CBR		40+	40+	40+	40+	40+	40+	40+	30+	30+	30+	20+	20+	N/A	N/A	N/A
LA Abrasion Max. Loss %		40	40	40	40	50	50	50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of the field investigation and subsequent laboratory testing are described on the following two pages.

The borehole logs are a graphical representation summarizing the soil profile as determined during site specific field investigation. The borehole logs may include test data from laboratory soil testing, if applicable. The materials, boundaries and conditions have been established only at the borehole locations at the time of drilling. The soil conditions shown on the borehole logs are not necessarily representative of the subsurface conditions elsewhere across the site. The transitions in soil profile usually have gradual rather than distinct unit boundaries as shown on this graphical representation.

1. **PRINCIPAL SOIL TYPE** - The major soil type by weight of material or by behavior.

Material	Grain Size
Boulders	Larger than 300 mm
Cobbles	75 mm to 300 mm
Coarse Gravel	19 mm to 75 mm
Fine Gravel	5 mm to 19 mm
Coarse Sand	2 mm to 5 mm
Medium Sand	0.425 mm to 2 mm
Fine Sand	0.75 mm to 0.425 mm
Silt & Clay	Smaller than 0.075 mm

2. **DESCRIPTION OF MINOR SOIL TYPE** - Minor soil types are identified by weight of minor component.

Percent	Descriptor
35 to 50	and
20 to 35	some
10 to 20	little
1 to 10	trace

3. **RELATIVE STRENGTH OF COARSE GRAINED SOIL** - The following terms are used relative to Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm.

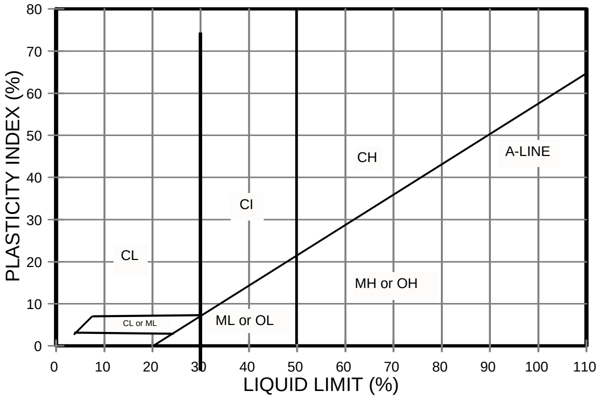
Description	N Value
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Over 50

4. **CONSISTENCY OF FINED GRAINED SOIL** - The following terms are used relative to unconfined strength in kPa and Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm.

Description	Unconfined Compressive Strength (kPa)	N Value
Very Soft	less than 25	Less than 2
Soft	25 to 50	2 to 4
Firm	50 to 100	4 to 8
Stiff	100 to 200	8 to 15
Very Stiff	200 to 380	15 to 30
Hard	Over 380	Over 30

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	░	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP	░	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO	NOT MEETING ALL OF THE ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM	▥	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW “A” LINE OR P.I. LESS THAN 4
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE “A” LINE OR P.I. MORE THAN
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW	░	WELL GRADED SANDS, GRAVELLY SANDS WITH LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP	░	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ALL OF THE ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM	▥	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW “A” LINE OR P.I. LESS THAN 4
			SC	▨	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE “A” LINE OR P.I. MORE THAN
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE)	SILTS BELOW “A” LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML	▥	INORGANIC SILTS & VERY FINE SANDS, ROCK FLUOR, SILTY SANDS OF SLIGHT	CLASSIFICATION IS BASED ON THE PLASTICITY CHART BELOW	
		$W_L > 50\%$	MH	▥	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY		
	CLAYS ABOVE “A” LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL	▨	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR		
		$30\% < W_L < 50\%$	CI	▨	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY		
	ORGANIC SILTS & CLAYS BELOW “A” LINE ON CHART	$W_L < 50\%$	OL	▥	ORGANIC SILT, AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50\%$	OH	▨	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	■	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	



NOTES ON SOIL CLASSIFICATION AND DESCRIPTION:

5. Soils are classified and described according to their engineering properties and behaviour.
6. Boundary classifications for soils with characteristics of two groups are given combined group symbols, eg. GW-GC is a well graded gravel-sand mixture with clay binder between 5 and 12 %.
7. Soil classification is in accordance with the Unified Soil Classification System, with the exception that an inorganic clay of medium plasticity (CI) is recognized.
8. The use of modifying adjectives may be employed to define the estimated percentage range by weight of minor components.

GENERAL TERMS AND CONDITIONS

The use of this attached report is subject to acceptance of the following general terms and conditions.

1. STANDARD OF CARE - In the performance of professional services, ParklandGEO will use that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession practicing in the same or similar localities. No other warranty expressed or implied is made or intended by this agreement or by furnishing oral or written reports of the findings made. ParklandGEO is to be liable only for damage directly caused by the negligence of ParklandGEO.

2. INTERPRETATION OF THE REPORT - The CLIENT recognizes that subsurface conditions will vary from those encountered at the location where borings, surveys, or explorations are made and that the data, interpretations and recommendation of ParklandGEO are based solely on the information available to him. Classification and identification of soils, rocks, geological units, contaminated materials and contaminant quantities will be based on commonly accepted practices in geotechnical consulting practice in this area. ParklandGEO will not be responsible for the interpretation by others of the information developed.

3. SITE INFORMATION - The CLIENT agrees to fully cooperate with ParklandGEO and provide all information with respect to the past, present and proposed conditions and use of the Site whether specifically requested or not. The CLIENT acknowledges that in order for ParklandGEO to properly advise and assist the CLIENT in respect of the investigation of the Site, ParklandGEO is relying upon full disclosure by the CLIENT of all matters pertinent to an investigation of the Site.

   Where specifically stated in the scope of work, ParklandGEO will perform a review of the historical information obtained or provided by the Client to assist in the investigation of the Site unless and except to the extent that such a review is limited or excluded from the scope of work.

4. RIGHT OF ENTRY - The CLIENT is responsible for ensuring that ParklandGEO is provided unencumbered access to the property to the extent necessary for ParklandGEO to complete the scope of work to ParklandGEO's satisfaction. The CLIENT is solely responsible for obtaining permission and permits for ParklandGEO to enter onto the subject site, including informing tenants. The CLIENT shall also provide ParklandGEO with the location of all underground utilities and structures on the subject site, unless otherwise agreed to in writing. While ParklandGEO will take all reasonable precautions to avoid and minimize any damage to any sub-terrain utilities or structures, the CLIENT agrees to hold ParklandGEO harmless for any damage to any sub-terrain utilities or structures or any damage occasioned in gaining access to the subject site.

5. COMPLETE REPORT - The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to ParklandGEO by the CLIENT, communications between ParklandGEO and the CLIENT, and to any other reports, writings or documents prepared by ParklandGEO for the CLIENT relative to the specific Site, all of which constitute the Report. The word "Report" shall refer to any and all of the documents referred to herein. In order to properly understand the suggestions, recommendations and opinions expressed by ParklandGEO, reference must be made to the whole of the Report. ParklandGEO cannot be responsible for use of any part or portions of the report without reference to the whole report. The CLIENT agrees that any and all reports prepared by ParklandGEO shall contain the following statement:

   > "This report has been prepared for the exclusive use of the named CLIENT. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. PARKLAND GEOTECHNICAL LTD. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report."

   The CLIENT agrees that in the event that any such report is released to a third party, such disclaimer shall not be obliterated or altered in any manner. The CLIENT further agrees that all such reports shall be used solely for the purposes of the CLIENT and shall not be released or used by others without the prior written permission of ParklandGEO.

6. LIMITATIONS ON SCOPE OF INVESTIGATION AND WARRANTY DISCLAIMER

There is no warranty, expressed or implied, by ParklandGEO that:

a) the investigation shall uncover all potential contaminants or environmental liabilities on the Site; or

b) the Site will be entirely free of all contaminants as a result of any investigation or cleanup work undertaken on the Site, since it is not possible, even with exhaustive sampling, testing and analysis, to document all potential contaminants on the Site.

The CLIENT acknowledges that:

a) the investigation findings are based solely on the information generated as a result of the specific scope of the investigation authorized by the CLIENT;

b) unless specifically stated in the agreed Scope of Work, the investigation will not, nor is it intended to assess or detect potential contaminants or environmental liabilities on the Site;

c) any assessment regarding geological conditions on the Site is based on the interpretation of conditions determined at specific sampling locations and depths and that conditions may vary between sampling locations, hence there can be no assurance that undetected geological conditions, including soils or groundwater are not located on the Site;

d) any assessment is also dependent on and limited by the accuracy of the analytical data generated by the sample analyses;

e) any assessment is also limited by the scientific possibility of determining the presence of unsuitable geological conditions for which scientific analyses have been conducted; and

f) the analytical parameters selected are limited to those outlined in the CLIENT's authorized scope of investigation; and

g) there are risks associated with the discovery of hazardous materials in and upon the lands and premises which may inadvertently discovered as part of this investigation. The CLIENT acknowledges that it may have a responsibility in law to inform the owner of any affected property of the existence or suspected existence of hazardous materials. The CLIENT further acknowledges that any such discovery may result in the fair market value of the lands and premises and of any other lands and premises adjacent thereto to be adversely affected in a material respect.

7. CONTROL OF WORK SITE AND JOBSITE SAFETY - ParklandGEO is only responsible for the activities of its employees on the jobsite. The presence of ParklandGEO personnel on the Site shall not be construed in any way to relieve the CLIENT or any contractors on Site from their responsibilities for Site safety. The CLIENT undertakes to inform ParklandGEO of all hazardous conditions, or possible hazardous conditions which are known to him. The CLIENT also recognizes that the activities of ParklandGEO may uncover previously unknown hazardous materials and that such a discovery may result in the necessity to undertake emergency procedures to protect ParklandGEO employees as well as the public at large and the environment in general. The CLIENT also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the CLIENT agrees that notification to such bodies by ParklandGEO will not be a cause of action or dispute.