FORM_C_V19 (Charge)

NEW WESTMINSTER LAND TITLE OFFICE

LAND TITLE ACT
FORM C (Section 233) CHARGE
GENERAL INSTRUMENT - PART 1 Province of British Columbia

Jan-09-2014 14:48:10.001

CA3540454

PAGE 1 OF 58 PAGES

Your electronic signature is a representation that you are a subscriber as defined by the Land Title Act, RSBC 1996 c.250, and that you have applied your electronic signature in accordance with Section 168.3, and a true copy, or a copy of that true copy, is in your possession.

Patrick Jerome Cotter 8UJX2L

Digitally signed by Patrick Jerome Cotter 8UJX2L
DN: c=CA, cn=Patrick Jerome Cotter 8UJX2L, o=Lawyer, ou=Verify ID at www.juricert.com/LKUP.cfm?id=8UJX2L
Date: 2014.01.09 14:26:48 -08'00'

1. APPLICATION: (Name, address, phone number of applicant, applicant's solicitor or agent)

Wilson King LLP
Lawyers
1000-299 Victoria Street
Prince George BC V2L 5B8

(250) 960-3200
Client No. 010894
File No. T4205 PJC/sc

Document Fees: $73.50

Deduct LTSA Fees? Yes ☑

2. PARCEL IDENTIFIER AND LEGAL DESCRIPTION OF LAND:
[PID] [LEGAL DESCRIPTION]

SEE SCHEDULE

STC? YES ☐

3. NATURE OF INTEREST CHARGE NO. ADDITIONAL INFORMATION

Covenant

4. TERMS: Part 2 of this instrument consists of (select one only)
(a) ☐ Filed Standard Charge Terms D.F. No. (b) ☑ Express Charge Terms Annexed as Part 2
A selection of (a) includes any additional or modified terms referred to in Item 7 or in a schedule annexed to this instrument.

5. TRANSFEROR(S):

DISTRICT OF MACKENZIE

6. TRANSFEREE(S): (including postal address(es) and postal code(s))

DISTRICT OF MACKENZIE, A MUNICIPAL CORPORATION

#1 MACKENZIE BOULEVARD, PO. BAG 340
MACKENZIE BRITISH COLUMBIA
V0J 2C0 CANADA

7. ADDITIONAL OR MODIFIED TERMS:
n/a

8. EXECUTION(S): This instrument creates, assigns, modifies, enlarges, discharges or governs the priority of the interest(s) described in Item 3 and the Transferor(s) and every other signatory agree to be bound by this instrument, and acknowledge(s) receipt of a true copy of the filed standard charge terms, if any.

Officer Signature(s)

Kim M. Guthrie
Notary Public
PO Box 260, Mackenzie, BC V0J 2C0
Phone: (250) 997-5778
Fax: (250) 997-5718

(As to all signatures)

Execution Date		
Y	M	D
13	12	19

Transferor(s) Signature(s)

DISTRICT OF MACKENZIE
by its authorized signatories:

Name: MARK FERCHO
Corporate Officer

Name: PATRICK CROOK
Acting Mayor

OFFICER CERTIFICATION:
Your signature constitutes a representation that you are a solicitor, notary public or other person authorized by the *Evidence Act*, R.S.B.C. 1996, c.124, to take affidavits for use in British Columbia and certifies the matters set out in Part 5 of the *Land Title Act* as they pertain to the execution of this instrument.

FORM_D1_V19

LAND TITLE ACT
FORM D

EXECUTIONS CONTINUED

Officer Signature(s)	Execution Date Y	M	D	Transferor / Borrower / Party Signature(s)
Kim M. Guthrie Notary Public PO Box 260, Mackenzie, BC V0J 2C0 Phone: (250) 997-5778 Fax: (250) 997-5718 (As to all signatures)	13	12	19	DISTRICT OF MACKENZIE by its authorized signatories: Name: MARK FERCHO Corporate Officer Name: PATRICK CROOK Acting Mayor This is an instrument required by the Approving Officer for subdivision Plan EPP35189 creating the condition or covenant entered into under s.219 of the Land Title Act. Signature of Approving Officer District of Mackenzie Name: MARK FERCHO

OFFICER CERTIFICATION:
Your signature constitutes a representation that you are a solicitor, notary public or other person authorized by the *Evidence Act*, R.S.B.C. 1996, c.124, to take affidavits for use in British Columbia and certifies the matters set out in Part 5 of the *Land Title Act* as they pertain to the execution of this instrument.

FORM_E_V19

LAND TITLE ACT
FORM E

SCHEDULE PAGE 3 OF 58 PAGES

2. PARCEL IDENTIFIER AND LEGAL DESCRIPTION OF LAND

STC for each PID listed below? YES ☐

[PID]	[LEGAL DESCRIPTION – must fit in a single text line]
023-586-885	**LOT A DISTRICT LOT 12479 CARIBOO DISTRICT PLAN PGP40629**
023-586-893	**LOT B DISTRICT LOT 12479 CARIBOO DISTRICT PLAN PGP40629**

LAND TITLE ACT
EXPRESS CHARGE TERMS – PART 2

SECTION 219 COVENANT

THIS AGREEMENT dated for reference the 16th day of December, 2013.

BETWEEN:

DISTRICT OF MACKENZIE, a municipal corporation,
#1 Mackenzie Boulevard, P.O. Bag 340, Mackenzie, B.C. V0J 2C0

(the "Owner")

OF THE FIRST PART

AND:

DISTRICT OF MACKENZIE, a municipal corporation,
#1 Mackenzie Boulevard, P.O. Bag 340, Mackenzie, B.C. V0J 2C0

(the "Municipality")

OF THE SECOND PART

WHEREAS:

A. The Owner is the registered owner of those lands and premises in the District of Mackenzie, British Columbia, legally described as:

PARCEL IDENTIFIER: 023-586-885
Lot A District Lot 12479 Cariboo District Plan PGP40629

PARCEL IDENTIFIER: 023-586-893
Lot B District Lot 12479 Cariboo District Plan PGP40629

(collectively, the "Lands").

B. The Grantor proposes to subdivide the Lands, according to a plan of subdivision completed and certified correct the 9th day of October, 2013, by Tyler Mikkeslson, British Columbia Land Surveyor, to create eleven lots (collectively, the "Lots" and individually, a "Lot").

C. R. Radloff & Associates Inc. conducted an onsite wastewater treatment and disposal investigation of each of the Lots and set out its recommendations in the Airport Subdivision Confirmation of Sustainability For Onsite Wastewater Treatment and Disposal Report dated October 21, 2013 (the "Onsite Wastewater Treatment and Disposal Report"), a copy of which is attached hereto as Schedule "A".

D. Section 219 of the *Land Title Act* provides, inter alia, that a covenant, whether of a negative or positive nature, in respect of the use of land in favour of the Grantee, may be registered as a charge against the title to that land.

E. It is a term and condition of the approval of the subdivision plan creating the Lots that the Grantor enter into the section 219 covenant contained in this Agreement.

THIS AGREEMENT is evidence that in consideration of payment of $1.00 by the Municipality to the Owner (the receipt of which is acknowledged by the Owner), and in consideration of the promises exchanged below, the Owner covenants and agrees with the Municipality in accordance with s. 219 of the *Land Title Act* as follows:

1. The Owner for itself and for its successors and assigns hereby covenants and agrees with the Municipality under s. 219 of the *Land Title Act*, R.S.B.C. 1996, c. 250 (being the intention of the parties that this covenant will be annexed to each of the Lots) that:

   (a) the Owner will comply with the recommendations set forth in the Onsite Wastewater Treatment and Disposal Report;

   (b) the Owner will not construct, install or permit a building or structure, including without limitation, a mobile home, modular home, park model home, recreational vehicle, travel trailer, travel home or camper of any type or description, or other area used for habitation on any of the Lots unless the Owner first complies with the recommendations set out in the Onsite Wastewater Treatment and Disposal Report in respect of each such Lot, which include, but are not limited to:

      > "It is the responsibility of the owner to obtain a Registered Onsite Wastewater Practitioner or a Professional Engineer to complete a full treatment system design and submit to the Northern Health Authority prior to construction."

      In this subsection 1(b), "area used for habitation" means any room or space within a building or structure which is or may be used for human occupancy, commercial sales, business or storage of goods but does not include an entrance foyer or parking facility; and

   (c) the Owner will not occupy a building or structure, including without limitation, a mobile home, modular home, park model home, recreational vehicle, travel trailer, travel home or camper of any type or description, or other area used for habitation on any of the Lots until the Owner constructs an onsite wastewater treatment and disposal system on such Lot in accordance with the recommendations set out in the Onsite Wastewater Treatment and Disposal Report.

2. The parties agree that this Agreement may only be modified or discharged with the consent of the Municipality under s. 219(9) of the *Land Title Act*.

3. The Owner will not be liable under any of the covenants and agreements contained herein where such liability arises by reason of an act or omission occurring after the Owner ceases to have any further interest in the applicable Lot.

4. Any opinion, decision, act or expression of satisfaction of the Municipality provided for in this Agreement is to be taken or made by the Municipality's Chief Administrative Officer or his or her delegate authorized as such in writing.

5. The Owner releases, and must indemnify and save harmless, the Municipality, its elected and appointed officials, contractors and employees, from and against all liability, actions, causes of action, claims, damages, expenses, costs, debts, demands or losses suffered or incurred by the Owner, or anyone else, arising from the granting or existence of this Agreement, from the performance by the Owner of this Agreement, or any default of the Owner under or in respect of this Agreement.

6. The parties agree that this Agreement creates only contractual obligations and obligations arising out of the nature of this document as a covenant under seal. The parties agree that no tort obligations or liabilities of any kind exist between the parties in connection with the performance of, or any default under or in respect of, this Agreement. The intent of this section is to exclude tort liability of any kind and to limit the parties to their rights and remedies under the law of contract and under the law pertaining to covenants under seal.

7. The rights given to the Municipality by this Agreement are permissive only and nothing in this Agreement imposes any legal duty of any kind on the Municipality to anyone, or obliges the Municipality to enforce this Agreement, or to perform any act or to incur any expense in respect of this Agreement.

8. Where the Municipality is required or permitted by this Agreement to form an opinion, exercise a discretion, express satisfaction, make a determination or give its consent, the Owner agrees that the Municipality is under no public law duty of fairness or natural justice in that regard and agrees that the Municipality may do any of those things in the same manner as if it were a private party and not a public body.

9. This Agreement does not:

   (a) affect or limit the discretion, rights or powers of the Municipality under any enactment (as defined in the *Interpretation Act*, R.S.B.C. 1996, c. 238, on the reference date of this Agreement) or at common law, including in relation to the use or subdivision of any of the Lots;

   (b) affect or limit any enactment relating to the use or subdivision of any of the Lots; or

   (c) relieve the Owner from complying with any enactment, including in relation to the use or subdivision of any of the Lots.

10. Every obligation and covenant of the Owner in this Agreement constitutes both a contractual obligation and a covenant granted under s. 219 of the *Land Title Act* in respect of each of the

Lots and this Agreement burdens the Lots and runs with them and binds the successors in title to each of the Lots. This Agreement burdens and charges all of the Lots and any parcel into which any of the Lots are subdivided by any means and any parcel into which any of the Lots are consolidated. The Owner is only liable for breaches of this Agreement that occur while the Owner is the registered owner of one of the Lots.

11. The Owner agrees to do everything reasonably necessary, at the Owner's expense, to ensure that this Agreement is registered against title to the Lots with priority over all financial charges, liens and encumbrances registered, or the registration of which is pending, at the time of application for registration of this Agreement.

12. An alleged waiver of any breach of this Agreement is effective only if it is an express waiver in writing of the breach in respect of which the waiver is asserted. A waiver of a breach of this Agreement does not operate as a waiver of any other breach of this Agreement.

13. If any part of this Agreement is held to be invalid, illegal or unenforceable by a court having the jurisdiction to do so, that part is to be considered to have been severed from the rest of this Agreement and the rest of this Agreement remains in force unaffected by that holding or by the severance of that part.

14. This Agreement is the entire agreement between the parties regarding its subject.

15. This Agreement binds the parties to it and their respective successors, heirs, executors and administrators.

16. The Owner must do everything reasonably necessary to give effect to the intent of this Agreement, including execution of further instruments.

17. By executing and delivering this Agreement each of the parties intends to create both a contract and a deed executed and delivered under seal.

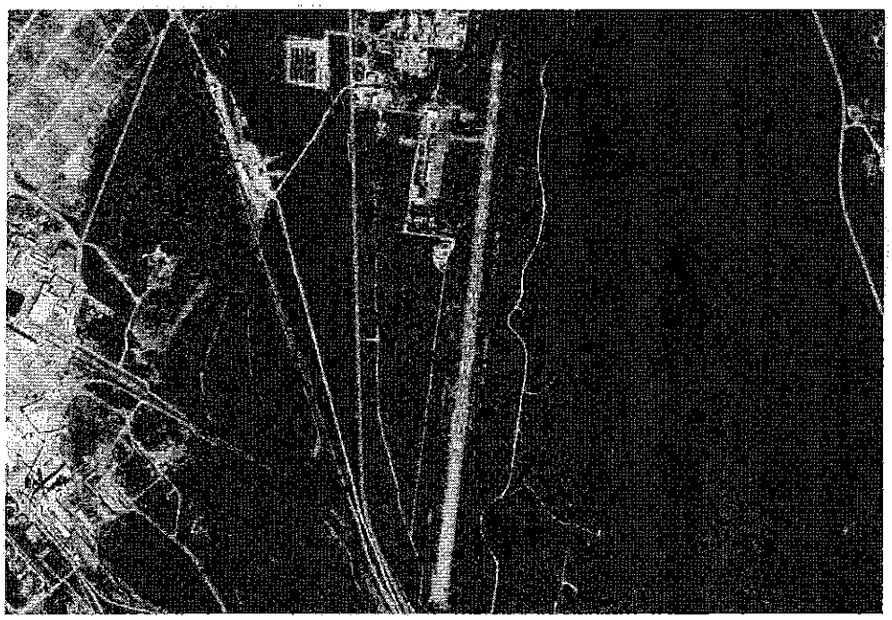
IN WITNESS WHEREOF the parties acknowledge that this Agreement has been duly executed and delivered by the parties executing Part 1 of Form C and Form D attached to and forming part of this Agreement.

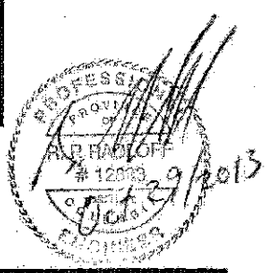
SCHEDULE "A"

Radloff

Helping build a better tomorrow

Airport Subdivision Confirmation of Sustainability
For Onsite Wastewater Treatment and Disposal
District of Mackenzie
October 21, 2013
812-008-03





ENGINEERING • PLANNING • CONSULTING

Contents

1. Purpose

The purpose of this report is to confirm that, based on field observations; the land within the proposed subdivision area is suitable for onsite treatment and disposal of sewage. The District of Mackenzie bylaws do not require industrial land to have municipal wastewater collection services, provided the developer can provide evidence of site suitability for onsite treatment and disposal. This report confirms the suitability of the subdivided properties for onsite treatment and disposal.

2. Findings and Discussion

It is proposed to subdivide Lot A District Lot 12479, Cariboo District, Plan PGP40629 and Lot B, District Lot 12479, Cariboo District, Plan PGP40629 creating 11 new parcels ranging in size from 2.0274 hectares to 4.3742 hectares. See **Appendix C**.

A total of four permeameter tests were completed for each proposed lot. Each permeameter test was performed at a depth of 0.75m and yielded a Kfs of >5000mm/day which is equivalent to a percolation rate of less than 2 minutes/inch. For the permeameter results please refer to **Appendix A**. Test pits for the proposed subdivision were also completed by GeoNorth Engineering in August 2012, as part of a geotechnical investigation; supplement field observations were undertaken by R. Radloff and Associates (RRA.) GeoNorth found that the soil on each lot consisted of a thin layer of silt over fine grained, loose sand and that sand density increased with depth. Roots were in the thin silt layer and up to 2 meters with intermittent silt restrictive layer at an average depth of 3.0 – 3.4m was located in several test pits. For test pit results refer to **Appendix B**. Based on the results of the permeameter and GeoNorth test pits it is RRA's opinion that onsite wastewater disposal is viable given the highly permeable soils; however a 0.6m thick sand layer conforming to ASTM C33-97 with fines <4% is required as a liner on the trench bottoms to ensure that adequate effluent remediation occurs before the effluent reaches groundwater table.

As noted in the Groundwater Potential Study, R. Radloff and Associates will be recommending utilization for aquifer 385 for well development. Aquifer 385 is a confined aquifer and is therefore protected from surficial contaminants by a silt/clay aquitard at 35-60 meters. This is complimentary to onsite treatment/ground disposal efforts.

Each system is required to be individually designed in accordance with the BC Sewage Regulations as onsite conditions encountered at the final disposal locations may vary from that encountered in this study. Permeameter tests, Daily Design Flows, Hydraulic Loading Rates and Lineal Loadings Rates have been completed in accordance with the guidelines set out by the British Columbia Ministry of Health (2007){Sewerage System Standard Practice Manual

Version 2 (SPM V2).} Should wastewater flows exceed 22.7m^3/day on any one individual lot the Provincial Municipal Wastewater Regulation (MWR) will form the basis of design.

3. Typical Design

As indicated in the previous section each lot will be required to have individual design for wastewater treatment and disposal in accordance with the BC Sewage System Regulation. Nevertheless to assist in assessing the viability/efficiency of ground disposal systems for this site a "Typical" design is provided in this section.

There are two main factors when designing the proposed drainfield: the first is to determine the daily design flow (DDF) for each lot using the SPM V2 Non-Residential Waste Design Flow Tables (Table 2-3). For this report, it was assumed that each lot would be occupied by a 50 employee industrial office, including showers, but excluding industrial waste. The design flow per employee for this style of industry is estimated to be 75 L per day. As a result, the onsite treatment system would need to be designed to handle 3,750 L of effluent per day.

The second design consideration is to determine the hydraulic loading rate (HLR) and linear loading rates (LLR) appropriate to local soils and topography. For this purpose HLR and LLR were determined using the: DDF, Kfs, soil types, and tables 2-8 and 2-11 from the SPM V2 and the Geotechnical Report, as found in Appendix B. The design soil type for each lot consists of fine grained sand with no visible structure to a depth of in excess of 3 meters. The permeameter results show the average permeability (Kfs) of the soils was >5000mm/day. Using this data, in conjunction with the soil hydraulic loading rates for Residential Strength Wastewater Table (Table 2-8), the HLR was determined for each Type of Treatment. For Type 1 systems, a total of 34 L per square meter per day is needed; for Type 2 systems a total of 68 L per square meter day is needed; for Type 3 systems a total of 103 liters per day per square meter is needed. As there are no constraints requiring advanced treatment, a Type 1 treatment is sufficient for this site resulting in a field area of 110 square meters.

The same information can be applied to determine linear loading rates for Wastewater Table (Table 2-11), doing so we find that a total of 74.5 L per day per meter can be applied to the soil on site. With an LLR of 74.5L the minimum system length for each field based on the DDF is 50.3 meters. The result for a Type 1 field is 2.2 meters wide by 50.3 meters long. Additional area is required for setback provisions of the regulation and SPM. According to the SPM V2, there also needs to be a set aside area equal to or greater than the design area to be saved in the event of the primary location failing.

The field design and size in this report are an example only. Exact locations and sizing of the fields may vary upon the owners specific needs. It is the responsibility of the owner to obtain a Registered Onsite Wastewater Practitioner or a Professional Engineer to complete a full treatment system design and submit to the Northern Health Authority prior to construction.

R. RADLOFF & ASSOCIATES INC.

Bob Radloff, P.Eng.

Appendix A (Permeameter Results)

		[illegible]										
LOT #	TEST I.D.	DEPTH (MM)	KFS (MM/DAY)	KFS RANGE (MM/DAY)	TYPE 1	TYPE 2	TYPE 3	0-4%	LPD	TYPE 1	TYPE 2	TYPE 3
1	1	750	6980	5584-6980	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	5584									
	3	750	6980									
	4	750	6980									
2	1	750	6980	5584-6980	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	6980									
	3	750	5584									
	4	750	5584									
3	1	750	6980	4188-6980	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	6980									
	3	750	5584									
	4	750	4188									
4	1	750	5584	2792-6980	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	5584									
	3	750	2792									
	4	750	6980									
5	1	750	6980	2792-8376	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	2792									
	3	750	8376									
	4	750	5584									
6	1	750	4188	2792-6980	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	6980									
	3	750	6980									
	4	750	2792									
7	1	750	9772	2792-9772	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	2792									
	3	750	5584									
	4	750	5584									
8	1	750	5584	2792-5584	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	2792									
	3	750	4188									
	4	750	2792									
9	1	750	9772	5584-9772	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	5584									
	3	750	5584									
	4	750	5584									
10	1	750	5584	2792-5584	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	5584									
	3	750	5584									
	4	750	2792									
11	1	750	5584	4188-5584	34	68	103	74.5	3,750	110 (2.2x50)	55 (1.1x50)	36 (0.75x50)
	2	750	5584									
	3	750	5584									
	4	750	4188									

Appendix B (Geotechnical Report)

GEOTECHNICAL REPORT

PROPOSED AIRPORT INDUSTRIAL SUBDIVISION, DISTRICT OF MACKENZIE, B.C.

Prepared for

R. RADLOFF & ASSOCIATES INC.

Prepared by

GEONORTH ENGINEERING LTD.
3975 18th AVENUE
PRINCE GEORGE, B.C., V2N 1B2
Phone: 250-564-4304 Fax: 250-564-9323

PROJECT No. K-3697

AUGUST 12, 2013

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Site Plan Showing Test Pit Locations	**Drawing 3697-A2**

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Explanation of Terms and Symbols	**3 pages**

APPENDIX C

Laboratory Test Results	**Plates 3697-C1 to C12**

APPENDIX D

Typical Insulated Foundation Detail	**Drawing 3697-D1**

1.0 INTRODUCTION

The District of Mackenzie intends to develop an industrial subdivision on part of the remainder of District Lot 12479, Cariboo District, near the Mackenzie Airport. R. Radloff & Associates Inc. (Radloff), civil engineers for the project, commissioned GeoNorth Engineering Ltd. (GeoNorth) to carry out a geotechnical investigation for the project. Authorization to proceed with the investigation was given in an email dated June 26, 2013 from Mr. Barry Woods, AScT of Radloff based on the project scope outlined in our proposal dated June 18, 2013. A plan showing the location of the site is on Drawing 3697-A1, in Appendix A.

The property is located adjacent to and west of the Mackenzie Airport and east of Coquiwaldy Road, about 3 km southwest of Mackenzie, B.C. The proposed subdivision will consist of eleven lots for commercial and industrial development ranging between 2 and 4.4 ha in area. They will be serviced with water and sanitary sewer services. Stormwater disposal will be to ditches or by ground infiltration. The subdivision will also include approximately 400 m of new access road. The property is bordered by Coquiwaldy Road to the west and south, by the airport to the east and by Airport Road to the north. The terrain is slightly undulating with about 4.5 m of relief, between about elevations 698.0 m and 692.5 m. A plans showing the conceptual layout of the subdivision is on Drawing 3697-A2, in Appendix A.

This report presents the results of our site investigation and provides geotechnical recommendations for design and construction of building foundations and grade-supported concrete floor slabs for relatively lightly loaded one and two-storey structures, pavement structures for parking areas and access roads, and for installation of underground utilities. It also includes conceptual geotechnical recommendations for design and construction of structures with large spans or heavily loaded foundations.

2.0 BACKGROUND INFORMATION

2.1 Surficial Geology

A report and map by Rutter[1] of the Geological Survey of Canada describes the surficial geology of the region. The map identifies the proposed development area as being underlain by glaciolacustrine deposits consisting of silt, clay and sand. The soil was deposited in an ice-dammed lake at the end of the last glaciation, about 10,000 years ago. The map identifies an area about 1 km north of the site as being underlain by aeolian (wind-blow) sand dunes, and a low, flat-lying area east of the site as being underlain by organic deposits. Higher elevation areas to the east are underlain by drumlinized glacial till.

2.2 Other Geotechnical Investigations

Our firm and our predecessor company have carried out geotechnical investigations for other industrial developments in the area and on similar soil deposits, including a subdivision approximately 200 m to the west and the local pulp mills. Soil conditions in those investigations typically encountered very loose sand over loose to compact, fine to medium grained sand to 12 m depth or less, over layered silt and clay to between 20 and 70 m depth, typically covering dense, sandy, gravelly silt. The top layer of very loose sand is likely an aeolian deposit, while the deeper layers of sand and the layered silt and clay are from glacial lake sediments. The dense, sandy, gravelly silt is glacial till deposited below advancing glacial ice that once covered the area.

Existing heavy industrial structures in the area are typically supported on spread footings placed on a layer of compacted granular fill. Some heavily loaded and settlement sensitive structures were preloaded prior to construction of spread or raft foundations. Other structures

[1] Rutter, H.W. 1969. Surficial Geology and Landforms, Williston Lake Area (Map 3), Map 1383A, Geological Survey of Canada.

are supported on driven pile foundations based in the dense, sandy, gravelly silt till. The amount of site preparation and the choice of foundation depends on site specific conditions, foundation loads and the tolerance of structures to settlement.

3.0 SITE INVESTIGATION AND SUBSURFACE CONDITIONS

On July 11, 2013, GeoNorth personnel observed soil and groundwater conditions in eight test pits, designated TP13-1 to 8. The test pits were excavated to between 2.9 and 4.0 m depth below the existing ground surface by Diggers Impact Ltd., on our behalf, using a Link Belt 210 tracked excavator. The test pits were excavated at locations staked in the field by Radloff personnel prior to our arrival on site and are at the locations shown on Drawing 3697-A2.

We logged soil and groundwater conditions as the test pits were excavated and obtained representative samples for laboratory testing and classification. Moisture content tests were carried out on all samples and grain size distribution tests were carried out on selected samples. Test pit logs describing subsurface conditions are on Plates 3697-B1 to B4 in Appendix B, and are followed by an explanation of terms and symbols used on the logs. The results of the moisture content tests are shown on the logs and the results of the grain size distribution tests are shown on Plates 3697-C1 to C12, in Appendix C.

Soil conditions encountered in the test pits generally consisted of a layer of organic silt and roots to about 100 mm depth, over natural, micaceous, layered sand with a variable fines content. The sand is loose in the top several meters and becomes compact at greater depth.

Seepage was encountered in TP13-5 and 7 below 2.8 and 3.6 m depth, elevations 687.0 and 686.7 m, respectively. Bedrock was not encountered in any of the test pits.

4.0 DISCUSSION AND RECOMMENDATIONS

The proposed development is underlain by layered, loose to compact sand that has moderate bearing capacity and relatively low compressibility under conventional building loads. We know from past investigations that relatively weak, moderately compressible fine grained sediments underlies the natural sand below between 6 and 8 m depth. The compressible fine grained sediments are below the depth of influence from lightly loaded spread footings less than about 2.5 m wide, but will be subjected to consolidation settlement from heavily loaded spread footings, or rafts, and from site grading fills over about 2 m high.

Conventional spread footing foundations supported on the loose to compact sand or on compacted structural fill placed on the natural sand are appropriate for conventional buildings and for relatively flexible structures. We recommend additional investigation and analysis for foundations that will be more than about 2.5 m wide, and if site grading requires more than about 2m of fill to be added to the existing ground surface.

The recommendations in this report are based on the necessary assumption that soil conditions encountered in the test pits are representative of soil conditions elsewhere on-site. Please contact our office for additional recommendations if conditions encountered during construction differ in any way from those described in this report.

4.1 Spread Footing Foundations

We recommend that spread footings be supported either directly on the natural, layered sand or on compacted granular fill placed on the natural sand. Design footings placed directly on the natural sand using a factored bearing resistance of 150 kPa (limit states design), and an allowable bearing pressure of 100 kPa (working stress design). Design footings placed on at least 600 mm of compacted structural fill placed on the natural sand using a factored bearing resistance of 225 kPa, and an allowable bearing pressure of 150 kPa. The allowable bearing pressure may be increased by one-third for transient loads from wind or seismic events.

We estimate that footings less than about 2.5 m wide, subjected to the design loading and bearing on the natural, undisturbed, loose to compact sand or on compacted structural fill placed on this deposit will settle less than 2 cm. Differential settlement could be as high as the total settlement. Please contact our office if detailed settlement assessments are required for specific foundation configurations.

Use a minimum footing width of 400 mm for strip footings and 600 mm for square pad footings. Provide at least 500 mm of confinement over heated, interior footings, measured from final grade to the base of the footing, and at least 1.2 m of cover over heated, perimeter footings to protect against frost heave. If vertical insulation is used against perimeter foundation walls we recommend it be placed against the outside face of the wall. If placed against the inside face of the foundation wall, we recommend it extend no more than 600 mm below the finished, outside grade.

Protect foundations not warmed by building heat by providing 2.4 m of soil cover or as follows:

- Remove frost-susceptible soil to 2.4 m depth from surfaces exposed to freezing temperatures and replace with compacted, non-frost-susceptible structural fill, or
- Use rigid, extruded polystyrene board insulation as shown on Drawing 3697-D1 in Appendix D, or
- Use a combination of these methods.

Construct adjacent footings that are at different elevations so the slope between adjacent edges is no steeper than 2 horizontal to 1 vertical (2H:1V) unless site specific analysis indicates that steeper angles are appropriate. Step strip footings that cross areas of different elevation using a maximum vertical rise of 600 mm between horizontal steps. Construct the steps at an overall slope no steeper than 2H:1V. If buried utilities are installed parallel to building foundations, place the footings or the utility so that the utility is above a line drawn down at a slope of 2H:1V from the edge of the footing.

To prepare the building areas, remove organic material, fill or disturbed soil that may have accumulated during construction and heavily rooted soil from below the building areas. Excavate to the natural, undisturbed soil using an excavator equipped with a smooth-edge bucket to minimize disturbance to the underlying soil. Compact the exposed natural soil with several passes of a vibrating plate compactor weighing at least 500 kg.

If compacted structural fill is used below the footings, use Select Granular Subbase (SGSB), as defined in Table 1, Section 4.2. Place the fill in uniform layers no thicker than 300 mm and compact each layer to at least 100% Standard Proctor Density (SPD) (ASTM D698). Extend the compacted structural fill out past the edges of the footings by a horizontal distance equal to the depth of fill under the footing to allow for distribution of foundation loading at 1H:1V through the compacted fill.

4.2 Grade-Supported Floor Slabs

To reduce the potential for cracking from settlement and frost heave, we recommend the following procedures:

- Remove organic material, fill or disturbed soil that may have accumulated during construction and heavily rooted soil from below the building area.
- Bring slab areas to grade, if required, using compacted, non-frost-susceptible granular fill that contains less than 5% fines such as fill that meets our specification for SGSB.
- Place the fill in layers no thicker than 300 mm and compact each layer to at least 100% SPD.
- Directly below the slab, place a minimum 100 mm thick layer of Well Graded Base (WGB), as defined in Table 1, below, and compact to 100% SPD.

Based on our estimates of soil stiffness and foundation loading, we recommend using a modulus of subgrade reaction of 12 MPa/m for design of the reinforcing steel requirements for the grade-supported floor slabs.

Use granular fill and drain rock that meets the following specifications:

Table 1 - Specified Gradation for Granular Fill

Sieve Size (mm)	Percentage Passing		
	Well Graded Base	Select Granular Subbase	Drain Rock
100	-	100	100
75	-	95-100	-
40	-	-	30-100
25	100	-	-
19	80-100	35-100	0-100
9.5	50-85	-	-
4.75	35-70	15-60	0-10
2.36	25-50	-	0-5
1.18	15-35	-	-
0.300	5-20	3-15	-
0.075	0-5	0-5	0-2

For WGB, use crushed and screened material that meets B.C. Ministry of Transportation and Infrastructure (BCMoT) Standard Specifications. The SGSB can be a pit run material that meets the gradation noted in Table 1. Use durable aggregate that will not degrade from exposure to water, freeze-thaw cycles or handling, spreading or compacting. It must not contain organic materials or an excess of flat or elongate stones. Do not place fill that is frozen and do not place fill on frozen ground.

4.3 Paved Parking and Access Roads

The natural, layered, loose to compact sand will provide adequate support and subgrade drainage for parking areas and access roads. To reduce the potential for future differential settlement remove existing fill and organic soil from below the proposed paved areas and replace it with granular fill, compacted to the specified density. The following recommendations assume the pavement structure will be constructed over the natural sand. We recommend the minimum pavement structure thickness noted in Table 2, below.

Table 2 - Recommended Pavement Structures

Pavement Type:	Parking Areas	Access Roads
Hot Mix Asphaltic Concrete	50 mm	75 mm
Well Graded Base	100 mm	150 mm
Select Granular Subbase	300 mm	450 mm

We recommend using asphalt that conforms to BCMoT, Standard Specification 502 for 16 mm Medium Mix Asphaltic Pavement. Use base and subbase fill that meet the specifications for WGB and SGSB, respectively, as noted above.

To prepare the parking and access road areas, remove all existing fill, organic soil and soft, deleterious material, to expose the natural sand. Compact the exposed surface with several passes of a vibrating compactor. Bring the excavated surface to subgrade elevation using material that meets the gradation specifications for SGSB. Place the fill in uniform layers no thicker than 300 mm and compact each layer to at least 97% SPD and to at least 100% within 1 m of the final pavement surface. Place SGSB and WGB in uniform layers no thicker than 300 mm and compact each layer to at least 100% SPD.

At loading ramps and large garbage bins where heavy trucks are expected to park, we recommend 150 mm of Portland Cement concrete pavement in place of asphaltic concrete

pavement. Concrete made with Portland Cement is more durable than asphaltic concrete and better able to resist deflection from wheel-loads applied by heavy vehicles.

Below sidewalks, we recommend 100 mm of WGB over at least 300 mm of SGSB, over a prepared subgrade. Compact the top 300 mm of the subgrade to at least 100% SPD and the subbase and base fills to at least 100% SPD. Use a finished surface of at least 50 mm of asphalt or 100 mm of concrete.

4.4 Buried Utilities

We recommend using a minimum soil cover of 3.0 m over water lines and 2.4 m over sanitary and storm sewer lines, measured perpendicular to the finished ground surface. Use temporary slopes for trench excavations no steeper than 1.3H:1V. We recommend that a geotechnical engineer review excavations if loose material or organic soils are encountered, if seepage is observed, and if excavations are more than 5 m deep.

Use a backhoe equipped with a smooth edge, clean-out bucket to minimise disturbance of the trench bottom. Excavate the trench bottom to a width equal to the pipe diameter plus at least 600 mm to allow room for equipment to compact on each side of the pipe. Place at least 100 mm of WGB or sand containing less than 10% fines below the pipes and up to 200 mm above. Fill above the pipe bedding using material excavated from the trench or use SGSB. Place all trench fill below pavement structures in uniform layers no thicker than 300 mm and compact each layer to at least 97% SPD and to at least 100% within 1 m of the final pavement surfaces.

If the base of the excavation is wet place a layer of nonwoven geotextile with a burst strength of at least 1800 kPa over the excavated surface then place a layer of drain rock at least 300 mm thick over the geotextile. Cover the drain rock with another layer of geotextile. The drain rock is free draining and will provide a good working surface. Use sumps and pumps to keep the water level below the top of the drain rock.

4.5 Hydraulic Conductivity

Sieve analyses of samples collected during the investigation indicate the sand has a fines content ranging between 0.9% and 5% above 3 m depth, and becomes silty in some areas, with up to 38% fines below 3 m depth. Soil with less than 5% fines is considered free draining.

Based on the results of the sieve analyses on samples collected during the investigation and a correlation between grain size distribution and hydraulic conductivity, we calculate the approximate hydraulic conductivity of the natural, layered sand above 3 m depth to be between $3.0x10^{-4}$ m/s and $1.5x10^{-5}$ m/s, and averaging $2.7x10^{-4}$ m/s. This correlates well with published values for soil with similar gradation.

Several test pits encountered infrequent layers of silt and silty clay. These units are significantly less permeable than the natural, layered sand and will impede groundwater infiltration and possibly cause perched groundwater conditions to develop. Perched groundwater will flow horizontally along the low permeability soil rather than vertically.

4.6 Site Classification for Seismic Response

The 2012 British Columbia Building Code defines the "Site Classification for Seismic Site Response", Table 4.1.8.4.A, which is based on properties of the soil at the site in the top 30 m. Based on the results of nearby Cone Penetration Tests (ASTM D1586), we estimate the Site Classification for Seismic Site Response is Site Class "D", "stiff soil", as defined in Table 4.1.8.4.A.

5.0 CONSTRUCTION REVIEW

We recommend that we review the design drawings before they are finalized to check that the intent of our recommendations has been adequately communicated and applied to the design and that the level of the investigation is adequate for the project.

We also recommend, and the B.C. Building Code specifies, that an experienced engineer or his designate carry out construction review and testing of the following:

- all foundation excavations, and
- all compacted, structural fill supporting structural building components.

Prior to us being able to complete Schedule C-B of the B.C. Building Code, which is a form titled "Assurance of Professional Field Review and Compliance", we will need to carry out the necessary field reviews. The Schedule C-B form is often required by Building Inspection Officials prior to an Occupancy Permit being issued.

The foundation excavation review will include checks that soil conditions are as expected and that the base is free of water or sloughed or loosened soil. If soil conditions are different than expected, we can provide recommendations for remedial measures, as required.

We recommend that an experienced geotechnical technician review the placement and compaction of all structural fill, starting with the first layer, to confirm that the fill materials and soil density meet the project specifications.

6.0 CLOSURE

This report was prepared by GeoNorth Engineering Ltd. for the use of the District of Mackenzie, R. Radloff & Associates Inc. and their consultants. The material in it reflects GeoNorth Engineering's judgement in light of the information available to us at the time of preparation. Any use which Third Parties make of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. GeoNorth Engineering 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.

Please contact the writers if any parts of this report need to be clarified or discussed in more detail.

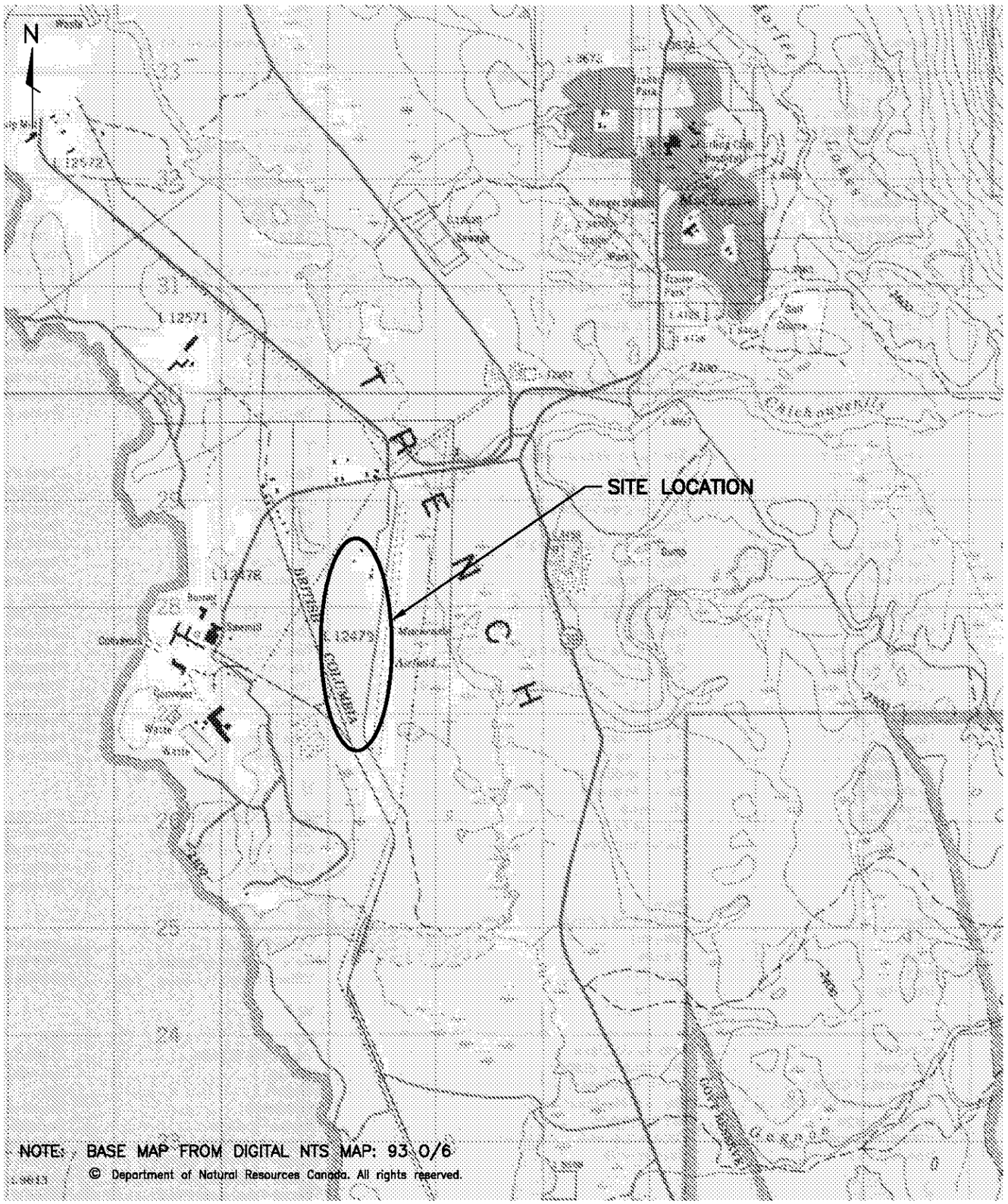
Yours truly,
GeoNorth Engineering Ltd.

Per: W.J. Lanenga, P.Eng.

Reviewed by,
GeoNorth Engineering Ltd.

Per: D.J. McDougall, M.Eng., P.Eng.

APPENDIX A



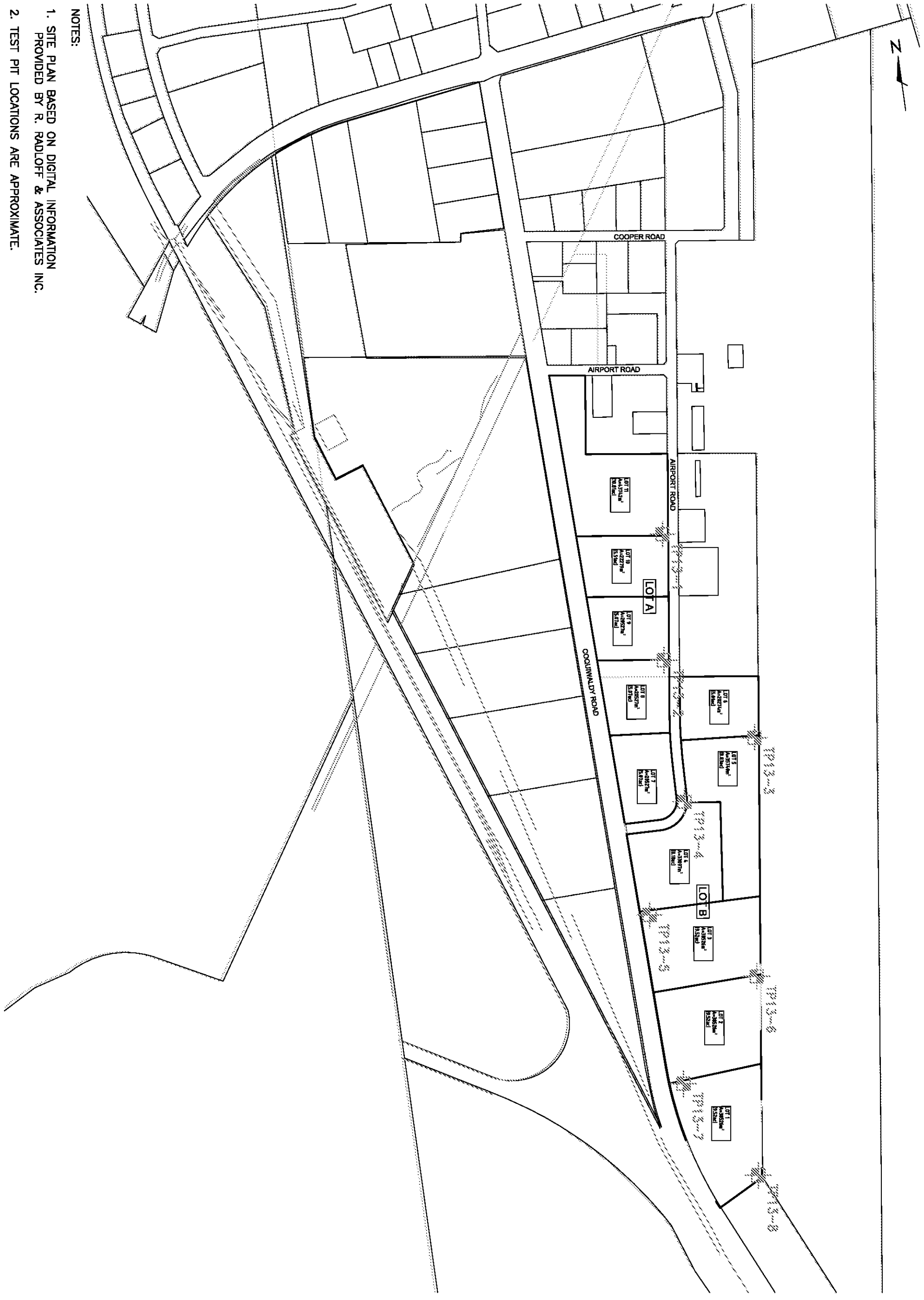
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-9323

R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
SITE LOCATION PLAN

SCALE: 1:50,000	DATE: 2013/08/12	DRAWN: LU	CHKD: –	PROJ: K-3697	DWG: 3697-A1

NOTES:

1. SITE PLAN BASED ON DIGITAL INFORMATION PROVIDED BY R. RADLOFF & ASSOCIATES INC.
2. TEST PIT LOCATIONS ARE APPROXIMATE.



SCALE: 1:7500	APPROVED:	R. RADLOFF & ASSOCIATES INC. PROPOSED AIRPORT INDUSTRIAL SUBDIVISION MACKENZIE, B.C. SITE PLAN SHOWING TEST PIT LOCATIONS	GEONORTH ENGINEERING LTD. 3975 18th Avenue Prince George, B.C. V2N 1B2 Tel. 250-564-4304 Fax 250-564-9323
DATE: 2013/08/12			
DWN BY: LU			
MAP REF: –			
DWG NO. 3697-A2	REV. –	PROJECT NO: K-3697	

APPENDIX B

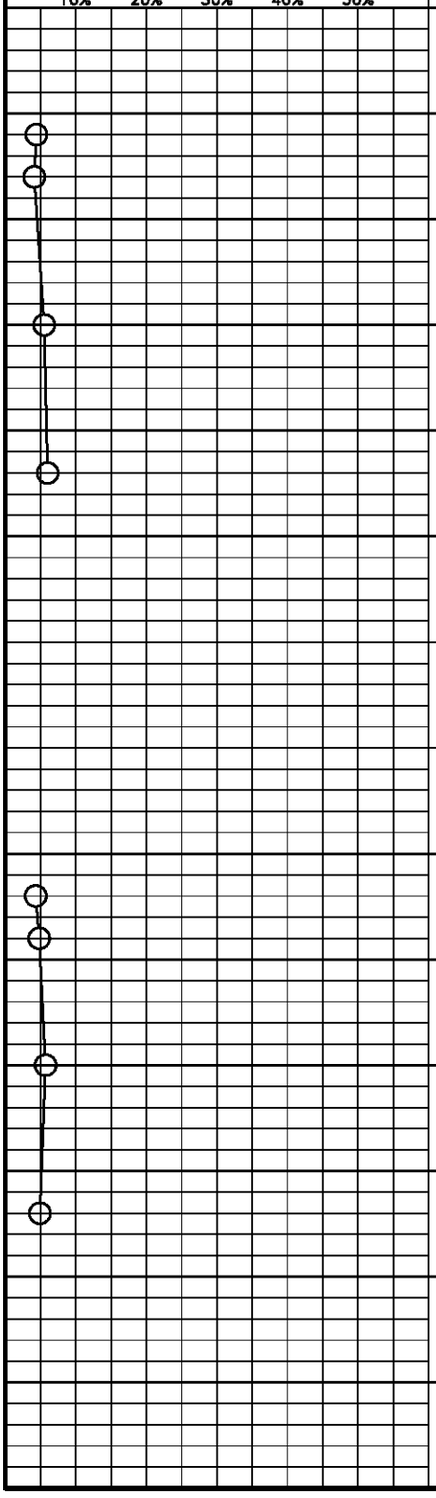
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-9323

TEST PIT LOG

CLIENT: R. RADLOFF & ASSOCIATES INC.
PROJECT: PROPOSED AIRPORT INDUSTRIAL SUBDIVISION MACKENZIE, B.C.

LOGGED	FILE NO.	DATE OF INVEST.	EXCAVATOR TYPE
WJL	K-3697	2013/07/11	LinkBelt

STRENGTH TEST RESULTS
◊ POCKET PENETROMETER RDG.
× PEAK VANE SHEAR STRENGTH
⊗ RESIDUAL VANE SHEAR STRENGTH
50 100 150 200 250 kPa
WATER CONTENT
10% W_P 20% 30% W_N 40% W_L 50%



DEPTH (m)	SYMBOL	SOIL DESCRIPTION	SAMPLES	COMMENTS
		TP13-1		10U 491245E 6128346N Elev. 690.6 m
0		**ORGANIC SILT,** roots, brown to black, damp.		
		0.1 **SAND,** primarily fine grained, trace to some fines, no visible structure, loose to compact, rust coloured, occasional root, damp.		
1		0.4 **SAND,** primarily medium grained, trace fines, no visible structure, loose to compact, brown, occasional root, moist.		
2				– Grain Size Analysis, See Plate 3697-C1
3		– below 3.2 m, some fines. – at 3.4 m, layer of silt, 0.1 m thick.		– Grain Size Analysis, See Plate 3697-C2
		3.6 End of hole at 3.6 m. No seepage observed. Test Pit walls sloughed.		
4				
5				
		TP13-2		10U 491212E 6128090N Elev. 689.9 m
0		**ORGANIC SILT,** roots, brown to black, damp.		
		0.1 **SAND,** primarily fine grained, trace to some fines, no visible structure, loose to compact, tan, occasional roots, damp.		– Grain Size Analysis, See Plate 3697-C3
1		0.6 **SAND,** primarily medium grained, trace fines, no visible structure, compact, brown, micaceous, moist.		
2				
3		– below 3.0 m, medium to coarse grained, layered.		– Grain Size Analysis, See Plate 3697-C4
		3.4 End of hole at 3.4 m. No seepage observed. Test Pit walls sloughed.		
4				
5				

PLATE NO. 3697-B1

GeoNorth Engineering Ltd.
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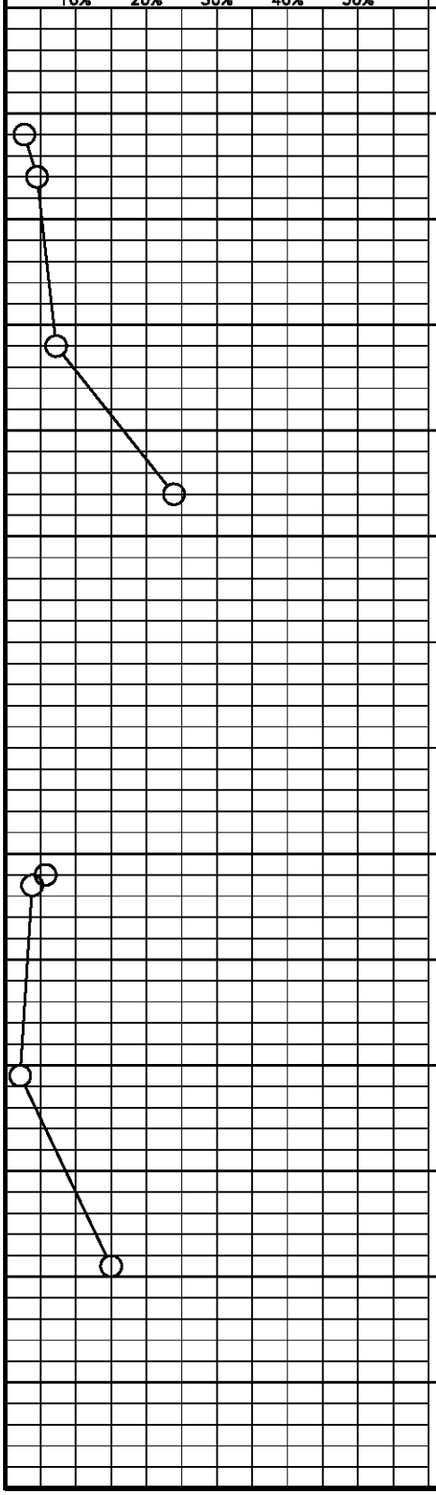
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-9323

TEST PIT LOG

CLIENT: R. RADLOFF & ASSOCIATES INC.
PROJECT: PROPOSED AIRPORT INDUSTRIAL SUBDIVISION MACKENZIE, B.C.

LOGGED: WJL | FILE NO.: K-3697 | DATE OF INVEST.: 2013/07/11 | EXCAVATOR TYPE: LinkBelt

STRENGTH TEST RESULTS
◊ POCKET PENETROMETER RDG.
× PEAK VANE SHEAR STRENGTH
⊗ RESIDUAL VANE SHEAR STRENGTH
50 100 150 200 250 kPa
WATER CONTENT
10% W_P 20% 30% W_N 40% W_L 50%



DEPTH (m)	SYMBOL	SOIL DESCRIPTION	SAMPLES	COMMENTS
		TP13-3		10U 491374E 6127907N Elev. 691.9 m
0		**ORGANIC SILT,** roots, brown to black, moist.		
		0.1		
1		**SAND,** primarily fine grained, trace to some fines, no visible structure, loose to compact, tan, occasional root, damp.		
		– fine to medium grained below 0.6 m.		
2		– some fines below 1.8 m, greyish brown, moist.		
3		– below 3.0 m, sand and silt, layered, moist.		
		3.6		– Grain Size Analysis, See Plate 3697-C5
4		End of hole at 3.6 m.		
		No seepage observed.		
5		Test Pit walls sloughed.		
		TP13-4		10U 491214E 6127797N Elev. 689.3 m
0		**ORGANIC SILT,** roots, brown to black, damp.		
		0.1		
1		**SAND,** fine to medium grained, trace fines, no visible structure, loose to compact, rust coloured, occasional root, damp.		
2		– below 0.2 m, medium grained, micaceous, brown.		
		– layered below 2.0 m.		– Grain Size Analysis, See Plate 3697-C6
3				
		4.0		
4		End of hole at 4.0 m.		
		No seepage observed.		
5		Test Pit walls sloughed.		

PLATE NO. 3697-B2

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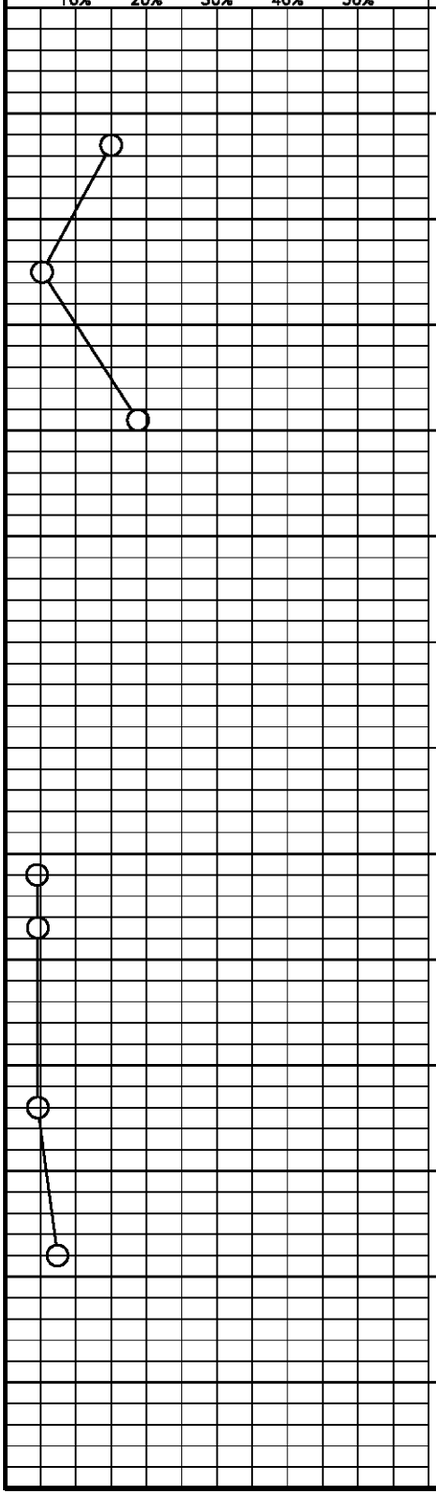
TEST PIT LOG

CLIENT: R. RADLOFF & ASSOCIATES INC.
PROJECT: PROPOSED AIRPORT INDUSTRIAL SUBDIVISION MACKENZIE, B.C.

LOGGED: SH/WJL | FILE NO.: K-3697 | DATE OF INVEST.: 2013/07/11 | EXCAVATOR TYPE: LinkBelt

STRENGTH TEST RESULTS
◊ POCKET PENETROMETER RDG.
× PEAK VANE SHEAR STRENGTH
⊗ RESIDUAL VANE SHEAR STRENGTH
50 100 150 200 250 kPa
WATER CONTENT
10% W_P 20% 30% W_N 40% W_L 50%



DEPTH (m)	SYMBOL	SOIL DESCRIPTION	SAMPLES	COMMENTS
		TP13-5		10U 491111E 6127577N Elev. 689.8 m
0		**ORGANIC SAND,** and silt, no visible structure, loose, black to brown, roots, small shrubs, wood debris, dry to damp.		
		0.05 **SAND,** fine grained, trace fines, no visible structure, loose to compact, rusty brown, occasional rootlets, damp.		
1				– Grain Size Analysis, See Plate 3697-C7
2		– below 1.5 m, medium grained, brown to grey, damp to moist.		
		– below 2.7 m, coarse grained, trace gravel, wet.		– Grain Size Analysis, See Plate 3697-C8
3		2.9 End of hole at 2.9 m. Seepage below 2.8 m. Test Pit walls sloughed.		
4				
5				
		TP13-6		10U 491311E 6127422N Elev. 690.5 m
0		**ORGANIC SILT,** roots, brown to black, moist.		
		0.05 **SAND,** fine to medium grained, trace gravel, no visible structure, loose to compact, rust coloured, occasional root, damp.		
1		0.4 **SAND,** primarily medium grained, trace fines, no visible structure, greyish brown, moist.		
2				– Grain Size Analysis, See Plate 3697-C9
3				
4		3.8 End of hole at 3.8 m. No seepage observed. Test Pit walls sloughed.		
5				

PLATE NO. 3697-B3

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Prince George, B.C. V2N 1B2
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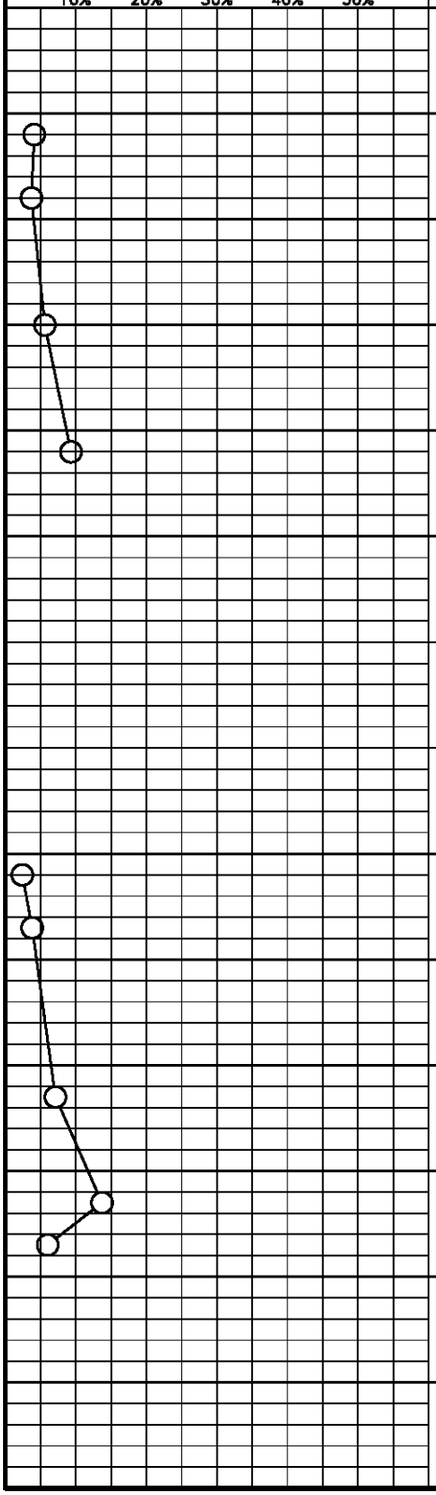
TEST PIT LOG

CLIENT: R. RADLOFF & ASSOCIATES INC.
PROJECT: PROPOSED AIRPORT INDUSTRIAL SUBDIVISION MACKENZIE, B.C.

LOGGED	FILE NO.	DATE OF INVEST.	EXCAVATOR TYPE
SH	K-3697	2013/07/11	LinkBelt

STRENGTH TEST RESULTS
◊ POCKET PENETROMETER RDG.
× PEAK VANE SHEAR STRENGTH
⊗ RESIDUAL VANE SHEAR STRENGTH
50 100 150 200 250 kPa
WATER CONTENT
10% W_P 20% 30% W_N 40% W_L 50%



DEPTH (m)	SYMBOL	SOIL DESCRIPTION	SAMPLES	COMMENTS
		TP13-7		10U 491132E 6127225N Elev. 690.3 m
0		**ORGANIC SILT,** and sand, no visible structure, loose, black to brown, roots, dry to damp.		
		0.05		
1		**SAND,** fine grained, trace fines, trace gravel, no visible structure, loose to compact, rusty brown, occasional rootlets, damp.		– Grain Size Analysis, See Plate 3697-C10
2		– below 2.0 m, medium to coarse grained.		
		– below 2.6 m, occasional layers of silty clay up to ~2 cm thick.		
3		– at 3.0 m, moist.		– Grain Size Analysis, See Plate 3697-C11
		– at 3.6 m, moderate seepage.		
		3.8		
4		End of hole at 3.8 m.		
		Seepage below 3.6 m.		
5		Test Pit walls sloughed.		
		TP13-8		10U 491258E 6127018N Elev. 692.3 m
0		**ORGANIC SILT,** and sand, no visible structure, loose, black to brown, roots, dry to damp.		
		0.05		
1		**SAND,** fine to medium grained, trace fines, trace gravel, no visible structure, loose to compact, brown and tan, occasional rootlets, damp.		
2				
3		– at 3.3 m, layered with silt, ~1 cm thick, moist to wet.		
		– at 3.6 m, medium to coarse grained, brown and grey.		– Grain Size Analysis, See Plate 3697-C12
		3.7		
4		End of hole at 3.7 m.		
		No seepage observed.		
5		Test Pit walls sloughed.		

PLATE NO. 3697-B4

EXPLANATION OF TERMS AND SYMBOLS USED ON DRILL HOLE & TEST PIT LOGS

SOIL DESCRIPTION

Soil is classified in accordance with the International Society of Soil Mechanics and Foundation Engineering (ISSMFE) system as described in the 1992 Canadian Foundation Engineering Manual (CFEM) 3rd Edition. Descriptions for each soil type encountered are divided by contact lines at interface depths. Each description has a corresponding graphic symbol which relates to soil type.

Major Soil Division
The major soil division is the main fraction of soil and constitutes at least 35% by weight. Soil is classified as GRAVEL, SAND, CLAY, SILT or ORGANIC according to the criteria on page 3.

Interpretation
Where applicable, a bracketed term such as (FILL) or (TILL) is included to describe soil genesis.

Grain Size and Shape
Grain size descriptions for soil follow the criteria on page 3.
The shape of coarse and oversized particles is described as:

angular – sharp corners
subangular – slightly rounded corners
subrounded – no angular corners
rounded – smooth rounded surface
platy – flat, plate shaped

Soil Composition
The following terms are used to describe the percentage of soil components by weight based on laboratory sieve analyses or field estimates.

Descriptive Term		Percentage Passing
"and"	and sand, and gravel, etc.	>35%
"___y"	clayey, sandy, etc.	20 to 35%
"some"	some silt, some gravel, etc.	10 to 20%
"trace"	trace of sand, trace of silt, etc.	0 to 10%

The amount of cobbles and boulders, in increasing proportion, are described as:
isolated < occasional < frequent < numerous.

Compactness and Consistency
The following terms are used to describe the compactness of cohesionless soil based on the Standard Penetration Test (SPT) or field estimates:

Descriptive Term	SPT 'N' Value
very loose	0 to 4
loose	4 to 10
compact	10 to 30
dense	30 to 50
very dense	over 50

The following terms are used to describe the consistency of fine grained soils based on unconfined compressive strength as determined by field or laboratory tests, or estimates:

Description Term	Unconfined Compressive Strength (kPa)
very soft	<25
soft	25 to 50
firm	50 to 100
stiff	100 to 200
very stiff	200 to 400
hard	>400

Structure
Soil macrostructure and microstructure are described.

Plasticity
Plasticity of fine grained soil is estimated or determined from Atterberg Limit tests based on the plasticity chart on page 3.

EXPLANATION OF TERMS AND SYMBOLS USED ON DRILL HOLE & TEST PIT LOGS

SOIL DESCRIPTION (cont'd)

Colour and Odour
Colour and odour of soil is described, especially where it may indicate organic inclusions or give evidence of soil contamination.

Inclusions
The quantity of inclusions is described using the same relative–amount terms used for cobbles and boulders, noted above.

Water Content
Soil moisture, in increasing amount, is subjectively described as:
dry < damp < moist < wet < saturated < excess water.

SOIL SAMPLES

Graphic symbols indicate the depth and condition of soil samples:

 Disturbed  Undisturbed

Undisturbed samples may be taken with tubes, from blocks or by coring. All other types of samples are disturbed.

FIELD TESTS

Standard Penetration Test (SPT) (ASTM D1586)
The SPT results are reported as the 'N' value at the appropriate depth. The 'N' value denotes the number of blows of a 63.5 kg hammer, freely dropping 760 mm, required to drive a 50.8 mm diameter split–spoon sampler from 150 mm to 460 mm into the bottom of a drill hole.

Dynamic Penetration Test (DPT)
Dynamic penetration test results are shown graphically. The number of blows required to drive a 50.8 mm diameter cone 305 mm is shown opposite the depth. The method of driving the cone is the same as for the SPT test described above.

Field Vane Test (FVT) (ASTM D2573–72)
Undrained shear strength of cohesive soil is measured using a 100 mm long by 50 mm diameter vane. Test results for peak and residual strengths are graphically reported at the appropriate depths using the following symbols:

× Peak Shear Strength
⊗ Residual Shear Strength

Pocket Penetrometer and Torvane Tests
The pocket penetrometer and torvane provide an indication of a soil's unconfined compressive strength and undrained shear strength, respectively. Pocket penetrometer results are shown graphically using ◊ symbols. Torvane results are reported using the same symbols used for the field vane test.

LABORATORY TESTS

The following symbols are used to denote laboratory test results:

○	Natural water content, w_N (ASTM D2216)
□	Atterberg Plastic Limit, w_P (ASTM D424)
△	Atterberg Liquid Limit, w_L (ASTM D423)
MA	Mechanical grain size (sieve) analysis or hydrometer test, or both (ASTM D422)
qu	Unconfined compressive strength test on an undisturbed sample (ASTM D2166)
SO_4	Test for concentration of water–soluble sulphates
γ	Unit weight of soil or rock
γ_d	Dry unit weight of soil or rock.

COMMENTS

Groundwater conditions are indicated using the following symbols:

—▼— groundwater table
⟵ seepage

Comments often included are additional test results, drilling progress, monitoring equipment installation details and other relevant information.

ISSMFE SOIL CLASSIFICATION SYSTEM

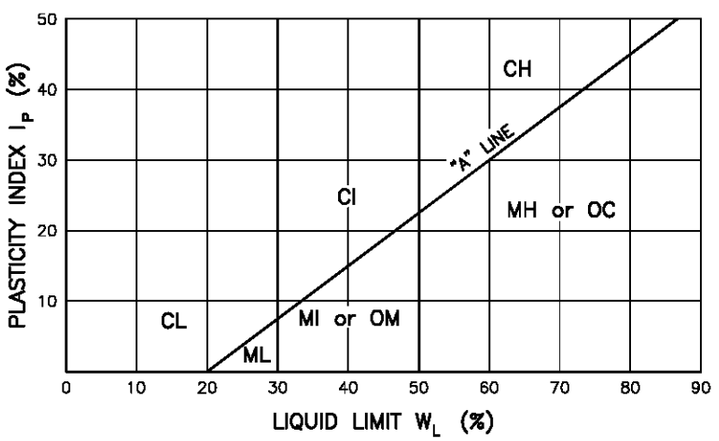
MAJOR DIVISION			GROUP SYMBOL	GRAPHIC SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE-GRAINED SOIL	GRAVEL 2.0 – 60.0 mm DIAMETER	CLEAN GRAVEL	GW		WELL-GRADED GRAVEL AND SANDY GRAVEL MIXTURES WITH LESS THAN 5% FINES.	$C_u = \frac{D_{60}}{D_{10}} > 6,\ C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			GP		POORLY-GRADED GRAVEL AND SANDY GRAVEL MIXTURES WITH LESS THAN 5% FINES.	NOT MEETING ABOVE REQUIREMENTS.
		DIRTY GRAVEL	GM		SILTY GRAVEL AND SILT-SAND-GRAVEL MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS BELOW "A" LINE.
			GC		CLAYEY GRAVEL AND CLAY-SAND-GRAVEL MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS ABOVE "A" LINE.
	SAND 0.06 – 2.0 mm DIAMETER	CLEAN SAND	SW		WELL-GRADED SAND AND GRAVELLY SAND MIXTURES WITH LESS THAN 5% FINES.	$C_u = \frac{D_{60}}{D_{10}} > 6,\ C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			SP		POORLY-GRADED SAND AND GRAVELLY SAND MIXTURES WITH LESS THAN 5% FINES.	NOT MEETING ABOVE REQUIREMENTS.
		DIRTY SAND	SM		SILTY SAND AND SILT-GRAVEL-SAND MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS BELOW "A" LINE.
			SC		CLAYEY SAND AND CLAY-GRAVEL-SAND MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS ABOVE "A" LINE.
FINE-GRAINED SOIL	SILT BELOW "A" LINE ON PLASTICITY CHART. NEGLIGIBLE ORGANIC CONTENT.		ML		INORGANIC SILT, VERY FINE SAND, ROCK FLOUR, AND SANDY SILT OF LOW PLASTICITY.	SEE PLASTICITY CHART BELOW
			MI		INORGANIC SILT OF INTERMEDIATE PLASTICITY.	
			MH		INORGANIC SILT AND MICACEOUS OR DIATOMACEOUS SOIL OF HIGH PLASTICITY.	
	CLAY ABOVE "A" LINE ON PLASTICITY CHART. NEGLIGIBLE ORGANIC CONTENT.		CL		INORGANIC CLAY OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAY, 'LEAN' CLAY	
			CI		INORGANIC CLAY OF INTERMEDIATE PLASTICITY, SILTY CLAY.	
			CH		INORGANIC CLAY OF HIGH PLASTICITY, 'FAT' CLAY.	
	ORGANIC SILT & CLAY BELOW "A" LINE ON PLASTICITY CHART		OC		ORGANIC CLAY	
			OM		ORGANIC SILT	
HIGHLY ORGANIC SOIL			Pt		PEAT AND OTHER HIGHLY ORGANIC SOIL	HIGH ORGANIC CONTENT AND FIBROUS TEXTURE.

GRAIN SIZE

Coarse-grained soil and silt is identified on the basis of grain size diameter as follows:

SILT:	Fine	0.002 – 0.006 mm
	Medium	0.006 – 0.020 mm
	Coarse	0.020 – 0.060 mm
SAND:	Fine	0.06 – 0.20 mm
	Medium	0.20 – 0.60 mm
	Coarse	0.60 – 2.00 mm
GRAVEL:	Fine	2.0 – 6.0 mm
	Medium	6.0 – 20.0 mm
	Coarse	20.0 – 60.0 mm
COBBLES:		60.0 – 200 mm
BOULDERS:		> 200 mm

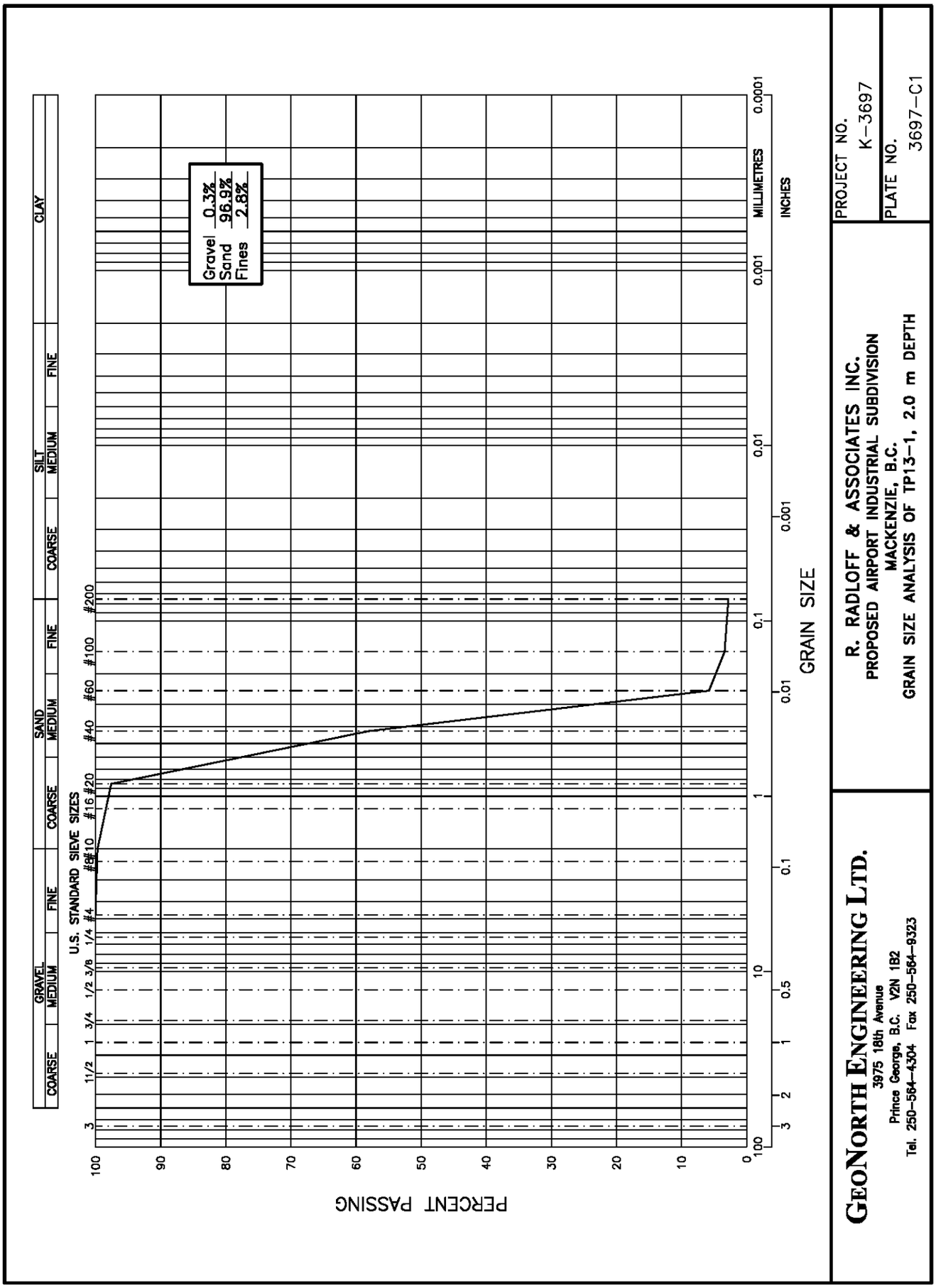
PLASTICITY CHART



GEONORTH ENGINEERING LTD.

PLATE 3 of 3

APPENDIX C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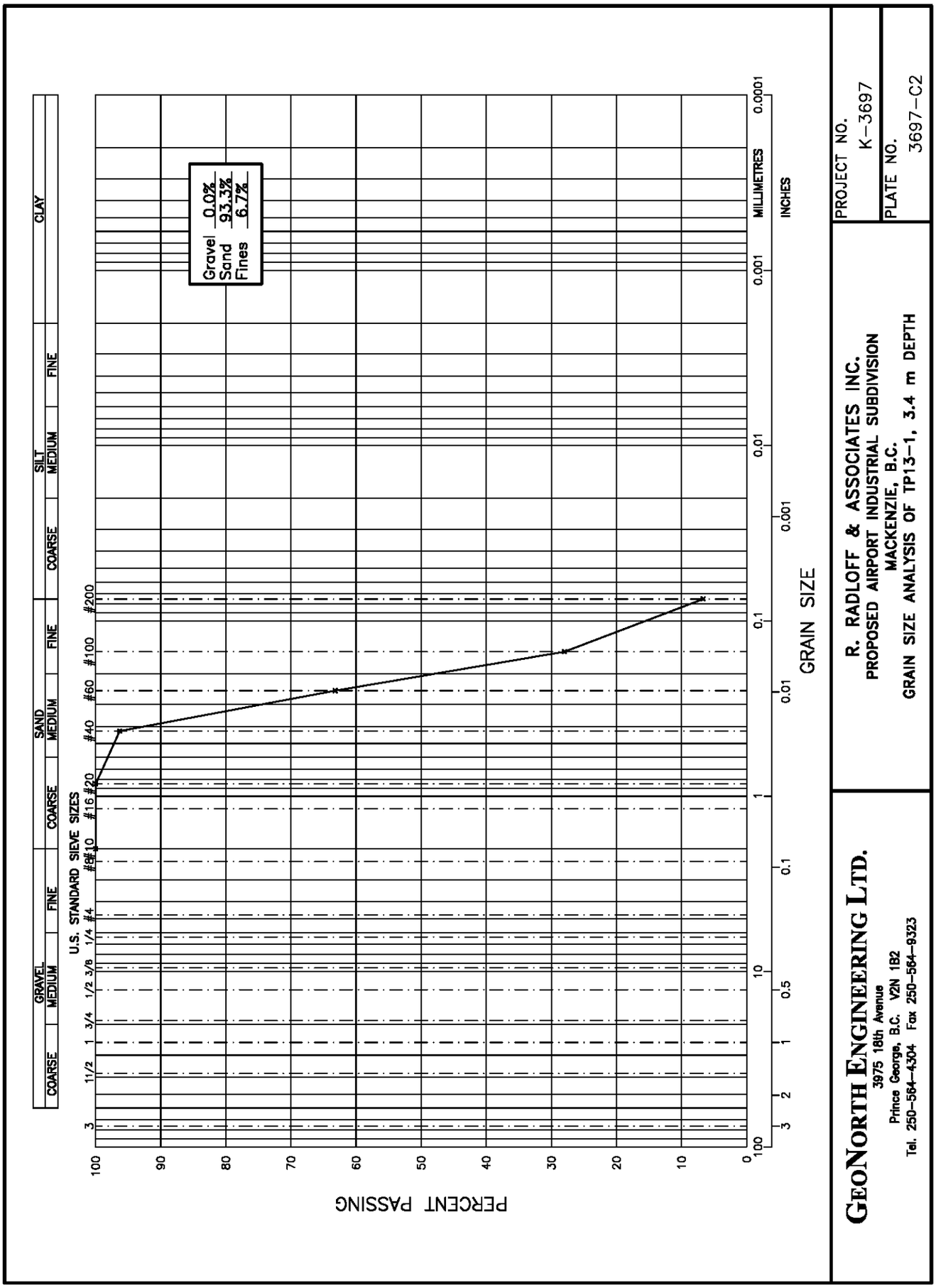
FINE
SAND
COARSE
MEDIUM
FINE
SILT
COARSE
MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
1 1/2
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.3%
Sand 96.9%
Fines 2.8%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
MILLIMETRES
3
2
1
0.5
0.1
0.01
0.001
INCHES
GRAIN SIZE
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-1, 2.0 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C1
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323

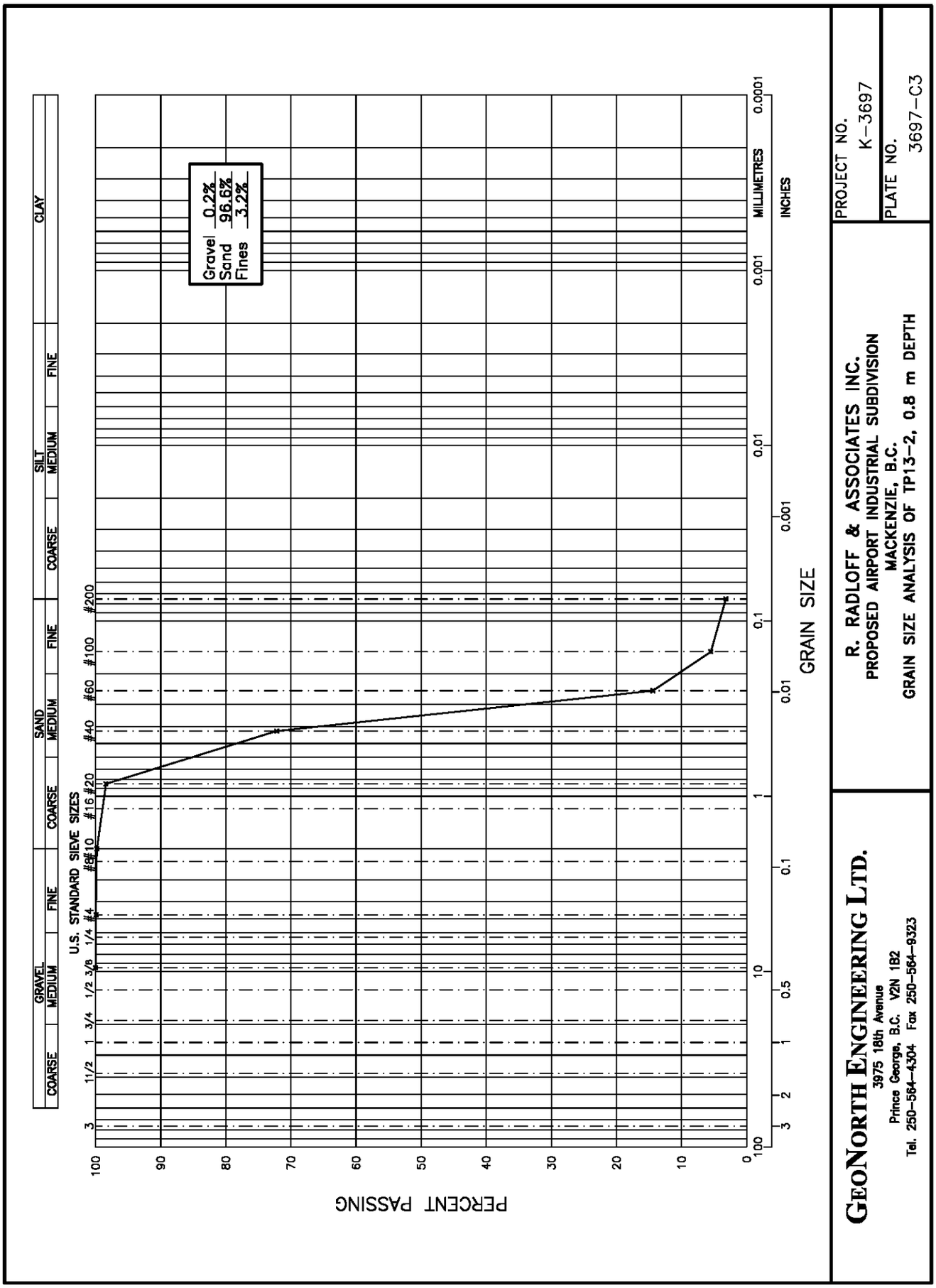


GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323

R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-1, 3.4 m DEPTH

PROJECT NO. K-3697

PLATE NO. 3697-C2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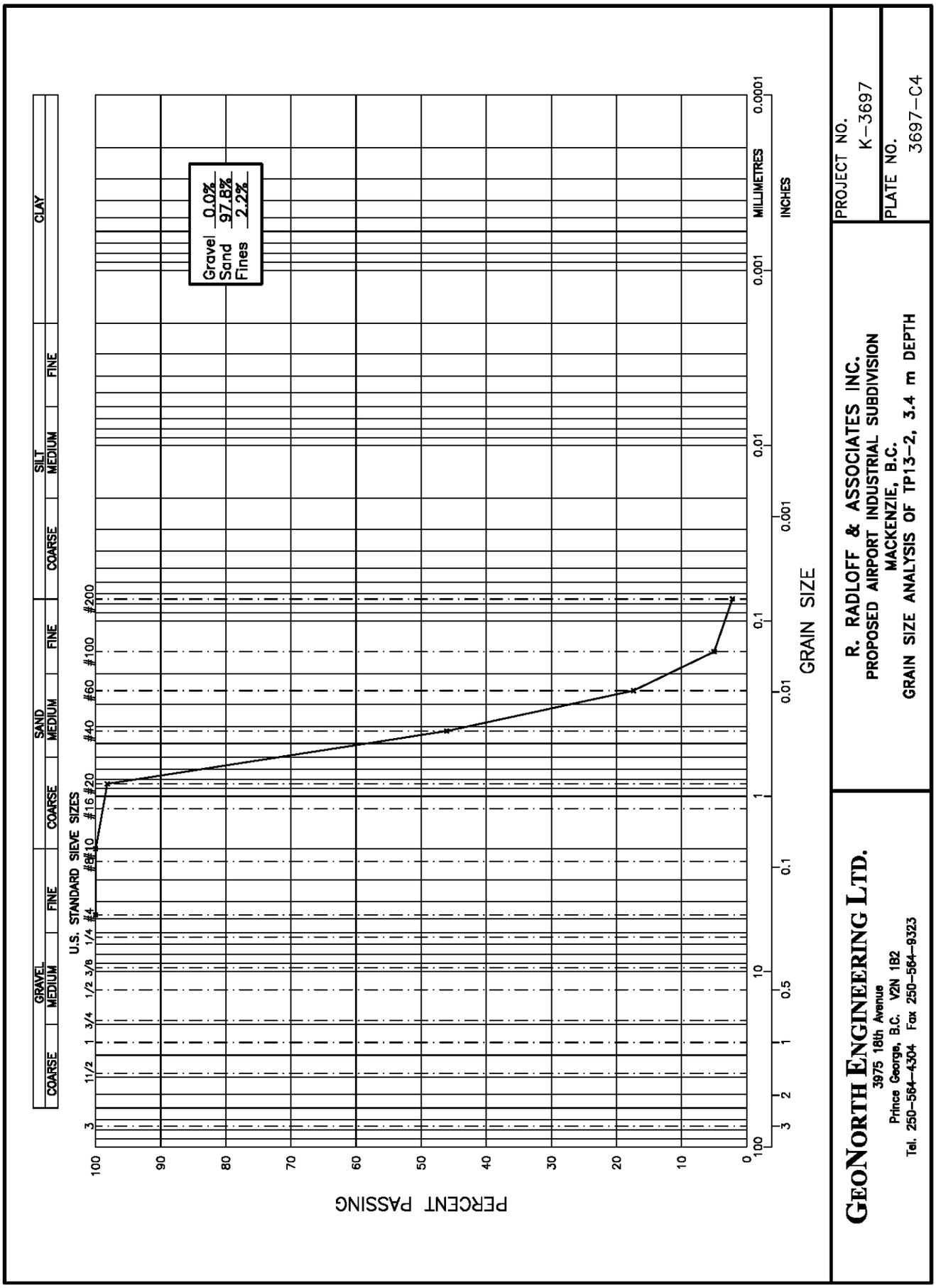
MEDIUM
FINE
SAND
COARSE
MEDIUM
FINE
SILT
COARSE
MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
11/2
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.2%
Sand 96.6%
Fines 3.2%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
MILLIMETRES
3
2
1
0.5
0.1
0.01
0.001
INCHES
GRAIN SIZE
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-2, 0.8 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C3
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323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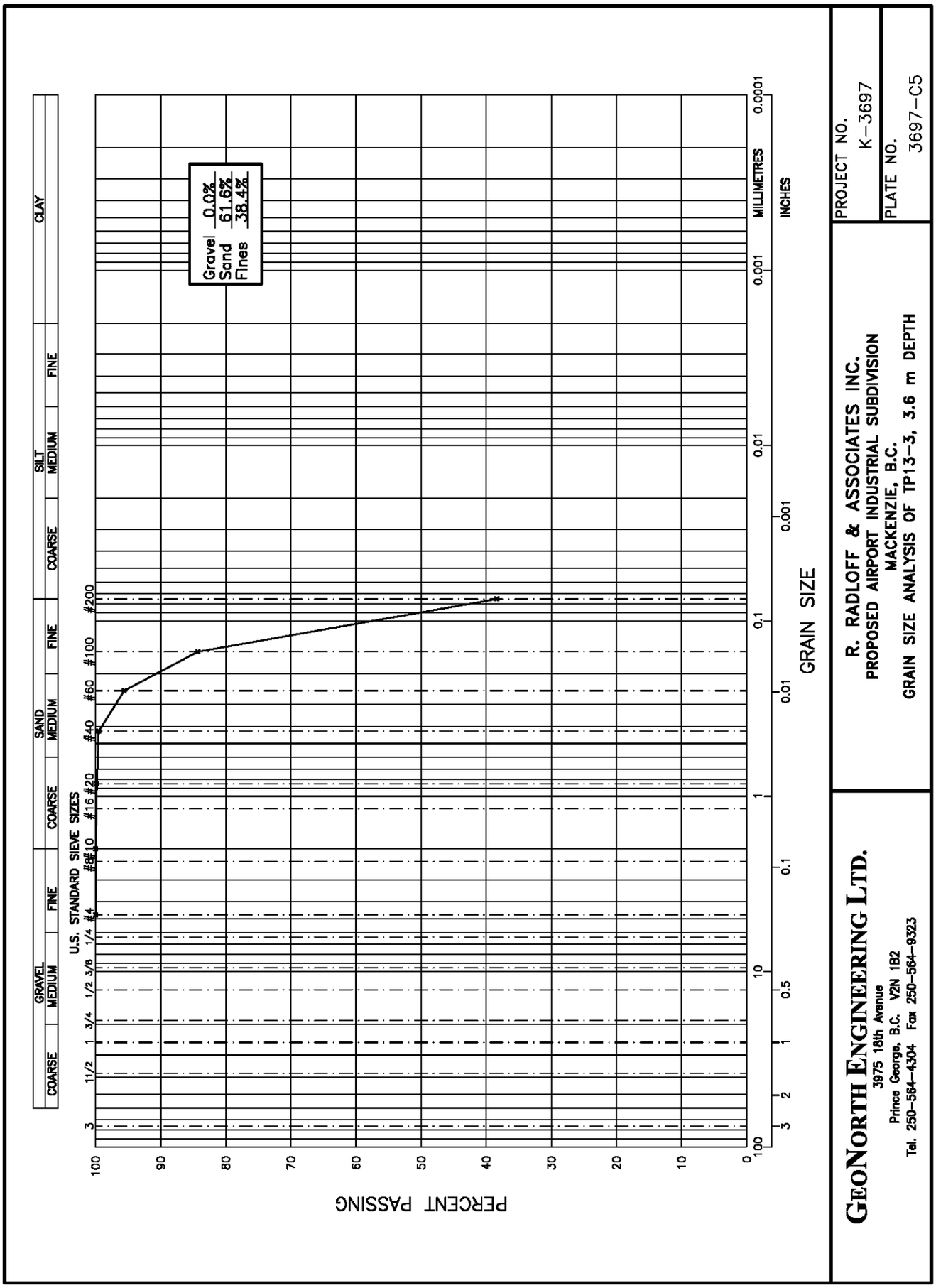
FINE
SAND
COARSE
MEDIUM
FINE
SILT
COARSE
MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
11/2
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.0%
Sand 97.8%
Fines 2.2%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
MILLIMETRES
3
2
1
0.5
0.1
0.01
0.001
INCHES
GRAIN SIZE
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-2, 3.4 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C4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SAND
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SILT
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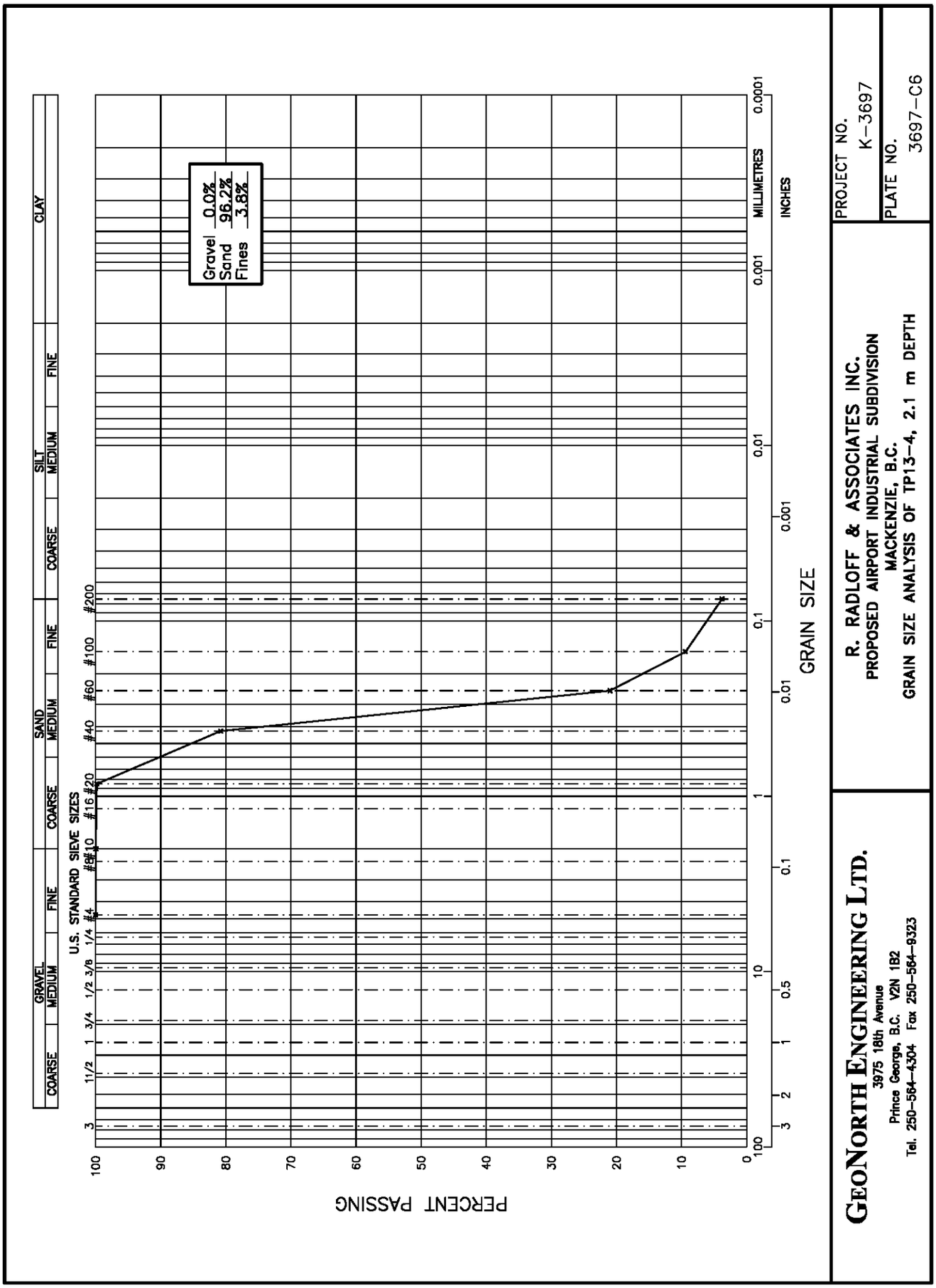
MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
1 1/2
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.0%
Sand 61.6%
Fines 38.4%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.5
0.1
0.01
0.001
0.0001
MILLIMETRES
INCHES
GRAIN SIZE
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-3, 3.6 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C5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FINE
SAND
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MEDIUM
FINE
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MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
11/2
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.0%
Sand 96.2%
Fines 3.8%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
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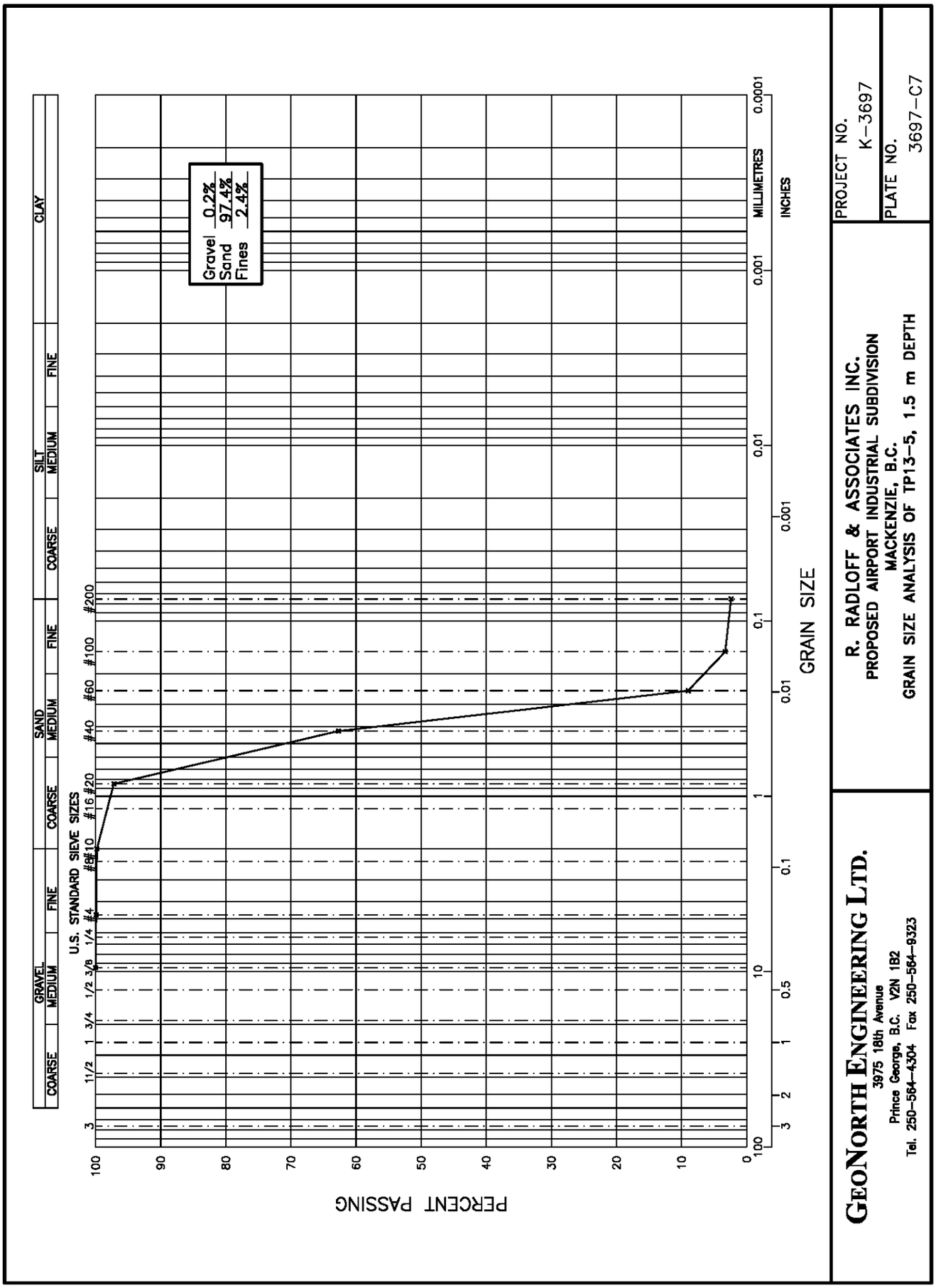
0.0001
MILLIMETRES
3
2
1
0.5
0.1
0.01
0.001
INCHES
GRAIN SIZE
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-4, 2.1 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C6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SILT
COARSE
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FINE
CLAY
U.S. STANDARD SIEVE SIZES
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1/2
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1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.2%
Sand 97.4%
Fines 2.4%
PERCENT PASSING
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100
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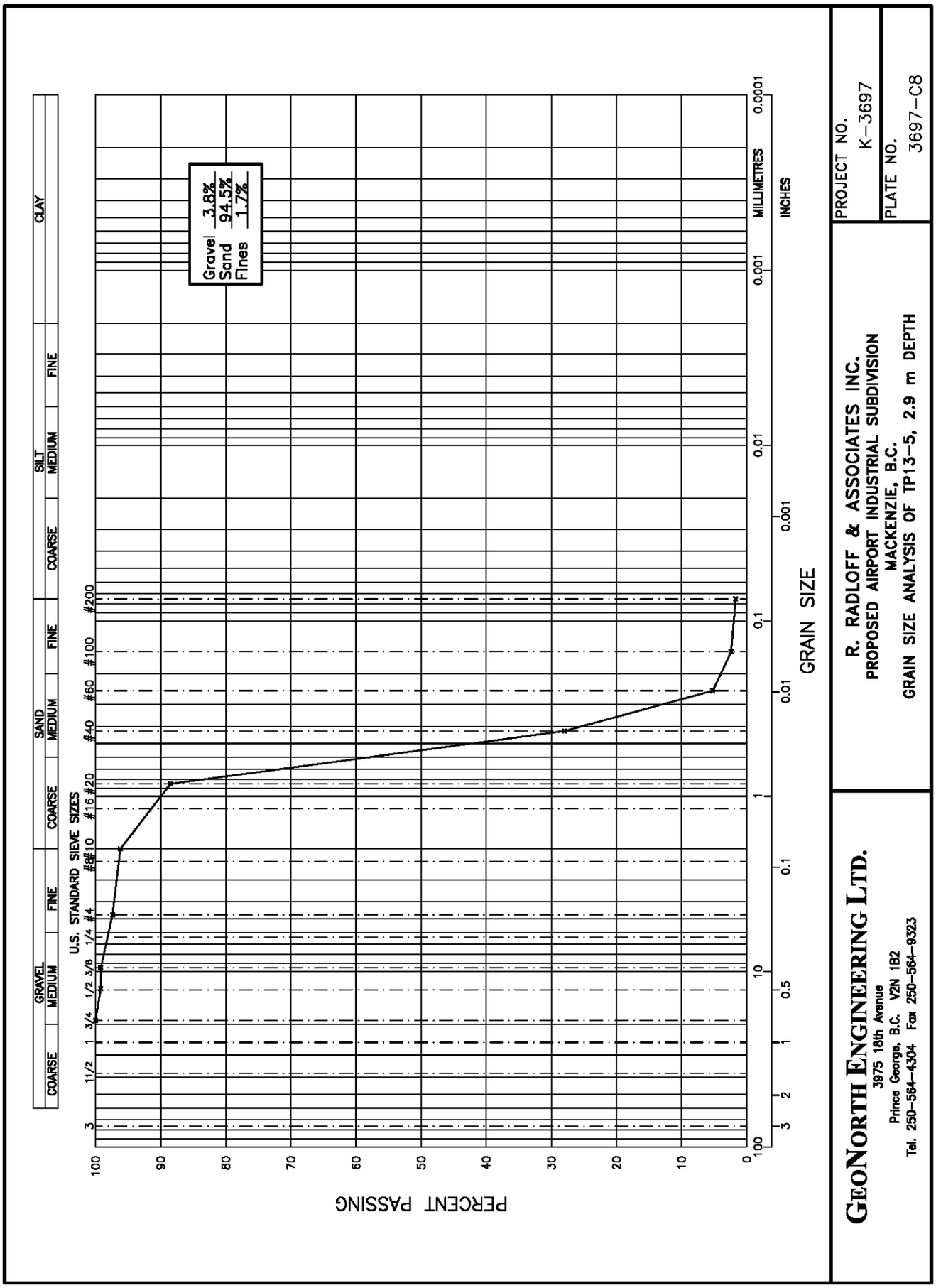
1
0.1
0.01
0.001
0.0001
MILLIMETRES
3
2
1
0.5
0.1
0.01
0.001
INCHES
GRAIN SIZE
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-5, 1.5 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C7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SAND
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FINE
SILT
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MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
11/2
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3/8
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#4
#8
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#16
#20
#40
#60
#100
#200
Gravel 3.8%
Sand 94.5%
Fines 1.7%
PERCENT PASSING
100
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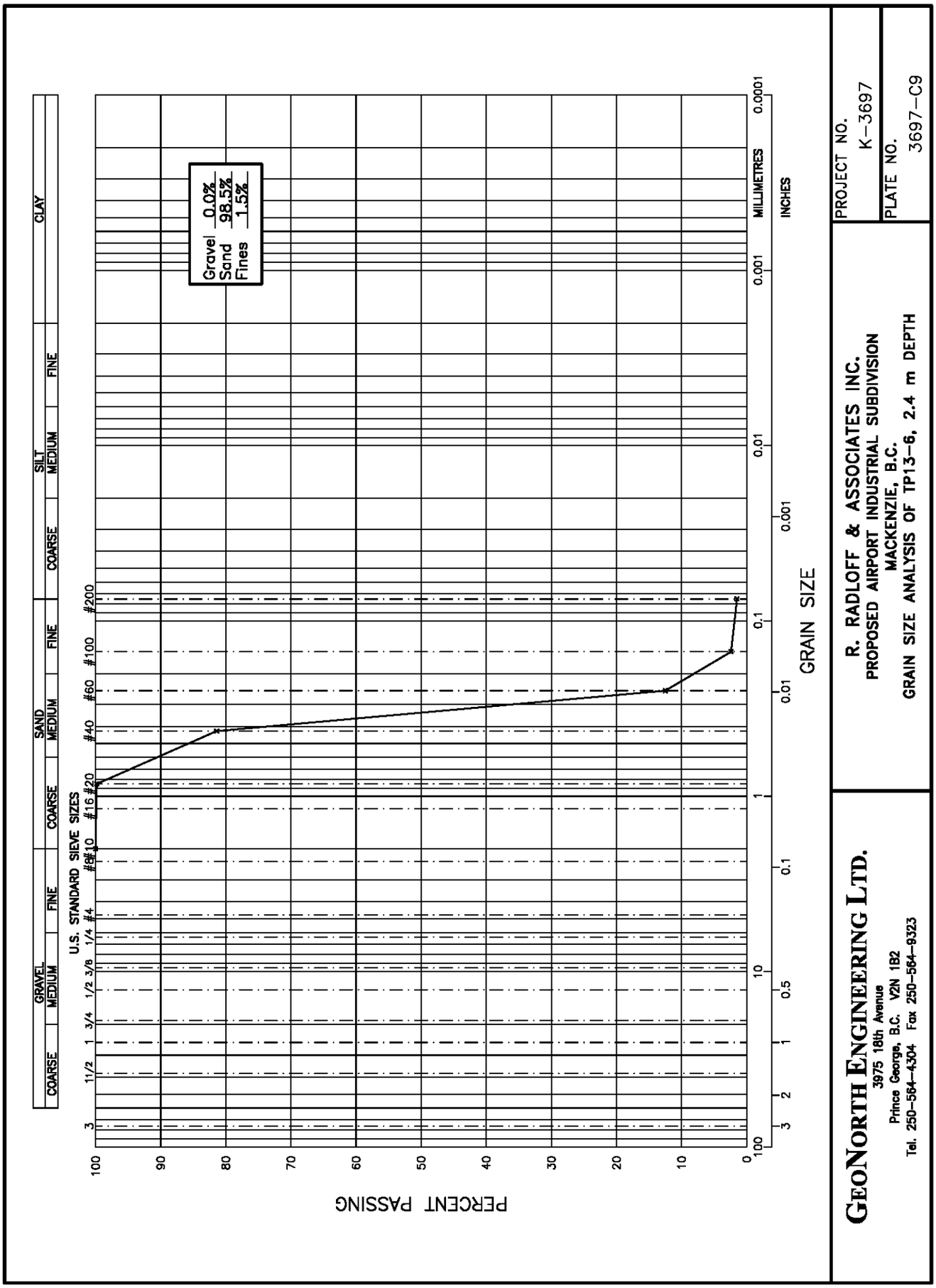
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
MILLIMETRES
INCHES
GRAIN SIZE
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-5, 2.9 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C8
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323

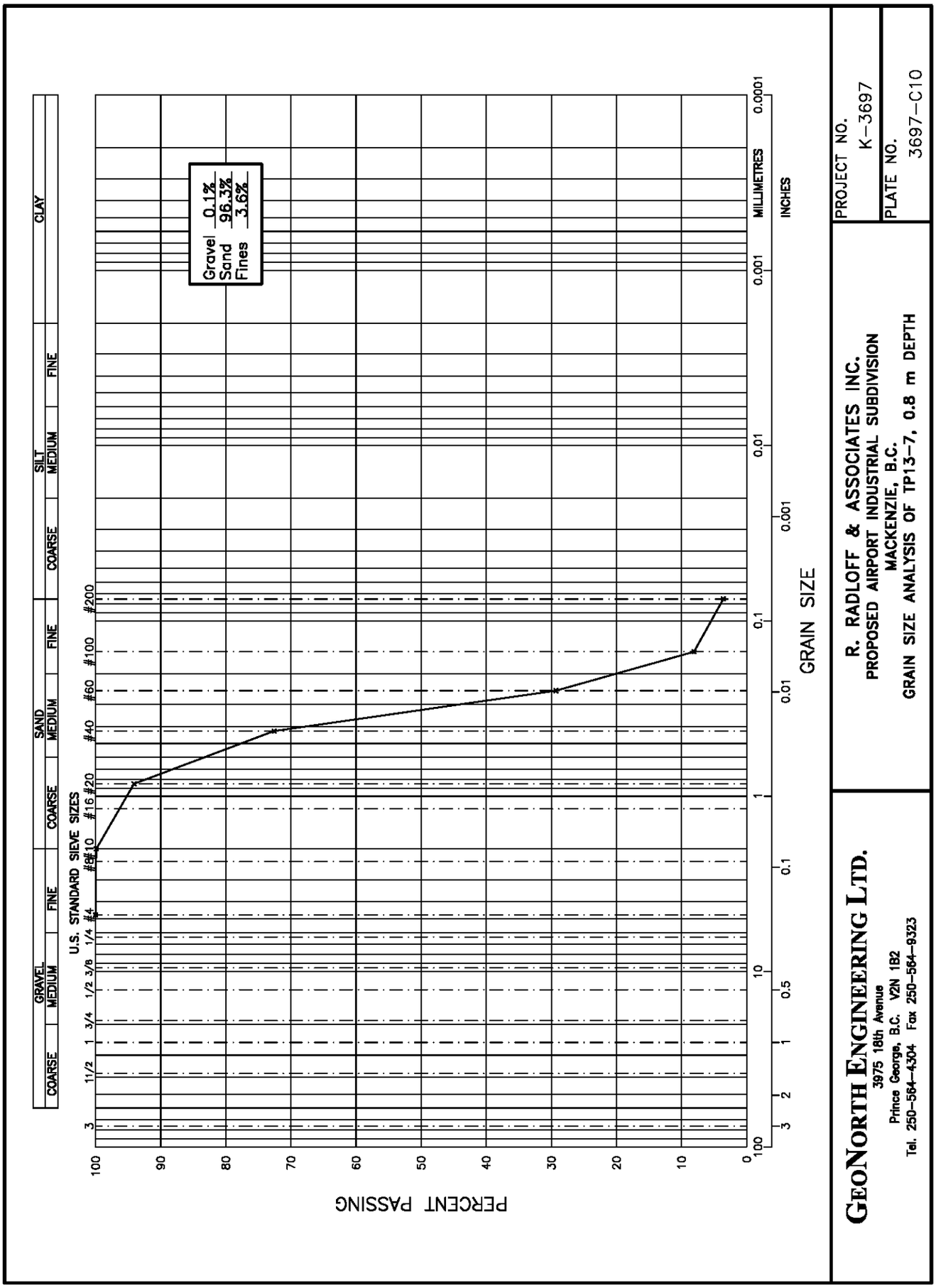


GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323

R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-6, 2.4 m DEPTH

PROJECT NO. K-3697

PLATE NO. 3697-C9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SAND
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FINE
SILT
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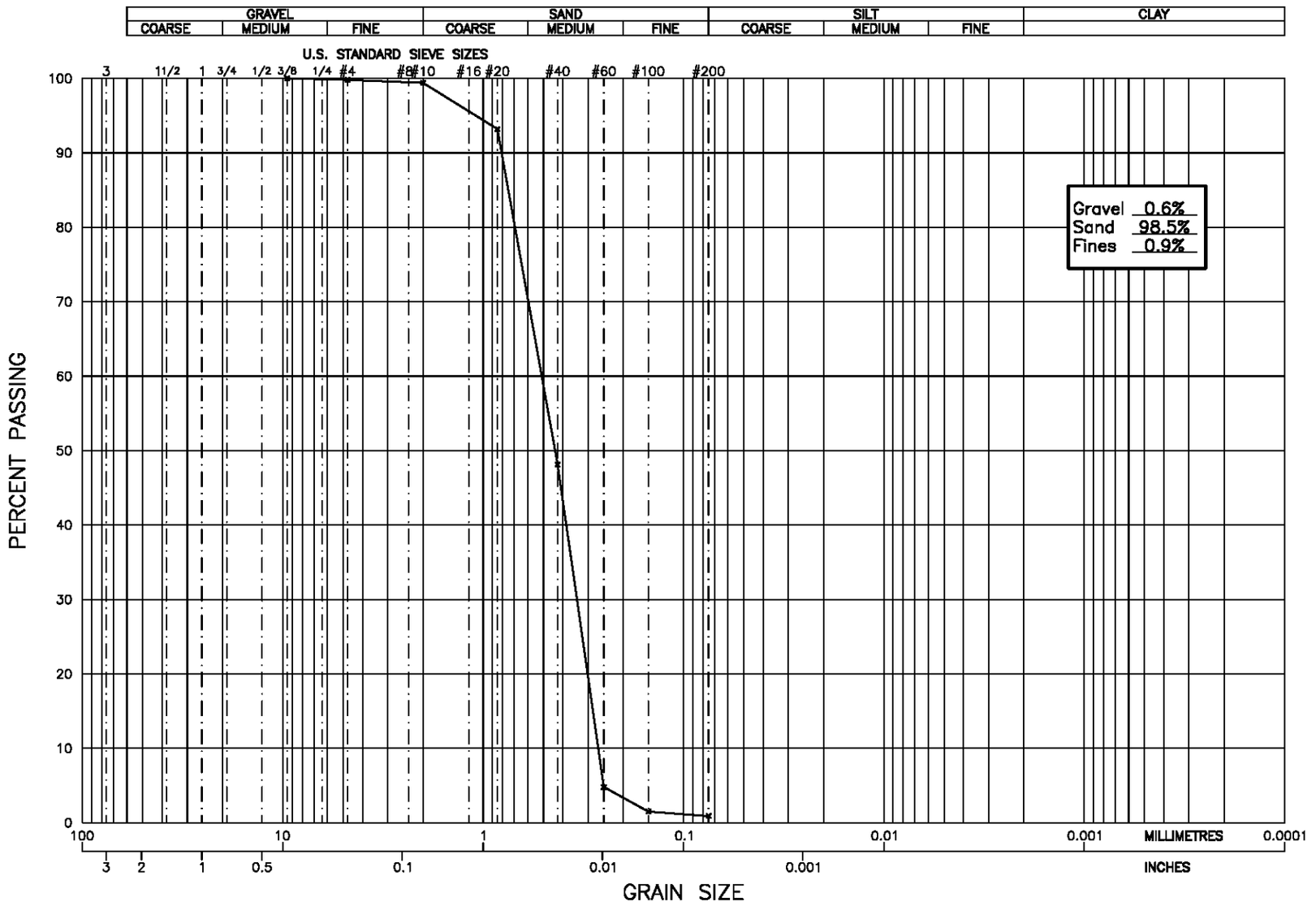
MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
11/2
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.1%
Sand 96.3%
Fines 3.6%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
MILLIMETRES
3
2
1
0.5
0.1
0.01
0.001
INCHES
GRAIN SIZE
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-7, 0.8 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C10
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323

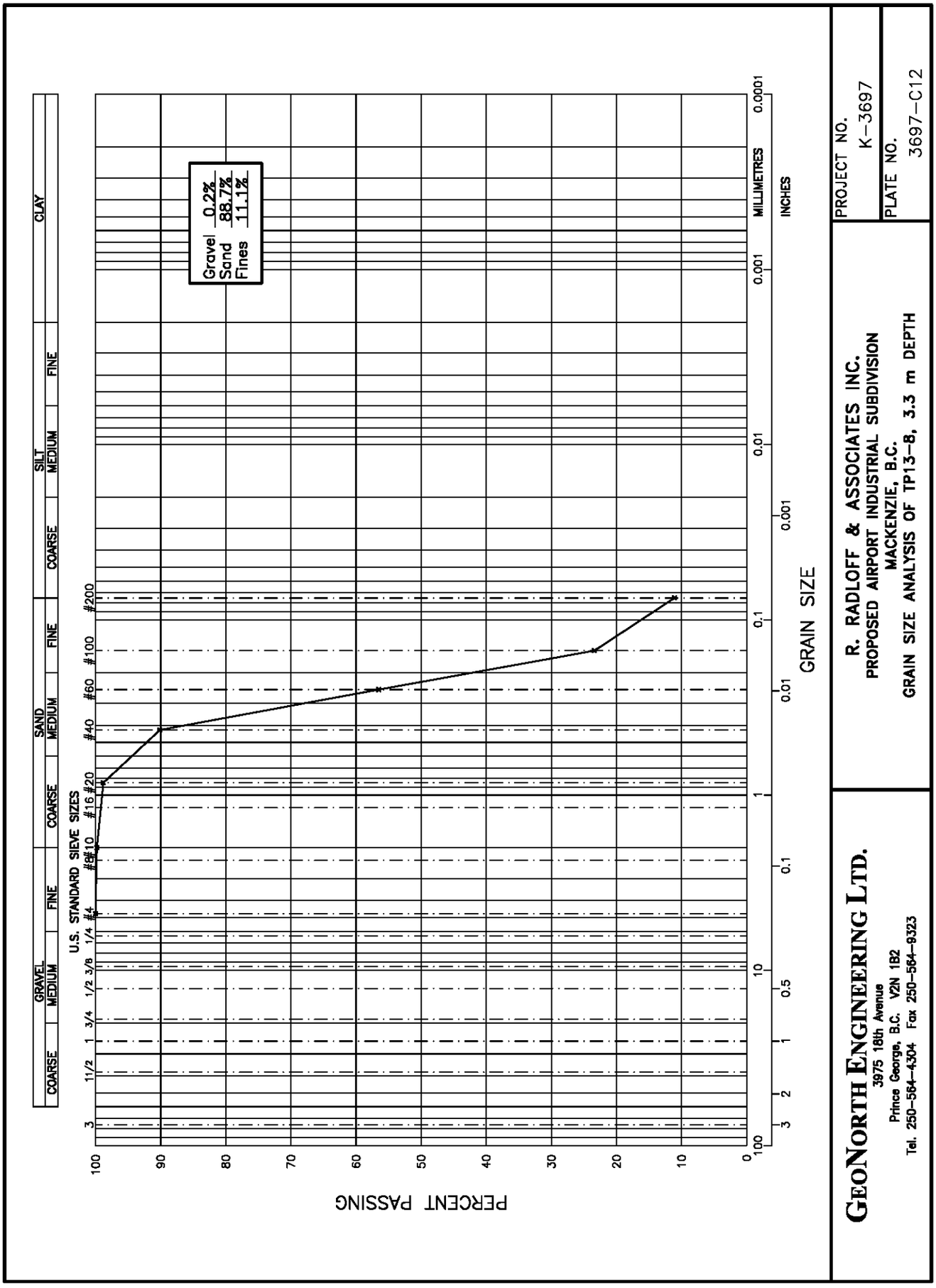


GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-9323

R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-7, 3.2 m DEPTH

PROJECT NO.
K-3697

PLATE NO.
3697-C11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SAND
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MEDIUM
FINE
SILT
COARSE
MEDIUM
FINE
CLAY
U.S. STANDARD SIEVE SIZES
3
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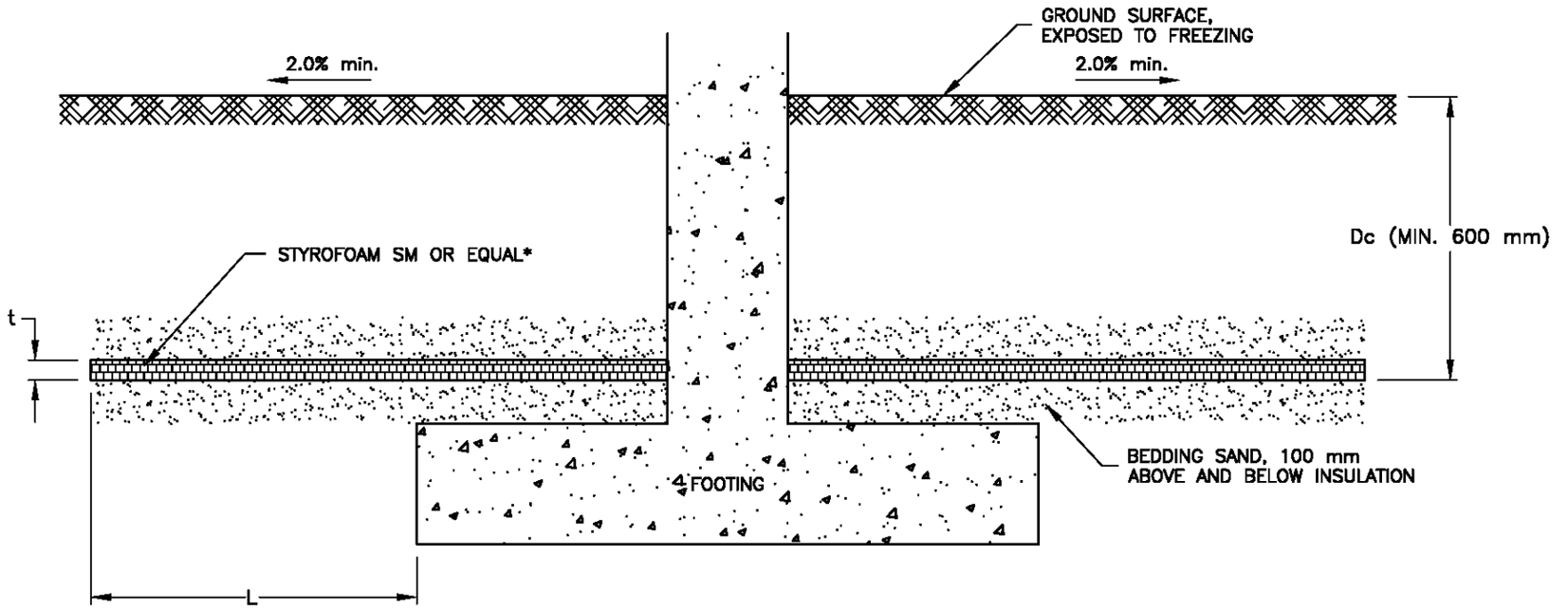
1
3/4
1/2
3/8
1/4
#4
#8
#10
#16
#20
#40
#60
#100
#200
Gravel 0.2%
Sand 88.7%
Fines 11.1%
PERCENT PASSING
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
MILLIMETRES
INCHES
3
2
1
0.5
0.1
0.01
0.001
GRAIN SIZE
R. RADLOFF & ASSOCIATES INC.
PROPOSED AIRPORT INDUSTRIAL SUBDIVISION
MACKENZIE, B.C.
GRAIN SIZE ANALYSIS OF TP13-8, 3.3 m DEPTH
PROJECT NO.
K-3697
PLATE NO.
3697-C12
GEONORTH ENGINEERING LTD.
3975 18th Avenue
Prince George, B.C. V2N 1B2
Tel. 250-564-4304 Fax 250-564-8323

APPENDIX D



EXTEND INSULATION PAST EDGE OF FOOTING
BY DISTANCE: L = 2.4 m − Dc ON UNHEATED SIDE

if D_c = 600 mm; t = 100 mm

if D_c = 900 mm; t = 75 mm

if D_c = 1.2 m; t = 65 mm

if D_c = 1.5 m; t = 50 mm

* USE STYROFOAM SM, OR EQUIVALENT IN AREAS OF NO TRAFFIC. USE STYROFOAM HL 60, OR EQUIVALENT UNDER AREAS SUBJECTED TO VEHICLE TRAFFIC.

GEONORTH ENGINEERING LTD. 3975 18th Avenue Prince George, B.C. V2N 1B2 Tel. 250-564-4304 Fax 250-564-9323	**R. RADLOFF & ASSOCIATES INC.** **PROPOSED AIRPORT INDUSTRIAL SUBDIVISION** **MACKENZIE, B.C.** **TYPICAL INSULATED FOUNDATION DETAIL**	SCALE: N.T.S.	DATE: 2013/08/12
		PROJECT NO: K-3697	DRAWING NO. 3697-D1

Appendix C (Site Plan & Proposed Effluent Field Locations)

Radloff
R. Radloff & Associates Inc.
Engineering, Planning & Consulting
1820 3rd Avenue
Prince George, B.C. V2M 1G4
Ph: (250) 562-6861, Fax: (250) 562-6826

DATE	DRAWING ISSUE	APPROVED

NO.	DATE	REVISION	BY	APPROVED

THE DISTRICT OF MACKENZIE
AIRPORT SUBDIVISION

PROPOSED EFFLUENT FIELD LOCATIONS

SCALE: HOR: 1:2000 VERT:

DESIGNED BY: RJR	JOB#: 812-008-03
DRAWN BY: RJR	FILE_#: 812-008-03
CHECKED BY: CEM	DWG.#:
DATE: 12/2013 REV. R0	SHEET 1