GEOTECHNICAL INVESTIGATION
PROPOSED MEDICINE VALLEY INDUSTRIAL PARK
SE 21-39-3-W5M, LACOMBE COUNTY, ALBERTA

Prepared for:

ISL ENGINEERING AND LAND SERVICES LTD.
RED DEER, ALBERTA

Prepared by:

PARKLAND GEOTECHNICAL LTD.
PROJECT NUMBER: RD3230
JULY 2009

TABLE OF CONTENTS

TABLES

APPENDICES

1.0 INTRODUCTION

An industrial park is proposed in SE 21-39-3-W5M, Lacombe County, Alberta. The site location is on the outskirts of the Town of Eckville as shown on the Key Plan, Figure 1 in Appendix A. Parkland Geotechnical Consulting Ltd. (ParklandGEO) was commissioned to conduct a geotechnical investigation for the proposed industrial park at the site. The scope of work was outlined in ParklandGEO's proposal letter dated April 28, 2009 (File#PRO1575). Authorization to proceed with the investigation was given by Mr. John Collier of ISL Engineering and Land Services Ltd., on behalf of the Owner.

This report summarizes results of field and laboratory testing programs and presents geotechnical recommendations for the proposed development. Geotechnical recommendations are provided with respect to design and installation of underground services, private sewage disposal roadway subgrades and flexible pavement design.

2.0 SITE DESCRIPTION

The subject site is situated west of Highway 766 and north of 4th Street on the north boundary of the Town of Eckville, in Lacombe County, Alberta. The subject site was 60 acres of undeveloped farm land at the time of drilling. The natural topography of the site was gently rolling with localized highs and lows located throughout the site. The ground surface elevation of the site ranged from 835 m to 842 m based on the contour information provided by ISL Engineering and Land Services Ltd. (see the Contour Plan, Figure 3, in Appendix A). The adjacent sites to the north, west and east were farmland and to the south was residential area. An aerial plan of the site is shown on Figure 4 in Appendix A.

3.0 FIELD AND LABORATORY PROGRAMS

On May 28, 2009, ten boreholes were drilled at the site to depths of ranging from 3.0 to 6.5 m below grade. The boreholes were drilled with a truck mounted solid stem auger drill. The locations of the boreholes are shown on the attached Site Plan, Figure 2, in Appendix A.

The soil encountered was visually examined during excavation 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 all boreholes. All soil samples were returned to the Red Deer laboratory for further testing to determine the soil classification and strength properties.

Standpipes were installed in all boreholes at the completion of drilling. Groundwater levels were measured at completion and on June 12, 2009. The borehole ground surface elevations were surveyed by ISL Engineering and Land Services Ltd. and referenced to a geodetic datum.

4.0 SOIL CONDITIONS

The soil profile encountered at this site was topsoil, clay and silt deposits overlying clay till. This is considered to be the typical soil profile in Eckville. Detailed descriptions of the soil conditions encountered at each borehole can be seen in the borehole logs in Appendix A. Individual laboratory test results and definitions of the terminology and symbols used on the borehole logs are also attached in Appendix A. The following is a brief description of the soil types encountered.

4.1 TOPSOIL

The surficial topsoil with a thickness of between 100 and 200 mm was encountered at all borehole locations. Based on observations and experience, topsoil thickness is expected to vary and may exist in greater thickness than those found at the boreholes. The topsoil was moderately organic, black and moist, and it is considered to be weak and highly compressible when subjected to loads.

4.2 SILT AND CLAY

Deposits of silt and clay were found below the topsoil in all boreholes extending to the depths of 1.4 to 3.0 m below grade. These deposits were medium plastic and of a soft to firm consistency with moisture contents of 24 to 34 percent. The estimated CBR value for these silt and clay deposits is about 3.0 in the soaked condition. From local experience these soils are highly frost susceptible and sensitive to disturbance when wet.

4.3 CLAY TILL

Clay till was encountered below the silt and clay deposits in all boreholes extending to the depths drilled. The till was clay till with inclusions of gravel and coal. In the clay till, the proportions of sand, silt and clay were roughly equal. A layer of water bearing sand/silt lense was found in the till at a depth of 5.5 m below grade in Borehole 8. Although not encountered during this investigation, till deposits in this area are known to contain large boulders. The clay till was low to medium plastic and the consistency was stiff to very stiff. Moisture contents of the till ranged from 16 to 22 percent, which are considered to be near or slightly above OMC.

4.4 SAND (POSSIBLE SANDSTONE)

A layer of fine grained and poorly graded sand was found below the clay till layer in Borehole 8. The sand layer is probably weathered sandstone bedrock. The sand was characterized as very dense with occasional rust stains. The moisture content of the sand was 9 percent.

4.5 WATER SOLUBLE SULPHATES

Soil samples at a depth of 2.0 m in Boreholes 1, 3, 6, 7 and 10 were tested for water soluble sulphate concentration tests. The concentrations of sulphates are expressed as a percent of the dry mass of soil. The concentrations of water soluble sulphate were all 0.04, which indicates a "negligible potential for sulphate attack on buried concrete in direct contact with soil."

5.0 GROUNDWATER

Groundwater seepage was not observed upon the completion of drilling in the boreholes. Stabilized groundwater levels were measured on June 12, 2009, about 15 days after the drilling. Following table summarizes the observed groundwater conditions.

TABLE 1
GROUNDWATER DEPTHS AND ELEVATIONS

Borehole #	Depth of Hole (m)	Ground Elevation (m)	At Completion (m)	June 12, 2009 (m)
BH1	6.5	937.48	Dry	Dry
BH2	3.0	935.10	Dry	Dry
BH3	3.5	936.70	Dry	Dry
BH4	3.0	937.10	Dry	Dry
BH5	3.5	939.12	Dry	Dry
BH6	5.0	939.31	Dry	Dry
BH7	6.5	940.16	Dry	Dry
BH8	6.3	937.45	Dry	Dry
BH9	3.5	940.30	Dry	Dry
BH10	3.0	938.93	Dry	Dry

Water level measurement on June 12, 2009 indicated that all ten boreholes were dry. Groundwater is expected to experience seasonal fluctuations. The upper soil is fissured which will provide temporary storage for seasonal precipitation infiltrating into the subgrade. Therefore, potential for seepage from the upper subgrade will be highest after snow melt and extended or heavy periods of precipitation. Normal seepage volumes will be low due to the low permeability of the clay subgrade.

6.0 PERCOLATION TESTING

The following table summarizes the stabilized soil percolation rates and groundwater measurements found at the location on site.

TABLE 2
PERCOLATION AND GROUNDWATER DATA

Borehole Location	Stabilized Percolation Rate (min/cm)	Depth to Groundwater (m)
1	20.0	>3.0
2	8.8	>3.0
3	15.0	>3.0
4	12.0	>3.0
5	20.0	>3.0
6	15.0	>3.0
7	30.0	>3.0
8	15.0	>3.0
9	36.0	>3.0
10	60.0	>3.0

The SCC Guidelines state that the acceptable range of percolation rates should fall between 2.0 and 23.6 min/cm. The acceptable groundwater level for the frost free period of the year when the test was taken is 1.8 m below grade or lower. Borehole 7, 9 and 10 had percolation rates of between 30 and 60 min/cm which were not between the acceptable 2.0 and 23.6 min/cm specified by the SCC Guidelines. Therefore, they were considered fail.

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 GEOTECHNICAL EVALUATION

The proposed Medicine Valley Industrial Park includes 60 acres farm land and will be developed in three 20 acre phases. It is understood that the gravel roads with open ditches are proposed for this industrial park. It is also understood that the lots will be privately serviced for potable water and sewage disposal. No deep services are proposed for the development.

The subsurface conditions at this site are considered to be suitable for the proposed industrial development. It is understood that site grading will be undertaken to level and raise areas to smooth out grades at the site. The main geotechnical issues regarding site development are:

1. the potential for filling below proposed building areas. Fills in some of the present topographical low areas may need to be raised more than 1.0 m. Placement of fill below footing elevations will need to be carefully addressed and monitored to minimize the potential for foundation problems due to settlement.

2. that the silty surficial soil is relatively soft and sensitive to disturbance which can result in potential problems during construction depending on actual weather and ground conditions. An observational approach based on the actual conditions at the time of construction is considered the best way to optimize costs by identifying problem areas before construction activity leads to subgrade failure.

3. that relatively sensitive silt and clay deposits will be encountered during site development trenching, depending on where the final grade is set. The siltier deposits are considered to be marginally suitable for use as road base and trench backfill, provided they can be dried to a workable soil moisture content since these soils can be very sensitive to disturbance when wet. Alternatively, wet soils could be mixed or replaced with drier fill or selectively used for general site fill. The till is considered to be better suited for use as an engineered fill and trench backfill.

4. the siltier surficial soils will be highly susceptible to frost if they are given access to free water or groundwater within the zone of seasonal frost (estimated to an average depth of 2.5 m).

5. The general foundation conditions at this site are considered to be fair depending on the magnitude of foundation loads. Bearing pressures for shallow foundations in the surficial silt and clay deposits will be relatively low. The site is suited to bored cast-in-place piles. Detailed recommendations for foundations will require site specific geotechnical investigations.

7.2 PRIVATE SEWAGE DISPOSAL

The observed groundwater table was acceptable for septic fields. Results of the percolation testing were within the Guidelines at seven of the ten test sites and acceptable for placement of a conventional septic field system. The subgrade soils at Borehole 7, 9 and 10 was low permeable, resulting in a percolation rate of over 23.6 min/cm which does not meet the Guidelines.

In areas of low permeable soils, a practical option for private sewage disposal at this development is to modify the existing silt and clay subgrade by mixing in silt and sand to achieve an acceptable low to moderate permeability subgrade which would support a normal septic field at proposed field locations. Tests suggest local soils are available for constructed fields. Other options acceptable according to the Standard of Practice guidelines include: the construction of a septic mound, construction of an engineered sewage disposal/treatment systems or installation of a septic tank with a pump out. The septic disposal systems should be constructed in accordance with applicable regulations and should be properly sized and installed by a licensed contractor based on normal testing and verification of actual field conditions.

7.3 SITE PREPARATION

7.3.1 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 at the site. Ideally, fill used to bring the site up to grade should be: select sand, well graded coarse gravel, or low to medium plastic inorganic clay. The native surficial silt and clay soils are suitable fill materials, provide they can be compacted to desired density levels. Moisture conditioning of the native silt and clay soils will be required prior to use as fill in order to achieve specified densities.

The engineered fill placed during site grading at this site should be compacted to at least 95 percent of SPMDD. Uniformity of compaction is most important. The lift thicknesses should be governed by the ability of the selected compaction equipment to uniformly achieve the recommended density. Maximum lift thicknesses of 200 mm for granular fill and 150 mm for clay fill are recommended. Granular fill is best compacted with large smooth drum vibratory rollers while 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 maximum density.

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. The control of moisture content is considered to be important for the sandy fills. Future wetting of these fill soils could cause significant settlement long after original construction due to changes in the groundwater regime from development. If these density levels

cannot be achieved using common fill during site grading, the footing bearing surfaces should be subcut and underlain with select granular fills compacted to at least 98 percent. The depth of subcut 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. To reduce settlement potential and the compactive efforts to achieve maximum density, it is recommended that granular fill be placed at moisture contents 0 to 2 percent below the Optimum Moisture Content.

7.3.2 Soft Subgrade Conditions

Initial 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 soils should be subexcavated 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 clay deposit subgrades in the Lacombe County area. Problems are most often encountered in the spring or during periods of wet weather when the groundwater table is shallowest and when shallow perched water conditions are encountered. In some cases, construction traffic on the fine grained 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.

Once these soft areas are identified, methods to avoid subgrade failure may include: limiting construction traffic, modification of site preparation procedures (scarification, recompaction etc), and use of backhoe excavation equipment and fill placement by end dumping and spreading with wide pad crawler equipment. In the most severe cases a layer of clean coarse gravel is placed across the area to protect the subgrade from disturbance and act as a working platform for compaction equipment. If coarse gravel is used as a granular fill, it is recommended to use a select sand or gravel with a maximum aggregate size of 150 mm.

Thicker layers may be required in very soft areas or where the subgrade has failed. In road areas, this extra gravel can be incorporated into the pavement subbase. Based on local experience with silty clay subgrade soils, a combined subgrade and improvement and subbase layer of 500 mm to 800 mm thick is typical for subgrade improvement when required. The gravel should be placed in a single lift on top of a 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. Vibration may have to be limited during compaction of this initial lift. The need for special measures and/or gravel fill in soft subgrade areas should be subject to review in the field during the construction based on the actual conditions, the required fill thickness, the proposed compaction equipment, and the intended use for the designated area.

7.4 SERVICE TRENCH INSTALLATION

If required, shallow buried services may be installed to depths within 3.0 m of the final ground surface. It is expected that trenches will be excavated through a range of materials including soft to firm silty clay and stiff clay till. The majority of services trenches are expected to be based in silt and clay deposits. Conventional trenched excavations with sloping sides and/or moveable shields are considered to be feasible.

7.4.1 Service Trench Excavation

The side slope of conventional unsupported trench excavations is dependent on the local soil conditions at any given location. Where the excavations are proposed, conventional trenched excavations with sloping sides and/or moveable shields are considered to be feasible. For excavations above the water table, side slopes of at least 1H:1V are recommended. In stiff tills, steeper sideslopes could be used subject to site specific review by a qualified Geotechnical Engineer. If saturated zones are encountered within the cut, flatter side slopes and/or dewatering may be required.

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 generally not expected. Exceptions may occur in seasonal conditions where perched water is encountered after precipitation or snow melt and possibly in low lying areas, if serviced. Base heave and/or boiling of the trench bottom could occur where a significant differential hydrostatic head exists at the bottom of the excavation and soils are not cohesive (eg. sand lenses in the till). Dewatering and other pressure relief measures are available to minimize problems with the stability of the trench bottom.

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. 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, because disturbed wet, cohesionless soils at depth are very expensive measures to rehabilitate.

7.4.2 Pipe Bedding

Minor deflections of the trench bedding are expected. Underground utility pipes should maintain watertight joints (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 a sand and gravel mixture which can be readily compacted around the pipe to achieve a high frictional strength.

Bedding soils 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.

In the event of significant groundwater seepage or wet base conditions, additional 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. It, therefore, needs to be strong enough to withstand construction activity.

7.4.3 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 clay. Wetter silt and clay are considered marginally suitable for use as trench backfill due to high moisture contents.

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 to achieve specified density throughout the entire lift. Uniformity is of most importance. The nominal lift thickness for select granular fill is 200 mm. Clay backfill should be placed in thin lifts with a nominal compacted thickness of 150 mm. This is especially important when backfilling very stiff clay soils. The backfill should be uniformly compacted to a minimum of 95 percent of the SPMDD. For road areas, the backfill should be compacted throughout the depth of the fill to a minimum 97 percent of the 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. 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 of the upper 0.5 to 1.0 m of the subgrade is recommended to help make the subgrade more uniform. This construction procedure is used with success on similar deep trench backfill situations in the City of Calgary. Design considerations required for roadway subgrade construction on recompacted and natural materials in this industrial park are discussed in the following section of this report.

To minimize the effects of potential settlements on completed roadway surfaces, it is recommended that staged pavement construction be adopted and that placement of final surfacing materials be delayed as long as possible, subsequent to completion of trench backfilling.

7.4.4 Concrete for Underground Structures

The water soluble sulphate concentration was negligible (0.04 %). As per CSA A23.1-M04, normal (Type 10) Portland cement may be used with a minimum 56 day compressive strength of 25 MPa. All concrete exposed to a freezing environment either during or after construction should be air entrained.

7.5 ROADWAY SUBGRADE CONSTRUCTION

The native silt and clay soils were estimated to have CBR values in the order of 2.5 to 3.0 in a soaked condition depending on the type of subgrade soil. These estimated CBR values are indicative of a low to moderate level of subgrade support.

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 7.3.2 Soft Subgrade Conditions. The recommended type of subgrade fill would be a relatively clean coarse graded gravel with a maximum aggregate size of 150 mm. A proposed coarse gravel gradation specification is provided below in Table 3:

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 gravel pavement 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.

Construction procedures should be designed to minimize disturbance to the subgrade and protect the integrity of the granular working mat. 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

7.6 FLEXIBLE PAVEMENT DESIGN

It is understood that gravel roads are proposed for this industrial park. Two flexible pavement designs are proposed for this light industrial park for a design period of 20 years:

1. a moderate traffic section for the industrial collector roads using a Design Traffic of 1×10^6 Equivalent Single Axle Loads (ESAL's).

2. a light traffic section for the local industrial streets using an Design Traffic of 5×10^5 ESAL's.

The proposed pavement designsections for this industrial park are based on the assumption of a stable subgrade having a CBR of 3 for the native subgrade in a soaked condition or a subgrade which has been improved to an equivalent level as described in Section 7.5. The majority of surficial soils across this site are expected to meet this minimum subgrade support condition, but there is the potential for some localized soft areas.

Since a gravel pavement is proposed it is assumed that the surface will be subject to periodic maintenance and gravel replenishment, so the surface tolerances will be more forgiving. The proposed gravel pavement sections are provided based on a section slightly thicker than the base/subbase thickness that would be required if these roads were to be paved.

Based on the preceding assumptions the following flexible pavement sections are proposed:

TABLE 4
FLEXIBLE PAVEMENT DESIGN

Pavement Sections	Local Industrial	Industrial Collector
Design traffic (ESAL's)	5×10^5	1×10^6
20 mm Crushed Gravel Surface Subbase Gravel (minimum)	200 mm 400 mm	200 mm 450 mm

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 subbase materials in the pavement section should be a minimum of 98 percent of SPMDD. The 20 mm crushed gravel surface should be compacted to a minimum of 99 percent of SPMDD.

If future asphalt concrete paving of these roads is proposed the recommended procedure would be to prepare the present base layer to provide at least 150 mm of uniformly compacted non-segregated base. Any soft areas should be rehabilitated. The recommended ACP layer thicknesses are 90 mm for the local industrial road and 100 mm for the industrial collector. These recommendations should be subject to review at the time of final paving.

Aggregate materials for grave surface 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 (AT) specifications.

TABLE 5
RECOMMENDED AGGREGATE SPECIFICATIONS

	AT Specifications
Asphalt Gravel	Designation 1, Class 16
Crushed Base Gravel	Designation 2, Class 20 or 25
Subbase Gravel	Designation 2, Class 40

A copy of the AT aggregate specifications 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 a 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. 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 pavement construction be adopted and that placement of final gravel surfacing materials be delayed as long as possible subsequent to completion of trench backfilling.

7.7 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 Alberta Building Code, adequate levels of inspection are considered to be: review of all completed bearing surface prior to concrete placement; full time monitoring of deep foundations and monitoring, and compaction control of engineered fill.

8.0 LIMITATIONS

This report is based on local experience and the findings at ten borehole locations. If different subsoil and groundwater conditions be encountered, this office should be notified and recommendations submitted herein will be reviewed and revised as required. This report has been prepared for the exclusive use of the **ISL Engineering and Land Services Ltd.**, and their approved agents for specified application to the proposed Industrial park Development in SE 21-39-3-W5M near Eckville, in Lacombe County, Alberta. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

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

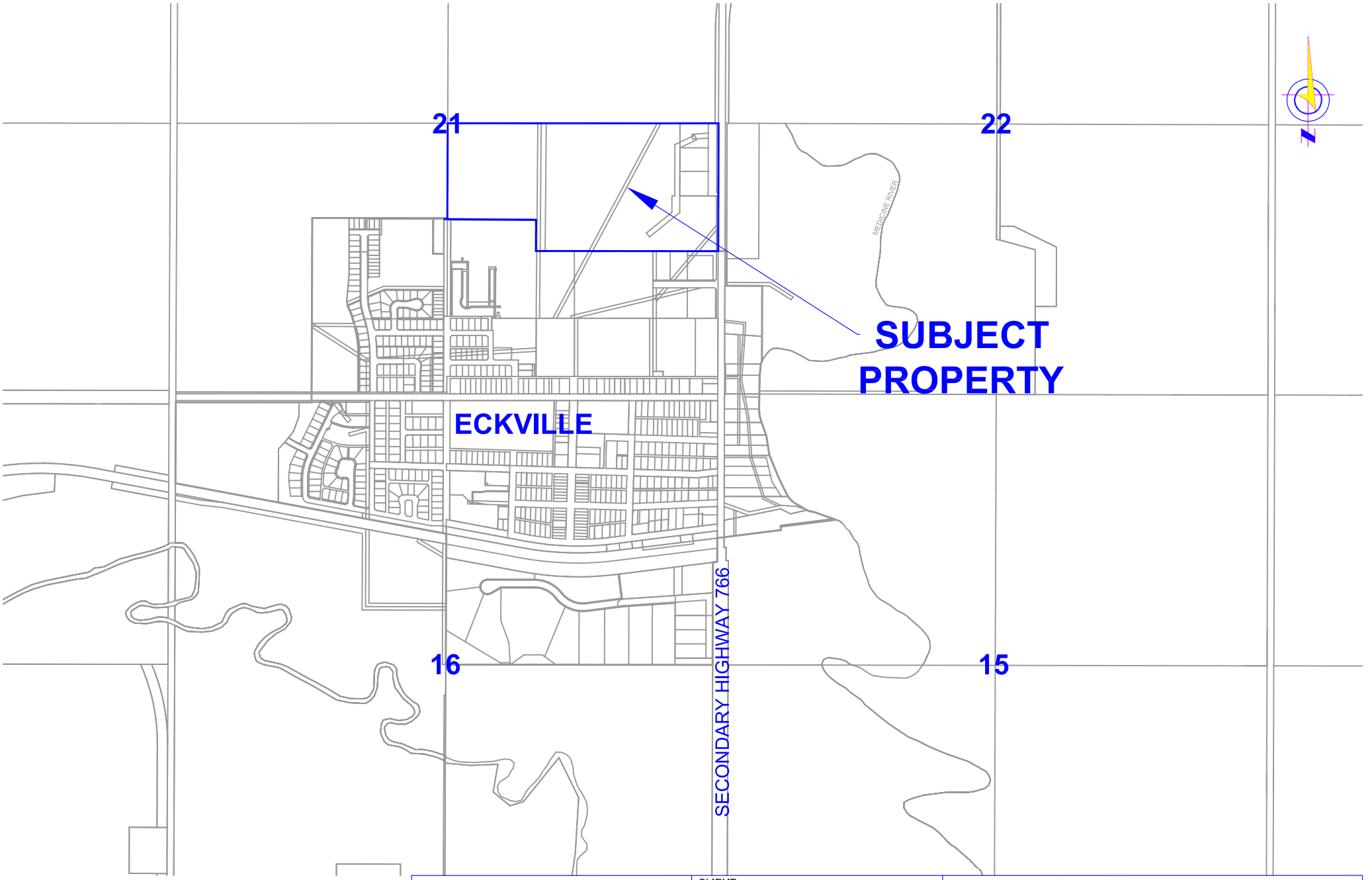
July 13, 2009

Minqiang Tu, M.Eng., P.Eng
Geotechnical Engineer

Reviewed by: Mark Brotherton, P.Eng.
Principal Geotechnical Engineer

APPENDIX A

Figure 1 - Key Plan
Figure 2 - Site Plan
Figure 3 - Contour Plan
Figure 4 - Aerial Plan
Borehole Logs (10)
Soil Test Results
Aggregate Specifications
Explanation Sheets



Parkland GEO

CLIENT:

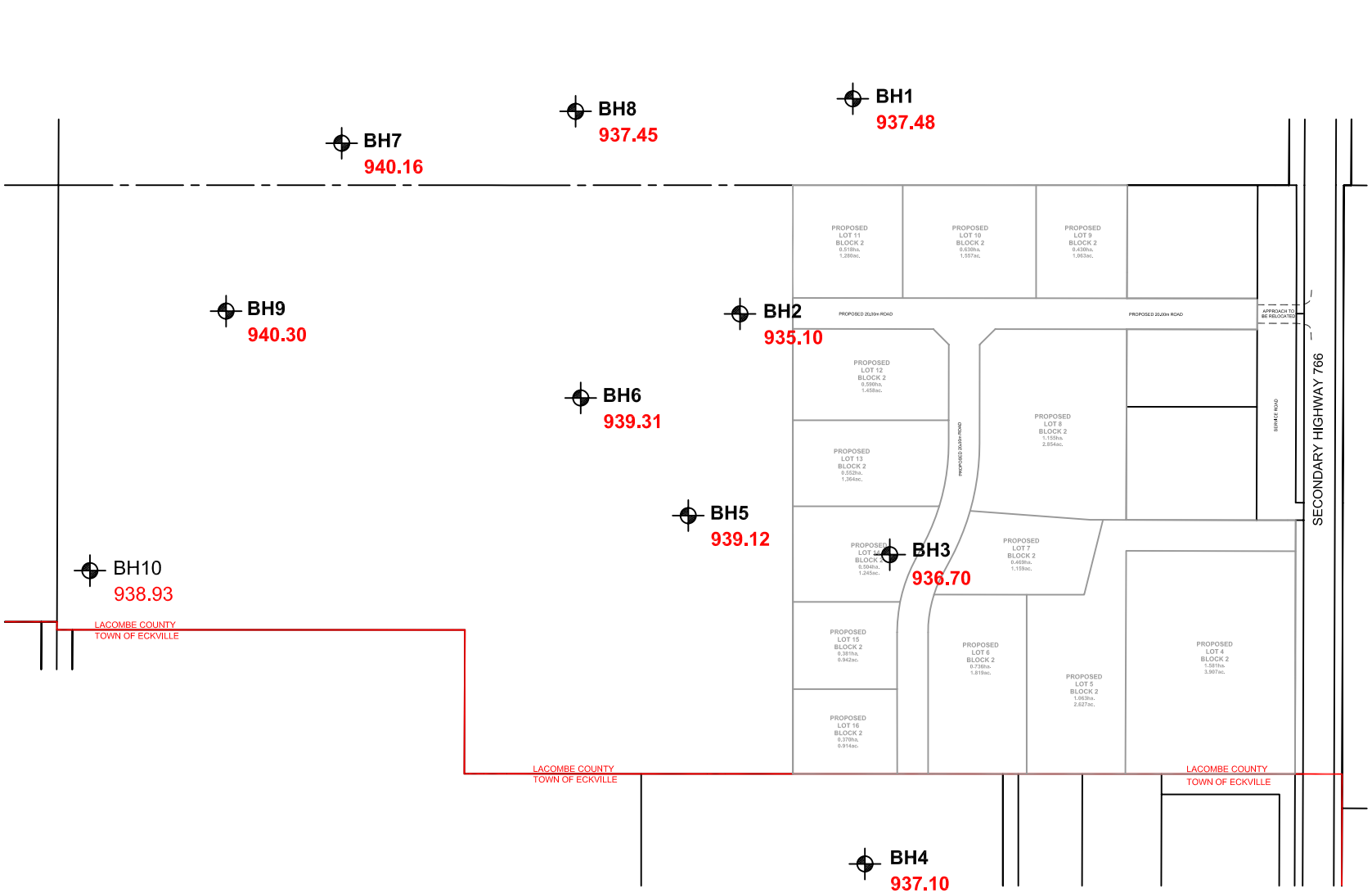
ISL Engineering and Land Services

KEY PLAN

MEDICINE VALLEY INDUSTRIAL PARK
SE-21-39-3-W5M, LACOMBE COUNTY, AB

DRAWN:	CHK'D.:	REV #:	DATE:
AW	MDB	1	JULY 2009

SCALE:	JOB NO.	DRAWING NO.
NTS	RD3230	FIGURE 1



SCALE (metres)

-80 -40 0 40 80 160

Parkland GEO

CLIENT:

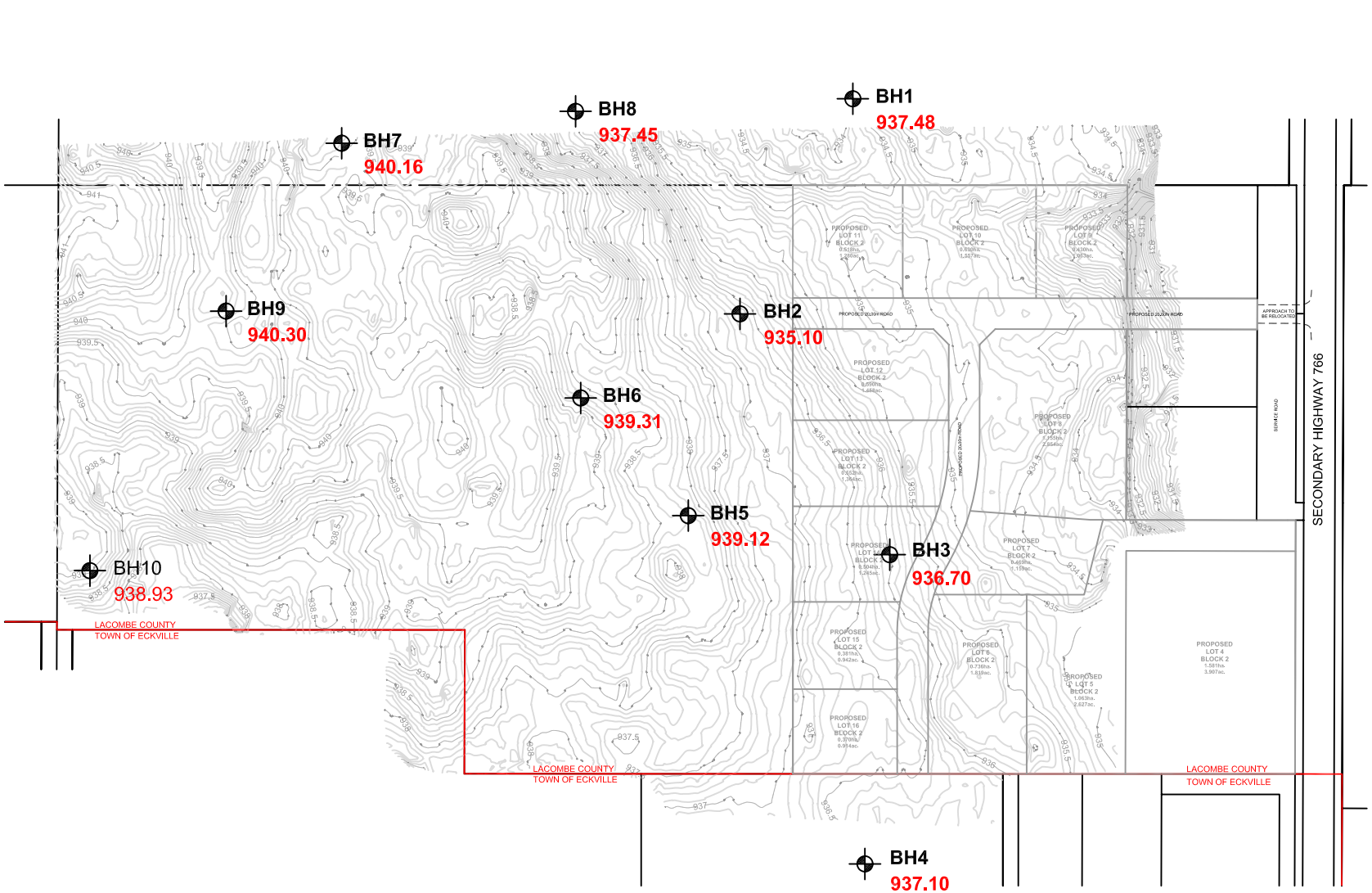
ISL Engineering and Land Services

SITE PLAN

MEDICINE VALLEY INDUSTRIAL PARK
SE-21-39-3-W5M, LACOMBE COUNTY, AB

DRAWN:	CHK'D.:	REV #:	DATE:
AW	MDB	1	JULY 2009

SCALE:	JOB NO.	DRAWING NO.
1:4000	RD3230	FIGURE 2



SCALE (metres)

-80 -40 0 40 80 160

Parkland GEO

CLIENT:

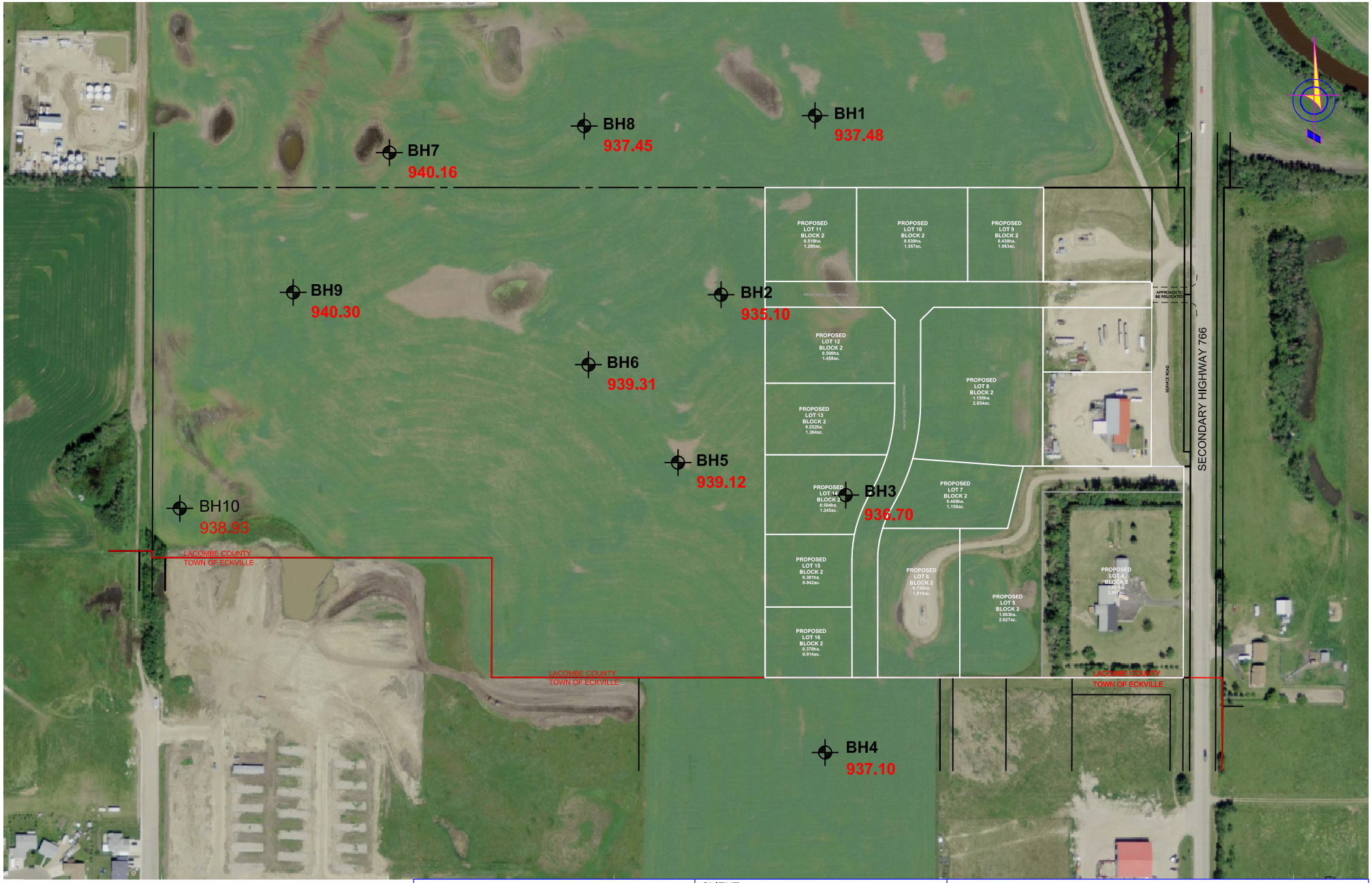
ISL Engineering and Land Services

CONTOUR PLAN

MEDICINE VALLEY INDUSTRIAL PARK
SE-21-39-3-W5M, LACOMBE COUNTY, AB

DRAWN:	CHK'D.:	REV #:	DATE:
AW	MDB	1	JULY 2009

SCALE:	JOB NO.	DRAWING NO.
1:4000	RD3230	FIGURE 3



SCALE (metres)

-80 -40 0 40 80 160

Parkland GEO

CLIENT:

ISL Engineering and Land Services

AERIAL PLAN

MEDICINE VALLEY INDUSTRIAL PARK
SE-21-39-3-W5M, LACOMBE COUNTY, AB

DRAWN:	CHK'D.:	REV #:	DATE:
AW	MDB	1	JULY 2009

SCALE:	JOB NO.	DRAWING NO.
1:4000	RD3230	FIGURE 4

BOREHOLE NO.: 1

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								937.48
0	***Topsoil*** Moderately organic, black, moist.								
	Silt and Clay Trace sand, soft to firm, medium plastic, brown, moist.		27						
1			30				**GRAIN SIZE ANALYSIS:** CLAY=48% SILT=52% SAND=0% GRAVEL=0% **SO4=0.04%**		
					1D1	3			
2			34						
3			34						
			23						933.48
4	***Till*** Clay, silty, trace sand, trace gravel, stiff to very stiff, low plastic, brown to grey, occasional coal inclusions, occasional rust stains, moist.								
5			20						
6			19						
					1D2	20			
	End of hole at 6.5m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								930.98
7									
8									929.48

25MM PVC STANDPIPE
25MM SLOTTED PVC PIPE
BACKFILLED WITH AUGER CUTTINGS

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 937.481
NORTHING: 5805394.3404
EASTING: 679277.5631

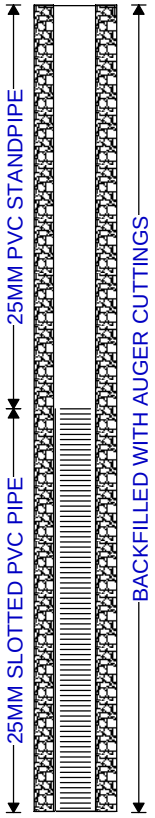
BOREHOLE NO.: 2

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								935.10
0	***Topsoil*** Moderately organic, black, moist.								935.00
	Silt and Clay Firm, low to medium plastic, brown, occasional rust stains, moist.		30						
1									
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.				2D1	11			933.70
2			22						
	End of hole at 3.0m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.		19						932.10
3									
4									
5									930.10



LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 935.096 m
NORTHING: 5805533.3727
EASTING: 679350.5560

BOREHOLE NO.: 3

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								936.70
0	***Topsoil*** Moderately organic, black, moist.								936.60
	Silt and Clay Trace sand, firm, medium plastic, brown, moist.		29						
1									
			34				SO4=0.04%		
2									
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.		22						934.20
3					3D1	11			
	End of hole at 3.5m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								933.20
4									
									931.70
5									

Well Completion Details: 25MM PVC STANDPIPE; 25MM SLOTTED PVC PIPE; BACKFILLED WITH AUGER CUTTINGS

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 936.7 m
NORTHING: 5805238.6332
EASTING: 679374.5868

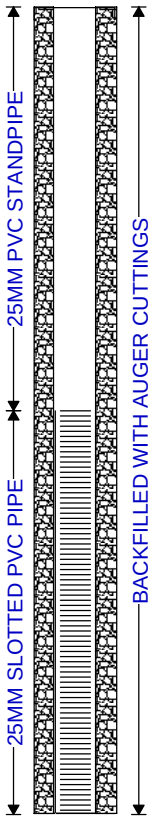
BOREHOLE NO.: 4

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								937.11
0	***Topsoil*** Moderately organic, black, moist.								936.91
	Silt and Clay Trace sand, firm, medium plastic, brown, moist.		29						
1									
					4D1	4			
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.		24						935.21
2									
			21						934.11
3	End of hole at 3.0m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								
4									
5									932.11



LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 937.105 m
NORTHING: 5805041.1816
EASTING: 679357.8508

BOREHOLE NO.: 5

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								939.12
0	***Topsoil*** Moderately organic, black, moist.								939.02
	Silt and Clay Soft to firm, medium plastic, brown, moist.		25					25MM PVC STANDPIPE	
1									
			33				**GRAIN SIZE ANALYSIS:** CLAY=55% SILT=45 SAND=0% GRAVEL=0%		
2									
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.								936.72
			22					25MM SLOTTED PVC PIPE	
3					5D1	11			
	End of hole at 3.5m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								935.62
4								BACKFILLED WITH AUGER CUTTINGS	
									934.12
5									

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 939.123 m
NORTHING: 5805263.9441
EASTING: 679244.0876

BOREHOLE NO.: 6

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								939.31
0	***Topsoil*** Moderately organic, black, moist.								
	Silt and Clay Firm, medium plastic, brown, occasional rust stains, moist.		28						
1									937.91
	Till Clay, silty, sandy, trace gravel, stiff to very stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.		18		6D1	10	**SO4=0.04%**		
2									
			19						
3									
			18						
4									
			19		6D2	20	**GRAIN SIZE ANAYLSIS:** CLAY=44% SILT=33% SAND=22% GRAVEL=1%		
5	End of hole at 5.0m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								934.31
6									933.31

Well Completion Details: 25MM PVC STANDPIPE; 25MM SLOTTED PVC PIPE; BACKFILLED WITH AUGER CUTTINGS

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 939.307 m
NORTHING: 5805339.9771
EASTING: 679174.5462

BOREHOLE NO.: 7

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								940.17
0	***Topsoil*** Moderately organic, black, moist.								
	Silt and Clay Firm, medium plastic, brown, occasional rust stains, moist.		30						
1									938.77
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.				7D1	12	**SO4=0.04%**		
2			18						
3			18						
4			18						
5			18						
6			17		7D2	13			
	End of hole at 6.5m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								933.67
7									
8									932.17

Well Completion Details: 25MM PVC STANDPIPE; 25MM SLOTTED PVC PIPE; BACKFILLED WITH AUGER CUTTINGS

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 940.165 m
NORTHING: 5805504.6380
EASTING: 679019.9644

BOREHOLE NO.: 8

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								937.45
0	***Topsoil*** Moderately organic, black, moist.								
	Silt and Clay Trace sand, firm, medium plastic, brown, moist.		28						
1									
									935.65
2	***Till*** Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.		21						
3			17		8D1	14		25MM PVC STANDPIPE	
4			18					BACKFILLED WITH AUGER CUTTINGS	
5			17						
									931.95
6	***Sand (Possible Sandstone)*** Silty, fine grained, poorly graded, very dense, brown, occasional rust stains, moist.		9		8D2	50		25MM SLOTTED PVC PIPE	
									931.15
7	End of hole at 6.3m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								
									929.45
8									

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 937.452 m
NORTHING: 5805525.2514
EASTING: 679171.2255

BOREHOLE NO.: 9

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industrial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								940.30
0	***Topsoil*** Moderately organic, black, moist.								940.20
	Silt and Clay Trace sand, firm, medium plastic, brown, moist.		30					25MM PVC STANDPIPE	
1									
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.		30						938.40
2									
			20		9D1	15		25MM SLOTTED PVC PIPE	
3								BACKFILLED WITH AUGER CUTTINGS	936.80
	End of hole at 3.5m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.								
4									
5									935.30

LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 940.301 m
NORTHING: 5805396.1064
EASTING: 678945.1707

BOREHOLE NO.: 10

CLIENT: ISL Engineering & Land Services Ltd
SITE: Medicine Valley Industial Park
NOTES: SE-21-39-3-W5M

PROJECT NO.: RD3230
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								938.93
0	***Topsoil*** Moderately organic, black, moist.								938.83
	Silt and Clay Soft to firm, medium plastic, brown, moist.		32					25MM PVC STANDPIPE	
1									
	Till Clay, silty, trace sand, trace gravel, stiff, low plastic, brown, occasional rust stains, occasional coal inclusions, moist.		20		10D1	7	SO4=0.04%		937.43
2									
	End of hole at 3.0m. 25mm standpipe installed. Backfilled with cuttings. Dry upon completion. Dry on June 12, 2009.		19					25MM SLOTTED PVC PIPE BACKFILLED WITH AUGER CUTTINGS	935.93
3									
4									
5									933.93

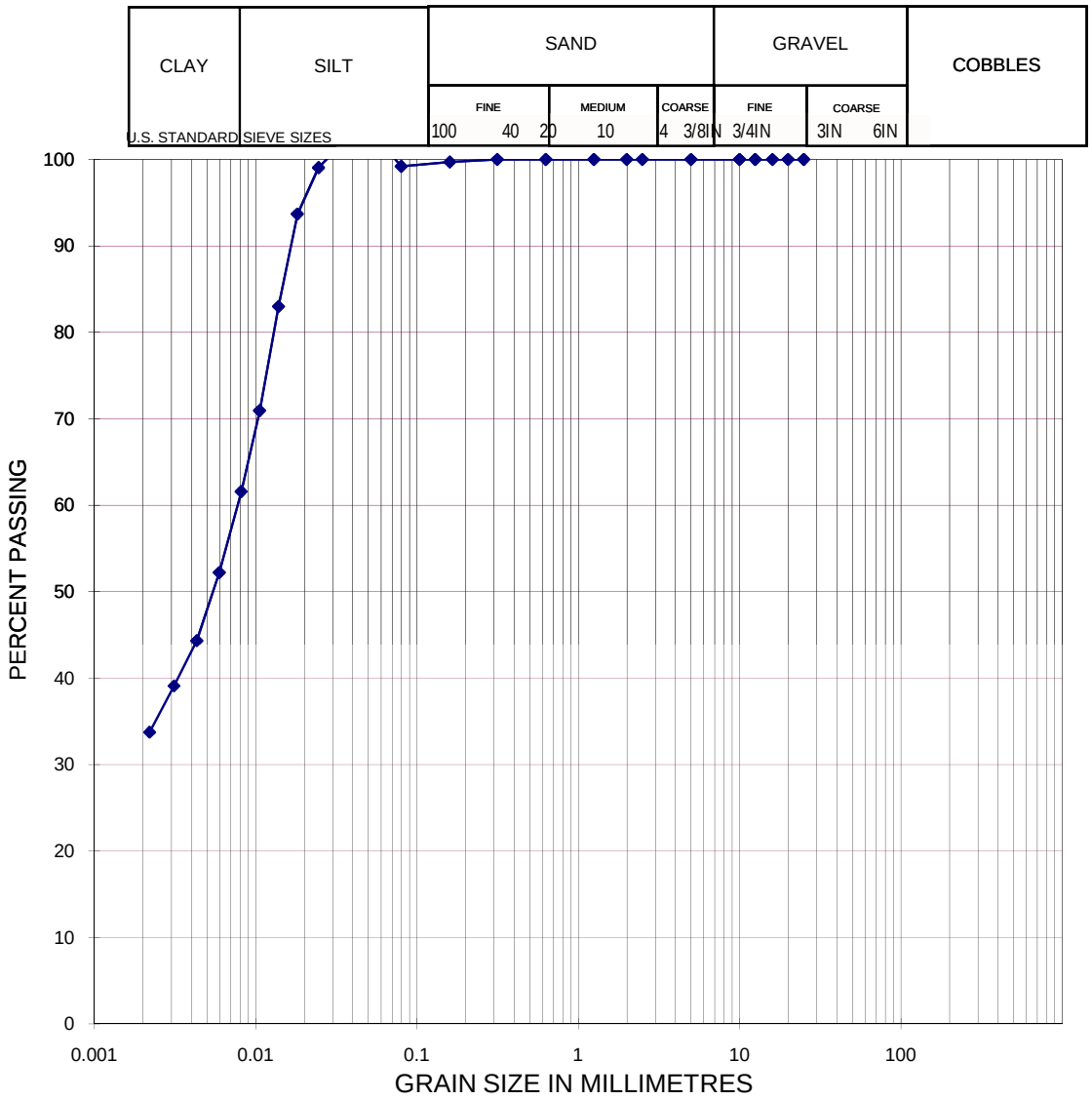
LOGGED BY: CLJ
CONTRACTOR: J.E.D. Anchors and Environmental Ltd
RIG/METHOD: Truck Mount / Solid Stem Auger
DATE: May 28, 2009
CALIBRATION:

GROUND ELEVATION: 938.934 m
NORTHING: 5805228.3555
EASTING: 678857.1116

PROJECT	Medicine Valley Industrial Park
PROJECT #	RD3230
BOREHOLE	1
DEPTH	1.5 m
SAMPLE	1D1
LOCATION	

DATE June 9/09
TECH JB

GRAIN SIZE DISTRIBUTION



COMMENTS:

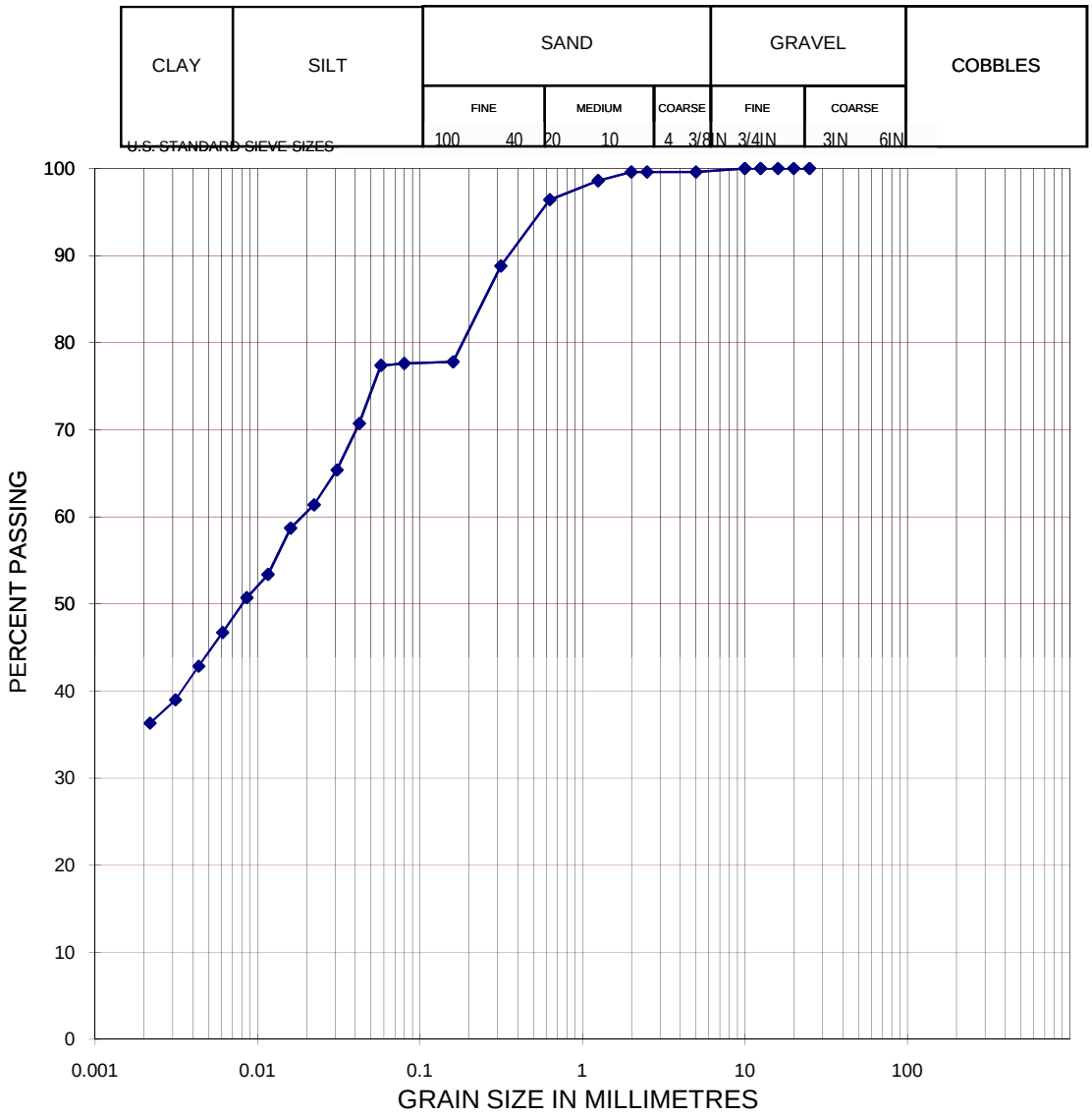
% Retained on 2 mm seive
Soil Type: Silt, and clay, trace sand

SUMMARY

D10	=	GRAVEL	0.00%
D30	=	SAND	0.02%
D60	=	SILT	52%
CU	=	CLAY	47.59%
CC	=		

PROJECT	Medicine Valley Industrial Park		
PROJECT #	RD3230		
BOREHOLE	6	**DATE**	June 9/09
DEPTH	4.5 m	**TECH**	JB
SAMPLE	6D2		
LOCATION			

GRAIN SIZE DISTRIBUTION



COMMENTS:

% Retained on 2 mm seive
Soil Type: Clay, some silt, some sand

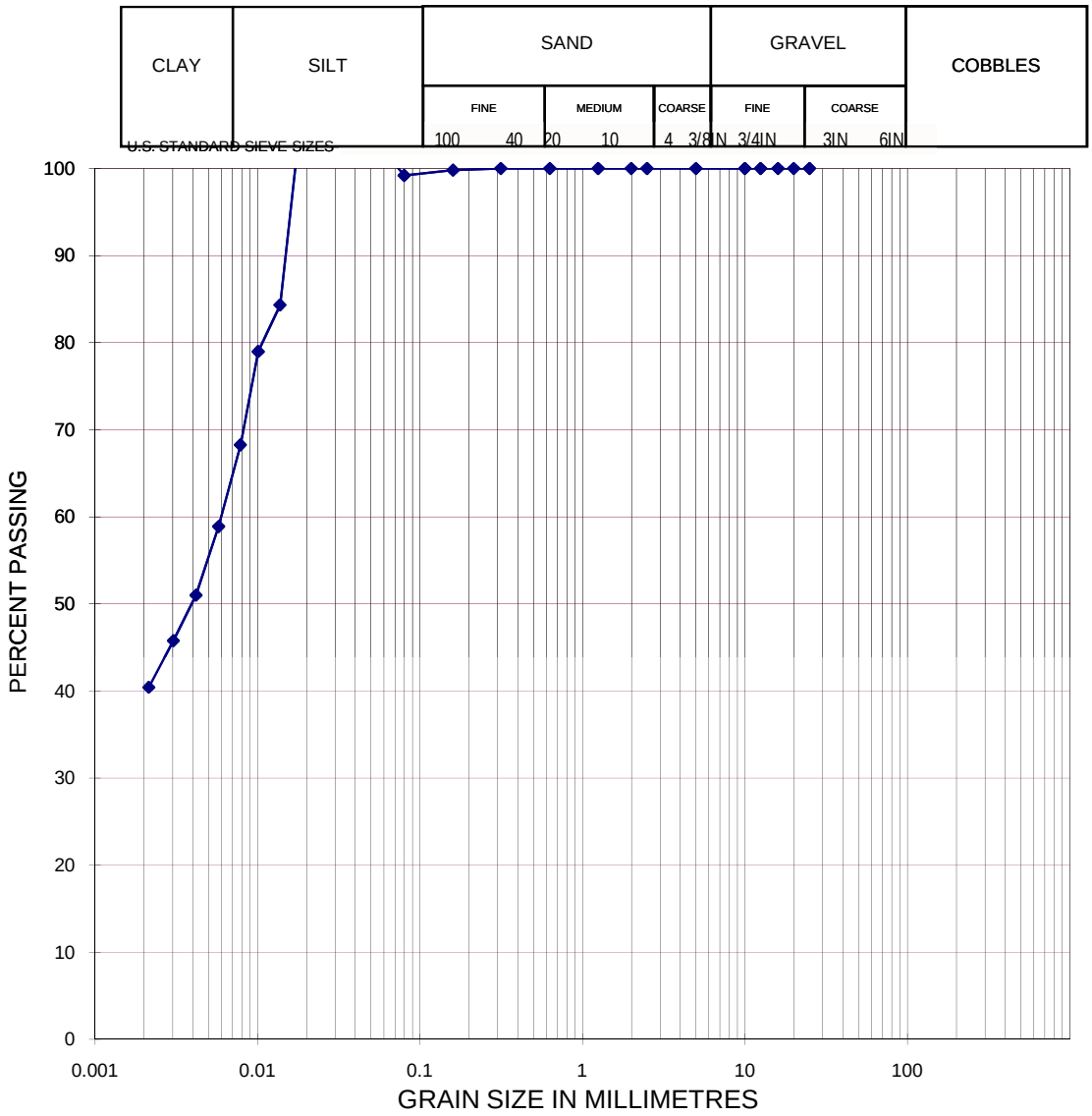
SUMMARY

D10	=	GRAVEL	0.40%
D30	=	SAND	22.45%
D60	=	SILT	33%
CU	=	CLAY	44.26%
CC	=		

PROJECT	Medicine Valley Industrial Park
PROJECT #	RD3230
BOREHOLE	5
DEPTH	2.0 m
SAMPLE	MC2
LOCATION	

DATE June 9/09
TECH JB

GRAIN SIZE DISTRIBUTION



COMMENTS:

% Retained on 2 mm seive
Soil Type: Clay, and silt, trace sand

SUMMARY

D10	=	GRAVEL	0.00%
D30	=	SAND	0.02%
D60	=	SILT	45%
CU	=	CLAY	55.06%
CC	=		

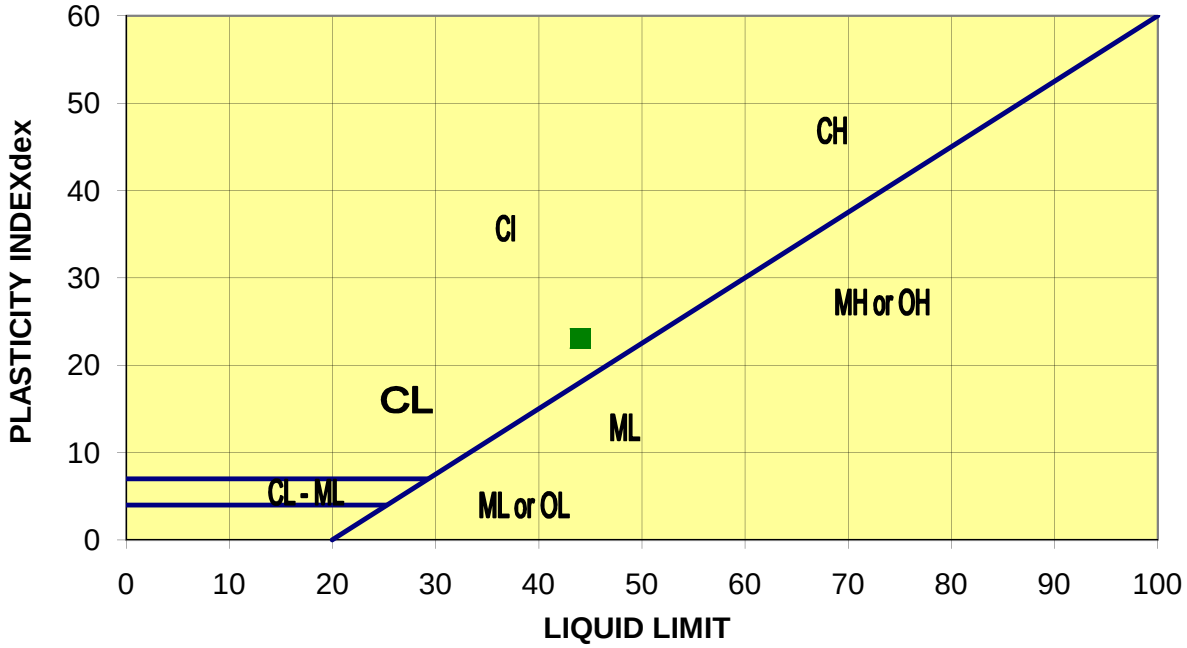
PROJECT# RD3230
PROJECT Medicine Valley Industrial Park
BOREHOLE 1
DEPTH 1.5 m
SAMPLE # 1D1
DATE June 9/09
TECH JB

SOIL PLASTICITY SUMMARY

LIQUID LIMIT (LL)		
Trial No.	1	2
No. Blows	21	22
Wt. Sample Wet + Tare	41.989	42.414
Wt. Sample Dry + Tare	33.982	34.357
Wt. Water	8.007	8.057
Tare Container	16.125	16.373
Wt. Dry Soil	17.857	17.984
Moisture Content	44.840	44.801
Corrected for Blow Count	43.903	44.113
Liquid Limit Average	**44.0**	

PLASTIC LIMIT (PL)			
Trial No.	1	2	3
Wt. Wet Worm + Tare	8.600	8.565	8.761
Wt. Dry Worm + Tare	8.201	8.169	8.335
Wt. Water	0.399	0.396	0.426
Tare Container	6.299	6.280	6.301
Wt. Dry Worm	1.902	1.889	2.034
Moisture Content	20.978	20.963	20.944
Plastic Limit Average		**21.0**	

PLASTICITY INDEX (PI) = LL-PL **23.0**



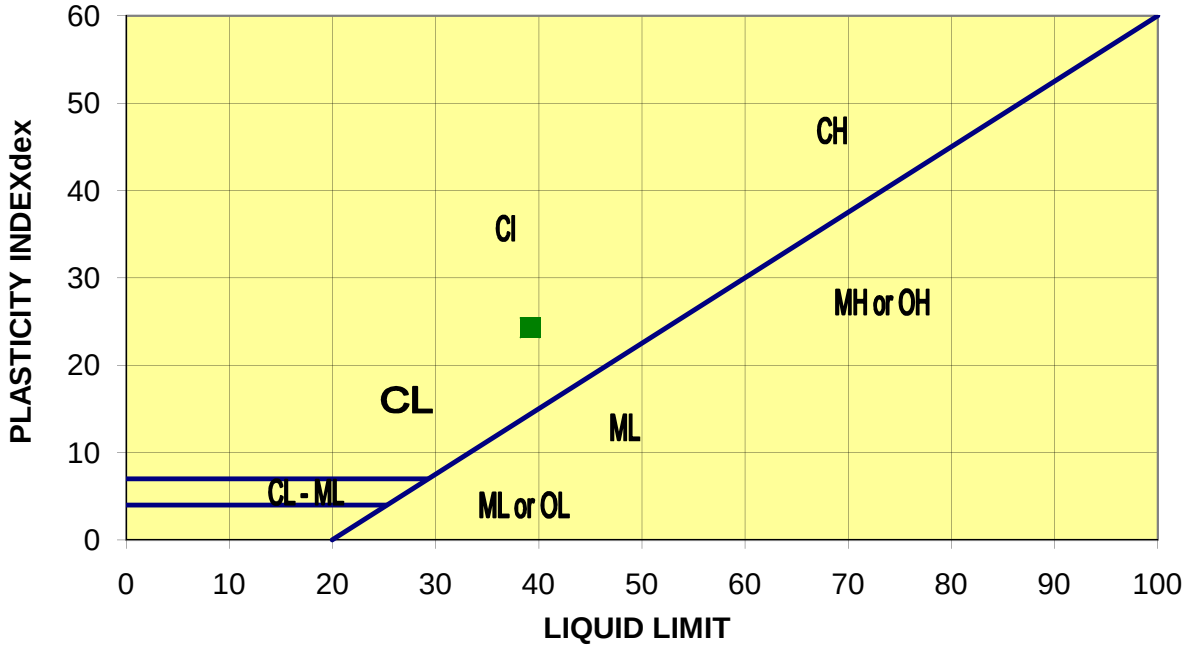
PROJECT# RD3230
PROJECT Medicine Valley Industrial Park
BOREHOLE 6
DEPTH 4.5 m
SAMPLE # 6D2
DATE June 9/09
TECH JB

SOIL PLASTICITY SUMMARY

LIQUID LIMIT (LL)		
Trial No.	1	2
No. Blows	24	25
Wt. Sample Wet + Tare	44.023	44.916
Wt. Sample Dry + Tare	36.286	36.772
Wt. Water	7.737	8.144
Tare Container	16.434	16.183
Wt. Dry Soil	19.852	20.589
Moisture Content	38.973	39.555
Corrected for Blow Count	38.781	39.555
Liquid Limit Average	**39.2**	

PLASTIC LIMIT (PL)			
Trial No.	1	2	3
Wt. Wet Worm + Tare	8.447	8.504	8.836
Wt. Dry Worm + Tare	8.174	8.222	8.510
Wt. Water	0.273	0.282	0.326
Tare Container	6.352	6.327	6.307
Wt. Dry Worm	1.822	1.895	2.203
Moisture Content	14.984	14.881	14.798
Plastic Limit Average		**14.9**	

PLASTICITY INDEX (PI) = LL-PL	**24.3**



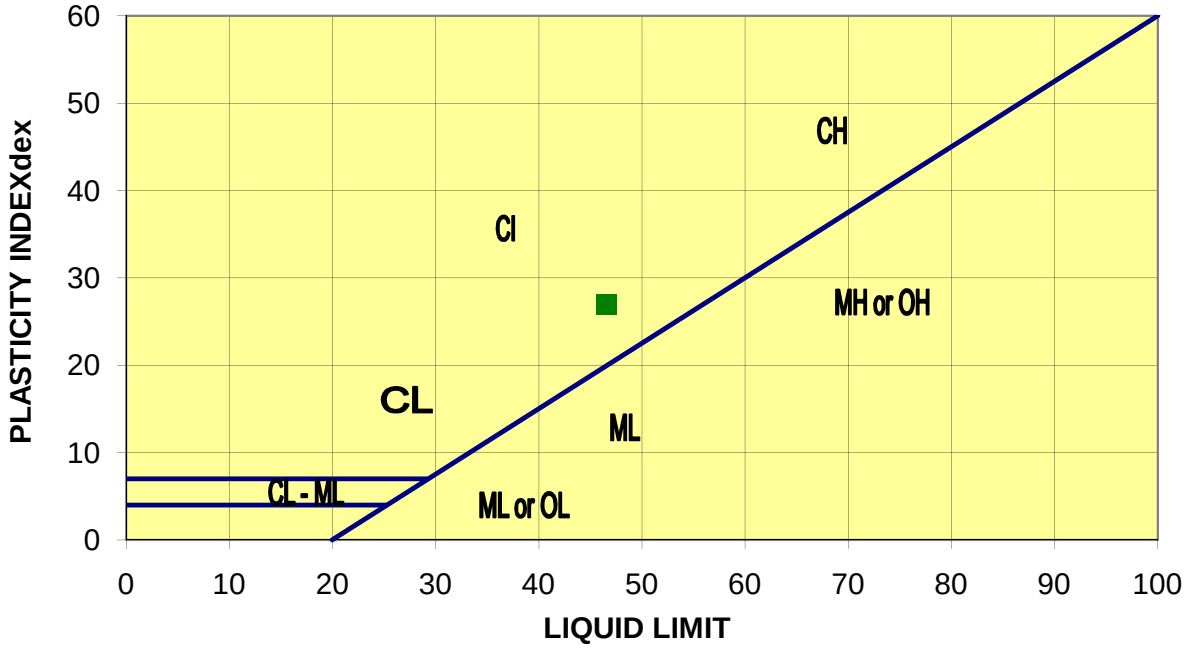
PROJECT# RD3230
PROJECT Medicine Valley Industrial Park
BOREHOLE 5
DEPTH 2.0 m
SAMPLE # MC2
DATE June 9/09
TECH JB

SOIL PLASTICITY SUMMARY

LIQUID LIMIT (LL)		
Trial No.	1	2
No. Blows	23	24
Wt. Sample Wet + Tare	41.244	42.172
Wt. Sample Dry + Tare	33.247	33.854
Wt. Water	7.997	8.318
Tare Container	16.319	15.986
Wt. Dry Soil	16.928	17.868
Moisture Content	47.241	46.552
Corrected for Blow Count	46.767	46.323
Liquid Limit Average	**46.5**	

PLASTIC LIMIT (PL)			
Trial No.	1	2	3
Wt. Wet Worm + Tare	8.477	8.399	8.593
Wt. Dry Worm + Tare	8.124	8.051	8.205
Wt. Water	0.353	0.348	0.388
Tare Container	6.322	6.263	6.236
Wt. Dry Worm	1.802	1.788	1.969
Moisture Content	19.589	19.463	19.705
Plastic Limit Average		**19.6**	

PLASTICITY INDEX (PI) = LL-PL **27.0**



Project: Medicine Valley Industrial Park
Subject: Geotechnical Testing - Soil Sulphate Test Results
Project #: RD3230 **Date:** June 10/09

Soil Sulphate Test Results

Laboratory: Parkland Geotechnical

Sample #: MC2 Borehole: 1 Depth: 2.0 m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC2 Borehole: 3 Depth: 2.0 m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC2 Borehole: 6 Depth: 2.0 m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC2 Borehole: 7 Depth: 2.0 m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC2 Borehole: 10 Depth: 2.0 m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):

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:**

DESIGNATION		1			2					3				4			5	6		7	8
CLASS (mm)		10	12.5	16	16	20	25	40	50	12.5A	12.5B	12.5C	16	20	25	40	10	80	125	40	40
PER CENT PASSING METRIC SIEVE (CGSB 8 - GP - 2M) µm	125 000																		100		
	80 000																	100			
	50 000								100									55-100	55-100		
	40 000							100								100				100	100
	25 000						100		63-90						100			38-100	38-100		
	20 000					100								100		55-90					
	16 000			100	100		70-94	55-85	47-79				100					32-85	32-85		
	12 500		100	80-92						100	100	100	72-95								
	10 000	100	83-92	70-84	70-93	63-86	52-79	44-74	38-70	35-65	55-75	70-93	53-85	35-77	30-77	25-72	100			85-100	78-95
	5 000	60-75	55-70	50-65	50-70	40-67	35-64	32-62	28-59	0-15	0-15	30-70	27-64	15-55	15-55	8-55	45-70	20-65	20-65		60-85
	1250	30-45	30-45	30-45	26-45	20-43	18-43	17-43	16-42	0-3	0-3	9-34	9-34	0-30	0-30	0-30	20-45			40-100	27-57
	630	22-38	22-38	22-38	19-38	14-34	12-34	12-34	12-34												
	315	15-30	15-30	15-30	14-30	9-26	8-26	8-26	8-26			0-18	0-18				9-22	6-30	6-30	17-100	5-29
	160	9-20	9-20	9-20	9-20	5-18	5-18	5-18	5-18			0-13	0-13				5-15				0-15
	80	4-10	4-10	4-10	4-10	2-10	2-10	2-10	2-10	0-2	0-2	0-8	0-8	0-12	0-12	0-12	0-10	2-10	2-15	6-30	0-5
% FRACTURE BY WEIGHT (2 FACES)	ALL +5000	60+	60+	60+	60+	60+	60+	50+	40+	75+	75+	60+	60+	40+	40+	25+	N/A	N/A	N/A	N/A	N/A
PLASTICITY INDEX (PI)		0-4	0-4	0-4	0-6	0-6	0-6	0-6	0-6	N/A	N/A	0-4	0-4	0-8	0-8	0-8	0-6	0-8	0-8	0-10	0-5
L.A. ABRASION LOSS PER CENT MAX.		40	40	40	50	50	50	50	50	35	35	35	35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
FLAKINESS INDEX		N/A								MAX 15		N/A									
COEFFICIENT OF UNIFORMITY (Cu)		N/A																		3+	N/A

DESIGNATION

1. ASPHALT CONCRETE AGGREGATE (CLASS 10 FOR SURFACE PREPARATION COURSE ONLY)
2. GRANULAR AND ASPHALT STABILIZED BASE COURSES, SUB-BASES AND DUST ABATEMENT AGGREGATES.
3. SEAL COAT AGGREGATE
4. GRAVEL SURFACING AGGREGATE
5. SANDING MATERIAL
6. PIT-RUN GRAVEL FILL
7. CEMENT STABILIZED BASE COURSE AGGREGATE
8. GRANULAR FILTER AGGREGATE

13 MAY 88
4127P1169

Alberta
TRANSPORTATION AND UTILITIES

CHART	3.2 A
	Date
Original	MARCH 1984
Revised	DEC. 1985
Revised	FEB. 1987
Revised	MAR.1988

SPECIFICATIONS FOR AGGREGATE

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.

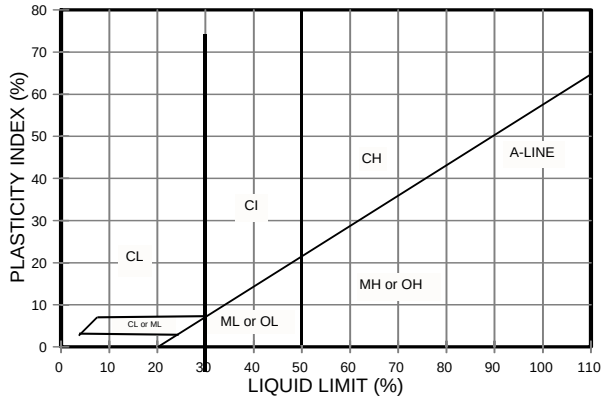
Description	N Value
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Over 50

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.