APPENDIX E:

Craig HydroGeoLogic Report

CRAIG HYDROGEOLOGIC INC.

Groundwater and Soil Contamination Groundwater Protection Resource Development Site Remediation Site Professional

> Grand Lake Timber, Limited Proposed Wood Waste and Ash Disposal Site Groundwater Assessment Kings Mines N.B.

Submitted To: Roy Consultants 364 York Street, Suite 201 Fredericton, NB E3B 3P7

Prepared by: Craig HydroGeoLogic Inc. 140 Meadow Cove Road Dipper Harbour, N.B. E5J 2S9

Date:

February 21, 2017

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<u>Grand Lake Timber, Limited</u> <u>Proposed Wood Waste and Ash</u> <u>Disposal Site</u> <u>Groundwater Assessment</u> <u>Kings Mines N.B.</u>

1.0 INTRODUCTION

Roy Consultants, acting on behalf of Grand Lake Timber, Limited, retained Craig Hydrogeologic Inc. to perform a groundwater assessment and evaluation of the proposed wood waste and ash disposal site located in Kings Mines, NB (PID 45073913). The groundwater assessment is part of an EIA necessary to obtain regulatory approval for a new wood waste and ash site to replace an existing site that is approaching capacity.

This report presents the results of the groundwater assessment and conclusions and recommendations based on the results of that groundwater assessment.

This report was prepared by Craig HydroGeoLogic Inc. for the clients, Roy Consultants Ltd. and Grand Lake Timber, Limited and the report presents the results of a groundwater assessment, conclusions and recommendations as described in this report.

The report is based on the application of scientific principles and professional judgment to certain facts with resultant subjective interpretations. For example, but not limited to, interpolation between boreholes is an accepted industry practice, however, actual subsurface conditions may vary from that interpolated and such variation could impact observations, discussions, conclusions and recommendations in the report. Professional judgments expressed herein are based on the facts currently available within the existing data, scope of work, budget and schedule. The material and information in the report reflects Craig HydroGeoLogic Inc.'s best judgment in light of the information available at the time of report preparation. Any use which a third party makes of this report, or any reliance on or decision(s) to be made based on this report are the responsibility of

the third party(ies). Craig HydroGeoLogic Inc. accepts no responsibility for damages, if any, suffered by any third party because of decisions made or actions taken based on this report.

2.0 SCOPE

The scope of the assessment is as follows:

- 1. To conduct a groundwater assessment of the proposed wood waste site, and;
- 2. based on the results of that information, perform a risk assessment of potential groundwater impacts on potential human and environmental receptors, and;
- 3. consider the need for a liner at the site, and,
- 4. produce a report with the findings of the groundwater risk assessment and recommendations based on those findings.

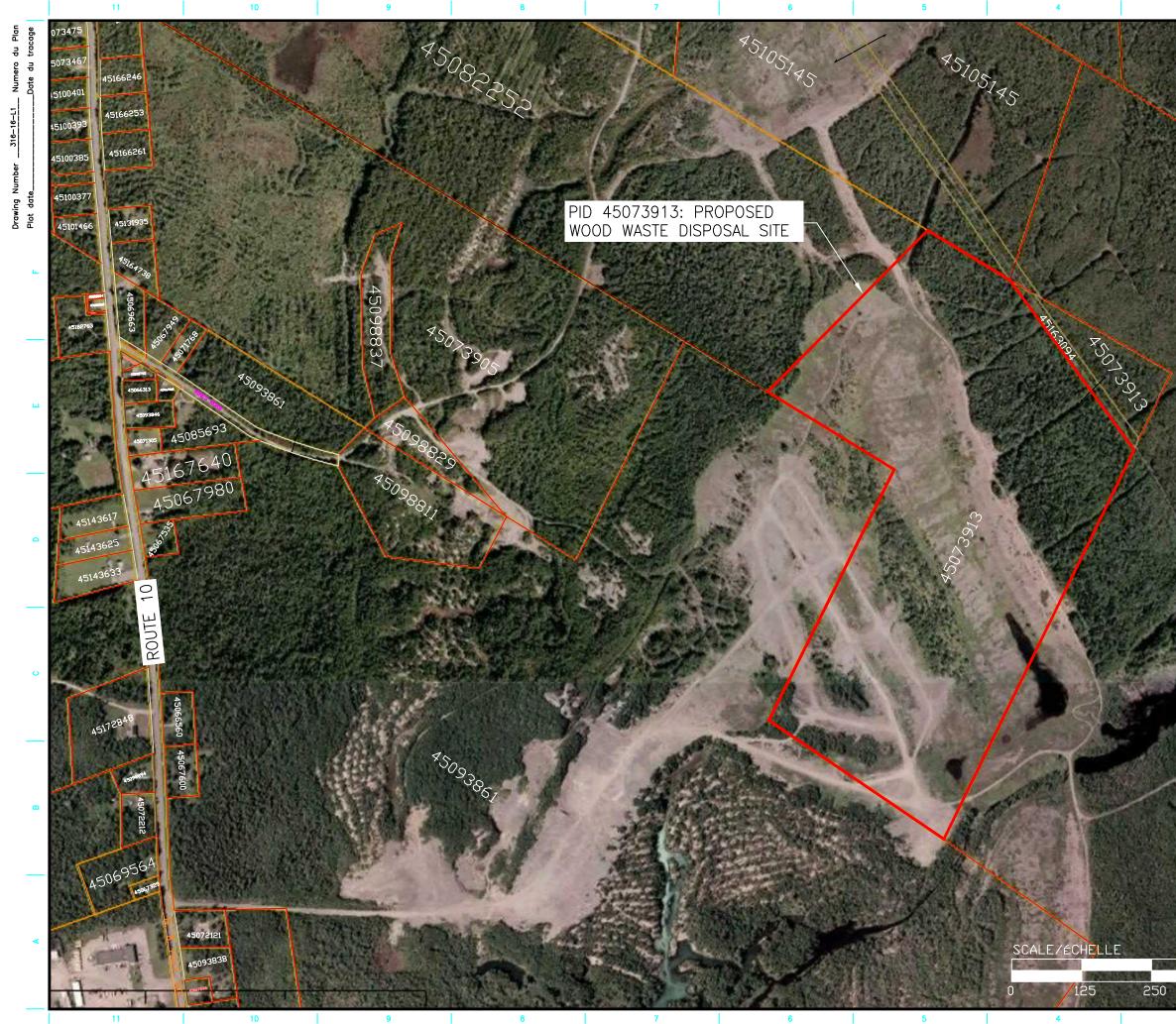
3.0 SITE DESCRIPTION

<u>General</u>

The site is located on former surface strip mined land south of Chipman, NB, in Kings Mines, NB (PID 45073913) (Figure 1). The historical coal mining operations have left the ground as a series of sub-parallel, sinuous ridges and valleys. Local surface and ground water drainage is modified and obscured by the old mine cuts. Surface waters are present as a series of unconnected ponds contained within the low areas and as defined streams. Ground water flow is difficult to predict with any degree of assurance if based only on topography. It is expected that groundwater will preferentially flow through the mine spoils, as they generally have higher hydraulic conductivities than the undisturbed bedrock in this area.

Topography, and Surface Drainage

The proposed disposal site is a linear depression trending downwards in a south – southeast direction from the northern boundary. The groundwater table outcrops south of the proposed site



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as a linear pond which drains into Wilson Brook to the south. There is no obvious surface drainage in or over the proposed disposal site itself as all surface water is assumed to infiltrate into the mine spoils.

Area Geology

The undisturbed surficial overburden at the site is red clay till of variable thickness. In some areas, this is overlain by a relatively thin veneer of sand. Based on local private well logs, the overburden in the area ranges in thickness from 1.2 to approximately 4.3 meters (4 to 14 feet).

The bedrock in the area is mapped as Pennsylvanian sandstone and shale which forms the local aquifer. Seams of coal are present in the area. The bedrock is known to be relatively transmissive (readily conducts the flow of ground water). The bedrock units or layers tend to be lenticular (i.e. of variable lateral extent and thickness) and are thought to have formed because of sedimentary particles deposited from flowing water (alluvial deposition). The sediments were deposited by meandering river systems, the river channel deposits being, in general, characterized by sands and gravels and the floodplain deposits being fine grained silts or clays. Many of the stratigraphic sub-units are of limited horizontal extent. It is not possible to extrapolate continuous sedimentary beds or layers over distances greater than 10 to 100 meters, except in general terms. The beds dip gently eastward. This mechanism of deposition has apparently resulted in locally (10 to 100 meters) variable well yields; however, over larger scales (1000 meters) the bedrock aquifer is quite uniform.

It is known that local groundwater quality may be compromised by the presence of coal seams, with relatively high concentrations of iron/or manganese being common in the area.

Area Hydrogeology

Private Water Supplies: Private wells are developed in the bedrock aquifer along Route 10 (Figure 1). The closest private well to the site is located at approximately 1,500 meters from the proposed wood waste disposal site. A search of the New Brunswick Department of Environment and Local Government (NBDELG) well log database for a 1,500 meter radius around the proposed development (PID 45073913) yielded a total of eight well logs. A summary of the information contained in the well logs is provided in Table 1, which follows. Copies of the well logs are provided in Appendix 1, at the back of this report.

		Depth to	
Well Depth	Estimated Yield	Bedrock	Casing Length
(feet)	(igpm)	Deuroek	(feet)
		(feet)	
Average: 97.6	Average: 9.8	Average: 8.0	Average: 21.3
Median: 64	Median: 7	Median: 7.5	Median: 20
Minimum: 40	Minimum: 3	Minimum: 40	Minimum: 20
Maximum: 285	Maximum: 20	Maximum: 14	Maximum: 30

 Table 1:
 Summary of hydrogeologic information derived from search of NBDELG well log

 database (1500 meter search radius).

As can be seen from the above information and the private well logs provided in Appendix 1, the eight private well logs found in the database for this general area have depths ranging from 40 to 285 feet with an average depth of 97.6 feet. The estimated safe yields range from 3 to 20 igpm with an average of 9.8 igpm. The minimum yield observed was 3.0 igpm in a 145-foot-deep well and the maximum yield observed was 20 igpm in a 65 feet deep well. The average well yield in the area is 9.8 igpm. All the private well logs for this area show that it is the undisturbed bedrock that forms the local water supply aquifer.

A search of the NBDELG well chemistry database for wells located within a 1,500 meter radius of the proposed wood waste disposal site provided results from a total of five wells for which groundwater inorganic chemistry was available. The precise locations of the wells from which the ground water chemistry was obtained are not available due to right to privacy considerations. The analytical results for the samples are provided in Table 2, which follows. In Table 2 any result that exceeds the Canadian Drinking Water Quality Guidelines (CDWQG) is bolded and shaded for ease of recognition. The water samples for the groundwater chemistry data in Table 2 were collected and analyzed using the water analysis certificate provided by the well driller when the well is new. The water samples are usually collected by the homeowner shortly thereafter in order to provide confidence that they can use the water. As a result the well from which the water sample was collected typically has not had enough time or use for the water to clear sufficiently prior to the water sample being collected. The result of this is that the chemistry data in Table 2 may overestimate the long term turbidity and some trace metal concentrations as most wells will clear naturally with use and time. Elevations in concentrations were observed for arsenic, chloride, iron, manganese, pH, turbidity and TDS (total Dissolved Solids).

Out of the five well chemistry records, two wells exceeded the CDWQG for arsenic of $10 \mu g/L$. The presence of elevated concentrations of arsenic in some waters from this aquifer is due to natural conditions.

Out of the five chemistry records available, two wells exceeded the CDWQG for chloride. The same wells also exceeded the CDWQG for TDS, possibly indicating relict seawater. In light of no information as to the potential source of this material, it is assumed that the elevated concentrations are of natural origin.

Out of the five records a total of two exceed the CDWQG for Iron and two exceed the CDWQG for manganese. The standard for both iron and manganese is based on esthetic considerations, not health. The presence of Iron and/or Manganese in the groundwater from this aquifer is not uncommon and is the result of natural conditions.

CDWQG = Canadian Drinking Water Quality Guideline

NB DELG Groundwater Chemistry Database

Parameter	ALK_T (mg/L)	AI (mg/L)	As (µg/L)	B (mg/L)	Ba (mg/L)	Br (mg/L)	COND (µSIE/cm)	Ca (mg/L)	Cd (µg/L)
	101	0.025	1.5	0.01	0.477	0.1	1250	117	0.5
	105	0.025	1.5	0.01	0.422	0.1	1280	115	0.5
	152	0.33	49	0.04	0.112	0.1	870	7.91	0.5
	114	0.25	25	0.048	0.116	0.1	318	8.78	0.5
	54.6	0.025	2.78	0.01	0.046	0.1	639	98	0.5
Mean	105.3	0.131	16.0	0.024	0.235	0.1	871	69.3	0.5
CDWQG			<10	<5.0	<1.0				<5.0

Parameter	CI (mg/L)	Cr (µg/L)	Cu (µg/L)	E_coli P/A (P/A)	F (mg/L)	Fe (mg/L)	HARD (mg/L)	K (mg/L)	Mg (mg/L)
	376	10	10	Ab	0.111	0.016	326	1.04	8.26
				Ab					
	296	16	10	Ab	0.15	0.034	321	1	8.3
	182	20	10	Ab	0.1	0.315	21.5	0.7	0.41
	27.9	11	10	Ab	1.08	0.193	23.7	0.6	0.44
	40.4	10	25	Ab	0.132	3.96	280.2	1.07	8.61
Mean	184.5	13	13		0.31	0.904	194.5	0.88	5.20
CDWQG	<250	<50	<1000		<1.5	<0.3			

Table 2

CDWQG = Canadian Drinking Water Quality Guideline

NB DELG Groundwater Chemistry Database

Parameter	Mn (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	Na (mg/L)	PH (pH)	Pb (µg/L)	SO4 (mg/L)	Sb (µg/L)
	0.035	0.05	0.05	0.05	98	7.64	1.5	15.3	1
	0.21	0.05	0.05	0.05	107	7.54	1	14.4	1
	0.01	0.05	0.05	0.06	178	8.79	3.3	15	2.8
	0.012	0.05	0.05	0.05	58.3	8.68	1.4	8.7	1.7
	3.61	0.05	0.05	0.05	16.6	6.91	1	193	1
Mean	0.775	0.05	0.05	0.05	91.58	7.91	1.6	49.28	1.50
CDWQG	<0.05	<10	<10	<10	<200	6.5-8.5	<10	<500	6

Parameter	Se (µg/L)	TC-P/A (P/A)	TURB (NTU)	TI (μg/L)	U (µg/L)	Zn (μg/L)	TDS (mg/L)
	1.5	Pr	0.44	1	0.5	18	677
		Pr					
	1.5	Ab	0.28	1	0.5	5	605
	8	Ab	80	1	2.6	5	476
	1.5	Ab	73	1	0.5	5	175
	1.5	Pr	14	1	0.5	102	399
Mean	2.8		33.5	1	0.9	27	466
CDWQG			<1.0		<20	<5000	<500

Out of the five records, a total of two slightly exceed the CDWQG for pH. The variations observed are minimal and for practical purposes it is doubtful that these variations in pH would impact the usability of the water in a private well or water source. The pH of water is important in determining water treatment methods; however, it is not a health-related water quality standard. The pH of water may be adjusted to prevent or reduce corrosion in the distribution system and this is easily accomplished using commercially available water treatment equipment.

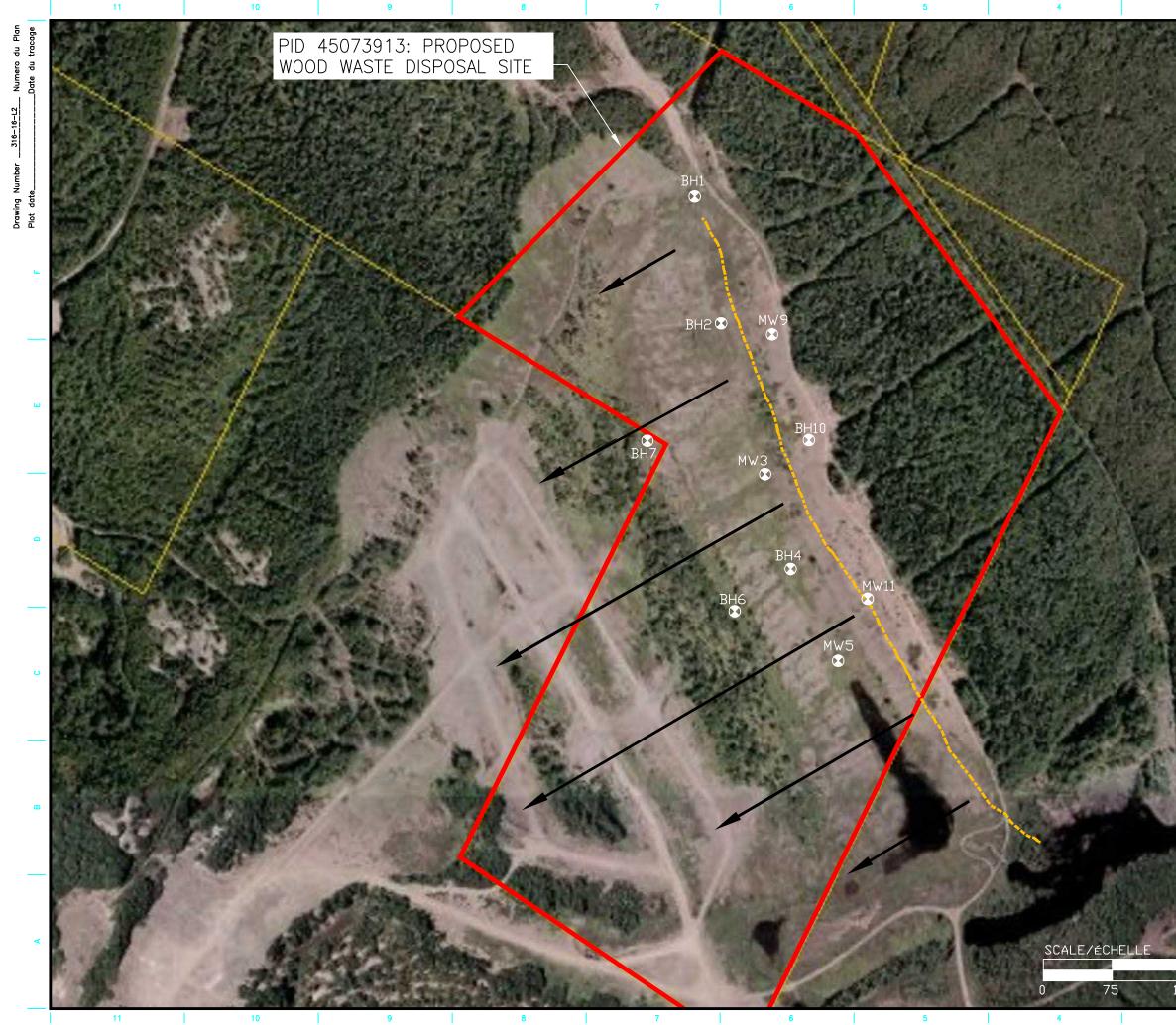
Out of the five records, a total of three exceed the CDWQG for turbidity. The elevated levels of turbidity may be related to the relative newness of the wells and they may not have had sufficient time, or use to clear naturally. Most new wells clear naturally with time and use.

The NBDELG well chemistry database provided results from a total of six wells for E coli analysis. Out of the six wells there were no detections of E. coli. A total of six wells had data for total coliforms and there were three detection of total coliforms. Total coliforms are natural soil bacteria and are commonly present in private well water systems, particularly associated with elevated turbidities.

In summary, the groundwater chemistries found in the NBDELG database are not unusual for this area and reflect natural aquifer conditions in this specific area. Specific groundwater chemistry problems are evident in the area. Exceedances of arsenic, chloride, iron, manganese, pH, turbidity, and TDS are observed.

Site Specific Geology and Hydrogeology

A site visit was carried out December 15, 2016, coincident with staff from Roy Consultants supervising the installation of monitoring wells and boreholes. The observations made during the site visit were consistent with the available background information. A total of four monitoring wells and six boreholes were constructed at the locations shown in Figure 2. The well and borehole logs are provided in Appendix 1, at the back of this report.



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Hydrogeology and Flow Direction: The proposed wood waste disposal site is located on former strip mined land. The boundary with undisturbed rock (not strip mined) is immediately east of the site and is shown in Figure 2 as a dotted yellow line. East of the dotted yellow line is undisturbed rock, west of the dotted yellow line are the spoils of the past strip mining operation. Well and borehole logs (MW9, MW11, and BH10) located in the undisturbed bedrock all display a similar stratigraphy. A relatively thin (0.28 to 2.77 meter thick) layer of unconsolidated intermixed dirty sand and gravel overlies consolidated sandstone. Well and borehole logs (MW3, MW5, BH1, BH2, BH4, BH6 and BH7) also display a similar stratigraphy within the group. A thick layer of unconsolidated mine spoils, described variously as varying fractions of gravel, sand, silt and clay in the well and borehole logs. Consolidated sandstone bedrock. MW5 is located at the lowest topographic elevation of all of the wells and boreholes. The rest of the wells and boreholes in this group do not intersect consolidated bedrock in any of these holes with a maximum depth of 9.14 meters.

Four soil samples of the unconsolidated mine spoils were selected for grain size analysis. The samples were located as follows:

- Sample 214-16 BH2 SS-10 at a depth of approximately 5.75 meters below ground surface in unconsolidated material described as silty sand.
- Sample 215-16 BH1 SS-4 at a depth of approximately 2.2 meters below ground surface in unconsolidated material described as sand, some gravel.
- Sample 216-16 BH6 SS-6 at a depth of approximately 3.3 meters below ground surface in unconsolidated material described as sand and gravel.
- Sample 217-16 MW3 SS-2 at a depth of approximately 0.9 meters below ground surface in unconsolidated material described as silty gravelly sand.

The results of the grain size analysis are provided in Appendix 2 at the back of this report. The sieve analysis was used to calculate hydraulic conductivities (K) for the four soil samples to represent the general condition of the mine spoils. This was done using the excel macro utility HydrogeoSieveXL. HydrogeoSieveXL is a utility that facilitates a quick means of obtaining hydraulic conductivity (K) estimates from grain size analyses. The utility tend to be most accurate in handling the coarser fractions of material common to aquifers, i.e., sand and gravel, although the values of K that are generated are generally only approximate. The presence of significant fractions of fines further degrades the quality of the K estimates. The output from HydrogeoSieveXL is provided in Appendix 2, at the back of this report. The K estimates are provided below in Table 3.

Sample ID	K (cm/s)	Soil Classification
Sample 214-16	0.0092	Poorly Sorted Gravelly Sand Low in Fines
Sample 215-16	0.013	Poorly Sorted Gravelly Sand Low in Fines
Sample 216-16	0.017	Poorly Sorted Sandy Gravel Low in Fines
Sample 217-16	0.0050	Poorly Sorted Gravelly Sand Low in Fines
Geometric Mean	0.01	

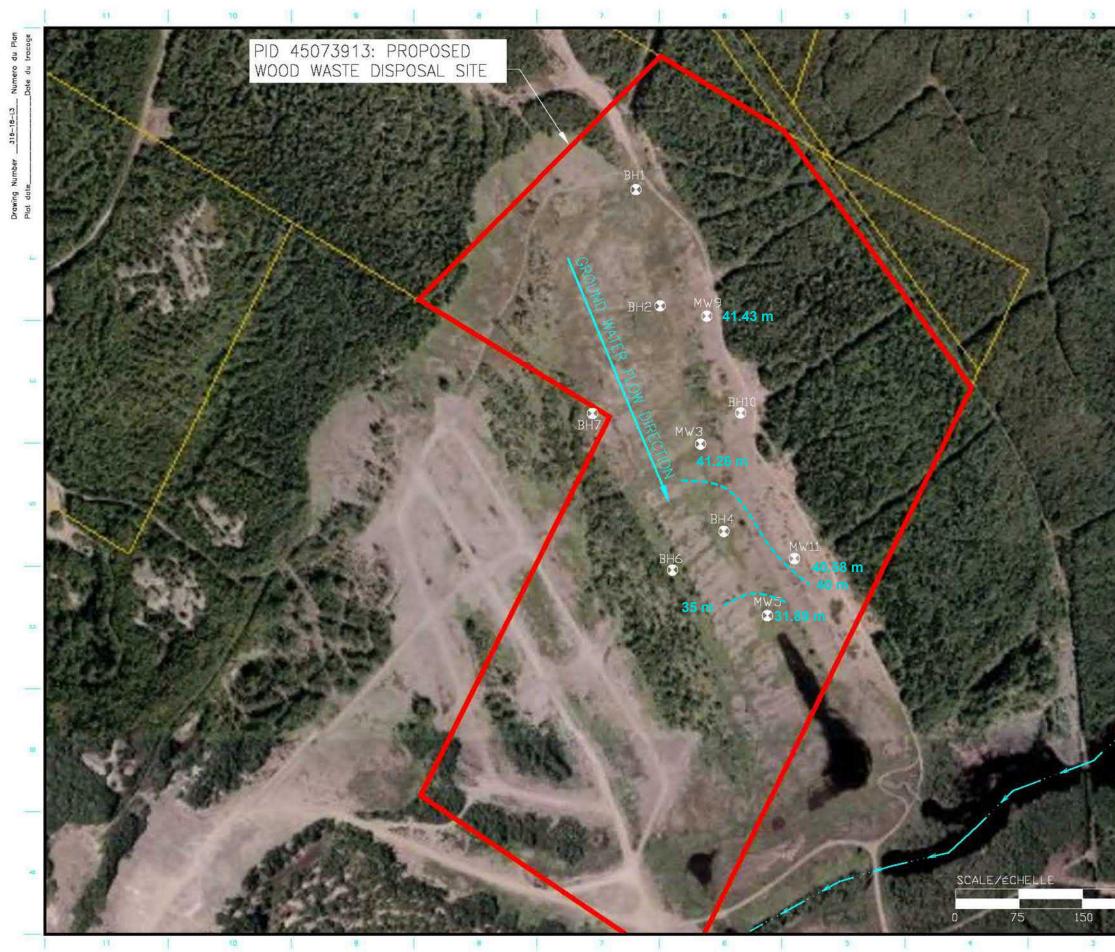
Table 3: Estimated hydraulic conductivity of soil samples (mine spoils).

Based on the soils analysis the estimated *K* of the mine spoils is 10^{-2} cm/sec. A report by GEMTEC ¹, dealing with a similar site nearby reported measured values of hydraulic conductivity for the undisturbed bedrock in the range of 10^{-4} to 10^{-2} cm/s and for the mine spoils approximately 10^{-1} cm/s. Given these values it is probable that a hydraulic conductivity contrast of at least 1 to 2

¹ GEMTEC, 1988: Surface and Groundwater Hydrology of The Fire Road Mine Site, Minto, N.B.

orders of magnitude will exist between the natural bedrock and the more conductive mine spoils. The net result of this will be a tendency for ground water flow to follow the mine spoils areas. Groundwater levels were measured in the monitoring wells prior to the samples being collected and the resulting groundwater flow direction is shown in Figure 3. The direction of shallow groundwater flow from the proposed disposal area is south southeast, towards the pond. It appears, based on the measured direction of groundwater flow, that the groundwater beneath the proposed footprint of the wood waste site does indeed follow the preferential flow path through the mine spoils in a southerly direction.

Groundwater Chemistry: Groundwater samples were collected from the four monitoring wells (Figure 2) on December 22, 2016. The samples were analyzed for general chemistry and the results are provided in Table 4 which follows. Monitoring wells MW3 and MW5 are constructed in the mining spoils while MW9 and MW11 are constructed in undisturbed bedrock. The difference in inorganic chemistry of the groundwater from the two units is pronounced and significant. The sample analysis from the mine spoils (shaded pink in Table 4) shows that the groundwater in the spoils is much more acidic than the groundwater in the background or undisturbed setting (shaded grey in Table 4). As a result of this acidity, the spoils groundwater has greatly elevated concentrations of calcium, magnesium, iron, manganese, ammonia, alkalinity, sulfate, conductivity, and hardness. Trace metal results are provided in Table 5. In Table 5 it can be seen that the measured concentration of mercury in the mine spoils exceeds the OMoE Table 9 Non-Potable Groundwater Standard within 30 m of a Waterbody. In Tables 6 and 7, the inorganic chemistry results are compared to the Canadian Drinking Water Quality Guidelines and the CCME Guidelines for the Protection of Aquatic Life. Comparison to the potable water guideline is for the purpose of comparison only, as the monitoring wells are not potable water wells. Comparison to the Guidelines for the Protection of Aquatic Life is carried out as it is Wilson Brook, a surface water, to which shallow groundwater flow (and any leachate) will ultimately discharge. It is apparent from Tables 6 and 7 that the groundwater from the mine spoils has elevated concentrations of iron, manganese, and sulfate when compared to the potable drinking water guidelines.



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Table 4: Inorganic	Location: Chipman Fredericton, NB E3B 3P7 Analysis of Water							Fredericton N Canada E3B (Tel: 506.45 Fax: 506.45
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Analytes	Units	RL	OMoE	22-Dec-10	22-Dec-10	22-Dec-10	22-Dec-10	22-Dec-10
Sodium	mg/L	0.05	1800	12.6	3.73	3.54	8.77	17.8
Potassium	mg/L	0.03	1000	5.17	4.82	4.51	6.16	2.35
Calcium	mg/L	0.02		198.	276.	265.	21.5	18.8
Magnesium	mg/L	0.03		24.6	32.9	31.1	2.96	1.94
Iron	mg/L	0.01		0.82	1.08	1.74	0.05	0.18
Manganese	mg/L	0.001		12.1	23.1	20.1	0.095	0.195
Copper	mg/L	0.001	0.069	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	0.001	0.89	0.003	0.004	0.004	0.001	0.002
Ammonia (as N)	mg/L	0.05	0.00	0.26	0.45	0.39	< 0.05	< 0.05
pH	units	-		6.7	6.5	6.6	8.7	8.2
Alkalinity (as CaCO ₃)	mg/L	2		250	200	200	73	98
Chloride	mg/L	0.5	1800	2.4	2.7	2.8	4.1	2.1
Sulfate	mg/L	1		440	670	620	19	5
Nitrate + Nitrite (as N)	mg/L	0.05		0.05	< 0.05	< 0.05	< 0.05	0.16
o-Phosphate (as P)	mg/L	0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
r-Silica (as SiO ₂)	mg/L	0.1		6.2	6.4	6.2	5.8	7.5
Carbon - Total Organic	mg/L	0.5		1.6	1.9	1.8	1.7	1.1
Turbidity	NŤU	0.1		> 1000	> 1000	> 1000	> 1000	> 1000
Conductivity	μS/cm	1	N/A	1110	1430	1400	196	194
Calculated Parameters								
Bicarbonate (as CaCO ₃)	mg/L	-		250.	200.	200.	69.5	96.5
Carbonate (as $CaCO_3$)	mg/L	-		0.118	0.059	0.075	3.27	1.44
Hydroxide (as CaCO ₃)	mg/L	-		0.003	0.002	0.002	0.251	0.079
Cation Sum	meq/L	-		13.1	17.7	16.9	1.86	1.95
Anion Sum	meq/L	-		14.2	18.0	17.0	1.97	2.13
Percent Difference	%	-		-4.17	-0.91	-0.23	-2.82	-4.51
Theoretical Conductivity	μS/cm	-	N/A	1260	1640	1560	191	187
Hardness (as CaCO ₃)	mg/L	0.2		596	825	790	65.9	54.9
Ion Sum	mg/L	-		855	1140	1080	113	116
Saturation pH (5°C)	units	-		7.1	7.0	7.1	8.4	8.3

CERTIFICATE OF ANALYSIS

for Roy Consultants Group

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

-

Tailings

-0.46

Un-mined

0.29

Langelier Index (5°C)

Report ID:

Report Date:

Date Received: 22-Dec-16

223255-IAS

10-Jan-17

-0.36

-0.55

-0.12

921 College Hill Rd

Report ID:	223255-IAS
Report Date:	10-Jan-17
Date Received:	22-Dec-16

Table 5: Metals

CERTIFICATE OF ANALYSIS

for

Roy Consultants Group 364 York Street, Suite 102 Fredericton, NB E3B 3P7

Analysis of Metals in Water

Project #: 316-16

Location: Chipman

	Allalysis Of Me							1 a
RPC Sample ID:				223255-1	223255-2	223255-3	223255-4	223255-5 ^{ww.rp}
Client Sample ID:				316-16 MW-3	316-16 MW-5	316-16 MW-5	316-16 MW-9	316-16 MW-11
Ontario Ministry of Environ	ment Table 9 Non-Po	table Groun	dwater					
Standards within 30m of a			dwater					
	Waterbody					Duplicate		
Exceedance								
Date Sampled:				22-Dec-16	22-Dec-16	22-Dec-16	22-Dec-16	22-Dec-16
Analytes	Units	RL	OMoE				400	4.0.4
Aluminum	µg/L	1	10000	2	2	2	129	161
Antimony	µg/L	0.1	16000	0.2	0.1	< 0.1	0.7	0.1
Arsenic	µg/L	1	1500	13	5	4	< 1	1
Barium	µg/L	1	23000	34	23	27	327	382
Beryllium	µg/L	0.1	53	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	µg/L	1		< 1	< 1	< 1	< 1	< 1
Boron	µg/L	1	36000	14	14	13	19	18
Cadmium	µg/L	0.01	2.1	0.02	0.17	0.14	< 0.01	< 0.01
Calcium	µg/L	50		198000	276000	265000	21500	18800
Chromium	µg/L	1	640	< 1	< 1	< 1	1	< 1
Cobalt	µg/L	0.1	52	6.6	10.7	6.9	< 0.1	0.1
Copper	μg/L	1	69	< 1	< 1	< 1	< 1	< 1
ron	µg/L	20		820	1080	1740	50	180
_ead	µg/L	0.1	20	< 0.1	< 0.1	< 0.1	< 0.1	0.1
_ithium	µg/L	0.1		2.6	3.0	2.7	8.0	8.0
Vagnesium	µg/L	10		24600	32900	31100	2960	1940
Vanganese	µg/L	1		12100	23100	20100	95	195
Vercury	µg/L	0.05	0.29	1.73	1.28	1.22	< 0.05	0.20
Molybdenum	µg/L	0.1	7300	3.9	1.7	1.2	6.1	0.8
Nickel	µg/L	1	390	5	6	3	< 1	< 1
Potassium	µg/L	20		5170	4820	4510	6160	2350
Rubidium	µg/L	0.1		4.7	5.5	5.1	3.5	2.2
Selenium	µg/L	1	50	< 1	< 1	< 1	< 1	< 1
Silver	µg/L	0.1	1.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	µg/L	50	1800000	12600	3730	3540	8770	17800
Strontium	µg/L	1		2660	2670	2670	586	556
Tellurium	µg/L	0.1		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thallium	µg/L	0.1	400	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Tin	µg/L	0.1		< 0.1	< 0.1	< 0.1	0.4	0.1
Jranium	µg/L	0.1	330	1.8	1.6	1.5	1.7	0.5
Vanadium	µg/L	1	200	< 1	< 1	< 1	3	1
Zinc	µg/L	1	890	3	4	4	1	2
This report relates only to the samp		od to the lehere		U	1	Tailings	Un-mined	_

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

921 College Hill Rd Fredericton NB Canada E3B 6Z9 Tel: 506.452.1212 Fax: 506.452.0594

Parame	eter		Guic	lelines
Date	22-Dec-16	22-Dec-16	Canadian Drinking Water ⁽²⁾	CCME F.W.A.L. ⁽¹⁾
Sample ID	316-16 MW-9	316-16 MW-11		
Sodium (mg/L)	8.77	17.8	≤200	
Potassium (mg/L)	6.16	2.35		
Calcium (mg/L)	21.5	18.8		
Magnesium (mg/L)	2.96	1.94		
Iron (mg/L)	0.05	0.18	≤0.3	0.3
Manganese (mg/L)	0.095	0.195	≤0.05	
Copper (mg/L)	< 0.001	< 0.001	≤1	0.002 - 0.004(2)
Zinc (mg/L)	0.001	0.002	≤5.0	
Ammonia (as N) (mg/L)	< 0.05	< 0.05		2.2(3)
рН	8.7	8.2	6.5-8.5	6.5-9.0
Alkalinity (as CaCO ₃) (mg/L)	73	98		
Chloride (mg/L)	4.1	2.1	≤250	
Sulphate (mg/L)	19	5	≤500	
Nitrate + Nitrite (as N) (mg/L)	< 0.05	0.16	10.0	0.06
o-Phosphate (as P) (mg/L)	< 0.01	< 0.01		
r-Silica (as SiO ₂) (mg/L)	5.8	7.5		
Carbon - Total Organic	1.7	1.1		
Turbidity (NTU)	> 1000	> 1000	1.0	
Conductivity (µS/cm)	196	194		
Hardness (calc) mg/l as CaCO ₃	65.9	54.9		
Cation Sum (meq/L)	1.86	1.95		
Anion Sum (meq/L)	1.97	2.13		
% Difference	-2.82	-4.51%		

Table 6: Inorganic Chemistry data for monitoring wells developed in undisturbed bedrock, proposed wood waste site.

(1)Canadian water quality guidelines, to protect freshwater aquatic life.

(2) 0.002 mg/L if hardness = 0-120 mg/L as CaCO₃; 0.003 mg/L if hardness = 120-180 mg/L as CaCO₃; 0.004 mg/L if hardness = >180 mg/L as CaCO₃.

(3) 2.2 mg/L if pH = 6.5 - 7.5 and temperature = $10 - 15^{\circ}$ C.

Parameter		Sample Resul	t	Guio	lelines
Date	22-Dec-16	22-Dec-16	22-Dec-16 Duplicate	Canadian Drinking Water ⁽²⁾	CCME F.W.A.L ^{.(1)}
Sodium (mg/L)	12.6	3.73	3.54	≤200	
Potassium (mg/L)	5.17	4.82	4.51		
Calcium (mg/L)	198.	276.	265.		
Magnesium (mg/L)	24.6	32.9	31.1		
Iron (mg/L)	0.82	1.08	1.74	≤0.3	0.3
Manganese (mg/L)	12.1	23.1	20.1	≤0.05	
Copper (mg/L)	< 0.001	< 0.001	< 0.001	≤1	0.002 - 0.004(2)
Zinc (mg/L)	0.003	0.004	0.004	≤5.0	
Ammonia (as N) (mg/L)	0.26	0.45	0.39		2.2(3)
рН	6.7	6.5	6.6	6.5-8.5	6.5-9.0
Alkalinity (as CaCO ₃) (mg/L)	250	200	200		
Chloride (mg/L)	2.4	2.7	2.8	≤250	
Sulphate (mg/L)	440	670	620	≤500	
Nitrate + Nitrite (as N) (mg/L)	0.05	< 0.05	< 0.05	10.0	0.06
o-Phosphate (as P) (mg/L)	< 0.01	< 0.01	< 0.01		
r-Silica (as SiO ₂) (mg/L)	6.2	6.4	6.2		
Carbon - Total Organic	1.6	1.9	1.8		
Turbidity (NTU)	> 1000	> 1000	> 1000	1.0	
Conductivity (µS/cm)	1110	1430	1400		
Hardness (calc) mg/l as CaCO ₃	596	825	790		
Cation Sum (meq/L)	13.1	17.7	16.9		
Anion Sum (meq/L)	14.2	08.0	17.0		
% Difference	-4.17%	-0.91%	-0.23%		

Table 7: Inorganic chemistry data from monitoring wells developed in mine spoils, proposed wood waste site.

(1)Canadian water quality guidelines, to protect freshwater aquatic life.

(2) 0.002 mg/L if hardness = 0-120 mg/L as CaCO₃; 0.003 mg/L if hardness = 120-180 mg/L as

 $CaCO_3$; 0.004 mg/L if hardness = >180 mg/L as CaCO_3.

(3) 2.2 mg/L if pH = 6.5 - 7.5 and temperature = $10 - 15^{\circ}$ C.

4.0 DISCUSSION

Potential human or environmental exposure to contaminants is considered in a risk assessment framework. In its simplest form the risk assessment can be broken down into the following components

- Potential <u>receptors;</u> and
- Characteristics and quantities of potential <u>contaminants</u> present within the site; and
- Potential exposure <u>pathways</u> for contaminants to leave the site.

The general methodology involves collecting existing background data and conducting a visual inspection of the site. The level of effort put into examining each site is limited in the initial stages. Should the initial assessment indicate potential significant exposure of receptors to contaminants then further assessment work would be recommended.

Potential Receptors

In terms of human receptors there are a number of private wells located adjacent to Route 10 which is west of the proposed site (Figure 1). The closest of this group of receptors approximately 1,500 meters from the proposed wood waste disposal area. Potential environmental receptors are a pond located south of the site, approximately 20 meters from the southern limit of the proposed site. This pond drains to Wilsons Brook via a small surface stream.

Potential Contaminants: Wood waste is commonly not suspected as a source of significant ground water contamination. It is known; however, that decomposing wood waste break-down products can potentially contaminate ground water with concentrations of tannin-lignin, BOD, COD, phenols, colour, odour and some metals in the ground water. A number of these potential contaminants are oxygen demanding and their presence can result in significantly increasing the concentration of iron and manganese in the groundwater.

The current existing wood waste disposal site for the Grand Lake Timber, Limited operation has been in place for years and the shallow groundwater chemistry below the site is monitored. This disposal site is also located in an area of former strip mine spoils. The results of the 2016 monitoring are presented in Table 8, which follows. In Table 8, the downgradient monitoring wells are represented by MW1-S, MW2-S, and MW4-S. As can be seen in Table 8, for the downgradient wells, the pH is low (acidic groundwater), with elevated concentrations of iron, manganese, and sulfate. The downgradient groundwater chemistry shown in Table 8 (below the existing wood waste site) is quite similar to the sample results for the groundwater samples collected within the mine spoils at the new proposed wood waste site. In other words, the principal groundwater chemistry impacts observed in the proposed new site, within the strip-mined area, which has not received any wood waste yet. The principal ground water impacts observed are due to the former strip mining activities and not the deposition of wood waste, in any significant way.

Potential Pathways

The potential pathways by which contaminants could leave the site are air, surface water, and groundwater.

Air Pathway: The air pathway is insignificant in terms of the materials present at a wood waste disposal site and the contaminants identified above. In the event that some wood dust or small particles is mobilized by wind there are no receptors close by and the wood dust would be deposited locally, in the surrounding woodland area, where its impact would be inconsequential.

Surface Water Pathway: There is no stream draining the south trending depression that holds the proposed wood waste disposal facilities footprint. The closest surface water is the pond located south of the proposed disposal area which drains to Wilson Brook. To prevent significant amounts of wood waste from reaching this potential pathway, the southernmost extension of the waste footprint should be kept a minimum of 10 meters from the high water point of the pond.

Groundwater Pathway: The groundwater pathway is the principal pathway via which potential contaminants can migrate off site. Precipitation and snowmelt will infiltrate through the wood waste and into the mine spoils below it. The measured groundwater flow direction is generally south, towards the existing pond which subsequently flows into Wilson Brook.

Potential human receptors (the private wells along Hwy 10) will not be impacted due to distance from the site (approximately 1.5 km) and the groundwater flow direction (south, eventually to Wilson Brook), not in the direction of the potential human receptors. In addition, the old Chipman dump site (PIDs 45098811, 45098829) is situated approximately midway between the proposed site and the closest private wells. When that dump site was closed in 1998, the closure included investigations and private well sampling to attempt to determine if the dump site was potentially impacting the closest private wells along Hwy

10. No discernable impacts were found. As the proposed new site is approximately twice as far away and in the same direction, it is very unlikely that human receptor impacts would occur.

The measured groundwater flow path, to the pond and into Wilson Brook indicates the potential for environmental aquatic impacts. Any potential environmental impact will be insignificant compared to the existing impacts from the historic strip mining activity. The comparison of the downgradient impacts from the existing wood waste site clearly showed minimal impacts due to the presence of the wood waste, compared to the impacts from the strip mine spoils.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following is concluded based on the site assessment;

- 1. Potential air transport of significant contamination from the proposed wood waste disposal site is not a significant concern.
- 2. Surface water transport is not a likely pathway for contaminant migration and in any event the surface water drainage from the proposed wood waste site is towards the south, away from the human receptors and in the general direction of Wilson Brook, located in that direction. In addition, there is no existing surface stream in the depression that forms the proposed footprint of the wood waste site.
- 3. Shallow groundwater transport is the most likely potential pathway for contaminant migration from the proposed wood waste site; however, groundwater flow was determined to be towards the south, in the general direction of the pond and Wilson Brook.
- 4. Potential Human receptors represented by private wells are not located in the directions of surface and ground water flow. Groundwater flow from the area of the proposed wood waste site will be within the mine spoils into the pond and eventually Wilson Brook.
- 5. The shallow groundwater flow beneath the wood waste footprint will slow and somewhat reduce the rate of contaminant migration to the pond and Wilson Brook through natural attenuation.
- 6. Ecological impacts from the discharge of the shallow groundwater into the pond/Wilson Brook will be of acceptable magnitude as demonstrated by the groundwater quality data. The magnitude of potential impacts from the wood waste is overwhelmed by existing acid mine drainage from the mine spoils.
- 7. A liner is not necessary at this site as a consequence of the existing state of conditions at the proposed wood waste site. The potential environmental impacts from the proposed wood waste site are inconsequential when compared to the existing environmental impacts from the previous strip mining activity and the acid mine drainage from the mine spoils. A liner would simply move the potential leachate from the wood waste into the pond and Wilson Brook faster than the shallow groundwater flow path.

The following is recommended, based on the results of the risk assessment to date.

1. It is recommended that the southern toe of the wood waste footprint be kept a minimum of 10 meters north of the pond high water mark.

Report Prepared By:

Craig Hydrogeologic Inc. 140 Meadow Cove Road. Dipper Harbour, NB E5J 2S9

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Douglas Craig, M.Sc., P.Geo. Hydrogeologist, Site Professional NB

Appendix 1

Well and Borehole Logs

		BC	REI	HOL	E I	_00	R R	EPC	RT									
CLIE	NT	J.D. IRVING, LIMITED								_	PAGE							
LOC/ DATE	ATION	GRAND LAKE WOOD WASTE DISPOSAL SITE DECEMBER 16, 2016	-								PROJI BORE						-	
				DEPTH		5.001					BOKE					,	_	
	<u>le type</u> Split sf	POON FIELD TESTS AND OBSERVATIONS	_					<u>Kator</u> Modifie		<u>ILYSIS</u> H			ESEN DROC			IN SO	ILS	
	CORE B	N : STANDARD					b : 6	BTEX					: NC : OD		EXIST, R	ANT		
AU :	AUGER	∑ : WATER LE					ן: c לי ה	PAH METALS	-			S	: ST/	AINE	D			
STATE	OF SA	LLLVATION						SIEVE		YSIS		FR	: F	REE	PHA	SE PR	.ODU	СТ
		LOST NOT SAMPLED SECONDETIC	-	-	-		0:	OTHER	!									
	(SAMPLE	/NO.	ε		۱ (%)	ANALYSIS	-		PRES	SENC	E				
V. (M)	DEPTH (M)	SOIL DESCRIPTION	PLOT	OF SAM	TYPE/NO.	0.15m	or N	RECUPARATION	/ ANAI	HYDROCARBON VAPOURS	_H)F CARE	SON	01	BSERVA	ATION	٩S
ELEV.	DEF		STRATA	STATE C	SAMPLE	BLOW /	R.Q.D. 0	CUPA	ESTS /	HYDROCAF VAPOURS	N	1		FR				
45.50			S	SI	7S	BI	.R.	17 17	Щ	1 1 ≥					<u> </u>			
45.59 (PVC)	- 1														-		-	+
44.87	- 0 =	ORGANIC SOIL AND SILTY SAND, SOME		\wedge		2 3									SAND -			
	 	CLAY, BROWN		ert	SS-1	3 2	6	0							SILICA S			
		SILTY GRAVELLY SAND, TRACES OF CLAY, BROWN		\bigvee	SS-2	1 3	5	50	SA									
	- 1 - 1.22 <u>-</u>			$\mid \rangle$		2 3 4									+			
		SILTY GRAVELLY SAND, TRACES TO SOME CLAY, BROWN; PRESENCE OF COBBLES		X	SS-3	9 6	15	13										PVC
	1.83 - - 2 -			$ \land $		9 6 7									- Bentonite			
				X	SS-4	3 3 2	6	0										
	_2.44 _ _ 2.74 _				AU-1													
	- 3 -	SILTY GRAVELLY SAND, TRACES TO SOME CLAY, BROWN; PRESENCE OF ORGANIC		\mathbb{N}	SS–5	3 2 3	5	25										
	 3.35	MATTER IN SS-5 GREY SANDSTONE FRAGMENTS IN SS-6		$\left(\right)$		4 5					_						-	Ť
				X	SS–6	2 2	4	25	∇								-	
	- ^{3,96} -			$ \land $		2 3 3											-	
	- 4.57 -			\wedge	SS-7	5 3	8	25	SA						- GND			
		SILTY SAND, SOME GRAVEL, TRACES OF CLAY, BROWN		\bigvee	SS-8	3	11	33							- SILICA			ed pvc
	- 5 - 5.18 -			\square		8 6 5										, " 	-	- SLOTTED
				\mathbb{N}	SS-9	5 11 7	18	29									-	
	5.79			\vdash		5 4					\vdash							
	- 6 -			X	SS-10	4 5 5	9	96										
	6.40			\bigtriangledown		5 5 3		05									-	
	_ 7 _	CONTINUED ON PAGE 2		\land	SS-11	5 4	8	25									÷.	
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	che	cked b	y <u>J.B</u>	<u>. </u>	date <u>(</u>	02/07	/17	rev. <u>0</u>			[Ŗ	[] ^R	ROY XONSULI	CANT	3

			BC	RE	HOL	.E	L00	R	EPC)RT							
CLIE	NT	J.D. IRVING, LIMITED									_	PA	GE _	2	OF	2	_
	ATION -	GRAND LAKE WOOD WA															<u>-16</u>
		DECEMBER 16, 2016			DEPTH		3.66n					BC					<u>W-3</u>
SS : CB : AU : <u>STATE</u> DISTURBE	LE TYPE SPLIT SI CORE B AUGER E OF SA CORE	POON ARREL <u>MPLE</u> LOST NOT SMMPLED	FIELD TESTS AN OBSERVATIONS N : STANDARI ▼ : HYDROCAI □ : WATER LE ELEVATION ⊠ GEODETIC □ LOCAL GRID) peni Rbon				a : 1 b : 1 c : 1 d : SA :	Modifii Btex	ed tpi S Anal`				HYD N O S	0 <u>ROC</u> : NC : OD : ST/	n-e: Our Ained	I <u>ns in soils</u> Kistant
ELEV. (M)	DEPTH (M)	SOIL DESCRIF		ATA PLOT	E OF SAMPLE	SAMPLE TYPE/NO.	N / 0.15m	D. or N	RECUPARATION (%)	S / ANALYSIS	HYDROCARBON	VAPOURS		0	ENC F CARE		OBSERVATIONS
38.37	6.50	CONTINUED FROM PAGE	1	STRATA	STATE	SAMF	BLOW	R.Q.D.	RECI	TESTS	IDAH	VAP(N	0	S	FR	
	- 7 -	SILTY SAND, SOME GRAV CLAY BROWN			X	SS-11											SAND
	7.01	CLAY BROWN; PRESENCI	VEL, TRACES OF E OF COBBLES		\square	SS-12 SS-13	6 6	17 >50	75								SILICA SA
		END OF BOREHOLE AT 7 BOULDER OR FRACTURED					50										
	- 9 -																
	- 10																
	- 11 -																
	- 12 -																
	-13 -																
	- 14 -																
		supervised by <u>J.B.</u>	drawn by <u>A.L.</u>	che	cked b) by _J.E	 !	date <u>(</u>	02/07,	/17_	rev	0				Ŗ	ROY

		BC	RE	HOL	E I	_00	R	EPC)RT						
CLIE	NT	J.D. IRVING, LIMITED								F	PAGE	_1_	. OF	_2	_
	ATION	GRAND LAKE WOOD WASTE DISPOSAL SITE						IB							-16
DATE		DECEMBER 15, 2016	VATER	DEPTH		3.66n	<u>ו</u>			E	BORE	HOLE	No.	N	1W-5
SS : CB : AU :	<u>e type</u> Split Sf Core B/ Auger <u>OF SA</u>	ARREL N : STANDARE ▼ : HYDROCAI ↓ : WATER LE) pene Rbon				a : b : [c : d :	Modifie Btex	ED TP			HYI N O S	: NC : OC : ST,	: <u>ARB(</u>)N-E)OUR AINE[<u>ons in soils</u> XISTANT
	CORE	LOST NOT SAMPLED SECODETIC	1				o :	OTHER	2	1					
ELEV. (M)	DEPTH (M)	SOIL DESCRIPTION	STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	R.Q.D. or N	RECUPARATION (%)	ESTS / ANALYSIS	HYDROCARBON VAPOURS		(DRO	SENC OF CARE		OBSERVATIONS
36.69 (PVC)			S	S S	S	Ш	8	8	-	>					
35.84	- 0	SAND, SOME GRAVEL, SOME SILT, TRACES				23									
	- 0.61	OF CLAY, BROWN; TRACES OF ORGANIC MATTER SAND, SOME GRAVEL, SOME SILT, TRACES		\land	SS-1	4 3 3	7	71							
	- 1 - 1.22 -	OF CLAY, BROWN	و میں اور	X	SS-2	3 3 2	6	42							BENTONITE
	- 1			\mathbb{X}	SS-3	335	8	54							
	1.83 <u>-</u> - 2 -			\square	SS-4	5 4 3 1	4	42							
	_2.44 _			\bigtriangledown	SS-5	1 1 2	3	42							
	- 3 - 3.05 -			\bigcirc	SS-6	1 3 2	4	54							
	3.66			$\left(\right)$		2 2 3 3									
	- 4 - 4.27 -			$\left \right\rangle$	SS-7	2 3 4 3	5	38	∇						SILICA SAND
				\square	SS-8	3 2 2	5	33							
	- 5 - - 5.49 -			X	SS-9	2 3 5 5	8	25							
				\mathbf{N}	SS-10	4 4 5	9	13							
	6.10 - - 6.10 - 			$\left \right\rangle$	SS-11		15	42							
	-6.58 _ 	BEDROCK: SANDSTONE, BROWN AND GREY				50									
	_ 7 _	CONTINUED ON PAGE 2													
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cheo	ked b	y <u>J.B</u>	<u>. </u>	date _	0/01,	/17_	rev. <u>0</u>	-			Ŗ	ROY CONSULTANTS

		BC	REI	HOL	E I	L00	R	EPC)RT							
CLIE	NT	J.D. IRVING, LIMITED									PA	GE _	2	OF	2	_
	ATION -	GRAND LAKE WOOD WASTE DISPOSAL SITE						IB								<u>–16</u>
DATE			VATER	DEPTH		3.66n					BC					I <u>W-5</u>
SS : CB : AU : <u>STATE</u> DISTURBED	LE TYPE SPLIT SI CORE B AUGER OF SA	POON OBSERVATIONS N : STANDARI ▲RREL I : HYDROCA ↓ : WATER LE MPLE <u>ELEVATION</u> LOST NOT SAMPLED ⊠ GEODETIC) pene Rbon		N		a : b : c : d : SA :		ed tp S Anal'	Η			HYD N O S	0 <u>ROC</u> : NC : OD : ST/	n-e our Ainei	<u>DNS IN SOILS</u> XISTANT
ELEV. (M)	DEPTH (M)	SOIL DESCRIPTION	STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	R.Q.D. or N	RECUPARATION (%)	TESTS / ANALYSIS	HYDROCARBON	VAPOURS		0 DRO(CARE		OBSERVATIONS
37.87		CONTINUED FROM PAGE 1 BEDROCK: SANDSTONE, REDDISH BROWN	S	S	S	•	R	R			>		-	_		
		AND GREY														SILICA SAND
	7.62	END OF BOREHOLE AT 7.62 METERS														<u>at Fair Tai Ta</u>
	- 8 -															
	-															
	-9 -															
	-															
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	-15 -													r		
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cheo	ked b	y <u>J.E</u>	l <u>. </u>	date _	10/01,	/17_	rev	0				Ŗ	ROY CONSULTANTS

		ВО	REł	HOL	E l	_00	R	EPC	RT							
		J.D. IRVING, LIMITED										GE _				
		GRAND LAKE WOOD WASTE DISPOSAL SITE DECEMBER 16 AND 17, 2016	-		-											<u>-16</u> IW-9
<u>SAMP</u> SS : CB : AU : <u>STATE</u> DISTURBE	LE TYPE SPLIT SF CORE B/ AUGER OF SAM	POON ARREL ARREL <u>IDEE</u> LIGST NOT SMUPLED FIELD TESTS AND OBSERVATIONS N : STANDARD N : STANDAR) Pene RBon I	TRATIC			LABO a : M b : E c : I d : I SA :	<u>rator'</u> Modifie Btex	<u>y ana</u> Ed tp S Anal'	<u>LYSIS</u> H			<u>HYD</u> N : O : S :	ROC NO OD ST/	n-e our Ainee	<u>DNS IN SOILS</u> XISTANT
ELEV. (M)	DEPTH (M)	SOIL DESCRIPTION	STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	R.Q.D. or N	RECUPARATION (%)	Tests / Analysis	HYDROCARBON	VAPOURS	HYD	0 RO(ENCI F CARB	ON	OBSERVATIONS
49.44 (PVC)																
48.63	-0 0.28 -1 -1.52 -2 -3.05 -3.05 -4 -4 -4.57 -5 -6 -6 -6 -6 -100 -1000 -1000 -1000 -1000	GRAVELLY SAND, SOME SILT, GREY BEDROCK: SANDSTONE, BROWN BEDROCK: SANDSTONE, BROWN AND/OR GREY			<u>SS-1</u> AU-1 AU-2 AU-3 AU-4	50	>50	100								
	_ / _	supervised by <u>J.B.</u> drawn by <u>A.L.</u>	chec	ked b	y <u>J.B</u>	•	date _1	1/01,	/17_	rev. <u>(</u>)	1			R	ROY CONSULTANTS

		BC	REI	HOL	E I	_00	R	EPC	RT							
CLIE	NT	J.D. IRVING, LIMITED									PA	GE _	2	0F	_2	_
	ATION	GRAND LAKE WOOD WASTE DISPOSAL SITE														<u>–16</u>
DATE		DECEMBER 16 AND 17, 2016		DENIH	_7.32	m (DE					BC					<u>W-9</u>
	<u>e type</u> Split si	ODD OBSERVATIONS						<u>rator`</u> Modifie		<u>LYSIS</u> H					<u>CE (</u> ARBO	<u>)F</u> DNS IN SOILS
	CORE B	ARREI N : STANDARI					b : [•					N-E	XISTANT
AU :	AUGER	▼ : HYDROCA ↓ : WATER LI		LEVEL			c :		_						AINE	
STATE	OF SAL							METALS SIEVE		rsis			FR	: Fl	REE	PHASE PRODUCT
disturbei	CORE	LOST NOT SAMPLED SECODETIC					o :	OTHER	2							
	0			PLE	NO.	_		(%)	YSIS			P	RES	ENC	E	
. (M)	(M) HI	SOIL DESCRIPTION	PLOT	SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	z	RECUPARATION	/ ANALYSIS	HYDROCARBON		1.0.45	0			OBSERVATIONS
ELEV.	DEPTH		STRATA F	TE OF	ЧЦ	/ M	R.Q.D. or	UPAR	tests /	ROCA	VAPOURS	НҮІ		CARE		
41.63	7	CONTINUED FROM PAGE 1	STR	STATE	SAN	BLC	R.Q	REC		НУС	VAF	N	0	S	FR	
		BEDROCK: SANDSTONE, BROWN AND/OR GREY			AU-5				∇							
	7.62	GRET														
	- 8 -			\setminus /												
				V	AU-6											SAND
																SILICA SA
	- 9 - 9.14 -			$/ \setminus$												
	-10				AU-7											
	13.11	END OF BOREHOLE AT 13.11 METERS														
	- 11 -															
	-12 -															
	111															
	-13 -															
	14															
	-14 -															
	-15 -															
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	che	cked b	y <u>J.B</u>	<u> </u>	date _	11/01,	/17_	rev. <u>(</u>)			[Ŗ	ROY CONSULTANTS

		BC	REI	HOL	E I	_00	R	EPC	RT						
CLIE	NT	J.D. IRVING, LIMITED									GE -				
LOC/ DATE	ation -	GRAND LAKE WOOD WASTE DISPOSAL SITI						IB							<u>6–16</u> /W–11
	 Le type	FIELD TESTS AN		DEFI		2.770		RATOR	Υ ΔΝΔ				SEN		
	split sf	OBSERVATIONS	_					MODIFIE				HYC	ROC	ARB	ONS IN SOILS
	CORE B	ARREL \mathbf{V} : HYDROCA			JN		b : [c :						: NC : OD		EXISTANT
	AUGER	∑ : WATER LI	EVEL					METALS	5				ST/		d Phase product
DISTURBE	<u>E OF SAI</u> d core	IDE <u>ELEVATION</u> LOST NOT SAMPLED ⊠ GEODETIC						SIEVE		YSIS			•••		
			1	1			o :	OTHER			1				
(W)	(W)			SAMPLE	TYPE/NO.	Бm		(%) N(ANALYSIS	z	F	PRES 0	ENC	E	
ELEV. (I	DEPTH	SOIL DESCRIPTION	V PLO]	Р	ΕIJ	/ 0.15m	or N	RECUPARATION	\sim	HYDROCARBON VAPOURS	HYI	-	CARE	BON	OBSERVATIONS
			STRATA PLOT	STATE	SAMPLE	BLOW	R.Q.D.	RECUP	TESTS	HYDROCAF VAPOURS	N	0	s	FR	
45.59 (PVC)															
(PVC)															
44.87															
	-	SAND AND GRAVEL, SOME SILT, GREYISH BROWN			<u>ISS-1</u> AU-2	15	<u>א/אך</u>	163							A SAND
	0.62 - 0.72 -			\times			>50	- 17 -							- SILCA
	- 1 _	GRAVELLY SAND, SOME SILT, GREYISH BROWN			AU-4										
	- 1.52 -				70-4										
	1.52	SILTY SAND, SOME GRAVEL, REDDISH BROWN		\bigvee	SS-5	9 10	27	83	SA						BENTONITE
	- 2 2.13 _					17 30									
					AU				∇						
	2.74 - 2.77 - - 3 -	BEDROCK: SANDSTONE, REDDISH BROWN			SS-6	50	>50								
		AND GREY													
	- 4 -														
															AND
	- 5														S CITED
	- 6 -														
	- 7 =	CONTINUED ON PAGE 2													
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	che	cked b	y <u>J.B</u>	<u>. </u>	date _	10/01,	/17	rev. <u>0</u>				Ķ	ROY CONSULTANTS

		BC)REF	HOL	E	LOG	R	EPC)RT						
CLIE	NT	J.D. IRVING, LIMITED									PAGE	2	. OF	_3	_
	ATION -									_					<u>-16</u>
		DECEMBER 15, 2016		DEPIH		<u>2.44n</u>					JORE				<u>IW-11</u>
SS : CB : AU : <u>STATE</u> DISTURBE	LE TYPE SPLIT SF CORE B/ AUGER E OF SAM	POON ARREL MPLE LOST_NOT SAMPLED NOBSERVATIONS N : STANDAR V : HYDROCA V : WATER L ELEVATION ⊠ GEODETIC	d pene Rbon i Evel		N		a : b : c : d : SA :	Modifie Stex	ed tpi S Anal'			<u>HYI</u> N O S	<u>DROC</u> : NC : OE : ST.)n-e)our Aine[<u>DNS IN SOILS</u> XISTANT
ELEV. (M)	J DEPTH (M)	SOIL DESCRIPTION	STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	R.Q.D. or N	RECUPARATION (%)	TESTS / ANALYSIS	HYDROCARBON VAPOURS	H	C	SENC)F CARE		OBSERVATIONS
	7 -8 -9 -9 -10 -11 -12 -12 -13 -14 -14 -15	CONTINUED FROM PAGE 1 BEDROCK: SANDSTONE, REDDISH BROWN AND GREY	STILL STIL		SA	BL	R.O.	RE		λΗ					
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	chec	ked b	y <u>J.E</u>	l	date _	10/01,	/17_	rev. <u>0</u>	_			Ŗ	ROY

		BO	RE	HOL	.E	LOG	R	EPC)RT							
CLIE	NT	J.D. IRVING, LIMITED									PAG	ε_	3	OF	3	_
	ATION	GRAND LAKE WOOD WASTE DISPOSAL SITE	<u>(PID</u>	45073	<u>3913),</u>	CHIP	MAN, M	NB								-16
DATE	<u> </u>	DECEMBER 15, 2016	IATER	DEPTH		2.44m	<u>۱</u>			_	BOF	REHO	OLE	No.	M	<u>W-11</u>
<u>SAMPI</u>	<u>LE TYPE</u>	FIELD TESTS AND	<u>)</u>				<u>LABO</u>	RATOR	<u>y ana</u>	<u>LYSIS</u>					CE O	
SS :	split s	POON <u>OBSERVATIONS</u> N : STANDARE		TRATIC	N			MODIFI	ed tp	Н						I <u>NS IN SOILS</u> (ISTANT
	CORE B	ARREL TITICAL					b : [OUR	
AU :	AUGER	$\overline{\nabla}$: water le					c:	PAH METALS	-				S :	: ST/	AINED	
<u>STATE</u>	OF SA	MPLE <u>ELEVATION</u>						SIEVE		YSIS			FR	: F	REE	PHASE PRODUCT
	D CORE	LOST NOT SAMPLED SEODETIC						OTHER								
	(SAMPLE	TYPE/NO.	ε		1 (%)	/ ANALYSIS	_		Ρ		ENC	E	
(W)	(W) H.	SOIL DESCRIPTION	PLOT	SAN	IYPE,	BLOW / 0.15m	z	RECUPARATION	ANAI	HYDROCARBON VAPOLIRS			0			OBSERVATIONS
ELEV.	DEPTH		TAP	E OF	Ľ IJ	\ \ \). or	JPAR		HYDROCAR		HYC	RO		BON	
29.87	15	CONTINUED FROM PAGE 2	STRATA	STATE	. SAMPLE	BLOV	R.Q.D.	RECL	TESTS	HYDF		N	0	S	FR	
20.07		BEDROCK: SANDSTONE, BROWN AND GREY														
		END OF BOREHOLE AT 15.24 METERS													010	
	-															
	-16 -															
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		our on the LD design by Al		المعال	.,	,	data '	10/01	/17	rov 0				[ŖĮ	ROY CONSULTANTS
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cned	жеа Б	y <u>J.E</u>)	uate _	10/01,	/1/	rev. <u>0</u>	_			l		alasian dalam da Silit VICIB artistationa

		BO	REI	HOL	E l	_00	R	EPC	RT							
CLIE	NT	J.D. IRVING, LIMITED								_					_2	
		GRAND LAKE WOOD WASTE DISPOSAL SITE	•													<u>16</u>
		DECEMBER 17, 2016 W		DEPIF		NO W					BC					-1
	<u>e type</u> Split si	OBSERVATIONS	<u>D</u>					<u>rator</u> Modifii							<u>ce of</u> Arbon	<u>. NS IN SOILS</u>
	CORE B	N : STANDARD					b:			•)n-ex)our	ISTANT
AU :	AUGER	₩NEL		LEVEL			c :								AINED	
<u>STATE</u>	OF SA							METALS SIEVE		(SIS			FR	: F	REE P	HASE PRODUCT
	CORE	LOST NOT SAMPLED GEODETIC						OTHER								
				ш				(%)	S						_	
(W)	(W)	SOIL DESCRIPTION	ц	SAMPLE	TYPE/NO.	15m	_		ANALYSIS	NO			RES 0		C.	OBSERVATIONS
ELEV. (M)	DEPTH	JUL DESCRIPTION	A PLOT	Р	ΕIJ	/ 0.15m	or N	RECUPARATION	/	HYDROCARBON	JRS	HY	ROC	CARE	BON	OBSERVATIONS
ш	Δ		STRATA	STATE	SAMPLE .	BLOW	R.Q.D.	RECUF	TESTS	HYDR(VAPOURS	N	0	S	FR	
							-									
51.74	- 0 =	SILTY GRAVELLY SAND WITH ORGANIC				2 10										
	 	SOIL, BROWN			SS-1	7 7 7	17	71								
	0.01	SILTY GRAVELLY SAND, BROWN		\bigvee	SS-2	7 8 8	16	79								
	- 1 - 1.22 -			\triangle	55-z	7	10	/5								
		SAND, SOME GRAVEL, SOME SILT, TRACES OF CLAY, BROWN; PRESENCE OF		\mathbb{N}	SS-3	4 8 9	17	100								
	1.83 _	COBBLES		$\langle \rangle$		9 10 11										
	- 2 -			X	SS-4	10	29	67	SA							
	_2.44 _	GRAVELLY SAND, SOME SILT, BROWN AND	4	$\left\{ \right\}$		19 18 22										
		GREY; PRESENCE OF COBBLES		Х	SS-5	25 16	41	79								
	- 3 - 3.05 <u>-</u>			$\langle \rangle$		17 15										
				X	SS-6	8 14 9	22	46								
	3.66 _			$ \land $		9 10 12										
	- 4 _ 4.27 _				SS–7	12 10	24	21								
			. A., 	\bigtriangledown	SS-8	15	21	29								
	4.88 _			\square	33-0	19	21	29								
	- 5			\mathbb{N}	SS-9	19 21 15	36	33								
	_ - 5.49 -			\square		8										
	-				SS-10	7 5 4	9	88								
	- 6 - 6.10 -			$\left(\right)$		6										
	- =		а. А.	X	SS-11	4 3 2	5	8								
	6.71	CONTINUED ON PAGE 2		\sim		2										
	- 7 -			I			<u> </u>							[ŖЯ	ROY CONSULTANTS
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cheo	cked b	y <u>J.B</u>	<u>. </u>	date _	11/01,	/17_	rev	0				IXI	

			BO	REł	HOL	E I	_00	R	EPC	ORT							
CLIE	:NT	J.D. IRVING, LIMITED									_					2	
	ation -	GRAND LAKE WOOD WASTE DISPO															-16
DATE		DECEMBER 17, 2016			DEPIH		NO W	ATER				BO					<u>i–1</u>
SS : CB : AU : <u>STATE</u> DISTURBE	LE TYPE SPLIT S CORE B AUGER <u>AUGER</u> <u>CORE</u>	POON <u>OBSERV</u> , ARREL ▼ : H ∑ : V <u>MPLE ELEVATIO</u> LOST NOT SMUPLED ⊠ GEO	TANDARD YDROCAR VATER LEV VN DETIC	PENE BON		N		a : b : [c : d : SA :	Modifie Btex	ed tpi S Analy				<u>HYD</u> N : O : S :	ROC NO OD ST/	N-E> OUR AINED	<u>ns in soils</u> (Istant
ELEV. (M)	DEPTH (M)	SOIL DESCRIPTION		strata plot	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	R.Q.D. or N	recuparation (%)	tests / analysis	HYDROCARBON	VAPOURS	HY	RES OI DROC	F CARB	BON	OBSERVATIONS
	6.50	CONTINUED FROM PAGE 1		STI	ST/	SAI	BL	R.(RE	Ĕ	Ŧ	A	N	0	S	FR	
45.03	- 7 -	GRAVELLY SAND, SOME SILT, BRON GREY; PRESENCE OF COBBLES	/N AND		X	SS-12	6 18 21 10	39	33								
	7.32 -				X	SS-13	9 9 14 17	23	42								
	- 8 -	END OF BOREHOLE AT 7.92 METER	S														
	- 9 -																
	- 10 -																
	- 11 -																
	-12 -																
	-13 -																
	-14 -																
		1													[ROY
		supervised by <u>J.B.</u> drawn by	<u>A.L.</u>	chec	ked b	y <u>J.B</u>	<u>. </u>	date _	1/01,	/17_	rev. <u>0</u>)				ŖĮ	ROY CONSULTANTS

		В	DRE	HOL	E I	_00	R	EPC	RT							
CLIE	NT	J.D. IRVING, LIMITED								_					2	
		GRAND LAKE WOOD WASTE DISPOSAL SIT	-													- <u>16</u> H–2
		DECEMBER 16, 2016		DEPTE		7.011					BC					
	<u>e type</u> Split si	POON OBSERVATIONS	_					MODIFIE					HYDI	ROC		NS IN SOILS
	CORE B	N : STANDAF					b :								N-E) OUR	(ISTANT
AU :	AUGER	∑ : WATER I					c : d :	PAH METALS	5						AINED	
	OF SA							SIEVE		rsis			FR	: FF	REE	PHASE PRODUCT
		LOST NOT SAMPLED SCOLETIC	T	1	1	[0:	OTHER	2			1				
((W)			MPLE	E/NO.	μΩ		N (%)	/ ANALYSIS	Z		P	RESE OF		Ξ	
ELEV. (M)	DEPTH (SOIL DESCRIPTION	PLOT	OF S4	INPI	/ 0.15m	or N	aratio	/ AN	CARBO	SL	HYE	OF DROC		ON	OBSERVATIONS
			STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW	R.Q.D.	RECUPARATION	TESTS	HYDROCARBON	VAPOURS	N	0	s	FR	
	6.50 6.71	CONTINUED FROM PAGE 1	0,	0,	0,			-			_					
31.98	- 7 -	SILTY SAND, SOME GRAVEL, TRACES TO SOME CLAY, BROWN; PRESENCE OF		\mathbb{N}	SS-12	6 7 12	19	88	∇							
	7.32	COBBLES		$\left\{ \right\}$		7 5								_		
				X	SS-13	9 6 15	15	42								
	- ^{7.92} -			\bigtriangledown	SS-14	6 6	27	38								
	 				55-14	21 20 33	21									
				IX	SS-15	10	17	50								
	- 9 - 9.14 <u>-</u>	END OF BOREHOLE AT 9.14 METERS		\sim		11								_		
	- 10 -															
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		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	, che	cked t			date _	11/01	/17_	rev(<u>)</u>		1	[Ŕ	ROY

		BC	REI	HOL	E l	_00	R	EPC	RT							
CLIE	NT	J.D. IRVING, LIMITED								_	PA	GE _	1	OF.	2	
	ATION	GRAND LAKE WOOD WASTE DISPOSAL SITE														16
		DECEMBER 16, 2016		DEPTH		7.01n					BO					-2
	<u>LE TYPE</u>	FIELD TESTS AN OBSERVATIONS	<u>D</u>					<u>rator</u> Modifii		LYSIS			PRES HYDF	SEN(Roc.	<u>CE OF</u> ARBON	<u>IS IN SOILS</u>
	SPLIT SF CORE B/	ARREI M : STANDARI			N		b : 6									STANT
	AUGER	▼ : HYDROCA ↓ : WATER LE		LEVEL			c :	PAH					0: S:		OUR	
STATE	OF SA		_VLL						-	1010						HASE PRODUCT
DISTURBED	D CORE							SIEVE OTHER		1212						
X			1				• .									
Ģ	(M)			SAMPLE	/NO.	,E		N (%)	ANALYSIS	z		Ρ	RESE		Ξ	
ELEV. (M)	рертн (SOIL DESCRIPTION	PLOT	OF SA	TYPE	/ 0.15m	or N	RATIO	/ ANA	ARBO	n	HYD	OF ROC		ON	OBSERVATIONS
ELE	DEI		strata plot	STATE (SAMPLE TYPE/NO.	BLOW /	R.Q.D.	RECUPARATION	TESTS /	HYDROCARBON	VAPUURS	N		s		
			SI	SI	SA	ВГ	R.	RE	Ш	÷ ÷	4		4	3	ΓK	
38.69	- 0 -					<u></u>										
		SILTY SAND, SOME GRAVEL, TRACES TO SOME CLAY, BROWN		\mathbb{N}	SS-1	2 3 6	9	46								
	0.61			$\langle \rangle$		3 4						_	_	_		
	- 1 -	SILTY SAND, SOME GRAVEL, TRACES TO SOME CLAY, BROWN; PRESENCE OF		X	SS-2	2 2	4	33								
	1.22	COBBLES (SANDSTONE FRAGMENTS)		\vdash		2 4							_	_		
				X	SS-3	10	30	21								
	1.83 - - 2 -			$ \land $		7						_				
				X	SS-4	6 4 37	10	63								
	_2.44 _			$ \land $		11										
	3.05 - - 3 -]	SS–5	6 5 12	11	33								
		SILTY SAND, SOME GRAVEL, TRACES TO		\square	SS-6	5	7	71								
	- 3.65 -	SOME CLAY, BROWN; PRESENCE OF COBBLES		\square	33-0	2 4	/	71								
				\mathbb{N}	SS–7	5 4	8	25								
	- 4 - 4.27 -			\square		4 3	-									
				\mathbb{N}	SS-8	5 5 8	13	71								
	4.88			\vdash		4 5								_		
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	5.49			$\left(\rightarrow \right)$		3 6							_	_		
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				X	SS-11	5 5 7	10	58								
	6.71	CONTINUED ON PAGE 2	14141			7										
	_ 7 _		I	I						<u> </u>		I	I	[ŖŦ	ROY CONSULTANTS
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	che	cked b	у <u>_ Ј.В</u>	<u>. </u>	date _	1/01,	/17	rev. <u>0</u>	_			l	тХı	SOLING DEVICE ADDRESS

		BC	REI	HOL	E l	_00	R	EPC	RT							
CLIE	NT	J.D. IRVING, LIMITED								_	PA	GE _	1	OF	_1_	-
	ATION	GRAND LAKE WOOD WASTE DISPOSAL SITE														-16
	<u> </u>	DECEMBER 15, 2016	NATER	DEPTH		<u>3.35n</u>					BC					1-4
SS :	<u>le type</u> Split Sf Core B/	NRFI N : STANDARI) pene					IODIFI	<u>y ana</u> Ed tp i	<u>lysis</u> H			HYD N :	ROC NC	N-EX	<u>e</u> <u>NS IN SOILS</u> (ISTANT
AU :	AUGER	▼ : HYDROCA ▽ : WATER LE		LEVEL			c :		5				S :	ST	OUR AINED REF	PHASE PRODUCT
DISTURBED	COF SAM	LOST NOT SAMPLED I GEODETIC						SIEVE OTHER	ANAL)	rsis						
(W)	(M) H	SOIL DESCRIPTION	PLOT	SAMPLE	TYPE/NO.	/ 0.15m	z	tion (%)	ANALYSIS	BON		P	rres O		E	OBSERVATIONS
ELEV. (M)	DEPTH		STRATA PI	state of	SAMPLE T	BLOW / 1	R.Q.D. or	RECUPARATION	tests / .	HYDROCARBON	VAPOURS	HYD N	0 0		SON FR	
				0,	0,		ш	ш	1							
38.02		SILTY GRAVELLY SAND, TRACES TO SOME CLAY, BROWN; TRACES OF ORGANIC MATTER		X	SS-1	2 2 3 4	5	50								
	0.61 - 1			\mathbf{X}	SS-2	3 2 3	5	17								
	1.22	SAND, SOME GRAVEL, SOME SILT, TRACES OF CLAY, BROWN; TRACES COBBLES			SS–3	2 2 3 10 9	13	46								
	1.83 = - 2 = _2.44 =				SS-4	4 3	5	50								
	- 3 - 3.05 -				SS–5	2 3 5 8 2 6 5	8	33								
	3.05			\square	SS-6		8	21	∇							
	- 4 4.27			\mid	SS–7	4 5 5 2 3 3 4	11	46								
				X	SS-8		6	75								
	- 5 - - - 5.49-				SS-9	2 3 3 4 3	6	58								
	- 6 6.10 -				SS-10	3 3 10 33 50	6	75								
	6.38	END OF BOREHOLE AT 6.38 METERS		\mid	SS-11	50 50	>50	0								
	_ , _															
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cheo	cked b	y <u>J.B</u>	<u> </u>	date _1	1/01	/17_	rev	0				ŖĮ	ROY CONSULTANTS

		BO	REI	HOL	.E l	_00	R	EPC	RT					
LOCA	TION	J.D. IRVING, LIMITED GRAND_LAKE_WOOD_WASTE_DISPOSAL_SITE DECEMBER_17, 2016	-							_	CT N	1 0	316	 _ <u>_16</u> H_6
SS : CB : AU : <u>STATE</u> DISTURBED		POON <u>OBSERVATIONS</u> ARREL N : STANDARD ▼ : HYDROCAR ▽ : WATER LE	PENE RBON				a : M b : E c : F d : T SA :		ed tp i S Analy	1	HYC N O S	D <u>ROC</u> : NC : OD : ST/)n-e)our Aine[<u>DNS IN SOILS</u> XISTANT
ELEV. (M)	DEPTH (M)	SOIL DESCRIPTION	STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	R.Q.D. or N	RECUPARATION (%)	tests / analysis	HYDROCARBON VAPOURS	PRES O DROO	F Care		OBSERVATIONS
48.98	- 0 - 0.61 - 1 1.22 - 1 1.22 - 2 - 2 - 2 - 3 - 2 - 2 - 3 - 2 - 3 - 2 - 3 - 3 - 2 - 3 - 3 - 3 - 3 - 6 - 4 - 6 - 6 - 6 - 6 - 6 - 6 - 7 -	SAND AND GRAVEL, SOME SILT, BROWN AND GREY; TRACES OF ORGANIC MATTER AND PRESENCE OF COBBLES SAND AND GRAVEL, SOME SILT, BROWN AND GREY; TRACES OF COBBLES END OF BOREHOLE AT 5.05 METERS ON POSSIBLE BOULDER			SS-1 SS-2 SS-3 SS-4 SS-5 SS-6 SS-7 SS-8 SS-8 SS-9	$\begin{array}{c} 2 \\ 4 \\ 9 \\ 9 \\ 6 \\ 7 \\ 12 \\ 14 \\ 6 \\ 10 \\ 6 \\ 5 \\ 4 \\ 4 \\ 5 \\ 6 \\ 6 \\ 5 \\ 7 \\ 10 \\ 6 \\ 5 \\ 7 \\ 7 \\ 4 \\ 7 \end{array}$	13 19 16 9 9 12 16 11 >50	58 88 42 63 83 75 63 71 57	SA					
	- 7	supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cheo	ked b	yJ.B	·	date <u>1</u>	2/01,	/17_	rev. <u>0</u>		[Ŗ	

		BC	RE	HOL	E l	_00	R	EPC	RT							
CLIE	NT	J.D. IRVING, LIMITED								_	PA	GE _	1	OF	2	_
	TION	GRAND LAKE WOOD WASTE DISPOSAL SITE														-16
DATE		DECEMBER 17, 2016	VATER	DEPTH		NO W					BC	REH	OLE	No.	Bł	1–7
	<u>.e type</u> Split sf	POON FIELD TESTS AND DBSERVATIONS N : STANDARE	_		M			<u>rator`</u> Modifie					HYD	ROC		<u>F</u> <u>NS IN SOILS</u> (ISTANT
	CORE BA	RREL T : HYDROCAI			///		ь:Е								OUR	
AU :	AUGER	abla : water le	EVEL				c : d :	-ah Metals	6						AINED	
	OF SAM							SIEVE		rsis			FR	: FI	REE I	PHASE PRODUCT
		LOST NOT SAMPLED GEODETIC					o :	OTHER								
				Ц	ò.			(%)	SIS			P	RES	ENC	E	
(W)	(W)	SOIL DESCRIPTION	PLOT	SAMPLE	TYPE/NO.	0.15m	z	NOIT	ANALYSIS	BON			Of	F		OBSERVATIONS
ELEV. (M)	DEPTH		TA PI	Ч	LE T). or	RECUPARATION	/	HYDROCARBON	VAPOURS	HYC	ROC	ARB	BON	
			STRATA	STATE	SAMPLE .	BLOW	R.Q.D.	RECL	TESTS	HYDF	VAPC	N	0	s	FR	
	- =															
52.12	- 0 =	SAND AND GRAVEL, SOME SILT, REDDISH		/		2										
		BROWN; PRESENCE OF COBBLES	- 4	X	SS-1	6 7 7	13	67								
	0.61			$\overline{)}$		4 4										
	- 1 =				SS-2	6 4	10	63								
	1.22 -			\square	oo 7	4 4	_	50								
	1.83 -				SS-3	3 2	7	50								
	- 2 =			\bigtriangledown	SS-4	3 2	4	29								
	_ _ 2.44 _			\wedge	33-4	2 3	4	29								
	_ 2.44 _ _ _ _	SILTY GRAVELLY SAND, SOME CLAY, BROWN		\bigvee	SS-5	3 4 2	5	58								
	- 3 - 3.05 -			$\left(\rightarrow \right)$		2 3										
	_]			Х	SS-6	3 1	4	88	∇							
	3.66	3.71 GRAVELLY SAND, SOME SILT, TRACES OF		$\left(\right)$		2 7										
	- 4 =	CLAY, GREY AND/OR BROWN; TRACES OF		Х	SS-7	6 6	12	100								
	4.27 -	COBBLES		$\langle \rangle$		8 10										
				X	SS-8	Э	13	96								
	4.88 <u>-</u> - 5 -			\mathbf{K}		6 5										
				X	SS-9	5 7 11	12	92								
	- 5.49			$ \land $		7										
	- 6 =				SS-10	12 10 10	22	67								
	- 6 6.10 -		Â	\bigwedge		7 12	4.7	00								
					SS-11	1 1 14	13	88								
	6.71 - - 7 -	CONTINUED ON PAGE 2														
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cher	ked h	y_J.B	•	date 1	2/01	/17	rev.	0	_	_		ŖĮ	ROY CONSULTANTS

		BC	REI	HOL	E I	_00	R	EPC)RT							
CLIE	NT	J.D. IRVING, LIMITED									PA	GE _	2	OF.	2	-
		GRAND LAKE WOOD WASTE DISPOSAL SITE														- <u>16</u>
		DECEMBER 17, 2016		DEPIH		NO W					BC					<u>1–7</u>
SS : CB : AU : <u>STATE</u> DISTURBE	LE TYPE SPLIT SI CORE B AUGER E OF SA	ARREL N : STANDARI ▼ : HYDROCA ↓ : WATER LI <u>MPLE</u> <u>ELEVATION</u> LOST NOT SAMPLED ⊠ GEODETIC) peni Rbon				a : b : [c : d : SA :	Modifii Btex	ed tpi S Analy				<u>HYD</u> N : O : S :	<u>ROC</u> NO OD ST/	n-ex our Ained	<u>ns in soils</u> (Istant
ELEV. (M)	DEPTH (M)	SOIL DESCRIPTION	STRATA PLOT	STATE OF SAMPLE	SAMPLE TYPE/NO.	BLOW / 0.15m	.D. or N	Recuparation (%)	ts / analysis	HYDROCARBON	VAPOURS	HYD	RESI OF DROC	. ARB	ON	OBSERVATIONS
	6.50	CONTINUED FROM PAGE 1	STR	STA	SAN	вго	R.Q.D.	REC	TESTS	۲.	VAP	N	0	S	FR	
45.41	- 7 =	GRAVELLY SAND, SOME SILT, TRACES OF CLAY, GREY AND/OR BROWN; TRACES OF COBBLES			SS-12	7 10 8 8	18	100								
	7.32 =			\bigtriangledown	SS-13	7 8	16	75								
	7.93 =				33 10	8 7 7								_		
	8.53			X	SS-14	6 7 7	13	100								
			4	\bigtriangledown	SS-15	5 6	15	83								
	- 9 - 9.14 -			\square	55-15	9 8										
		END OF BOREHOLE AT 9.14 METERS														
	- 10															
	- 11 -															
	-12 -															
	-13 =															
	-14 -															
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	che	cked b	y <u>J.B</u>	•	date _	12/01	/17_	rev. <u>0</u>)			[Ŕł	ROY CONSULTANTS

		BC	REI	HOL	E l	_00	R	EPC)RT							
CLIEI	NT	J.D. IRVING, LIMITED								_	PA	GE _	1	OF	_1	_
	TION	GRAND LAKE WOOD WASTE DISPOSAL SITE														-16
DATE		DECEMBER 16, 2016	IATER	DEPTH		NO W					BC	REH	OLE	No.	<u>B</u>	<u>H–10</u>
	<u>E TYPE</u>	FIELD TESTS ANI OBSERVATIONS	<u>)</u>					RATOR							<u>CE</u> C ARBO	<u>)F</u> DNS IN SOILS
	SPLIT SF CORE B/	N : STANDARD			ON		a: M b: E	MODIFIE STFX	LD IPI	H			N :	NO	N-E	XISTANT
	AUGER	▼ : HYDROCAF		LEVEL			c :								OUR AINE[
STATE	OF SAM	₩ S WATER LE	.VEL					METALS								, PHASE PRODUCT
DISTURBED	CORE	LOST NOT SAMPLED ZECODETIC						SIEVE OTHER		rsis						
			1				0.					1				
	Ŷ			SAMPLE	/NO.	ε		۱ (%)	YSIS_	-7		P		ENC	E	
/. (M)	TH (M)	SOIL DESCRIPTION	PLOT	OF SAM	TYPE/NO.	/ 0.15m	or N	ATION	/ ANALYSIS	RBON	<i>(</i> 0			F Carb		OBSERVATIONS
ELEV.	DEPTH		STRATA	state o	SAMPLE	BLOW /	R.Q.D. o	RECUPARATION	tests /	HYDROCARBON	VAPOURS					
			STF	STA	SAN	BLC	R.Q	REC	TES	Щ	VAF	N	0	S	FR	
	=															
-	-]															
48.14																
40.14		SAND AND GRAVEL, SOME SILT, BROWN TO GREY; TRACES OF ORGANIC MATTER		\bigvee	SS–1	9 35 19	54	36								BEDROCK AT 0.41
	- 0.56 -		X N			50										METERS
	,	BEDROCK: SANDSTONE, GREY AND BROWN														
	- 1 -				AU-1											
	_ 1.52 _ 1.60 _			X	SS-2	50	>50	0 г								
	Ξ	END OF BOREHOLE AT 1.60 METERS			00 2											
	- 2 =															
-	- =															
	- 3 -															
	- =															
	=															
-	- 4 =															
	=															
	- 5 =															
-	- 6 =															
	_ , _															
		supervised by <u>J.B.</u> drawn by <u>A.L.</u>	cheo	ked b	y <u>J.B</u>	<u>. </u>	date _1	1/01,	/17_	rev.	0				Ř	ROY

Kings Mines

count

7

	Well Depth (Feet)	Estimated Yield (igpm)	Depth to Bedrock (Feet)	Casing Length (Feet)
	(1000)	(181)	(1000)	
	52	20	6	20
	53	20	6	30
	63	4	8	20
	285	10	10	20
	145	3	10	20
	65	20	14	20
	40	7	7	20
	60	7	4	20
	Well Depth	Estimated Yield	Depth to Bedrock	Casing Length
	(Feet)	(igpm)	(Feet)	(Feet)
			-	
ian	63	7	8	
ge	101.6		8.4	
	<u> </u>			
	285 40	20 3	14 4	30 20



Well Driller's Report

Date printed 2016/12/09

Drilled b			14/	T	D.II.M.I	-1			
Well Us Drinkin	-	, Domestic	Work [•] New V		Drill Metho Cable Too	-		Work Cor 06/18/	
	Casing	Information		Casing a	bove ground 2ft	Di	rive Shoe	Used? Yes	,
	Well Log	Casing Type	Di	ameter	From	End S	Slotted?		
	3011	Steel	6 i	nch	Oft	30ft			
Aquifer Method	Test/Yi	eld Initial Water Level (BTC)	Pumping Rate	Duratio	Final Water n Level (BTC		d Fl	owing Ve ll ?	Rate
Air		5ft (BTC - Below to	0 igpm p of casina)	0hr	Oft	20 igprr	ı	Νο	0 igpm
Well Gro	outing			illing Fluids	Used	Disinfectant		ump Installe	
т	here is no	o Grout informatio		one		Chlorine Pu	lr	ubmersible Itake Setting (B Oft	-
Driller's	Loa							I Well Depth	_
Nell Log	From	End Cold	bur		Rock Type		53ft		I
	Oft 6ft	6ft Brown 53ft Grey	1		Overburden Conglomerate		Bedro	ck Level	
Water B	earing F	racture Zone		Setbacks					
Nell Log	Depth	Rate		Well Log	Distance S	Setback From			
3011	45ft	20 igpm		3011	55ft 8	Septic Tank			



Date pri	inted	2016/1	2/09							
Dri ll ed b	by									
Well Us	se			Work	Туре	Drill Method	1		Work	Completed
Drinkin	ig Water	, Domest	tic	New V		Rotary				10/2003
		, 				-				
	Casing	Informa	tion		Casing abo	ove ground 1ft 6	in	Driv	ve Shoe Used?	Yes
	Well Log	Casing T	уре	Di	ameter	From	End	Sl	otted?	
	6251	Steel		8 i	nch	Oft	20ft			
Aquife	r Test/Yi	eld					Fs	stimated		
		nitial V	Vater	Pumping		Final Water		fe Yield	Flowing	
Method		Level (BTC)	Rate	Duration	Level (BTC)			Well?	Rate
Air		Of	ť	0 igpm	0hr	Oft	4	igpm	No	0 igpm
		(BTC -	Below top	of casina)				•		•.
Well Gr	outing			Di	illing Fluids L	Jsed	Disinf	fectant	Pump Ins	talled
	Those is a	o Grout in	(one		N/A		N/A	
	nere is n	o Grout III	ormatio	1.					Intake Settir	ig (B⊤C)
							Qty	0 ig	55ft	
Driller's	Log								Overall Well De	enth
Well Log	From	End	Colou	ur		Rock ⊺ype			63ft	opur
6251	Oft	8ft	Brown			Topsoil			Bedrock Level	
6251	8ft	55ft	Grey			Sandstone			Oft	
6251	55ft	63ft	Brown	and red		Shale			on	
Water E	Bearing I	racture	Zone		Setbacks					
Well Log	Depth		Rate			There is no S	Setbac	k informa	tion.	
	55ft		4 lgpm	L						



Environment

Report Number 6272

Date pr	rinted	2016	12/09									
Drilled	by											
Well U	se			Wor	к Туре	Dri	Method	I		١	Nork Cor	npleted
Drinki	ng Water,	, Dome	stic	New	/ Well	Ro	tary				11/22/2	2004
	Casing	Inform	ation		Casing	above gro	und 2ft		Driv	ve Shoe Us	ed? Yes	7
	Well Log				Diameter	-	rom	End		otted?		_
	6272	Steel	Туре		10 inch		ft	2ft	30			_
		01001				•						
-	er Test/Yi	Initia	Water	Pumpir	•		al Water		imated e Yie l d	Flowi		
Method	b		(BTC)	Rate	Durat	ion Lev	el (BTC)			We	?	Rate
Air			Oft C - Below to	0.35 igr o of casina)	om 2hr	S	Oft	10	igpm	No)	0 igpm
Well G	routing				Drilling Fluid	ls Used		Disinfe	ectant		p Installe	d
Well Log	Grout Ty	ne	From	End	None			Chlori	ne Puck			
6272				10ft				~	<u>.</u> .		e Setting (B	FC)
9272	Clay(cutti	ngs)	Oft	IUIL				Qty	0 ig	Oft		
Driller's	s Log									Overa ll W	ell Denth	
Well Log	From	End	Colo	ur		Rock ⊺y	rpe			285ft	on Dopui	
6272	Oft	10ft	Tan			Sand				Bedrock L	eve	
6272	1 0ft	100ft	Red			Shale				10ft		
6272	100ft	285ft	Grey			Shale an	d Slate			TOIL		
Water I	Bearing F	ractur	e Zone		Setbacks	;						
Well Log	Depth		Rate		Well Log	Distance	S	etback	From			
6272	100ft		10 lgpm		6272	50ft	Se	eptic Ta	nk			
6272	180ft		10 igpm		6272	75ft	Le	each Fle	Id			



Date pri	inted	2016/1	2/09								
Dri ll ed I	by										
Well Us	se			Worl	к Туре	Di	rill Method	ł		Work	Completed
Drinkin	ng Water	Domes	stic	New	Well	R	Rotary (Hammer)			11/	22/2004
	Casing	Informa	ation		Casing	above gro	ound 1ft 6	in	Driv	e Shoe Used? ۱	/es
	Well Log			[Diameter	-	From	End	S	otted?	
	6273	Steel	.] Þ •		6 inch		Oft	20ft			
Δαμίξοι	r Test/Yi	eld									
Aquilo	1 1030 11	Initial	Wator	Pumpin	a	Fir	nal Water		stimated	Flowing	
Method	l	Level		Rate	5 Durat		vel (BTC)			Well?	Rate
Air			(_ · c))ft	3 igpm	n 2hr	S	Oft	3	3 igpm	No	0 igpm
		(BTC	- Below top	of casina)					51		51
Nell Gr	outing			[Drilling Fluid	ds Used		Disin	fectant	Pump Inst	alled
٦	There is no	o Grout i	nformatio		None			N/A		Submersi Intake Settin	
								Qty	0 ig	125ft	
Driller's	Log									Overall Well De	enth
Vell Log	From	End	Colo	ur		Rock T	уре			145ft	span
5273	Oft	10ft	Tan			Sand				Bedrock Level	
5273	10ft	95ft	Red			Shale				Oft	
273	95ft	145ft	Grey			Shale a	nd Slate			on	
Nater E	Bearing F	racture	Zone		Setbacks	3					
Nell Log	Depth		Rate		Well Log	Distance	e S	etback	From		
6273	30ft		0.5 lgpm		6273	75ft	S	eptic Ta	ank		
5273	100ft		2 igpm		6273	100ft		each Fl			
6273	145ft		3 igpm		6273	300ft	R	ight of	any Public	: Way Road	



Date pri	inted	2016/12	/09								
Drilled I	by										
Well Us	se			Work	Туре		Drill Method	ł		Work	Completed
Drinkin	g Water,	Domesti	с	New V	21		Cable Tool				/22/2007
	Casing	Informati	on		Casing a	abov	e ground 2ft		Driv	ve Shoe Used?	Yes
		Casing Ty	ре	Di	ameter		From	End	SI	otted?	
	16536	Steel		6 i	nch		Oft	20ft			
Aquife	r Test/Yi	əld						Fe	timated		
·		nitial W	ater	Pumping			Final Water	Sa	fe Yield	Flowing	
Method	l	Level (B	TC)	Rate	Durati	on	Level (BTC)			Well?	Rate
Bailer		39fi	t	20 igpm	1hr 35r	nin	39ft	20) igpm	No	0 igpm
		(BTC - B	elow top	of casina)							
Well Gr	outing				illing Fluid	s Use	ed	Disinf	ectant	Pump Ins	stalled
	Thoro is no	Grout info	rmation		one			N/A		N/A	
		Grout mit	mation	•				~	<u>.</u> .	Intake Setti	ng (BTC)
								Qty	0 ig	Oft	
Driller's	Log									Overall Well D	epth
Well Log	From	End	Colou	r		Ro	ock ⊺ype			65ft	
16536	Oft	14ft	Brown			М	ıd			Bedrock Leve	
16536	14ft	65ft	Grey			Sa	ndstone			14ft	
Water E	Bearing F	racture Z	Zone		Setbacks						
Well Log	Depth	F	Rate		Well Log	Dis	tance S	etback	From		
16536	45ft		igpm		16536	72ft	S	eptic Ta	ink		
16536	55ft		lgpm	[16536	92ft		each Fie			
16536	60ft	1	3 igpm		16536	37ft	R	ight of a	any Public	: Way Road	



Date pri	inted	2016/12/09						
Drilled b Well Us Drinkin	se	Domestic	k Type ∕ Well (NEW - L)	Drill Methoo Rotary (RO	-	1		Completed 29/1996
	Casing	Information	Casing abo	ve ground 1ft 7	ïn	Drive	e Shoe Used? Y	es
	Well Log	Casing Type	Diameter	From	End	Slo	tted?	
	90670600	Steel	6 inch	Oft	20ft			
Method Air Well Gro	outing	eld Initial Water Level (BTC) Oft (BTC - Below	 Duration	Final Water Level (BTC) 5ft sed	Saf 7 Disinfe	imated e Yield igpm ectant (Javex) 1.0 ig	Flowing Well? No Pump Insta N/A Intake Setting 35ft	
Driller's Well Log 90670600 90670600	From Oft	End Co 7ft Brov 40ft Gre	5	Rock Type Sand Sandstone			Overall Well De 40ft Bedrock Level 0ft	pth
Water B Well Log 90670600	Depth	racture Zone Rate 7 Igpm	 Setbacks	There is no S	Setback	informat	tion.	



Date prir	nted	2016/12/09							
Drilled b Well Use	-				Drill Method	4		Mork	Completed
	-	Domestic	Nev	⁺k Type v Well (NEW LL)	Rotary (RO	-			2/1996
	Casing	Information		Casing ab	ove ground 1ft 5	iin	Driv	ve Shoe Used? Y	es
F	Well Log 90739800	Casing Type Steel		Diameter 6 inch	From Oft	End 20ft	Sk	otted?	
Aquifer Method Air	Test/Yi	eld Initial Water Level (BTC) 0ft	Pumpir Rate 7 igp r	Duration	Final Water Level (BTC) 17ft	Safe	mated e Yie l d gpm	Flowing Well? No	Rate 0 igpm
Well Gro	outina	(BTC - Below		Drilling Fluids l	lsed	Disinfe		Pump Insta	
		Grout informa	tion.	None		Bleach Qty	(Javex 1.0 ig		
Driller's Well Log	Log From	End Co	blour		Rock Type			Overall Well De 60ft	pth
90739800 90739800 90739800 90739800 90739800	4ft 27ft 28ft 49ft	4ftBro27ftGree28ftBro49ftBro52ftBro	y wn wn		Gravel Sandstone Sandstone Sandstone Sandstone			Bedrock Level Oft	
90739800	52ft	60ft Bro	wn		Sandstone				
Water B	earing F	racture Zone	9	Setbacks					
Well Log 90739800 90739800	Depth 40ft 50ft	Rate 2 Igpn			There is no S	Setback i	informa	tion.	
90/08000	5011	5 igpn	I	l					



Date prir	nted	2016/1	2/09							
Drilled b Well Use	-			Work	Туре	Dri ll M	ethod		Wor	k Completed
	g Water,	Domes [.]	tic	New		Rotary				7/04/2001
	Casing	Informa	tion		Casing a	above ground	1ft 5in	Dri	ve Shoe Used	? Yes
,	Well Log	Casing T	уре	D	liameter	From	En	d S	lotted?	
!	92195000	Steel		6	inch	Oft	20	ît 👘		
Aquifer	Test/Yie	eld						Estimated	1	
Method		Initial V Level (Pumping Rate) Duratio	Final W on Level (B	ater g	Safe Yield	· · ·	Rate
Air		01	,	7 igpm	1hr	12f	t	7 igpm	No	0 igpn
		(BTC -	Below top	of casina)						
Nell Gro	uting			D	rilling Fluids	s Used	Dis	infectant	Pump Ir	nstalled
т	here is no	Groutin	formation	N	lone		Ble	ach (Jave		
	nere is no	Grout in	Tormation				-			tting (B⊤C)
							Qty	1.0 ig	55ft	
Driller's I	Log								Overall Well	Denth
Nell Log	From	End	Colou	ır		Rock ⊺ype			70ft	Doput
92195000	Oft	5ft	Brown			Gravel			Bedrock Leve	el
92195000		26ft	Grey			Sandstone			Oft	-
2195000		26ft	Brown			Sandstone				
92195000 2 92195000 (60ft 60ft	Grey Brown			Sandstone Sandstone			4	
92195000 (92195000 (70ft	Grey			Sandstone			-	
									-	
Water Be	earing F	racture	Zone		Setbacks]	
Well Log	Depth		Rate			There is	s no Seth	ack inform	ation.	
92195000	26ft		3 igpm		L				~~~~	
92195000	60ft		4 lgpm							

Appendix 2

Grain Size Analysis and K Output



Г

lient rand Lake T	ïmber (JD Irving)	Chipman	Lot-Station				Project Number 316-16			
ature of San		Cimpinian	Proposed Us	se			Sample Number			
	some gravel, trace	es to some clay	Geotechn				214-16			
t or Quarry			Location				Reference			
unicipality,			Sampled by		Date		Contract			
Chipman, I			Jon Burtt		17-Dec-16					
ampling Site			Tested by	1 /	Date					
BH-2 SS-1		· · · · · · · · · · · · · · · · · · ·	Daniel Al	bert	11-Jan-17	X 7				
-		eve Analysis				V	arious Tests			
Sieve	% Passing	% Passing		rements					rements	
Size 100 mm	Separated	Combined 100.0	Low	High	% Gravel		10 1	Low	High	
100 mm 90 mm		100.0	+	<u> </u>	% Gravel % Sand		18.1 46.0		+	
90 mm 75 mm		100.0	1		% Silt and Clay		35.9		1	
63 mm		100.0			, t She and Chay					
50 mm		100.0	1	1	Atterberg Limits			1	1	
37.5 mm		100.0			Liquid Limit					
31.5 mm		100.0			Plastic Limit					
25 mm		100.0			Plasticity Index					
19 mm		100.0	I	 	Natural Water C	ontent	14.4%	_		
12.5 mm		95.6		<u> </u>			<u> </u>			
9.5 mm	100.0	92.5				ammer				
4.75 mm 2.36 mm	100.0 86.6	81.9 71.0				est eparation				
2.30 mm	83.2	68.1				ethod				
1.18 mm	73.9	60.6				aximum Dry Dens	sitv			
600 µm	64.7	53.0				otimum Water Cor				
425 µm	60.7	49.7								
300 µm	57.1	46.8			100				• • • • • • •	
150 µm	49.2	40.3			90					
75 µm	43.8	35.9			80					
	TT				4					
	Нус	Irometer Analysis	3	1	70 9					
					assin					
			1		A 60					
				1	40					
				1	30					
					20					
					10					
			1	ļ	0					
					0.001	0.01	0.1 1	10	100	
					l		Grain Size (mm)			

٦



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lient		Chimmen	Lot-Station				Project Number	Project Number 316-16			
	imber (JD Irving)	Chipman	Proposed Us								
ature of Sar	npie e gravel, some silt	traces of clay	Geotechni				Sample Number 215-16				
t or Quarry	-	, traces of clay	Location	ical study			Reference				
it of Quality	I valle		Location				Reference				
Iunicipality,			Sampled by		Date		Contract				
Chipman, I			Jon Burtt		17-Dec-16	5					
ampling Site BH-1 SS-4			Tested by Daniel Al	hert	Date 12-Jan-17	,					
DII-1 55-4		eve Analysis		ben	12-Jan-17		arious Tests				
Sieve	% Passing	% Passing	-	rements		•		Requi	rements		
Size	Separated	Combined	Low	High				Low	High		
100 mm		100.0			% Gravel		19.9				
90 mm		100.0			% Sand		60.6				
75 mm		100.0			% Silt and C	lay	19.5				
63 mm		100.0									
50 mm		100.0			Atterberg Lin						
37.5 mm		100.0	 		Liquid Limit			_	<u> </u>		
31.5 mm		100.0			Plastic Limit				 		
25 mm		95.6			Plasticity Inc		7.5%		┨────		
19 mm 12.5 mm		94.3 90.5			Natural Wate	er Content	7.5%				
12.5 mm 9.5 mm		90.5 88.9	+			Hammer	<u> </u>		1		
9.5 mm 4.75 mm	100.0	88.9	+		Proctor	Test					
2.36 mm	81.1	62.3				Preparation					
2.00 mm	75.3	56.7			-1	Method					
1.18 mm	59.5	41.9				Maximum Dry Den	sity				
600 µm	50.1	33.1			1	Optimum Water Co					
425 µm	47.4	30.5									
300 µm	44.9	28.1			100						
150 µm	38.8	22.4			90			<i>_</i>	•		
75 µm	35.7	19.5									
	~~				80			1			
-	Нус	Irometer Analysis	1	1	70 9						
					00 Bercent Passing						
					50		······································				
					40		····				
			1		30	┝╍┼╍┼┥╢╢╍╌┼╍┼╷┼					
			1		20						
					10						
					0.001	0.01	0.1 1	10	10		
							Grain Size (mm)				
emarks											
<u> </u>	ust not be reprodu					y Daniel Albert, P.Teo					



of Roy Consultants.

Laboratory report: Soils and Aggregates Client Lot-Station Project Number Grand Lake Timber (JD Irving) Chipman 316-16 Sample Number Proposed Use Nature of Sample Geotechnical study Gravel and Sand, some silt 216-16 Pit or Quarry Name Location Reference Municipality, County Sampled by Date Contract Chipman, NB Jon Burtt 17-Dec-16 Sampling Site Tested by Date BH-6 SS-6 Daniel Albert 11-Jan-17 Various Tests **Sieve Analysis** % Passing % Passing Sieve Requirements Requirements Size Separated Combined Low High Low High 100.0 100 mm % Gravel 42.9 90 mm 100.0 % Sand 42.0 75 mm 100.0 % Silt and Clay 15.1 100.0 63 mm 100.0 50 mm Atterberg Limits 37.5 mm 100.0 Liquid Limit 31.5 mm 100.0 Plastic Limit 25 mm 89.9 Plasticity Index 82.5 Natural Water Content 19 mm 5.9% 12.5 mm 75.9 9.5 mm 70.4 Hammer 4.75 mm 100.0 57.1 Proctor Test 2.36 mm 76.4 43.6 Preparation 2.00 mm 40.8 71.5 Method 32.4 1.18 mm 56.7 Maximum Dry Density 600 µm 44.4 25.4 Optimum Water Content 425 µm 40.0 22.8 300 µm 36.7 20.9 100 31.0 150 µm 17.7 90 75 µm 26.5 15.1 80 Hydrometer Analysis 70 Percent Passing 60 50 40 30 20 10 0 0.1 Grain Size (mm) 0.001 0.01 10 100 Remarks Calculated by Pierre Lanteigne, P.Eng. This report must not be reproduced, in part or in whole, without the written permission Reviewed by: Daniel Albert, P.Tech.

18-01-2017

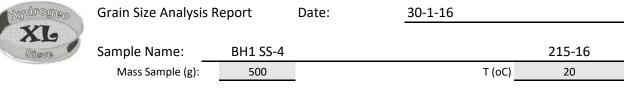
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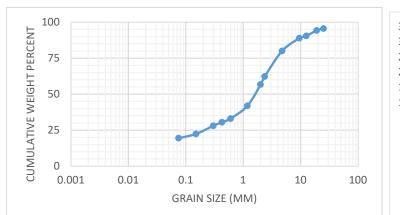


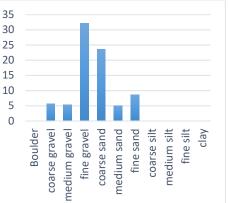
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lient rand Lake Ti	mber (JD Irving) C	hipman	Lot-Station				Project Number 316-16		
ature of Sam		*	Proposed Us	e			Sample Number		
	y sand, traces to so	me clay	Geotechni			015-17			
t or Quarry N	Name		Location				Reference		
Iunicipality, C			Sampled by		Date		Contract		
Chipman, N	В		Jon Burtt		17-Dec-16)			
ampling Site MW3 SS-7			Tested by Pierre Lar	nteione	Date 7-Feb-17	1			
10100 5 55-7		ve Analysis		licigite	/-100-17		arious Tests		
Sieve	% Passing	% Passing	-	rements				Requi	rements
Size	Separated	Combined	Low	High				Low	High
100 mm					% Gravel		27.3		
90 mm					% Sand		37.4		
75 mm					% Silt and Cla	ay	35.3		
63 mm			_					_	
50 mm					Atterberg Lim	iits	_		
37.5 mm					Liquid Limit				
31.5 mm		100.0			Plastic Limit				
25 mm 19 mm		100.0 94.6			Plasticity Inde Natural Water		17.1%		
12.5 mm		82.6			Ivalui ai vvalei	Content	17.170		
9.5 mm		80.1				Hammer			
4.75 mm	100.0	72.7			Proctor	Test			
2.36 mm	89.3	65.0				Preparation			
2.00 mm	86.2	62.7				Method			
1.18 mm	78.3	57.0				Maximum Dry Densit			
600 µm	70.1	51.0				Optimum Water Cont	tent		
425 µm	66.4	48.3							
300 µm	63	45.8			100				
150 μm 75 μm	55.1 48.6	40.1 35.3			90			/	
75 pill	10.0	55.5			80			·····	
	Hyd	rometer Analysis	•		70				
					Passing				
					- 40				
					30				
			+		20				
					10				
			+		0				
			+		0.001	0.01	0.1 1 Grain Size (mm)	10	100
emarks			•		_!				
is report mu	st not be reproduce	d in part			Calculated by	: Pierre Lanteigne, P.E.	29		

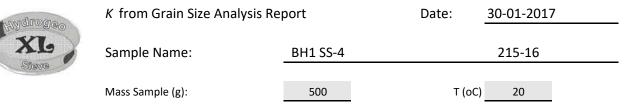
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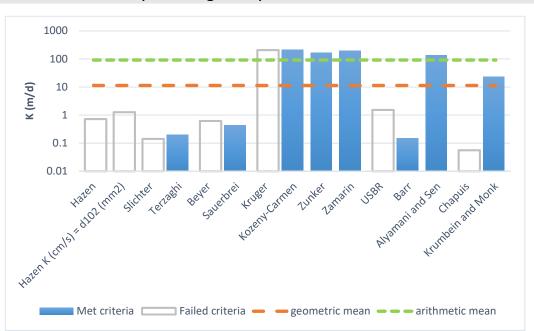






Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)	Effective Grain	n Diameters (mm)	Other Useful	Parameters
25	22	0.044	95.6	d10	0.038	Uniformity Coef.	57.52
19	6.5	0.013	94.3	d17	0.065	n computed	0.26
12.5	19	0.038	90.5	d20	0.088	g (cm/s ²)	980.00
9.5	8	0.016	88.9	d50	1.629	$ ho$ (g/cm 3)	0.9981
4.75	44	0.088	80.1	d60	2.212	μ (g/cm s)	0.0098
2.36	89	0.178	62.3	de (Kruger)	1.096	ρ g/ μ (1/cm s)	9.9327E+04
2	28	0.056	56.7	de (Kozeny)	0.993	tau (Sauerbrei)	1.053
1.18	74	0.148	41.9	de (Zunker)	1.026	$d_{geometric\ mean}$	1.585
0.6	44	0.088	33.1	de (Zamarin)	1.061	σ_{ϕ}	3.242
0.425	13	0.026	30.5	Io (Alyameni)	-0.359		
0.3	12	0.024	28.1		mm	0	% in sample
0.15	28.5	0.057	22.4		>64	Boulder	
0.075	14.5	0.029	19.5	1	6 - 64	coarse gravel	5.7
				8	3 - 16	medium gravel	5.4
					2 - 8	fine gravel	32.2
				0	.5 - 2	coarse sand	23.6
				0.2	25 - 0.5	medium sand	5
				0.06	63 - 0.25	fine sand	8.6
				0.01	6 - 0.063	coarse silt	
				0.00	8 - 0.016	medium silt	
				0.00	2 - 0.008	fine silt	
				<	0.002	clay	





stimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.838E-03	.838E-05	0.72	
Hazen K (cm/s) = d_{10} (mm)	.148E-02	.148E-04	1.28	
Slichter	.165E-03	.165E-05	0.14	
Terzaghi	.235E-03	.235E-05	0.20	
Beyer	.718E-03	.718E-05	0.62	
Sauerbrei	.501E-03	.501E-05	0.43	
Kruger	.238E+00	.238E-02	205.96	
Kozeny-Carmen	.243E+00	.243E-02	210.02	
Zunker	.190E+00	.190E-02	164.16	
Zamarin	.230E+00	.230E-02	198.85	
USBR	.178E-02	.178E-04	1.54	
Barr	.176E-03	.176E-05	0.15	
Alyamani and Sen	.153E+00	.153E-02	132.59	
Chapuis	.648E-04	.648E-06	0.06	
Krumbein and Monk	.268E-01	.268E-03	23.16	
geometric mean	.132E-01	.132E-03	11.38	
arithmetic mean	.106E+00	.106E-02	91.20	

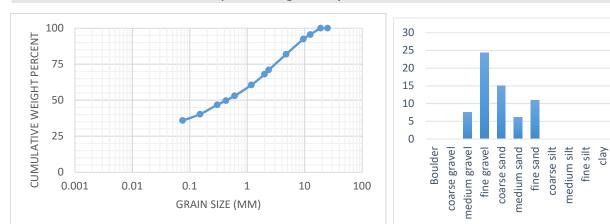


Grain Size Analysis Report Da

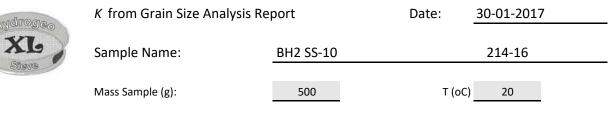
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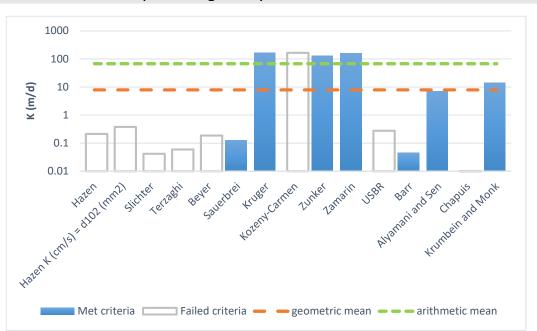
 Sample Name:
 BH2 SS-10
 214-16

 Mass Sample (g):
 500
 T (oC)
 20



Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)	Effective Grain	Effective Grain Diameters (mm)		Other Useful Parameters		
25	0	0	100	d10	0.021	Uniformity Coef.	54.29		
19	0	0	100	d17	0.036	n computed	0.26		
12.5	22	0.044	95.6	d20	0.042	g (cm/s ²)	980.00		
9.5	15.5	0.031	92.5	d50	0.441	ho (g/cm ³)	0.9981		
4.75	53	0.106	81.9	d60	1.134	μ (g/cm s)	0.0098		
2.36	54.5	0.109	71	de (Kruger)	0.979	ρ g/ μ (1/cm s)	9.9327E+04		
2	14.5	0.029	68.1	de (Kozeny)	0.885	tau (Sauerbrei)	1.053		
1.18	37.5	0.075	60.6	de (Zunker)	0.915	d _{geometric mean}	1.374		
0.6	38	0.076	53	de (Zamarin)	0.947	σ_{ϕ}	3.392		
0.425	16.5	0.033	49.7	Io (Alyameni)	-0.084				
0.3	14.5	0.029	46.8	mm		0	% in sample		
0.15	32.5	0.065	40.3	>64		Boulder			
0.075	22	0.044	35.9	1	16 - 64		0		
				8	3 - 16	medium gravel	7.5		
					2 - 8	fine gravel	24.4		
				0	.5 - 2	coarse sand	15.1		
				0.2	25 - 0.5	medium sand	6.2		
				0.06	53 - 0.25	fine sand	10.9		
				0.01	0.016 - 0.063				
				0.00	0.008 - 0.016				
				0.00	2 - 0.008	fine silt			
				<	0.002	clay			





stimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.247E-03	.247E-05	0.21	
Hazen K (cm/s) = d_{10} (mm)	.436E-03	.436E-05	0.38	
Slichter	.486E-04	.486E-06	0.04	
Terzaghi	.692E-04	.692E-06	0.06	
Beyer	.217E-03	.217E-05	0.19	
Sauerbrei	.148E-03	.148E-05	0.13	
Kruger	.190E+00	.190E-02	164.41	
Kozeny-Carmen	.193E+00	.193E-02	166.58	
Zunker	.151E+00	.151E-02	130.48	
Zamarin	.183E+00	.183E-02	158.40	
USBR	.321E-03	.321E-05	0.28	
Barr	.521E-04	.521E-06	0.04	
Alyamani and Sen	.815E-02	.815E-04	7.04	
Chapuis	.116E-04	.116E-06	0.01	
Krumbein and Monk	.165E-01	.165E-03	14.29	
geometric mean	.917E-02	.917E-04	7.93	
arithmetic mean	.785E-01	.785E-03	67.83	

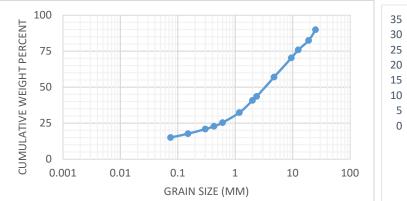


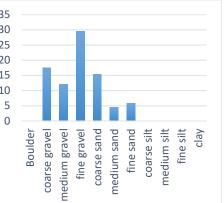
Grain Size Analysis Report Date:

 Sample Name:
 BH6 SS-6
 216-16

 Mass Sample (g):
 500
 T (oC)
 20

Poorly sorted sandy gravel low in fines

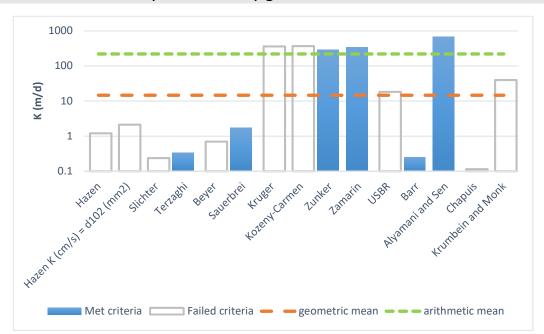




Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)	Effective Grain	n Diameters (mm)	Other Useful Parameters		
25	50.5	0.101	89.9	d10	0.050	Uniformity Coef.	116.49	
19	37	0.074	82.5	d17	0.130	n computed	0.26	
12.5	33	0.066	75.9	d20	0.258	g (cm/s ²)	980.00	
9.5	27.5	0.055	70.4	d50	3.493	ho (g/cm ³)	0.9981	
4.75	66.5	0.133	57.1	d60	5.786	μ (g/cm s)	0.0098	
2.36	67.5	0.135	43.6	de (Kruger)	1.449	ρ g/ μ (1/cm s)	9.9327E+04	
2	14	0.028	40.8	de (Kozeny)	1.315	tau (Sauerbrei)	1.053	
1.18	42	0.084	32.4	de (Zunker)	1.358	$d_{geometric\ mean}$	2.356	
0.6	35	0.07	25.4	de (Zamarin)	1.404	σ_{ϕ}	3.435	
0.425	13	0.026	22.8	lo (Alyameni)	-0.811			
0.3	9.5	0.019	20.9		mm	0	% in sample	
0.15	16	0.032	17.7		>64	Boulder		
0.075	13	0.026	15.1	1	6 - 64	coarse gravel	17.5	
				8	3 - 16	medium gravel	12.1	
				2	2 - 8	fine gravel	29.6	
				0	.5 - 2	coarse sand	15.4	
				0.2	25 - 0.5	medium sand	4.5	
				0.06	63 - 0.25	fine sand	5.8	
				0.01	6 - 0.063	coarse silt		
				0.00	8 - 0.016	medium silt		
				0.00	2 - 0.008	fine silt		
				<	0.002	clay		

Hydrogeo	K from Grain Size Analysis Re	port	Date:	30-01-2017
XL Steve	Sample Name:	BH6 SS-6		216-16
	Mass Sample (g):	500	T (oC	20

Poorly sorted sandy gravel low in fines



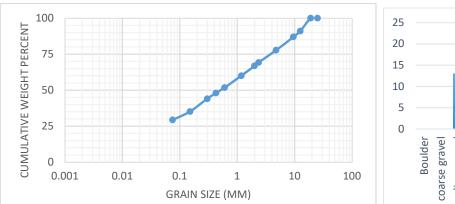
stimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.140E-02	.140E-04	1.21	
Hazen K (cm/s) = d_{10} (mm)	.247E-02	.247E-04	2.13	
Slichter	.274E-03	.274E-05	0.24	
Terzaghi	.391E-03	.391E-05	0.34	
Beyer	.806E-03	.806E-05	0.70	
Sauerbrei	.197E-02	.197E-04	1.71	
Kruger	.417E+00	.417E-02	360.25	
Kozeny-Carmen	.426E+00	.426E-02	367.93	
Zunker	.333E+00	.333E-02	287.45	
Zamarin	.403E+00	.403E-02	348.00	
USBR	.211E-01	.211E-03	18.23	
Barr	.294E-03	.294E-05	0.25	
Alyamani and Sen	.791E+00	.791E-02	683.48	
Chapuis	.133E-03	.133E-05	0.12	
Krumbein and Monk	.459E-01	.459E-03	39.69	
geometric mean	.170E-01	.170E-03	14.68	
arithmetic mean	.255E+00	.255E-02	220.20	

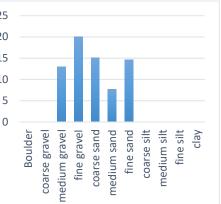


Grain Size Analysis Report Date:

 Sample Name:
 MW3 SS-2
 217-16

 Mass Sample (g):
 500
 T (oC)
 20





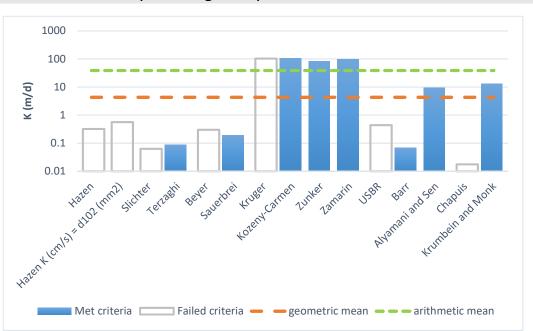
Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)	Effective Grain	n Diameters (mm)	Other Useful Parameters		
25	0	0	100	d10	0.026	Uniformity Coef.	45.98	
19	0	0	100	d17	0.043	n computed	0.26	
12.5	44.5	0.089	91.1	d20	0.051	g (cm/s ²)	980.00	
9.5	20.5	0.041	87	d50	0.517	$ ho$ (g/cm 3)	0.9981	
4.75	46	0.092	77.8	d60	1.173	μ (g/cm s)	0.0098	
2.36	42.5	0.085	69.3	de (Kruger)	0.778	ρ g/ μ (1/cm s)	9.9327E+04	
2	12	0.024	66.9	de (Kozeny)	0.702	tau (Sauerbrei)	1.053	
1.18	34	0.068	60.1	de (Zunker)	0.726	$d_{geometric\ mean}$	1.375	
0.6	41.5	0.083	51.8	de (Zamarin)	0.752	σ_{ϕ}	3.452	
0.425	19	0.038	48	Io (Alyameni)	-0.097			
0.3	19.5	0.039	44.1		mm	0	% in sample	
0.15	44.5	0.089	35.2		>64	Boulder		
0.075	29	0.058	29.4	1	6 - 64	coarse gravel	0	
				8	3 - 16	medium gravel	13	
				:	2 - 8	fine gravel	20.1	
				0).5 - 2	coarse sand	15.1	
				0.2	25 - 0.5	medium sand	7.7	
				0.06	53 - 0.25	fine sand	14.7	
				0.01	6 - 0.063	coarse silt		
				0.00	8 - 0.016	medium silt		
				0.00	2 - 0.008	fine silt		
				<	0.002	clay		



 K from Grain Size Analysis Report
 Date:
 30-01-2017

 Sample Name:
 MW3 SS-2
 217-16

 Mass Sample (g):
 500
 T (oC)
 20



stimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.369E-03	.369E-05	0.32	
Hazen K (cm/s) = d_{10} (mm)	.651E-03	.651E-05	0.56	
Slichter	.725E-04	.725E-06	0.06	
Terzaghi	.103E-03	.103E-05	0.09	
Beyer	.348E-03	.348E-05	0.30	
Sauerbrei	.221E-03	.221E-05	0.19	
Kruger	.120E+00	.120E-02	103.73	
Kozeny-Carmen	.121E+00	.121E-02	104.92	
Zunker	.952E-01	.952E-03	82.22	
Zamarin	.116E+00	.116E-02	99.89	
USBR	.508E-03	.508E-05	0.44	
Barr	.777E-04	.777E-06	0.07	
Alyamani and Sen	.109E-01	.109E-03	9.41	
Chapuis	.204E-04	.204E-06	0.02	
Krumbein and Monk	.153E-01	.153E-03	13.23	
geometric mean	.501E-02	.501E-04	4.33	
arithmetic mean	.449E-01	.449E-03	38.75	