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INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D SUMMARY REPORT

Manitoba Infrastructure

KGS GROUP PROJECT
16-0300-006
Final - Rev 0

May 2017

Kontzamanis | Graumann | Smith | MacMillan | Inc.

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FINAL – REV 0

KGS Group 16-0300-006
May 2017

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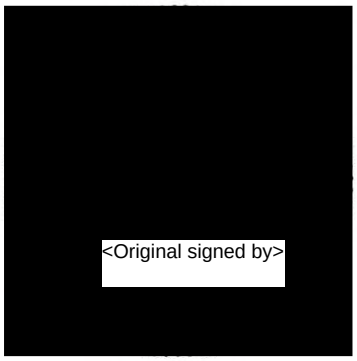

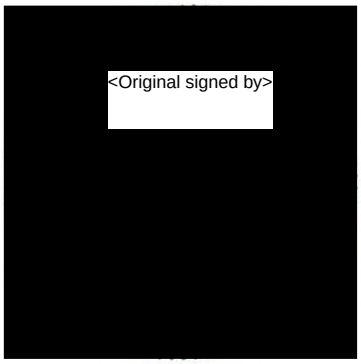

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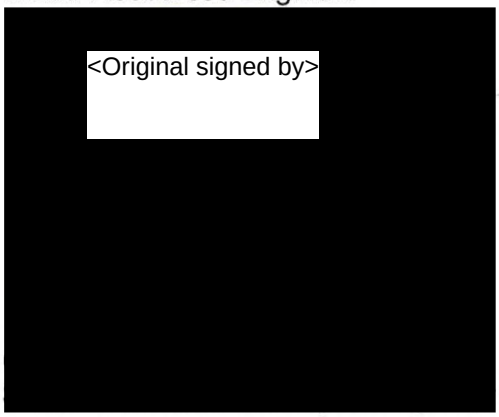

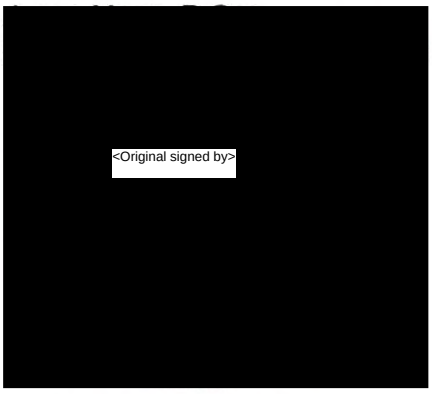

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May 18, 2017

File No: 16-0300-006

Manitoba Infrastructure
Water Management and Structures
2nd Floor 280 Broadway
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ATTENTION: Mr. Jared Baldwin, P.Eng.
Project Manager

RE: Investigations & Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D Summary Report, Final – Rev 0

Dear Mr. Baldwin:

KGS Group is pleased to submit an electronic copy of our Final Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C and D Summary Report. Three hard copies of the report will follow by courier.

We appreciate the opportunity to have worked with MI on this project and look forward to our potential future involvement at the next stages of design and execution. If you have any questions or comments regarding the enclosed report, please contact the undersigned.

Sincerely,

<Original signed by>

Dave MacMillan, P.Eng.
Principal / Project Manager

PAL/ama
Enclosure

cc: Mr. Mark Allard, P.Eng. Project Director (MI)
Mr. Colin Siepman, P.Eng. (KGS Group)
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1.0 INTRODUCTION

1.1 BACKGROUND

In 2011, record widespread flooding occurred across much of southwestern Manitoba, resulting in unprecedented inflows into Lake Manitoba and Lake St. Martin. These high flows extended well into the summer and overwhelmed the capacity of the existing flood control and protection infrastructure. Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by Manitoba Infrastructure (MI) shortly after the 2011 flood to undertake a two-stage process to advance the Lake Manitoba & Lake St. Martin Outlet Channels Conceptual Design Study.

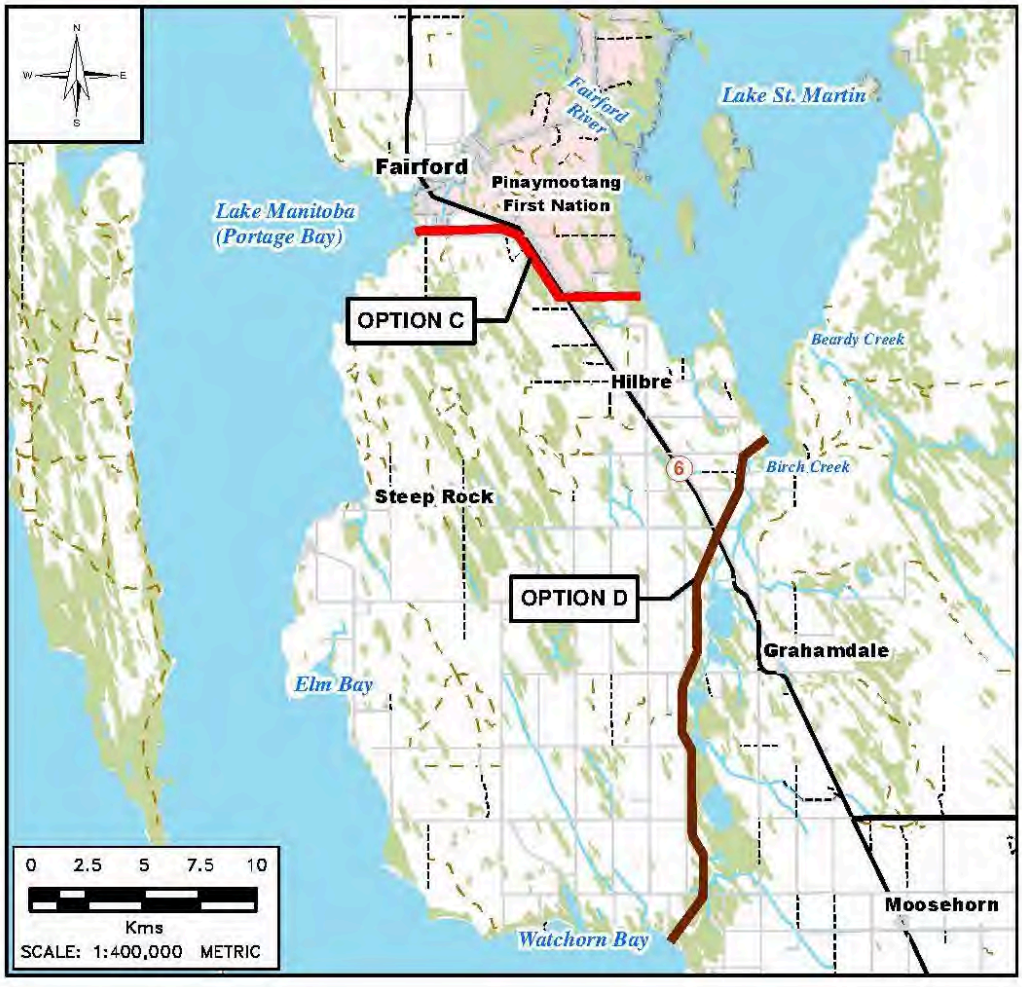
One of the fundamental scope items in the Stage 1 study was to identify outlet options for Lake Manitoba (LMB) and Lake St. Martin (LSM) followed by a comprehensive evaluation of the options and the recommendation of preferred alternatives. Six Lake Manitoba outlet options were identified in Stage 1 (Options A through F). Based on screening criteria and economic analyses completed for each of the 6 options, Options C and D were recommended for further review within Stage 2 (detailed review of preferred alternatives).

The Province of Manitoba announced in the fall of 2014 that it was proceeding with the Stage 2 conceptual design of the preferred Lake Manitoba Outlet Channel alternatives (Options C and D) with a design capacity of 212 m^3/s (7,500 cfs). The Stage 2 study was initiated in January of 2015, and final conceptual designs for Options C and D were completed as a part of the study. This current study involves additional groundwater, surface water and geotechnical investigations and preliminary engineering to assist in the identification of a preferred Option, to move forward with final design and construction.

The proposed Options C and D Outlet Channels are located within the Interlake area of the Manitoba Lowland physiographic region, an area of relatively gentle relief situated east of the Manitoba Escarpment. The ground surface in the project area is characterized by tills, proglacial lacustrine sediments, and more recent organic deposits found in low-lying depressions. The study area lies within the Lake Manitoba and Lake Winnipeg drainage basins where surface water is directed from Lake Manitoba through Lake St. Martin before discharging to Lake

Winnipeg. The Project area and location of the proposed Lake Manitoba Options C and D outlet channels are shown on Figure 1.

FIGURE 1
LOCATION PLAN OF LAKE MANITOBA OUTLET CHANNEL OPTIONS C AND D



Option C is an approximately 11.6 km long channel located immediately south of the Pinaymootang First Nation border and is situated on privately held lands and leased Crown lands joining Lake Manitoba to Lake St. Martin. The inlet is located approximately 2 km south of the existing Fairford River Water Control Structure (FRWCS) in Portage Bay on Lake Manitoba. The alignment of the channel is generally to the east for 5 km before turning southeast along PTH 6 for approximately 3 km. The channel then turns directly east to cross PTH 6 and enters Lake St. Martin approximately 3.5 km downstream.

Option D is an approximately 24.0 km long channel, situated on privately held and leased Crown land, which connects Watchorn Bay on Lake Manitoba to the outlet of Birch Creek on Lake St. Martin. This proposed route alignment is adjacent to low-lying terrain between Lake Manitoba and Lake St. Martin along which numerous marshes and small lakes exist. It is likely that these low-lying lands interconnected Lake Manitoba and Lake St. Martin during high lake level intervals that would have existed in the geologic past, specifically during deglaciation and establishment of incipient drainage of the post-glacial landscape of Manitoba. Today, local land drainage in the area is generally from the west to the east. Construction of the channel to the west of the marshes and lakes, rather than through the middle of these areas is preferred to minimize environmental impacts, and also to minimize the cost of excavating the channel in wet conditions.

1.2 SCOPE OF WORK

The scope of work for the assignment was based on the study terms of reference and focused on potential groundwater, surface water and geotechnical concerns and impacts for both Options C and D and included:

- **Drilling and Monitoring Program** including a testhole and groundwater investigation program; a geotechnical drilling, sampling and testing program; and a groundwater and surface water monitoring program.
- **Groundwater Study** including assessment of existing well use; regional geological setting; regional groundwater flow and quality; and impacts of channel project on groundwater and recommendations.
- **Surface Water Study** including surface water monitoring and water quality testing programs; assessment of existing and future surface water hydrology, surface water interactions with groundwater and of potential erosion; development of a preliminary surface water management plan and recommendations including any modifications to the proposed routes if desirable.
- **Geotechnical Investigations and Analyses** including slope stability analyses and channel cross section optimization; assessment of aquifer depressurization and water handling/management;, assessment of mitigation measures; preliminary design parameters for the structure foundations and recommendations.
- **Risk Assessment, Mitigation and Cost Allowances for Risk** including identification of risks and mitigation strategies; development of recommendations for design and construction; assessment of residual risks and impacts; development of cost allowances for risks; risk assessment rating of options; and a Technical Workshop and Presentation.

This report summarizes the results for the scope of work identified above and includes as Appendices the individual reports that describe in detail all of the investigations and analyses that were conducted. These include:

- Appendix A – Assessment of Existing Well Use and Suitability as Drinking Water (Deliverable D4)
- Appendix B – Regional Geological Setting (Deliverable D5)
- Appendix C – Groundwater Study (Deliverable D6)
- Appendix D – Surface Water Study (Deliverable D7)
- Appendix E – Geotechnical Investigations and Analyses Deliverable (D8)
- Appendix F – Risk Assessment and Budget Quantification (Deliverable D11)

2.0 DRILLING AND MONITORING PROGRAM

The study included a field program that was developed to collect the necessary data required to provide a better understanding of the geological, hydrological, hydrogeological and geotechnical considerations of the Option C and Option D outlet channels. More specifically, the program was developed to:

- Provide environmental and preliminary engineering data with respect to the groundwater and surface water regime, and geotechnical data to augment existing information.
- Provide a better understanding of the groundwater regime and assess potential groundwater issues (both engineering and environmental) for each route, including existing well use and regional groundwater flow and quality.
- Provide a better understanding of the surface water regime and assess potential surface water issues (both engineering and environmental) for each route including interaction of surface water, wetlands, and groundwater, and impacts to surface water hydrology and potential erosion.
- Provide a preliminary understanding of the geotechnical components of the project including preliminary foundation design parameters for bridges and control structures, confirmation of soil strength parameters with respect to channel and spoil pile side slope stability and geometry, preliminary level assessment of the need for groundwater depressurization/ water handling during construction and long term, preliminary assessment of the permeability and hydraulic conductivity resulting from bedrock fractures and the potential requirement for mitigation measures.

A data gap analysis was conducted to develop an investigation and monitoring plan that optimized the type, number and location of installations, using existing sites as practicable, and supplemented with new installations and instrumentation to meet the study objectives. Based on the program objectives, the data necessary to fulfil these goals were identified with consideration to existing information from past studies and investigations. The 2016 investigation and monitoring program conducted for this assignment is summarized below.

1. Domestic Well Inventory

- Option C – 3 wells.
- Option D – 19 wells.

2. Environmental and Geotechnical Drilling Programs

- Option C – two (2) boreholes for environmental, four (4) for geotechnical, and three (3) 125 mm diameter test wells (and pumping tests).
- Option D – two (2) environmental boreholes, five (5) geotechnical boreholes, two (2) shallow wetland boreholes, and one (1) 125 mm diameter test well (and pumping test).

3. Surface Water Monitoring

- Options C & D - 10 water quality sample locations.
- Option D – 2 water level monitoring locations in the wetlands.

All investigations and monitoring advanced to date on the project, including previous 2011 and 2015 investigations are shown on the drawings included within Appendix C (*Groundwater Study)*. Details of the Domestic Well Inventory program are provided in Appendix A (*Assessment of Existing Well Use and Suitability as Drinking Water*). Details of the Environmental and Geotechnical Drilling Programs are provided in Appendix C (*Groundwater Study*) and Appendix E (*Geotechnical Investigations and Analyses).* Details on the Surface Water Monitoring program are provided in Appendix C (*Groundwater Study)* and Appendix D (Surface Water Study). All of the borehole logs for the 2016 investigation programs are included in the Appendix E (*Geotechnical Investigations and Analyses*).

Continued seasonal monitoring of water level and water quality until the spring of 2018 is planned to occur at a number of groundwater wells and at the surface water monitoring locations. Results from future monitoring events will be documented independently in Annual Monitoring Technical Data Reports to be issued in July of 2017 and 2018.

3.0 GROUNDWATER STUDY

3.1 REGIONAL GEOLOGICAL SETTING

The geological setting of the proposed Options C and D channels reflects a diverse cross section of geological history. While the geological setting for both channels is the same, the variability in the geological conditions in the region result in a key distinction between the Options C and D channels; namely that Option C would be incised into the bedrock whereas Options D would be excavated entirely within the till. A detailed documentation of the regional geological settings is included in Deliverable D5 in Appendix B and includes detailed stratigraphic profiles and cross sections of both Options C and D. Simplified profiles are provided in Figures 2 and 3.

FIGURE 2
PROFILE OF OPTION C

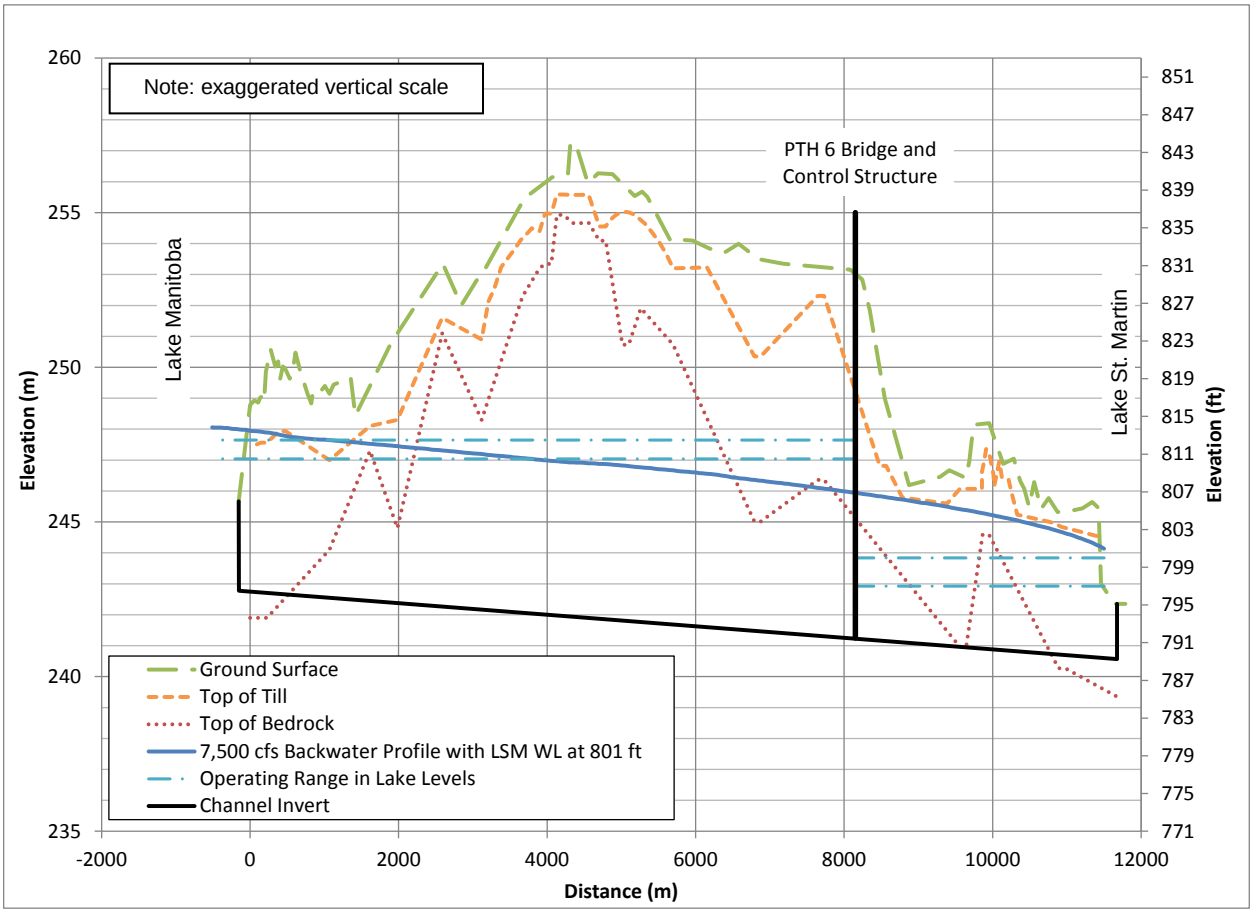
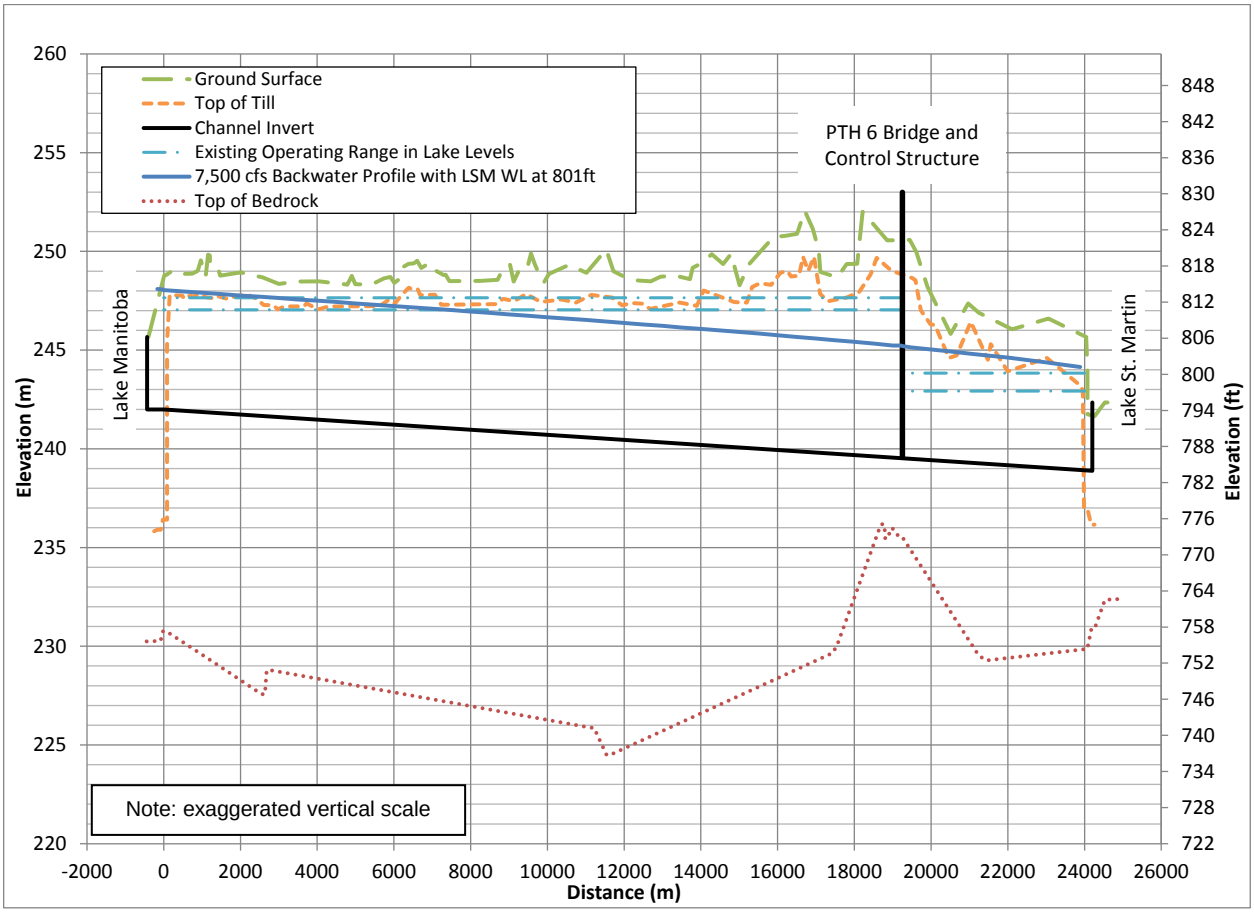


FIGURE 3
PROFILE OF OPTION D



The morphology and topography of the bedrock surface in the region varies drastically due to structural discontinuities (i.e. joints and bedding plane partings), textural/compositional variability inherent within the rockmass due to its depositional history, paleokarst processes that enhanced pre-existing bedrock structural discontinuities and emplaced discontinuity infills, preglacial erosional events, and finally, erosion during glaciation and subsequent emplacement of the overlying till sediments.

For Option D, the relatively low ground surface topography along the route between Watchorn Bay of Lake Manitoba and Lake St. Martin is a result of relict surface drainage of Lake Manitoba to Lake St. Martin during deglaciation. This topographic low may also be a reflection of glacial sediment infilling of a large underlying bedrock structural feature, and associated deep depths to bedrock along the route. In directions orthogonal to Option D, the bedrock surface rises

drastically within distances of approximately 1 km to 3 km of the route centerline. Relatively high ground surface topography along the majority of Option C is a reflection of a high elevation bedrock surface, and thin overburden cover along the upstream portion of the route. Bedrock topography in the vicinity of Highway 6 along Option C, to Lake St. Martin, varies drastically over relatively short distances, where thicker sediment cover and infills are present.

High elevation bedrock areas with thin sediment cover are typical of unconfined groundwater recharge areas. Relatively lower bedrock elevation areas are typically confined by overlying tills, and are characteristic of groundwater discharge, where the confined bedrock aquifer may be under a flowing artesian condition. In all cases, the uppermost approximately 10 m of the rock mass is affected the most severely by paleokarst processes, which enhances general bedrock permeability, where succeeding karstic infills do not govern the rockmass permeability condition. Thus the relationship between overall bedrock conditions (including permeability, bedrock topography/regional structural conditions), overburden type/thickness, and groundwater conditions, are all important contributors in defining the design, optimization, or environmental implications associated with each alignment option.

Analyses of local conditions along both the Option C and Option D alignments were based on the field investigations conducted for this study, as well as those compiled from previous studies since 2011. Considering the variability of the bedrock surface in the region, as described above, and potential impacts to the channel design, further discussed in Section 3.3 (Groundwater Regime) and Section 5.0 (Geotechnical Investigations and Analyses), supplemental investigations in key or select areas along the preferred channel alignment should be conducted for design optimization or risk reduction at the next stages of the project development. This would likely include, for example, seismic refraction along the channel centerline and selected cross section locations, as well as additional drilling investigations at the proposed control structure locations.

3.2 ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER

The groundwater study included an assessment on the condition of wells in the region to provide an understanding of existing well use and suitability as drinking water, based on existing data sources and limited field verifications as summarized herein. A detailed documentation of

the assessment and study findings is included Deliverable D4 (Appendix A). Detailed summary tables and inventory location plans illustrating the result of the assessment are also included in Appendix A.

3.2.1 Regional Water Supply Use

Groundwater is the sole supply of domestic water for the region surrounding both the Option C and Option D channels, serving residences, farms, and community supplies. A description of information on wells serving multiple residences, or buildings or community locations is given in Deliverable D4 in Appendix A. This information was gathered primarily from public sources and is considered to be general.

A three kilometre distance from the channel centerline was selected as a reasonable distance within which to conduct evaluations of potential groundwater effects of the project. A second distance of 500 m was used to evaluate effects on water supplies close to the channel. The 500 m distance is a general buffer distance used for screening bedrock wells next to surface water for GUDI effects (Groundwater under Direct Influence of Surface Water).

Based on a review of the air photo imagery and the limited well inventory, a count of wells located within the 3km and 500m distance was conducted for both Options C and D. The results are summarized in Table 1.

TABLE 1
ESTIMATED NUMBER OF RESIDENTIAL WELLS

	Option C		Option D	
	Within 3 km	Within 500 m	Within 3 km	Within 500 m
Total Number of Possible Resident Locations	137	29	66	15
Number of Locations Assumed to be Served by Community Systems	45	0	0	0
Estimated Number of Wells	95 to 100	29	66	15

Although the wells identified on Table 1 were considered “residential”, some of these locations could be other buildings, farmyards, or other structures without an active well. Alternatively, a number of residences may not have been captured in this high level analysis. A door to door survey in the area would be required at the next stage of design to confirm well locations.

In addition to the review of the air photo imagery, the Provincial well record database (GWDrill as of 2013) was searched within 3 km of the proposed outlet channels. An attempt was made to match wells with possible residences using location and any identifying information on the well log. Wells described as monitoring wells, test holes, observation wells or abandoned or sealed wells were excluded. The results are summarized in Table 2.

TABLE 2
ESTIMATED NUMBER OF WELLS BASED ON GWDRILL RECORDS

	Option C		Option D	
	Within 3 km	Within 500 m	Within 3 km	Within 500 m
Wells for Domestic Use or for Domestic and Livestock Use	87*	21	96	14
Wells for Livestock Use Only	9	2	36	4

* Note: includes a small number of unidentified users assumed to be domestic use, as well as one well used for air conditioning.

The total number of wells included in the Provincial database included wells drilled on a range of dates, extending back to the 1900’s. Although these have been included in the evaluation, some of these older wells may no longer be in use. In addition, wells used for livestock at the time of drilling may not be active today. In addition not all wells drilled in the area may be captured on the data base.

3.2.2 Community Water Supply and Pinaymootang First Nation

Several community supply systems were identified within the Pinaymootang First Nation land, which is located north and directly adjacent to most of the Option C channel. This included a community supply with 2 wells providing for 38 homes and a second community supply with one well providing for 7 homes. Other community systems that were identified within the Pinaymootang First Nation land included a water treatment/bottling plant, the Community

School and Arena, as well as other public buildings and businesses. In addition, a private resort and Campground near the Fairford River was identified, which has a seasonal, semi-public groundwater system.

For Option D, the population centre of Moosehorn is distant from the project. Local communities of Grahamdale and Hilbre are located outside the 3 km distance evaluated, but were assumed to have individual domestic wells. There is also a well supply at the Watchorn Provincial Park. No community water supplies were identified in the 3 km distance evaluated.

3.2.3 Aquifer Systems and Piezometric Levels

Information on aquifer systems and piezometric levels was collected from investigations in the Stage 2 study (2015) and the 2016 study, as well as from regional information from the GWDrill database. The major aquifer system for the water supply wells was determined to be the bedrock carbonate (limestone) aquifer.

In the vicinity of Option C, the piezometric surface was generally shallow, from 0 to 4 m below ground surface. In general, the topographic high area with shallow depth to bedrock was a recharge area with downward gradients, as confirmed in the 2016 investigation program. Flowing (artesian) wells were present towards the channel outlet close to Lake St. Martin.

In the vicinity of Option D the piezometric surface was generally shallow, from 0 to 3 m below ground surface in the higher bedrock areas located within 3km east and west of the channel. Many areas had flowing artesian wells along, and close to the alignment, with piezometric elevations from 0 to 6 m above ground surface indicating upward gradients in the regional flow system.

3.2.4 Well Construction

Construction of the wells is an important factor in assessing sensitivity to drawdown. During construction, pumps are set within the well casing so that when the well is pumped, the water level remains above the pump intake. If temporary or permanent drawdown, resulting from Outlet Channel construction or operation, causes pumping water levels to approach the pump

setting, mitigation may become necessary. For wells with deep casings and high water levels, lowering the pump within a casing is a typical mitigation measure. If, however the casing is shallow relative to the pumping water level, the pump may not be able to be lowered, without requiring specialized casing extensions, or drilling a new well. Data collected on the well casing depths from GW Drill was used to assess the risk to water supplies for various drawdown scenarios. This is summarized in Table 3.

TABLE 3
SUMMARY OF WELL CASING DEPTHS

Number of Wells with Casing Depths	Option C		Option D	
	Within 3 km	Within 500 m	Within* 3 km	Within 500 m
Less than 10m	43	10	39	0
Between 10m to 20m	33	10	46	11
Between 20m to 30m	4	0	31	8
Between 30m to 40m	1	0	6	0
Greater than 40m	2	1	1	0

*Notes: Wells within 3km distance of the Option D Channel includes areas of higher bedrock that are away from the channel. Total number of wells differs from the totals in Table 2 since not all records contained information, or in some cases information was not complete.

For Option C, since the channel invert is proposed at 6 to 16 m below ground surface and into the bedrock aquifer, approximately 50 % of the wells with casing depths from 0 to 10 m, and 40% of the wells with casing depths of 10 to 20 m would be situated above the channel invert. At those locations, lowering pumps alone would not be possible as a potential mitigation measure against drawdown effects, and new wells would have to be drilled. In addition, a number of wells could be affected due to potential for GUDI conditions, as discussed in Section 3.3.3. Individual treatment systems or a community water treatment and distribution system would therefore be required to address the risk of impacts to the individual and community groundwater wells at an additional cost to the project (see cost allowances for risk in Section 6.0).

For Option D, there is anticipated to be a low risk of water supplies losing capacity during construction and operation because of the higher groundwater piezometric pressures, flowing

artesian conditions, thick till cover over bedrock, and casings depths exceeding 10m in the vicinity of the channel. However, the risk is higher east of the Birch Creek wetland drainage area and in the northern third of the channel on the west side in locations where there are shallow casing depths. A detailed local in well assessment would be required at the next stage of design to identify vulnerability and collect information in locations of potential groundwater impacts.

3.2.5 Well Capacities and Calculated Aquifer Transmissivities

Well yields can be highly variable in the bedrock carbonate aquifer (limestone), which is a direct result of the fractured rock conditions. Water yields depend on the number of fractures intersected by a well, their size (aperture), extent, and interconnection to other fractures. Based on the studies conducted in 2016, the representative aquifer transmissivity was low, less than 1000 USgpd/ft. Regional variability in transmissivity is anticipated; however, along both channel alignments.

An estimate of transmissivity was made based on the pumping rates and static and pumping levels for individual wells contained within the GWDrill data base and is summarized in Table 4.

TABLE 4
SUMMARY OF AQUIFER TRANSMISSIVITY

Number of Wells with Calculated Transmissivities	Option C	Option D
	Within 3 km	Within 3 km
Very low (<1000 USgpd/ft)	24	54
Low (1000 to 5000 USgpd/ft)	49	26
Low to Moderate (5000 to 15,000 USgpd/ft)	4	13
Moderate (15 to 50,000 USgpd/ft)	1	5
High (>50,000 USgpd/ft)	3	1

*Note: Option C based on total of 81 wells, and Option D based on a total of 109 wells, since not all records contained information, or in some cases information was not complete.

A range of 1,000 to 15,000 USgpd/ft was considered to be a reasonable estimate of bulk aquifer transmissivity, based on the review of the well records. However, the estimated transmissivity of the aquifer was based on fractures and solution channels that vary in the region. Therefore it

was considered possible to encounter zones of higher transmissivity in some locations as shown in Table 4.

3.2.6 Aquifer Vulnerability

Aquifer vulnerability refers to the sensitivity of the aquifer to contamination. In this area, bedrock aquifers with a thin to absent cover are most vulnerable, while bedrock aquifers buried beneath thick till deposits are least vulnerable.

For Option C, bedrock elevation is high along a significant portion of the channel alignment. Overburden cover thins as the bedrock controlled topography increases. Existing wells in much of this area have little to no overburden above bedrock and have a high vulnerability to potential surface contaminant sources. In addition, the proposed channel side slope and invert of Option C will be in the bedrock and into the aquifer in this area, increasing this vulnerability.

For Option D the channel alignment lies along the deepest till deposits roughly parallel to the Birch Creek drainage system. The thick low permeability till sediments beneath the channel and to the west of the channel protects the bedrock aquifer from potential surface water intrusion from the channel. The proposed invert of the channel will be within the till overburden, with approximately 12 to 14 m of till remaining between the invert and the underlying bedrock in the southern portion of the channel and 10 m to less than 5 m in the northern portion. Groundwater depressurization will be required during construction to protect against blowout of the channel. A channel blowout would result in a direct connection between the surface water in the channel and the underlying bedrock. The significance of this connection; however, will depend on the water levels in the channel relative to the piezometric head, which is strongly upwards in this area and would protect against downward movement of surface water. The relative risk with varying channel surface water levels could be determined in future studies. Additional drilling between existing testhole locations where artesian conditions have been measured could be beneficial during detailed design.

3.2.7 Well Inventory Program and Water Quality

A well inventory and water quality program was developed for the area surrounding both Options C and D. Wells were selected based on locations identified from the air-photo imagery for residences within a 3 km radius of the proposed alignments. A number of considerations were made in determining which wells to include in the well inventory and water quality sampling program. Groups of wells were identified on both sides of the proposed channels. One sample from each grouping was identified for collection. Manitoba Infrastructure then made inquiries to landowners to conduct the well inventory and sample the well water. If the initial well selected was unavailable, another well from the grouping was selected. For Option C, contact was made with the Pinaymootang First Nation to participate in the program; however the First Nation declined to participate.

A well inventory and water quality sampling program was completed on October 19 and 20, 2016. A total of 3 residences were visited for Option C and 19 residences for Option D. Interviews were conducted with each homeowner regarding their well, construction, water quality and use and possible contaminant sources. Some homeowners had detailed knowledge of their systems age and construction and possible pump settings, while others did not. Individual forms were prepared for each well documenting the responses to the inventory questions, the field sampling results and photographs are included in Deliverable D4 in Appendix A.

Regional information from Provincial Groundwater Availability Map Series (Dauphin Lake Area) indicated that east of Lake Manitoba the water quality is generally fresh, with Total Dissolved Solids (TDS) less than 1,000 mg/L. Water quality is generally magnesium- calcium-bicarbonate, with TDS in the order of 400 mg/L to 650 mg/L. This water quality reflects the significant meteoric water, aquifer recharge zone noted within the Interlake area.

Groundwater samples were collected from the residences included in the water quality program and analyzed at an accredited analytical testing laboratory. The results indicated a potable groundwater with elevated hardness and sulphate. The water quality varied from magnesium-calcium-bicarbonate or calcium-magnesium-bicarbonate to magnesium -bicarbonate. In general, Nitrates were notably very low, as well as chloride and sodium, with an exception near

Option C. Some, but not all residents used softeners or other filters on their water supplies, with one owner near Option C reporting that they boil their water. Four wells had total coliform counts (1 to 3 MPN/100 ML); however no *E. coli* was detected.

3.3 GROUNDWATER REGIME

The Groundwater Study included an assessment of regional groundwater flow and quality and potential impacts of the channel project on groundwater wells. A detailed documentation of the assessment and study findings is included Deliverable D6 attached in Appendix C. The results of the assessment were based on data collected as part of the field program described in Section 2.0. In summary, the groundwater field program included drilling, installation of vibrating wire piezometers and transducers, pump testing and hydraulic conductivity measurements, lugeon testing, and water quality testing. Details on the groundwater component of the program, including methodology and results, are included in the Deliverable D6 (Appendix C).

3.3.1 Regional Groundwater flow

Option C

The regional bedrock groundwater flow system in the vicinity of Option C is from the central higher elevation areas between the lakes toward the Fairford River, Lake Manitoba and Lake St. Martin. An area of high bedrock located approximately 3 to 5 km from the inlet represents an approximately 15 km^2 regional recharge zone. The bedrock aquifer is confined by the silty clay unit found above the till. Confined conditions are found throughout the area. Artesian conditions are variable, with the piezometric surface close to ground surface near the inlet and stronger artesian conditions near the outlet. Seasonal variations in groundwater piezometric pressure are expected, with higher elevations anticipated in spring and periods of high lake levels due to flooding, and lower elevations later in the fall and during dry cycles. Groundwater in the overburden till deposits is hydraulically connected to the bedrock. The till is confined by the overlying silty clay.

Horizontal hydraulic gradients along the alignment varied between approximately 0.0012 m/m and 0.0021 m/m. Vertical Gradients between the bedrock and the till varied depending on the location

with some locations of upward gradients and others of downward gradients. Within the bedrock, a downward gradient was found between the upper and lower bedrock at two monitoring locations (0.018m/m and 0.056m/m). These vertical gradients reflect the presence of a groundwater recharge zone in the high bedrock areas. Although some of the wells with measured downward gradients were completed above the invert of the channel, downward gradients within the bedrock groundwater are also expected below the proposed channel invert and in the high bedrock zone extending on both sides of the channel.

Seasonal changes were observed at some locations based on limited historic measurements and generally showed increasing piezometric elevations since 2011. Additional data to evaluate seasonal changes will be collected during future monitoring periods as deemed necessary.

Aquifer transmissivity and storativity was estimated based on pumping test results. A low to very low transmissivity of approximately 4 to 2600 USgpd/ft was estimated depending on location while storativity was estimated as 3.6 x 10^{-2} to 4.8 x 10^$^{-9}$. Hydraulic conductivity was measured as follows:

• Silt till/ clay till	3 tests	1.2 x10^{-6} m/s; 1.7 x10^{-6} m/s; 2.7 x10^{-6} m/s
• Clay shale	1 test	3.2 x10^{-8} m/s
• Upper cobbles/bedrock	1 test	6.8 x 10^{-7} m/s
• Bedrock	8 tests	Six of eight values were less than or equal to 7.2 x10^{-6} m/s with the maximum 2.4 x 10^{-4} m/s and minimum 3.9 x 10^{-7} m/s.

Lugeon testing showed a high degree of variability typical of near surface karstic carbonate aquifers.

Option D

The regional bedrock groundwater flow system in the vicinity of Option D is from the eastern high bedrock areas west toward Lake Manitoba and north towards Lake St. Martin. A secondary discharge system exists on and adjacent to the alignment controlled by a buried pre-glacial bedrock channel extending from Lake Manitoba to Lake St. Martin. This channel is also believed to have been a glacial drainage between the lakes as discussed in Section 3.1, subsequently infilled by till and later pro-glacial lacustrine sediments and more recent organic deposits. Areas

with the greatest depth of sediments are located along the deepest portion of the bedrock channel.

Regional recharge occurs in areas of shallow bedrock. Given the overall westward groundwater flow, the major recharge area for the alignment of Option D would be east of the alignment in the higher bedrock areas. The bedrock aquifer is confined by the silty clay unit found above the till. Confined conditions are found throughout the area. Artesian conditions and upward gradients in the bedrock are found extensively within the buried bedrock valley. Downward gradients in the bedrock are expected in the higher bedrock areas, although drilling investigations were not conducted there for this study. Artesian conditions within the bedrock were found at all of the bedrock holes drilled and ranged between 1.7 m and 7.9 m above ground surface.

Groundwater in the overburden till deposits is hydraulically connected to the bedrock. The till is confined by the overlying silty clay. Artesian conditions within the till, as well as in the silty clay, were found at a number of locations.

Horizontal hydraulic gradients along the alignment have not been calculated due to the complexities of the regional westward and northward groundwater flow. Upward gradients were found at all locations with instrumentation but were not calculated due to approximate piezometric elevations in flowing wells. The upward vertical gradients observed reflect the presence of a groundwater discharge zone beneath the buried bedrock valley. Although upward gradients may be present, groundwater will not physically move from the aquifer to the surface unless an area of interconnection is present. Areas of thick low permeability deposits above groundwater with upward gradients will not discharge locally, but will flow toward regional discharge points such as larger lakes. The low permeability till and confining clay restrict the outflow of water, maintaining the high piezometric conditions in the area.

Seasonal changes were observed at some locations based on limited historic measurements and generally showed increasing piezometric elevations since 2011. Additional data to evaluate seasonal changes will be collected during future monitoring periods as deemed necessary.

Aquifer transmissivity and storativity was estimated based on pumping test results. A very low transmissivity of approximately 400 USgpd/ft was estimated while storativity was estimated as 5.6 x 10^{-6}. Hydraulic conductivity was measured as follows:

- Silty clay till 3 tests 1.9 x10^{-5}, 1.4 x10^{-9}, 2.9 x10^{-10} m/s
- Bedrock 2 tests 1.7 x10^{-5}, 5.2 x 10^{-5} m/s

Lugeon test results were within the range of permeability values typical of fractured carbonate bedrock.

3.3.2 Regional Groundwater and Surface Water Quality

Surface and groundwater samples were taken at a number of locations along and near the Options C and D alignments. Data was collected on field chemistry, general water quality including metals, ion balances and water types. Groundwater results were compared against Canadian Drinking Water Quality Guidelines, since the aquifer is potable and is the sole source of drinking water in the region, as discussed in Section 3.2.1. Surface water results were compared to the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG). Where applicable, the Canadian Council of Ministers of the Environment (CCME) criteria for Freshwater Aquatic life was also referenced. Results exceeding the applicable guidelines were highlighted. The details of the field program methodology and results are described in Deliverable D6 (Appendix C). Additional data to evaluate seasonal changes and to develop baseline information will be collected during future monitoring periods.

3.3.3 Groundwater under Direct Influence of Surface Water

A Groundwater under Direct Influence of Surface Water (GUDI) Screening Study was conducted as a factor in the selection of the preferred route. For Option C, the channel was identified as a potential risk as it would be excavated into bedrock and could provide a direct surface to groundwater interconnection in proximity to domestic and community water supply wells. The surface water in the channel would be in direct contact with the bedrock groundwater through the channel walls and base. Downward (recharge) groundwater gradients in the central portion of the channel have been measured, where the bedrock is topographically high and sediment cover is very thin. Introducing a large and direct interconnection of a surface water

source within the channel in an aquifer recharge area will increase the potential for downward infiltration of surface water into the bedrock, with associated water quality changes and widespread risk of potential bacterial contamination in the aquifer and to groundwater wells.

For Option D, the channel was identified as a low risk, as it would be excavated into till and a direct connection of surface water to groundwater in the bedrock confined aquifer would be unlikely. Depressurization during construction, design optimization and passive long-term depressurization in certain areas of the channel will be needed to protect against blowout of the till channel base on the northern third and possibly other areas of the channel, due to the bedrock artesian pressures beneath the channel. In addition to construction difficulties, channel blow out would create a pathway between the surface water and the groundwater. The upward gradients below the channel would mitigate the effects of a blowout should it occur and protect against downward migration of surface water. Nevertheless, a blowout would be undesirable and would increase the risk of the potential adverse impacts from the surface water on the groundwater.

3.3.4 Wetlands Evaluation

Wetlands are in close proximity along the channel alignment of Option D. Data collected at and near the wetlands was assessed to determine if there was evidence of interconnection to bedrock groundwater flow systems, through the till aquitard. A review of domestic well logs closest to the wetland indicated that till was present above bedrock at all locations, ranging between 7 m to 24 m in thickness. Bedrock rises to the east of the wetlands; however, the exact elevation of the bedrock on the east side of the wetlands is not known and has been interpolated based on a limited number of area well logs, of which few are close to the wetlands.

Based on information obtained from the drilling and pump testing programs, there was no evidence of a groundwater interconnection to the wetland. The low permeability till beneath the wetland limits or precludes water level changes in the wetland due to any groundwater piezometric pressure drawdown in the bedrock aquifer and overlying till that will be necessary during channel construction, or that will occur associated with subsequent channel operations. Furthermore, isotopic sampling of the surface water within Clear Lake that has been conducted to date was distinct from the groundwater samples, and closely reflected the regional meteoric

water line. This suggested no particular interconnection of the groundwater and surface water systems at this location, though further sampling and analyses are planned as part of the ongoing monitoring programs.

The artesian conditions present within the area will be maintained. The existing discharge of groundwater in the area of the channel alignment is very low to negligible due to the thick, low permeability layer of till above the bedrock. Bedrock depressurization is required during construction and long term to protect against blowout and instability in the channel base and side slopes. This depressurization will result in a lower artesian groundwater pressure local to the channel, but essentially no change in the already negligible groundwater discharge to surface.

Similar concerns were not considered for Option C since there are no wetlands in close proximity to the alignment.

3.3.5 Drawdown Predictions

The impact of the channel project on groundwater wells was evaluated for a multi-year construction period and for the long-term operational period. The estimated drawdown for Option C varies along the channel based on the original piezometric surface, channel invert, geologic conditions, drainage to the channel invert during construction, and long-term groundwater discharge equilibrium with the channel operating water levels. For the majority of the channel, where excavation occurs through the bedrock, only half of the exposed rock face was assumed to dewater. In remaining locations, where the bedrock is at or below the channel invert, construction conditions assume that dewatering will occur to the channel invert. Long term, the aquifer piezometric water level was assumed to re-equilibrate to the surface water levels within the channel.

For Option D it was assumed that bedrock groundwater depressurization will be required to maintain a factor of safety during construction of 1.3 and a long term factor of safety of up to 1.5, as discussed in Sections 5.2 and 5.3. Depending on the final location of the control structure, bedrock aquifer depressurization will be required along approximately the northern third and possibly other areas of the channel with active depressurization anticipated during

construction, and passive depressurization required during long-term operation. Temporary drawdown estimates during construction at the channel were estimated at 2.5 m to 13 m depending on the current bedrock groundwater piezometric pressure elevation. During operation slightly less drawdown is anticipated, from between approximately 1 m to 11 m, with the most drawdown occurring in the areas of highest artesian pressures.

A separate analysis of drawdown with distance during construction was conducted for both Options C and D based on radial flow equations using a variety of aquifer transmissivities and a duration of 10 months. The maximum drawdown of 14 m was estimated to the channel invert and at the channel centerline. A drawdown of 1.5 to 3.3 m was predicted at the 3 km distance from the channel, decreasing to 0.9 to 2.7 m at 5 km distance. The analysis does not account for boundary conditions such as the Fairford River,Lake Manitoba and Lake St. Martin, or for complex bedrock surface topography and till infill conditions at the channel, which could influence drawdown. Beyond the 3 km distance, in general, the predicted aquifer drawdowns are in the order of long-term seasonal variability noted within the regional aquifer system.

The potential impact of the bedrock aquifer piezometric pressure drawdown on area water supply wells was assessed. The impact of the drawdown on water supply wells will depend on the aquifer properties, original well construction and the groundwater elevations. For wells at the same location and the same casing depth, wells with higher water levels, will be less sensitive to drawdown, assuming the aquifer properties are similar, and the pumps are set at the base of the casing. Wells with deep casings will presumably either have deep pump settings, or will allow for the opportunity to lower the pump in the casing. This maximizes the standing column of water above the pump within the well. Wells with shallow casings and low aquifer water levels (i.e. a relatively small standing column of water in the well above the pump) are often more sensitive to the amount of regional drawdown they can accommodate before the active water level in the well is drawn to the pump. Aquifer characteristics are also a factor. Wells with high specific capacities are less sensitive than those with low specific capacities. These factors were evaluated on a regional basis and are discussed in Section 3.2.4.

4.0 SURFACE WATER STUDY

The Surface Water Study was conducted to provide an understanding of the surface water regime to allow for an assessment of potential surface water issues for Options C and D of the Lake Manitoba Outlet Channel and to provide recommendations for design and construction. The surface water study considered existing and future (post-project) surface water hydrology, the interaction with wetlands and groundwater, as well as surface water management during construction and operation. A detailed documentation of the Study analyses and results are included in Deliverable D7 – Appendix D.

4.1 SURFACE WATER HYDROLOGY

4.1.1 Option C

The surficial geology in the region surrounding Option C is typically calcareous loamy till while moderately to excessively stony. Bedrock is also present near or at the surface in a number of locations. The topography is relatively flat, or gently undulating. Although there is some agricultural activity in the area (mostly hay and pasture), the terrestrial environment is mostly forested, and intermixed of grasslands and small wetlands. In general, the area is poorly drained and has only a few small creeks or drainage ditches. On an annual basis, the largest surface water runoff typically occurs in the spring during the snowmelt period. However, large storm water events may result in peak flows occurring in the summer or in the fall.

Overland flow in the vicinity of the Option C channel alignment was sub-divided into four small basins that either drain east to Lake St. Martin at and near Harrison Creek, or north and west to Lake Manitoba, the Fairford River and Inlet Creek. The Option C Outlet Channel will intercept a portion of these basins as shown on Figure 4.

FIGURE 4
IMPACTS TO DRAINAGE BASINS SURROUNDING OPTION C

Inlet Creek was determined to have the largest percent reduction in drainage area (estimated 52%) as a result of the project, while there would be no change on Harrison Creek.

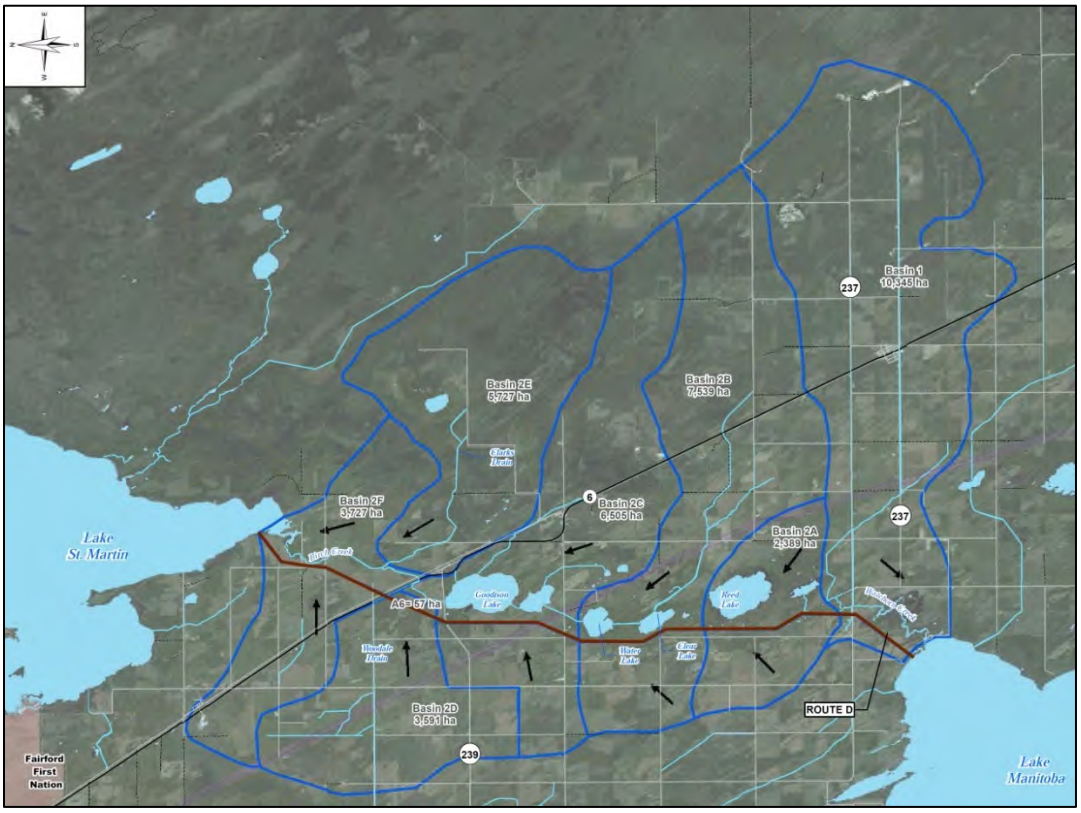
A preliminary hydrologic assessment of the drainage area of Inlet Creek was conducted and the existing flows expected at the outlet of Inlet Creek during the 1:10 year and 1:100 year flood events were estimated to range between approximately 3 m^3/s and 4.5 m^3/s (100 cfs and 160 cfs) and the median annual flow (1 in 2 year flood event) was estimated at approximately 1.1 m^3/s (40 cfs). These flows are relatively small when compared to the estimated flows on watercourses surrounding the Option D Outlet Channel (Section 4.1.2) and the design flow of the Lake Manitoba Outlet Channel (212 m^3/s or 7,500 cfs). Although the reduction in drainage area is anticipated to result in a reduction in flow in Inlet Creek, the overall impacts of this reduction are not expected to be significant.

4.1.2 Option D

The surficial geology and topography in the region surrounding Option D is similar to the area surrounding Option C, but with fewer areas of bedrock present near or at the surface, particularly in proximity to the outlet channel alignment. The terrestrial environment is very diverse, and includes agricultural areas (mostly hay and pasture), intermixed of grasslands, forested areas and larger regions of wetlands and small lakes. Although landowners have expressed concerns with poor drainage in the region, the existing drainage network is typically more developed compared to Option C, particularly in proximity to the proposed Option D channel alignment. On an annual basis, the largest surface water runoff typically occurs in the spring during the snowmelt period. However, large storm water events may result in peak flows occurring in the summer or in the fall.

Overland flow in the vicinity of Option D generally travels in a westerly direction towards the wetlands and small lakes which include Goodison Lake, Reed Lake, Water Lake and Clear Lake. These lakes and wetlands in turn discharge into Birch Creek, which flows northerly towards Lake St. Martin. Only a relatively small area near the channel inlet drains towards Lake Manitoba (Watchorn Creek). The Option D Outlet Channel will intercept a portion of these drainage basins as shown on Figure 5.

FIGURE 5
IMPACTS TO DRAINAGE BASINS SURROUNDING OPTION D



The reduction in drainage area for the wetlands and small lakes due to construction of the Option D Outlet Channel was estimated to range between approximately 23% and 45%. On Birch Creek, the drainage area was estimated to be reduced by approximately 32%, whereas on Watchorn Creek, only by approximately 2%.

A preliminary hydrologic assessment of the existing drainage area of Birch Creek was conducted and flows expected at the outlet of Birch Creek during the 1:10 year and 1:100 year flood events were estimated to range between approximately 40 m^3/s and 75 m^3/s (1400 cfs and 2600 cfs). The median annual flow (1 in 2 year flood event) was estimated at approximately 15 m^3/s (540 cfs). The reduction in size of the drainage area is expected to reduce flows in Birch Creek as well as inflows to the various wetlands and small lakes. Potential mitigation measures that address this concern are outlined in Section 4.4.2.

4.1.3 Interaction with Groundwater

The potential for current and future (post construction) interaction of surface water with groundwater along Options C and D has been discussed in Section 3.3. In summary, the surface water in the Option C channel would be in direct contact with the bedrock groundwater aquifer through the channel walls and base excavated in bedrock.

On Option D, a direct inter-connection is not anticipated with implementation of mitigation measures, namely aquifer piezometric pressure reduction (depressurization) of the bedrock aquifer to protect against hydraulic fracturing (blow out) of the till channel base. Beneath the adjacent wetlands, the low permeability till will limit or preclude water level changes in the adjacent wetlands due to any groundwater piezometric pressure drawdown in the bedrock aquifer and overlying till that will be necessary during channel construction, or that will occur associated with subsequent channel operations.

4.2 PRELIMINARY SURFACE WATER MANAGEMENT PLAN

The purpose of the Surface Water Management Plan (SWMP) for the Lake Manitoba Outlet Channel is to minimize impacts to overland flow as a result of the Project, during construction and for long term operation. The Preliminary SWMP is included in Deliverable D7 (Appendix D) and should be enhanced at the next stage of design and over the course of the project as further details are defined. The following short and long term objectives were incorporated in the SWMP:

- Control of surface water sources within or in close proximity to the project area that may be impacted during construction, including surface water in adjacent water courses and water bodies, surface water from construction dewatering activities due to seepage or depressurizing systems, surface water from rainfall and/or snow melt runoff.
- Accommodate construction staging and sequencing with consideration for ditching requirements, alignments, and risks associated with runoff and flooding.
- Accommodate surface water runoff during long-term operation with consideration given to ditching requirements, preliminary sizing of the drains and required structures.
- Considerations to sediment and erosion control during construction and long-term operation.

The Preliminary SWMP has been prepared with consideration of the temporary and permanent changes to the existing drainage system for the short term (during construction) as well as for long term operation. The short term water management controls for this SWMP consider methods to manage potential groundwater inflow into the construction area, as well as measures to manage precipitation and surface run-off. Details of the short term measures to be developed at the next stage of design should be designed with sufficient capacity such that the measures can be constructed and maintained without damage to the constructed work or significant delay to the project completion. The storm event selected as the criteria will be identified at the next stage of design and is anticipated to be within the 1 in 5-year and the 1 in 25-year event.

The long term water management controls identified in the SWMP consider drainage re-alignments that minimize impacts to the environment. The design capacity selected as the criteria for the long term measures will be identified at the next stage of design with consideration of environmental sensitivities, risk and long term costs, and is anticipated be within the 1 in 10-year and the 1 in 100-year flood event.

To prevent soil erosion and the discharge of sediment bearing water runoff, erosion and sediment control measures should be designed, installed and maintained until an effective vegetation cover has been established on disturbed areas. Proposed measures to be implemented will be in accordance with Provincial Best Management Practices (BMP).

4.2.1 Construction Staging and Sequencing

The SWMP will be designed to accommodate the proposed construction staging and sequencing plan that will be developed at the next stage of design. Construction is tentatively expected to occur over a period of approximately 3 years and may be tendered in one or multiple contracts. Construction activities are likely to start at the downstream end of the channel near Lake St. Martin, however the proposed contracting strategy and schedule may require starting at other locations. It is anticipated that the construction method will consist of isolating the channel in sections, gradually moving upstream as each section is completed. Each section will likely be isolated from the next, as required, for dewatering purposes. Duration of construction for each individual section is anticipated to take several weeks, however this will

depend on the channel length and the total volume of excavation per section. Construction staging and sequencing should be coordinated to maximize excavation while minimizing the time of exposure of newly excavated slopes. Temporary and permanent Re-vegetation activities would begin as soon as possible after finished grades are established.

Bridges and control structures are anticipated to be tendered separately. Construction at those locations may start before or after the channel immediately upstream and downstream of the structure has been excavated in the area. The duration of construction for the structures is anticipated to take up to three years depending on the structure.

Construction of outside drains and/or temporary ditches to redirect surface water and runoff away from the outlet channel excavation area and the control structure/bridge locations will be completed prior to proceeding with major excavation activities.

4.2.2 Surface Water Drainage Plan

Option C

The proposed alignment for Option C bisects three local drainage basins, resulting in the need to address surface water drainage on the south and west side of the outlet channel. Temporary drainage measures will be required in the short term during construction and will depend on construction staging and sequencing until the permanent drainage works are completed.

Due to the presence of bedrock at or near the ground surface in the area, construction of an outside drain is not desirable along the entire length of the channel. Surface water from the Inlet Creek basin will be allowed to runoff naturally into the outlet channel with only minor provision of drainage measures to address the risk of erosion. Alternatively, surface runoff could be captured along Cook Road (existing east-west municipal road that runs parallel to the upstream portion of the outlet channel) and redirected into either Lake Manitoba or the outlet channel near its inlet with a culvert or drop structure.

Further downstream, there may be enough overburden to construct an outside drain on the west side of the channel, upstream of the PTH 6 control structure/bridge location. In this area, the

land surface slopes towards Lake St. Martin, and therefore the outside drain would also direct flows towards Lake St. Martin. Flows in the drain could also be redirected into the outlet channel upstream of the control structure location with a culvert or drop structure. This would eliminate the need for a bridge/culvert structure through PTH 6 in the outside drain. Outside drains are not anticipated to be required along the entire north and east side of the outlet channel, neither along the south side of the most downstream 3km.

Option D

The proposed alignment for Option D bisects a number of drainage basins that feed the Birch Creek and upstream wetlands and small lakes, resulting in the need to address surface water drainage on the west side of the outlet channel. A preliminary drainage plan has been developed for Option D and is included in Deliverable D7 (Appendix D). Detailed surveys of all existing drains, ditches, culverts and bridge crossings will be required in the area to develop a thorough drainage plan at the next phase of design. The drainage plan will be based on survey data collected and a detailed hydraulic assessment of the drainage requirements. Temporary drainage measures will be required in the short term during construction until the permanent drainage works are completed.

With the exception of a small area of the Watchorn Creek Basin near the Lake Manitoba inlet, all drainage is expected to be routed in a northern direction towards Lake St. Martin with the construction of an outside drain along the west side of the outlet channel. The majority of the flow will be re-directed into the channel upstream of the PTH 6 control structure with a rockfill structure. This structure could also be located downstream of PTH 6 but would require an additional bridge/culvert crossing under the Highway. Additional drop structures could also be considered at intermediate points along the outlet channel to either reduce the construction costs of the outside drain, or alternatively to improve local drainage if deemed necessary.

It is assumed that flows within the outside drain collected downstream of PTH 6 will be conveyed directly into Lake St. Martin, or alternatively re-directed into the outlet channel near its Lake St. Martin outlet. The preferred method will have to consider risks of sedimentation and reduced outflow capacity. On the east side of the channel, outside drains are not anticipated to be required since surface runoff slopes away from the channel.

The outside drain will have a minimum base width of 4m with 4H:1V side slopes. Although detailed surveys and hydraulic analyses will be required to define the final geometry of the drain, an average longitudinal slope of 0.013% was assumed appropriate at this stage of design based on the local topography. The depth of flow will range between approximately 1m to 2m resulting in average velocities below 0.5 m/s.

Depending on the outcome of the environmental approval process, mitigation measures may be required to address the reduction in the contributing drainage area to the wetlands and Birch Creek. Potential mitigation measures may include one or multiple of the following:

- Construction of a syphon under the outlet channel at Woodale Drain (and/or at other locations) to maintain connectivity with Birch Creek.
- Construction of small control structure(s) at the outlet of the wetland/lakes to maintain higher water levels during periods of low runoff.
- Pumping, and/or small supply channel(s) from the outlet channel to Birch Creek and/or the wetlands to provide an additional source representative of the area cutoff by the outlet channel.

Depending on the mitigation measures that may be adopted for the project, a review of hydraulic conditions at the existing PTH 6 and PR 239 road crossings over Birch Creek should be considered at the next stage of design. Upgrades to the crossings may be required if they are found to be hydraulically undersized with regard to current Provincial hydraulic design criteria for road crossings (1% event) or considering potential requirements for future fish passage.

4.2.3 Erosion and Sediment Control Plan

The erosion and sediment control plan is a component of the Preliminary SWMP that identifies temporary and permanent measures that should be incorporated during construction until vegetation has been established on disturbed areas. The measures will consider the short and long term drainage plan to ensure they achieve their intended purpose to minimize and mitigate the transport and deposition of sediment beyond construction areas and into off-site receiving water bodies. The Erosion and Sediment Control Plan considers the following items:

- **Re-Vegetation** – Re-vegetation is required to mitigate the potential for surface water erosion and the potential colonization of the channel by weeds. Re-vegetation will be conducted using a staged approach and start as soon as practical after construction commences. Additional mitigation measures may also be required to address the risk of poor vegetation growth on portions of the channel side slopes that will experience alternating periods of submergence and exposure as a result of long term operation and closure of the outlet channel.
- **Construction Management Practices** – Various methods and techniques on the installation, monitoring, and management of erosion and sediment control measures have been identified and include, for example, drainage ditches, check dams, silt fences, sediment ponds, and temporary slope stabilization.
- **Water Quality Monitoring and Follow-up Requirements** – A water quality monitoring program will be developed to assess any changes that may result from channel construction activities and the effectiveness or proposed mitigation, and of the Erosion and Sediment Control Plan. Provision of riparian flow through the control structure is proposed to address the concern that there could be poor water quality in the channel when it is not in operation due to stagnant water conditions
- **Adaptive Management Strategies** – Adaptive management is designed to create opportunity to use the initial designs while managing the risk, to learn from field performance and to incorporate new knowledge into subsequent management steps.
- **Contingency and Emergency Response Planning and Controls** – Contingency and emergency response measures are deployed in the event that the “base” erosion and sediment control measures do not meet the water quality objectives or if the prescribed measures are overwhelmed during a severe runoff event greater than the design.

4.3 OUTLET CHANNEL ALIGNMENT

Based on the preliminary surface water management plan, modifications to the proposed Options C and D alignments are not considered necessary to address surface water drainage in the area. For Option D, the proposed outlet channel alignment was shifted to the west during the previous Stage 2 study to avoid directly impacting the adjacent wetlands. Although more costly due to increased length and excavation quantities, the revised alignment has significantly contributed to reducing potential environmental impacts of the alignment. The final channel alignment will therefore be based on the land acquisition process, any proposed bridge and road re-alignments, as well as channel design optimization.

There is a short reach of Birch Creek that is approximately 200 m to 300 m in length which meanders close to the proposed Option D outlet channel alignment near Lake St. Martin. Mitigation and/or optimization of the channel design and alignment should be considered at this

location to address this concern. At the current stage of design, re-alignment of Birch Creek outside of the proposed project ROW has been tentatively assumed as this could be incorporated into the Project offsetting plans.

4.4 ROADWAY RE-ALIGNMENTS

Options to re-align the PTH 6 and PR 239 roadways are being considered by MI to minimize cost and improve constructability of the control and bridge structures. In general, moving the control structure downstream along the alignment of Option D is better from a groundwater perspective due to the higher upstream water level, which is beneficial where the existing overburden thickness between the bedrock and channel invert is small. Shifting the channel alignment to accommodate roadway re-alignments and the two crossings in this area may also be considered if necessary, as long as the channel does not encroach on Birch Creek or Goodison Lake.

5.0 GEOTECHNICAL INVESTIGATIONS AND ANALYSES

As described in Section 2.0, the study included a field program that was developed to collect the necessary data required to provide a better understanding of the geological, hydrological, hydrogeological and geotechnical considerations of the Option C and Option D outlet channels. This section summarizes the results of the preliminary stability analysis and foundations in light of the 2016 investigations. Details of the geotechnical assessment are documented in Deliverable D8 in Appendix E.

5.1 INVESTIGATION RESULTS

In general, the stratigraphy along Options C and D consisted of a thin layer of topsoil (0.1 m to 0.3 m) overlying till materials and then bedrock. The till deposits contained varying amounts of clay, silt, sand and gravel. The predominant grain size within the till varied spatially and with depth. The thickness of the till ranged from approximately 1.0 m to 9.4 m for Option C compared to 16.0 m to 25.0 m for Option D. The till was grey in colour, moist to wet, compact to hard and contained occasional cobbles and boulders. Based on SPT tests performed in the till, the uncorrected SPT blow counts (N) ranged from a minimum of 7 to 91 for Option C. For Option D, the range was 0 to 96, generally increasing with depth, suggesting that there are two layers within the till: an upper softer till layer with blow counts ranging from 0 to 30 and a lower dense to very dense till with blow counts ranging from 30 to 96. A total of 3 of the 11 SPT tests performed in the till encountered refusal for Option C compared to 10 of 61 SPT tests for Option D.

On Option C, an approximate 3.0 m thick layer of cobbles was encountered in one test hole which was separating the till and bedrock. On Option D, an approximately 3.2 m thick layer of sand or silty sand was encountered at two locations.

Dolomitic limestone bedrock was encountered in all boreholes for Option C at approximate depths ranging from 1.0 m to 9.4 m. Dolomitic limestone bedrock was encountered at three locations along Option D at an approximate depths ranging between approximately 16.1 m to 23.5 m. A detailed description of the rock mass characteristic, such as permeability, Rock Quality Designation (RQD) Index and drill core recovery are presented in Deliverable D5 (Appendix B). Generally, the limestone was highly fractured and showed karstic characteristics.

The bedrock overall, based on core recoveries and RQD, appeared to be in very poor to fair condition. RQD rankings varied between approximately 0% and 100%, ranging from very poor to excellent rock quality designation.

5.2 STABILITY ANALYSIS

Based on the results of the investigations program, stability analyses of the proposed outlet channel geometry for both Options C and D were conducted. Typical cross sections of the proposed geometry are included in Appendix E.

The following design criteria were used in conjunction with the measured groundwater conditions, stratigraphy and material properties in order to establish side slope requirements for the channel excavation. Four stability cases were examined to determine the side slope requirements:

Case 1 - Long Term Condition (after construction) with a minimum estimated factor of safety (FS) of 1.5: under full channel flow condition or no flow condition with water at lake levels.

Case 2 - Short Term Condition (during construction) with a minimum estimated factor of safety (FS) of 1.3: under dry excavated channel condition.

Case 3 - Short Term Condition with a minimum estimated factor of safety (FS) of 1.2: under rapid drawdown conditions during channel operation with Open Gate Upstream conditions.

Case 4 - Short Term Condition with a minimum estimated factor of safety (FS) of 1.2: under rapid drawdown conditions during channel operation with Closed Gate Downstream conditions.

The results of the Stability Analysis are summarized in Table 5 and are based on laboratory testing results from a “composite till” material (i.e. reconstituted till samples by combining individual samples).

TABLE 5
ESTIMATED FACTOR OF SAFETY FOR OPTIONS C AND D

ROUTE	STATION	ESTIMATED FACTOR OF SAFETY			
		Case 1	Case 2	Case 3	Case 4
C	6+800	1.61	<1.0 (0.56)	1.98	2.29
D	11+600	1.61	<1.0 (0.85)	1.93	NA
	19+000	1.51	<1.0 (0.10)	NA	2.32

Notes:
1. Composite Till Shear Strength Option C - c' = 4 kPa and ϕ' = 31^{o}
2. Composite Till Shear Strength Option D - c' = 4 kPa and ϕ' = 33^{o}

Based on the results of the slope stability analysis, the proposed channel geometry for both Options C and D were recommended to proceed to the next stage of design with 4H:1V slope with a mid-height bench. Temporary depressurization will be required for both Options C and D during construction in order to maintain a safe excavation. Without depressurization, the estimated FS for overall stability within the overburden (Case 2) is below 1.0. In order to achieve the design FS of 1.3 during construction, the lower confined groundwater pressures in the bedrock must be lowered by approximately 4.0 m for Option C and by approximately 6 m to 11 m for Option D. Along Option D, depressurization is also required for the long term conditions by pumping and/or gravity drainage from the bedrock to the channel water level. Long term along Option it was assumed that the bedrock cut will act as a drain and the groundwater levels will drawdown passively equilibrating to channel surface water levels. Further discussion of requirements to lower groundwater pressures is discussed in Section 5.3.

With the potential for intertill granular deposits along Option D, it is recommended that additional investigations be undertaken at the critical structures, bridge abutments and piers and control structures, as well as along the channel, in order to help delineate potential granular deposits, their extents and potential mitigation measures that may be necessary. Extensive granular zones may result in “design growth” (i.e. as a result of the increased level of details added to the design from conceptual phase to detailed design and until construction) as there may be difficulties in designing remedial options should these zones be encountered and may result in increased quantities than originally allowed for in the construction cost. Additional investigations will also help confirm the soil conditions assumed in the stability analysis and the potential optimization of the channel cross section.

5.3 GROUNDWATER DEPRESSURIZATION

Depressurization of the confined bedrock aquifer will be required to achieve the required factor of safety criteria for both Options C and D during construction.

On Option C, dewatering where the channel is deeply incised within the bedrock is anticipated to be handled within the channel using a series of sumps, and/or gravity drainage to downstream channel areas, as practicable, depending on the contractor's program. A depressurization system will not be required during construction as this groundwater discharge from the bedrock channel wall seepage face will occur naturally into the channel. In channel areas where the bedrock surface is at or below the channel invert, it is assumed that active dewatering will occur during construction to the channel invert, or below as required. This would likely be facilitated via active groundwater pumping wells. Long-term, the aquifer groundwater levels will re-equilibrate to the surface water levels within the channel. Seepage will occur to the channel via the direct interconnection of the bedrock aquifer and the channel.

On Option D, an active depressurization system will be required in the bedrock aquifer during construction along the channel to protect against blowout of the till channel base, in particular on the last 8 km of the channel (downstream end), due to the high bedrock flowing artesian pressures beneath the channel. The preferred method for active depressurization is likely a series of drilled groundwater wells, with submersible pumps. The extent of the active depressurization well system necessary would be determined during detailed design and optimization of the channel and would be designed (as practicable) also to act as a long-term passive bedrock aquifer depressurization system.

The long term depressurization condition for Option D will be necessary to protect the channel from ongoing basal heave and blowout concerns. Maintaining the intact till channel base protects the regional aquifer system from any potential environmental and water quality concerns that could arise from Option D construction and operations, long term. Detailed design should address optimization of the channel geometry, which will control the depressurization design. This optimization may include raising of the channel invert in key areas to increase the thickness of overburden between the bedrock and channel invert, and/or moving the control structure into downstream areas to increase the channel surface water elevation over larger

extents of the upstream portions of the Option D channel. It is possible, with extreme drought conditions on Lake St. Martin, that re-activation of an active depressurization system via temporary installation of submersible pumps in the existing well system, would be necessary to protect the till channel invert from blowout conditions in the extreme case. This kind of scenario would be evaluated during final design and optimization, and if necessary would be incorporated into the operations manual for the Option D flood control channel.

5.4 FOUNDATION CONSIDERATIONS

Several foundation types were considered for bridges and control structures. The preferred foundation type for each structure will have to be determined at the next stage of design and will depend on site conditions at the selected structure locations and the final design of the structures. Further investigations at the piers and abutments for all bridges will help with the optimization of the foundations once abutment and pier locations are known.

5.4.1 Control Structure Foundations

For Option C, the control structure will be founded on limestone bedrock. Seepage control measures such as grouting of the upper fractured bedrock should be considered in the next stage of design to protect the structural integrity of the control structure.

For Option D, the control structure will be founded on the stiff till or intertill deposits. Minor settlement is anticipated and should be investigated further as part of the next stage of design. Final design of the structure should also incorporate seepage control measures such as French drains where granular layers are encountered within the till. If seepage is left uncontrolled, it can result in the migration of soils through piping and may undermine the integrity of the control structure. Consideration for excavation within granular intertill units should also be further investigated as these units will be water bearing and the extents can be variable.

Depending on the final location of the control structure and foundation design, active bedrock aquifer depressurization is likely necessary for both options in key structure foundation areas, to control temporary excavation stability, as well as for channel stability, to protect against basal heave/blowout, and groundwater seepage conditions during foundation construction.

5.4.2 Bridge Foundations

Shallow foundations may be considered for lightly loaded structures at the site with the provision that all footings are to be placed at 2.4 m (8 ft) or deeper below finished grade, which is the recommended design depth for frost penetration.

Cast-in-place (CIP) concrete friction piles may be used to support the proposed structures depending on the design structural loads. Suitable CIP piling methods for the site include the continuous flight auger (CFA) method and the plain bored method depending on the pile diameters. Temporary casing may be required for bored piles due to the potential caving of the overburden soils along the depth.

Driven steel piles (H-piles or pipe piles) to practical refusal could occur within the very hard till layers. Dynamic pile testing using pile driving analyzer (PDA Testing) and CAPWAP analysis should be performed during pile installation to verify the pile capacity. The steel pipe pile may be left open or filled with concrete. The pile filled with concrete will have higher bending capacity and lower potential for local buckling of the thin wall and should be strongly considered based on cost and long term performance.

Seepage of water up bridge foundation piles should be expected and would be uncontrolled, potentially affecting construction activities. Depressurization wells may be necessary to help mitigate these flows. Potential long-term seepage controls such as seepage “boots” around the piers or grouting around the foundations should also be considered if deemed necessary.

6.0 RISK ASSESSMENT, MITIGATION AND COST ALLOWANCES FOR RISK

A Risk Assessment was conducted to provide MI information related to the engineering and environmental risks associated with Options C and D of the Lake Manitoba Outlet Channel. The assessment focused on potential groundwater, surface water and geotechnical concerns and impacts, and identified technically and economically feasible measures to mitigate the associated risks. The costs of these measures were estimated and the residual risks assessed to more rigorously facilitate a comparison of the two Outlet Channel Options. The results of this assessment were used to evaluate the Options at a Technical Workshop and to identify the preferred Option recommended to proceed to the next stage of Design. A detailed documentation of the Risk Assessment and results are included Deliverable D11 attached in Appendix F.

6.1 RISK IDENTIFICATION, MITIGATION, AND RESIDUAL RISKS

KGS Group identified and evaluated engineering and environmental risks associated with Options C and D of the Lake Manitoba Outlet Channel. Based on the information and assessments identified in Deliverable D11 (Appendix F), a comprehensive list of risk items for the Options C and D channels was developed. The severity and probability of each individual risk item was rated on a scale of low, medium, and high using engineering judgement. Risk response and mitigation strategies were also developed for each individual risk item.

The Risk Assessment was focused on potential groundwater, surface water and geotechnical concerns and impacts. Other risks, such as, but not limited to risks related to design and construction (e.g. weather, channel inlet/outlet, bridges…), land acquisition, or socio-economic factors, were also identified and incorporated into the assessment, but were not evaluated in detail. These additional risk items should be evaluated separately at the next stage of design.

The results of the assessment were presented to a technical panel of senior experts and engineers from KGS Group, MI and other external experts at a one-day long Technical Workshop/Meeting held on December 21, 2016. The Workshop/Meeting process followed a systematic approach and included a detailed Technical Presentation of the groundwater study, surface water study, and geotechnical analyses, a comprehensive review and discussion of the

Project risks and mitigation, as well as a rigorous comparison and evaluation of the options. Each individual risk item was thoroughly discussed at the Workshop/Meeting as well as the risk severity/probability ratings. The risk responses/mitigation were also refined and updated based on the collaborative input of the Workshop/Meeting attendees. Additional risk items were identified and incorporated into the assessment as deemed necessary.

6.2 COST ALLOWANCE FOR RISK AND MITIGATION

For each of the individual risk items identified, cost allowances for mitigation were developed and included in the project budget. These cost allowances were subdivided into the following three categories:

1. **Base Mitigation Cost –** An expenditure that was identified and included in previous Project base cost estimates to mitigate impacts of an expected environmental risk.
2. **Updated Mitigation Cost –** An allowance that replaced the 5% mitigation allowance included in previous project estimates for an expected environmental risk. This allowance was assessed on a risk by risk basis. In some cases, the mitigation allowance was judged to be sufficient to reduce the residual risk to an insignificant level.
3. **Residual Risk Cost –** An allowance included in the Project cost estimates to address the risk remaining following the implementation of technically and economically feasible risk reduction measures. This allowance is representative of what is typically covered by the Project contingency, and therefore the summation of all residual risk allowances replaces the 20% contingency allowance included in previous project estimates.

Table 6 summarizes the estimated cost allowance for risk and mitigation for both Options C and D.

TABLE 6
SUMMARY OF COST ALLOWANCE FOR RISK AND MITIGATION

	Base Mitigation Cost	Updated Mitigation Cost	Residual Risk Cost
Option C	$3,081,000	$11,492,000	$113,649,000
Option D	$4,081,000	$10,400,000	$50,795,000

The cost allowances for risk and mitigation were used to update the project cost estimates developed during the Stage 2 study. The Stage 2 study cost estimates were considered to be an Association for the Advancement of Cost Engineering (AACE) Class 3 estimate (i.e. based on semi-detailed unit costs sufficient of budget authorization, with an accuracy range of -20% to +30%), and included a 5% allowance for Mitigation and 20% Contingency Allowance. As described above, these previous 5% and 20% allowances were replaced with the actual Mitigation Cost and Residual Risk Cost allowances estimated as part of the Risk Assessment. The Stage 2 Study cost estimates and the updated cost estimates considering risk and mitigation are summarized in Tables 7 and 8.

TABLE 7
SUMMARY OF STAGE 2 STUDY PROJECT COST ESTIMATES

	Option C	Option D
Base Cost	$142,755,000	$173,771,000
Mitigation Cost (5%)	$7,138,000	$8,688,550
Engineering, Contract Admin. Approvals (20%)	$28,551,000	$34,754,200
Contingency Cost (20%)	$35,689,000	$43,442,800
Total	$214,133,000	$260,656,550

TABLE 8
UPDATED PROJECT COST ESTIMATES BASED ON RISK ASSESSMENT

	Option C	Option D
Base Cost	$142,755,000	$173,771,000
Updated Mitigation Cost	$11,492,000*	$10,400,000*
Engineering, Contract Admin. Approvals (20%)	$28,551,000	$34,754,200
Residual Risk Cost	$113,649,000*	$50,795,000*
Total	$296,447,000*	$269,720,200*

Note: * indicates a value that has been updated based on the Risk Assessment.

Based on the results of the Risk Assessment, the estimated project cost for Option D has increased by approximately $9 million, which is within the bounds of the Class 3 estimate (-20% to +30%). However, for Option C, the estimated project cost has increased by $82 million, which made this alignment more costly than Option D. The most significant component of the cost increase to Option C was attributed to the likely need for a regional water treatment plant and distribution system for the First Nation Community located within the impact zone of the proposed channel. It was judged that there is a high probability that the water treatment plant and distribution system would be required to address the risk of impacts to the individual and community groundwater wells in the region and due to the high potential for GUDI conditions.

The updated cost estimates identified in Table 8 contributed significantly to the evaluation process of options discussed in Section 6.3. The cost allowances for risk and mitigation should be updated at the next stage of design for the recommended channel alignment as project details are refined, with inputs from additional investigations, analyses and monitoring. Further assessments of risk items not considered in detail should also be undertaken for the recommended channel alignment to refine the overall estimated project cost.

6.3 EVALUATION OF OPTIONS

A one-day long Technical Workshop/Meeting was held on December 21, 2016 which included the following three sessions:

1. A detailed Technical Presentation of the groundwater study, surface water study, and geotechnical analyses that provided a preliminary summary of the findings and recommendations.
2. A comprehensive review and discussion of the Project risks and mitigation measures.
3. A rigorous comparison and evaluation of the options. Information from the Technical Presentation and the Risk Assessment formed the basis to evaluate and rank the suitability of the Option C and Option D Outlet Channels and to identify a preferred option to proceed with Preliminary Design.

The comparison and evaluation of the options followed a systematic approach and was conducted with input from MI, KGS Group Staff, as well as external experts. The following

categories were identified at the beginning of the evaluation process as the basis for comparing the options:

1. **Constructability –** considered construction access and monitoring; type of material and ease of excavation; dewatering requirements; extents of inlet and outlet works; and total number of bridge structures.

2. **Operation & Maintenance –** considered geotechnical performance of channel such as slope stabilities and seepage; risk of erosion and sedimentation; potential concerns with vegetation growth; long term access for maintenance; potential concerns with winter operation; signage and fencing requirements for public safety; number of structures and channel length; long term maintenance of mitigation measures (e.g. wells and water treatment plant); and overall inspection cost.

3. **Groundwater Impacts –** considered concerns associated with GUDI conditions (bacteria); potential for aquifer drawdown and impacts; the total number of well users; existing well conditions and proximity to the outlet channel; interaction of groundwater with adjacent wetlands and streams.

4. **Surface Water Impacts –** considered existing network of streams and wetlands; concerns with existing and future surface water drainage; extents of required drainage upgrades and mitigation; and potential impacts to surface water quality;

5. **Physical / Biological Environment Impacts –** considered potential impacts to terrestrial environment (e.g. vegetation, wildlife, habitat, etc…); potential impacts to aquatic environment (e.g. wetlands, streams, habitat, fish, water quality, etc.); ease and extents of environmental approval process; and potential mitigation measures.

6. **Social Economic Considerations –** considered public safety concerns and access; social implications of project impacts on groundwater quality/quantity; proximity of project to First Nation land; past litigation claims; ease and extents of approval processes; existing land use (e.g. agricultural land) and associated loss/reduction in operation (i.e. revenue); potential issues with severance of land parcels, and local acceptance.

7. **Cost –** evaluation based on the difference between options in the estimated Base Cost.

8. **Risk –** evaluation based on results of the Risk Assessment which considered Risk Consequence, Risk Probability and Residual Risk Cost.

One category at a time, the workshop attendees discussed the evaluation criteria definition and then rated the two options considering the results of the Risk Assessment and the results of the various studies and analyses documented here-in. The rating system considered both the suitability of the options in meeting the objectives of the project, and the performance of one option relative to the other based on the following priority scale:

1. Poor
2. Mediocre
3. Satisfactory
4. Good
5. Superior

In general, the rating of Options C & D was considered at least satisfactory when compared to the four previous options that were dismissed at the end of the Stage 1 study. However, in order to better differentiate the suitability and performance of one option compared to the other, a lower or higher rating was at times assigned for some categories. Therefore, although a "Poor" or "Mediocre" rating was selected in some instances, the lower rating was typically selected to indicate that the option rated less favorably relative to the other option in that category.

As part of the workshop process, weighting factors were established for each category. A score was then calculated for each category by multiplying together the category's weight and rating. The total score was then computed and Option D was identified as the preferred Option as it had the highest total score. The groundwater impacts, social economic considerations and risk were the major factors that contributed to Option D being the preferred Option compared to Option C as summarized below.

- **Groundwater Impacts –** Option C rated poorly due to the concerns associated with GUDI conditions, aquifer drawdown, and the large number of well users in close proximity of the channel, whereas Option D does not have the same level of concerns. Results of the Groundwater Study are provided in Deliverable D6.
- **Social Economic Considerations –** The following factors contributed to a poor rating for Option C compared to Option D:
    - The potential Groundwater Impacts along Option C could affect the water quality and quantity of a large number of groundwater users in the region, resulting in significant socio-economic implications. Option D does not have the same level of concerns with groundwater quantity and quality and the potential impacts affect a lesser number of groundwater users.
    - Option C has Public Safety concerns and reduced access in the region due to the steep bedrock side slopes of the channel, which Option D does not have. The steep bedrock side slopes exceed 8m in depth above the water surface in the channel at some locations, posing a substantial safety threat, particularly to recreational users (e.g. ATV's and snowmobiles) in the region.
- **Risk –** Option C was assessed with additional and significant risk items compared to Option D, which resulted in a significant Residual Risk Cost for Option C as described in Section 2.0.

After the Technical Workshop and upon completing the evaluation of the options, MI held meetings with potentially affected landowners located along the proposed Option D channel alignment. Based on feedback received at the meetings, loss of revenue as well as stress and anxiety were identified as Social Economic factors that required further consideration in the evaluation of the options.

The concern with loss of revenue was primarily attributed to the loss of agricultural land as a result of channel construction and the associated purchase of Right of Way (ROW) for the project. The concern with stress and anxiety was related to the stress that may be experienced by some individuals who are directly impacted by the construction of the Outlet Channel on their existing property. Based on a review of existing land use along the Options C and D channels, Option D affects a much larger footprint of agricultural and forage land than Option C. Also, in general, the quality of the affected agricultural land along Option D is likely better than Option C. Based on the concerns with Loss in Revenue and Stress and Anxiety described above, the evaluation results were revised. The final results are summarized in Table 9 and described in more detail in Deliverable D11 (Appendix F).

TABLE 9
OPTIONS C AND D EVALUATION RESULTS

MAIN CATEGORY	WEIGHT	OPTION C		OPTION D	
		RATING	SCORE	RATING	SCORE
1. Constructability	10	3	30	3	30
2. Operation and Maintenance	10	2	20	3	30
3. Groundwater Impacts	15	1	15	4	60
4. Surface Water Impacts	5	4	20	3	15
5. Physical / Biological Environment Impacts	15	4	60	3	45
6. Social Economic Considerations	20	1	20	1	20
7. Cost	10	4	40	3	30
8. Risk	15	1	15	3	45
TOTAL SCORE			**220**		**275**

Although a low rating of 1 (poor) was considered for Option D in the Social Economic Category, Option D maintained an overall higher score compared to Option C. On this basis, the Lake Manitoba Outlet Channel was recommended to proceed to the next stage of design with Option D as the preferred Alternative.

7.0 SUMMARY RECOMMENDATIONS

The Lake Manitoba Outlet Channel has been recommended to proceed to the next stage of design with Option D as the preferred route alignment based on the results of the preliminary engineering study and the evaluation of Options carried out at the Technical Workshop. The Technical Workshop included a rigorous comparison of the options with input from MI, KGS Group Staff, as well as external experts, as described in Section 6.3.

Recommendations specific to the Option D alignment that were developed based on the groundwater, surface water and geotechnical investigations, assessments and the preliminary engineering work conducted for this assignment are summarized in Sections 7.1 to 7.3 that follows.

7.1 CHANNEL DESIGN AND CONSTRUCTION

Groundwater

- Mitigation measures should be incorporated into the design to address the potential of aquifer water levels dropping below the existing pump settings or below the casing of individual or community groundwater well users (while the well is pumping) due to aquifer piezometric pressure drawdown from channel construction or operation. More detailed site specific well inspections are required in the region of the project to quantify the required well remediation efforts.
- In the vicinity of Option D, appropriate design and construction procedures (i.e. channel construction in till, appropriate control of blowout piezometric pressures from the underlying bedrock aquifer, and maintenance of upward groundwater discharge gradients) should be implemented to protect against the potential for bacterial and virus contamination of individual or community groundwater wells. This is necessary to protect against interconnection to the aquifer and groundwater under direct influence of surface water (GUDI) conditions.
- Design and construction factors will play a large role in protecting the bedrock aquifer from direct connection with the channel base, while minimizing drawdown. Optimization of the channel route, geometry and control structures, as well as construction methods (including depressurization) should be implemented to control the bedrock artesian pressures during construction and long-term operation.
- The preliminary Channel Design should be optimized during detailed design considering the requirements for active bedrock groundwater depressurization using pumping wells

during construction and the same wells as practical for passive long-term bedrock aquifer depressurization to mitigate the potential for blowouts / basal heave conditions.

- Although wetlands direct connection to the bedrock aquifer is not anticipated, potential mitigation measures to maintain minimum flows in the wetlands system should be considered in conjunction with those being considered to address impacts to surface water drainage.

Geotechnical

- Monitoring of the groundwater wells and the artesian pressures along the preferred channel alignment should continue through to the next stage of design. As determined from the existing data, depressurization of the bedrock aquifer is necessary in order for the channel slope stability to meet the design criteria and in order to construct the channel. A bedrock/till depressurization system will have to be developed at the next stage of design in order to complete construction of the outlet channel.
- The potential for seepage to occur across the Option D control structure foundation through a pervious zone must be addressed at the detailed design stage. Mitigation options could include but not be limited to grout curtains.
- The potential for seepage occurring along the piles of the bridge foundations needs to be addressed at the next stage of design.
- The proposed channel geometry is recommended to proceed to the next stage of design, with 4H:1V slope in overburden and a mid-height bench.

Surface Water

- To address the impacts to existing surface water drainage, the outlet channel design should incorporate an outside drain on the west side. An outside drain on the east side of the channel is not required. With the exception of a small area near Lake Manitoba, flow intercepted by the project should be routed towards Lake St. Martin, with an intermediate discharge location into the outlet channel upstream of PTH 6 with a culvert/drop structure. Future analyses should consider additional culvert / drop structures at intermediate points to reduce construction costs or improve local drainage if deemed necessary.
- Mitigation measures should be considered to address the reduction in contributing area to the wetlands and Birch Creek. Potential mitigation measures identified include: construction of a syphon under the outlet channel at Woodale Drain (and/or at other locations) to maintain connectivity with Birch Creek; construction of small control structure(s) at the outlet of the wetland/lakes to maintain higher water levels during periods of low runoff; pumping, and/or small water supply channel(s) from the outlet channel to Birch Creek and/or the wetlands to provide an additional water source representative of the area cutoff by the outlet channel.
- A review of hydraulic conditions at the existing PTH 6 and PR 239 road crossings over Birch Creek should be considered at the next stage of design. Upgrades to the crossings

may be required if they are found to be hydraulically undersized with regard to current Provincial hydraulic design criteria for road crossings (1% event) or considering potential requirements for future fish passage.

- The Surface Water Management Plan, which includes the Erosion and Sediment Control Plan, should be customized at the next stage of design. This will allow the short and long term objectives of controlling all surface water sources within or in close proximity to the project area that may be impacted during construction and future operation to be achieved. The methods and measures identified in the Surface Water Management Plan should be implemented in accordance with Provincial Best Management Practices.

- The design capacity selected as the criteria for the temporary and long term water management plan should be identified at the next stage of design with consideration of environmental sensitivities, risk and long term costs. Temporary measures are anticipated to be designed within the 1 in 5-year and the 1 in 25-year events. Permanent measures are anticipated to be designed within the 1 in 10-year and the 1 in 100-year flood events.

7.2 RISK ASSESSMENT

- The cost allowances for risk and mitigation should be updated at the next stage of design as project details are refined, with inputs from additional investigations, analyses and monitoring.

- Further assessments of risk items not considered in detail should be undertaken for the recommended channel alignment to refine the overall estimated project cost.

7.3 FUTURE INVESTIGATIONS AND SURVEYS

- A detailed door to door survey should be conducted at the next stage of design to confirm well locations. The survey should incorporate an inventory and water quality program as deemed necessary to identify vulnerability and collect information in locations of potential groundwater impacts.

- Detailed surveys of all existing drains, ditches, culverts and bridge crossings should be conducted on the west side of the proposed Option D outlet channel alignment to develop a thorough understanding of the existing condition and capacity of the drainage network, such that an appropriate and customized drainage plan can be developed at the next phase of design.

- The geophysical data set available for the preferred route should be expanded, in particular where bedrock surface data is sparse or varies considerably in quality or elevation over short distances, or in the inlet/outlet areas. Any future geophysical data collection should be tied to the existing network of available boreholes, or new boreholes, if/as necessary. This would likely include, for example, seismic refraction along the channel centerline and selected cross section locations.

- Supplemental drilling investigations in key or select areas along the preferred route should be conducted where design optimization or risk reduction is necessary. This would likely include, for example, the proposed control structure and each of the bridge (piers and abutments) locations. This will allow for optimization of the bridge and control structure foundations and any mitigation measures necessary such as depressurization wells, grout curtains, etc. Supplemental drilling investigations along the channel will also help confirm soil conditions assumed in the stability analysis and potential optimization of the channel cross section.

8.0 STATEMENT OF LIMITATIONS AND CONDITIONS

8.1 THIRD PARTY USE OF REPORT

This report has been prepared for Manitoba Infrastructure to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

8.2 CAPITAL COST ESTIMATE STATEMENT OF LIMITATIONS

The cost estimates included with this report have been prepared by KGS Group using professional judgment and exercising due care consistent with the level of detail required for the stage of the project for which the estimate has been developed. These estimates represent KGS Group's opinion of the probable costs and are based on factors over which KGS Group has no control. These factors include, without limitation, site conditions, availability of qualified labour and materials, present workload of the Bidders at the time of tendering and overall market conditions. KGS Group does not assume any responsibility to Manitoba Infrastructure, in contract, tort or otherwise in connection with such estimates and shall not be liable to Manitoba Infrastructure if such estimates prove to be inaccurate or incorrect.

APPENDIX A

ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER (DELIVERABLE D4)

KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D4
ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER

FINAL – REV 0

KGS Group 16-0300-006
May 2017

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1.0 INTRODUCTION AND SCOPE OF WORK

1.1 INTRODUCTION

This study focuses on the assessment of existing well use and suitability as drinking water in the vicinity of Lake Manitoba Outlet Channels Route C and Route D. The location of these routes is shown on Plate D4-1 General Site Plan- Route C and D. The information collected in this study will be used to evaluate potential effects of the Route C or Route D channel options on area water supplies.

1.2 SCOPE OF WORK

The scope of work for the study includes defining the following for each route:

- Location of Residences and GWDrill Records
- Regional Water Supply Use
- General Stratigraphy
- Aquifer Systems and Piezometric Levels
- Well Construction
- Well Capacities and Calculated Aquifer Transmissivities
- Aquifer Vulnerability
- Well Inventory Results
- Water Quality

2.0 ROUTE C

2.1 LOCATION OF RESIDENCES AND GWDRILL RECORDS

2.1.1 General

The location of potential Third-Party wells is shown on Plate D4-2 Potential Third-Party Well and 2016 Inventory Locations-Route C. A three kilometre distance from the project was selected in the Stage 2 report as a reasonable distance within which to conduct evaluations of groundwater effects of the project. This distance has been used in this report as proposed in the RFP. A second distance of 500 m has been used to evaluate effects on water supplies close to the channel. The 500 m distance is a general buffer distance used for screening bedrock wells next to surface water for GUDI effects (Groundwater under Direct Influence of Surface Water). The GUDI evaluation is contained in the D6 Groundwater Study Report.

Based on a review of the air photo imagery and the limited well inventory a count of wells was conducted as shown in Appendix D4-A Regional Information Route C. There were 137 possible residential locations identified within a 3 km distance of the proposed channel centreline Plates D4-2.1 and D4-2.2). These include 45 locations assumed to be served by community systems, with 3 wells discussed in Section 2.1.2. An estimate of 95 to 100 wells within 3 km has been used for this study, with 29 of these locations within 500 m of the channel right-of-way. Three of these locations are within the channel alignment. Some of these locations may be other buildings, farmyards, or other structures with no active well. In addition, there may be some number of residences that were not captured in this high level analysis. A door to door survey in the area would be required in the final design stage to confirm well locations if Option C were selected. An analysis of GW drill records and well use is given in Section 2.2.

Groundwater is the sole supply of domestic water for the region serving individual residences, farms and community supplies. A description of information on wells serving multiple residences, or buildings or community locations is given in Table D4-1 Summary of Regional Water Supply Use- Route C. This information was gathered primarily from public sources and is considered to be general.

2.1.2 Pinaymootang First Nation

Pinaymootang First Nation land is located north of the Route C proposed alignment and is directly adjacent to Route C for much of its length. Pinaymootang First Nation declined to participate in the study and therefore detailed information on wells within the First Nation boundary needs to be confirmed. Domestic water supply use for Route C is shown on Table D4-1. Homes are on individual domestic wells. A community supply with 2 wells is provided for 38 homes in a subdivision north of Station 3+000 of the proposed Route C alignment. A second community supply with one well is provided for 7 homes near the wastewater lagoon (north of Station 8+00) of Route C (see Plate D4-2.2). A water treatment/bottling plant serves the community and is located near the Arena north of Station 3+400. The Pinaymootang School has its own well and treatment system. Three other systems are listed as semi-public systems by Health Canada: the Pinaymootang Arena (Hwy 6) the Pinay Gas Bar (near Fairford River) and the Pinaymootang IRTC office. Other public building and businesses will have individual wells. A private resort and Campground near the Fairford River has a seasonal, semi-public water system regulated by Manitoba Office of Drinking Water and is considered a secure groundwater system and is not treated. Other potential non-domestic wells identified in the GWDrill data base are listed on Table D4-1.

2.1.3 Other Areas

Some areas of land in the R.M. of Grahamdale are present north of the Route C alignment from station 0+000 to 4+000 along the south side of Hwy 6 and from Station 8+000 to the Outlet Plates D4.2.1 and D4-2.2. All land south of the channel is in the R.M. of Grahamdale. Land use is primarily rural and agricultural within 3 km, with rock quarry present at two locations. No community supplies have been identified in this area.

2.1.4 Well Log Matching

The Provincial well record database (GWDrill) was searched within 3 km of the proposed Route C channel. Wells described as monitoring wells, test holes, observation wells or abandoned or sealed wells were excluded. The location of the GWDrill logs is shown on Plate D4-3 GWDrill

Logs-Location, Aquifer and Use- Route C. These wells are located to various accuracies, from exact, to within the Section.

An attempt was made to match wells with possible residences using location and any identifying information on the well log. The results of this high level matching exercise are shown in Appendix D4-B Well Log Matching Route C.

2.2 REGIONAL WATER SUPPLY USE

The regional water supply use is shown on Plate D4-3 GWDrill Logs-Location, Aquifer and Use-Route C. Well use is also summarized on Table D4-A1. Based on the GWDrill data base (as of 2013) approximately 86 well records were identified which can be assumed to be domestic users. These included all users noted as either domestic use, or domestic and livestock use, and a small number of unidentified users assumed to be domestic use. One well was noted as being used for air conditioning. Another 9 wells in the area are noted as livestock wells. Within 500 m of the channel right-of-way, a total of 21 wells can be considered to be domestic, with 2 wells noted as serving livestock only.

The total number of wells includes wells drilled on a range of dates. For example there are many wells with drilling dates prior to 1976, which would put the well at 40 years old. Well records in the area extend back to the 1900's. Some of these older wells may no longer be in use. In addition, wells used for livestock at the time of drilling may not be active today. In addition not all wells drilled in the area may be captured on the data base.

2.3 GENERAL STRATIGRAPHY

A detailed discussion of the stratigraphy found in the 2011 and 2015 drilling programs was given in the KGS Group Stage 2 report. A discussion of the 2016 stratigraphy is given in the Geotechnical Report Deliverable D8. A discussion of the regional Geology is given in the Assessment of Regional Geologic Setting Report Deliverable D5.

Surficial sediments in the region were deposited on an extensively eroded carbonate (limestone) bedrock surface, which results in variability in overburden thicknesses in the region.

Sediments overlying the bedrock are generally less than 10 m in thickness in most areas. Sediments above bedrock throughout the Route C area are relatively thin with numerous bedrock outcrops at surface, consisting of glacially striated dolomites and limestones. The central area of the channel traverses a regional topographic and bedrock high. There are several rock quarries in this area where the overburden thickness is minimal or non-existent. Localized overburden areas in the vicinity of the Fairford River are in excess of 20 m thick.

Based on the 2011, 2015 and 2016 drilling, the stratigraphy at Route C consists of a thin layer of topsoil overlying till materials including variable silt to clay till, silt till, clay till, underlain by bedrock. Structurally, the limestone appeared to be highly fractured, and showed karstic characteristics.

2.4 AQUIFER SYSTEMS AND PIEZOMETRIC LEVELS

The major aquifer system for the water supply wells is the bedrock carbonate (limestone) aquifer. This aquifer is confined beneath the till overburden. Piezometric pressures in the bedrock aquifer are between approximately El. 240 m to El. 250 m, close to ground surface elevation in the Fairford River area based on regional information. Flowing artesian well conditions are present in the vicinity of Lake St. Martin. Information on aquifer systems and piezometric levels has been collected from investigations in the Stage 2 study (2015) and the 2016 study, as well as from regional information from the GWDrill database.

2.4.1 Groundwater Investigations

Based on the 2011 to 2015 data, piezometric pressures range from confined pressure near ground surface, to flowing artesian conditions nearer to the Lake St. Martin side of the proposed channel alignment. This reflects a decreasing ground surface elevation toward this end of the proposed Route C alignment.

2.4.2 GWDrill Database

Aquifer Systems

The Provincial well record database (GWDrill) was searched within 3 kilometers of the proposed Route C channel to identify the aquifer in which the well was completed. Of the 137 well logs 128 were completed in limestone bedrock, with 6 completed in the sand and gravel and 1 in shale (Table D4-A1). The distribution of the wells completed in aquifers other than the main limestone aquifer is shown on Plate D4-3 GWDrill Logs-Location, Aquifer and Use- Route C.

Piezometric elevations from the GWDrill logs were summarized for the regions to determine the extent and distribution of artesian conditions. The piezometric surface is generally shallow, from 0 to 4 m below ground surface. It is deepest in the central area of the Route C alignment from 1 to 4 m below ground surface. This topographic high area with shallow depth to bedrock is a recharge area with downward gradients, as confirmed in the 2016 investigation program. Flowing (artesian) wells are present towards the Route C alignment outlet close to Lake St. Martin. A further discussion of these conditions is contained in Deliverable D6, Groundwater Study Report.

2.5 WELL CONSTRUCTION

Construction of the wells is an important factor in assessing sensitivity to drawdown. Pumps are set within the well casing so that when the well is pumped, the water level remains above the pump intake. If temporary or permanent drawdown causes pumping water levels to approach the pump setting, mitigation may become necessary. For wells with deep casings and high water levels, lowering the pump within a casing is a typical mitigation measure. If, however the casing is shallow relative to the pumping water level, the pump may not be able to be lowered, without requiring specialized casing extensions, or drilling a new well. Collecting data on the well casing depths has been used to assess the risk to water supplies for various drawdown scenarios.

The distributions of well casing depths are shown on Plate D4-4 GWDrill Logs Casing Depth-Route C and Table D4-A1. Within 500 m of the channel, there are 10 wells with casing depths

less than 10 m, 10 wells with casing depths of 10 to 20 m, and 1 well with casing depth of greater than 40 m. At the 3 km distance there are 43 wells with casing depths of less than10 m, 33 wells with casing depths from 10 to 20 m, and 4 wells with casing depths from 20 to 30 m. Very long casing depths between 30 to 40 m were found at 1 well and casing depth of greater than 40 m at 2 wells. These large casing depths are generally associated with shale bedrock in which the well is drilled to the deeper limestone zone beneath the shale units.

The Route C channel invert is proposed at 6 to 16 m below ground surface, which would be below the 50 % of wells with casing depths from 0 to 10 m, and below some of the 40% of wells with casing depths of 10 to 20 m. This means that if these wells needed to be mitigated against drawdown effects, lowering pumps alone would not be possible and new wells would have to be drilled. However, should new water supplies be required, the potential GUDI status of the Channel area may pose risks to untreated individual water supplies and may require individual treated systems , or a community water treatment and distribution system. A more detailed discussion of the casing depths in relation to the channel invert is given in Deliverable D6 Groundwater Study.

2.6 WELL CAPACITIES AND CALCULATED AQUIFER TRANSMISSIVITIES

Well yields can be highly variable in the carbonate aquifer which is a direct result of the fractured rock conditions. Water yields depend on the number of fractures intersected by a well, their size (aperture), extent, and interconnection to other fractures.

Information on well capacity and aquifer transmissivity has been collected from investigations in the 2016 study, as well as from regional information from the GWDrill database.

2.6.1 Groundwater Investigations

Based on the studies conducted in 2016, the representative aquifer transmissivity was low, less than 1000 USgpd/ft. Regional variability in transmissivity is anticipated; however, along the Route C alignment.

2.6.2 GWDrill Database

The GWDrill data base contains pumping rates and static and pumping levels for individual wells. Not all records have this information, or in some cases information is not complete. Records containing complete information within the project area were summarized. Drawdowns were calculated and specific capacity was summarized as pumping rate divided by drawdown. An estimate of transmissivity was made using the empirical formula for confined aquifers:

Transmissivity = Specific capacity x 2000

The calculations are summarized in Appendix D4-C Calculated Specific Capacity and Transmissivity. The calculated transmissivity was plotted at the location of the GWDrill record on Plate D4-5 Estimated Aquifer Transmissivity–Route C. Colours were added to the map to identify the distribution of transmissivity in the area, with the lighter colours indicating lower transmissivity.

A summary of aquifer transmissivity at the 3 km and 500 m distance is shown in Appendix D4-A. At the 3 km distance from the channel, of the 81 wells with calculated transmissivities, 24 were very low (<1000 USgpd/ft), 49 were low (1000 to 5000 USgpd/ft), 4 were low to moderate (5000 to 15,000 USgpd/ft), 1 was moderate (15 to 50,000 USgpd/ft) and 3 were high (>50,000 USgpd/ft). It should be noted that not all wells have pumping information that can be used to calculated transmissivities.

A range of 1,000 to 15,000 USgpd/ft is considered to be a reasonable estimate of bulk aquifer transmissivity, based on the review of the well records. However, the transmissivity of the aquifer is based on fractures and solution channels which vary in the region. Therefore it is possible to encounter zones of higher transmissivity in particular locations as shown by the 3 wells with transmissivities over 50,000 USgpd/ft.

2.7 AQUIFER VULNERABILITY

Aquifer vulnerability refers to the sensitivity of the aquifer to contamination. In this area, bedrock aquifers with a thin to absent cover are most vulnerable, while bedrock aquifers buried beneath

thick till deposits are least vulnerable. Aquifer vulnerability has been assessed based on the overburden thickness map presented in the Assessment of Regional Geologic Setting Deliverable D5. The existing aquifer vulnerability of wells is discussed, as well as any changes in aquifer vulnerability posed by construction of the Route C channel. The channel centerline stations are used as reference.

Station 0+000 to Station 1+000- Overburden deposits in the area near the Route C invert are thick and existing wells in this area receive some protection from potential surface contaminant sources. However, the proposed channel sideslopes and invert will be close to or in the bedrock in this area, removing this protection permanently.

Station 1+00 to Station 9+000- A bedrock high is found between Lake Manitoba and Lake St. Martin. Overburden cover thins as the bedrock controlled topography increases in elevation and then the overburden thickens towards the east before the surface topography drops. Existing wells in much of this area have little to no overburden above bedrock and have a high vulnerability to potential surface contaminant sources. The proposed Route C channel sideslope and invert will be in the bedrock in this area, increasing this vulnerability.

Station 9+00 to the Outlet - Overburden units become thicker in the eastern portion of the channel. Existing wells in this area receive some protection from potential surface contaminant sources. However, the proposed channel invert will be in the bedrock in this area, removing this protection permanently, with only the side slopes in the overburden materials.

2.8 WELL INVENTORY PROGRAM

2.8.1 Methodology

A well inventory and water quality program was developed for the area surrounding Route C. Wells were selected based on the locations from the air-photo imagery to identify residences within a 3 km radius of the proposed Route C alignment. A number of considerations were made in determining which wells to include in the well inventory and water quality sampling program. Groups of wells were identified on both sides of the proposed channels. One sample from each grouping was identified for collection. Contacts were made with Pinaymootang First Nation to participate in the program; however the First Nation declined to participate. Manitoba Infrastructure then made inquiries to landowners outside of the First Nation for permission to conduct the well inventory and sample the well water. If the initial well selected was unavailable, another well from the grouping was selected. The location of the wells inventoried is shown with a star on Plate D4-1 Potential Third-Party Well and Inventory Locations- Route C.

2.8.2 Well Inventory Summary

The well inventory and water quality sampling program was completed on October 19 and 20, 2016. A total of 3 residences were visited. Interviews were conducted with each homeowner regarding their well, construction, water quality and use and possible contaminant sources. Some homeowners had a detailed knowledge of their systems age and construction and possible pump settings, while others did not. Individual forms were prepared for each well containing the responses to the inventory questions, the field sampling results and photographs as shown in Appendix D4-D.

2.9 WATER QUALITY

2.9.1 Regional

Regional information indicates that east of Lake Manitoba the water quality is generally fresh, with Total Dissolved Solids (TDS) less than 1,000 mg/L. Water quality is generally magnesium-calcium-bicarbonate, with TDS in the order of 400 mg/L to 650 mg/L. This water quality reflects the significant meteoric water, aquifer recharge zone noted within the Interlake area.

2.9.2 Well Inventory

Groundwater samples were collected from a total of 3 residences in the Route C area, including two field duplicates for the program.

The tap sampled in the residence was selected in consultation with the property owner to confirm an untreated sample was obtained. Prior to collecting the sample, the tap was cleaned and disinfected with a bleach/water mixture. Water was run to purge the storage tank. The tap to be sampled was then run until the temperature stabilized, indicating a fresh water sample from the well. The water sample was collected in sterilized bottles provided by the analytical laboratory.

Preservatives were added, as required. The water sample collected was stored in a cooler at 4°C for transportation to ALS Laboratory in Winnipeg, Manitoba, an accredited analytical testing laboratory.

Field chemistry results collected by KGS Group are shown on Table D4-2. The results of the laboratory analysis are presented in Table D4-3 for general water quality and Table D4-4 for metals in water. An ion balance is shown in Table D4-5 along with an identification of the major water type. The applicable Health Canada Canadian Drinking Water Quality Guidelines (HC-CDWQG) are included for comparison. The Certificate of Analyses issued by ALS Laboratory is included in Appendix D4-I. A letter and laboratory results were sent to residents by MI.

The water quality results were variable generally indicating a potable groundwater with elevated hardness. The water type varied from magnesium-bicarbonate at well ID12C and ID153 C to sodium- magnesium-calcium-bicarbonate at well ID152. Total dissolved solids were above 500 mg/L at well 12C and 153 C. Nitrates were notably very low at well ID 152C and 153 C, but were above the CDWG of 10 mg/L nitrate as N (11.9 mg/L) in well ID 12C. Chloride was also elevated in well ID 12C. Iron was above the Canadian Drinking Water Quality Guidelines in well 152 C. This well also had copper and lead elevated above CDWG, but this was not confirmed in the duplicate sample. The well owner reports that the well had an odour and had *E. coil* in the past, therefore they boil their water. One well (ID 153C) had a total coliform count of 1 MPN/100 ML; however no *E. coli* was detected. Well ID 12C also reported past sediment in the well and may be influenced by the septic field.

Analysis of duplicate samples showed a low RPD less than 5%, except for boron, copper and iron. Values for boron were consistent in the two duplicate samples; however the copper, iron and lead values that were above CDWG in the original samples, decreased in the duplicate sample and were below CDWG except for iron.

3.0 ROUTE D

3.1 LOCATION OF RESIDENCES AND GWDRILL RECORDS

3.1.1 General

The location of potential Third-Party wells is shown on Plate D4-6 Potential Third-Party Well and 2016 Inventory Locations - Route D. A three kilometer distance from the project was selected in the Stage 2 report as a reasonable distance within which to conduct evaluations of groundwater effects of the project. This distance has been used in this report as proposed in the RFP. A second distance of 500 m has been used to evaluate effects to water supplies close to the channel. The 500 m distance is a general buffer distance used for screening bedrock wells next to surface water for GUDI effects (Groundwater under Direct Influence of Surface water).

Based on a review of the air photo imagery and the limited well inventory, a count of wells was conducted as shown in Appendix D4-E Regional Information Route D. There were 66 possible residential locations identified within a 3 km distance of the proposed channel centreline with 15 of these locations within 500 m of the channel right-of-way (Plates D4-6.1 and D4-6.2). Some of these locations may be other buildings, farmyards or other structures with no active well. In addition, there may be some number of residences that were not captured in this high level analysis. A door to door survey in the area would be required in the final design stage to confirm well locations if this option is selected.

Groundwater is the sole source of domestic water for the region serving individual residences, farms and community supplies. A description of information on wells serving buildings or community locations is given in Table D4-6 Summary of Regional Water Supply Use- Route D. This information was gathered primarily from public sources and is general. The population centre of Moosehorn is distant from the project. Local communities of Grahamdale and Hilbre are located outside the 3 km distance evaluated, but are assumed to have individual domestic wells. There is also a well supply at the Watchorn Provincial Park. No community water supplies were identified in the 3 km distance evaluated.

3.1.2 Well Log Matching

The Provincial well record database (GWDrill) was searched within 3 kilometers of the proposed Route D channel. Wells described as monitoring wells, test holes, observation wells or abandoned or sealed wells were excluded. The location of the GWDrill logs is shown on Plate D4-7 GWDrill Logs-Location, Aquifer and Use- Route D. The GWDrill well logs are located to various accuracies, from exact to within the Section.

An attempt was made to match wells with possible residences using location and any identifying information on the well log. The results of this high level matching exercise are shown in Appendix D4-F Well Log Matching Route D.

3.2 REGIONAL WATER SUPPLY USE

The regional water supply use is shown on Plate D4-7 GWDrill Logs-Location, Aquifer and Use-Route D. Approximately 98 well records were identified which can be assumed to be domestic users. These included all users noted as either domestic use or domestic and livestock use, and a small number of unidentified users assumed to be domestic use. Another 36 wells in the area are noted as livestock wells. Within 500 m of the channel right-of-way, a total of 14 wells can be considered to be for domestic use, with 4 wells for livestock use only.

The total number of wells includes wells drilled on a range of dates. For example there are many wells with drilling dates prior to 1976, which would put the well at 40 years old. Well records in the area extend back to the 1920's. Some of these older wells may no longer be in use. In addition, wells used to livestock at the time of drilling may not be active today.

3.3 GENERAL STRATIGRAPHY

A detailed discussion of the stratigraphy found in the 2011 and 2015 drilling programs was given in the KGS Group Stage 2 report. A discussion of the 2016 stratigraphy is given in the Geotechnical Report Deliverable D8. A discussion of the regional Geology is given in the Assessment of Regional Geologic Setting Report Deliverable D5.

Surficial sediments were deposited on an extensively eroded carbonate (limestone) bedrock surface, which results in variability in overburden thicknesses in the region. A pre-glacial bedrock valley is present just west of the Birch Creek drainage system. The valley is filled with low permeability till that includes intertill sand areas in some locations. The Route D alignment follows the valley in the northern portion and is on the side of the valley in the southern section. The till is thickest in the deepest part of the valley and thins east of the Birch Creek wetland system and to the west at approximately 2 km from the channel alignment. Outside of the bedrock valley till overlying the bedrock is generally less than 10 m in thickness in most areas.

Based on the 2011, 2015 and 2016 drilling programs, the stratigraphy at Route D consists of a thin layer of topsoil overlying a thicker till unit (including clay till, silty clay till, silt till, or sandy clay till) with layers of sand, underlain by carbonate bedrock.

3.4 AQUIFER SYSTEMS AND PIEZOMETRIC LEVELS

The major aquifer system for the water supply wells is the bedrock carbonate aquifer. Information on aquifer systems and piezometric levels has been collected from investigations in the Stage 2 study (2015) and the 2016 study, as well as from regional information from the GWDrill database.

3.4.1 Groundwater Investigations

Piezometric pressures in the bedrock aquifer are above ground surface along the alignment ranging from El. 246 to 255 m close to ground elevation as shown in regional cross-sections in Deliverable D6 Groundwater Study.

3.4.2 GWDrill Database

Aquifer Systems

The Provincial well record database (GWDrill) was searched within 3 kilometers of the of the proposed Route D channel to identify the aquifer in which the well was completed. Of the 135 well logs 123 were completed in limestone bedrock, with 8 completed in the sand and gravel

and 1 in shale (Table D4-E). The distribution of the wells completed in aquifers other than the main limestone aquifer is shown on Plate D4-3 GWDrill Logs-Location, Aquifer and Use- Route D.

Piezometric elevations from the GWDrill logs were summarized for the regions to determine the extent and distribution of artesian conditions. The piezometric surface is generally shallow, from 0 to 3 m below ground surface in the higher bedrock areas east and west of the channel. Many areas have flowing artesian wells along, and close to the alignment, with piezometric elevations from 0 to 6 m above ground surface indicating upward gradients in the regional flow system. A further discussion of these conditions is contained in Deliverable D6, Groundwater Study Report.

3.5 WELL CONSTRUCTION

Collecting data on the well casing depths has been used to assess the risk to water supplies for various drawdown scenarios.

Distribution of well casing depths are shown on Plate D4-8 GWDrill Logs Casing Depth- Route D. Casing depths generally follow the bedrock depth, with deeper casings along the alignment and shallower casings to the east and west. Within 500 m of the channel, there are no casing depths less than 10 m, with 11 wells at 10 to 20 m casing depth and 8 wells at 20 to 30 m casing depth. At the 3 km distance (which includes areas of higher bedrock away from the channel) there are 39 wells with casing depths less than 10 m, 46 wells with casing depths from 10 to 20 m and 31 wells with casing depths from 20 to 30 m. Very long casing depths between 30 to 40 m were found at 6 wells and casing depths greater than 40 m at 1 well. These large casing depths are generally associated with area with shale bedrock in which the well is drilled to the limestone zone beneath the shale units.

3.6 WELL CAPACITIES AND CALCULATED AQUIFER TRANSMISSIVITIES

Well yields can be highly variable in the carbonate aquifer, which is a direct result of the fractured rock conditions. Water yields depend on the number of fractures intersected by a well, their size (aperture), extent and interconnection to other fractures. Information on well capacity

and aquifer transmissivity has been collected from investigations in the 2016 study, as well as from regional information from the GWDrill database.

3.6.1 Groundwater Investigations

Based on the studies conducted in 2016 the representative aquifer transmissivity was low, less than 1000 USgpd/ft; however, regional variability is expected along the Route D alignment.

3.6.2 GWDrill Database

The GWDrill data base contains pumping rates and static and pumping levels for individual wells. Not all records have this information, or in some cases information is not complete. Records containing complete information within the project area were summarized. Drawdowns were calculated and specific capacity was summarized as pumping rate divided by drawdown. An estimate of transmissivity was made using the empirical formula for confined aquifers:

Transmissivity = Specific capacity x 2000

The calculations are summarized in Appendix D4-G Calculated Specific Capacity and Transmissivity. The calculated transmissivity was plotted at the location of the GWDrill record on Plate D4-9 Estimated Aquifer Transmissivity–Route D. Colours were added to the map to identify the distribution of transmissivity in the area, with the lighter colours indicating lower transmissivity.

A summary of aquifer transmissivity at the 3 km and 500 m distance is shown in Appendix D4-E. Of the 109 wells with calculated transmissivities 54 were very low (<1000 USgpd/ft), 26 were low (1000 to 5000 USgpd/ft), 13 were low to moderate 5000 to 15,000 USgpd/ft, 5 were moderate 15 to 50,000 USgpd/ft and only 1 high (>50,000 USgpd/ft). It should be noted that not all wells have pumping information that can be used to calculated transmissivities.

A range of 1,000 to 15,000 USgpd/ft is considered to be a reasonable estimate of bulk aquifer transmissivity, based on the review of the well records. However, the transmissivity of the aquifer is based on fractures and solution channels which vary in the region. Therefore it is

possible to encounter zones of higher transmissivity in particular locations as shown by the 6 wells in the database in the range of 15,000 to >50,000 USgpd/ft.

3.7 AQUIFER VULNERABILITY

Aquifer vulnerability refers to the sensitivity of the aquifer to contamination. In this area, bedrock aquifers with a thin to absent overburden cover are most vulnerable, while bedrock aquifers buried beneath thick till deposits are least vulnerable. Aquifer vulnerability has been assessed based on the overburden thickness map presented in the Assessment of Regional Geological Setting Deliverable D6. The Route D channel alignment lies along the deepest till deposits roughly parallel to the Birch Creek Drainage System. The thick low permeability till sediments beneath the channel and to the west of the channel protect the bedrock aquifer from potential surface water intrusion from the channel.

The proposed invert of the Route D channel will be within the till overburden, with approximately 12 to 14 m of till remaining between the invert and the underlying bedrock in the southern portion of the channel and 10 m to less than 5 m in the northern portion. Groundwater depressurization will be required during construction to protect against blowout of the channel. A channel blowout would result in a direct connection between the surface water in the channel and the underlying bedrock. The significance of this connection; however, will depend on the water levels in the channel relative to the piezometric head, which is strongly upwards in this area and would protect against downward movement of surface water. The relative risk during varying channel stage heights could be determined in future studies. Additional drilling between existing testhole locations where artesian conditions have been measured could be beneficial during detailed design.

3.8 WELL INVENTORY PROGRAM

3.8.1 Methodology

A well inventory and water quality program was developed for the area surrounding Route D. Wells were selected based on the locations from the air-photo imagery to identify residences within a 3 km radius of the proposed Route D alignment. A number of considerations were

made in determining which wells to include in the well inventory and water quality sampling program. Groups of wells were identified on both sides of the proposed channels. One sample from each grouping was identified for collection. Manitoba Infrastructure then made inquiries to landowners to conduct the well inventory and sample the well water. If the initial well selected was unavailable, another well from the grouping was selected. The location of the wells inventoried is shown with a star on Plate D4-6 Potential Third-Party Well and Inventory Locations- Route D.

3.8.2 Well Inventory Summary

A well inventory and water quality sampling program was completed on October 19 and 20, 2016. A total of 19 residences were visited. Interviews were conducted with each homeowner regarding their well, construction, water quality and use and possible contaminant sources. Some homeowners have detailed knowledge of their systems age and construction and possible pump settings, while others do not. Individual forms were prepared for each well containing the responses to the inventory questions, the field sampling results and photographs as shown in Appendix D4-G

3.9 WATER QUALITY

3.9.1 Regional

Regional information indicates that east of Lake Manitoba the water quality is generally fresh, with Total Dissolved Solids (TDS) less than 1,000 mg/L. Water quality is generally magnesium-calcium-bicarbonate, with TDS in the order of 400 mg/L to 650 mg/L. This water quality reflects the significant meteoric water, aquifer recharge zone noted within the Interlake area.

3.9.2 Well Inventory

Groundwater samples were collected from a total of 19 residences in the Route D area, including two field duplicates for the program. The tap sampled at each residence was selected in consultation with the property owner to confirm an untreated sample was obtained. Prior to collecting the sample, the tap was cleaned and disinfected with a bleach/water mixture. Water

was run to purge the storage tank. The tap to be sampled was then run until the temperature stabilized, indicating a fresh water sample from the well. The water sample was collected in sterilized bottles provided by the analytical laboratory. Preservatives were added, as required. The water sample collected was stored in a cooler at 4°C for transportation to ALS Laboratory in Winnipeg, Manitoba, an accredited analytical testing laboratory.

Field chemistry results are shown on Table D4-7. The results of the laboratory analysis are presented in Table D4-8 for general water quality and Table D4-9 for metals in water.. An ion balance is shown in Table D4-10 along with an identification of the major water type. The applicable Health Canada Canadian Drinking Water Quality Guidelines (HC-CDWQG) are included for comparison. The Certificate of Analyses issued by ALS Laboratory is included in Appendix D4-G. A letter and laboratory results were sent to residents by MI.

The water quality results indicate a potable groundwater with elevated hardness and sulphate. The water type was generally magnesium-calcium-bicarbonate or calcium-magnesium-bicarbonate, showing little contribution from sodium and sulphate; however, only three wells showed total dissolved solids above 500 mg/L. Nitrates were notably very low, as was chloride and sodium. Iron was above the Canadian Drinking Water Quality Guidelines in five wells. Some, but not all residents used softeners or other filters on their water supplies. Three wells had total coliform counts (2 to 3 MPN/100 ML); however no *E. coli* was detected.

Analysis of duplicates showed a low relative percent difference (RPD) less than 5%, except for copper; however concentrations were very low, for this parameter.

4.0 STATEMENT OF LIMITATIONS AND CONDITIONS

4.1 THIRD PARTY USE OF REPORT

This report has been prepared for Manitoba Infrastructure to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

4.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

KGS Group prepared the geo-environmental conclusions and recommendations for this report in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this report is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of Manitoba Infrastructure. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

TABLES

TABLE D4-1
SUMMARY OF REGIONAL WATER SUPPLY USE - ROUTE C

	GWDrill PID	Date Drilled	AANDC Treatment System Number	Population Served	Type of System	Type of Treatment	Location of Wells	Number of Wells	Drinking Water Advisory
Pinaymootang First Nation Water Systems									
Pinaymootang School Plant (Notes 1 and 2)			6560	School (1971)		disinfection		1	
Pinaymootang Bottling Plant (Note 1 and 2)			15979	1531 people (Neegan Burnside 2011)		disinfection	Bottling Plant Hwy 6 (near Arena) (2005)	1	
Pump House 1 (Note 2)			NEW002	(2008) 19 homes	with storage	no disinfection (as of 2011) may have changed	Serves 2008 subdivision (Note 4)	1	
Pump House 2 (Note 2)			NEW002	(2008) 15 homes	with storage	disinfection	Serves 2008 subdivision (Note 4)	1	
Pump House 3 (Note 2)			NEW002	7 homes (1990)		no disinfection as of 2011 (may have changed)	North of Waste water Lagoon (Note 4)	1	
Pinaymootang Arena (Note 3)			-		Semi-Public Water System (Health Canada)		Arena	1	Boil Water Advisory (8/17/2015) date set
Pinay Gas Bar Semi-Public Water System (Note 3)			-		Semi-Public Water System (Health Canada)		Gas Bar	1	Do not consume (date set 8/24/2012)
Pinaymootang IRTC (Note 3)			-		Semi-Public Water System (Health Canada)		IRTC	1	Boil Water Advisory (8/8/2016)
Other Water Systems									
Roviera Resort and Campground (Note 4)				50 to 100 on peak summer day	Seasonal, semi-public, Regulated by Manitoba Office of Drinking Water	Not treated, considerd "secure" groundwater by Office of Drinking Water	Roviera Resort East/ Roviera Resort West	2	
Potential non-domestic Wells (Note 6)									
WAWATAIK BUILDING SUPPLIES LTD.	123837	27/05/2002							
SIGFUSSON NORTHERN	155741	23/10/2009							
HILBRE GOSPEL CHAPEL	18952	19/04/1973							

Notes:

1. AANDC. Water and Wastewater Infrastructure Investment Report April 2012 to March 2013. https://www.aadnc-aandc.gc.ca/eng/1403198954861/1403199074561
2. Neegan Burnside. National Assessment of First Nations Water and Wastewater Systems, Manitoba Regional Roll Up Report. Final January 2011. https://www.aadnc-aandc.gc.ca/eng/1315322645420/1315322706937.
3. Health Canada. Drinking Water Advisories in First Nations Communities. Accessed December 5, 2016. http://www.hc-sc.gc.ca/fniah-spnia/promotion/public-publique/water-dwa-eau-aqep-eng.php
4. Indigenous and Northern Affairs Canada. Professional and Technical Services, Winnipeg Manitoba. Personal Communication. December 2016.
5. Manitoba Sustainable Development, Water Stewardship Division, Water Science and Management Branch, Water Stewardship Office of Drinking Water, Interlake Region, Personal Communication October 2016.
6. Manitoba Sustainable Development, Water Stewardship Division, Water Science and Management Branch, Groundwater Management Program, GWDrill 2013.
7. Water Supply Information has not been confirmed with Pinaymootang First Nation.

TABLE D4-2
THIRD-PARTY WELLS FIELD CHEMISTRY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	E.C. (µS/cm)	Temp. (^{o}C)	ORP (mV)	DO (mg/L)	Turbidity	Odour	Colour	Comments
12C	20-Oct-16	7.4	1,464	7.0	-	-	none	none	none	-
152C	20-Oct-16	7.9	789	8.0	-	-	none	none	none	-
153C	20-Oct-16	7.6	992	8.0	-	-	none	none	none	-

Notes:
1. "-" = No Data
2. NA = Not Applicable
3. E.C. = Electrical Conductivity
4. D.O. = Dissolved Oxygen
5. O.R.P. = Oxidation-Reduction Potential

TABLE D4-3
THIRD PARTY WELLS GENERAL WATER QUALITY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

MI Well ID	Location	Sample Date	Field / Lab Dup. Info	Parameter (1)																
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride (5)	Fluoride	Sulphate	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	T.D.S.	Total Coliform (MPN/100mL)	E. Coli (MPN/100 mL)
EQL				*0.1*	*0.1*	*1*	*1*	*1.2*	*0.6*	*0.34*	*0.25*	*0.1*	*0.02*	*0.3*	*0.0051*	*0.005*	*0.001*	*5*	-	-
12C		20-Oct-16		0.84	7.74	1230	583	711	<0.60	<0.34	680	86.1	0.261	66.6	11.9	11.9	0.0157	808	0	0
152C		20-Oct-16		3.17	8.10	699	350	427	<0.60	<0.34	258	9.34	0.883	59.6	<0.0051	<0.0050	<0.0010	443	0	0
1052C		20-Oct-16	152C Dup	4.05	8.11	712	345	421	<0.60	<0.34	260	9.36	0.892	59.7	<0.0051	<0.0050	<0.0010	442	0	0
			RPD	*24.4%*	*0.1%*	*1.8%*	*1.4%*	*1.4%*	-	-	*0.8%*	*0.2%*	*1.0%*	*0.2%*	-	-	-	*0.2%*	-	-
153C		20-Oct-16		0.92	8.05	864	526	642	<0.60	<0.34	513	22.5	0.29	13	0.0141	0.0141	<0.0010	520	1	0
HC-CDWQ (2)																				
Drinking Water				0.3/1.0/0.1 (MAC)(7)	6.5 - 8.5 (AO)	-	-	-	-	-	(8)	≤250 (AO)	1.5 (MAC)	500 (AO)	-	10 (4) (MAC)	1.0 (4) (MAC)	500 (AO)	None Detectable per 100 mL (MAC)	None Detectable per 100 mL (MAC)
CCME(3) (Shown for Reference Only)																				
Freshwater Aquatic Life				Narrative (6)	6.5 - 9.0	-	-	-	-	-	-	120(5a)/640 (5b)	0.12	-	-	3 - 7 124(9)	0.06	-	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.D.S. = Total Dissolved Solids
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L, which is equivalent to 1 mg/L nitrite-nitrogen.
5. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation
   b. Short-term exposure - derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
6. Turbidity Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.
7. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
   a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
   b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
   c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process.
   Turbidity values greater than 1 NTU are shaded.
8. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as $CaCO_3$) , provide acceptable balance between corrosion and incrustation; where a water softener is used, a separate unsoftened supply for cooking and drinking purposes is recommended.
9. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
   These are NOT protective guidelines.
10. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).

- Exceedance of HC-CDWQ Guidelines

TABLE D4-3
THIRD PARTY WELLS GENERAL WATER QUALITY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

TABLE D4-4
THIRD PARTY WELLS METALS IN WATER - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

MI Well ID	Location	Sample Date	Parameter [1]																	
			Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
12C		20-Oct-16	0.0089	<0.00020	0.00026	0.195	<0.00020	<0.00020	0.134	<0.000010	85.9	<0.00010	<0.0010	0.00082	0.00953	0.017	0.000381	0.0328	113	0.0458	0.00061
152C		20-Oct-16	0.0333	<0.00020	0.00123	0.0466	<0.00020	<0.00020	1.2	<0.000010	50.5	<0.00010	<0.0010	0.00067	1.39	1.02	0.0252	0.0583	32	0.00798	0.0013
1052C		20-Oct-16	0.0121	<0.00020	0.0011	0.0466	<0.00020	<0.00020	1.3	<0.000010	49.8	<0.00010	<0.0010	0.00027	0.28	0.628	0.00825	0.0576	32.8	0.00615	0.00132
		RPD	-	-	*11.2%*	*0.0%*	-	-	*8.0%*	-	*1.4%*	-	-	*85.1%*	*132.9%*	*47.6%*	-	*1.2%*	*2.5%*	*25.9%*	*1.5%*
153C		20-Oct-16	<0.0050	<0.00020	<0.00020	0.182	<0.00020	<0.00020	0.126	<0.000010	66	<0.00010	<0.0010	<0.00020	0.00201	0.111	0.000369	0.025	84.7	0.0054	0.00074
EQL			*0.005*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.1*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0003*	*0.0002*
HC-CDWQ [2]																					
Drinking Water			0.1- 0.2 [4] (OG)	0.006 (MAC)	0.010 (MAC)	1.0 (MAC)	-	-	5.0 (MAC)	0.005 (MAC)	-	-	0.05 (MAC)	-	1.0 (AO)	0.3 (AO)	0.010 (MAC)	-	-	0.05 (AO)	-
CCME[3] (Shown for Reference Only)																					
Freshwater Aquatic Life			0.005 - 0.1 [5]	-	0.005	-	-	-	(29 [6]) 1.5 [7]	0.09 µg/L [8a] 1.0 µg/L [8b]	-	-	0.0089 (III), 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	-	0.073

MI Well ID	Location	Sample Date	Parameter [1]																	
			Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
12C		20-Oct-16	0.0062	<0.10	16.1	0.0134	<0.0010	6.24	<0.00010	37.8	0.251	<0.00020	0.00013	<0.00010	<0.00020	<0.00050	<0.00010	0.00421	<0.00020	0.0653	<0.00040
152C		20-Oct-16	0.0029	<0.10	20.4	0.00851	<0.0010	6.61	<0.00010	60.9	0.603	<0.00020	<0.00010	<0.00010	0.00104	0.00171	<0.00010	0.00012	<0.00020	0.004	<0.00040
1052C		20-Oct-16	<0.0020	<0.10	20.8	0.00853	<0.0010	6.52	<0.00010	62.4	0.634	<0.00020	<0.00010	<0.00010	0.00028	<0.00050	<0.00010	0.00012	<0.00020	0.004	0.00047
		RPD	-	-	*1.9%*	*0.2%*	-	*1.4%*	-	*2.4%*	*5.0%*	-	-	-	*115.2%*	-	-	*0.0%*	-	*0.0%*	-
153C		20-Oct-16	<0.0020	<0.10	3.3	0.00385	<0.0010	5.1	<0.00010	15.1	0.188	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00322	<0.00020	0.0233	<0.00040
EQL			*0.002*	*0.1*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.03*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
HC-CDWQ [2]																					
Drinking Water			-	-	-	-	0.05 (MAC)	-	-	200 (AO)	-	-	-		-	-	-	0.02 (MAC)	-	5 (AO)	-
CCME[3] (Shown for Reference Only)																					
Freshwater Aquatic Life			[8e]	[9]	-	-	0.001	-	0.00025	-	-	-	0.0008		-	-	-	(0.033[6]) 0.015 [7]	-	0.03	-

Notes:
EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence
"-" = No Data
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
   OG = Operational Guideline
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants.
The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
5. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5. The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater than or equal to 6.5.
6. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances). These are NOT protective guidelines.
7. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).

8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <17 mg/L, CWQG is 0.04 µg/L. At other hardness values, the CWQG can be calculated with the equation CWQG = 10^{0.83[log(hardness)] - 3.2} µg/L valid for hardness between 17 and 280 mg $CaCO_3$/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <5.3 mg/L, CWQG is 0.11 µg/L. At other hardness values, the benmark can be calculated with the equation Benchmark - 10^{1.016(log[hardness])-1.71}, valid for hardness between 5.3 and 360 mg CaCO3/L.
   c. **Copper** Guideline = e^(0.8545[ln(hardness)]-1.465) * 0.2 µg/L;
   d. **Lead** Guideline = e^(1.273[ln(hardness)]-4.705) µg/L;
   e. **Nickel** Guideline = e^(0.76[ln(hardness)]+1.06) µg/L

Well No.	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
12C	680	0.000142	0.014717	0.012	0.037	0.410
153C	513	0.000112	0.011053	0.010	0.026	0.331
152C	258	0.000063	0.005498	0.005	0.011	0.196

9. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

- Exceedance of HC-CDWQ Criteria

TABLE D4-4
THIRD PARTY WELLS METALS IN WATER - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

TABLE D4-5
THIRD-PARTY WELLS ION BALANCE AND WATER TYPE - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic	12C	20-Oct-16		152C	20-Oct-16		1052C 20-Oct-16 (Duplicate 152C)			153C	20-Oct-16	
	Weight	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.74	1.82E-05	0.00%	8.1	7.94E-06	0.00%	8.11	7.76E-06	0.00%	8.05	8.91E-06	0.00%
Calcium	0.0499	85.9	4.29	27.40%	50.5	2.52	30.27%	49.8	2.49	29.47%	66.0	3.29	29.92%
Magnesium	0.0823	113	9.30	59.45%	32	2.63	31.64%	32.8	2.70	32.02%	84.7	6.97	63.34%
Sodium	0.0435	37.8	1.64	10.51%	60.9	2.65	31.82%	62.4	2.71	32.19%	15.1	0.66	5.97%
Potassium	0.03	16.1	0.41	2.63%	20.4	0.52	6.27%	20.8	0.53	6.32%	3.3	0.08	0.77%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**252.8**	**15.64**	**100.0%**	**164**	**8.3**	**100.0%**	**166**	**8.4**	**100.0%**	163.8	**11.0**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	583	11.66	71.43%	350	7.00	82.32%	345	6.90	82.08%	526	10.52	92.07%
Bicarbonate [4]	0.02	580.0	11.60	71.06%	345.8	6.92	81.34%	340.8	6.82	81.09%	520.5	10.41	91.10%
Carbonate [4]	0.02	3.0	0.06	0.37%	4.1	0.08	0.96%	4.1	0.08	0.98%	5.5	0.11	0.96%
Hydroxide [4]	0.02	0.0	0.00	0.00%	0.1	0.00	0.01%	0.1	0.00	0.02%	0.1	0.00	0.01%
Nitrate	0.0714	11.9	0.85	5.21%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.0141	0.00	0.01%
Chloride	0.0282	86.1	2.43	14.87%	9.34	0.26	3.10%	9.36	0.26	3.14%	22.5	0.63	5.55%
Sulphate	0.0208	66.6	1.39	8.49%	59.6	1.24	14.58%	59.7	1.24	14.77%	13	0.27	2.37%
SUM		**748**	**16.32**	**100.0%**	**419**	**8.5**	**100.0%**	**414**	**8.4**	**100.0%**	**562**	**11.4**	**100.0%**
Silica (as SiO_2)		6			7			7			5		
TDS (mg/L) [2]		814			449			448			525		
TDS (mg/L) (Lab) [3]		808			443			442			520		
Ion Balance		2.13%			1.06%			0.15%			1.87%		
Ion Balance (Lab) [3]		-			-			-			-		

Notes:

"-" = No Data

1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

ID	Water Type
12C	Magnesium-Bicarbonate
152/1052C	Sodium-Magnesium - Calcium-Bicarbonate
153C	Magnesium-Bicarbonate

TABLE D4-6
SUMMARY OF REGIONAL WATER SUPPLY USE- ROUTE D

	GWDrill PID	Date Drilled	Population Served	Type of System	Type of Treatment	Location of Wells	Number of Wells	Advisories or Restricted Use	Source of Information		Aquifer or Water Quality Information
Moosehorn									Manitoba Water Stewardship Office of Drinking Water (ODW), Interlake Region	ODW has not conducted a survey of public or semi-public water systems in this area, but such systems are likely (such as an arena or motel). ODW does not regulate any Federal systems or any private/at home Day cares	
Alf Cuthbert School			90 to 100 students	Secure Groundwater	UV Disinfection	school	1	ODW reports that there are none as of October 2016	Manitoba Water Stewardship Office of Drinking Water, Interlake Region		
Grahamdale											
Grahamdale Community Well	31962	11/08/1977					1		Manitoba Water Stewardship, GWDrill database		
LGD-Grahamdale Community Hall	22423	17/10/1974				community hall	1		Manitoba Water Stewardship, GWDrill database		T=556IGPD/FT. CHEMICAL ANALYSIS(1974), NACL=37.5 PPM, FE=0.1 PPM, H=342 PPM
Hilbre									Manitoba Water Stewardship Office of Drinking Water, Interlake Region	ODW has not conducted a survey of public or semi-public water systems in this area, but such systems are likely (such as an arena or motel). ODW does not regulate any Federal systems or any private/at home Day cares	
Hilbre Gospel Chapel	58328	02/06/1987				church	1		Manitoba Water Stewardship,GWDrill database		
Hilbre Gospel Chapel	18952	19/04/1973				church	1		Manitoba Water Stewardship, GWDrill database		
Hilbre School	4199	09/08/1963				school	1		Manitoba Water database		
C N R Hwy 6 and Main St. Hilbre	6927	24/09/1965					1		Manitoba Water database		

TABLE D4-6
SUMMARY OF REGIONAL WATER SUPPLY USE- ROUTE D

	GWDrill PID	Date Drilled	Population Served	Type of System	Type of Treatment	Location of Wells	Number of Wells	Advisories or Restricted Use	Source of Information		Aquifer or Water Quality Information
Faulkner										ODW has not conducted a survey of public or semi-public water systems in this area, but such systems are likely (such as an arena or motel). ODW does not regulate any Federal systems or any private/at home Day cares	
None Noted											
Watchorn Provincial Park											
Parks Branch Watchorn Campground	180639	09/10/1973					1		Manitoba Water database		
Parks Branch Watchorn Campground Between Lots 15 and 27	42414	19/08/1981					1				WELL SET UP FOR NATURAL FLOW, NO HANDPUMP REQD, FLOWING AT 0.1 L/S, GROUND LEVEL ELEV EST 820 FT, NACL=200 MG/L, FE=0.1 MG/L, H=19 GPG, EC=800, CHEMICAL ANALYSIS (1981)
Kissman School District #1648	3241	14/03/1922					1			Historic building	
Kissman School District #1648	3242	13/03/1922					1			Historic Building	
Other											
Northern Affairs	25636	01/01/1975					1				

TABLE D4-7
THIRD-PARTY WELLS FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	E.C. (µS/cm)	Temp. (^{o}C)	ORP (mV)	DO (mg/L)	Turbidity	Odour	Colour	Comments
7D	20-Oct-16	8.2	803	5.0	-	-	none	none	none	
8D	20-Oct-16	8.0	783	7.0	-	-	none	none	none	
13D	20-Oct-16	8.5	721	6.0	-	-	none	none	none	
18D	19-Oct-16	7.9	816	7.0	-	-	none	none	none	
26D	19-Oct-16	7.5	802	7.0	-	-	none	none	none	
27D	20-Oct-16	7.6	798	6.0	-	-	none	sulphur	none	
29D	20-Oct-16	8.1	890	6.0	-	-	none	none	none	
37D	19-Oct-16	7.5	820	7.0	-	-	none	sulphur	none	
38D	19-Oct-16	7.5	918	8.0	-	-	none	none	none	
44D	20-Oct-16	7.8	861	7.0	-	-	none	none	none	
50D	20-Oct-16	8.1	745	6.0	-	-	none	none	none	
54D	19-Oct-16	7.4	831	8.0	-	-	none	none	none	
68D	19-Oct-16	7.6	986	6.0	-	-	none	none	none	
72D	20-Oct-16	7.8	855	7.0	-	-	none	none	none	
73D	19-Oct-16	7.6	895	5.0	-	-	none	none	none	
76D	19-Oct-16	7.7	873	6.0	-	-	none	sulphur	none	
77D	19-Oct-16	7.5	840	7.0	-	-	none	sulphur	none	

Notes:
1. "-" = No Data
2. NA = Not Applicable
3. E.C. = Electrical Conductivity
4. D.O. = Dissolved Oxygen
5. O.R.P. = Oxidation-Reduction Potential

TABLE D4-8
THIRD PARTY WELLS GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

MI Well ID	Location	Sample Date	Field / Lab Dup. Info	Parameter [1]																
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [6]	Fluoride	Sulphate	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	T.D.S.	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)
EQL				*0.1*	*0.1*	*1*	*1*	*1.2*	*0.6*	*0.34*	*0.25*	*0.1*	*0.02*	*0.3*	*0.0051*	*0.005*	*0.001*	*5*	-	-
7D		20-Oct-16		1.62	8.17	729	246	300	<0.60	<0.34	310	16.3	0.522	144	<0.0051	<0.0050	<0.0010	458	0	0
8D		20-Oct-16		0.45	7.94	685	236	288	<0.60	<0.34	298	17.3	0.525	141	<0.0051	<0.0050	<0.0010	448	0	0
13D		20-Oct-16		0.13	8.01	628	208	253	<0.60	<0.34	231	22.1	0.793	116	<0.0051	<0.0050	<0.0010	397	0	0
18D		19-Oct-16		0.56	7.95	679	244	298	<0.60	<0.34	287	13.7	0.687	145	<0.0051	<0.0050	<0.0010	452	0	0
26D		19-Oct-16		1.11	7.66	658	332	405	<0.60	<0.34	372	3.03	0.944	81.7	<0.0051	<0.0050	<0.0010	422	0	0
1026D		19-Oct-16	26D Dup	0.69	7.70	660	328	400	<0.60	<0.34	371	3.03	0.943	81.7	<0.0051	<0.0050	<0.0010	419	0	0
			RPD	*46.7%*	*0.5%*	*0.3%*	*1.2%*	*1.2%*	-	-	*0.3%*	*0.0%*	*0.1%*	*0.0%*	-	-	-	*0.7%*	-	-
27D		20-Oct-16		3.86	7.67	712	309	377	<0.60	<0.34	372	5.67	0.821	119	<0.0051	<0.0050	<0.0010	459	0	0
29D		20-Oct-16		3.07	7.75	767	287	350	<0.60	<0.34	379	10.6	0.592	163	<0.0051	<0.0050	<0.0010	514	0	0
37D		19-Oct-16		1.5	7.66	672	337	411	<0.60	<0.34	378	2.68	0.572	88.5	<0.0051	<0.0050	<0.0010	435	3	0
38D		19-Oct-16		7.47	7.74	744	336	410	<0.60	<0.34	388	5.03	0.581	129	<0.010	<0.010	<0.0020	501	2	0
44D		20-Oct-16		0.35	7.73	738	320	391	<0.60	<0.34	370	7.69	1.22	124	<0.0051	<0.0050	<0.0010	483	0	0
50D		20-Oct-16		0.57	7.97	636	228	279	<0.60	<0.34	279	12.2	0.616	125	<0.0051	<0.0050	<0.0010	410	0	0
54D		19-Oct-16		3.13	7.70	681	337	411	<0.60	<0.34	373	2.79	0.905	89.9	<0.010	<0.010	<0.0020	440	0	0
68D		19-Oct-16		3.44	7.65	791	403	491	<0.60	<0.34	424	5.53	0.323	103	<0.010	<0.010	<0.0020	525	2	0
72D		20-Oct-16		0.31	8.05	734	333	406	<0.60	<0.34	360	7.14	0.915	111	<0.0051	<0.0050	<0.0010	477	0	0
73D		19-Oct-16		2.53	7.66	721	346	422	<0.60	<0.34	389	5.44	1.04	100	0.336	0.331	0.0043	472	0	0
76D		19-Oct-16		11.9	7.76	712	326	397	<0.60	<0.34	360	7.5	1.1	101	<0.010	<0.010	<0.0020	462	0	0
77D		19-Oct-16		3.58	7.77	679	323	394	<0.60	<0.34	358	4.35	1.08	89.4	<0.010	<0.010	0.0025	435	0	0
HC-CDWQ [2]																				
Drinking Water				0.3/1.0/0.1 (MAC)[7]	6.5 - 8.5 (AO)	-	-	-	-	-	[8]	≤250 (AO)	1.5 (MAC)	500 (AO)	-	10 [4] (MAC)	1.0 [4] (MAC)	500 (AO)	None Detectable per 100 mL (MAC)	None Detectable per 100 mL (MAC)
CCME[4] (Shown for Reference Only)																				
Freshwater Aquatic Life				Narrative [6]	6.5 - 9.0	-	-	-	-	-	-	120[5a]/640 [5b]	0.12	-	-	3[10]/ 124[9]	0.06	-	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.D.S. = Total Dissolved Solids
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L, which is equivalent to 1 mg/L nitrite-nitrogen.
5. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation
   b. Short-term exposure - derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
6. Turbidity Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.

7. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
   a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
   b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
   c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process.
   Turbidity values greater than 1 NTU are shaded.
8. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as $CaCO_3$) , provide acceptable balance between corrosion and incrustation; where a water softener is used, a separate unsoftened supply for cooking and drinking purposes is recommended.
9. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
   These are NOT protective guidelines.
10. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).

- Exceedance of HC-CDWQ Guidelines

TABLE D4-8
THIRD PARTY WELLS GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

TABLE D4-9
THIRD PARTY WELLS METALS IN WATER - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

MI Well ID	Location	Sample Date	Parameter [1]																	
			Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
7D		20-Oct-16	<0.0050	<0.00020	<0.00020	0.0252	<0.00020	<0.00020	0.662	<0.000010	60.6	<0.00010	<0.0010	<0.00020	0.00088	0.207	<0.000090	0.0373	38.6	0.00902	0.00054
8D		20-Oct-16	<0.0050	<0.00020	<0.00020	0.0253	<0.00020	<0.00020	0.623	<0.000010	57.8	<0.00010	<0.0010	<0.00020	0.00361	0.155	<0.000090	0.0357	37.2	0.00813	0.00058
13D		20-Oct-16	<0.0050	<0.00020	<0.00020	0.0208	<0.00020	<0.00020	0.526	<0.000010	45.2	<0.00010	<0.0010	<0.00020	0.00025	0.039	<0.000090	0.0314	28.7	0.00641	0.0008
18D		19-Oct-16	<0.0050	<0.00020	<0.00020	0.0263	<0.00020	<0.00020	0.598	<0.000010	54.7	<0.00010	<0.0010	<0.00020	0.00117	0.073	<0.000090	0.0334	36.6	0.0181	0.00048
26D		19-Oct-16	<0.0050	<0.00020	0.00032	0.0228	<0.00020	<0.00020	0.316	<0.000010	66.5	<0.00010	<0.0010	0.0002	0.00133	0.098	<0.000090	0.027	50	0.0155	0.00038
1026D		19-Oct-16	<0.0050	<0.00020	0.00033	0.023	<0.00020	<0.00020	0.318	<0.000010	66.5	0.00011	<0.0010	<0.00020	0.00107	0.1	<0.000090	0.0262	49.9	0.0156	0.00039
		RPD	-	-	*3.1%*	*0.9%*	-	-	*0.6%*	-	*0.0%*	-	-	-	*21.7%*	*2.0%*	-	*3.0%*	*0.2%*	*0.6%*	*2.6%*
27D		20-Oct-16	<0.0050	<0.00020	0.00026	0.02	<0.00020	<0.00020	0.53	<0.000010	73	<0.00010	<0.0010	<0.00020	0.00137	0.997	0.000119	0.0342	46	0.009	0.00038
29D		20-Oct-16	<0.0050	<0.00020	<0.00020	0.017	<0.00020	<0.00020	0.617	<0.000010	78	<0.00010	<0.0010	<0.00020	0.00079	0.247	<0.000090	0.0355	44.8	0.00931	0.00052
37D		19-Oct-16	<0.0050	<0.00020	0.00053	0.0196	<0.00020	<0.00020	0.356	<0.000010	70.3	0.00012	<0.0010	<0.00020	0.00131	0.14	<0.000090	0.0272	49.1	0.00383	0.00044
38D		19-Oct-16	<0.0050	<0.00020	0.0033	0.0176	<0.00020	<0.00020	0.577	<0.000010	77.4	0.0001	<0.0010	0.00036	0.00167	0.546	0.000104	0.0348	47.4	0.00543	0.00081
44D		20-Oct-16	<0.0050	<0.00020	<0.00020	0.0235	<0.00020	<0.00020	0.556	<0.000010	74.7	<0.00010	<0.0010	<0.00020	0.00312	0.049	0.000423	0.0355	44.6	0.00432	0.00033
50D		20-Oct-16	<0.0050	<0.00020	0.00052	0.0263	<0.00020	<0.00020	0.503	<0.000010	53.9	<0.00010	<0.0010	<0.00020	0.00161	0.081	0.000117	0.0257	35	0.00962	0.00045
54D		19-Oct-16	<0.0050	<0.00020	0.00206	0.0199	<0.00020	<0.00020	0.459	<0.000010	72.3	0.00013	<0.0010	0.00151	0.00209	0.306	0.000152	0.0292	46.8	0.00752	0.00047
68D		19-Oct-16	0.0391	<0.00020	<0.00020	0.0205	<0.00020	<0.00020	0.527	<0.000010	79.3	0.00018	<0.0010	0.00025	<0.00020	0.034	<0.000090	0.0406	54.8	0.0251	<0.00020
72D		20-Oct-16	<0.0050	<0.00020	<0.00020	0.0173	<0.00020	<0.00020	0.525	<0.000010	72.9	<0.00010	<0.0010	<0.00020	<0.00020	0.034	<0.000090	0.0354	43.2	0.0086	0.00021
73D		19-Oct-16	<0.0050	<0.00020	0.00042	0.0218	<0.00020	<0.00020	0.6	<0.000010	76.1	0.00019	<0.0010	0.00058	0.001	0.336	<0.000090	0.0359	48.4	0.00521	0.00192
76D		19-Oct-16	0.0071	<0.00020	<0.00020	0.0174	<0.00020	<0.00020	0.471	<0.000010	73.3	0.00021	<0.0010	<0.00020	0.00089	0.993	<0.000090	0.0341	42.9	0.0165	0.00028
77D		19-Oct-16	<0.0050	<0.00020	<0.00020	0.0195	<0.00020	<0.00020	0.432	<0.000010	70.2	0.00032	<0.0010	0.00021	0.00101	0.281	<0.000090	0.0301	44.3	0.0183	0.00047
EQL			*0.005*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.1*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0003*	*0.0002*
HC-CDWQ [2]																					
Drinking Water			0.1- 0.2 [4] (OG)	0.006 (MAC)	0.010 (MAC)	1.0 (MAC)	-	-	5.0 (MAC)	0.005 (MAC)	-	-	0.05 (MAC)	-	1.0 (AO)	0.3 (AO)	0.010 (MAC)	-	-	0.05 (AO)	-
CCME[3] (Shown for Reference Only)																					
Freshwater Aquatic Life			0.005 - 0.1 [5]	-	0.005	-	-	-	(29 [6]) 1.5 [7]	0.09 µg/L [8a] 1.0 µg/L [8b]	-	-	0.0089 (III), 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	-	0.073

TABLE D4-9
THIRD PARTY WELLS METALS IN WATER - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

MI Well ID	Location	Sample Date	Parameter [1]																	
			Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
7D		20-Oct-16	<0.0020	<0.10	10.2	0.00488	<0.0010	4.33	<0.00010	41.5	0.453	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00121	<0.00020	0.0624	<0.00040
8D		20-Oct-16	<0.0020	<0.10	9.06	0.00457	<0.0010	4.41	<0.00010	44.4	0.427	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00127	<0.00020	0.0197	<0.00040
13D		20-Oct-16	<0.0020	<0.10	7.68	0.00369	<0.0010	4	<0.00010	52.8	0.337	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00095	<0.00020	<0.0020	<0.00040
18D		19-Oct-16	<0.0020	<0.10	8.99	0.00476	<0.0010	4.17	<0.00010	46.3	0.39	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00122	<0.00020	0.0686	<0.00040
26D		19-Oct-16	<0.0020	<0.10	6.99	0.00567	<0.0010	4.38	<0.00010	14.1	0.375	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00015	<0.00020	0.0034	<0.00040
1026D		19-Oct-16	<0.0020	<0.10	7.04	0.00552	<0.0010	4.39	<0.00010	14	0.387	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00015	<0.00020	0.0034	<0.00040
		RPD	-	-	*0.7%*	*2.7%*	-	*0.2%*	-	*0.7%*	*3.1%*	-	-	-	-	-	-	*0.0%*	-	*0.0%*	-
27D		20-Oct-16	<0.0020	<0.10	9.83	0.00685	<0.0010	4.8	<0.00010	20.2	0.52	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00013	<0.00020	0.0378	<0.00040
29D		20-Oct-16	<0.0020	<0.10	10.6	0.00763	<0.0010	4.86	<0.00010	35.2	0.576	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.0005	<0.00020	0.007	<0.00040
37D		19-Oct-16	<0.0020	<0.10	7.24	0.00554	<0.0010	4.36	<0.00010	14.9	0.379	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00034	<0.00020	0.0034	<0.00040
38D		19-Oct-16	<0.0020	<0.10	11.4	0.00672	<0.0010	5.23	<0.00010	29.2	0.575	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00047	<0.00020	0.0206	<0.00040
44D		20-Oct-16	<0.0020	<0.10	10	0.00735	<0.0010	4.52	<0.00010	30.4	0.586	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00036	<0.00020	0.0036	<0.00040
50D		20-Oct-16	<0.0020	<0.10	7.09	0.00424	<0.0010	4.23	<0.00010	39.7	0.357	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00081	<0.00020	0.0133	<0.00040
54D		19-Oct-16	0.0049	<0.10	9.72	0.00668	<0.0010	4.38	<0.00010	16.6	0.454	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00017	<0.00020	0.0112	<0.00040
68D		19-Oct-16	<0.0020	<0.10	11	0.00736	<0.0010	5.57	<0.00010	30.3	0.52	<0.00020	<0.00010	<0.00010	<0.00020	0.00162	<0.00010	0.00212	<0.00020	<0.0020	<0.00040
72D		20-Oct-16	<0.0020	<0.10	10.5	0.00637	<0.0010	5.19	<0.00010	32.6	0.53	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00054	<0.00020	<0.0020	<0.00040
73D		19-Oct-16	<0.0020	<0.10	12.4	0.00838	<0.0010	4.27	<0.00010	20.3	0.635	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00038	<0.00020	0.0051	<0.00040
76D		19-Oct-16	<0.0020	<0.10	9.9	0.00757	<0.0010	4.89	<0.00010	31.5	0.522	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00052	<0.00020	0.0221	<0.00040
77D		19-Oct-16	<0.0020	<0.10	8.95	0.00593	<0.0010	5.32	<0.00010	24.2	0.492	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.0003	<0.00020	0.0056	<0.00040
EQL			*0.002*	*0.1*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.03*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
HC-CDWQ [2]																					
Drinking Water			-	-	-	-	0.05 (MAC)	-	-	200 (AO)	-	-	-		-	-	-	0.02 (MAC)	-	5 (AO)	-
CCME[3] (Shown for Reference Only)																					
Freshwater Aquatic Life			(8e)	(9)	-	-	0.001	-	0.00025	-	-	-	0.0008		-	-	-	(0.033[6]) 0.015 [7]	-	0.03	-

Notes:

EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence

"-" = No Data

RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
   OG = Operational Guideline
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants.
The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
5. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5. The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater than or equal to 6.5.
6. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances). These are NOT protective guidelines.

7. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <17 mg/L, CWQG is 0.04 µg/L. At other hardness values, the CWQG can be calculated with the equation CWQG = 10^{0.83[log(hardness)] - 3.2} µg/L valid for hardness between 17 and 280 mg $CaCO_3$/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <5.3 mg/L, CWQG is 0.11 µg/L. At other hardness values, the benmark can be calculated with the equation Benchmark - 10^{1.016(log[hardness])-1.71}, valid for hardness between 5.3 and 360 mg CaCO3/L.
   c. **Copper** Guideline = e^(0.8545[ln(hardness)]-1.465) * 0.2 µg/L;
   d. **Lead** Guideline = e^(1.273[ln(hardness)]-4.705) µg/L;
   e. **Nickel** Guideline = e^(0.76[ln(hardness)]+1.06) µg/L

Well No.	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
77D	358	0.000083	0.007669	0.007	0.016	0.252
76D	360	0.000084	0.007713	0.007	0.016	0.253
68D	424	0.000096	0.009108	0.008	0.020	0.287
73D	389	0.000089	0.008344	0.008	0.018	0.268
54D	373	0.000086	0.007996	0.007	0.017	0.260
37D	378	0.000087	0.008105	0.007	0.017	0.263
38D	388	0.000089	0.008322	0.008	0.018	0.268
26D	372	0.000086	0.007974	0.007	0.017	0.259
18D	287	0.000069	0.006126	0.006	0.012	0.213
29D	379	0.000087	0.008126	0.007	0.017	0.263
13D	231	0.000058	0.004914	0.005	0.009	0.181
8D	298	0.000071	0.006365	0.006	0.013	0.219
27D	372	0.000086	0.007974	0.007	0.017	0.259
44D	370	0.000085	0.007930	0.007	0.017	0.258
50D	279	0.000068	0.005953	0.006	0.012	0.208
72D	360	0.000084	0.007713	0.007	0.016	0.253
7D	310	0.000074	0.006626	0.006	0.013	0.226

9. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

- Exceedance of HC-CDWQ Criteria

TABLE D4-10
THIRD-PARTY WELLS ION BALANCE AND WATER TYPE - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic Weight	7D	20-Oct-16		8D	20-Oct-16		13D	20-Oct-16		18D	19-Oct-16		26D	19-Oct-16		1026D	19-Oct-16	
		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	8.17	6.76E-06	0.00%	7.94	1.15E-05	0.00%	8.01	9.77E-06	0.00%	7.95	1.12202E-05	0.00%	7.66	2.19E-05	0.00%	7.7	1.99526E-05	0.00%
Calcium	0.0499	60.6	3.02	36.58%	57.8	2.88	35.57%	45.2	2.26	31.72%	54.7	2.73	34.18%	66.5	3.32	40.34%	66.5	3.32	40.40%
Magnesium	0.0823	38.6	3.18	38.43%	37.2	3.06	37.75%	28.7	2.36	33.22%	36.6	3.01	37.72%	50	4.12	50.03%	49.9	4.11	49.99%
Sodium	0.0435	41.5	1.81	21.84%	44.4	1.93	23.82%	52.8	2.30	32.30%	46.3	2.01	25.22%	14.1	0.61	7.46%	14	0.61	7.41%
Potassium	0.03	10.2	0.26	3.16%	9.06	0.23	2.86%	7.68	0.20	2.76%	8.99	0.23	2.88%	6.99	0.18	2.18%	7.04	0.18	2.19%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**150.9**	**8.27**	**100.0%**	**148**	**8.1**	**100.0%**	**134**	**7.1**	**100.0%**	**146.6**	**7.99**	**100.0%**	**137.6**	**8.23**	**100.0%**	**137**	**8.21**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	246	4.92	58.74%	236	4.72	57.98%	208	4.16	57.81%	244	4.88	58.92%	332	6.64	78.81%	328	6.56	78.61%
Bicarbonate [4]	0.02	242.6	4.85	57.92%	234.0	4.68	57.50%	206.0	4.12	57.24%	241.9	4.84	58.42%	330.6	6.61	78.47%	326.4	6.53	78.23%
Carbonate [4]	0.02	3.4	0.07	0.81%	1.9	0.04	0.47%	2.0	0.04	0.55%	2.0	0.04	0.49%	1.4	0.03	0.34%	1.5	0.03	0.37%
Hydroxide [4]	0.02	0.1	0.00	0.02%	0.0	0.00	0.01%	0.1	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.01%
Nitrate	0.0714	0.005	0.00	0.00%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.005	0.00	0.00%
Chloride	0.0282	16.3	0.46	5.49%	17.3	0.49	5.99%	22.1	0.62	8.66%	13.7	0.39	4.66%	3.03	0.09	1.01%	3.03	0.09	1.02%
Sulphate	0.0208	144	3.00	35.76%	141	2.93	36.02%	116	2.41	33.53%	145	3.02	36.41%	81.7	1.70	20.17%	81.7	1.70	20.36%
SUM		**406**	**8.38**	**100.0%**	**394**	**8.1**	**100.0%**	**346**	**7.2**	**100.0%**	**403**	**8.28**	**100.0%**	**417**	**8.43**	**100.0%**	**413**	**8.35**	**100.0%**
Silica (as SiO_2)		5			4			4			4			4			4		
TDS (mg/L) [2]		464			453			401			456			426			423		
TDS (mg/L) (Lab) [3]		458			448			397			452			422			419		
Ion Balance		0.65%			0.20%			0.60%			1.82%			1.20%			0.79%		
Ion Balance (Lab) [3]		-			-			-			-			-			-		

Cations	Atomic Weight	27D	20-Oct-16		29D	20-Oct-16		37D	19-Oct-16	
		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.67	2.14E-05	0.00%	7.75	1.78E-05	0.00%	7.66	2.19E-05	0.00%
Calcium	0.0499	73	3.64	42.56%	78	3.89	41.49%	70.3	3.51	41.85%
Magnesium	0.0823	46	3.79	44.23%	44.8	3.69	39.30%	49.1	4.04	48.21%
Sodium	0.0435	20.2	0.88	10.27%	35.2	1.53	16.32%	14.9	0.65	7.73%
Potassium	0.03	9.83	0.25	2.94%	10.6	0.27	2.89%	7.24	0.19	2.21%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**149.0**	**8.56**	**100.0%**	**168.6**	**9.38**	**100.0%**	**141.5**	**8.38**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	309	6.18	70.10%	287	5.74	60.87%	337	6.74	77.86%
Bicarbonate [4]	0.02	307.6	6.15	69.79%	285.5	5.71	60.55%	335.5	6.71	77.52%
Carbonate [4]	0.02	1.4	0.03	0.31%	1.5	0.03	0.32%	1.4	0.03	0.33%
Hydroxide [4]	0.02	0.0	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.01%
Nitrate	0.0714	0.005	0.00	0.00%	0.005	0.00	0.00%	0.005	0.00	0.00%
Chloride	0.0282	5.67	0.16	1.81%	10.6	0.30	3.17%	2.68	0.08	0.87%
Sulphate	0.0208	119	2.48	28.08%	163	3.39	35.95%	88.5	1.84	21.26%
SUM		**434**	**8.82**	**100.0%**	**461**	**9.43**	**100.0%**	**428**	**8.66**	**100.0%**
Silica (as SiO_2)		5			5			4		
TDS (mg/L) [2]		464			519			439		
TDS (mg/L) (Lab) [3]		459			514			435		
Ion Balance		1.48%			0.25%			1.61%		
Ion Balance (Lab) [3]		-			-			-		

Water Types	
7D	Magnesium-Calcium-Bicarbonate
8D	Magnesium-Calcium-Bicarbonate
13D	Magnesium-Calcium-Sodium Bicarbonate
18D	Magnesium-Calcium-Bicarbonate
26D/ 1026D	Magnesium-Calcium-Bicarbonate
27D	Magnesium-Calcium-Bicarbonate
29D	Calcium-Magnesium-Bicarbonate
37D	Magnesium-Calcium-Bicarbonate

Notes:

"-" = No Data

1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
3. Laboratory results may slightly differ due to rounding of numbers.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

TABLE D4-10
THIRD-PARTY WELLS ION BALANCE - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic Weight	38D 19-Oct-16			44D 20-Oct-16			50D 20-Oct-16			54D 19-Oct-16			68D 19-Oct-16			72D 20-Oct-16		
		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.74	1.82E-05	0.00%	7.73	1.86E-05	0.00%	7.97	1.07E-05	0.00%	7.7	2E-05	0.00%	7.65	2.24E-05	0.00%	8.05	8.91251E-06	0.00%
Calcium	0.0499	77.4	3.86	41.42%	74.7	3.73	41.53%	53.9	2.69	35.96%	72.3	3.61	44.10%	79.3	3.96	40.44%	72.9	3.64	42.24%
Magnesium	0.0823	47.4	3.90	41.83%	44.6	3.67	40.89%	35	2.88	38.52%	46.8	3.85	47.08%	54.8	4.51	46.09%	43.2	3.56	41.29%
Sodium	0.0435	29.2	1.27	13.62%	30.4	1.32	14.73%	39.7	1.73	23.09%	16.6	0.72	8.83%	30.3	1.32	13.47%	32.6	1.42	16.47%
Potassium	0.03	11.4	0.29	3.13%	10	0.26	2.85%	7.09	0.18	2.43%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**165.4**	**9.33**	**100.0%**	**160**	**9.0**	**100.0%**	**136**	**7.5**	**100.0%**	**135.7**	**8.18**	**100.0%**	**164.4**	**9.79**	**100.0%**	**149**	**8.61**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	336	6.72	70.40%	320	6.40	69.59%	228	4.56	60.76%	337	6.74	77.57%	403	8.06	77.81%	333	6.66	72.62%
Bicarbonate [4]	0.02	334.2	6.68	70.03%	318.4	6.37	69.24%	226.0	4.52	60.22%	335.4	6.71	77.20%	401.3	8.03	77.48%	329.5	6.59	71.85%
Carbonate [4]	0.02	1.7	0.03	0.36%	1.6	0.03	0.35%	2.0	0.04	0.53%	1.6	0.03	0.36%	1.7	0.03	0.33%	3.5	0.07	0.76%
Hydroxide [4]	0.02	0.0	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.00%	0.1	0.00	0.01%
Nitrate	0.0714	0.01	0.00	0.01%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.01	0.00	0.01%	0.01	0.00	0.01%	0.005	0.00	0.00%
Chloride	0.0282	5.03	0.14	1.49%	7.69	0.22	2.36%	12.2	0.34	4.58%	2.79	0.08	0.91%	5.53	0.16	1.51%	7.14	0.20	2.20%
Sulphate	0.0208	129	2.68	28.11%	124	2.58	28.05%	125	2.60	34.65%	89.9	1.87	21.52%	103	2.14	20.68%	111	2.31	25.18%
SUM		**470**	**9.55**	**100.0%**	**452**	**9.2**	**100.0%**	**365**	**7.5**	**100.0%**	**430**	**8.69**	**100.0%**	**512**	**10.36**	**100.0%**	**451**	**9.17**	**100.0%**
Silica (as SiO_2)		5			5			4			4			6			5		
TDS (mg/L) [2]		506			488			414			435			520			472		
TDS (mg/L) (Lab) [3]		501			483			410			440			525			477		
Ion Balance		1.17%			1.21%			0.17%			3.01%			2.85%			3.15%		
Ion Balance (Lab) [3]		-			-			-			-			-			-		

Cations	Atomic Weight	73D 19-Oct-16			76D 19-Oct-16		
		mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.66	2.19E-05	0.00%	7.76	1.74E-05	0.00%
Calcium	0.0499	76.1	3.80	43.83%	73.3	3.66	42.74%
Magnesium	0.0823	48.4	3.98	45.98%	42.9	3.53	41.25%
Sodium	0.0435	20.3	0.88	10.19%	31.5	1.37	16.01%
Potassium	0.03	-	0.00	0.00%	-	0.00	0.00%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%
SUM		**144.8**	**8.66**	**100.0%**	**147.7**	**8.56**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	346	6.92	75.41%	326	6.52	73.81%
Bicarbonate [4]	0.02	344.5	6.89	75.08%	324.2	6.48	73.41%
Carbonate [4]	0.02	1.5	0.03	0.32%	1.8	0.04	0.40%
Hydroxide [4]	0.02	0.0	0.00	0.00%	0.0	0.00	0.01%
Nitrate	0.0714	0.331	0.02	0.26%	0.01	0.00	0.01%
Chloride	0.0282	5.44	0.15	1.67%	7.5	0.21	2.39%
Sulphate	0.0208	100	2.08	22.67%	101	2.10	23.78%
SUM		**452**	**9.18**	**100.0%**	**435**	**8.83**	**100.0%**
Silica (as SiO_2)		4			5		
TDS (mg/L) [2]		464			457		
TDS (mg/L) (Lab) [3]		472			462		
Ion Balance		2.88%			1.58%		
Ion Balance (Lab) [3]		-			-		

Water Type	
38D	Magnesium-Calcium-Bicarbonate
44D	Calcium-Magnesium-Bicarbonate
50D	Magnesium-Calcium-Bicarbonate
54D	Magnesium-Calcium-Bicarbonate
68D	Magnesium-Calcium-Bicarbonate
72D	Calcium-Magnesium-Bicarbonate
73D	Magnesium-Calcium-Bicarbonate
76D	Calcium-Magnesium-Bicarbonate

Notes:
"-" = No Data
1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
3. Laboratory results may slightly differ due to rounding of numbers.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

PLATES

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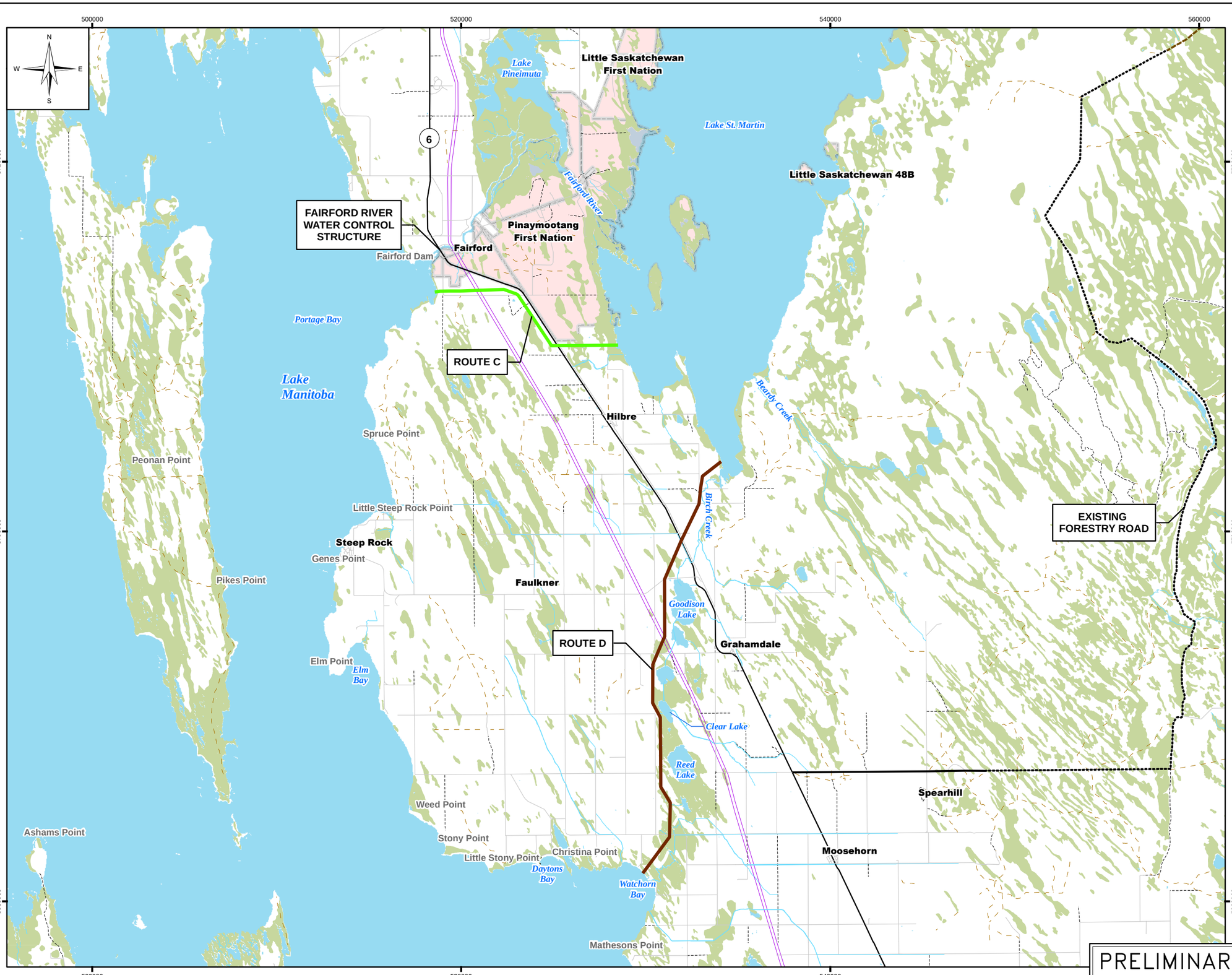

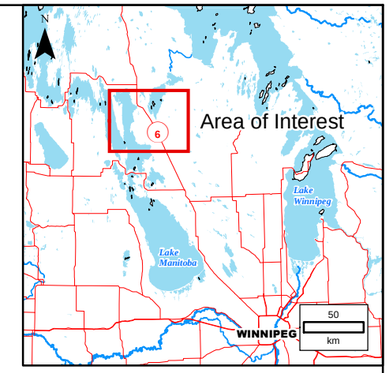

LEGEND:

- LMB Channel Option C
- LMB Channel Option D
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Wetlands
- Waterbody
- First Nation

NOTES:

1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8
Kilometres
SCALE: 1:200,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GENERAL SITE PLAN
ROUTE C AND D

MAY 2017 | PLATE D4-1 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-1_Rev0.mxd
11"x17" PLOT SCALE 1:1

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MATCHLINE

PINAYMOOTANG FIRST NATION

SEE INSET A

TH-GC02

Proposed Bridge & Road Re-alignment

TH-EC01P

TH-EC01WW1

TH-EC01WW2

4 + 000

See Note 2

TH-EC04

3 + 000

See Note 2

2 + 000

1 + 000

See Note 2

TH-GC01

Permanent Groin

0 + 0

Proposed Bridge

Temporary Cofferdam & Other Inlet Works

Lake Manitoba

INSET A

MATCHLINE

6

5717000 5716000 5715000 5714000 5713000 5712000 5711000 5710000 5709000 5708000

523000 522000 521000 520000 519000 518000 517000 516000

N

Lake Winnipeg

6

Lake St. Martin

1 2

Area of Interest

Lake Manitoba

10 km

LEGEND:

- Potential Domestic Well Location (MI ID)
- Domestic Well Location (MI ID) In Well Inventory
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- River (Intermittent)
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

NOTES:
1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers,
3. Surface Water Sample D9 from Route D represents outlet Water Quality for Route C and Route D. road realignments, privately owned structures, etc.
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0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE C

MAY 2017 | PLATE D4-2.1 | REV: 0

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-2_Rev0.mxd
11"x17" PLOT SCALE 1:1

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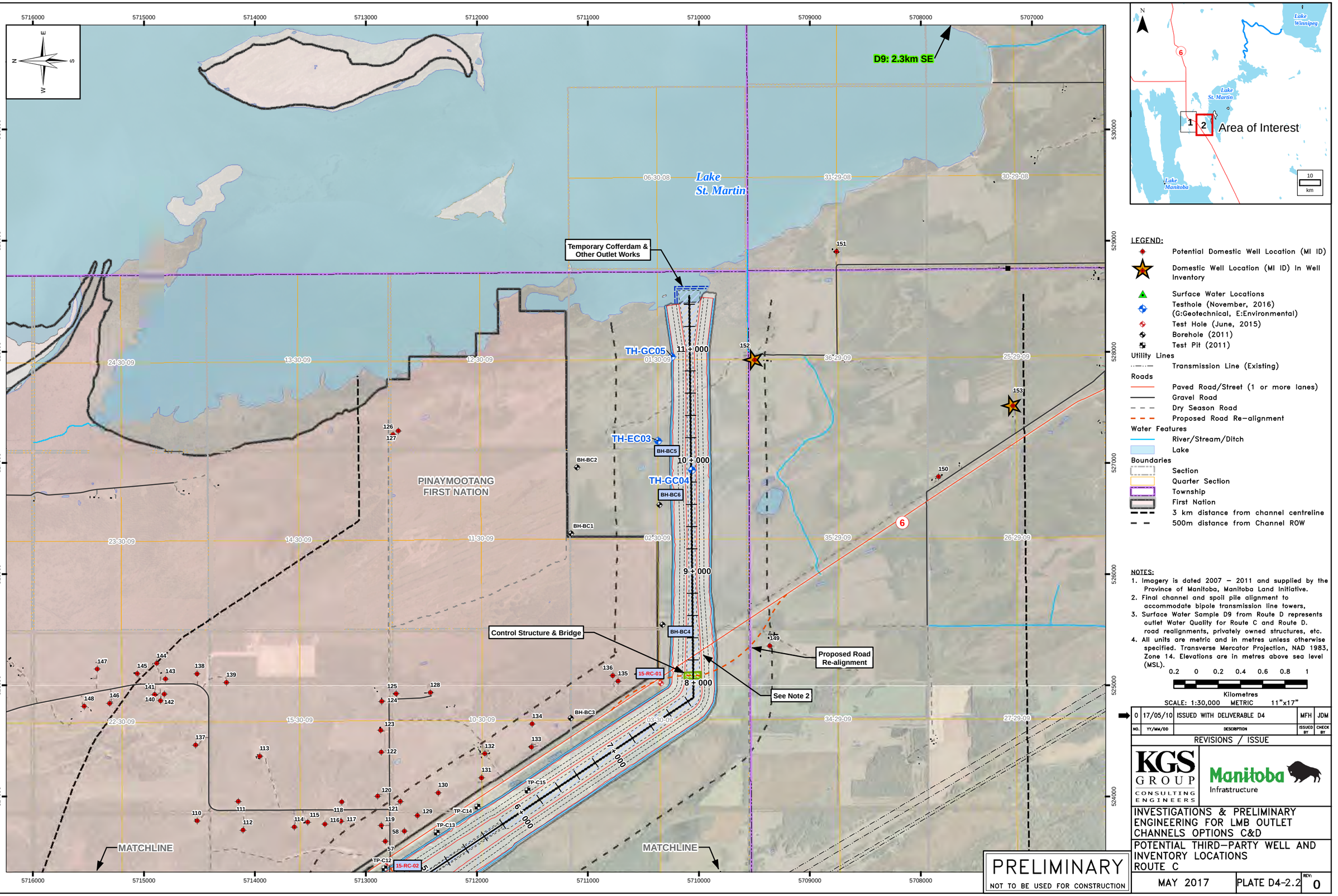

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- Domestic Well Location (MI ID) In Well Inventory
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
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- Test Pit (2011)

Utility Lines
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Roads
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- Dry Season Road
- Proposed Road Re-alignment

Water Features
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0.2 0 0.2 0.4 0.6 0.8 1
Kilometres
SCALE: 1:30,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE C

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-2.2 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-2_Rev0.mxd
11"x17" PLOT SCALE 1:1

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MATCHLINE

PINAYMOOTANG FIRST NATION

MATCHLINE

SAND AND GRAVEL

SHALE

OTHER

UNKNOWN

TH-GC02

Proposed Bridge & Road Re-alignment

TH-EC01P

TH-EC01WW1

TH-EC01WW2

4 + 000

See Note 2

TH-EC04

3 + 000

See Note 2

2 + 000

SAND AND GRAVEL

6

1 + 000

See Note 2

TH-GC01

0 + 0

Permanent Groin

Proposed Bridge

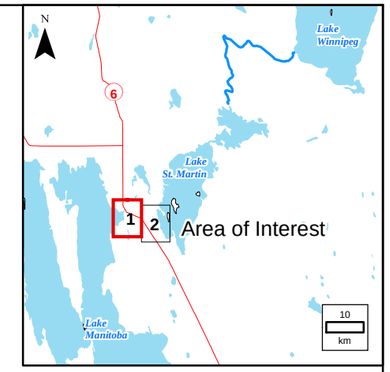
Temporary Cofferdam & Other Inlet Works

Lake Manitoba

GW_Drill

SAND AND GRAVEL — Aquifer Type (as marked, all others are limestone bedrock)

L — Well Use (L; Livestock only, LD: Livestock and Domestic, ACD: Air conditioning and Domestic. All others assumed domestic).



LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Test Pit (2011)
- 145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section
- Within Township

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

- River/Stream/Ditch
- River (Intermittent)
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

NOTES:

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0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS LOCATION, AQUIFER AND USE ROUTE C

MAY 2017 | PLATE D4-3.1 | REV: 0

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-3_Rev0.mxd
11"x17" PLOT SCALE 1:1

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D9: 2.3km SE

Temporary Cofferdam & Other Outlet Works

Control Structure & Bridge

Proposed Road Re-alignment

See Note 2

Lake St. Martin

PINAYMOOTANG FIRST NATION

MATCHLINE

MATCHLINE

TH-GC05

TH-EC03

TH-GC04

BH-BC1

BH-BC2

BH-BC3

BH-BC4

BH-BC5

BH-BC6

15-RC-01

15-RC-02

TP-C12

TP-C13

TP-C14

TP-C15

SHALE

SAND AND GRAVEL

LD

6

11 + 000

10 + 000

9 + 000

8 + 000

7 + 000

6 + 000

5 + 000

06-30-08

31-29-08

24-30-09

13-30-09

12-30-09

36-29-09

25-29-09

23-30-09

14-30-09

11-30-09

35-29-09

26-29-09

22-30-09

15-30-09

03-30-09

34-29-09

27-29-09

5716000 5715000 5714000 5713000 5712000 5711000 5710000 5709000 5708000 5707000

530000 529000 528000 527000 526000 525000 524000

GW_Drill

SAND AND GRAVEL — Aquifer Type (as marked, all others are limestone bedrock)

L — Well Use (L; Livestock only, LD: Livestock and Domestic, ACD: Air conditioning and Domestic. All others assumed domestic).

N

Lake Winnipeg

Lake St. Martin

Lake Manitoba

1 2 Area of Interest

10 km

LEGEND:

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- Test Pit (2011)

145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
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- Dry Season Road
- Proposed Road Re-alignment

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- Quarter Section
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0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

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0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS LOCATION, AQUIFER AND USE ROUTE C

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-3.2 | REV: 0

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MATCHLINE

PINAYMOOTANG FIRST NATION

SEE INSET A

MATCHLINE

TH-GC02

Proposed Bridge & Road Re-alignment

TH-EC01P

TH-EC01WW1

TH-EC01WW2

4 + 000

See Note 2

TH-EC04

3 + 000

See Note 2

2 + 000

1 + 000

See Note 2

TH-GC01

0 + 0

Permanent Groin

Proposed Bridge

Temporary Cofferdam & Other Inlet Works

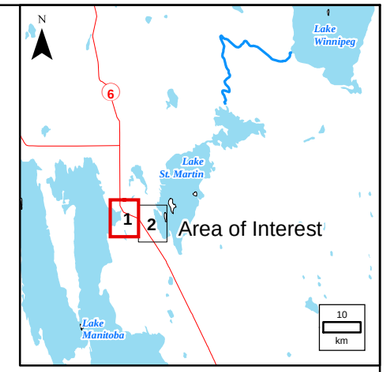
Lake Manitoba

INSET A

6

5717000 5716000 5715000 5714000 5713000 5712000 5711000 5710000 5709000 5708000

523000 522000 521000 520000 519000 518000 517000 516000



LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Test Pit (2011)

145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section
- Within Township

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

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- River (Intermittent)
- Lake

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- Quarter Section
- Township
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0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

GW_Drill – Casing Depth

- 113216, Depth: 7 — PID 0–10 m Casing Depth
- 127247, Depth: 12 — PID 10–20 Casing Depth (m)
- 33885, Depth: 23 — PID 20–30 Casing Depth (m)
- 65742, Depth: 34 — PID 30–40 Casing Depth (m)
- 180733, Depth: 53 — PID >40 Casing Depth (m)

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS
CASING DEPTH
ROUTE C

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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D9: 2.3km SE

Lake St. Martin

Temporary Cofferdam & Other Outlet Works

TH-GC05

11+000

TH-EC03

BH-BC5

10+000

TH-GC04

BH-BC6

9+000

BH-BC4

8+000

7+000

6+000

5+000

Control Structure & Bridge

Proposed Road Re-alignment

See Note 2

PINAYMOOTANG FIRST NATION

MATCHLINE

MATCHLINE

BH-BC1

BH-BC2

BH-BC3

15-RC-01

15-RC-02

TP-C12

TP-C13

TP-C14

TP-C15

06-30-08

31-29-08

30-29-08

24-30-09

13-30-09

12-30-09

36-29-09

25-29-09

23-30-09

14-30-09

11-30-09

35-29-09

26-29-09

22-30-09

15-30-09

12-30-09

34-29-09

6

53146, Depth: 10

26011, Depth: 2

38545, Depth: 4

70032, Depth: 12

48885, Depth: 5

66809, Depth: 13

62647, Depth: 7

22891, Depth: 29

73168, Depth: 3

73182, Depth: 12

70687, Depth: 15

32856, Depth: 6

6929, Depth: 2

69990, Depth: 6

113216, Depth: 7

31631, Depth: 6

12251, Depth: 7

158001, Depth: 7

159282, Depth: 7

68768, Depth: 12

180399, Depth: 18

175480, Depth: 25

180397, Depth: 25

180398, Depth: 20

180394, Depth: 12

180390, Depth: 12

180393, Depth: 9

180376, Depth: 9

180377, Depth: 18

180378, Depth: 19

180391, Depth: 10

180380, Depth: 9

169054, Depth: 6

169056, Depth: 9

169055, Depth: 6

175556, Depth: 13

175557, Depth: 18

33189, Depth: 22

80173, Depth: 11

80174, Depth: 11

180640, Depth: 18

180280, Depth: 8

38601, Depth: 12

175568, Depth: 8

175550, Depth: 6

169088, Depth: 6

169032, Depth: 17

118394, Depth: 17

50375, Depth: 12

115095, Depth: 11

115094, Depth: 12

115079, Depth: 13

115096, Depth: 13

115097, Depth: 54

76837, Depth: 37

9460, Depth: 28

13643, Depth: 6

169037

126

127

151

152

153

150

149

107

135

136

134

133

132

131

130

129

128

125

124

123

122

121

120

119

118

117

116

115

114

112

111

110

109

3019

105

1473

3016

58

57

137

113

147

148

146

145

144

143

142

141

140

139

138

Lake Winnipeg

Lake St. Martin

Lake Manitoba

1

2

Area of Interest

10 km

LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

NOTES:

1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. Surface Water Sample D9 from Route D represents outlet Water Quality for Route C and Route D. road realignments, privately owned structures, etc.
4. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

GW_Drill – Casing Depth

- 113216, Depth: 7 — PID 0–10 m Casing Depth
- 127247, Depth: 12 — PID 10–20 Casing Depth (m)
- 33885, Depth: 23 — PID 20–30 Casing Depth (m)
- 65742, Depth: 34 — PID 30–40 Casing Depth (m)
- 180733, Depth: 53 — PID >40 Casing Depth (m)

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS CASING DEPTH ROUTE C

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-4.2 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\WX0\Rev0\D4_TDR\16-0300-006_Plate_D4-4_Rev0.mxd 11"x17" PLOT SCALE 1:1

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MATCHLINE

PINAYMOOTANG FIRST NATION

SEE INSET A

MATCHLINE

TH-GC02

Proposed Bridge & Road Re-alignment

TH-EC01P

TH-EC01W,W1

TH-EC01WW2

4 + 000

See Note 2

TH-EC04

3 + 000

See Note 2

2 + 000

1 + 000

See Note 2

TH-GC01

0 + 0

Permanent Groin

Proposed Bridge

Temporary Cofferdam & Other Inlet Works

Lake Manitoba

INSET A

6

Transmissivity (USgpd/ft)

33885, T:480	PID 0–1,000
180642, T:1263	PID 1,000–5,000
12291, T:8404	PID 5,000–15,000
69970, T:28503	PID 15,000–50,000
104473, T: 55933	PID > 50,000

N

Lake Winnipeg

Lake St. Martin

Lake Manitoba

6

1 2

Area of Interest

10 km

LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Test Pit (2011)
- 145385 GW_Drill – PID

ACCURACY

- 1 Exact [<5M] [GPS]
- [Within 1/4–Section]
- [Within Section]

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

- River/Stream/Ditch
- River (Intermittent)
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

NOTES:

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0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

ESTIMATED AQUIFER TRANSMISSIVITY ROUTE C

MAY 2017 | PLATE D4-5.1 | REV: 0

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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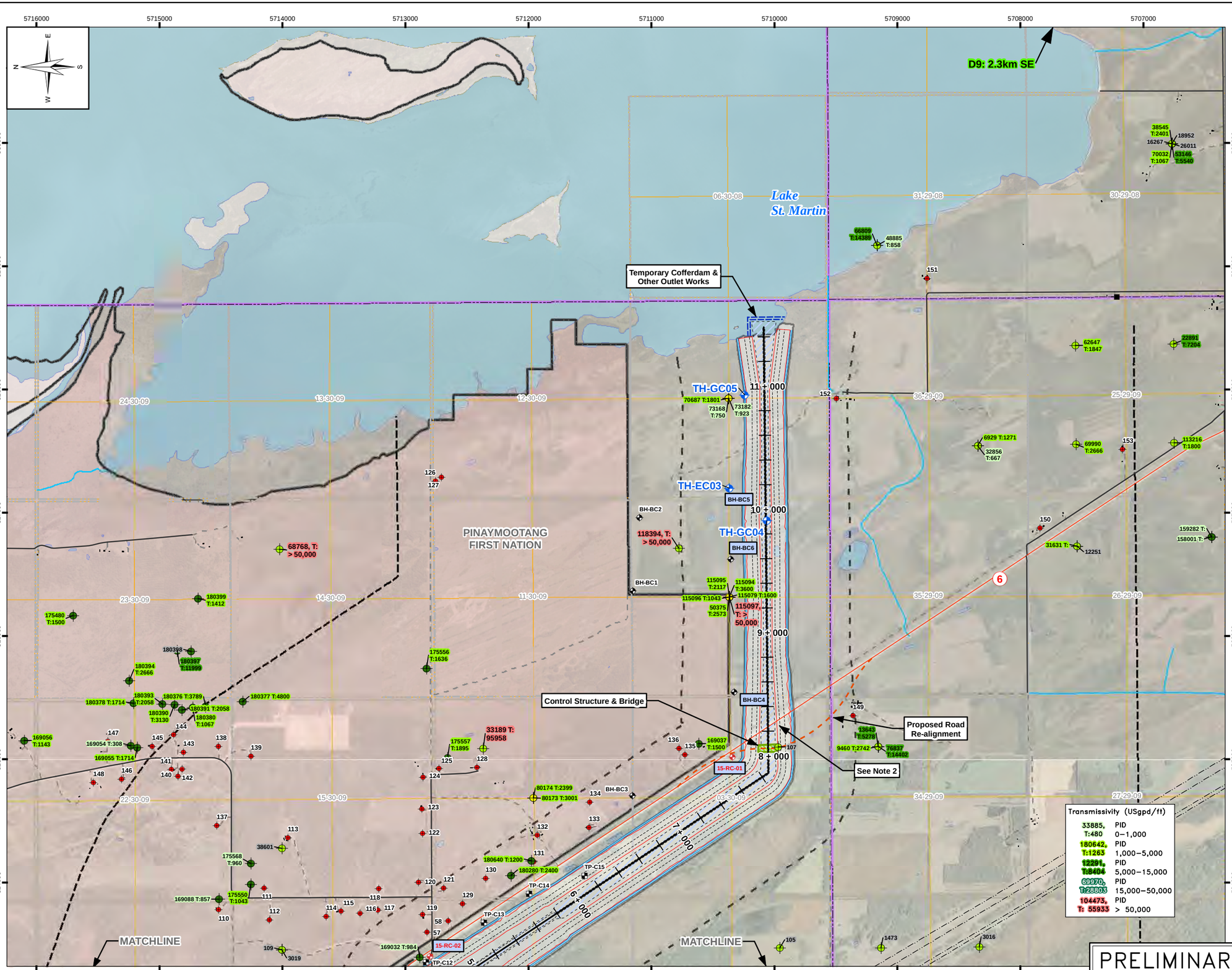

LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

145385 GW_Drill – PID

ACCURACY

- 1 Exact [<5M] [GPS]
- [Within 1/4–Section]
- [Within Section]

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

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0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

ESTIMATED AQUIFER TRANSMISSIVITY ROUTE C

MAY 2017 | PLATE D4-5.2 | REV: 0

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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MATCHLINE

MATCHLINE

Lemiez Ponds

Reed Lake

Water Lake

Clear Lake

Watchorn Creek

Mercer Creek

Lake Manitoba (Watchorn Bay)

Watchorn Provincial Park

TH-ED01PP2

TH-ED01PP1

TH-ED01P

TH-ED01W

D3

D4

TH-GD02

Proposed Bridge

15-RD-01

See Note 2

Cemetery

Permanent Groin

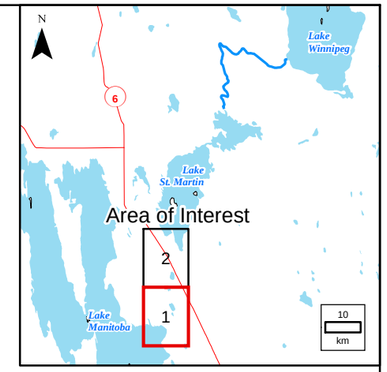
Temporary Cofferdam & Other Inlet Works

Permanent Groin

TP-D16 TP-D17 TP-D18 TP-D19 TP-D20 TP-D21 TP-D22 TP-D23 TP-D24 TP-D25 TP-D26 TP-D27 TP-D28 TP-D29 TP-D30 TP-D31

BH-D100 BH-D101 BH-D102 BH-D104 BH-D105 BH-D106 BH-D107 BH-D108 BH-D109

10+000 11+000 8+000 7+000 6+000 5+000 4+000 3+000 2+000 1+000 0+000



LEGEND:

- Potential Domestic Well Location (MI ID)
- Domestic Well Location (MI ID) In Well Inventory
- Surface Water Locations
- Logger (November, 2016)
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:
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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

MAY 2017 | PLATE D4-6.1 | REV: 0

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11"x17" PLOT SCALE 1:1

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Temporary Cofferdam & Other Outlet Works
Birch Creek
Lake St. Martin
TH-GD08
See Note 2
Proposed Bridge
Control Structure & Bridge
Proposed Road Re-alignment
TH-GD07
Clarks Drain
Goodison Lake
Proposed Bridge & Road Re-alignment
TH-GD05
TH-GD06
Woodale Drain
TH-ED03
MATCHLINE
Lake Winnipeg
Lake Manitoba
Area of Interest
D5
D6
D7
D8
D9
239
6

LEGEND:

- Potential Domestic Well Location (MI ID)
- Domestic Well Location (MI ID) In Well Inventory
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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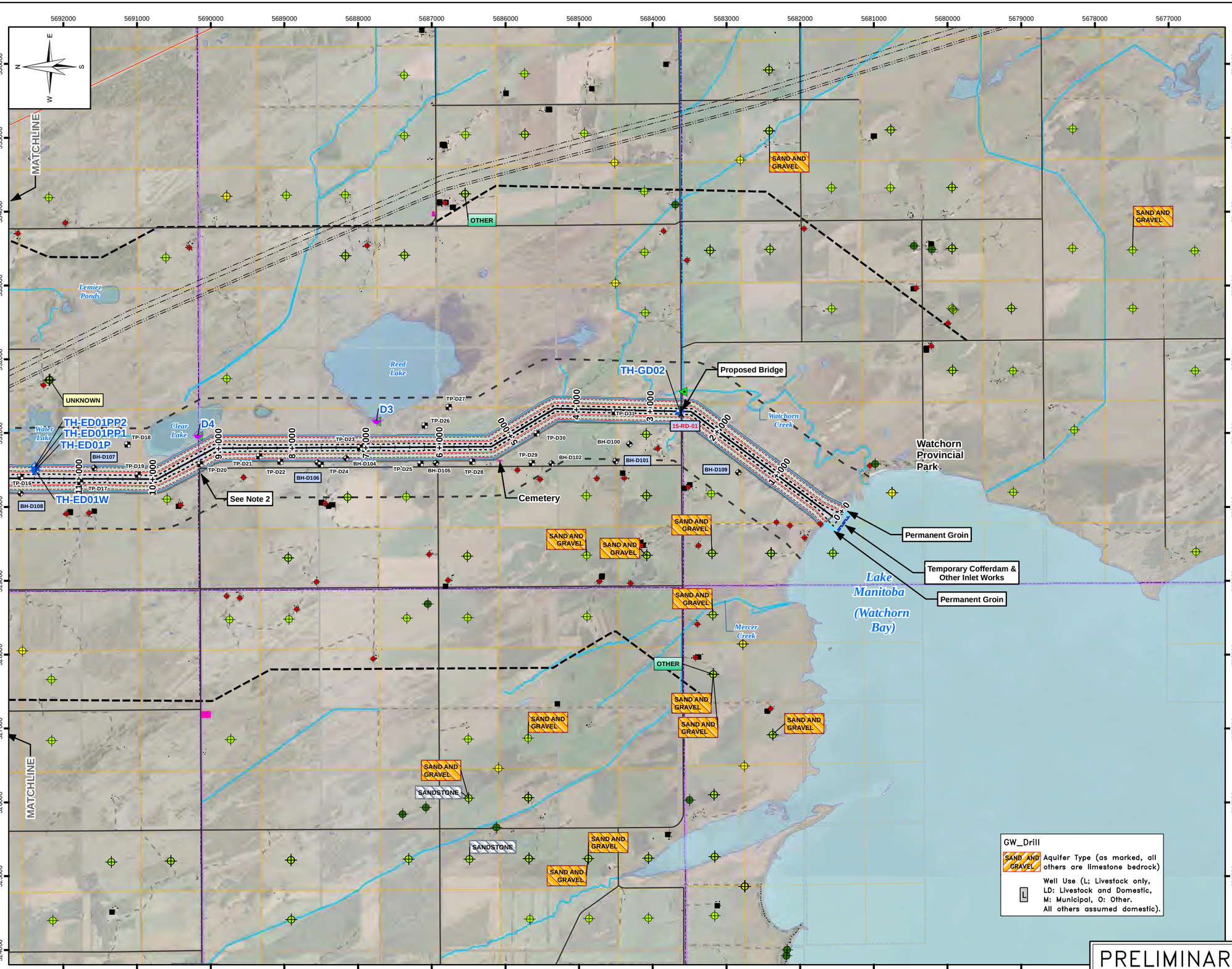

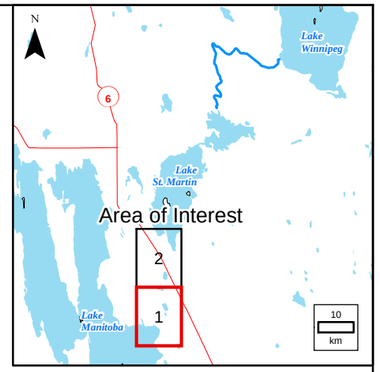

LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Logger (November, 2016)
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

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0.5 0 0.5 1 1.5 2

Kilometres

SCALE: 1:50,000 METRIC 11"x17"

GW_Drill

SAND AND GRAVEL — Aquifer Type (as marked, all others are limestone bedrock)

L — Well Use (L: Livestock only, LD: Livestock and Domestic, M: Municipal, O: Other. All others assumed domestic).

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS LOCATION, AQUIFER AND USE ROUTE D

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-7.1 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-7_Rev0.mxd 11"x17" PLOT SCALE 1:1

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Temporary Cofferdam & Other Outlet Works
Birch Creek
Lake St. Martin
SAND AND GRAVEL
TH-GD08
Proposed Bridge
See Note 2
Control Structure & Bridge
TH-GD07
TH-GD06
TH-GD05
TH-ED03
Proposed Road Re-alignment
Proposed Bridge & Road Re-alignment
Proposed Bridge
Clarks Drain
Goodison Lake
Woodale Drain
MATCHLINE
SHALE
SANDSTONE
239
D5
D6
D7
D8
D9
6
15-RD-04
15-RD-05
15-RD-10A
15-RD-03
15-RD-03A
15-RD-02
15-RD-02A
BH-D1
BH-D2
BH-D3
BH-D4
BH-D5
BH-D6
BH-D7
BH-D8
BH-D9
TP-D1
TP-D2
TP-D3
TP-D4
TP-D4a
TP-D5
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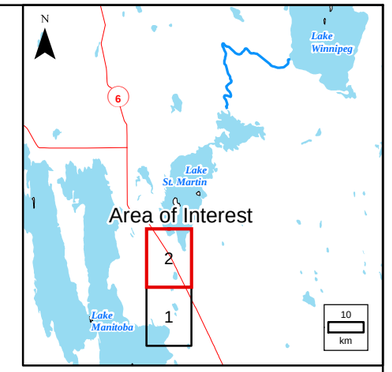
TP-D14
TP-D15



LEGEND:

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- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
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145385 GW_Drill – PID

GW_Drill Accuracy

- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

GW_Drill

SAND AND GRAVEL — Aquifer Type (as marked, all others are limestone bedrock)

L — Well Use (L; Livestock only, LD: Livestock and Domestic, M: Municipal, O: Other. All others assumed domestic).

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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS
LOCATION, AQUIFER AND USE
ROUTE D

MAY 2017 | PLATE D4-7.2 | REV: 0

PRELIMINARY
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FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-7_Rev0.mxd
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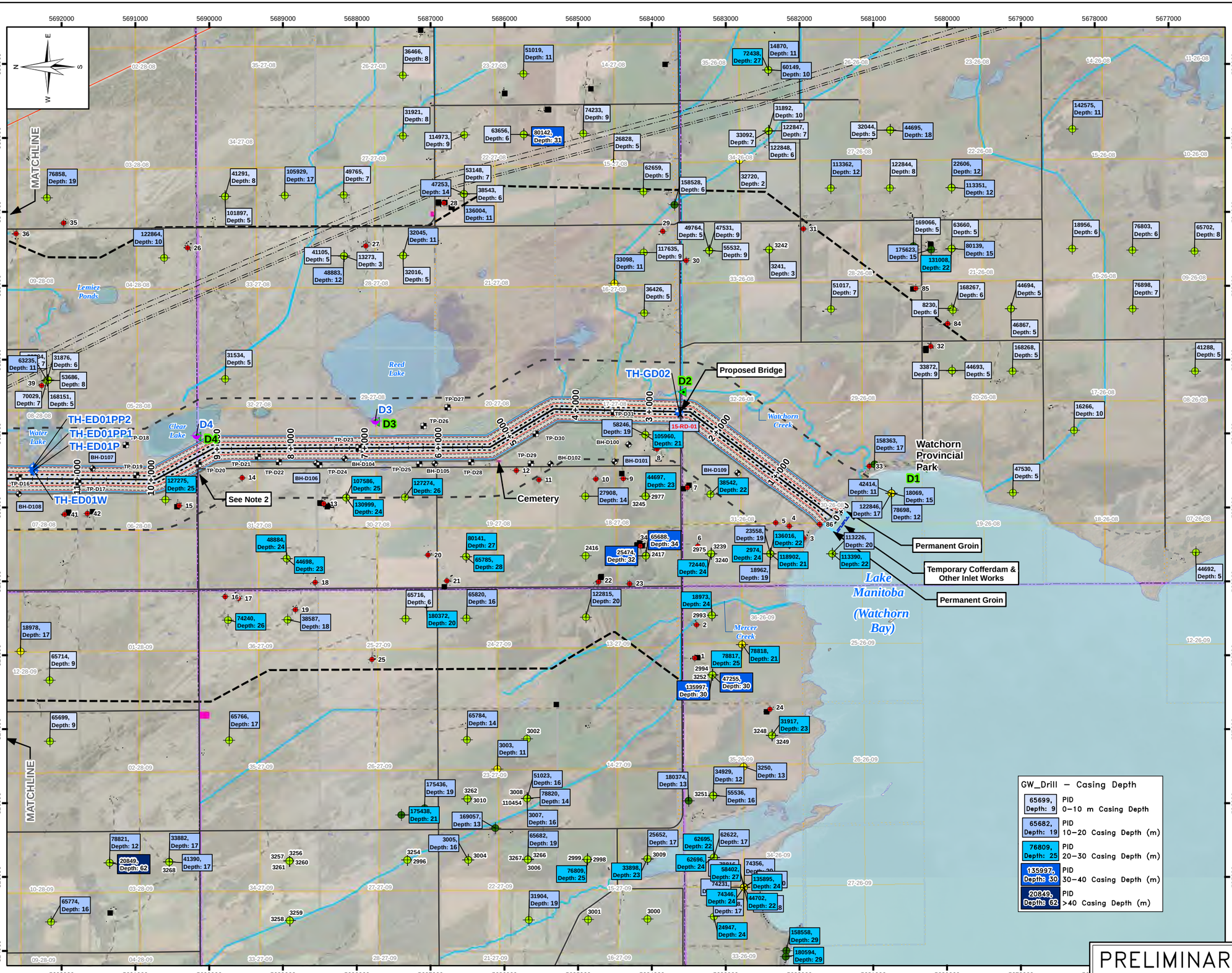

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Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
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- 500m distance from Channel ROW

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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

GW_Drill – Casing Depth

65699, Depth: 9	PID 0–10 m Casing Depth
65682, Depth: 19	PID 10–20 Casing Depth (m)
76809, Depth: 25	PID 20–30 Casing Depth (m)
135997, Depth: 30	PID 30–40 Casing Depth (m)
20849, Depth: 62	PID >40 Casing Depth (m)

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS
CASING DEPTH
ROUTE D

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-8.1 | REV: 0

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11"x17" PLOT SCALE 1:1

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Temporary Cofferdam & Other Outlet Works
Birch Creek
Lake St. Martin
TH-GD08
See Note 2
Proposed Bridge
Control Structure & Bridge
TH-GD07
Clarks Drain
Birch Creek
Goodison Lake
Proposed Bridge & Road Re-alignment
TH-GD05
Proposed Bridge
Proposed Road Re-alignment
Woodale Drain
TH-GD06
See Note 2
TH-ED03
MATCHLINE
239
6
24+000
23+000
22+000
21+000
20+000
19+000
18+000
17+000
16+000
15+000
14+000
13+000
12+000
BH-D4
TP-D1
BH-D3
TP-D2
BH-D5
15-RD-05
TP-D3
TP-D4a
BH-D1
TP-D5
TP-D4
BH-D2
15-RD-04
BH-D6
TP-D7
TP-D6
TP-D8
BH-D7
15-RD-10A
15-RD-03
15-RD-03A
TP-D9
TP-D10
BH-D8
TP-D11
TP-D12
TP-D13
TP-D14
BH-D9
15-RD-02
TP-D15
15-RD-02A

Area of Interest
Lake Winnipeg
Lake St. Martin
Lake Manitoba
10 km

LEGEND:
- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

145385 GW_Drill – PID

GW_Drill Accuracy
- 1 Exact [<5m] [GPS]
- Within 1/4–Section
- Within Section

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:
1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

GW_Drill – Casing Depth

65699, Depth: 9	PID 0–10 m Casing Depth
65682, Depth: 19	PID 10–20 Casing Depth (m)
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20849, Depth: 62	PID >40 Casing Depth (m)

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GW DRILL LOGS
CASING DEPTH
ROUTE D

PRELIMINARY
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MAY 2017 | PLATE D4-8.2 | REV: 0

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MATCHLINE

MATCHLINE

Lemiez Ponds

Reed Lake

Clear Lake

Water Lake

Watchorn Creek

Mercer Creek

Lake Manitoba (Watchorn Bay)

Watchorn Provincial Park

TH-ED01PP2

TH-ED01PP1

TH-ED01P

TH-ED01W

D3

D4

TH-GD02

15-RD-01

BH-D107

BH-D108

BH-D106

BH-D104

BH-D105

BH-D100

BH-D101

BH-D102

BH-D109

TP-D16

TP-D17

TP-D18

TP-D19

TP-D20

TP-D21

TP-D22

TP-D23

TP-D24

TP-D25

TP-D26

TP-D27

TP-D28

TP-D29

TP-D30

TP-D31

Proposed Bridge

See Note 2

Cemetery

Permanent Groin

Temporary Cofferdam & Other Inlet Works

Permanent Groin

Area of Interest

Lake Winnipeg

Lake St. Martin

Lake Manitoba

10 km

LEGEND:

- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Logger (November, 2016)
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June 2015)
- Borehole (2011)
- Test Pit (2011)

145385 GW_Drill – PID

ACCURACY

- 1 Exact [<5M] [GPS]
- [Within 1/4–Section]
- [Within Section]

Utility Lines

- Transmission Line (Existing)

Roads

- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re–alignment

Water Features

- River/Stream/Ditch
- Lake

Boundaries

- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:

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3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.5 0 0.5 1 1.5 2

Kilometres

SCALE: 1:50,000 METRIC 11"x17"

Transmissivity (USgpd/ft)

41105, T:924	PID 0–1,000
105929, T:1655	PID 1,000–5,000
114973, T:10908	PID 5,000–15,000
136004, T:20569	PID 15,000–50,000
101897, T:143985	PID > 50,000

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

ESTIMATED AQUIFER TRANSMISSIVITY ROUTE D

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-9.1 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\RevA\D4_TDR\16-0300-006_Plate_D4-9.mxd 11"x17" PLOT SCALE 1:1

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Temporary Cofferdam & Other Outlet Works
Birch Creek
Lake St. Martin
TH-GD08
See Note 2
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Proposed Road Re-alignment
Proposed Bridge & Road Re-alignment
TH-GD05
TH-GD06
TH-ED03
MATCHLINE
Clarks Drain
Goodison Lake
Woodale Drain
D5
D6
D7
D8
D9
6
239
Area of Interest
Lake Winnipeg
Lake St Martin
Lake Manitoba

LEGEND:
- Potential Domestic Well Location (MI ID)
- Surface Water Locations
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June 2015)
- Borehole (2011)
- Test Pit (2011)
- 145385 GW_Drill – PID
- ACCURACY
  - 1 Exact [<5M] [GPS]
  - [Within 1/4–Section]
  - [Within Section]
- Utility Lines
  - Transmission Line (Existing)
- Roads
  - Paved Road/Street (1 or more lanes)
  - Gravel Road
  - Dry Season Road
  - Proposed Road Re-alignment
- Water Features
  - River/Stream/Ditch
  - Lake
- Boundaries
  - Section
  - Quarter Section
  - Township
  - First Nation
  - 3 km channel buffer
  - 500m distance from Channel ROW

NOTES:
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0.5 0 0.5 1 1.5 2
Kilometres
SCALE: 1:50,000 METRIC 11"x17"

Transmissivity (USgpd/ft)

41105, T:924	PID	0–1,000
105929, T:1655	PID	1,000–5,000
114973, T:10908	PID	5,000–15,000
136004, T:20569	PID	15,000–50,000
101897, T:143985	PID	> 50,000

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D4	MFH	JDM

REVISIONS / ISSUE

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

ESTIMATED AQUIFER TRANSMISSIVITY ROUTE D

MAY 2017 | PLATE D4-9.2 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

APPENDIX D4-A

REGIONAL INFORMATION ROUTE C

TABLE D4-A1
ROUTE C SUMMARY WELL COUNT

		500 m Distance from Channel ROW	3 km Distance from Channel Centreline [2]	Comments
No. of Potential Wells Based on Residence Locations from Imagery [1]		29	137	
No. of GW Drill Logs		24	96	Well groups located to township are excluded.
No. of GW Drill Logs with Well Use	Domestic Only	21	85	
	Livestock and Domestic	0	1	
	Livestock Only	2	9	
	Other	0	0	
	Air Conditioning and Domestic	1	1	
No. of Non-Limestone Wells	Sand and Gravel	4	6	
	Sandstone	0	0	
	Shale	1	1	
	Unknown	0	2	
No. of GW Drill Logs with Casing Depth in Range	0-10 m	10	43	
	10-20 m	10	33	
	20-30 m	0	4	
	30-40 m	0	1	
	>40 m	1	2	
No. of GW Drill Logs with Transmissivity in Range	0-1000 USgpd/ft	5	24	
	1000-5000 USgpd/ft	15	49	
	5000-15000 USgpd/ft	1	4	
	15000-50000 USgpd/ft	0	1	
	>50000 USgpd/ft	1	3	

Notes:
1. Number of residences/buildings estimated from imagery and has not been confirmed in the field.
2. 3 km disance from channel centreline includes wells at 500 m distance from channel ROW.

APPENDIX D4-B

WELL LOG MATCHING ROUTE C

Table D4 B-1
GW Drill Logs Near Identified Properties - Route C

MI Well #	Northing	Easting	Land Location	MI Ownership Map Information		Potential Ownership to be Confirmed [1]	GW Drill Database
				Landowner	Description	Landowner	Proximal Wells
8	518945	5714308	NE 1/4 13-30-10			Pinaymootang First Nation	18064.2
11	519629	5712705	NW 1/4 07-30-09			0	No logs in quarter section
12	519950	5712668	NE 1/4 07-30-09				12252
13	520191	5712689	NE 1/4 07-30-09				106
15	519559	5714230	NE 1/4 18-30-09			Pinaymootang First Nation	72448 123855 123856
16	519580	5714514	SW 1/4 19-30-09				113381 123837 123849 123850
17	519698	5714538	SW 1/4 19-30-09				
50	520532	5714189	NE 1/4 18-30-09				72448 123855 123856
51	520613	5714239	NE 1/4 18-30-09				
24	520905	5715904	NW 1/4 20-30-09			N/A	No logs coordinate with location
38	521663	5715792	NE 1/4 20-30-09			Pinaymootang First Nation	1488.8
52	521925	5713674	NE 1/4 17-30-09			Pinaymootang First Nation	8017.5
53	522305	5713583	SW 1/4 16-30-09				No logs coordinate with location
54	522366	5713492	SW 1/4 16-30-09				17555.9
55	522583	5713432	SW 1/4 16-30-09				No logs coordinate with location
56	522690	5713426	SW 1/4 16-30-09				No logs coordinate with location
109	521791	5713684	NE 1/4 17-30-09				8017.5
57	523598	5712825	SE 1/4 16-30-09			Pinaymootang First Nation	No logs coordinate with location
58	523690	5712652	NE 1/4 09-30-09				
59	523180	5713158	SE 1/4 16-30-09				
60	523059	5713330	SW 1/4 16-30-09				

Table D4 B-1
GW Drill Logs Near Identified Properties - Route C

MI Well #	Northing	Easting	Land Location	MI Ownership Map Information		Potential Ownership to be Confirmed [1]	GW Drill Database
				Landowner	Description	Landowner	Proximal Wells
65	522136	5714569	SE 1/4 20-30-09			Pinaymootang First Nation	158054 158055 158339 158340 158572 158573 158574 159284 159285 160237 160240 160241 160242 160243 160253
66	522076	5714526	SE 1/4 20-30-09				
67	522135	5714500	SE 1/4 20-30-09				
68	522079	5714458	SE 1/4 20-30-09				
69	521908	5714719	SE 1/4 20-30-09				
70	521877	5714657	SE 1/4 20-30-09				
71	521946	5714659	SE 1/4 20-30-09				
72	521922	5714597	SE 1/4 20-30-09				
73	521981	5714596	SE 1/4 20-30-09				
74	521962	5714543	SE 1/4 20-30-09				
75	521991	5714462	SE 1/4 20-30-09				
76	521953	5714446	SE 1/4 20-30-09				
77	521923	5714417	NE 1/4 17-30-09				
78	521954	5714370	NE 1/4 17-30-09				
79	521894	5714386	NE 1/4 17-30-09				
80	521883	5714352	NE 1/4 17-30-09				
81	521929	5714334	NE 1/4 17-30-09				
82	521870	5714313	NE 1/4 17-30-09				
83	521921	5714300	NE 1/4 17-30-09				
84	521858	5714283	NE 1/4 17-30-09				
85	521909	5714262	NE 1/4 17-30-09				
86	521846	5714243	NE 1/4 17-30-09				
87	521893	5714228	NE 1/4 17-30-09				
88	521828	5714214	NE 1/4 17-30-09				
89	521883	5714196	NE 1/4 17-30-09				
90	521819	5714176	NE 1/4 17-30-09				
91	521870	5714161	NE 1/4 17-30-09				
92	521809	5714144	NE 1/4 17-30-09				
93	521861	5714127	NE 1/4 17-30-09				
94	521794	5714109	NE 1/4 17-30-09				
95	521844	5714094	NE 1/4 17-30-09				
96	521780	5714076	NE 1/4 17-30-09				
97	521832	5714052	NE 1/4 17-30-09				
98	521771	5714041	NE 1/4 17-30-09				
99	521825	5714022	NE 1/4 17-30-09				
100	521757	5714008	NE 1/4 17-30-09				
101	521804	5713987	NE 1/4 17-30-09				
102	521748	5713971	NE 1/4 17-30-09				
103	521798	5713953	NE 1/4 17-30-09				
104	521732	5713936	NE 1/4 17-30-09				
105	521783	5713919	NE 1/4 17-30-09				
106	521719	5713903	NE 1/4 17-30-09				
107	521767	5713884	NE 1/4 17-30-09				
108	521713	5713870	NE 1/4 17-30-09				

Table D4 B-1
GW Drill Logs Near Identified Properties - Route C

MI Well #	Northing	Easting	Land Location	MI Ownership Map Information		Potential Ownership to be Confirmed [1]	GW Drill Database
				Landowner	Description	Landowner	Proximal Wells
131	524170	5711958	SW 1/4 10-30-09			Pinaymootang First Nation	18064
132	524385	5711928	SW 1/4 10-30-09				80173
133	524447	5711508	SW 1/4 10-30-09				80174
135	525038	5710728	NE 1/4 03-30-09			Pinaymootang First Nation	16903.7
136	525089	5710777	NE 1/4 03-30-09			Pinaymootang First Nation	16903.7
138	525106	5714520	SE 1/4 22-30-09			Pinaymootang First Nation	No logs coordinate with location
140	524863	5714849	SE 1/4 22-30-09				
141	524918	5714903	SE 1/4 22-30-09				
142	524921	5714816	SE 1/4 22-30-09				
143	525060	5714805	SE 1/4 22-30-09				
144	525200	5714885	SE 1/4 22-30-09				
149	525354	5709361	NE 1/4 34-29-09				7683.7
150	526877	5707840	SW 1/4 25-29-09				1225.1
153	527516	5707169	NW 1/4 26-29-09				6999
152	527929	5709496	NW 1/4 36-29-09				No logs coordinate with location
Near TH-EC-03			SW 1/4 01-30-09		North 1/2 sec 1-30-9W		73168 73182 70687

Notes:
1 - Land Ownership Map

APPENDIX D4-C

CALCULATED SPECIFIC CAPACITY AND TRANSMISSIVITY ROUTE C

Table D4-C
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level End (m)	Pump Rate (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft)[1]	Calculation Notes/ Assumptions
6926	C	29-29-9W	-0.914	-5.486	3.788	2:00:00	0.829	4.000	8000	
6929	CD	SW-36-29-9W	-2.743	-7.925	0.682	2:00:00	0.132	0.635	1271	
6931	C	9-30-9W	-0.61	-5.182	3.031	2:10:00	0.663	3.201	6401	
9460	CD	NE-34-29-9W	-8.534	-10.668	0.606	3:30:00	0.284	1.371	2742	
9461	C	SW-30-30-9W	-2.438	-4.267	1.515	4:00:00	0.828	3.999	7998	
12252	C	NE7-30- 09W	-2.743	-6.096	0.53	5:00:00	0.158	0.763	1526	
12291	C	NE-24-30-10W	-4.877	-6.096	1.061	4:30:00	0.870	4.202	8404	
13643	CD	NE-34-29-9W	-2.438	-3.962	0.833	4:30:00	0.547	2.639	5278	
14888	C	NE-20-30-9W	-4.572	-7.01	3.788	6:15:00	1.554	7.501	15003	
22891	CD	SE-25-29-9W	-7.62	-9.144	1.137	15:45:00	0.746	3.602	7204	
32856	CD	SW-36-29-9W	-3.658	-9.144	0.379	1:00:00	0.069	0.334	667	
33189	C	NE-10-30-9W	-3.353	-3.658	3.031	1:00:00	9.938	47.979	95958	
33885	C	SE-25-30-10W	-4.572	-10.668	0.303	6:00:00	0.050	0.240	480	
38545	CD	SE30-29- 08W	-3.048	-7.62	1.137	1:00:00	0.249	1.201	2401	
47259	C	1-30- 10W	-0.914	-4.572	2.652	3:00:00	0.725	3.500	7000	
48885	CD	NW31-29-8W	0	-8.534	0.758	1:00:00	0.089	0.429	858	
50375	C	2-30- 09W	-2.743	-7.01	1.137	1:00:00	0.266	1.286	2573	
53146	CD	SE30-29- 08W	-0.61	-4.572	2.273	1:00:00	0.574	2.770	5540	
58266	C	SE30-30- 09W	-4.572	-2.438	0.758	12:00:00	0.355	1.715	3430	
62647	CD	NE25-29- 09W	-4.572	-8.534	0.758	1:00:00	0.191	0.924	1847	
65690	C	SW8-30- 09W	-5.486	-6.401	0.379	1:00:00	0.414	2.000	4000	
65691	C	NW4-30- 09W	-7.01	-13.716	1.137	1:00:00	0.170	0.819	1637	
66809	CD	NW-31-29-8W	-4.267	-4.877	0.909	1:10:00	1.490	7.195	14389	
68768	C	NE-14-30-9W	-2.438	-2.438	0.985	:30:00	19.700	95.112	190223	Assume 0.05 m drawdown occurred. Calculated transmissivity is a low end estimate. Represent at >50,000 on figures.
69970	C	1-30- 10W	0	-1.524	4.546	1:00:00	2.983	14.402	28803	
69990	CD	NW25-29- 09W	-2.438	-7.925	1.515	1:00:00	0.276	1.333	2666	
70032	CD	SE30-29- 08W	-3.353	-11.582	0.909	1:00:00	0.110	0.533	1067	
70687	C	1-30-9W	-1.219	-7.315	1.137	2:00:00	0.187	0.900	1801	
72448	C	18-30- 09W	0	-8.23	0.758	1:00:00	0.092	0.445	889	
72452	C	SW17-30- 09W	-3.048	-6.096	0.758	1:00:00	0.249	1.201	2401	
73168	C	1-30-9W	-4.267	-9.144	0.379	2:00:00	0.078	0.375	750	
73182	C	1-30-9W	-2.743	-6.706	0.379	1:00:00	0.096	0.462	923	
76837	CD	NE34-29- 09W	-4.572	-6.096	2.273	1:00:00	1.491	7.201	14402	
76887	C	NW6-30- 09W	-3.658	-8.23	0.606	1:00:00	0.133	0.640	1280	
80173	C	10-30- 09W	-5.791	-8.23	0.758	1:00:00	0.311	1.500	3001	
80174	C	10-30- 09W	-4.572	-8.23	0.909	1:00:00	0.248	1.200	2399	
80175	C	17-30- 09W	-3.048	-7.62	1.515	1:00:00	0.331	1.600	3200	
104473	C	NE23-30-10W	0.153	-0.305	2.653	1:00:00	5.793	27.967	55933	
107845	C	1-30-10W	0.915	-2.44	4.548	1:00:00	1.356	6.545	13090	
113216	CD	SW25-29-9W	0	-6.1	1.137	1:00:00	0.186	0.900	1800	
113381	C	SW19-30-9W	-1.22	-18.3	0.758	1:00:00	0.044	0.214	429	

Table D4-C
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level End (m)	Pump Rate (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft)[1]	Calculation Notes/ Assumptions
115079	C	2-30-9W	-4.575	-9.15	0.758	1	0.166	0.800	1600	
115094	C	2-30-9W	-9.15	-12.2	1.137	1	0.373	1.800	3600	
115095	C	2-30-9W	-2.44	-7.625	1.137	1	0.219	1.059	2117	
115096	C	2-30-9W	-1.22	-8.235	0.758	1	0.108	0.522	1043	
115097	C	2-30-9W	-0.915	-0.915	4.548	1	90.960	439.155	878310	Assume 0.05 m drawdown occurred. Calculated transmissivity is a low end estimate. Represent at >50,000 on figures.
118394	C	NE2-30-9W	-0.305	-0.305	2.274		45.480	219.577	439155	Assume 0.05 m drawdown occurred. Calculated transmissivity is a low end estimate. Represent at >50,000 on figures.
118930	C	SE29-30-9W	-1.22	-7.625	1.516		0.237	1.143	2285	
123837	C	19-30-9W	-4.27	-9.15	0.758		0.155	0.750	1500	
123849	C	19-30-9W	-4.575	-10.675	0.758		0.124	0.600	1200	
123850	C	19-30-9W	-6.405	-10.675	0.758		0.178	0.857	1714	
123855	C	18-30-9W	-10.675	-15.25	0.91		0.199	0.960	1921	
123856	C	18-30-9W	-3.965	-9.15	0.91		0.176	0.847	1695	
127247	C	SE30-30-9W	-3.66	-7.625	0.531		0.134	0.647	1293	
158052	C	NW19-30-9W	-2.745	-12.2	1.137		0.120	0.581	1161	
158054	C	SE20-30-9W	-3.05	-9.15	1.516		0.249	1.200	2400	
158055	C	NE17-30-9W	-7.015	-10.675	1.516		0.414	2.000	4000	
158339	C	SE20-30-9W	-3.66	-9.15	0.379		0.069	0.333	667	
158340	C	SE20-30-9W	-3.66	-12.2	0.379		0.044	0.214	429	
158572	C	SE20-30-9W	-0.915	-9.15	0.758		0.092	0.444	889	
158573	C	SE20-30-9W	-2.44	-30.5	0.379		0.014	0.065	130	
158574	C	SE20-30-9W	0.61	-7.625	0.758		0.092	0.444	889	
159283	C	NW19-30-9W	-2.745	-12.2	1.137		0.120	0.581	1161	
159284	C	SE20-30-9W	-3.05	-9.15	1.516		0.249	1.200	2400	
159285	C	NE17-30-9W	-7.015	-10.675	1.516		0.414	2.000	4000	
160237	C	SE20-30-9W	-2.44	-7.625	0.758		0.146	0.706	1412	
160240	C	SE20-30-9W	-2.44	-9.15	0.758		0.113	0.545	1091	
160241	C	SE20-30-9W	-2.44	-15.25	1.137		0.089	0.429	857	
160242	C	SE20-30-9W	-2.44	-9.15	0.758		0.113	0.545	1091	
160243	C	SE20-30-9W	-3.66	-9.15	0.758		0.138	0.667	1333	
160253	C	SE20-30-9W	-2.44	-7.625	0.758		0.146	0.706	1412	
167451	C	-30-9W	-8.235	-12.2	0.758		0.191	0.923	1846	
168084	C	-30-9W	-1.373	-8.235	0.493		0.072	0.347	694	
169032	C	SE16-30-9W	-5.795	-24.4	1.895	1:00:00	0.102	0.492	984	
169037	C	NE3-30-9W	-4.88	-12.2	1.137		0.155	0.750	1500	
169054	C	NE22-30-9W	-5.185	-28.975	0.758	1:00:00	0.032	0.154	308	
169055	C	SE22-30-9W	-4.88	-9.15	0.758	1:00:00	0.178	0.857	1714	
169056	C	SE27-30-9W	-5.795	-12.2	0.758	1:00:00	0.118	0.571	1143	
169083	C	SW29-30-9W	-4.575	-12.2	0.91	1:00:00	0.119	0.576	1152	
169084	C	SW29-30-9W	-4.575	-10.675	0.758	1:00:00	0.124	0.600	1200	
169086	C	SW29-30-9W	-2.44	-9.15	0.91	1:00:00	0.136	0.655	1310	
169088	C	SW22-30-9W	-3.66	-12.2	0.758	1:00:00	0.089	0.429	857	
175479	C	SE20-30-9W	-2.44	-12.2	0.758	1:00:00	0.078	0.375	750	

Table D4-C
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level End (m)	Pump Rate (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft)[1]	Calculation Notes/ Assumptions
175480	C	NW23-30-9W	-7.32	-12.2	0.758	1:00:00	0.155	0.750	1500	
175489	C	SE27-30-9W	-6.405	-12.2	0.758	1:00:00	0.131	0.632	1263	
175524	C	SE29-30-9W	-4.27	-12.2	0.758	1:00:00	0.096	0.461	923	
175527	C	NW16-30-9W	-5.185	-12.2	0.758	1:00:00	0.108	0.522	1043	
175531	C	SE24-30-10W	-3.05	-5.49	1.137	1:00:00	0.466	2.250	4500	
175532	C	NW16-30-9W	-4.27	-12.2	0.758	1:00:00	0.096	0.461	923	
175534	C	NW18-30-9W	-1.83	-9.15	0.758	1:00:00	0.104	0.500	1000	
175550	C	NW15-30-9W	-5.185	-12.2	0.758	1:00:00	0.108	0.522	1043	
175556	C	SW14-30-9W	-2.44	-9.15	1.137	1:00:00	0.169	0.818	1636	
175557	C	NE10-30-9W	-3.355	-9.15	1.137	1:00:00	0.196	0.947	1895	
175558	C	NE17-30-9W	-2.44	-12.2	1.137	1:00:00	0.116	0.562	1125	
175559	C	SW16-30-9W	-3.05	-27.45	0.379	1:00:00	0.016	0.075	150	
175568	C	NW15-30-9W	-3.05	-12.2	0.91	1:00:00	0.099	0.480	960	
175891	C	NW21-30-9W	-3.66	-10.675	0.758	1:00:00	0.108	0.522	1043	
180275	C	NW20-30-9W	-3.66	-12.2	0.758		0.089	0.429	857	
180276	C	SW20-30-9W	-9.15	-4.27	-1.061	0:30:00				Appears to records recovery, therfore not calculated.
180277	C	NE19-30-9W	-2.44	-12.2	0.758		0.078	0.375	750	
180279	C	NW20-30-9W	-2.44	-12.2	0.758		0.078	0.375	750	
180280	C	NW10-30-9W	-4.575	-7.625	0.758		0.249	1.200	2400	
180376	C	SE22-30-9W	-4.88	-10.675	2.274		0.392	1.895	3789	
180377	C	NE15-30-9W	-6.1	-10.675	2.274		0.497	2.400	4800	
180378	C	NE22-30-9W	-4.88	-9.15	0.758		0.178	0.857	1714	
180380	C	SE33-30-9W	-5.49	-13.725	0.91		0.111	0.534	1067	
180390	C	SE22-30-9W	-3.66	-10.675	2.274		0.324	1.565	3130	
180391	C	SE22-30-9W	-4.88	-9.15	0.91	1:00:00	0.213	1.029	2058	
180393	C	SE22-30-9W	-4.88	-9.15	0.91		0.213	1.029	2058	
180394	C	NW23-30-9W	-5.185	-10.675	1.516		0.276	1.333	2666	
180397	C	SW23-30-9W	-9.455	-10.675	1.516		1.243	5.999	11999	
180399	C	SE23-30-9W	-4.88	-15.25	1.516		0.146	0.706	1412	
180596	C	SW16-30-9W	-2.135	-7.625	0.758	1:00:00	0.138	0.667	1333	
180613	C	SE29-30-9W	-5.49	-12.2	0.758	1:00:00	0.113	0.545	1091	
180635	C	SW28-30-9W	-3.05	-6.1	0.758	1:00:00	0.249	1.200	2400	
180636	C	NW20-30-9W	-7.015	-9.15	0.758	1:00:00	0.355	1.714	3428	
180640	C	NW10-30-9W	-3.05	-12.2	1.137	1:00:00	0.124	0.600	1200	
180641	C	NE19-30-9W	-3.05	-12.2	0.758	1:00:00	0.083	0.400	800	
180642	C	SE24-30-10W	-1.83	-7.625	0.758	1:00:00	0.131	0.632	1263	

Notes:

1. Transmissivity calculated based on emperical formula relating well capacity to transmissivity. Calculation does not consider variables, such as well effeciency.

APPENDIX D4-D

WELL INVENTORY ROUTE C

WELL INVENTORY

Date: 20-Oct-16

Survey ID	12C	
GW Drill PID		
UTM	N: 5712719	E: 519819
Name	First:	Last:
Home Address		
Land Location	NE7-30-9W	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential & agricultural	
Well Location	West side of house, outside.	
Owner When Drilled	No	
Water Use	Drinking water	
Driller		
Date Completed		
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter	
Depth to Pump		
Depth to Water		
Flowing Artesian Well	No	
Depth of Well		
Water Treatment	RO/ softener/ iron/ none & sediment filter	
Location of untreated taps	Basement	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Gets full of sediment if pump too hard	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)	Gets full of sediment if pump too hard	
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	Too much calcium	
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Basement
Tap Disinfected (Y/N)	Bleach
Time	7:15 PM
Initial Temp.	8°C
Final Temp.	7°C
Purging Time	10 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	7.4
Field Conductivity	1464 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N	6' in hole beside house outside
Drainage at base of well	Mounded / Flat / Depressed / unknown	
Septic (Field / Tank)	Age: 1980s Distance: Direction: East side of house.	
Agricultural	Animals / Fields / Chemical / Fuel Storage/ None	
Industrial	Mining Pit Quarries nearby	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of septic tank located on the east side of the house.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	152C	
GW Drill PID		
UTM	N: 5709491	E: 527936
Name	First:	Last:
Home Address		
Land Location	NW36-29-9W	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	South side of house	
Owner When Drilled	No	
Water Use	Drinking water	
Driller		
Date Completed	1960s	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel 8"	
Pump Type	Size / age / diameter	
Depth to Pump		
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	32'	
Water Treatment	RO/softener/ iron/ none	
Location of untreated taps	Kitchen	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Fishy smell sometimes	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)	Fishy smell sometimes	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)	Have had ecoli - boil water prior to drinking	
Chemical Concerns (Y/N)	Hard Water	
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Kitchen
Tap Disinfected (Y/N)	Bleach - but water was continuously dripping from tap
Time	5:20 PM
Initial Temp.	12°C
Final Temp.	8°C
Purging Time	15 Minutes - had bathroom tap purging also
Colour	(visual) clear
Odour	(visual) none
Turbidity	(visual) clear
Field pH	7.9
Field Conductivity	789 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N - Unknown, Located under a hut	
Drainage at base of well	Mounded / Flat / Depressed/ Underground/ Unknown	
Septic (Field , Tank)	Age: 1975 Distance: Direction: North side of property under straw	
Agricultural	Animals / Fields / Chemical / Fuel Storage	
Industrial	Mining Pit Quarries/ none	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of well located in hut under shovel located on the south side of the house.

View of the septic tank, under hay, located at the north side of the house.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	153C	
GW Drill PID		
UTM	N: 5707216	E: 527176
Name	First:	Last:
Home Address	NW25-29-9W	
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	outside, North side of house	
Owner When Drilled	Yes	
Water Use	Drinking water	
Driller	Alan Bruce	
Date Completed	1991~	
Formation	Limestone	
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter	
Depth to Pump		
Depth to Water		
Flowing Artesian Well		
Depth of Well	60'	
Water Treatment	RO/softener/ iron	
Location of untreated taps	Kitchen - drinking water tap	
Last Well Maintenance	None - although recently had a problem with the pump from a dead frog	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments	Sees brown rings forming	

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Kitchen
Tap Disinfected (Y/N)	Bleach - sampled through black spout but no filter was present on the spout
Time	5:30 PM
Initial Temp.	12°C
Final Temp.	8°C
Purging Time	15 Minutes
Colour	(visual) clear
Odour	(visual) none
Turbidity	(visual) clear
Field pH	7.6
Field Conductivity	992 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N	Basement
Drainage at base of well	Mounded / Flat / Depressed/ Underground/ Unknown	
Septic (Field , Tank)	Age: Distance: Direction: West side of property under wood	
Agricultural	Animals / Fields / Chemical / Fuel Storage/ none	
Industrial	Mining Pit Quarries, none	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of monitoring well located at the north side of the house.

View of pump located in the basement.

View of septic tank located under the wood slab at the front of the house (west side).

APPENDIX D4-E

REGIONAL INFORMATION ROUTE D

TABLE D4-E1
ROUTE D SUMMARY WELL COUNT

		500 m Distance from Channel ROW	3 km Distance from Channel Centreline [2]	Comments
No. of Potential Wells Based on Residence Locations from Imagery [1]		15	66	
No. of GW Drill Logs		19	135	Well groups located to township are excluded.
No. of GW Drill Logs with Well Use	Domestic Only	5	63	
	Livestock and Domestic	9	35	
	Livestock Only	4	36	
	Other	1	1	
No. of Non-Limestone Wells	Sand and Gravel	0	8	
	Sandstone	0	1	
	Shale	0	1	
	Unknown	0	1	
	Other	0	1	
No. of GW Drill Logs with Casing Depth in Range	0-10 m	0	39	
	10-20 m	11	46	
	20-30 m	8	31	
	30-40 m	0	6	
	>40 m	0	1	
No. of GW Drill Logs with Transmissivity in Range	0-1000 USgpd/ft	9	54	
	1000-5000 USgpd/ft	4	36	
	5000-15000 USgpd/ft	5	13	
	15000-50000 USgpd/ft	0	5	
	>50000 USgpd/ft	0	1	

Notes:
1. Number of residences/buildings estimated from imagery and has not been confirmed in the field.
2. 3 km disance from channel centreline includes wells at 500 m distance from channel ROW.

APPENDIX D4-F

WELL LOG MATCHING ROUTE D

Table D4 F-1

GW Drill Logs Near Identified Properties - Route D

MI Well #	Northing	Easting	Land Location	MI Ownership Map Information		Potential Ownership to be Confirmed [1]	GW Drill Database
				Landowner	Description	Landowner	Proximal Wells
3	529587	5681940	NW 1/4 30-26-08			N/A	113226 113390
4	529748	5682137	SW 1/4 31-26-08			N/A	2974
5	529795	5682322	SE 1/4 31-26-08		SE 31-26-8W	N/A	18962
8	530791	5683933	SW 1/4 17-27-08		SW 17-27-8W		10596
9	530392	5684388	SE 1/4 18-27-08				4469.7
10	530385	5684761	NE 1/4 18-27-09				2790.8
11	530373	5685531	SE 1/4 19-27-09				No wells in quarter section
12	530500	5685838	SE 1/4 19-27-09				No wells in quarter section
13	530054	5688447	NE 1/4 30-27-08				107586 130999
14	530405	5689553	NE 1/4 31-27-08		Frac of 31-27-8W		No wells in quarter section
15	530027	5690407	SE 1/4 06-28-08		SE 6-28-8W		12727.5
25	527942	5687796	SW 1/4 25-27-09				No wells in quarter section
26	533516	5690292	SE 1/4 04-28-08				12286.4
27	533540	5687878	NE 1/4 28-27-08				13273 41105 48883
29	533735	5683854	SE 1/4 16-27-08				11763.5
30	533343	5683536	NE 1/4 33-26-08				5553.2
33	530559	5681054	SE 1/4 30-26-08			N/A	15836.3
37	533388	5693575	SE 1/4 16-28-08				62673 63669 28158 80144 28155 80143
38	532531	5693337	NW 1/4 09-28-08				4753.2
39	531651	5692271	SE 1/4 08-28-08				31876 63235 168151 53686 70029 55534
40	529988	5693460	SE 1/4 18-28-08		SE 18-28-8W		38544 - Doug Smith
44	529063	5693030	NW 1/4 07-28-08				169043 - Brad Stabner 31923 - R Stabner
45	529064	5692762	NW 1/4 07-28-08				70679 - B Stabner

Table D4 F-1

GW Drill Logs Near Identified Properties - Route D

MI Well #	Northing	Easting	Land Location	MI Ownership Map Information		Potential Ownership to be Confirmed [1]	GW Drill Database
				Landowner	Description	Landowner	Proximal Wells
41	529910	5691959	SE 1/4 07-28-08		East 1/2 7-28-8W		No wells in quarter section
49	530401	5698253	SE 1/4 31-28-08				3479.9
50	530612	5695686	SW 1/4 20-28-08		West 1/2 20-28-8W Burnett Road		942
51	530151	5694814	NE 1/4 18-28-08				No wells in quarter section
52	533450	5696712	SE 1/4 28-28-08				No wells in quarter section
53	533616	5695625	SE 1/4 21-28-08				No wells in quarter section
54	533697	5694830	NE 1/4 16-28-08				32916 32917 32918 32919
67	531600	5700594	SE 1/4 05-29-08		SE 5-29-8W		No wells in quarter section
68	531360	5701048	NE 1/4 05-29-08				16903.4
69	530981	5701145	NW 1/4 05-29-08				51018 70026 105933
72	532650	5701734	SW 1/4 09-29-08		SW 9-29-8W		1362.7
73	533813	5698195	NW 1/4 27-28-08				80145 51020
74	533836	5698569	SW 1/4 34-28-08				140093 33191
75	533757	5699176	NW 1/4 34-28-08				12192 105931
76	532726	5702366	NW 1/4 09-29-08		NW 9-29-8W		32857 62675 78700
77	533867	5702203	SW 1/4 10-29-08				32851 168658
78	533769	5702379	NW 1/4 10-29-08				31883 55535
79	533026	5703319	SE 1/4 16-29-08		Fraction SE 16-29-8W	N/A	22597 37244
					SE 16-29-8W		
80	532960	5704029	NE 1/4 16-29-08			N/A	105934 37244

Notes:

1 - Land Ownership Map

APPENDIX D4-G

CALCULATED SPECIFIC CAPACITY AND TRANSMISSIVITY ROUTE D

Table D4-G
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level (m)	Level Start (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft) [1]	Calculation Notes/ Assumptions
4198	D	24-29- 09W	-3.048	-6.096	0.379	2:00:00	0.124	0.600	1201	
4199	D	NE-24-29-9W	-1.829	-8.23	0.606	1:30:00	0.095	0.457	914	
6902	D	NW20-29- 08W	1.372	-5.486	2.273	2:00:00	0.331	1.600	3200	
6924	D	NE-25-28-9W	-0.305	-2.743	3.258	1:30:00	1.336	6.452	12904	
6927	D	24-29-9W	-1.524	-7.925	1.515	1:30:00	0.237	1.143	2285	
6928	D	24-29-9W	-4.572	-7.925	0.53	2:00:00	0.158	0.763	1526	
9420	D	SW-20-28-8W	0.914	-7.925	1.288	3:00:00	0.146	0.704	1407	
9460	CD	NE-34-29-9W	-8.534	-10.668	0.606	3:30:00	0.284	1.371	2742	
12192	D	NW-34-28-8W	-2.438	-10.668	0.189	15:00:00	0.023	0.111	222	
12250	D	SW13-29- 09W	-4.267	-5.791	0.606	8:00:00	0.398	1.920	3840	
13273	D	NE-28-27-8W	-1.219	-7.62	0.53	1:30:00	0.083	0.400	800	
13627	D	SW-9-29-8W	3.048	-8.839	0.53	2:00:00	0.045	0.215	431	
13643	CD	NE-34-29-9W	-2.438	-3.962	0.833	4:30:00	0.547	2.639	5278	
16266	D	NW-17-26-8W	-0.305	-7.925	0.606	3:00:00	0.080	0.384	768	
16311	D	NE-24-29-9W	-3.962	-6.096	0.379	2:00:00	0.178	0.857	1715	
18069	D	SE30-26-8W	0	-0.61	0.758	: :00	1.243	5.999	11999	
18960	D	NW20-29- 08W	0	-0.61	0.909	1:00:00	1.490	7.195	14389	
18973	D	NE-36-26-9W	0.61	-1.829	4.546	6:00:00	1.864	8.999	17998	
18978	D	12-28-9W	-4.267	-6.096	1.743	1:30:00	0.953	4.601	9202	
20848	D	NW-27-28-9W	-3.658	-6.096	0.909	3:00:00	0.373	1.800	3600	
20849	D	NE-3-28-9W	-2.438	-9.144	4.546	14:00:00	0.678	3.273	6546	
22423	D	NE24-29-9W	-3.353	-6.096	0.758	2:00:00	0.276	1.334	2668	
22596	D	NE-10-28-9W	-2.438	-6.096	0.379	4:00:00	0.104	0.500	1000	
22597	D	SE-16-29-8W	0.305	-7.62	0.379	4:00:00	0.048	0.231	462	
22606	D	NW-22-26-8W	-2.438	-9.754	0.606	4:00:00	0.083	0.400	800	
22870	D	SW-8-29-8W	0		0.606	8:00:00				
22891	CD	SE-25-29-9W	-7.62	-9.144	1.137	15:45:00	0.746	3.602	7204	
22901	D	NE-24-29-9W	-5.486	-6.706	1.288	1:40:00	1.056	5.097	10194	
22902	D	24-29-9W	-3.353	-4.267	1.515	1: 2:00	1.658	8.003	16005	
23485	D	SE-30-28-8W	0	-3.962	22.73	4:00:00	5.737	27.698	55396	
23487	D	SW-25-28-9W	-3.048	-3.048	22.73	8:00:00	454.600	2194.809	4389618	Assume 0.05 m drawdown occurred. Calculated transmissivity is a low end estimate. Represent at >50,000 on figures.
23488	D	NE-27-28-9W	-1.524	-3.048	22.73	4:00:00	14.915	72.008	144016	
24940	D	NE-19-28-8W	0.61	-4.572	1.894	1:30:00	0.365	1.765	3529	
25474	D	SW-18-27-8W	-2.743	-4.877	1.137	4:00:00	0.533	2.572	5145	
25636	D	15-28-8W	-7.925		1.515	: :00	0.191	0.923	1846	
25898	D	SW-6-29-8W	-1.524		3.031	:30:00	1.989	9.602	19204	
26008	D	SW-18-29-8W	0.61	-4.572	0.379	: :00	0.073	0.353	706	
26828	D	15-27-8W	-1.829	-4.572	0.985	1:00:00	0.359	1.734	3467	
27908	D	NE-18-27-8W	0.61		0.379	3:00:00	0.621	3.000	5999	
28155	D	SE-16-28-8W	-2.134	-12.192	0.758	3:00:00	0.075	0.364	728	
28156	D	NW-14-28-8W	-3.353	-4.572	0.985	1:00:00	0.808	3.901	7802	
28158	D	SE-16-28-8W	-3.353	-12.192	0.985	1:00:00	0.111	0.538	1076	
31534	D	NE-32-27-8W	-1.524	-7.925	0.379	001:00:00	0.059	0.286	572	
31631	CD	NE-26-29-9W	-4.572		1.137	:45:00	0.249	1.201	2401	

Table D4-G
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level (m)	Level Start (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft) [1]	Calculation Notes/ Assumptions
31876	D	SE-8-28-8W	-0.61	-3.658	0.53	3:00:00	0.174	0.840	1679	
31883	D	NW-10-29-8W	0.305	-5.182	0.379	2:00:00	0.069	0.333	667	
31892	D	SE-34-26-8W	-4.267	-7.925	0.379	2:00:00	0.104	0.500	1000	
31904	D	SW-22-27-9W	-2.438	-8.534	0.303	3:00:00	0.050	0.240	480	
31917	D	SE-35-26-9W	-0.305	-3.658	1.137	2:15:00	0.339	1.637	3274	
31921	D	SE-27-27-8W	-0.914	-3.048	0.606	2:00:00	0.284	1.371	2742	
31923	D	NW7-28-8W	-5.486	-18.288	0.379	2:00:00	0.030	0.143	286	
31962	D	15-28-8W	-0.914	-1.219	2.273	1:30:00	7.452	35.980	71961	
32016	D	SE-28-27-8W	0	-4.572	0.909	1:15:00	0.199	0.960	1920	
32044	D	SE-27-26-8W	-1.219	-5.486	0.455	2:00:00	0.107	0.515	1030	
32720	D	34-26-8W	-2.438	-6.706	0.833	2:00:00	0.195	0.942	1885	
32851	D	SW-10-29-8W	3.048	-15.24	0.379	: :00	0.021	0.100	200	
32856	CD	SW-36-29-9W	-3.658	-9.144	0.379	1:00:00	0.069	0.334	667	
32857	D	NW-9-29-8W	4.572		6.061	: :00	1.326	6.400	12801	
32858	D	SE-12-29-9W	-1.524	-8.534	0.758	2:00:00	0.108	0.522	1044	
32879	D	24-29-9W	-1.219	-4.572	0.758	2:00:00	0.226	1.091	2183	
32916	D	NE-16-28-8W	0.61	4.267	0.303	5:00:00	0.083	0.400	800	
33092	D	SE-34-26-8W	-1.829	-7.925	0.758	1:00:00	0.124	0.600	1201	
33098	D	16-27-8W	1.829	-7.62	0.606	1:00:00	0.064	0.310	619	
33190	D	NW-18-29-8W	-1.829	-3.658	2.273	1:00:00	1.243	6.000	12000	
33191	D	SW-34-28-8W	-2.438	-8.23	0.379	1:00:00	0.065	0.316	632	
33872	D	NE-20-26-8W	0	-8.23	0.758	2:00:00	0.092	0.445	889	
33879	D	SE-36-28-9W	-1.219	-7.315	0.606	6:00:00	0.099	0.480	960	
33882	D	SE-3-28-9W	-1.219	-6.706	0.682	6:00:00	0.124	0.600	1200	
33898	D	SE-15-27-9W	1.219	-8.534	0.227	4:00:00	0.023	0.112	225	
34742	D	24-29-9W	-2.134	-5.182	0.606	2:00:00	0.199	0.960	1920	
34821	D	24-29-9W	-0.305		0.379	2:00:00	1.243	5.999	11999	
34929	D	NW-35-26-9W	0.305	-7.315	0.455	2:30:00	0.060	0.288	577	
36426	D	SW-16-27-8W	-0.61	-8.23	0.455	1:00:00	0.060	0.288	577	
36466	D	SW-26-27-8W	0	-7.62	1.515	1:00:00	0.199	0.960	1920	
36538	D	SE-2-29-9W	-3.048	-7.62	3.788	:30:00	0.829	4.000	8000	
37883	D	SW-2-29-9W	-3.658	-3.658	0.606	:45:00	12.120	58.515	117031	Assume 0.05 m drawdown occurred. Calculated transmissivity is a low end estimate. Represent at >50,000 on figures.
38266	D	SE-15-28-8W	-3.658	-6.706	0.303	4:00:00	0.099	0.480	960	
38542	D	NE31-26- 08W	1.524	-4.572	0.758	1:00:00	0.124	0.600	1201	
38543	D	NW22-27- 08W	-1.829	-7.315	1.515	1:00:00	0.276	1.333	2667	
38544	D	SE18-28-8W	1.524	-8.23	0.379	8:00:00	0.039	0.188	375	
38545	CD	SE30-29- 08W	-3.048	-7.62	1.137	1:00:00	0.249	1.201	2401	
38587	D	SE36-27- 09W	-2.743	-7.01	1.515	1:00:00	0.355	1.714	3428	
41105	D	NE-28-27-8W	-4.572	-8.534	0.379	2:00:00	0.096	0.462	924	
41106	D	SW-23-28-8W	-1.219	-3.048	0.758	2:00:00	0.414	2.001	4002	
41288	D	NE8-26- 08W	-1.524	-2.134	2.273	1:00:00	3.726	17.990	35980	
41291	D	NW34-27- 08W	-0.61	-6.096	2.273	1:00:00	0.414	2.000	4001	
41293	D	NW19-29- 08W	-1.219	-7.62	0.758	1:00:00	0.118	0.572	1143	
41390	D	SE3-28- 09W	-2.438	-5.486	0.455	1:00:00	0.149	0.721	1441	

Table D4-G
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level (m)	Level Start (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft) [1]	Calculation Notes/ Assumptions
42414	D	SE30-26-8W	-0.61	-7.01	0.379	1:00:00	0.059	0.286	572	
42419	D	24-29- 09W	-0.61	-8.23	0.379	1:00:00	0.050	0.240	480	
43284	D	15-28- 08W	-1.219	-7.315	0.379	1:00:00	0.062	0.300	600	
43285	D	24-29- 09W	-0.914	-8.23	0.379	1:00:00	0.052	0.250	500	
44477	D	SE27-28- 08W	-1.524	-8.839	0.303	1:00:00	0.041	0.200	400	
44692	D	NW7-26- 08W	-1.524	-7.01	1.137	1:00:00	0.207	1.001	2001	
44693	D	NE20-26- 08W	0.914	-3.048	1.515	1:00:00	0.382	1.846	3692	
44694	D	SW21-26- 08W	-0.914	-6.401	1.515	2:00:00	0.276	1.333	2666	
44695	D	SE27-26- 08W	-3.048	-7.925	0.758	1:00:00	0.155	0.750	1501	
44696	D	SW17-27- 08W	1.219	-4.572	0.758	1:00:00	0.131	0.632	1264	
44698	D	SW31-27- 08W	-3.048	-8.23	0.53	1:00:00	0.102	0.494	988	
44699	D	NE19-29- 08W	-2.134	-6.706	0.758	1:00:00	0.166	0.800	1601	
44702	D	34-26-9W	0	-3.048	2.273	1:00:00	0.746	3.600	7201	
46867	D	SW21-26- 08W	-0.914	-6.401	1.515	2:00:00	0.276	1.333	2666	
47253	D	NW22-27- 08W	-0.61	-4.572	1.515	6:00:00	0.382	1.846	3692	
47255	D	NW36-26-9W	-0.61	-3.048	3.788	1:00:00	1.554	7.501	15003	
47530	D	SE19-26- 08W	-1.219	-5.182	2.273	1:00:00	0.574	2.769	5538	
47531	D	NE33-26- 08W	-1.829	-8.23	1.894	1:00:00	0.296	1.429	2857	
47532	D	NW9-28- 08W	3.048	-5.486	0.379	1:00:00	0.044	0.214	429	
47535	D	SE36-28- 09W	-3.048	-6.706	0.379	6:00:00	0.104	0.500	1000	
48883	D	NE28-27- 08W	-0.914	-6.096	1.515	1:00:00	0.292	1.412	2823	
48884	D	SW31-27- 08W	-1.524	-6.706	0.606	1:00:00	0.117	0.565	1129	
48885	CD	NW31-29-8W	0	-8.534	0.758	1:00:00	0.089	0.429	858	
48887	D	SE36-28- 09W	-3.048	-8.534	0.303	1:00:00	0.055	0.267	533	
49527	D	NE28-26-8W	-2.134	-4.267	1.637	1:01:00	0.767	3.705	7411	
49764	D	NE33-26- 08W	-4.267	-7.315	0.379	1:00:00	0.124	0.600	1201	
49765	D	NW27-27- 08W	0	-7.315	0.985	1:00:00	0.135	0.650	1300	
49766	D	NE27-28- 09W	-4.572	-7.315	0.379	1:00:00	0.138	0.667	1334	
51017	D	NW28-26- 08W	-3.962	-6.706	1.515	1:00:00	0.552	2.666	5331	
51018	D	NW5-29- 08W	-0.61	-7.925	0.53	: :00	0.072	0.350	700	
51019	D	SW23-27- 08W	-2.438	-6.096	1.137	1:00:00	0.311	1.501	3001	
51020	D	NW27-28- 08W	-1.829	-8.839	0.303	50:00:00	0.043	0.209	417	
51023	D	SW23-27- 09W	-2.438	-7.01	1.515	1:00:00	0.331	1.600	3200	
52809	D	SW27-28- 09W	-4.572	-7.62	1.137	1:00:00	0.373	1.801	3602	
53138	D	NW24-28- 09W	-4.572	-7.62	0.379	1:00:00	0.124	0.600	1201	
53146	CD	SE30-29- 08W	-0.61	-4.572	2.273	1:00:00	0.574	2.770	5540	
53147	D	15-28- 08W	-0.305	-6.096	0.758	1:00:00	0.131	0.632	1264	
53148	D	NW22-27- 08W	-0.305	-7.62	0.455	1:00:00	0.062	0.300	601	
53685	D	SW19-29- 08W	-0.914	-7.925	0.568	1:00:00	0.081	0.391	782	
55088	D	34-26-9W	0	-8.23	0.379	1:00:00	0.046	0.222	445	
55532	D	NE33-26- 08W	1.524	-7.925	0.303	1:00:00	0.032	0.155	310	
55534	D	SE8-28- 08W	-1.524		0.227	:15:00	0.149	0.719	1438	

Table D4-G
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level (m)	Level Start (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft) [1]	Calculation Notes/ Assumptions
55535	D	NW10-29- 08W	0	-7.62	0.189	1:00:00	0.025	0.120	239	
55536	D	NW35-26-9W	1.829	-7.62	0.758	1:00:00	0.080	0.387	775	
58243	D	NW19-29- 08W	-2.743	-7.925	1.743	1:00:00	0.336	1.624	3248	
58328	D	24-29- 09W	-1.219	-8.23	0.53	1:00:00	0.076	0.365	730	
58329	D	24-29- 09W	-1.219	-7.315	0.303	4:00:00	0.050	0.240	480	
58402	D	34-26-9W	0.914	-5.486	0.758	1:00:00	0.118	0.572	1144	
60149	D	SW-35-26-8W	0.305	-7.01	0.303	4:00:00	0.041	0.200	400	
62622	D	NE34-26-9W	2.438	-7.925	1.515	1:00:00	0.146	0.706	1412	
62647	CD	NE25-29- 09W	-4.572	-8.534	0.758	1:00:00	0.191	0.924	1847	
62659	D	SW15-27- 08W	-0.914	-7.315	1.894	1:00:00	0.296	1.429	2857	
62673	D	SE16-28- 08W	-1.219	-7.62	1.515	1:00:00	0.237	1.143	2285	
62675	D	NW9-29- 08W	3.566	-7.62	0.606	1:00:00	0.054	0.262	523	
62695	D	NE34-26-9W	1.829	-1.219	1.137	1:00:00	0.373	1.801	3602	
62696	D	NE34-26-9W	-1.524	-8.534	0.455	1:00:00	0.065	0.313	627	
62705	D	SW26-28- 09W	-3.962	-7.315	2.273	1:00:00	0.678	3.273	6546	
63234	D	NE20-26- 08W	-1.524	-8.534	0.606	1:00:00	0.086	0.417	835	
63235	D	SE8-28- 08W	1.219	-8.534	0.682	1:00:00	0.070	0.338	675	
63656	D	SE-22-27-8W	-5.486	-8.534	0.455	4:00:00	0.149	0.721	1441	
63660	D	NE-21-26-8W	-4.877	-10.668	0.568	2:00:00	0.098	0.474	947	
63669	D	SE-16-28-8W	-7.925	-10.973	0.303	1:00:00	0.099	0.480	960	
65682	D	SE22-27- 09W	-3.962	-8.534	0.379	1:00:00	0.083	0.400	800	
65688	D	SW18-27- 08W	-3.658	-9.144	1.137	: :00	0.207	1.001	2001	
65699	D	SE11-28- 09W	-7.925	-14.021	1.515	1:00:00	0.249	1.200	2400	
65702	D	NE9-26- 08W	-3.048	-8.839	0.758	1:00:00	0.131	0.632	1264	
65709	D	NW35-28- 09W	-5.486	-8.23	0.833	1:00:00	0.304	1.466	2931	
65714	D	SW12-28- 09W	-6.706	-7.62	0.758	1:00:00	0.829	4.004	8008	
65716	D	SE25-27- 09W	-4.267	-7.62	0.909	1:00:00	0.271	1.309	2618	
65740	D	24-29- 09W	-4.267	-10.363	0.758	1:00:00	0.124	0.600	1201	
65752	D	SW2-29- 09W	-7.925	-12.192	0.379	10:00:00	0.089	0.429	858	
65766	D	NE35-27- 09W	-3.658	-7.62	0.909	1:00:00	0.229	1.108	2215	
65773	D	SW26-28- 09W	-5.791	-7.925	1.137	1:00:00	0.533	2.572	5145	
65774	D	SW10-28- 09W	-6.401	-8.23	0.758	1:00:00	0.414	2.001	4002	
65781	D	NW12-28- 09W	-5.791	-6.706	2.273	1:00:00	2.484	11.993	23987	
65782	D	SE17-28- 08W	0.457	-7.01	1.137	1:00:00	0.152	0.735	1470	
65784	D	NE23-27- 09W	-4.572	-7.925	0.909	1:00:00	0.271	1.309	2618	
65785	D	NW19-27- 08W	0.457	-8.23	0.606	1:00:00	0.070	0.337	674	
65820	D	NE24-27- 09W	-3.658	-4.572	2.273	1:00:00	2.487	12.007	24013	
66809	CD	NW-31-29-8W	-4.267	-4.877	0.909	1:10:00	1.490	7.195	14389	
66818	D	24-29-9W	-4.877	-4.267	1.364	2:10:00	2.236	10.796	21591	
66995	D	NE-28-28-8W	-3.962	-8.23	1.515	2:00:00	0.355	1.714	3428	
69990	CD	NW25-29- 09W	-2.438	-7.925	1.515	1:00:00	0.276	1.333	2666	
69992	D	SE13-28- 09W	-3.962	-8.534	3.334	2:00:00	0.729	3.521	7041	
69999	D	NW27-28- 09W	-6.401	-7.315	0.455	1:00:00	0.498	2.403	4807	
70026	D	NW5-29- 08W	0.61	-8.534	0.379	1:00:00	0.041	0.200	400	
70029	D	SE8-28- 08W	0	-8.534	0.606	1:00:00	0.071	0.343	686	
70031	D	NE19-28- 08W	-0.914	-7.62	1.894	1:00:00	0.282	1.364	2727	

Table D4-G
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level (m)	Level Start (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft) [1]	Calculation Notes/ Assumptions
70032	CD	SE30-29- 08W	-3.353	-11.582	0.909	1:00:00	0.110	0.533	1067	
70679	D	NW-7-28-8W	-3.658	-15.24	0.568	1:30:00	0.049	0.237	474	
72438	D	SW35-26- 08W	-0.914	-16.154	0.758	10:00:00	0.050	0.240	480	
72440	D	NW31-26- 08W	-0.914	-7.925	1.137	4:00:00	0.162	0.783	1566	
72441	D	34-26-9W	1.524	-7.925	0.53	1:00:00	0.056	0.271	542	
74230	D	SE13-28- 09W	-3.658	-7.925	1.137	2:00:00	0.266	1.286	2573	
74231	D	34-26-9W	1.829	-5.791	2.273	1:00:00	0.298	1.440	2880	
74233	D	NE15-27- 08W	-1.829	-6.706	2.273	1:00:00	0.466	2.250	4500	
74240	D	NE36-27- 09W	-2.743	-7.925	0.379	1:00:00	0.073	0.353	706	
74346	D	34-26-9W	-1.829	-8.23	0.758	1:00:00	0.118	0.572	1143	
74356	D	34-26-9W	-2.134	-8.534	0.758	1:00:00	0.118	0.572	1144	
76803	D	SE16-26- 08W	-1.829	-5.486	1.137	1:00:00	0.311	1.501	3002	
76809	D	NE15-27- 09W	0	-8.23	1.515	1:00:00	0.184	0.889	1778	
76818	D	SE18-29- 08W	0.457	-6.706	0.758	22:00:00	0.106	0.511	1022	
76837	CD	NE34-29- 09W	-4.572	-6.096	2.273	1:00:00	1.491	7.201	14402	
76858	D	SW10-28- 08W	-2.134	-8.23	0.909	1:00:00	0.149	0.720	1440	
76865	D	SE1-29- 09W	1.219	-8.23	0.606	1:00:00	0.064	0.310	619	
76898	D	SW16-26- 08W	-0.914	-3.048	4.546	1:00:00	2.130	10.285	20570	
78698	D	SE30-26- 08W	0.61	-18.288	0.758	: :00	0.040	0.194	387	
78700	D	NW9-29- 08W	1.524	-2.134	4.546	1:00:00	1.243	6.000	12000	
78815	D	34-26-9W	0.61	-7.62	0.758	1:00:00	0.092	0.445	889	
78816	D	34-26-9W	0.914	-8.23	0.455	1:00:00	0.050	0.240	480	
78817	D	36-26-9W	-0.914	-8.23	0.909	1:00:00	0.124	0.600	1200	
78818	D	36-26-9W	0.914	-7.62	0.758	1:00:00	0.089	0.429	858	
78820	D	SW23-27- 09W	-4.572	-14.63	0.758	: :00	0.075	0.364	728	
78821	D	NE3-28- 09W	-6.096	-8.23	0.455	1:00:00	0.213	1.029	2059	
78823	D	NW23-28- 09W	-4.572	-14.021	1.137	1:00:00	0.120	0.581	1162	
80139	D	NE21-26-8W	-3.048	-14.63	0.758	2:00:00	0.065	0.316	632	
80141	D	NW19-27- 08W	-1.829	-22.555	0.53	2:00:00	0.026	0.123	247	
80142	D	SE22-27- 08W	-4.877		2.273	4:00:00				
80143	D	SE16-28- 08W	0	-9.144	0.379	1:00:00	0.041	0.200	400	
80144	D	SE16-28- 08W	-0.914	-8.839	0.758	1:00:00	0.096	0.462	924	
80145	D	NW27-28- 08W	-1.829	-9.449	0.379	: :00	0.050	0.240	480	
80172	D	SE35-28- 09W	1.219	-0.305	2.273	1:00:00	1.491	7.201	14402	
101897	D	NW34-27-8W	-1.22	-1.525	4.548	1:00:00	14.911	71.993	143985	
105929	D	SW34-27-8W	0.61	-8.235	1.516	1:00:00	0.171	0.828	1655	
105931	D	NW34-28-8W	-1.83	-8.235	0.91	1:00:00	0.142	0.686	1372	
105932	D	SE15-28-8W	-1.525	-7.625	1.516	1:00:00	0.249	1.200	2400	
105933	D	NW5-29-8W	-1.22	-10.675	0.531	1:00:00	0.056	0.271	542	
105934	D	NE16-29-8W	-0.305	-7.93	1.137	1:00:00	0.149	0.720	1440	
105960	D	SW17-27-8W	1.22	-2.135	3.032	1:00:00	0.904	4.363	8726	
107586	D	NE30-27-8W	0.305	-13.725	0.758	10:00:00	0.054	0.261	522	
107587	D	SE19-29-8W	-1.525	-6.71	2.274	1:00:00	0.439	2.117	4235	
107701	D	SE36-28-9W	-0.61	-8.235	0.606	8:00:00	0.079	0.384	767	
113216	CD	SW25-29-9W	0	-6.1	1.137	1:00:00	0.186	0.900	1800	
113226	D	NW30-26-8W	0.915	-7.625	1.516	1:00:00	0.178	0.857	1714	
113351	D	NW22-26-8W	-2.135	-9.15	0.758	1:00:00	0.108	0.522	1043	
113362	D	NW27-26-8W	-5.49	-8.235	0.531	1:00:00	0.193	0.934	1868	
113390	D	NW30-26-8W	-1.83	-7.625	1.137	1:00:00	0.196	0.947	1895	

Table D4-G
Calculated Specific Capacity and Transmissivity

Well PID	Route	Full Location	Level Start (m)	Level (m)	Level Start (l/s)	Pump Duration (hh/mm/ss)	Well Specific Capacity (L/s/m)	Well Specific Capacity (USgpm/ft)	T (USgpd/ft) [1]	Calculation Notes/ Assumptions
114973	D	NE22-27-8W	-1.22	-4.575	3.79	1	1.130	5.454	10908	
114980	D	NE9-28-8W	-3.05	-4.575	0.379	50	0.249	1.200	2400	
117635	D	SE16-27-8W	-4.575	-21.35	0.455		0.027	0.131	262	
118892	D	NE6-29-8W	0.915	-8.235	0.531		0.058	0.280	560	
118902	D	SW31-26-8W	-0.61	-7.625	0.758		0.108	0.522	1043	
122811	D	SW26-29-8W	-3.66	-30.5	2.274		0.085	0.409	818	
122815	D	NE13-27-9W	-4.88	-21.35	1.516		0.092	0.444	889	
122844	D	SW27-26-8W	3.66	-25.925	1.137		0.038	0.186	371	
122846	D	SE30-26-8W	-0.61	-6.1	3.79		0.690	3.333	6666	
122847	D	SE34-26-8W	-3.66	-7.625	1.895		0.478	2.307	4615	
122848	D	SE34-26-8W	-2.44	-7.625	0.91		0.176	0.847	1695	
122864	D	SE4-28-8W	0.305	-8.235	1.516		0.178	0.857	1714	
127274	D	SE30-27-8W	0.915	-9.15	0.758		0.075	0.364	727	
127275	D	SE6-28-8W	-0.61	-7.625	0.379		0.054	0.261	522	
127286	D	SE30-28-8W	0.61	-8.235	1.137		0.129	0.621	1241	
127300	D	NW10-28-8W	-2.135	-8.235	0.303		0.050	0.240	480	
130999	D	NE30-27-8W	0	-7.625	1.516	1:00:00	0.199	0.960	1920	
131008	D	NE21-26-8W	-5.49	-21.35	1.137	1:00:00	0.072	0.346	692	
135895	D	34-26-9W	0.61	-9.15	0.455		0.047	0.225	450	
135988	D	SW18-28-8W	-0.305	-30.5	0.758	1:00:00	0.025	0.121	242	
135989	D	SW18-28-8W	-0.305	-18.3	1.137	1:00:00	0.063	0.305	610	
135997	D	NW36-26-9W	0.915	0	0.758		0.828	4.000	7999	
136004	D	NW22-27-8W	-2.44	-4.575	4.548	1:00:00	2.130	10.285	20569	
136016	D	SW31-26-8W	0.61	-9.15	0.038	1:00:00	0.004	0.019	38	
140093	D	SW34-28-8W	-3.66	-15.25	1.137		0.098	0.474	947	
142351	D	SE13-29-9W	-3.66	-15.25	1.516		0.131	0.632	1263	
142431	D	NW2-29-9W	-4.27	-30.5	0.91		0.035	0.167	335	
142575	D	NE15-26-8W	-1.83	-7.625	2.274		0.392	1.895	3789	
158001	D	SE26-29-9W	-1.83	-30.5	0.758		0.026	0.128	255	
158363	D	SE30-26-8W		-8.845	1.137		0.129	0.621	1241	
158528	D	NW10-27-8W	-0.61	-18.3	1.137		0.064	0.310	621	
158558	D	SE33-26-9W	0.61	-25.925	0.758		0.029	0.138	276	
159282	D	SE26-29-9W	-1.83	-30.5	0.758		0.026	0.128	255	
160257	D	NW21-29-8W	-0.763	-3.05	1.137		0.497	2.400	4801	
168267	D	NW21-26-8W	-2.44	-3.355	0.569	2:00:00	0.622	3.002	6005	
168268	D	SE20-26-8W	-3.66	-5.49	1.289	2:00:00	0.704	3.401	6801	
168658	D	SW10-29-8W	-1.83	-7.32	1.516	1:00:00	0.276	1.333	2666	
169034	D	NE5-29-8W	-5.185	-18.3	1.516	1:00:00	0.116	0.558	1116	
169043	D	NW7-28-8W	-0.915	-15.25	1.137	1:00:00	0.079	0.383	766	
169057	D	NW23-27-9W	-0.915	-6.1	1.137		0.219	1.059	2117	
169066	D	SE28-26-8W	-2.44	-10.675	1.516	1:00:00	0.184	0.889	1778	
175436	D	SW26-27-9W	-4.27	-18.3	1.137	1:00:00	0.081	0.391	783	
175438	D	SW26-27-9W	-1.525	-18.3	3.79	1:00:00	0.226	1.091	2182	
175623	D	NE21-26-8W	-3.66	-13.725	1.137		0.113	0.545	1091	
180372	D	SE25-27-9W	-1.22	-6.1	1.137		0.233	1.125	2250	
180374	D	NW11-27-9W	0.458	-12.2	1.137		0.090	0.434	867	
180404	D	SW26-28-9W	-3.66	-27.45	0.758		0.032	0.154	308	
180594	D	SE33-26-9W	1.22	-9.15	0.152	1:00:00	0.015	0.071	142	
180594	D	SE33-26-9W	1.22	-9.15	0.152	1:00:00	0.015	0.071	142	

Notes:
1. Transmissivity calculated based on emperical formula relating well capacity to transmissivity. Calculation does not consider variables, such as well effeciency.

APPENDIX D4-H

WELL INVENTORY RESULTS ROUTE D

WELL INVENTORY

Date: 20-Oct-16

Survey ID	7D	
GW Drill PID		
UTM	N: 5683492	E: 530325
Name	First:	Last:
Home Address		
Land Location	NE31-26-8	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential, agricultural	
Well Location	Separate pump house - south side of house	
Owner When Drilled	No	
Water Use	Drinking and cooking	
Driller		
Date Completed	50-60 years ago	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter	Above ground pump only a few years old
Depth to Pump	above ground	
Depth to Water	at surface	
Flowing Artesian Well	Yes	
Depth of Well	60'	
Water Treatment	RO/softener/ iron/ none	
Location of untreated taps	Beside pump house	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)	Low pressure - water cattle then the house	
Seasonal Changes (Y/N)	Rust in spring & fall	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)	Tested during flooding and no problems	
Chemical Concerns (Y/N)	Iron from time to time	
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside pumphouse
Tap Disinfected (Y/ N)	Bleach
Time	6:08 PM
Initial Temp.	6°C
Final Temp.	5°C
Purging Time	5 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	8.2
Field Conductivity	803 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N	
Drainage at base of well	Mounded / Flat / Depressed	
Septic (Field / Tank	Age: <1987 Distance: Direction: East side of house.	
Agricultural	Animals / Fields / Chemical / Fuel Storage/ None	
Industrial	Mining Pit Quarries/ None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of pump house and sampling tap located south of the house.

View of well in pump house.

View of east side of house where the septic tank is located.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	8D	
GW Drill PID		
UTM	N: 5683855	E: 530689
Name	First:	Last:
Home Address		
Land Location	SW17-27-8W	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential/ agricultural (cows)	
Well Location	Outside beside tap, west side of house	
Owner When Drilled	No	
Water Use	Drinking and cooking	
Driller		
Date Completed	1982-1984	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel/ unknown	
Pump Type	Size / age / diameter / unknown	
Depth to Pump		
Depth to Water		
Flowing Artesian Well	No	
Depth of Well		
Water Treatment	RO, softener/ iron	
Location of untreated taps	Outside and in kitchen	
Last Well Maintenance	None	
Last Well Disinfection	Shocked well couple of years ago (2012) during flooding	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)	Lots of iron, drink through a Brita filter	
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	Lots of iron	
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside
Tap Disinfected (Y/N)	Bleach
Time	11:00 AM
Initial Temp.	8°C
Final Temp.	7°C
Purging Time	5 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	8
Field Conductivity	783 µS/cm

Potential Contaminant Sources	
Piping Inspected to verify untreated supply?	Y / N
Is well located in a pit?	Y / N - Underground
Drainage at base of well	Mounded / Flat / Depressed
Septic (Field / Tank)	Age: ~1982 Distance: Direction: East side of house
Agricultural	Animals / Fields / Chemical / Fuel Storage / None
Industrial	Mining Pit Quarries / None

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of sampling tap and venting pipe on the west side of the house.

Tank is located under the decking on the east side of the house. Access is by the trap door.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	13D	
GW Drill PID		
UTM	N: 5688442	E: 530002
Name	First:	Last:
Home Address		
Land Location	NE30-27-8	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential/ cattle farm	
Well Location	North side of property	
Owner When Drilled	Yes	
Water Use	Drinking and cooking	
Driller		
Date Completed	Original well in pumphouse, new one drilled approximatly 10 years ago (2006)	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel 6"	
Pump Type	Size / age / diameter	Submersible, 10 years old
Depth to Pump	40'	
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	80-90'	
Water Treatment	RO/softener/ iron/ none	
Location of untreated taps	All taps	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	High iron	
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside of house
Tap Disinfected (Y/N)	Bleach
Time	12:00 PM
Initial Temp.	9°C
Final Temp.	6°C
Purging Time	5 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	8.5
Field Conductivity	721 µS/cm

Potential Contaminant Sources	
Piping Inspected to verify untreated supply?	Y / N
Is well located in a pit?	Y / N
Drainage at base of well	Mounded / Flat / Depressed
Septic (Field / Tank)	Age: 1974 Distance: Direction: South side of house.
Agricultural	Animals / Fields / Chemical / Fuel Storage/ None
Industrial	Mining Pit Quarries/ None

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of sampling tap located on the north side of the house.

View of well located in wishing well, located on the north side of the property.

View of septic tank located at the south side of the house.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	18D	
GW Drill PID		
UTM	N: 5688643	E: 528969
Name	First:	Last:
Home Address		
Land Location	SW31-27-8N	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential/ agricultural	
Well Location	Outside	
Owner When Drilled	No	
Water Use	Drinking	
Driller		
Date Completed	1983-1984	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter - Pump jet is original in outside housing unit	
Depth to Pump		
Depth to Water		
Flowing Artesian Well		
Depth of Well	145'	
Water Treatment	RO/softener/ iron / none	
Location of untreated taps	Outside, north side of house, beside well	
Last Well Maintenance	None, replaced pressure tank only	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results	1 year ago - results were good	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	More iron in the last couple of years	
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Outside of house
Tap Disinfected (Y/N)	Bleach
Time	5:40 PM
Initial Temp.	8°C
Final Temp.	7°C
Purging Time	5 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	7.9
Field Conductivity	816 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N - Concrete	
Drainage at base of well	Mounded / Flat / Depressed - Concrete	
Septic (Field / Tank)	Age: 1983-1984 Distance: Direction: East side of house	
Agricultural	Animals / Fields / Chemical / Fuel Storage	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of well housing unit on the north side of the house.

View of septic tank located on the east side of the house.

View of well in housing unit.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	26D	
GW Drill PID		
UTM	N: 5690279	E: 533596
Name	First:	Last:
Home Address	SE4-28W	
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Unknown	
Owner When Drilled	No	
Water Use	Drink water	
Driller		
Date Completed		
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter	
Depth to Pump		
Depth to Water		
Flowing Artesian Well		
Depth of Well		
Water Treatment	RO/softener/ iron	
Location of untreated taps	Kitchen - drinking water tap	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)	Sulphur	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	Hard water	
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Kitchen drinking water tap
Tap Disinfected (Y/N)	Bleach
Time	4:48 PM
Initial Temp.	14°C
Final Temp.	7°C
Purging Time	Ran bathroom tap for more than 10 minutes
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	7.5
Field Conductivity	802 µS/cm
Potential Contaminant Sources	
Piping Inspected to verify untreated supply?	Y / N
Is well located in a pit?	Y / N / Unknown
Drainage at base of well	Mounded / Flat / Depressed / unknown
Septic (Field / Tank)	Age: Distance: Direction: South
Agricultural	Animals / Fields / Chemical / Fuel Storage / None
Industrial	Mining Pit Quarries / None

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of septic field on the south side of the house.

View of the septic tank located on the south side of the house.

View of the pump located in the basement.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	27D	
GW Drill PID		
UTM	N: 5687834	E: 533581
Name	First:	Last:
Home Address		
Land Location	NE27, 28, 8W	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential & agricultural	
Well Location	Outside, north side of house, beside tap	
Owner When Drilled	No	
Water Use	Do not drink or cook with since the flood (2012)	
Driller		
Date Completed	50 years ago	
Formation		
Copy of Log		
Casing Type	Size / PVC / steel	
Pump Type	Size / age / diameter	
Depth to Pump	50'	
Depth to Water		
Flowing Artesian Well	No	
Depth of Well	55'	
Water Treatment	RO, softener / iron - and charcoal and sediment filters	
Location of untreated taps	outside	
Last Well Maintenance	wells blown out, got new piping	
Last Well Disinfection	Shocked the well last fall with pellets and powder	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	when lots of rain	
Copy of Previous Water Quality Results	Very good, once had bacteria then treated.	
Taste Concerns (Y/N)	Tastes bad	
Odour Concerns (Y/N)	Strong sulphur smell	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	Nitrates	
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside tap
Tap Disinfected (Y/N)	Bleach
Time	12:45 PM
Initial Temp.	9°C
Final Temp.	6°C
Purging Time	5 min
Colour	(visual) Clear
Odour	(visual) Sulphur
Turbidity	(visual) Clear
Field pH	7.6
Field Conductivity	798 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	**Note:** Septic tank was not visible during site visit.
Is well located in a pit?	Y / N / Unknown	Well located under a cover
Drainage at base of well	Mounded / Flat / Depressed / unknown	
Septic (Field / Tank)	Age: 50 Distance: Direction: SW side of house	
Agricultural	Animals / Fields / Chemical / Fuel Storage / None	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of well located under brick cover under bucket on the north side of the house.

View of the west side of the house.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	29D	
GW Drill PID	117635	
UTM	N: 5683855	E: 533734
Name	First: Dave and Marlene	Last: Metner
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Back of house under deck	
Owner When Drilled	Yes	
Water Use	Drinking and cooking	
Driller		
Date Completed	1978 - 1979	
Formation		
Copy of Log		
Casing Type	Size / PVC / steel / 4-5"	
Pump Type	Size / age / diameter - original don't know size	
Depth to Pump		
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	99-100'	
Water Treatment	RO / softener / iron	
Location of untreated taps	In front of house	
Last Well Maintenance	Treated before with pressure and chemicals	
Last Well Disinfection	Unknown	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results	Very good, once had bacteria then treated.	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside front of house, east side
Tap Disinfected (Y/ N)	Bleach
Time	10:15 AM
Initial Temp.	7°C
Final Temp.	6°C
Purging Time	6 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	8.1
Field Conductivity	890 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	**Notes:** Was told well located under deck but saw what looked like a septic tank. Home owner not home to verify septic or well location.
Is well located in a pit?	Y / N - Under deck	
Drainage at base of well	Mounded / Flat / Depressed / Unknown	
Septic (Field / Tank)	Age: Distance: Direction:	
Agricultural	Animals / Fields / Chemical / Fuel Storage/ None	
Industrial	Mining Pit Quarries/ None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of sample tap location on the east side of the house.

View of piping under the deck on the west side of the house, which could be septic or a well.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	37D	
GW Drill PID		
UTM	N: 5693481	E: 533429
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Outside southeast corner of house	
Owner When Drilled	Yes	
Water Use	Don't cook or drink water	
Driller		
Date Completed	~1996	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel 5"	
Pump Type	Size / age / diameter	Submersible 1 horsepower, ~1996
Depth to Pump	60'	
Depth to Water	`8'	
Flowing Artesian Well	No	
Depth of Well	110'	
Water Treatment	RO/softener/ iron / none	
Location of untreated taps	Kitchen tap	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Smells in the fall	
Copy of Previous Water Quality Results	Yes - see picture below	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)	Smells in the fall	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)	Had TC 4 months ago, with result of 13.	
Chemical Concerns (Y/N)	High iron	
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Kitchen tap
Tap Disinfected (Y/N)	Bleach
Time	3:45 PM
Initial Temp.	-
Final Temp.	7°C
Purging Time	5 minutes, total of 10, because ran bathtub while bleaching
Colour	(visual) clear
Odour	(visual) No
Turbidity	(visual) clear
Field pH	7.5
Field Conductivity	820 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N Buried under soil, vent pipe present	
Drainage at base of well	Mounded / Flat / Depressed / Underground	
Septic (Field / Tank)	Age: Field (50 yrs old) Tank (45 yrs old) Distance: Direction: NE side of house	
Agricultural	Animals / Fields / Chemical / Fuel Storage / None - Used to be cattle	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of laboratory results.

View of septic tank, under the yellow cap on the NE side of the house.

View of black pipe venting the buried well located on the SE side of the house.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	38D	
GW Drill PID		
UTM	N: 5693324	E: 532537
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Underground - don't know where it is	
Owner When Drilled	No	
Water Use	Drinking and cooking	
Driller		
Date Completed	20-25 years ago	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter	
Depth to Pump		
Depth to Water		
Flowing Artesian Well		
Depth of Well		
Water Treatment	RO/ softener/ iron - and sediment filter	
Location of untreated taps	Outside of house	
Last Well Maintenance	None	
Last Well Disinfection	Unknown	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results	1 year ago - results were good	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	Rusty	
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Outside of house
Tap Disinfected (Y/N)	Bleach
Time	4:15 PM
Initial Temp.	10°C
Final Temp.	8°C
Purging Time	10 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	7.5
Field Conductivity	918 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N Underground	
Drainage at base of well	Mounded / Flat / Depressed	
Septic (Field / Tank)	Age: Distance: Direction: South	
Agricultural	Animals / Fields / Chemical / Fuel Storage / None	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of septic tank on the south side of the house.

View of septic tank.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	44D	
GW Drill PID		
UTM	N: 5693001	E: 529071
Name	First:	Last:
Home Address		
Land Location	NW7, 28, 8W	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	North side of house	
Owner When Drilled	Yes	
Water Use	Drinking water	
Driller		
Date Completed	2012 - due to flood	
Formation		
Copy of Log		
Casing Type	Size / PVC / steel 5"	
Pump Type	Size / age / diameter 1/2 H - year 2012	
Depth to Pump	Submersible	
Depth to Water	6'	
Flowing Artesian Well	No	
Depth of Well	~120'	
Water Treatment	RO/softener/ iron - RO for coffee and ice	
Location of untreated taps	Inside tap - basement	
Last Well Maintenance	None	
Last Well Disinfection	Summer - 2016 - used javex	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)	Sediment filter full of stuff, therefore, shocked the well	
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Inside basement
Tap Disinfected (Y/N)	Bleach
Time	2:18 PM
Initial Temp.	7°C (was runnig hose outside to flush well)
Final Temp.	7°C
Purging Time	6 Minutes
Colour	(visual) clear
Odour	(visual) no
Turbidity	(visual) clear
Field pH	7.8
Field Conductivity	861 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N - Unknown	
Drainage at base of well	Mounded / Flat / Depressed/ Underground	
Septic (Field / Tank)	Age: 1981 Distance: Direction: West side of house	
Agricultural	Animals / Fields / Chemical / Fuel Storage/ None	
Industrial	Mining Pit Quarries/ None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of sampling tap located in the basement.

View of well located at the north side of the house.

View of well.

View of septic tank located at the west side of the house.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	50D	
GW Drill PID		
UTM	N: 5695655	E: 530603
Name	First:	Last:
Home Address		
Land Location	SW20-28-8W	
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential, agricultural (cattle)	
Well Location	East side	
Owner When Drilled	No	
Water Use	Drinking and cooking	
Driller		
Date Completed	1960-1970	
Formation	Bedrock (80-90')	
Copy of Log		
Casing Type	Size / PVC / steel - 6"	
Pump Type	Size / age / diameter - outside of well	
Depth to Pump		
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	100'	
Water Treatment	RO/softener/ iron / none	
Location of untreated taps	Outside off of well	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Tastes different if overflow isn't running	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)	Tastes different if overflow isn't running	
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside well tap - through yellow nozzle- east side of house
Tap Disinfected (Y/N)	Bleach
Time	3:00 PM
Initial Temp.	7°C
Final Temp.	6°C
Purging Time	5 min
Colour	(visual) Clear
Odour	(visual) No
Turbidity	(visual) Clear
Field pH	8.1
Field Conductivity	745 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N - Basement concrete	
Drainage at base of well	Mounded / Flat / Depressed	
Septic (Field / Tank)	Age: early 1970s Distance: Direction: Tank (south), field (west)	
Agricultural	Animals / Fields / Chemical / Fuel Storage - Cattle	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of well cover located on the east side of the house.

View of septic field located on the south side of the house.

View of well.

View of well equipment.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	54D	
GW Drill PID		
UTM	N: 5694833	E: 533713
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Under hay bale, located on the north side of the house	
Owner When Drilled	Yes	
Water Use	Cooking - boil water first	
Driller		
Date Completed	1976 ~	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter	Pump in house, replaced 4-5 years ago
Depth to Pump		
Depth to Water		
Flowing Artesian Well	No	
Depth of Well	30-60'	
Water Treatment	RO/softener/ iron	Sediment filter only
Location of untreated taps	outside, south side of the house	
Last Well Maintenance	None	
Last Well Disinfection	2 years ago, shocked well with powder chlorine	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results	Never sampled before.	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)	High iron	
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Outside, south side of house
Tap Disinfected (Y / N)	Bleach
Time	3:00 PM
Initial Temp.	11°C
Final Temp.	8°C
Purging Time	10 min
Colour	(visual) clear
Odour	(visual) no
Turbidity	(visual) clear
Field pH	7.4
Field Conductivity	831 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N	
Drainage at base of well	Mounded / Flat / Depressed	
Septic (Field / Tank)	Age: Distance: Direction: North	
Agricultural	Animals / Fields / Chemical / Fuel Storage / None	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of hay bail in distance covering well (south side).

View of hay bails covering the septic tank (north side).

WELL INVENTORY

Date: 19-Oct-16

Survey ID	68D	
GW Drill PID		
UTM	N: 5700995	E: 531369
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential - drink water through sediment filter	
Well Location	West side of home	
Owner When Drilled	yes	
Water Use	Drinking and cooking	
Driller		
Date Completed	2010	
Formation		
Copy of Log		
Casing Type	Size / (PVC) / steel - 5"	
Pump Type	Size / age / diameter - 1/2 Horsepower 4" pump (2010)	
Depth to Pump	60' submersible	
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	80'	
Water Treatment	RO/softener/ iron / (sediment)	
Location of untreated taps	Direct from well	
Last Well Maintenance	None	
Last Well Disinfection	None - although sampled last year and had a small amount of bacteria	
Adequate Supply (Y/N)	Yes	
Seasonal Changes (Y/N)	Lake water formation - loose shale formation, changes with wind direction	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)	Sandy	
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	From well
Tap Disinfected (Y/N)	Could not, sampled from flowing well
Time	1:30 PM
Initial Temp.	7°C
Final Temp.	6°C
Purging Time	10 minutes
Colour	(visual) clear
Odour	(visual) no
Turbidity	(visual) clear
Field pH	7.6
Field Conductivity	986 µS/cm

Potential Contaminant Sources	
Piping Inspected to verify untreated supply?	Y / N
Is well located in a pit?	Y / N
Drainage at base of well	Mounded / Flat / Depressed
Septic (Field / Tank)	Age: 15yrs Distance: 250' from house Direction: East
Agricultural	Animals / Fields / Chemical / Fuel Storage
Industrial	Mining Pit Quarries / None

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

Septic tank pump out, 250' from houseout back and 300' from well (but pic much closer)

Well located at front of house on the west side.

Septic tank and pump pit located at back of house on the east side.

WELL INVENTORY

Date: 20-Oct-16

Survey ID	72D	
GW Drill PID		
UTM	N: 5701734	E: 532655
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type		
Well Location		
Owner When Drilled		
Water Use		
Driller		
Date Completed		
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel / unknown	
Pump Type	Size / age / diameter / unknown	
Depth to Pump		
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	60'	
Water Treatment	RO/softener/ iron/ none / unknown	
Location of untreated taps		
Last Well Maintenance		
Last Well Disinfection		
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Unknown	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)		
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	20-Oct-16
Tap Used	Outside trough from well
Tap Disinfected (Y/N)	Bleached around outside hose
Time	4:00 PM
Initial Temp.	7°C
Final Temp.	7°C
Purging Time	Constantly flowing
Colour	(visual) clear
Odour	(visual) none
Turbidity	(visual) clear
Field pH	7.8
Field Conductivity	855 µS/cm

Potential Contaminant Sources	
Piping Inspected to verify untreated supply?	Y / N
Is well located in a pit?	Y N
Drainage at base of well	Mounded / Flat / Depressed/ Underground/ Unknown
Septic (Field / Tank)	Age: Distance: Direction: No septic field or tank
Agricultural	Animals / Fields / Chemical / Fuel Storage
Industrial	Mining Pit Quarries/ None

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of sampling spout.

Top view of well and sampling spout.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	73D	
GW Drill PID		
UTM	N: 5697723	E: 534285
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	residential	
Well Location	Outside under the deck (south side)	
Owner When Drilled	yes	
Water Use	Drinking	
Driller		
Date Completed	1983	
Formation		
Copy of Log		
Casing Type	Size / PVC / steel	
Pump Type	Size / age / diameter - New Pump - last couple of years, located inside house	
Depth to Pump	Located inside house	
Depth to Water	45'	
Flowing Artesian Well	no	
Depth of Well	150'	
Water Treatment	RO/softener/ iron / sediment	
Location of untreated taps	All taps go through sediment filter	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Smells in the spring time	
Copy of Previous Water Quality Results		
Taste Concerns (Y/N)		
Odour Concerns (Y/N)	Fixed with filter	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)	Tested in 2011 and no problems	
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	outside
Tap Disinfected (Y/N)	Bleach
Time	2:07pm
Initial Temp.	7°C
Final Temp.	5°C
Purging Time	5 minutes
Colour	(visual) clear
Odour	(visual) no
Turbidity	(visual) clear
Field pH	7.6
Field Conductivity	895 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N	
Drainage at base of well	Mounded / Flat / Depressed / Unknown	
Septic (Field / Tank)	Age: 1982 Distance: 10' from house Direction: North	
Agricultural	Animals / Fields / Chemical / Fuel Storage large ASTs located approx. 100' from house	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of well located under deck housed in little shed on the South side

View of septic tank located on the north side.

View of large ASTs in the distance.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	76D	
GW Drill PID		
UTM	N: 5702353	E: 532837
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Other side of lilacs, north side of house	
Owner When Drilled	Yes	
Water Use	Drinking water	
Driller		
Date Completed	1978	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel	
Pump Type	Size / age / diameter - Submersible - couple of years old, have had problems with the pump in the last of couple of years	
Depth to Pump		
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well	116'	
Water Treatment	RO/softener/ iron	
Location of untreated taps	Outside North side of house	
Last Well Maintenance	Couple years ago - something detached	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)	Smelly in spring	
Copy of Previous Water Quality Results	Someone sampled last year and the results were good.	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)	Smelly in spring	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Outside North side of house
Tap Disinfected (Y/N)	Bleach
Time	12:45 PM
Initial Temp.	9.5°C
Final Temp.	6°C
Purging Time	5 Minutes
Colour	(visual) clear
Odour	(visual) Sulphur
Turbidity	(visual) clear
Field pH	7.7
Field Conductivity	873 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N - Unknown	
Drainage at base of well	Mounded / Flat / Depressed/ Underground	
Septic (Field / Tank)	Age: 1978 Distance:	Direction:
Agricultural	Animals / Fields / Chemical / Fuel Storage	
Industrial	Mining Pit Quarries / None	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

Location of septic tank underneath the picnic table on the northwest side of the house.

Location of well buried below the ground on the north side of the house.

WELL INVENTORY

Date: 19-Oct-16

Survey ID	77D	
GW Drill PID		
UTM	N: 5702268	E: 533841
Name	First:	Last:
Home Address		
Land Location		
Mailing Address		
Home/Business Phone		
Cell Phone		
e-mail		
Property Type	Residential	
Well Location	Basement	
Owner When Drilled	Yes	
Water Use	Drinking and cooking	
Driller		
Date Completed	1965	
Formation		
Copy of Log		
Casing Type	Size / PVC/ steel 4"	
Pump Type	Size / age / diameter Replaced external artesional pump (pressure pump)	
Depth to Pump	ok	
Depth to Water	At surface	
Flowing Artesian Well	Yes	
Depth of Well		
Water Treatment	RO/ softener/ Iron - and Microfiber filter	
Location of untreated taps	Outside, south side of house	
Last Well Maintenance	None	
Last Well Disinfection	None	
Adequate Supply (Y/N)		
Seasonal Changes (Y/N)		
Copy of Previous Water Quality Results	Never sampled before.	
Taste Concerns (Y/N)		
Odour Concerns (Y/N)	Sulphur	
Clarity Concerns (Y/N)		
Bacteria Concerns (Y/N)		
Chemical Concerns (Y/N)		
Additional Comments		

Water Test (use only untreated tap)	
Date:	19-Oct-16
Tap Used	Outside, south side of house
Tap Disinfected (Y/N)	Bleach
Time	11:45AM
Initial Temp.	7°C
Final Temp.	6°C
Purging Time	5 Minutes
Colour	(visual) clear
Odour	(visual) Sulphur
Turbidity	(visual) clear
Field pH	7.5
Field Conductivity	840 µS/cm

Potential Contaminant Sources		
Piping Inspected to verify untreated supply?	Y / N	
Is well located in a pit?	Y / N	
Drainage at base of well	Mounded / Flat / Depressed	Photo Numbers:
Septic (Field / Tank)	Age: 1965 Distance: 5' Direction: south side	
Agricultural	Animals / Fields / Chemical / Fuel Storage - for tractors	
Industrial	Mining Pit Quarries / none	

Field Sketch (with approx. distances of residence, well, septic, road, & landmarks)

View of well located inside the basement.

View of septic tank located on the south side of the house.

APPENDIX D4-I

LABORATORY RESULTS ROUTE C AND D

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 77D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-1
Matrix: GW

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	394		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.010		mg/L	10		24-OCT-16
pH						
pH	7.77		pH units			21-OCT-16
Turbidity						
*Turbidity	3.58		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0195		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.432		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	70.2		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00032		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	0.00021		mg/L			28-OCT-16
Copper (Cu)-Total	0.00101		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.281		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0301		mg/L			28-OCT-16
Magnesium (Mg)-Total	44.3		mg/L			28-OCT-16
Manganese (Mn)-Total	0.0183		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00047		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	8.95		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00593		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	5.32		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	24.2		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.492		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 77D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00030		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0056		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	435		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	89.4		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0025	DLM	mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	358	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	1.08		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	679		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.35		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	323		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 77D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

<Original signed by>

Approved by _____
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 76D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	397		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.010		mg/L	10		24-OCT-16
pH						
pH	7.76		pH units			21-OCT-16
Turbidity						
*Turbidity	11.9		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0071		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0174		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.471		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	73.3		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00021		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			28-OCT-16
Copper (Cu)-Total	0.00089		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.993		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0341		mg/L			28-OCT-16
Magnesium (Mg)-Total	42.9		mg/L			28-OCT-16
Manganese (Mn)-Total	0.0165		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00028		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	9.90		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00757		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.89		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	31.5		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.522		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 76D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00052		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0221		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	462		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	101		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	360	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	1.10		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	712		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	7.50		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	326		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 76D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 68D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	491		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.010		mg/L	10		24-OCT-16
pH						
pH	7.65		pH units			21-OCT-16
Turbidity						
*Turbidity	3.44		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0391		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0205		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.527		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	79.3		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00018		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	0.00025		mg/L			28-OCT-16
Copper (Cu)-Total	<0.00020		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.034		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0406		mg/L			28-OCT-16
Magnesium (Mg)-Total	54.8		mg/L			28-OCT-16
Manganese (Mn)-Total	0.0251		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	<0.00020		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	11.0		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00736		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	5.57		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	30.3		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.520		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	0.00162		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 68D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-3
Matrix: GW

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00212		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	<0.0020		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	525		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	103		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	424	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.323		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	791		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.53		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	403		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	2		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 68D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 73D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	422		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	0.336		mg/L	10		24-OCT-16
pH						
pH	7.66		pH units			21-OCT-16
Turbidity						
*Turbidity	2.53		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	0.00042		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0218		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.600		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	76.1		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00019		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	0.00058		mg/L			28-OCT-16
Copper (Cu)-Total	0.00100		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.336		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0359		mg/L			28-OCT-16
Magnesium (Mg)-Total	48.4		mg/L			28-OCT-16
Manganese (Mn)-Total	0.00521		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00192		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	12.4		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00838		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.27		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	20.3		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.635		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 73D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00038		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0051		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	472		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	100		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0043		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.331		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	389	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	1.04		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	721		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.44		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	346		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 73D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 54D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	411		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.010		mg/L	10		24-OCT-16
pH						
pH	7.70		pH units			21-OCT-16
Turbidity						
*Turbidity	3.13		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	0.00206		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0199		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.459		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	72.3		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00013		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	0.00151		mg/L			28-OCT-16
Copper (Cu)-Total	0.00209		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.306		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	0.000152		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0292		mg/L			28-OCT-16
Magnesium (Mg)-Total	46.8		mg/L			28-OCT-16
Manganese (Mn)-Total	0.00752		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00047		mg/L			28-OCT-16
Nickel (Ni)-Total	0.0049		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	9.72		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00668		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.38		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	16.6		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.454		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

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Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 54D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00017		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0112		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	440		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	89.9		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	373	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.905		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	681		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.79		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	337		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 54D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 37D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	411		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		24-OCT-16
pH						
pH	7.66		pH units			21-OCT-16
Turbidity						
*Turbidity	1.50		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	0.00053		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0196		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.356		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	70.3		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00012		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			28-OCT-16
Copper (Cu)-Total	0.00131		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.140		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0272		mg/L			28-OCT-16
Magnesium (Mg)-Total	49.1		mg/L			28-OCT-16
Manganese (Mn)-Total	0.00383		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00044		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	7.24		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00554		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.36		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	14.9		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.379		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 37D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00034		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0034		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	435		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	88.5		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	378	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.572		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	672		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.68		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	337		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	3		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 37D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

<Original signed by>

Approved by _____
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 38D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	410		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.010		mg/L	10		24-OCT-16
pH						
pH	7.74		pH units			21-OCT-16
Turbidity						
*Turbidity	7.47		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	0.00330		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0176		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.577		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	77.4		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00010		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	0.00036		mg/L			28-OCT-16
Copper (Cu)-Total	0.00167		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.546		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	0.000104		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0348		mg/L			28-OCT-16
Magnesium (Mg)-Total	47.4		mg/L			28-OCT-16
Manganese (Mn)-Total	0.00543		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00081		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	11.4		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00672		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	5.23		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	29.2		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.575		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 38D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-7
Matrix: GW

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ATTN: Marci Friedman Hamm

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00047		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0206		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	501		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	129		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	388	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.581		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	744		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.03		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	336		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	2		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 38D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by _<Original signed by>_____
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 26D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	405		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		24-OCT-16
pH						
pH	7.66		pH units			21-OCT-16
Turbidity						
*Turbidity	1.11		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	0.00032		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0228		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.316		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	66.5		mg/L			28-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	0.00020		mg/L			28-OCT-16
Copper (Cu)-Total	0.00133		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.098		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0270		mg/L			28-OCT-16
Magnesium (Mg)-Total	50.0		mg/L			28-OCT-16
Manganese (Mn)-Total	0.0155		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00038		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	6.99		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00567		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.38		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	14.1		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.375		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 26D
Sampled By: LSA/RC
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Lab Sample ID: L1846236-8
Matrix: GW

KGS Group Consultants (Winnipeg)
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Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00015		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0034		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	422		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	81.7		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	372	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.944		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	658		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	3.03		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 26D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-8
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 18D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-9
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	298		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		24-OCT-16
pH						
pH	7.95		pH units			21-OCT-16
Turbidity						
*Turbidity	0.56		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0263		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.598		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	54.7		mg/L			28-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			28-OCT-16
Copper (Cu)-Total	0.00117		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.073		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0334		mg/L			28-OCT-16
Magnesium (Mg)-Total	36.6		mg/L			28-OCT-16
Manganese (Mn)-Total	0.0181		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00048		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	8.99		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00476		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.17		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	46.3		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.390		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

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Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 18D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-9
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00122		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0686		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	452		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	145		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	287	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.687		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	679		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.7		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	244		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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Sample ID: 18D
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Date Collected: 19-OCT-16
Lab Sample ID: L1846236-9
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

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ATTN: Marci Friedman Hamm

Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 1026D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-10
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	400		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		24-OCT-16
pH						
pH	7.70		pH units			21-OCT-16
Turbidity						
*Turbidity	0.69		NTU			21-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	28-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		28-OCT-16
Arsenic (As)-Total	0.00033		mg/L	0.01		28-OCT-16
Barium (Ba)-Total	0.0230		mg/L	1		28-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			28-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			28-OCT-16
Boron (B)-Total	0.318		mg/L	5		28-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		28-OCT-16
Calcium (Ca)-Total	66.5		mg/L			28-OCT-16
Cesium (Cs)-Total	0.00011		mg/L			28-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		28-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			28-OCT-16
Copper (Cu)-Total	0.00107		mg/L		1.0	28-OCT-16
Iron (Fe)-Total	0.100		mg/L		0.3	28-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		28-OCT-16
Lithium (Li)-Total	0.0262		mg/L			28-OCT-16
Magnesium (Mg)-Total	49.9		mg/L			28-OCT-16
Manganese (Mn)-Total	0.0156		mg/L		0.05	28-OCT-16
Molybdenum (Mo)-Total	0.00039		mg/L			28-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			28-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			28-OCT-16
Potassium (K)-Total	7.04		mg/L			28-OCT-16
Rubidium (Rb)-Total	0.00552		mg/L			28-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		28-OCT-16
Silicon (Si)-Total	4.39		mg/L			28-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			28-OCT-16
Sodium (Na)-Total	14.0		mg/L		200	28-OCT-16
Strontium (Sr)-Total	0.387		mg/L			28-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			28-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			28-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			28-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			28-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			28-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			28-OCT-16

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Date: 31-OCT-16
PO No.:
WO No.: L1846236
Project Ref: 16-0300-006.1020
Sample ID: 1026D
Sampled By: LSA/RC
Date Collected: 19-OCT-16
Lab Sample ID: L1846236-10
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00015		mg/L	0.02		28-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			28-OCT-16
Zinc (Zn)-Total	0.0034		mg/L		5.0	28-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			28-OCT-16
TDS calculated						
TDS (Calculated)	419		mg/L		500	31-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	81.7		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	371	HTC	mg/L		500	31-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.943		mg/L	1.5		21-OCT-16
Conductivity						
Conductivity	660		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	3.03		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	328		mg/L			21-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		20-OCT-16
Escherichia Coli	0		MPN/100mL	0		20-OCT-16

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Date Collected: 19-OCT-16
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Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by _<Original signed by>__
Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1846236 Report Date: 31-OCT-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3577176								
WG2416510-19 LCS								
Alkalinity, Total (as CaCO3)			105.9		%		85-115	21-OCT-16
WG2416510-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	21-OCT-16
EC-WP	**Water**							
Batch R3577176								
WG2416510-18 LCS								
Conductivity			98.1		%		90-110	21-OCT-16
WG2416510-16 MB								
Conductivity			<1.0		umhos/cm		1	21-OCT-16
MET-T-L-MS-WP	**Water**							
Batch R3583093								
WG2421133-2 LCS								
Aluminum (Al)-Total			104.9		%		80-120	28-OCT-16
Antimony (Sb)-Total			102.2		%		80-120	28-OCT-16
Arsenic (As)-Total			104.0		%		80-120	28-OCT-16
Barium (Ba)-Total			106.4		%		80-120	28-OCT-16
Beryllium (Be)-Total			103.8		%		80-120	28-OCT-16
Bismuth (Bi)-Total			107.0		%		80-120	28-OCT-16
Boron (B)-Total			106.5		%		80-120	28-OCT-16
Cadmium (Cd)-Total			105.8		%		80-120	28-OCT-16
Calcium (Ca)-Total			106.4		%		80-120	28-OCT-16
Cesium (Cs)-Total			106.6		%		80-120	28-OCT-16
Chromium (Cr)-Total			104.4		%		80-120	28-OCT-16
Cobalt (Co)-Total			102.9		%		80-120	28-OCT-16
Copper (Cu)-Total			101.9		%		80-120	28-OCT-16
Iron (Fe)-Total			98.2		%		80-120	28-OCT-16
Lead (Pb)-Total			106.2		%		80-120	28-OCT-16
Lithium (Li)-Total			102.9		%		80-120	28-OCT-16
Magnesium (Mg)-Total			107.8		%		80-120	28-OCT-16
Manganese (Mn)-Total			107.3		%		80-120	28-OCT-16
Molybdenum (Mo)-Total			110.2		%		80-120	28-OCT-16
Nickel (Ni)-Total			102.5		%		80-120	28-OCT-16
Phosphorus (P)-Total			108.0		%		80-120	28-OCT-16
Potassium (K)-Total			104.6		%		80-120	28-OCT-16
Rubidium (Rb)-Total			107.3		%		80-120	28-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3583093								
WG2421133-2 LCS								
Selenium (Se)-Total			97.0		%		80-120	28-OCT-16
Silicon (Si)-Total			98.0		%		80-120	28-OCT-16
Silver (Ag)-Total			105.6		%		80-120	28-OCT-16
Sodium (Na)-Total			104.7		%		80-120	28-OCT-16
Strontium (Sr)-Total			107.7		%		80-120	28-OCT-16
Tellurium (Te)-Total			99.7		%		80-120	28-OCT-16
Thallium (Tl)-Total			103.8		%		80-120	28-OCT-16
Thorium (Th)-Total			101.3		%		80-120	28-OCT-16
Tin (Sn)-Total			107.4		%		80-120	28-OCT-16
Titanium (Ti)-Total			101.2		%		80-120	28-OCT-16
Tungsten (W)-Total			100.9		%		80-120	28-OCT-16
Uranium (U)-Total			103.2		%		80-120	28-OCT-16
Vanadium (V)-Total			105.9		%		80-120	28-OCT-16
Zinc (Zn)-Total			95.9		%		80-120	28-OCT-16
Zirconium (Zr)-Total			108.0		%		80-120	28-OCT-16
WG2421133-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	28-OCT-16
Antimony (Sb)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Arsenic (As)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Barium (Ba)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Beryllium (Be)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Boron (B)-Total			<0.010		mg/L		0.01	28-OCT-16
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	28-OCT-16
Calcium (Ca)-Total			<0.10		mg/L		0.1	28-OCT-16
Cesium (Cs)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Chromium (Cr)-Total			<0.0010		mg/L		0.001	28-OCT-16
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Copper (Cu)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Iron (Fe)-Total			<0.010		mg/L		0.01	28-OCT-16
Lead (Pb)-Total			<0.000090		mg/L		0.00009	28-OCT-16
Lithium (Li)-Total			<0.0020		mg/L		0.002	28-OCT-16
Magnesium (Mg)-Total			<0.010		mg/L		0.01	28-OCT-16
Manganese (Mn)-Total			<0.00030		mg/L		0.0003	28-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3583093								
WG2421133-1 MB								
Molybdenum (Mo)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Nickel (Ni)-Total			<0.0020		mg/L		0.002	28-OCT-16
Phosphorus (P)-Total			<0.10		mg/L		0.1	28-OCT-16
Potassium (K)-Total			<0.020		mg/L		0.02	28-OCT-16
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Selenium (Se)-Total			<0.0010		mg/L		0.001	28-OCT-16
Silicon (Si)-Total			<0.10		mg/L		0.1	28-OCT-16
Silver (Ag)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Sodium (Na)-Total			<0.030		mg/L		0.03	28-OCT-16
Strontium (Sr)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Thorium (Th)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Tin (Sn)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Titanium (Ti)-Total			<0.00050		mg/L		0.0005	28-OCT-16
Tungsten (W)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Uranium (U)-Total			<0.00010		mg/L		0.0001	28-OCT-16
Vanadium (V)-Total			<0.00020		mg/L		0.0002	28-OCT-16
Zinc (Zn)-Total			<0.0020		mg/L		0.002	28-OCT-16
Zirconium (Zr)-Total			<0.00040		mg/L		0.0004	28-OCT-16
PH-WP	**Water**							
Batch R3577176								
WG2416510-17 LCS								
pH			7.42		pH units		7.3-7.5	21-OCT-16
TC,EC-QT51-WP	**Water**							
Batch R3576658								
WG2415107-1 DUP		**L1846236-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-10 DUP		**L1846236-10**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-2 DUP		**L1846236-2**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R3576658								
WG2415107-2 DUP		**L1846236-2**						
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-3 DUP		**L1846236-3**						
Total Coliforms		2	0	DUPM	MPN/100mL	2	2	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-4 DUP		**L1846236-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-5 DUP		**L1846236-5**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-6 DUP		**L1846236-6**						
Total Coliforms		3	0	DUPM	MPN/100mL	3	2	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-7 DUP		**L1846236-7**						
Total Coliforms		2	1	J	MPN/100mL	1	2	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-8 DUP		**L1846236-8**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-9 DUP		**L1846236-9**						
Total Coliforms		0	0		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	20-OCT-16
WG2415107-11 MB								
Total Coliforms			0		MPN/100mL		1	20-OCT-16
Escherichia Coli			0		MPN/100mL		1	20-OCT-16
WG2415107-12 MB								
Total Coliforms			0		MPN/100mL		1	20-OCT-16
Escherichia Coli			0		MPN/100mL		1	20-OCT-16
WG2415107-13 MB								
Total Coliforms			0		MPN/100mL		1	20-OCT-16
Escherichia Coli			0		MPN/100mL		1	20-OCT-16
TURBIDITY-WP	**Water**							
Batch R3577894								
WG2416498-9 LCS								
Turbidity			101.5		%		85-115	21-OCT-16
WG2416498-7 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WP	**Water**							
Batch R3577894								
WG2416498-7 MB								
Turbidity			<0.10		NTU		0.1	21-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
J	Duplicate results and limits are expressed in terms of absolute difference.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	19-OCT-16 11:30	21-OCT-16 11:30	0.25	48	hours	EHTR-FM
	2	19-OCT-16 12:45	21-OCT-16 11:30	0.25	47	hours	EHTR-FM
	3	19-OCT-16 13:30	21-OCT-16 11:30	0.25	46	hours	EHTR-FM
	4	19-OCT-16 14:07	21-OCT-16 11:30	0.25	45	hours	EHTR-FM
	5	19-OCT-16 15:20	21-OCT-16 11:30	0.25	44	hours	EHTR-FM
	6	19-OCT-16 16:00	21-OCT-16 11:30	0.25	43	hours	EHTR-FM
	7	19-OCT-16 16:20	21-OCT-16 11:30	0.25	43	hours	EHTR-FM
	8	19-OCT-16 17:00	21-OCT-16 11:30	0.25	42	hours	EHTR-FM
	9	19-OCT-16 17:45	21-OCT-16 11:30	0.25	42	hours	EHTR-FM
	10	19-OCT-16 17:15	21-OCT-16 11:30	0.25	42	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	19-OCT-16 11:30	21-OCT-16 13:00	48	49	hours	EHTL
Nitrite in Water by IC (Low Level)							
	1	19-OCT-16 11:30	21-OCT-16 13:00	48	49	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1846236 were received on 20-OCT-16 13:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

L1846236-COFC

10-373386

L1846236

Page 1 of 1

Report To	Report Format / Distribution	Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company: KGS Group	Standard: ✓ Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact: Marci Friedman-Hamm	Select: PDF ✓ Excel ✓ Digital Fax	Priority (2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address: 3rd Floor 865 Waverley St.	Email 1: mfhamm@Kgsgroup.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Email 2: landres@kgsgroup.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone: (204) 896-1209 Fax:		
Invoice To Same as Report ? (circle) (Yes) or No (if No, provide details)	Client / Project Information	Analysis Request
Copy of Invoice with Report? (circle) Yes or No	Job #: 16-0300-006.1020	(Indicate Filtered or Preserved, F/P)
Company:	PO / AFE:	
Contact:	LSD:	
Address:		
Phone: Fax:	Quote #: Q58403	
Lab Work Order # (lab use only)	ALS Contact: Judy Sampler: LSA /RC	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROU4W+MET-T-L4WP	TC/EC/QTSI	Number of Containers
1	77D	19-10-16	11:30 am	GW	X	X	3
2	76D		12:45pm				
3	68D		1:30pm				
4	73D		2:07pm				
5	54D		3:20pm				
6	37D		4:00pm				
7	38D		4:20pm				
8	26D		5:00pm				
9	18D		5:45pm				
10	10260		5:15pm				

all metals & bacteria had preservative added.

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: <Original signed by>	Date: Oct. 20/16	Time: 13:00	Received by: A.K.	Date: Oct 20/16	Time: 1:00PM	Temperature: 2.0 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 29D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-1
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	350		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	7.75		pH units			24-OCT-16
Turbidity						
*Turbidity	3.07		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0170		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.617		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	78.0		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00079		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.247		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0355		mg/L			31-OCT-16
Magnesium (Mg)-Total	44.8		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00931		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00052		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	10.6		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00763		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.86		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	35.2		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.576		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 29D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-1
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00050		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0070		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	514		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	163		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	379	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.592		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	767		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	10.6		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	287		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 29D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-1
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 13D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-2
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	253		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	8.01		pH units			24-OCT-16
Turbidity						
*Turbidity	0.13		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0208		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.526		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	45.2		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00025		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.039		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0314		mg/L			31-OCT-16
Magnesium (Mg)-Total	28.7		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00641		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00080		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	7.68		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00369		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.00		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	52.8		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.337		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 13D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-2
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00095		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	<0.0020		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	397		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	116		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	231	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.793		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	628		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	22.1		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	208		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 13D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-2
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 8D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-3
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	288		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	7.94		pH units			24-OCT-16
Turbidity						
*Turbidity	0.45		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0253		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.623		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	57.8		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00361		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.155		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0357		mg/L			31-OCT-16
Magnesium (Mg)-Total	37.2		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00813		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00058		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	9.06		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00457		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.41		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	44.4		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.427		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
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Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 8D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-3
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00127		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0197		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	448		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	141		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	298	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.525		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	685		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.3		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	236		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

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Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 8D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-3
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 27D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-4
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	377		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	7.67		pH units			24-OCT-16
Turbidity						
*Turbidity	3.86		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	0.00026		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0200		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.530		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	73.0		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00137		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.997		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.000119		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0342		mg/L			31-OCT-16
Magnesium (Mg)-Total	46.0		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00900		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00038		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	9.83		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00685		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.80		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	20.2		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.520		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 27D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-4
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00013		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0378		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	459		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	119		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	372	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.821		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	712		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.67		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	309		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 27D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-4
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 44D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-5
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	391		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	7.73		pH units			24-OCT-16
Turbidity						
*Turbidity	0.35		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0235		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.556		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	74.7		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00312		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.049		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.000423		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0355		mg/L			31-OCT-16
Magnesium (Mg)-Total	44.6		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00432		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00033		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	10.0		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00735		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.52		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	30.4		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.586		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 44D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-5
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00036		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0036		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	483		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	124		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	370	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	1.22		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	738		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	7.69		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	320		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 44D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-5
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 50D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-6
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	279		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	7.97		pH units			24-OCT-16
Turbidity						
*Turbidity	0.57		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	0.00052		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0263		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.503		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	53.9		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00161		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.081		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.000117		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0257		mg/L			31-OCT-16
Magnesium (Mg)-Total	35.0		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00962		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00045		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	7.09		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00424		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.23		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	39.7		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.357		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

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Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 50D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-6
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00081		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0133		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	410		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	125		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	279	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.616		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	636		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	12.2		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	228		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 50D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-6
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 12C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-7
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	711		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	11.9		mg/L	10		25-OCT-16
pH						
pH	7.74		pH units			24-OCT-16
Turbidity						
*Turbidity	0.84		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0089		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	0.00026		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.195		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.134		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	85.9		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	0.00082		mg/L			31-OCT-16
Copper (Cu)-Total	0.00953		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.017		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.000381		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0328		mg/L			31-OCT-16
Magnesium (Mg)-Total	113		mg/L			31-OCT-16
Manganese (Mn)-Total	0.0458		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00061		mg/L			31-OCT-16
Nickel (Ni)-Total	0.0062		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	16.1		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.0134		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	6.24		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	37.8		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.251		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	0.00013		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 12C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-7
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00421		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0653		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	808		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	66.6		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0157		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	11.9		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	680	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.261		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	1230		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	86.1		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	583		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 12C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-7
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 153C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-8
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	642		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	0.0141		mg/L	10		25-OCT-16
pH						
pH	8.05		pH units			24-OCT-16
Turbidity						
*Turbidity	0.92		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.182		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.126		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	66.0		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00201		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.111		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.000369		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0250		mg/L			31-OCT-16
Magnesium (Mg)-Total	84.7		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00540		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00074		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	3.30		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00385		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	5.10		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	15.1		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.188		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 153C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-8
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00322		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0233		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	520		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	13.0		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0141		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	513	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.290		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	864		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	22.5		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	526		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	1		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 153C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-8
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 152C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-9
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	427		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	8.10		pH units			24-OCT-16
Turbidity						
*Turbidity	3.17		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0333		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	0.00123		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0466		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	1.2		mg/L	5		01-NOV-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	50.5		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	0.00067		mg/L			31-OCT-16
Copper (Cu)-Total	1.39		mg/L		1.0	01-NOV-16
Iron (Fe)-Total	1.02		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.0252		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0583		mg/L			31-OCT-16
Magnesium (Mg)-Total	32.0		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00798		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00130		mg/L			31-OCT-16
Nickel (Ni)-Total	0.0029		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	20.4		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00851		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	6.61		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	60.9		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.603		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	0.00104		mg/L			31-OCT-16
Titanium (Ti)-Total	0.00171		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 152C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-9
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00012		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0040		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	443		mg/L		500	02-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	59.6		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	258	HTC	mg/L		500	02-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.883		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	699		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.34		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	350		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 152C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-9
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 72D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-10
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	406		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	8.05		pH units			24-OCT-16
Turbidity						
*Turbidity	0.31		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0173		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.525		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	72.9		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	<0.00020		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.034		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0354		mg/L			31-OCT-16
Magnesium (Mg)-Total	43.2		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00860		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00021		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	10.5		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00637		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	5.19		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	32.6		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.530		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
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Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 72D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-10
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00054		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	<0.0020		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	477		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	111		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	360	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.915		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	734		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	7.14		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	333		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

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Winnipeg MB R3T 5P4
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Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 72D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-10
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 7D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-11
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	300		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	8.17		pH units			24-OCT-16
Turbidity						
*Turbidity	1.62		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	<0.0050		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	<0.00020		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0252		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	0.662		mg/L	5		31-OCT-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	60.6		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	<0.00020		mg/L			31-OCT-16
Copper (Cu)-Total	0.00088		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.207		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	<0.000090		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0373		mg/L			31-OCT-16
Magnesium (Mg)-Total	38.6		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00902		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00054		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	10.2		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00488		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	4.33		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	41.5		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.453		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	<0.00020		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 7D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-11
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00121		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0624		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	<0.00040		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	458		mg/L		500	01-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	144		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	310	HTC	mg/L		500	01-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.522		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	729		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	16.3		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	246		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

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ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 7D
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-11
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 1052C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-12
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Bicarbonate (HCO3)	421		mg/L			26-OCT-16
Carbonate (CO3)	<0.60		mg/L			26-OCT-16
Hydroxide (OH)	<0.34		mg/L			26-OCT-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		25-OCT-16
pH						
pH	8.11		pH units			24-OCT-16
Turbidity						
*Turbidity	4.05		NTU			22-OCT-16
Total Metals by ICP-MS						
Aluminum (Al)-Total	0.0121		mg/L		0.1	31-OCT-16
Antimony (Sb)-Total	<0.00020		mg/L	0.006		31-OCT-16
Arsenic (As)-Total	0.00110		mg/L	0.01		31-OCT-16
Barium (Ba)-Total	0.0466		mg/L	1		31-OCT-16
Beryllium (Be)-Total	<0.00020		mg/L			31-OCT-16
Bismuth (Bi)-Total	<0.00020		mg/L			31-OCT-16
Boron (B)-Total	1.3		mg/L	5		01-NOV-16
Cadmium (Cd)-Total	<0.000010		mg/L	0.005		31-OCT-16
Calcium (Ca)-Total	49.8		mg/L			31-OCT-16
Cesium (Cs)-Total	<0.00010		mg/L			31-OCT-16
Chromium (Cr)-Total	<0.0010		mg/L	0.05		31-OCT-16
Cobalt (Co)-Total	0.00027		mg/L			31-OCT-16
Copper (Cu)-Total	0.280		mg/L		1.0	31-OCT-16
Iron (Fe)-Total	0.628		mg/L		0.3	31-OCT-16
Lead (Pb)-Total	0.00825		mg/L	0.01		31-OCT-16
Lithium (Li)-Total	0.0576		mg/L			31-OCT-16
Magnesium (Mg)-Total	32.8		mg/L			31-OCT-16
Manganese (Mn)-Total	0.00615		mg/L		0.05	31-OCT-16
Molybdenum (Mo)-Total	0.00132		mg/L			31-OCT-16
Nickel (Ni)-Total	<0.0020		mg/L			31-OCT-16
Phosphorus (P)-Total	<0.10		mg/L			31-OCT-16
Potassium (K)-Total	20.8		mg/L			31-OCT-16
Rubidium (Rb)-Total	0.00853		mg/L			31-OCT-16
Selenium (Se)-Total	<0.0010		mg/L	0.05		31-OCT-16
Silicon (Si)-Total	6.52		mg/L			31-OCT-16
Silver (Ag)-Total	<0.00010		mg/L			31-OCT-16
Sodium (Na)-Total	62.4		mg/L		200	31-OCT-16
Strontium (Sr)-Total	0.634		mg/L			31-OCT-16
Tellurium (Te)-Total	<0.00020		mg/L			31-OCT-16
Thallium (Tl)-Total	<0.00010		mg/L			31-OCT-16
Thorium (Th)-Total	<0.00010		mg/L			31-OCT-16
Tin (Sn)-Total	0.00028		mg/L			31-OCT-16
Titanium (Ti)-Total	<0.00050		mg/L			31-OCT-16
Tungsten (W)-Total	<0.00010		mg/L			31-OCT-16

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 1052C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-12
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W with Total Metals						
Total Metals by ICP-MS						
Uranium (U)-Total	0.00012		mg/L	0.02		31-OCT-16
Vanadium (V)-Total	<0.00020		mg/L			31-OCT-16
Zinc (Zn)-Total	0.0040		mg/L		5.0	31-OCT-16
Zirconium (Zr)-Total	0.00047		mg/L			31-OCT-16
TDS calculated						
TDS (Calculated)	442		mg/L		500	02-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	59.7		mg/L		500	22-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		22-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		22-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	260	HTC	mg/L		500	02-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.892		mg/L	1.5		22-OCT-16
Conductivity						
Conductivity	712		umhos/cm			24-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.36		mg/L		250	22-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	345		mg/L			24-OCT-16
Total Coliform and E.coli						
Total Coliforms	0		MPN/100mL	0		21-OCT-16
Escherichia Coli	0		MPN/100mL	0		21-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 02-NOV-16
PO No.:
WO No.: L1846666
Project Ref: 16-300-06-1020
Sample ID: 1052C
Sampled By: LSA/LR
Date Collected: 20-OCT-16
Lab Sample ID: L1846666-12
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1846666 Report Date: 02-NOV-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Marci Friedman Hamm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3579445								
WG2417994-20 DUP		**L1846666-4**						
Alkalinity, Total (as CaCO3)		309	311		mg/L	0.4	20	24-OCT-16
WG2417994-14 LCS								
Alkalinity, Total (as CaCO3)			104.5		%		85-115	24-OCT-16
WG2417994-19 LCS								
Alkalinity, Total (as CaCO3)			103.9		%		85-115	24-OCT-16
WG2417994-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	24-OCT-16
WG2417994-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	24-OCT-16
CL-L-IC-N-WP	**Water**							
Batch R3579484								
WG2417171-6 LCS								
Chloride (Cl)			100.6		%		90-110	22-OCT-16
WG2417171-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	22-OCT-16
EC-WP	**Water**							
Batch R3579445								
WG2417994-20 DUP		**L1846666-4**						
Conductivity		712	711		umhos/cm	0.1	10	24-OCT-16
WG2417994-13 LCS								
Conductivity			99.6		%		90-110	24-OCT-16
WG2417994-18 LCS								
Conductivity			100.0		%		90-110	24-OCT-16
WG2417994-11 MB								
Conductivity			<1.0		umhos/cm		1	24-OCT-16
WG2417994-16 MB								
Conductivity			<1.0		umhos/cm		1	24-OCT-16
F-IC-N-WP	**Water**							
Batch R3579484								
WG2417171-6 LCS								
Fluoride (F)			103.8		%		90-110	22-OCT-16
WG2417171-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	22-OCT-16
MET-T-L-MS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3584595								
WG2422592-2 LCS								
Aluminum (Al)-Total			101.0		%		80-120	31-OCT-16
Antimony (Sb)-Total			96.1		%		80-120	31-OCT-16
Arsenic (As)-Total			99.2		%		80-120	31-OCT-16
Barium (Ba)-Total			101.2		%		80-120	31-OCT-16
Beryllium (Be)-Total			104.0		%		80-120	31-OCT-16
Bismuth (Bi)-Total			100.7		%		80-120	31-OCT-16
Boron (B)-Total			105.2		%		80-120	31-OCT-16
Cadmium (Cd)-Total			98.4		%		80-120	31-OCT-16
Calcium (Ca)-Total			103.2		%		80-120	31-OCT-16
Cesium (Cs)-Total			105.1		%		80-120	31-OCT-16
Chromium (Cr)-Total			98.8		%		80-120	31-OCT-16
Cobalt (Co)-Total			98.8		%		80-120	31-OCT-16
Copper (Cu)-Total			96.8		%		80-120	31-OCT-16
Iron (Fe)-Total			96.9		%		80-120	31-OCT-16
Lead (Pb)-Total			102.4		%		80-120	31-OCT-16
Lithium (Li)-Total			109.1		%		80-120	31-OCT-16
Magnesium (Mg)-Total			102.2		%		80-120	31-OCT-16
Manganese (Mn)-Total			102.5		%		80-120	31-OCT-16
Molybdenum (Mo)-Total			106.4		%		80-120	31-OCT-16
Nickel (Ni)-Total			98.0		%		80-120	31-OCT-16
Phosphorus (P)-Total			108.3		%		80-120	31-OCT-16
Potassium (K)-Total			102.0		%		80-120	31-OCT-16
Rubidium (Rb)-Total			101.4		%		80-120	31-OCT-16
Selenium (Se)-Total			94.1		%		80-120	31-OCT-16
Silicon (Si)-Total			101.5		%		80-120	31-OCT-16
Silver (Ag)-Total			102.3		%		80-120	31-OCT-16
Sodium (Na)-Total			102.7		%		80-120	31-OCT-16
Strontium (Sr)-Total			112.6		%		80-120	31-OCT-16
Tellurium (Te)-Total			97.3		%		80-120	31-OCT-16
Thallium (Tl)-Total			100.8		%		80-120	31-OCT-16
Thorium (Th)-Total			102.7		%		80-120	31-OCT-16
Tin (Sn)-Total			100.9		%		80-120	31-OCT-16
Titanium (Ti)-Total			99.0		%		80-120	31-OCT-16
Tungsten (W)-Total			104.2		%		80-120	31-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3584595								
WG2422592-2 LCS								
Uranium (U)-Total			107.5		%		80-120	31-OCT-16
Vanadium (V)-Total			101.3		%		80-120	31-OCT-16
Zinc (Zn)-Total			92.9		%		80-120	31-OCT-16
Zirconium (Zr)-Total			98.0		%		80-120	31-OCT-16
WG2422592-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	31-OCT-16
Antimony (Sb)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Arsenic (As)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Barium (Ba)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Beryllium (Be)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Boron (B)-Total			<0.010		mg/L		0.01	31-OCT-16
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	31-OCT-16
Calcium (Ca)-Total			<0.10		mg/L		0.1	31-OCT-16
Cesium (Cs)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Chromium (Cr)-Total			<0.0010		mg/L		0.001	31-OCT-16
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Copper (Cu)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Iron (Fe)-Total			<0.010		mg/L		0.01	31-OCT-16
Lead (Pb)-Total			<0.000090		mg/L		0.00009	31-OCT-16
Lithium (Li)-Total			<0.0020		mg/L		0.002	31-OCT-16
Magnesium (Mg)-Total			<0.010		mg/L		0.01	31-OCT-16
Manganese (Mn)-Total			<0.00030		mg/L		0.0003	31-OCT-16
Molybdenum (Mo)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Nickel (Ni)-Total			<0.0020		mg/L		0.002	31-OCT-16
Phosphorus (P)-Total			<0.10		mg/L		0.1	31-OCT-16
Potassium (K)-Total			<0.020		mg/L		0.02	31-OCT-16
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Selenium (Se)-Total			<0.0010		mg/L		0.001	31-OCT-16
Silicon (Si)-Total			<0.10		mg/L		0.1	31-OCT-16
Silver (Ag)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Sodium (Na)-Total			<0.030		mg/L		0.03	31-OCT-16
Strontium (Sr)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	31-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3584595								
WG2422592-1 MB								
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Thorium (Th)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Tin (Sn)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Titanium (Ti)-Total			<0.00050		mg/L		0.0005	31-OCT-16
Tungsten (W)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Uranium (U)-Total			<0.00010		mg/L		0.0001	31-OCT-16
Vanadium (V)-Total			<0.00020		mg/L		0.0002	31-OCT-16
Zinc (Zn)-Total			<0.0020		mg/L		0.002	31-OCT-16
Zirconium (Zr)-Total			<0.00040		mg/L		0.0004	31-OCT-16
NO2-L-IC-N-WP	**Water**							
Batch R3579484								
WG2417171-6 LCS								
Nitrite (as N)			99.3		%		90-110	22-OCT-16
WG2417171-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	22-OCT-16
NO3-L-IC-N-WP	**Water**							
Batch R3579484								
WG2417171-6 LCS								
Nitrate (as N)			100.8		%		90-110	22-OCT-16
WG2417171-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	22-OCT-16
PH-WP	**Water**							
Batch R3579445								
WG2417994-20 DUP		**L1846666-4**						
pH		7.67	7.70	J	pH units	0.03	0.2	24-OCT-16
WG2417994-12 LCS								
pH			7.40		pH units		7.3-7.5	24-OCT-16
WG2417994-17 LCS								
pH			7.40		pH units		7.3-7.5	24-OCT-16
SO4-IC-N-WP	**Water**							
Batch R3579484								
WG2417171-6 LCS								
Sulfate (SO4)			100.7		%		90-110	22-OCT-16
WG2417171-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	22-OCT-16
	Water							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R3577998								
WG2415833-1 DUP		**L1846666-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-10 DUP		**L1846666-10**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-11 DUP		**L1846666-11**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-12 DUP		**L1846666-12**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-2 DUP		**L1846666-2**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-3 DUP		**L1846666-3**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-4 DUP		**L1846666-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-5 DUP		**L1846666-5**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-6 DUP		**L1846666-6**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-7 DUP		**L1846666-7**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-8 DUP		**L1846666-8**						
Total Coliforms		1	1		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-9 DUP		**L1846666-9**						
Total Coliforms		0	0		MPN/100mL	0.0	65	21-OCT-16
Escherichia Coli		0	0		MPN/100mL	0.0	65	21-OCT-16
WG2415833-13 MB								
Total Coliforms			0		MPN/100mL		1	21-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R3577998								
WG2415833-13 MB								
Escherichia Coli			0		MPN/100mL		1	21-OCT-16
WG2415833-14 MB								
Total Coliforms			0		MPN/100mL		1	21-OCT-16
Escherichia Coli			0		MPN/100mL		1	21-OCT-16
TURBIDITY-WP	**Water**							
Batch R3577893								
WG2417115-3 LCS								
Turbidity			102.0		%		85-115	22-OCT-16
WG2417115-1 MB								
Turbidity			<0.10		NTU		0.1	22-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	20-OCT-16 10:15	24-OCT-16 12:03	0.25	98	hours	EHTR-FM
	2	20-OCT-16 12:00	24-OCT-16 12:03	0.25	96	hours	EHTR-FM
	3	20-OCT-16 11:00	24-OCT-16 12:03	0.25	97	hours	EHTR-FM
	4	20-OCT-16 12:45	24-OCT-16 12:03	0.25	95	hours	EHTR-FM
	5	20-OCT-16 14:30	24-OCT-16 12:03	0.25	94	hours	EHTR-FM
	6	20-OCT-16 15:00	24-OCT-16 12:03	0.25	93	hours	EHTR-FM
	7	20-OCT-16 19:15	24-OCT-16 12:03	0.25	89	hours	EHTR-FM
	8	20-OCT-16 17:30	24-OCT-16 12:03	0.25	90	hours	EHTR-FM
	9	20-OCT-16 17:20	24-OCT-16 12:03	0.25	91	hours	EHTR-FM
	10	20-OCT-16 16:00	24-OCT-16 12:03	0.25	92	hours	EHTR-FM
	11	20-OCT-16 18:15	24-OCT-16 12:03	0.25	90	hours	EHTR-FM
	12	20-OCT-16 17:20	24-OCT-16 12:03	0.25	91	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	20-OCT-16 10:15	22-OCT-16 12:00	48	50	hours	EHT
	3	20-OCT-16 11:00	22-OCT-16 12:00	48	49	hours	EHT
Nitrite in Water by IC (Low Level)							
	1	20-OCT-16 10:15	22-OCT-16 12:00	48	50	hours	EHT
	3	20-OCT-16 11:00	22-OCT-16 12:00	48	49	hours	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1846666 were received on 21-OCT-16 08:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10- 373388

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: ✓	Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact:	Marci Friedman-Hamm	Select: PDF ✓	Excel ✓ Digital Fax	Priority (2-4 Busines
Address:	3rd floor 865 Waverley	Email 1:	mfhamm@kgsgroup.com	Emergency (1-2 B
		Email 2:	dandres@kgsgroup.com	Same Day or Wee
Phone:	204 896 1209 Fax:			
Invoice To	Same as Report ? (circle) Yes or No (If No, provide details)	Client / Project Information		(Inc
	Copy of Invoice with Report? (circle) Yes or No	Job #:	16-300-06-1020	
Company:		PO / AFE:		
Contact:		LSD:		
Address:				
Phone:	Fax:	Quote #:	Q58403	
Lab Work Order # (lab use only)		ALS Contact:	Judy	Sampler: BSA/RC

L1846666-COFC

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	groundwater	Number of Containers
1	29D	20-10-16	10:15am	ground water	✓	3
2	~~BKD~~ 13D		12pm			
3	8D		11 am			
4	~~BKD~~ 27D		12:45pm			
5	44D		2:30pm			
6	50D		3:00pm			
7	12C		7:15pm			
8	153C		5:30pm			
9	152C		5:20pm			
10	72D		4:00pm			
11	7D		6:15pm			
12	1052C		5:20pm			

all bacteria & metals preserved.

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

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APPENDIX B

REGIONAL GEOLOGICAL SETTING (DELIVERABLE D5)

KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D5
REGIONAL GEOLOGICAL SETTING

FINAL – REV 0

KGS Group 16-0300-006
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1.0 INTRODUCTION

In 2011, record widespread flooding occurred across much of southwestern Manitoba, resulting in unprecedented inflows into Lake Manitoba and Lake St. Martin. These high flows extended well into the summer and overwhelmed the capacity of the existing flood control and protection infrastructure. Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by Manitoba Infrastructure (MI) to develop a two-stage process to advance the Lake Manitoba & Lake St. Martin Outlet Channels Conceptual Design Study. One of the fundamental scope items in the Stage 1 study was to identify outlet options for Lake Manitoba (LMB) and Lake St. Martin (LSM). Six Lake Manitoba outlet options were identified in Stage 1 (Options A through F).

Based on screening criteria and economic analyses (among other tasks) completed for each of the 6 options identified within the Stage 1 study (detailed review of preferred alternatives), options C and D were put forward for further review within Stage 2. The Province of Manitoba announced in the fall of 2014 that it was proceeding with the Stage 2 conceptual design of the preferred Lake Manitoba Outlet Channel alternatives (Routes C and D) with a design capacity of 212 m^3/s (7,500 cfs) for the Lake Manitoba Outlet Channel. The Stage 2 study was initiated in January of 2015, and finalized the conceptual design of the Routes C and D preferred alternatives for the Lake Manitoba Outlet Channel. The current study involves preliminary design, additional geotechnical and hydrogeological investigations and associated data analyses to identify a preferred route (Route C or D), to move forward with final design and construction.

Route C is an approximately 11.6 km long channel located immediately south of the Pinaymootang First Nation border, and is situated on privately held lands and leased Crown lands joining Lake Manitoba to Lake St. Martin, as shown on Plate D5-1. Its inlet is located approximately 2 km south of the existing Fairford River Water Control Structure (FRWCS) in Portage Bay on Lake Manitoba. The alignment of the channel is generally to the east for 5 km before turning southeast along PTH 6 for approximately 3 km. The channel then turns directly east to cross PTH 6 and enters Lake St. Martin approximately 3.5 km downstream.

The Route D outlet channel connects Watchorn Bay on Lake Manitoba to the outlet of Birch Creek on Lake St. Martin, as shown on Plate D5-1. The proposed route is approximately 24.0

km long and situated on privately held and leased Crown lands. This proposed route alignment is adjacent to low-lying terrain between Lake Manitoba and Lake St. Martin along which numerous marshes and small lakes exist. It is likely that these low-lying lands interconnected Lakes Manitoba and Saint Martin during high lake level intervals that would have existed in the geologic past, specifically during deglaciation and establishment of incipient drainage of the post-glacial landscape of Manitoba. Today, local land drainage in the area is generally from the west to the east. Construction of the channel to the west of the marshes and lakes, rather than through the middle of these areas is preferred to minimize environmental impacts, and also to minimize the cost of excavating the channel in wet conditions.

The proposed Route C and D Outlet Channels are located within the Interlake area of the Manitoba Lowland physiographic region, an area of relatively gentle relief situated east of the Manitoba Escarpment. The ground surface in the project area is characterized by tills, proglacial lacustrine sediments, and more recent organic deposits found in low-lying depressions (Plate D5-2). The study area lies within the Lake Manitoba and Lake Winnipeg drainage basins. The lakes within the Manitoba Lowland collect drainage from the southern portion of the Province, which is directed through Lake Winnipeg into the Nelson River system. Discharge of the drainage system ultimately occurs at Hudson Bay. The region is underlain by gently southwestward dipping Paleozoic and Mesozoic sediments consisting of carbonate rocks (Plate D5-3), with minor clastic and argillaceous units, that formed along the eastern edge of the Western Canada Sedimentary Basin (Williston Basin).

For the purposes of the current study, which culminates with the selection of a preferred route between Routes C and D, a broader look at all available data from all investigations (including new investigations and testing within the current study) was necessary to evaluate in detail the geological, hydrogeological, and geotechnical aspects of the Routes C and D project region.

1.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Investigations completed along the LMB-LSM flood channel routes generally consisted of:

- Drilling of boreholes and excavation of test pits for overburden classification and determination of depth to bedrock at select locations;

- Installation of standpipe piezometers and grouted in vibrating wire piezometers at select sites to monitor groundwater levels within the overburden and bedrock;
- Performing seismic refraction surveys to estimate the bedrock surface elevation along selected line locations; and
- Installing 125 mm diameter test wells to perform aquifer pumping tests.

For reference, all investigations advanced to date on the project are shown on the drawings contained within the groundwater study Deliverable D6, Appendix D6-A, and Appendix D6-C. The geotechnical deliverable, D8, includes the borehole logs for the 2016 investigation programs.

2011 Investigations

The investigation program in 2011 focused on Routes B through E between Lake Manitoba and Lake St. Martin. Route A, between Lake Manitoba and Lake St. Martin was excluded from the investigation program as it was abandoned early during desktop studies due to constructability, cost, and other logistical issues.

In the LMB-LSM channel area, 2011 investigations included the following:

- Route B - (16) test pits, six (6) boreholes, and approximately 2.7 kilometers of seismic refraction survey lines;
- Route C - Field investigations along this route consisted of fifteen (15) test pits, six (6) boreholes, and approximately 3.8 kilometers of seismic refraction survey lines;
- Route D - Field investigations along this route consisted of thirty-two (32) test pits, eighteen (18) boreholes, and approximately 3.6 kilometers of seismic refraction survey lines; and
- Route E - Field investigations along this route consisted of nineteen (19) boreholes, and approximately 1.5 kilometers of seismic refraction survey lines.

2015 Investigations

The investigation program in 2015 focused on Routes C and D, between Lake Manitoba and Lake St. Martin.

In the LMB-LSM channel area, 2015 investigations included the following:

- Route C - four (4) boreholes, focused to gather additional information for foundation design at the proposed outlet channel control structure, and the proposed bridges structures;
- Route D - six (6) boreholes, focused to gather additional information for foundation design of the proposed outlet channel control structure, and the proposed bridge structures; and
- Route D – two (2) boreholes and one 125 mm diameter pumping well. A pumping test was conducted to establish some basic aquifer transmissivity parameters and distance drawdown relationships.

2016 Investigations

The investigation program in 2016 (this study) focused on Routes C and D, between Lake Manitoba and Lake St. Martin. Boreholes and 125 mm diameter test wells were advanced for geotechnical, environmental, and hydrogeological purposes.

In the LMB-LSM channel area, 2016 investigations included the following:

- Route C – two (2) boreholes for environmental, four (4) for geotechnical, and three (3) 125 mm diameter test wells (and pumping tests); and
- Route D – two (2) environmental boreholes, five (5) geotechnical boreholes, two (2) shallow wetland boreholes, and one (1) 125 mm diameter test well (and pumping test)

All investigations advanced to date on the project are shown on the drawings contained within Deliverable D6, Appendix D6-A, and Appendix D6-C. The geotechnical deliverable, D8, includes the borehole logs for the 2016 investigation programs.

2.0 GEOLOGICAL SETTING OF THE ROUTE C AND ROUTE D LAKE MANITOBA CHANNELS

2.1 REGIONAL GEOLOGICAL SETTING OF THE PROJECT

The geological setting of the proposed Route C and D channels reflects a diverse cross section of geological history. While the geological setting for both channels is the same, the variability in the geological conditions in the region result in a key distinction between the Route C and D channels; namely that the Route C option would be incised into the bedrock, and the Route D option would be excavated entirely within the till.

Inundation of the intercratonic Canadian Shield basin was preceded by erosion of the Precambrian peneplain of low hills and valleys, developed in metamorphosed volcanic and sedimentary rocks within terranes comprised predominantly of igneous intrusions. Deposition of carbonate bedrock was initiated during the Ordovician. The first transgression of a shallow sea into the basin, resulted in deposition of interbedded sandstones and shales of the Winnipeg Formation. These sediments were succeeded by carbonate strata deposition from the Ordovician through the Devonian. Bedrock within the region of the Routes C and D channels are of Silurian to Devonian age, and as such these geologic periods will be the focus of the report sections below.

Available data suggests that the tectonic framework was relatively stable throughout Silurian time, with almost no evidence of basin differentiation in Manitoba. This is also evidenced by the relative lithologic uniformity of the Silurian strata, generally unaffected by terrigenous inflows and high-energy clastic deposition. These strata are representative of deposition under shallow-water, in part slightly restricted conditions, and have been interpreted as intertidal to supratidal deposits. In the central part of the basin, the uppermost Silurian beds, consist of dolomites with brecciated textures, desiccation cracks, fenestral fabrics, dolomite cements, and erosional surfaces. These features indicate periodic subaerial exposure and diagenesis of carbonate deposited under marine or fresh water conditions. Cycles of transgressive (i.e. deepening water levels) and regressive (i.e. shallowing water levels) events resulted in variability in texture, composition, and fauna found within the Paleozoic strata. As such, the rock types include micritic (e.g. carbonate mud) argillaceous (e.g. shaly), reefoid, stromatolitic and crystalline dolomite with scattered fossil-fragmental interbeds.

The relatively monotonous dolomite sequence is interrupted only by a number of thin sandy argillaceous marker beds that are believed to represent para-time-stratigraphic markers, minor depositional hiatuses that are very persistent and can be traced throughout most of the Williston Basin area. The uniformity of Silurian lithology and the persistence of the marker beds attest to the tectonic stability during Silurian time. As the carbonate sediments consolidated with deposition and burial, discontinuous sub-vertical tension cracks developed.

Regression of the shallow seas marked the onset of an preglacial erosional period in the basin, which lasted until the Middle to Upper Devonian. During this time, older carbonate strata that were once continuous between southern Manitoba and Hudson Bay were eroded to become separated by exposed Precambrian bedrock across north-northeastern Manitoba. Subaerial exposure allowed surficial waters rich in carbon dioxide and undersaturated with respect to carbonate, to infiltrate the rockmass and initiate karstification. Thereafter, a subsequent transgression established the Elk Point basin, within which initiated deposition of the shale and argillaceous dolomite of the Devonian aged Ashern Formation, subsequently overlain by the Devonian Elm Point Formation strata.

Following deposition of these carbonate bedrock sequences, another period of preglacial erosion, and further karstic processes dominated (i.e. during the post-Devonian, to Mesozoic period). Sinkholes and bedrock channels, formed during erosional and karstic weathering events, were thereafter infilled with younger sediments comprised predominantly of sandy shales and organics (including low-grade lignite). Karstification was generally concentrated in the upper portion of the carbonate rock mass, nearest to the source of surface water inundation. The decline in bedrock karstification at depth may be due to the tight condition of the vertical master joints at depth within the rock mass, or because the apertures became plugged with younger infills, thus limiting the downward flux of infiltrating surface waters.

Additionally, Silurian aged dolomites in the vicinity of Lake St Martin underwent structural deformation related to a meteorite impact centered on Gypsumville, Manitoba. Within the structural disturbance zone north of Lake St Martin, the bedrock is highly variable with sedimentary and evaporitic rocks varying in age from the Jurassic, to Precambrian aged granites. This geological feature is shown on the bedrock map in Plate D5-3, but has no direct bearing on the geological conditions along Routes C and D.

Following these periods of preglacial erosion, glacial processes were initiated. The carbonate bedrock in the region had effectively reached its present day condition by the beginning of the Pleistocene period (approximately 2 million years ago). At this time, the area was covered by repeated advances of the continental ice sheet, emplacing the overlying till soils, and effectively ending the karstification/solutioning process of the carbonate bedrock strata.

A succession of glaciations occurred, associated with the deposition of till and stratified drift, separated by nonglacial stratified alluvial, lacustrine, interglacial deposits. The bedrock surface, shaped previously by karst processes, and preglacial erosion, would take its final shape during these glacial advances and retreats in the region. Interglacial sediments may have been removed by interglacial runoff erosion or by subsequent glacial erosion during later ice sheet advances, as they are not predominant in the stratigraphy in the region. The discontinuous intertill granular deposits noted within some boreholes in the region are likely a localized representation of locally fluctuating ice margins, a remnant of the most recent glacial event. The deposition of the youngest tills (i.e. Inwood and Komarno), and associated stratified drift, created the fluted till blanket morphology typical of the region today, marking the last glacial advance in the area.

During glaciation, stresses were transmitted to the rock mass that could have caused additional shearing along the previously filled discontinuities. Bedding plane shears, as a result of glacial activity during the Pleistocene period, are common features in interbedded sedimentary rock sequence in the plains region of Western Canada. The shearing forces imparted to the rock mass due to the effects of repeated ice movement often exceed the strength of the bedding plane infill, causing shear movement between beds. The depth of rock affected by such shear action can be considerable, and the removal of karstic bedrock materials associated with these shear events was common.

Final deglaciation of the region was accompanied by inundation by glacial Lake Agassiz. The Komarno till is interpreted to have been at least partially deposited within, or along the margins of Lake Agassiz. Wave erosion of pre-existing glacial deposits occurred, with deposition of a discontinuous blanket of Lake bottom clay, silt, and sand, though within the Interlake these deposits are poorly preserved. The upper till sheet was disturbed and ploughed by icebergs within Lake Agassiz, producing the turbate deposits that are noted on the till sheet in the region.

The last drainage of Lake Agassiz is represented by discontinuous relict beach ridge/shoreline deposits, which today form limited granular borrow sources in the region.

2.2 BEDROCK GEOLOGY OVERVIEW

The carbonate rocks (Plate D5-3) of Southern Manitoba and the Interlake region were deposited in a shallow tropical sea that had inundated an intracratonic basin formed by the underlying Precambrian bedrock surface. These strata form a basinward thickening wedge of dolomite and dolomitic limestone, sloping toward the southwest, dipping gently at approximately 2 m/km to 10 m/km. Dolomite and dolomitic limestone comprise the lower Paleozoic bedrock sequence that outcrops in the Interlake region of Manitoba between Winnipeg and The Pas, marking the northwestern edge of the Williston Basin. During Devonian time, a shift in the depocentre of sedimentation to the west-southwest in the Williston Basin resulted in slightly different pattern of sedimentation and development of strata, within a sub basin area referred to as the Elk Point Basin.

Because of the location of the study area along the continental basin margin, and with the basinward (southwestward) dip of the strata, surface erosion of the bedrock resulted in the exposure of the oldest bedrock strata toward the east, and the younger and overlying strata exposed to the west. Thus the youngest (Devonian aged) rock units are located immediately along the east shore of Lake Manitoba, followed by Silurian Interlake Group bedrock units to the east (see Plate D5-3), and thereafter the oldest (Ordovician aged) rock units situated further to the east between the east shore of Lake St. Martin, and Lake Winnipeg.

Near Steep Rock, along the east shore of Lake Manitoba, the bedrock consists of high-calcium limestone belonging to the Devonian aged Elm Point Formation. Eastward, bedrock transitions to dolomitic shale, which belongs to the Devonian Ashern Formation. Between Faulkner and the east end of Lake St. Martin, the bedrock consists of Silurian aged Interlake Group dolomites (generally fossiliferous, but microcrystalline in places), namely of the Cedar Lake Formation. East of Lake St. Martin there are dolomites and limestones belonging to the Ordovician aged Stonewall Formation and Stony Mountain Formation; these strata subcrop to the east of the Route C and D project area and as such will not be discussed further herein.

The Silurian aged dolomites in the vicinity of Lake St. Martin have undergone structural deformation related to a meteorite impact centered on Gypsumville, Manitoba. Within the structural disturbance zone north of Lake St. Martin (see Plate D5-3), the bedrock is highly variable with rocks varying in age from the Jurassic (relatively young) to Precambrian aged granites (relatively old). This structural deformation zone does not extend into the immediate project areas of the Route C or Route D channel, and will not be discussed further herein.

The carbonate bedrock surface is found generally between El. 220 m and El. 260 m in most Route C and D study areas, in particular between Lake Manitoba and Lake St. Martin. In the area of structural deformation related to the Gypsumville meteorite impact, bedrock contact elevations are less than El 200 m, in localized areas. More detail on the bedrock surface and associated thickness of overburden cover will follow in subsequent sections of the report. Photos of representative bedrock units cored during the 2016 investigations programs are provided in the geotechnical deliverable, D8.

2.3 SURFICIAL GEOLOGY OVERVIEW

The bedrock in the vicinity of the Route C and D channels is overlain by carbonate-rich clayey silt till (which in places includes silty sand intertill zones), and variably saturated and stratified postglacial sediments, including clay, silt, sand and gravel, and in places and relatively thin and discontinuous peat at ground surface (Plate D5-2). The calcareous silt till ground moraine is derived from the underlying Paleozoic aged dolomites and limestones, and has a fluted morphology. The fluted morphology of the till surface is particularly apparent with the distribution of low-lying organic deposits within these till troughs, as noted to the west of Hilbre, and as shown on Plate D5-2. Recent organic deposits (i.e., swamp, marsh, or bog) are common in relatively low-lying troughs between streamlined and till surface flutes. Localized, discontinuous areas of glaciolacustrine silts and clays, or relict shoreline sands, gravels, and silty littoral sands are scattered in the region and overlying the till surface.

Overburden sediments were deposited on an extensively preglacially and glacially eroded bedrock surface, which in turn resulted in variability in overburden thicknesses in the region. Sediments overlying the bedrock are generally less than 10 m thick in most areas. Localized overburden areas along Watchorn Bay (i.e., Route D) and in the vicinity of the Fairford River are in excess of 20 m (65 ft) in thickness. In the area loosely bound by Fairford, Grahamdale and

the shores of Lake Manitoba, sediments above bedrock are relatively thin, and there are numerous bedrock outcrops at surface consisting of glacially striated dolomites and limestones.

There are several rock quarries in this area where the overburden thickness is minimal or non-existent (Plates D5-2 and D5-3). In fact, nearly all of the quarries in the region were opened for construction of Highway 6, and date back to the 1960's and 1970's. Bedrock outcrop is also common along the east shores of Lake Manitoba, in the Steep Rock area, and at localized sites east of Birch Creek (Route D). Limited bedrock outcrops are present along the west and southwest shores of Lake St. Martin as well. Photos of representative overburden units sampled during the 2016 investigations programs are provided in the geotechnical deliverable, D8.

2.4 HYDROGEOLOGICAL OVERVIEW

The bedrock aquifers in the study area are comprised of the Paleozoic rock sequence commonly referred to in Manitoba as the "Carbonate Aquifer System". Pervious bedrock strata are separated by argillaceous (clayey or shaley) aquitards or aquicludes. Groundwater movement occurs through interconnected networks of bedrock discontinuities consisting of joints, bedding planes, and karstic solution features. The density and interconnection of these discontinuities exhibits considerable spatial variability in the vertical and horizontal directions. Where the development of solution enhanced discontinuity features is extensive, high bulk bedrock conductivities are usually present and the bedrock forms a productive aquifer. Where the bedrock may be more massive, less affected by karstic processes, or where the interconnectivity of discontinuity features are limited by geologically younger infills emplaced following geological periods of karstic erosion and solution enhancement, the hydraulic conductivity of the bulk bedrock may be quite low, and the unit will function locally as an aquitard. In general, often the uppermost 10 m or so of the carbonate bedrock aquifer exhibits some fairly significant karsticity.

Based on regional data, potentiometric surface maps, the locations of groundwater springs, and general topography, a relatively fresh groundwater quality mound is found in the Interlake area. This area is a major zone of fresh water recharge to the carbonate aquifer, due to the relatively thin sediment cover comprised predominantly of till, with bedrock outcrops common. Because the bedrock aquifer in the Interlake is in general characterized by: 1) high elevation bedrock,

thin overburden cover, and unconfined groundwater recharge areas; 2) associated relatively high piezometric heads; and 3) resultant “groundwater mounding”, regional groundwater flow within the Interlake area in general radiates from the recharge zone groundwater mound easterly towards Lake Winnipeg, but also westerly toward Lake Manitoba and Lake St. Martin. Localized flow system discharge from the aquifer occurs as seepage and flow discharges into streams, marshes, and lakes found throughout the Interlake. Groundwater discharge areas are characterized by confined bedrock aquifer conditions capped by till and postglacial sediments, and upward gradients for groundwater discharge, in places under a flowing artesian aquifer condition.

Aquifer recharge areas occur under unconfined conditions where bedrock elevations are relatively high and sediment cover is thin to non-existent. Groundwater discharge occurs in low lying areas where aquifers are confined by overlying low permeability sediments, with discharge to bogs, streams, and lakes, most notably in the region of Routes C and D, to Lake Manitoba, Lake St. Martin, and Lake Pineimuta. Changes in the water levels at these discharge boundary conditions (i.e. lake level changes, rising or falling) effect a re-equilibration piezometric pressure response of the aquifer system.

Aquifer piezometric pressures rise and fall seasonally, importantly according to the recharge that occurs to the aquifer from spring snowmelt and additional short-term summer to fall precipitation events, along with some contribution from the seasonal variability in lake levels that occur at Lake St. Martin and Lake Manitoba. The total seasonal variability in lake levels is typically less than the seasonal aquifer piezometric pressure variability measured within the aquifer system; the difference being attributable to seasonal aquifer recharge. Over multi-year timeframes, the aquifer groundwater levels will also vary following consecutive years of “wet” or “dry” conditions, based on precipitation levels that are more than, or less than, the typical average for the region. This phenomenon has been described for the area, and the aquifer system response to the variability in precipitation and recharge conditions lags by months in time.

Detailed hydrogeological data and analysis is contained in the groundwater study Deliverable D6, and will not be discussed further within this report.

2.5 OVERBURDEN UNITS

2.5.1 Peat/Organic Soils and Postglacial Sediments

A discontinuous layer of peat/ organic soil materials and postglacial sediments, approximately 0.3 to 1.2 m in thickness, overlies the till overburden material in the region of Routes C and D. There are relatively few areas of clay in the region, and the presence of glacial lake Agassiz is primarily indicated by discontinuous relict beach deposits and areas of iceberg scouring of the till surface, and drift-ice turbate (see till section below). These beach ridges form the main sources of sand and gravel resources in the region (see Plate D5-2). Nearly all of these deposits are relatively limited in size and in particular by thickness, where many are typically 1.0 to 1.5 m in thickness. These beach deposits are typically a sandy fine pebble gravel, with a maximum grainsize of 5 cm to 8 cm.

2.5.2 Till

The till in the Interlake region forms a nearly continuous sheet overlying the bedrock. Widespread occurrences of shallow bedrock to bedrock outcrop in the region (Plate D5-2) indicate that overlying till sediments are in general relatively thin. However, till thicknesses can vary widely where the underlying preglacially and glacially eroded bedrock surface declines in elevation, in particular along bedrock structural and/or discontinuity features.

The till surface morphology is characterized by drumlinoid ridges, clustered in fields and variously trending south-southwest, south, and southeast, and are a common feature of the Interlake. These streamlined forms are generally parallel in the north but fan out towards the south and southeast (see Plate D5-2). The drumlinoid ridges are up to 10 km long and 400 m wide, but vary in size considerably throughout the region. They are generally only 1 to 2 m high, but can reach heights in excess of 10 m. The drumlinoid ridges in the southern Interlake may be due to late glacial surging of the ice front into Lake Agassiz.

Most of the southern Interlake till surface is covered with 0.5 to 3 m of drift-ice turbate (i.e. a sediment disturbed by a process that occurs post-deposition), formed by the action of wind-driven icebergs and shore ice which impinged on the till and glaciolacustrine sediments at the

bottom of Lake Agassiz. The resulting sediment consists of complex mixtures of buff coloured till and olive grey glaciolacustrine silt and clay. Iceberg plough marks also occur extensively in the southern Interlake. These features typically are about 30 m wide, and from 0.5 to 6 km long, with berms less than a metre high on both sides. The plough marks curve and intersect, forming a network of low depressions superimposed on the drumlionoid, fluted till surface in the region.
In the Interlake, ice flow recorded by striations and the orientation of drumlinoid ridges indicates a complex sequence. Older striations indicate southwesterly and southerly flow, but the final, major flow was to the southeast, and is the most pervasive event, captured by the orientation of the regionally fluted till surface (Plate D5-2). Southeasterly ice flows originating from the northwest apparently converged with southwesterly ice flow originating from Canadian Shield areas to the northeast. Topography also influenced the final surge of southeasterly ice flow in the Interlake.

Two tills have been mapped in the project region, both being silty, carbonate-rich tills that reflect the underlying bedrock geology. These tills are the lower (basal) Inwood till, and the overlying Komarno till. Till of the Interlake is silty, very calcareous, and contains an abundant gravel fraction consisting mostly of carbonate pebbles. Both tills have very similar composition, in particular with respect to the relative proportions of carbonate clasts. In some areas, the Komarno till contains clay inclusions indicating that it was deposited by ice surging or glacial advances into glacial Lake Agassiz.

The basal Inwood till is over-consolidated, pinkish grey in colour, and associated with striae on the underlying bedrock trending 170°. Drumlinoid ridges in the area consist of >0.5 m of relatively soft diamicton in places mixed with glaciolacustrine clay. This diamicton, termed Komarno till, resembles the underlying Inwood till in texture, but may be differentiated from it by the presence of olive grey glaciolacustrine clay inclusions, a slightly darker colour and, more importantly, a lower consolidation (i.e. the Komarno till is softer than the Inwood till). The presence of horizontal fissility, a discontinuous boulder pavement at the contact with the underlying Inwood till, the fluted surface, the southeasterly fabric and associated striae trending southeast (105-140°) indicate the Komarno till was deposited subglacially. Surficial iceberg turbate is differentiated from Komarno till by the presence of iceberg plough marks.

2.5.3 Intertill

Discontinuous intertill sediments are present within the tills in the project area, most strongly represented within the thicker till sections associated with the Route D channel alignment. Often, these intertill granular zones are discontinuous, and mark the separation between multiple till sheets. Maximum thickness of intertill sediments encountered within individual boreholes along Route D is in the order of 4.0 m. The intertill sediments are comprised mostly of light grey to buff-grey in colour, moist, stiff and locally laminated silt, with variable amounts of clay, very fine grained sand, and pebble gravel. The deposits may be formed of washed, winnowed and reworked till surfaces with fluctuating ice margins during deposition. In some cases, the intertill deposits may be difficult to discern from the tills themselves.

Limited gradation data was collected on the intertill sediments, however samples analysed during 2015 investigations were comprised of between 18% - 31% gravel, 41% - 46% sand, 18% - 32% silt, and 5% - 9% clay. This is distinct from typical Route C and D till compositions of approximately 3% - 10% gravel, 25% - 33% sand, 41% to 48% silt, and 15% - 19% clay, based on composite till samples analysed during the 2016 program (see geotechnical deliverable D8). Intertill granular zones are typically confined by the tills that surround them. When exposed in excavation, often they will drain; though depending on regional continuity and interconnectivity to the overall groundwater flow system, intertill zones may seep groundwater for extended periods of time, if daylighted within excavations.

2.6 BEDROCK

2.6.1 General Bedrock Lithology Description: Overview

Route C is located entirely within the Silurian aged Cedar Lake Formation of the Interlake group. The Route D channel is planned for construction entirely within the till, however Route D traverses the underlying Devonian aged Ashern Formation and Elm Point Formation bedrock in the inlet areas (to approximately Station 5+500 of Route D), and the Silurian aged Interlake Group Cedar Lake Formation in all downstream areas beyond approximately Station 5+500 of Route D.

The regional bedrock geology in the region of the Route C and Route D channels consists of Paleozoic dolomites and limestones with the youngest (Devonian aged) Elm Point and Ashern Formations located along the east shore of Lake Manitoba, followed by Silurian-aged Interlake Group bedrock to the east, and the oldest (Ordovician aged) rock units situated between the east shore of Lake St Martin and Lake Winnipeg (see Plate D5-3). Near Steep Rock, and at the inlet of the Route D channel along the east shore of Lake Manitoba, the underlying bedrock consists of high-calcium limestone belonging to the Elm Point Formation. Moving eastward, the underlying bedrock transitions to dolomitic shale belonging to the Ashern Formation. Between Faulkner and the east end of Lake St Martin, the bedrock consists of Silurian aged Interlake Group dolomites (generally fossiliferous, but microcrystalline in places).

2.6.2 Silurian Interlake Group (S) – Cedar Lake Formation

The proposed Route C channel excavation will intersect, incise, and variably expose the Silurian Interlake Group bedrock, namely the Cedar Lake Formation. The proposed Route D channel is designed within the overlying till sediments, however the route overlies the Cedar Lake Formation between approximately Station 5+500 of Route D to Lake Saint Martin. The Cedar Lake Formation is the youngest Silurian unit found in southern Manitoba.

The lithology of the Cedar Lake Formation is described as follows:

- yellow-buff colored, finely crystalline, stromatolitic, fragmental, micritic, reefoid (biohermal/biostromal) dolomites, fossiliferous dolomite;
- thinly bedded; and
- common lensoid and dome structures, such as formed by algal mounds.

The lower contact of the Cedar Lake Formation, is difficult to distinguish, and typically is noted as a transitional change from yellowish-grey fine grained dolomite, to a coarser grained, yellow-orange massively bedded dolomite rich in fossil content. The upper contact is an erosional disconformity at the top of the Interlake Group, and the overlying beds are the distinctive red dolomite of the Devonian aged Ashern Formation. Available drilling information indicates that the Cedar Lake Formation varies typically between approximately 13 m and 15 m in thickness (and up to 45 m thickness, though the entire unit is not exposed at any one outcrop). The upper

portion of the unit has been truncated by the present day erosional surface, and paleo-karst features are common, infilled with Cretaceous-aged (geologically younger) shales and lignite. Due to these paleo-karst features and impact-related fracturing surrounding the Gypsumville impact structure, this unit is can be highly permeable.

2.6.3 Devonian Ashern Formation (Da)

The Ashern Formation is a brick red to greyish orange argillaceous dolomite that overlies with slight angular unconformity, the dolomite strata of the Silurian Interlake Group, and paraconfomably underlies limestone beds of the Elm Point Formation. Outcrops of the Ashern Fomation are confined to a narrow southeast trending belt approximately 3 km to 8 km wide, immediately east and roughly parallel to the east side of Lake Manitoba. Erosional remnants of the formation occur as outliers located north-northwest of and north-northeast of Moosehorn (see Plate D5-3). The lithology of the Ashern Formation is described as follows:

- Dusky red to greyish orange finely granular variably argillaceous dolomite;
- Irregular bedding spaced at approximately 8 cm to 28 cm;
- Patchy mottling associated with irregular fractures and joint faces; and
- Iron sulphide as disseminated specks and fine nodules are common in some beds.

The base of the formation in places is characterized by brecciated angular fragments of pale grey dolomite, interpreted to have been derived from the underlying Silurian Interlake group. The upper contact of the formation to the overlying Elm Point is sharp, often marked by a 0.3 m to 0.6 m thick mottled red to greyish green shale, interpreted to indicate an erosional unconformity.

Available drilling information and isopach (i.e. thickness maps) indicate that the Ashern Formation varies between approximately 3 m and 12 m in thickness, and that the formation is largely representative of the infilling of topographic lows on an eroded Silurian bedrock surface. Strata thickness maps also suggests the drainage pattern of the eroded Silurian surface trends toward the northeast.

2.6.4 Devonian Elm Point Formation (Dep)

The Elm Point Formation overlies the Ashern Formation, and is in turn overlain by the Winnipegosis Formation. It was named for the good exposure of bedrock in cliffs north of Elm Point, on the East side of Portage Bay, near the northeast end of Lake Manitoba. Scattered outcrops occur in a narrow belt approximately 9 km to 12 km wide along the east side of Lake Manitoba. A small outlier, and erosional remnant, occurs at Spearhill, located well east of the outcrop belt, as a hill that rises approximately 15 m above the surrounding terrain (see Plate D5-3). The lithology of the Elm Point Formation is described as follows:

- Mottled, yellowish grey, finely granular and pale yellowish brown, fine grained high-calcium limestone, in places variable dolomitized;
- Irregular bedding approximately 5 cm to 28 cm thick;
- Occasional partings and thin argillaceous beds, in places oxidized to a purplish red color; and
- Sparry calcite is abundant within irregular fractures and as infills within vugs.

The contact between the Elm Point Formation and the underlying red argillaceous dolomite and dolomitic shale of the Ahern Formation is typically sharp, suggesting a paraconformity. The upper contact to the overlying Winnipegosis Formation is also sharp. The thickness of the Elm Point formation varies between approximately 9 m and 15 m. Cliff sections of about 6 m in height occur along the east shore of Portage Bay near Steep Rock. The Ashern Formation, resting directly on the eroded Silurian surface, indicates a long period of subaerial exposure and karsticity during the late Silurian to early Devonian time period, that was followed by a weak marine transgression. Thus the succeeding Elm Point strata represent a deepening of the sea during middle Devonian time, with the transgression extending considerably further than the erosional edge of the formation, as indicated by the outliers near Spearhill (Plate D5-3).

2.6.5 Paleokarst

The carbonate bedrock within the Interlake is an example of strata that have undergone paleokarst processes. This condition is defined by solutioning or karstification that occurred at earlier geologic time, which is subsequently buried and made inactive by later deposition of

overlying sediments and/or changes in groundwater flows. The carbonate rock within the Interlake was deposited in a shallow marine environment, with periodic hiatuses in deposition and subaerial exposure in advance of any preglacial or glacial depositional periods.

During periods in time where carbonate bedrock deposition was slowed or stopped (i.e. a depositional hiatus), relatively fresh surface water undersaturated with respect to carbonate was available to flow into pre-existing discontinuities of the rockmass, and over time wall rock solutioning processes widened and eroded these discontinuities into larger features.

Karstification is often most pronounced in freshwater zones in the upper parts (e.g. upper 8 to 10 m) of soluble aquifers; examples of this occur throughout Manitoba. As well, high fracture frequency and low Rock Quality Designation (RQD) are suggestive of extensive karstification. Karstification leads to continuous to semi-continuous, large aperture pathways along pre-existing discontinuities throughout the relatively soluble carbonate bedrock, which ultimately form a permeable conduit network. This results in a double porosity aquifer with groundwater storage within the lower permeability rock matrix, and most groundwater flow pathways via the high permeability channels that develop along discontinuities within the aquifer.

2.6.6 Physical Bedrock Features/Structural Geology

Jointing observed in the bedrock is composed predominantly of sub-horizontal fractures which vary in degree of weathering, iron staining, or have had calcite and iron minerals precipitate along groundwater fracture flow pathways formed by the bedrock fracture networks. The majority of the bedrock shows distinct signs of weathering and/or karsticity, including outside of the joint faces themselves and into the rock matrix. Vuggy porosity is common, where voids vary from “pin point porosity” to individual vugs in the order of 2 mm – 10 mm, and up to 60 mm in size. Structurally, the bedrock is highly fractured shows karstic characteristics, and broken core zones/broken lost core zones are identified within all cored test holes, with core losses in the order of 0.02 m to approximately 1.5 m. These lost core zones typically represent either partially infilled voids in the bedrock, or grinding and disintegration of friable, and weak karstic bedrock features, and/or other karstic infill zones (e.g. vertical to subvertical joints), that wash out during coring, or are otherwise unrecoverable.

Regional, basin-wide trends in master joints or faulting within the carbonate bedrock trend from the northeast to the southwest. Associated major and minor joint sets are estimated to subparallel (major joints) and trend orthogonal to (typically minor joints) these basin wide features, and have generally limited visible continuity due to till cover. However, these joint sets are likely systematically developed within all areas of the project. While these joints are generally not surface mappable features, they would be interpreted to act together in defined sets to influence the overall geotechnical behavior and overall structure of the rock mass.

Based on analogous areas within the province of Manitoba, major joints would be expected to occur with a spacing of approximately 30 m to 60 m, and would be steeply inclined to sub-vertical, with somewhat varying strike orientations. The aperture width of these master joints would not be unusual to be approximately 200 mm within shallow, and karstic bedrock zones. These aperture widths would generally narrow to between 2 mm to 10 mm within deeper bedrock zones. Minor joints would be expected to occur on spacing of a few metres to a few tens of metres; also subvertical to vertical in orientation, and with similar aperture widths as the major joints.

2.6.7 Bedding Plane Partings

In addition to the vertical joint sets, major carbonate bedrock discontinuities consist of horizontal to subhorizontal bedding planes (bedding plane partings). These partings form in sedimentary rocks as separation between individual rock layers, or as the rock becomes stratified. They are horizontal where sediments are deposited as flat-lying layers, such as within the project area. Stratification and associated bedding plane partings may result from changes in texture or composition during deposition, and/or may result from pauses in deposition that allow the older deposits to undergo changes before additional overlying sediments are deposited.

Bedding plane partings are often solutioned (i.e. enlarged or enhanced by karst), because they form structurally or texturally derived preferential pathways for groundwater flows. Where solutioned or enhanced by karst, these partings are often infilled with clay and silt. Major naturally occurring horizontal bedding plane partings typically are confirmed by exploratory drilling, downhole data collection, and examination of outcrop sections, where available. Typical bedding plane partings, along with infill lensing and shale inclusions, are observable in the

region, within exposed quarry faces. The mapped bedding planes and bedding plane partings between bedrock units within the region would be generally horizontal, with a very slight dip observable only over very long distances that is consistent with the bedrock structure within the basin.

Within the province of Manitoba, limited horizontal movement of bedrock strata along some of the major bedding plane partings is clearly indicated by observations in outcrop of horizontal offsets in vertical bedrock jointing of up to 500 mm. These movements are likely related to glacial loading and movement of the rock slabs along weak silty and clay infills found within the bedding plane discontinuities. Typical apertures associated with bedding plane partings are in the order of ≤ 5 mm to ≤ 100 mm, where severely karst affected. Individual parting surfaces often exhibit some waviness, a reflection of their origin as a depositional surface within a sedimentary basin.

2.7 ROCK MASS CHARACTERISTICS AND PERMEABILITY OF THE BEDROCK

The overall karsticity and/or general rock mass quality can be characterized in a semi-quantitative manner using core indicies such as RQD and recovery. High fracture frequencies, and low RQD/core recoveries in carbonate strata are in general suggestive of extensive karstification.

2.7.1 Rock Quality Designation (RQD) Index

The available bedrock coring data indicates that the upper horizons (i.e. uppermost 10 m) of the rock mass in the region of the Lake Manitoba Route C and D flood channels range from very poor, to excellent quality rock (i.e. RQD between 0% and 100%). However, proportionally within these upper bedrock strata, approximately 60% of the results fall below an RQD of 50% (i.e. poor rock quality to very poor rock quality). RQD and core recovery data are provided on Plate D5-4, and is discussed in more detail below.

In looking at RQD data calculated for bedrock strata 10 m or more below the bedrock surface (Plate D5-4), in general the rock mass ranks between an RQD of 50% to 100% (i.e. fair rock quality to excellent rock quality). While there are a few exceptions of low RQD rankings, 75% of

the results 10 m or more below the bedrock surface indicate RQD values in excess of 50%. These results are overall consistent with the interpretation of paleokarst affected bedrock strata, in particular for the uppermost 10 m of the bedrock.

By elevation, the RQD data do not present a particular trend, in that very low (i.e. 0% RQD) to very high (i.e. 100% RQD) designations are apparent at the full range of elevations where bedrock was cored and assessed in the region of the project. The inference is that as elevation decreases, RQD should increase, or as discussed above, the deeper into the rock mass (i.e. lower elevation) the higher the RQD. However, with the highly variable bedrock surface elevation in the region, low elevation bedrock areas (such as along Route D) may still have low RQD designations where the calculations are based on rock strata within 10 m of the bedrock surface. The clear trend is that the uppermost 10 m of bedrock in the region, regardless of the elevation at which it was intersected, has relatively lower RQD rankings, and thus supports the interpretation of the effects of paleokarst activity that has occurred within the upper bedrock in geologic history.

One other characteristic to assess is whether a particularly low RQD occurs at similar elevation between numerous boreholes. Low RQD at a particular elevation across a series of boreholes could for example indicate a pervasive karst feature, such as a highly solutioned bedding plane parting zone, or series of closely spaced and karst affected bedding planes. The available data set is relatively limited, however along Route C, there appears to be a very distinct poor quality bedrock zone (i.e. 0% RQD) at approximately El. 243.5 m +/- , as noted within testholes TH-GC-01, 15-RC-06, TH-GC-02, and TH-GC-04.

2.7.2 Drill Core Recovery

A percentage of core recovery less than 100% indicates a core loss, reflecting core that was ground by the drilling process, or denotes a core section that contains significant discontinuities (e.g., joints, fractures, etc), resulting in loss of core due to drilling processes, and/or because of large aperture discontinuities, or a void within the bedrock.

In general, available data indicates good core recoveries (see plate D5-4), ranging between approximately 40% and 100%. There are a few examples where core recoveries were very low

(i.e. ≤25%), typically within the uppermost bedrock, which was the most highly weathered due to paleokarst. One interval of 0% recovery at testhole 15-RC-06, and relatively reduced recovery of approximately 40% at THGC-02, correlates with the very low RQD values (i.e. 0%) recorded at these boreholes at approximately El. 243.5 m +/-. This data is suggestive of a pervasive paleokarst feature within the bedrock at this elevation.

2.7.3 Rock Mass Permeability

While trends in rock quality indicies from coring tends to correlate with the overall interpretation of karstic conditions of the rock mass as a whole, and in particular the poor quality uppermost 10 m of karstic bedrock, the water pressure testing permeability results (i.e. Lugeon tests) are highly variable. Lugeon permeability testing was conducted at TH-GC-01, TH-EC-01P, and at TH-GD-07 (see Plate D5-4). In summary:

- Testing at TH-EC-01P included intervals of zero take water pressure tests, to relatively high permeabilities (i.e. approximately 50 Lugeons). A number of the test results from this borehole indicate washout or filling of discontinuities, which is indicative of the movement of unconsolidated fracture infills (i.e. silts and very fine sands), induced by the water pressure testing.
- Testing at TH-GC-01 included a result of relatively low take of approximately 12 Lugeons based on testing approximately 1.7 m below the bedrock surface, with a relatively large permeability of approximately 260 Lugeons (with washout of the discontinuities) within the uppermost 1.4 m of the bedrock.
- Testing of a single interval within the upper 1.5 m of the bedrock at TH-GD-07 included a result of relatively low take of approximately 4 Lugeons.

For comparison purposes, 1 Lugeon is approximately equivalent to a permeability value of 1.3×10^{-7} m/s. The high degree of permeability variability within these test results indicate that permeability characteristics of the upper bedrock are controlled not only by discontinuities at the borehole scale, but also their geometry, continuity, connectivity, and infilling characteristics at larger scale away from the borehole. Permeability testing via rising head methods for the bedrock vary between approximately 4×10^{-7} m/s and 2×10^{-4} m/s. Hydrogeological studies of near surface karstic carbonate aquifers typically show aquifer scale hydraulic conductivities of 10^{-4} m/s to 10^{-6} m/s, comparable to results observed here. Additional discussion of the project hydrogeological conditions and associated permeability values is found within Deliverable D6.

Bedrock in the region is comprised of a complex assemblage of carbonate limestone and dolomitic limestone bedrock. Paleokarst processes have enhanced the permeability of the uppermost 8 m to 10 m of the bedrock, as well as resulting in solutioning along pre-existing bedrock discontinuities. There are series of sub-vertical to vertical master joints and horizontal bedding plane partings, aside from the typical smaller-scale bedrock discontinuities (fractures), and broken core zones, that provide secondary permeability, as relatively pervious and hydraulically conductive zones within the bedrock mass. Because of this, permeability distributions in carbonate bedrock tend to be bimodal, due to the relatively low hydraulic conductivity matrix blocks and high conductivity fractures and paleokarst dissolution zones.

Karstification of carbonate bedrock leads to continuous to semi-continuous, large aperture pathways through soluble rock, which form a permeable conduit network. With karstic systems, primary and secondary rock discontinuities are typically enhanced by dissolution; this is reflected in the complex hydraulic conductivity distribution many aquifers of this type tend to have. Aside from the permeability enhancement resultant from solutioning processes, many of these secondary permeability features are also infilled with sediments, from sand and fine sand to silts and clays.

Fracture properties such as parting (aperture), frequency, length, interconnectivity, orientation, and infillings are known to significantly affect the groundwater flow within a carbonate and karstic rockmass. The fracture hydraulic properties are a result of in-situ processes, as well as a product of the geological history of the region. Even though it is well known that groundwater flow is significantly affected by fracture properties, it can be difficult to compare hydraulic conductivity measured during packer testing, and the fractured rockmass conditions at the regional scale. This is due to the complexities associated with discontinuity persistence, connectivity, hydraulic aperture, orientation, and infill characteristics which govern flow through the fracture system to the packer testing interval. In addition, flow through discontinuities and complex fracture systems in karstic environments is characterized by fracture flow conditions (i.e. versus traditional porous media or Darcy flow conditions), which in some cases may also include turbulent versus strictly laminar flow conditions.

Larger scale tests of aquifer permeability (i.e. pumping tests) stress a larger zone of the bedrock aquifer, and often result in calculation of increased bulk aquifer permeability in comparison to

borehole scale packer tests. The resultant measurement of flows through larger scale discontinuity systems, which are a product of connectivity, continuity, and infill characteristics of the fracture zones at a larger well pumping test scale, cannot be assessed effectively at the borehole scale using only packer tests. Further detailed discussion of aquifer pumping tests conducted in the region of Routes C and D is contained in the groundwater study (Deliverable D6).

3.0 STRATIGRAPHY OF ROUTES C AND D

Bedrock topography and overburden thickness were modeled in detail along the Route C and D channels. In addition, longitudinal geological sections were prepared for the Route C and Route D channel alignments, to illustrate the general stratigraphy and geological conditions along each route. Two additional cross sections were prepared transverse to Route D, to demonstrate typical areas where the bedrock surface topography varies drastically over relatively short distances. In general, boreholes closest to the channel centerline alignment were chosen for detailing the cross section. In some cases, testpit data (e.g. stratigraphic contacts) were included on the sections, however testpit locations were not shown for clarity. Depending on regional geological conditions and alignment of the channel route to the geology, in some cases boreholes further from the channel centerline were detailed on the sections.

3.1 ROUTE C – BEDROCK TOPOGRAPHY AND OVERBURDEN THICKNESS

Route C bedrock surface topography and overburden thickness models are provided in Plates D5-5, and D5-6 respectively. The longitudinal geologic cross section for Route C is provided in Plate D5-7, and includes relevant drilling information, water levels, and the design channel invert profile, for reference. From Lake Manitoba to approximately Station 6+000 (i.e., the first 6 km of this route), the proposed Route C channel cuts through a relatively high elevation bedrock area comprised entirely of Silurian Aged Cedar Lake Formation, with the sides and invert (i.e., bottom) of the channel incised into the bedrock. The remainder of the channel to Lake St. Martin cuts primarily through till material with the occasional occurrence of bedrock, though the invert of the channel along this reach throughout may be at, or slightly above, the bedrock surface, based on available information to date.

The proposed Route C channel has an invert of El 242.75 m (El 796.4 ft) at Lake Manitoba and El 240.6 m (El 789.4 ft) at Lake St. Martin. The depth of excavation below ground surface varies between approximately 4 m and 14 m, with the deepest cut located in the high elevation bedrock area, between approximately Station 3+500 and Station 4+500 (i.e. 3.5 km to 4.5 km along the channel from Lake St. Martin). Since the invert of the channel would be lower than water levels in Lake Manitoba and Lake St. Martin, there would be standing water in the channel when it is not in operation.

In summary:

- Bedrock topography along the Route C alignment varies between approximately El. 242 m near the inlet, El. 240 m near the outlet, and as high as El. 255.6 m in the highest elevation bedrock area located between approximately Station 4+000 and Station 5+000.
- The Route C channel will be incised within the bedrock over much of its length, with inlet and outlet invert areas of the channel, at a minimum, founded on the bedrock surface, with till side slopes.
- The bedrock surface near the proposed control structure, located at Highway 6 (i.e. approximately Station 7+500 to Station 8+000) and in channel areas downstream, varies in elevation quite drastically, in both the north-south and east-west directions. Borehole data in this area indicates depths to bedrock that vary by more than 10 m to 15 m over relatively short distances. The east side of the Route C bedrock mound, in and around the location of Highway 6, appears to be controlled by a structural bedrock feature (i.e. bedrock low) that runs approximately from the northwest to the southeast in this area. This may be a reflection of a karst infill of a solutioned and preglacially and glacially eroded master joint, or some other bedrock lithological discontinuity.
- Accordingly, the overburden thickness along Route C is in general in the order of 5 m to 8 m in upstream and downstream channel areas, with the exception of very thin (i.e. <1.0 m) overburden in areas of the bedrock high or “mound”, and relatively thick (i.e. >10.0 m) overburden in areas associated with the bedrock structural low immediately east of the bedrock mound, and in the vicinity of Highway 6.

3.2 ROUTE D - BEDROCK TOPOGRAPHY AND OVERBURDEN THICKNESS

Route D bedrock surface topography and overburden thickness models are provided in Plates D5-8 and D5-9 respectively. The longitudinal geologic cross section for Route D is provided in Plate D5-10, with transverse cross sections provided in Plate D5-11. The sections include relevant drilling information, water levels, and the design channel invert profile, for reference.

Route D is situated within relatively low lying topographic ground conditions along Birch Creek, running northward from Watchorn Bay of Lake Manitoba, to Lake St. Martin (See Plate D5-1). The Route D channel has an invert of El 242.0 m (El 793.0 ft) at Lake Manitoba and El 239.0 m (El 784.1 ft) at Lake St. Martin. The depth of excavation below ground surface varies between approximately 6 m and 12 m, with the deepest channel cut located near PTH 6, where the ground topography is relatively highest along the route. Excavation of the proposed Route D channel is entirely within the till; however bedrock below the till is comprised of Devonian aged

Elm Point and Ashern formation bedrock within the uppermost reaches of the channel in the west nearest to Lake Manitoba (i.e. to approximately Station 5+500), and is underlain by Silurian aged Cedar Lake Formation in all downstream channel areas, and at Lake Saint Martin. Since the invert of the channel would be lower than water levels in Lake Manitoba and Lake St. Martin, there would be standing water in the channel when it is not in operation.

In summary:

- The Route D channel excavation is entirely within the till, and intersects various intertill granular pockets.
- The low topography area along Birch Creek, where Route D is situated, is a relict drainage channel that interconnected Lakes Manitoba and Saint Martin, sometime during final deglaciation of the region. The low topography area is a result of glacial erosion and relict surface drainage, but also reflects infilling of an underlying structurally controlled bedrock channel, running north-south between Watchorn Bay of Lake Manitoba, and Lake Saint Martin.
- The underlying bedrock channel represents a structural bedrock feature, that in geologic history was subject to paleokarst processes, preglacial erosion, and subsequent glacial erosion during emplacement of the tills in the region.
- The bedrock surface in the vicinity of the proposed Route D channel, along the deep bedrock conduit varies between approximately El. 225 m, to approximately El. 236 m near the proposed control structure at Highway 6. Transverse to the channel, the bedrock surface rises drastically to elevations in the order of El. 245 m to El. 250 m within approximately 1 km to 3 km east or west of the channel centerline.
- Deep coring of till at a few locations, namely TH-ED-01P, encountered over-consolidated and well cemented basal till (i.e. the Inwood Till, which underlies the more loosely consolidated Komarno Till, which is found at surface within the region).
- In general, there is approximately 10 m to 14 m of till underlying the invert of the proposed channel excavation, and above the bedrock surface. At the location of the proposed control structure near Highway 6, the bedrock surface rises to become within approximately 4 m of the proposed channel invert.
- In areas to the east and west of the channel alignment, where the bedrock surface rises drastically to approximately El. 245 m to El. 250 m, overburden thickness in places can be approximately 3.0 m, or less, in particular on the east side of the channel alignment.

4.0 SUMMARY

The geological setting of the Routes C and D Lake Manitoba Channels is in general typical of the Interlake region of Manitoba, where outcropping to relatively shallowly buried limestone and dolomitic limestone bedrock is overlain by till, and discontinuous postglacial sediments at ground surface. The proposed channel alignments differ in one fundamental way, in that the Route C channel would be incised directly into the bedrock, and the Route D channel would be constructed entirely within the till sediments overlying the bedrock.

The morphology and topography of the bedrock surface in the region varies drastically due to structural discontinuities (i.e. joints and bedding plane partings), textural/compositional variability inherent within the rockmass due to its depositional history, paleokarst processes which enhanced pre-existing bedrock structural discontinuities and emplaced discontinuity infills, preglacial erosional events, and finally, erosion during glaciation and subsequent emplacement of the overlying till sediments.

For Route D, the relatively low ground surface topography along the route between Watchorn Bay of Lake Manitoba and Lake St. Martin is a result of relict surface drainage of Lake Manitoba to Lake St. Martin during deglaciation. This topographic low may also be a reflection of glacial sediment infilling of a large underlying bedrock structural feature, and associated deep depths to bedrock along the route. In directions orthogonal to Route D, the bedrock surface rises drastically within distances of approximately 1 km to 3 km of the route centerline. Relatively high ground surface topography along the majority of Route C is a reflection of a high elevation bedrock surface, and thin overburden cover along the upstream portion of the route. Bedrock topography in the vicinity of Highway 6 along Route C, to Lake St. Martin, varies drastically over relatively short distances, where thicker sediment cover and infills are present.

High elevation bedrock areas with thin sediment cover are typical of unconfined groundwater recharge areas. Relatively lower bedrock elevation areas are typically confined by overlying tills, and are characteristic of groundwater discharge, where the confined bedrock aquifer may be under a flowing artesian condition. In all cases, the uppermost approximately 10 m of the rock mass is affected the most severely by paleokarst processes, which enhances general bedrock permeability, where succeeding karstic infills do not govern the rockmass permeability condition.

Thus the relationship between overall bedrock conditions (including permeability, bedrock topography/regional structural conditions), overburden type/thickness, and groundwater conditions, are all important contributors in defining the design, optimization, or environmental implications associated with each routing option.

5.0 RECOMMENDATIONS

Based on the data examined to date, recommendations to move forward with final design tasks that may include, (but are not limited to), optimization of route layouts, optimization of channel cross sections and inverts, and finalization of control structure locations, are as follows:

- Expand the geophysical data set available for the preferred route, in particular where bedrock surface data is sparse or varies considerably in quality or elevation over short distances, or in the inlet/outlet areas. Any future geophysical data collection should be tied to the existing network of available boreholes, or new boreholes, if/as necessary.
- Supplemental drilling investigations in key or select areas along the preferred route, where design optimization or risk reduction is necessary. This could include, for example, proposed control structure locations.

6.0 REFERENCES

1. Bannatyne, B.B. (1988). Dolomite Resources of Southern Manitoba. Economic Geology Report ER85-1, Manitoba Energy and Mines, Geological Services.

2. Betcher, R., Grove, G., and Pupp, C. (1995). Groundwater in Manitoba: Hydrogeology, Quality Concerns, Management. NHRI Contribution No. CS-93017.

3. Bezys, R.K., and Bamburak, J.D. (2004). Lower to Middle Paleozoic Stratigraphy of Southwestern Manitoba. WCSB/TGI II Field Trip. May 25 – 28, 2004.

4. Groom, H.D. (2006). Aggregate Resources in the Rural Municipality of Grahamdale, Manitoba. Manitoba Industry, Economic Development, and Mines, Manitoba Geologic Survey, Geoscientific Map, Map2006-1, Scale 1:100,000.

5. Groom, H.D. (2004). Aggregate Resources in the Rural Municipality of Grahamdale, Manitoba; in Report of Activities 2004, Manitoba Industry, Economic Development, and Mines, Manitoba Geological Survey, p. 301-308.

6. Nicholas, M.P.B., Matile, G.L.D., Keller, G.R., and Bamburak, J.D. (2010) Phanerozoic Geology of Southern Manitoba. Manitoba Innovation, Energy, and Mines, Manitoba Geological Survey, Stratigraphic Map SM2010-1, 2 Sheets, Scale 1:600,000.

7. Nicholas, M.P.B. (2009). Williston Basin Project (TGI II): Summary Report on Mesozoic Stratigraphy, Mapping, and Hydrocarbon Assessment, Southwestern Manitoba. Geoscientific Paper GP2009-1.

8. Nielsen, E., and Thorleifson, L.H. (2003). Quaternary Geology of the Lake Winnipeg Area; in, 1999 Lake Winnipeg project: cruise report and scientific results; Simpson, S L (ed.); Thorleifson, L H (ed.); Lewis, C F M (ed.); King, J W (ed.); Geological Survey of Canada, Open File 4196, 2003.

9. Norris, A.W., Uyeno, T.T., McCabe, H.R. (1982). Devonian Rocks of the Lake Winnipegosis – Lake Manitoba Outcrop Belt, Manitoba. Geological Survey of Canada Memoir 392.

10. Stearn, C.W. (1956). Stratigraphy and Paleontology of the Interlake Group and Stonewall Formation of Southern Manitoba. Geological Survey of Canada Memoir 281.

PLATES

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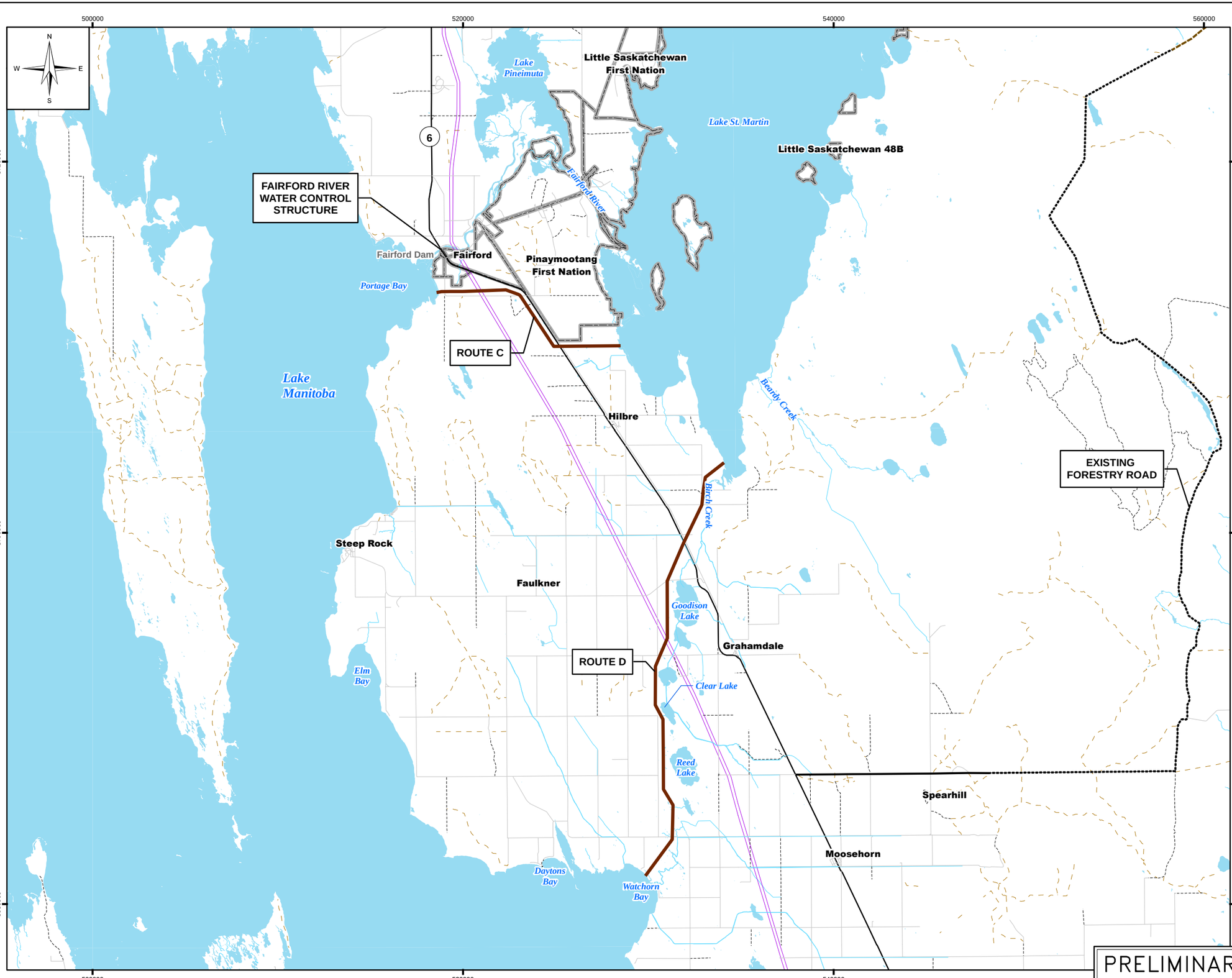

LEGEND:

- LMB Channel Option
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Waterbody
- First Nation

NOTES:

1. Contours generated from LiDAR (2011).
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8

Kilometres

SCALE: 1:200,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D5	JDM	JBS

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

LOCATION PLAN

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D5-1 | REV: 0

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11"x17" PLOT SCALE 1:1

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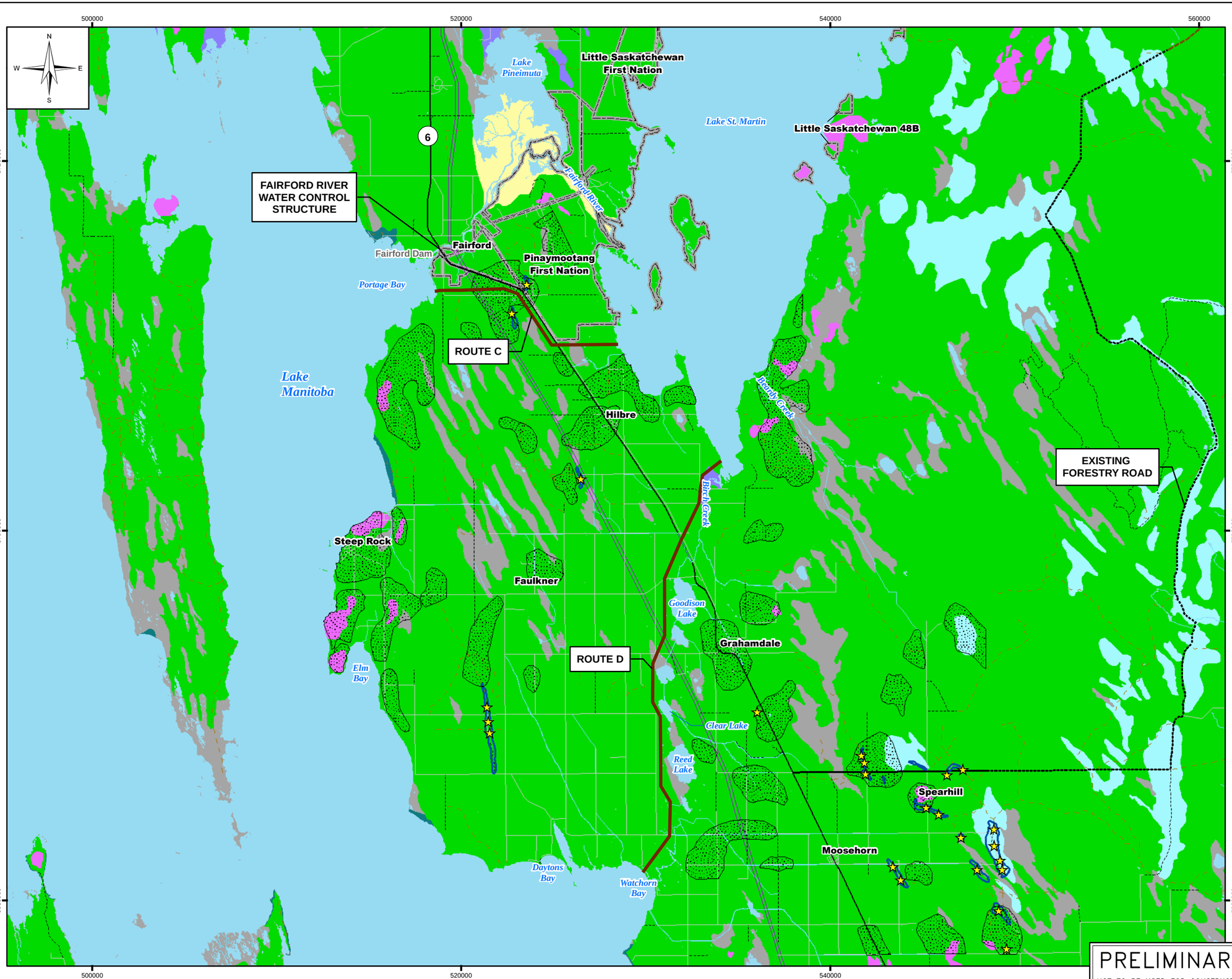

LEGEND:

- LMB Channel Option
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Waterbody
- First Nation

Geology

- Gravel Pit
- Glaciolacustrine Beach Ridges
- Near Surface Bedrock (<2.5m depth to Bedrock)

Surficial Geology

- Organic
- Lacustrine – modern shoreline
- Alluvium
- Glaciolacustrine – littoral
- Glaciolacustrine – silt and clay
- Till – silt-rich
- Rock – Paleozoic

NOTES:

1. Reference: Groom, H.D. 2006: Aggregate resources in the rural Municipality of Grahamdale, Manitoba; Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, Geoscientific Map, Map2006-1, scale 1:100,000.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8
Kilometres
SCALE: 1:200,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

OVERVIEW
SURFICIAL GEOLOGY

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D5-2 | REV: 0

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11"x17" PLOT SCALE 1:1

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FAIRFORD RIVER WATER CONTROL STRUCTURE

ROUTE C

ROUTE D

EXISTING FORESTRY ROAD

Fairford

Fairford Dam

Pinaymootang First Nation

Little Saskatchewan First Nation

Hilbre

Steep Rock

Faulkner

Grahamdale

Spearhill

Moosehorn

Lake Manitoba

Lake St. Martin

Lake Pineimuta

Portage Bay

Fairford River

Beardy Creek

Birch Creek

Goodison Lake

Clear Lake

Reed Lake

Elm Bay

Daytons Bay

Watchorn Bay

P

Orr

Os,sm

S

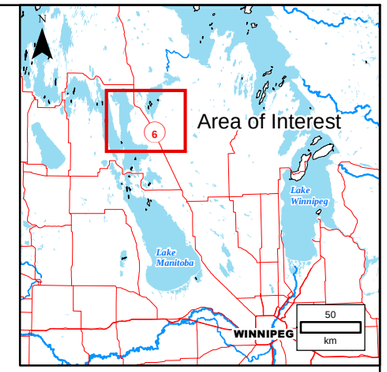
Da

Dep

Ddb

Dw/ep

Symbol	EON	ERA	PERIOD	FORMATION	DESCRIPTION
P	Phanerozoic	Paleozoic	Permian	St. Martin Complex	Carbonate breccia (fragments Ordovician to Devonian), polymict breccia, granitic microbreccia, trachyandesite
Da	Phanerozoic	Paleozoic	Devonian	Ashern Formation	Dolomitic shale and argillaceous dolomite, red to greenish grey; local basal breccia
Ddb	Phanerozoic	Paleozoic	Devonian	Dawson Bay Formation	Basal red shale; bituminous dolomite, micritic limestone, brachiopod micrite; calcareous shale; fossiferous coral stomatoporoid limestone
Dep	Phanerozoic	Paleozoic	Devonian	Elm Point Formation	High-calcium limestone biomicrite (platform facies)
Dw/ep	Phanerozoic	Paleozoic	Devonian	Winnipegosis Formation	High-calcium limestone biomicrite, siltstone, sandstone
S	Phanerozoic	Paleozoic	Silurian	Interlake Group	Micritic, fossiliferous, stromatolitic and biostromal dolomites with several sandy/argillaceous marker beds
Orr	Phanerozoic	Paleozoic	Ordovician	Red River Formation	Limestone, dolomitic limestone, dolomite
Os,sm	Phanerozoic	Paleozoic	Ordovician	Stonewall Formation	Dolomite, fine-grained, sparcely fossiliferous; in part conglomeratic



LEGEND:

- LMB Channel Option
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Waterbody
- First Nation

Geology

- Observed Bedrock Outcrop
- Quarry (small)
- Quarry (large)

Bedrock Geology (See Table)

- P
- Da
- Ddb
- Dep
- Dw/ep
- S
- Orr
- Os,sm

NOTES:

1. Reference: Groom, H.D. 2006: Aggregate resources in the rural Municipality of Grahamdale, Manitoba; Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, Geoscientific Map, Map2006-1, scale 1:100,000.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8
Kilometres
SCALE: 1:200,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

OVERVIEW
BEDROCK GEOLOGY

MAY 2017 | PLATE D5-3 | REV: 0

PRELIMINARY
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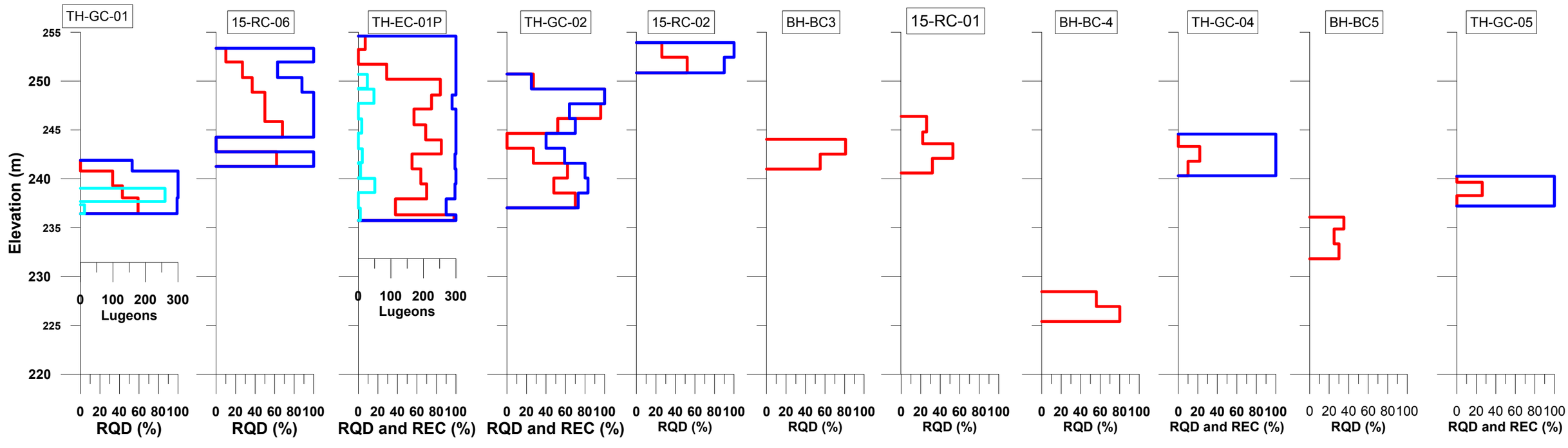
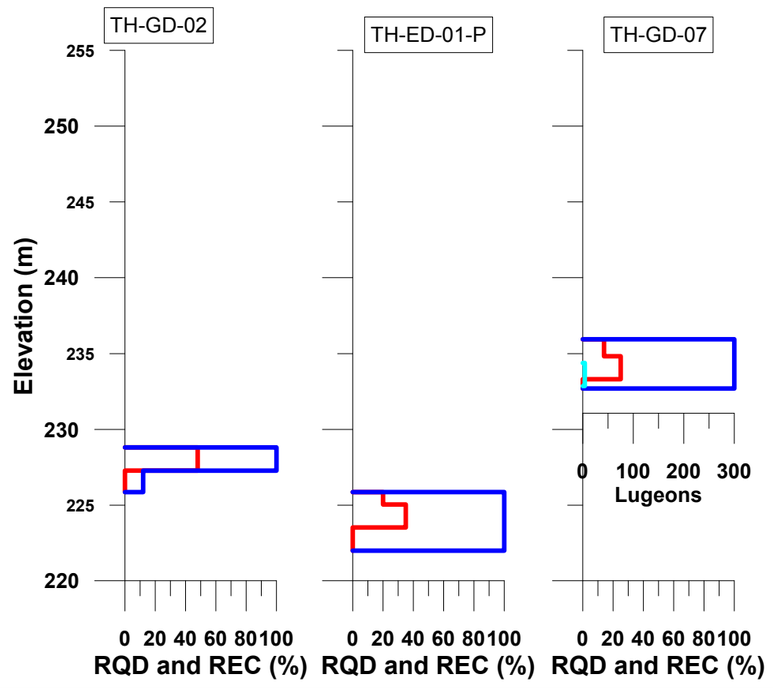
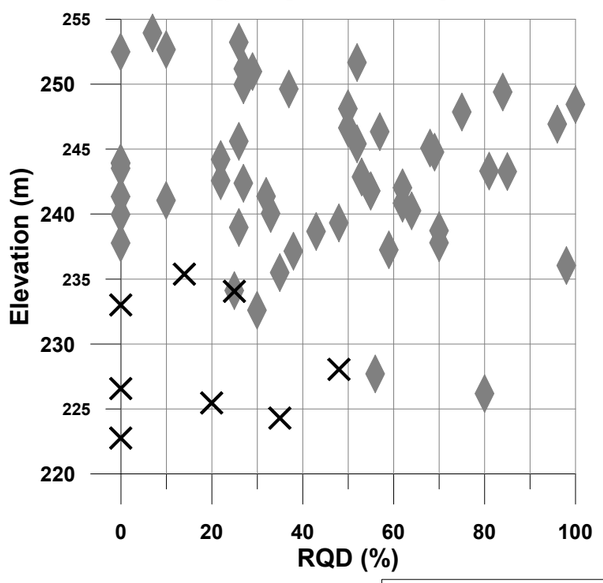
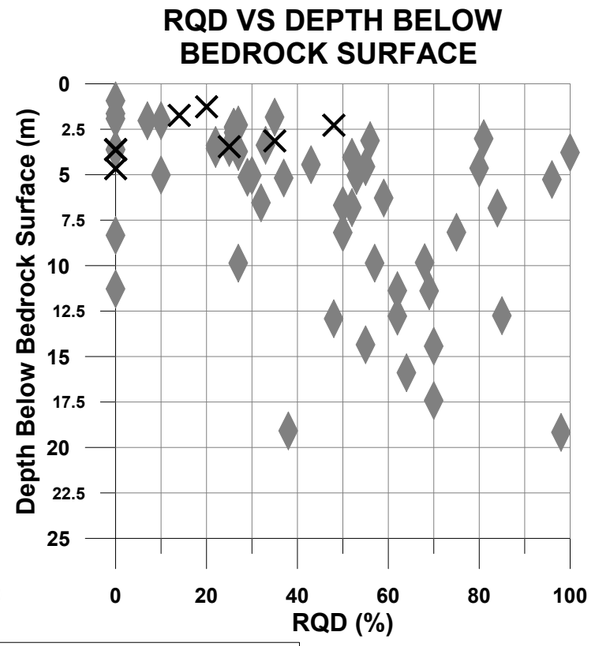
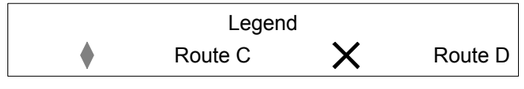


LMB

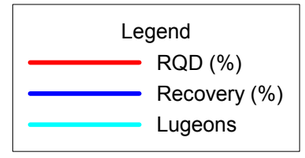








LSM



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Manitoba Infrastructure

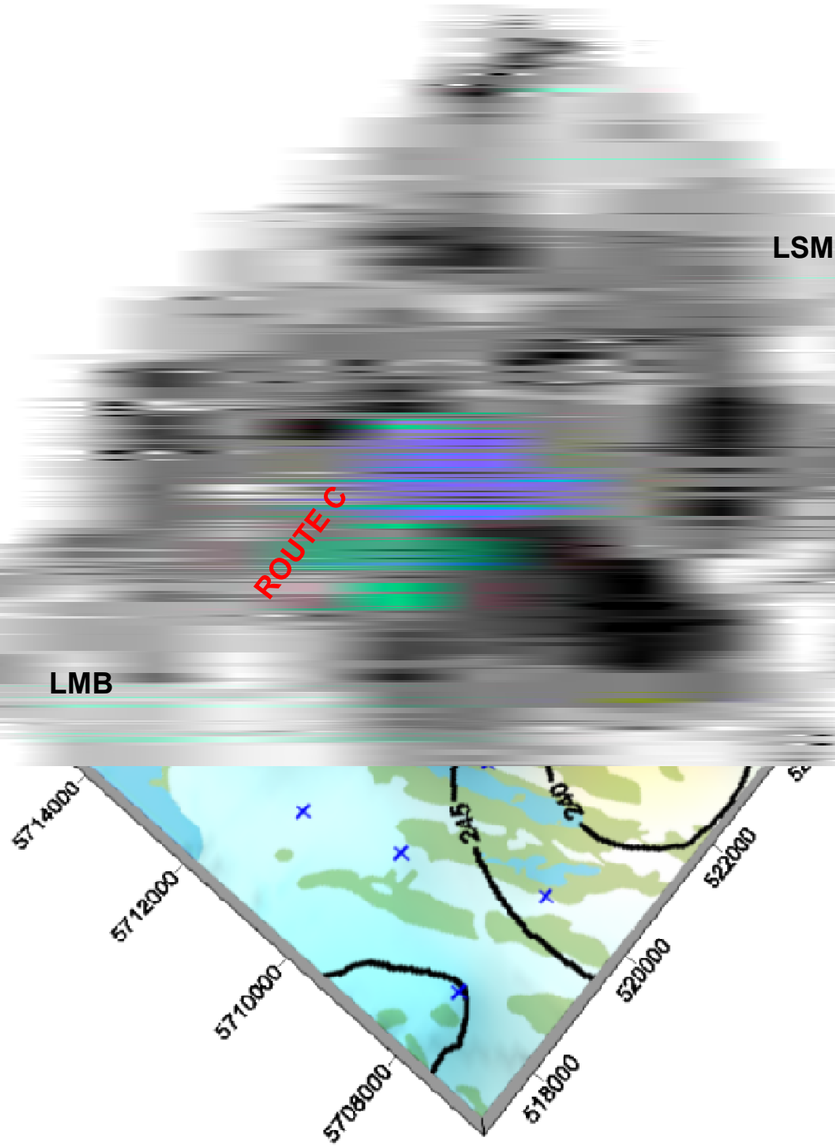
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PLOTS OF ROCK QUALITY DESIGNATION (RQD), CORE RECOVERY, AND LUGEON PERMEABILITY

MAY 2017	PLATE D5-4	REV: 0

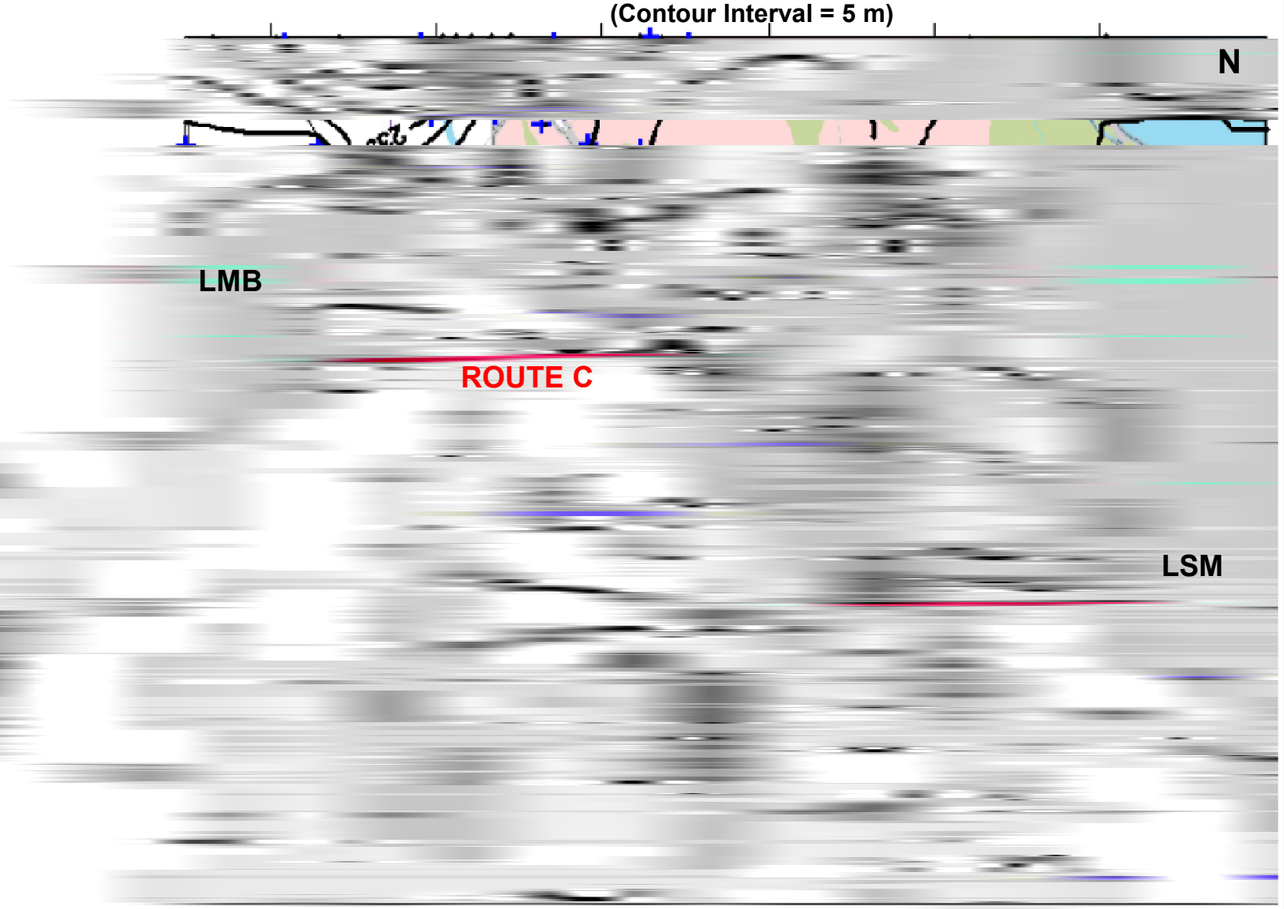
3D BEDROCK SURFACE - PERSPECTIVE VIEW

(Contour Interval = 5 m; Vertical Exaggeration 100X)



BEDROCK SURFACE CONTOURS - PLAN VIEW

(Contour Interval = 5 m)



+ = Available Datapoint

NOTES:

1. Data compiled from 2011, 2015, and 2016 investigation programs and provincial GWDRILL Database.
2. Data kriged in Surfer. Search radii for kriging optimized based on data distribution.
3. Grid in UTM (m).

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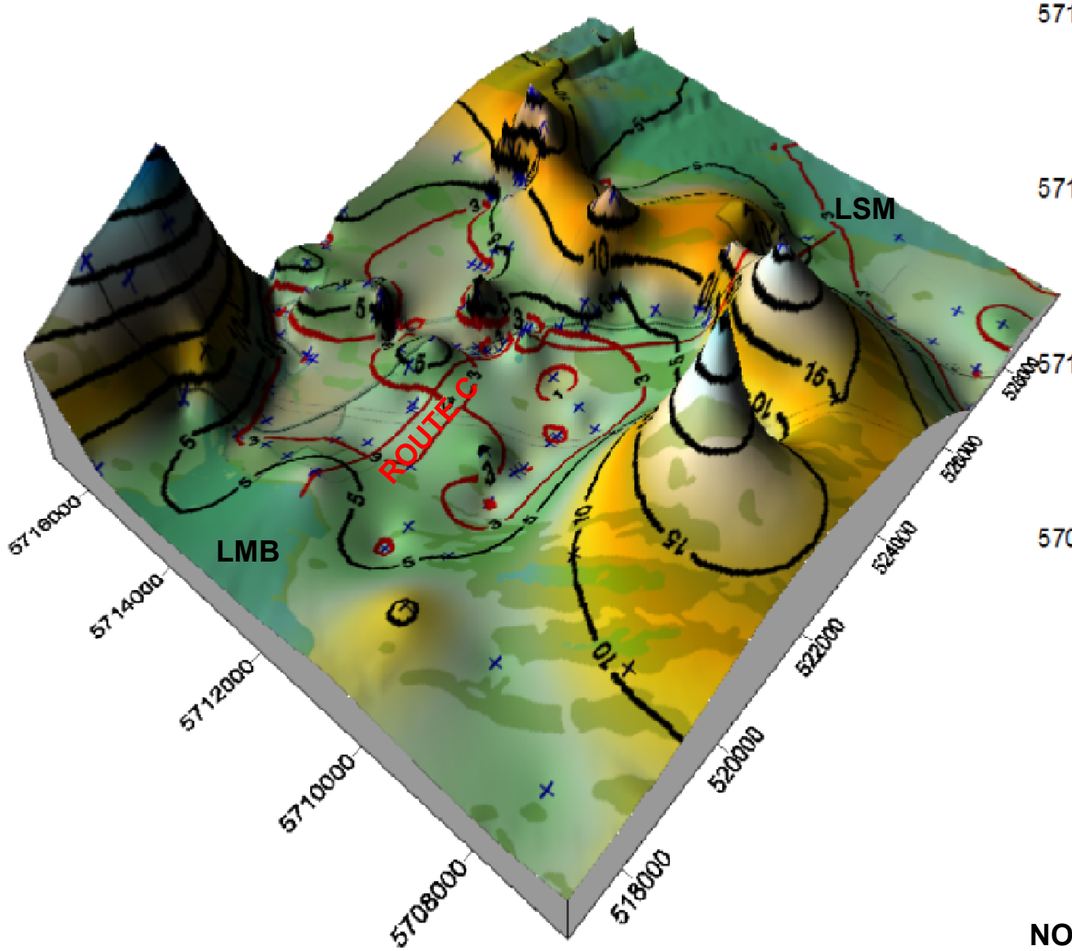
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

3D MODEL AND PLAN VIEW CONTOURS OF BEDROCK SURFACE ROUTE C

MAY 2017	PLATE D5-5	REV. 0

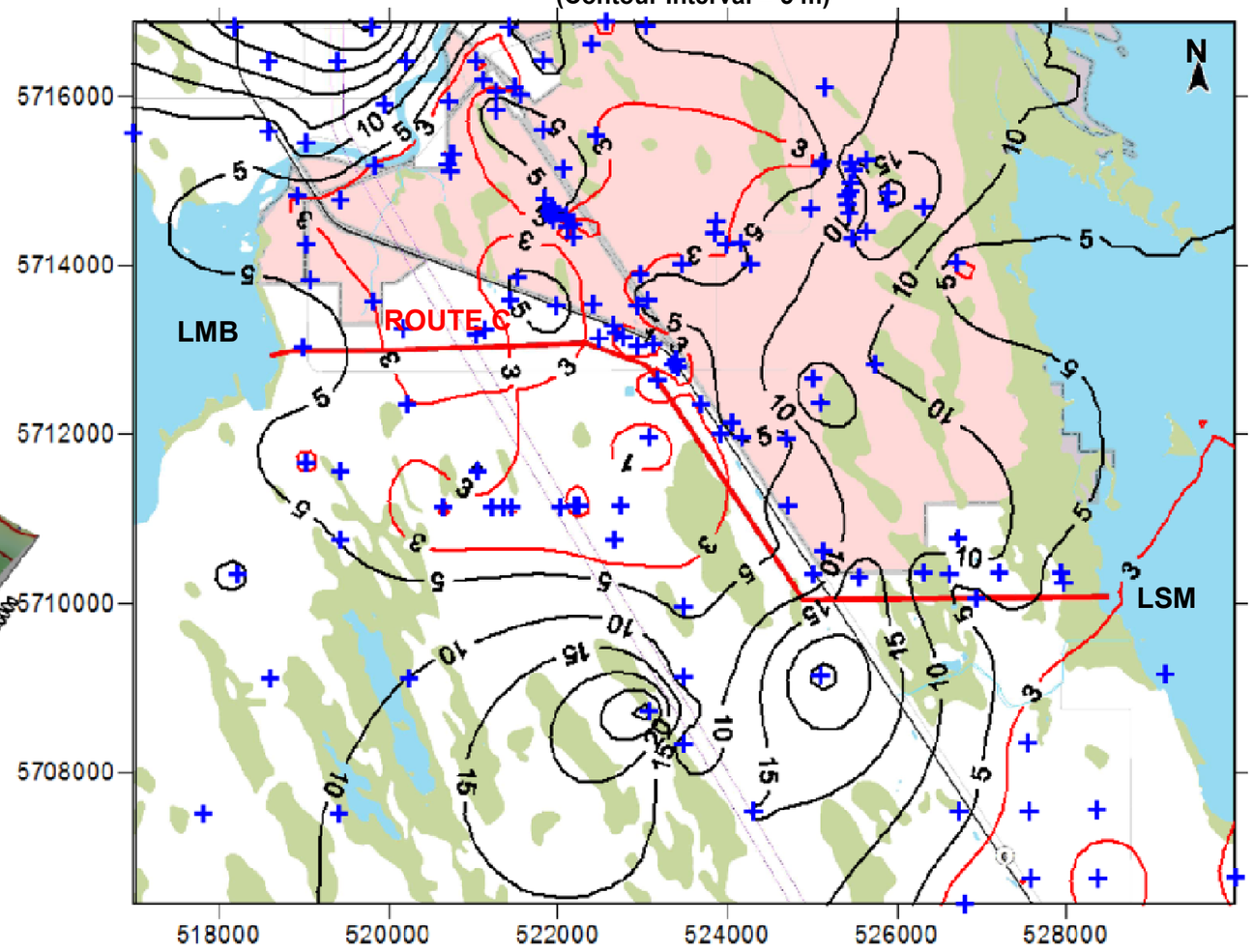
3D SURFACE OF OVERBURDEN THICKNESS - PERSPECTIVE VIEW

(Contour Interval = 5 m; Vertical Exaggeration 100X)



OVERBURDEN THICKNESS CONTOURS - PLAN VIEW

(Contour Interval = 5 m)



+ = Available Datapoint

NOTES:

1. Data compiled from 2011, 2015, and 2016 investigation programs and provincial GWDRILL Database.
2. Data kriged in Surfer. Search radii for kriging optimized based on data distribution.
3. 1.0 m and 3.0 m contours shown in red.
4. Grid in UTM (m).

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
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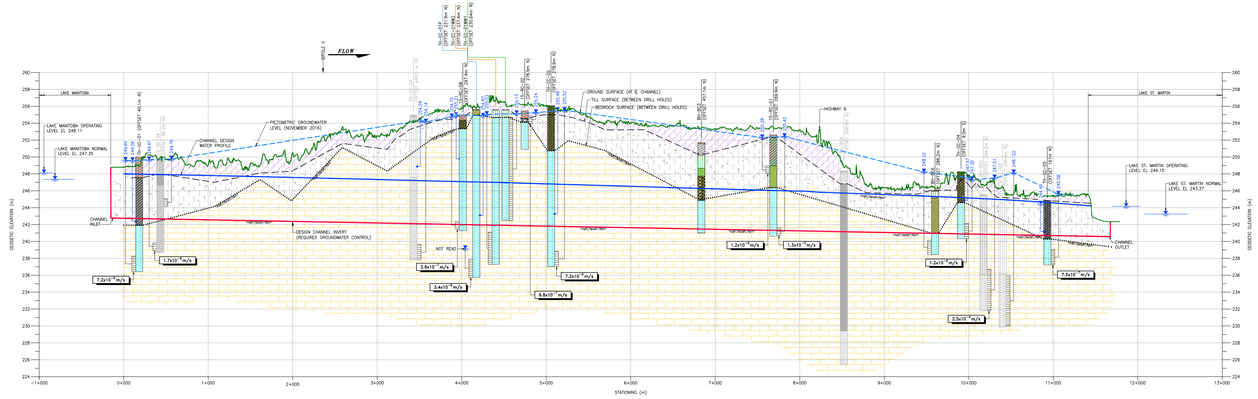
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

3D MODEL AND PLAN VIEW CONTOURS OF OVERBURDEN THICKNESS ROUTE C

MAY 2017	PLATE D5-6	REV: 0



LEGEND:

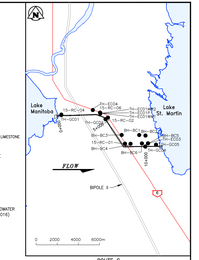
STRATIGRAPHY:

- ICE
- WATER
- TOPSOIL
- SANDY SILT
- BOULDERS
- SAND
- SAND AND GRAVEL
- CLAY
- SILT
- SILTY SAND
- SILTY CLAY
- CLAY TILL
- TILL
- BEDROCK (UNDIFFERENTIATED LIMESTONE AND DOLOMITIC LIMESTONE)

- ORIGINAL GROUND SURFACE
- WATER SURFACE PROFILE
- TILL SURFACE
- DESIGN CHANNEL INVERT
- BEDROCK

DRILL HOLE — PIEZOMETRIC GROUNDWATER LEVEL (NOVEMBER 2016)

GROUNDWATER MONITORING ZONE



ROUTE C

NOTE:
1. ALL UNITS ARE IN METERS.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

SCALE : 1000 METRIC

SCALE : 25000 METRIC

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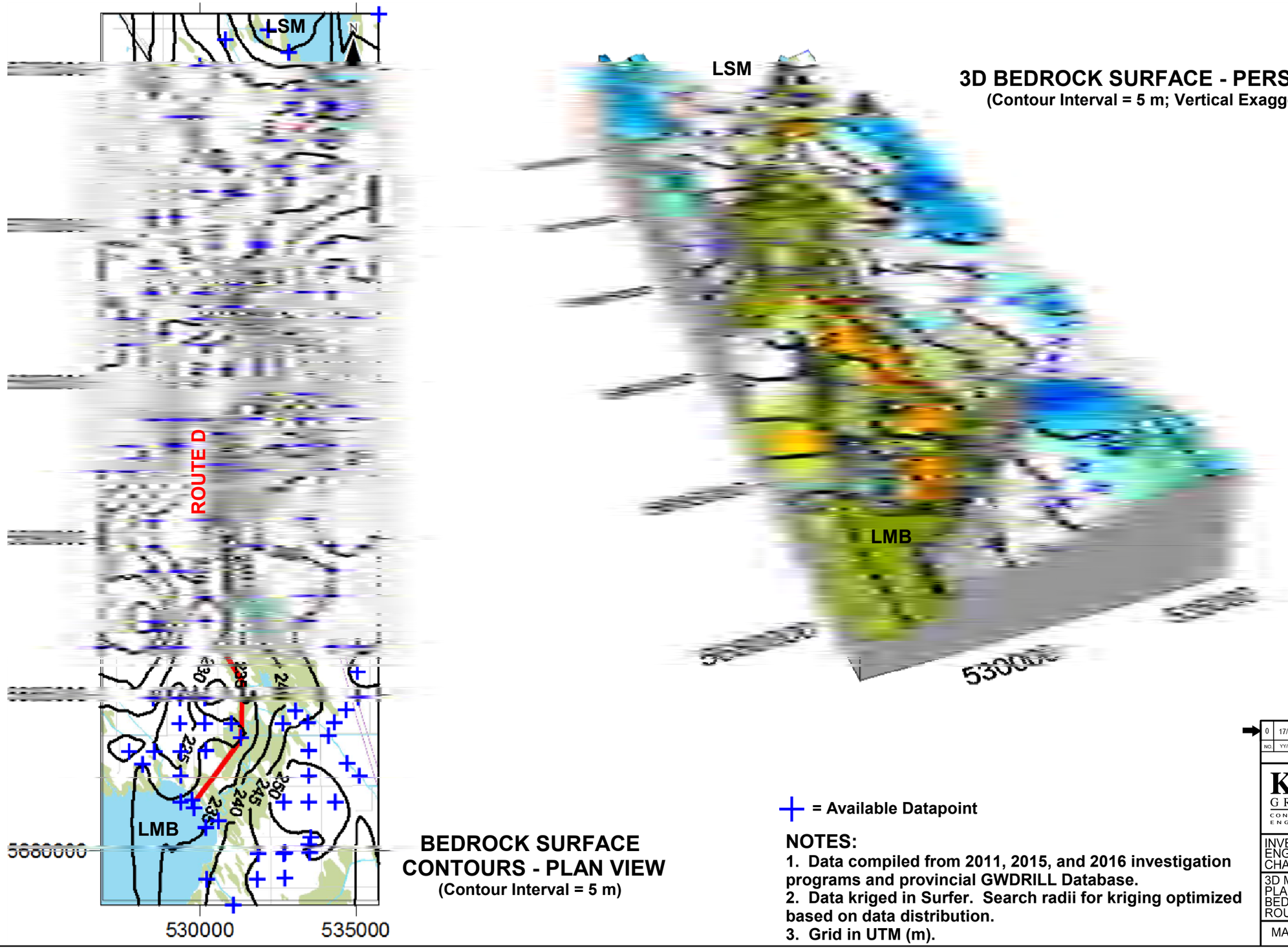
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LAKE MANITOBA OUTLET CHANNEL, OPTIONS C & D

LONGITUDINAL STRATIGRAPHIC PROFILE ALONG ROUTE C

MAY 2017 | PLATE D5-7 | 0



3D BEDROCK SURFACE - PERSPECTIVE VIEW

(Contour Interval = 5 m; Vertical Exaggeration 100X)

BEDROCK SURFACE CONTOURS - PLAN VIEW

(Contour Interval = 5 m)

+ = Available Datapoint

NOTES:

1. Data compiled from 2011, 2015, and 2016 investigation programs and provincial GWDRILL Database.
2. Data kriged in Surfer. Search radii for kriging optimized based on data distribution.
3. Grid in UTM (m).

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
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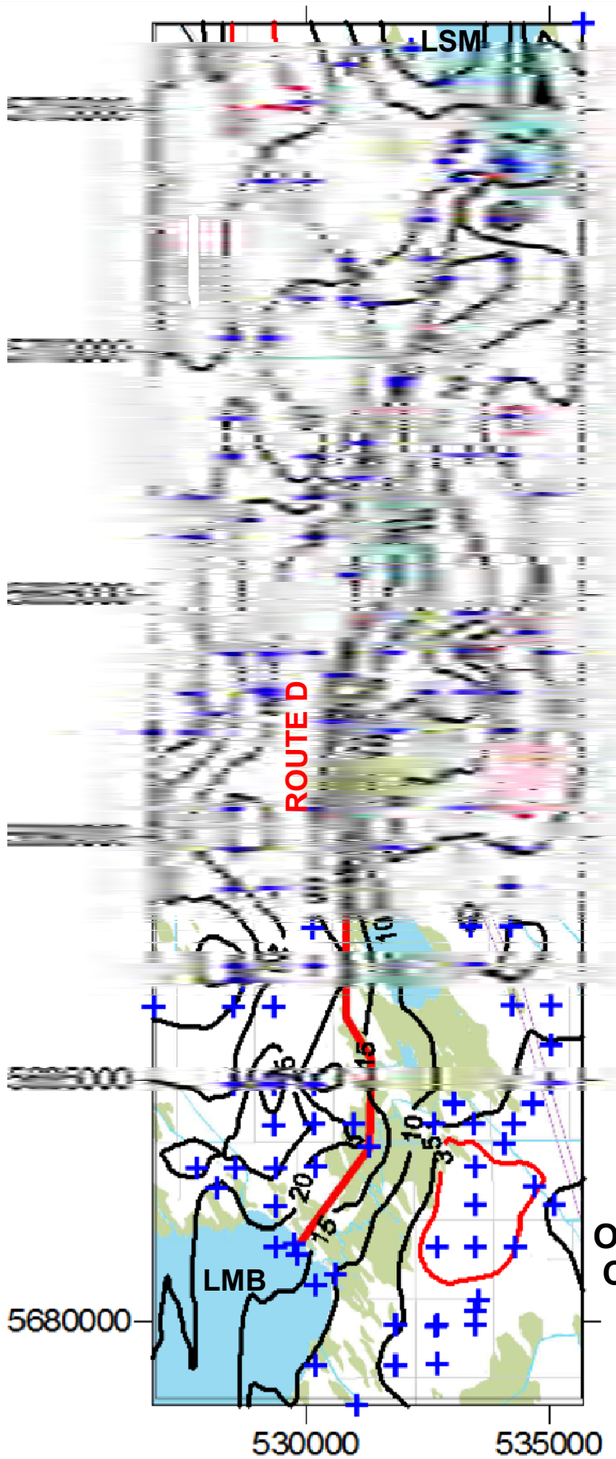
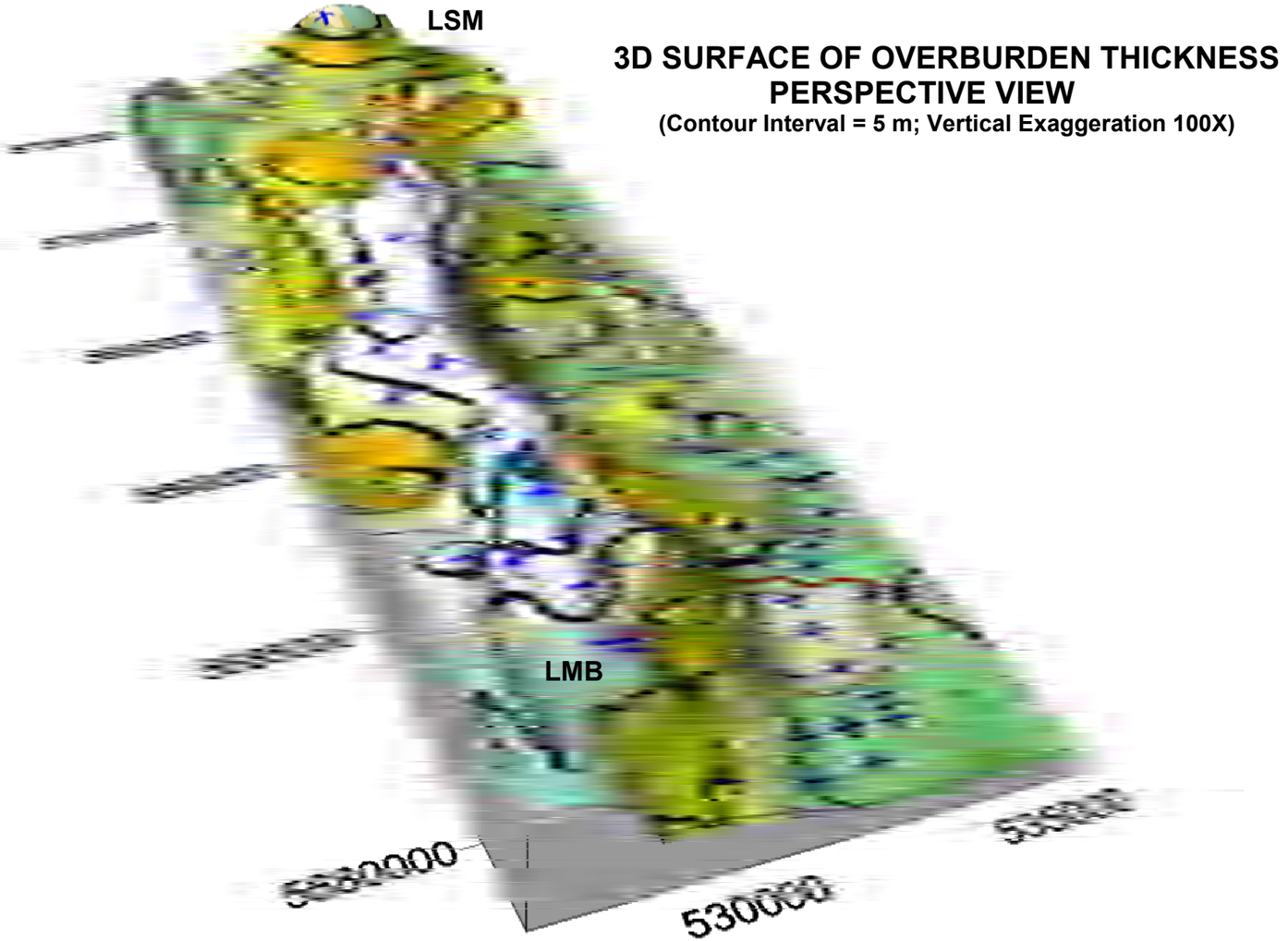
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

3D MODEL AND PLAN VIEW CONTOURS OF BEDROCK SURFACE ROUTE D

MAY 2017 | PLATE D5-8 | REV: 0



OVERBURDEN THICKNESS CONTOURS - PLAN VIEW
(Contour Interval = 5 m)



3D SURFACE OF OVERBURDEN THICKNESS PERSPECTIVE VIEW

(Contour Interval = 5 m; Vertical Exaggeration 100X)

+ = Available Datapoint

NOTES:

1. **Data compiled from 2011, 2015, and 2016 investigation programs and provincial GWDRILL Database.**
2. **Data kriged in Surfer. Search radii for kriging optimized based on data distribution.**
3. **3.0 m contour shown in red.**
4. **Grid in UTM (m).**

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
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REVISIONS / ISSUE

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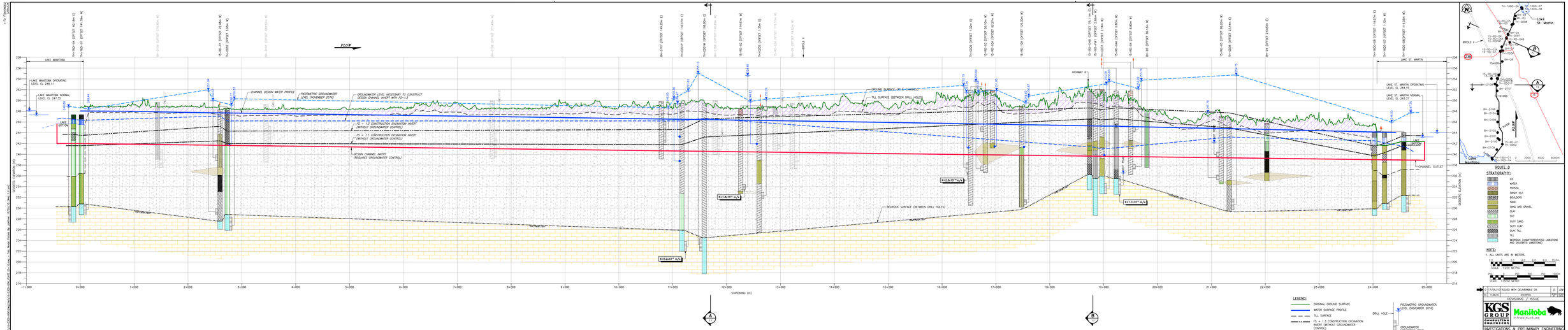
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

3D MODEL AND PLAN VIEW CONTOURS OF OVURBURDEN THICKNESS ROUTE D

MAY 2017	PLATE D5-9	REV. 0



ROUTE D

STRATIGRAPHY:

- ICE
- WATER
- TOPSOIL
- SANDY SILT
- BOULDERS
- SAND
- SAND AND GRAVEL
- CLAY
- SILT
- SILTY SAND
- SILTY CLAY
- CLAY TILL
- TILL
- BEDROCK (UNDIFFERENTIATED LIMESTONE AND DOLOMITIC LIMESTONE)

NOTE:

1. ALL UNITS ARE IN METERS.

SCALE: 1:2000 METRIC

SCALE: 1:20000 METRIC

LEGEND:

- ORIGINAL GROUND SURFACE
- WATER SURFACE PROFILE
- TILL SURFACE
- FS = 1.3 CONSTRUCTION EXCAVATION INVERT (WITHOUT GROUNDWATER CONTROL)
- FS = 1.1 CONSTRUCTION EXCAVATION INVERT (WITHOUT GROUNDWATER CONTROL)
- DESIGN CHANNEL INVERT
- BEDROCK
- DRILL HOLE
- PIEZOMETRIC GROUNDWATER LEVEL (NOVEMBER 2016)
- GROUNDWATER MONITORING ZONE

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NO.	BY	DD/MM/YY	REVISIONS / ISSUE
1		17/05/16	ISSUED WITH DELIVERABLE 05
0		17/05/16	ISSUED FOR USE

JS | JDM

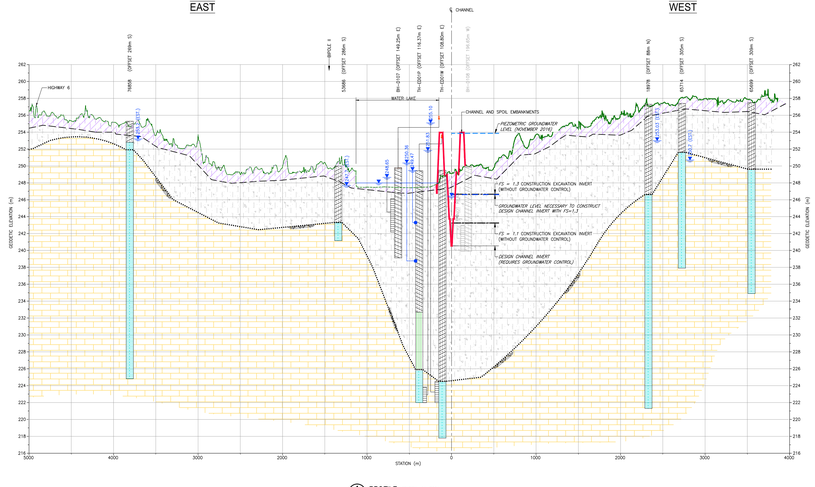
KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

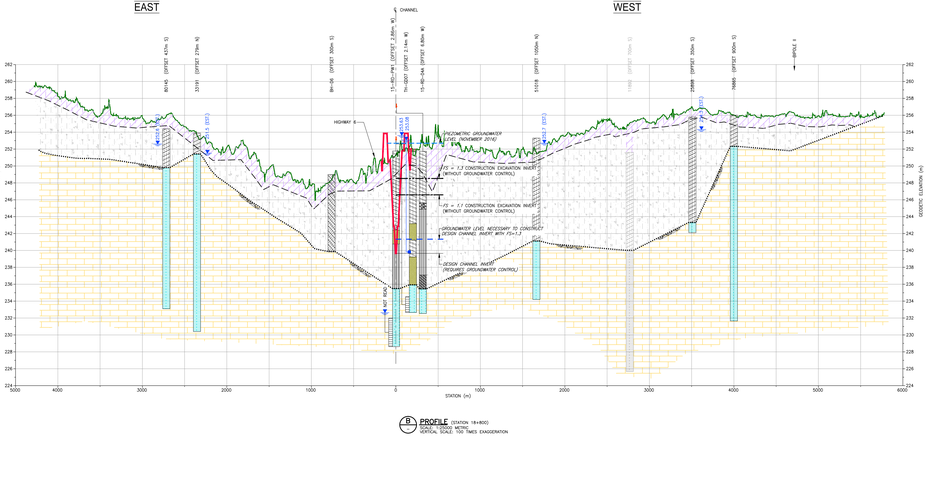
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LAKE MANITOBA OUTLET CHANNEL, OPTIONS C & D

LONGITUDINAL STRATIGRAPHIC PROFILE ALONG ROUTE D

MAY 2017 | PLATE 05-10 | 0



A **PROFILE** (STATION 11+700)
SCALE: 1:5000 METRIC
VERTICAL SCALE: 1000 TIMES EXAGGERATION



B **PROFILE** (STATION 18+800)
SCALE: 1:5000 METRIC
VERTICAL SCALE: 1000 TIMES EXAGGERATION

LEGEND:

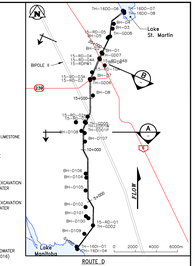
STRATIGRAPHY:

- ICE
- WATER
- TOPSOIL
- SANDY SILT
- BOULDERS
- SAND
- SAND AND GRAVEL
- CLAY
- SILT
- SILTY SAND
- SILTY CLAY
- CLAY TILL
- TILL
- BEDROCK (UNDIFFERENTIATED LIMESTONE AND DOLOMITIC LIMESTONE)

- ORIGINAL GROUND SURFACE
- WATER SURFACE PROFILE
- TILL SURFACE
- FS = 1.3 CONSTRUCTION EXCAVATION INVERT (WITHOUT GROUNDWATER CONTROL)
- FS = 1.1 CONSTRUCTION EXCAVATION INVERT (WITHOUT GROUNDWATER CONTROL)
- DESIGN CHANNEL INVERT
- BEDROCK

DRILL HOLE — PIEZOMETRIC GROUNDWATER LEVEL (NOVEMBER 2016)

GROUNDWATER MONITORING ZONE



NOTE:
1. ALL UNITS ARE IN METERS.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

2.5 0 2.5 5.0 7.5 10.0km
SCALE: 1:250 METRIC
50 0 50 100 150 200 250m
SCALE: 1:2500 METRIC

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No.	Issued to	Issued by	Date

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D

TRANSVERSE STRATIGRAPHIC PROFILES ALONG ROUTE D

MAY 2017 | PLATE 05-11 | 0

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APPENDIX C

GROUNDWATER STUDY (DELIVERABLE D6)

KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D6
GROUNDWATER STUDY

FINAL – REV 0

KGS Group 16-0300-006
May 2017

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1.0 INTRODUCTION AND SCOPE OF WORK

1.1 INTRODUCTION

This report summarizes the results of the Groundwater Study conducted for the Lake Manitoba Outlet Channels Route C and Route D. The location of these routes is shown in Appendix D6-A Plate D4-1. The information collected in this study will be used to evaluate the potential effects of the Route C or Route D channel options on groundwater conditions, wells and wetlands.

1.2 SCOPE OF WORK

The Scope of Work for Deliverable D6 includes the following:

1. Assessment of Regional Groundwater Flow and Quality (WBS 1020.03) including:
    - Regional Groundwater Flow
    - Regional Groundwater and Surface Water Quality
    - Groundwater under Direct Influence of Surface Water
    - Wetlands Evaluation- Route D only

2. Assessment of Impacts of the Channel Project on Groundwater Wells (WBS 1020.04) including:
    - Re-evaluating Drawdown Predictions
    - Assessment of Potential Impact on Domestic Wells

3. Analysis and Information for Risk Assessment (WBS 1020.05)
    - Key analyses from the 2016 monitoring to support the Route C vs. D risk assessment. The information and analyses referenced in the WBS 1020.05 have been integrated into the above assessments (WBS 1020.03 and WBS 1020.04 and are not given in a separate section.

The groundwater and surface water monitoring and sampling data base for 2016 contained in this report will be updated in Subsequent Deliverables D2 and D3, the Annual Monitoring TDRs (due in July 2017 and July 2018). Long-term transducer hydrographs will be included in the 2017 and 2018 reports as these instruments were installed in December 2016.

1.3 REGIONAL GEOLOGY

A detailed report on the Regional Geologic Setting is contained in Deliverable D5. The regional geology of the area consists predominantly of till overburden overlying carbonate bedrock. The overburden consists of sandy silt tills and discontinuous inter-till granular zones. In low-lying areas glaciolacustrine silts and clays are found. Scattered discontinuous relict beach ridges are found in the area and have been used for aggregate sources.

Bedrock in the area is from the Silurian Interlake Group, to the Devonian Ashern and Elm Point Formations (found near the inlet of Route D). The carbonate bedrock is primarily dolomite with argillaceous (shale) zones with a thickness varying between 15 m and 45 m. The upper bedrock is truncated by the erosional surface. Paleokarst features are common; especially upland bedrock ridges. Some karst features are infilled with Cretaceous aged shales, and carboniferous sediments.

1.4 REGIONAL HYDROGEOLOGY

Routes C and D are located in the central portion of the Interlake between Lake Manitoba and Lake Winnipeg as shown in Plate D6-1. This area is a major recharge area to the freshwater bedrock aquifer. A recharge mound exists between the lakes (Plate D6-1 A) with eastward flow to Lake Winnipeg and westward flow to Lake Manitoba. Recharge occurs in bedrock outcrop areas (Plate D6-1 B), areas with high subsurface elevation bedrock, and areas with thin overburden.

Topography along Route C and D is shown in Deliverable D5 Regional Geologic Setting Plate D5-1. A bedrock recharge area is located in the western portion of Route C. Bedrock recharge areas are shown just east of the Birch Creek drainage system, east of Reed Lake and Goodison Lake. In these recharge areas; the bedrock aquifer is in an unconfined condition exposed to the atmosphere with vertically downward gradients. Where interconnections with surface water are present through high permeability sediments or fractures, localized flow systems discharge from the aquifer (as seepage and spring flow) to lakes, streams and marshes. The unconfined aquifer transitions into a confined aquifer condition in areas where the carbonate bedrock is capped by a low permeability layer of till, clay or shale and siltstone, and the groundwater level/piezometric

pressure is above the confining layer. Groundwater discharge areas are characterized by generally low topography, confined bedrock aquifer conditions capped by till and postglacial sediments, and upward hydraulic gradients (in places under a flowing artesian aquifer condition). Although upward gradients may be present, groundwater will not physically move from the aquifer to the surface unless an area of interconnection is present. Areas of thick low permeability deposits above groundwater with upward gradients will not discharge locally, but will flow toward regional discharge points such as larger lakes. There is also a shallow perched system in the postglacial silts, sands and underlying tills, where the strata overlying the bedrock are of sufficient thickness.

Regional bedrock aquifer contours (Plate D6-1 B) show flow in the confined bedrock aquifer; however, local conditions west of the Birch Creek drainage are not identified at this scale and are discussed in Section 3.0. Groundwater in the Route C and Route D areas is generally fresh, with low dissolved solids. Saline groundwater along the west side of Lake Manitoba (Plate D6-1A) discharges to the lake and contributes to the dissolved solids, sodium and chloride concentrations found in Lake Manitoba, the Fairford River and Lake St. Martin.

2.0 ROUTE C

2.1 ASSESSMENT OF REGIONAL GROUNDWATER FLOW AND QUALITY

2.1.1 Regional Groundwater Flow

2.1.1.1 Field Program Methodology

The locations of instruments are shown on the plan set in Appendix D6A and on Table D6-1. This plan set was developed for Deliverable D4 Assessment of Existing Well Use and Suitability as Drinking Water. It shows all testhole installations in 2016, as well as prior testholes drilled in 2015 and 2011. Stationing is included. Drilling methodology and logs for the 2016 program (GC and EC series) is contained in the Deliverable D8 Geotechnical Report. Logs for the 2015 (RC series) and 2011 (BC series) drilling have been issued previously, however a PDF copy only of these logs is also included in the D8 geotechnical report. Locations of surface water sampling are also shown on the Figures.

Vibrating wire piezometers were installed in piezometers as indicated on the logs and summarized in Table D6-1. Transducers were installed at various wells and piezometers during programs for pump testing and hydraulic conductivity measurements. Transducers were installed for long-term measurements at TH-ED-01W, TH-EC-03W, TH-EC-01WW1, and TH-EC-01WW2 on December 8, 2016. The instruments used were Heron DipperLogs. Transducers were installed at depth so that the tips were in the open bedrock or screened zone. Transducers installed in these wells were purchased for and are owned by Manitoba Infrastructure (MI).

Mechanical packers were installed where wells were under a flowing artesian condition. The packers were installed to mitigate flowing well conditions and to allow for longer-term continuous monitoring and water quality sampling to occur. These packers were installed on December 8, 2016. The status of transducer and packer installation as of January 2017 is summarized in the notes to Table D6-1.

Groundwater elevations were taken using either a downhole water level meter, or by reading the vibrating wire piezometers, or by reading pressure from a pressure gauge installed in the well

cap. Lugeon testing was conducted on discrete fracture zones within the bedrock at test holes TH-GC-01 (2 intervals) and TH-EC-01P (10 intervals).

Pumping Tests were conducted for measurement of aquifer parameters (hydraulic conductivity, transmissivity, and storativity) at TH-EC-01 (shallow well WW1 for 10 hours duration; deep well WW2 for 8 hours duration) and TH-EC-03 (for 6.2 hours duration). Recovery of each pumped well was measured until approximately 80% recovery of static conditions was achieved. Monitoring of observation wells was conducted at available installations to allow for assessment of overall aquifer properties (e.g. transmissivity and storativity), along with direct measurement of distance drawdown relationships.

Rising or falling head tests were conducted by first instrumenting the standpipe with a pressure transducer (Heron DipperLog or Level TROLL 700) and then lowering a small diameter submersible pump (Tornado) or Waterra tubing affixed with a foot valve into the standpipe and pumping until water level was drawn down approximately 3 m, or as low as conditions would allow. The rising water level was measured both manually, as practical, and with the transducer. Where flowing well conditions were present, the top of casing was used as the static water level for the tests.

2.1.1.2 Results

Results of the groundwater monitoring program are shown on Table D6-1 showing all instrumentation monitored, instrument details and groundwater depth to water, pressure or vibrating wire readings and appropriate conversions to geodetic elevations. Transducer hydrographs will be included in the 2017 and 2018 reports, since transducers were installed at the end of the field program in December 2016. Pump test results, rising head and Lugeon tests are summarized in Appendix D6-B.

2.1.1.3 Regional Piezometric Surface

Regional Flow Systems

A detailed longitudinal stratigraphic profile prepared from the project drilling and monitoring data is presented in Deliverable D5 Plate D5-7 (including stations) and should be used for reference. The channel alignment, test holes and Stations are also shown in Appendix D6A Plate D4-2.1 and 2.2. This profile includes piezometric elevations for the bedrock and overburden monitoring zones for the standpipe and vibrating wire piezometers and piezometric elevations. Reference lines are also included for the proposed channel invert and channel water profile between Lake Manitoba and Lake St. Martin. Hydraulic conductivity of the monitoring zones is also shown. A bedrock surface model and contours, and overburden thickness model and contours are found in Deliverable D5 Plate D5-5 and D5-6 respectively.

The regional bedrock groundwater flow system in the vicinity of Route C is from the central higher elevation areas between the lakes toward the Fairford River, Lake Manitoba and Lake St. Martin. The bedrock high near Station 3+000 to 5+000 as shown on Deliverable D5 Plate D5-5 and D5-7 represents a regional recharge zone. The areal extent of this zone is approximately 15 km as shown by the near surface bedrock (less than 2.5 m to bedrock) area mapped in Deliverable D5 Plate D5-2. The bedrock aquifer is confined by the silty clay unit found above the till. Confined conditions are found throughout the area. Artesian conditions are variable, with the piezometric surface close to ground surface near the inlet at TH-GC-01 in November 2016, and stronger artesian conditions found between Station 9+000 and the outlet of Route C (TH-EC-03W, TH-GC-05, and 15-RC-06 (upper zone). The upper zone at 15-RC-06 will be confirmed by subsequent monitoring. Seasonal variations in groundwater piezometric pressure are expected, with higher elevations anticipated in spring and periods of high lake levels due to flooding, and lower elevations later in the fall and during dry cycles. Conditions in November 2016; however, were unseasonably wet due to high precipitation in October 2016. Seasonal data will be collected during field programs in 2017 and 2018.

Groundwater in the overburden till deposits is hydraulically connected to the bedrock. The till is confined by the overlying silty clay. Piezometric pressures in the till were slightly artesian in the upper till near the Inlet, off-set from the channel at 15-RC-04 in November 2016.

Hydraulic Gradients

Piezometric elevations are shown in the longitudinal stratigraphic profile in Deliverable D5 Plate D5-7 including stationing. The channel alignment test holes and stations are also shown in Appendix D6A Plate D4-2.1 and D4-2.2.

Horizontal hydraulic gradients along the alignment are as follows:

- Approximately 0.0014 m/m west between Station 3+400 (TH-EC-04) and the inlet (GC-01).
- Approximately 0.0012 m/m east between Station 4+800 (TH-GC-02) and Station 8+000 (15-RC-01)
- Approximately 0.0021 m/m east between Station 8+000 (15-RC-01) and the outlet (TH-GC-05)

Vertical gradients between the bedrock and the till are shown on the stratigraphic profile. Upward gradients from the bedrock to the till were found at TH-GC-01 (0.008m/m) at the inlet, 15- RC-01 (0.02 m/m) at Station 8+000, and at TH-GC-05 (0.28 m/m) at the outlet. Downward vertical gradients between the bedrock and the till were found at TH-GC-04 (0.06 m/m) near the outlet (to be confirmed in future monitoring) and TH-EC-04 (0.014 m/m in shale bedrock) at Station 3+ 400 in the high bedrock area.

Within the bedrock, a downward gradient was found between the upper and lower bedrock at 15-RC-06 (0.056m/m), and between the upper bedrock at TH-EC-01WW1 and the lower bedrock pumping well at TH-EC-01WW2 (0.018m/m). This downward gradient within the bedrock at TH-EC-01 may actually be greater; however, the upper well has a long monitoring zone which has little separation from the lower monitoring zone. These vertical gradients reflect the presence of a groundwater recharge zone in the high bedrock areas. Although some of the wells with measured downward gradients were completed above the invert of the channel, downward gradients within the bedrock groundwater are also expected below the proposed channel invert and in the high bedrock zone extending on both sides of the channel.

Evaluation of Seasonal Changes

Seasonal changes were observed in locations listed below based on limited historic measurements in 2011 and 2015. Most instruments showed increasing piezometric elevations during July through November 2015 monitoring, with a further increase in November 2016. These fluctuations are typical of the region, where spring recharge to the bedrock aquifer system from relatively high elevation bedrock outcrop areas (or bedrock areas with thin overburden cover) is reflected in rising groundwater levels in the spring/early summer. These rises are punctuated by additional recharge inputs from summer rainfall/storm events. Generally declining piezometric pressures are noted in the late summer/fall, and winter periods, when precipitation inputs are much less. The rise in November 2016 was likely a consequence of a very wet fall of 2016 (in particular October, 2016).

Review of previous groundwater measurements was available at the following installations:

- ***15-RC-04*** (Upper and lower clay till)
- ***15-RC-06*** (Upper and lower bedrock)
- ***15-RC-02*** (Shallow limestone bedrock)
- ***15-RC-01*** (Silt and underlying limestone bedrock)

For bedrock test holes drilled in 2011 (BH-BC6 and BH-BC5) piezometric pressure elevations in general increased between 2012 and November 2016.

If Route C is selected for construction, additional data to evaluate seasonal changes will be collected during future monitoring periods (i.e. Deliverables D2 and D3) using groundwater elevation data collected from the instrumentation as well as from continuous transducer monitoring. If Route C is not selected for construction, wells and instrumentation (transducers) should remain at Route C to allow for future monitoring of the aquifer relative to any possible regional impacts that may occur with construction/operation of a channel at Route D.

2.1.1.4 Aquifer Parameters

Pumping Test Results

The results of the pumping tests conducted along Route C are summarized on Table D6-2 and in Appendix D6B. For each pumping test, individual time drawdown and recovery plots have been prepared for the pumping well and each observation well. A distance drawdown plot has been prepared for each pumping test showing the maximum drawdown at the end of the test, before pump shutdown. Aquifer transmissivity and storativity estimated from the distance drawdown plot is summarized in Appendix D6-B-1-1, D6-B-2-1 and D6-B-3-1.

EC-01 WW1 (10 hour duration) – This well is located between Sta. 4+000 and 5+000 in the area of relatively high elevation bedrock along Route C. This well could only be pumped at a very low rate of 7 USgpm. A very low transmissivity of approximately 400 USgpd/ft was estimated at this location. A drawdown of approximately 7 m was measured at the pumping well with less than 0.5 m of drawdown measured at the nearby bedrock observation well located 8 m away. Storativity was estimated as 3.6×10^{-2} from the distance drawdown plot.

EC-01 WW2 (8 hour duration) – This well is located adjacent to EC-01 WW1. The well was cased into the lower bedrock to determine if there was a difference in transmissivity between the lower and upper bedrock zones. The well could only be pumped at a very low rate of 4 USgpm. A very low transmissivity of approximately 140 USgpd/ft was estimated at this location. A drawdown of 10 m was measured at the pumping well with no drawdown measured at the nearby bedrock observation well located 8 m away. Storativity was estimated as 2×10^{-2} from the distance drawdown plot.

EC-03 (6 hour duration) –The well is located between Sta. 10+000 and 11+000 toward the outlet area of the Route C channel where the bedrock is at lower elevation, capped by till, and under a flowing artesian condition. This well could only be pumped at a very low rate of 7 USgpm. A low transmissivity of approximately 2600 USgpd/ft was estimated at this location. A drawdown of 5 m was measured at the pumping well with a drawdown of 4 m measured at the nearest bedrock observation well located 1 m away. Storativity was estimated as 4.8×10^{-9} from the distance drawdown plot. An alternate storativity of 1×10^{-6} was calculated assuming a smaller zero drawdown distance (r_0) of 10,000 ft.

The results of the hydraulic conductivity (rising head) and Lugeon Tests (packer tests) conducted along Route C are summarized on Table D6-3 with data plots for hydraulic conductivity testing shown in Appendix D6-B-4.

Hydraulic conductivity was measured as follows:

- Silt till/ clay till 3 tests 1.2 x10^{-6} m/s, 1.7 x10^{-6} m/s 2.7 x10^{-6} m/s
- Clay shale infill 1 test 3.2 x10^{-8} m/s
- Upper cobbles/bedrock 1 test 6.8 x 10^{-7} m/s
- Bedrock 8 tests Six of eight values were less than or equal to 7.2x10^{-6} m/s with the maximum 2.4 x 10^{-4} m/s and minimum 3.9 x 10^{-7} m/s.

The completed Lugeon testing is described in more detail within deliverable D5 Section 2.7.3. Testing showed a relatively high degree of variability typical of near surface karstic carbonate aquifers.

2.1.2 Regional Groundwater and Surface Water Quality

2.1.2.1 Field Program Methodology

Surface Water Sampling

One site along Route C was sampled on November 8, 2016 as follows:

Site	Name	Zone	Easting	Northing
C2	Inlet Cr.	14U	519639.85 m E	5713261.99 m N

Regional information was used for Lake Manitoba at Fairford River (C1) provided by North/ South Consultants based on the Water Quality database from Manitoba Sustainable Development Water Quality, prepared for Lake St. Martin Emergency Relief Channel- Monitoring and Development of Habitat Compensation- Volume 3- Water Quality- November 2016 Draft.

Site C2 (Inlet Creek) was sampled near the waypoint listed above where there was sufficient water (approximately 500 m walk from road). A reacher pole with a disposable surface water sampling cup was used to collect water. The creek was shallow and stagnant with very little to no flow observed. The water quality may not be representative because of the stagnant conditions and invertebrates which may have been present in the sample. Surface water

samples for metals were not filtered and represent total metals samples. KGS Group recorded field parameters (dissolved oxygen, specific conductance, temperature, pH and ORP) using the YSI Pro meter.

Groundwater

Groundwater samples were taken at seven locations:

- Pump well TH-EC01 (shallow - WW1) and deep - WW2 at start and end of pumping (4 samples total)
- Pump well TH-EC-03 at start and end of pumping
- TH-GC-01
- TH-GC-05
- TH-EC-03
- TH-EC-04

Wells were purged using a combination of small diameter submersible pumps, or dedicated inertial pumps (Waterra tubing with foot valves) for the smaller diameter wells. In order to ensure groundwater samples were representative of the natural formation water, the monitoring wells were purged a minimum of three well volumes, or until groundwater parameters (conductivity and temperature) stabilized. For flowing wells, the well cap was removed and water was allowed to purge (if not already flowing upon arrival). A disposable bailer was held to the top of the well casing and the upward artesian pressure was used to fill the bailer. Samples were then transferred to a field measurement cup and laboratory provided sampling containers which was then used to fill a field measurement cup and laboratory provided sample containers. Field measurements were taken at the start of purging and at set intervals of 5 to 10 minutes. Stable groundwater parameters were achieved at all sample locations within 20 minutes.

Field measurements for pH, conductivity and dissolved oxygen were taken of each sample. A flow through cell was used for groundwater samples. Groundwater and surface water samples were stored in a cooler chest at 4°C for transport to the laboratory. The samples were analyzed at ALS Laboratory in Winnipeg, Manitoba. Groundwater samples for metals analyses were

filtered in the field through 45 micron filters and acidified in the field. There were a few instances where field filtering was not possible and instructions were given to the lab to filter in the lab, or instructions were given not to analyse the metals samples.Samples for isotope analysis were collected in clean 40 ml glass vials and shipped to the Environmental Isotope Laboratory at the University of Waterloo in Waterloo Ontario.

A quality control/quality assurance assessment of all groundwater data was performed, including review of laboratory QA/QC, replicate samples and any trip or field blanks.

Quality Assurance/Quality Control

Standardized sampling procedures and protocols were used during the sampling event to ensure representative samples were collected in a controlled manner so that scientifically defendable comparisons can be made.

Chain of Custody – KGS Group ensured all Chain-of-Custody procedures were properly undertaken and holding times were not exceeded.

Sample Collection – Samples were collected directly from the pump outlet. Disposable latex gloves were worn when handling each piece of equipment and groundwater sample, using a new pair for each sample collection. Samples were collected in clean containers (supplied by the lab) and stored at the appropriate temperature using the proper preservatives.

Laboratory Qualification – ALS Environmental of Winnipeg, Manitoba, is a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited analytical testing laboratory. Criteria and guidelines used for assessment of analytical data were clearly established with the laboratory to ensure the appropriate detection limits were used.

Duplicate Samples – Duplicate samples were submitted at a frequency of 10% for the total samples submitted to assess the quality of the laboratory analysis. The field duplicates were labelled such that the laboratory did not know the samples were duplicates. Laboratory standards and duplicates are run regularly by ALS and are on file. One duplicate and one field blank were collected for QA/QC for the surface water program and two duplicate samples were collected for the groundwater program for Route C and D and data for these are shown in both data sets.

Field Equipment – Field equipment such as field chemistry meters were calibrated prior to use or installation.

2.1.2.2 Results

Groundwater

All samples on Route C were taken from carbonate bedrock monitoring wells with sampling zones found on Table D6-1. Field chemistry from the groundwater program is show in Table D6-4. General water quality is shown on Table D6-5, with metals shown on Table D6-6. Ion balances and water types are shown on Table D6-7. Results were compared against Canadian Drinking Water Quality Guidelines, since the aquifer is potable and is the sole source of drinking water in the region. Results exceeding the applicable guidelines were highlighted. The Canadian Council of Ministers of the Environment (CCME) criteria for Freshwater Aquatic life was shown on the tables for reference.

Water Type – Water types ranged from magnesium-calcium-bicarbonate or calcium-magnesium-bicarbonate (TH-EC-01WW1, THEC-01WW2, TH-EC-03, and TH-GC-05) to magnesium-bicarbonate (TH-GC-01, TH-EC-04).

Water Quality Criteria – The water samples collected exceeded the drinking water criteria for turbidity; however, these samples are from monitoring wells and are not used for drinking water. All samples exceeded the criterion for hardness, typical of the carbonate aquifer. The sample from TH-EC-04 was at the criterion for fluoride (value 1.6 mg/L, criterion 1.6 mg/L). All sulphate samples were below criterion; however, samples at TH-GC-05 and TH-EC-03 near the outlet and TH-EC-04 near the Arena had higher sulphate and conductivity values than samples in other areas. Sample TH-EC-04 near the Arena also exceeded the criterion for total dissolved solids (value 557 mg/L, criterion 500 mg/L), iron (value 2.25 mg/L, criterion 0.3 mg/L) and manganese (value 0.452 mg/L, criterion 0.05 mg/L).

Bacteria Sampling - Bacteria were sampled at each pump well at the start and end of the test. Monitoring wells were not disinfected prior to sampling; however, bacteria were sampled to detect any changes while pumping. At the shallow nested well TH-EC-01 WW1 total coliform increased during the pump test from 8 to 34 MPN/100 mL while *E. coli* decreased from 1 to <1 MPN/100 mL. At the deeper nested well TH-EC-01 WW2, total coliform also increased during the pump test from 34 to 50 MPN/100 mL, while *E. coli* was < 1 MPN/100 mL at the end of the test. The detection limit for *E. coli* on October 18 was raised by the laboratory based on their judgment but subsequent samples will be analyzed at a lower detection limit to allow for a more detailed interpretation of bacterial conditions. At well TH-EC-03, total coliform decreased during pumping from 37 to <1 MPN/100 mL and *E. coli* decreased from 4 to <1 mg/L. In summary, at the end of the tests none of the three wells had detectable concentrations of *E.coli*, TH-EC-03 had no total coliform or *E.coli* detected and TH-EC-01 WW2 had only a low total coliform count of 2 MPN/100 mL. TH EC-01 WW1, the shallow nested well, had a higher total coliform count, which may represent background conditions in that location.

Surface Water

Background data from sampling at the Fairford River at Lake Manitoba conducted by Manitoba Sustainable Development is included in Appendix D6-B-5. Field chemistry from the surface water program is show in Table D6-8. Inlet Creek (C2) had an elevated conductivity and depressed dissolved oxygen consistent with the low flow to stagnant water conditions found. Lake St. Martin at the Provincial Hydrometric Station (D9) had a moderate conductivity and typical dissolved oxygen of 10 mg/L. General water quality is shown on Table D6-9, with metals shown on Table D6-10. Ion balances and water types are shown on Table D6-11. The Manitoba Water Quality Standards, Objectives and Guidelines MWQSOG November 28, 2011 were used where available for parameters analyzed. The Canadian Council of Ministers of the Environment (CCME) criteria for Freshwater Aquatic life are also shown and were used where MWQSOG were not listed. Results exceeding the applicable guidelines were highlighted.

Water type - The sample from Inlet Creek (C2) had a magnesium-calcium water type, while the sample from Lake St. Martin (D9) was sodium-magnesium-bicarbonate.

Water Quality Criteria - The sample from Lake St. Martin (D9) exceeded the CCME criterion for chloride for long term exposure (value 130 mg/L, criterion 120 mg/L). The higher chloride in Lake St. Martin reflects the contribution of saline groundwater on the west side of Lake Manitoba and the elevated chloride in Lake Manitoba and the Fairford River. Sample D9 (Lake St. Martin) and Inlet Creek (C2) exceeded the CCME long-term criterion for fluoride (values 0.2 mg/L, criterion 0.12 mg/L). Inlet Creek also exceeded the CCME trigger criterion for hypereutrophic conditions for phosphorous (value 0.67 mg/L, criterion >1 mg/L) in this sample, which was very low flow or stagnant. Lake St. Martin exceeded the CCME trigger criterion for meso-eutrophic conditions for phosphorous (value 0.021 mg/L, criterion 0.01 to 0.02 mg/L) in this sample. Total dissolved phosphorous concentrations were approximately 50% of the total phosphorus values for low level samples, but were approximately 90% of the total phosphorous values for the high level sample (C2). Unionized ammonia values at Inlet Creek (C2) were calculated based on field pH and temperature as shown on the bottom of Table D6-9 and were below the criteria of 0.019 mg/L.

Bacteria Sampling- Bacteria sampling was conducted for surface water; however, the low level detection limits were not used by the laboratory in December 2016. Bacteria were present in Lake St. Martin (D9 duplicate) as shown by values of total coliform and *E. coli* at 100 MPN/100 mL. Total coliform was also present in Inlet Creek (C2). Subsequent samples in 2017 and 2018 will be analyzed at a lower detection limit to allow for a more detailed interpretation of bacterial conditions within the surface water system.

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Quality Assurance/Quality Control Evaluation

For groundwater the ion balances on Table D6-7 were below 10% and were acceptable. Replicate analysis of one duplicate sample at GC-05 had a RPD (relative percent difference) of less than 10% for all parameters where the analysis value was more than 5 times the detection limit except for turbidity. For surface water, the ion balances on Table D6-11 were below 10% and were acceptable. Replicate analysis of one duplicate sample taken at Lake St. Martin had a RPD of less than 10% for all samples where the analysis value was more than 5 times the detection limit except for (aluminum) which would be expected to vary in an unfiltered surface water sample. A field blank was taken for the surface water samples with analyses below detection for all parameters except total dissolved phosphorous, total phosphorous and calcium, all detected at very low concentrations that do not affect the interpretation of the analytical results.

Water Quality Plots

Visual plots (Durov Plots and Stiff diagrams) were prepared for water quality using the software program Aquachem. These plots have been used to differentiate water types during this phase of background water quality analysis, as well as to compare water quality changes during the pumping tests conducted.

The Durov Plot is shown in Figure D6-2. Major ions are plotted as percentages of milliequivalents in two triangles, with both the total cations and the total anions set equal to 100%. The data from the two triangles are projected onto the central square. Samples with similar geochemical compositions cluster together. The expanded plot used adds a grid for conductivity and pH measurements.

Plate D6-2 shows the Durov plot for Route C. Surface water locations are shown with numbers in black, while groundwater locations are shown with letter symbols in red. Pump test samples are shown with lower case letters for samples at the start of the pump test, and capital letters for samples at the end of the pump test.

The distinct geochemical composition of Lake St. Martin sample D9 (symbol 2) can be seen on the plot, due to its elevated sodium and chloride typical of drainage from Lake Manitoba relative to the other surface water sample (symbol 1 Inlet Creek- C2) and the groundwater samples. The surface water at Inlet Creek sample C2 (symbol 1) is more similar to the groundwater samples in the region. The pump test samples show the same water type at the beginning and end of the test as seen by the capital letter symbol for A, B and C overlying the lower case letter symbol. Water quality at the outlet end of the channel at TH-GC-05 (symbol f) is very similar to that at TH-EC-03 (symbol C, c) and also similar to TH-EC-04 (symbol d) near the Arena. Deep and shallow bedrock well samples at TH-EC-01 (symbols A,a and B,b) cluster together, while TH-GC-01 (symbol e) at the inlet is intermediate between the two.

Stiff diagrams are plotted for individual samples. They compare the concentration (in equivalents per million) of selected anions and cations. Samples with similar compositions will have similar shapes. Total dissolved solids and conductivity are also listed on Stiff diagrams. The Stiff diagrams for Route C are found in Appendix D6-B-6. The shapes of the diagrams confirm the distinct water quality at Lake St. Martin (D9) and also show the difference in composition between Inlet Creek (C2), which was taken during near stagnant conditions, and the groundwater samples. The similar shapes at the start and end of the pump tests can be seen, as well as the similar shapes at groundwater locations TH-GC-05, TH-EC-03 and EC-04.

Stable Isotopes

The stable isotopes Oxygen 18 (^{18}O) and deuterium (^{2}H) are used as surface water tracers in water quality studies. These isotopes are conservative tracers, reflecting the origin of the water. Surface water containing fresh snowmelt during a spring runoff or flood would typically have more negative ^{18}O values than samples taken during other parts of the year. Less negative ^{18}O values would be expected later in the season, particularly in lakes where evaporation occurs. Groundwater in areas of recent recharge has less negative ^{18}O values, while more negative values can indicate older water.

Isotope samples were collected for ^{18}O and ^{2}H at the pumping wells on November 8, 2016 at Lake St. Martin (sample D9). Sample results are shown on Table D6-12 and are plotted on Plate D6-3. The Global meteoric water line and the Gimli, Manitoba meteoric water line are

plotted as reference. These lines are an approximate composition of precipitation (rain and snow) based on a large number of published reference values. Surface water samples that plot to the right of these lines can indicate evaporation.

The sample for Lake Saint Martin (D9) plots far to the right of the meteoric water lines and has the least negative value of -8 VSMOW, which would be expected from this fall sample, as this water would have been subjected to a summer season of evaporation from the lake. The ^{18}O content of the groundwater samples were found in a narrow range from -14 to -14.7 VSMOW, with the least negative value at the shallow pumping well TH-EC-01 WW1 followed by the deeper pumping well TH-EC-01WW2 and then TH-EC-03W towards the channel outlet where the bedrock is confined by overburden and artesian conditions are present. These results would suggest that this groundwater is much more reflective of a meteoric (precipitation – rain and snow) source, subjected to much less evaporation than the surface water (lake) system. This is expected since groundwater aquifer recharge in the region is known to be via rain and snowmelt within high elevation bedrock areas with thin overburden cover. This signature for the groundwater source reflects the limited surface residence time of surface waters prior to recharging of the groundwater system, and/or that the groundwater system is primarily comprised of older waters with longer subsurface residence times. Some groundwater-rock interactions may be involved as well.

2.1.3 Groundwater under Direct Influence of Surface Water Screening Study

A Groundwater under Direct Influence of Surface Water Screening Study (GUDI) was conducted as a factor in the selection of the preferred route. The Route C channel was identified as a potential risk as it would be excavated into bedrock and could provide a direct surface to groundwater interconnection in proximity to domestic and community water supply wells. The surface water in the Route C channel would be in direct contact with the bedrock groundwater through the channel walls and base. Downward (recharge) groundwater gradients in the central portion of the channel are measured currently, where the bedrock is topographically high and sediment cover is very thin. Introducing a large and direct interconnection of a surface water source (i.e. rain/snowmelt runoff, and Lake Manitoba waters) within the Route C channel in an aquifer recharge area will increase the potential for downward infiltration of surface water into

the bedrock, with associated water quality changes and widespread risk of potential bacterial contamination in the aquifer and to groundwater wells.

The GUDI screening looked at the potential for GUDI conditions to develop if the Route C channel were constructed.

GUDI studies assess public regulated water well supply systems (Manitoba Drinking Water Safety Act / Drinking Water Safety Regulation 40/2007), but there are no regulations for domestic well supplies. The GUDI methodology was used for this project to evaluate risks to domestic wells, semi-public water systems and community wells. The Province of Manitoba conducts a GUDI screening for public and semi-public groundwater supply wells, based on well location, well construction, and surrounding aquifer properties, with wells classified as non-GUDI, potentially GUDI, or GUDI. Water quality testing (including changes in turbidity, temperature and water quality) from existing or new well systems is then used to further support the designation. Ontario and Saskatchewan have detailed methodologies for GUDI assessments that are accepted in Manitoba for evaluations by qualified professionals outside of government.

A GUDI screening was conducted for the water supply wells within 3 km of channel Route C using criteria from the Ontario Ministry of the Environment 2003. These criteria were found to be sufficient to identify the potential for GUDI conditions that could be created with construction of the Route C channel option. The screening was a high level assessment to enable a comparison for the route selection process.

The results of the GUDI screening are shown on Table D6-13. Route C has a high potential to create GUDI conditions for the following reasons:

- A direct pathway would be created between surface water in the channel and the underlying bedrock aquifer at the invert of the channel in all areas and along the slideslopes in most areas.
- Bacterial contamination of the aquifer could be expected with surface water infiltration from Lake Manitoba.
- Many wells are located within 500 m of the channel right-of-way, which is a screening distance for bedrock aquifer use. Approximately 21 potential bedrock wells were

identified within 500 m, including both sides of the channel; however, the actual number may be higher since a well inventory could not be conducted in the areas in Pinaymootang First Nation. In addition, several wells serving the community were identified within 500 m of the channel in this area including the arena and the bottling plant, which are located adjacent to the proposed Route C alignment. Community water supplies for a subdivision are located just outside the 500 m distance. The channel may lie within the 50-day saturated travel time to these wells if these studies were performed. Additional wells serving the school, a campground and other community buildings and businesses as well as residences are located north and downgradient of the alignment. If surface water infiltrated into the groundwater, this water would be transported downgradient through this area, toward the Fairford River and the Lake Manitoba and Lake St. Martin.

- The bedrock aquifer will become unconfined adjacent to the channel and in the local area after construction.
- Local wells draw water from the upper bedrock formation.
- There is a high potential for domestic or community well pumping to induce downward and outward gradients in the fractured bedrock from the channel toward the pumping well. The risk is higher for higher capacity community wells, or wells located closer to the channel.
- There is a high potential for wells to become turbid and show changes in chemistry because of the potential surface water to groundwater pathway that could be created.

2.2 ASSESSMENT OF IMPACT OF THE CHANNEL PROJECT ON GROUNDWATER WELLS

2.2.1 Re-evaluate Drawdown Predictions

The impacts of the Route C channel project on groundwater wells were evaluated. A re-evaluation of the groundwater drawdown predictions performed during channel construction and operation phases in the Stage 2 Conceptual Study were reviewed and revised based on data from the fall 2016 investigations. The drawdown predictions were made using a range in measured aquifer properties, and applying a calculation method that estimates radial groundwater flow to a well source. For this preliminary prediction, any aquifer boundary conditions influenced by Lake Manitoba and Lake Saint Martin were not included. The drawdown effect was evaluated for a multi-year construction period, assuming a dewatered channel, and active aquifer drainage/pumping to facilitate construction. Aquifer drawdown estimates were made for the long-term operational period as well, with operational channel

water levels upstream of the control structure at LMB levels, and with operational channel water levels at LSM levels downstream of the control structure.

Estimated Drawdown at the Channel

The preliminary drawdown estimates at the channel for Route C are shown in Plate D6-4. Drawdown will vary along the channel based on the original piezometric surface, channel invert, geologic conditions, drainage to the channel invert during construction, and long-term groundwater discharge equilibrium with the channel operating water levels. The graph should be used in conjunction with the stratigraphic profile at Route C found in Deliverable D-5 Regional Geology Report Plate D-5-7, recognizing that a more rigorous model would be required to include aquifer boundary conditions and area well influences. Construction conditions for Route C assume that dewatering will occur to the channel invert where bedrock is at or below the channel invert (such as at Station 0+000 to 0+500 and station 9+500 to the Outlet). For the majority of the channel where excavation occurs through the bedrock, only half of the exposed rock face is assumed to dewater where H=Z (H is the groundwater elevation at the seepage face, while Z is the elevation of the rock face). For long-term construction, the long term aquifer piezometric water level is assumed to equilibrate to the channel water level, at the channel.

Estimated Drawdown with Distance

A separate analysis of drawdown with distance during construction and in the long term was conducted, which was estimated for Routes C and D based on radial flow equations, using a variety of aquifer transmissivities, and a duration of 10 months. The analysis does not account for area well use, boundary conditions such as the Fairford River and Lake Manitoba and Lake St. Martin, or for complex bedrock surface topography and till infill conditions at the channel (i.e. such as along Route D), which could influence actual drawdown. The original bedrock groundwater elevation is shown as a flat line with two drawdown cones shown, the larger cone representing an aquifer transmissivity of 30,000 USgpd/ft, and the smaller cone representing an aquifer transmissivity of 1,000 USgpd/ft. The maximum drawdown is shown as 14 m (El. 241 m), to the channel invert and at the channel centerline which is slightly more than the drawdown estimates at the channel shown in Plate D6-4 for Route C and in Plate D6-11 for Route D. The difference in drawdowns estimated at Route C is attributable to the assumption that only

approximately half of the exposed rock face in the channel will actually dewater during construction. At Route D, the difference is due to the fact that less total depressurization is necessary to achieve a FS=1.3 against basal heave during construction, versus depressurizing the aquifer to the channel invert.

A drawdown of 1.5 to 3.3 m is predicted at the 3 km distance from the channels, decreasing to 0.9 to 2.7 m at 5 km distance. The lakes are located approximately 10 km apart and the Fairford River is approximately within 5 km of the channels, therefore drawdown effects beyond the lake and river boundaries have not been defined for Route C. Similarly, the lakes at either end of Route D, and possibly the Fairford River at distance to the north are expected to act as boundary conditions to any regional aquifer depressurization. A drawdown estimate and sensitivity analysis is shown on Plate D6-6 focusing on drawdown at the 1 km and 3 km distance with a variety of storage coefficients from 1×10^{-4} to 5×10^{-5}. Beyond the 3 km distance, in general, the predicted aquifer drawdowns are in the order of long-term seasonal variability noted within the regional aquifer system.

2.2.2 Assess Potential Impact on Water Supply Wells

The potential impact of regional aquifer drawdown on area water supply wells was assessed. The impact of the drawdown on a water supply well will depend on the aquifer properties, original well construction and the groundwater elevations. For wells with the same casing depth, wells with higher water levels are less sensitive to drawdown, assuming the aquifer properties are similar, and that the pumps are set at the base of the casing. Wells with deep casings will presumably either have deep pump settings, or will allow for the opportunity to lower the pump in the casing. This maximizes the standing column of water above the pump within the well. Wells with shallow casings and low aquifer water levels (i.e. a relatively small standing column of water in the well above the pump) are often more sensitive to the amount of regional drawdown they can accommodate before the active water level in the well is drawn to the pump, as a combination of regional drawdown,depressurization, and drawdown in the well due to well pumping. Aquifer characteristics are also a factor. Wells with higher specific capacities are less sensitive to drawdown than those with poor specific capacities. These factors were evaluated on a regional basis.

Plate D6-7 shows the interpreted Bedrock Groundwater Piezometric surface depth below ground surface at Route C. The blue contours show the majority of the areas where the piezometric surface is below ground surface, the red contours show a small area near the Outlet where artesian (flowing) conditions are encountered. In almost all areas with water supply wells, the piezometric surface is below ground surface between approximately 1 m and 5 m, which provides a lesser advantage to mitigating drawdown effects in comparison to flowing artesian well areas. Flowing well areas, particularly where aquifer properties are similar to non-flowing well areas, offer the advantage of the additional available drawdown because the existing piezometric aquifer pressures extend above the ground surface.

The depth of well casing was plotted in Deliverable D4, Plate D4-4.2 for available water supply wells. Plate D6-8 shows this information relative to the proposed channel invert. The contours in blue show where the bottom of the casing is below the channel invert (i.e. wells with deeper casings), while the contours in red show where the bottom of casing is above the channel invert. A large portion of the populated areas have wells with shallow casings, completed above the bottom of the channel invert. Depending on the extent of drawdown away from the channel, particularly during construction, many of these wells may not have sufficient available drawdown and the water supply could be lost, requiring a new well to be drilled. This would also be the case for wells where the bottom of the casing is only slightly above the invert of the channel.

The transmissivity of the aquifer, as plotted from the individual well specific capacities, can be used to evaluate good versus poor capacity wells on a regional basis. Approximately 90% of the 81 wells with calculated transmissivities had either very low (< 1000 USgpd/ft) or low (1000 to 5000 USgpd/ft) transmissivities. This indicates that most wells in the area could experience substantial drawdown during normal well operations, which may leave little room for additional drawdown from the project. In summary, the combination of lower groundwater water levels, shallow casings and poor well capacities in the vicinity of Route C increases the risk of water supplies going dry during construction, and potentially during operation, at some locations. This is a general regional assessment and a detailed local in-well site-specific assessment would be required. Since there is limited ability to correlate well logs with individual properties on Route C, counting the number of water supply wells potentially requiring mitigation would not be reliable. Furthermore, because of the risk to water quality from GUDI effects, remediating water level

effects on an individual well basis would not be sufficient. A regional water supply system would be required to protect public health as well as provide adequate supply.

2.2.3 Analysis and Information for Risk Assessment

The groundwater regime was described for groundwater seasonal levels, flow and water quality for the initial year (2016) in this study (Deliverable D6). All information collected for the 2016 study is included in this report. A description of these factors for the two subsequent monitoring years 2017 and 2018 will be submitted in Deliverables D2 and D3-Annual Monitoring TDRs in July 2017 and July 2018.

Key information and analyses conducted during the 2016 program has been used to support the Route C versus D risk assessment included in Deliverable D11.

3.0 ROUTE D

3.1 ASSESSMENT OF REGIONAL GROUNDWATER FLOW AND QUALITY

3.1.1 Regional Groundwater Flow

3.1.1.1 Field Program Methodology

The locations of instruments are shown on the plan set in Appendix D6C and on Table D6-15 as described in Section 2.1.1.1 for Route C. Vibrating wire piezometers were installed in piezometers as indicated on the logs and summarized in Table D6-15. Transducers were installed in the 125 mm diameter pumping wells TH-ED-01W and 15-RD-PW1. Instruments used were Heron DipperLogs. Transducers were installed at depth so that the tips were in the open bedrock or screened zone. Transducers installed in these wells were purchased for and are owned by MI.

Mechanical packers were installed where wells were under a flowing artesian condition as described in Section 2.1.1.1 for Route C. The status of transducer and packer installation as of January 2017 is summarized in the notes to Table D6-15. Methodology for groundwater elevation monitoring, Lugeon testing and pump testing and hydraulic conductivity testing was as described in Section 2.1.1.1 for Route C.

Pumping Tests were conducted for measurement of aquifer parameters (hydraulic conductivity, transmissivity, storativity) at TH-ED-01W for 9 hours duration.

Transducers were installed at two surface water locations Reed Lake (D3) and Clear Lake (D4) on November 7, 2016. Locations were surveyed and a staff gauge board was installed at each site. Transducers were secured to a base and placed in approximately 0.9 m of water. A cable was attached to the transducer, which was secured to a metal rod closer to shore where data uploads can be done in the future without retrieving transducers. A lead line was also installed connecting the logger base to a metal rod. Due to the high water conditions at the time of installation, the end of cable locations were still in knee-deep water in November 2016. The staff gauge board will be inspected, re-surveyed and re-calibrated with the transducer in spring 2017.

3.1.1.2 Results

Results of the groundwater monitoring program on Route D are shown on Table D6-15 showing all instrumentation monitored, instrument details and depth to groundwater level, pressure or vibrating wire readings and appropriate conversions to geodetic elevations. Transducer hydrographs will be included in the 2017 and 2018 reports, since transducers were installed at the end of the field program in December 2016. Pump Test Results, Rising head and Lugeon Tests are summarized in Appendix D6-D.

3.1.1.3 Regional Piezometric Surface

Regional flow systems

A detailed north-south stratigraphic profile from Lake Manitoba to Lake St. Martin, and two east-west stratigraphic profiles on Route D prepared from the project drilling and monitoring data is presented in Deliverable D5 Plate D-5-10 and should be used for reference. A bedrock surface model and contours and an overburden thickness map is also included in Deliverable D5 plates D5-8 and D5-9 respectively. This section includes piezometric elevations for the bedrock and overburden monitoring zones for the standpipe and vibrating wire piezometers and piezometric elevations. Reference lines are also included for the proposed channel invert and channel water profile between Lake Manitoba and Lake St. Martin. Hydraulic conductivity of the monitoring zones is also shown.

The regional bedrock groundwater flow system in the vicinity of Route D is from the eastern high bedrock areas west toward Lake Manitoba and north towards Lake St. Martin. A secondary flow system exists on and adjacent to the alignment controlled by a buried pre-glacial bedrock channel extending from Lake Manitoba to Lake St. Martin as shown in Deliverable D5 Plate D5-8 and D5-9. This channel is also believed to have been a glacial drainage between the lakes. Subsequent infill by till and later pro-glacial lacustrine sediments and more recent organic deposits are shown in the overburden thickness contour plot, which shows the greatest depth of sediments along the deepest portion of the bedrock channel.

Regional recharge occurs in areas of shallow bedrock. Given the overall westward groundwater flow, the major recharge area for the Route D alignment would be east of the alignment in the higher bedrock areas as shown in Deliverable D5 Plate D5-2. The bedrock aquifer is confined by the silty clay unit found above the till. Confined conditions are found throughout the area. Artesian conditions and upward gradients in the bedrock are found extensively within the buried bedrock valley. Downward gradients in the bedrock are expected in the higher bedrock areas, although drilling investigations were not conducted there for this study.

Artesian conditions within the bedrock were found at all of the bedrock holes drilled: TH-GD-02 (>1.7 m above ground surface ags), TH-GD-07 (>1.6 m ags), TH-ED-01P (>2.4 m ags) and TH-ED-01W (5.6 m ags). At TH-GD-08 in the till close to the bedrock, artesian conditions were >7.9 m ags.

Groundwater in the overburden till deposits is hydraulically connected to the bedrock. The till is confined by the overlying silty clay. Artesian conditions within the till were found in November 2016 in all but 8 wells as shown in Table D6-15. Artesian conditions were also found in the silty clay at four locations.

Seasonal variations in groundwater piezometric pressure is expected, with higher elevations expected in spring, and periods of high lake levels due to precipitation and/or flooding, and lower elevations later in the fall and during dry cycles. Conditions in November 2016, however, were unseasonably wet due to high precipitation. Seasonal data will be collected during field programs in 2017 and 2018.

Hydraulic Gradients

Horizontal hydraulic gradients along the Route D alignment have not been calculated due to the complexities of the regional westward and northward groundwater flow. Regional estimates can be made from historical (outdated) data sources, such as regional groundwater studies, or from historical well records. On a year-to year basis, these horizontal hydraulic gradients would not be expected to vary significantly. A comparison of historical data to current conditions could be considered during subsequent design studies, in order to provide a baseline to which any future

piezometric pressure conditions may be compared. Additional monitoring points away from the channel would need to be established to complete this task.

Vertical hydraulic gradients between the bedrock and the till are calculated from groundwater elevations as shown on the stratigraphic profile. Upward gradients from the bedrock to the till were found at all locations with instrumentation in both units and between the upper and lower till at all locations with two measuring points within the till Upward hydraulic gradients were not calculated since many of the wells that are flowing have only approximate static piezometric elevations measured, as well casings were not feasibly extended in all cases to the full height necessary to measure the absolute piezometric pressure elevation.

The upward vertical gradients observed reflect the presence of a groundwater discharge zone beneath the buried bedrock valley. The low permeability till and confining clay, however, restrict the outflow of water, maintaining the high piezometric conditions in the area. Although nested bedrock wells were not installed along Route D, upward gradients would be expected within at least the upper zone of the bedrock aquifer and the overlying overburden. Discharge from the confined bedrock aquifer occurs into Lake Manitoba and Lake St. Martin.

Evaluation of Seasonal Changes

Seasonal changes were observed in the following locations based on limited historic measurements in 2011 and 2015, primarily with an increase in piezometric levels from 2012 and 2015 to November 2016. The interpretation of these trends are as discussed for Route C, reflecting regional seasonal aquifer recharge, and associated seasonality in aquifer piezometric pressures.

Additional data to evaluate seasonal changes will be collected during future monitoring periods using groundwater elevation data collected from the instrumentation as well as from continuous values from transducers.

3.1.1.4 Aquifer Parameters

The results of the pumping tests conducted along Route D are summarized on Table D6-16 and in Appendix D6-D. For each pumping test, individual time drawdown and recovery plots have been prepared for the pumping well and each observation well. A distance drawdown plot has been prepared for each pumping test showing the maximum drawdown at the end of the test, before pump shutdown. Aquifer transmissivity and storativity estimated from the distance drawdown plot is summarized in Appendix D6-D-1.

TH-ED-01 (9 hour duration) – This well is located between Sta. 11+000 and 12+000, adjacent to the wetland areas. This well could only be pumped at a relatively low rate of 12 USgpm. A very low transmissivity of approximately 400 USgpd/ft ($5.8X10^{-5}$ m^2/s) was estimated at this location based on the distance drawdown plot (Appendix D6-D-1-1). A drawdown of approximately 22 m was measured at the pumping well with 11 m of drawdown measured at the nearest bedrock observation well located 8 m away. Storativity was estimated as 5.6×10^{-6} from the distance drawdown plot.

The results of the hydraulic conductivity and Lugeon Test conducted along Route D are summarized on Table D6-17 with data plots shown in Appendix D6-D-2.

Hydraulic conductivity was estimated as follows:

- Silty clay till 3 tests 1.9×10^{-5}, 1.4×10^{-9}, 2.9×10^{-10} m/s
- Bedrock 2 tests 1.7×10^{-5}, 5.2×10^{-5} m/s

Lugeon testing was conducted on discrete fracture zones within the bedrock at testhole TH-GD-07. Lugeon test results are described in Deliverable D5 Section 2.7.3. Testing at TH-GD-07 was within the lower range of tests conducted on Route C, but was within the range of permeability values typical of fractured carbonate bedrock.

3.1.2 Regional Groundwater and Surface Water Quality

3.1.2.1 Field Program Methodology

Surface Water

Nine sites were sampled for surface water along Route D. Sites D3 and D4 were sampled on November 7. The remainders were sampled on December 8 as follows:

Site	Name	Zone	Easting	Northing
D1	L. Manitoba	14U	530539.95 m E	5680326.47 m N
D2	Watchorn Cr.	14U	531563.42 m E	5683591.34 m N
D3	Reed L.	14U	531162.00 m E	5687747.00 m N
D4	Clear L.	14U	530962.69 m E	5690166.46 m N
D5	Clark's Drain	14U	533740.43 m E	5697563.34 m N
D6	Birch Cr.	14U	532476.89 m E	5698322.06 m N
D7	Woodale Drain	14U	531665.45 m E	5699876.73 m N
D8	Birch Cr.	14U	533225.95 m E	5702310.91 m N
D9	L. St. Martin	14U	532723.36 m E	5706356.42 m N

Sites were all sampled on upstream side of roads (where roads were present). A reacher pole with disposable surface water sampling cup was used to collect water from most sampling sites to minimize shore effects and any disturbance from sampling activities. At a few locations samples were collected directly into the sample bottle.

Some sampling locations varied from the locations originally proposed due to access or other field conditions as follows:

D1 (Lake Manitoba) - Landowner permission could not be obtained for the initial location therefore the site was moved to end of the mile road near the entrance to Watchorn Provincial Park with sampling occurring 200 m into lake to reduce the shoreline effect.

D2 (Watchorn Creek) - was initially proposed mid-stream, at a location which would require a 1.2 km walk through marsh to access. The site was moved upstream to be along P.R.237 on the same stream for ease of access.

D3 (Reed Lake) - was accessed by walking approximately 700 m from a gravel road through a pasture and was sampled on the west side of the lake. The lake was surrounded by cattails and appears shallow and soft-bottomed. There was pasture adjacent to the lake near the sampling location.

D4 (Clear Lake) – The initial site plotted was Water Lake, but upon evaluation of satellite imagery it was found to be likely very shallow with difficult access. The sampling point was moved to Clear Lake. The location was accessed by walking approximately 500m along an old road allowance. The sample was collected on the west side of the lake. The lake is surrounded by cattails and appears shallow and soft-bottomed.

D5 (Clark's Drain) - Was initially plotted approximately 250 m off the road**.** The site was moved to the southeast to where the drain crossed the road.

D6 (Birch Creek at PTH6) - *the* site was moved to be upstream of Highway #6.

D7 (Woodale Drain) – The site was sampled approximately 150 m west of Hwy 6. The drain is a ditch with a moderate flow, which flows south along Hwy 6 to the D6 sampling site, where it drains into Birch Creek.

D8 (Birch Creek) - *the* sampling location was moved to the upstream side of the road.

D9 (Lake St. Martin) - Sampled at location of hydrometric station (at the end of Hilbre Rd.). Location is between Route C and Route D outlets.

Methodology for sample collection is described in Section 2.1.2.1 for Route C.

Groundwater

Groundwater samples along Route D were taken at seven locations:

- 15-RD-PW1
- TH-ED-01W Pump well at start and end of pumping

- TH-ED-01P
- TH-ED-03
- TH-GD-02 (Dup. TH-100)
- TH-GD-07
- TH-GD-08 (Sample lab filtered/preserved)

Purging and sampling methodology and quality control/quality assurance is described in Section 2.1.2.1 for Route C.

A transducer was installed for long-term measurements at TH-ED-01W.

3.1.2.2 Results

Groundwater

All groundwater samples were taken from bedrock monitoring wells with sampling zones found on Table D6-15, except TH-ED-03 which was completed in the till. Field chemistry from the groundwater program is shown in Table D6-18. General groundwater quality is shown on Table D6-19, with metals shown on Table D6-20. Ion balances and water types are shown on Table D6-21. Results were compared against Canadian Drinking Water Quality Guidelines, since the aquifer is potable and is the sole source of drinking water in the region. Results exceeding the applicable guidelines were highlighted. The Canadian Council of Ministers of the Environment (CCME) criteria for Freshwater Aquatic life was shown on the tables for reference.

Water type – Water types ranged from magnesium-calcium-bicarbonate or calcium-magnesium-bicarbonate (TH-ED-01, THED-01P, TH-GD-08, TH-GD-02, TH-GD-07, 15-RD-PW1) to magnesium-bicarbonate (TH-GD-03- till well).

Water Quality Criteria – The groundwater samples collected exceeded the drinking water criterion for turbidity; however, these samples are from monitoring wells and are not used for drinking water. All samples exceeded the criterion for hardness, typical of the carbonate aquifer and the till unit. All sulphate samples were below criterion, the sample at till well THED-03 had

much lower sulphate and lower conductivity and hardness values than the bedrock samples. Nitrate values were below detection, or at very low concentrations at all samples except the till well, where they were still at a low concentration (0.2 mg/L), but higher than in the bedrock wells. Boron, calcium, potassium and strontium, values were also noticeably lower in the till well. Manganese, molybdenum, nickel, tungsten, uranium, and vanadium were found at low concentrations, but were higher than in the bedrock samples.

A comparison was made of the water quality at the pumping well at the start and end of pumping to determine if there was any evidence of surface water infiltration. Water quality at the end of the test was nearly identical to the beginning of the test with the exception of bacteria as discussed below.

Bacteria Sampling- Bacteria were sampled at the pump well at the start and end of the test. The pump well was not disinfected prior to sampling; however, bacteria were sampled to detect any changes while pumping. At TH-ED-01 total coliform decreased during the pump test from 24 to 2 MPN/100 mL while *E. coli* was not detected in either sample.

Surface Water

Field chemistry from the surface water program is shown in Table D6-22. Dissolved oxygen in samples ranged from 7.6 to 12.7 mg/L in November 2016. Turbidity values were 5 to 10 NTU at the Inlet (D1 Lake Manitoba) and Outlet (D9 Lake St. Martin) and were less than 5 NTU in the remainder of the samples. General surface water quality is shown on Table D6-23, with metals shown on Table D6-24. Ion balances and water types are shown on Table D6-25. The Manitoba Water Quality Standards, Objectives and Guidelines MWQSOG November 28, 2011 were used where available for parameters analyzed. The Canadian Council of Ministers of the Environment (CCME) criteria for Freshwater Aquatic life are also shown and were used where MWQSOG were not listed. Results exceeding the applicable guidelines were highlighted.

Water type - The Inlet surface water sample (D1 Lake Manitoba) had a magnesium-calcium-bicarbonate water type, which is not typical of Lake Manitoba and will be confirmed in future sampling. The Outlet sample (D9 Lake St. Martin) had a sodium-magnesium-chloride-

bicarbonate water type. The remainder of the samples had a magnesium-bicarbonate water type.

Water Quality Criteria - The sample from Lake St. Martin (D9) exceeds the CCME criterion for chloride for long term exposure (value 130 mg/L, criterion 120 mg/L). As discussed in Section 2.1.2.2 the sodium concentration in Lake Manitoba and Lake St. Martin reflect the contribution of saline groundwater on the west side of the Lake Manitoba. The Birch Creek drainage is isolated from this system, and drains into Lake St. Martin. All samples except Reed Lake (D3) and Woodale Drain (D7) exceed the CCME long-term criterion for fluoride (values 0.13 to 0.23 mg/L, criterion 0.12 mg/L). Four samples exceeded the MWQSOG for phosphorous for streams entering lakes: Watchorn Creek (D2), Reed Lake (D3), Clear Lake (D4) and Birch Creek downstream (D8). Clear Lake and Reed Lake were evaluated with these criteria because of the interconnected nature of the Birch Creek drainage system. However, the Birch Creek sample D9 has a lower total phosphorous (0.02 mg/L) than upstream Reed Lake and Clear Lake samples (0.03 to 0.04 mg/L). Surface water samples at Watchorn Creek (D2) and Clear Lake (D4) for total phosphorous exceeded the CCME eutrophic trigger range of 0.035 to 0.1 mg/L, samples from Lake Manitoba (D1), Reed Lake (D3), Birch Creek (D8), Lake St. Martin (D9) exceeded the meso-eutropic trigger range of 0.02 to 0.035 mg/L, and samples from Clark's Drain (D5), South Birch Creek (D6), Woodale Drain (D7) exceeded the mesotropic trigger range of 0.01 to 0.02 mg/L. Dissolved phosphorous ranges from 55% to 90 % of total phosphorous concentrations for the Birch creek samples and 35% for Lake Manitoba and 70% for Lake St. Martin.

Unionized ammonia values were calculated by KGS Group based on field pH and temperature as shown Table D6-23 with all samples below the CCME criterion of 0.019 mg/L.

Bacteria Sampling- Bacteria sampling was conducted for surface water, however the low level detection limits, allowing for more specific counts of smaller bacterial communities, were not used by the laboratory based on their judgement. This is not necessarily an issue as one of the main outcomes in the work was to determine the presence or absence of bacteria within these watercourses. Going forward, the low level detection limits will be applied to allow for relative comparison of bacterial counts between surface water sources. Bacteria were present in Lake St. Martin (D9) as shown by values of total coliform. *E. coli* was found at 100 MPN/100 mL in

the duplicate of D9 just above the detection limit of <100 MPN/100 mL. Bacteria at Clear Lake (D4) will have to be confirmed in the next sampling period. Total coliform ranged from 100 to 1350 MPN/100 mL. *E. coli* values were <100 MPN/100 mL at all locations. Subsequent samples in 2017 and 2018 will be run at a lower detection limit.

Quality Assurance/Quality Control Evaluation

For groundwater, the ion balances on Table D6-21 were below 5% and were acceptable. Replicate analysis of one duplicate sample at GD-02 had a RPD relative percent difference of less than 10% for all parameters where the analysis value was more than 5 times the detection limit. For surface water, the ion balances on Table D6-25 were below 10% and were acceptable. Replicate analysis of one duplicate sample taken at Lake St. Martin had a RPD of less than 10% for all samples where the analysis value was more than 5 times the detection limit except for aluminum, which would be expected to vary in an unfiltered surface water sample. A field blank was taken for the surface water samples with analyses below detection for all parameters except total dissolved phosphorous, total phosphorous and calcium, all detected at very low concentrations that do not affect the interpretation of the analytical results.

Water Quality Plots

Visual plots (Durov Plots and Stiff diagrams) were prepared for water quality using the software program Aquachem as explained in Section 2.1.2.2. The Durov Plot is shown in Plate D6-9.
Surface water locations are shown with numbers in black, while groundwater locations are shown with letter symbols in red. Pump test samples are shown with lower case letters for samples at the start of the pump test, and capital letters for samples at the end of the pump test.

The surface water (excluding Lake Manitoba and Lake St. Martin) differs from the groundwater in sodium content. The surface water type (Table D6-25) is generally magnesium-bicarbonate, with up to 60% of the cations being magnesium, and sodium percentages from 3 to 7 %. In contrast, the groundwater samples are calcium-magnesium or magnesium-calcium bicarbonate with both cation percentages below 50%, and higher sodium percentages of 14 to 18% for the groundwater (Table D6-21). This can be seen on the Durov plot in Plate D6-9 in the clustering of surface water points in the far left triangle.

The distinct geochemical composition of Lake St. Martin sample D9 (symbol 9) can be seen on the plot, due to its elevated sodium and chloride relative to the other samples. Lake Manitoba plots closer to the other surface water points. Lake Manitoba is known to have a variable water quality due to the contribution of saline groundwater sources on the west side of Lake Manitoba, which is not reflected in this analysis. Subsequent analyses in 2017 and 2018 will better define the variability at this location.

Samples from Clark's Drain D-5 and Woodale Drain D-7 are not in the main Birch Creek drainage system, and plot to the right of the other surface and groundwater samples because of their lower percentage of chloride and sulphate. Till well TH-ED-03 plots to the right and below the other groundwater sample because of its lower percentage of sulphate. The other groundwater wells cluster in one area except for GD-02, which has a lower alkalinity.

Stiff diagrams are plotted for individual samples. They compare the concentration (in equivalents per million) of selected anions and cations. Samples with similar compositions will have similar shapes. Total dissolved solids and conductivity are also listed on the plots. The Stiff diagrams for Route D are found in Appendix D6-D-3. The shapes of the diagrams confirm the distinct water quality at Lake St. Martin (D9) and also show the difference in composition between the surface water and the groundwater samples. The similar shapes at the start and end of the pumping tests can be seen for ED-01W, indicating that for the duration of this testing, there was no shift in water quality.

Stable Isotopes

The stable isotopes Oxygen 18 (^{18}O) and deuterium (^{2}H) are used as surface water tracers in water quality studies. These isotopes are conservative tracers, reflecting the origin of the water. Surface water containing fresh snowmelt during a spring runoff or flood would typically have more negative ^{18}O values, in comparison to other times of the year. Less negative ^{18}O values would be expected later in the season, particularly in lakes where evaporation occurs. Groundwater in areas of recent recharge has less negative ^{18}O values, while more negative values can indicate older water.

Isotope samples were collected for the ^{18}O and ^{2}H for the pumping well TH-ED-01W and the flowing well in the sand unit just above bedrock at TH-GD-08, as well as Lake Manitoba (D1), Clear Lake (D4), and at Lake St. Martin (D9). Sample results are shown on Table D6-26 and are plotted on Plate D6-10. The Global meteoric water line and the Gimli, Manitoba meteoric water line are plotted as reference. Surface water samples that plot to the right of these lines can indicate evaporation.

The sample for Lake Saint Martin (D9) plots far to the right of the meteoric water lines and has the least negative ^{18}O value (-8.5 VSMOW), with the Lake Manitoba sample having a slightly more negative value of -9.7 VSMOW. As with the isotope discussion regarding the Route C area, these values are indicative of these surface waters having undergone a summer season of evaporation from the lakes. The groundwater samples, such as at Route C, range from -14.7 to -14.9 VSMOW, with the least negative value at pumping well TH-ED-01W, followed by the confined sand and gravel interconnected to the bedrock at TH-GD-08. Like at Route C, these results would suggest that this groundwater is reflective of relatively recent recharge from meteoric precipitation (rain and snow) with a relatively low residence time in the subsurface. This is expected since groundwater aquifer recharge in the region is known to be via rain and snowmelt within high elevation bedrock areas with thin overburden cover.

The surface water sample at Clear Lake (D-4) plots at -11.3 VSMOW, which is distinct from both the Lake Manitoba/Lake Saint Martin samples, and the groundwater samples. This Clear Lake sample, plotting nearest the meteoric water lines, suggests its water signature is dominated by precipitation (rain and snowmelt) with little evaporation. Based on the smaller basin area and volume, and depending on the timing of sampling, this signature could vary toward the Lake Manitoba and Lake Saint Martin samples (i.e. reflecting evaporative processes) in the future, if, for example, the sample was taken following an extended period of dry summer weather. However, because of the relatively small basin volume, collection of surface runoff from a large drainage system into Clear Lake, and the relatively wet fall conditions prior to collection of this sample, it is not unexpected that this sample would appear to have a signature mostly tied to regional precipitation oxygen isotope conditions with little evaporation. Despite the wet fall conditions and contributions of precipitation to the much larger Lake Manitoba and Lake St. Martin during this sampling the evaporative signature was present. Going forward, isotope monitoring in Clear Lake seasonally, or following summer storm events, may allow further

interpretation of the proportion of surface runoff versus groundwater contributions (if any) to the surface water flow system in the vicinity of Route D.

3.1.3 Groundwater under Direct Influence of Surface Water Study

A Groundwater under Direct Influence of Surface Water Screening Study (GUDI) study was conducted as a factor in the selection of the preferred route as described in Section 2.1.3. The Route D channel was identified as a low risk, as it would be excavated into till and a direct connection of surface water to groundwater in the bedrock confined aquifer would be unlikely, with depressurization of the underlying bedrock aquifer to mitigate against channel invert blowout. Depressurization during construction and design optimization and passive long-term depressurization in certain areas of the channel will be needed to protect against blowout of the till channel base on the northern third of the channel, due to the bedrock aquifer artesian pressures beneath the channel. In addition to construction difficulties, channel blow out would create a pathway between the surface water and the groundwater systems. The maintenance of upward gradients below the channel from the bedrock aquifer would mitigate the effects of a blowout should it occur and protect against downward migration of surface water, as the aquifer system would constantly discharge to the channel via any interconnected blowout zone. Nevertheless, a blowout would be undesirable and would increase the risk of the potential adverse impacts from the surface water on the groundwater, in particular if there were heavy groundwater well users in very close proximity to the channel.

The GUDI screening looked at the potential for GUDI conditions to develop if the Route D channel were constructed.

The results of the GUDI screening are shown on Table D6-27. Route D has a low potential to create GUDI conditions for the following reasons:

- A depressurization program during construction, and an optimized channel design and long-term passive depressurization system would protect against blowout of the till channel base and reduce the potential for a direct pathway between surface water and groundwater.
- Approximately 14 bedrock wells are located within 500 m of the channel right of way, which is a screening distance for bedrock aquifer use. High capacity community wells

have not been identified within 3 km of the channel based on the current high level screening and limited field inventory.

- Flowing artesian bedrock aquifer conditions are present beneath the channel decreasing the likelihood of downward migration of surface water.
- If surface water infiltrated temporarily into the groundwater, upward groundwater gradients would soon become re-established to reverse this flow.
- The bedrock aquifer will remain confined in the channel and in the local area after construction.
- Local wells draw water from the bedrock formation, which is greater than 15 m below ground surface.
- There is a low potential for domestic well pumping to induce downward and outward gradients in the fractured bedrock from the channel toward the pumping well. However, a site specific in-well survey of nearby domestic and regional supply well systems will be necessary in subsequent design phases to establish baseline local well conditions and well performance characteristics.
- There is low potential for wells to become turbid and show changes in chemistry due to surface water infiltration.

3.1.4 Wetlands Evaluation

3.1.4.1 General

Wetlands are in close proximity along the Route D channel alignment. Data collected at and near the wetlands was assessed to determine if there was evidence of interconnection to bedrock groundwater flow systems, through the till aquitard. A review of domestic well logs closest to the wetland indicated that till was present above bedrock at all locations. The position of Water Lake in relation to the till is shown on the stratigraphic profile in Deliverable D-5 Plate D-5-11 Profile A. A minimum of 7 m of till is anticipated beneath the wetland ranging to 24 m, consistent with the larger depth of overburden sediments in the bedrock valley. Bedrock rises to the east of the wetlands; however, the exact elevation of the bedrock on the east side of the wetlands is not known and has been interpolated based on a limited number of area well logs, of which few are close to the wetlands.

3.1.4.2 Responses to Short-Term Pumping Test

Based on the information obtained from the drilling and pump testing programs, there was no evidence of a groundwater interconnection to the wetland as discussed below.

The results of the short term pumping test adjacent to Water Lake were discussed in Section 3.1.1.4. The test consisted of a bedrock water well TH-ED-01W with an open zone in bedrock ending at El. 217.8 m, a piezometer (TH-ED-01 P) with the bedrock piezometer monitoring zone ending at El. 221.7 m, and 2 vibrating wires installed at El. 243.3 m and El. 238.8 m within the till. Two shallow piezometers (PP1 and PP2) were also installed in the peat and standing water at the edge of the lake with tips at El. 247.5 m and El. 247.3 m (Table D6-15). The drawdown plots are found in Appendix D6-D-1. Surface water levels at PP1 were rising prior to the test and continued to rise until 100 min into the test where they began dropping. Surface water levels at PP2 also began dropping after about 100 min into the test. The maximum decline in surface water levels as measured at PP1 and PP2 was 0.06 m. This change was measured after 9 hours of pumping at 12 USgpm within the adjacent bedrock aquifer pumping well. Water levels continued to decline another 0.007 m at PP1 after the pump test ended, before rising; however surface water levels recovered only 0.019 m by the end of the recovery measurement period. The observed response is not consistent with a water level drawdown from pumping within the underlying bedrock aquifer for a number of reasons:

- Although the bedrock pumping well produced a drawdown of 10.6 m in the bedrock observation well ED-01P, drawdown in upper and lower vibrating wires installed in the till at ED-01 P (not shown on the plot) had a negligible response, indicating that a minimal amount of leakage through the till if any would be anticipated during pumping of the bedrock aquifer. The effect of bedrock groundwater drawdown in the buried valley (bedrock El. 224 m) on the area just east of the wetland (bedrock El. 243 m) would be determined by the amount of vertical interconnection between the bedrock units (Deliverable D-5 Plate D-5-11 Profile A).
- Falling barometric pressure during the testing period may be assumed to be correlated with increasing winds, which may have influenced surface water levels.
- Finally, the total volume of water pumped at 12 USgpm (0.8 L/s) for 9 hours is approximately 28 m3. This volume comparatively is equivalent to the observed surface water level decline of 0.06 m over an area of approximately 500 m2. The estimated area of Water Lake and associated surrounding marsh/peat areas is orders of magnitude larger (approximately 800,000 m2). Thus the observed surface water level response (decline) cannot be attributed to a drainage effect resulting from drawdown of the

underlying confined bedrock aquifer. As such, this interpretation supports other causes such as wind driving the surface water level decline during the period of the pumping test.

3.1.4.3 Response to Long-term Monitoring

The response of the shallow groundwater and surface water systems to seasonal recharge and short-term precipitation events is an objective of the study. Likewise, the water quality of surface water/shallow groundwater systems, and the bedrock aquifer were compared as described in Section 3.1.2.2. Initial baseline data was collected during the fall 2016 program, with long-term data to be collected in 2017 and 2018.

3.1.4.4 Wetland Water Level Drawdown Sensitivity Analysis

Because of the lack of evidence for a groundwater connection to the wetland a sensitivity analysis of hypothetical drawdown assuming varying degrees of interconnection was not warranted at this stage. The low permeability till beneath the wetland limits or precludes water level changes in the wetland due to any groundwater piezometric pressure drawdown in the bedrock aquifer and overlying till that will be necessary during channel construction, or that will occur associated with subsequent channel operations. To date, isotopic sampling of the surface water within Clear Lake is distinct from the groundwater samples, and closely reflects the regional meteoric water line. This suggests no particular interconnection of the groundwater and surface water systems at this location, though further sampling and analyses are planned as part of the ongoing monitoring programs.

The artesian conditions present within the area will be maintained. The existing discharge of groundwater in the area of the channel alignment is very low to negligible due to the thick, low permeability layer of till above the bedrock. Bedrock depressurization is required during construction and long term to protect against blowout and instability in the channel base and sideslopes. This depressurization will result in a lower artesian groundwater pressure local to the channel, but essentially no change in the already negligible groundwater discharge to surface.

3.2 ASSESSMENT OF IMPACT OF THE CHANNEL PROJECT ON GROUNDWATER WELLS

3.2.1 Re-evaluate Drawdown Predictions

The impacts of the Route D channel project on groundwater wells were evaluated. A re-evaluation of the groundwater drawdown predictions performed during channel construction and operation phases in the Stage 2 Conceptual Study were reviewed and revised based on data from the fall 2016 investigations, using a calculation for radial flow to a well source. The drawdown effect was evaluated for a multi-year construction period, assuming a dry channel and depressurized aquifer system to protect against excavation blowout. As well, the long-term operational period was evaluated, with a depressurized aquifer, channel water elevations upstream of the control structure at Lake Manitoba levels, and channel water levels downstream of the control structure at Lake St. Martin levels.

Estimated Drawdown at the Channel

The drawdown estimates at the channel for Route D are shown in Plate D6-11. The graph should be used in conjunction with the stratigraphic profile at Route D found in Deliverable D-5 Regional Geology Report Plate D5-10. Construction conditions for Route D assume that bedrock groundwater depressurization will be required to maintain a factor of safety during construction of 1.3 and a long term factor of safety of up to 1.5 with a minimum channel operating level and passive bedrock aquifer depressurization to approximately El. 244 m in critical channel areas. Depending on the final location of the control structure, bedrock aquifer depressurization will be required along approximately the northern one-third of the channel, with active depressurization anticipated during construction, and passive depressurization required during long-term operation. Temporary drawdown estimates during construction at the channel are estimated at 2.5 m to 13 m depending on the current bedrock groundwater piezometric pressure elevation. During operation, slightly less drawdown is estimated from between approximately 1 m to 11 m with the most drawdown in the areas of highest artesian pressures as shown in Deliverable D-5 Plate D5-10.

Estimated Drawdown with Distance

A separate preliminary analysis of drawdown with distance during construction was estimated, which is valid for Routes C and D based on radial flow to well equations, while applying a variety of aquifer transmissivities, and duration of approximately 10 months. The analysis does not account for boundary conditions such as Lake Manitoba and Lake St. Martin (and the more distant Fairford River), or for complex bedrock surface topography and till infill conditions at the Route D channel, which could influence aquifer drawdown responses at distance.

Lake Manitoba is located approximately 15 km west of Route D. A potential boundary is located at Lake St. Martin within 5 km of the area of greatest predicted drawdown (northern 1/3 of channel). The effect of these boundaries would be to decrease drawdown effects to the west, south and north at greater distances from the channel. The original bedrock groundwater elevation is shown as a flat line with two drawdown cones shown, the deeper one for a transmissivity of 30,000 USgpd/ft (4.3×10^{-3} m^2/s) and the shallower one for a transmissivity of 1000 USgpd/ft (1.4×10^{-4} m^2/s). The maximum drawdown is shown as 14 m at the channel invert, or, El. 241 m. An estimated drawdown of 1.5 to 3.3 m is predicted at the 3 km distance from the segments of the channel being depressurized, decreasing to an estimated 0.9 to 2.7 m at 5 km distance. A drawdown estimate and sensitivity analysis is shown on Plate D6-6 focusing on drawdown at the 1 km and 3 km distance with a variety of storage coefficients from 1×10^{-4} to 5×10^{-5}.

3.2.2 Assess Potential Impact on Domestic Wells

The potential impact of the bedrock aquifer piezometric pressure drawdown for Route D on area water supply wells was assessed. The impact of the possible aquifer drawdown on water supply wells will depend on the variability of the aquifer transmissivity, construction of the wells and the groundwater piezometric pressure elevations. As with Route C, factors such as well casing completion depths, relation to static piezometric pressure conditions in the aquifer (i.e. flowing artesian, or not; the relative height of a standing water column available within a particular well), and well specific capacities were evaluated on a regional basis.

Plate D6-12 shows the interpreted bedrock groundwater piezometric surface depth below ground surface at Route D. The red contours show the majority of the areas where the interpreted piezometric surface is above ground surface (artesian conditions) along the buried bedrock valley and channel alignment, where depths to bedrock are greatest, and deeper aquifer zones are tapped by these wells. The blue contours show areas where the piezometric level is below ground surface, but still confined by the overlying tills. The data points represent domestic well records. In the areas closest to the channel (buried bedrock valley), domestic wells are primarily flowing artesian, while at distance, groundwater piezometric pressure elevations are only slightly (e.g. 1 m to 3 m) below ground surface.

The depth of well casing completions relative to the channel invert was shown in Deliverable D4 Plate D4-8.2. This information is based on provincial well records. There has not been a comprehensive well inventory of the area and some of these wells may represent livestock wells, or older wells that are no longer in use.

As noted in Deliverable D4 Table D4-E1 no wells with casings less than 10 m in length were found within 500 m of the channel. Almost 70% (84) of the 123 wells within 3 km proximity to the Route D channel had casing lengths greater than 10 m, while only 30% of wells had casings less than 10 m in length. Casing depths in the 20 m to 30 m range are common on the west side of the channel alignment. In the northern third of the channel area casings less than 10 m were found in a few locations within 3 km and in many locations further west, including the community of Hilbre. These shallower casings were also common east of the Birch Creek drainage system within 3 km of the channel, and further east in Grahamdale.

Based on the regional records of all of the well logs within 500 m of the Route D channel, these deep casings and high piezometric pressure conditions suggest that a decline in piezometric pressure of 3.5 m could likely be accommodated within the well either as is, or with lowering of a pump setting. Most wells within the 3 km on the west side of the channel may be able to accommodate this estimated range of aquifer drawdown. This information would have to be verified in final design with site specific well inspections and field studies.

Many wells on the east side of the Route D channel near the edge of the 3 km buffer zone have shallow casings, and drilling of new wells may be required depending on actual aquifer

drawdown effected by construction and operation of the Route D channel. The amount of drawdown in these wells will depend on the vertical interconnection between the bedrock beneath and adjacent to the Route D channel within the underlying buried bedrock channel zone, and the adjacent upper bedrock zones where these shallow wells are completed, as well as the individual well capacity of a given well. The estimated transmissivity of the aquifer as plotted from the individual well specific capacities can be used as a preliminary guideline to evaluate good versus poor capacity wells on the regional basis. Approximately 90% of the 109 wells with calculated transmissivities in the vicinity of Route D had either very low (< 1000 USgpd/ft) or low (1000 to 5000 USgpd/ft) transmissivities.

In summary, there is anticipated to be a low risk of water supplies losing capacity during construction and operation because of the higher groundwater piezometric pressures, flowing artesian conditions and generally deep casings in the immediate vicinity of Route D. However, the risk is higher east of the Birch Creek wetland drainage, and in the northern third of the channel on the west side within and outside of the 3 km channel buffer zone area evaluated within this study. Wells with shallow casings in population centers outside of the 3 km buffer zone in Grahamdale on the east and Hilbre on the west may also be affected. This is a general regional assessment, and a detailed, local in well site specific assessment is required in final design.

3.2.3 Analysis and Information for Risk Assessment

The groundwater regime was described for groundwater seasonal levels, flow and water quality for the initial year (2016) in this study (Deliverable D6). All information collected for the 2016 study is included in this report. A description of these factors for the two subsequent monitoring years 2017 and 2018 will be submitted in Deliverables D2 and D3-Annual Monitoring TDRs in July 2017 and July 2018.

Key information and analyses conducted during the 2016 program has been used to support the Route C versus D risk assessment included in Deliverable D11.

4.0 RECOMMENDATIONS

Based on the results of the groundwater study, the following recommendations have been developed for the project and should be included within the Risk Assessment report Deliverable D11:

1. Mitigation measures should be incorporated for both the Option C and Option D channels to address the potential of aquifer water levels dropping below the existing pump settings or below the casing of individual or community groundwater well users (while the well is pumping), due to aquifer piezometric pressure drawdown from channel construction or operations. Extensive mitigation will be required for Option C, while a lesser degree of potential mitigation is anticipated for Option D. More detailed site specific well inspections are required in the region of the project to quantify the required well remediation efforts.

2. Mitigation measures should be incorporated on Option C to address the potential for bacterial and virus contamination of individual or community groundwater well users, as a result of interconnection to the aquifer in an aquifer recharge area, and in the event of groundwater under direct influence of surface water (GUDI) conditions. On Option C, a regional water treatment plant and distribution system should be considered. On Option D a lesser degree of potential mitigation is anticipated, as direct interconnection is unlikely (assuming channel construction in till, appropriate control of blowout piezometric pressures from the underlying bedrock aquifer, and maintenance of upward groundwater discharge gradients), and because community/public water supplies are not located close to the project.

3. On Route D, design and construction factors will play a large role in protecting the bedrock aquifer from direct connection with the channel base, while minimizing drawdown. Optimization of the channel route, geometry and control structures, as well as construction methods (including depressurization) should be implemented to control the bedrock artesian pressures during construction and long-term operation,

4. The preliminary Channel Design for Option D should be optimized considering the requirements for active bedrock groundwater depressurization using pumping wells during construction and the same wells as practical for passive long-term bedrock aquifer depressurization to mitigate the potential for blowouts / basal heave conditions. On Option C, active dewatering of the bedrock aquifer using pumping wells will be required during construction. Detailed recommendations for depressurization are addressed in deliverable D8.

5. Although wetlands connection to the bedrock aquifer is not anticipated, potential mitigation measures to maintain minimum flows in the wetlands system should be considered in conjunction with those being considered as part of the Surface Water Study (Deliverable D7).

5.0 STATEMENT OF LIMITATIONS AND CONDITIONS

5.1 THIRD PARTY USE OF REPORT

This report has been prepared for Manitoba Infrastructure to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

5.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

KGS Group prepared the geo-environmental conclusions and recommendations for this report in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this report is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of Manitoba Infrastructure. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

TABLES

TABLE D6-1
TESTHOLE DATA SUMMARY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Groundwater Depth (m)	Groundwater Elevation (m)	VW Reading (Hz)	Groundwater Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-GC-01	Next to RC-04	5713039.768	518984.551		till	VW #1602941		249.995	7.62	242.375	-	-	08-Nov-16	-	-	-	2785.6	249.56	no	
					Limestone	STP	25	249.995	13.56	236.435	0.86	250.855	08-Nov-16	-	1.254	249.601	-	-	no	
TH-GC-02	Bridge at RC-02	5712649.169	523179.628		Limestone	VW #1602927		256.06	12.8	243.26	-	-	08-Nov-16	-	-	-	2775.9	255.48	no	
					Limestone	STP	20	256.06	18.9	237.16	0.78	256.84	08-Nov-16	-	1.322	255.518	-	-	no	
TH-GC-04		5710060.991	526935.826	9+600	till	VW #1602930		248.246	3.35	244.896	-	-	08-Nov-16	-	-	-	2977.2	247.57	no	
					Limestone	STP	25	248.246	7.92	240.326	0.83	249.076	08-Nov-16	-	1.775	247.301	-	-	no	
TH-GC-05		5710241.636	527956.468	11+200	till	VW #1602926		244.837	3.66	241.177	-	-	08-Nov-16	-	-	-	2904.5	244.46	no	
					Limestone	STP	25	244.837	7.62	237.217	0.80	245.637	08-Nov-16	-	0.058	245.579	-	-	yes	
TH-EC-01P	Next to TH-EC-01WW1	5713201.412	522685.673	3+875	Limestone	VW #1602936		255.589	12.50	243.089	-	-	08-Nov-16	-	-	-	2643.8	254.87	no	
					Limestone	STP	25	255.589	19.81	235.779	0.62	256.209	08-Nov-16	-	-	-	-	-	no	Standpipe was blocked, so could not get true DTW. (now unblocked)
TH-EC-01WW1	Water Well	5713200.004	522685.692	3+875	Limestone	STP	125	255.566	13.11	242.456	0.99	256.556	08-Nov-16	-	1.430	255.126	-	-	no	
TH-EC-01WW2	Water Well	5713204.866	522692.415	3+875	Limestone	STP	125	255.584	18.29	237.294	0.91	256.494	08-Nov-16	-	1.460	255.034	-	-	no	
TH-EC-03W	Water Well	5710366.863	527199.247	10+250	Limestone	STP	125	245.682	15.54	230.142	1.22	246.902	08-Nov-16	-	-1.220	248.122	-	-	yes	Flowing over top of casing.
TH-EC-04	N of channel near TH-EC-01	5713517.955	521973.821		till	VW #1602925		254.973	6.10	248.873	-	-	08-Nov-16	-	-	-	2918.3	254.29	no	
					Limestone	STP	25	254.973	17.37	237.603	0.64	255.613	08-Nov-16	-	1.475	254.138	-	-	no	
15-RC-04				0+464	Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	16-Jul-15	-	1.93	248.70	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	04-Aug-15	-	1.55	249.08	-	-	no	
					Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	09-Nov-15	-	1.21	249.42	-	-	no	
					Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	07-Nov-16	-	0.875	249.755	-	-	yes	
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	16-Jul-15	-	1.91	248.68	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	04-Aug-15	-	1.67	248.92	-	-	no	
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	09-Nov-15	-	1.30	249.29	-	-	no	
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	07-Nov-16	-	0.922	249.668	-	-	no	
15-RC-06				4+200	Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	16-Jul-15	-	-	253.37			no	Water level at bottom of hole upon completion of drilling
					Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	04-Aug-15	-	-	253.62			no	Water level at bottom of hole upon completion of drilling
					Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	09-Nov-15	-	-	254.59			no	
					Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	07-Nov-16	-	-	-	2705.1	255.21	yes	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	16-Jul-15	-	2.14	253.86	-	-	no	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	04-Aug-15	-	2.70	253.31	-	-	no	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	09-Nov-15	-	1.68	254.32	-	-	no	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	07-Nov-16	-	1.255	254.745	-	-	no	
15-RC-02				5+168	Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	16-Jul-15	-	2.02	254.33	-	-	no	
					Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	04-Aug-15	-	1.72	254.63	-	-	no	
					Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	09-Nov-15	-	1.38	254.97	-	-	no	
					Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	08-Nov-16	-	1.108	255.242	-	-	no	
15-RC-01				8+100	Silt	STP	25	252.62	4.6	248.02	0.82	253.44	16-Jul-15	-	1.87	251.57	-	-	no	
					Silt	STP	25	252.62	4.6	248.02	0.82	253.44	04-Aug-15	-	2.19	251.25	-	-	no	
					Silt	STP	25	252.62	4.6	248.02	0.82	253.44	09-Nov-15	-	1.53	251.91	-	-	no	
					Silt	STP	25	252.62	4.6	248.02	0.82	253.44	08-Nov-16	-	1.163	252.277	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	16-Jul-15	-	2.21	251.30	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	04-Aug-15	-	2.31	251.20	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	09-Nov-15	-	1.65	251.86	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	08-Nov-16	-	1.087	252.423	-	-	no	

TABLE D6-1
TESTHOLE DATA SUMMARY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

TABLE D6-1
GROUNDWATER ELEVATION RESULTS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Groundwater Depth (m)	Groundwater Elevation (m)	VW Reading (Hz)	Groundwater Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
BH-BC6		5710352.022	526616.717		Limestone	STP	25	246.071	7.6	238.471	0.88	246.951	21-Jul-12	-	-	-	-	-	yes	No water depths taken due to artesian conditions.
					Limestone	STP	25	246.071	7.6	238.471	0.88	246.951	29-Aug-12	-	-	247.58	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					Limestone	STP	25	246.071	7.6	238.471	0.88	246.951	08-Nov-16	1.8	-1.27	248.2175	-	-	yes	
BH-BC5		5710366.741	527198.084		Limestone	STP	25	245.543	13.6	231.943	0.91	246.453	21-Jul-12	-	-	-	-	-	yes	No water depths taken due to artesian conditions.
					Limestone	STP	25	245.543	13.6	231.943	0.91	246.453	29-Aug-12	-	-	246.87	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					Limestone	STP	25	245.543	13.6	231.943	0.91	246.453	08-Nov-16	1.5	-1.06	247.51	-	-	yes	

VW = Vibrating Wire
STP = Standpipe

Notes:
1. BH-BC series drilled and surveyed in 2011.
2. 15-RC series drilled in 2015. Ground elevations were estimated using LiDAR.
3. TH-GC and TH-EC series drilled and surveyed in 2016.
4. Transducers Installed December 8, 2016 at:
TH-ED-01W
TH-EC-03W
TH-EC-01WW1
TH-EC-01WW2

TABLE D6-2
SUMMARY OF PUMP TEST RESULTS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Date	Observation Well	Distance From Pump Well (m)	Maximum Drawdown at End of Test (m)	Elevation	UTM Northing	UTM Easting
TH-EC-01WW1 Pump Test - 10 hr Duration - 7 USgpm						
Oct. 19, 2016	TH-EC-01WW1	0	6.80	255.566	5713200.105	522685.704
	TH-EC-01WW2	8	0.42	255.584	5713204.847	522692.317
	15-RC-06	84	0.10	255.133	5713280.249	522659.084
	QUARRY	537	0.00	255.932	5712666.529	522742.144
	TH-GC-02	740	0.06	256.06	5712649.239	523179.582
	TH-EC-04	780	0.05	254.973	5713518.02	521973.793
	15-RC-02	821	0.01	255.559	5712795.406	523400.432
TH-EC-01WW2 Pump Test - 8 hr Duration - 4 USgpm						
Oct. 18, 2016	TH-EC-01WW2	0	10.15	255.584	5713204.847	522692.317
	TH-EC-01WW1	8	0.00	255.566	5713200.105	522685.704
	15-RC-06	82	0.02	255.133	5713280.249	522659.084
	QUARRY	541	0.00	255.932	5712666.529	522742.144
	TH-GC-02	739	0.03	256.06	5712649.239	523179.582
	TH-EC-04	784	0.02	254.973	5713518.02	521973.793
	15-RC-02	818	0.04	255.559	5712795.406	523400.432
TH-EC-03 Pump Test - 6.17 hr Duration - 7 USgpm						
Oct. 26, 2016	TH-EC-03	0	5.33	255.566	5710366.954	527199.235
	BH-BC-05	1	4.15	255.584	5,710,367	527,198
	TH-GC-04	404	0.02	255.133	5710061.06	526935.786
	BH-BC-06	582	0.00	255.932	5,710,352	526,617
	TH-GC-05	768	0.03	256.06	5710241.732	527956.525
	15-RC-01 Shallow	2182	0.06	254.973	5710337.471	525017.492
	15-RC-01 Deep	2182	0.01	255.559	5710337.471	525017.492

TABLE D6-3
SUMMARY OF RISING HEAD AND LUGEON TEST RESULTS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Well ID	Ground Elevation (m)	Monitoring Zone		Geology	K Result (m/s)
		Top of Casing Elevation (m)	Bottom of Casing Elevation (m)		
Route C					
15-RC-01 (2; Shallow)	254.837	253.788	250.237	Silt Till	1.23E-06
15-RC-02	255.559	256.544	254.059	Topsoil, Cobbles, Limestone	6.84E-07
15-RC-04 (Shallow)	249.602	250.638	244.102	Clay Till	2.68E-06
15-RC-04 (Deep)	249.602	250.499	238.902	Clay Till	1.66E-06
TH-EC-04	254.973	255.653	237.823	Clay Shale	3.19E-08
TH-GC-01	249.995	250.865	236.435	Dolomite	7.19E-06
TH-GC-02	256.060	256.903	237.010	Dolomite	7.20E-06
TH-GC-04	248.246	249.083	240.326	Dolomite	1.16E-06
TH-GC-05	244.837	245.745	237.217	Dolomite	7.48E-07
15-RC-06	255.133	256.242	241.633	Limestone	3.85E-07
TH-EC-01P	255.589	256.239	235.779	Dolomitic Limestone	3.40E-06
15-RC-01 (1; Deep)	254.837	253.818	242.937	Limestone Bedrock	1.32E-05
BH-BC5	245.544	246.450	231.944	Limestone Bedrock	2.48E-04
Lugeon (packer) Test Results	**Ground Elevation (m)**	**Top of Test Internal Elevation (m)**		**Geology**	**Result (Lu)**
TH-EC-01P	255.590	250.710	249.270	Dolomitic Limestone	27.6
TH-EC-01P	255.590	249.190	247.740	Dolomitic Limestone	47.9
TH-EC-01P	255.590	247.670	246.220	Dolomitic Limestone	0
TH-EC-01P	255.590	246.140	244.690	Dolomitic Limestone	10.9
TH-EC-01P	255.590	244.620	243.170	Dolomitic Limestone	0.4
TH-EC-01P	255.590	243.090	241.650	Dolomitic Limestone	11.9
TH-EC-01P	255.590	241.570	240.120	Dolomitic Limestone	6.5
TH-EC-01P	255.590	240.050	238.600	Dolomitic Limestone	50.7
TH-EC-01P	255.590	238.520	237.070	Dolomitic Limestone	0
TH-EC-01P	255.590	237.000	235.750	Dolomitic Limestone	6.2
THGC-01	250.000	239.030	237.680	Dolomitic Limestone	259.9
TH-GC-01	250.000	237.350	236.440	Dolomitic Limestone	12.3

TABLE D6-4
GROUNDWATER FIELD CHEMISTRY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (^{o}C)	ORP (mV)	DO (mg/L)	Turbidity	Odour	Colour	Comments
TH-EC-01WW1	19-Oct-16	6.6	610	8.3	197.7	NA	none to very low	none	none	start of pump test
TH-EC-01WW1	19-Oct-16	6.8	629	8.7	181.3	NA	none to very low	none	none	end of pump test
TH-EC-01WW2	18-Oct-16	7.4	528	7.6	177.0	NA	none to very low	none	none	start of pump test
TH-EC-01WW2	18-Oct-16	6.9	533	7.3	220.9	NA	none to very low	none	none	end of pump test
TH-EC-03W	27-Oct-16	(1)	614	7.4	201.2	NA	none to very low	none	none	-
TH-EC-03W	27-Oct-16	(1)	648	6.8	236.5	NA	none to very low	none	none	-
TH-EC-04	09-Nov-16	(1)	918	8.2	-258.5	1.35	none to very low	none	none	-
TH-GC-01	09-Nov-16	(1)	691	8.1	-256.0	2.40	none to very low	none	none	-
TH-GC-05	09-Nov-16	(1)	834	8.8	-188.5	1.17	none to very low	none	none	-

Notes:
"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

1. Equipment malfunction.

TABLE D6-5
GROUNDWATER GENERAL WATER QUALITY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Field / Lab Dup. Info	Parameter [1]																					
			Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [5]	Fluoride	Sulphate	Ammonia (as N)	Un-ionized Ammonia	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Iron	Manganese	Free Cyanide	Total Phosphorus	T.D.S.	T.K.N.	E. Coli (MPN/ 100 mL)	Total Coliform (MPN/100mL)
EQL			*0.2*	*0.01*	*1*	*1*	*1*	*1*	*1*	*1*	*0.5*	*0.02*	*0.5*	*0.01*	*0.03*	*0.07*	*0.2*	*0.2*	*0.03*	*0.005*	*0.001*	*0.05*	*2*	*0.03*	*1*	*1*
TH-EC-01WW1 (B)	19-Oct-16	test start	76.1	8.03	544	338	412	<0.60	<0.34	303	3.22	0.124	4.62	0.013	-	0.273	0.273	<0.0010	-	-	-	0.169	314	<0.20	1	8
TH-EC-01WW1 (E)	19-Oct-16	test end	-	8.14	535	332	405	<0.60	<0.34	318	2.73	-	4.67	<0.010	-	0.256	0.256	<0.0010	-	-	-	0.025	315	<0.20	<1	34
TH-EC-01 WW2 TEST START	18-Oct-16	test start	90.3	8.10	564	339	414	<0.60	<0.34	367	2.34	0.132	5.09	0.017	-	0.264	0.264	<0.0010	-	-	-	0.411	333	<0.20	<10	50
TH-EC-01 WW2 TEST STOP	18-Oct-16	test end	-	8.14	556	338	412	<0.60	<0.34	352	1.81	-	4.56	<0.010	-	0.262	0.262	<0.010	-	-	-	0.021	325	<0.20	<1	2
TH - EC - 03 START	27-Oct-16	test start	-	7.59	747	437	533	<0.60	<0.34	342	6.06	-	53.1	0.52	-	<0.070	<0.020	<0.010	-	-	-	18.1	491	1.18	4	37
TH - EC - 03 END	27-Oct-16	test end	-	7.57	736	401	489	<0.60	<0.34	343	6.04	-	53.5	0.52	-	<0.070	<0.020	<0.010	-	-	-	3.52	470	0.46	<1	<1
TH-EC-03	9-Nov-16		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	0.023	-	-	-	-
TH-GC-01	9-Nov-16		12.7	7.95	682	379	462	<0.60	<0.34	414	7.61	0.25	10.6	-	-	0.695	0.689	0.0067	-	-	-	-	387	-	-	-
TH-GC-05	9-Nov-16		205	7.64	745	377	460	<0.60	<0.34	341	6.33	1.04	56.4	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	461	-	-	-
TH-GC-05	9-Nov-16	Dup	293	7.68	749	382	466	<0.60	<0.34	360	6.37	1.04	56.6	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	473	-	-	-
		RPD	35%	0.50%	0.50%	1.30%	1.30%	-	-	5.40%	0.60%	0%	0.40%	-	-	-	-	-	-	-	-	-	2.60%	-	-	-
TH-EC-04	9-Nov-16		174	7.83	876	415	507	<0.60	<0.34	497	5.74	1.6	100	-	-	0.0245	0.0211	0.0034	-	-	-	-	557	-	-	-
HC-CDWQ [2]																										
Drinking Water			0.3/1.0/0.1 (MAC)[7]	6.5 - 8.5 (AO)	-	-	-	-	-	[9]	≤250 (AO)	1.5 (MAC)	500 (AO)	-	-	-	10 [4] (MAC)	1.0 [4] (MAC)	0.3 (AO)	0.05 (AO)	0.2 (MAC)	-	500 (AO)	-	None Detectable per 100 mL (MAC)	None Detectable per 100 mL (MAC)
CCME[3] (Shown for Reference Only)																										
Freshwater Aquatic Life			Narrative [8]	6.5 - 9.0	-	-	-	-	-	-	120[5a]/640 [5b]	0.12	-	-	0.019 [6]	-	3[12]/ 124[11]	0.06	0.3	-	0.005	[10]	-	-	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.K.N. = Total Kjeldahl Nitrogen
T.D.S. = Total Dissolved Solids
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
3. Health Canada - Guidelines for Canadian Recreational Water Quality. April 2012.
   a. Colour should not be so intense as to impede visibility in areas used for swimming.
   b. Geometric mean concentration (minimum 5 samples). *E.coli* is the most appropriate indicator of feacal contmination in fresh recreational waters, and entrococci is for marine recreational waters.
   c. Single sample maximum concentration. E.coli is the most appropriate indicator of feacal contmination in fresh recreational waters, and entrococci is for marine recreational waters.
   d. Total Cyanobacteria
   e. Total Microcystins.
4. Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L, which is equivalent to 1 mg/L nitrite-nitrogen.
5. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation
   b. Short-term exposure - derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
   c. Guideline is dependant on type of plant. See CCME summary table for details.
      Foliar damage
      = 100-178 mg/L for almond apricots and plums
      = 178-355 mg/L for grapes, peppers, potatoes and tomatoes
      = 355-710 mg/L for alfalfa, barley, corn, and cucumbers
      >710 mg/L for cauliflower, cotton, safflower, sesame, sorghum, sugar beets, and sunflowers

Rootstocks
= 180-600 mg/L for stone fruit (peaches, plums, etc.)
= 710-900 mg/L for grapes
Cultivars
= 110-180 mg/L for strawberries
= 230-460 mg/L for grapes
= 250 mg/L for boysenberries, blackberries, and raspberries

6. Guideline for total ammonia is pH and Temperature dependent. See Factsheet for details.

7. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process.
Turbidity values greater than 1 NTU are shaded.

8. Turbidity Guidelines (see fact sheet for complete details):
Clear Flow:
Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
High Flow or Turbid Waters:
Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
Should not increase more than 10% of background levels when background is >80 NTUs.

9. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as $CaCO_3$) , provide acceptable balance between corrosion and incrustation; where a water softener is used, a separate unsoftened supply for cooking and drinking purposes is recommended.

10. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):			
	ultra-oligotr <4	meso-eutrophic	20-35
	oligotrophic 4-10	eutrophic	35-100
	mesotrophi 10-20	hyper-eutrophic	>100

11. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
These are NOT protective guidelines.

12. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).

- Exceedance of HC-CDWQ Guidelines

TABLE D6-5
GROUNDWATER GENERAL WATER QUALITY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

TABLE D6-6
GROUNDWATER METALS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Well No.	Date	Parameter [1]																		
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
TH-EC-01WW1 (B)	19-Oct-16	<0.0020	<0.00020	<0.00020	0.0453	<0.00020	<0.00020	0.011	<0.000010	59.2	<0.00010	<0.0010	<0.00020	0.00121	<0.010	<0.000090	0.0048	37.7	0.00022	0.00039
TH-EC-01WW1 (E)	19-Oct-16	-	-	-	-	-	-	-	-	61.4	-	-	-	-	-	-	-	40	-	-
TH-EC-01 WW2 TEST START	18-Oct-16	0.0023	<0.00020	<0.00020	0.076	<0.00020	<0.00020	0.017	<0.000010	63.4	<0.00010	<0.0010	<0.00020	0.00198	<0.010	0.00012	0.0078	50.8	0.00071	0.00033
TH-EC-01 WW2 TEST STOP	18-Oct-16	-	-	-	-	-	-	-	-	61.3	-	-	-	-	-	-	-	48.3	-	-
TH - EC - 03 START	27-Oct-16	-	-	-	-	-	-	-	-	69.7	-	-	-	-	-	-	-	40.9	-	-
TH - EC - 03 END	27-Oct-16	-	-	-	-	-	-	-	-	69.1	-	-	-	-	-	-	-	41.3	-	-
TH-GC-01	9-Nov-16	<0.0020	<0.00020	<0.00020	0.115	<0.00020	<0.00020	0.072	<0.000010	64.5	<0.00010	<0.0010	<0.00020	0.00094	<0.010	<0.000090	0.0134	61.4	0.0104	0.00168
TH-GC-05	9-Nov-16	<0.0020	<0.00020	0.00179	0.0371	<0.00020	<0.00020	1.27	<0.000010	69.9	0.0001	<0.0010	<0.00020	<0.00020	0.102	<0.000090	0.0603	40.4	0.00377	0.00079
TH-GC-05 Dup	9-Nov-16	<0.0020	<0.00020	0.00184	0.0388	<0.00020	<0.00020	1.37	<0.000010	71.2	<0.00010	<0.0010	<0.00020	<0.00020	0.102	<0.000090	0.0575	44.3	0.00389	0.00079
RPD		-	-	*2.75%*	*4.48%*	-	-	*7.58%*	-	*1.84%*	-	-	-	-	*0.00%*	-	*4.75%*	*9.21%*	*3.13%*	*0.00%*
TH - EC - 04	9-Nov-16	<0.0020	0.00173	<0.00020	0.0725	<0.00020	<0.00020	1.28	0.000014	78.2	<0.00010	<0.0010	0.00691	0.00051	2.25	<0.000090	0.0473	73.3	0.452	0.0121
EQL		*0.002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.05*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0001*	*0.001*
HC-CDWQ [2]																				
Drinking Water		0.1- 0.2 [4] (OG)	0.006 (MAC)	0.010 (MAC)	1.0 (MAC)	-	-	5.0 (MAC)	0.005 (MAC)	-	-	0.05 (MAC)	-	1.0 (AO)	0.3 (AO)	0.010 (MAC)	-	-	0.05 (AO)	-
CCME[3] (Shown for Reference Only)																				
Freshwater Aquatic Life		0.005 - 0.1 [5]	-	0.005	-	-	-	(29 [6]) 1.5 [7]	0.09 µg/L [8a] 1.0 µg/L [8b]	-	-	0.0089 (III), 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	-	0.073

Well No.	Date	Parameter [1]																		
		Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
TH-EC-01WW1 (B)	19-Oct-16	<0.0010	<0.030	0.555	0.00138	<0.0010	4.9	<0.00010	4.85	0.043	<0.00020	<0.00010	<0.00010	0.00082	<0.00050	0.0004	0.00051	<0.00020	<0.0020	<0.00040
TH-EC-01WW1 (E)	19-Oct-16	-	-	0.581	-	-	-	-	4.87	-	-	-	-	-	-	-	-	-	-	-
TH-EC-01 WW2 TEST START	18-Oct-16	<0.0010	<0.030	0.74	0.00185	<0.0010	4.39	<0.00010	5.48	0.046	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00052	<0.00020	0.0029	<0.00040
TH-EC-01 WW2 TEST STOP	18-Oct-16	-	-	0.67	-	-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	-
TH - EC - 03 START	27-Oct-16	-	-	21.6	-	-	-	-	37.6	-	-	-	-	-	-	-	-	-	-	-
TH - EC - 03 END	27-Oct-16	-	-	21.1	-	-	-	-	38.2	-	-	-	-	-	-	-	-	-	-	-
TH-GC-01	9-Nov-16	<0.0010	<0.030	2.95	0.0023	<0.0010	5.8	<0.00010	9.51	0.139	<0.00020	<0.00010	<0.00010	0.00021	<0.00050	0.00035	0.00175	<0.00020	0.0029	<0.00040
TH-GC-05	9-Nov-16	<0.0010	<0.030	22.7	0.00939	<0.0010	6.81	<0.00010	39	0.944	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00024	<0.00020	<0.0020	<0.00040
TH-GC-05 Dup	9-Nov-16	<0.0010	<0.030	23.6	0.0095	<0.0010	6.93	<0.00010	41.6	0.925	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00024	<0.00020	<0.0020	<0.00040
RPD		-	-	*3.89%*	*1.16%*	-	*1.75%*	-	*6.45%*	*2.03%*	-	-	-	-	-	-	*0.00%*	-	-	-
TH-EC-04	9-Nov-16	0.0199	<0.030	16.5	0.00736	<0.0010	4.47	<0.00010	33.5	0.693	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	0.00646	0.00163	<0.00020	0.0261	<0.00040
EQL		*0.03*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.02*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
HC-CDWQ [2]																				
Drinking Water		-	-	-	-	0.05 (MAC)	-	-	200 (AO)	-	-	-		-	-	-	0.02 (MAC)	-	5 (AO)	-
CCME[3] (Shown for Reference Only)																				
Freshwater Aquatic Life		[8e]	[9]	-	-	0.001	-	0.00025	-	-	-	0.0008		-	-	-	(0.033[6]) 0.015 [7]	-	0.03	-

TABLE D6-6
GROUNDWATER METALS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Notes:
EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence
"-" = No Data
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
   OG = Operational Guideline
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants.
The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
5. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5.
   The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater or equal to 6.5.
6. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
   These are NOT protective guidelines.
7. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <17 mg/L, CWQG is 0.04 µg/L. At other hardness values, the CWQG can be calculated with the equation CWQG = 10^{0.83[log(hardness)] - 3.2} µg/L valid for hardness between 17 and 280 mg $CaCO_3$/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <5.3 mg/L, CWQG is 0.11 µg/L.
   At other hardness values, the benmark can be calculated with the equation Benchmark - 10^{1.016(log[hardness])-1.71}/1000, valid for hardness between 5.3 and 360 mg CaCO3/L.
   c. **Copper** Guideline = e^(0.8545[ln(hardness)]-1.465) * 0.2 µg/L;
   d. **Lead** Guideline = e^(1.273[ln(hardness)]-4.705) µg/L;
   e. **Nickel** Guideline = e^(0.76[ln(hardness)]+1.06) µg/L

Well No.	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-EC-01WW1 (B)	303	0.000072	0.006474	0.006	0.013	0.222
TH-EC-01WW1 (E)	318	0.000075	0.006799	0.006	0.014	0.230
TH-EC-01 WW2 TEST START	367	0.000085	0.007865	0.007	0.017	0.257
TH-EC-01 WW2 TEST STOP	352	0.000082	0.007539	0.007	0.016	0.249
TH - EC - 03 START	342	0.000080	0.007321	0.007	0.015	0.243
TH - EC - 03 END	343	0.000080	0.007343	0.007	0.015	0.244
TH-GC-01	414	0.000094	0.008889	0.008	0.019	0.281
TH-GC-05	341	0.000080	0.007299	0.007	0.015	0.243
TH-GC-05 DUP	360	0.000084	0.007713	0.007	0.016	0.253
TH-EC-04	497	0.000109	0.010703	0.009	0.024	0.323

9. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):				
	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

- Exceedance of HC-CDWQ Criteria

TABLE D6-7
GROUNDWATER ION BALANCE AND WATER TYPE - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic Weight	TH-EC-01WW1 test start 19-Oct-16			TH-EC-01WW1 test end 19-Oct-16			TH-EC-01WW2 test start 18-Oct-16			TH-EC-01WW2 test end 18-Oct-16			TH - EC - 03W test start 27-Oct-16			TH - EC - 03W test end 27-Oct-16		
		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	8.03	9.33E-06	0.00%	8.14	7.24E-06	0.00%	8.1	7.94E-06	0.00%	8.14	7.24E-06	0.00%	7.59	2.57E-05	0.00%	7.57	2.69153E-05	0.00%
Calcium	0.0499	59.2	2.95	47.02%	61.4	3.06	46.54%	63.4	3.16	41.61%	61.3	3.06	42.38%	69.7	3.48	40.84%	69.1	3.45	40.35%
Magnesium	0.0823	37.7	3.10	49.38%	40	3.29	50.01%	50.8	4.18	54.99%	48.3	3.98	55.08%	40.9	3.37	39.52%	41.3	3.40	39.77%
Sodium	0.0435	4.85	0.21	3.36%	4.87	0.21	3.22%	5.48	0.24	3.14%	4.2	0.18	2.53%	37.6	1.64	19.20%	38.2	1.66	19.44%
Potassium	0.03	0.555	0.01	0.23%	0.581	0.01	0.23%	0.74	0.02	0.25%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
Ammonia-N	0.07	0.013	0.00	0.01%	0.01	0.00	0.01%	0.017	0.00	0.02%	0.01	0.00	0.01%	0.52	0.04	0.44%	0.52	0.04	0.43%
SUM		**102.3**	**6.28**	**100.0%**	**107**	**6.6**	**100.0%**	**120**	**7.6**	**100.0%**	**113.8**	**7.22**	**100.0%**	**148.7**	**8.52**	**100.0%**	**149**	**8.55**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	338	6.76	97.04%	332	6.64	97.18%	339	6.78	97.26%	338	6.76	97.62%	437	8.74	87.25%	401	8.02	86.19%
Bicarbonate [4]	0.02	334.6	6.69	96.05%	327.7	6.55	95.92%	335.0	6.70	96.11%	333.6	6.67	96.35%	435.4	8.71	86.93%	399.6	7.99	85.89%
Carbonate [4]	0.02	3.4	0.07	0.97%	4.3	0.09	1.24%	4.0	0.08	1.14%	4.3	0.09	1.25%	1.6	0.03	0.32%	1.4	0.03	0.30%
Hydroxide [4]	0.02	0.1	0.00	0.02%	0.1	0.00	0.02%	0.1	0.00	0.02%	0.1	0.00	0.02%	0.0	0.00	0.00%	0.0	0.00	0.00%
Nitrate	0.0714	0.273	0.02	0.28%	0.256	0.02	0.27%	0.264	0.02	0.27%	0.262	0.02	0.27%	0.02	0.00	0.01%	0.02	0.00	0.02%
Chloride	0.0282	3.22	0.09	1.30%	2.73	0.08	1.13%	2.34	0.07	0.95%	1.81	0.05	0.74%	6.06	0.17	1.71%	6.04	0.17	1.83%
Sulphate	0.0208	4.62	0.10	1.38%	4.67	0.10	1.42%	5.09	0.11	1.52%	4.56	0.09	1.37%	53.1	1.10	11.03%	53.5	1.11	11.96%
SUM		**346**	**6.97**	**100.0%**	**340**	**6.8**	**100.0%**	**347**	**7.0**	**100.0%**	**345**	**6.92**	**100.0%**	**496**	**10.02**	**100.0%**	**461**	**9.30**	**100.0%**
Silica (as SiO_2)		5			-			4			-			-			-		
TDS (mg/L) [2]		319			315			337			324			470			449		
TDS (mg/L) (Lab) [3]		314			315			333			325			491			470		
Ion Balance		5.16%			1.86%			4.34%			2.07%			8.09%			4.25%		
Ion Balance (Lab) [3]		0.00%			0.0%			0.0%			0.00%			0.00%			0.0%		

Cations	Atomic Weight	TH-GC-01 09-Nov-16			TH-GC-05 09-Nov-16			TH-GC-05 DUP 09-Nov-16			TH-EC-04 09-Nov-16		
		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.95	1.12E-05	0.00%	7.64	2.29E-05	0.00%	7.68	2.09E-05	0.00%	7.83	1.48E-05	0.00%
Calcium	0.0499	64.5	3.22	37.06%	69.9	3.49	38.37%	71.2	3.55	36.96%	78.2	3.90	33.03%
Magnesium	0.0823	61.4	5.05	58.18%	40.4	3.32	36.58%	44.3	3.65	37.93%	73.3	6.03	51.06%
Sodium	0.0435	9.51	0.41	4.76%	39	1.70	18.66%	41.6	1.81	18.83%	33.5	1.46	12.33%
Potassium	0.03	-	0.00	0.00%	22.7	0.58	6.39%	23.6	0.60	6.29%	16.5	0.42	3.58%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**135.4**	**8.69**	**100.0%**	**172.0**	**9.09**	**100.0%**	**180.7**	**9.61**	**100.0%**	**201.5**	**11.81**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	379	7.58	93.99%	377	7.54	84.80%	382	7.64	84.91%	415	8.30	78.72%
Bicarbonate [4]	0.02	375.8	7.52	93.20%	375.4	7.51	84.44%	380.3	7.61	84.53%	412.3	8.25	78.22%
Carbonate [4]	0.02	3.1	0.06	0.78%	1.5	0.03	0.35%	1.7	0.03	0.38%	2.6	0.05	0.50%
Hydroxide [4]	0.02	0.0	0.00	0.01%	0.0	0.00	0.00%	0.0	0.00	0.01%	0.0	0.00	0.01%
Nitrate	0.0714	0.689	0.05	0.61%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.0211	0.00	0.01%
Chloride	0.0282	7.61	0.21	2.66%	6.33	0.18	2.01%	6.37	0.18	2.00%	5.74	0.16	1.54%
Sulphate	0.0208	10.6	0.22	2.73%	56.4	1.17	13.19%	56.6	1.18	13.08%	100	2.08	19.73%
SUM		**398**	**8.06**	**100.0%**	**440**	**8.89**	**100.0%**	**445**	**9.00**	**100.0%**	**521**	**10.54**	**100.0%**
Silica (as SiO_2)		6			7			7			4		
TDS (mg/L) [2]		390			468			480			561		
TDS (mg/L) (Lab) [3]		387			-			-			-		
Ion Balance		3.71%			1.10%			3.31%			5.69%		
Ion Balance (Lab) [3]		0.00%			0.00%			0.00%			0.00%		

LOCATION	WATER TYPE
TH-EC-01WW1 (test start)	magnesium-calcium-bicarbonate
TH-EC-01WW1 (test end)	magnesium-calcium-bicarbonate
TH-EC-01WW2 (test start)	magnesium-calcium-bicarbonate
TH-EC-01WW2 (test end)	magnesium-calcium-bicarbonate
TH-EC-03 (test start)	calcium-magnesium-bicarbonate
TH-EC-03 (test end)	calcium-magnesium-bicarbonate
TH-GC-01	magnesium-bicarbonate
TH-GC-05	calcium-magnesium-bicarbonate
TH-GC-05 DUP	magnesium-calcium-bicarbonate
TH-EC-04	magnesium-bicarbonate

Notes:
"-" = No Data
1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
3. Laboratory results may slightly differ due to rounding of numbers.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

TABLE D6-8
SURFACE WATER FIELD CHEMISTRY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (^{o}C)	ORP (mV)	DO (mg/L)	Turbidity	Odour	Colour	Comments
C2 - Inlet Creek	07-Nov-16	7.6	886	5.4	53.3	4.20	2.32	none	none	-
D9 - LSM	07-Nov-16	8.4	691.4	6.6	-26.1	10.58	5.15	none	none	sampled at prov. hydrometric station

Notes:
"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D6-9
SURFACE WATER GENERAL WATER QUALITY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Location	Date	Field / Lab Dup. Info	Parameter (mg/L unless otherwise specified)																				
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [3]	Fluoride	Sulphate	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Total Nitrogen	TKN	Phos-phorous, Total Dissolved	Total Phosphorous	Ammonia, total as N	T.D.S.	T.S.S.	E. Coli (MPN/ 100 mL)	Total Coliform (MPN/100mL)
EQL				*0.1*	*0.1*	*1*	*1*	*1.2*	*0.6*	*0.34*	*0.01*	*0.25*	*0.1*	*0.02*	*0.3*	*0.0051*	*0.005*	*0.001*	*0.2*	*0.2*	*0.001*	*0.001*	*5*	*2*	*1*	*1*
C2	Inlet Creek	8-Nov-16		1	7.86	1020	648	790	<0.60	<0.34	712	16.6	0.204	16.5	0.071	0.061	0.0102	4.76	4.69	0.614	**0.678**	1.51 [14]	660	<2.0	<100	200
D9	Lake St. Martin	8-Nov-16		3.53	8.47	813	182	211	5.4	<0.34	261	130	0.239	77.5	0.117	0.103	0.0139	1.36	1.24	0.0116	0.021	0.014	503	7	<100	<100
D9	Lake St. Martin	8-Nov-16	Dup	3.72	8.48	814	185	214	5.76	<0.34	248	128	0.238	76.7	0.027	0.022	0.0051	1.3	1.27	0.0141	0.02	0.016	491	6.6	100	100
			RPD	*5.2%*	*0.1%*	*0.1%*	*1.6%*	*1.4%*	*6.5%*	-	*5.1%*	*1.6%*	-	*1.0%*	-	-	-	*4.5%*	*2.4%*	-	*4.9%*	*13.3%*	*2.4%*	-	-	-
FB	Distilled water	8-Nov-16	Field Blank	<0.10	**5.98**	<1.0	<1.0	<1.2	<0.60	<0.34	0.25	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	0.0011	0.0045	<0.010	<5.0	<2.0	<100	<100
MWQSOG [1]																										
Surface Water - Tier III																										
Freshwater Aquatic Life				[2]	6.5 - 9.0	-	-	-	-	-	-	-	-	-	-	13	0.06	-	-	-	0.025 (lakes and streams entering lakes)/ 0.05 (other streams) [3]	[4]	-	[5]	-	-
CCME[6]																										
Canadian Water Quality Guidelines for the Protection of Aquatic Life																										
Freshwater				Narrative [7]	6.5 - 9.0	-	-	-	-	-	-	120[8a]/640 [8b]	0.12	-	-	13[9] / 550[10]	0.06	-	-	-	[11]	[12]	-	Narrative [13]	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.D.S. = Total Dissolved Solids
T.S.S. = Total Suspended Solids
TKN = Total Kjeldahl Nitrogen
RPD = Relative Percent Difference

1. MWQSOG - Manitoba Water Quality Standards , Objectives, and Guidelines - Manitoba Water Stewardship Report 2011-01, November 28, 2011.
2. MWQSOG Tier II Objective - Equivalent induced levels of change as calculated from site-specific or regional correlation between total suspended sediment and turbidity.
3. MWQSOG Tier II Objective - Unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L.
4. MWQSOG Tier II Objective - Cool Water, All Periods (Eq. 3). Manitoba Water Stewardship, November 2011.
5. Total Suspended Sediment Guidelines:
   5 mg/L Induced Change over 30 days from background TSS <= 25 mg/L
   25 mg/L Induced Change over 1 day from background TSS <= 250 mg/L
   10% Induced Change over 1 day from background TSS > 250 mg/L
6. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
7. Turbidity Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.
8. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation.
   b. Short-term exposure - Derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
9. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).
10. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
    These are NOT protective guidelines.
11. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.
Trigger ranges (µg/L):

ultra-oligotrophic	<4	meso-eutrophic	20 - 35
oligotrophic	4 - 10	eutrophic	35 - 100
mesotrophic	10 - 20	hyper-eutrophic	>100

12. Guideline for total ammonia is pH and temperature dependent. See factsheet for details.
13. Total Suspended Solids:
    Clear flow - Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).
    High flow - Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is ≥ 250 mg/L.
14. Unionized ammonia, calculated as 0.0077 mg/L for this sample is based on a field pH of 7.6 and a field temperature of 5.4 °C. The CCME freshwater aquatic life guideline for unionized ammonia is 0.019 mg/L.

- Exceedance of CCME Guidelines
BOLD - Exceedance of MWQSOG Guidelines

TABLE D6-10
SURFACE WATER METALS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
C2	Inlet Creek	8-Nov-16	0.0107	<0.00020	0.00093	0.0865	<0.00020	<0.00020	0.058	<0.000010	98.9	<0.00010	<0.0010	0.00043	0.00037	0.174	<0.000090	0.0256	113	0.117	0.00041
D9	Lake St. Martin	8-Nov-16	0.0421	<0.00020	0.00172	0.0398	<0.00020	<0.00020	0.086	<0.000010	43.3	<0.00010	<0.0010	<0.00020	0.00043	0.037	0.000118	0.0283	37.1	0.00489	0.00203
D9 Dup	Lake St. Martin	8-Nov-16	0.0357	<0.00020	0.00166	0.0396	<0.00020	<0.00020	0.083	<0.000010	40.4	<0.00010	<0.0010	<0.00020	0.00038	0.036	0.000113	0.0262	35.8	0.00476	0.00185
		RPD	*16.5%*	-	*3.6%*	*0.5%*	-	-	*3.6%*	-	*6.9%*	-	-	-	*12.3%*	*2.7%*	*4.3%*	*7.7%*	*3.6%*	*2.7%*	*9.3%*
FB	Field Blank	8-Nov-16	<0.0050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.010	<0.000010	0.1	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	<0.0020	<0.010	<0.00030	<0.00020
EQL			*0.005*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.1*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0003*	*0.0002*
MWQSOG [1]																					
Surface Water - Tier III																					
Freshwater Aquatic Life			0.005 - 0.1 [3]	-	0.15 - 0.34 [4]	-	-	-	-	[7]	-	-	[7]	-	[7]	0.3	[7]	-	-	-	0.073
CCME[2]																					
Freshwater Aquatic Life			0.005 - 0.1 [3]	-	0.005	-	-	-	(29 [5]) 1.5 [6]	0.09 µg/L [Ba] 1.0 µg/L [Bb]	-	-	0.0089 (III), 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	-	0.073

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
C2	Inlet Creek	8-Nov-16	<0.0020	0.67	8.31	0.00284	<0.0010	14.8	<0.00010	17.6	0.311	<0.00020	<0.00010	<0.00010	<0.00020	0.00069	<0.00010	0.00455	0.0009	<0.0020	<0.00040
D9	Lake St. Martin	8-Nov-16	<0.0020	<0.10	8.74	0.00359	<0.0010	5.78	<0.00010	96.8	0.231	<0.00020	<0.00010	<0.00010	<0.00020	0.00138	<0.00010	0.00189	0.00152	<0.0020	<0.00040
D9 Dup	Lake St. Martin	8-Nov-16	<0.0020	<0.10	8.34	0.00351	<0.0010	5.58	<0.00010	91	0.213	<0.00020	<0.00010	<0.00010	<0.00020	0.00126	<0.00010	0.0018	0.00145	<0.0020	<0.00040
		RPD	-	-	*4.7%*	*2.3%*	-	*3.5%*	-	*6.2%*	*8.1%*	-	-	-	-	*9.1%*	-	*4.9%*	*4.7%*	-	-
FB	Field Blank	8-Nov-16	<0.0020	<0.10	<0.020	<0.00020	<0.0010	<0.10	<0.00010	<0.030	0.00013	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	<0.00010	<0.00020	<0.0020	<0.00040
EQL			*0.002*	*0.1*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.03*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
MWQSOG [1]																					
Surface Water - Tier III																					
Freshwater Aquatic Life			[7]	0.025 (lakes and streams entering lakes)/ 0.05 (other streams) [9]	-	-	0.001	-	0.0001	-	-	-	0.0008	-	-	-	-	(0.033 [5]) 0.015 [6]	-	[7]	-
CCME[2]																					
Freshwater Aquatic Life			[8e]	[10]	-	-	0.001	-	0.00025	-	-	-	0.0008	-	-	-	-	(0.033 [5]) 0.015 [6]	-	0.03	-

Notes:

EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence

"-" = No Data

RPD = Relative Percent Difference

1. MWQSOG - Manitoba Water Quality Standards , Objectives, and Guidelines - Manitoba Water Stewardship Report 2011-01, November 28, 2011.
2. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
3. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5. The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater than or equal to 6.5.
4. Short term duration (1 hour) should not exceed 0.34 mg/L long term duration (4 days) should not exceed 0.15 mg/L.
5. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances). These are NOT protective guidelines.
6. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
7. The following table provides guidelines for parameters based on the samples hardness and the toxicity of the metal.

Hardness (mg/L)	*Cadmium (mg/L)*		*Chromium (mg/L)*		*Copper (mg/L)*		*Lead (mg/L)*		*Nickel (mg/L)*		*Zinc (mg/L)*	
	Chronic	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*
245	0.00046	0.00481	0.15439	1.18692	0.01926	0.03126	0.00657	0.16872	0.11099	0.99931	0.25243	0.25038
270	0.00049	0.00528	0.16718	1.28523	0.02093	0.03426	0.00728	0.18684	0.1205	1.08492	0.27409	0.27186
295	0.00052	0.00576	0.17976	1.38191	0.02257	0.03724	0.00799	0.20496	0.12988	1.16932	0.29544	0.29305
320	0.00055	0.00623	0.19214	1.47711	0.0242	0.04021	0.00869	0.22307	0.13913	1.25263	0.31652	0.31396
345	0.00058	0.0067	0.20435	1.57097	0.0258	0.04316	0.0094	0.24116	0.14827	1.33493	0.33736	0.33462
370	0.00061	0.00717	0.2164	1.66361	0.02739	0.0461	0.0101	0.25922	0.15731	1.41633	0.35796	0.35505
400	0.00064	0.00774	0.02067	1.7733	0.02928	0.04962	0.01094	0.28025	0.16804	1.51289	0.3824	0.3793

8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);

TABLE D6-10
SURFACE WATER METALS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is 0 to <17 mg/L, CWQG is 0.04 µg/L.
At hardness ≥ 17 to ≤ 280, the CWQG can be calculated with the equation CWQG (ug/L) = 10^{0.83[log(hardness (mg/L)] - 2.46}. At hardness >280 mg/L, the CWQG is 0.37 ug/L.
b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness.
When water hardness is 0 to <5.3 mg/L, the short-term CWQG is 0.11 µg/L. At hardness ≥5.3 to ≤360 mg/L, the short term bench mark is calculated using this equation CWQG (ug/L) = 10^{1.016(log[hardness (mg/L])-1.71}. At hardness >360 mg/L, the short term benchmark is 7.7 ug/L
c. **Copper** Guideline = When the water hardness is 0 to <82 mg/L, the CWQG is 2 ug/L.
At hardness ≥ 82 to ≤180 mg/L the CDWQ is calculated using this equation: CWQG (ug/L) = e^(0.8545[ln(hardness (mg/L)]-1.465) * 0.2;
At hardness > 180 mg/L, the CWQG is 4 ug/L, if the hardness is not known, the CDQG is 2 ug/L.
d. **Lead** Guideline =When the hardness is 0 to ≤60 mg/L, the CWQG is 1 ug/L. At hardness >60 to ≤180 mg/L the CWQG is calculated using: CWQG(ug/L) = e^(1.273[ln(hardness (mg/L))]-4.705) µg/L; At hardness >180 mg/L, the CWQG is 7 ug/L, If the hardness is unknown, the CWQG is 1 ug/L.
e. **Nickel** Guideline = Whan water hardness is 0 to ≤60 mg/L, the CWQG is 25 ug/L.
At hardness >60 to ≤180 mg/L the CWQG is calculated using the following equation: CWQG (ug/L) = e^(0.76[ln(hardness)]+1.06). At hardness >180 mg/L, the CWQG is 150 ug/L. If the hardness is unknown, the CWQG is 25 ug/L.

Well No.	*Hardness*	*10a. Cadmium (long-term) mg/L*	*10b. Cadmium (short-term) (mg/L)*	*10c. Copper (mg/L)*	*10d. Lead (mg/L)*	*10e. Nickel (mg/L)*
C2	712	0.000808274	0.015421253	0.012654143	0.038712525	0.424851295
FB	0.25	1.09721E-06	4.76768E-06	1.41361E-05	1.54961E-06	0.001006437
D9	261	0.000351408	0.00556297	0.005367943	0.010790159	0.198152217

9. MWQSOG Tier II Objective - Unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L.
10. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):				
	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

	- Exceedance of CCME Guidelines
BOLD	- Exceedance of MWQSOG Guidelines

TABLE D6-11
SURFACE WATER ION BALANCE AND WATER TYPE - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic	C2 08-Nov-16			D9 08-Nov-16			D9 DUP 08-Nov-16		
	Weight	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.86	1.38E-05	0.00%	8.47	3.39E-06	0.00%	8.48	3.31E-06	0.00%
Calcium	0.0499	98.9	4.94	32.21%	43.3	2.16	22.39%	40.4	2.02	22.07%
Magnesium	0.0823	113	9.30	60.70%	37.1	3.05	31.64%	35.8	2.95	32.25%
Sodium	0.0435	17.6	0.77	5.00%	96.8	4.21	43.64%	91	3.96	43.33%
Potassium	0.03	8.31	0.21	1.39%	8.74	0.22	2.32%	8.34	0.21	2.34%
Ammonia-N	0.07	1.51	0.11	0.70%	0.014	0.00	0.01%	0.016	0.00	0.01%
SUM		**239.3**	**15.32**	**100.0%**	**186**	**9.6**	**100.0%**	**176**	**9.1**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	648	12.96	94.08%	182	3.64	40.78%	185	3.70	41.54%
Bicarbonate [4]	0.02	643.6	12.87	93.44%	176.9	3.54	39.65%	179.7	3.59	40.36%
Carbonate [4]	0.02	4.4	0.09	0.64%	4.9	0.10	1.10%	5.1	0.10	1.15%
Hydroxide [4]	0.02	0.0	0.00	0.01%	0.1	0.00	0.03%	0.2	0.00	0.03%
Nitrate	0.0714	0.061	0.00	0.03%	0.103	0.01	0.08%	0.022	0.00	0.02%
Chloride	0.0282	16.6	0.47	3.40%	130	3.67	41.07%	128	3.61	40.53%
Sulphate	0.0208	16.5	0.34	2.49%	77.5	1.61	18.06%	76.7	1.60	17.91%
SUM		**681**	**13.78**	**100.0%**	**390**	**8.9**	**100.0%**	**390**	**8.9**	**100.0%**
Silica (as SiO_2)		15			6			6		
TDS (mg/L) [2]		677			509			497		
TDS (mg/L) (Lab) [3]		660			503			491		
Ion Balance		5.31%			3.90%			1.27%		
Ion Balance (Lab) [3]		-			-			-		

LOCATION	WATER TYPE
C2	magnesium-bicarbonate
D9	sodium-magnesium-chloride-bicarbonate
D9 Dup	sodium-magnesium-chloride-bicarbonate

Notes:

"-" = No Data

1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
3. Laboratory results may slightly differ due to rounding of numbers.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

TABLE D6-12
STABLE ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

#	Sample	Date	Lab#	δ18O	Result	Repeat	δ^2H	Result	Repeat	pH	Conductivity
				H_2O	VSMOW		H_2O	VSMOW			µS/cm
GROUNDWATER											
1	TH-EC-01WW1	19-Oct-16	373022	X	-13.96	-13.81	X	-103.88	-103.42	6.64	610
2	TH-EC-01WW2	18-Oct-16	373021	X	-14.59	-	X	-109.82	-	7.35	352
3	TH-EC-03W	28-Oct-16	373024	X	-14.74	-14.72	X	-114.47	-114.81	-	614
SURFACE WATER											
1	D-9 LSM	08-Nov-16	374372	X	-8.46	-8.49	X	-72.86	-73.00	8.41	691
2	D-9 LSM-DUP	08-Nov-16	374373	X	-8.51	-	X	-72.83	-	8.41	691

TABLE D6-13
GUDI SCREENING MATRIX - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Condition	Route C
Wells Regularly Contain Total Coliforms and/or/periodically contain E. coli	High Potential for bacterial contamination in including E. coli
Located within 50 days horizontal saturated travel time from surface water or	Not calculated
Located within 100 m of surface water (overburden wells), or	Few overburden wells indicated in regional study
Located within 500 m of surface water (bedrock wells) and meet one of more of the following criteria:	Approximately 21 bedrock wells within 500 m of channel ROW including domestic wells, bottling plant and arena. Community water supply for subdivision and individual community wells located further north in potential downgradient direction of groundwater flow from beneath channel.
● Wells may be drawing water from an unconfined aquifer	Bedrock aquifer will become unconfined beneath channel and in local surrounding area after channel is excavated.
● Wells may be drawing water from formations within approximately 15 m of surface	Bedrock formation is within 1 m of surface in central portion of channel with other areas between 1 and 8 m below ground surface. Bedrock is fractured carbonate.
● Wells are part of an enhanced recharge/infiltration project	Not applicable
● When the well is pumped, water levels in surface water rapidly change or hydraulic gradients beside the surface water significantly increase in a downward direction	High potential for domestic or community well pumping to induce downward and outward gradients in the fractured bedrock from the channel toward the pumping well. Higher risk for higher capacity community or other wells closer to channel.
● Chemical water quality parameters such as temperature, conductivity, turbidity, total dissolved solids, pH, colour, oxygen) are more consistent with nearby surface water than local groundwater and/or if they fluctuate significantly and rapidly in response to climatological or surface water conditions	High potential for wells to become turbid and to show changes in chemistry consistent with surface water due to high potential for pathways between bedrock groundwater and surface water.

Reference: Ontario MOEE Terms of Reference 2001

Terms of Reference: Hydrogeological Study to Examine Groundwater Sources Potentially Under Direct Influence of Surface Water

TABLE D6-14
SUMMARY ASSESSMENT OF THE CHANNEL PROJECT ON GROUNDWATER WELLS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Condition	Route C
Estimated Drawdown at Channel	1 to 11 m
Estimated Drawdown with Distance	A drawdown of 1.5 to 3.3 m is predicted at the 3 km distance from the channel, decreasing to 0.9 to 2.7 m at 5 m distance.
Bedrock Groundwater Piezometric surface depth below ground surface	In almost all areas with water supply wells the piezometric surface is below ground surface from 1 to 5 m, which does not provide an advantage to mitigating drawdown effects.
Depth to well casing below channel invert	A large portion of the populated areas have wells with shallow casings, above the bottom of the channel invert.
Transmissivity/Specific Capacity	Approximately 90% of the 81 wells with calculated transmissivities had either very low < 1000 USgpd/ft or low 1000 to 5000 USgpd/ft transmissivities.

TABLE D6-15
TESTHOLE DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-GD-02		5683632.07	531290.40		till	VW #1602935		248.625	6.91	241.715	-	-	09-Nov-16	-	-	-	2887.4	249.17	yes	
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	09-Nov-16	-	>-0.85	>250.33	-	-	yes	Flowing at TOC; no extension available >1.7m ags
TH-GD-05		5693350.95	530617.18		till	VW #1602924		248.66	6.71	241.95	-	-	09-Nov-16	-	-	-	2772.2	249.83	yes	
					till	STP	20	248.66	16.92	231.74	0.80	249.461	09-Nov-16	-	>-0.8	>250.261	-	-	yes	Flowing at TOC; no extension available
TH-GD-06		5697400.98	531025.08		till	VW #1602923		251.918	10.67	241.248	-	-	10-Nov-16	-	-	-	2738.5	251.56	no	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	10-Nov-16	-	0.02	252.791	-	-	yes	
TH-GD-07		5699453.66	531900.65		till	VW #1602937		252.045	12.19	239.855	-	-	09-Nov-16	-	-	-	2726.0	253.08	yes	
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	09-Nov-16	-	>-0.79	>253.626	-	-	yes	Flowing at TOC; no extension available >1.6m ags
TH-GD-08		5701521.62	532917.21		till	VW #1602938		246.807	7.32	239.487	-	-	09-Nov-16	-	-	-	2721.1	250.41	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	09-Nov-16	-	-	-	2590.2	227.26	no	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	09-Nov-16	-	>-7.92	>254.75	-	-	yes	Flowing at TOC; only able to extend by 7.92 m safely >7.9m ags
TH-ED-01P		5692376.38	530502.82	11+625	till	VW #1602932		249.431	6.10	243.331	-	-	09-Nov-16	-	-	-	2830.4	249.47	yes	
					till	VW #1602939		249.431	10.67	238.761	-	-	09-Nov-16	-	-	-	2771.9	250.36	yes	
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	09-Nov-16	2.1	-1.48	>251.826	-	-	yes	Flowing at TOC; no extension available >2.4m ags
TH-ED-01W		5692378.37	530495.27	11+625	bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	09-Nov-16	-	-4.57	255.1	-	-	yes	Artesian at 5.6m ags
TH-ED-01PP1		5692378.65	530536.08		till	STP	25	248.717	1.22	247.497	0.97	249.688	09-Nov-16	-	1.130	248.558	-	-	no	
TH-ED-01PP2		5692380.13	530549.75		till	STP	25	248.456	1.22	247.236	1.06	249.519	09-Nov-16	-	1.03	248.493	-	-	yes	
TH-ED-03		5693404.42	529670.69		till	VW #1602931		252.218	6.10	246.118	-	-	09-Nov-16	-	-	-	2854.2	251.54	no	
					till	STP	25	252.218	13.41	238.808	0.86	253.076	09-Nov-16	-	0.580	252.496	-	-	yes	
BH-D109		5682844.41	530474.731		till	STP	20	249.716	12.85	236.866	0.96	250.676	21-Jul-12	-	-	250.68	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	29-Aug-12	-	-	250.68	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	09-Nov-16	-	1.11	249.571	-	-	no	
15-RD-01				2+672	Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	16-Jul-15	1	-0.70	250.00	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	04-Aug-15	1	-0.70	250.00	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	09-Nov-15	1	-0.70	250.00	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	09-Nov-16	1.1	-0.77	250.07	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	16-Jul-15	3.5	-2.46	251.73	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	04-Aug-15	2.9	-2.04	251.31	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	09-Nov-15	3	-2.11	251.38	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	09-Nov-16	3.8	-2.67	251.94	-	-	yes	
BH-D101		5684505.014	530628.736		till	STP	25	249.251	8.94	240.311	1.12	250.371	21-Jul-12	-	-	248.09	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	29-Aug-12	-	-	247.69	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	09-Nov-16	-	1.33	249.04	-	-	no	
BH-D106		5682844.413	530474.731		till	STP	50	249.917	11.23	238.687	0.89	250.807	21-Jul-12	-	-	248.06	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.917	11.23	238.687	0.89	250.807	29-Aug-12	-	-	247.58	-	-	no	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	09-Nov-16	-	0.86	249.951	-	-	yes	

TABLE D6-15
TESTHOLE DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
BH-D107		5691570.348	530533.122		till	STP	50	249.81	8.69	241.12	0.86	250.67	21-Jul-12	-	-	248.97	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	29-Aug-12	-	-	248.65	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	09-Nov-16	-	-	-	-	-	-	No permission for access
15-RD-02				12+776	Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	16-Jul-15	7.1	-5.00	254.45	-	-	yes	
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	04-Aug-15	7.1	-5.00	254.45	-	-	yes	
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	09-Nov-15	7.7	-5.42	254.87	-	-	yes	
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	09-Nov-16	7.4	-5.21	254.66	-	-	yes	
15-RD-02A				12+776	Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	16-Jul-15	-	0.91	248.39	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	04-Aug-15	-	0.98	248.33	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	09-Nov-15	-	0.65	248.65	-	-	yes	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	09-Nov-16	-	>-0.67	>249.97	-	-	yes	Flowing at TOC; no extension available
BH-D9		5693949.149	530788.559		till	STP	25	249.495	12.376	237.119	0.90	250.395	21-Jul-12	-	-	248.96	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	29-Aug-12	-	-	248.77	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	09-Nov-16	-	1.23	249.161	-	-	no	
15-RD-03				17+032	Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	16-Jul-15	-	1.75	250.99	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	04-Aug-15	-	1.68	251.06	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	09-Nov-15	-	1.30	251.44	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	09-Nov-16	-	1.238	251.502	-	-	no	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	16-Jul-15	-	0.36	252.39	-	-	yes	Water level 0.9 m below grade upon completion of drilling
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	04-Aug-15	-	0.32	252.42	-	-	yes	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	09-Nov-15	-	0.00	252.74	-	-	yes	Water level at Top Of Casing (TOC)
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	09-Nov-16	-	>-0.9	>253.64	-	-	yes	Flowing at TOC; no extension available
15-RD-03A				17+032	Sand	VW #1403291		251.86	10.4	241.46	-	-	16-Jul-15	-	-	250.52	-	-	no	Water level at bottom upon completion of drilling
					Sand	VW #1403291		251.86	10.4	241.46	-	-	04-Aug-15	-	-	251.18	-	-	no	Water level at bottom upon completion of drilling
					Sand	VW #1403291		251.86	10.4	241.46	-	-	09-Nov-15	-	-	251.94	-	-	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	09-Nov-16	-	-	-	2816.1	251.93	yes	
15-RD-04				19+256	Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	16-Jul-15	-	1.03	251.73	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	04-Aug-15	-	2.51	250.255	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	09-Nov-15	-	0.75	252.01	-	-	yes	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	09-Nov-16	-	0.54	252.216	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	16-Jul-15	1.6	-1.13	253.89	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	04-Aug-15	1.1	-0.77	253.53	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	09-Nov-15	2.5	-1.76	254.52	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	09-Nov-16	-	>-1	>253.76	-	-	yes	Flowing at TOC; no extension available

TABLE D6-15
TESTHOLE DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
15-RD-10A				17+800	Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	16-Jul-15	-	-	-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	04-Aug-15	-		-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	09-Nov-15	-	-	-	-	-	-	Was not read
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	09-Nov-16	-	-	-	2727.5	249.60	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	16-Jul-15	-	-	-	-	-	-	Water level at bottom of hole upon completion of drilling
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	04-Aug-15	-	-	-	-	-	-	No Access
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	09-Nov-15	-	0.1	249.77	-	-	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	09-Nov-16	-	>-1	>250.87	-	-	yes	Flowing at TOC; no extension available
15-RD-05				21+464	Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	16-Jul-15	-	1.90	246.14			no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	04-Aug-15	-	1.89	246.15			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	09-Nov-15	-	1.37	246.67			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	09-Nov-16	-	-	-	-	-	-	Blocked at 0.61 m.
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	16-Jul-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	04-Aug-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	09-Nov-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	09-Nov-16	-	0.23	247.791			yes	

VW = Vibrating Wire
STP = Standpipe

Notes:
1. BH-BC series drilled and surveyed in 2011.
2. 15-RC series drilled in 2015. Ground elevations were estimated using LiDAR.
3. TH-GC and TH-EC series drilled and surveyed in 2016.
4. Transducers installed December 8, 2016:
   TH-ED-01W
   15-RD-PW1

TABLE D6-16
SUMMARY OF PUMP TEST RESULTS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Date	Observation Well	Distance From Pump Well (m)	Maximum Drawdown at End of Test (m)	Elevation	UTM Northing	UTM Easting
TH-ED-01W Pump Test - 9 hr Duration 12 US gpm						
Oct. 26, 2016	TH-ED-01W	0.0	22.32	249.492	5692378.3	530495.3
	TH-ED-01P	7.8	10.83	249.431	5692376.3	530502.8
	TH-ED-01PP1	40.8	0.06	248.717	5692378.6	530536.1
	TH-ED-01PP2	54.5	0.06	248.456	5692380.2	530549.8
	BHD108	367.5	0.03	249.980	5692583.0	530190.0
	TH-GD-05	980.3	0.02	248.660	5693351.0	530617.2
	15-RD-02	1037.6	0.00	248.638	5693415.7	530517.3
	TH-ED-03	1316.4	0.02	252.218	5693404.5	529670.7

TABLE D6-17

SUMMARY OF RISING HEAD AND LUGEON TEST RESULTS - ROUTE D

LAKE MANITOBA OUTLET CHANNELS

Well ID	Ground Elevation (m)	Monitoring Zone		Geology	K Result (m/s)
		Top of Casing Elevation (m)	Bottom of Casing Elevation (m)		
Route D					
TH-ED-03	252.218	253.096	238.808	Silty Clay Till	1.42E-09
TH-GD-05	248.660	249.521	231.740	Silty Clay Till	1.85E-05
TH-GD-06	251.918	252.871	236.628	Silty Clay Till	2.87E-10
TH-ED-01P	249.431	250.358	222.001	Dolomite	5.23E-05
TH-GD-07	252.045	252.881	232.695	Dolomite	1.67E-05
Lugeon (packer) Test Results	**Ground Elevation (m)**	**Top of Test Internal Elevation (m)**		**Geology**	**Result (Lu)**
TH-GD-07	252.050	234.370	232.850	Dolomitic Limestone	4.2

TABLE D6-18
GROUNDWATER FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (^{o}C)	ORP (mV)	DO (mg/L)	Turbidity	Odour	Colour	Comments
TH-ED-01W	26-Oct-16	6.5	793	6.4	174.9	NA	none to very low	none	none	start of pump test
TH-ED-01W	26-Oct-16	-	901	6.3	399.7	NA	none to very low	none	none	end of pump test - not sure if YSI was working properly
TH-ED-01P	09-Nov-16	-	868	9.1	-185.1	1.21	none to very low	none	none	pH not calibrating
TH-ED-03	09-Nov-16	-	616	9.7	-172.9	80.00	none to very low	none	none	pH not calibrating
TH-GD-02	09-Nov-16	-	796	5.7	-24.6	1.54	none to very low	none	none	pH not calibrating
TH-GD-07	09-Nov-16	-	782	7.4	-296.5	1.15	none to very low	none	none	pH not calibrating

Notes:
"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D6-19
GROUNDWATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Field / Lab Dup. Info	Parameter [1]																					
			Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [5]	Fluoride	Sulphate	Ammonia (as N)	Un-ionized Ammonia	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Iron	Manganese	Free Cyanide	Total Phosphorus	T.D.S.	T.K.N.	E. Coli	Total Coliform (MPN/100mL)
EQL			*0.2*	*0.01*	*1*	*1*	*1*	*1*	*1*	*1*	*0.5*	*0.02*	*0.5*	*0.01*	*0.03*	*0.0051*	*0.005*	*0.001*	*0.03*	*0.005*	*0.001*	*0.05*	*2*	*0.03*	*1*	*1*
TH-ED-01W TEST START	26-Oct-16		17.6	7.7	741	321	392	<0.60	<0.34	374	6.09	0.757	149	0.247	-	<0.010	<0.010	<0.0100	-	-	-	0.025	513	0.26	<1	24
TH-ED-01W TEST STOP	26-Oct-16		-	7.7	744	339	413	<0.60	<0.34	375	6	-	148	0.246	-	<0.070	<0.040	<0.020	-	-	-	0.0129	521	0.28	<1	2
TH-GD-08	29-Oct-16		-	7.79	732	324	395	<0.60	<0.34	384	6.26	-	115	0.17	-	<0.010	<0.010	<0.0020	-	-	-	0.081	-	0.26	-	-
TH-ED-01P	9-Nov-16		1.41	7.72	776	301	368	<0.60	<0.34	398	6.18	0.821	149	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	508	-	-	-
TH-ED-03	9-Nov-16		694	8.11	616	377	460	<0.60	<0.34	319	14.6	0.466	21.6	-	-	0.23	0.211	0.0191	-	-	-	-	390	-	-	-
TH-GD-02	9-Nov-16		0.67	7.83	760	266	324	<0.60	<0.34	369	13.6	0.483	159	-	-	0.0063	0.0063	<0.0010	-	-	-	-	498	-	-	-
TH-GD-02	9-Nov-16	Dup	1.44	7.85	757	267	326	<0.60	<0.34	382	14	0.573	165	-	-	0.007	0.007	<0.0010	-	-	-	-	508	-	-	-
		RPD	-	*0.3%*	*0.4%*	*0.4%*	*0.6%*	-	-	*3.5%*	*2.9%*	*17.0%*	*3.7%*	-	-	-	-	-	-	-	-	-	*2.0%*	-	-	-
TH-GD-07	9-Nov-16		2.96	7.7	751	320	391	<0.60	<0.34	391	5.62	0.765	120	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	482	-	-	-
15-RD-PW1	9-Nov-16		8.91	7.78	745	320	390	<0.60	<0.34	388	5.65	0.697	121	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	483	-	-	-
HC-CDWQ [2]																										
Drinking Water			0.3/1.0/0.1 (MAC)[8]	6.5 - 8.5 (AO)	-	-	-	-	-	[9]	≤250 (AO)	1.5 (MAC)	500 (AO)	-	-	-	10 [4] (MAC)	1.0 [4] (MAC)	0.3 (AO)	0.05 (AO)	0.2 (MAC)	-	500 (AO)	-	None Detectable per 100 mL (MAC)	None Detectable per 100 mL (MAC)
CCME[3] (Shown for Reference Only)																										
Freshwater Aquatic Life			Narrative [7]	6.5 - 9.0	-	-	-	-	-	-	120[5a]/640 [5b]	0.12	-	-	0.019 [6]	-	3[12]/ 124[11]	0.06	0.3	-	0.005	[10]	-	-	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.K.N. = Total Kjeldahl Nitrogen
T.D.S. = Total Dissolved Solids
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objectives
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
Canadian Water Quality Guidelines for the Protection of Aquatic Life
4. Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L, which is equivalent to 1 mg/L nitrite-nitrogen.
5. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation
b. Short-term exposure - derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function.
but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information
c. Guideline is dependant on type of plant. See CCME summary table for details.
Foliar damage
= 100-178 mg/L for almond apricots and plums
= 178-355 mg/L for grapes, peppers, potatoes and tomatoes
= 355-710 mg/L for alfalfa, barley, corn, and cucumbers
>710 mg/L for cauliflower, cotton, safflower, sesame, sorghum, sugar beets, and sunflowers
Rootstocks
= 180-600 mg/L for stone fruit (peaches, plums, etc.)
= 710-900 mg/L for grapes
Cultivars
= 110-180 mg/L for strawberries
= 230-460 mg/L for grapes
= 250 mg/L for boysenberries, blackberries, and raspberries
6. Guideline for total ammonia is pH and Temperature dependent. See Factsheet for details.
7. Turbidity Guidelines (see fact sheet for complete details):
Clear Flow:
Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
High Flow or Turbid Waters:
Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
Should not increase more than 10% of background levels when background is >80 NTUs.
8. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process.
Turbidity values greater than 1 NTU are shaded.
9. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as $CaCO_3$) , provide acceptable balance between corrosion and incrustation; where a water softener is used, a separate unsoftened supply for cooking and drinking purposes is recommended.
10. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):				
ultra-oligotrophic	<4	meso-eutrophic	20-35
oligotrophic	4-10	eutrophic	35-100
mesotrophic	10-20	hyper-eutrophic	>100

11. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
These are NOT protective guidelines.
12. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).

- Exceedance of HC-CDWQ Guidelines

TABLE D6-19
GROUNDWATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

TABLE D6-20
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Date	Parameter [1]																		
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
TH-ED-01W TEST START	26-Oct-16	<0.0020	<0.00020	0.00063	0.015	<0.00020	<0.00020	0.529	<0.000010	77.4	<0.00010	<0.0010	0.00025	0.00024	0.125	0.000108	0.0281	44	0.0144	0.00037
TH-ED-01W TEST STOP	26-Oct-16	-	-	-	-	-	-	-	-	78.1	-	-	-	-	-	-	-	43.6	-	-
TH-GD-08	29-Oct-16	-	-	-	-	-	-	-	-	74.3	-	-	-	-	-	-	-	48.3	-	-
TH-ED-01P	9-Nov-16	<0.0020	<0.00020	0.00071	0.0156	<0.00020	<0.00020	0.645	<0.000010	79.5	<0.00010	<0.0010	0.00026	<0.00020	0.154	<0.000090	0.0326	48.5	0.0153	0.00029
TH-ED-03	9-Nov-16	0.0035	0.00021	0.00034	0.0275	<0.00020	<0.00020	0.184	<0.000010	38.8	<0.00010	<0.0010	0.00048	0.00146	0.01	<0.000090	0.0193	53.8	0.0321	0.0148
TH-GD-02	9-Nov-16	<0.0020	<0.00020	<0.00020	0.0212	<0.00020	<0.00020	0.709	<0.000010	67.5	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.0377	48.8	0.0121	0.00041
TH-GD-02 Dup	9-Nov-16	<0.0020	<0.00020	<0.00020	0.0203	<0.00020	<0.00020	0.65	<0.000010	66.5	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	0.0364	52.3	0.0123	0.00042
RPD		-	-	-	*4.34%*	-	-	*8.68%*	-	*1.49%*	-	-	-	-	-	-	*3.51%*	*6.92%*	*1.64%*	*2.41%*
TH-GD-07	9-Nov-16	<0.0020	<0.00020	<0.00020	0.0211	<0.00020	<0.00020	0.579	<0.000010	74.4	<0.00010	<0.0010	<0.00020	0.00023	<0.010	<0.000090	0.0323	49.8	0.00827	0.00022
15-RD-PW1	9-Nov-16	<0.0020	<0.00020	0.00089	0.0201	<0.00020	<0.00020	0.594	<0.000010	72.4	<0.00010	<0.0010	<0.00020	<0.00020	0.028	<0.000090	0.0326	50.3	0.0056	0.00018
EQL		*0.002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.05*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0001*	*0.001*
HC-CDWQ [2]																				
Drinking Water		0.1- 0.2 [4] (OG)	0.006 (MAC)	0.010 (MAC)	1.0 (MAC)	-	-	5.0 (MAC)	0.005 (MAC)	-	-	0.05 (MAC)	-	1.0 (AO)	0.3 (AO)	0.010 (MAC)	-	-	0.05 (AO)	-
CCME[3] (Shown for Reference Only)																				
Freshwater Aquatic Life		0.005 - 0.1 [5]	-	0.005	-	-	-	(29 [6]) 1.5 [7]	0.09 µg/L [9a] 1.0 µg/L [9b]	-	-	0.0089 (III), 0.001 (VI)	-	[9c]	0.3	[9d]	-	-	-	0.073

Well No.	Date	Parameter [1]																		
		Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
TH-ED-01W TEST START	26-Oct-16	<0.0010	<0.030	9.2	0.00629	<0.0010	5.31	<0.00010	34.9	0.574	<0.00020	<0.00010	<0.00010	0.00135	<0.00050	0.00015	0.0012	<0.00020	<0.0020	<0.00040
TH-ED-01W TEST STOP	26-Oct-16	-	-	9.18	-	-	-	-	32.9	-	-	-	-	-	-	-	-	-	-'	-
TH-GD-08	29-Oct-16	-	-	10	-	-	-	-	35.4	-	-	-	-	-	-	-	-	-	-	-
TH-ED-01P	9-Nov-16	<0.0010	<0.030	10	0.00606	<0.0010	5.54	<0.00010	33.8	0.546	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00114	<0.00020	<0.0020	<0.00040
TH-ED-03	9-Nov-16	0.0019	<0.030	3.11	0.00164	<0.0010	4.56	<0.00010	30.9	0.131	<0.00020	<0.00010	<0.00010	0.00029	<0.00050	0.00133	0.00376	0.00048	<0.0020	<0.00040
TH-GD-02	9-Nov-16	<0.0010	<0.030	10.3	0.007	<0.0010	4.45	<0.00010	38.6	0.53	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00173	<0.00020	<0.0020	<0.00040
TH-GD-02 Dup	9-Nov-16	<0.0010	<0.030	10.5	0.00727	<0.0010	4.65	<0.00010	39.9	0.521	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00164	<0.00020	<0.0020	<0.00040
RPD		-	-	*1.92%*	*3.78%*	-	*4.40%*	-	*3.31%*	*1.71%*	-	-	-	-	-	-	*5.34%*	-	-	-
TH-GD-07	9-Nov-16	<0.0010	<0.030	10.7	0.0062	<0.0010	5.04	<0.00010	30.4	0.532	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00064	<0.00020	0.0049	<0.00040
15-RD-PW1	9-Nov-16	<0.0010	<0.030	10.1	0.00586	<0.0010	5.55	<0.00010	31.1	0.54	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00094	<0.00020	<0.0020	<0.00040
EQL		*0.03*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.02*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
HC-CDWQ [2]																				
Drinking Water		-	-	-	-	0.05 (MAC)	-	-	200 (AO)	-	-	-		-	-	-	0.02 (MAC)	-	5 (AO)	-
CCME[3] (Shown for Reference Only)																				
Freshwater Aquatic Life		[8e]	[9]	-	-	0.001	-	0.00025	-	-	-	0.0008		-	-	-	(0.033[6]) 0.015 [7]	-	0.03	-

TABLE D6-20
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Notes:
EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence
"-" = No Data
RPD = Relative Percent Difference

1. All values are expressed in milligrams per litre (mg/L) unless otherwise specified.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014.
   MAC = Maximum Acceptable Concentration
   AO = Aesthetic Objectives
   OG = Operational Guideline
3. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Guidelines for Canadian Drinking Water Quality.
   Community Water Supplies (Health Canada - Canadian Drinking Water Quality Guidelines)
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
   Canadian Water Quality Guidelines for the Protection of Agriculture Water Uses
4. This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants.
The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
5. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5.
   The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater or equal to 6.5.
6. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
   These are NOT protective guidelines.
7. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <17 mg/L, CWQG is 0.04 µg/L. At other hardness values, the CWQG can be calculated with the equation CWQG = 10^{0.83[log(hardness)] - 3.2} µg/L
   valid for hardness between 17 and 280 mg $CaCO_3$/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is >0 to <5.3 mg/L,
   CWQG is 0.11 µg/L. At other hardness values, the benmark can be calculated with the equation Benchmark - 10^{1.016(log[hardness])-1.71},
   valid for hardness between 5.3 and 360 mg CaCO3/L.
   c. **Copper** Guideline = e^(0.8545[ln(hardness)]-1.465) * 0.2 µg/L;
   d. **Lead** Guideline = e^(1.273[ln(hardness)]-4.705) µg/L;
   e. **Nickel** Guideline = e^(0.76[ln(hardness)]+1.06) µg/L

Well No.	Hardness	10a. Cadmium (long-term) mg/L	10b. Cadmium (short-term) (mg/L)	10c. Copper (mg/L)	10d. Lead (mg/L)	10e. Nickel (mg/L)
TH-ED-01W TEST START	374	0.000086	0.008017	0.007	0.017	0.260
TH-ED-01W TEST STOP	375	0.000086	0.008039	0.007	0.017	0.261
TH-GD-08	384	0.000088	0.008235	0.007	0.018	0.266
TH-ED-01P	398	0.000091	0.008540	0.008	0.018	0.273
TH-ED-03	319	0.000076	0.006821	0.006	0.014	0.231
TH-GD-02	369	0.000085	0.007909	0.007	0.017	0.258
TH-GD-02 Dup	382	0.000088	0.008192	0.007	0.018	0.265
TH-GD-07	391	0.000089	0.008388	0.008	0.018	0.269
15-RD-PW1	388	0.000089	0.008322	0.008	0.018	0.268

9. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded,
   but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

- Exceedance of HC-CDWQ Criteria

TABLE D6-21
GROUNDWATER ION BALANCE AND WATER TYPE - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic	TH-ED-01W test start 26-Oct-16			TH-ED-01W test end 26-Oct-16			TH-GD-08 29-Oct-16			TH-ED-01P 09-Nov-16			TH-ED-03 09-Nov-16			TH-GD-02 ########		
	Weight	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.7	2E-05	0.00%	7.7	2E-05	0.00%	7.79	1.62E-05	0.00%	7.72	1.90546E-05	0.00%	8.11	7.76E-06	0.00%	7.83	1.48E-05	0.00%
Calcium	0.0499	77.4	3.86	41.73%	78.1	3.90	42.50%	74.3	3.71	39.07%	79.5	3.97	40.96%	38.8	1.94	24.86%	67.5	3.37	36.11%
Magnesium	0.0823	44	3.62	39.13%	43.6	3.59	39.13%	48.3	3.98	41.88%	48.5	3.99	41.21%	53.8	4.43	56.86%	48.8	4.02	43.06%
Sodium	0.0435	34.9	1.52	16.40%	32.9	1.43	15.61%	35.4	1.54	16.23%	33.8	1.47	15.18%	30.9	1.34	17.26%	38.6	1.68	18.00%
Potassium	0.03	9.2	0.24	2.54%	9.18	0.24	2.56%	10	0.26	2.70%	10	0.26	2.64%	3.11	0.08	1.02%	10.3	0.26	2.83%
Ammonia-N	0.07	0.247	0.02	0.19%	0.246	0.02	0.19%	0.17	0.01	0.13%	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**165.7**	**9.25**	**100.0%**	**164**	**9.2**	**100.0%**	**168**	**9.5**	**100.0%**	**171.8**	**9.68**	**100.0%**	**126.6**	**7.79**	**100.0%**	**165**	**9.33**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	321	6.42	66.24%	339	6.78	67.59%	324	6.48	71.61%	301	6.02	64.77%	377	7.54	89.59%	266	5.32	59.04%
Bicarbonate [4]	0.02	319.5	6.39	65.93%	337.4	6.75	67.27%	322.1	6.44	71.19%	299.5	5.99	64.45%	372.4	7.45	88.50%	264.3	5.29	58.66%
Carbonate [4]	0.02	1.5	0.03	0.31%	1.6	0.03	0.32%	1.9	0.04	0.41%	1.5	0.03	0.32%	4.5	0.09	1.07%	1.7	0.03	0.37%
Hydroxide [4]	0.02	0.0	0.00	0.01%	0.0	0.00	0.00%	0.0	0.00	0.01%	0.0	0.00	0.01%	0.1	0.00	0.02%	0.0	0.00	0.01%
Nitrate	0.0714	0.01	0.00	0.01%	0.04	0.00	0.03%	0.01	0.00	0.01%	0.005	0.00	0.00%	0.211	0.02	0.18%	0.0063	0.00	0.00%
Chloride	0.0282	6.09	0.17	1.77%	6	0.17	1.69%	6.26	0.18	1.95%	6.18	0.17	2.07%	14.6	0.41	4.89%	13.6	0.38	4.26%
Sulphate	0.0208	149	3.10	31.98%	148	3.08	30.69%	115	2.39	26.43%	149	3.10	33.35%	21.6	0.45	5.34%	159	3.31	36.70%
SUM		**476**	**9.69**	**100.0%**	**493**	**10.0**	**100.0%**	**445**	**9.0**	**100.0%**	**456**	**9.29**	**100.2%**	**413**	**8.42**	**100.0%**	**439**	**9.01**	**100.0%**
Silica (as SiO_2)		5			-			-			6			5			4		
TDS (mg/L) [2]		518			522			484			513			395			502		
TDS (mg/L) (Lab) [3]		513			521			-			508			390			498		
Ion Balance		2.31%			4.49%			2.38%			2.06%			3.88%			1.72%		
Ion Balance (Lab) [3]		-			-			-			-			-			-		

Cations	Atomic	TH-GD-02 Dup 09-Nov-16			TH-GD-07 09-Nov-16			15-RD-PW1 09-Nov-16		
	Weight	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	7.85	1.41E-05	0.00%	7.7	2E-05	0.00%	7.78	1.66E-05	0.00%
Calcium	0.0499	66.5	3.32	34.47%	74.4	3.71	39.46%	72.4	3.61	38.58%
Magnesium	0.0823	52.3	4.30	44.71%	49.8	4.10	43.57%	50.3	4.14	44.21%
Sodium	0.0435	39.9	1.74	18.03%	30.4	1.32	14.06%	31.1	1.35	14.45%
Potassium	0.03	10.5	0.27	2.79%	10.7	0.27	2.91%	10.1	0.26	2.76%
Ammonia-N	0.07	-	0.00	0.00%	-	0.00	0.00%	-	0.00	0.00%
SUM		**169.2**	**9.63**	**100.0%**	**165.3**	**9.41**	**100.0%**	**163.9**	**9.36**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	267	5.34	58.25%	320	6.40	70.68%	320	6.40	70.51%
Bicarbonate [4]	0.02	265.2	5.30	57.86%	318.5	6.37	70.34%	318.2	6.36	70.11%
Carbonate [4]	0.02	1.8	0.04	0.39%	1.5	0.03	0.33%	1.8	0.04	0.40%
Hydroxide [4]	0.02	0.0	0.00	0.01%	0.0	0.00	0.01%	0.0	0.00	0.01%
Nitrate	0.0714	0.007	0.00	0.01%	0.005	0.00	0.00%	0.005	0.00	0.00%
Chloride	0.0282	14	0.39	4.31%	5.62	0.16	1.75%	5.65	0.16	1.76%
Sulphate	0.0208	165	3.43	37.44%	120	2.50	27.57%	121	2.52	27.73%
SUM		**446**	**9.17**	**100.0%**	**446**	**9.05**	**100.0%**	**447**	**9.08**	**100.0%**
Silica (as SiO_2)		5			5			6		
TDS (mg/L) [2]		513			488			488		
TDS (mg/L) (Lab) [3]		508			482			483		
Ion Balance		2.45%			1.91%			1.56%		
Ion Balance (Lab) [3]		-			-			-		

Location	Water Type
TH-ED-01W (test start	calcium-magnesium-bicarbonate
TH-ED-01W (test end	calcium-magnesium-bicarbonate
TH-GD-08	magnesium-calcium-bicarbonate
TH-ED-01P	magnesium-calcium-bicarbonate
TH-ED-03	magnesium-bicarbonate
TH-GD-02	magnesium-calcium-bicarbonate
TH-GD-02 DUP	magnesium-calcium-bicarbonate
TH-GD-07	magnesium-calcium-bicarbonate
15-RD-PW1	magnesium-calcium-bicarbonate

Notes:

"-" = No Data

1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
3. Laboratory results may slightly differ due to rounding of numbers.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

TABLE D6-22
SURFACE WATER FIELD CHEMISTRY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Date	Parameter								
		pH (units)	EC (µS/cm)	Temp. (^{o}C)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Odour	Colour	Comments
D1 - Lake MB	07-Nov-16	8.1	491.9	4.6	35.9	12.68	9.17	none	slightly cloudy	sampled adjacent to Watchorn Prov. Park
D2 - Watchorn Creek	07-Nov-16	7.8	485.4	4.5	31.8	8.31	0.79	none	none	sampled from side road off gravel road
D3 - Reed Lake	07-Nov-16	7.5	468.9	6.2	-24.4	7.77	1.32	none	none	sampled at 3.5' depth beyond logger
D4 - Clear Lake	07-Nov-16	7.8	532.2	6.6	34.2	10.96	4.01	none	none	sampled approximately 5 m beyond reeds in open water
D5 - Clark's Drain	07-Nov-16	8.2	481.5	4.1	-32.8	10.63	0.96	none	none	sampled on E side of road
D6 - Birch Creek	07-Nov-16	8.1	583.9	5.4	-48.3	7.64	0.89	none	none	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek
D7 - Woodale Drain	07-Nov-16	8.2	476.7	5.6	-51.0	8.68	1.08	none	none	sampled on N side of #167N, 75 m from Hwy 6
D8 - Birch Creek	07-Nov-16	8.3	566.8	5.5	-54.4	9.83	1.89	none	none	sampled upstream of bridge
D9 - LSM	07-Nov-16	8.4	691.4	6.6	-26.1	10.58	5.15	none	none	sampled at prov. hydrometric station

Notes:
"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D6-23
SURFACE WATER GENERAL WATER QUALITY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample No.	Location	Date	Field / Lab Dup. Info	Parameter (mg/L unless otherwise specified)																				
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Hardness as $CaCO_3$	Chloride [3]	Fluoride	Sulphate	Nitrate & Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Total Nitrogen	TKN	Phos-phorous, Total Dissolved	Total Phosphorous	Ammonia, total as N	Calculated Unionized Ammonia	T.D.S.	T.S.S.	E. Coli	Total Coliform (MPN/100mL)
EQL				*0.1*	*0.1*	*1*	*1*	*1.2*	*0.6*	*0.34*	*0.25*	*0.1*	*0.02*	*0.3*	*0.0051*	*0.005*	*0.001*	*0.2*	*0.2*	*0.001*	*0.001*	*0.01*	-	*5*	*2*	*1*	*1*
D-1	Lake Manitoba	8-Nov-16		5.91	8.35	604	260	310	3.72	<0.34	322	33.1	0.153	46.2	<0.0051	<0.0050	<0.0010	1.06	1.06	0.0111	**0.032**	0.042	0.0011036	373	8.8	<100	1350
D-2	Watchorn Creek	8-Nov-16		0.63	7.94	582	229	279	<0.60	<0.34	321	10.1	0.138	95.6	0.0174	0.0162	0.0011	1.7	1.69	0.072	**0.082**	0.021	0.0002164	366	<2.0	<100	860
D-3	Reed Lake	7-Nov-16		1.15	7.88	564	240	293	<0.60	<0.34	335	4.78	0.113	85.6	0.0067	0.0051	0.0016	1.88	1.87	0.02	**0.031**	0.15	0.0015453	352	2.2	<100	300
D-4	Clear Lake	7-Nov-16		3.39	8.15	633	280	341	<0.60	<0.34	394	7.76	0.185	97	<0.0051	<0.0050	<0.0010	1.41	1.41	0.025	**0.04**	0.018	0.0003532	410	6	<100	<100
D-5	North Clarks Drain	8-Nov-16		0.77	8.27	574	322	393	<0.60	<0.34	362	1.68	0.234	32.9	<0.0051	<0.0050	<0.0010	1.06	1.06	0.0062	0.0109	0.012	0.0002531	346	<2.0	<100	750
D-6	South Birch Creek	8-Nov-16		0.76	8.05	683	295	359	<0.60	<0.34	424	8.45	0.235	112	0.0173	0.0173	<0.0010	1.75	1.74	0.017	0.0181	0.019	0.0002703	445	<2.0	<100	100
D-7	Woodale Drain	8-Nov-16		0.9	8.07	564	280	341	<0.60	<0.34	353	3.05	0.088	60.6	<0.0051	0.0051	<0.0010	1.41	1.41	0.0196	0.02	0.063	0.000953	353	<2.0	<100	410
D-8	Birch Creek	8-Nov-16		1.31	8.18	667	308	376	<0.60	<0.34	430	7.07	0.231	96.1	0.0185	0.0185	<0.0010	1.55	1.53	0.0173	**0.029**	0.018	0.0003465	436	<2.0	<100	310
D-9	Lake St. Martin	8-Nov-16		3.53	8.47	813	182	211	5.4	<0.34	261	130	0.239	77.5	0.117	0.103	0.0139	1.36	1.24	0.0116	0.021	0.014	0.000562	503	7	<100	<100
D-9	Lake St. Martin	8-Nov-16	Dup	3.72	8.48	814	185	214	5.76	<0.34	248	128	0.238	76.7	0.027	0.022	0.0051	1.3	1.27	0.0141	0.02	0.016	0.0006566	491	6.6	100	100
			RPD	*5.2%*	*0.1%*	*0.1%*	*1.6%*	*1.4%*	*6.5%*	-	*5.1%*	*1.6%*	-	*1.0%*	-	-	-	*4.5%*	*2.4%*	-	*4.9%*	*13.3%*	*15.5%*	*2.4%*	-	-	-
FB		8-Nov-16	Field Blank	<0.10	5.98	<1.0	<1.0	<1.2	<0.60	<0.34	0.25	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	0.0011	0.0045	<0.010	-	<5.0	<2.0	<100	<100
MWQSOG [1]																										
Surface Water - Tier III																										
Freshwater Aquatic Life				[2]	6.5 - 9.0	-	-	-	-	-	-	-	-	-	-	13	0.06	-	-	-	0.025 (lakes and streams entering lakes)/ 0.05 (other streams) [3]	[4]		-	[5]	-	-
CCME[6]																										
Canadian Water Quality Guidelines for the Protection of Aquatic Life																										
Freshwater				Narrative [7]	6.5 - 9.0	-	-	-	-	-	-	120[8a]/640 [8b]	0.12	-	-	13[9]/ 330[10]	0.06	-	-	-	[11]	[12]	0.019	-	Narrative [13]	-	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
"-" = No Data
E.C. = Electrical Conductivity
T.D.S. = Total Dissolved Solids
T.S.S. = Total Suspended Solids
TKN = Total Kjeldahl Nitrogen
RPD = Relative Percent Difference

1. MWQSOG - Manitoba Water Quality Standards , Objectives, and Guidelines - Manitoba Water Stewardship Report 2011-01, November 28, 2011.
2. MWQSOG Tier II Objective - Equivalent induced levels of change as calculated from site-specific or regional correlation between total suspended sediment and turbidity.
3. MWQSOG Tier II Objective - Unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L.
4. MWQSOG Tier II Objective - Cool Water, All Periods (Eq. 3). Manitoba Water Stewardship, November 2011.
5. Total Suspended Sediment Guidelines:
   5 mg/L Induced Change over 30 days from background TSS <= 25 mg/L
   25 mg/L Induced Change over 1 day from background TSS <= 250 mg/L
   10% Induced Change over 1 day from background TSS > 250 mg/L
6. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
7. Turbidity Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g. 30 day period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.
8. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation.
   b. Short-term exposure - Derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
9. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7d exposures for fish and invertebrates, 24h exposures for aquatic plants and algae).
10. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
    (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances).
    These are NOT protective guidelines.
11. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.
Trigger ranges (µg/L):

ultra-oligotrophic	<4	meso-eutrophic	20 - 35
oligotrophic	4 - 10	eutrophic	35 - 100
mesotrophic	10 - 20	hyper-eutrophic	>100

12. Guideline for total ammonia is pH and temperature dependent. See factsheet for details.
13. Total Suspended Solids:
    Clear flow - Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).
    High flow - Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is ≥ 250 mg/L.

- Exceedance of CCME Guidelines
BOLD - Exceedance of MWQSOG Guidelines

TABLE D6-24
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Molybdenum
D-1	Lake Manitoba	8-Nov-16	**0.111**	<0.00020	0.00087	0.0328	<0.00020	<0.00020	0.058	<0.000010	49	<0.00010	<0.0010	<0.00020	0.00059	0.126	0.000097	0.0172	48.6	0.00595	0.00069
D-2	Watchorn Creek	8-Nov-16	0.0098	<0.00020	0.00053	0.0235	<0.00020	<0.00020	0.05	<0.000010	41.6	<0.00010	<0.0010	<0.00020	0.00029	0.024	<0.000090	0.0154	52.9	0.00797	0.0003
D-3	Reed Lake	7-Nov-16	0.0107	<0.00020	0.00057	0.0209	<0.00020	<0.00020	0.039	<0.000010	42.5	<0.00010	<0.0010	<0.00020	0.00038	0.021	<0.000090	0.0122	55.5	0.00874	0.00032
D-4	Clear Lake	7-Nov-16	0.0617	<0.00020	0.00077	0.0342	<0.00020	<0.00020	0.051	<0.000010	58.3	<0.00010	<0.0010	<0.00020	0.00085	0.069	<0.000090	0.0165	60.3	0.0108	0.00052
D-5	North Clarks Drain	8-Nov-16	0.0179	<0.00020	0.00056	0.0285	<0.00020	<0.00020	0.043	<0.000010	56.5	<0.00010	<0.0010	<0.00020	0.00043	0.036	<0.000090	0.0121	53.6	0.00746	0.00028
D-6	South Birch Creek	8-Nov-16	0.0132	<0.00020	0.00064	0.0328	<0.00020	<0.00020	0.07	<0.000010	61.2	<0.00010	<0.0010	<0.00020	0.00053	0.031	<0.000090	0.0198	65.8	0.00491	0.0006
D-7	Woodale Drain	8-Nov-16	0.025	<0.00020	0.00064	0.03	<0.00020	<0.00020	0.02	<0.000010	56.4	<0.00010	<0.0010	<0.00020	0.00043	0.059	<0.000090	0.0111	51.5	0.0108	0.00033
D-8	Birch Creek	8-Nov-16	0.0357	<0.00020	0.00064	0.0327	<0.00020	<0.00020	0.064	<0.000010	63.2	<0.00010	<0.0010	<0.00020	0.0006	0.059	<0.000090	0.0179	66.1	0.00712	0.00054
D9	Lake St. Martin	8-Nov-16	0.0421	<0.00020	0.00172	0.0398	<0.00020	<0.00020	0.086	<0.000010	43.3	<0.00010	<0.0010	<0.00020	0.00043	0.037	0.000118	0.0283	37.1	0.00489	0.00203
D9 Dup	Lake St. Martin	8-Nov-16	0.0357	<0.00020	0.00166	0.0396	<0.00020	<0.00020	0.083	<0.000010	40.4	<0.00010	<0.0010	<0.00020	0.00038	0.036	0.000113	0.0262	35.8	0.00476	0.00185
		RPD	*16.5%*	-	*3.6%*	*0.5%*	-	-	*3.6%*	-	*6.9%*	-	-	-	-	-	-	*7.7%*	*3.6%*	*2.7%*	*9.3%*
FB		8-Nov-16	<0.0050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.010	<0.000010	0.1	<0.00010	<0.0010	<0.00020	<0.00020	<0.010	<0.000090	<0.0020	<0.010	<0.00030	<0.00020
EQL			*0.005*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.0002*	*0.01*	*0.00001*	*0.1*	*0.0001*	*0.001*	*0.0002*	*0.0002*	*0.01*	*0.00009*	*0.002*	*0.01*	*0.0003*	*0.0002*
MWQSOG [1]																					
Surface Water - Tier III																					
Freshwater Aquatic Life			0.005 - 0.1 [3]	-	0.15 - 0.34 [4]	-	-	-	-	[7]	-	-	[7]	-	[7]	0.3	[7]	-	-	-	0.073
CCME[2]																					
Freshwater Aquatic Life			0.005 - 0.1 [3]	-	0.005	-	-	-	(29 [5]) 1.5 [6]	0.09 µg/L [8a] 1.0 µg/L [8b]	-	-	0.0089 (III), 0.001 (VI)	-	[8c]	0.3	[8d]	-	-	-	0.073

Well No.	Location	Date	Parameter (mg/L unless otherwise specified)																	
			Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
D-1	Lake Manitoba	8-Nov-16	<0.0020	<0.10	7.98	0.00403	<0.0010	8.01	<0.00010	32.5	0.15	<0.00020	<0.00010	<0.00010	<0.00020	0.00472	<0.00010	0.00188	0.00094	0.0021	<0.00040
D-2	Watchorn Creek	8-Nov-16	<0.0020	<0.10	15.6	0.00724	<0.0010	7.84	<0.00010	12.6	0.108	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	0.00104	<0.00020	<0.0020	<0.00040
D-3	Reed Lake	7-Nov-16	<0.0020	<0.10	9.16	0.00467	<0.0010	9.2	<0.00010	10.9	0.0965	<0.00020	<0.00010	<0.00010	<0.00020	0.00053	<0.00010	0.00143	<0.00020	<0.0020	<0.00040
D-4	Clear Lake	7-Nov-16	<0.0020	<0.10	8.33	0.00475	<0.0010	9.33	<0.00010	10.6	0.146	<0.00020	<0.00010	<0.00010	<0.00020	0.00231	<0.00010	0.0034	0.00076	<0.0020	<0.00040
D-5	North Clarks Drain	8-Nov-16	<0.0020	<0.10	2.57	0.00253	<0.0010	7.23	<0.00010	5.75	0.114	<0.00020	<0.00010	<0.00010	<0.00020	0.00084	<0.00010	0.00201	0.00048	<0.0020	<0.00040
D-6	South Birch Creek	8-Nov-16	<0.0020	<0.10	8.57	0.00425	<0.0010	9.89	<0.00010	12.3	0.17	<0.00020	<0.00010	<0.00010	<0.00020	0.00061	<0.00010	0.0038	0.00036	<0.0020	<0.00040
D-7	Woodale Drain	8-Nov-16	<0.0020	<0.10	6.78	0.00244	<0.0010	8.99	<0.00010	6.58	0.0966	<0.00020	<0.00010	<0.00010	<0.00020	0.00105	<0.00010	0.00352	0.00053	0.0029	<0.00040
D-8	Birch Creek	8-Nov-16	<0.0020	<0.10	7.31	0.00376	<0.0010	9.25	<0.00010	11.5	0.166	<0.00020	<0.00010	<0.00010	<0.00020	0.00155	<0.00010	0.0038	0.0005	<0.0020	<0.00040
D9	Lake St. Martin	8-Nov-16	<0.0020	<0.10	8.74	0.00359	<0.0010	5.78	<0.00010	96.8	0.231	<0.00020	<0.00010	<0.00010	<0.00020	0.00138	<0.00010	0.00189	0.00152	<0.0020	<0.00040
D9 Dup	Lake St. Martin	8-Nov-16	<0.0020	<0.10	8.34	0.00351	<0.0010	5.58	<0.00010	91	0.213	<0.00020	<0.00010	<0.00010	<0.00020	0.00126	<0.00010	0.0018	0.00145	<0.0020	<0.00040
		RPD	-	-	*4.7%*	*2.3%*	-	*3.5%*	-	*6.2%*	*8.1%*	-	-	-	-	-	-	*4.9%*	*4.7%*	-	-
FB		8-Nov-16	<0.0020	<0.10	<0.020	<0.00020	<0.0010	<0.10	<0.00010	<0.030	0.00013	<0.00020	<0.00010	<0.00010	<0.00020	<0.00050	<0.00010	<0.00010	<0.00020	<0.0020	<0.00040
EQL			*0.002*	*0.1*	*0.02*	*0.0002*	*0.001*	*0.1*	*0.0001*	*0.03*	*0.0001*	*0.0002*	*0.0001*	*0.0001*	*0.0002*	*0.0005*	*0.0001*	*0.0001*	*0.0002*	*0.002*	*0.0004*
MWQSOG [1]																					
Surface Water - Tier III																					
Freshwater Aquatic Life			[7]	0.025 (lakes and streams entering lakes)/ 0.05 (other streams) [9]	-	-	0.001	-	0.0001	-	-	-	0.0008	-	-	-	-	(0.033 [5]) 0.015 [6]	-	[7]	-
CCME[2]																					
Freshwater Aquatic Life			[8e]	[10]	-	-	0.001	-	0.00025	-	-	-	0.0008	-	-	-	-	(0.033 [5]) 0.015 [6]	-	0.03	-

TABLE D6-24
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Notes:
EQL = Estimated Quantitation Limit = Lowest level of the parameter that can be quantified with confidence
"-" = No Data
RPD = Relative Percent Difference

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1. MWQSOG - Manitoba Water Quality Standards , Objectives, and Guidelines - Manitoba Water Stewardship Report 2011-01, November 28, 2011.
2. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Updated February 6, 2014.
   Canadian Water Quality Guidelines for the Protection of Aquatic Life
3. Total aluminum should not exceed 0.005 mg/L in waters with a pH below 6.5. The concentration of total aluminum should not exceed 0.1 mg/L in waters with a pH greater than or equal to 6.5.
4. Short term duration (1 hour) should not exceed 0.34 mg/L long term duration (4 days) should not exceed 0.15 mg/L.
5. Short-term exposure (24 to 96 hours) concentrations which indicate potential for severe effects during transient events
   (spill events to aquatic receiving environments and infrequent releases of short-lived/non-persistent substances). These are NOT protective guidelines.
6. Long-term exposure guideline that protects all forms of aquatic life for indefinite exposure periods (>7 day exposures for fish and invertebrates, 24 hour exposures for aquatic plants and algae).
7. The following table provides guidelines for parameters based on the samples hardness and the toxicity of the metal.

Hardness (mg/L)	*Cadmium (mg/L)*		*Chromium (mg/L)*		*Copper (mg/L)*		*Lead (mg/L)*		*Nickel (mg/L)*		*Zinc (mg/L)*	
	Chronic	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*	*Acute*
245	0.00046	0.00481	0.15439	1.18692	0.01926	0.03126	0.00657	0.16872	0.11099	0.99931	0.25243	0.25038
270	0.00049	0.00528	0.16718	1.28523	0.02093	0.03426	0.00728	0.18684	0.1205	1.08492	0.27409	0.27186
295	0.00052	0.00576	0.17976	1.38191	0.02257	0.03724	0.00799	0.20496	0.12988	1.16932	0.29544	0.29305
320	0.00055	0.00623	0.19214	1.47711	0.0242	0.04021	0.00869	0.22307	0.13913	1.25263	0.31652	0.31396
345	0.00058	0.0067	0.20435	1.57097	0.0258	0.04316	0.0094	0.24116	0.14827	1.33493	0.33736	0.33462
370	0.00061	0.00717	0.2164	1.66361	0.02739	0.0461	0.0101	0.25922	0.15731	1.41633	0.35796	0.35505
400	0.00064	0.00774	0.02067	1.7733	0.02928	0.04962	0.01094	0.28025	0.16804	1.51289	0.3824	0.3793

8. For the following equations, hardness is expressed as $CaCO_3$ in mg/L and the guideline is in µg/L. exposure);
   a. **Cadmium** Guideline: The long-term CWQG of 0.09 ug/L is for waters of 50 mg $CaCO_3$/L hardness. When water hardness is 0 to <17 mg/L, CWQG is 0.04 µg/L.
   At hardness ≥ 17 to ≤ 280, the CWQG can be calculated with the equation CWQG (ug/L) = 10^{0.83[log(hardness (mg/L)] - 2.46}. At hardness >280 mg/L, the CWQG is 0.37 ug/L.
   b. **Cadmium** Guideline: The short-term benchmark concentration of 1.0 ug/L is for waters of 50 mg $CaCO_3$/L hardness.
   When water hardness is 0 to <5.3 mg/L, the short-term CWQG is 0.11 µg/L. At hardness ≥5.3 to ≤360 mg/L, the short term bench mark is calculated using this equation CWQG (ug/L) = 10^{1.016(log[hardness (mg/L])-1.71}. At hardness >360 mg/L, the short term benchmark is 7.7 ug/L
   c. **Copper** Guideline = When the water hardness is 0 to <82 mg/L, the CWQG is 2 ug/L.
   At hardness ≥ 82 to ≤180 mg/L the CDWQ is calculated using this equation: CWQG (ug/L) = e^(0.8545[ln(hardness (mg/L)]-1.465) * 0.2;
   At hardness > 180 mg/L, the CWQG is 4 ug/L, if the hardness is not known, the CDQG is 2 ug/L.
   d. **Lead** Guideline =When the hardness is 0 to ≤60 mg/L, the CWQG is 1 ug/L. At hardness >60 to ≤180 mg/L the CWQG is calculated using: CWQG(ug/L) = e^(1.273[ln(hardness (mg/L))]-4.705) µg/L; At hardness >180 mg/L, the CWQG is 7 ug/L, If the hardness is unknown, the CWQG is 1 ug/L.
   e. **Nickel** Guideline = Whan water hardness is 0 to ≤60 mg/L, the CWQG is 25 ug/L.
   At hardness >60 to ≤180 mg/L the CWQG is calculated using the following equation: CWQG (ug/L) = e^(0.76[ln(hardness)]+1.06). At hardness >180 mg/L, the CWQG is 150 ug/L. If the hardness is unknown, the CWQG is 25 ug/L.

Well No.	*Hardness*	*8a. Cadmium (long-term) mg/L*	*8b. Cadmium (short-term) (mg/L)*	*8c. Copper (mg/L)*	*8d. Lead (mg/L)*	*8e. Nickel (mg/L)*
D-1	322	0.00042	0.00689	0.00642	0.01410	0.23245
D-2	321	0.00042	0.00686	0.00641	0.01404	0.23190
D-3	335	0.00043	0.00717	0.00664	0.01483	0.23954
D-4	394	0.00049	0.00845	0.00763	0.01823	0.27098
D-5	362	0.00046	0.00776	0.00710	0.01636	0.25408
D-6	424	0.00053	0.00911	0.00813	0.02001	0.28652
D-7	353	0.00045	0.00756	0.00695	0.01585	0.24926
D-8	430	0.00053	0.00924	0.00822	0.02037	0.28959
D-9	261	0.00035	0.00556	0.00537	0.01079	0.19815

9. MWQSOG Tier II Objective - Unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L.
10. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (µg/L):				
	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

	- Exceedance of CCME Guidelines
BOLD	- Exceedance of MWQSOG Guidelines

TABLE D6-25
SURFACE WATER ION BALANCE AND WATER TYPE - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Cations	Atomic Weight	D-1 08-Nov-16			D-2 08-Nov-16			D-3 07-Nov-16			D-4 07-Nov-16			D-5 08-Nov-16			D-6 08-Nov-16		
		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
pH	-	8.35	4.467E-06	0.00%	7.94	1.148E-05	0.00%	7.88	1.318E-05	0.00%	8.15	7.079E-06	0.00%	8.27	5.37E-06	0.00%	8.05	8.91251E-06	0.00%
Calcium	0.0499	49	2.45	30.31%	41.6	2.08	28.13%	42.5	2.12	28.63%	58.3	2.91	34.04%	56.5	2.82	37.36%	61.2	3.05	33.10%
Magnesium	0.0823	48.6	4.00	49.59%	52.9	4.35	59.00%	55.5	4.57	61.66%	60.3	4.96	58.06%	53.6	4.41	58.45%	65.8	5.42	58.70%
Sodium	0.0435	32.5	1.41	17.53%	12.6	0.55	7.43%	10.9	0.47	6.40%	10.6	0.46	5.39%	5.75	0.25	3.31%	12.3	0.54	5.80%
Potassium	0.03	7.98	0.20	2.53%	15.6	0.40	5.41%	9.16	0.23	3.17%	8.33	0.21	2.49%	2.57	0.07	0.87%	8.57	0.22	2.38%
Ammonia-N	0.07	0.042	0.00	0.04%	0.021	0.00	0.02%	0.15	0.01	0.14%	0.018	0.00	0.02%	0.012	0.00	0.01%	0.019	0.00	0.01%
SUM		**138.1**	**8.07**	**100.0%**	**123**	**7.4**	**100.0%**	**118**	**7.4**	**100.0%**	**137.5**	**8.55**	**100.0%**	**118.4**	**7.55**	**100.0%**	**148**	**9.23**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	260	5.20	73.29%	229	4.58	66.82%	240	4.80	71.47%	280	5.60	71.46%	322	6.44	89.79%	295	5.90	69.66%
Bicarbonate [4]	0.02	254.5	5.09	71.75%	227.1	4.54	66.26%	238.3	4.77	70.96%	276.3	5.53	70.50%	316.4	6.33	88.22%	291.9	5.84	68.92%
Carbonate [4]	0.02	5.4	0.11	1.51%	1.9	0.04	0.54%	1.7	0.03	0.51%	3.7	0.07	0.94%	5.5	0.11	1.54%	3.1	0.06	0.73%
Hydroxide [4]	0.02	0.1	0.00	0.03%	0.0	0.00	0.01%	0.0	0.00	0.01%	0.1	0.00	0.02%	0.1	0.00	0.03%	0.1	0.00	0.01%
Nitrate	0.0714	0.005	0.00	0.01%	0.0162	0.00	0.02%	0.0051	0.00	0.01%	0.005	0.00	0.00%	0.005	0.00	0.00%	0.0173	0.00	0.01%
Chloride	0.0282	33.1	0.93	13.16%	10.1	0.28	4.16%	4.78	0.13	2.01%	7.76	0.22	2.79%	1.68	0.05	0.66%	8.45	0.24	2.81%
Sulphate	0.0208	46.2	0.96	13.54%	95.6	1.99	29.01%	85.6	1.78	26.51%	97	2.02	25.75%	32.9	0.68	9.54%	112	2.33	27.51%
SUM		**339**	**7.09**	**100.0%**	**335**	**6.9**	**100.0%**	**330**	**6.7**	**100.0%**	**385**	**7.84**	**100.0%**	**357**	**7.17**	**100.0%**	**415**	**8.47**	**100.0%**
Silica (as SiO_2)		9			8			9			9			7			10		
TDS (mg/L) [2]		382			374			362			420			353			455		
TDS (mg/L) (Lab) [3]		373			366			352			410			346			445		
Ion Balance		6.41%			3.68%			4.90%			4.34%			2.55%			4.27%		
Ion Balance (Lab) [3]		-			-			-			-			-			-		

Cations	Atomic Weight	D-7 08-Nov-16			D-8 08-Nov-16		
		mg/L	meq/l	%	mg/L	meq/l	%
pH	-	8.07	8.511E-06	0.00%	8.18	6.607E-06	0.00%
Calcium	0.0499	56.4	2.81	37.44%	63.2	3.15	33.97%
Magnesium	0.0823	51.5	4.24	56.38%	66.1	5.44	58.61%
Sodium	0.0435	6.58	0.29	3.81%	11.5	0.50	5.39%
Potassium	0.03	6.78	0.17	2.31%	7.31	0.19	2.02%
Ammonia-N	0.07	0.063	0.00	0.06%	0.018	0.00	0.01%
SUM		**121.3**	**7.52**	**100.0%**	**148.1**	**9.28**	**100.0%**
Anions		mg/L	meq/l	%	mg/L	meq/l	%
Alkalinity	0.02	280	5.60	80.61%	308	6.16	73.69%
Bicarbonate [4]	0.02	276.9	5.54	79.71%	303.6	6.07	72.64%
Carbonate [4]	0.02	3.1	0.06	0.88%	4.3	0.09	1.03%
Hydroxide [4]	0.02	0.1	0.00	0.02%	0.1	0.00	0.02%
Nitrate	0.0714	0.0051	0.00	0.01%	0.0185	0.00	0.02%
Chloride	0.0282	3.05	0.09	1.24%	7.07	0.20	2.38%
Sulphate	0.0208	60.6	1.26	18.14%	96.1	2.00	23.91%
SUM		**344**	**6.95**	**100.0%**	**411**	**8.36**	**100.0%**
Silica (as SiO_2)		9			9		
TDS (mg/L) [2]		362			445		
TDS (mg/L) (Lab) [3]		353			436		
Ion Balance		3.94%			5.23%		
Ion Balance (Lab) [3]		-			-		

Location	Water Type
D1	magnesium-calcium-bicarbonate
D2	magnesium-bicarbonate
D3	magnesium-bicarbonate
D4	magnesium-bicarbonate
D5	magnesium-bicarbonate
D6	magnesium-bicarbonate
D7	magnesium-bicarbonate
D8	magnesium-bicarbonate
D9	sodium-magnesium-chloride-bicarbonate
D9 Dup	sodium-magnesium-chloride-bicarbonate

Notes:
"-" = No Data

1. Ion balance calculated using formula: (Sum(Anions)-Sum(Cations))/(Sum(Anions)+Sum(Cations))
2. Only listed parameters were used to calculated TDS.
3. Laboratory results may slightly differ due to rounding of numbers.
4. Calculations for bicarbonate, carbonate and hydroxide done by KGS Group.

TABLE D6-26
STABLE ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

#	Sample	Date	Lab#	δ18O H_2O	Result VSMOW	Repeat VSMOW	δ^2H H_2O	Result VSMOW	Repeat VSMOW	pH	Conductivity µS/cm
GROUNDWATER											
1	TH-ED-01W	26-Oct-16	373023	X	-14.72	-14.89	X	-113.02	-112.97	6.51	511
2	TH-GD-08	29-Oct-16	373025	X	-14.86	0.16	X	-113.64	-	-	*
SURFACE WATER											
1	D-1 LMB	Nov. 08, 2016	374371	X	-9.72	-	X	-75.68	-	8.05	492
2	D-4 Clear Lake	Nov. 07, 2016	374374	X	-11.31	-11.29	X	-80.81	-80.67	8.84	532
3	D-9 LSM	Nov. 08, 2016	374372	X	-8.46	-8	X	-72.86	-73.00	8.41	691
4	D-9 LSM-DUP	Nov. 08, 2016	374373	X	-8.51	-	X	-72.83	-	8.41	691

* Conductivity not recorded - same area/aquifer as other samples.

TABLE D6-27
GUDI SCREENING MATRIX - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

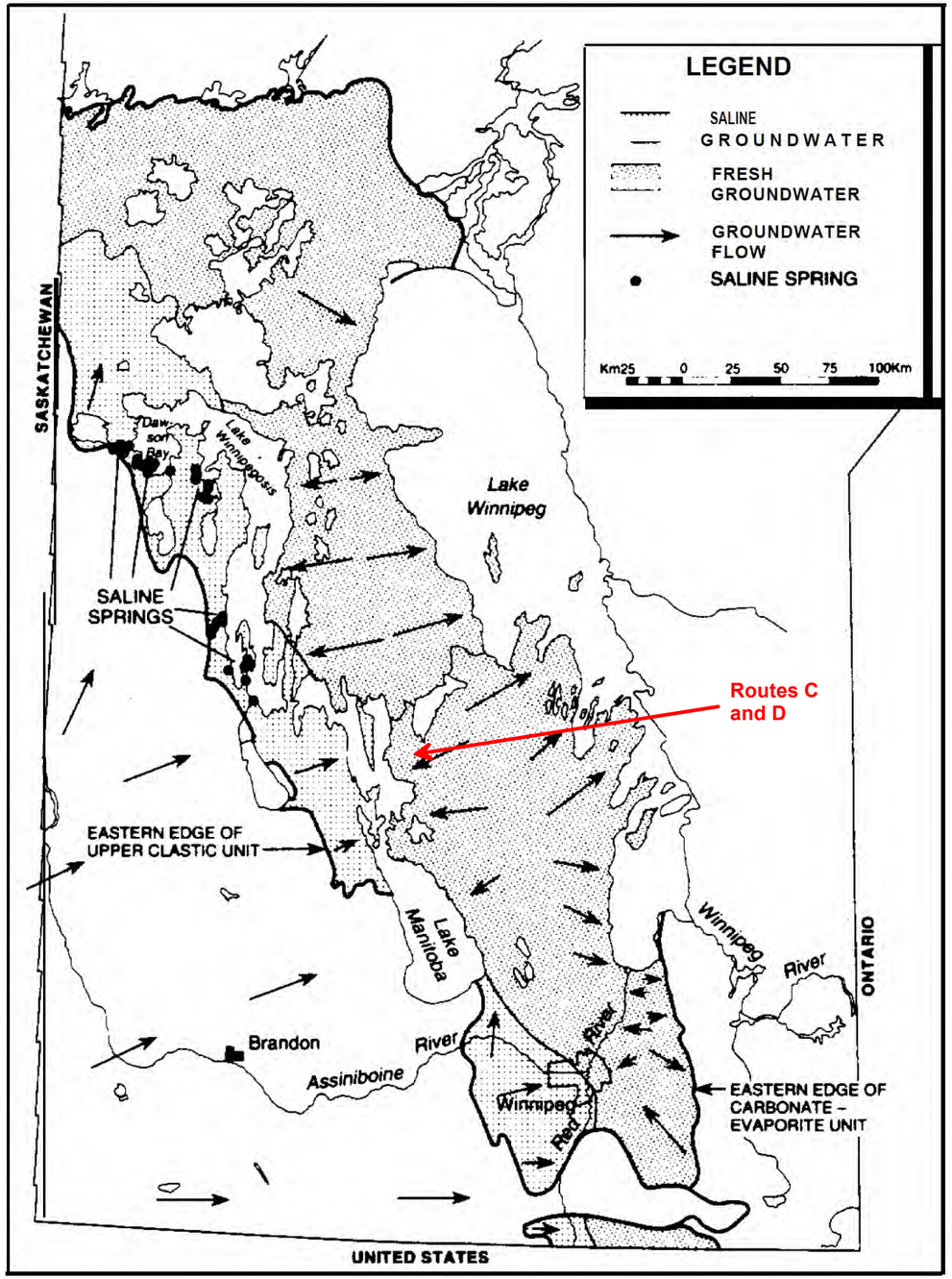
Condition	Route D
Wells Regularly Contain Total Coliforms and/or/periodically contain E. coli	Low Potential for bacterial contamination including E. coli
Located within 50 days horizontal saturated travel time from surface water or	Not calculated
Located within 100 m of surface water (overburden wells), or	Few overburden wells indicated from regional study
Located within 500 m of surface water (bedrock wells) and meet one of more of the following criteria:	Approximately 14 bedrock wells within 500 m of channel ROW.
● Wells may be drawing water from an unconfined aquifer	Bedrock aquifer will remain confined after construction. Final design will protect against potential for blowout and interconnection of bedrock groundwater with channel. Upward gradients from the bedrock groundwater to the channel would be maintained further decreasing potential risks.
● Wells may be drawing water from formations within approximately 15 m of surface	Bedrock formation beneath the channel is approximately 14 to 16 m below ground surface at highest point with bedrock depth up to 25 m below ground surface.
● Wells are part of an enhanced recharge/infiltration project	Not applicable
● When the well is pumped, water levels in surface water rapidly change or hydraulic gradients beside the surface water significantly increase in a downward direction	Low potential for domestic well pumping to induce downward and outward gradients in the till, which is the unit in proximity to the surface water in the channel. Thick till cover exists between surface water and proposed channel.
● Chemical water quality parameters such as temperature, conductivity, turbidity, total dissolved solids, pH, colour, oxygen) are more consistent with nearby surface water than local groundwater and/or if they fluctuate significantly and rapidly in response to climatological or surface water conditions	Low potential for wells to become turbid and to show changes in chemistry consistent with surface water, based on low potential for pathways between bedrock groundwater and surface water.

Reference: Ontario MOEE Terms of Reference 2001
Terms of Reference: Hydrogeological Study to Examine Groundwater Sources Potentially Under Direct Influence of Surface Water

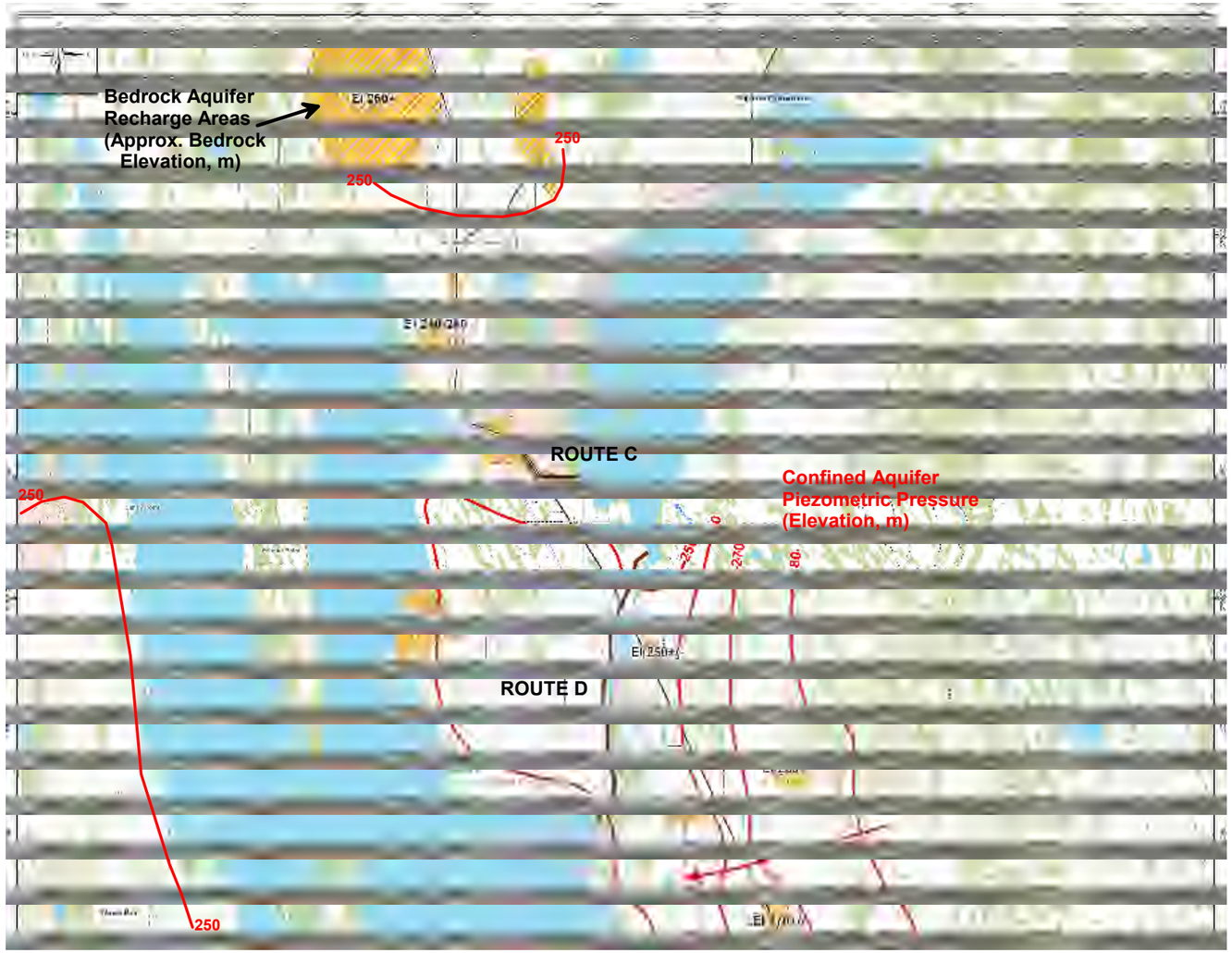
TABLE D6-28
SUMMARY ASSESSMENT OF THE CHANNEL PROJECT ON GROUNDWATER WELLS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Condition	Route D
Estimated Drawdown at Channel	Construction 2.5 to 13 m, long term 1 to 11 m
Estimated Drawdown with Distance	A drawdown of 1.5 to 3.3 m is predicted at the 3 km distance from the channel, decreasing to 0.9 to 2.7 m at 5 km distance.
Bedrock Groundwater Piezometric surface depth below ground surface	In the areas closes to the channel the piezometric surface is artesian, while at distance water elevations are only slightly below ground surface which provides an advantage to mitigating drawdown effects.
Depth to well casing below channel invert	A large portion of the areas adjacent to the channel have wells with deep casings, below the bottom of the channel invert, which is in the till.
Transmissivity/Specific Capacity	Approximately 83% of the 109 wells with calculated transmissivities had either very low < 1000 USgpd/ft or low 1000 to 5000 USgpd/ft transmissivities.

PLATES



A: INTERLAKE GROUNDWATER FLOW



B: REGIONAL BEDROCK AQUIFER PIEZOMETRIC CONTOURS

Notes:

1. References: A - Betcher, B, Grove, G, and Pupp, C. (1995), Groundwater In Manitoba:Hydrogeology, Quality Concerns, Management. NHRI Contribution CS-93017.
   B - Betcher, B. (1986). Groundwater Availability Study, Dauphin Lake Area. Province of Manitoba Department of Natural Resources, Water Resource Branch.

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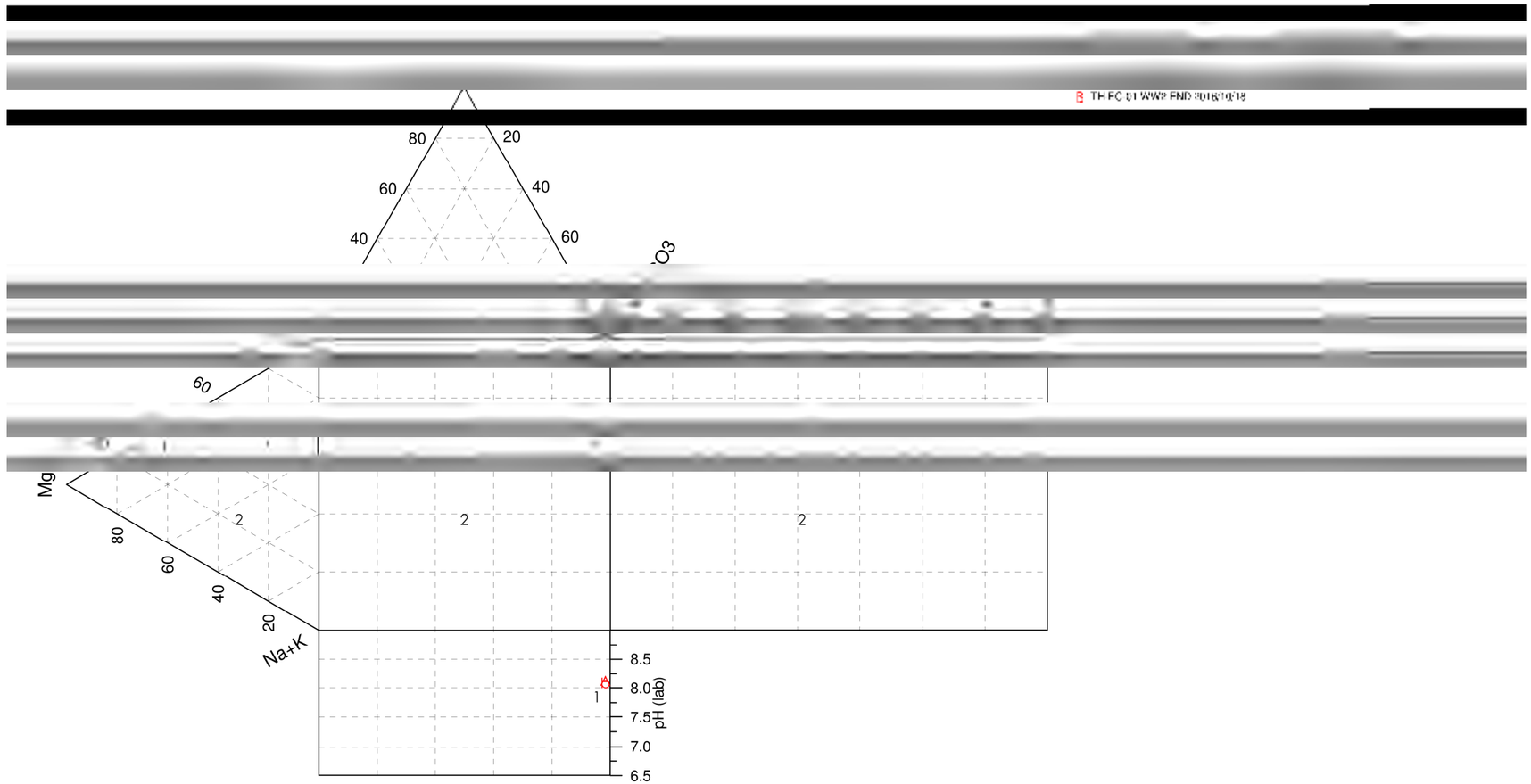
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

REGIONAL GROUNDWATER CONDITIONS ROUTE C & D

MAY 2017	PLATE D6-1	REV: 0



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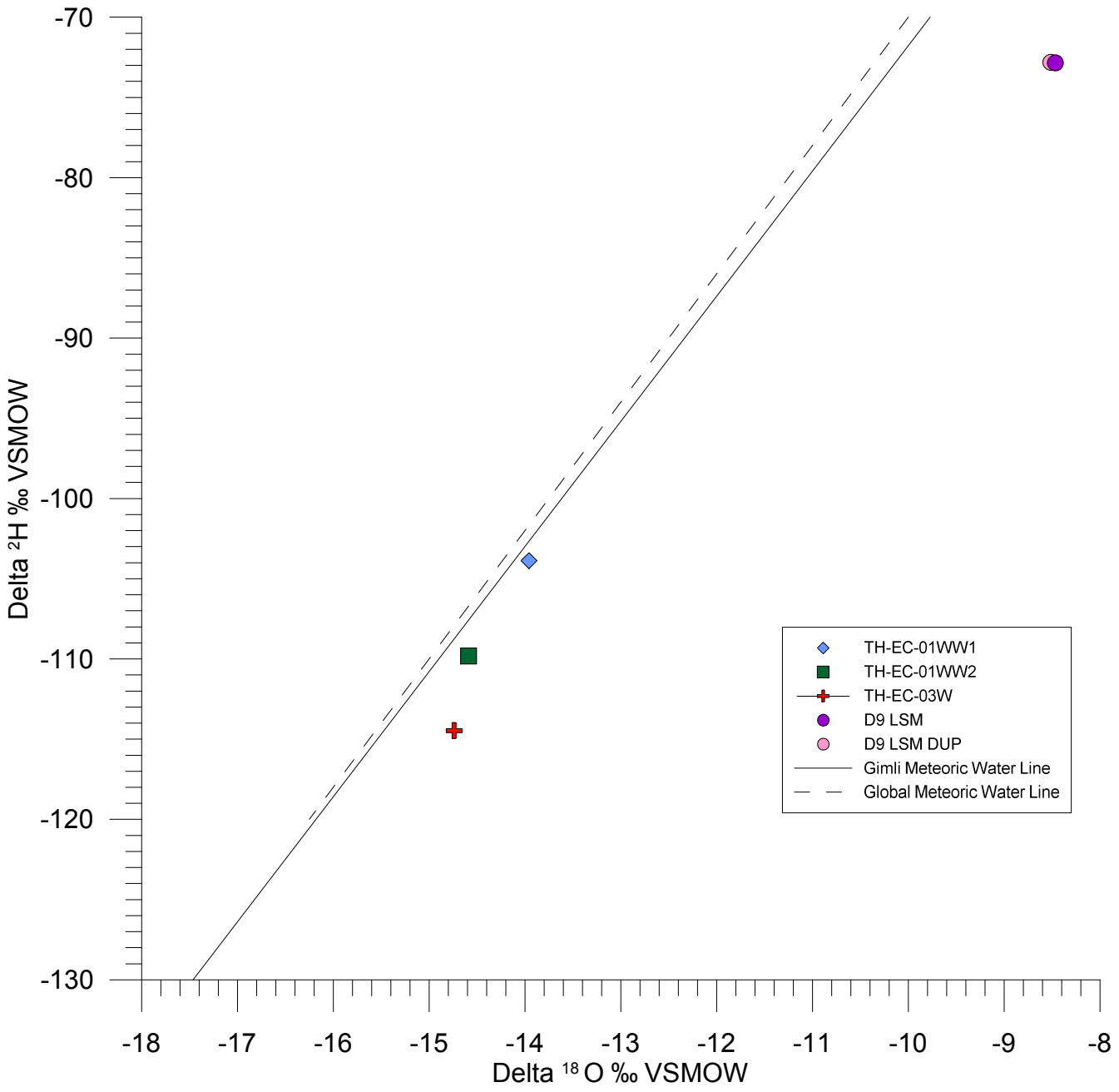
GROUNDWATER AND SURFACE WATER QUALITY - HYDROGEOCHEMICAL PLOTS - ROUTE C

MAY 2017	PLATE D6-2	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\Figures\Plate D6-2 Groundwater and Surface Water Quality - Hydrogeochemical Plots 11x17.gpj



Gimli Meteoric Water Line

Delta ^{2}H = (7.8) Delta ^{18}O + 6.2

Global Meteoric Water Line

Delta ^{2}H = (8) Delta ^{18}O + 10

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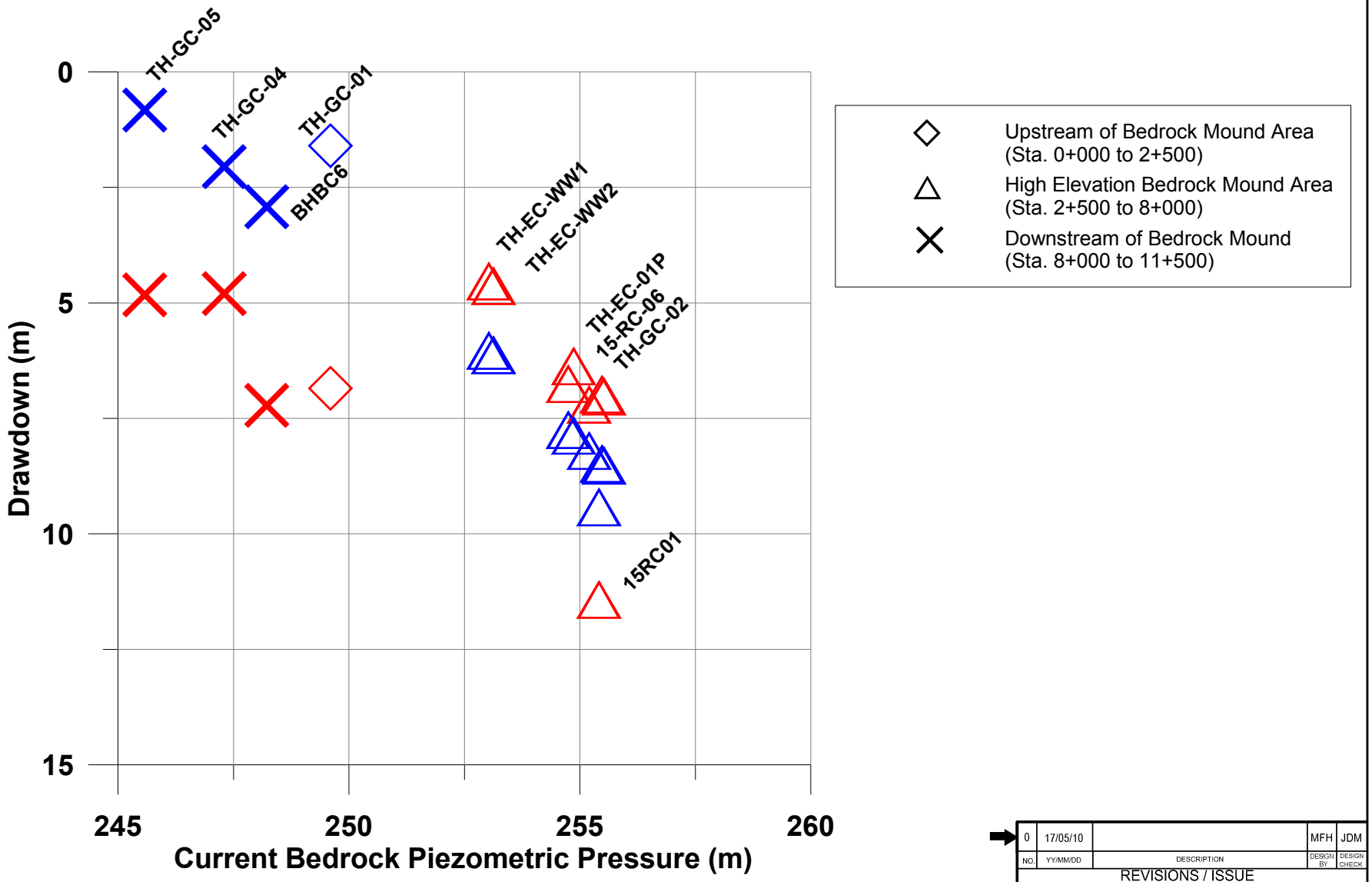
ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE C

MAY 2017	PLATE D6-3	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\Tables\Master Tables\Isotopes\Route C\Figure D6-4 Route C_isotopes.pdf



RED Route C - Construction (assume dewatering to channel invert where bedrock is below invert; assume half of exposed rock face to channel invert dewaters where H=Z)

BLUE Route C - Long Term (assume long term aquifer piezometric pressure at channel equilibrates to channel water level)

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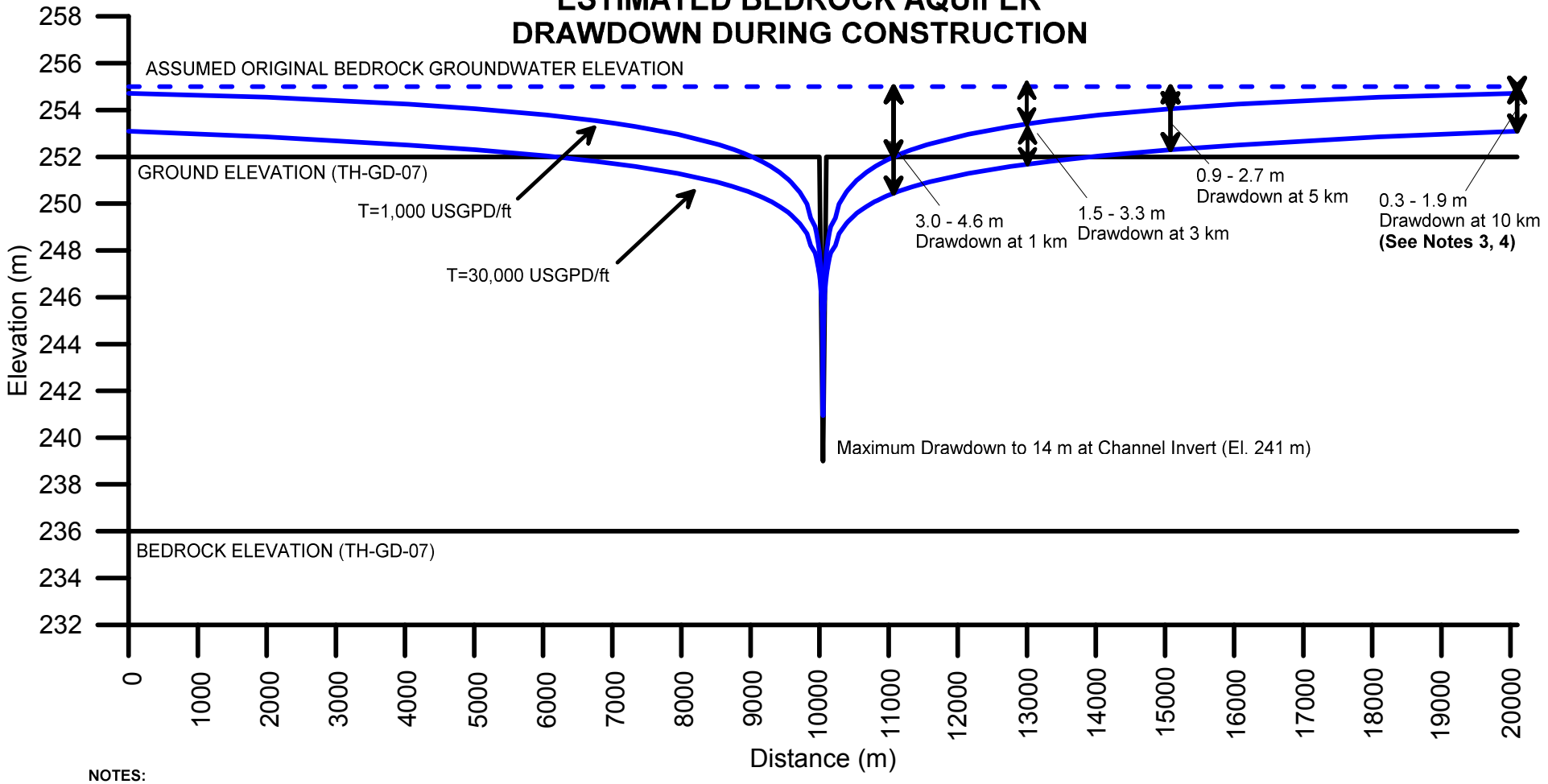
DRAWDOWN ESTIMATES AT CHANNEL ROUTE C

MAY 2017 | PLATE D6-4 | REV: 0

ESTIMATED BEDROCK AQUIFER DRAWDOWN DURING CONSTRUCTION



NOTES:

1. Drawdown calculated based on:
   T = 1000 to 30,000 USgpd/ft
   S = 0.0001
   t = 10 months
   Calculations based on radial well flow equations.
2. Example shown for Route D TH-GD-07. Basic bedrock Parameters and estimated relative drawdowns are similar on Route C.
3. On Route C, potential lake boundary conditions exist within 5 km of the channel. Estimated drawdowns beyond this distance are not defined herein.
4. On Route D, potential Lake Manitoba boundary condition occurs within 15 km of much of the route, and potential Lake St. Martin boundary condition occurs within 5 km of the area of greatest drawdown (northern 1/3 of the channel), which may reduce estimated drawdown in the west, north, and south directions. Estimated drawdowns beyond these distances are not defined herein.

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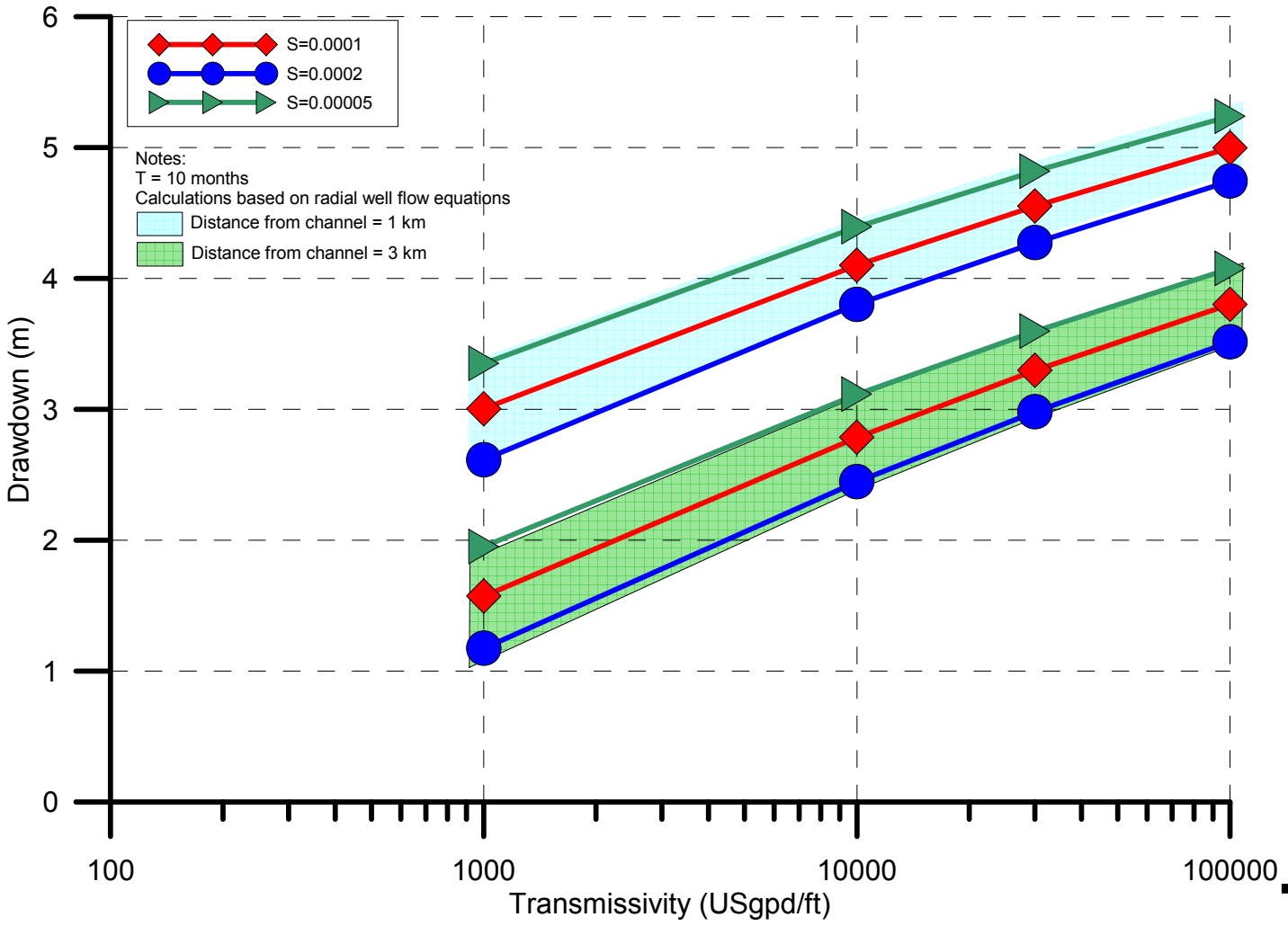
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

DRAWDOWN ESTIMATES WITH DISTANCE - ROUTE C AND D

MAY 2017	PLATE D6-5	REV: 0

TRANSMISSIVITY AND DRAWDOWN AT 1 KM AND 3 KM



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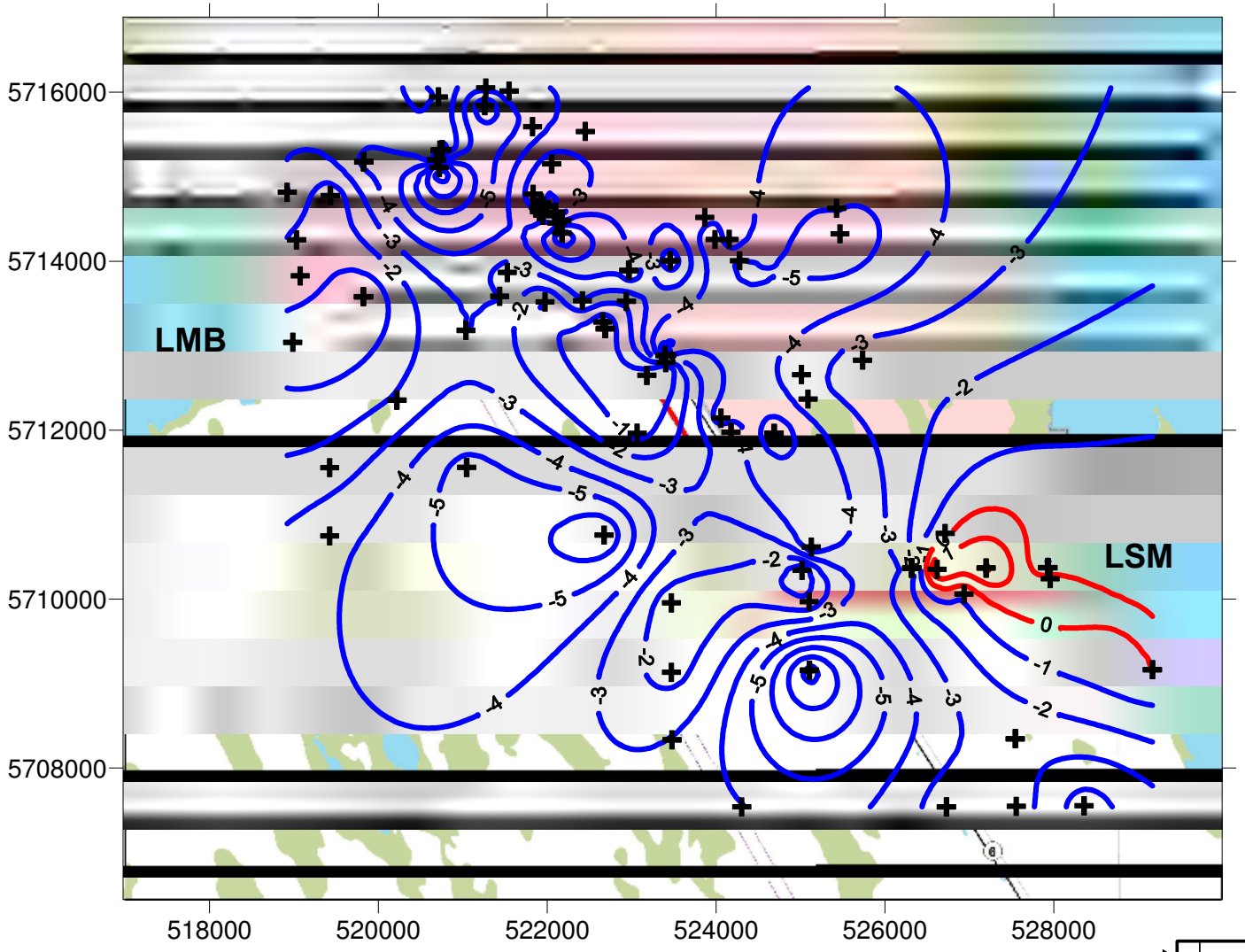
DRAWDOWN ESTIMATES SENSITIVITY ANALYSIS - ROUTE C AND D

MAY 2017	PLATE D6-6	REV: 0



-1 Piezometric Surface Below Ground Surface (m)
1 Piezometric Surface Above Ground Surface (m)
(flowing artesian conditions)
+ = Available Data Point

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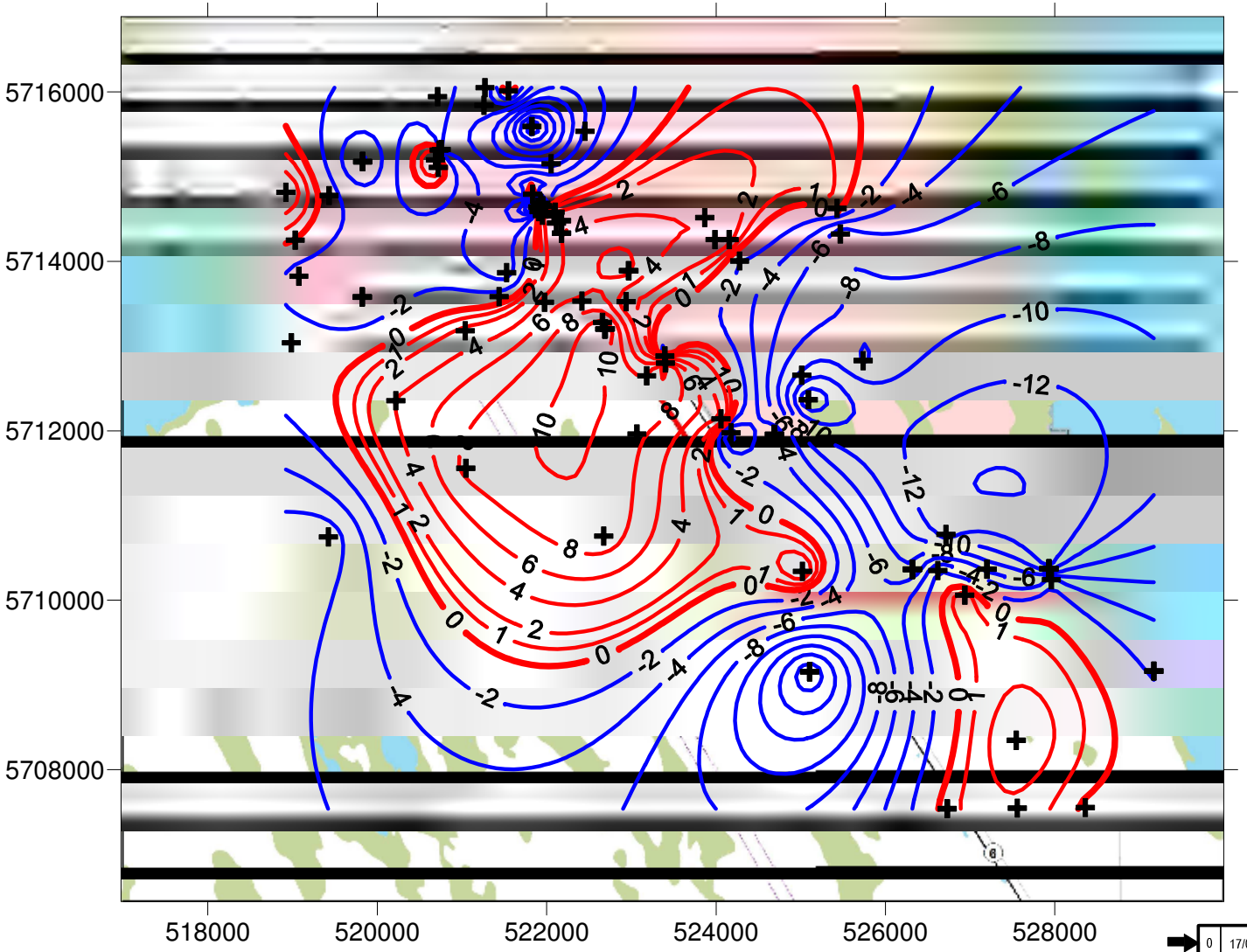
BEDROCK GROUNDWATER PIEZOMETRIC SURFACE, DEPTH BELOW GROUND SURFACE - ROUTE C

MAY 2017	PLATE D6-7	REV: 0



-2 Bottom of Well Casing Below Proposed Channel Invert (m)

2 Bottom of Well Casing Above Proposed Channel Invert (m)

✚ = Available Data Point

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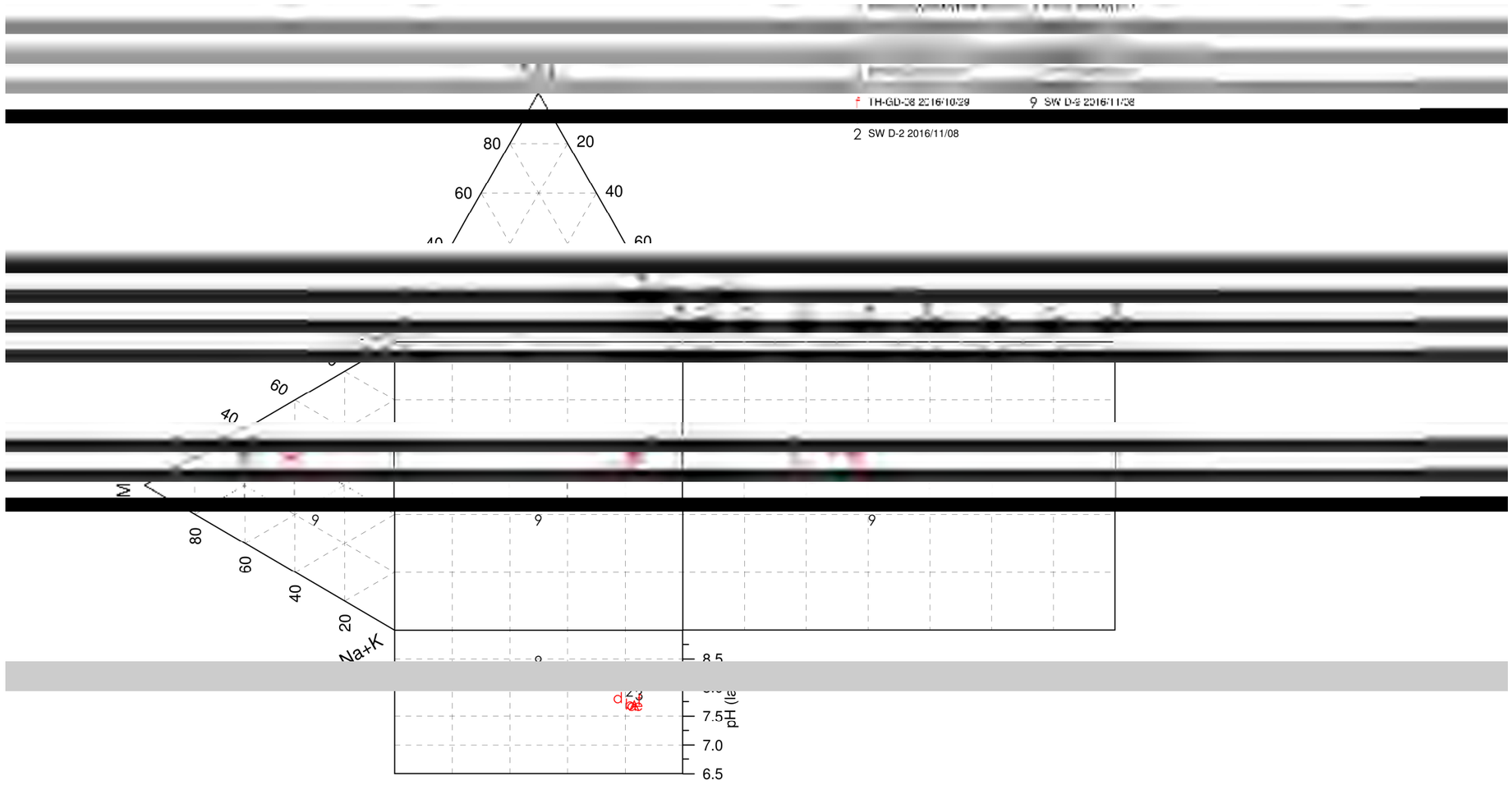
WELL CASING COMPLETIONS RELATIVE TO CHANNEL INVERT - ROUTE C

MAY 2017	PLATE D6-8	REV: 0



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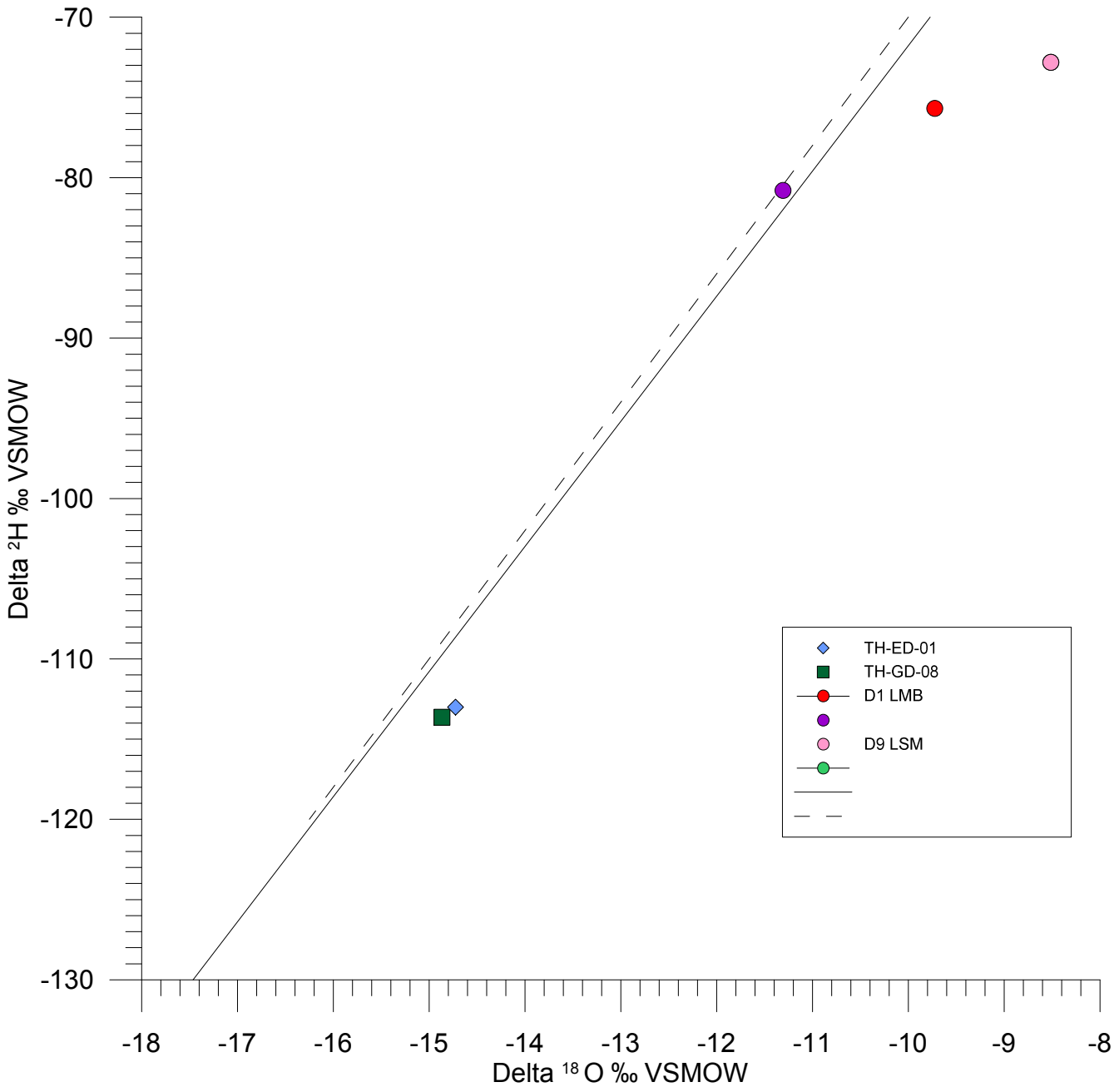
GROUNDWATER AND SURFACE WATER QUALITY - HYDROGEOCHEMICAL PLOTS - ROUTE D

MAY 2017	PLATE D6-9	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\Figures\Plate D6-9 Groundwater and Surface Water Quality - Hydrogeochemical Plots - Route D 11x17.gpj



Delta ^{2}H = (7.8) Delta ^{18}O + 6.2

Global Meteoric Water Line

Delta ^{2}H = (8) Delta ^{18}O + 10

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ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE D

MAY 2017	PLATE D6-10	REV: 0

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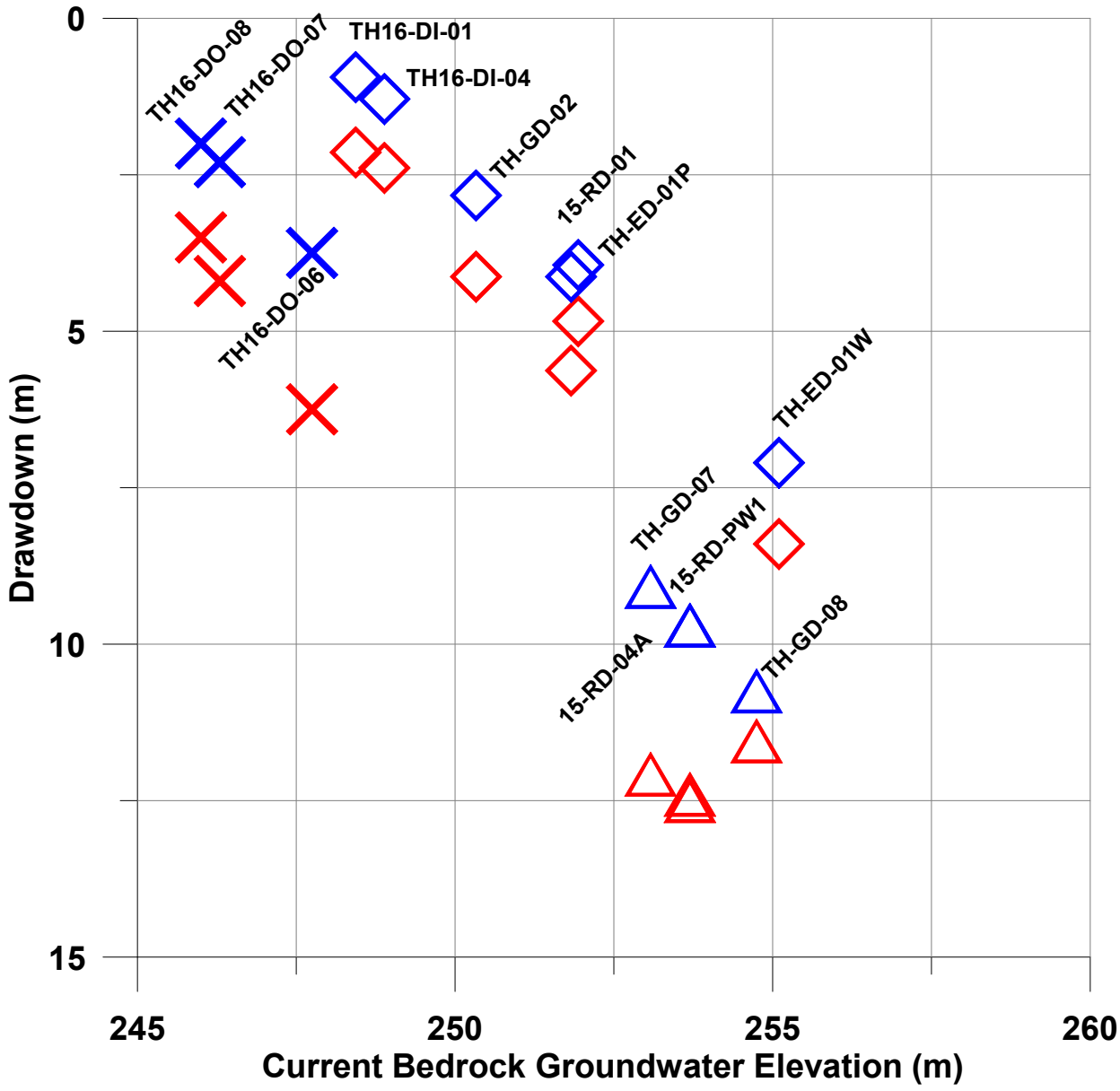

RED Route D - Construction (FS = 1.3)

BLUE Route D - Long Term (FS = 1.5, with minimum channel operating level, and passive depressurization to El. 244 m in downstream channel areas, beyond approx. Sta. 17+000)

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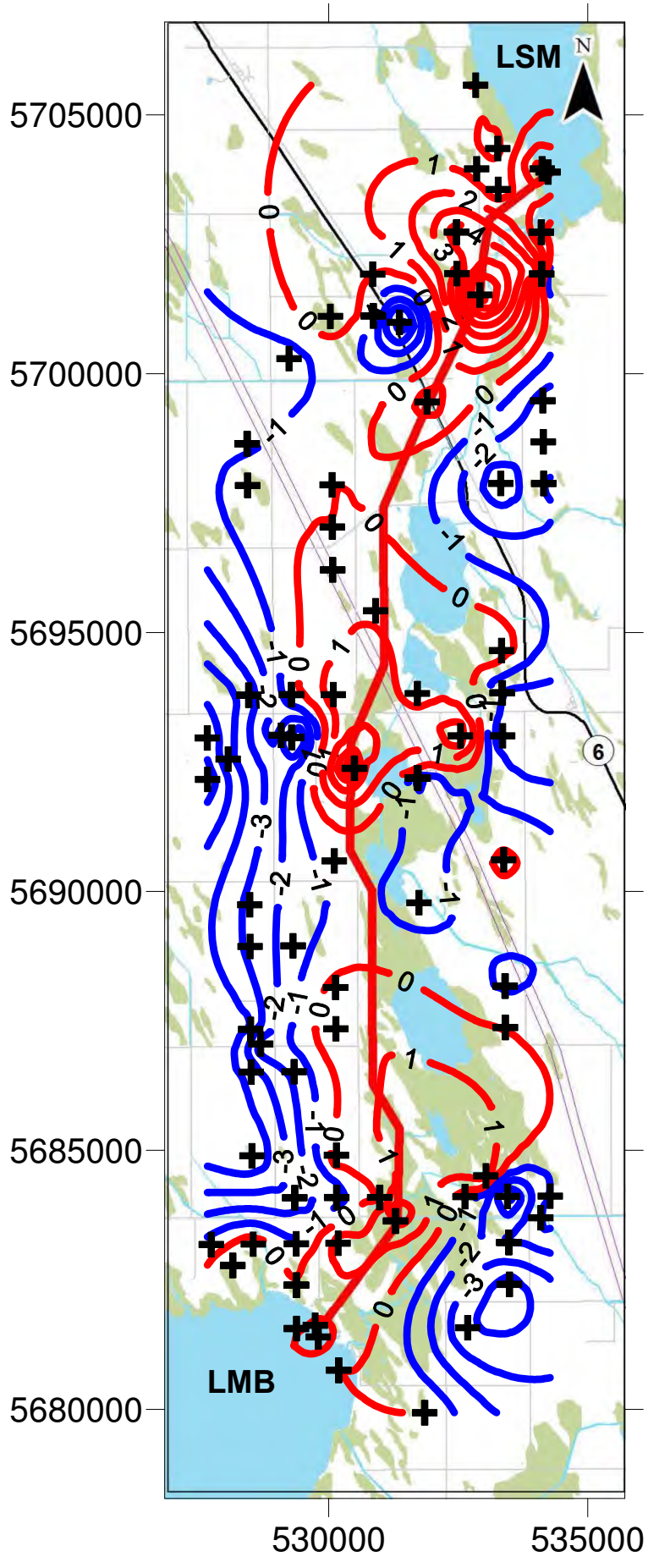
DRAWDOWN ESTIMATES AT CHANNEL ROUTE D

MAY 2017	PLATE D6-11	REV: 0



-1 Piezometric Surface Below Ground Surface (m)

1 Piezometric Surface Above Ground Surface (m) (flowing artesian conditions)

+ = Available Data Point

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BEDROCK GROUNDWATER PIEZOMETRIC SURFACE, DEPTH BELOW GROUND SURFACE - ROUTE D

MAY 2017	PLATE D6-12	REV: 0

APPENDIX D6-A

SEE LOCATION PLANS FROM DELIVERABLE D4 ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER- ROUTE C

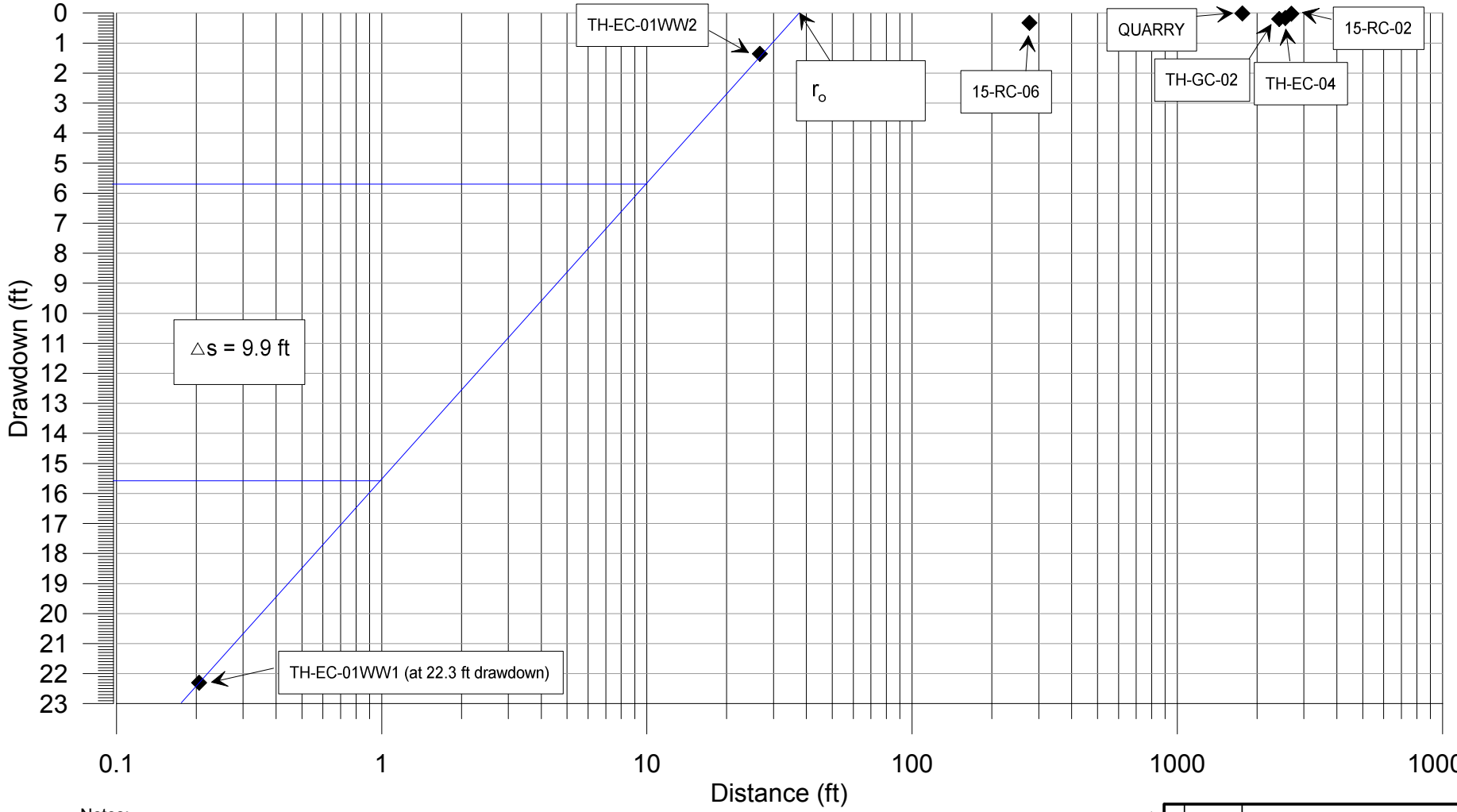
(NOT INCLUDED IN DELIVERABLE D6)

APPENDIX D6-B

ASSESSMENT OF REGIONAL GROUNDWATER FLOW AND QUALITY- ROUTE C

APPENDIX D6-B-1

PUMP TEST TH-EC01-WW1



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Distance Drawdown
Pump Rate (Q) = 7 USgpm
Duration = 10 hr

$T = (528)(Q)/\triangle s$	**T= 373 USgpd/ft**
$\triangle s$= 9.9 ft	Q = 7 USgpm

$S = 0.3Tt/r_o^2$	$S = 3.55 \times 10^{-2}$
r_0 = 36.4 ft	t = 0.42 days

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
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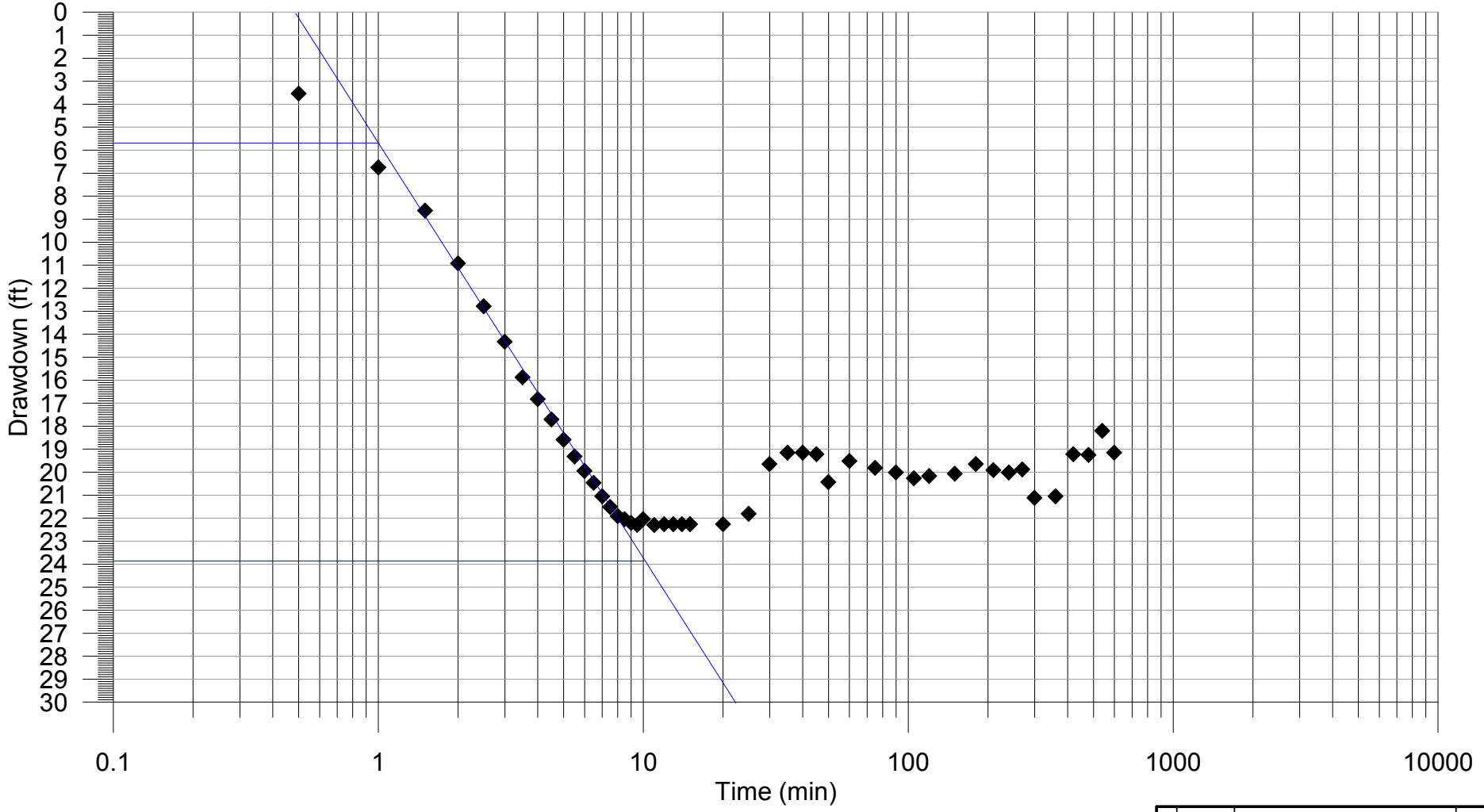
PUMP TEST AT TH-EC-01WW1
DISTANCE DRAWDOWN

		REV:
MAY 2017	APP D6-B-1-1	0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-19_TH-EC-01WW1 Pump test\D6-B-1-01_2016-10-19_TH-EC-WW1_Pump Test_Distance Drawdown.grf



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-01WW1
Drawdown
Pump Rate (Q) = 7 USgpm

T =(264)(Q)/△s	**T= 102 USgpd/ft**
△s= 18.15 ft	Q = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT TH-EC-01WW1

		REV:
MAY 2017	APP D6-B-1-2	0

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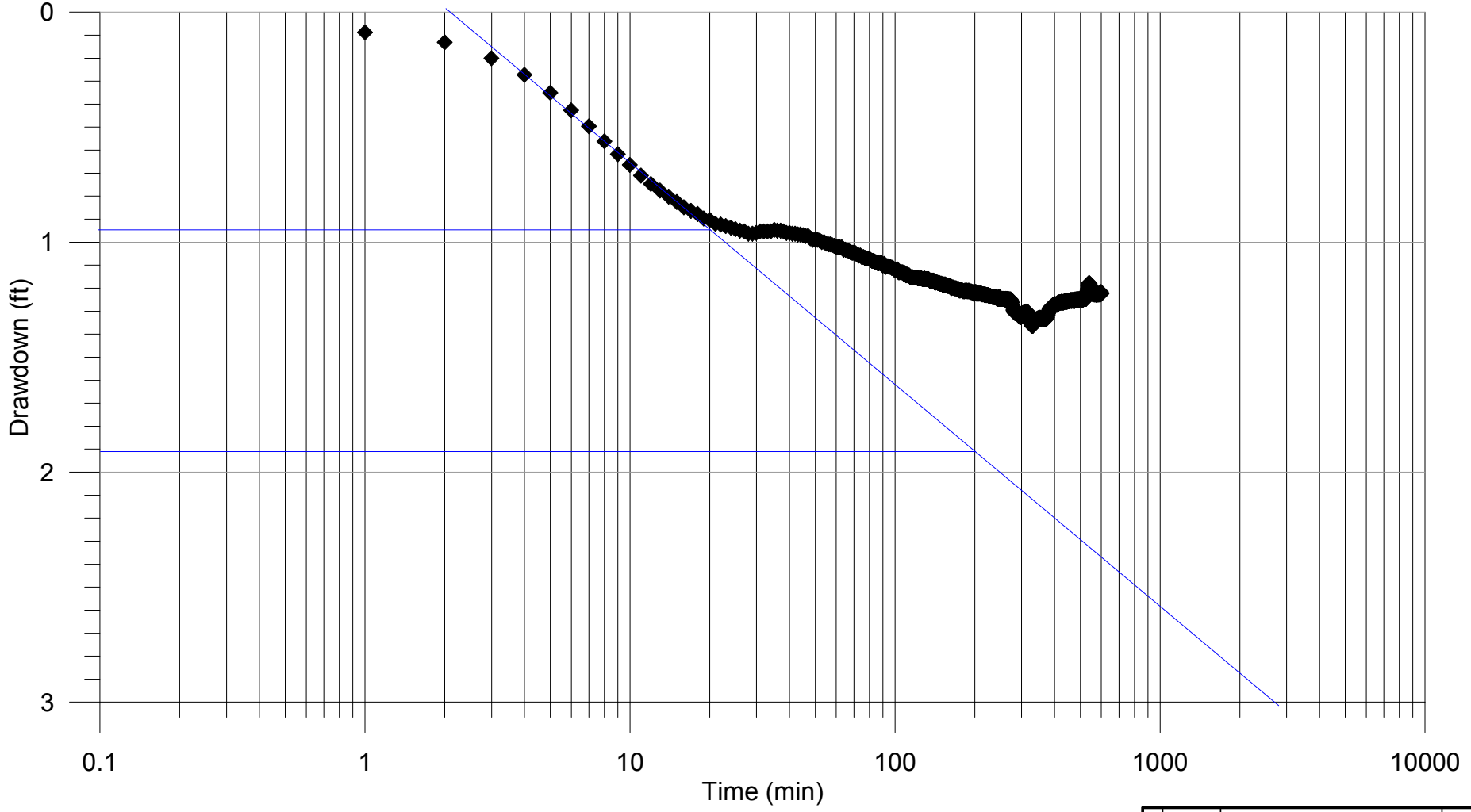

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-01WW2
Drawdown
Pump Rate (Q) = 7 USgpm

T =(264)(Q)/△s **T= 1886 USgpd/ft**

△s= 0.98 ft Q = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
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PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT TH-EC-01WW2

MAY 2017	APP D6-B-1-3	REV: 0

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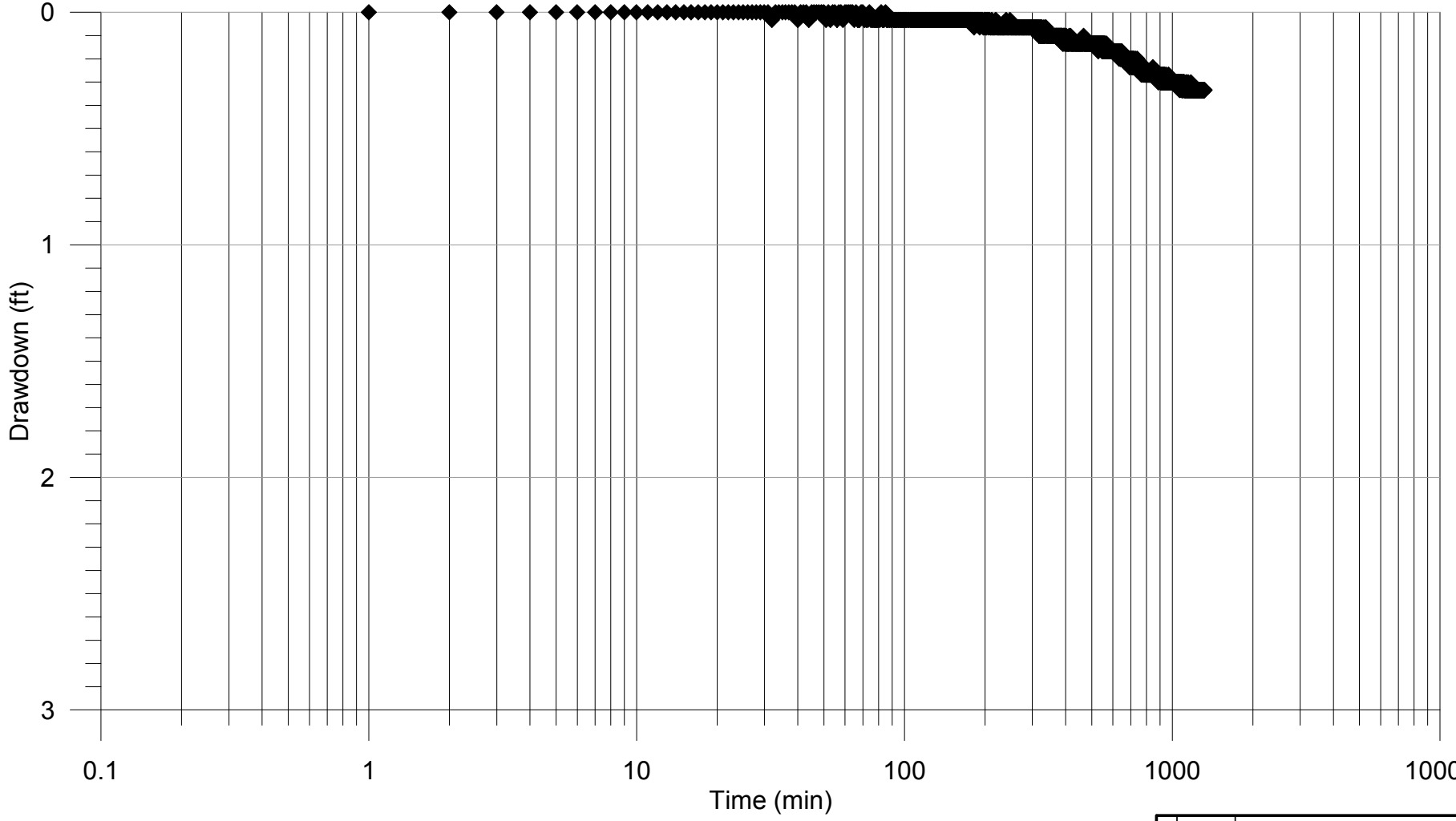

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: 15-RC-06
Drawdown
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT 15-RC-06

MAY 2017	APP D6-B-1-4	REV: 0

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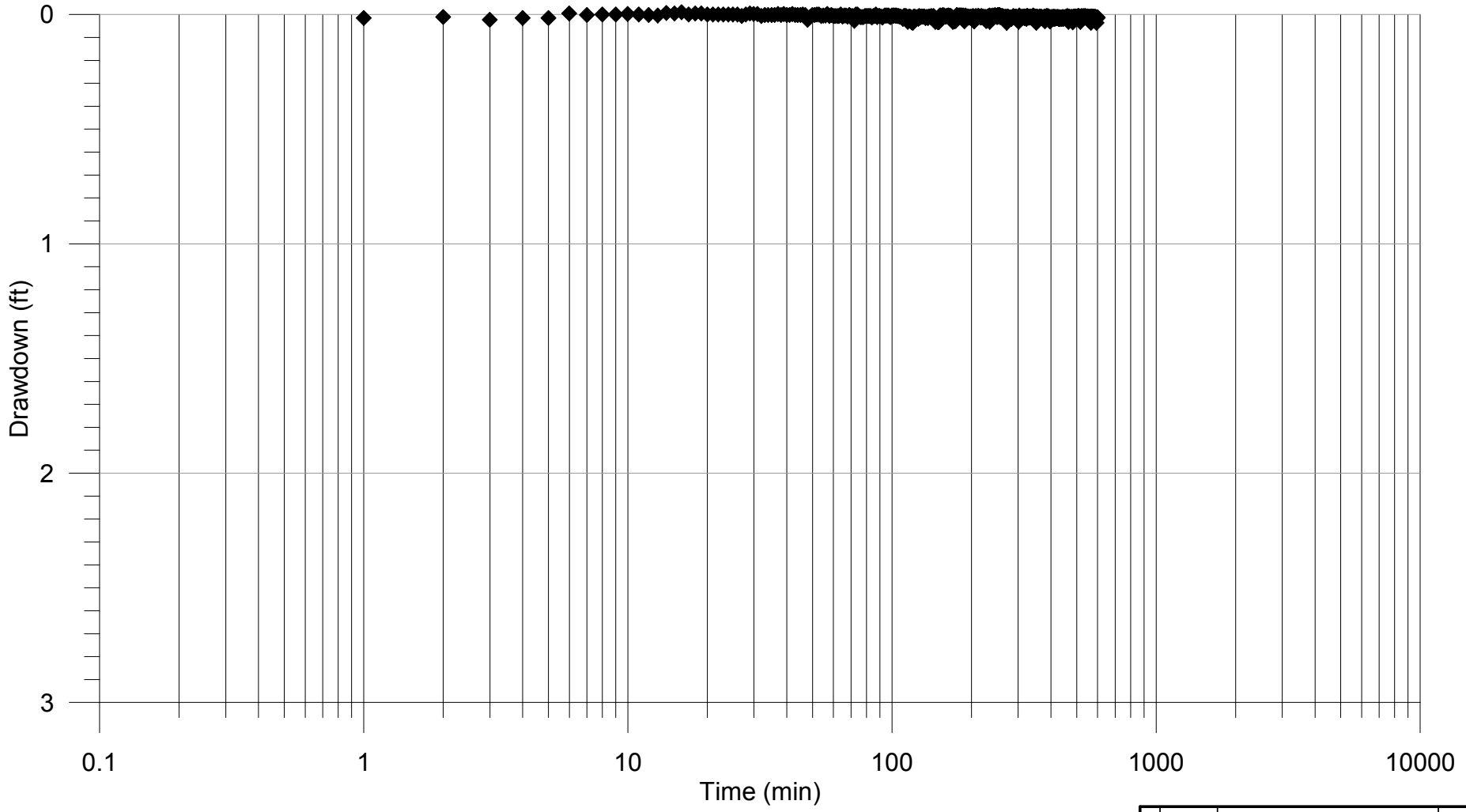

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: QUARRY
Drawdown
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT THE QUARRY

MAY 2017	APP D6-B-1-5	REV: 0

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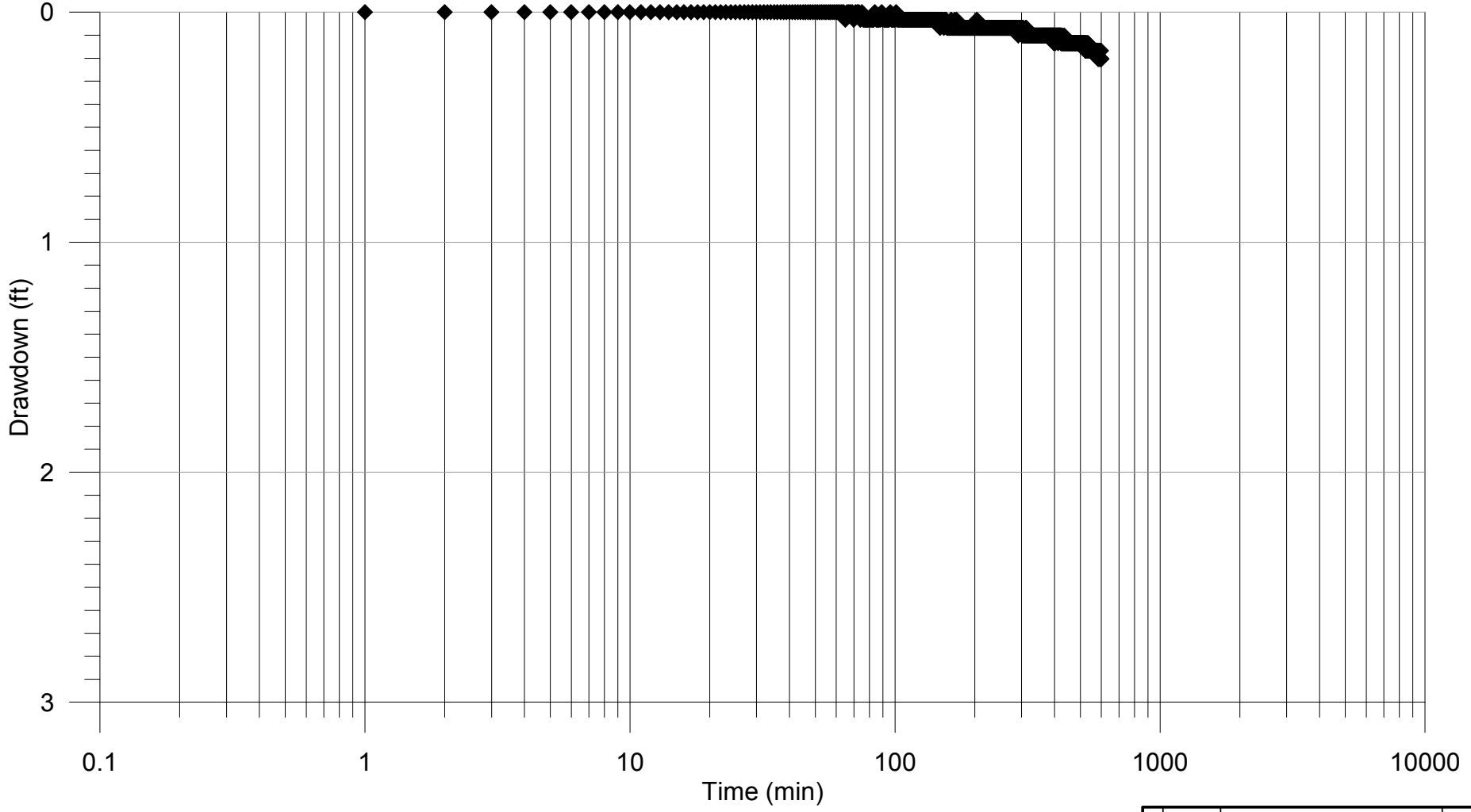

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-GC-02
Drawdown
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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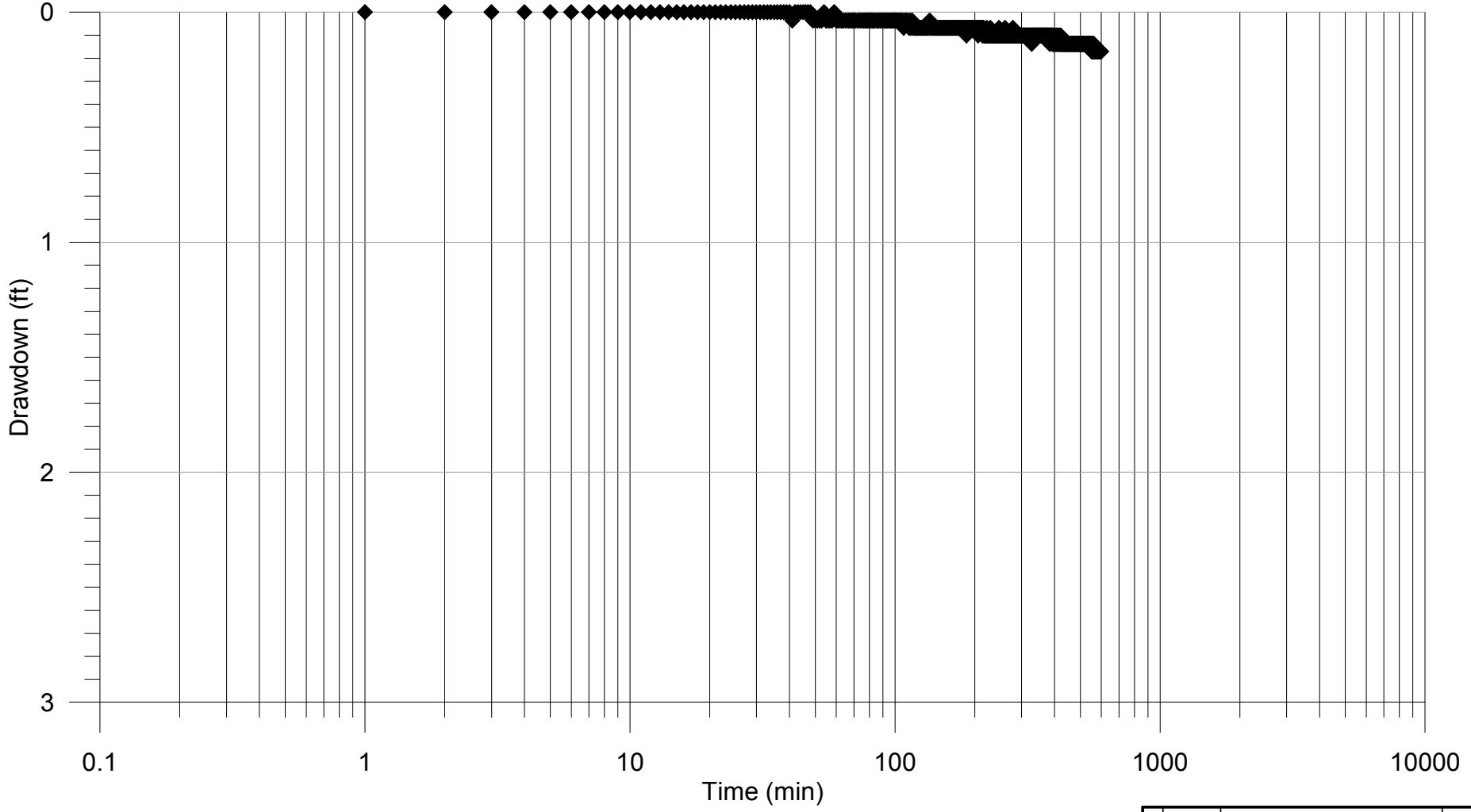
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT TH-GC-02

MAY 2017	APP D6-B-1-6	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-19_TH-EC-01WW1 Pump test\D6-B-1-06_2016-10-19_TH-EC-WW1_Pump Test_obs-TH-GC-02.grf



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-04
Drawdown
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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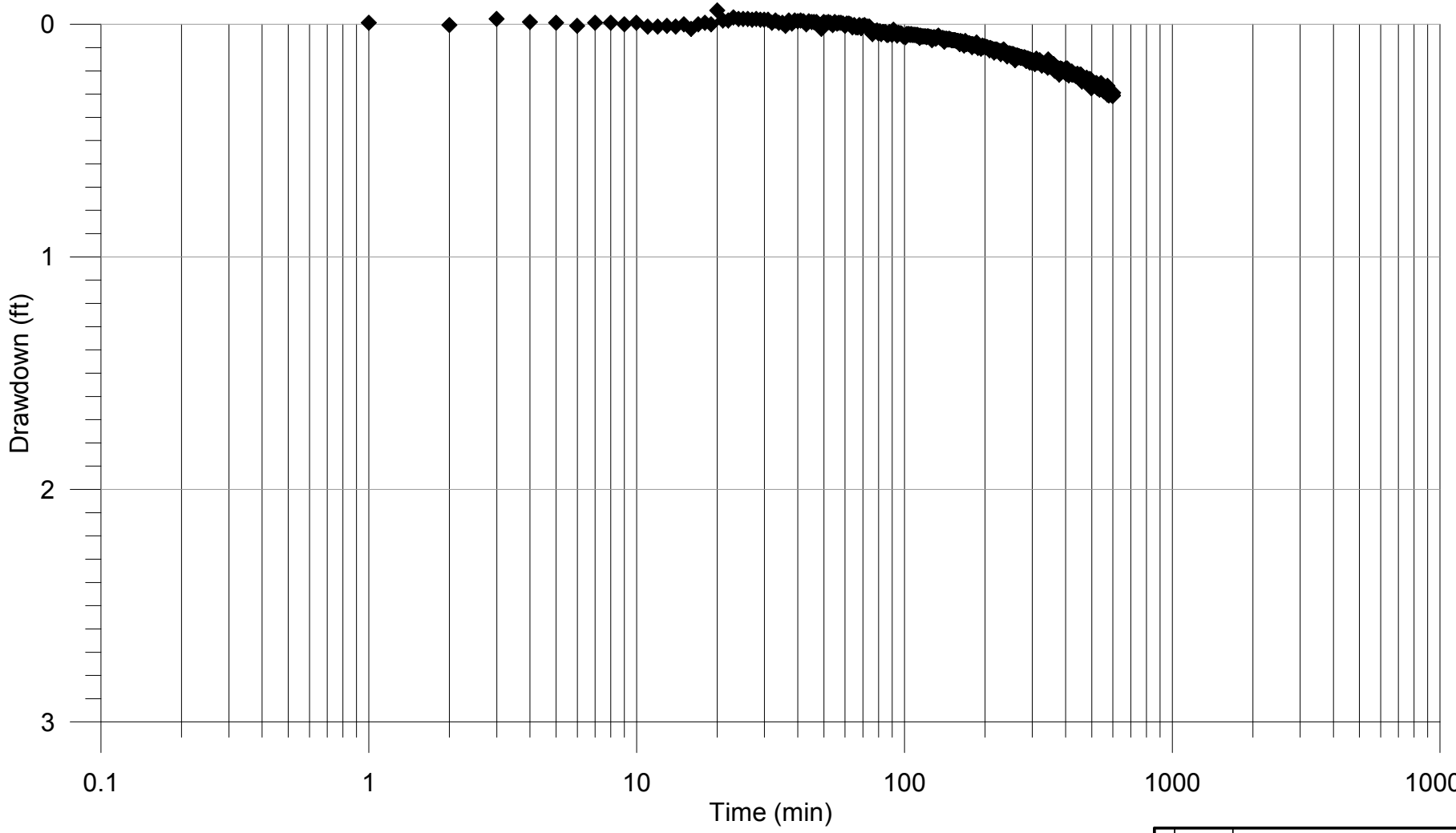
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT TH-EC-04

MAY 2017	APP D6-B-1-7	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-19_TH-EC-01WW1 Pump test\D6-B-1-07_2016-10-19_TH-EC-WW1_Pump Test_obs-TH-EC-04.grf



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: 15-RC-02
Drawdown
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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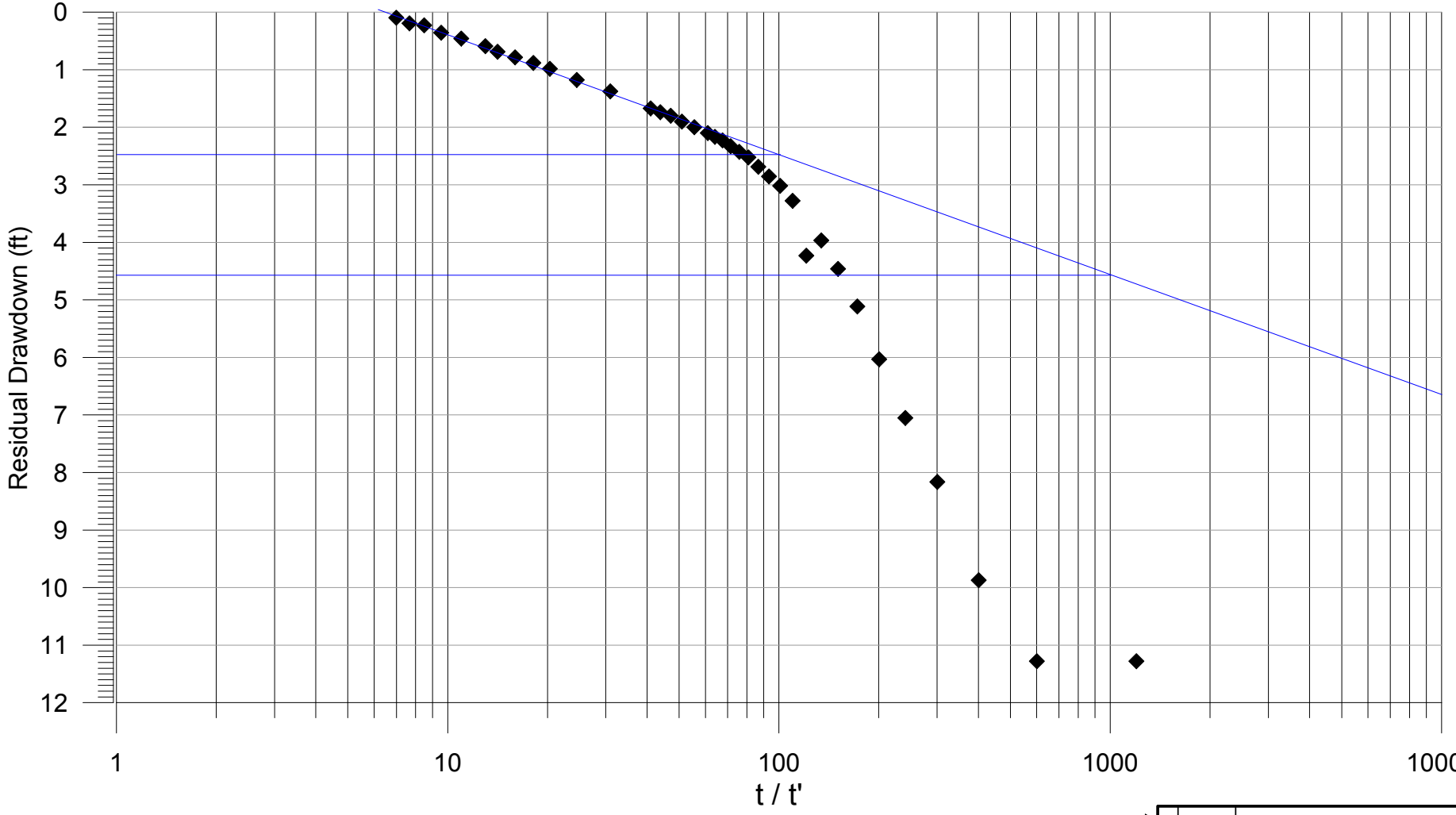
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
DRAWDOWN AT 15-RC-02

MAY 2017	APP D6-B-1-8	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-19_TH-EC-01WW1 Pump test\D6-B-1-08_2016-10-19_TH-EC-WW1_Pump Test_obs-15-RC-02.grf



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-01WW1
Recovery
Pump Rate (Q) = 7 USgpm

T =(264)(Q)/△s **T= 888 USgpd/ft**

△s= 2.08 ft Q = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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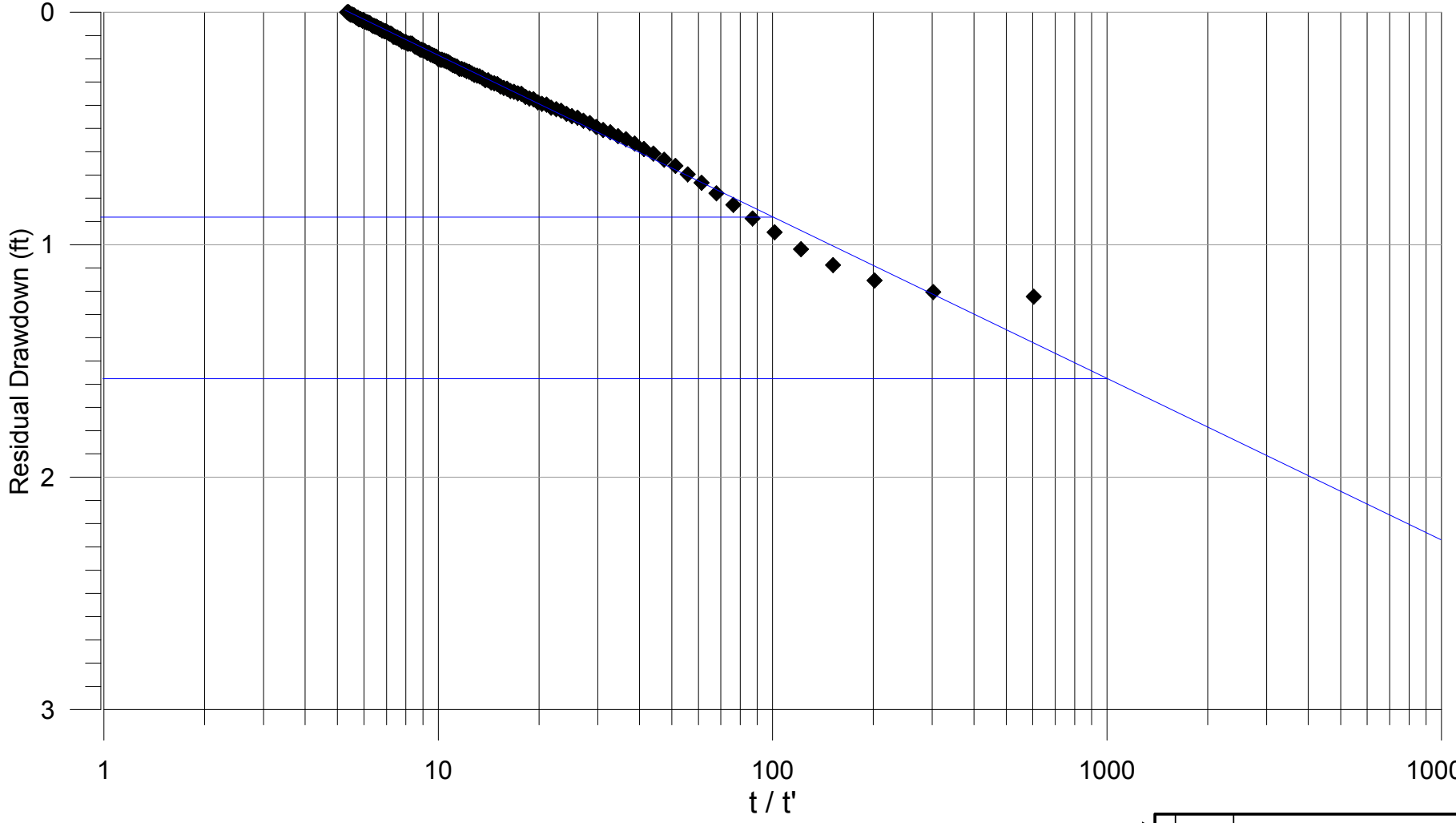
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT TH-EC-01WW1

MAY 2017	APP D6-B-1-9	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-19_TH-EC-01WW1 Pump test\D6-B-1-09_REC_WW1_WW1_Manual.grf



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-01WW2
Recovery
Pump Rate (Q) = 7 USgpm

T =(264)(Q)/△s **T= 2640 USgpd/ft**

△s= 0.7 ft Q = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT TH-EC-01WW2

MAY 2017	APP D6-B-1-10	REV: 0

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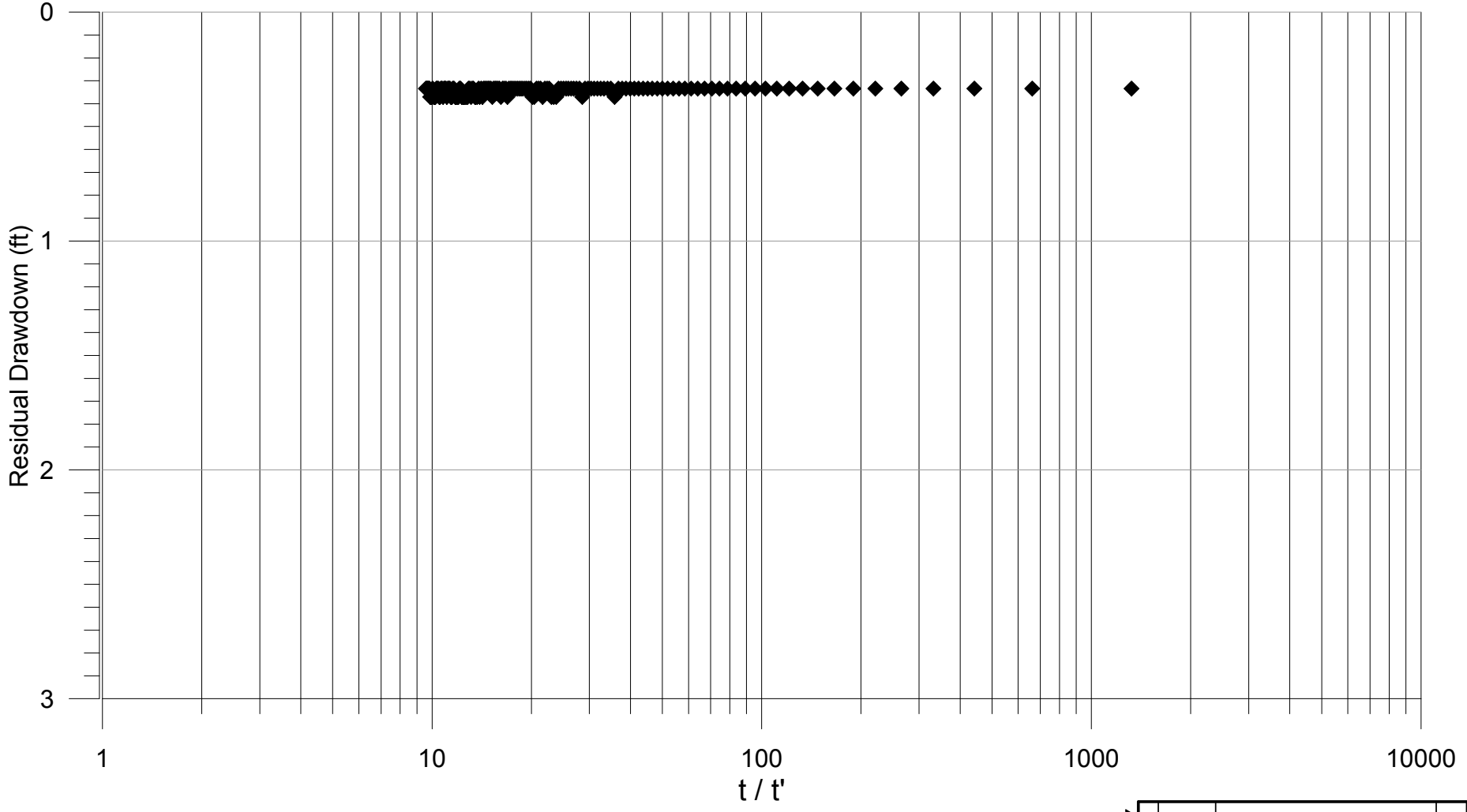

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: 15-RC-06
Recovery
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT 15-RC-02

MAY 2017	APP D6-B-1-11	REV: 0

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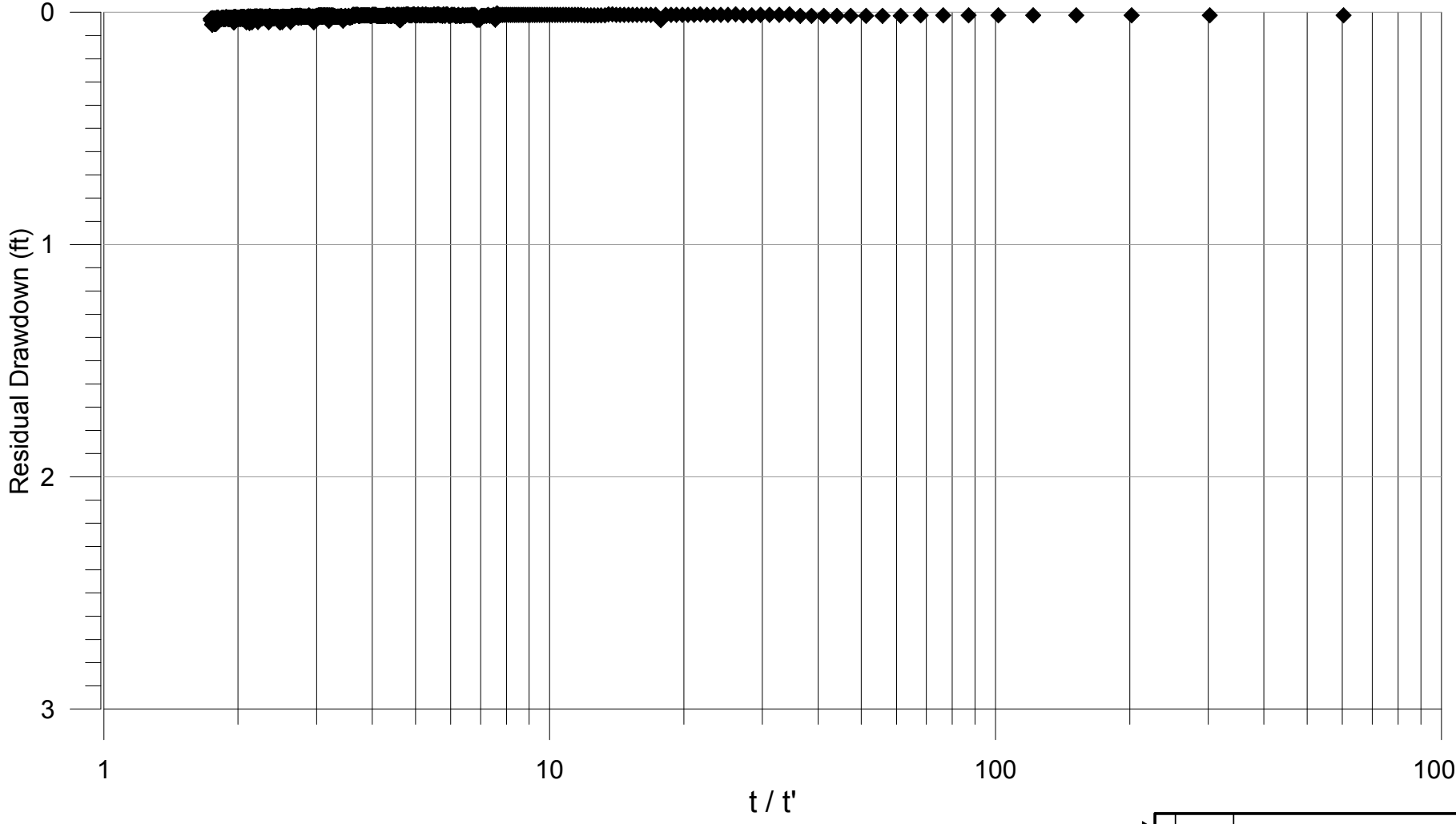

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: QUARRY
Recovery
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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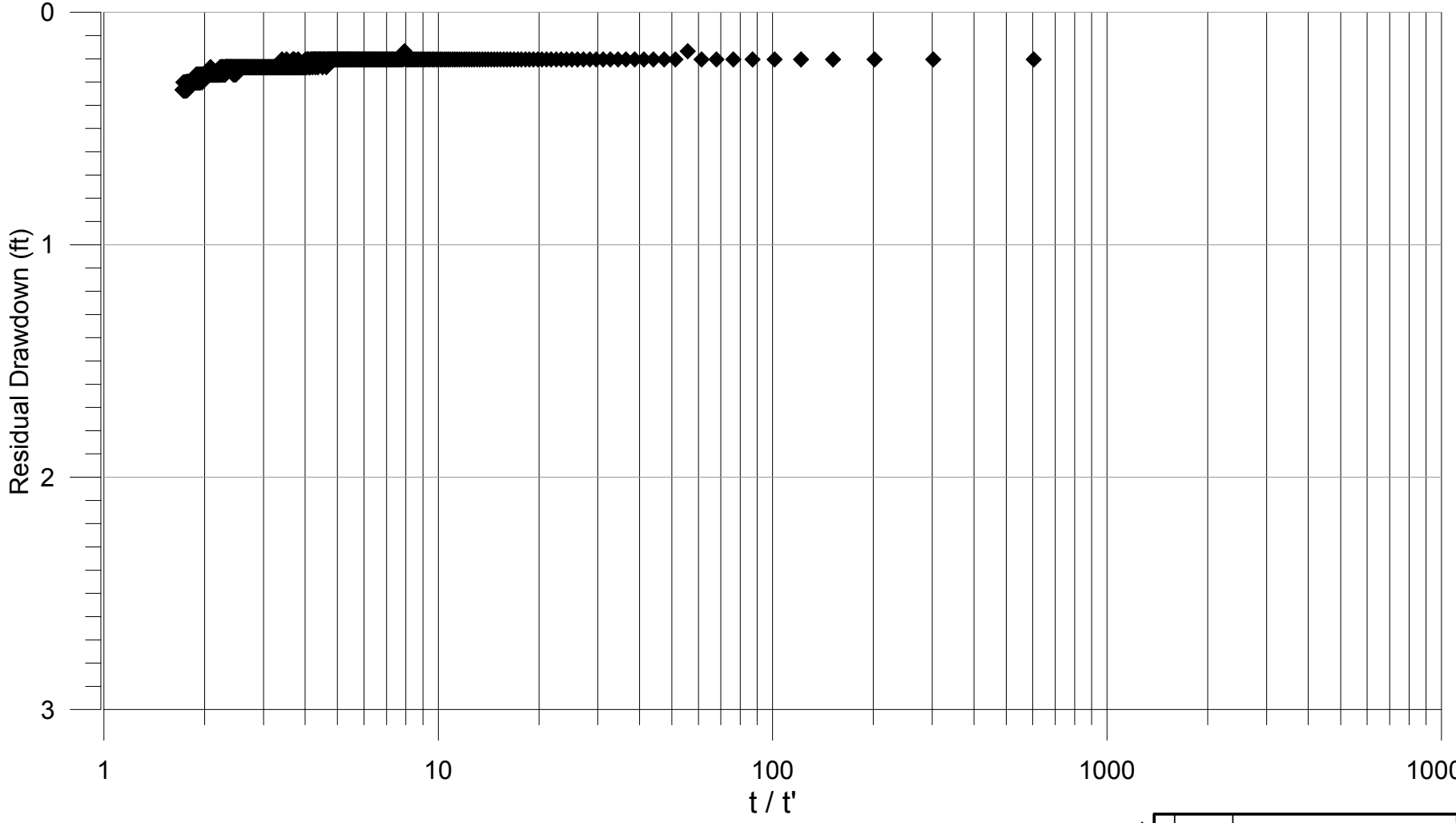
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT THE QUARRY

MAY 2017	APP D6-B-1-12	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-19_TH-EC-01WW1 Pump test\D6-B-1-12_REC_WW1_QUARRY.grf



Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-GC-02
Recovery
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT TH-GC-02

MAY 2017	APP D6-B-1-13	REV: 0

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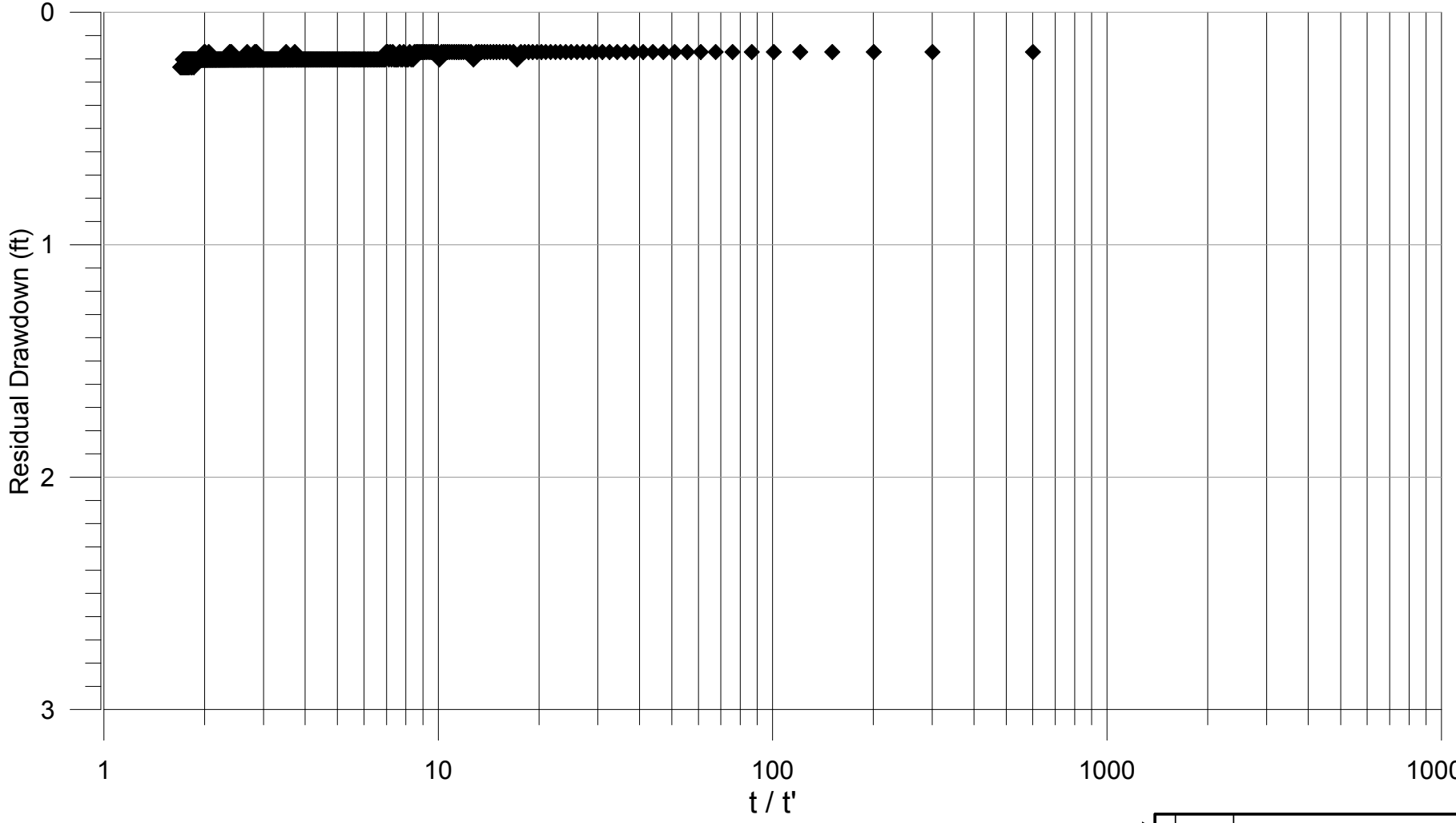

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-04
Recovery
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT TH-EC-04

MAY 2017	APP D6-B-1-14	REV: 0

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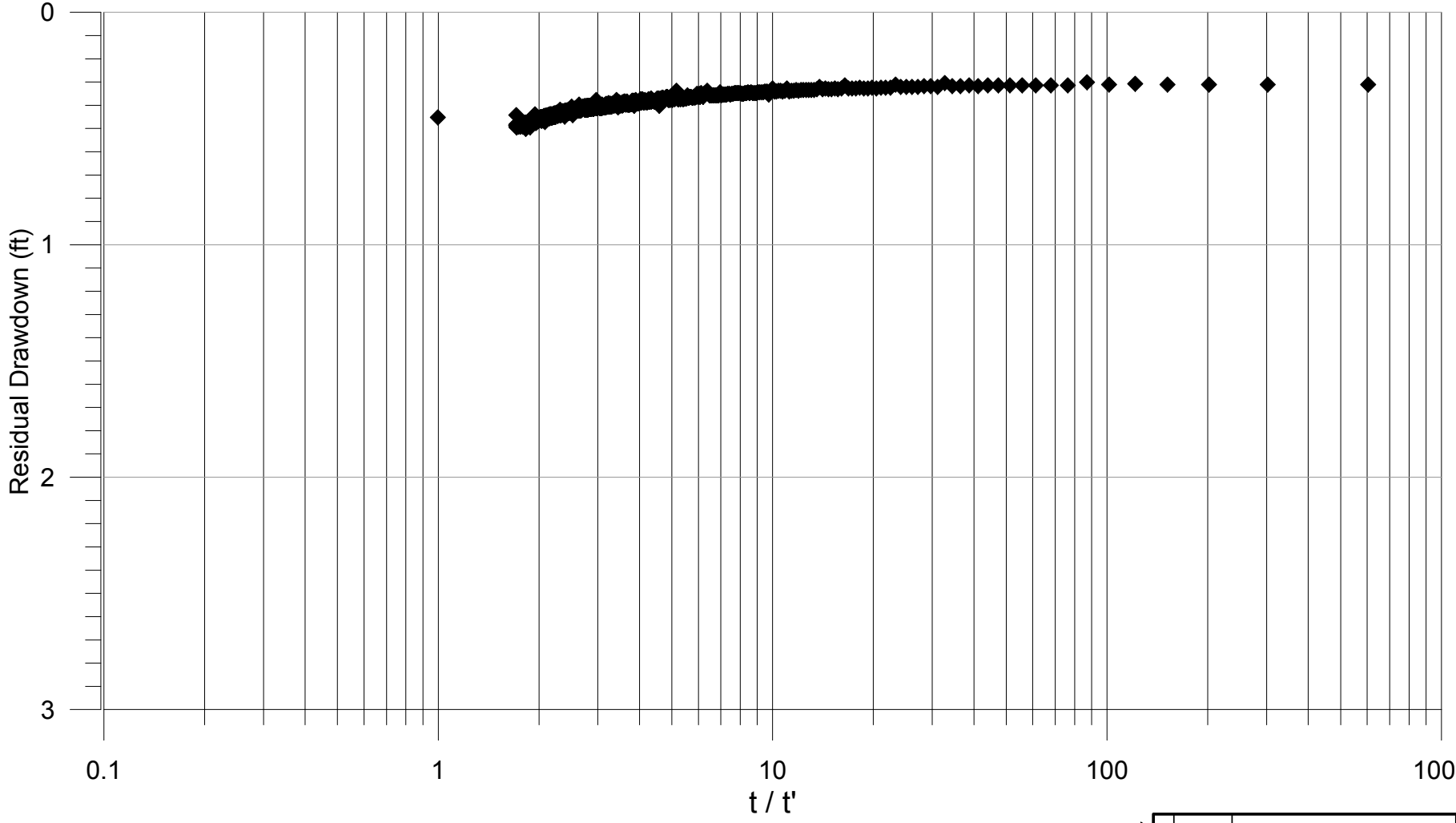

Notes:
Date: October 19, 2016
Pumping Well: TH-EC-01WW1
Observation: 15-RC-02
Recovery
Pump Rate (Q) = 7 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW1
RECOVERY AT 15-RC-02

MAY 2017	APP D6-B-1-15	REV: 0

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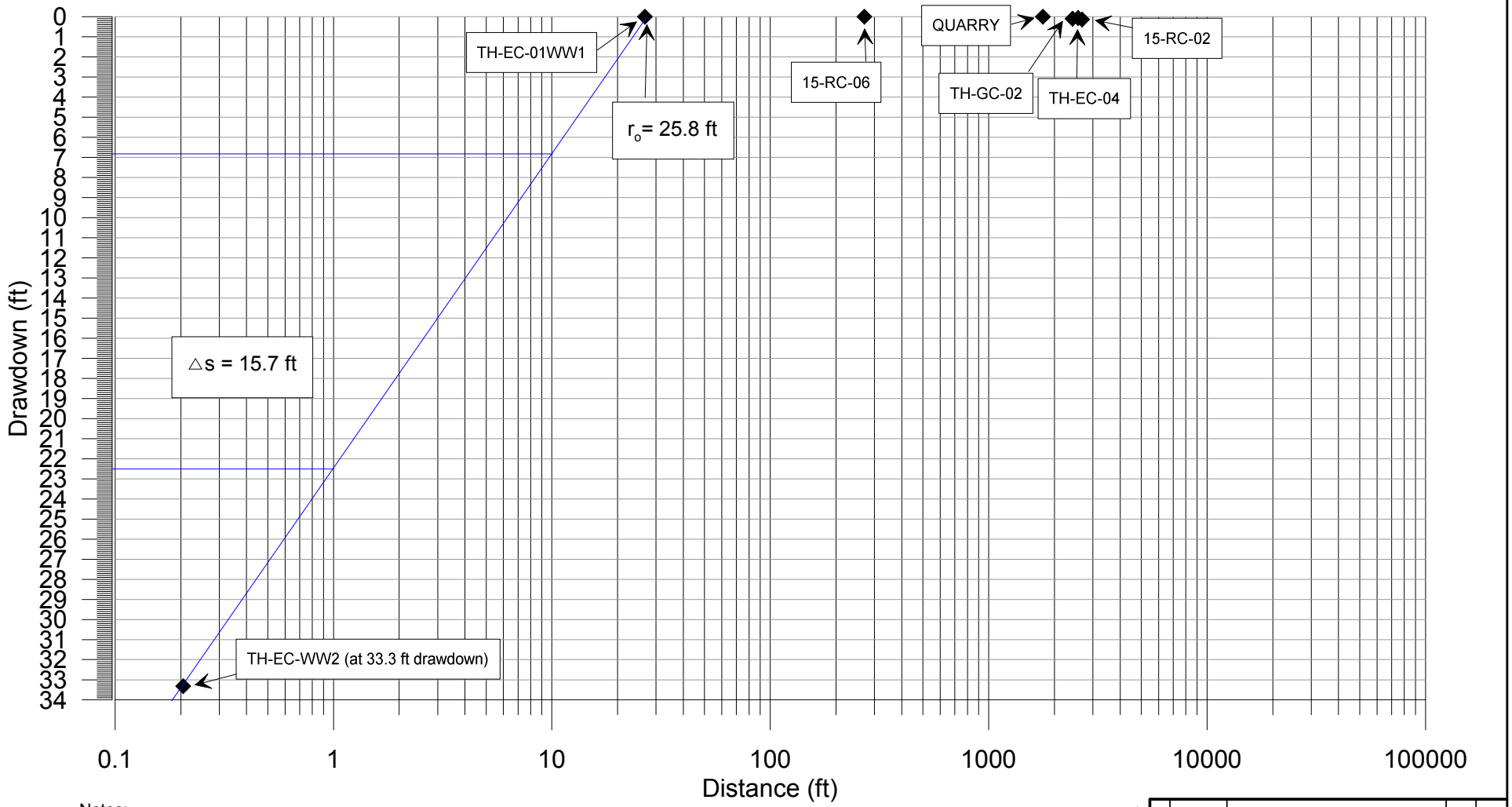
APPENDIX D6-B-2

PUMP TEST TH-EC01-WW2



Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Distance Drawdown
Pump Rate (Q) = 4 USgpm
Duration = 8 hr

$T = (528)(Q)/\triangle s$	**T= 135 USgpd/ft**
$\triangle s$= 15.7 ft	Q = 4 USgpm

$S = 0.3Tt/r_o^2$	$S = 2.01 \times 10^{-2}$
r_0 = 25.8 ft	t = 0.33 days

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DISTANCE DRAWDOWN

		REV:
MAY 2017	APP D6-B-2-1	0

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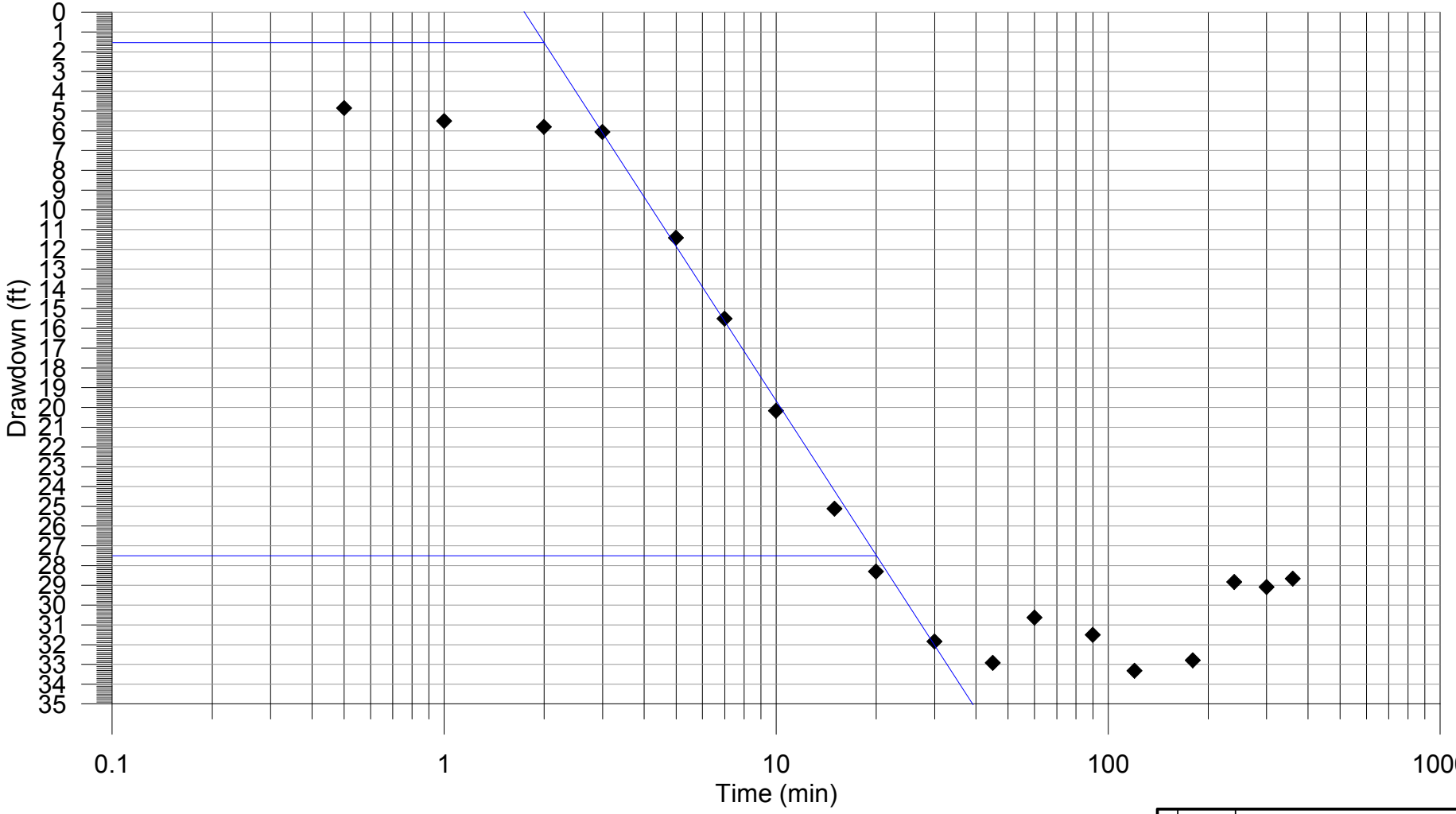

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: TH-EC-01WW2
Drawdown
Pump Rate (Q) = 4 USgpm

T =(264)(Q)/△s **T= 41 USgpd/ft**

△s= 26.0 ft Q = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT TH-EC-01WW2

MAY 2017	APP D6-B-2-2	REV: 0

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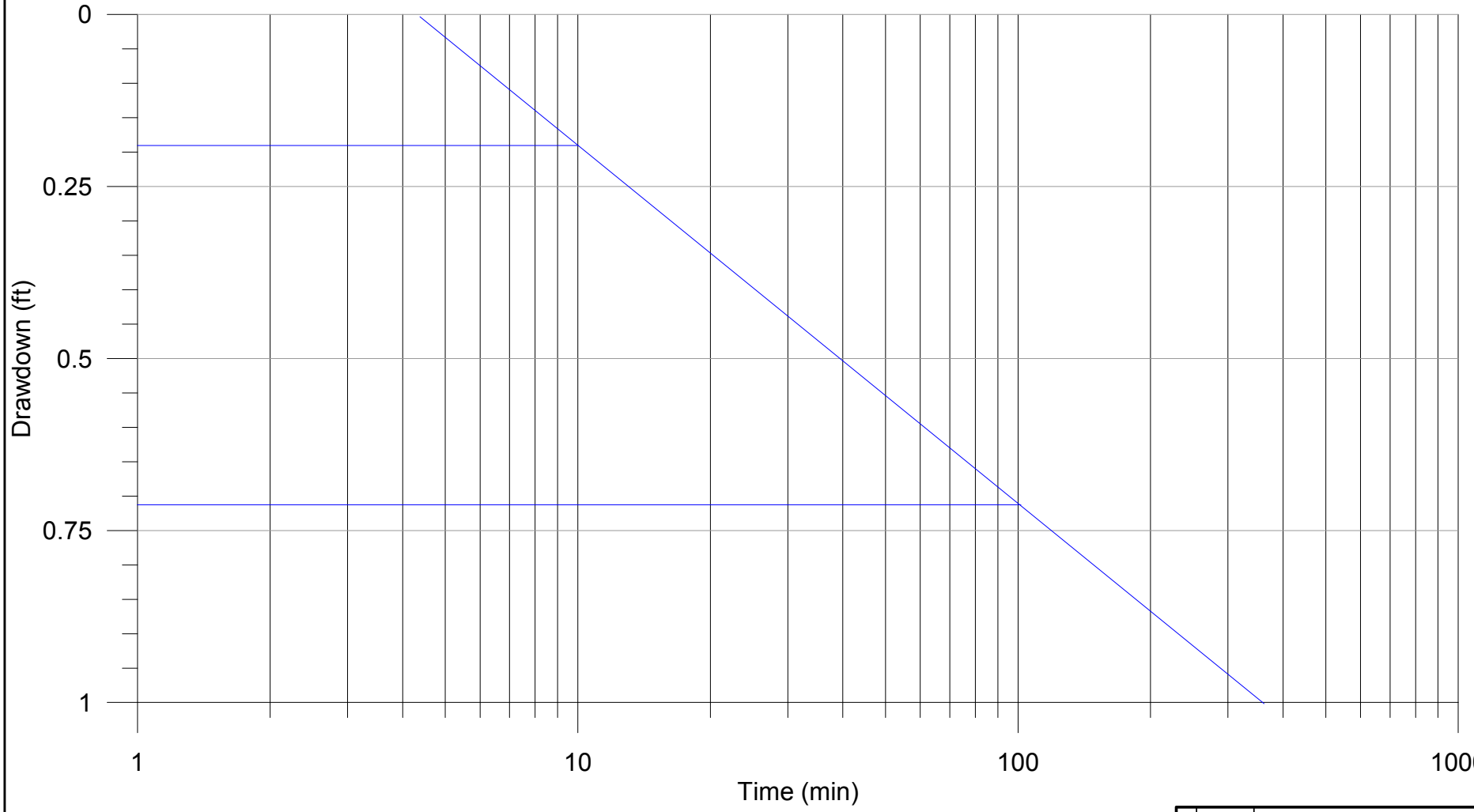

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: TH-EC-01WW1
Drawdown
Pump Rate (Q) = 4 USgpm

T =(264)(Q)/△s	**T= 1720 USgpd/ft**
△s= 0.614 ft	Q = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT TH-EC-01WW1

		REV:
MAY 2017	APP D6-B-2-3	0

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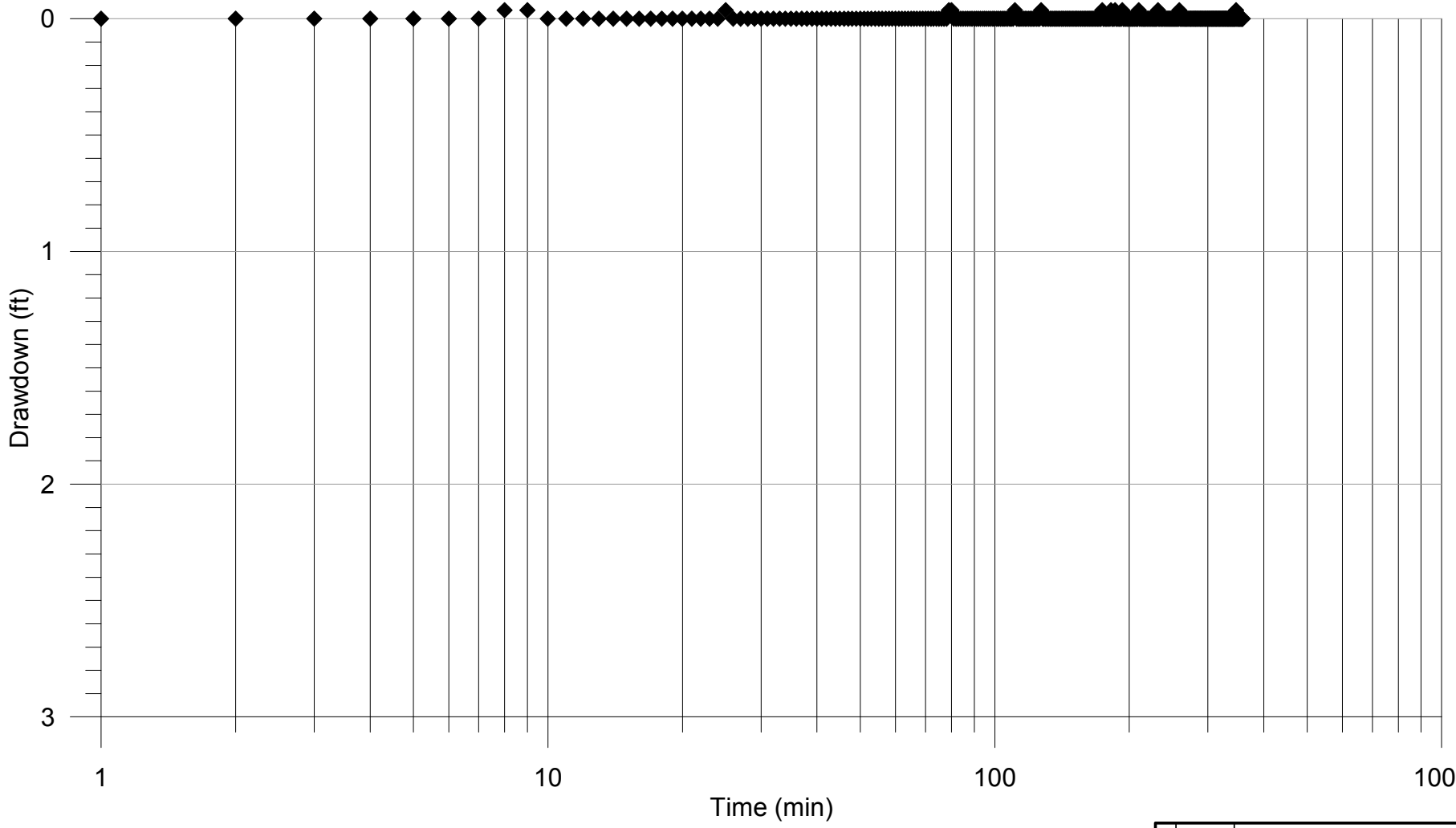

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: 15-RC-06
Drawdown
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT 15-RC-06

MAY 2017	APP D6-B-2-4	REV: 0

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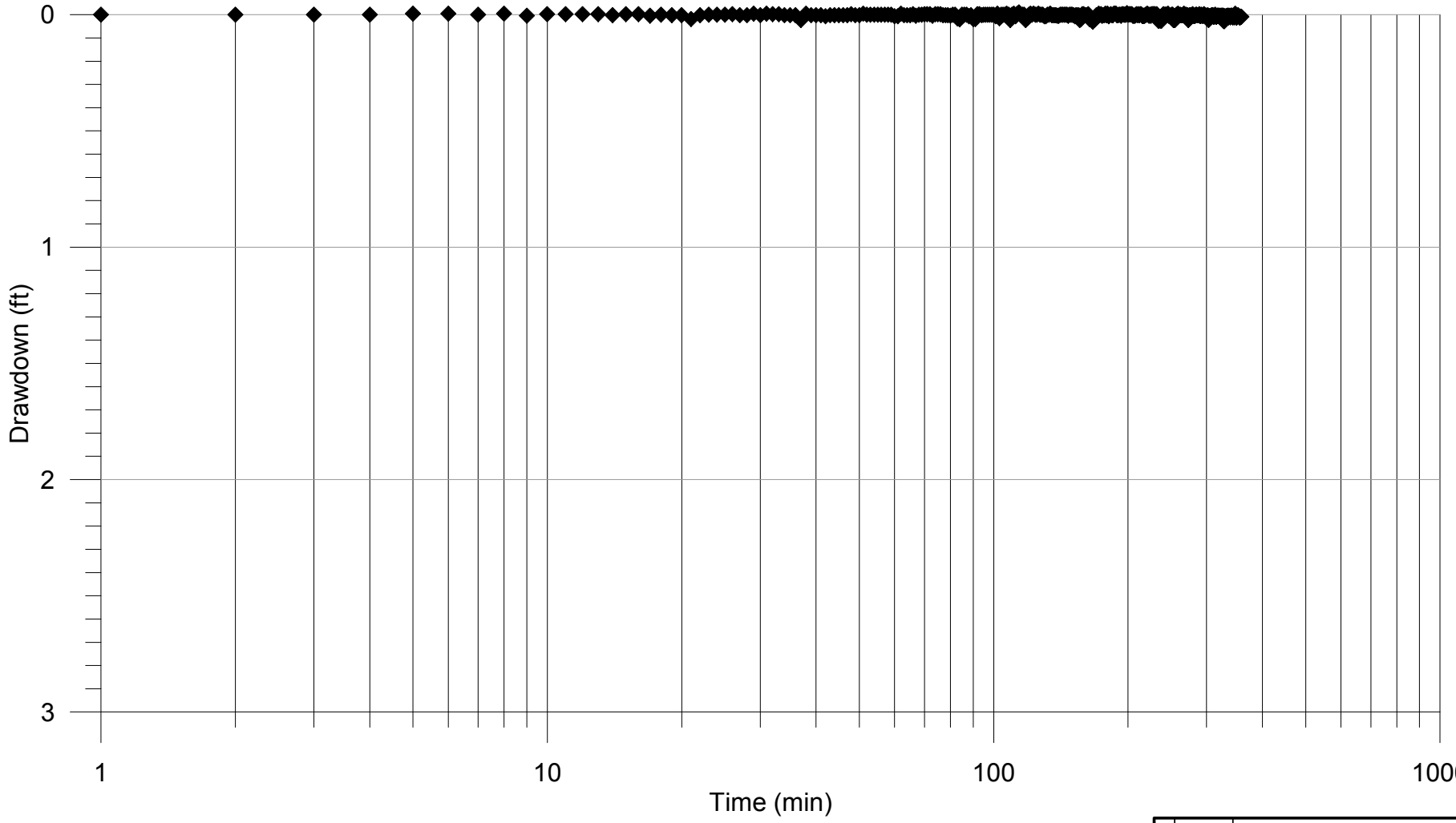

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: QUARRY
Drawdown
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT THE QUARRY

MAY 2017	APP D6-B-2-5	REV: 0

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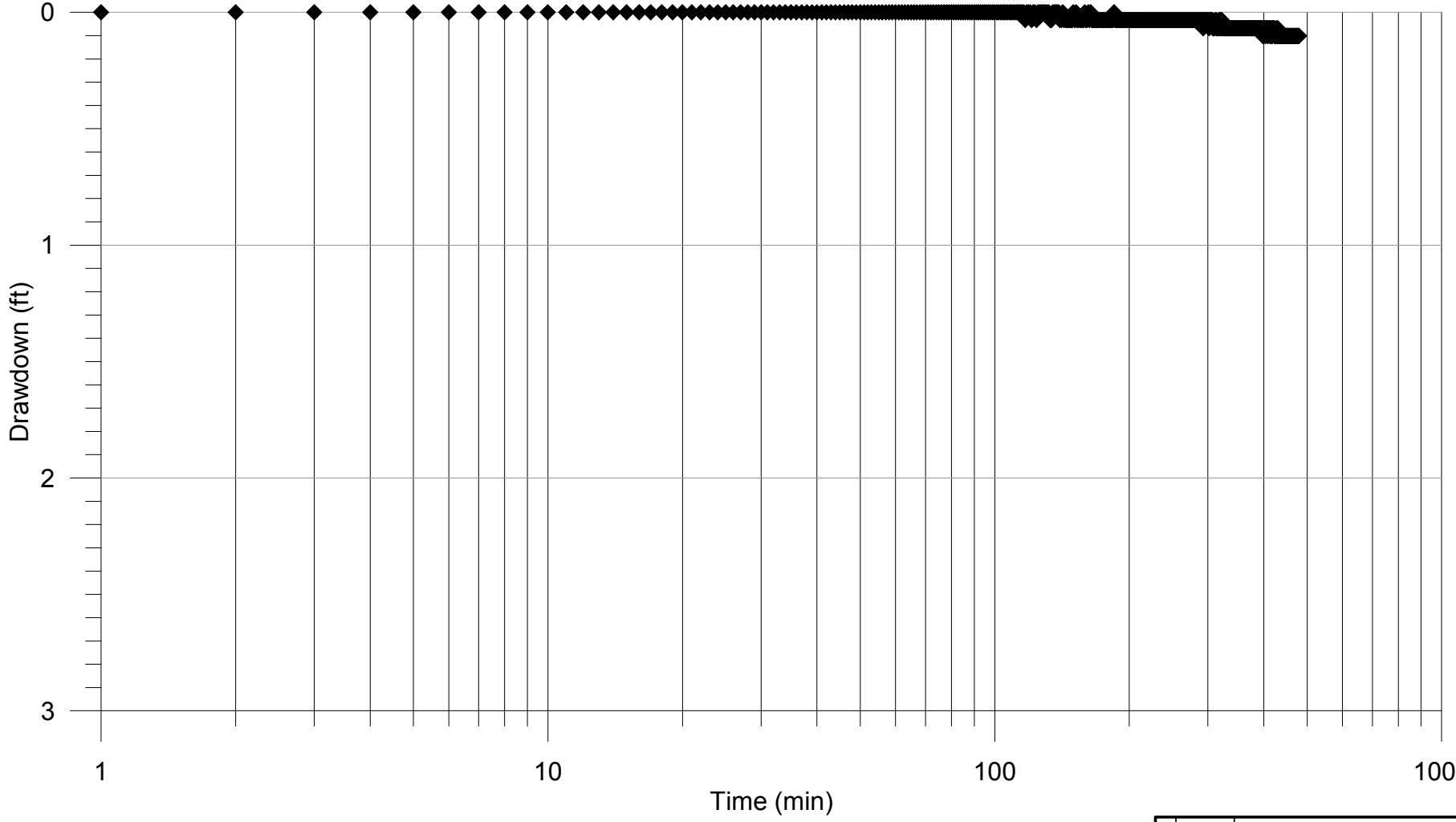

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: TH-GC-02
Drawdown
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT TH-GC-02

MAY 2017	APP D6-B-2-6	REV: 0

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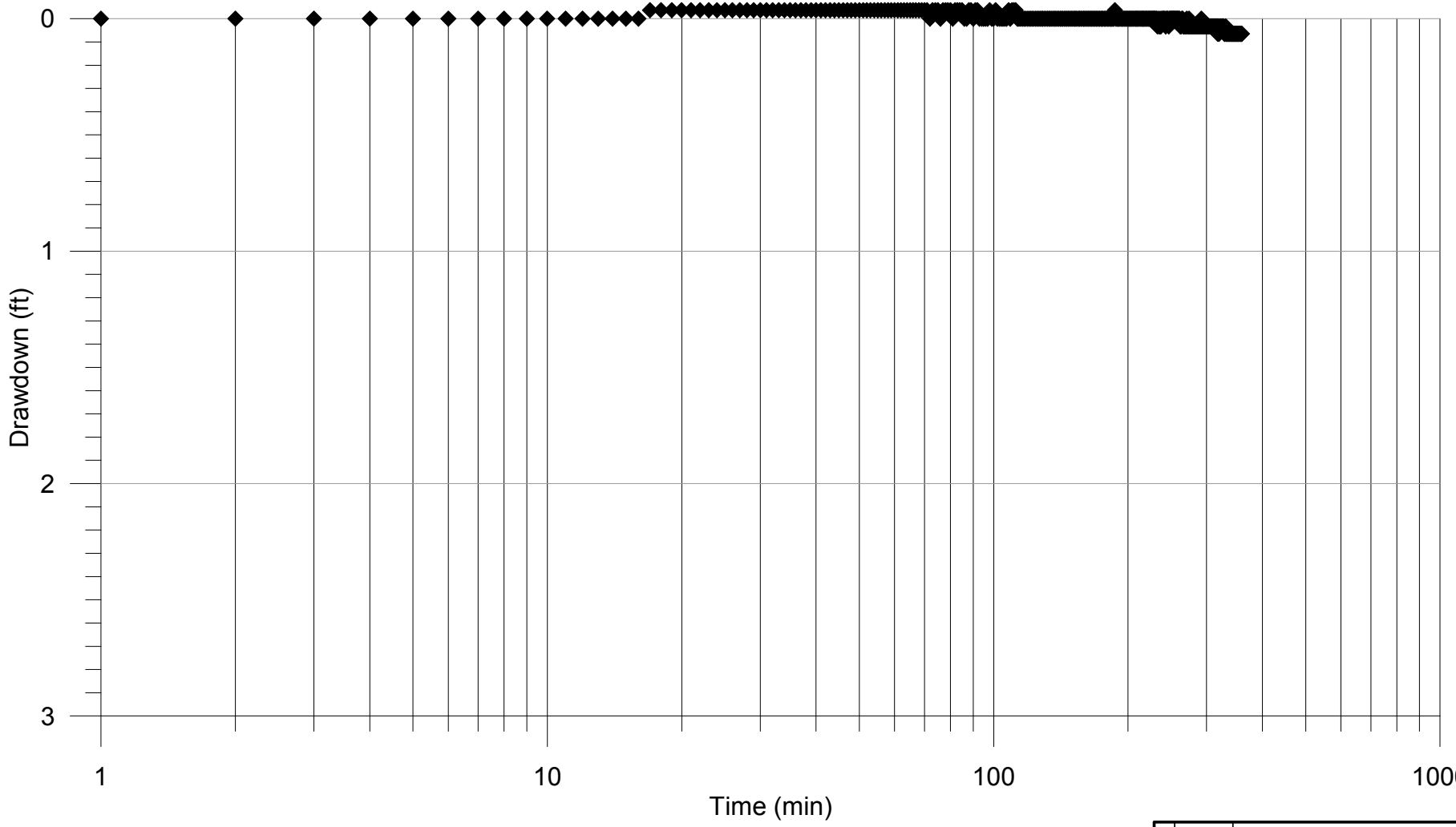

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: TH-EC-04
Drawdown
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT TH-EC-04

MAY 2017	APP D6-B-2-7	REV: 0

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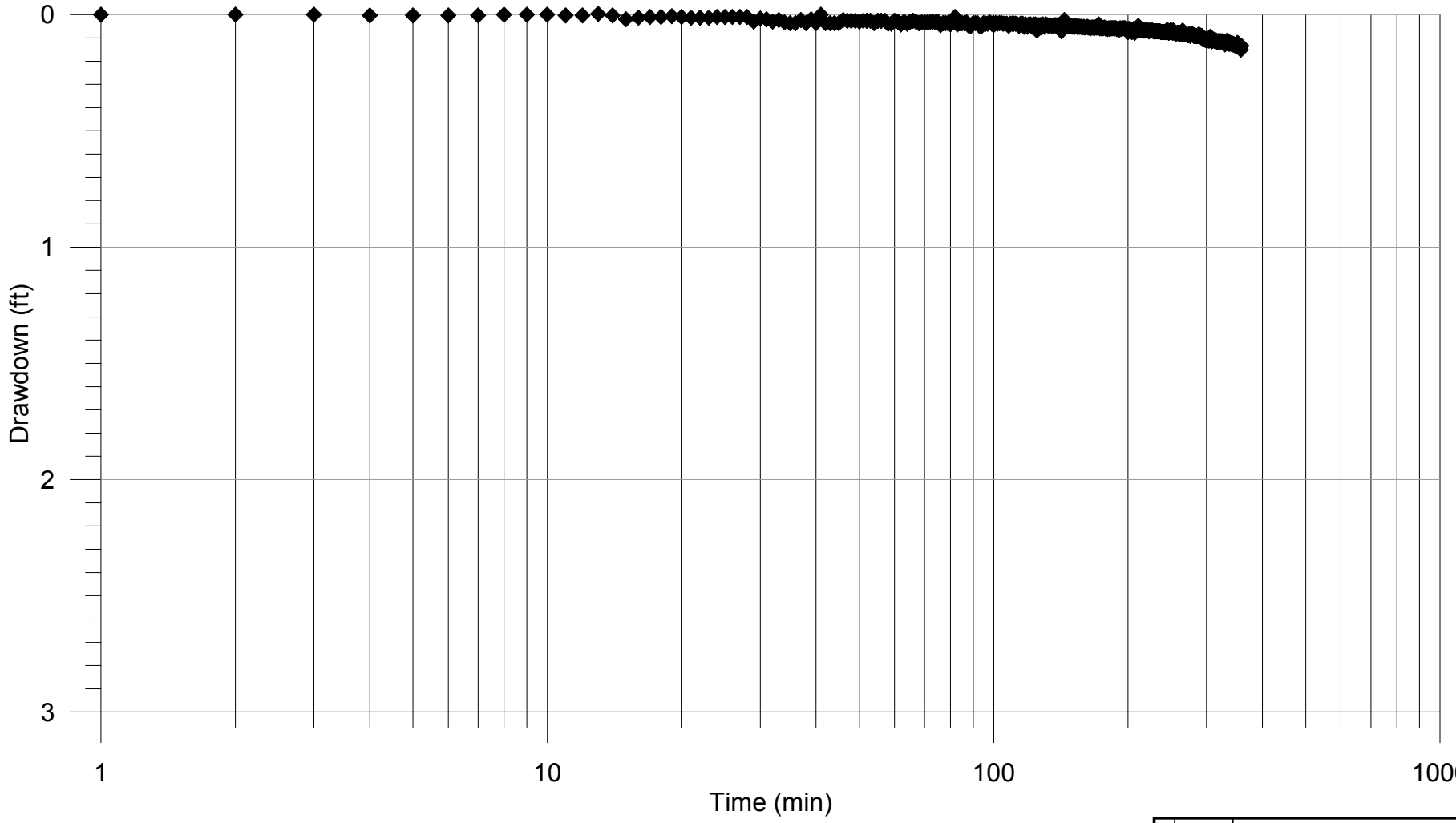

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: 15-RC-02
Drawdown
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
DRAWDOWN AT 15-RC-02

MAY 2017	APP D6-B-2-8	REV: 0

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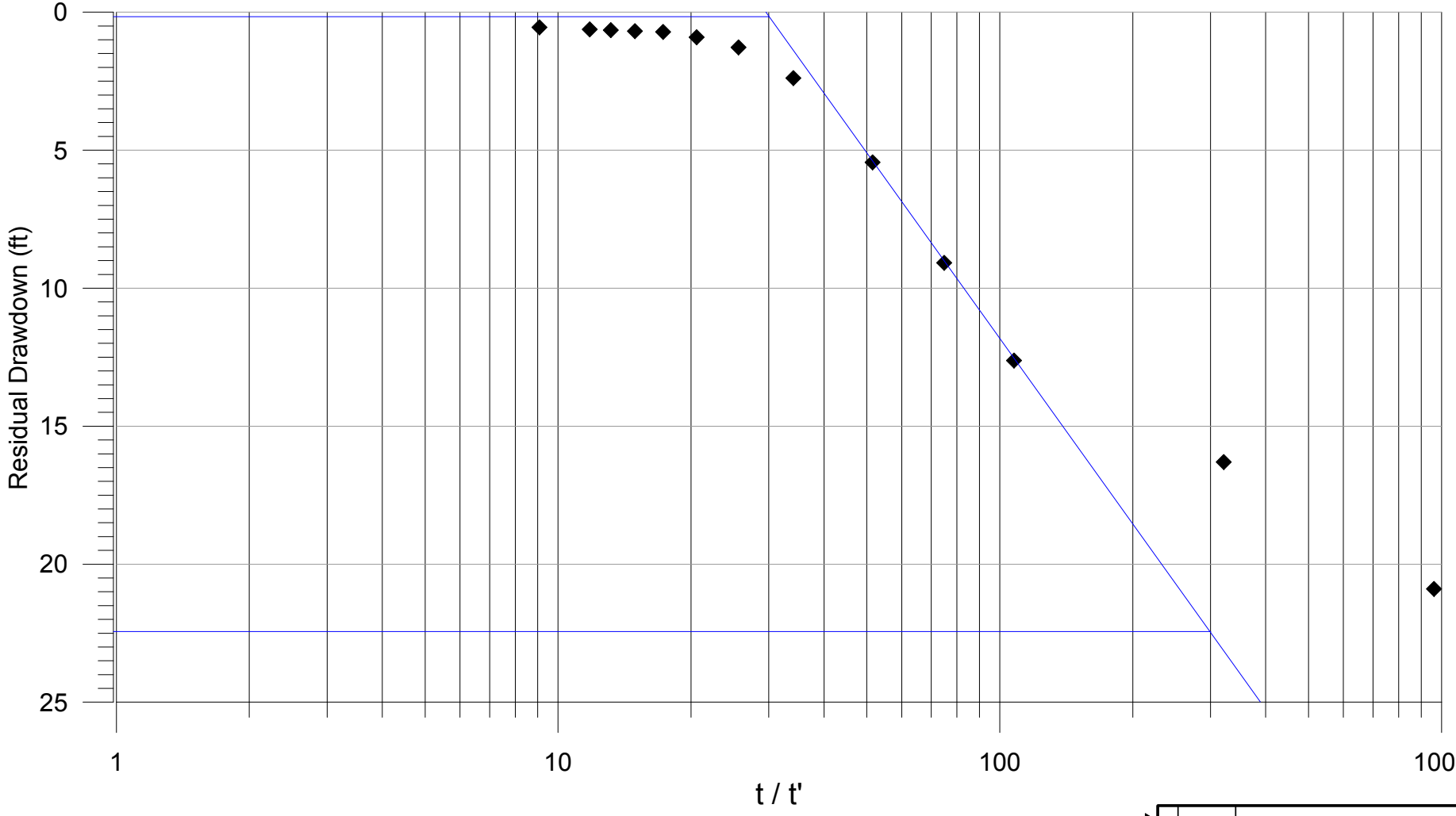

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: TH-EC-01WW2
Recovery
Pump Rate (Q) = 4 USgpm

T =(264)(Q)/△s **T= 43 USgpd/ft**

△s= 24.7 ft Q = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT TH-EC-01WW2

MAY 2017	APP D6-B-2-9	REV: 0

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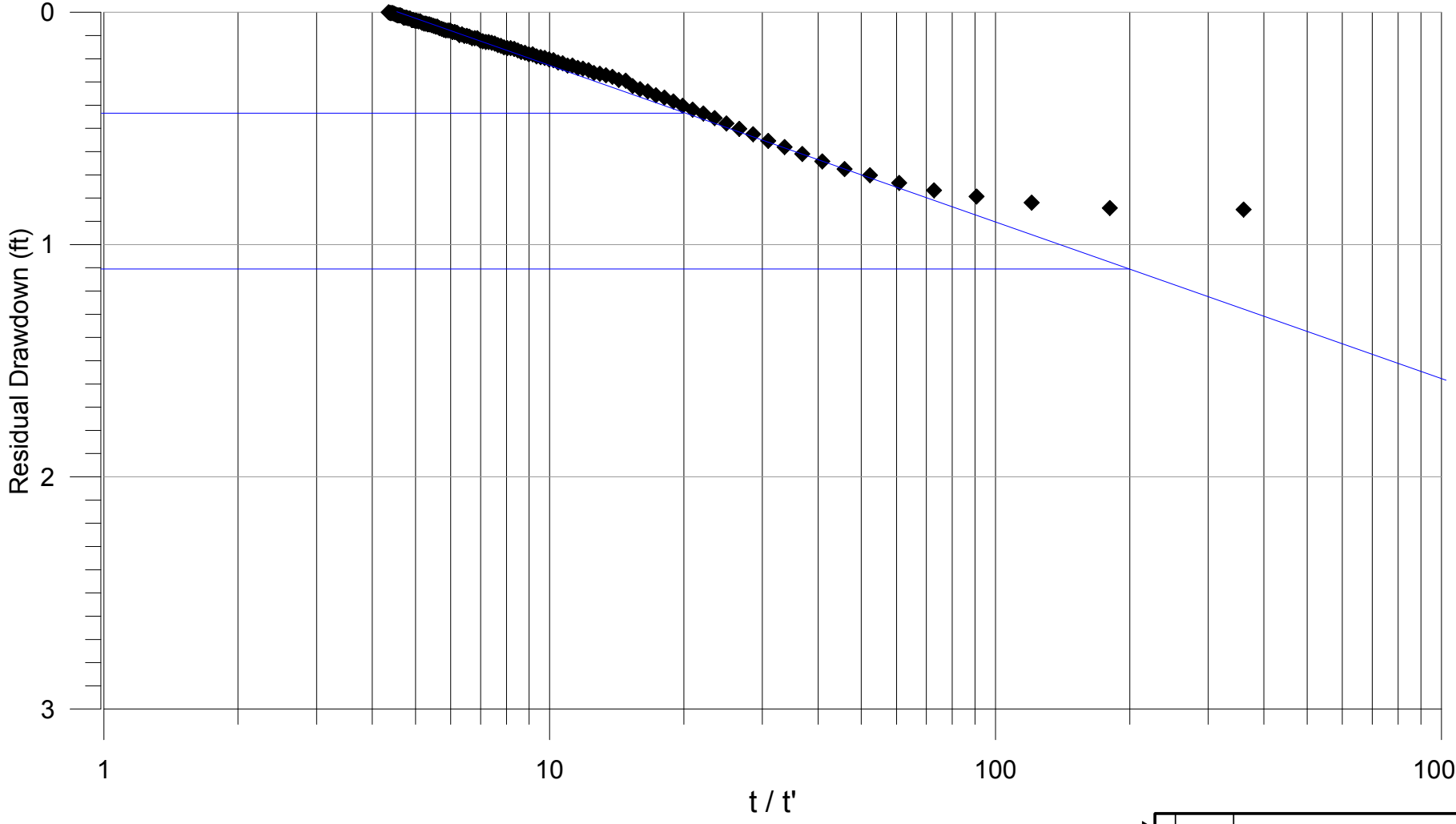

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: TH-EC-01WW1
Recovery
Pump Rate (Q) = 4 USgpm

T =(264)(Q)/△s **T= 1553 USgpd/ft**

△s= 0.68 ft Q = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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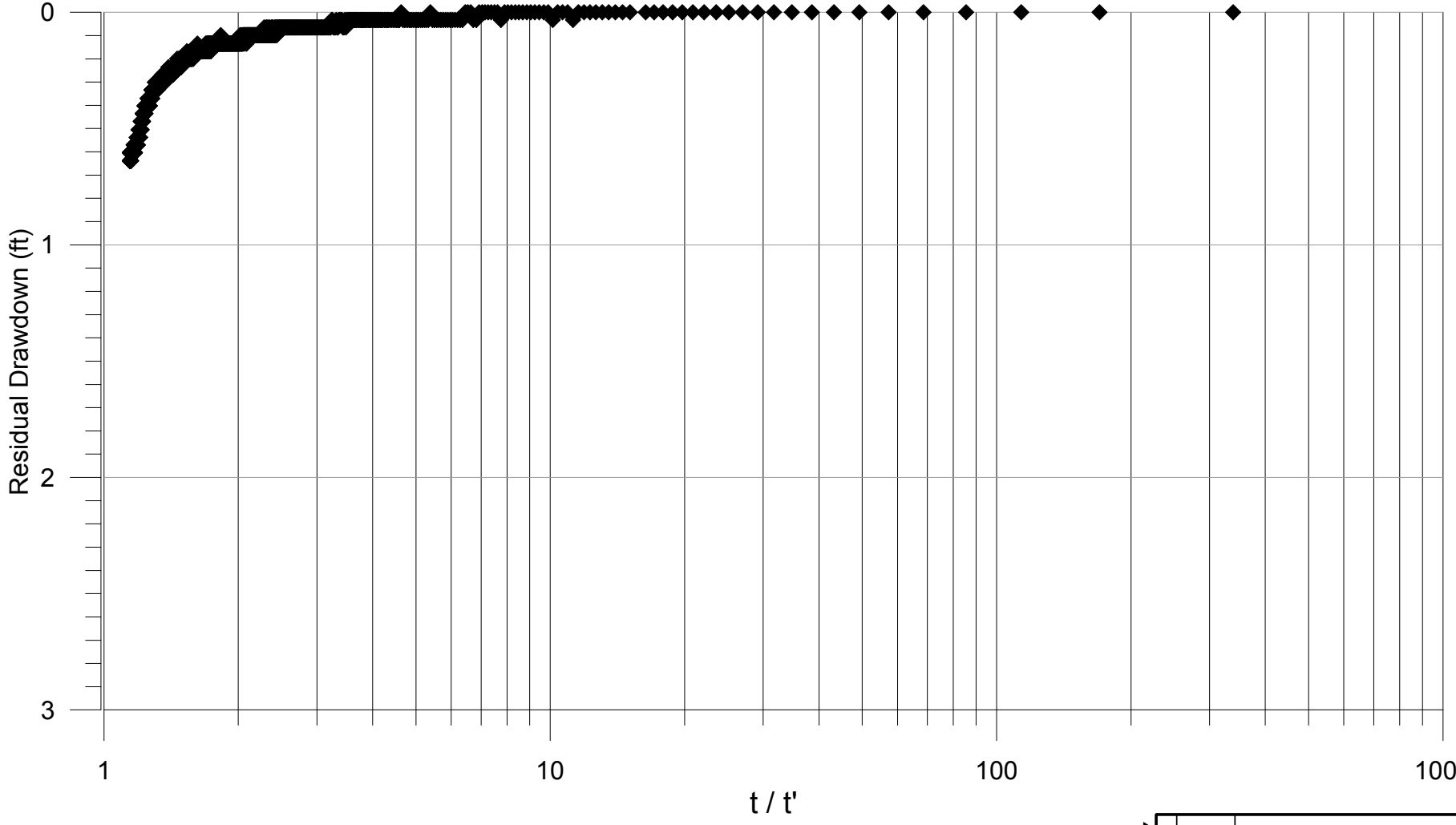
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT TH-EC-01WW1

MAY 2017	APP D6-B-2-10	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-18_TH-EC-01WW2 Pump Test\D6-B-2-10_REC_Pump-TH-EC-01WW2_Obs-TH-EC-01WW1.grf



Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: 15-RC-06
Recovery
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

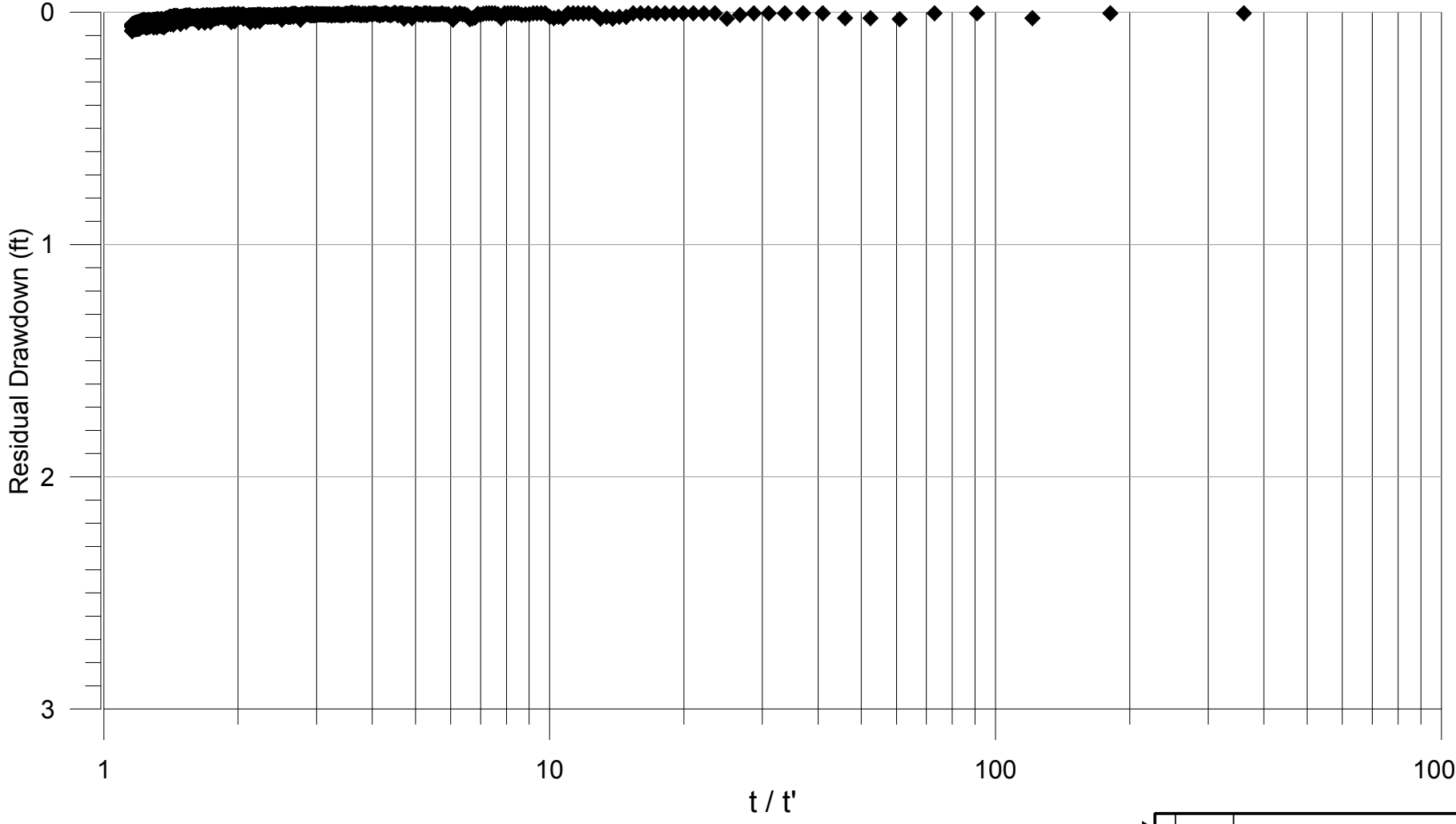
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT 15-RC-06

MAY 2017	APP D6-B-2-11	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-18_TH-EC-01WW2 Pump Test\D6-B-2-11_REC_Pump-TH-EC-01WW2_Obs-15-RC-06.grf



Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: QUARRY
Recovery
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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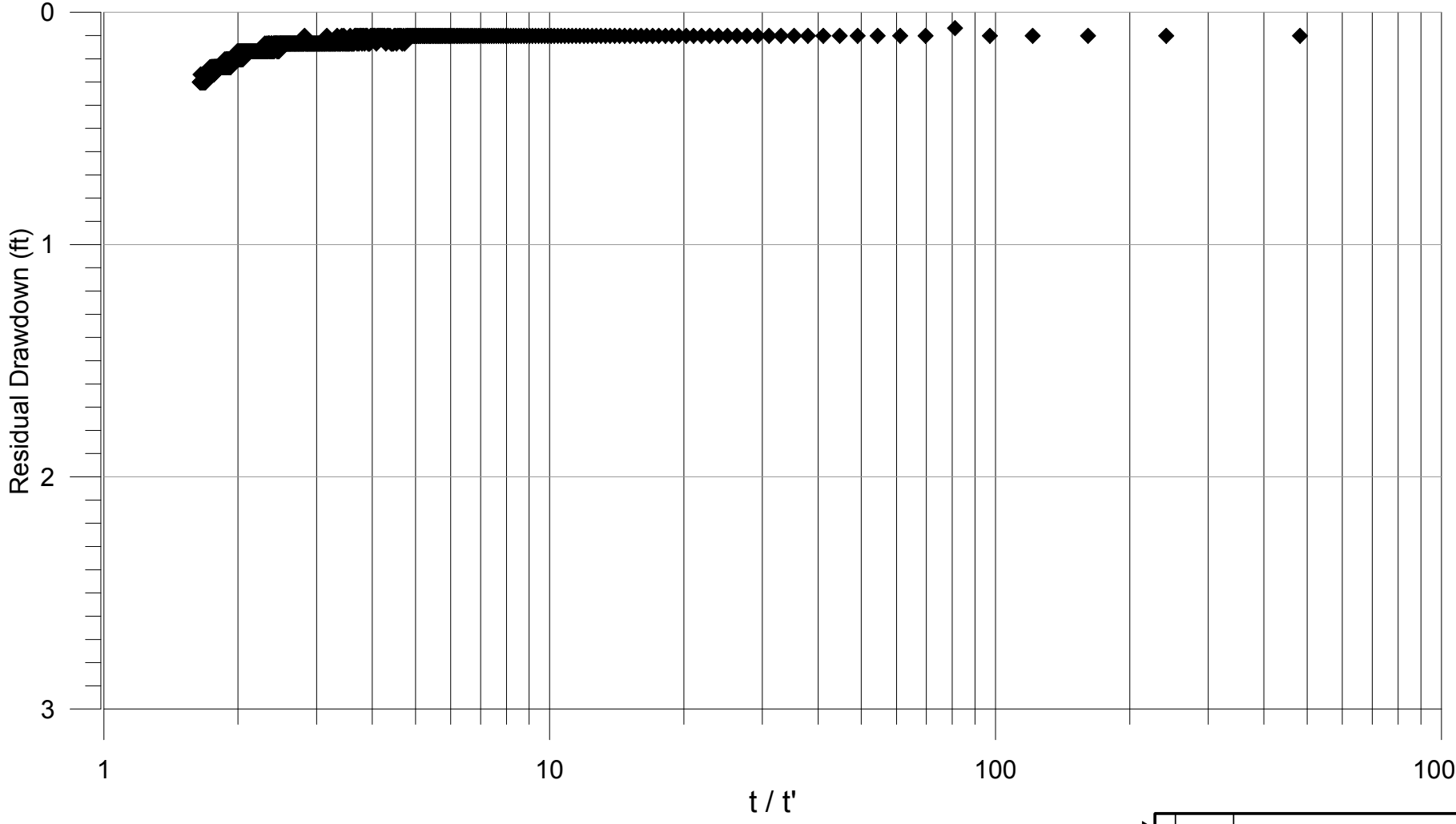
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT THE QUARRY

MAY 2017	APP D6-B-2-12	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-18_TH-EC-01WW2 Pump Test\D6-B-2-12_REC_Pump-TH-EC-01WW2_Obs-QUARRY.grf



Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-GC-02
Recovery
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT TH-GC-02

MAY 2017	APP D6-B-2-13	REV: 0

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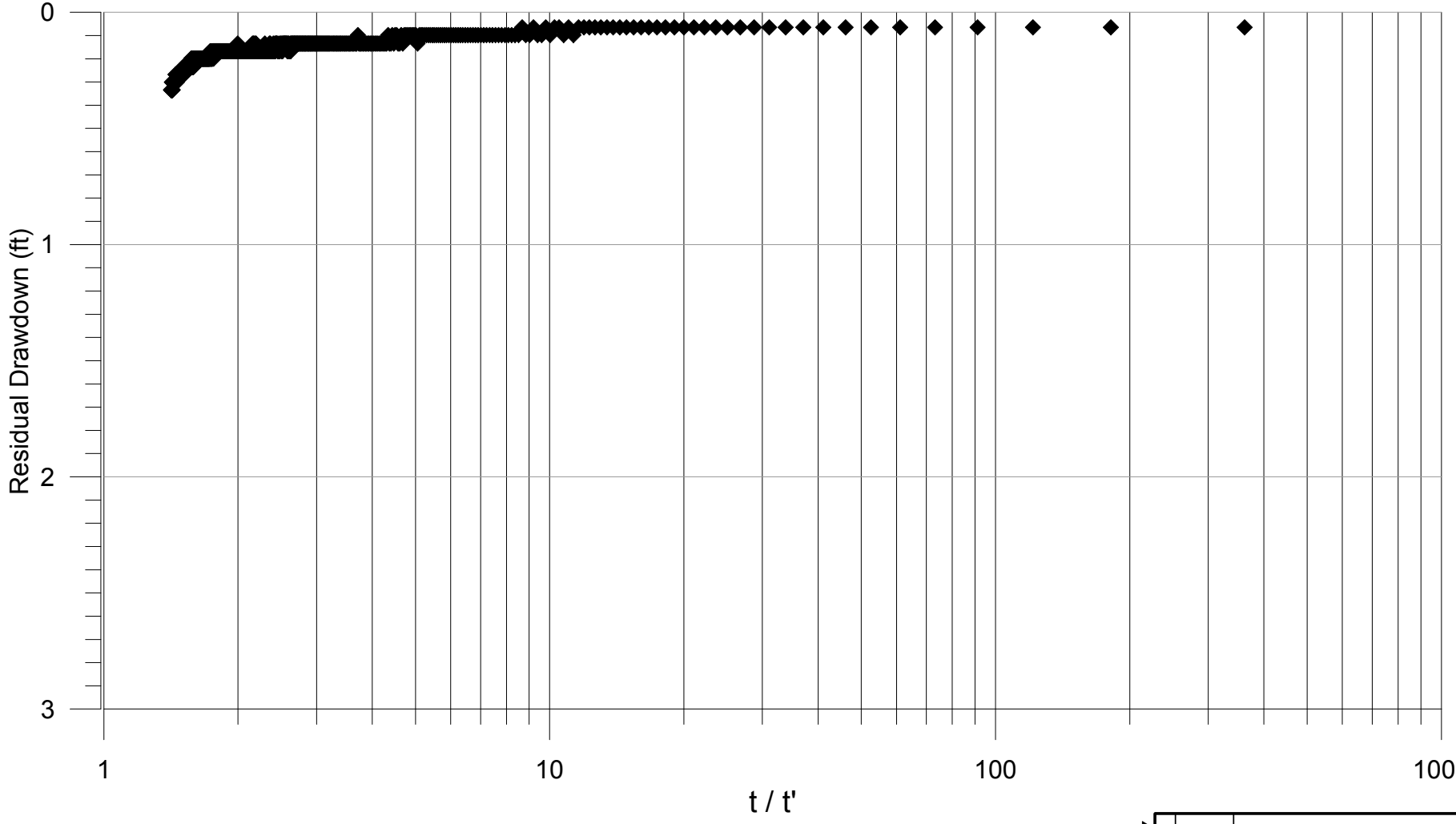

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW1
Observation: TH-EC-04
Recovery
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT TH-EC-04

MAY 2017	APP D6-B-2-14	REV: 0

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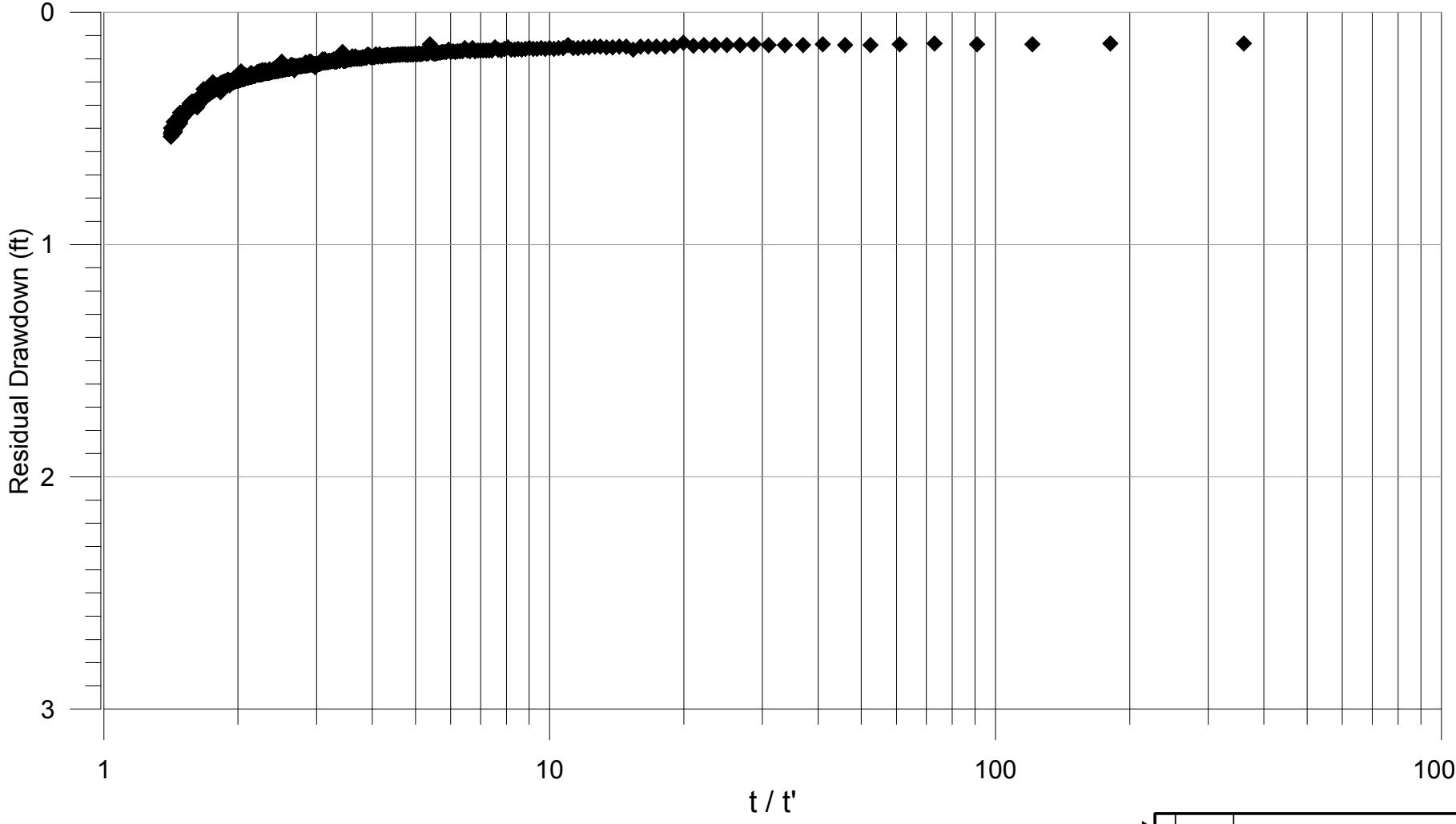

Notes:
Date: October 18, 2016
Pumping Well: TH-EC-01WW2
Observation: 15-RC-02
Recovery
Pump Rate (Q) = 4 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-01WW2
RECOVERY AT 15-RC-02

MAY 2017	APP D6-B-2-15	REV: 0

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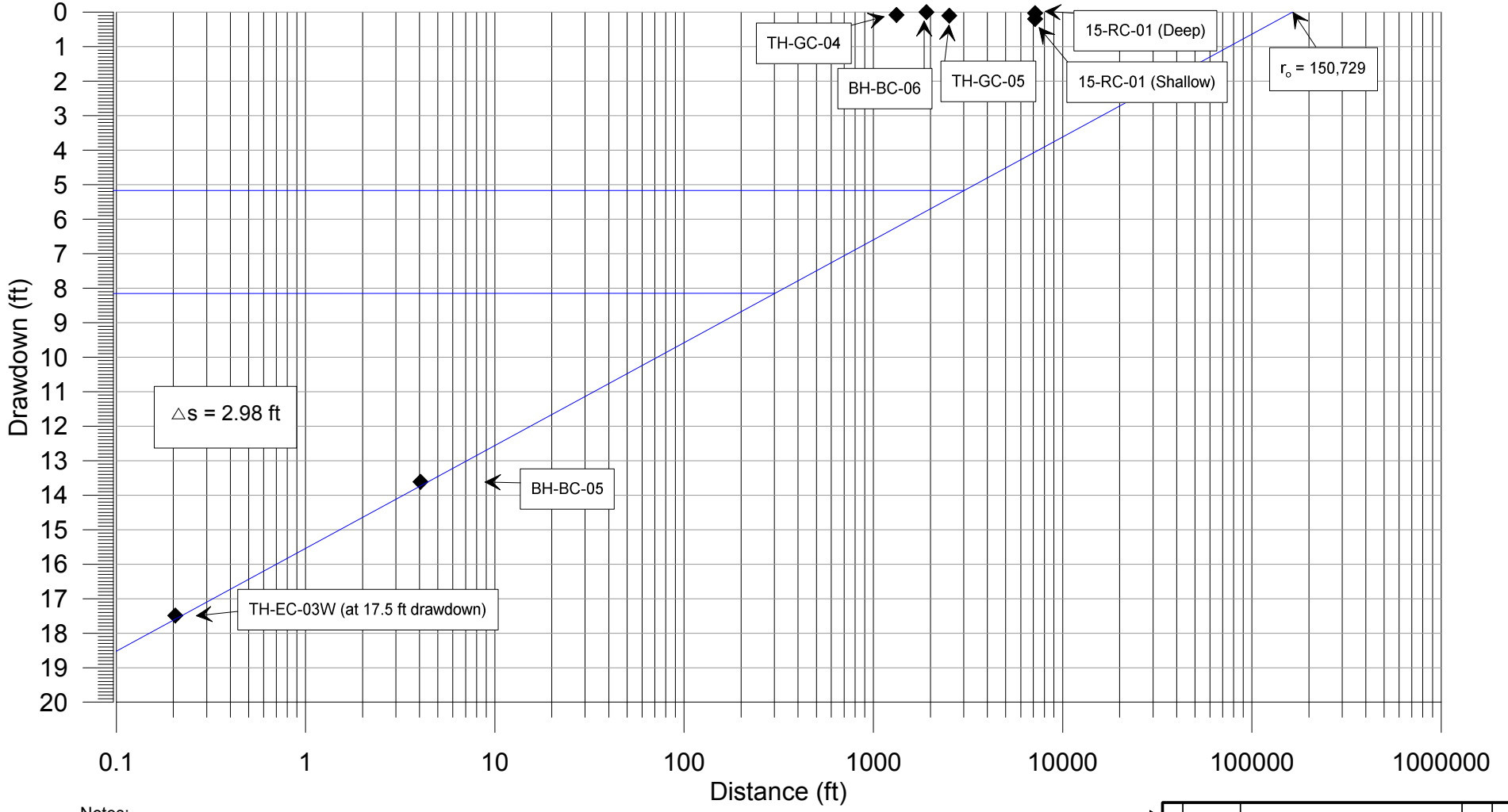
APPENDIX D6-B-3

PUMP TEST TH-EC03



Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Distance Drawdown
Pump Rate (Q) = 15 USgpm
Duration = 6.17 hr

$T = (528)(Q)/\triangle s$	**T= 1240 USgpd/ft**
$\triangle s$= 2.98 ft	Q = 7 USgpm

$S = 0.3Tt/r_o^2$	$S = 4.78 \times 10^{-9}$
r_0 = 150,729 ft	t = 0.292 days

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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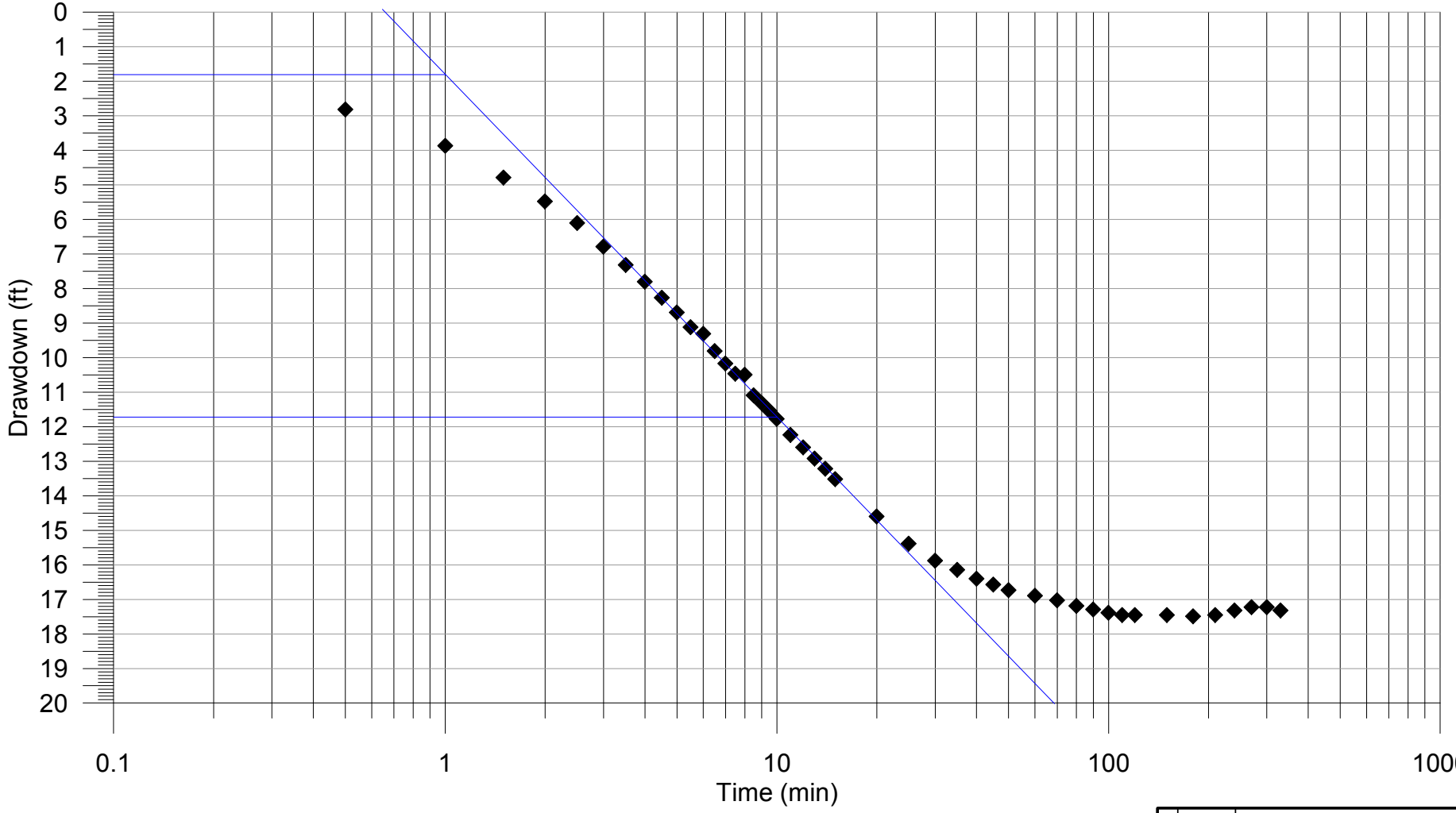
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
DISTANCE DRAWDOWN

MAY 2017	APP D6-B-3-1	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-27_TH-EC-03_Pump Test\D6-B-3-01_2016-10-27_TH-EC-03W_Pump Test_Distance Drawdown.grf



Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: TH-EC-03W
Drawdown
Pump Rate (Q) = 15 USgpm

T =(264)(Q)/△s **T= 400 USgpd/ft**

△s= 9.9 ft Q = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
DRAWDOWN AT TH-EC-03W

MAY 2017	APP D6-B-3-2	REV: 0

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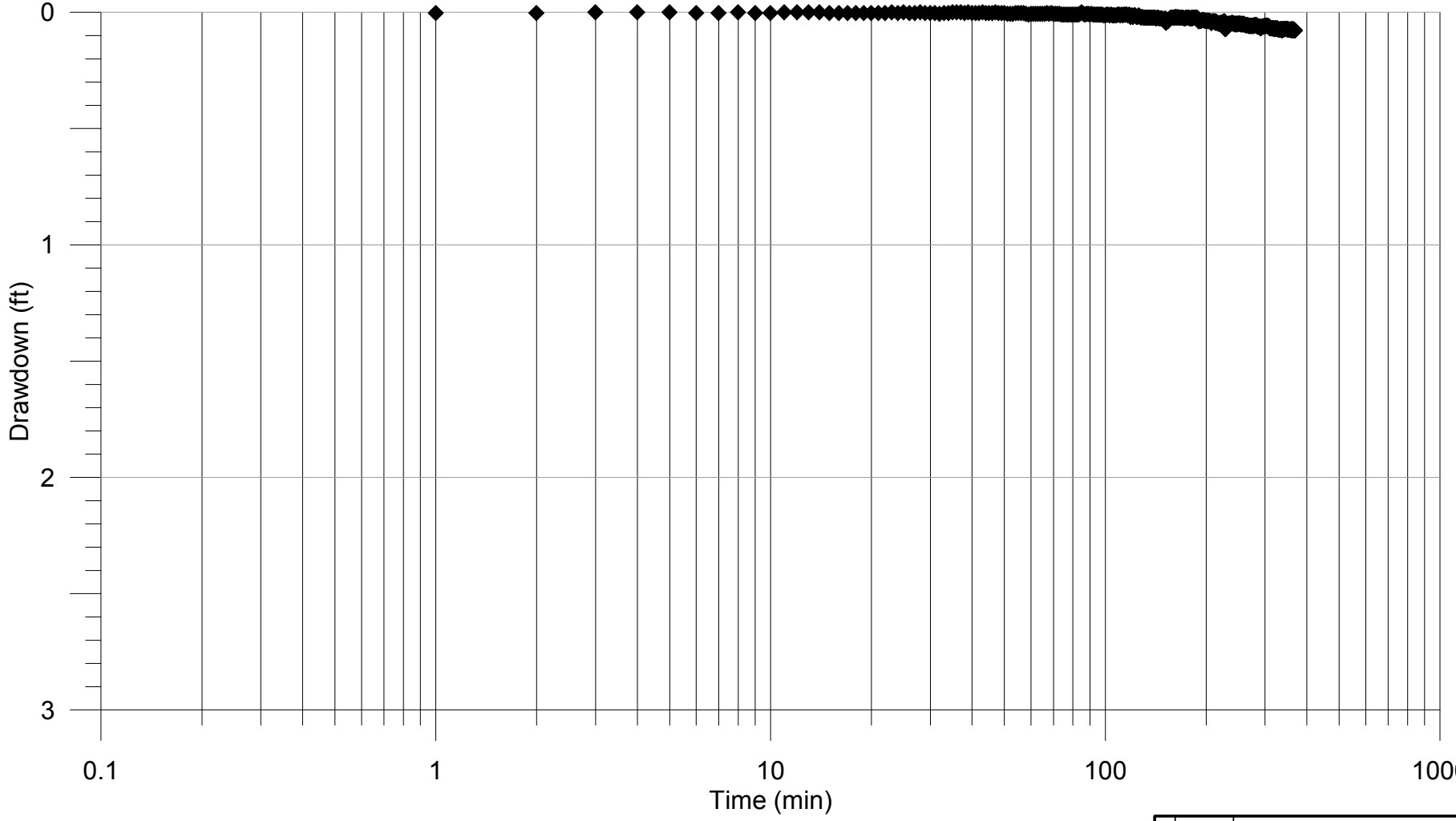

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-01W
Observation: TH-GC-04
Drawdown
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
DRAWDOWN AT TH-GC-04

MAY 2017	APP D6-B-3-3	REV: 0

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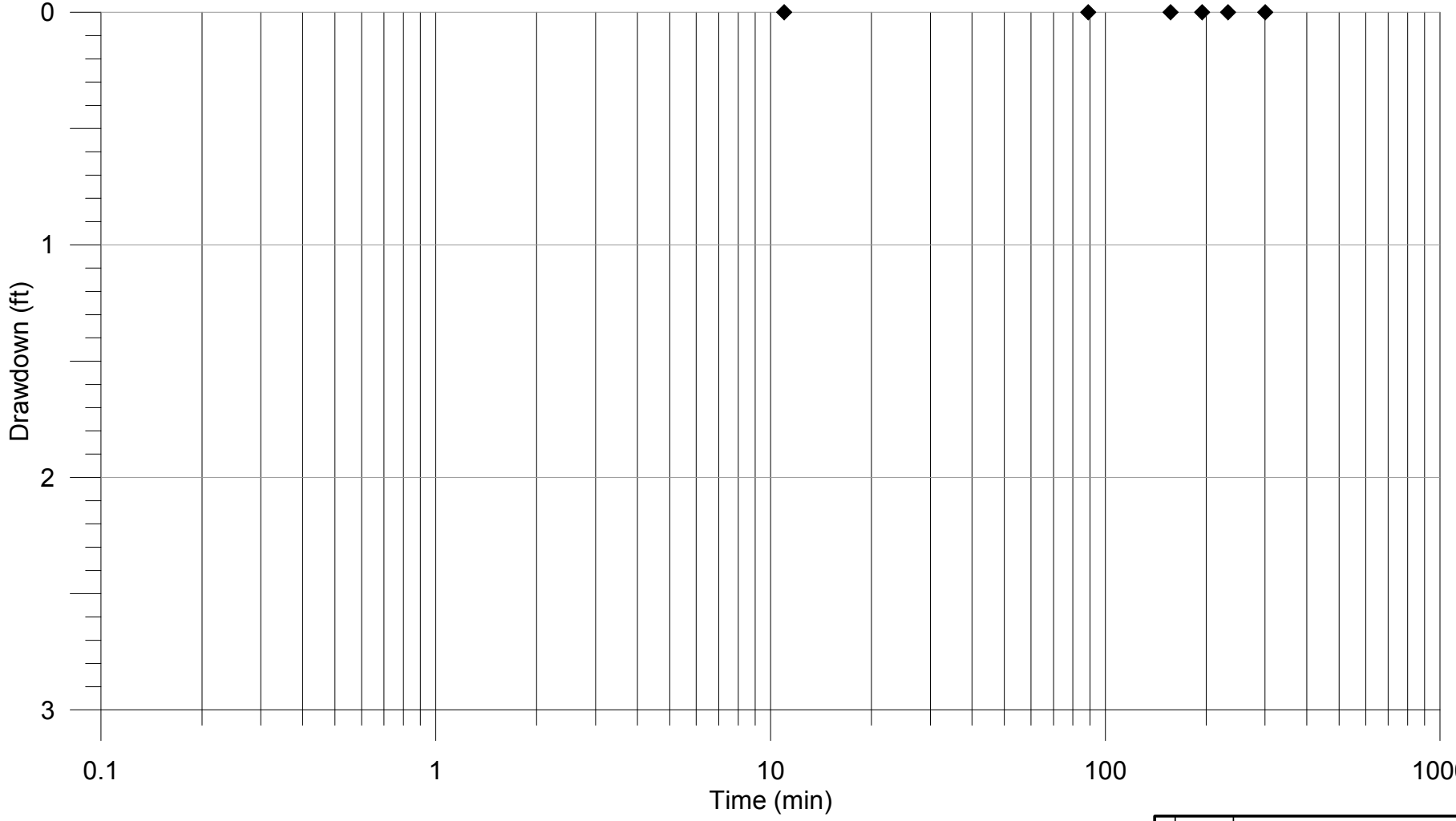

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-01W
Observation: BH-BC-06
Drawdown
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
DRAWDOWN AT BH-BC-06

MAY 2017	APP D6-B-3-4	REV: 0

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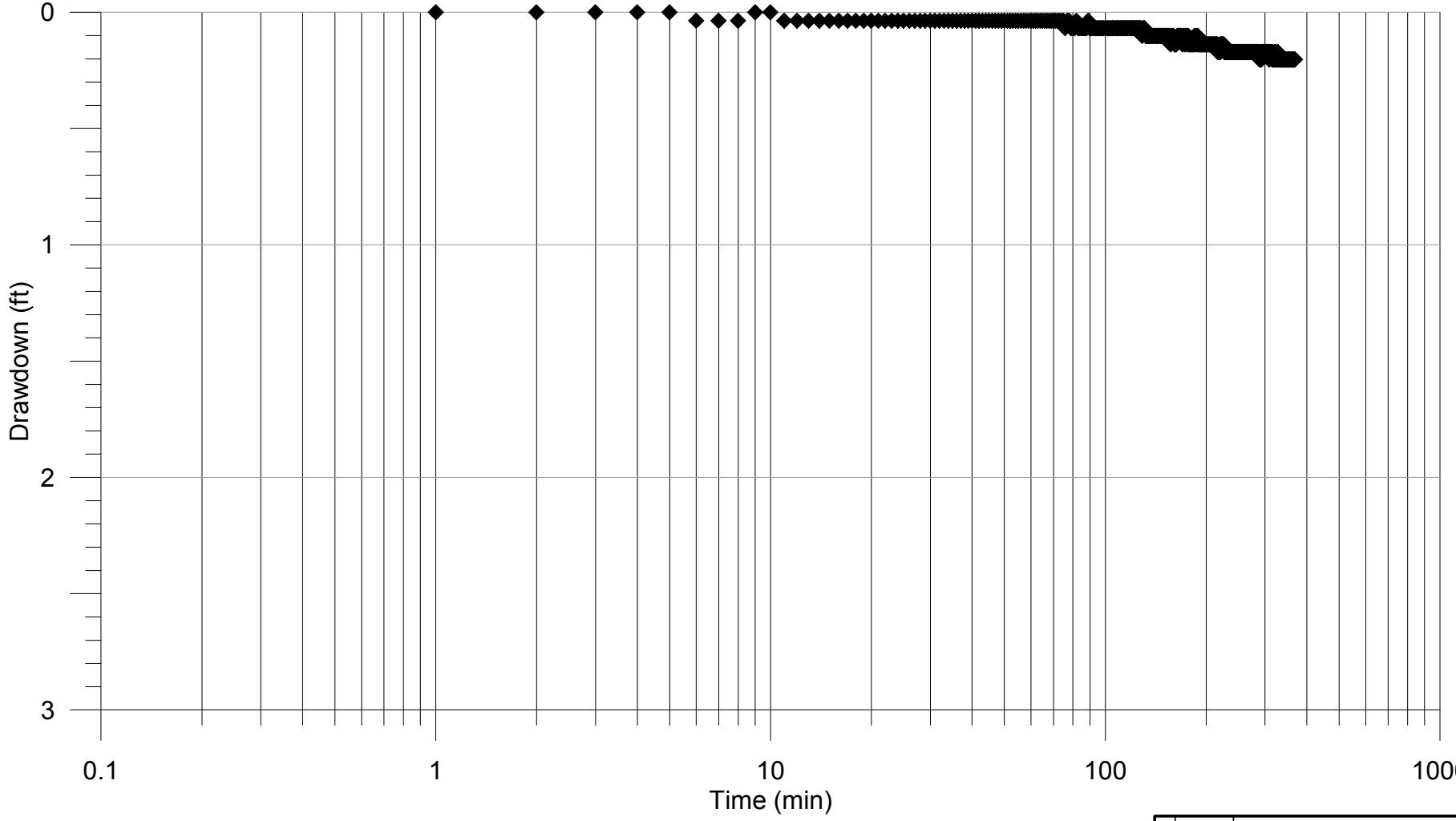

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: 15-RC-01 Shallow
Drawdown
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
DRAWDOWN AT 15-RC-01 (SHALLOW)

MAY 2017	APP D6-B-3-5	REV: 0

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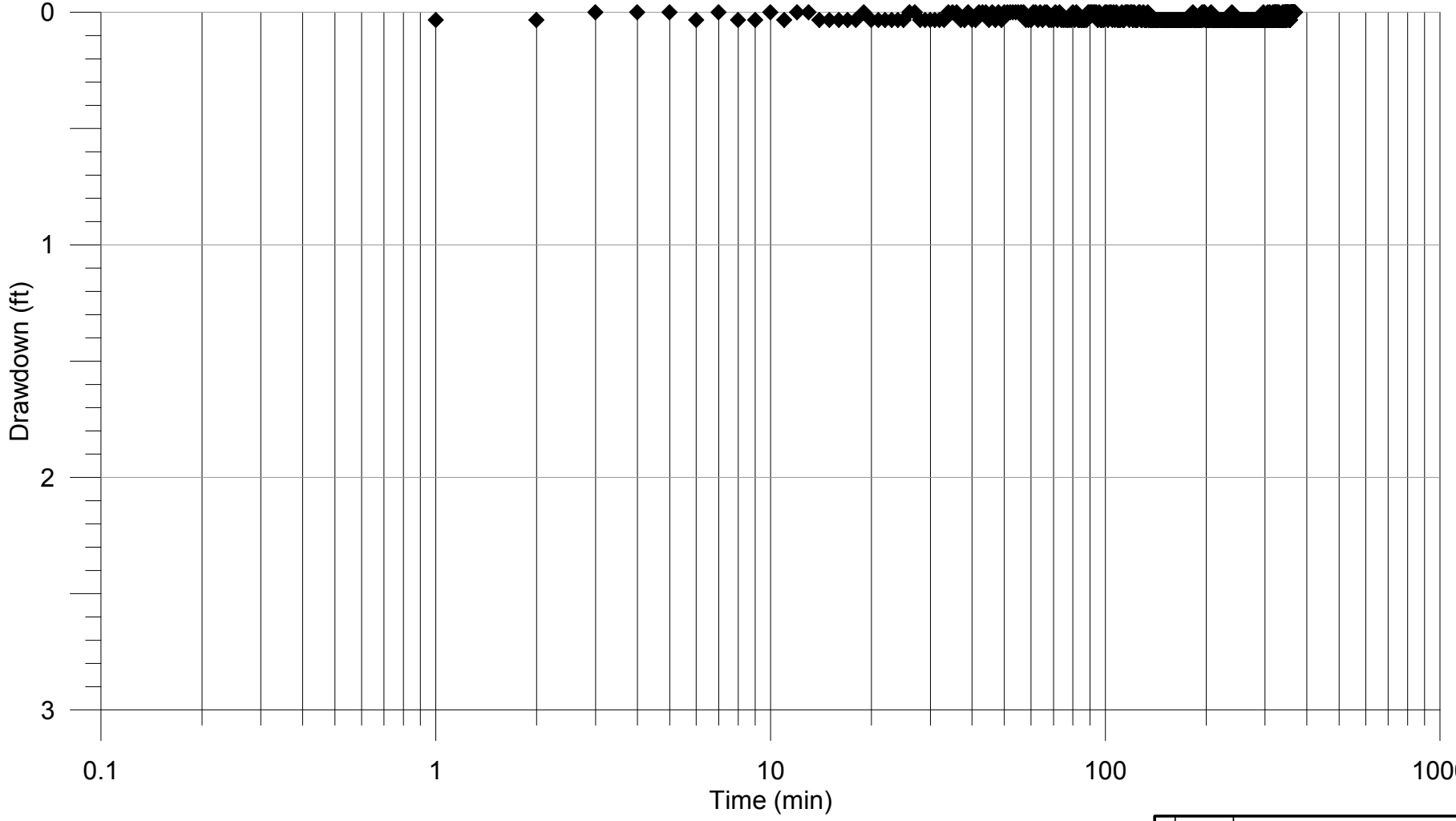

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: 15-RC-01 Deep
Drawdown
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
DRAWDOWN AT 15-RC-01 (DEEP)

MAY 2017	APP D6-B-3-6	REV: 0

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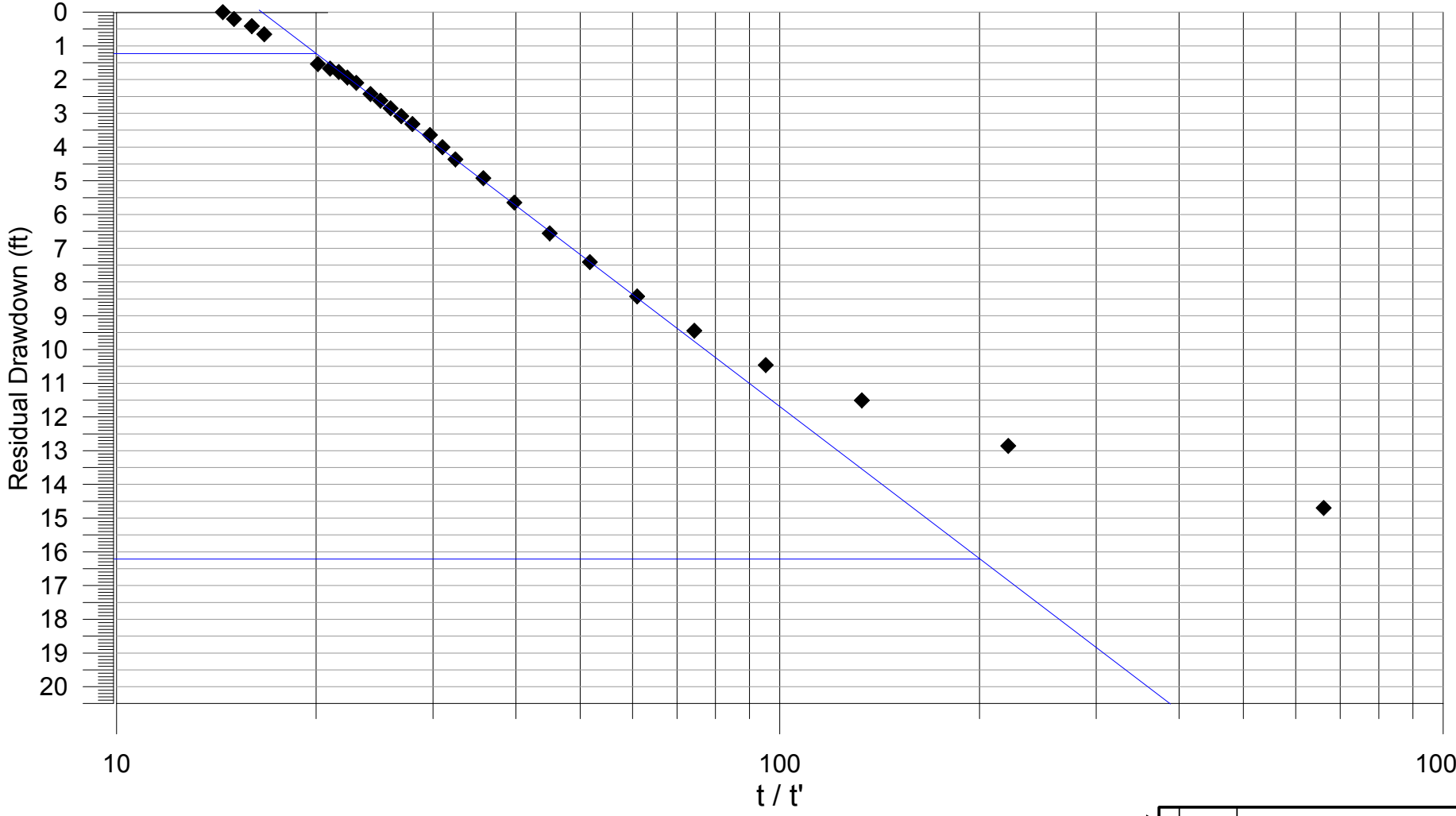

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: TH-EC-03W
Recovery
Pump Rate (Q) = 15 USgpm

T =(264)(Q)/△s **T= 264 USgpd/ft**

△s= 15.0 ft Q = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
RECOVERY AT TH-EC-03W

MAY 2017	APP D6-B-3-7	REV: 0

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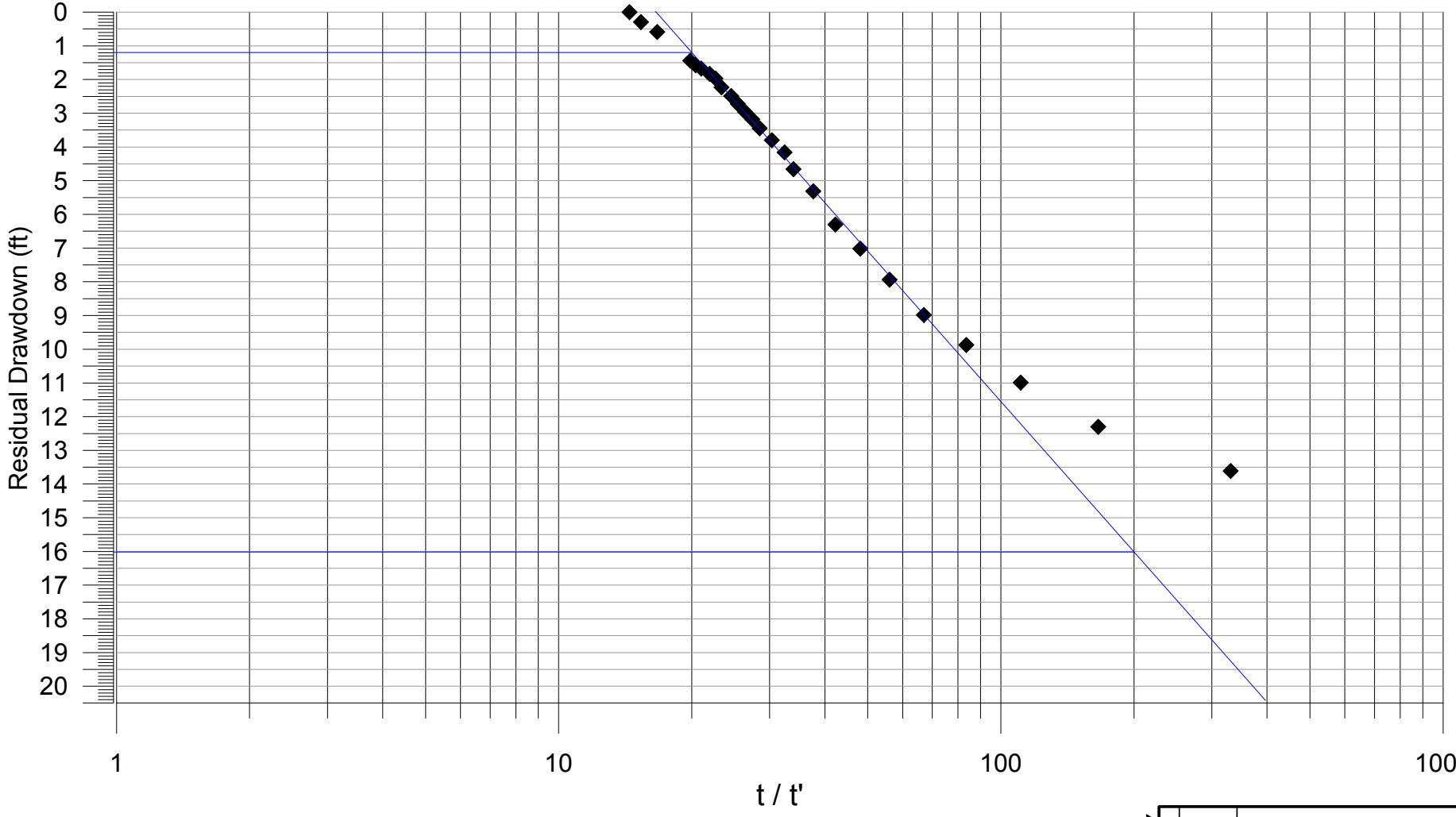

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: BH-BC-05
Recovery
Pump Rate (Q) = 15 USgpm

T =(264)(Q)/△s	**T= 267 USgpd/ft**
△s= 14.81 ft	Q = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
RECOVERY AT BH-BC-05

		REV:
MAY 2017	APP D6-B-3-8	0

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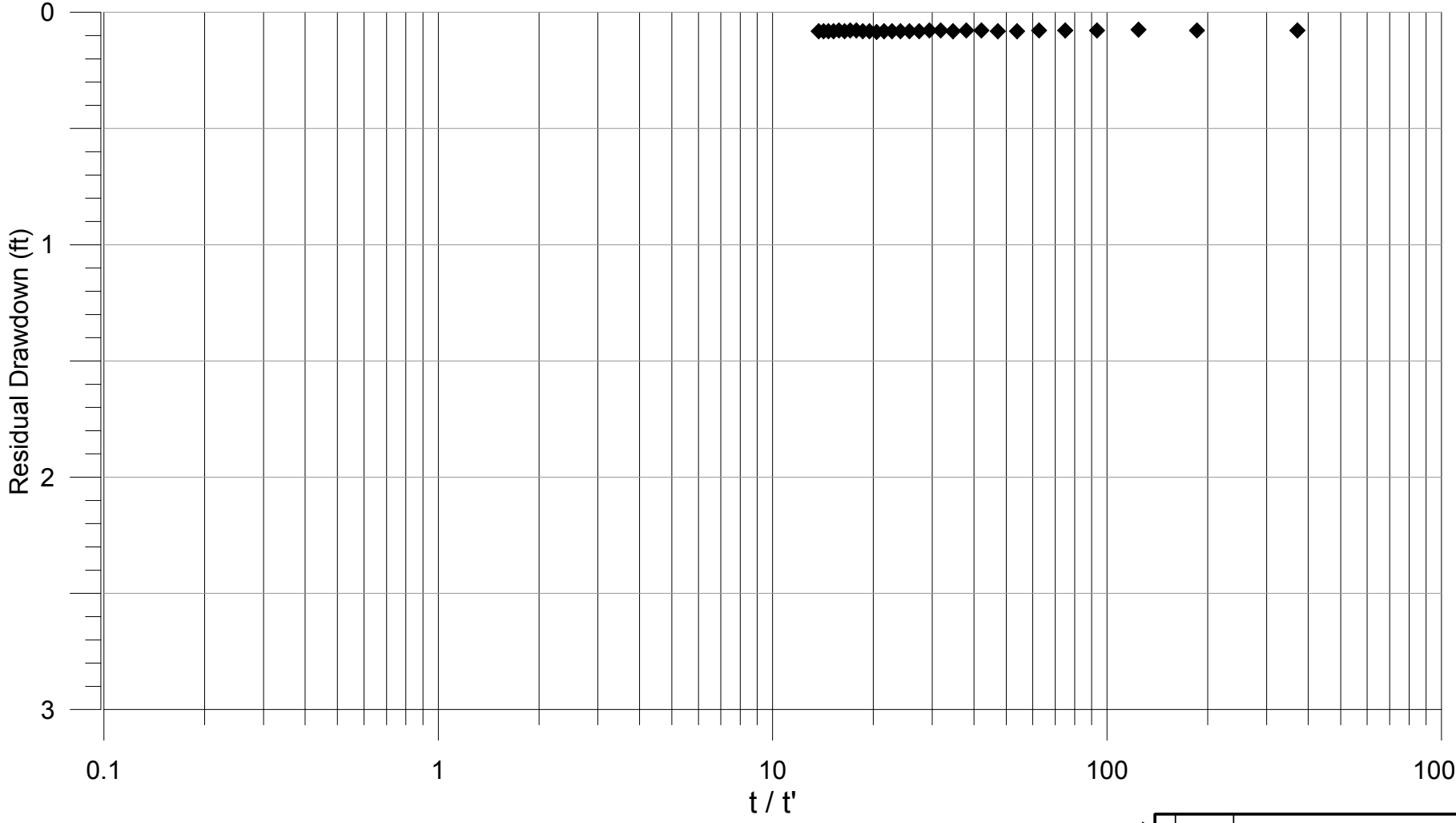

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: TH-GC-04
Recovery
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
RECOVERY AT TH-GC-04

MAY 2017	APP D6-B-3-9	REV: 0

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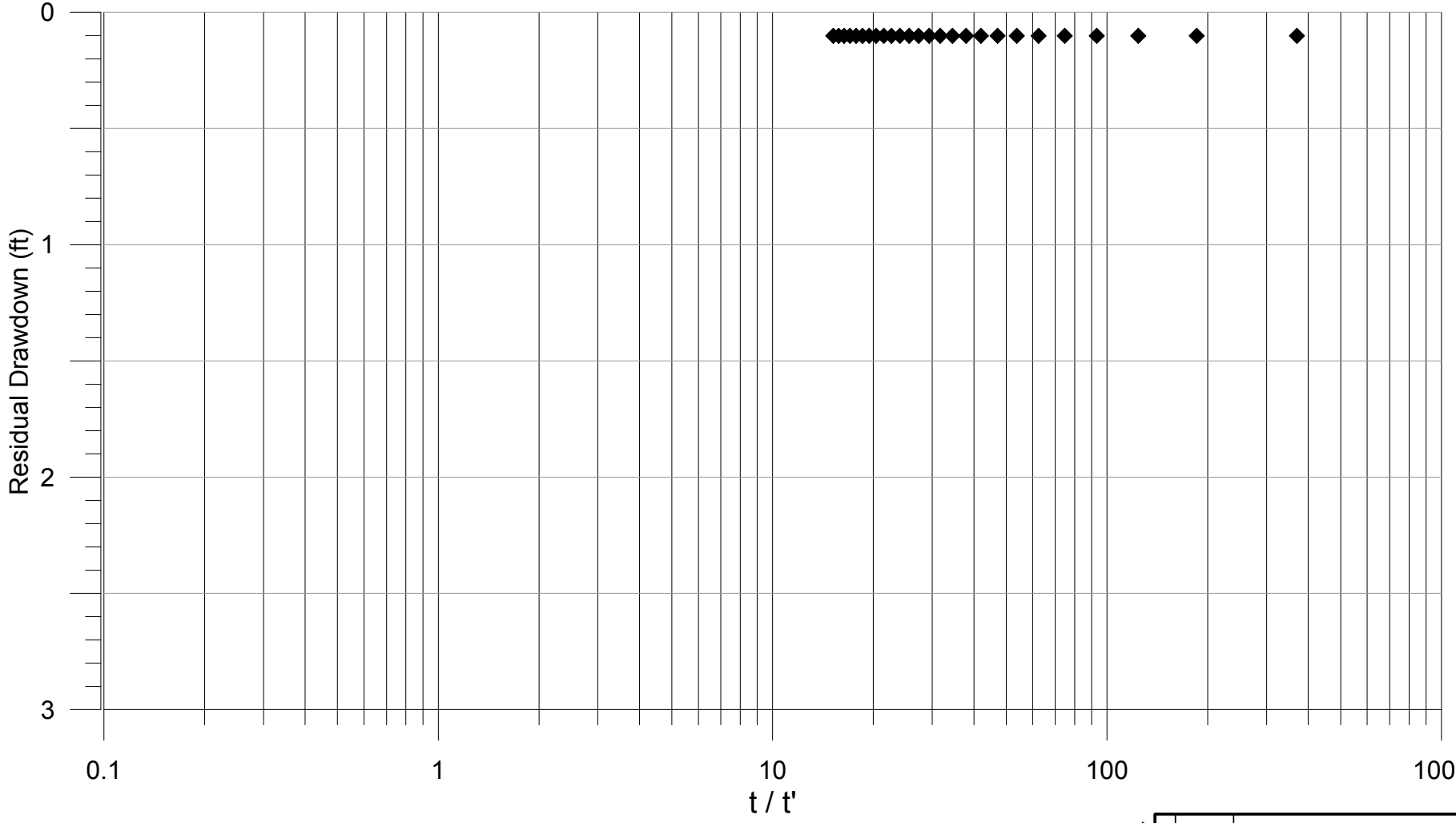

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: TH-GC-05
Recovery
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

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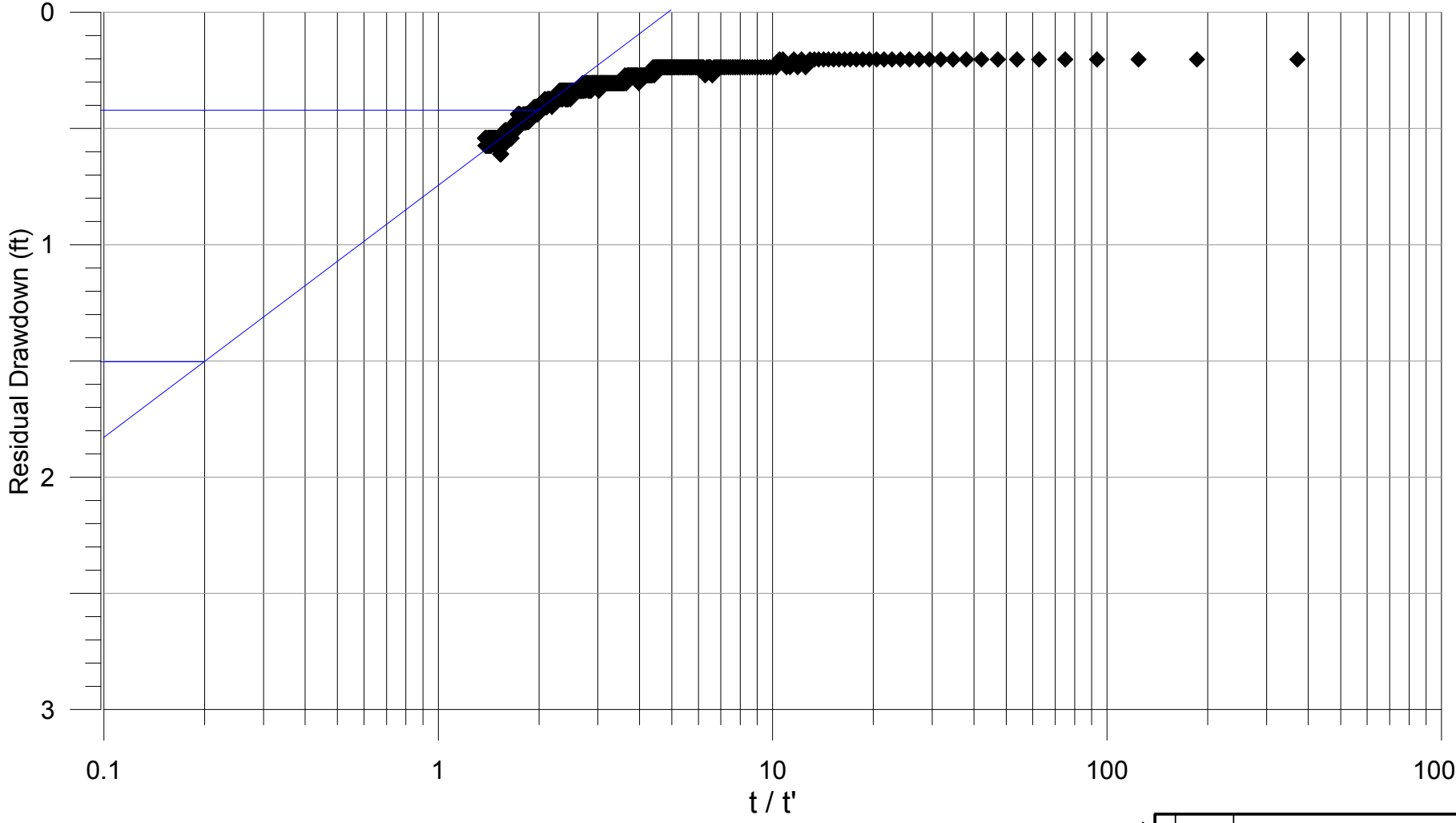
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
RECOVERY AT TH-GC-05

MAY 2017	APP D6-B-3-10	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-27_TH-EC-03_Pump Test\D6-B-3-10_REC_Pump-TH-EC-03W_Obs-TH-GC-05.grf



Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: 15-RC-01 Shallow
Recovery
Pump Rate (Q) = 15 USgpm

T =(264)(Q)/△s **T= 3960 USgpd/ft**

△s= 1.08 ft Q = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
RECOVERY AT 15-RC-01 (SHALLOW)

MAY 2017	APP D6-B-3-11	REV: 0

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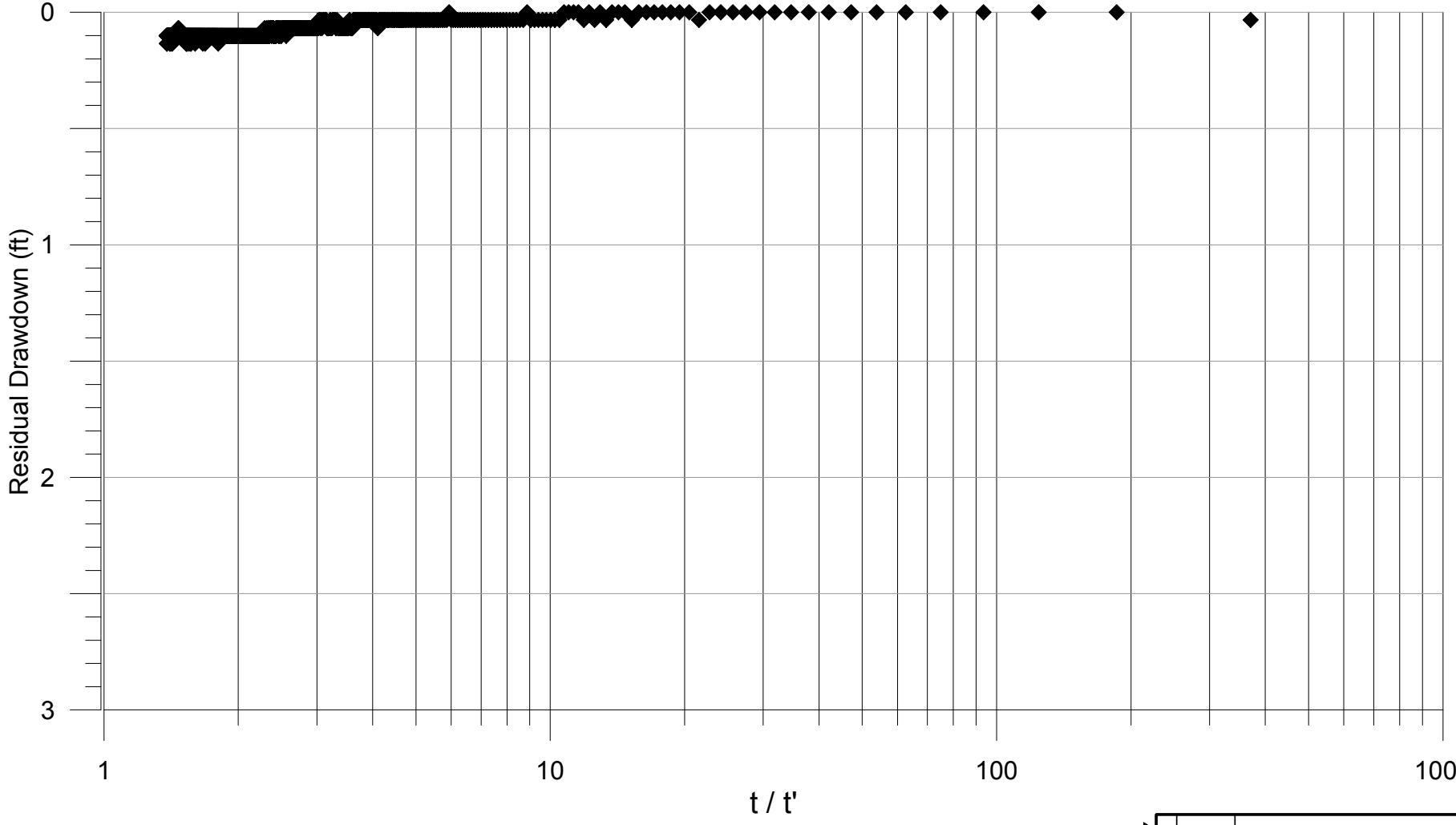

Notes:
Date: October 27, 2016
Pumping Well: TH-EC-03W
Observation: 15-RC-01 Deep
Recovery
Pump Rate (Q) = 15 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-EC-03W
RECOVERY AT 15-RC-01 (DEEP)

MAY 2017	APP D6-B-3-12	REV: 0

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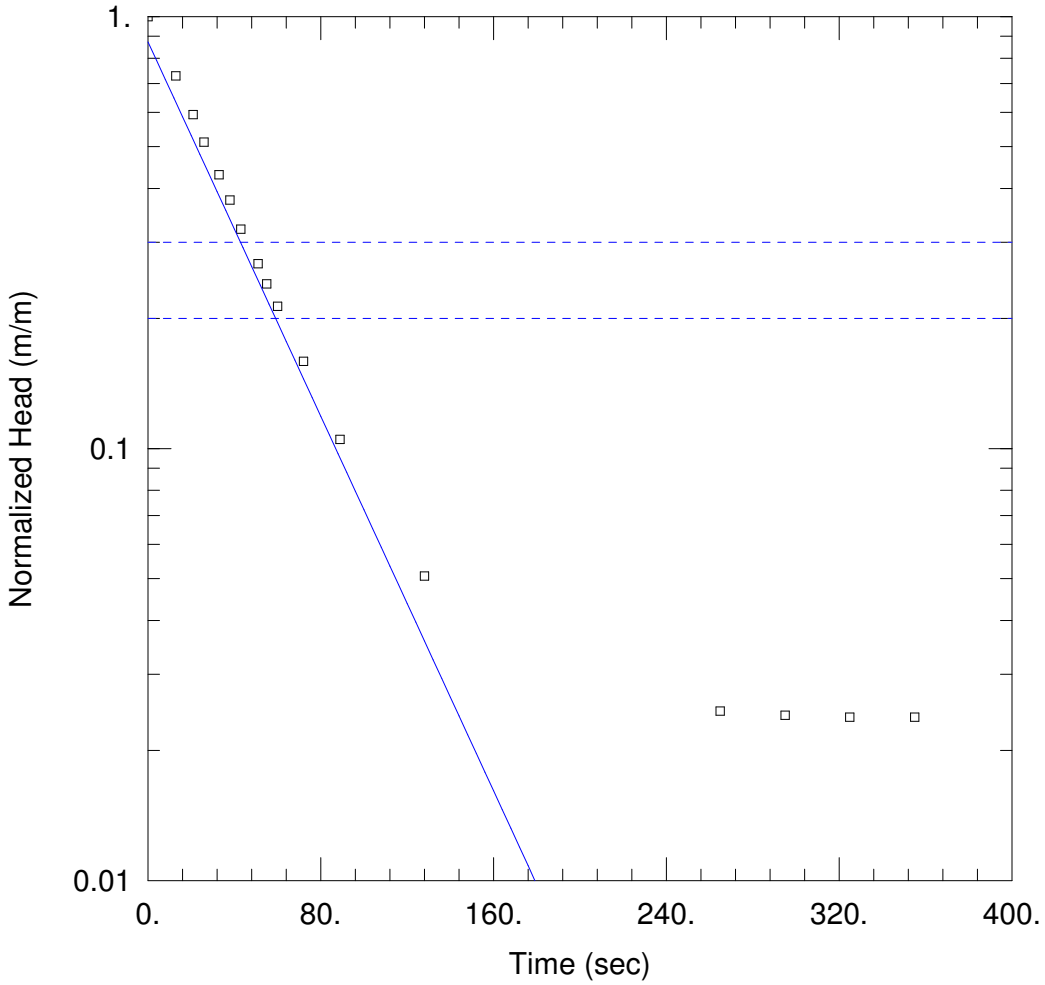
APPENDIX D6-B-4

RISING HEAD AND LUGEON TEST RESULTS- ROUTE C



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\15-RC-01(1; Deep).aqt
Date: 12/14/16 Time: 17:31:06

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: 15-RC-01 (1; Deep)
Test Date: Nov. 8, 2016

AQUIFER DATA

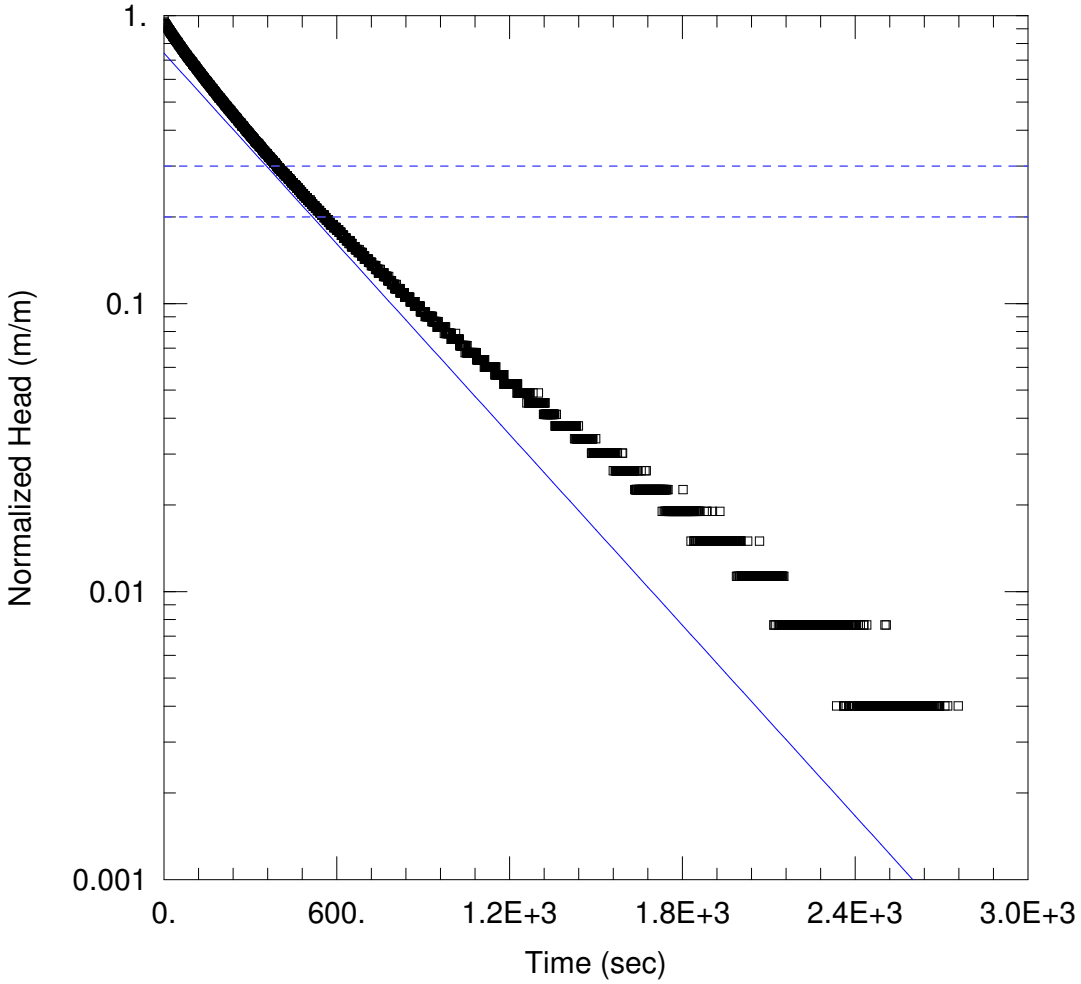
Saturated Thickness: 11.99 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (15-RC-01 (1; Deep))

Initial Displacement: 3.687 m
Total Well Penetration Depth: 13.11 m
Casing Radius: 0.0127 m
Static Water Column Height: 11.99 m
Screen Length: 0.9 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.324E-5 m/sec
y0 = 3.221 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\15-RC-01(2; shallow).aqt
Date: 12/14/16 Time: 13:53:58

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: 15-RC-01 (2; Shallow)
Test Date: Nov. 8, 2016

AQUIFER DATA

Saturated Thickness: 4.335 m Anisotropy Ratio (Kz/Kr): 0.1

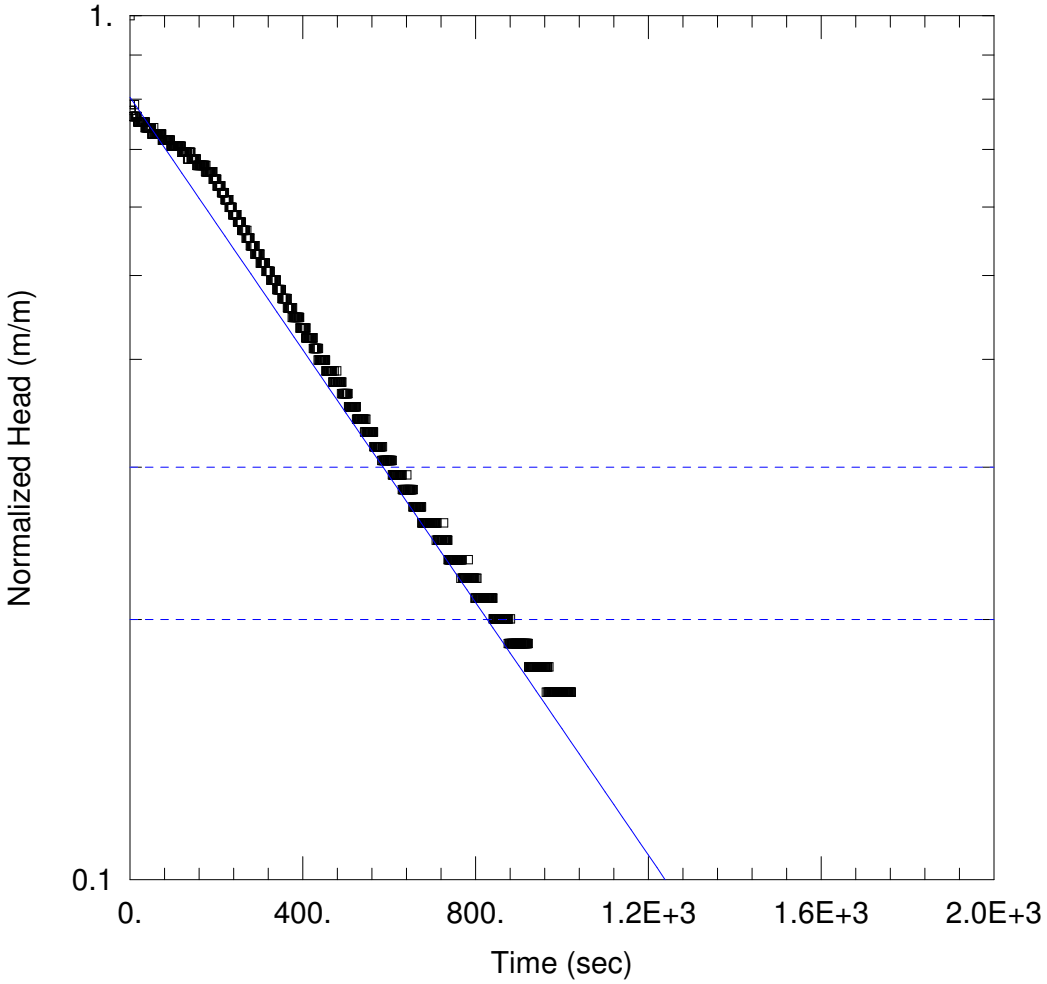
WELL DATA (15-RC-01 (2; Shallow))

Initial Displacement: 2.742 m
Total Well Penetration Depth: 5.498 m
Casing Radius: 0.0127 m
Static Water Column Height: 4.335 m
Screen Length: 0.9 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.229E-6 m/sec y0 = 2.031 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\15-RC-02_LMB_161108_RHT.aqt
Date: 12/14/16 Time: 13:54:57

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-300-006
Location: Fairford, MB (Pinaymootang)
Test Well: 15-RC-02
Test Date: Nov. 08, 2016

AQUIFER DATA

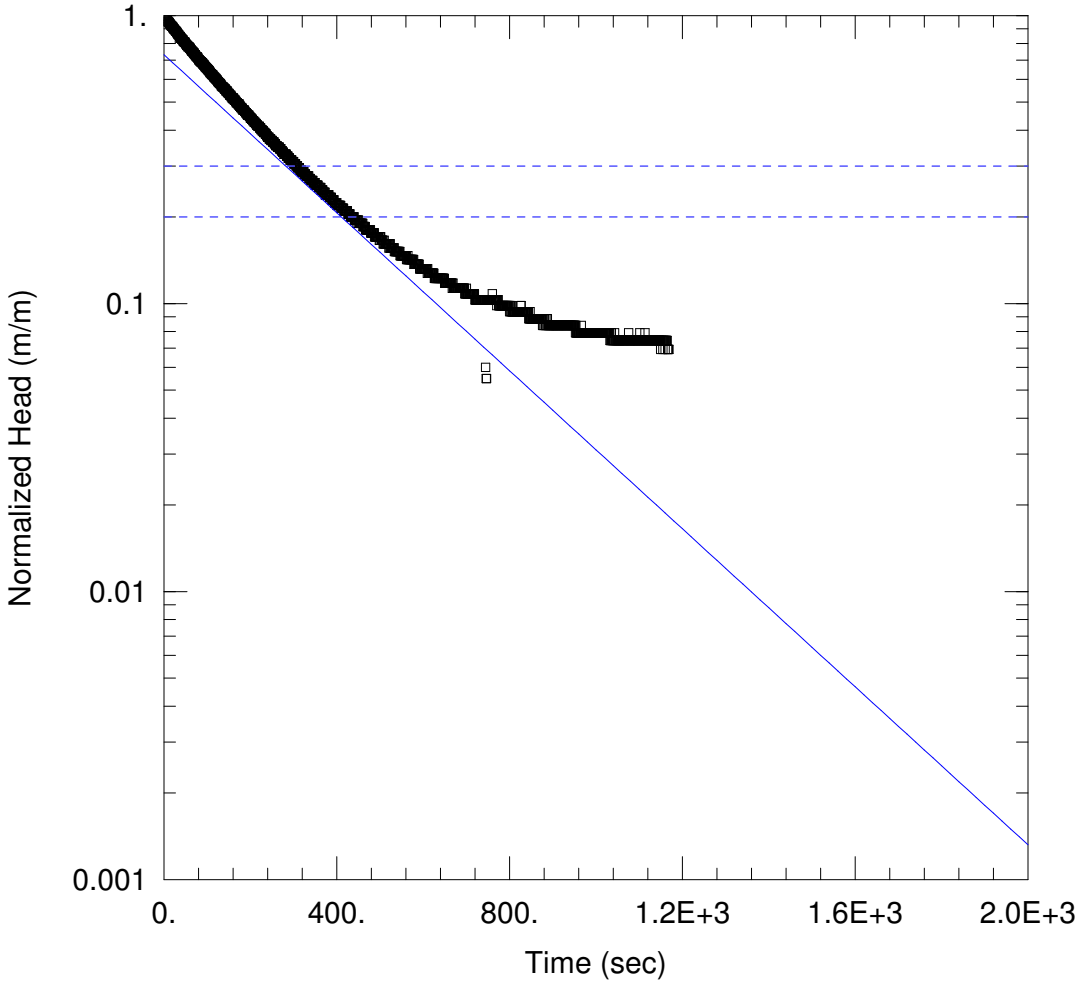
Saturated Thickness: 1. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (15-RC-02)

Initial Displacement: 0.874 m
Total Well Penetration Depth: 1.418 m
Casing Radius: 0.0127 m
Static Water Column Height: 1. m
Screen Length: 0.9 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 6.841E-7 m/sec
y0 = 0.703 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\15-RC-04(Deep).aqt
Date: 12/14/16 Time: 13:51:04

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: 15-RC-04 (Deep)
Test Date: Nov. 7, 2016

AQUIFER DATA

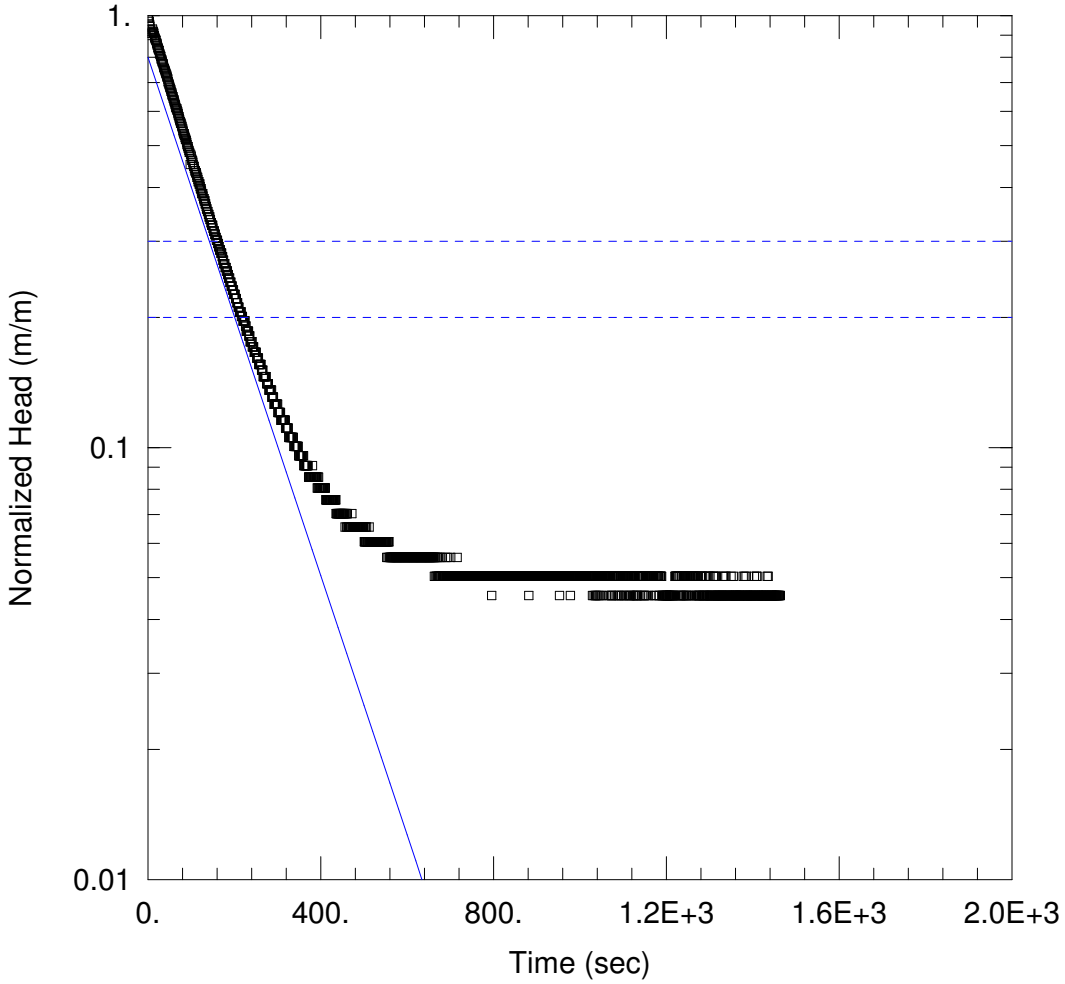
Saturated Thickness: 10.82 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (15-RC-04)

Initial Displacement: 2.134 m
Total Well Penetration Depth: 11.7 m
Casing Radius: 0.0127 m
Static Water Column Height: 10.82 m
Screen Length: 0.9 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.657E-6 m/sec
y0 = 1.56 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\15-RC-04(Shallow)_.aqt
Date: 12/14/16 Time: 13:52:55

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: 15-RC-04 (Shallow)
Test Date: Nov. 7, 2016

AQUIFER DATA

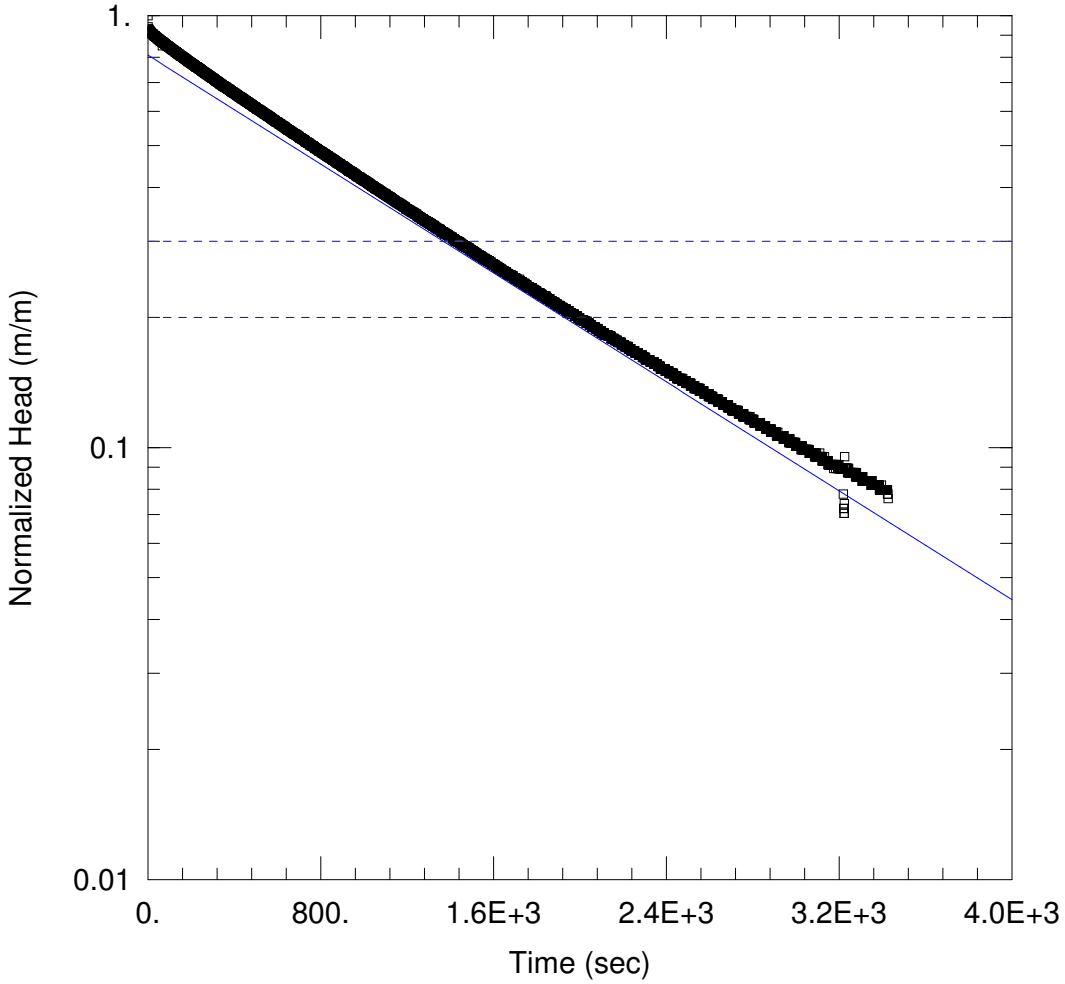
Saturated Thickness: 5.522 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (15-RC-04 (Shallow))

Initial Displacement: 2.048 m
Total Well Penetration Depth: 2.697 m
Casing Radius: 0.0127 m
Static Water Column Height: 5.522 m
Screen Length: 0.9 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.68E-6 m/sec
y0 = 1.641 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\15-RC-06_161108_RHT.aqt
Date: 12/14/16 Time: 13:55:55

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-300-006
Location: Fairford, MB (Pinaymootang)
Test Well: 15-RC-06
Test Date: Nov. 08, 2016

AQUIFER DATA

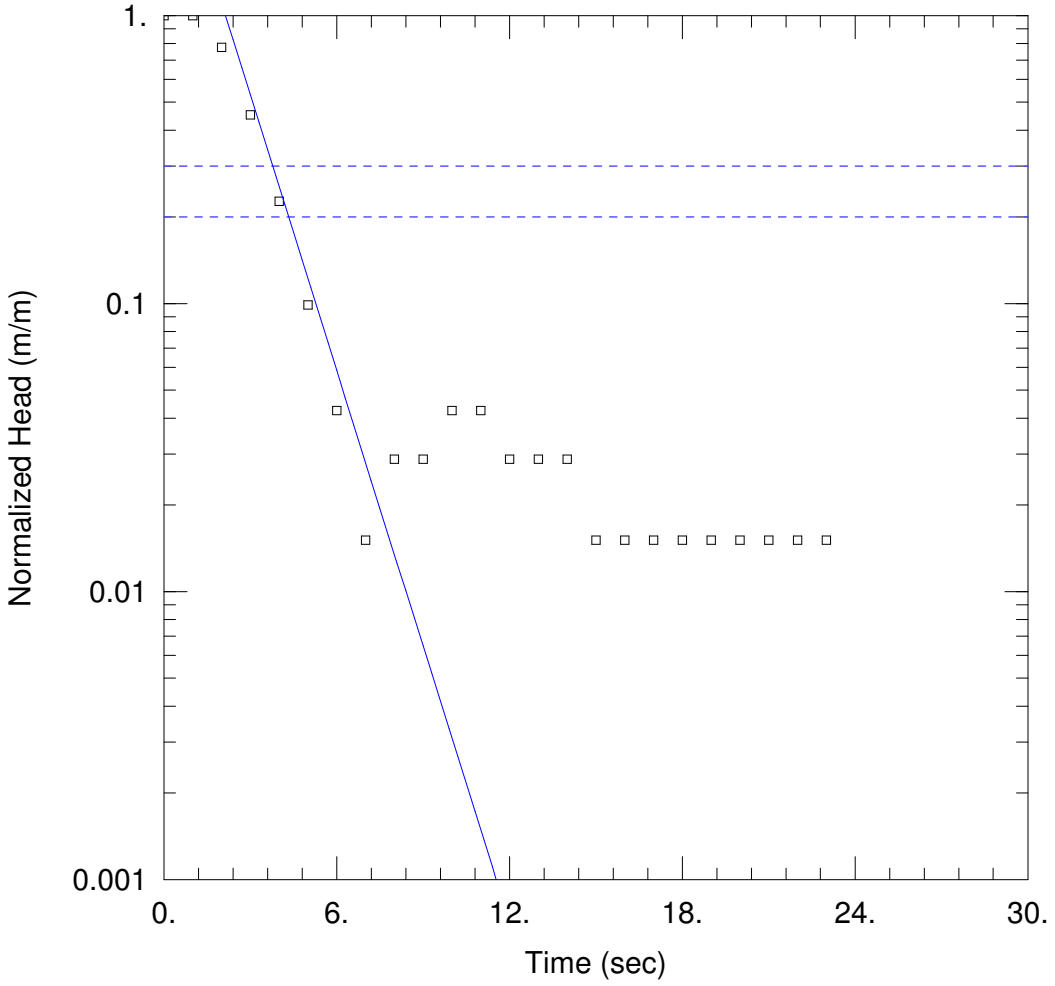
Saturated Thickness: 13.15 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (15-RC-06)

Initial Displacement: 5.411 m
Total Well Penetration Depth: 13.15 m
Casing Radius: 0.0127 m
Static Water Column Height: 13.15 m
Screen Length: 0.9 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.851E-7 m/sec
y0 = 4.38 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\BH-BC5.aqt
Date: 12/14/16 Time: 15:56:55

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: BH-BC5
Test Date: Nov. 8, 2016

AQUIFER DATA

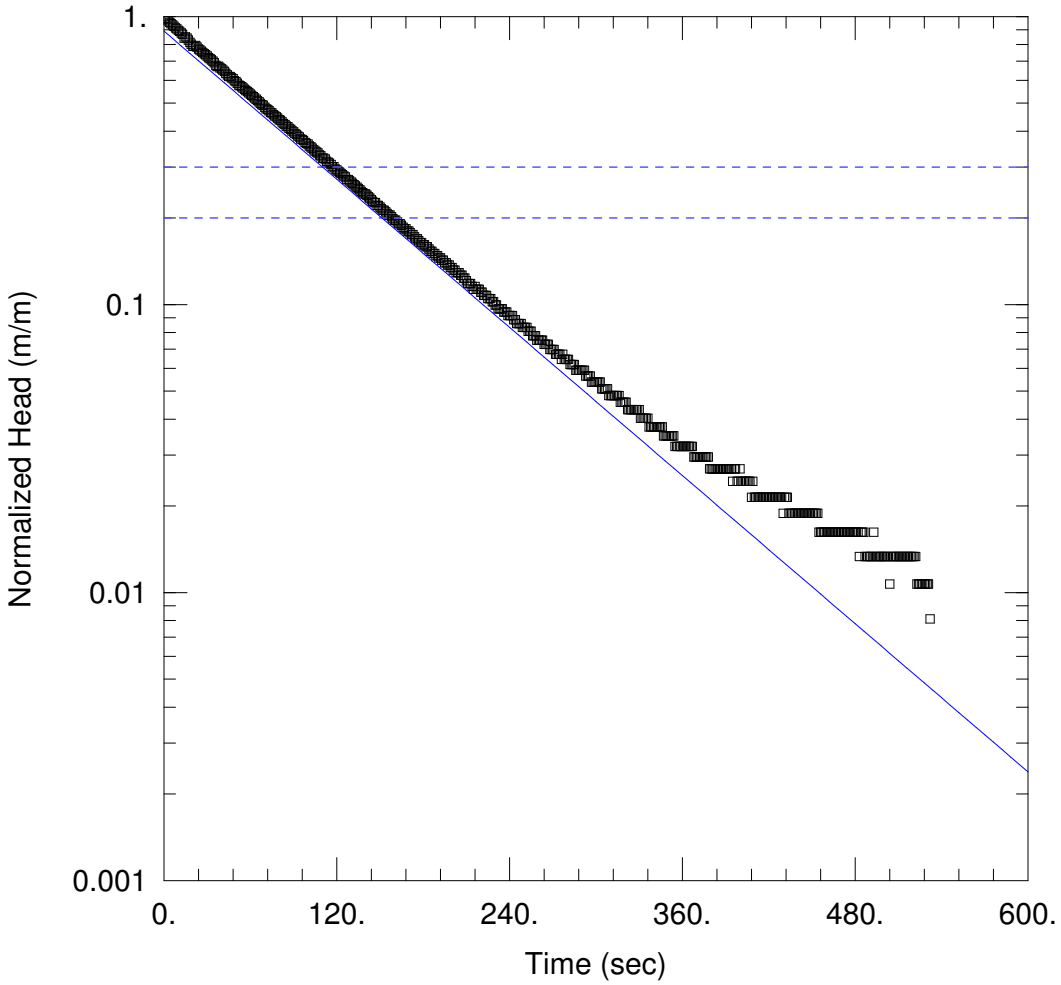
Saturated Thickness: 13.6 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH-BC5)

Initial Displacement: 0.729 m
Total Well Penetration Depth: 17.99 m
Casing Radius: 0.0127 m
Static Water Column Height: 13.6 m
Screen Length: 1.53 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0002482 m/sec
y0 = 3.506 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-EC-01P_RHT.aqt
Date: 12/14/16 Time: 14:05:45

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-EC-01P
Test Date: Nov. 10, 2016

AQUIFER DATA

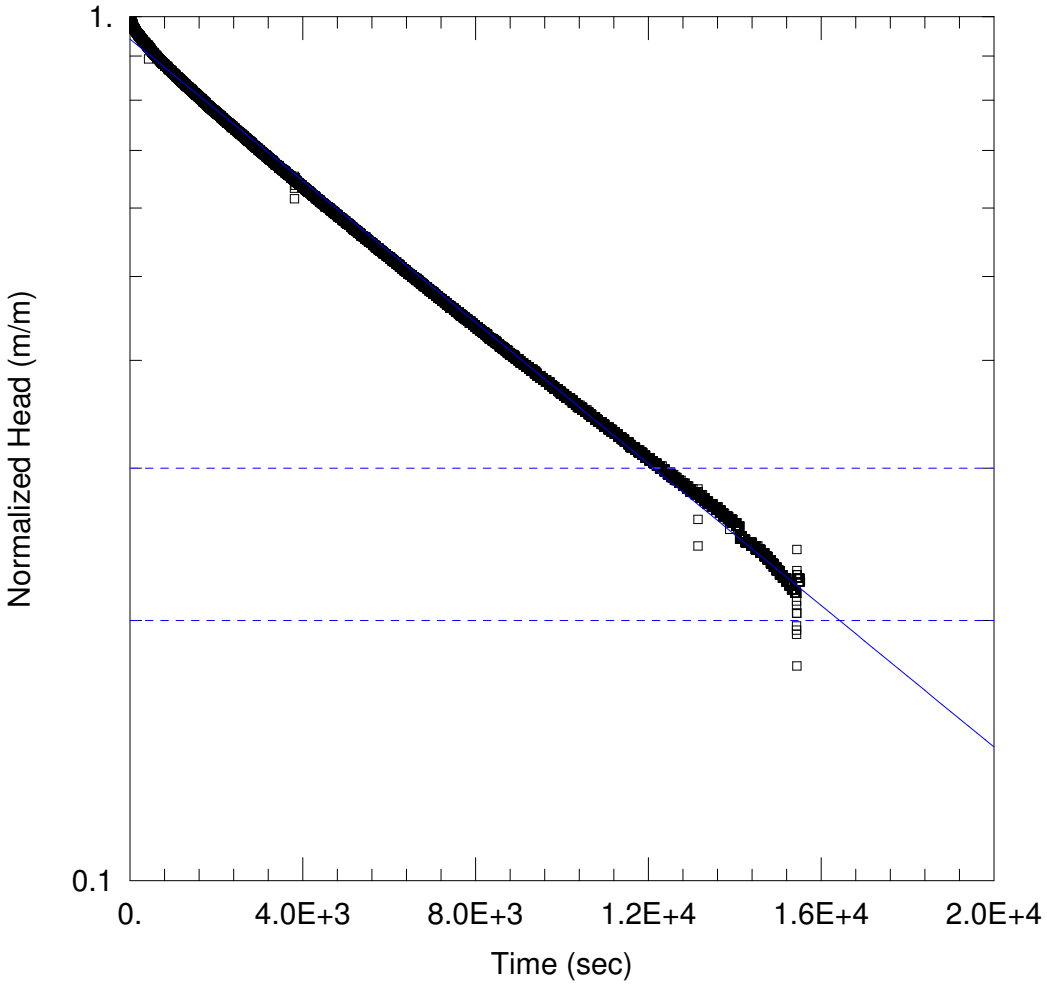
Saturated Thickness: 19.1 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-EC-01P)

Initial Displacement: 3.827 m
Total Well Penetration Depth: 20.46 m
Casing Radius: 0.0127 m
Static Water Column Height: 19.1 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.398E-6 m/sec
y0 = 3.405 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-EC-04.aqt
Date: 12/14/16 Time: 13:59:13

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-EC-04
Test Date: Nov. 8, 2016

AQUIFER DATA

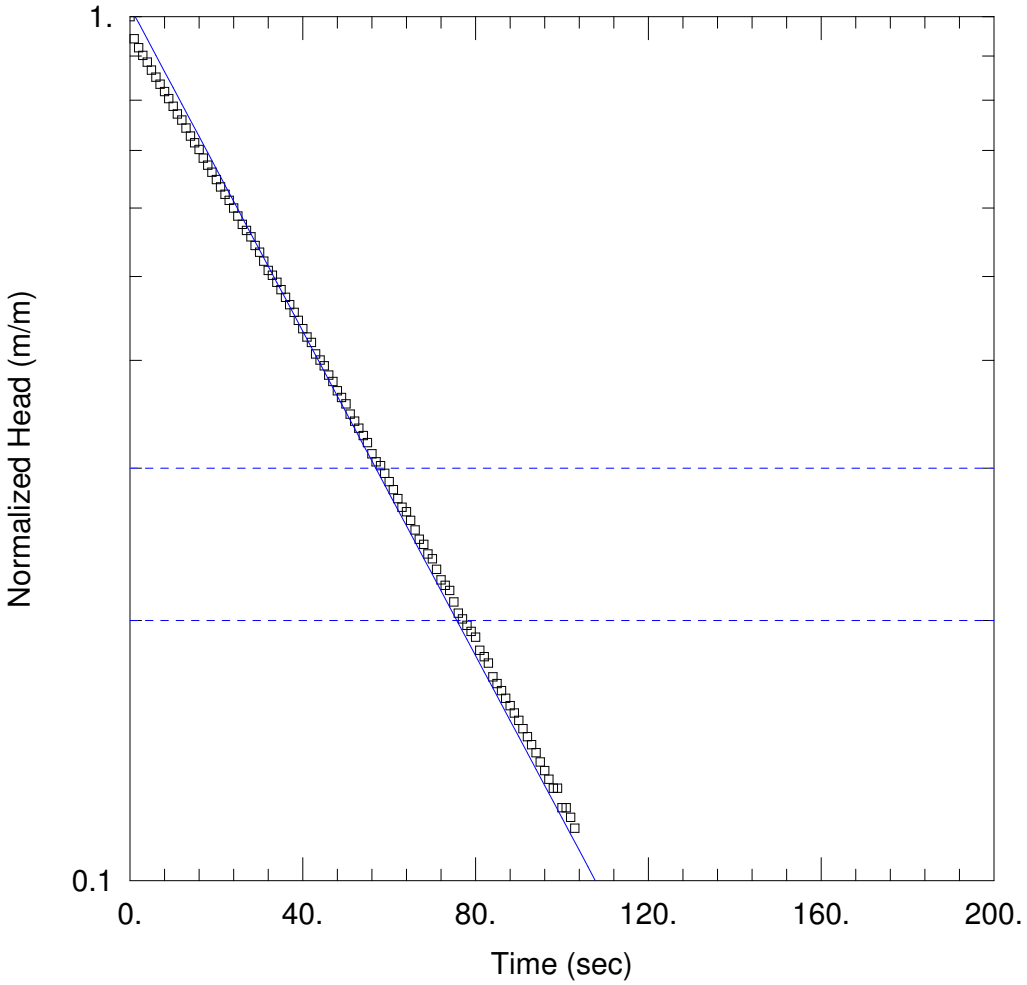
Saturated Thickness: 16.52 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-EC-04)

Initial Displacement: 4.616 m
Total Well Penetration Depth: 17.99 m
Casing Radius: 0.0127 m
Static Water Column Height: 16.52 m
Screen Length: 1.53 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.188E-8 m/sec
y0 = 4.347 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GC-01.aqt
Date: 12/14/16 Time: 14:00:33

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-GC-01
Test Date: Nov. 8, 2016

AQUIFER DATA

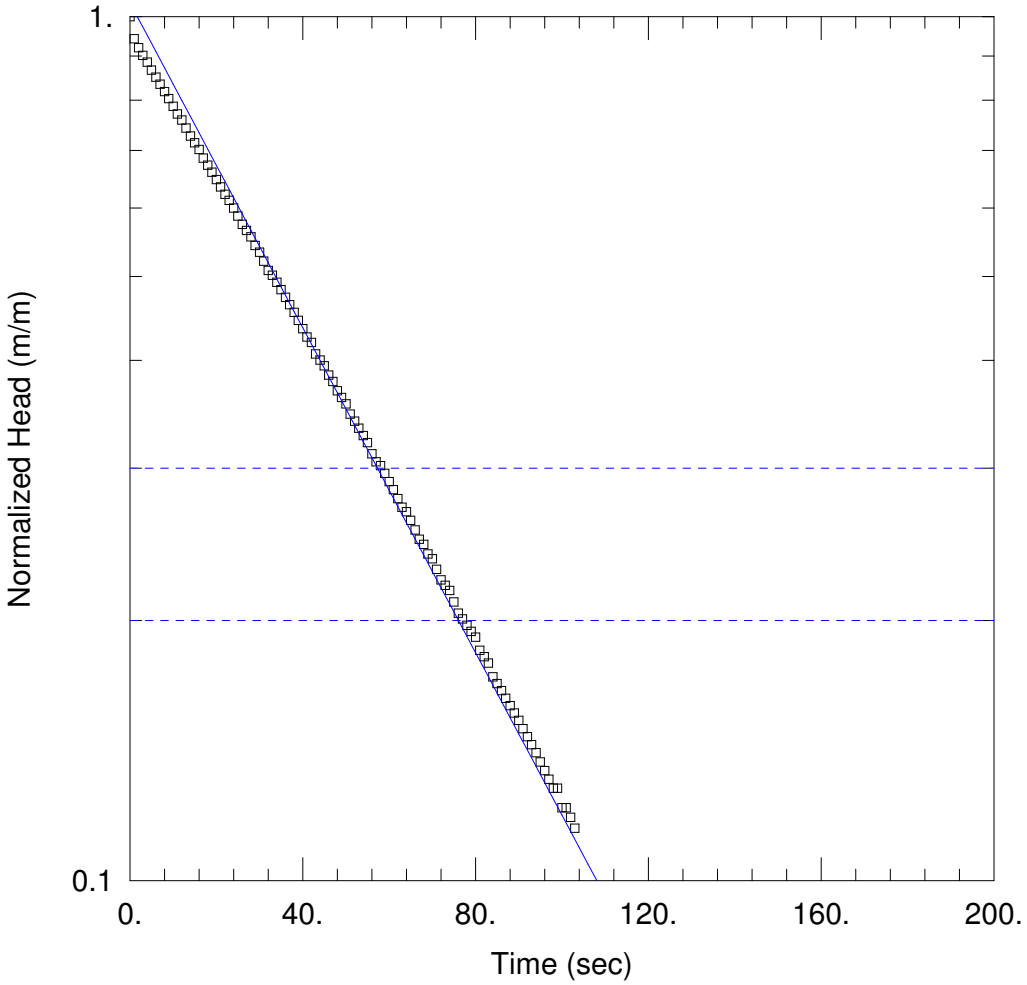
Saturated Thickness: 13.16 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GC-01)

Initial Displacement: 3.237 m
Total Well Penetration Depth: 14.42 m
Casing Radius: 0.0127 m
Static Water Column Height: 13.16 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.186E-6 m/sec
y0 = 3.323 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GC-02.aqt
Date: 12/14/16 Time: 14:01:28

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-GC-02
Test Date: Nov. 8, 2016

AQUIFER DATA

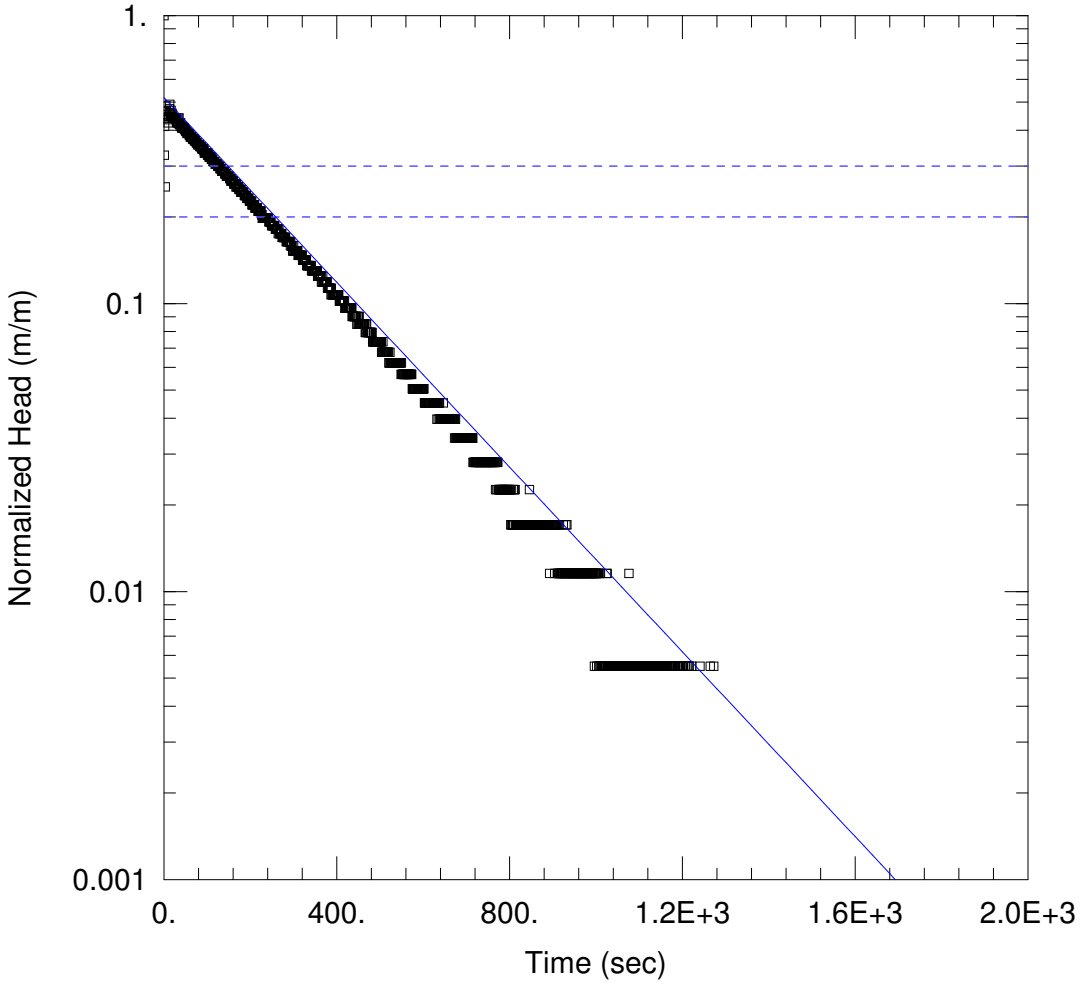
Saturated Thickness: 13.16 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GC-01)

Initial Displacement: 3.237 m
Total Well Penetration Depth: 14.42 m
Casing Radius: 0.0127 m
Static Water Column Height: 13.16 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.196E-6 m/sec
y0 = 3.357 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GC-04.aqt
Date: 12/14/16 Time: 14:02:25

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-GC-04
Test Date: Nov. 8, 2016

AQUIFER DATA

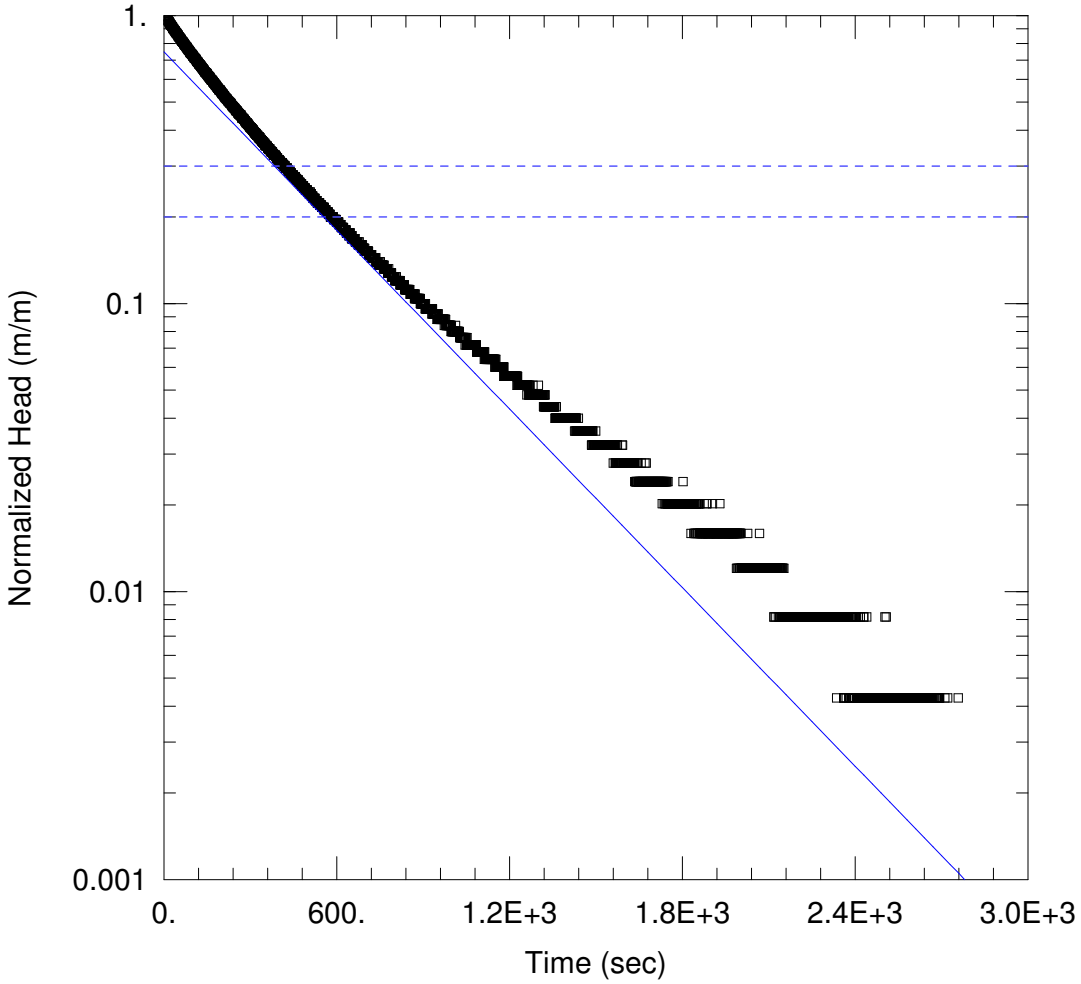
Saturated Thickness: 6.983 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GC-04)

Initial Displacement: 1.817 m
Total Well Penetration Depth: 8.758 m
Casing Radius: 0.0127 m
Static Water Column Height: 6.983 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.164E-6 m/sec
y0 = 0.9425 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GC-05.aqt
Date: 12/14/16 Time: 14:03:26

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-GC-05
Test Date: Nov. 7, 2016

AQUIFER DATA

Saturated Thickness: 8.47 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GC-05)

Initial Displacement: 2.576 m
Total Well Penetration Depth: 8.528 m
Casing Radius: 0.0127 m
Static Water Column Height: 8.47 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.479E-7 m/sec
y0 = 1.926 m

APPENDIX D6-B-5

BACKGROUND DATA FAIRFORD RIVER AT PTH#6 (PDF ONLY)

						Field	Field	Field	Field	Field	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Sampling depth (m)	Temperature (field) (^{o}C)	Conductivity (Field) (µS/cm)	Turbidity (field) (NTU)	Secchi disk (m)	Alkalinity- total as CO_3 (calc) (mg/L)	Alkalinity- total as OH (calc) (mg/L)	Alkalinity- total as $CaCO_3$ (mg/L)	Alkalinity- total as HCO_3 (calc) (mg/L)	Ammonia (NH_3) (mg/L)	Ammonia- dissolved (mg/L)	Ammonia- soluble (mg/L)	Nitrate NO_3 (mg/L)	Nitrite (NO2-N) (mg/L)	NITRATE/ NITRITE (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	0	-	1700	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	0	-	1650	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	0	-	1600	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	0	-	1350	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	0	-	1300	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	0	-	1350	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	0	-	1400	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	0	-	1400	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	0	-	1350	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	0	-	1400	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	0	-	1600	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	0	-	1750	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	0	-	1750	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	0	-	1800	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	0	-	1600	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	0	-	1600	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	0	-	1000	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	0	-	1400	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	0	-	1400	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	0	-	1368	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	0	-	1335	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	0	-	1397	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	0	-	1690	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	0	-	1323	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	0	-	1279	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	0	-	1650	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	0	-	1500	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	0	-	1500	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	0	-	1300	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	0	-	1450	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	0	-	1500	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	0	-	1500	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	0	-	1500	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	0	-	1450	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	0	-	1550	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	0	-	1500	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	0	-	1527	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	0	-	1700	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	0	-	1693	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	0	-	1518	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	0	-	1853	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	0	-	1373	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	0	-	1408	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	0	-	1437	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	0	-	1422	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	0	-	1492	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	0	-	1506.6	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	0	-	900	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	0	-	1700	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	0	-	1708.5	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	0	-	1843	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	0	-	1545	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	0	-	1480	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	0	-	1545	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	0	-	1317	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	0	-	1519	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	0	-	1642	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	0	-	1640	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	0	-	1700	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	0	-	1597	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	0	-	1725	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	0	-	1217	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	0	-	1492	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	0	-	1480	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	0	-	1480	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	0	-	1499	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	0	-	1444	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	0	-	1465	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	0	-	1765	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	1	-	-	-	-	<18	<10.2	174	180	-	-	<0.02			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	1	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	0	-	-	-	-	<0.5	<0.5	202	246	-	0.16	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	0	-	-	-	-	4.8	<0.5	192	224	-	0.04	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	-	-	-	-	4.8	<0.5	188	220	-	0.71	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	0	0	-	-	-	<0.5	<0.5	224	273	-	0.2	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	0	0	-	-	-	-	-	-	-	-	0.23	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	0	5	-	-	-	<0.5	<0.5	174	212	-	0.12	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	0	19.4	-	-	-	-	-	-	-	-	0.06	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	0	20	-	-	-	<0.5	<0.5	191	220	-	0.03	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	0	12	-	-	-	2.4	<0.5	192	229	-	0.07	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	0	0	-	-	-	<0.5	<0.5	210	256	-	0.14	-			

						Field	Field	Field	Field	Field	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Sampling depth (m)	Temperature (field) (^{o}C)	Conductivity (Field) (µS/cm)	Turbidity (field) (NTU)	Secchi disk (m)	Alkalinity- total as CO_3 (calc) (mg/L)	Alkalinity- total as OH (calc) (mg/L)	Alkalinity- total as $CaCO_3$ (mg/L)	Alkalinity- total as HCO_3 (calc) (mg/L)	Ammonia (NH_3) (mg/L)	Ammonia- dissolved (mg/L)	Ammonia- soluble (mg/L)	Nitrate NO_3 (mg/L)	Nitrite (NO2-N) (mg/L)	NITRATE/ NITRITE (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	0	-	-	-	-	-	-	-	-	0.18	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	0	2	-	-	-	<0.5	<0.5	218	266	-	0.19	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	0	19	-	-	-	2.4	<0.5	198	237	-	0.02	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	0	10	-	-	-	<0.5	<0.5	180	220	-	0.04	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	0	-	-	-	<0.5	<0.5	204	248	-	0.22	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	0	-	-	-	-	-	-	-	-	-	0.42	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	-	4.2	-	-	-	<0.5	<0.5	206	251	-	0.39	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	0	21	-	-	-	7.3	<0.5	174	197	-	0.18	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	-	10	-	-	-	<0.5	<0.5	171	209	-	0.01	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	-	0	-	-	-	<0.5	<0.5	181	221	-	0.15	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	-	4	-	-	-	<0.5	<0.5	198	242	-	0.28	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	-	19.1	-	-	-	<0.5	<0.5	179	218	-	0.06	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	-	13	-	-	-	2.3	<0.5	175	208	-	0.03	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	-	-0.5	-	-	-	<0.5	<0.5	200	244	-	0.19	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	0	3.3	-	-	-	6.61	<0.4	184	211	-	0.172	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	0	11.5	-	-	-	-	-	-	-	-	0.0145	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	0	19	-	-	-	-	-	-	-	-	0.08	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	0	22.7	-	-	-	8.9	<0.4	189	212	-	0.005	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	0	3.7	-	-	-	3.27	<0.4	180	213	-	0.02	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	0	0.4	-	-	-	2.62	<0.4	208	248	0.091	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	0	20.2	-	-	-	10.5	<0.4	179	197	0.0086	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	0	-1	-	-	-	2.49	<0.4	191	227	0.066	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	0	2.4	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	0	2.4	-	-	-	<0.6	<0.4	219	268	0.206	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	0	9.1	-	-	-	2.56	<0.4	203	236	0.091	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	0	14.7	-	-	-	6.22	<0.4	189	224	<0.01	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	0	20.9	-	-	-	6.42	<0.4	192	220	0.018	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	0	20.9	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	0	23.6	-	-	-	9.55	<0.4	193	214	<0.01	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	0	20.6	-	-	-	8.44	<0.4	195	218	<0.01	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	0	-	-	-	-	8.51	<0.4	192	212	0.011	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	0	19.5	-	-	-	12.8	<0.4	189	201	0.016	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	0	13.3	-	-	-	9.82	<0.4	196	212	0.02	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	0	-	-	-	-	9.49	<0.4	197	215	0.021	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	0	14.2	-	-	-	9.1	<0.4	196	215	0.02	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	0	13.4	-	-	-	8.64	<0.4	197	220	0.017	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	0	11.4	-	-	-	9.03	<0.4	201	224	0.025	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	0	5.9	-	-	-	7.72	<0.4	202	229	0.023	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	0	6.3	-	-	-	6.74	<0.4	197	224	0.016	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	0	3.7	-	-	-	6.87	<0.4	197	226	0.013	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	0	1.4	-	-	-	6.22	<0.4	199	227	0.016	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	0	0.2	-	-	-	5.37	<0.4	201	231	0.019	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	0	-	-	-	-	8.83	<0.4	211	236	0.03	-	-			
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	0	-	-	-	-	-	-	-	-	-	-	-			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	0	1				L12	L6.8	212	259	0.139			0.023	L0.002	0.023
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	0	2.6				L12	L6.8	225	275	0.207					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13	0	2.8								0.207					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13	0	7.9								0.205					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	0	26.6				L12	L6.8	188	211	0.022			L0.01	L0.002	L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13	0	12.8				L12	L6.8	171	194	L0.01					L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	0	0.3				7.66	L0.4	221	253	0.025			L0.01		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	0	-1				L12	L8	235	268	0.06			0.011		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	0	-0.7				L12	L6.8	249	289	0.087			0.02		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	0	6.5				L12	L6.8	198	229	0.075			0.016		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	0	13.9				L12	L6.8	208	237	0.016			L0.01		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	0	24.4				L12	L6.8	193	220	0.024			L0.025		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	0	10.7				L12	L6.8	195	217	0.022					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	0	-0.4				L12	L6.8	194	232	0.034					L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14	0	5.2								0.147					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	0	1.9				L12	L6.8	207	253	0.164					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14	0	3.5								0.087					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	0	15.6				L12	L6.8	184	213	L0.01					L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14	0	21.4								L0.01					L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	0	16.9				L12	L6.8	179	204	L0.01					L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	0	8.3				L12	L6.8	176	208	0.014					0.02
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	0	-0.8				L12	L6.8	185	216	0.033					L0.01

						Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Nitrogen- dissolved NO_3 and NO_2 (mg/L)	Nitrogen- soluble NO_3 and NO_2 (mg/L)	Nitrogen- dissolved Kjeldahl (mg/L)	Nitrogen- total Kjeldahl (mg/L)	Nitrogen- total Kjeldahl particulate (mg/L)	PHOSPHOROUS ACID HYDROLYSES (mg/L)	PHOSPHOROUS-ACID HYDROLYZABLE (mg/L)	Phosphorus- total acid reactive (mg/L)	Phosphorus- total ortho (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	0.04	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	0.31	-	-	0.7	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	0.09	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	0.36	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	0.13	-	-	0.8	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	0.06	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	0.14	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	<0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	<0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	0.02	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	0.17	-	-	1.4	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	0.06	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	0.21	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	0.23	-	-	2.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	0.07	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	0.01	-	-	1.4	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	<0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	<0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	0.02	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	0.08	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	0.1	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	0.04	-	-	0.8	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	<0.01	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	<0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	<0.01	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	0.01	-	-	1.4	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	0.02	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	0.03	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	0.03	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	0.07	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	0.05	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	0.02	-	-	1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	0.02	-	-	1.5	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	0.03	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	0.03	-	-	1.4	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	0.02	-	-	1.5	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	<0.01	-	-	1.4	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	<0.01	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	0.01	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	0.02	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	0.03	-	-	1.1	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	0.05	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	0.05	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	<0.01	-	1.86	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	<0.01	-	-	1.8	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	<0.01	-	-	1.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	0.01	-	-	1.5	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	0.04	-	-	1.8	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	0.02	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	1.56	-	-	1.4	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	<0.01	-	-	1.3	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	<0.01	-	-	1.8	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	<0.01	-	-	1.6	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	<0.01	-	-	0.8	-			-	-

						Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Nitrogen- dissolved NO_3 and NO_2 (mg/L)	Nitrogen- soluble NO_3 and NO_2 (mg/L)	Nitrogen- dissolved Kjeldahl (mg/L)	Nitrogen- total Kjeldahl (mg/L)	Nitrogen- total Kjeldahl particulate (mg/L)	PHOSPHOROUS ACID HYDROLYSES (mg/L)	PHOSPHOROUS-ACID HYDROLYZABLE (mg/L)	Phosphorus- total acid reactive (mg/L)	Phosphorus- total ortho (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	<0.01	-	-	1.7	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	0.03	-	-	2.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	<0.01	-	-	1.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	<0.01	-	-	2.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	<0.01	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	0.01	-	-	2.2	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	0.03	-	-	2.3	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	<0.01	-	-	0.8	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	<0.01	-	-	1.7	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	0.03	-	-	1.5	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	0.03	-	-	1.69	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	0.02	-	-	1.4	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	<0.01	-	-	1.3	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	<0.01	-	-	1.3	-			-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	0.052	-	-	0.87	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	0.0234	-	-	0.84	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	<0.005	-	-	0.68	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	0.006	-	-	0.9	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	0.008	-	-	1.01	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	0.0136	-	-	2.07	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	<0.006	-	-	0.96	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	<0.05	-	-	0.91	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	<0.05	-	-	1.08	-			0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	<0.05	-	-	0.93	-			0.012	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	<0.05	-	-	0.95	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	<0.05	-	-	0.82	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	<0.05	-	-	0.97	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	<0.05	-	-	1.5	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	<0.05	-	-	1.06	-			0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	<0.05	-	-	1.11	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	<0.05	-	-	1.22	-			0.014	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	<0.05	-	-	1.42	-			0.013	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	<0.05	-	-	1.15	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	<0.05	-	-	1.18	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-			-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	<0.05	-	-	0.97	-			0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	<0.05	-	-	1.17	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	<0.05	-	-	1.13	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	<0.05	-	-	1.15	-			0.013	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	<0.05	-	-	1.36	-			0.013	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	<0.05	-	-	1.27	-			0.012	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	<0.05	-	-	0.98	-			<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-			-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	L0.05			0.99			0.0027		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	0.052			1.04		L0.014		0.011	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13	0.091			1.12		L0.014		0.017	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13	0.067			0.99		L0.014		0.012	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	L0.05			0.81		L0.014		0.013	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13				0.99		L0.014		0.013	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	L0.05			1.02		L0.014	0.0058	L0.01	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	L0.05			1.06		L0.014		0.0047	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	L0.05			0.93		L0.014	L0.01	L0.01	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	L0.05			0.86		L0.0014			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	L0.05			0.86		L0.014	0.012	L0.01	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12				1.03		0.014			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	0.073			1.09		L0.01			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13				0.92			0.00424		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14	0.121			0.97		0.015	0.0068	L0.01	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	0.065			0.93			0.0111		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14	0.065			0.96			0.0082		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14				0.77			0.0098		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14				0.77			0.0107		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14				0.89			0.0082		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14				0.99			0.0096		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14				0.91			0.0085		

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Routine Phosphorus- dissolved ortho (mg/L)	Routine Phosphorus- particulate (calc) (mg/L)	Routine Phosphorus- total (P) (mg/L)	Routine Phosphorus- total dissolved (mg/L)	Routine PHOSPHORUS TOTAL INORGANIC (mg/L)	Routine Carbon- dissolved inorganic (DIC) (mg/L)	Routine Carbon- dissolved organic (calc) (mg/L)	Routine Carbon- dissolved total (mg/L)	Routine Carbon- inorganic particulate (calc) (mg/L)	Routine Carbon- organic particulate (calc) (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	<0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	<0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	0.12	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	0.06	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	0.014	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	0.06	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	0.06	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	0.06	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	0.2	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	<0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	0.05	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	<0.001	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	0.01	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	0.013	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	0.007	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	0.006	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	0.01	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	0.01	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	0.06	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	0.014	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	0.05	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	0.05	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	0.01	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	0.12	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	0.01	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	0.04	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	0.03	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	0.02	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	0.05	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	0.05	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	0.01	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	0.011	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	0.048	0.008		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	-	0.007	0.012	0.005		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-	0.003	0.011	0.008		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	0.019	0.024	0.005		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-	0.004	0.012	0.008		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	0.003	0.014	0.011		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-	0.007	0.012	0.005		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	0.016	0.022	0.006		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-	0.034	0.041	0.007		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-	0.031	0.039	0.008		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-	0.009	0.015	0.006		-	-	-	-	-

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Routine Phosphorus- dissolved ortho (mg/L)	Routine Phosphorus- particulate (calc) (mg/L)	Routine Phosphorus- total (P) (mg/L)	Routine Phosphorus- total dissolved (mg/L)	Routine PHOSPHORUS TOTAL INORGANIC (mg/L)	Routine Carbon- dissolved inorganic (DIC) (mg/L)	Routine Carbon- dissolved organic (calc) (mg/L)	Routine Carbon- dissolved total (mg/L)	Routine Carbon- inorganic particulate (calc) (mg/L)	Routine Carbon- organic particulate (calc) (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	0.014	0.016	0.002		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-	0.012	0.019	0.007		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-	0.018	0.035	0.017		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-	0.037	0.045	0.008		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	0.001	0.002	0.001		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	0.006	0.016	0.01		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	-	0.007	0.014	0.007		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	-	0.01	0.01	<0.001		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	-	0.01	0.022	0.012		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	-	0.013	0.019	0.006		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	-	0.012	0.018	0.006		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	-	0.008	0.016	0.008		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	-	0.029	0.031	0.002		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	-	0.013	0.019	0.006		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	<0.001	0.0204	0.0328	0.0051		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	0.0071	-	0.0194	0.0087		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	0.0075	-	0.0189	0.0108		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	0.0094	0.0056	0.0158	0.0102		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	0.0116	0.0022	0.0242	0.016		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	0.006	<0.001	0.0127	0.0124		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	0.0102	0.012	0.0228	0.0108		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	0.0108	0.0069	0.0192	0.0123		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	-	<0.014	0.021	0.015		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	<0.014	0.023	0.014		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	0.0072	<0.014	0.015	0.011		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	0.0049	<0.014	0.024	0.017		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	0.007	<0.014	0.023	0.017		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	0.0129	0.016	0.024	<0.01		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	-	<0.014	0.02	0.012		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	0.0103	<0.014	0.021	0.011		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	-	0.018	0.029	0.01		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	-	0.017	0.029	0.013		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	0.0051	0.014	0.027	0.013		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	<0.001	<0.014	0.024	0.014		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	-	0.028	0.031	<0.01		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	0.0049	0.025	0.038	0.012		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	0.0074	<0.014	0.027	0.014		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	-	<0.014	0.027	0.018		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	-	<0.014	0.028	0.017		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	-	<0.014	0.029	0.022		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	0.0066	<0.014	0.023	0.015		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-		-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	L0.001	0.0048	0.0079	0.0031	0.0027					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13		0.0056	0.008	0.0024	0.008					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13			0.013	0.0043	0.0059					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13			0.012	0.0045	0.0065					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13		0.015	0.019	0.0033	0.015					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13		0.016	0.021	0.0042	0.015					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	0.0061	L0.014	0.016	0.013	0.0119					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12		L0.01	0.0163	0.0133	0.0109					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	0.0044	L0.014	0.012	L0.01	0.012					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	0.0092	0.0087	0.0135	0.0048	0.0066					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	0.0026	L0.014	0.019	0.012	0.014					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	L0.001	0.019	0.023	0.004	0.014					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	0.0063	0.024	0.027	0.0036	0.016					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	L0.001	L0.014	0.013	0.0047	0.0042					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14	L0.001		0.02	0.015	0.0074					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	L0.001	0.0102	0.0186	0.0084	0.011					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14	L0.001	0.0036	0.0132	0.0095	0.0082					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	L0.001	0.016	0.022	0.0055	0.0108					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14	L0.001		0.02	0.0047	0.0106					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	L0.001	0.014	0.02	0.0052	0.0083					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	L0.001	0.015	0.02	0.0055	0.0102					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	L0.001	0.0121	0.0182	0.0061	0.0082					

						Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Carbon- total inorganic (TIC) (mg/L)	Carbon- total organic (calc) (mg/L)	Carbon- total organic (TOC) (mg/L)	Carbon- total particulate (calc) (mg/L)	Carbon- total (mg/L)	Conductivity (@ 25C) (µS/cm)	Solids- total dissolved (mg/L @105C)	Solids- total dissolved (mg/L @180C)	Solids- total dissolved (mg/L)	Solids- total (mg/L)	Solids- total suspended (mg/L)	Residue- fixed nonfiltrable (mg/L)	Turbidity (JTU)	Turbidity (NTU)	pH (pH units)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	41	23.5	-	-	-	1630	-	-	-	-	6	-	-	-	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	37.5	24	-	-	-	1730	-	-	-	-	<5	-	-	-	8
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	48.5	22.5	-	-	-	1790	-	-	-	-	<5	-	-	-	7.95
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	49.5	22	-	-	-	1750	-	-	-	-	<5	-	-	-	7.9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	37.5	19	-	-	-	1370	-	-	-	-	<5	-	-	-	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	38	21.5	-	-	-	1390	-	-	-	-	18	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	40	22	-	-	-	1460	-	-	-	-	18	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	38	22	-	-	-	1420	-	-	-	-	14	-	-	-	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	76	48.5	-	-	-	1450	-	-	-	-	21	-	-	-	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	38	23.5	-	-	-	1470	-	-	-	-	26	-	-	-	8.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	40.5	23	-	-	-	1530	-	-	-	-	16	-	-	-	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	44	23	-	-	-	1710	-	-	-	-	10	-	-	-	8.2
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	45	24	-	-	-	1820	-	-	-	-	<5	-	-	-	8.2
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	42	22	-	-	-	1770	-	-	-	-	<5	-	-	-	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	47	31	-	-	-	1840	-	-	-	-	<5	-	-	-	8
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	46	38	-	-	-	1800	-	-	-	-	8	-	-	-	7.8
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	45	26.5	-	-	-	1710	-	-	-	-	36	-	-	-	8
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	29	21.5	-	-	-	1130	-	-	-	-	<5	-	-	-	7.9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	36.5	20	-	-	-	1470	-	-	-	-	22	-	-	-	8.2
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	36	20.5	-	-	-	1440	-	-	-	-	18	-	-	-	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	36.5	20	-	-	-	1470	-	-	-	-	21	-	-	-	8.45
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	34	27	-	-	-	1480	-	-	-	-	20	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	1450	-	-	-	-	24	-	-	-	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	1470	-	-	-	-	16	-	-	-	8.25
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	1510	-	-	-	-	<5	-	-	-	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	44.5	19	-	-	-	1590	-	-	-	-	<5	-	-	-	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	49	22	-	-	-	1660	-	-	-	-	<5	-	-	-	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	47.5	20.5	-	-	-	1680	-	-	-	-	<5	-	-	-	7.9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	43.5	19	-	-	-	1640	-	-	-	-	5	-	-	-	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	35	16.5	-	-	-	1390	-	-	-	-	<5	-	-	-	8.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	38.5	19	-	-	-	1480	-	-	-	-	13	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	37.5	18	-	-	-	1470	-	-	-	-	9	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	36.5	22	-	-	-	1440	-	-	-	-	13	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	37	26.5	-	-	-	1390	-	-	-	-	64	-	-	-	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	37.5	19	-	-	-	1390	-	-	-	-	11	-	-	-	8.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	39.5	23.5	-	-	-	1490	-	-	-	-	18	-	-	-	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	41	18.5	-	-	-	1510	-	-	-	-	<5	-	-	-	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	43.5	18.5	-	-	-	1600	-	-	-	-	<5	-	-	-	8.2
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	42	22.5	-	-	-	1630	-	-	-	-	<5	-	-	-	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	49	24.5	-	-	-	1720	-	-	-	-	<5	-	-	-	8
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	41.5	37	-	-	-	1500	-	-	-	-	19	-	-	1	8.2
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	38.5	27	-	-	-	1460	-	-	-	-	9	-	-	3.5	8.35
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	36.5	19.5	-	-	-	1410	-	-	-	-	<5	-	-	5.5	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	36.5	21.5	-	-	-	1450	-	-	-	-	21	-	-	10	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	34	20	-	-	-	1460	-	-	-	-	25	-	-	8	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	40	21	-	-	-	1460	-	-	-	-	28	-	-	15	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	42	35	-	-	-	1470	-	-	-	-	49	-	-	30	8.32
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	40.5	28	-	-	-	1450	-	-	-	-	15	-	-	15	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	44	21.5	-	-	-	1420	-	-	-	-	5	-	-	5	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	52.5	28.5	-	-	-	1850	-	-	-	-	<5	-	-	2.5	8.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	48	23	-	-	-	1900	-	-	-	-	<5	-	-	2	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	44	23	-	-	-	1927	-	-	-	-	<5	-	-	1	8.25
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	42	24	-	-	-	1679	-	-	-	-	7	-	-	2	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	40.5	20	-	-	-	1550	-	-	-	-	19	-	-	3	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	37	21.5	-	-	-	1450	-	-	-	-	17	-	-	7.5	8.65
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	36	22.5	-	-	-	1530	-	-	-	-	22	-	-	10	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	1560	-	-	-	-	17	-	-	10	8.45
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	16.5	-	-	-	1560	-	-	-	-	16	-	-	7.5	8.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	39.5	18.5	-	-	-	1740	-	-	-	-	12	-	-	3.5	8.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	45.5	20.5	-	-	-	1810	-	-	-	-	<5	-	-	2	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	48	22.5	-	-	-	1880	-	-	-	-	8	-	-	1.5	8.15
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	50	20	-	-	-	1880	-	-	-	-	<5	-	-	1	8.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	49.5	19.5	-	-	-	1860	-	-	-	-	<5	-	-	1.5	8.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	36.5	28.5	-	-	-	1510	-	-	-	-	12	-	-	4.5	8.35
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	33.5	20.5	-	-	-	1530	-	-	-	-	20	-	-	9	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	36.5	20.5	-	-	-	1550	-	-	-	-	21	-	-	9.5	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	38.5	18.5	-	-	-	1550	-	-	-	-	21	-	-	6.5	8.6
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	35.5	33	-	-	-	1590	-	-	-	-	11	-	-	5.5	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	36	32	-	-	-	1590	-	-	-	-	18	-	-	10	8.45
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	41	17.5	-	-	-	1700	-	-	-	-	5	-	-	3	8.25
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	44.5	21	-	-	-	1850	-	-	-	-	<5	-	-	1.5	8.25
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	48.5	22.5	-	-	-	1930	-	-	-	-	10	-	-	1.5	8.5
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	50.5	21	-	-	-	2030	-	-	-	-	<5	-	-	1	8.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	1830	1100	-	-	1100	<5	-	-	8.1	8.59
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	51	-	19	-	69	1450	-	935	-	-	2	-	-	2.5	7.59
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	52	-	23	-	75	1530	-	748	-	-	6	-	-	5.4	8.49
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	40	-	19	-	59	1660	-	943	-	-	12	-	-	6.8	8.44
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	51	-	15	-	67	1940	-	1480	-	-	3	-	-	2.2	8.07
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	2000	-	1150	-	-	1	-	-	-	8.07
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	41	-	13	-	55	1590	-	869	-	-	5	-	-	3.3	8.19
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	1670	-	947	-	-	8	-	-	-	8.49
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	40	-	14	-	54	1630	-	974	-	-	11	-	-	6.8	8.41
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	41	-	17	-	58	1520	-	896	-	-	29	-	-	15	8.39
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	49	-	17	-	66	1640	-	1010	-	-	1	-	-	1.8	7.99

						Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Carbon- total inorganic (TIC) (mg/L)	Carbon- total organic (calc) (mg/L)	Carbon- total organic (TOC) (mg/L)	Carbon- total particulate (calc) (mg/L)	Carbon- total (mg/L)	Conductivity (@ 25C) (µS/cm)	Solids- total dissolved (mg/L @105C)	Solids- total dissolved (mg/L @180C)	Solids- total dissolved (mg/L)	Solids- total (mg/L)	Solids- total suspended (mg/L)	Residue- fixed nonfiltrable (mg/L)	Turbidity (JTU)	Turbidity (NTU)	pH (pH units)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	1530	-	949	-	-	2	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	50	-	20	-	70	1570	-	988	-	-	2	-	-	1.3	7.92
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	44	-	18	-	62	1490	-	900	-	-	22	-	-	11.4	8.44
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	44	-	18	-	62	1500	-	870	-	-	32	-	-	14	8.2
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	47	-	18	-	64	1720	-	925	-	-	3	-	-	1	7.93
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	1740	-	-	-	-	-	-	-	1.5	7.94
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	46	-	14	-	59	1760	-	930	-	-	3	-	-	1.2	7.95
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	38	-	14	-	52	1470	-	828	-	-	14	-	-	9.5	8.36
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	40	-	8.1	-	48	1490	-	825	-	-	21	-	-	18.3	8.34
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	42	-	8.1	-	50	1600	-	858	-	-	5	-	-	4.2	8.3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	44	-	14	-	59	1710	-	976	-	-	10	-	-	5.7	8.11
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	38	-	16	-	54	1520	-	790	-	-	13	-	-	8.9	8.49
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	42	-	20	-	62	1390	-	777	-	-	29	-	-	17.9	8.59
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	49	-	16	-	65	1670	-	898	-	-	1	-	-	1.2	8.08
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	44.7	14.3	-	-	59.1	1330	-	792	-	-	7	-	-	2.3	8.52
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	45.7	13.7	-	-	59.4	1420	-	-	-	-	17	-	-	-	8.41
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	43.9	14.3	-	-	58.2	1330	-	-	-	-	7	-	-	-	8.37
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	43.7	14.3	-	-	58.1	1360	-	842	-	-	15	-	-	10	8.64
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	41.3	12.7	-	-	54	1370	-	758	-	-	16	-	-	17	8.41
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	47.6	15.8	-	-	63.4	1550	-	848	-	-	<5	-	-	1.5	8.26
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	39.4	14	-	-	53.4	1280	-	742	-	-	<5	-	-	6.05	8.67
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	42.3	16.2	-	-	58.5	1390	-	816	-	-	<5	-	-	2.58	8.38
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	49.1	15.3	-	-	64.5	1440	-	860	-	-	<5	-	-	1.34	8.19
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	47	13.8	-	-	60.8	1250	-	762	-	-	8	-	-	4.88	8.36
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	43.1	13.6	-	-	56.6	1140	-	656	-	-	6	-	-	5.47	8.49
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	43.7	-	13.5	-	57.1	1100	-	708	-	-	11	-	-	7.06	8.51
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	43.5	-	13.9	-	57.3	1100	-	690	-	-	9	-	-	0.22	8.63
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	43.5	-	13.6	-	57.1	966	-	698	-	-	44	-	-	29.2	8.58
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	43.3	-	14.2	-	57.5	1090	-	692	-	-	14	-	-	8.24	8.59
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	42.7	-	13.2	-	55.9	1140	-	632	-	-	11	-	-	8.2	8.63
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	43.9	-	14.1	-	58.1	1060	-	664	-	-	19	-	-	18.4	8.61
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	44.6	-	14.3	-	58.9	964	-	626	-	-	36	-	-	17.7	8.59
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	44.2	-	14	-	58.1	1060	-	670	-	-	14	-	-	9.01	8.57
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	43.8	-	13.9	-	57.8	1050	-	632	-	-	20	-	-	8.38	8.56
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	46.4	-	12.2	-	58.6	1040	-	670	-	-	15	-	-	10.2	8.57
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	45.9	-	12.4	-	58.3	974	-	646	-	-	36	-	-	35	8.51
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	44	-	11.8	-	55.8	1040	-	702	-	-	18	-	-	12.5	8.49
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	44.8	-	14.2	-	59	1050	-	660	-	-	19	-	-	14.6	8.49
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	44.3	-	14.4	-	58.7	1010	-	648	-	-	27	-	-	27	8.47
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	45.1	-	13.6	-	58.8	1030	-	636	-	-	28	-	-	33	8.43
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	47.7	-	12.7	-	60.4	1070	-	694	-	-	<5	-	-	4.6	8.55
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	47.8		14.8		62.5	1270		750			L5			1.72	8.28
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	52.4		15.3		67.7	1350		795			L5			1.03	8.12
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13	55.7		15.7		71.4	1380					7				7.86
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13	52.1		15.3		67.5	1220					L5				8.11
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	43.2		11.8		55	1040		600			7			6.25	8.57
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13	38.4		13.9		52.2	1030		582			16			11.5	8.56
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	51.1		14.2		65.2	1160		692			L5			2.03	8.51
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	54.2		13.4		67.6	1130		732			L5			1.24	8.52
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	56.7		14.8		71.4	1160		802			L5			1.09	8.46
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	45.9		13.6		59.5	1080		612			L5			2.25	8.47
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	46.5		13		59.4	1110		658			8			4.25	8.53
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	43.8		11.4		55.2	1060		713			24			8.51	8.51
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	41.4		13.8		55.3	1240		668			24			18.5	8.6
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	45.3		14.3		59.6	1080		617			5			2	8.34
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14	55.9	15			70.9	1270					L5				8.18
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	50.9	14.3			65.2	1150		668			7			1.1	8.16
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14	50.1		13.2		63.2	1190					L5				8.11
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	32.3		11.5		43.8	919		526			18			14.2	8.49
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14	39.6	13.8			53.5	920					18				8.5
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	40.1	14.5			54.6	905		534			23			14.7	8.55
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	39.6	13.4			53.1	902		520			13			5.85	8.39
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	40.1	13.4			53.5	948		542			15			9.08	8.47

						Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Temperature (°C)	True Colour (CU)	True Colour (rel units)	Oxygen- biochemical demand (BOD) (mg/L)	Oxygen- dissolved (mg/L)	Chlorophyll *a* phytoplankton (µg/L)	Chlorophyll *a* (µg/L)	Pheophytin *a* (µg/L)	ODB/ODA (CHLOROPHYLL-A / PHEOPHYTIN-A RATIO) -	E.Coli (CFU/100 mL)	Escherichia, coli (CFU/100 mL)	Escherichia, coli (CFU/100 mL)	ESCHERICHIA, COLI (MPN/100 mL)	Coliforms- fecal (CFU/100 mL)	Coliforms- fecal (MPN/100 mL)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	0	-	-	-	17.2	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	0	-	-	-	10.9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	0	-	-	-	9.3	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	6.5	-	-	-	10.7	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	15	-	-	-	15.1	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	18	-	-	-	11.2	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	21	-	-	-	12	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	18	-	-	-	9.6	-	-	-		-	-	-		-	9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	12	-	-	-	10.2	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	6.5	-	-	-	13	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	1.5	-	-	-	-	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	0.5	-	-	-	15.1	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	0	-	-	-	15.1	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	0	-	-	-	13.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	0	-	-	-	14.2	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	5.5	-	-	-	8.6	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	3.5	-	-	-	9.9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	11	-	-	-	8.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	18.5	-	-	-	9.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	23	-	-	-	9.8	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	18	-	-	-	10.4	-	-	-		-	-	-		-	9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	11.5	-	-	-	9.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	5	-	-	-	11.6	-	-	-		-	-	-		-	39
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	1.2	-	-	-	14.3	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	0	-	-	-	13.1	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	0	-	-	-	14	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	1.5	-	-	-	8.3	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	0	-	-	-	-	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	6	-	-	-	11.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	12	-	-	-	11.3	-	-	-		-	-	-		-	9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	23	-	-	-	8.7	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	19.5	-	-	-	8.5	-	-	-		-	-	-		-	9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	19	-	-	-	8.7	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	14.5	-	-	-	9.9	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	4.5	-	-	-	12.9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	1.5	-	-	-	9.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	0	-	-	-	15	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	0.5	-	-	-	15.9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	0.5	-	-	-	14.6	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	1	-	-	-	14.6	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	1	-	-	-	12.8	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	15	-	-	-	6.1	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	14	-	-	-	9.6	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	24	-	-	-	9.6	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	20	-	-	-	9.8	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	16	-	-	-	10	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	5	-	-	-	11.9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	3.5	-	-	-	14	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	0	-	-	-	12.2	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	1.5	-	-	-	12.3	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	15	-	-	-	12	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	2.5	-	-	-	13	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	6	-	-	-	11.3	-	-	-		-	-	-		-	9
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	19	-	-	-	9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	23.5	-	-	-	8.4	-	-	-		-	-	-		-	23
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	13	-	-	-	7.9	-	-	-		-	-	-		-	3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	7.5	-	-	-	8.9	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	3	-	-	-	12.6	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	0.4	-	-	-	11.8	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	1.4	-	-	-	11.3	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	5.1	-	-	-	13.4	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	7	-	-	-	11.3	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	12.6	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	15.5	-	-	-	13	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	20	-	-	-	9.5	-	-	-		-	-	-		-	4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	25	-	-	-	9.1	-	-	-		-	-	-		-	23
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	25	-	-	-	9.1	-	-	-		-	-	-		-	3
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	11	-	-	-	11.4	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	5	-	-	-	13.4	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	0	-	-	-	13.8	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	0	-	-	-	14.5	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	0	-	-	-	12.8	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	13.4	-	-	-		-	-	-		-	0
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	5	-	-	8.7	-	-	-		-	-	-		<10	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	4	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	-	13	-	-	12.2	-	-	-		-	-	40		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-	10	-	-	7.3	-	-	-		-	-	<10		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	<5	-	-	8.5	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-	<5	-	-	8.5	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-	<5	-	-	11.7	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-	<5	-	-	8.2	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-	<5	-	-	9.2	-	-	-		-	-	-		-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-	<5	-	-	10.4	-	-	-		-	-	-		-	-

						Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine	Routine
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Temperature (°C)	True Colour (CU)	True Colour (rel units)	Oxygen- biochemical demand (BOD) (mg/L)	Oxygen- dissolved (mg/L)	Chlorophyll *a* phytoplankton (µg/L)	Chlorophyll *a* (µg/L)	Pheophytin *a* (µg/L)	ODB/ODA (CHLOROPHYLL-A / PHEOPHYTIN-A RATIO) -	E.Coli (CFU/100 mL)	Escherichia, coli (CFU/100 mL)	Escherichia, coli (CFU/100 mL)	ESCHERICHIA, COLI (MPN/100 mL)	Coliforms- fecal (CFU/100 mL)	Coliforms- fecal (MPN/100 mL)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-	<5	-	-	10.5	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-	<5	-	-	8.5	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-	<5	-	-	8.9	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	<5	-	-	11.2	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	-	<5	-	7	9.2	-	2	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	-	<5	-	<1	8.5	-	7	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	-	<5	-	-	9.7	-	19.5	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	-	<5	-	2	9.9	-	2	4.3		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	-	8	-	1	11.7	-	3.59	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	-	6	-	1	8	-	8.98	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	-	11	-	<1	9.6	-	<0.5	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-		-	<10	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	-	6	-	<1	13.2	-	5.98	<0.5		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	15	1.7	13	-	3.05	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-		-	<10	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-		-	20	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	1.9	-	-	6.87	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-		-	<10	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	2.3	-	-	3.05	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-		-	<10	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	20	<1	9.4	-	4.2	1.95		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-		-	<10	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	-	-	5	1.1	11.8	-	9.55	1.41		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-		<1	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	-	-	10	1.8	10	-	8.4	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	-	-	10	1.5	8.4	-	4.58	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	7.5	-	1.4	12.9	-	4.39	0.69		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-		10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	-	30.5	-	<1	9.6	-	1.53	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	9	-	1.7	11.5	-	6.49	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	-	7.4	-	1.1	10.2	-	7.83	0.86		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	8.8	-	<1	7.6	-	5.92	1.3		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	9	-	1.5	7.5	-	6.3	1.05		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	-	9.6	-	1.5	7.4	-	8.59	2.9		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	-	10.4	-	1.9	8.1	-	7.06	0.82		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	-	8.3	-	1	8.6	-	7.06	<0.6		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	-	9.7	-	2.3	9.4	-	8.21	1.68		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	-	8.5	-	1.5	9.4	-	10.3	3.05		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	-	5.7	-	1.3	9.6	-	7.64	1.18		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	6.8	-	<1	9.8	-	8.4	1.89		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	-	7.8	-	1.3	9.6	-	13.7	2.02		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	-	10.7	-	2.3	10.5	-	14.5	3.53		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	-	16.4	-	<1	10.8	-	12.8	1.91		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	-	9.9	-	1.4	10.2	-	12.8	1.91		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	-	7.5	-	2.7	11.9	-	14.3	3.19		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	-	8.2	-	2.8	12.9	-	15.3	3.04		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	6.7	-	1.3	12.7	-	9.74	0.69		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-		<10	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13		L5		L6	5.6		2.29	L0.6			L10				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13		7.1		L6	11.4		2.67	1.07	1.5		L10				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13				L6			2.29	L0.6	1.6						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13				11.7			1.6	L0.6	1.6						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13		11.2		L6	7.9		5.35	L0.6			20				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13		7.9		L6	9.7		8.29	1.44	1.6		30				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12		8.6		2.1	14.8		8.59	1.03	1.6	L10					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12		9.7		L1	12		3.05	1.62	1.5	L10					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12		10.4		3.3	13		3.63	L1	1.7	L10					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12		7.5		1.7	12		1.07	1.92	1.3		L10				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12		6.9		L1	9.2		5.16	L0.6	1.6			4			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12		5.2		L1	7.6		4.81	0.8	1.6		L10				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12		5.2		1.5	9.1		6.42	0.69	1.6		340				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13		5.9		1.9	4.4		5.54	0.61	1.6		L10				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14				L1.2			1.72	L0.6	1.7						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14		8.6		1.4	11.4		1.53	L0.6	1.6			30			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14				L1.4			2.41	L0.6	1.7						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14		13.3		L1	8.8		5.88	0.67	1.6			30			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14				1			4.81	0.99	1.6			20			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14		10.2		1.7	7		7.22	1.2	1.6			100			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14		6.3		1.5	10.7		5.88	L0.6	1.7			L10			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14		8.3		1.9	5.7		6.68	1.36	1.6			L10			

						Routine	Routine	Routine	Routine	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Coliforms- total (CFU/100 mL)	Coliforms- total (MPN/100 mL)	Fecal Streptococci (CFU/100 mL)	Fecal Streptococci (MPN/100 mL)	Hardness- total as $CaCO_3$ (calc) (mg/L)	Hardness- total as $CaCO_3$ (mg/L)	Aluminum- dissolved (mg/L)	Aluminum- extractable (mg/L)	Aluminum- total (mg/L)	Antimony- total (mg/L)	Arsenic- extractable (mg/L)	Arsenic- total (mg/L)	Barium- total (mg/L)	Beryllium- total (mg/L)	Bismuth- total (mg/L)	Boron- extractable (mg/L)	Boron- soluble (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	4600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	15	-	<10	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	290	-	-	-	-	-	-	0.001	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	-	-	-	-	288	-	0.021	-	0.073	0.0005	-	0.0022	0.046	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-	-	-	-	308	-	0.013	-	0.073	0.0006	-	0.002	0.049	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	-	-	-	305	-	0.005	-	0.06	0.0006	-	0.0024	0.044	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-	-	-	-	321	-	0.006	-	0.017	0.0005	-	0.0024	0.055	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-	-	-	-	269	-	0.015	-	0.048	0.0006	-	0.002	0.052	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-	-	-	-	284	-	0.02	-	0.062	0.0005	-	0.0023	0.056	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-	-	-	-	276	-	0.033	-	0.25	0.0005	-	0.0022	0.065	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-	-	-	-	315	-	0.007	-	0.009	0.0006	-	0.0021	0.063	<0.0002	<0.0002	-	-

						Routine	Routine	Routine	Routine	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Coliforms- total (CFU/100 mL)	Coliforms- total (MPN/100 mL)	Fecal Streptococci (CFU/100 mL)	Fecal Streptococci (MPN/100 mL)	Hardness- total as $CaCO_3$ (calc) (mg/L)	Hardness- total as $CaCO_3$ (mg/L)	Aluminum- dissolved (mg/L)	Aluminum- extractable (mg/L)	Aluminum- total (mg/L)	Antimony- total (mg/L)	Arsenic- extractable (mg/L)	Arsenic- total (mg/L)	Barium- total (mg/L)	Beryllium- total (mg/L)	Bismuth- total (mg/L)	Boron- extractable (mg/L)	Boron- soluble (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-	-	-	-	302	-	0.016	-	0.016	0.0005	-	0.0018	0.054	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-	-	-	-	283	-	0.018	-	0.065	0.0006	-	0.0023	0.059	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-	-	-	-	273	-	<0.001	-	0.089	0.0005	-	0.0019	0.053	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	-	-	-	293	-	0.002	-	0.013	0.0005	-	0.0018	0.06	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	-	-	-	-	275	-	0.001	-	0.015	0.0005	-	0.0016	0.055	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	-	-	-	-	252	-	0.002	-	0.048	0.0005	-	0.0014	0.049	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	-	-	-	-	243	-	0.002	-	0.068	0.0005	-	0.0017	0.051	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	-	-	-	-	253	-	0.002	-	0.027	0.0005	-	0.0016	0.049	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	-	-	-	-	289	-	<0.001	-	0.046	0.0005	-	0.0015	0.047	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	-	-	-	-	259	-	<0.001	-	0.032	0.0005	-	0.0018	0.046	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	-	-	-	-	250	-	0.001	-	0.095	0.0004	-	0.0019	0.049	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	-	-	-	-	290	-	0.003	-	0.024	0.0006	-	0.0021	0.056	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	246	-	0.0043	-	0.0245	<0.0002	-	0.00273	0.0468	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	0.0861	<0.0002	-	0.00294	0.0525	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	0.0522	<0.0002	-	0.00307	0.0571	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	269	-	0.0024	-	0.0289	<0.0002	-	0.00406	0.0553	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	-	-	-	-	266	-	0.0059	-	0.0362	<0.0002	-	0.0028	0.056	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	602	-	<0.002	-	0.0225	0.00027	-	0.00064	0.0413	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	-	-	-	-	236	-	0.0021	-	0.0522	0.0002	-	0.00306	0.0473	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	294	-	<0.002	-	0.0425	<0.0002	-	0.00272	0.0455	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	-	-	-	-	335	-	<0.002	-	0.011	<0.0002	-	0.00325	0.0513	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	280	-	<0.002	-	0.0571	<0.0002	-	0.00236	0.0422	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	-	-	-	-	239	-	0.0029	-	0.039	<0.0002	-	0.00355	0.045	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	267	-	0.005	-	0.0499	<0.0002	-	0.00282	0.0487	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	261	-	<0.002	-	0.0336	<0.0002	-	0.00297	0.0533	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	-	-	-	-	303	-	0.0034	-	0.133	<0.0002	-	0.00295	0.0592	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	-	-	-	-	294	-	0.0064	-	0.051	<0.0002	-	0.00309	0.0557	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	-	-	-	-	270	-	0.0032	-	0.0232	<0.0002	-	0.00284	0.0481	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	-	-	-	-	277	-	<0.002	-	0.077	<0.0002	-	0.00271	0.0527	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	-	-	-	-	290	-	<0.002	-	0.0884	<0.0002	-	0.00261	0.0485	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	-	-	-	-	260	-	0.0021	-	0.0313	<0.0002	-	0.00284	0.051	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	273	-	0.0026	-	0.0329	<0.0002	-	0.00281	0.0493	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	-	-	-	-	247	-	<0.002	-	0.0524	<0.0002	-	0.00282	0.048	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	-	-	-	-	271	-	0.0217	-	0.148	<0.0002	-	0.00315	0.0543	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	-	-	-	-	328	-	<0.002	-	0.137	<0.0002	-	0.00254	0.0488	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	-	-	-	-	348	-	<0.002	-	0.104	0.00021	-	0.00267	0.049	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	-	-	-	-	251	-	0.0038	-	0.136	<0.0002	-	0.00249	0.0483	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	-	-	-	-	331	-	<0.002	-	0.223	<0.0002	-	0.00321	0.0529	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	265	-	0.0044	-	0.0279	<0.0002	-	0.00269	0.0503	<0.0002	<0.0002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13							L0.002		0.0117	L0.0002		0.00217	0.0515	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13							L0.002		0.0111	L0.0002		0.00223	0.0504	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13							L0.002		0.05	L0.0002		0.00207	0.046	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13					240		L0.002		0.102	L0.0002		0.00174	0.0441	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12					322		L0.002		0.0122	L0.0002		0.00275	0.0533	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12					328		L0.002		0.013	L0.0002		0.00309	0.0603	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12					334		0.0082		0.0177	L0.0002		0.00326	0.0659	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12							L0.002		0.0179	L0.0002		0.00169	0.0475	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12							L0.002		0.0105	L0.0002		0.00216	0.0532	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12							0.0218		0.0438	L0.0002		0.00228	0.0487	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12							0.0039		0.0881	L0.0002		0.00216	0.0532	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13					203		0.0131		0.02	L0.0002		0.00197	0.042	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14					250		L0.002		0.0133	L0.0002		0.00193	0.0492	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14					220		L0.002		0.0628	L0.0002		0.0017	0.0403	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14					241		L0.002		0.0886	L0.0002		0.00189	0.0453	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14					224		0.002		0.0494	0.00022		0.00153	0.0395	L0.0002	L0.0002		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14					245		L0.002		0.0812	0.00026		0.00187	0.0431	L0.0002	L0.0002		

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Metal Boron- total (mg/L)	Metal Cadmium- extractable (mg/L)	Metal Cadmium- total (mg/L)	Metal Calcium- dissolved (mg/L)	Metal Calcium- extractable (mg/L)	Metal Calcium- total (mg/L)	Metal Cesium- total (mg/L)	Metal Chloride (mg/L)	Metal Chloride- dissolved (mg/L)	Metal Chromium- hexavalent dissolved (mg/L)	Metal Chromium- total (mg/L)	Metal Cobalt- total (mg/L)	Metal Copper- extractable (mg/L)	Metal Copper- total (mg/L)	Metal Iron- extractable (mg/L)	Metal Iron- dissolved (mg/L)	Metal Iron- total (mg/L)	Metal Lead- extractable (mg/L)	Metal Lead- total (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	<0.001	-	-	41.5	-	-	-	-	-	-	-	<0.01	-	0.08	-	-	<0.002	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	0.13	-	<0.00004	-	-	39.9	<0.0001	-	331	<0.02	0.0006	<0.0002	-	0.0019	-	-	<0.01	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	0.12	-	<0.00004	-	-	42.4	<0.0001	-	297	<0.02	0.0003	<0.0002	-	0.0008	-	-	0.09	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	0.14	-	<0.00004	-	-	41.4	<0.0001	-	341	<0.02	0.0006	<0.0002	-	0.0011	-	-	0.11	-	0.0003
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	0.16	-	<0.00004	-	-	42.7	<0.0001	-	383	<0.02	0.0003	<0.0002	-	0.0012	-	-	0.04	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	0.13	-	<0.00004	-	-	36.3	<0.0001	-	307	<0.02	0.0003	<0.0002	-	0.0008	-	-	0.04	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	0.13	-	<0.00004	-	-	39.5	<0.0001	-	328	<0.02	0.0005	<0.0002	-	0.001	-	-	0.11	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	0.16	-	<0.00004	-	-	41.1	<0.0001	-	340	<0.02	0.0007	0.0002	-	0.0039	-	-	0.26	-	0.0005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	0.14	-	<0.00004	-	-	45	<0.0001	-	370	<0.02	0.0002	<0.0002	-	0.0015	-	-	0.03	-	0.0002

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Metal Boron- total (mg/L)	Metal Cadmium- extractable (mg/L)	Metal Cadmium- total (mg/L)	Metal Calcium- dissolved (mg/L)	Metal Calcium- extractable (mg/L)	Metal Calcium- total (mg/L)	Metal Cesium- total (mg/L)	Metal Chloride (mg/L)	Metal Chloride- dissolved (mg/L)	Metal Chromium- hexavalent dissolved (mg/L)	Metal Chromium- total (mg/L)	Metal Cobalt- total (mg/L)	Metal Copper- extractable (mg/L)	Metal Copper- total (mg/L)	Metal Iron- extractable (mg/L)	Metal Iron- dissolved (mg/L)	Metal Iron- total (mg/L)	Metal Lead- extractable (mg/L)	Metal Lead- total (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	0.14	-	<0.00004	-	-	48.9	<0.0001	-	359	<0.02	0.0006	<0.0002	-	0.0009	-	-	0.03	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	0.13	-	<0.00004	-	-	39.7	<0.0001	-	310	<0.02	0.0004	<0.0002	-	0.0009	-	-	0.12	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	0.13	-	<0.00004	-	-	39.5	<0.0001	-	306	<0.02	0.0004	<0.0002	-	0.0015	-	-	0.17	-	0.0016
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	0.14	-	<0.00004	-	-	46.3	<0.0001	-	367	<0.02	0.0003	<0.0002	-	0.0009	-	-	0.07	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	0.12	-	<0.00004	-	-	48.1	<0.0001	-	269	<0.02	<0.0002	<0.0002	-	0.0007	-	-	0.06	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	0.19	-	<0.00004	-	-	40.3	<0.0001	-	298	<0.02	0.0002	<0.0002	-	0.0006	-	-	0.12	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	0.11	-	<0.00004	-	-	41.8	<0.0001	-	316	<0.02	0.0004	<0.0002	-	0.0009	-	-	0.12	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	0.11	-	<0.00004	-	-	44.2	<0.0001	-	351	<0.02	0.0003	<0.0002	-	0.0009	-	-	0.05	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	0.13	-	<0.00004	-	-	54.3	<0.0001	-	379	<0.02	<0.0002	<0.0002	-	0.0008	-	-	0.05	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	0.12	-	<0.00004	-	-	45	<0.0001	-	305	<0.02	<0.0002	<0.0002	-	0.0014	-	-	0.05	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	0.1	-	<0.00004	-	-	43.6	<0.0001	-	281	<0.02	0.0004	<0.0002	-	0.0008	-	-	0.14	-	0.0003
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	0.12	-	<0.00004	-	-	50.1	<0.0001	-	362	<0.02	0.0003	<0.0002	-	0.001	-	-	0.04	-	<0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	0.112	-	0.00004	-	-	43.8	<0.0001	-	276	<0.01	<0.001	<0.0002	-	<0.001	-	-	0.045	-	0.00011
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	0.115	-	<0.00001	-	-	49.2	<0.0001	-	282	-	<0.001	<0.0002	-	<0.001	-	-	0.069	-	0.00016
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	0.112	-	<0.00001	-	-	50.7	<0.0001	-	260	-	<0.001	<0.0002	-	<0.001	-	-	<0.02	-	0.00012
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	0.123	-	<0.00001	-	-	44.9	<0.0001	-	258	<0.01	<0.001	<0.0002	-	<0.001	-	-	0.06	-	0.00014
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	0.132	-	<0.00001	-	-	42.1	<0.0001	-	244	<0.01	<0.001	<0.0002	-	<0.001	-	-	0.053	-	0.00029
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	0.093	-	<0.00001	-	-	105	<0.0001	-	320	<0.01	<0.001	0.00032	-	0.0069	-	-	0.462	-	0.00022
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	0.126	-	<0.00001	-	-	36.3	<0.0001	-	243	<0.01	<0.001	<0.0002	-	0.00074	-	-	0.047	-	0.00014
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	0.11	-	<0.00001	-	-	50.7	<0.0001	274	-	<0.01	<0.001	<0.0002	-	0.0007	-	0.031	<0.1	-	0.00012
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	0.101	-	<0.00001	-	-	72.4	<0.0001	305	-	<0.01	<0.001	<0.0002	-	0.00071	-	0.015	<0.1	-	0.00025
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	0.084	-	<0.00001	-	-	53.5	<0.0001	255	-	<0.01	<0.001	<0.0002	-	0.00074	-	-	0.12	-	0.00009
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	0.107	-	<0.00001	-	-	42.4	<0.0001	216	-	<0.01	<0.001	<0.0002	-	0.00069	-	0.046	<0.1	-	0.0001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	0.096	-	0.00001	-	-	44.7	<0.0001	209	-	<0.01	<0.001	<0.0002	-	0.00073	-	0.05	<0.1	-	0.00012
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	0.108	-	<0.00001	-	-	46.2	<0.0001	207	-	<0.01	<0.001	<0.0002	-	0.00089	-	0.032	<0.1	-	0.00013
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	0.108	-	<0.00001	-	-	53.9	<0.0001	203	-	<0.01	<0.001	<0.0002	-	0.00084	-	-	0.22	-	0.00036
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	0.115	-	<0.00001	-	-	49.4	<0.0001	208	-	<0.01	<0.001	<0.0002	-	0.0007	-	0.038	<0.1	-	0.00013
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	0.108	-	<0.00001	-	-	45.4	<0.0001	201	-	<0.01	<0.001	<0.0002	-	0.00057	-	0.023	<0.1	-	0.00012
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	0.105	-	<0.00001	-	-	49.9	<0.0001	203	-	<0.01	<0.001	<0.0002	-	0.00066	-	0.092	<0.1	-	0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	0.093	-	<0.00001	-	-	48.2	<0.0001	200	-	<0.01	<0.001	<0.0002	-	0.00077	-	-	0.14	-	0.00024
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	0.108	-	<0.00001	-	-	43.3	<0.0001	199	-	<0.01	<0.001	<0.0002	-	0.0008	-	0.037	<0.1	-	0.00015
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	0.098	-	0.00001	-	-	49.2	<0.0001	202	-	<0.01	<0.001	<0.0002	-	0.00083	-	0.038	<0.1	-	0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	0.098	-	<0.00001	-	-	43	<0.0001	195	-	<0.01	<0.001	<0.0002	-	0.00065	-	0.091	<0.1	-	0.00022
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	0.087	-	0.00002	-	-	48.1	<0.0001	241	-	<0.01	<0.001	<0.0002	-	0.00091	-	-	0.22	-	0.0005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	0.106	-	<0.00001	-	-	52.3	<0.0001	195	-	<0.01	<0.001	<0.0002	-	0.00073	-	-	0.14	-	0.00024
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	0.106	-	0.00001	-	-	54.3	<0.0001	193	-	<0.01	<0.001	<0.0002	-	0.00082	-	-	0.15	-	0.00022
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	0.086	-	0.00001	-	-	47.3	<0.0001	198	-	<0.01	<0.001	<0.0002	-	0.00079	-	-	0.16	-	0.00031
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	0.155	-	<0.00001	-	-	47.1	<0.0001	190	-	<0.01	<0.001	<0.0002	-	0.00065	-	-	0.22	-	0.00033
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	0.092	-	0.00001	-	-	48.2	<0.0001	204	-	<0.01	<0.001	<0.0002	-	0.00061	-	0.026	<0.1	-	0.0002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	0.111		L0.00001			48.1	L0.0001	228		L0.01	L0.001	L0.0002	0.0006		0.012			L0.00009	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	0.109		L0.00001			53.8	L0.0001	248		L0.01	L0.001	L0.0002	0.00064		0.012			L0.00009	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	0.087		L0.00001			45.3	L0.0001	176		L0.01	L0.001	L0.0002	0.00059		0.052			0.0001	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13	0.074		L0.00001			44.7	L0.0001	183		L0.01	L0.001	L0.0002	0.00097		0.08			0.00017	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	0.09		L0.00001			49.6	L0.0001	207		L0.01	L0.001	L0.0002	0.00058		0.016	L0.1		L0.00009	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	0.122		L0.00001			55.5	L0.0001	204		L0.01	L0.001	L0.0002	0.00065		0.023	L0.1		L0.00009	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	0.126		0.00001			55.6	L0.0001	198		L0.01	L0.001	L0.0002	0.00083		L0.01	L0.1		0.0001	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	0.09		L0.00001			42.8	L0.0001	174		L0.01	L0.001	L0.0002	0.00061		0.02	L0.1		0.00017	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	0.114		0.00001			50.3	L0.0001	178		L0.01	L0.001	L0.0002	0.00058		0.037	L0.1		L0.00009	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	0.101		L0.00001			49.2	L0.0001	179		L0.01	L0.001	L0.0002	0.00063		0.076	L0.1		0.0001	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	0.102		0.00001			51.2	L0.0001	210		L0.01	L0.001	L0.0002	0.00082		0.148			0.00026	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	0.081		L0.00001			38.3	L0.0001	202		L0.01	L0.001	L0.0002	0.00125		0.014			0.00013	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	0.095		L0.00001			44.1	L0.0001	197		L0.01	L0.001	L0.0002	0.00053			0.015		L0.00009	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	0.075		L0.00001			40.1	L0.0001	133		L0.01	L0.001	L0.0002	0.00065			0.062		0.00014	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	0.085		L0.00001			43.6	L0.0001	141		L0.01	L0.001	0.00038	0.00047			0.092		0.00017	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	0.085		L0.00001			41.8	L0.0001	137		L0.01	L0.001	L0.0002	0.00313			0.036		0.00015	
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	0.093		L0.00001			45.1	L0.0001	146		L0.01	L0.001	L0.0002	0.00059			0.055		0.00017	

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Metal Lithium- total (mg/L)	Metal Magnesium- dissolved (mg/L)	Metal Magnesium- extractable (mg/L)	Metal Magnesium- total (mg/L)	Metal Manganese- dissolved (mg/L)	Metal Manganese- extractable (mg/L)	Metal Manganese- total (mg/L)	Metal Mercury- extractable (µg/L)	Metal Mercury- total (mg/L)	Metal Molybdenum- total (mg/L)	Metal Nickel- extractable (mg/L)	Metal Nickel- total (mg/L)	Metal Phosphorus- total (metals scan) (mg/L)	Metal Potassium- dissolved (mg/L)	Metal Potassium- extractable (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	45.3	-	-	<0.02	-	-	-	-	<0.005	-	-	-	14.4
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	0.039	-	-	45.7	-	-	0.0029	-	-	0.0023	-	0.0024	0.21	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	0.038	-	-	49	-	-	0.0048	-	-	0.0019	-	0.0012	0.07	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	0.052	-	-	49	-	-	0.0062	-	-	0.0027	-	0.0013	0.12	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	0.059	-	-	52.1	-	-	0.003	-	-	0.0029	-	0.0006	0.07	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	0.047	-	-	43.3	-	-	0.0039	-	-	0.0023	-	0.0008	0.08	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	0.04	-	-	45.1	-	-	0.0081	-	-	0.0026	-	0.0013	0.11	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	0.051	-	-	42	-	-	0.0097	-	-	0.0021	-	0.0013	0.12	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	0.052	-	-	49.1	-	-	0.0034	-	-	0.003	-	0.0012	<0.002	-	-

						Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Lithium- total (mg/L)	Magnesium- dissolved (mg/L)	Magnesium- extractable (mg/L)	Magnesium- total (mg/L)	Manganese- dissolved (mg/L)	Manganese- extractable (mg/L)	Manganese- total (mg/L)	Mercury- extractable (µg/L)	Mercury- total (mg/L)	Molybdenum- total (mg/L)	Nickel- extractable (mg/L)	Nickel- total (mg/L)	Phosphorus- total (metals scan) (mg/L)	Potassium- dissolved (mg/L)	Potassium- extractable (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	0.049	-	-	43.7	-	-	0.0056	-	-	0.0027	-	0.0008	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	0.048	-	-	44.6	-	-	0.0085	-	-	0.0026	-	0.0009	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	0.046	-	-	42.2	-	-	0.0089	-	-	0.0024	-	0.0008	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	0.041	-	-	43.1	-	-	0.0026	-	-	0.0027	-	0.0008	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	0.039	-	-	37.5	-	-	0.0066	-	-	0.0024	-	0.0009	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	0.037	-	-	36.7	-	-	0.0042	-	-	0.0023	-	0.0007	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	0.038	-	-	33.7	-	-	0.0092	-	-	0.0023	-	0.0009	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	0.039	-	-	34.6	-	-	0.0044	-	-	0.0025	-	0.0008	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	0.038	-	-	37.2	-	-	0.0054	-	-	0.0023	-	0.0008	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	0.039	-	-	35.6	-	-	0.0058	-	-	0.0023	-	0.0043	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	0.036	-	-	34.1	-	-	0.0096	-	-	0.0022	-	0.0012	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	0.042	-	-	40.1	-	-	0.0022	-	-	0.0027	-	0.0007	<0.002	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	0.036	-	-	33.1	-	-	0.0124	-	-	0.00237	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	0.0419	-	-	43.1	-	-	0.00618	-	-	0.00261	-	<0.002	<0.2	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	0.0443	-	-	42.1	-	-	0.00584	-	-	0.00262	-	<0.002	<0.2	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	0.0449	-	-	38.2	-	-	0.00667	-	-	0.00254	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	0.0507	-	-	39	-	-	0.00893	-	-	0.00253	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	0.0515	-	-	82.3	-	-	0.0167	-	-	0.00072	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	0.0369	-	-	35.4	-	-	0.00573	-	-	0.00231	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	0.0357	-	-	40.6	-	-	0.00261	-	-	0.00245	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	0.037	-	-	37.5	-	-	0.00386	-	-	0.00282	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	0.0343	-	-	35.6	-	-	0.00547	-	-	0.00237	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	0.0329	-	-	32.3	-	-	0.00576	-	-	0.002	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	0.0397	-	-	37.9	-	-	0.0108	-	-	0.00235	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	0.0374	-	-	35.4	-	-	0.007	-	-	0.00215	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	0.0352	-	-	41	-	-	0.0202	-	-	0.00203	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	0.0362	-	-	41.5	-	-	0.00655	-	-	0.00216	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	0.0373	-	-	38	-	-	0.00546	-	-	0.00201	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	0.0349	-	-	36.9	-	-	0.0112	-	-	0.0021	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	0.0329	-	-	41.3	-	-	0.011	-	-	0.00203	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	0.0348	-	-	36.8	-	-	0.00641	-	-	0.00213	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	0.0348	-	-	36.5	-	-	0.00802	-	-	0.00222	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	0.0345	-	-	33.9	-	-	0.00885	-	-	0.00195	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	0.0337	-	-	36.6	-	-	0.0163	-	-	0.0022	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	0.0335	-	-	48.1	-	-	0.00989	-	-	0.00212	-	0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	0.0364	-	-	51.6	-	-	0.00985	-	-	0.00207	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	0.0327	-	-	32.2	-	-	0.0127	-	-	0.00206	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	0.0405	-	-	51.7	-	-	0.0133	-	-	0.00226	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	0.0342	-	-	35	-	-	0.00453	-	-	0.00228	-	<0.002	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	0.033			34.4			0.00262		L0.00002	0.00259		L0.002	L0.1		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	0.0382			38.1			0.00279		L0.00002	0.00262		L0.002	L0.1		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13															
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13															
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	0.0307			30.1			0.00686			0.00179		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13	0.0263			31.1			0.0143		L0.00002	0.00186		L0.002	L0.1		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	0.0367			48.2			0.0026			0.00243		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	0.0308			46			0.00225			0.00302		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	0.0473			47.4			0.00195			0.00277		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	0.0314			31.3			0.00332			0.00191		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	0.0398			37.4			0.00422		L0.00002	0.00207		L0.002	L0.1		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	0.0328			38.8			0.00539			0.00206		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	0.0355			39.5			0.0155		L0.00002	0.00241		L0.002	L0.1		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	0.0266			26.2			0.00342		L0.00002	0.00209		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14															
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	0.0267			34			0.00543		L0.00002	0.00195		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14															
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	0.0218			29.3			0.00766		L0.00002	0.00165		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14															
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	0.0252			32.1			0.0098		L0.00002	0.00172		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	0.0335			29.1			0.0231		L0.00002	0.00193		L0.002			
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	0.028			32.2			0.00552		L0.00002	0.0021		L0.002			

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Metal Potassium- total (mg/L)	Metal Rubidium- total (mg/L)	Metal Selenium- total (mg/L)	Metal Silicon- total (mg/L)	Metal Silver- total (mg/L)	Metal Sodium- dissolved (mg/L)	Metal Sodium- extractable (mg/L)	Metal Sodium- total (mg/L)	Metal Strontium- total (mg/L)	Metal Sulphate (mg/L)	Metal Sulphate- dissolved (mg/L)	Metal Tellurium- total (mg/L)	Metal Thallium- total (mg/L)	Metal Thorium- total (mg/L)	Metal Tin- total (mg/L)	Metal Titanium- total (mg/L)	Metal Tungsten- total (mg/L)	Metal Uranium- total (mg/L)	Metal Vanadium- total (mg/L)	Metal Zinc- extractable (mg/L)	Metal Zinc- total (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	258	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	11.4	0.0042	<0.0004	3	0.00012	-	-	182	0.28	-	130	<0.0002	<0.00002	<0.0001	<0.0002	0.0022	-	0.002	0.0011	-	0.006
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	11.6	0.0044	<0.0004	2.57	<0.00002	-	-	173	0.26	-	109	<0.0002	<0.00002	<0.0001	<0.0002	0.0031	-	0.0013	0.001	-	0.002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	14.4	0.0051	<0.0004	1.75	<0.00002	-	-	209	0.3	-	120	<0.0002	<0.00002	<0.0001	<0.0002	0.003	-	0.0022	0.0013	-	0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	15.4	0.0054	<0.0004	1.94	0.00008	-	-	254	0.37	-	134	<0.0002	<0.00002	<0.0001	0.0002	0.0007	-	0.0023	0.0009	-	0.003
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	12.7	0.0049	0.0005	1.48	<0.00002	-	-	184	0.26	-	101	<0.0002	0.00004	<0.0001	<0.0002	0.0018	-	0.0016	0.0007	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	14.4	0.0054	0.0006	0.99	<0.00002	-	-	196	0.29	-	112	<0.0002	<0.00002	<0.0001	<0.0002	0.003	-	0.0019	0.0012	-	0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	12.9	0.0056	<0.0004	2.93	0.00011	-	-	180	0.27	-	102	<0.0002	<0.00002	<0.0001	0.0009	0.009	-	0.0016	0.0016	-	0.003
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	14.3	0.0059	<0.0004	3.01	<0.00002	-	-	225	0.32	-	114	<0.0002	<0.00002	0.0001	0.0002	0.0008	-	0.0019	0.0012	-	<0.001

						Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal	Metal
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Potassium- total (mg/L)	Rubidium- total (mg/L)	Selenium- total (mg/L)	Silicon- total (mg/L)	Silver- total (mg/L)	Sodium- dissolved (mg/L)	Sodium- extractable (mg/L)	Sodium- total (mg/L)	Strontium- total (mg/L)	Sulphate (mg/L)	Sulphate- dissolved (mg/L)	Tellurium- total (mg/L)	Thallium- total (mg/L)	Thorium- total (mg/L)	Tin- total (mg/L)	Titanium- total (mg/L)	Tungsten- total (mg/L)	Uranium- total (mg/L)	Vanadium- total (mg/L)	Zinc- extractable (mg/L)	Zinc- total (mg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	12.6	0.0061	<0.0004	2.85	<0.00002	-	-	210	0.32	-	115	<0.0002	<0.00002	<0.0001	<0.0002	0.0008	-	0.0019	0.0011	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	13.5	0.005	<0.0004	2.05	<0.00002	-	-	188	0.28	-	107	<0.0002	<0.00002	<0.0001	<0.0002	0.0038	-	0.0018	0.0016	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	12.9	0.0048	<0.0004	3.25	<0.00002	-	-	201	0.3	-	90.9	<0.0002	<0.00002	<0.0001	<0.0002	0.0053	-	0.0022	0.0015	-	0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	11.9	0.005	<0.0004	3.77	<0.00002	-	-	222	0.37	-	108	<0.0002	<0.00002	<0.0001	<0.0002	0.0007	-	0.0021	0.0013	-	0.002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	11.6	0.005	<0.0004	3.94	<0.00002	-	-	208	0.35	-	95.1	<0.0002	<0.00002	<0.0001	<0.0002	0.0007	-	0.0021	0.0008	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	10.1	0.0042	<0.0004	2.55	<0.00002	-	-	181	0.31	-	86.5	<0.0002	<0.00002	<0.0001	<0.0002	0.0019	-	0.0016	0.0012	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	10.3	0.0047	<0.0004	3.38	<0.00002	-	-	185	0.3	-	85.9	<0.0002	<0.00002	<0.0001	<0.0002	0.0037	-	0.0012	0.0016	-	0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	10.9	0.0044	<0.0004	3.97	<0.00002	-	-	200	0.34	-	88	<0.0002	<0.00002	<0.0001	<0.0002	0.0012	-	0.0015	0.0013	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	11.6	0.0048	<0.0004	5.1	<0.00002	-	-	223	0.38	-	84.8	<0.0002	<0.00002	<0.0001	<0.0002	0.0025	-	0.0018	0.001	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	10.6	0.0044	<0.0004	3.02	<0.00002	-	-	187	0.34	-	80	<0.0002	<0.00002	<0.0001	<0.0002	0.002	-	0.0014	0.0014	-	0.007
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	9.82	0.0045	<0.0004	4.53	<0.00002	-	-	168	0.31	-	73.3	<0.0002	<0.00002	<0.0001	<0.0002	0.0058	-	0.0014	0.0017	-	<0.001
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	12.2	0.0051	<0.0004	5.41	<0.00002	-	-	213	0.36	-	97.8	<0.0002	<0.00002	<0.0001	0.0002	0.0009	-	0.0018	0.0017	-	0.002
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	10.5	0.0044	0.0013	-	<0.0001	-	-	160	0.356	-	74.4	<0.0002	0.00035	<0.0001	<0.0006	0.00117	<0.0002	0.00171	0.00175	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	13.1	0.00467	<0.001	4.34	<0.0001	-	-	196	0.37	-	-	<0.0002	0.00031	<0.0001	<0.0006	0.00369	<0.0002	0.00196	0.00169	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	13.3	0.00455	0.0012	3.6	<0.0001	-	-	184	0.326	-	-	<0.0002	<0.0001	<0.0001	<0.0006	0.00187	<0.0002	0.00192	0.00224	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	13.1	0.00445	0.0013	-	<0.0001	-	-	195	0.352	-	98.3	<0.0002	<0.0001	<0.0001	<0.0006	0.00249	<0.0002	0.00224	0.00205	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	12	0.00523	<0.001	-	<0.0001	-	-	186	0.334	-	71.8	<0.0002	<0.0001	<0.0001	<0.0006	0.00189	<0.0002	0.00188	0.00196	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	4.35	0.00126	<0.001	-	<0.0001	-	-	30.7	0.518	-	115	<0.0002	<0.0001	<0.0001	<0.0006	<0.0009	<0.0002	0.007	<0.0002	-	0.124
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	10.4	0.00426	<0.001	-	<0.0001	-	-	164	0.264	-	93	<0.0002	<0.0001	<0.0001	<0.0002	0.00256	<0.001	0.00193	0.00162	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	10.5	0.00453	<0.001	-	<0.0001	-	-	172	0.323	89	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00117	<0.001	0.00175	0.0013	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	10.9	0.00575	<0.001	-	<0.0001	-	-	231	0.434	85	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00068	<0.001	0.00201	0.00091	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	9.86	0.00433	0.0011	-	<0.0001	-	-	164	0.335	80.5	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00288	<0.001	0.00164	0.00113	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	9.08	0.00387	<0.001	-	<0.0001	-	-	178	0.254	77.6	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00198	<0.001	0.00172	0.00103	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	11.3	0.00466	<0.001	-	<0.0001	-	-	137	0.327	84.3	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00239	<0.001	0.00152	0.00153	-	0.0053
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	11.7	0.00429	0.0012	-	<0.0001	-	-	145	0.326	91.1	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00189	<0.001	0.00183	0.00144	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	10.6	0.00438	<0.001	-	<0.0001	-	-	145	0.317	92.5	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00623	<0.001	0.00166	0.0019	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	12.1	0.00405	<0.001	-	<0.0001	-	-	144	0.312	92.9	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00203	<0.001	0.00168	0.0015	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	10.8	0.00364	<0.001	-	<0.0001	-	-	143	0.281	89.1	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00137	<0.001	0.00148	0.00139	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	10.4	0.00435	<0.001	-	<0.0001	-	-	142	0.302	88	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00399	<0.001	0.0015	0.00148	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	10.8	0.00403	<0.001	-	<0.0001	-	-	135	0.295	89.8	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00421	<0.001	0.00155	0.00159	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	10.8	0.0038	<0.001	-	<0.0001	-	-	132	0.28	90.4	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00195	<0.001	0.00155	0.00146	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	11.2	0.00416	0.0011	-	<0.0001	-	-	138	0.308	90.2	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00185	<0.001	0.00167	0.00168	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	10	0.00354	<0.001	-	<0.0001	-	-	119	0.265	95.3	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00238	<0.001	0.00151	0.00159	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	10.1	0.00403	<0.001	-	<0.0001	-	-	139	0.285	111	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00565	<0.001	0.00167	0.00189	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	11.4	0.00389	<0.001	-	<0.0001	-	-	147	0.299	85.6	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00412	<0.001	0.0015	0.00162	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	8.51	0.0042	0.0012	-	<0.0001	-	-	121	0.299	85.8	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00313	<0.001	0.00164	0.00164	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	9.16	0.00424	<0.001	-	<0.0001	-	-	125	0.312	86	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00554	<0.001	0.0016	0.00164	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	8.86	0.00396	<0.001	-	<0.0001	-	-	120	0.286	90.9	-	<0.0002	<0.0001	<0.0001	<0.0002	0.0066	<0.001	0.0018	0.00186	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	10.3	0.00382	<0.001	-	<0.0001	-	-	134	0.276	96.2	-	<0.0002	<0.0001	<0.0001	<0.0002	0.00134	<0.001	0.00179	0.00151	-	<0.005
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	10.8	0.00406	L0.001	4.95	L0.0001			144	0.29	96.3		L0.0002	L0.0001	L0.0001	L0.0002	0.00215	L0.0001	0.00192	0.00136		0.0021
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	11.5	0.00484	L0.001	6.08	L0.0001			167	0.329	95.5		L0.0002	L0.0001	L0.0001	L0.0002	0.00217	L0.0001	0.00199	0.00142		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	9.21	0.00397	L0.001	3.84	L0.0001			122	0.288	79.6		L0.0002	L0.0001	L0.0001	L0.0002	0.00369		0.00141	0.00114		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13	9	0.00372	L0.001	4.9	L0.0001			124	0.264	67.1		L0.0002	L0.0001	L0.0001	L0.0002	0.0049	L0.0001	0.00126	0.00151		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	11.2	0.00401	L0.001		L0.0001			142	0.316	105		L0.0002	L0.0001	L0.0001	L0.0002	L0.0002	L0.001	0.00186	0.00169		L0.005
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	13.8	0.00431	L0.001		L0.0001			149	0.351	118		L0.0002	L0.0001	L0.0001	L0.0002	0.00058	L0.001	0.0021	0.00183		L0.005
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	13.6	0.00417	L0.001		L0.0001			141	0.346	133		L0.0002	L0.0001	L0.0001	L0.0002	0.00103	L0.001	0.00221	0.00194		L0.005
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	8.92	0.00308	L0.001	3.28	L0.0001			118	0.243	93.1		L0.0002	L0.0001	L0.0001	L0.0002	0.00234		0.00167	0.00109		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	10.9	0.00337	L0.001	3.11	L0.0001			129	0.28	105		L0.0002	L0.0001	L0.0001	L0.0002	0.00222	L0.0001	0.00152	0.00118		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	11.3	0.00354	L0.001	3.45	L0.0001			150	0.286	90.9		L0.0002	L0.0001	L0.0001	L0.0002	0.00299		0.00157	0.00148		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	10.9	0.00428	L0.001	4.88	L0.0001			127	0.3	94.5		L0.0002	L0.0001	L0.0001	L0.0002	0.00432	L0.0001	0.00173	0.0017		0.0021
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	7.79	0.00382	L0.001	5.23	L0.0001			134	0.247	71		L0.0002	L0.0001	L0.0001	L0.0002	0.0033	L0.0001	0.00147	0.00127		0.0025
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	9.31	0.00402	L0.001	5.81	L0.0001			142	0.264	81.3		L0.0002	L0.0001	L0.0001	L0.0002	L0.0005	L0.0001	0.00145	0.00131		L0.002
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	7.55	0.00337	L0.001	4.35	L0.0001			90.3	0.228	64.1		L0.0002	L0.0001	L0.0001	L0.0002	0.00222	L0.001	0.00126	0.00122		L0.005
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	7.72	0.00341	L0.001	4.73	L0.0001			96.1	0.234	72		L0.0002	L0.0001	L0.0001	L0.0002	0.00326	L0.001	0.00135	0.00148		L0.005
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	7.92	0.00311	L0.001	5.21	L0.0001			92.3	0.232	70.3		L0.0002	L0.0001	L0.0001	L0.0002	0.00187	L0.001	0.00151	0.00127		L0.005
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	8.97	0.00346	L0.001	5.98	L0.0001			96.2	0.254	82.4		L0.0002	L0.0001	L0.0001	L0.0002	0.00232	L0.001	0.00157	0.00139		L0.005

						Metal	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide		Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Zirconium- total (mg/L)	2,4,5-TP (µg/L)	2,4,5-T (µg/L)	2,4-DB (µg/L)	2,4-D (µg/L)	Alachlor (µg/L)	Aldrin (µg/L)	Alpha BHC (µg/L)	AMPA (aminomethylphosphonic acid) (µg/L)	Atrazine desethyl (µg/L)	Atrazine (µg/L)	Azinphos methyl (µg/L)	BENOMYL (µg/L)	Beta BHC (µg/L)	Bromacil (µg/L)	Bromoxynil (µg/L)	Captan (µg/L)	Carbamate (EPTC) (µg/L)	Carbofuran (µg/L)	Carboxin (Carbothin) (µg/L)	Chlordane-CIS (µg/L)	Chlordane- trans (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	-	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	-	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

						Metal	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Zirconium- total (mg/L)	2,4,5-TP (µg/L)	2,4,5-T (µg/L)	2,4-DB (µg/L)	2,4-D (µg/L)	Alachlor (µg/L)	Aldrin (µg/L)	Alpha BHC (µg/L)	AMPA (aminomethylphosphonic acid) (µg/L)	Atrazine desethyl (µg/L)	Atrazine (µg/L)	Azinphos methyl (µg/L)	BENOMYL (µg/L)	Beta BHC (µg/L)	Bromacil (µg/L)	Bromoxynil (µg/L)	Captan (µg/L)	Carbamate (EPTC) (µg/L)	Carbofuran (µg/L)	Carboxin (Carbothin) (µg/L)	Chlordane-CIS (µg/L)	Chlordane- trans (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	<0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	<0.002	<0.05	-	<0.05	<0.05	<0.2	-	-	<1	<0.05	<0.1	<1	-	<0.2	<0.02	<10	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	<0.0004	-	-	<0.05	<0.05	<0.1	-	-	<0.2	-	<0.1	-	-	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	<0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	<0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	<0.0004	-	-	<0.05	<0.05	<0.1	-	-	<0.2	-	<0.1	-	-	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	<0.0004	-	-	<0.05	<0.05	<0.1	-	-	<0.2	-	<0.1	-	-	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	<0.0004	-	-	<0.05	<0.05	<0.1	-	-	<0.2	-	<0.1	-	-	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	<0.0004	-	-	<0.05	<0.05	<0.1	-	-	<0.2	-	<0.1	-	-	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	<0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	<0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	<0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	<0.0004	-	-	<0.05	<0.05	<0.1	-	<0.1	<0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.02	-	-	<0.2	<0.1	<0.01	<0.01
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	L0.0004			L0.05	L0.05	L0.1			L0.2	L0.05	L0.1	L0.1	L0.1		L0.1	L0.02			L0.2	L0.1	L0.01	L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	L0.0004			L0.05	L0.05	L0.1		L0.1	L0.2	L0.1	L0.1	L0.1	L0.1	L0.1	L0.1	L0.02			L0.2	L0.1	L0.01	L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	L0.0004			L0.05	L0.05	L0.1			L0.2	L0.05	L0.1	L0.1	L0.1		L0.1	L0.02			L0.2	L0.1	L0.01	L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	L0.0004			L0.05	L0.05	L0.1			L0.2	L0.05	L0.1	L0.1	L0.1		L0.1	L0.02			L0.2	L0.1	L0.01	L0.01
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14	L0.0004																					
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14	L0.0004																					

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Pesticide Chlorothalonil (µg/L)	Pesticide Chlorpyrifos-ethyl (Dursban) (µg/L)	Pesticide Cyanazine (µg/L)	Pesticide Delta BHC (µg/L)	Pesticide Deltamethrin (µg/L)	Pesticide Diazinon (µg/L)	Pesticide Dicamba (Banvel) (µg/L)	Pesticide Dichloroprop (2,4-DP) (µg/L)	Pesticide Diclofop- methyl (µg/L)	Pesticide Diclofop (µg/L)	Pesticide Dieldrin (µg/L)	Pesticide Dimethoate (Cygon) (µg/L)	Pesticide Dinoseb (µg/L)	Pesticide DIURON (µg/L)	Pesticide Endosulfan I (µg/L)	Pesticide Endrin (µg/L)	Pesticide Eptam (µg/L)	Pesticide Ethalfluralin (Edge) (µg/L)	Pesticide Fenoprop (Silvex)(2,4,5-TP) (µg/L)	Pesticide Fenoxaprop (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05	-	-	<0.2	<0.02	-	<0.1	
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

						Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Chlorothalonil (µg/L)	Chlorpyrifos-ethyl (Dursban) (µg/L)	Cyanazine (µg/L)	Delta BHC (µg/L)	Deltamethrin (µg/L)	Diazinon (µg/L)	Dicamba (Banvel) (µg/L)	Dichloroprop (2,4-DP) (µg/L)	Diclofop- methyl (µg/L)	Diclofop (µg/L)	Dieldrin (µg/L)	Dimethoate (Cygon) (µg/L)	Dinoseb (µg/L)	DIURON (µg/L)	Endosulfan I (µg/L)	Endrin (µg/L)	Eptam (µg/L)	Ethalfluralin (Edge) (µg/L)	Fenoprop (Silvex)(2,4,5-TP) (µg/L)	Fenoxaprop (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	<0.06	<0.02	<0.5	-	<0.04	<0.03	<0.02	<0.05	<0.1	-	-	<0.2	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	<0.06	<0.02	-	-	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	<0.06	<0.02	-	-	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	-	<0.02	-	-	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	-	<0.02	-	-	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	<0.06	<0.02	-	-	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	<0.06	<0.02	<0.1	<0.1	<0.04	<0.03	<0.006	<0.05	<0.1	-	-	<0.1	<0.05		-	-	<0.2	<0.02	-	<0.1
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	L0.06	L0.02	L0.1		L0.04	L0.03	L0.006	L0.05	L0.1			L0.1	L0.05	L0.018		L0.2	L0.02			L0.1
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	L0.06	L0.02	L0.1	L0.1	L0.04	L0.03	L0.006	L0.05	L0.1			L0.1	L0.05	L0.018		L0.2	L0.02			L0.1
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	L0.06	L0.02	L0.1		L0.04	L0.03	L0.006	L0.05	L0.1			L0.1	L0.05	L0.018		L0.2	L0.02			L0.1
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	L0.06	L0.02	L0.1		L0.04	L0.03	L0.006	L0.05	L0.1			L0.1	L0.05	L0.018		L0.2	L0.02			L0.1
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14																				
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14																				

						Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Gamma-Benzenehexachloride (Lindane) (µg/L)	Glyphosate (Roundup) (µg/L)	Heptachlor epoxide (µg/L)	Heptachlor (µg/L)	Imazamethabenz-ME (ng/L)	Imazamethabenz-methyl UG/L	Lindane (Gamma-BHC) (µg/L)	Malathion (µg/L)	MCPA (µg/L)	MCPP (Mecoprop) (µg/L)	Metasulfuron- ME (ng/L)	Methoxychlor (P,P'- Methoxychlor) (µg/L)	Metribuzin (µg/L)	Metsulfuron- methyl (µg/L)	Mirex (µg/L)	P,P'-DDD (TDE) (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	<0.01	-	-	-	-	-	-	<0.2	<0.05	<0.05	-	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

						Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide	Pesticide
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Gamma-Benzenehexachloride (Lindane) (µg/L)	Glyphosate (Roundup) (µg/L)	Heptachlor epoxide (µg/L)	Heptachlor (µg/L)	Imazamethabenz-ME (ng/L)	Imazamethabenz-methyl UG/L	Lindane (Gamma-BHC) (µg/L)	Malathion (µg/L)	MCPA (µg/L)	MCPP (Mecoprop) (µg/L)	Metasulfuron- ME (ng/L)	Methoxychlor (P,P'- Methoxychlor) (µg/L)	Metribuzin (µg/L)	Metsulfuron- methyl (µg/L)	Mirex (µg/L)	P,P'-DDD (TDE) (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	<0.01	<1	-	-	<10	-	-	<0.2	<0.05	<0.05	<10	<0.04	<0.2	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	<0.2	-	-	-	<0.01	-	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	<0.2	-	-	-	-	-	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	-	<0.2	-	-	-	-	-	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	-	0.59	-	-	-	-	-	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	-	<0.2	-	-	-	-	-	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	-	0.48	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	0.35	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.11	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	-	0.93	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	-	<0.2	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	0.32	-	-	-	-	<0.1	<0.1	<0.025	<0.05	-	<0.01	<0.2	<0.01	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13		L0.2				L0.01	L0.1	L0.1	L0.025	L0.05		L0.01	L0.2	L0.01		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12		L0.2					L0.1	L0.1	L0.025	L0.05		L0.01	L0.2	L0.01		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12		L0.2				L0.01	L0.1	L0.1	L0.025	L0.05		L0.01	L0.2	L0.01		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12		0.22				L0.01	L0.1	L0.1	L0.025	L0.05		L0.01	L0.2	L0.01		
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14																
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14																

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Pesticide P,P'-DDE (µg/L)	Pesticide P,P'-DDT (µg/L)	Pesticide Parathion ethyl (µg/L)	Pesticide Parathion methyl (µg/L)	Pesticide PARATHION (µg/L)	Pesticide Pentachlorophenol (µg/L)	Pesticide Picloram (tordon) (µg/L)	Pesticide Propachlor (µg/L)	Pesticide Propanil (µg/L)	Pesticide Propoxur (µg/L)	Pesticide Quizalofop (µg/L)	Pesticide SETHOXYDIM (µg/L)	Pesticide Simazine (µg/L)	Pesticide Tebuthiuron (µg/L)	Pesticide Terbufos (µg/L)	Pesticide Thifensulfuron methyl (µg/L)	Pesticide Thifensulfuron- ME (ng/L)	Pesticide TRALKOXYDIM (µg/L)	Pesticide Triallate (Avadexbw) (µg/L)	Pesticide Tribenuron methyl (µg/L)	Pesticide Tribenuron (ng/L)	Pesticide Triclopyr (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	-		<0.1	-	-	<0.05	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-	-

Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Pesticide P,P'-DDE (µg/L)	Pesticide P,P'-DDT (µg/L)	Pesticide Parathion ethyl (µg/L)	Pesticide Parathion methyl (µg/L)	Pesticide PARATHION (µg/L)	Pesticide Pentachlorophenol (µg/L)	Pesticide Picloram (tordon) (µg/L)	Pesticide Propachlor (µg/L)	Pesticide Propanil (µg/L)	Pesticide Propoxur (µg/L)	Pesticide Quizalofop (µg/L)	Pesticide SETHOXYDIM (µg/L)	Pesticide Simazine (µg/L)	Pesticide Tebuthiuron (µg/L)	Pesticide Terbufos (µg/L)	Pesticide Thifensulfuron methyl (µg/L)	Pesticide Thifensulfuron- ME (ng/L)	Pesticide TRALKOXYDIM (µg/L)	Pesticide Triallate (Avadexbw) (µg/L)	Pesticide Tribenuron methyl (µg/L)	Pesticide Tribenuron (ng/L)	Pesticide Triclopyr (µg/L)
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	-	-	<0.2	<0.2			<0.2	<0.2	<0.2	<0.2	<0.1		<0.1	<2	<0.5	-	<10		<0.1	-	<10	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	-	-	-	-			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	-	-	-	-			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	-	-	-	-			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	0.012	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	0.023	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	<0.1			<0.2	-	<0.2	<0.2	<0.1		<0.1	-	<0.1	<0.01	-		<0.1	<0.01	-	<0.05
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-	-	-	-			-	-	-	-	-		-	-	-	-	-		-	-	-	-
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13				L0.1	L0.1	L0.02	L0.2		L0.2	L0.2	L0.1	L0.1	L0.1		L0.1	L0.01		L0.1	L0.1	L0.01		L0.05
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12				L0.1	L0.1	L0.02	L0.2		L0.2	L0.2	L0.1	L0.1	L0.1		L0.1	L0.01		L0.1	L0.1	0.011		L0.05
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12				L0.1	L0.1	L0.02	L0.2		L0.2	L0.2	L0.1	L0.1	L0.1		L0.1	L0.01		L0.1	L0.1	L0.01		L0.05
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12				L0.1	L0.1	L0.02	L0.2		L0.2	L0.2	L0.1	L0.1	L0.1		L0.1	L0.01		L0.1	L0.1	L0.01		L0.05
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14																						
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14																						

						Pesticide	Algae	Algae	Algae	Algae	Algae	Algae	Algae
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Trifluralin (Treflan) (µg/L)	TOTAL CYANOBACTERIAL CELL COUNT cells/mL	ANABAENA cells/mL	APHANOCAPSA cells/mL	APHANOTHECE cells/mL	GOMPHOSPHAERIA cells/mL	MICROCYSTIN ug/L	PSEUDOANABAENA cells/mL
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/1978	16-Jan-78	1/16/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/21/1978	21-Feb-78	2/21/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1978	20-Mar-78	3/20/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/24/1978	24-Apr-78	4/24/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/16/1978	16-May-78	5/16/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/1978	19-Jun-78	6/19/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/24/1978	24-Jul-78	7/24/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1978	29-Aug-78	8/29/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/1978	26-Sep-78	9/26/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1978	23-Oct-78	10/23/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/13/1978	13-Nov-78	11/13/1978	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/11/1978	11-Dec-78	12-Nov-78	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/29/1979	29-Jan-79	1/29/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/19/1979	19-Feb-79	2/19/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1979	20-Mar-79	3/20/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/30/1979	30-Apr-79	4/30/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/7/1979	07-May-79	5-Jul-79	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/28/1979	28-May-79	5/28/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/25/1979	25-Jun-79	6/25/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/23/1979	23-Jul-79	7/23/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/27/1979	27-Aug-79	8/27/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/1/1979	01-Oct-79	10-Jan-79	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/23/1979	23-Oct-79	10/23/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/20/1979	20-Nov-79	11/20/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/1979	13-Dec-79	12/13/1979	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/7/1980	07-Jan-80	1-Jul-80	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/4/1980	04-Feb-80	2-Apr-80	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/11/1980	11-Mar-80	3-Nov-80	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/17/1980	17-Apr-80	4/17/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/5/1980	05-May-80	5-May-80	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/23/1980	23-Jun-80	6/23/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/1980	21-Jul-80	7/21/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1980	18-Aug-80	8/18/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/1980	15-Sep-80	9/15/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/21/1980	21-Oct-80	10/21/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/25/1980	25-Nov-80	11/25/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/15/1980	15-Dec-80	12/15/1980	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/5/1981	05-Jan-81	1-May-81	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/10/1981	10-Feb-81	2-Oct-81	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/10/1981	10-Mar-81	3-Oct-81	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/13/1981	13-Apr-81	4/13/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/19/1981	19-May-81	5/19/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/15/1981	15-Jun-81	6/15/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/13/1981	13-Jul-81	7/13/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/18/1981	18-Aug-81	8/18/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/14/1981	14-Sep-81	9/14/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/19/1981	19-Oct-81	10/19/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/16/1981	16-Nov-81	11/16/1981	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/1981	07-Dec-81	12-Jul-81	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/25/1982	25-Jan-82	1/25/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/23/1982	23-Feb-82	2/23/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/22/1982	22-Mar-82	3/22/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/20/1982	20-Apr-82	4/20/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1982	27-May-82	5/27/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/15/1982	15-Jul-82	7/15/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1982	31-Aug-82	8/31/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/28/1982	28-Sep-82	9/28/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/20/1982	20-Oct-82	10/20/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/24/1982	24-Nov-82	11/24/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/29/1982	29-Dec-82	12/29/1982	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/22/1983	22-Feb-83	2/22/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/24/1983	24-Mar-83	3/24/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/18/1983	18-Apr-83	4/18/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/1983	27-May-83	5/27/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/22/1983	22-Jun-83	6/22/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/1983	04-Aug-83	8-Apr-83	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/31/1983	31-Aug-83	8/31/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/4/1983	04-Oct-83	10-Apr-83	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/2/1983	02-Nov-83	11-Feb-83	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/30/1983	30-Nov-83	11/30/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/20/1983	20-Dec-83	12/20/1983	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/14/1984	14-Feb-84	2/14/1984	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/20/1984	20-Mar-84	3/20/1984	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/29/1994	29-Aug-94	8/29/1994	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2004 8:30:00 AM	19-Apr-04	4/19/2004	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2004 8:15:00 AM	14-Jun-04	6/14/2004	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2004 8:35:00 AM	27-Sep-04	9/27/2004	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/10/2005 10:00:00 AM	10-Jan-05	1-Oct-05	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	2/27/2005 5:50:00 PM	27-Feb-05	2/27/2005	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/25/2005 9:15:00 AM	25-Apr-05	4/25/2005	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/14/2005 3:00:00 PM	14-Jun-05	6/14/2005	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/21/2005 9:00:00 AM	21-Jun-05	6/21/2005	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/26/2005 9:05:00 AM	26-Sep-05	9/26/2005	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/16/2006 10:20:00 AM	16-Jan-06	1/16/2006	-							

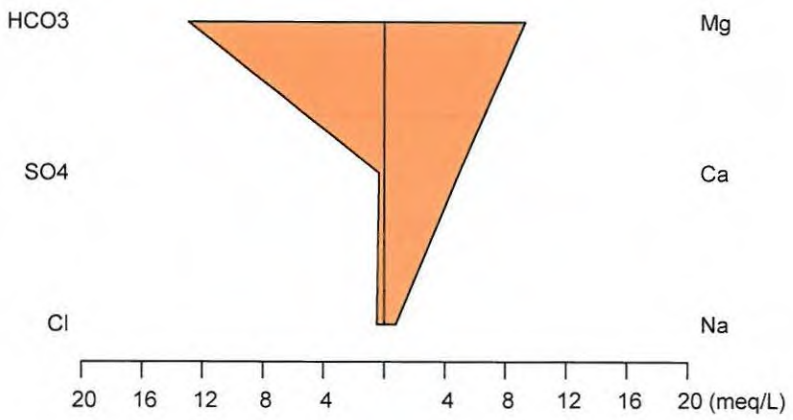
						Pesticide	Algae	Algae	Algae	Algae	Algae	Algae	Algae
Station Number	Station Name	Station Description	SAMPLE_DATETIME	Sample Date	SAMPLE_DATETIME	Trifluralin (Treflan) (µg/L)	TOTAL CYANOBACTERIAL CELL COUNT cells/mL	ANABAENA cells/mL	APHANOCAPSA cells/mL	APHANOTHECE cells/mL	GOMPHOSPHAERIA cells/mL	MICROCYSTIN ug/L	PSEUDOANABAENA cells/mL
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/25/2006 12:00:00 PM	25-Mar-06	3/25/2006	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/10/2006 9:15:00 AM	10-Apr-06	4-Oct-06	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/19/2006 9:20:00 AM	19-Jun-06	6/19/2006	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2006 9:30:00 AM	25-Sep-06	9/25/2006	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/15/2007 9:30:00 AM	15-Jan-07	1/15/2007	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	3/14/2007 2:30:00 PM	14-Mar-07	3/14/2007	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/16/2007 8:40:00 AM	16-Apr-07	4/16/2007	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/9/2007 10:15:00 AM	09-Jul-07	7-Sep-07	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/25/2007 9:50:00 AM	25-Sep-07	9/25/2007	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/12/2007 3:05:00 PM	12-Dec-07	12-Dec-07	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/23/2008 3:05:00 PM	23-Apr-08	4/23/2008	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/7/2008 8:40:00 AM	07-Jul-08	7-Jul-08	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/24/2008 3:15:00 PM	24-Sep-08	9/24/2008	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 1:20:00 PM	26-Jan-09	1/26/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/26/2009 2:50:00 PM	26-Jan-09	1/26/2009	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/15/2009 11:25:00 AM	15-Apr-09	4/15/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/13/2009 9:40:00 AM	13-May-09	5/13/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/27/2009 9:45:00 AM	27-May-09	5/27/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/16/2009 11:30:00 AM	16-Jun-09	6/16/2009	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/8/2009 1:45:00 PM	08-Jul-09	7-Aug-09	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/13/2009 9:35:00 AM	13-Oct-09	10/13/2009	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:00:00 AM	11-Jan-10	1-Nov-10	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	1/11/2010 9:40:00 AM	11-Jan-10	1-Nov-10	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/21/2010 9:29:00 AM	21-Jul-10	7/21/2010	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/22/2010 12:05:00 PM	22-Sep-10	9/22/2010	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/13/2010 11:40:00 AM	13-Dec-10	12/13/2010	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 9:30:00 AM	19-Apr-11	4/19/2011	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	4/19/2011 11:10:00 AM	19-Apr-11	4/19/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	5/17/2011 2:35:00 PM	17-May-11	5/17/2011	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 11:45:00 AM	06-Jun-11	6-Jun-11	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	6/6/2011 1:20:00 PM	06-Jun-11	6-Jun-11	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	7/11/2011 11:20:00 AM	11-Jul-11	7-Nov-11	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/4/2011 12:10:00 PM	04-Aug-11	8-Apr-11	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/24/2011 12:30:00 PM	24-Aug-11	8/24/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	8/30/2011 12:15:00 PM	30-Aug-11	8/30/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/6/2011 12:15:00 PM	06-Sep-11	9-Jun-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/15/2011 10:17:00 AM	15-Sep-11	9/15/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/19/2011 12:10:00 PM	19-Sep-11	9/19/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	9/27/2011 11:55:00 AM	27-Sep-11	9/27/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/3/2011 12:00:00 PM	03-Oct-11	10-Mar-11	-							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/11/2011 1:15:00 PM	11-Oct-11	10-Nov-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/18/2011 1:45:00 PM	18-Oct-11	10/18/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	10/24/2011 12:30:00 PM	24-Oct-11	10/24/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/3/2011 10:00:00 AM	03-Nov-11	11-Mar-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/9/2011 11:45:00 AM	09-Nov-11	11-Sep-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	11/15/2011 10:30:00 AM	15-Nov-11	11/15/2011	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	<0.03							
MB05LMS001	Fairford River	West of Fairford, at PTH #6	12/7/2011 2:00:00 PM	07-Dec-11	12-Jul-11	-							
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Jan-13	24-Jan-13	24-Jan-13								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	24-Apr-13	24-Apr-13	24-Apr-13								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-May-13	2-May-13	2-May-13								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	14-May-13	14-May-13	14-May-13								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-13	3-Jul-13	3-Jul-13	L0.03							
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	30-Sep-13	30-Sep-13	30-Sep-13								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5-Jan-12	5-Jan-12	5-Jan-12	L0.03							
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8-Feb-12	8-Feb-12	8-Feb-12								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	29-Feb-12	29-Feb-12	29-Feb-12								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12-Apr-12	12-Apr-12	12-Apr-12	L0.03							
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	15-May-12	15-May-12	15-May-12								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	3-Jul-12	3-Jul-12	3-Jul-12	L0.03							
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	2-Oct-12	2-Oct-12	2-Oct-12								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	12/9/2013 12:20:00 PM	09-Dec-13	09-Dec-13								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/23/2014 12:55:00 PM	23-Apr-14	23-Apr-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	4/28/2014 10:30:00 AM	28-Apr-14	28-Apr-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	5/8/2014 9:20:00 AM	08-May-14	08-May-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	7/14/2014 8:40:00 AM	14-Jul-14	14-Jul-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	8/12/2014 8:00:00 AM	12-Aug-14	12-Aug-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	9/2/2014 8:40:00 AM	02-Sep-14	02-Sep-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	10/15/2014 9:47:00 AM	15-Oct-14	15-Oct-14								
MB05LMS001	FAIRFORD RIVER	FAIRFORD RIVER AT PTH #6, WEST OF FAIRFORD	11/12/2014 10:00:00 AM	12-Nov-14	12-Nov-14								

APPENDIX D6-B-6

STIFF DIAGRAM ROUTE C

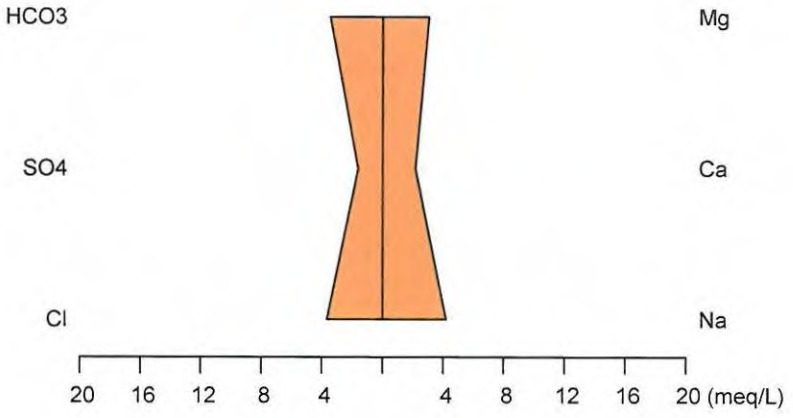
SW-C2 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 660
El Cond. (uS/cm) =1020



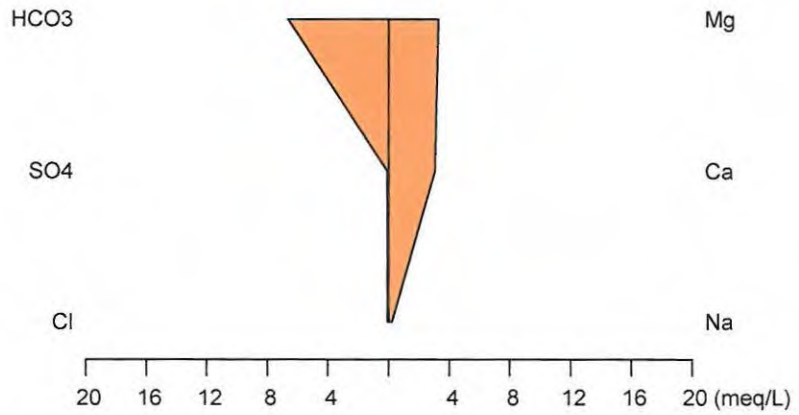
SW-D9 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 503
El Cond. (uS/cm) =813



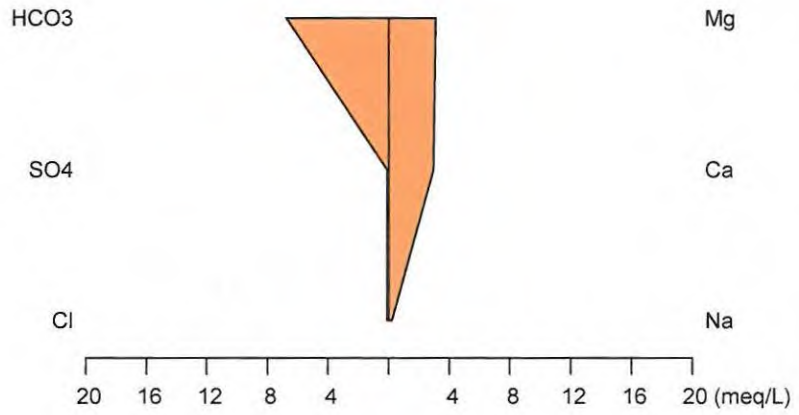
TH-EC-01 WW1 END 2016/10/19,19/10/2016

Date: 19/10/2016
TDS (mg/l) = 315
El Cond. (uS/cm) =535



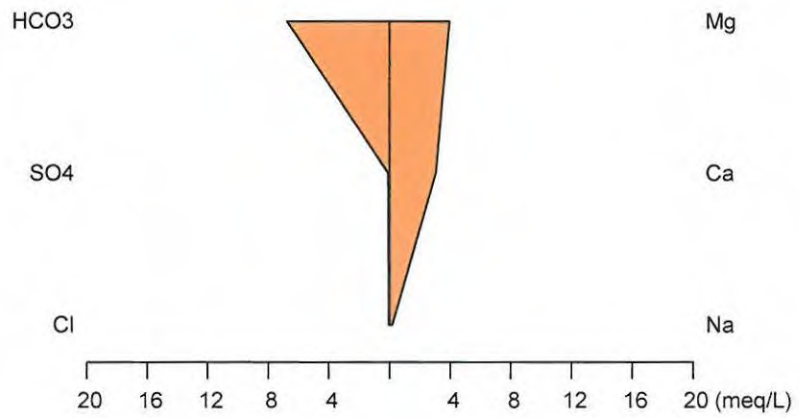
TH-EC-01 WW1 START 2016/10/19,19/10/2016

Date: 19/10/2016
TDS (mg/l) = 314
El Cond. (uS/cm) =544



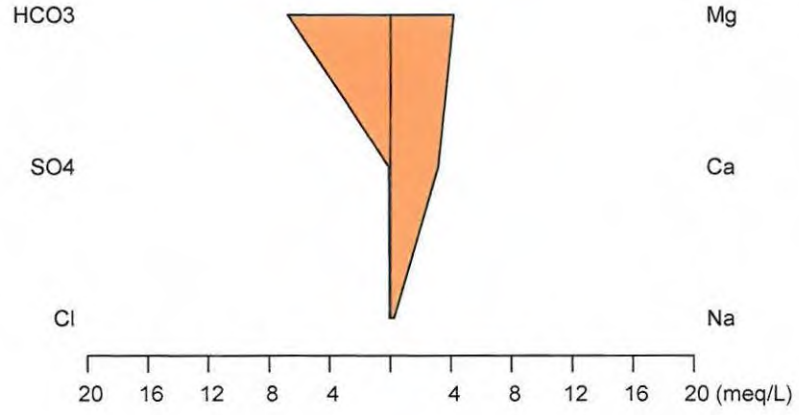
TH-EC-01 WW2 END 2016/10/18,18/10/2016

Date: 18/10/2016
TDS (mg/l) = 325
El Cond. (uS/cm) =556



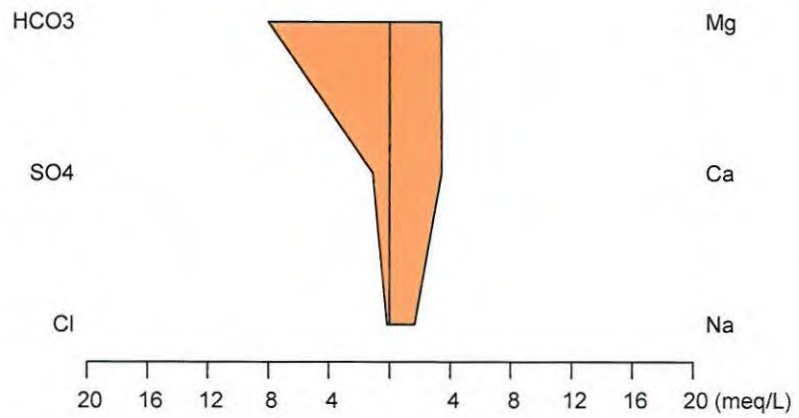
TH-EC-01 WW2 START 2016/10/18,18/10/2016

Date: 18/10/2016
TDS (mg/l) = 333
El Cond. (uS/cm) =564



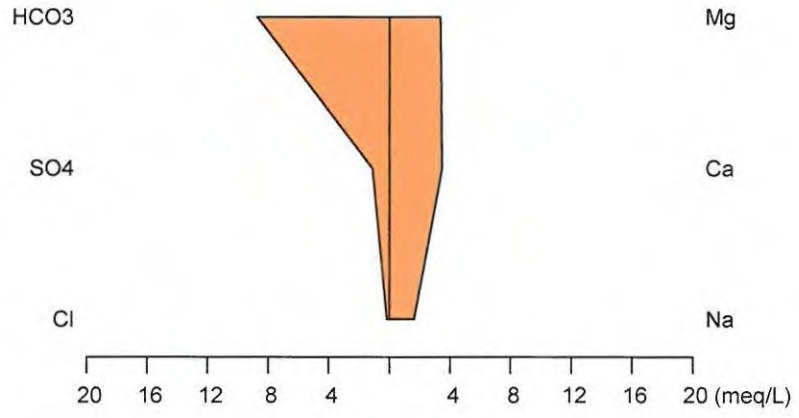
TH-EC-03 END 2016/10/27,27/10/2016

Date: 27/10/2016
TDS (mg/l) = 470
El Cond. (uS/cm) =736



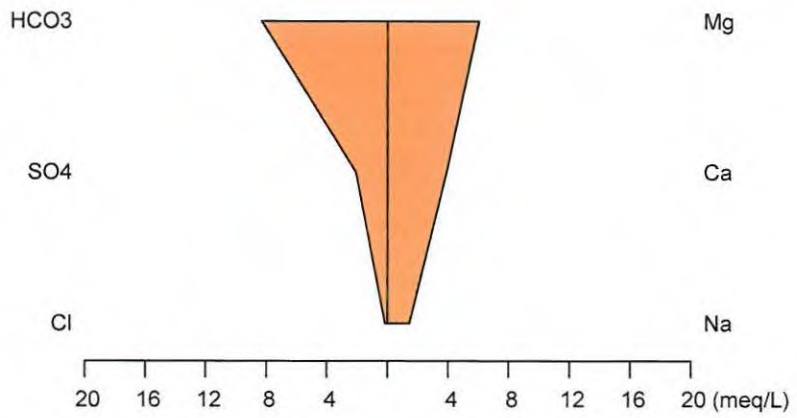
TH-EC-03 START 2016/10/27,27/10/2016

Date: 27/10/2016
TDS (mg/l) = 491
El Cond. (uS/cm) =747



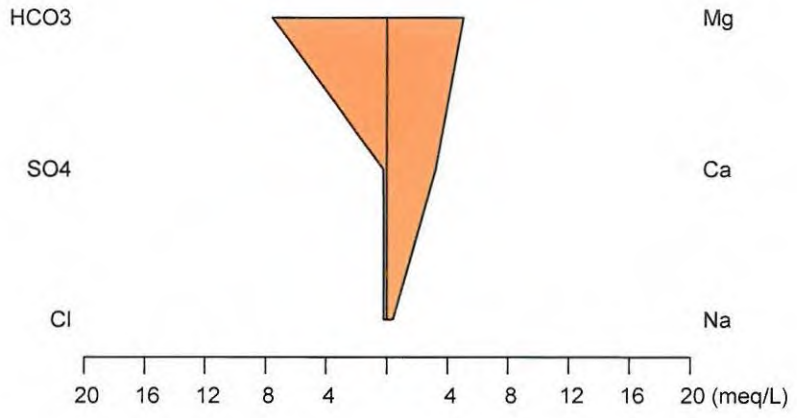
TH-EC-04 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 557
El Cond. (uS/cm) =876



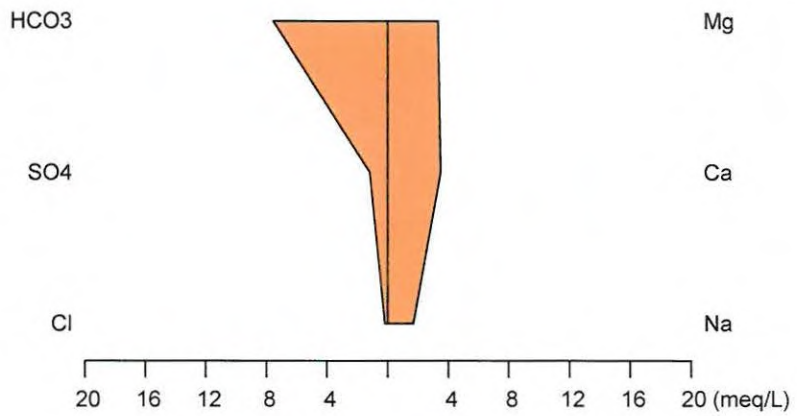
TH-GC-01 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 387
El Cond. (uS/cm) =682



TH-GC-05 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 461
El Cond. (uS/cm) =745



APPENDIX D6-C

SEE LOCATION PLANS FROM DELIVERABLE D4 ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER- ROUTE D

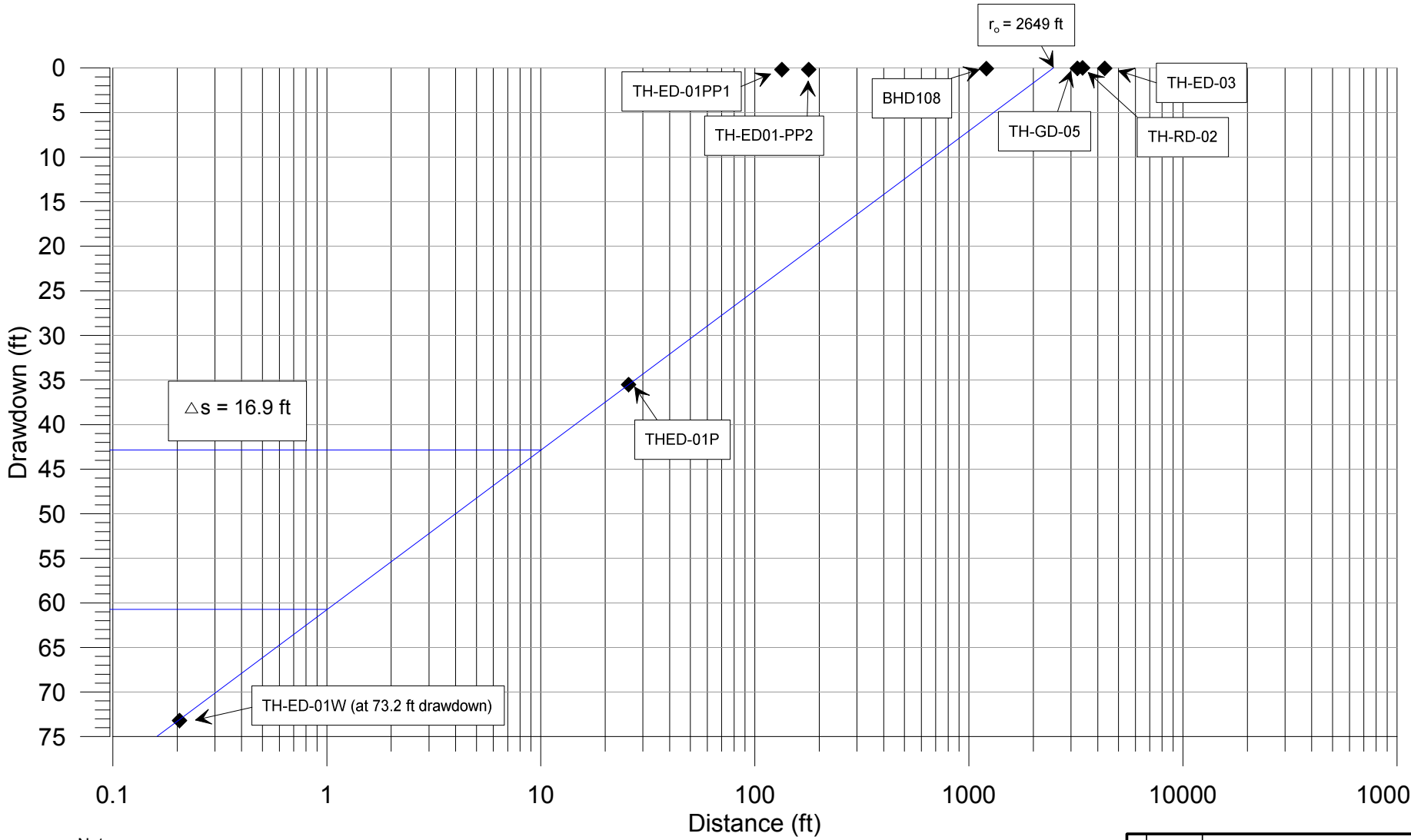
(NOT INCLUDED IN DELIVERABLE D6)

APPENDIX D6-D

ASSESSMENT OF REGIONAL GROUNDWATER FLOW AND QUALITY- ROUTE D

APPENDIX D6-D-1

PUMP TEST TH-ED-01



Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Distance Drawdown
Pump Rate (Q) = 12 USgpm
Duration = 9 hr

T =(528)(Q)/△s	**T= 352 USgpd/ft**
△s= 18.0 ft	Q = 12 USgpm

$S = 0.3Tt/r_o^2$	$S = 5.64 \times 10^{-6}$
r_0 = 2649 ft	t = 0.375 days

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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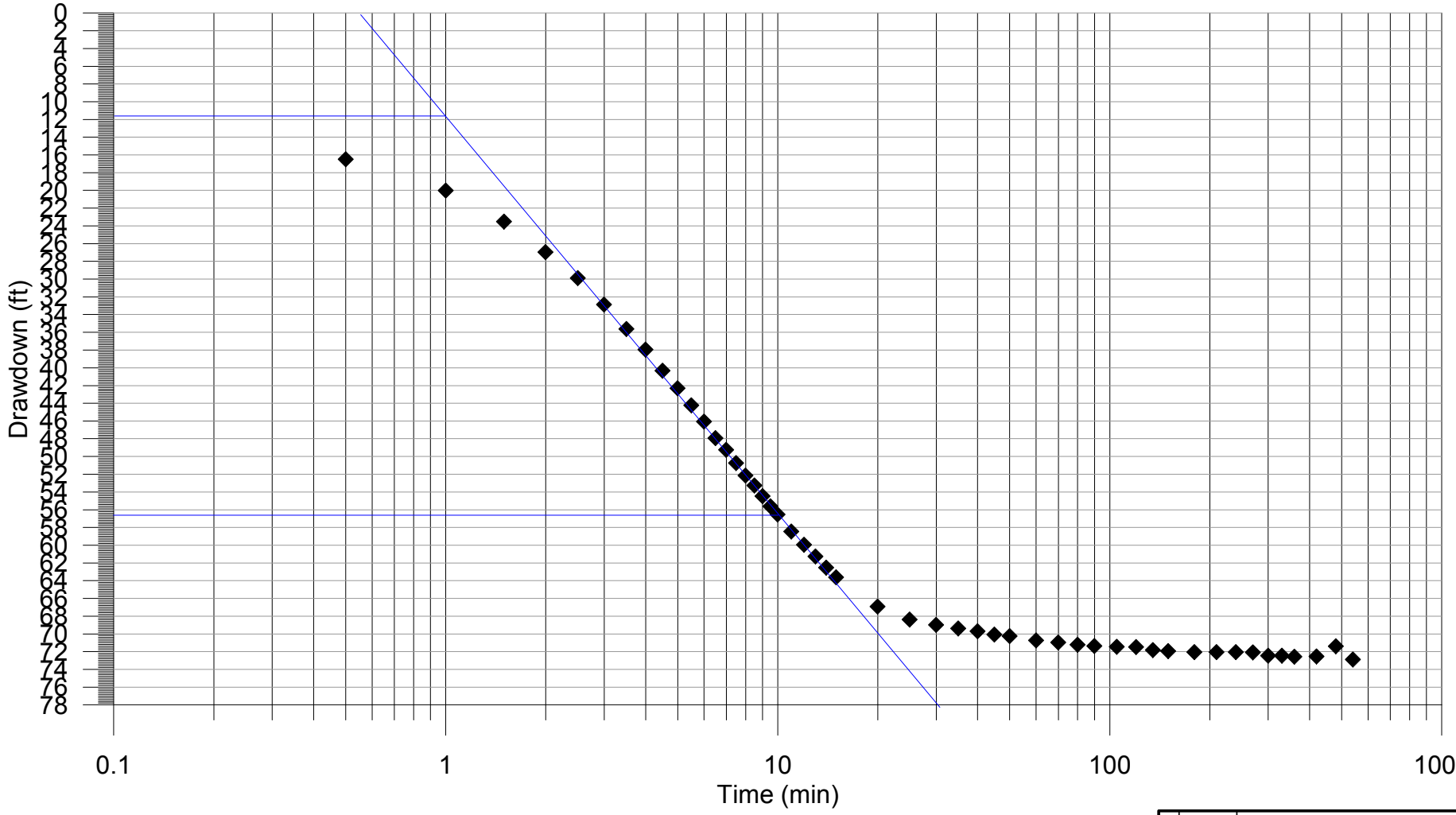
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DISTANCE DRAWDOWN

		REV:
MAY 2017	APP D6-D-1-1	0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-01_2016-10-26_TH-ED-01W_Pump Test_Distance Drawdown.grf



Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01W
Drawdown
Pump Rate (Q) = 12 USgpm

T =(264)(Q)/△s **T= 71 USgpd/ft**

△s= 45.0 ft Q = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT TH-ED-01W

MAY 2017	APP D6-D-1-2	REV: 0

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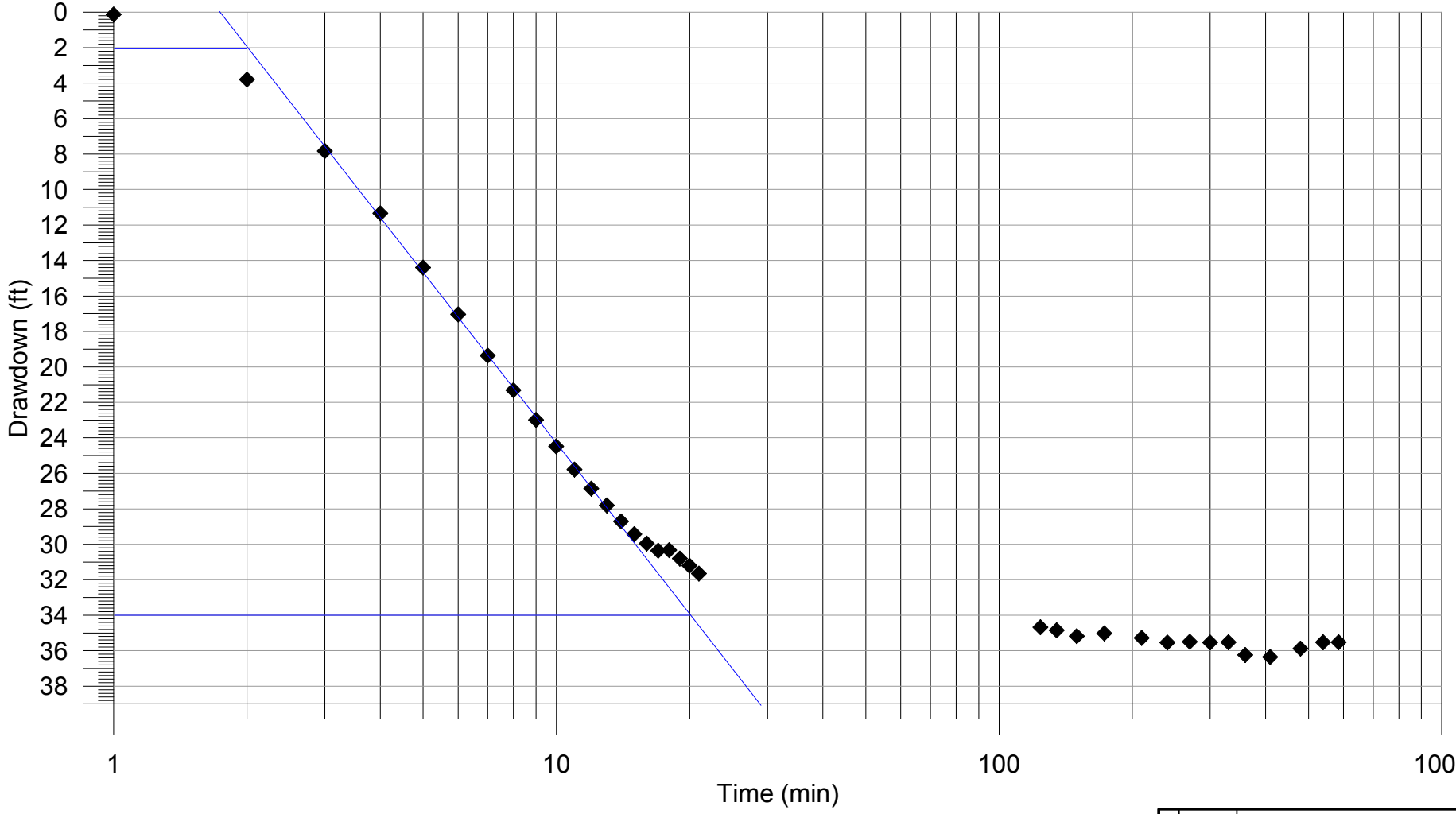

Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01P
Drawdown
Pump Rate (Q) = 12 USgpm

T =(264)(Q)/△s **T= 99 USgpd/ft**

△s= 32.0 ft Q = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT TH-ED-01P

MAY 2017	APP D6-D-1-3	REV: 0

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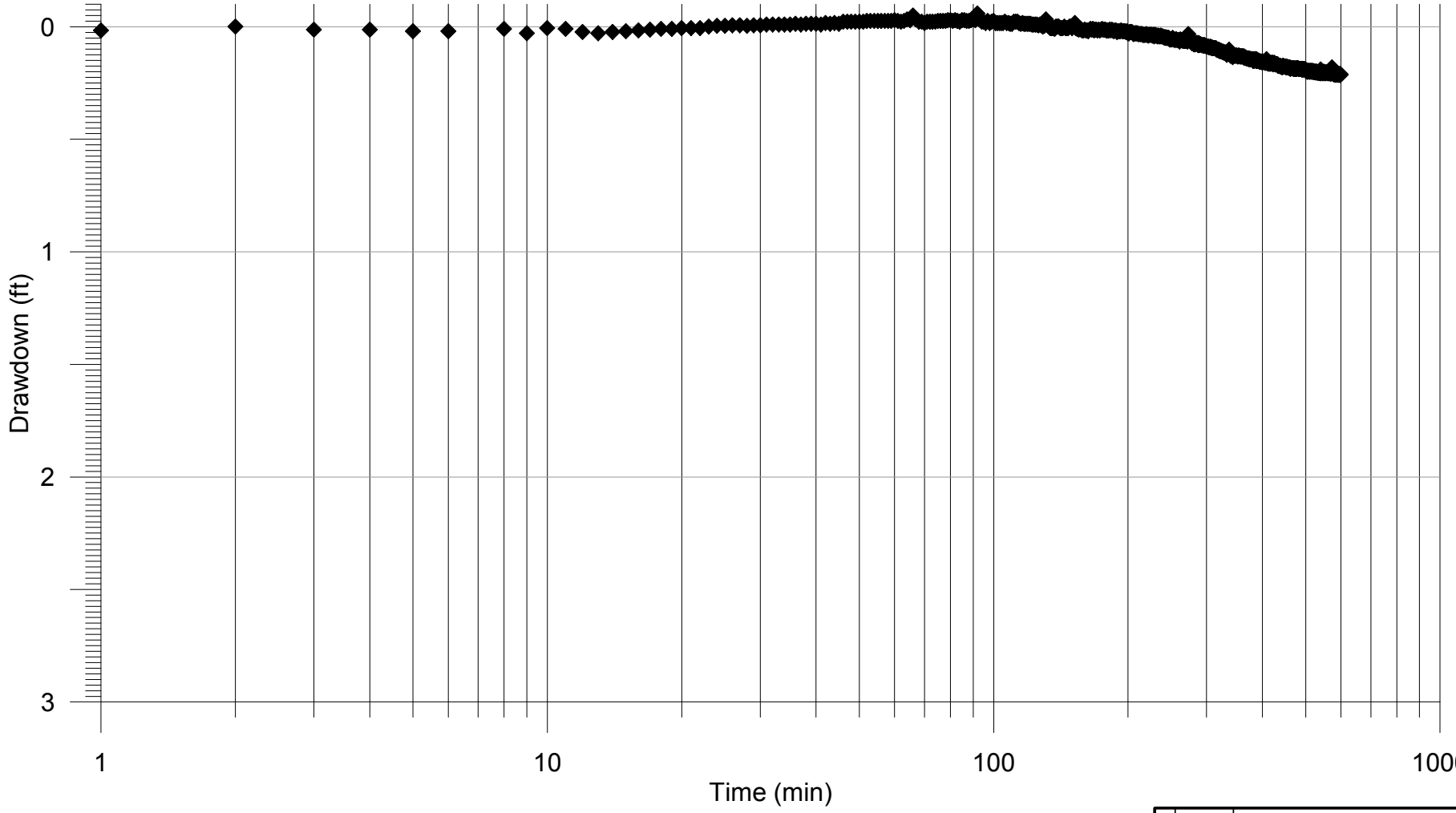

Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01PP1
Drawdown
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT TH-ED-01PP1

MAY 2017	APP D6-D-1-4	REV: 0

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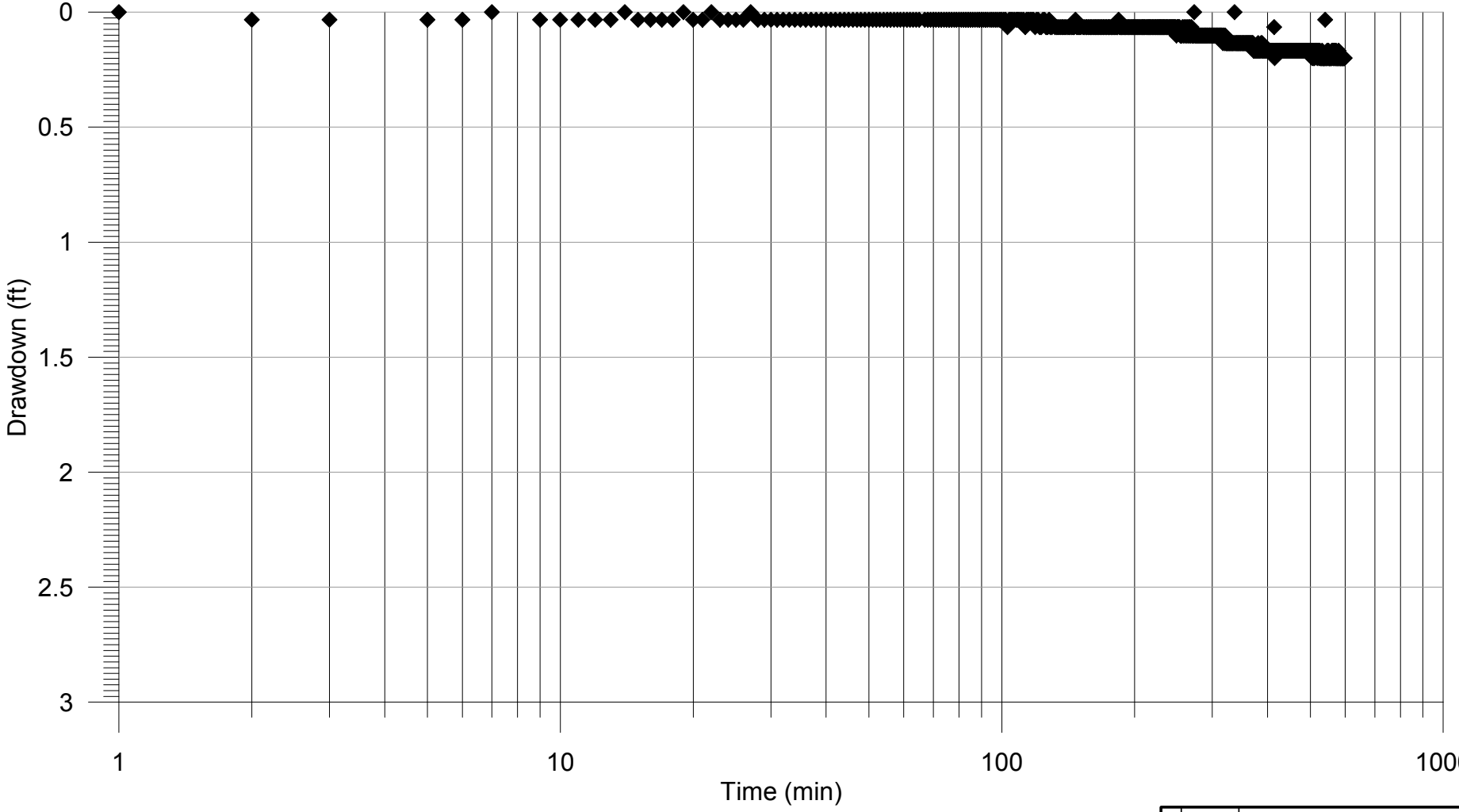

Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01PP2
Drawdown
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT TH-ED-01PP2

MAY 2017	APP D6-D-1-5	REV: 0

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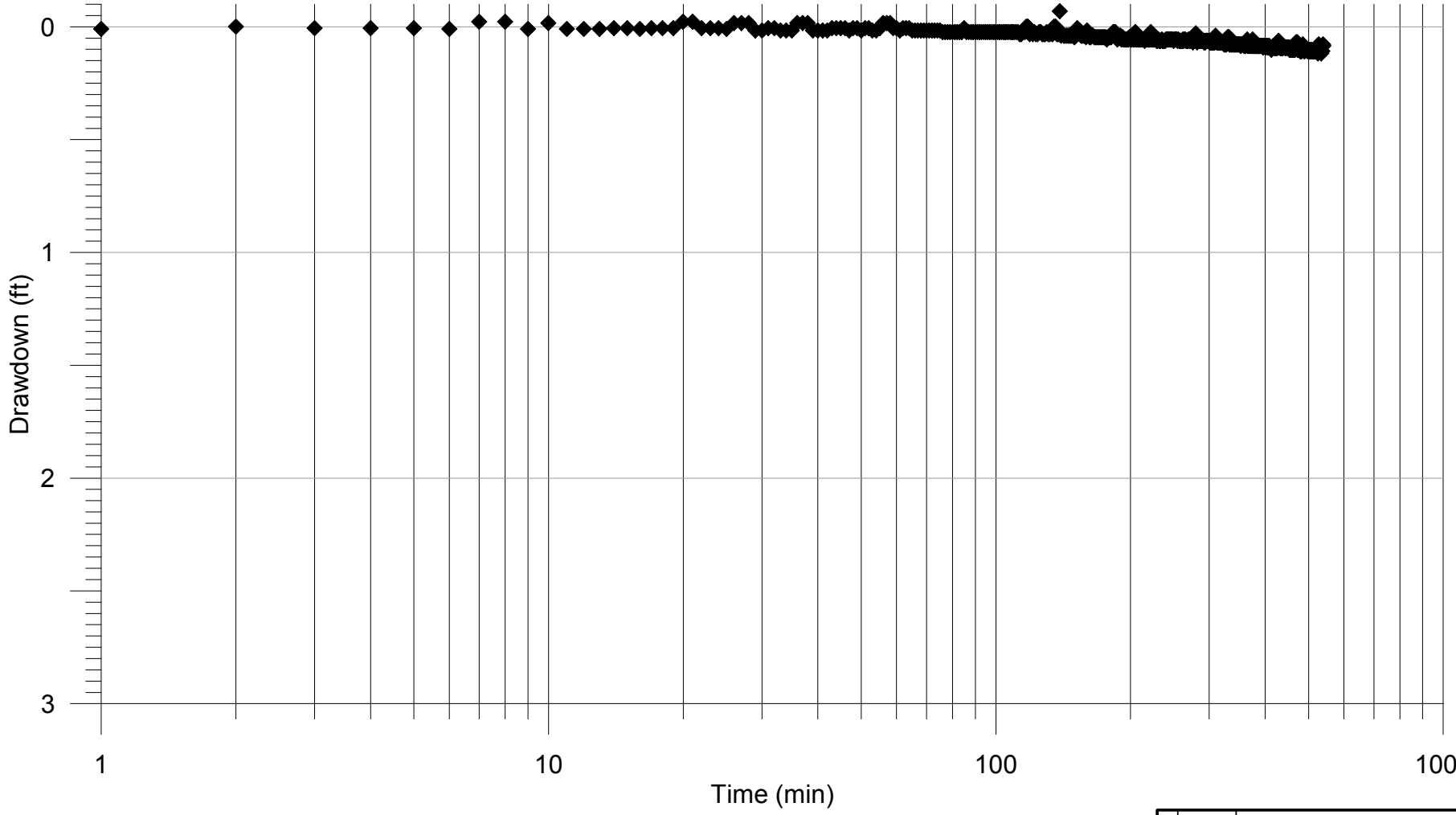

Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: BHD108
Drawdown
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT BHD108

MAY 2017	APP D6-D-1-6	REV: 0

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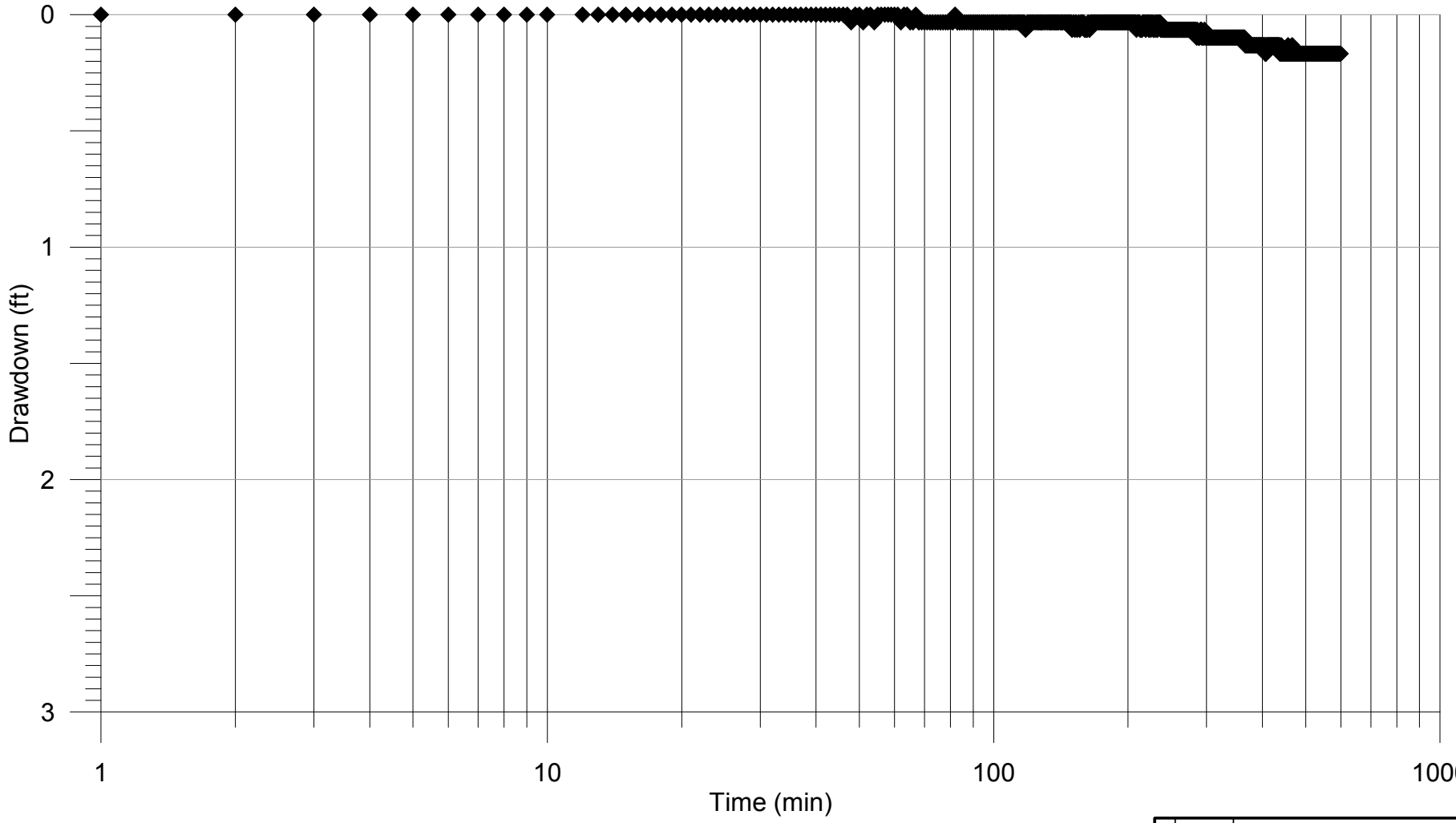

Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-GD-05
Drawdown
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT TH-GD-05

MAY 2017	APP D6-D-1-7	REV: 0

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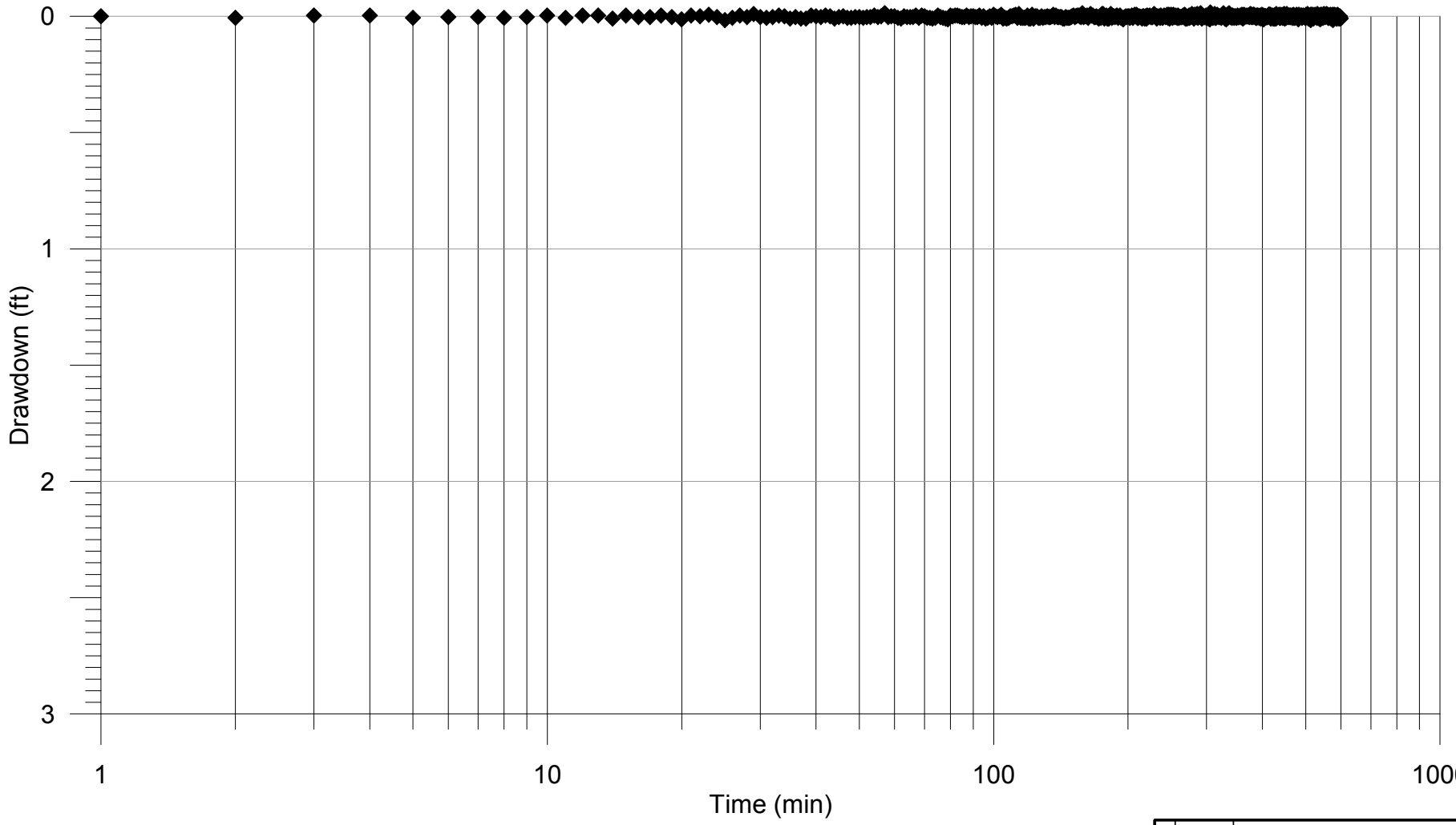

Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: 15-RD-02
Drawdown
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT 15-RD-02

MAY 2017	APP D6-D-1-8	REV: 0

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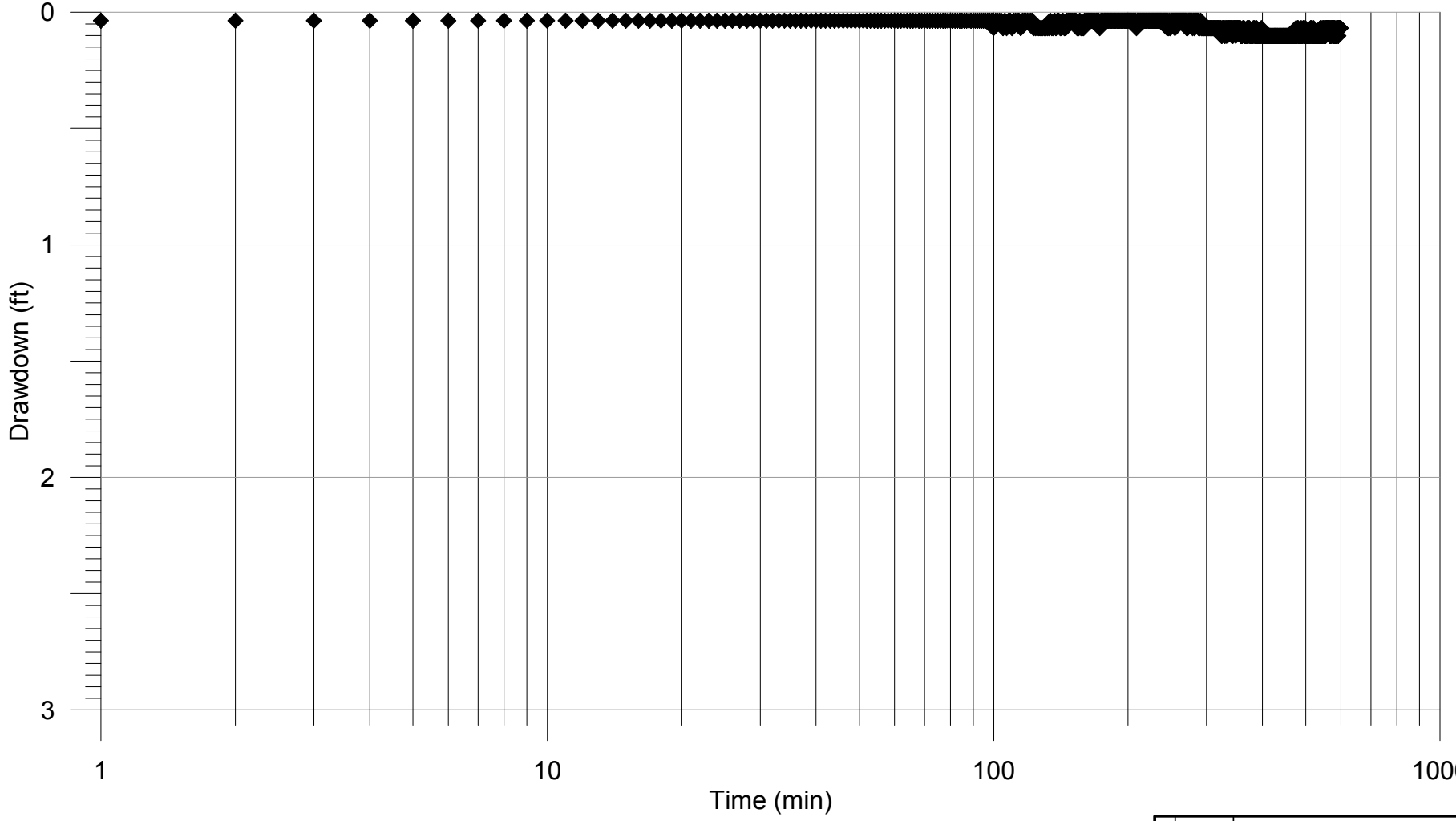


Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-03
Drawdown
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

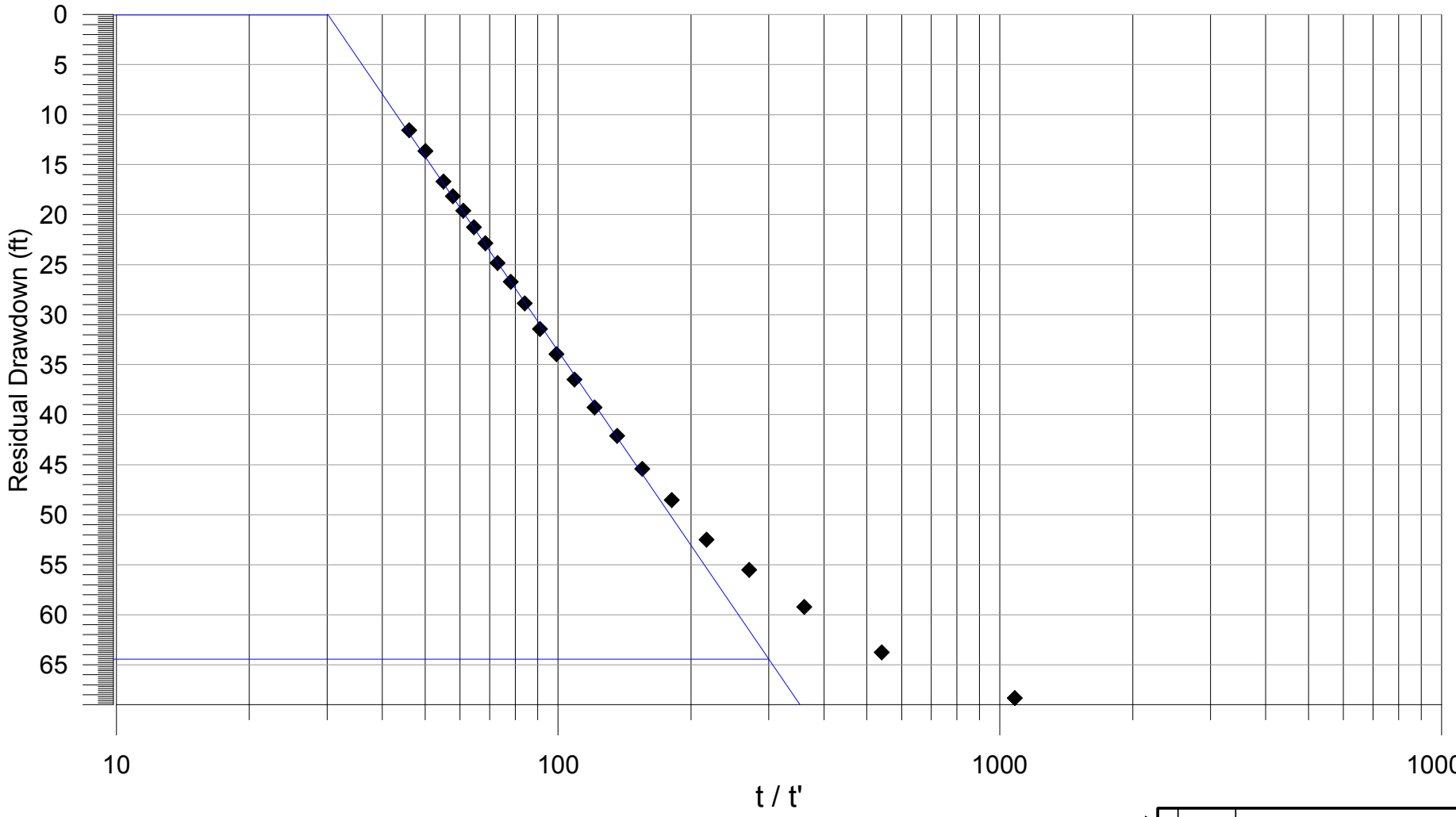
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
DRAWDOWN AT TH-ED-03

MAY 2017	APP D6-D-1-9	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-09_2016-10-26_TH-ED-01W_Pump Test_obs-TH-ED-03.grf



Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01W
Recovery
Pump Rate (Q) = 12 USgpm

T =(264)(Q)/△s **T= 50 USgpd/ft**

△s= 64 ft Q = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

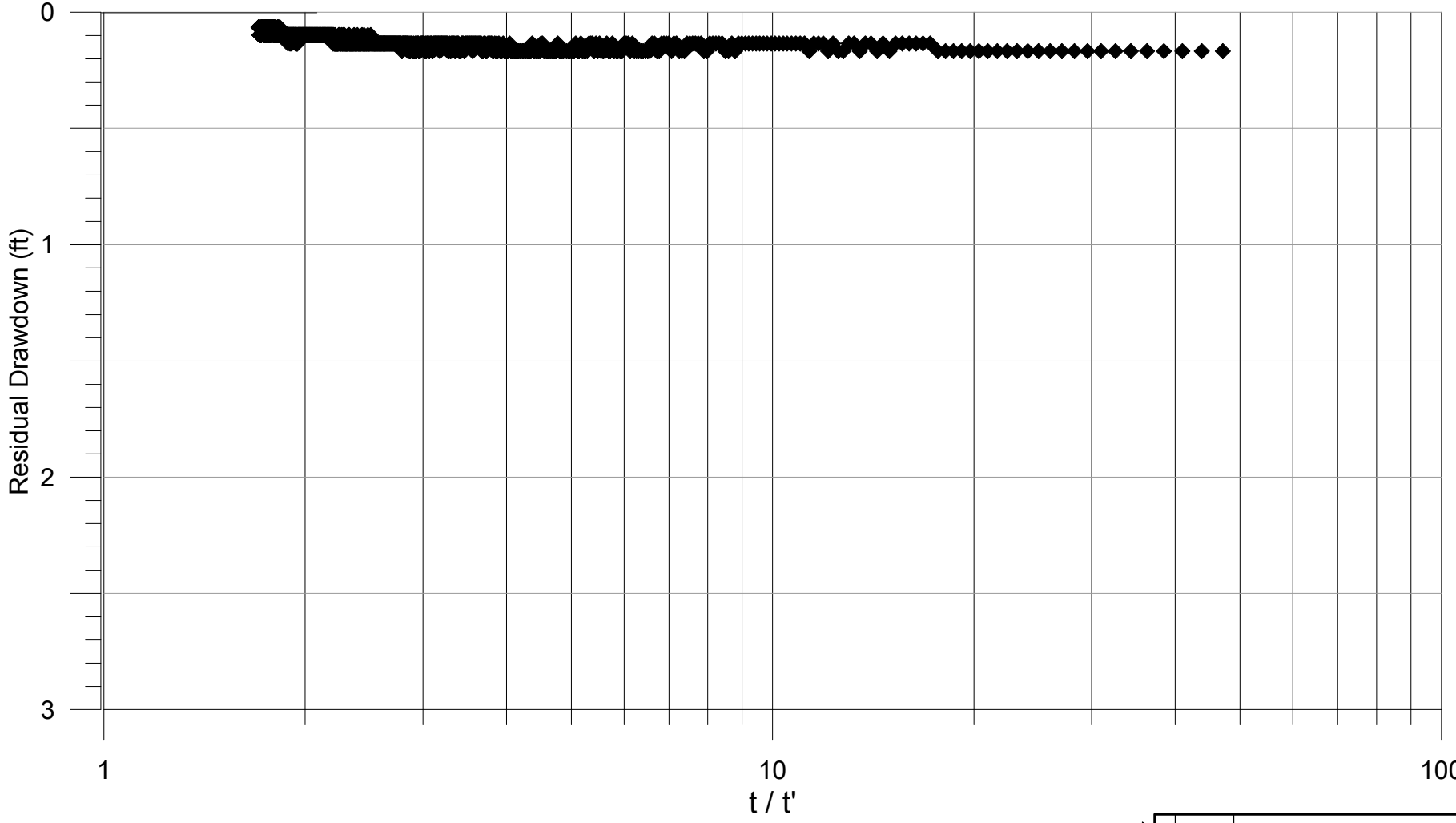
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
RECOVERY AT TH-ED-01W

MAY 2017	APP D6-D-1-10	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-10_REC_Pump-TH-ED-01W_Obs-TH-ED-01W.grf



Notes: Recovery Data not available
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01P
Recovery
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

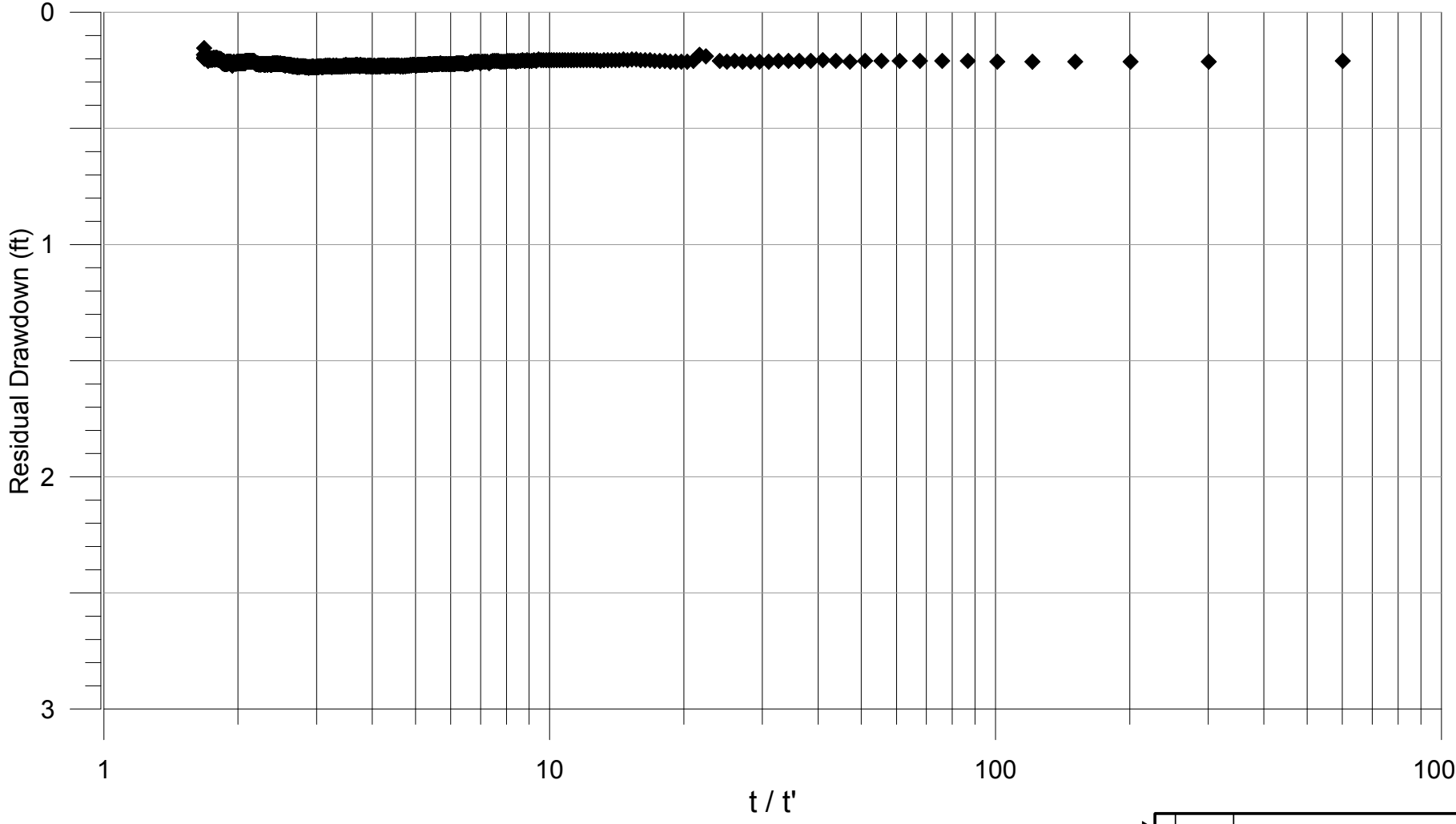
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
RECOVERY AT TH-ED-01P

MAY 2017	APP D6-D-1-11	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-11_REC_Pump-TH-ED-01W_Obs-TH-ED-01P.grf



Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01PP1
Recovery
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
RECOVERY AT TH-ED-01PP1

MAY 2017	APP D6-D-1-12	REV: 0

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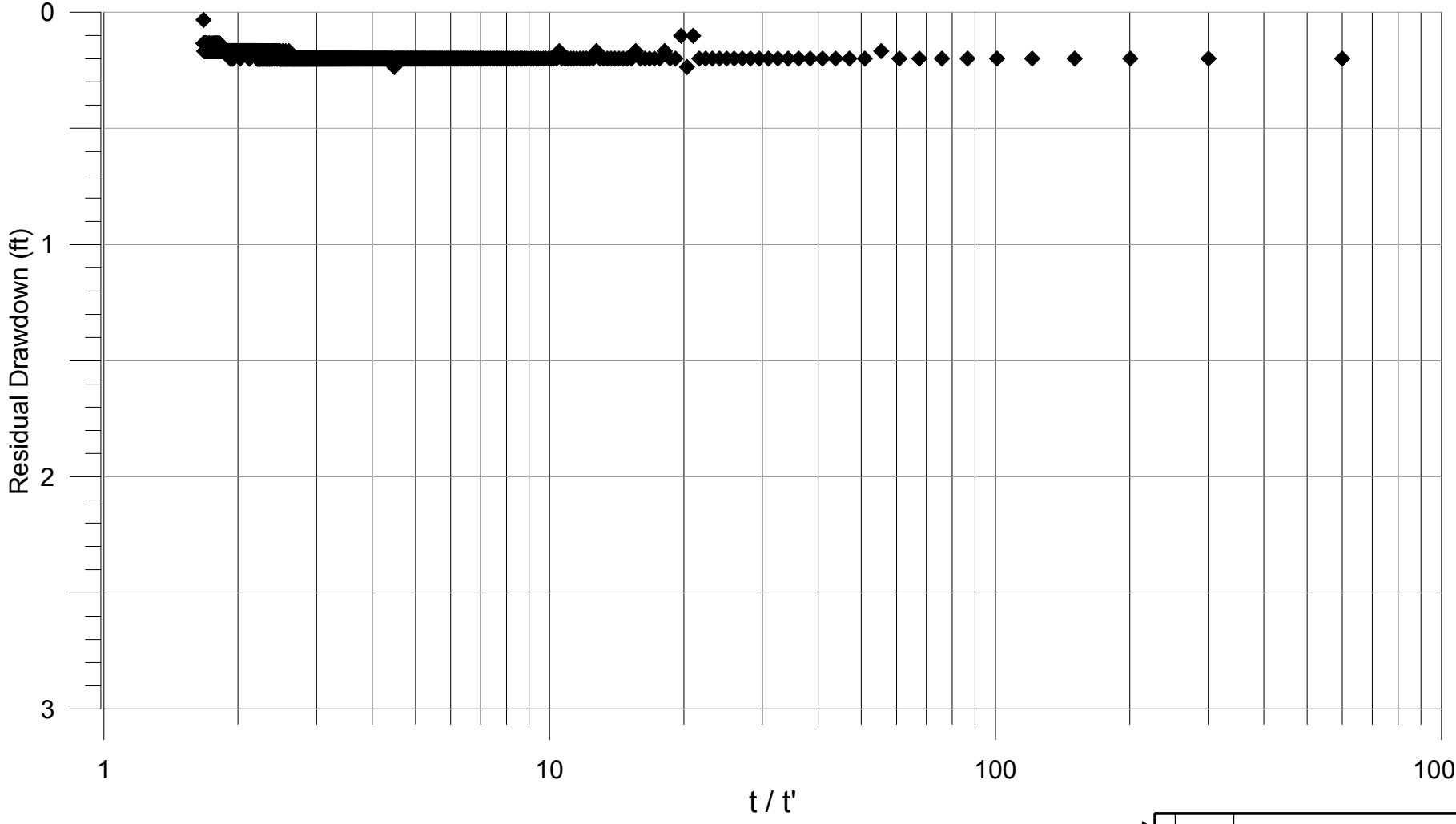


Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-01PP2
Recovery
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

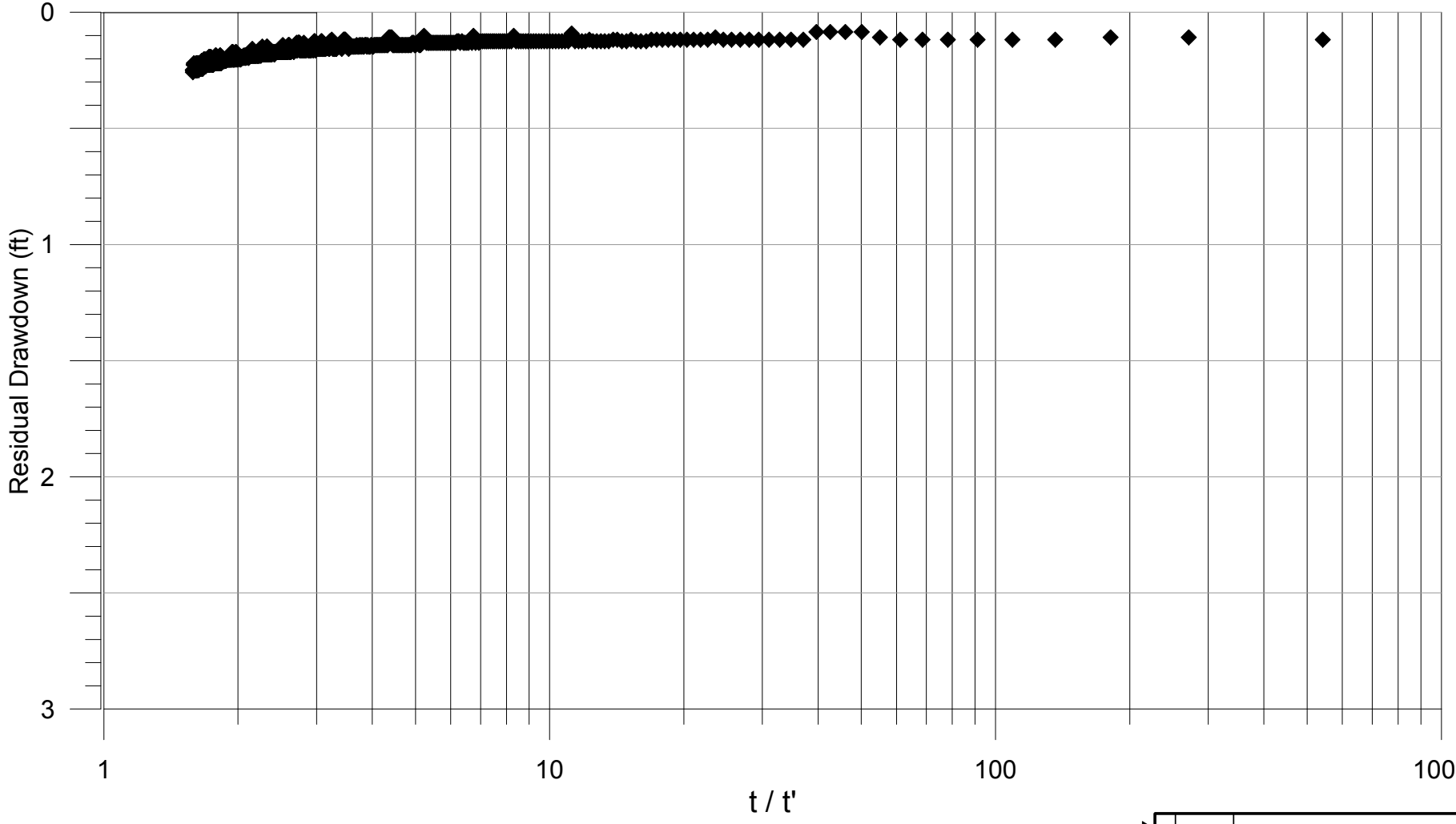
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
RECOVERY AT TH-ED-01PP2

MAY 2017	APP D6-D-1-13	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-13_REC_Pump-TH-ED-01W_Obs-TH-ED-01PP2.grf



Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: BH-D108
Recovery
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
RECOVERY AT BH-D108

MAY 2017	APP D6-D-1-14	REV: 0

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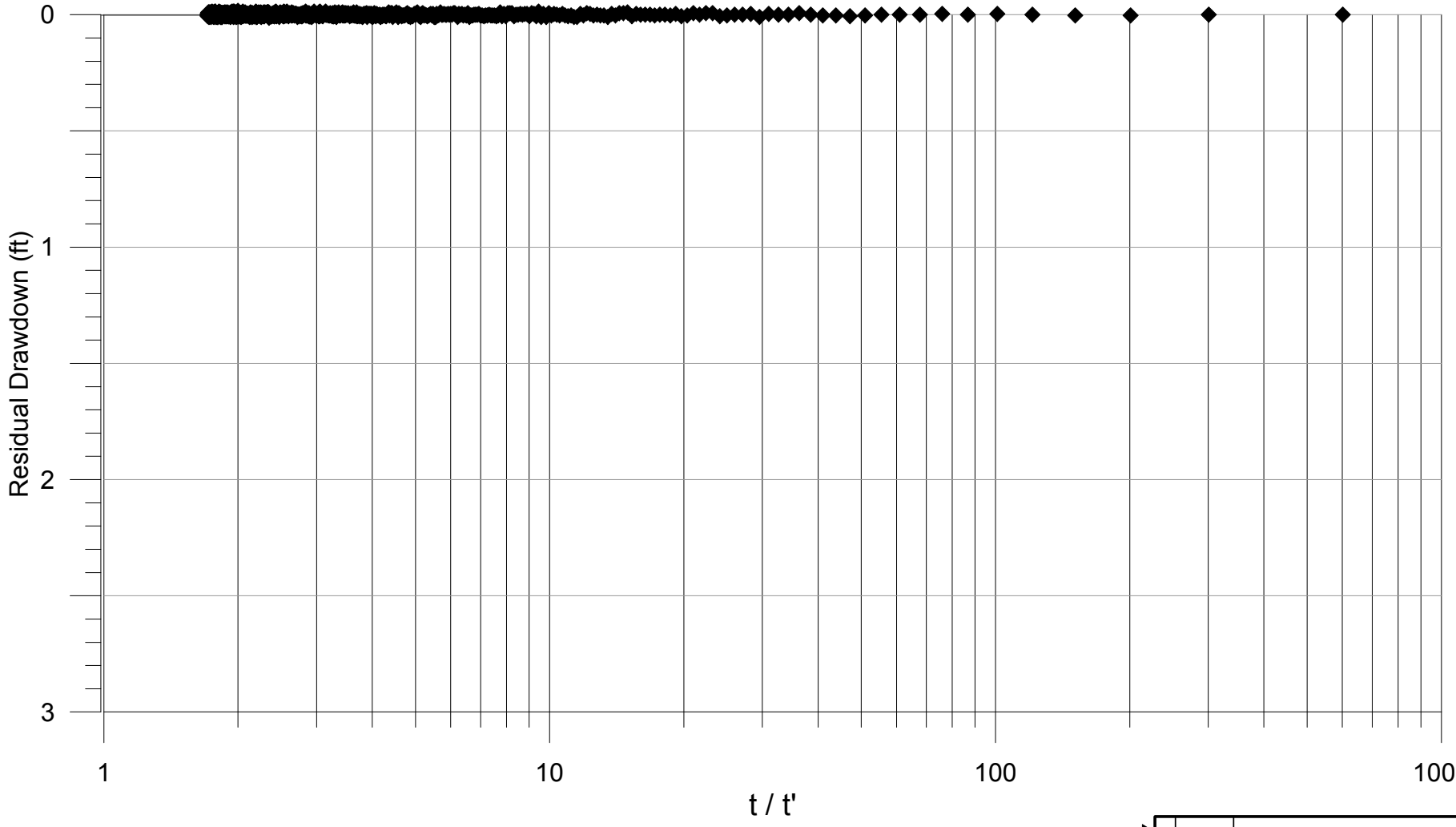


Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: 15-RD-02
Recovery
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

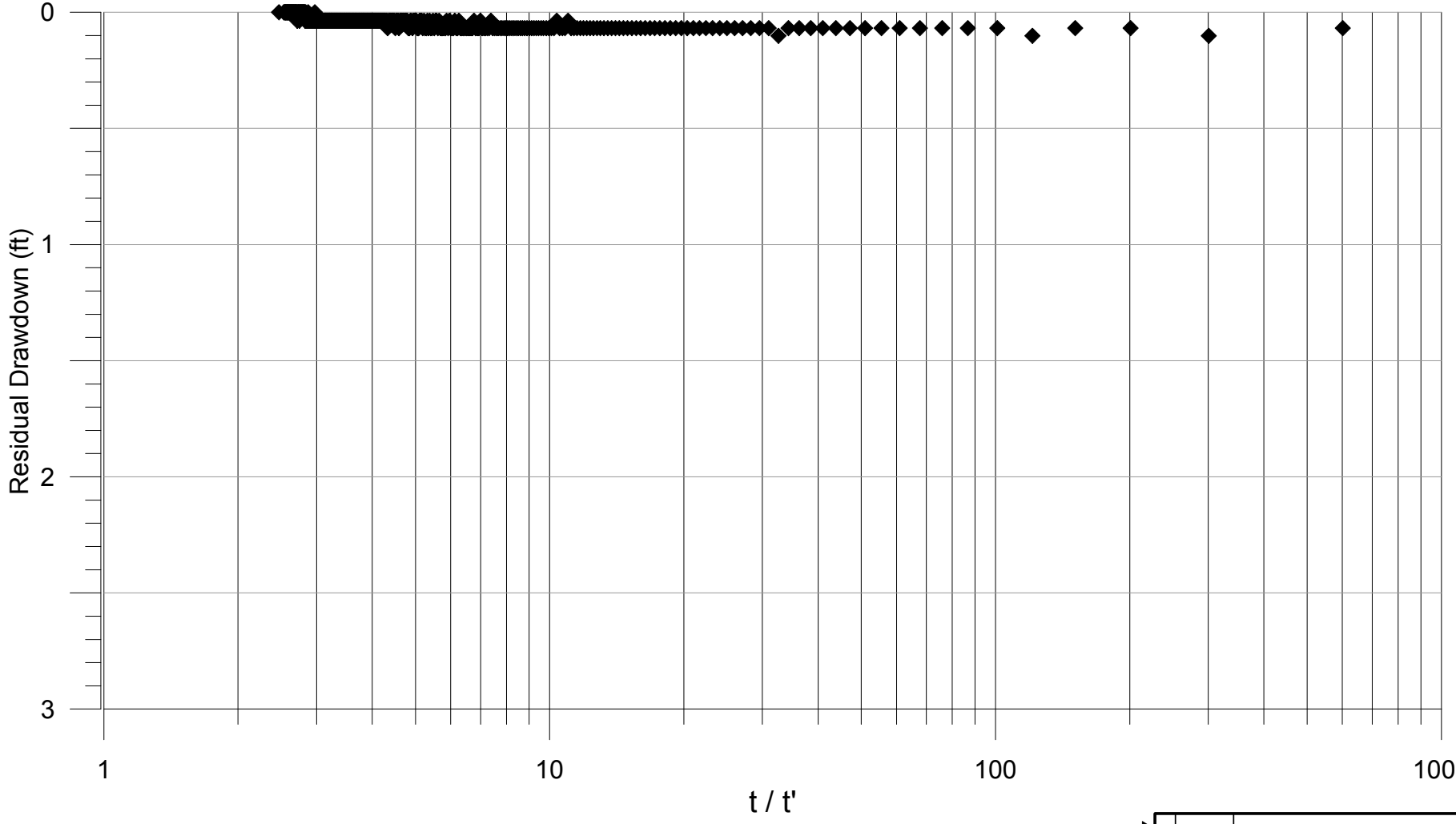
Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

PUMP TEST AT TH-ED-01W
RECOVERY AT 15-RD-02

MAY 2017	APP D6-D-1-16	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-16_REC_Pump-TH-ED-01W_Obs-15-RD-02.grf



Notes:
Date: October 26, 2016
Pumping Well: TH-ED-01W
Observation: TH-ED-03
Recovery
Pump Rate (Q) = 12 USgpm

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/05/10		PJL	JDM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

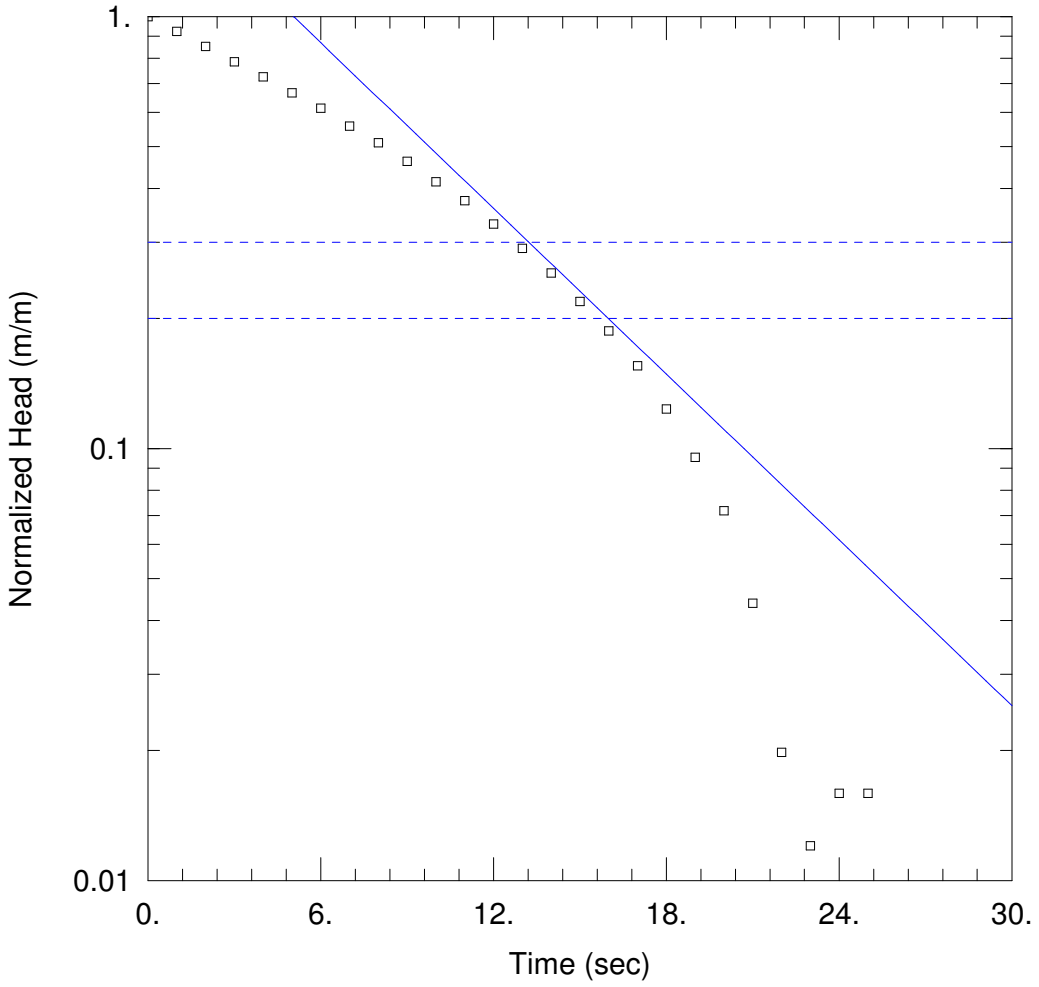
PUMP TEST AT TH-ED-01W
RECOVERY AT TH-ED-03

MAY 2017	APP D6-D-1-17	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Pump Test Data\2016-10-26_TH-ED-01W_Pump Test\D6-D-1-17_REC_Pump-TH-ED-01W_Obs-TH-ED-03.grf

APPENDIX D6-D-2

RISING HEAD AND LUGEON TEST RESULTS- ROUTE D



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-ED-01P_RHT.aqt
Date: 12/14/16 Time: 14:06:45

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-ED-01P
Test Date: Nov. 10, 2016

AQUIFER DATA

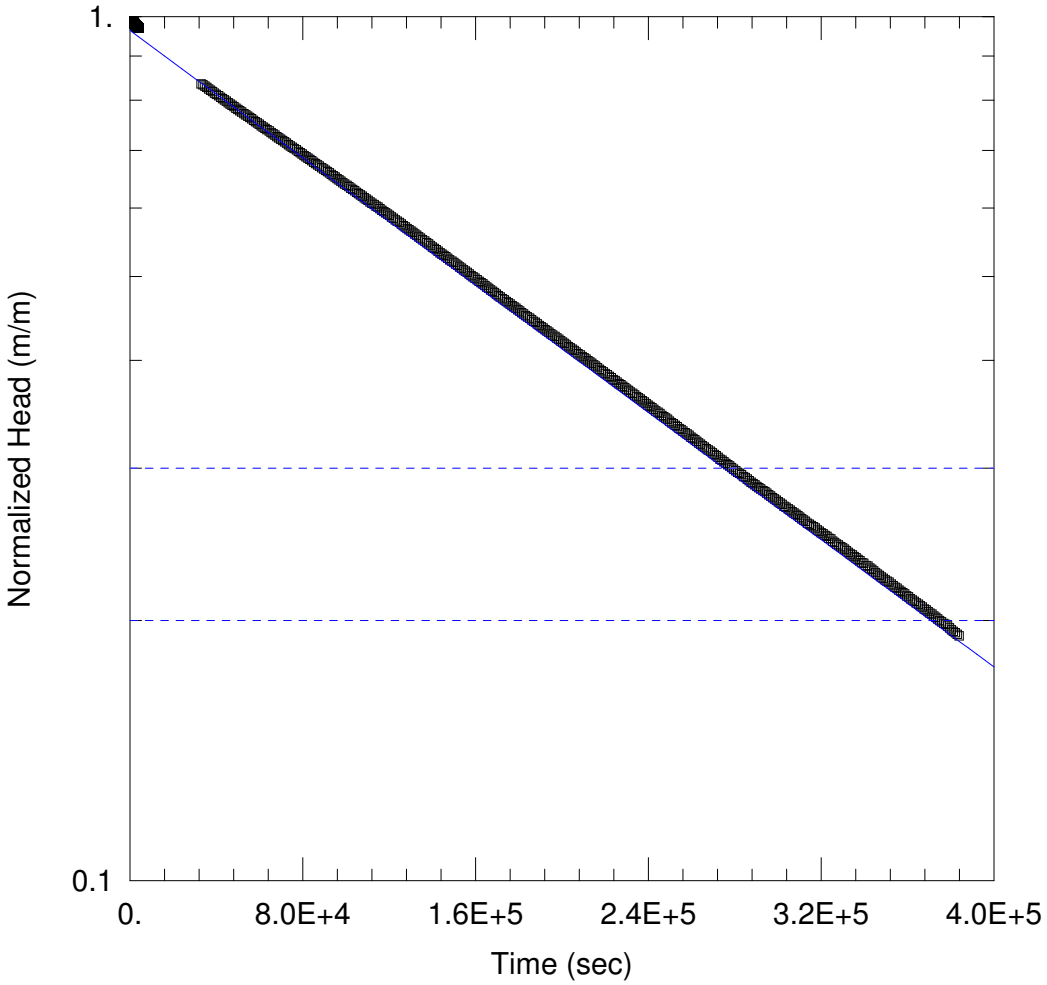
Saturated Thickness: 28.36 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-ED-01P)

Initial Displacement: 2.576 m
Total Well Penetration Depth: 28.36 m
Casing Radius: 0.0127 m
Static Water Column Height: 28.36 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 5.231E-5 m/sec
y0 = 5.423 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-ED-03.aqt
Date: 12/14/16 Time: 13:46:12

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-ED-03
Test Date: Nov. 9, 2016

AQUIFER DATA

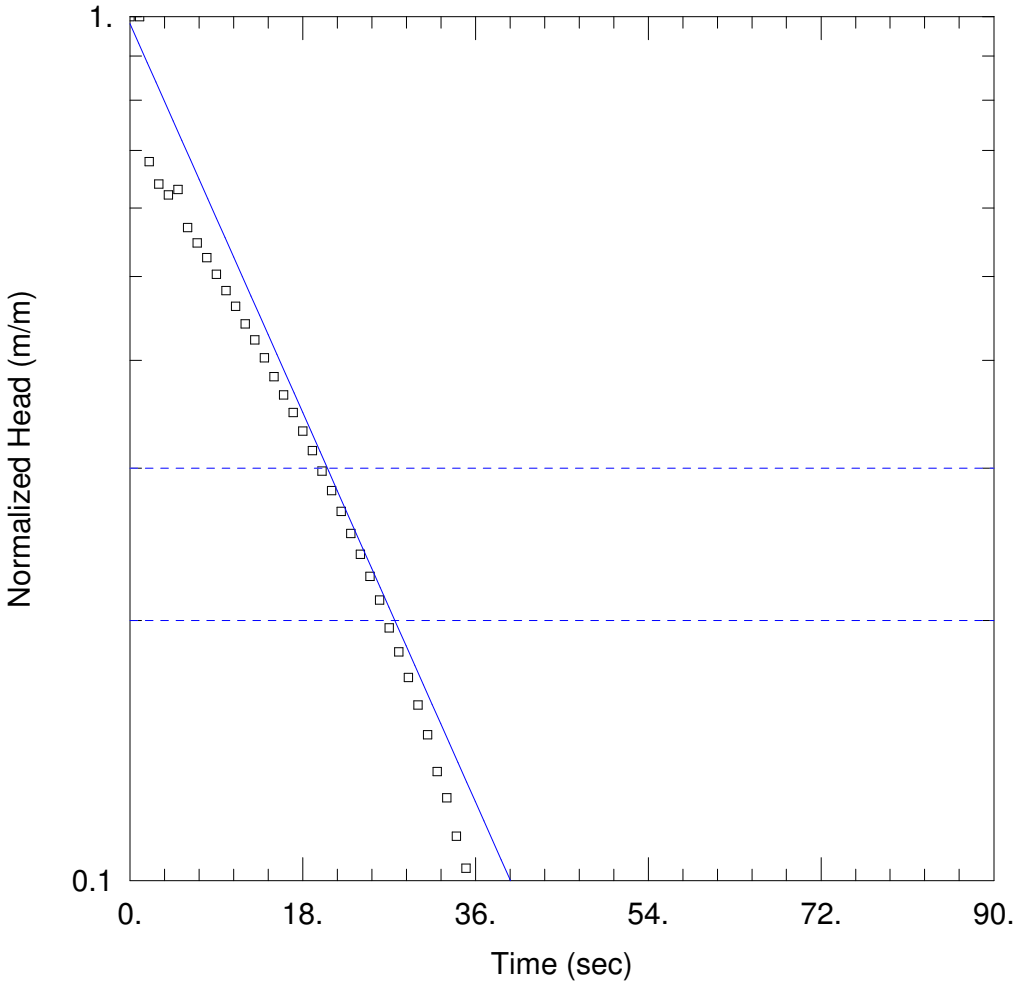
Saturated Thickness: 14.63 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-ED-03)

Initial Displacement: 9.97 m
Total Well Penetration Depth: 15.21 m
Casing Radius: 0.0127 m
Static Water Column Height: 14.63 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.417E-9 m/sec
y0 = 9.604 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GD-05_RHT.aqt
Date: 12/14/16 Time: 15:53:44

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: THGD-05
Test Date: Nov. 10, 2016

AQUIFER DATA

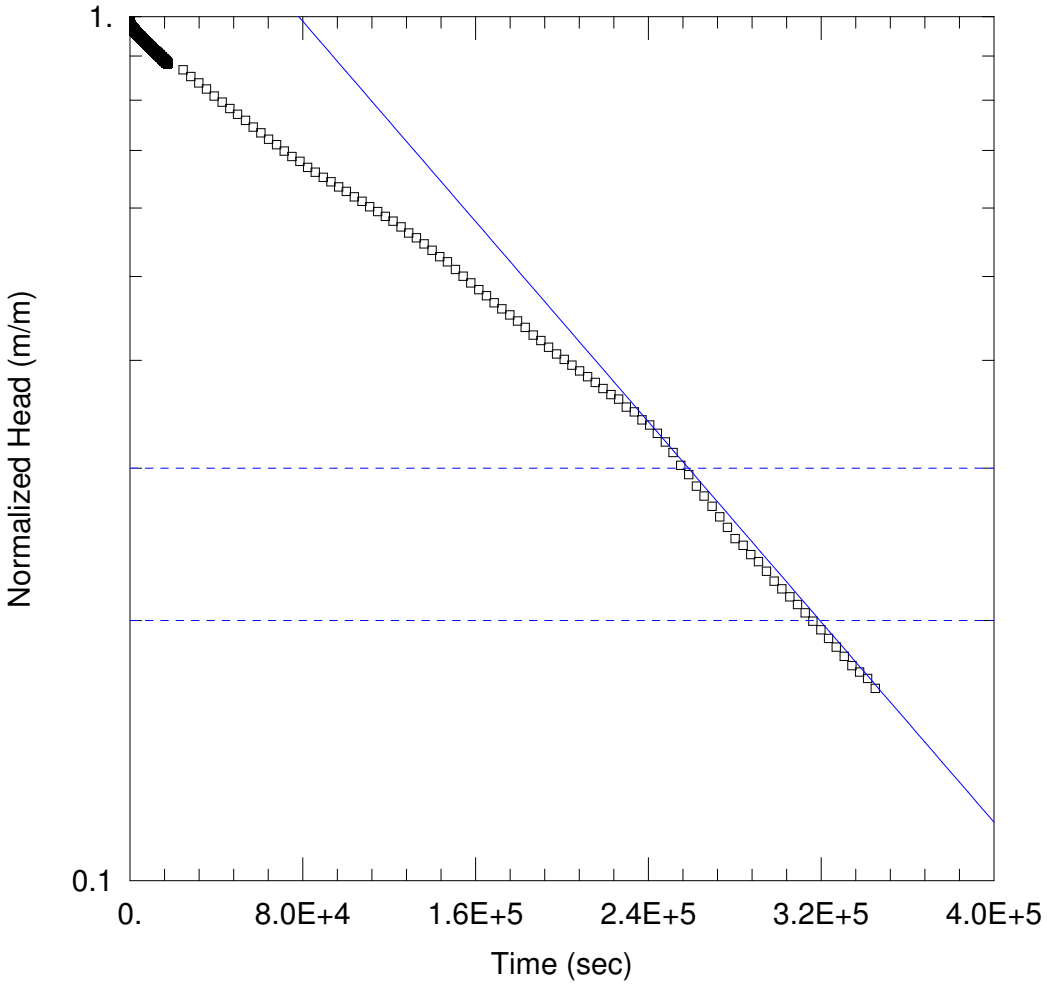
Saturated Thickness: 19.76 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GD-05)

Initial Displacement: 6.755 m
Total Well Penetration Depth: 19.76 m
Casing Radius: 0.009525 m
Static Water Column Height: 19.76 m
Screen Length: 0.92 m
Well Radius: 0.009525 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.848E-5 m/sec
y0 = 6.627 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GD-06_RHT.aqt
Date: 12/14/16 Time: 14:32:59

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-GD-06
Test Date: Nov. 10, 2016

AQUIFER DATA

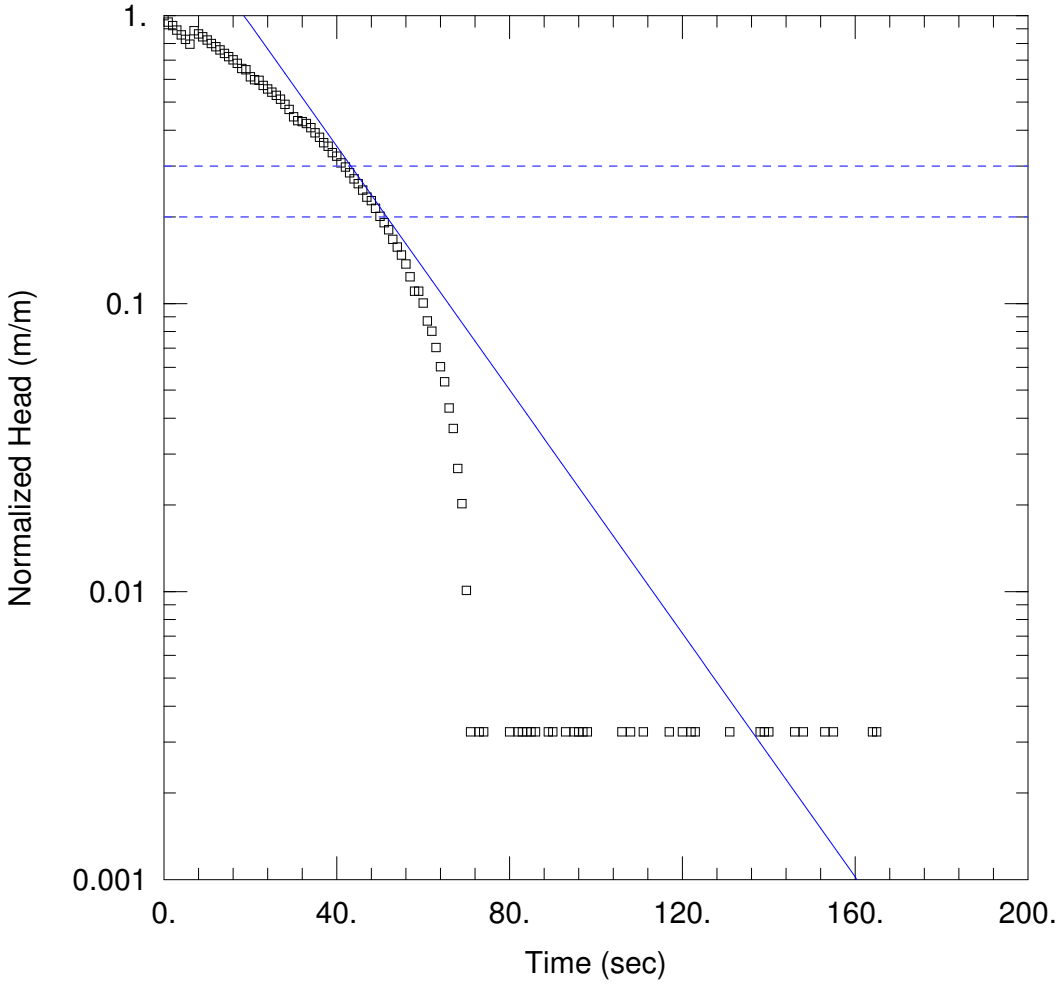
Saturated Thickness: 16.23 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GD-06)

Initial Displacement: 6.888 m
Total Well Penetration Depth: 29.45 m
Casing Radius: 0.0127 m
Static Water Column Height: 16.23 m
Screen Length: 14.72 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.87E-10 m/sec
y0 = 11.6 m



WELL TEST ANALYSIS

Data Set: U:\FMS\16-0300-006\TH-GD-07.aqt
Date: 12/14/16 Time: 13:49:17

PROJECT INFORMATION

Company: KGS Group
Client: LMB Channel
Project: 16-0300-006
Location: Fairford, MB (Pinaymootang)
Test Well: TH-GD-07
Test Date: Nov. 9, 2016

AQUIFER DATA

Saturated Thickness: 20.19 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH-GD-07)

Initial Displacement: 3.069 m
Total Well Penetration Depth: 20.19 m
Casing Radius: 0.0127 m
Static Water Column Height: 20.19 m
Screen Length: 1.52 m
Well Radius: 0.0127 m
Gravel Pack Porosity: 0.

SOLUTION

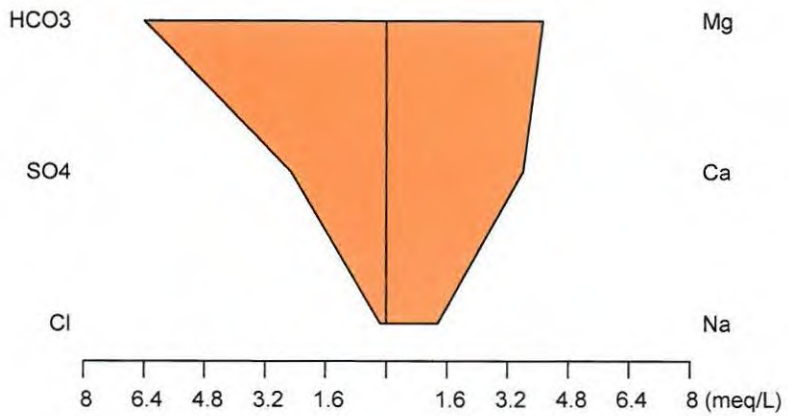
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.674E-5 m/sec
y0 = 7.558 m

APPENDIX D6-D-3

STIFF DIAGRAMS ROUTE D

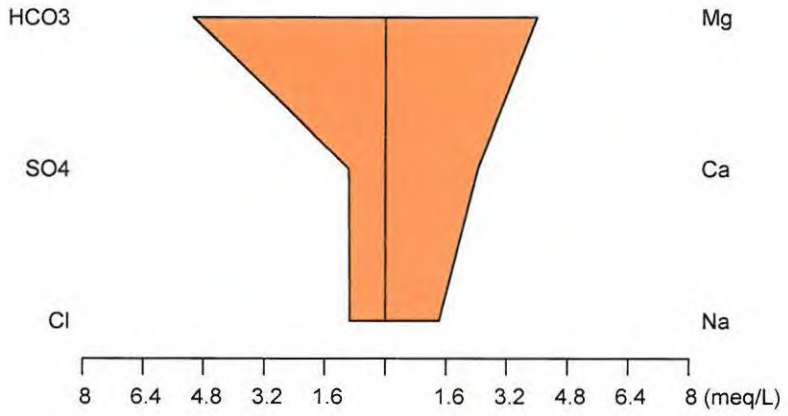
15-RD-PW1 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 483
El Cond. (uS/cm) =745



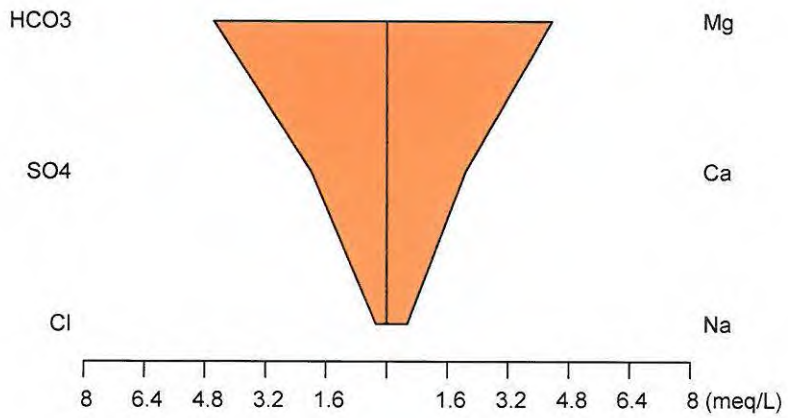
SW D-1 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 373
El Cond. (uS/cm) =604



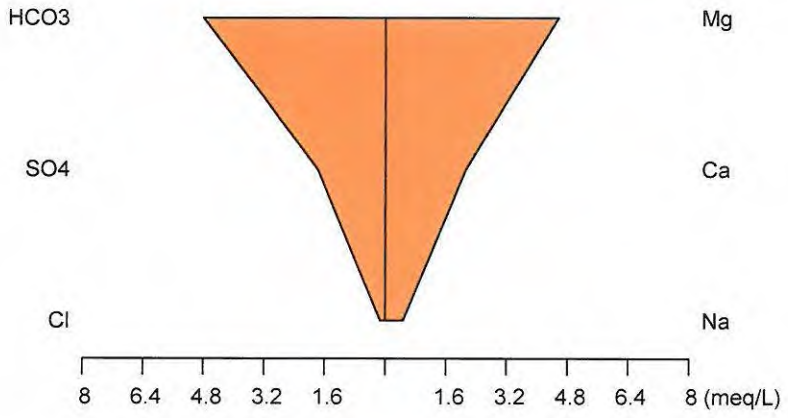
SW D-2 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 366
El Cond. (uS/cm) =582



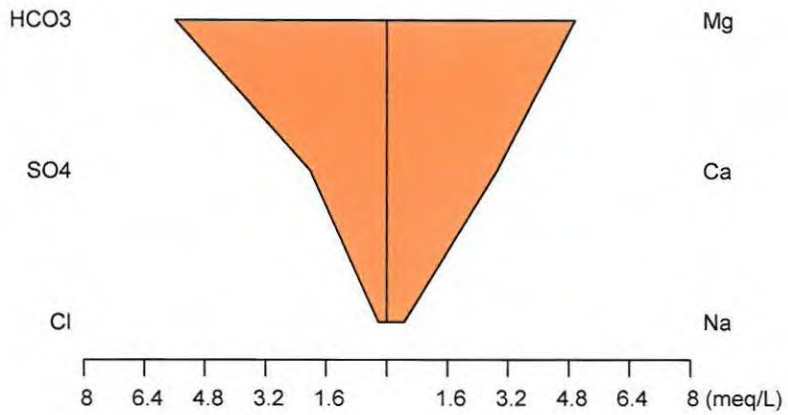
SW D-3 2016/11/07,11/07/2016

Date: 11/07/2016
TDS (mg/l) = 352
El Cond. (uS/cm) =564



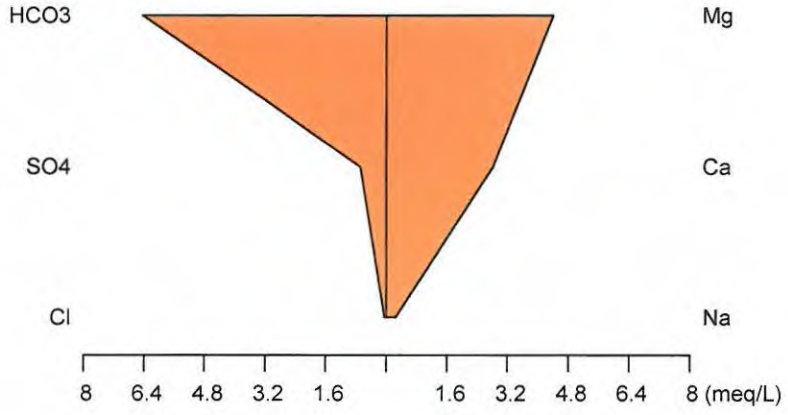
SW D-4 2016/11/07,11/07/2016

Date: 11/07/2016
TDS (mg/l) = 410
El Cond. (uS/cm) =633



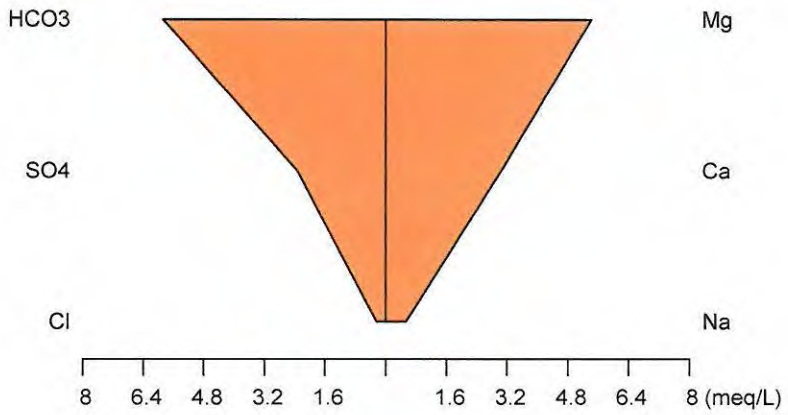
SW D-5 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 346
El Cond. (uS/cm) =574



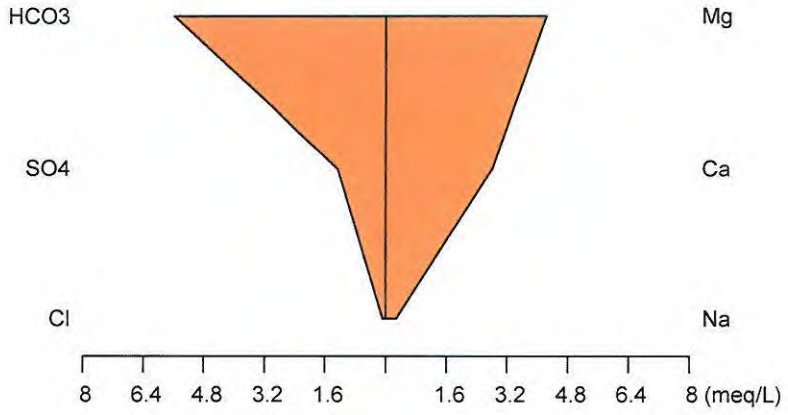
SW D-6 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 445
El Cond. (uS/cm) =683



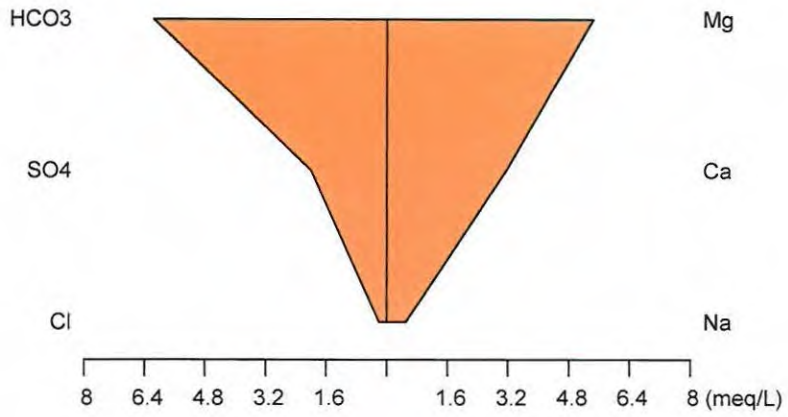
SW D-7 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 353
El Cond. (uS/cm) =564



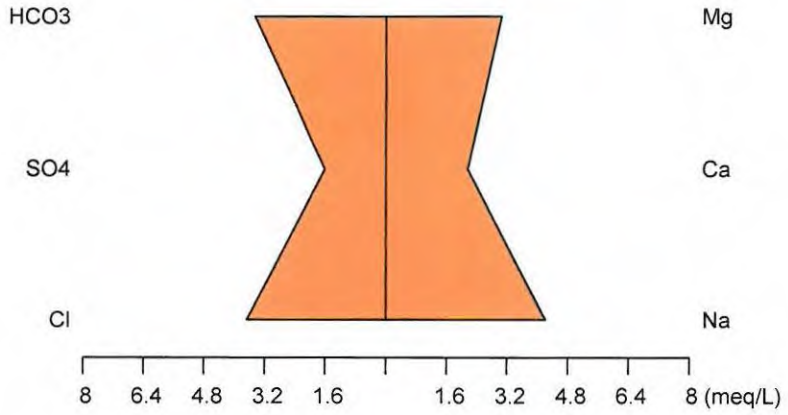
SW D-8 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 436
El Cond. (uS/cm) =667



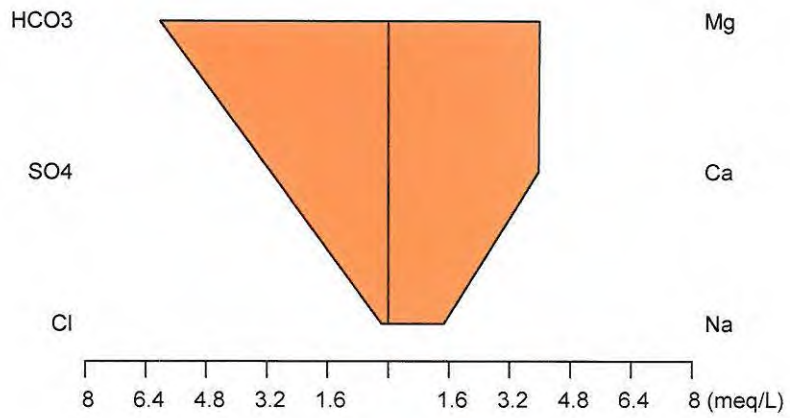
SW D-9 2016/11/08,11/08/2016

Date: 11/08/2016
TDS (mg/l) = 503
El Cond. (uS/cm) =813



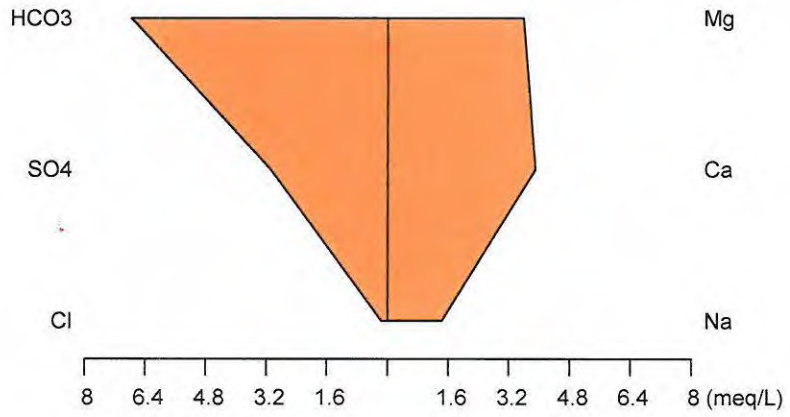
TH-ED-01P 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 508
El Cond. (uS/cm) =776



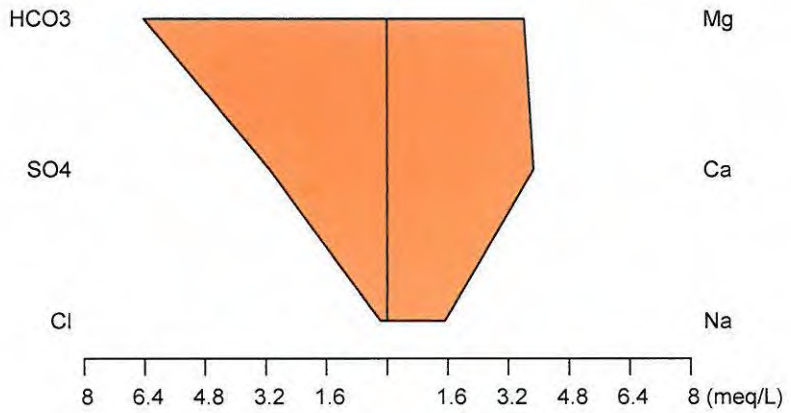
TH-ED-01W END 2016/10/26,26/10/2016

Date: 26/10/2016
TDS (mg/l) = 521
El Cond. (uS/cm) =744



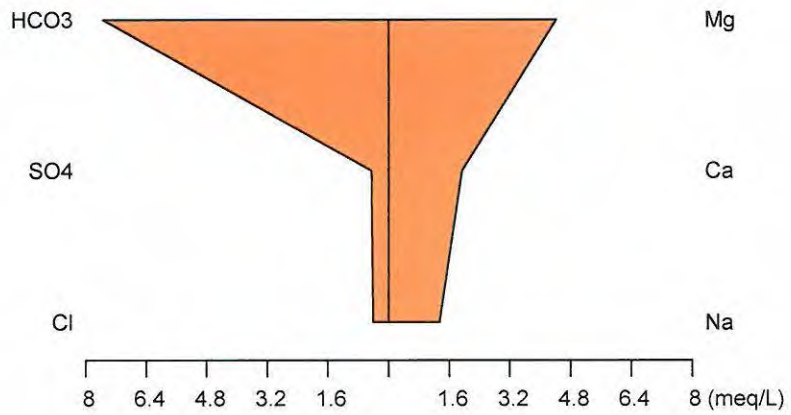
TH-ED-01W START 2016/10/26,26/10/2016

Date: 26/10/2016
TDS (mg/l) = 513
El Cond. (uS/cm) =741



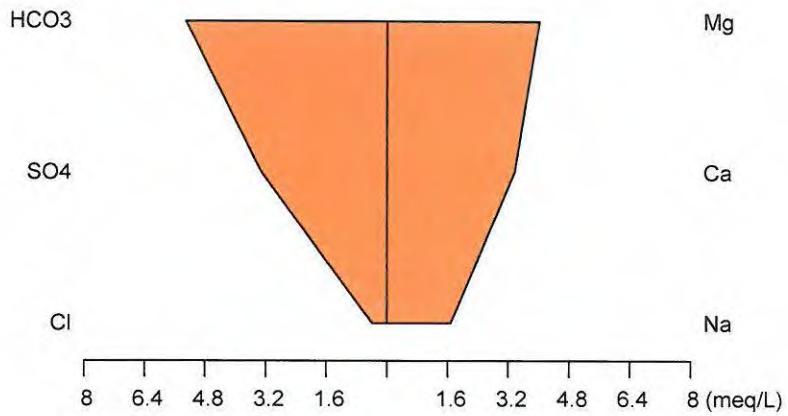
TH-ED-03 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 390
El Cond. (uS/cm) =616



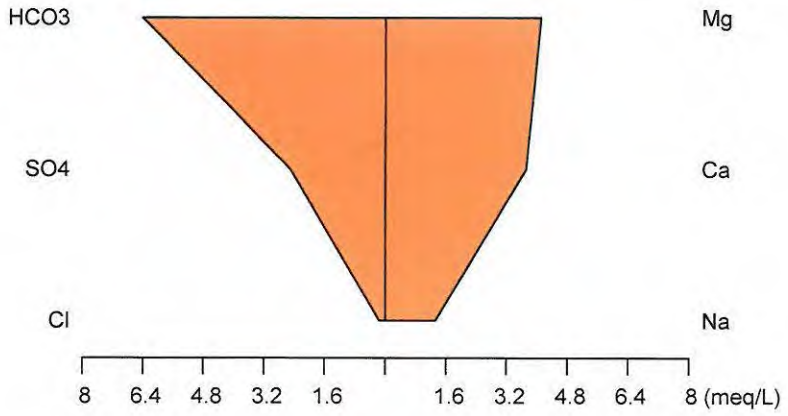
TH-GD-02 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 498
El Cond. (uS/cm) =760



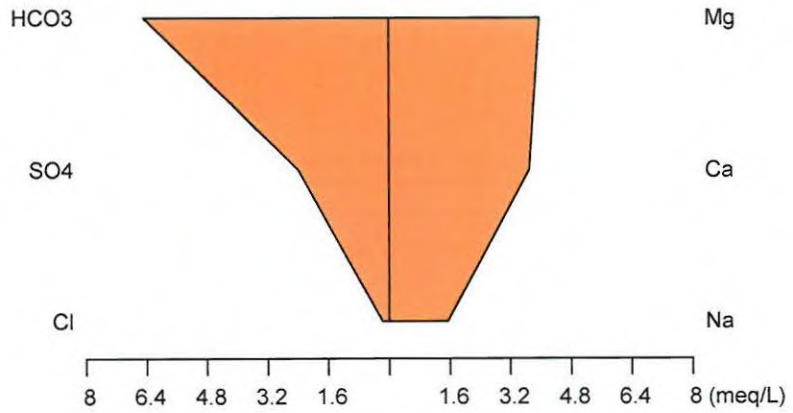
TH-GD-07 2016/11/09,11/09/2016

Date: 11/09/2016
TDS (mg/l) = 482
El Cond. (uS/cm) =751



TH-GD-08 2016/10/29,29/10/2016

Date: 29/10/2016
El Cond. (uS/cm) =732



APPENDIX D6-E

LABORATORY RESULTS ROUTE C AND D

APPENDIX D6-E1

GROUNDWATER

KGS Group Consultants (Winnipeg)
ATTN: Jason Mann
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

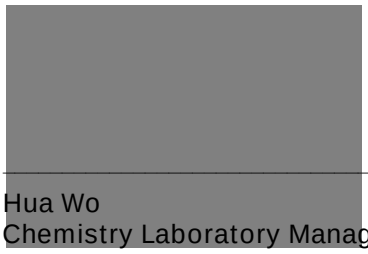
Date Received: 19-OCT-16
Report Date: 02-NOV-16 12:05 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1845200

Project P.O. #: NOT SUBMITTED
Job Reference: 16-0300-006
C of C Numbers:
Legal Site Desc:



Hua Wo
Chemistry Laboratory Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1845200-1 TH-EC-01 WW2 TEST START							
Sampled By: CLIENT on 18-OCT-16 @ 13:30							
Matrix: Water							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.017		0.010	mg/L		25-OCT-16	R3579452
Phosphorus (P)-Total	0.411		0.050	mg/L		24-OCT-16	R3578486
Total Kjeldahl Nitrogen	<0.20		0.20	mg/L	27-OCT-16	31-OCT-16	R3585833
Total Coliform and E.coli by MPN QT97							
Total Coliforms	50	DLA	10	MPN/100mL		19-OCT-16	R3575740
Escherichia Coli	<10		10	MPN/100mL		19-OCT-16	R3575740
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	414		1.2	mg/L		21-OCT-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		21-OCT-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		21-OCT-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	339		1.0	mg/L		20-OCT-16	R3576387
Chloride in Water by IC (Low Level)							
Chloride (Cl)	2.34		0.10	mg/L		19-OCT-16	R3575524
Conductivity							
Conductivity	564		1.0	umhos/cm		20-OCT-16	R3576387
Dissolved Metals by ICP-MS							
Aluminum (Al)-Dissolved	0.0023		0.0020	mg/L	22-OCT-16	25-OCT-16	R3579739
Antimony (Sb)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Arsenic (As)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Barium (Ba)-Dissolved	0.0760		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Beryllium (Be)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Bismuth (Bi)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Boron (B)-Dissolved	0.017		0.010	mg/L	22-OCT-16	25-OCT-16	R3579739
Cadmium (Cd)-Dissolved	<0.000010		0.000010	mg/L	22-OCT-16	25-OCT-16	R3579739
Calcium (Ca)-Dissolved	63.4		0.050	mg/L	22-OCT-16	25-OCT-16	R3579739
Cesium (Cs)-Dissolved	<0.00010		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Chromium (Cr)-Dissolved	<0.0010		0.0010	mg/L	22-OCT-16	25-OCT-16	R3579739
Cobalt (Co)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Copper (Cu)-Dissolved	0.00198		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Iron (Fe)-Dissolved	<0.010		0.010	mg/L	22-OCT-16	25-OCT-16	R3579739
Lead (Pb)-Dissolved	0.000120		0.000090	mg/L	22-OCT-16	25-OCT-16	R3579739
Lithium (Li)-Dissolved	0.0078		0.0020	mg/L	22-OCT-16	25-OCT-16	R3579739
Magnesium (Mg)-Dissolved	50.8		0.010	mg/L	22-OCT-16	25-OCT-16	R3579739
Manganese (Mn)-Dissolved	0.00071		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Molybdenum (Mo)-Dissolved	0.00033		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Nickel (Ni)-Dissolved	<0.0010		0.0010	mg/L	22-OCT-16	25-OCT-16	R3579739
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	22-OCT-16	25-OCT-16	R3579739
Potassium (K)-Dissolved	0.740		0.020	mg/L	22-OCT-16	25-OCT-16	R3579739
Rubidium (Rb)-Dissolved	0.00185		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Selenium (Se)-Dissolved	<0.0010		0.0010	mg/L	22-OCT-16	25-OCT-16	R3579739
Silicon (Si)-Dissolved	4.39		0.10	mg/L	22-OCT-16	25-OCT-16	R3579739
Silver (Ag)-Dissolved	<0.00010		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Sodium (Na)-Dissolved	5.48		0.020	mg/L	22-OCT-16	25-OCT-16	R3579739
Strontium (Sr)-Dissolved	0.0460		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Thallium (Tl)-Dissolved	<0.00010		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Tin (Sn)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1845200-1 TH-EC-01 WW2 TEST START							
Sampled By: CLIENT on 18-OCT-16 @ 13:30							
Matrix: Water							
Dissolved Metals by ICP-MS							
Titanium (Ti)-Dissolved	<0.00050		0.00050	mg/L	22-OCT-16	25-OCT-16	R3579739
Tungsten (W)-Dissolved	<0.00010		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Uranium (U)-Dissolved	0.00052		0.00010	mg/L	22-OCT-16	25-OCT-16	R3579739
Vanadium (V)-Dissolved	<0.00020		0.00020	mg/L	22-OCT-16	25-OCT-16	R3579739
Zinc (Zn)-Dissolved	0.0029		0.0020	mg/L	22-OCT-16	25-OCT-16	R3579739
Zirconium (Zr)-Dissolved	<0.00040		0.00040	mg/L	22-OCT-16	25-OCT-16	R3579739
Fluoride in Water by IC							
Fluoride (F)	0.132		0.020	mg/L		19-OCT-16	R3575524
Hardness Calculated							
Hardness (as CaCO3)	367		0.20	mg/L		26-OCT-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.264		0.0050	mg/L		19-OCT-16	R3575524
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.264		0.0051	mg/L		20-OCT-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		19-OCT-16	R3575524
Sulfate in Water by IC							
Sulfate (SO4)	5.09		0.30	mg/L		19-OCT-16	R3575524
TDS calculated							
TDS (Calculated)	333		5.0	mg/L		26-OCT-16	
Turbidity							
Turbidity	90.3		0.10	NTU		21-OCT-16	R3577894
pH							
pH	8.10		0.10	pH units		20-OCT-16	R3576387
L1845200-2 TH-EC-01 WW2 TEST STOP							
Sampled By: CLIENT on 18-OCT-16 @ 18:00							
Matrix: Water							
Miscellaneous Parameters							
Ammonia, Total (as N)	<0.010		0.010	mg/L		24-OCT-16	R3579014
Phosphorus (P)-Total	0.021		0.010	mg/L		24-OCT-16	R3578486
Total Kjeldahl Nitrogen	<0.20		0.20	mg/L	21-OCT-16	25-OCT-16	R3580239
Total Coliform and E.coli by MPN QT97							
Total Coliforms	2		1	MPN/100mL		19-OCT-16	R3576285
Escherichia Coli	<1		1	MPN/100mL		19-OCT-16	R3576285
Routine Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	412		1.2	mg/L		21-OCT-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		21-OCT-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		21-OCT-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	338		1.0	mg/L		20-OCT-16	R3576387
Chloride in Water by IC							
Chloride (Cl)	1.81		0.50	mg/L		19-OCT-16	R3575524
Conductivity							
Conductivity	556		1.0	umhos/cm		20-OCT-16	R3576387
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	61.3		0.20	mg/L	22-OCT-16	25-OCT-16	R3579739
Magnesium (Mg)-Dissolved	48.3		0.050	mg/L	22-OCT-16	25-OCT-16	R3579739
Potassium (K)-Dissolved	0.67		0.10	mg/L	22-OCT-16	25-OCT-16	R3579739

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1845200-2 TH-EC-01 WW2 TEST STOP							
Sampled By: CLIENT on 18-OCT-16 @ 18:00							
Matrix: Water							
Dissolved Metals by ICP-MS							
Sodium (Na)-Dissolved	4.20		0.050	mg/L	22-OCT-16	25-OCT-16	R3579739
Hardness Calculated							
Hardness (as CaCO3)	352		0.54	mg/L		26-OCT-16	
Nitrate in Water by IC							
Nitrate (as N)	0.262		0.020	mg/L		19-OCT-16	R3575524
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.262		0.070	mg/L		20-OCT-16	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		19-OCT-16	R3575524
Sulfate in Water by IC							
Sulfate (SO4)	4.56		0.30	mg/L		19-OCT-16	R3575524
TDS calculated							
TDS (Calculated)	325		5.0	mg/L		26-OCT-16	
pH							
pH	8.14		0.10	pH units		20-OCT-16	R3576387

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-L-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A -DL

This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

MET-D-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A-D

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	APHA 4500 NorgD (modified)
Aqueous samples are digested in a block digester with sulfuric acid and copper sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a discrete analyzer with colorimetric detection.			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2+NO3-CALC-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-WP	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-N-WP	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
P-T-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97
This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1845200 Report Date: 02-NOV-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Jason Mann

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3576387								
WG2415727-4 LCS								
Alkalinity, Total (as CaCO3)			104.4		%		85-115	20-OCT-16
WG2415727-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	20-OCT-16
CL-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Chloride (Cl)			101.2		%		90-110	19-OCT-16
WG2413975-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-OCT-16
CL-L-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Chloride (Cl)			101.2		%		90-110	19-OCT-16
WG2413975-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	19-OCT-16
EC-WP	**Water**							
Batch R3576387								
WG2415727-3 LCS								
Conductivity			101.3		%		90-110	20-OCT-16
WG2415727-1 MB								
Conductivity			<1.0		umhos/cm		1	20-OCT-16
F-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Fluoride (F)			101.5		%		90-110	19-OCT-16
WG2413975-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	19-OCT-16
MET-D-L-MS-WP	**Water**							
Batch R3579739								
WG2417265-2 LCS								
Aluminum (Al)-Dissolved			104.7		%		80-120	25-OCT-16
Antimony (Sb)-Dissolved			102.4		%		80-120	25-OCT-16
Arsenic (As)-Dissolved			101.6		%		80-120	25-OCT-16
Barium (Ba)-Dissolved			101.6		%		80-120	25-OCT-16
Beryllium (Be)-Dissolved			98.5		%		80-120	25-OCT-16
Bismuth (Bi)-Dissolved			99.4		%		80-120	25-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3579739								
WG2417265-2 LCS								
Boron (B)-Dissolved			102.0		%		80-120	25-OCT-16
Cadmium (Cd)-Dissolved			101.1		%		80-120	25-OCT-16
Calcium (Ca)-Dissolved			98.3		%		80-120	25-OCT-16
Cesium (Cs)-Dissolved			101.0		%		80-120	25-OCT-16
Chromium (Cr)-Dissolved			101.5		%		80-120	25-OCT-16
Cobalt (Co)-Dissolved			102.6		%		80-120	25-OCT-16
Copper (Cu)-Dissolved			100.4		%		80-120	25-OCT-16
Iron (Fe)-Dissolved			97.3		%		80-120	25-OCT-16
Lead (Pb)-Dissolved			103.1		%		80-120	25-OCT-16
Lithium (Li)-Dissolved			99.1		%		80-120	25-OCT-16
Magnesium (Mg)-Dissolved			107.8		%		80-120	25-OCT-16
Manganese (Mn)-Dissolved			102.3		%		80-120	25-OCT-16
Molybdenum (Mo)-Dissolved			96.4		%		80-120	25-OCT-16
Nickel (Ni)-Dissolved			102.5		%		80-120	25-OCT-16
Phosphorus (P)-Dissolved			102.7		%		80-120	25-OCT-16
Potassium (K)-Dissolved			104.0		%		80-120	25-OCT-16
Rubidium (Rb)-Dissolved			105.0		%		80-120	25-OCT-16
Selenium (Se)-Dissolved			99.4		%		80-120	25-OCT-16
Silicon (Si)-Dissolved			104.8		%		80-120	25-OCT-16
Silver (Ag)-Dissolved			100.8		%		80-120	25-OCT-16
Sodium (Na)-Dissolved			102.7		%		80-120	25-OCT-16
Strontium (Sr)-Dissolved			98.8		%		80-120	25-OCT-16
Tellurium (Te)-Dissolved			100.3		%		80-120	25-OCT-16
Thallium (Tl)-Dissolved			98.9		%		80-120	25-OCT-16
Thorium (Th)-Dissolved			101.5		%		80-120	25-OCT-16
Tin (Sn)-Dissolved			101.1		%		80-120	25-OCT-16
Titanium (Ti)-Dissolved			102.2		%		80-120	25-OCT-16
Tungsten (W)-Dissolved			102.3		%		80-120	25-OCT-16
Uranium (U)-Dissolved			100.3		%		80-120	25-OCT-16
Vanadium (V)-Dissolved			104.8		%		80-120	25-OCT-16
Zinc (Zn)-Dissolved			97.2		%		80-120	25-OCT-16
Zirconium (Zr)-Dissolved			95.2		%		80-120	25-OCT-16
WG2417265-1 MB								
Aluminum (Al)-Dissolved			<0.0020		mg/L		0.002	25-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3579739								
WG2417265-1 MB								
Antimony (Sb)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Arsenic (As)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Barium (Ba)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Beryllium (Be)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Bismuth (Bi)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	25-OCT-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	25-OCT-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
Cesium (Cs)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Chromium (Cr)-Dissolved			<0.0010		mg/L		0.001	25-OCT-16
Cobalt (Co)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	25-OCT-16
Lead (Pb)-Dissolved			<0.000090		mg/L		0.00009	25-OCT-16
Lithium (Li)-Dissolved			<0.0020		mg/L		0.002	25-OCT-16
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	25-OCT-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Molybdenum (Mo)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Nickel (Ni)-Dissolved			<0.0010		mg/L		0.001	25-OCT-16
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	25-OCT-16
Potassium (K)-Dissolved			<0.020		mg/L		0.02	25-OCT-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	25-OCT-16
Silicon (Si)-Dissolved			<0.10		mg/L		0.1	25-OCT-16
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	25-OCT-16
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Thallium (Tl)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Tin (Sn)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Titanium (Ti)-Dissolved			<0.00050		mg/L		0.0005	25-OCT-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3579739								
WG2417265-1 MB								
Vanadium (V)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Zinc (Zn)-Dissolved			<0.0020		mg/L		0.002	25-OCT-16
Zirconium (Zr)-Dissolved			<0.00040		mg/L		0.0004	25-OCT-16
MET-D-MS-WP	**Water**							
Batch R3579739								
WG2417265-2 LCS								
Calcium (Ca)-Dissolved			98.3		%		80-120	25-OCT-16
Magnesium (Mg)-Dissolved			107.8		%		80-120	25-OCT-16
Potassium (K)-Dissolved			104.0		%		80-120	25-OCT-16
Sodium (Na)-Dissolved			102.7		%		80-120	25-OCT-16
WG2417265-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	25-OCT-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	25-OCT-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
N-TOTKJ-WP	**Water**							
Batch R3580239								
WG2415181-10 LCS								
Total Kjeldahl Nitrogen			105.8		%		75-125	25-OCT-16
WG2415181-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	25-OCT-16
Batch R3585833								
WG2419527-2 LCS								
Total Kjeldahl Nitrogen			103.4		%		75-125	31-OCT-16
WG2419527-1 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	31-OCT-16
NH3-COL-WP	**Water**							
Batch R3579014								
WG2417588-10 LCS								
Ammonia, Total (as N)			105.5		%		85-115	24-OCT-16
WG2417588-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	24-OCT-16
Batch R3579452								
WG2418545-2 LCS								
Ammonia, Total (as N)			101.1		%		85-115	25-OCT-16
WG2418545-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-COL-WP	**Water**							
Batch R3579452								
WG2418545-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	25-OCT-16
NO2-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Nitrite (as N)			101.1		%		90-110	19-OCT-16
WG2413975-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	19-OCT-16
NO2-L-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Nitrite (as N)			101.1		%		90-110	19-OCT-16
WG2413975-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-OCT-16
NO3-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Nitrate (as N)			101.3		%		90-110	19-OCT-16
WG2413975-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	19-OCT-16
NO3-L-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Nitrate (as N)			101.3		%		90-110	19-OCT-16
WG2413975-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-OCT-16
P-T-COL-WP	**Water**							
Batch R3578486								
WG2417145-14 LCS								
Phosphorus (P)-Total			99.4		%		80-120	24-OCT-16
WG2417145-13 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	24-OCT-16
PH-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WP	**Water**							
Batch R3576387								
WG2415727-2 LCS								
pH			7.41		pH units		7.3-7.5	20-OCT-16
SO4-IC-N-WP	**Water**							
Batch R3575524								
WG2413975-2 LCS								
Sulfate (SO4)			101.3		%		90-110	19-OCT-16
WG2413975-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-OCT-16
TC,EC-QT97-WP	**Water**							
Batch R3575740								
WG2415032-2 DUP		**L1845200-1**						
Total Coliforms		50	10	DUPM	MPN/100mL	135	65	19-OCT-16
Escherichia Coli		<10	<10	RPD-NA	MPN/100mL	N/A	65	19-OCT-16
WG2415032-1 MB								
Total Coliforms			<1		MPN/100mL		1	19-OCT-16
Escherichia Coli			<1		MPN/100mL		1	19-OCT-16
Batch R3576285								
WG2414341-2 DUP		**L1845200-2**						
Total Coliforms		2	2		MPN/100mL	0.0	65	19-OCT-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	19-OCT-16
WG2414341-1 MB								
Total Coliforms			<1		MPN/100mL		1	19-OCT-16
Escherichia Coli			<1		MPN/100mL		1	19-OCT-16
TURBIDITY-WP	**Water**							
Batch R3577894								
WG2416498-3 LCS								
Turbidity			100.5		%		85-115	21-OCT-16
WG2416498-1 MB								
Turbidity			<0.10		NTU		0.1	21-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Turbidity							
	1	18-OCT-16 13:30	21-OCT-16 11:00	48	70	hours	EHT
pH							
	1	18-OCT-16 13:30	20-OCT-16 13:54	0.25	48	hours	EHTR-FM
	2	18-OCT-16 18:00	20-OCT-16 13:54	0.25	44	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1845200 were received on 19-OCT-16 08:25.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10-373419

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1845200

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush)
Company:	KGS Group	Standard: ✓	Other (specify):	✓ Regular (Stand
Contact:	Jason Mann	Select: PDF ✓	Excel ✓ Digital Fax	Priority (2-4 Bu
Address:	865 Waverley St. Winnipeg, MB	Email 1:	jmann@kgsgroup.com	Emergency (1-
		Email 2:		Same Day or W
Phone:	204-896-1209 Fax:			

L1845200-COFC

Invoice To	Client / Project Information
Same as Report ? (circle) (Yes) or No (if No, provide details)	Job #: 16-0350-006
Copy of Invoice with Report? (circle) (Yes) or No	PO / AFE:
Company:	LSD:
Contact:	
Address:	Quote #:
Phone: Fax:	

Lab Work Order # (lab use only)	ALS Contact:	Sampler:

(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROU4W+MET-D-L-WP	N-TOTKJ-WP	NH3-COL-WP	P-T-COL-WP	TC,EC-QT97	ROU1W-D	↑ leb to filter + preserve						Number of Containers
1	TH-EC-01WW2 ~~pre~~ test start	18-Oct-16	13:30	water	X	X	X	X	X								4
2	TH-EC-01WW2 test stop	18-Oct-16	18:00	water		X	X	X	X	X							4

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
			JN	Oct 19	8:25 a.m.	4 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 28-OCT-16
PO No.:
WO No.: L1846234
Project Ref: 16-0300-006
Sample ID: TH-EC-01WW1 (B)
Sampled By: PJL
Date Collected: 19-OCT-16
Lab Sample ID: L1846234-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	412		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	0.273		mg/L	10		24-OCT-16
pH						
pH	8.03		pH units			21-OCT-16
Turbidity						
*Turbidity	76.1		NTU			21-OCT-16
TDS calculated						
TDS (Calculated)	314		mg/L		500	27-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	4.62		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.273		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	303		mg/L		500	27-OCT-16
Fluoride in Water by IC						
Fluoride (F)	0.124		mg/L	1.5		21-OCT-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	26-OCT-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		26-OCT-16
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		26-OCT-16
Barium (Ba)-Dissolved	0.0453		mg/L	1		26-OCT-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			26-OCT-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			26-OCT-16
Boron (B)-Dissolved	0.011		mg/L	5		26-OCT-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		26-OCT-16
Calcium (Ca)-Dissolved	59.2		mg/L			26-OCT-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			26-OCT-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		26-OCT-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			26-OCT-16
Copper (Cu)-Dissolved	0.00121		mg/L		1.0	26-OCT-16
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	26-OCT-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		26-OCT-16
Lithium (Li)-Dissolved	0.0048		mg/L			26-OCT-16
Magnesium (Mg)-	37.7		mg/L			26-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 28-OCT-16
PO No.:
WO No.: L1846234
Project Ref: 16-0300-006
Sample ID: TH-EC-01WW1 (B)
Sampled By: PJL
Date Collected: 19-OCT-16
Lab Sample ID: L1846234-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.00022		mg/L		0.05	26-OCT-16
Molybdenum (Mo)-Dissolved	0.00039		mg/L			26-OCT-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			26-OCT-16
Phosphorus (P)-Dissolved	<0.030		mg/L			26-OCT-16
Potassium (K)-Dissolved	0.555		mg/L			26-OCT-16
Rubidium (Rb)-Dissolved	0.00138		mg/L			26-OCT-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		26-OCT-16
Silicon (Si)-Dissolved	4.90		mg/L			26-OCT-16
Silver (Ag)-Dissolved	<0.00010		mg/L			26-OCT-16
Sodium (Na)-Dissolved	4.85		mg/L		200	26-OCT-16
Strontium (Sr)-Dissolved	0.0430		mg/L			26-OCT-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			26-OCT-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			26-OCT-16
Thorium (Th)-Dissolved	<0.00010		mg/L			26-OCT-16
Tin (Sn)-Dissolved	0.00082		mg/L			26-OCT-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			26-OCT-16
Tungsten (W)-Dissolved	0.00040		mg/L			26-OCT-16
Uranium (U)-Dissolved	0.00051		mg/L	0.02		26-OCT-16
Vanadium (V)-Dissolved	<0.00020		mg/L			26-OCT-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	26-OCT-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			26-OCT-16
Conductivity						
Conductivity	544		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	3.22		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	338		mg/L			21-OCT-16
Phosphorus (P)-Total	0.169		mg/L			26-OCT-16
Ammonia, Total (as N)	0.013		mg/L			25-OCT-16
Total Kjeldahl Nitrogen	<0.20		mg/L			27-OCT-16
Total Coliform and E.coli by MPN QT97						
Total Coliforms	8	MBHT	MPN/100mL	0		20-OCT-16
Escherichia Coli	1		MPN/100mL	0		20-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 28-OCT-16
PO No.:
WO No.: L1846234
Project Ref: 16-0300-006
Sample ID: TH-EC-01WW1 (B)
Sampled By: PJL
Date Collected: 19-OCT-16
Lab Sample ID: L1846234-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 28-OCT-16
PO No.:
WO No.: L1846234
Project Ref: 16-0300-006
Sample ID: TH-EC-01WW1 (E)
Sampled By: PJL
Date Collected: 19-OCT-16
Lab Sample ID: L1846234-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	405		mg/L			24-OCT-16
Carbonate (CO3)	<0.60		mg/L			24-OCT-16
Hydroxide (OH)	<0.34		mg/L			24-OCT-16
*Nitrate and Nitrite as N	0.256		mg/L	10		24-OCT-16
pH						
pH	8.14		pH units			21-OCT-16
TDS calculated						
TDS (Calculated)	315		mg/L		500	27-OCT-16
Sulfate in Water by IC						
Sulfate (SO4)	4.67		mg/L		500	21-OCT-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		21-OCT-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.256		mg/L	10		21-OCT-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	318		mg/L		500	27-OCT-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	61.4		mg/L			26-OCT-16
Magnesium (Mg)-Dissolved	40.0		mg/L			26-OCT-16
Potassium (K)-Dissolved	0.581		mg/L			26-OCT-16
Sodium (Na)-Dissolved	4.87		mg/L		200	26-OCT-16
Conductivity						
Conductivity	535		umhos/cm			21-OCT-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	2.73		mg/L		250	21-OCT-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			21-OCT-16
Phosphorus (P)-Total	0.025		mg/L			26-OCT-16
Ammonia, Total (as N)	<0.010		mg/L			25-OCT-16
Total Kjeldahl Nitrogen	<0.20		mg/L			27-OCT-16
Total Coliform and E.coli by MPN QT97						
Total Coliforms	34		MPN/100mL	0		20-OCT-16
Escherichia Coli	<1		MPN/100mL	0		20-OCT-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 28-OCT-16
PO No.:
WO No.: L1846234
Project Ref: 16-0300-006
Sample ID: TH-EC-01WW1 (E)
Sampled By: PJL
Date Collected: 19-OCT-16
Lab Sample ID: L1846234-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
MBHT	The APHA 30 hour hold time was exceeded for microbiological testing. Samples processed within 48 hours from time of sampling may

be valid in some cases (refer to Health Canada guidance).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1846234 Report Date: 28-OCT-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: JASON MANN

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3577176								
WG2416510-20 DUP		**L1846234-1**						
Alkalinity, Total (as CaCO3)		338	339		mg/L	0.3	20	21-OCT-16
WG2416510-14 LCS								
Alkalinity, Total (as CaCO3)			101.9		%		85-115	21-OCT-16
WG2416510-19 LCS								
Alkalinity, Total (as CaCO3)			105.9		%		85-115	21-OCT-16
WG2416510-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	21-OCT-16
WG2416510-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	21-OCT-16
CL-L-IC-N-WP	**Water**							
Batch R3578429								
WG2416347-6 LCS								
Chloride (Cl)			101.1		%		90-110	21-OCT-16
WG2416347-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	21-OCT-16
EC-WP	**Water**							
Batch R3577176								
WG2416510-20 DUP		**L1846234-1**						
Conductivity		544	537		umhos/cm	1.3	10	21-OCT-16
WG2416510-13 LCS								
Conductivity			96.8		%		90-110	21-OCT-16
WG2416510-18 LCS								
Conductivity			98.1		%		90-110	21-OCT-16
WG2416510-11 MB								
Conductivity			<1.0		umhos/cm		1	21-OCT-16
WG2416510-16 MB								
Conductivity			<1.0		umhos/cm		1	21-OCT-16
F-IC-N-WP	**Water**							
Batch R3578429								
WG2416347-6 LCS								
Fluoride (F)			103.5		%		90-110	21-OCT-16
WG2416347-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	21-OCT-16
MET-D-L-MS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3580733								
WG2417273-2 LCS								
Aluminum (Al)-Dissolved			106.3		%		80-120	26-OCT-16
Antimony (Sb)-Dissolved			101.5		%		80-120	26-OCT-16
Arsenic (As)-Dissolved			102.9		%		80-120	26-OCT-16
Barium (Ba)-Dissolved			105.6		%		80-120	26-OCT-16
Beryllium (Be)-Dissolved			102.3		%		80-120	26-OCT-16
Bismuth (Bi)-Dissolved			97.7		%		80-120	26-OCT-16
Boron (B)-Dissolved			104.4		%		80-120	26-OCT-16
Cadmium (Cd)-Dissolved			99.9		%		80-120	26-OCT-16
Calcium (Ca)-Dissolved			99.5		%		80-120	26-OCT-16
Cesium (Cs)-Dissolved			107.5		%		80-120	26-OCT-16
Chromium (Cr)-Dissolved			100.6		%		80-120	26-OCT-16
Cobalt (Co)-Dissolved			101.3		%		80-120	26-OCT-16
Copper (Cu)-Dissolved			98.3		%		80-120	26-OCT-16
Iron (Fe)-Dissolved			97.5		%		80-120	26-OCT-16
Lead (Pb)-Dissolved			100.5		%		80-120	26-OCT-16
Lithium (Li)-Dissolved			105.2		%		80-120	26-OCT-16
Magnesium (Mg)-Dissolved			105.1		%		80-120	26-OCT-16
Manganese (Mn)-Dissolved			104.2		%		80-120	26-OCT-16
Molybdenum (Mo)-Dissolved			101.2		%		80-120	26-OCT-16
Nickel (Ni)-Dissolved			100.7		%		80-120	26-OCT-16
Phosphorus (P)-Dissolved			107.6		%		80-120	26-OCT-16
Potassium (K)-Dissolved			106.4		%		80-120	26-OCT-16
Rubidium (Rb)-Dissolved			101.2		%		80-120	26-OCT-16
Selenium (Se)-Dissolved			97.4		%		80-120	26-OCT-16
Silicon (Si)-Dissolved			105.8		%		80-120	26-OCT-16
Silver (Ag)-Dissolved			101.6		%		80-120	26-OCT-16
Sodium (Na)-Dissolved			104.5		%		80-120	26-OCT-16
Strontium (Sr)-Dissolved			97.4		%		80-120	26-OCT-16
Tellurium (Te)-Dissolved			102.8		%		80-120	26-OCT-16
Thallium (Tl)-Dissolved			98.8		%		80-120	26-OCT-16
Thorium (Th)-Dissolved			98.1		%		80-120	26-OCT-16
Tin (Sn)-Dissolved			103.6		%		80-120	26-OCT-16
Titanium (Ti)-Dissolved			100.8		%		80-120	26-OCT-16
Tungsten (W)-Dissolved			104.1		%		80-120	26-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3580733								
WG2417273-2 LCS								
Uranium (U)-Dissolved			105.4		%		80-120	26-OCT-16
Vanadium (V)-Dissolved			103.6		%		80-120	26-OCT-16
Zinc (Zn)-Dissolved			96.0		%		80-120	26-OCT-16
Zirconium (Zr)-Dissolved			97.5		%		80-120	26-OCT-16
WG2417273-1 MB								
Aluminum (Al)-Dissolved			<0.0020		mg/L		0.002	26-OCT-16
Antimony (Sb)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Arsenic (As)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Barium (Ba)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Beryllium (Be)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Bismuth (Bi)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	26-OCT-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	26-OCT-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	26-OCT-16
Cesium (Cs)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Chromium (Cr)-Dissolved			<0.0010		mg/L		0.001	26-OCT-16
Cobalt (Co)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	26-OCT-16
Lead (Pb)-Dissolved			<0.000090		mg/L		0.00009	26-OCT-16
Lithium (Li)-Dissolved			<0.0020		mg/L		0.002	26-OCT-16
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	26-OCT-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Molybdenum (Mo)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Nickel (Ni)-Dissolved			<0.0010		mg/L		0.001	26-OCT-16
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	26-OCT-16
Potassium (K)-Dissolved			<0.020		mg/L		0.02	26-OCT-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	26-OCT-16
Silicon (Si)-Dissolved			<0.10		mg/L		0.1	26-OCT-16
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	26-OCT-16
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3580733								
WG2417273-1 MB								
Thallium (Tl)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Tin (Sn)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Titanium (Ti)-Dissolved			<0.00050		mg/L		0.0005	26-OCT-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	26-OCT-16
Vanadium (V)-Dissolved			<0.00020		mg/L		0.0002	26-OCT-16
Zinc (Zn)-Dissolved			<0.0020		mg/L		0.002	26-OCT-16
Zirconium (Zr)-Dissolved			<0.00040		mg/L		0.0004	26-OCT-16
N-TOTKJ-WP	**Water**							
Batch R3582212								
WG2416142-10 LCS								
Total Kjeldahl Nitrogen			93.2		%		75-125	27-OCT-16
WG2416142-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	27-OCT-16
NH3-COL-WP	**Water**							
Batch R3579452								
WG2418545-2 LCS								
Ammonia, Total (as N)			101.1		%		85-115	25-OCT-16
WG2418545-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	25-OCT-16
NO2-L-IC-N-WP	**Water**							
Batch R3578429								
WG2416347-6 LCS								
Nitrite (as N)			100.7		%		90-110	21-OCT-16
WG2416347-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-OCT-16
NO3-L-IC-N-WP	**Water**							
Batch R3578429								
WG2416347-6 LCS								
Nitrate (as N)			100.6		%		90-110	21-OCT-16
WG2416347-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-OCT-16
P-T-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-WP	**Water**							
Batch R3580417								
WG2418198-14 LCS								
Phosphorus (P)-Total			105.0		%		80-120	26-OCT-16
WG2418198-13 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	26-OCT-16
PH-WP	**Water**							
Batch R3577176								
WG2416510-20 DUP		**L1846234-1**						
pH		8.03	8.03	J	pH units	0.00	0.2	21-OCT-16
WG2416510-12 LCS								
pH			7.42		pH units		7.3-7.5	21-OCT-16
WG2416510-17 LCS								
pH			7.42		pH units		7.3-7.5	21-OCT-16
SO4-IC-N-WP	**Water**							
Batch R3578429								
WG2416347-6 LCS								
Sulfate (SO4)			101.4		%		90-110	21-OCT-16
WG2416347-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	21-OCT-16
TC,EC-QT97-WP	**Water**							
Batch R3576484								
WG2415137-1 DUP		**L1846234-1**						
Total Coliforms		8	8		MPN/100mL	0.0	65	20-OCT-16
Escherichia Coli		1	<1	RPD-NA	MPN/100mL	N/A	65	20-OCT-16
WG2415137-2 MB								
Total Coliforms			<1		MPN/100mL		1	20-OCT-16
Escherichia Coli			<1		MPN/100mL		1	20-OCT-16
TURBIDITY-WP	**Water**							
Batch R3577894								
WG2416498-9 LCS								
Turbidity			101.5		%		85-115	21-OCT-16
WG2416498-7 MB								
Turbidity			<0.10		NTU		0.1	21-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Turbidity							
	1	19-OCT-16 09:40	21-OCT-16 11:00	48	49	hours	EHTL
pH							
	1	19-OCT-16 09:40	21-OCT-16 11:30	0.25	50	hours	EHTR-FM
	2	19-OCT-16 18:40	21-OCT-16 11:30	0.25	41	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	19-OCT-16 09:40	21-OCT-16 13:00	48	51	hours	EHTL
Nitrite in Water by IC (Low Level)							
	1	19-OCT-16 09:40	21-OCT-16 13:00	48	51	hours	EHTL
Bacteriological Tests							
Total Coliform and E.coli by MPN QT97							
	1	19-OCT-16 09:40	20-OCT-16 17:45	30	32	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1846234 were received on 20-OCT-16 13:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1846234-COFC

L1846234 **10-** 373420

ALS Environmental

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: ✓	Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact:	Jason Mann	Select: PDF ✓	Excel ✓ Digital Fax	Priority (2-4 Business Days) - 50% surcharge - Contact ALS to confirm TAT
Address:	865 Waverley St. Winnipeg MB	Email 1:	jmann@kgsgroup.com	Emergency (1-2 Business Days) - 100% Surcharge - Contact ALS to confirm TAT
		Email 2:		Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	204-896-1209 Fax:			

Invoice To	Client / Project Information	
Same as Report ? (circle) (Yes) or No (if No, provide details)	Job #:	16-0300-006
Copy of Invoice with Report? (circle) (Yes) or No	PO / AFE:	
Company:	LSD:	
Contact:		
Address:		
Phone: Fax:	Quote #:	Q58403
Lab Work Order # (lab use only)	ALS Contact: Judy.	Sampler: PJL

Analysis Request (Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RQAWHET-D-L-USP	N-TOTKJ-USP	NH3-COL-USP	P-T-COL-USP	TIC,EC-GTGT	RQAW(W)-D-Lab to filter + preserve						Number of Containers
1	TH-EC-01WW1 (B)	19-Oct-16	09:40	water	X	X	X	X	X	X						4
2	TH-EC-01WW1 (E)	19-Oct-16	18:40	water		X	X	X	X	X	X					4

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: <Original signed by>	Date: Oct 20/16	Time: 13:00	Received by: A-K.	Date: Oct 20/16	Time: 1:00	Temperature: 1.8 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

KGS Group Consultants (Winnipeg)
ATTN: Jason Mann
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

Date Received: 27-OCT-16
Report Date: 07-NOV-16 10:44 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1849559

Project P.O. #: NOT SUBMITTED
Job Reference: 16-0300-006
C of C Numbers:
Legal Site Desc:

<Original signed by>

Hua Wo
Chemistry Laboratory Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1849559-1 TH-ED-01W START							
Sampled By: CLIENT on 26-OCT-16 @ 08:42							
Matrix: Water							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.247		0.010	mg/L		31-OCT-16	R3584794
Phosphorus (P)-Total	0.025		0.010	mg/L		30-OCT-16	R3583236
Total Kjeldahl Nitrogen	0.26		0.20	mg/L	31-OCT-16	03-NOV-16	R3587815
Total Coliform and E.coli by MPN QT97							
Total Coliforms	24		1	MPN/100mL		27-OCT-16	R3581817
Escherichia Coli	<1		1	MPN/100mL		27-OCT-16	R3581817
ROU4W Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	392		1.2	mg/L		01-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		01-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		01-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	321		1.0	mg/L		28-OCT-16	R3584015
Chloride in Water by IC (Low Level)							
Chloride (Cl)	6.09		0.20	mg/L		28-OCT-16	R3584714
Conductivity							
Conductivity	741		1.0	umhos/cm		28-OCT-16	R3584015
Dissolved Metals by ICP-MS							
Aluminum (Al)-Dissolved	<0.0020		0.0020	mg/L	01-NOV-16	04-NOV-16	R3589097
Antimony (Sb)-Dissolved	<0.00020		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Arsenic (As)-Dissolved	0.00063		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Barium (Ba)-Dissolved	0.0150		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Beryllium (Be)-Dissolved	<0.00020		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Bismuth (Bi)-Dissolved	<0.00020		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Boron (B)-Dissolved	0.529		0.010	mg/L	01-NOV-16	04-NOV-16	R3589097
Cadmium (Cd)-Dissolved	<0.000010		0.000010	mg/L	01-NOV-16	04-NOV-16	R3589097
Calcium (Ca)-Dissolved	77.4		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Cesium (Cs)-Dissolved	<0.00010		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Chromium (Cr)-Dissolved	<0.0010		0.0010	mg/L	01-NOV-16	04-NOV-16	R3589097
Cobalt (Co)-Dissolved	0.00025		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Copper (Cu)-Dissolved	0.00024		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Iron (Fe)-Dissolved	0.125		0.010	mg/L	01-NOV-16	04-NOV-16	R3589097
Lead (Pb)-Dissolved	0.000108		0.000090	mg/L	01-NOV-16	04-NOV-16	R3589097
Lithium (Li)-Dissolved	0.0281		0.0020	mg/L	01-NOV-16	04-NOV-16	R3589097
Magnesium (Mg)-Dissolved	44.0		0.010	mg/L	01-NOV-16	04-NOV-16	R3589097
Manganese (Mn)-Dissolved	0.0144		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Molybdenum (Mo)-Dissolved	0.00037		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Nickel (Ni)-Dissolved	<0.0010		0.0010	mg/L	01-NOV-16	04-NOV-16	R3589097
Phosphorus (P)-Dissolved	<0.030		0.030	mg/L	01-NOV-16	04-NOV-16	R3589097
Potassium (K)-Dissolved	9.20		0.020	mg/L	01-NOV-16	04-NOV-16	R3589097
Rubidium (Rb)-Dissolved	0.00629		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Selenium (Se)-Dissolved	<0.0010		0.0010	mg/L	01-NOV-16	04-NOV-16	R3589097
Silicon (Si)-Dissolved	5.31		0.10	mg/L	01-NOV-16	04-NOV-16	R3589097
Silver (Ag)-Dissolved	<0.00010		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Sodium (Na)-Dissolved	34.9		0.020	mg/L	01-NOV-16	04-NOV-16	R3589097
Strontium (Sr)-Dissolved	0.574		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Tellurium (Te)-Dissolved	<0.00020		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Thallium (Tl)-Dissolved	<0.00010		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Thorium (Th)-Dissolved	<0.00010		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Tin (Sn)-Dissolved	0.00135		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1849559-1 TH-ED-01W START							
Sampled By: CLIENT on 26-OCT-16 @ 08:42							
Matrix: Water							
Dissolved Metals by ICP-MS							
Titanium (Ti)-Dissolved	<0.00050		0.00050	mg/L	01-NOV-16	04-NOV-16	R3589097
Tungsten (W)-Dissolved	0.00015		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Uranium (U)-Dissolved	0.00120		0.00010	mg/L	01-NOV-16	04-NOV-16	R3589097
Vanadium (V)-Dissolved	<0.00020		0.00020	mg/L	01-NOV-16	04-NOV-16	R3589097
Zinc (Zn)-Dissolved	<0.0020		0.0020	mg/L	01-NOV-16	04-NOV-16	R3589097
Zirconium (Zr)-Dissolved	<0.00040		0.00040	mg/L	01-NOV-16	04-NOV-16	R3589097
Fluoride in Water by IC							
Fluoride (F)	0.757		0.040	mg/L		28-OCT-16	R3584714
Hardness Calculated							
Hardness (as CaCO3)	374		0.20	mg/L		07-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.010	DLM	0.010	mg/L		28-OCT-16	R3584714
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.010		0.010	mg/L		01-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0100	DLM	0.0020	mg/L		28-OCT-16	R3584714
Sulfate in Water by IC							
Sulfate (SO4)	149		0.60	mg/L		28-OCT-16	R3584714
TDS calculated							
TDS (Calculated)	513		5.0	mg/L		07-NOV-16	
Turbidity							
Turbidity	17.6		0.10	NTU		27-OCT-16	R3581778
pH							
pH	7.70		0.10	pH units		28-OCT-16	R3584015
L1849559-2 TH-ED-01W END							
Sampled By: CLIENT on 26-OCT-16 @ 17:30							
Matrix: Water							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.246		0.010	mg/L		31-OCT-16	R3584794
Phosphorus (P)-Total	0.0129		0.0010	mg/L		02-NOV-16	R3585909
Total Kjeldahl Nitrogen	0.28		0.20	mg/L	31-OCT-16	03-NOV-16	R3587815
Total Coliform and E.coli by MPN QT97							
Total Coliforms	2		1	MPN/100mL		27-OCT-16	R3581817
Escherichia Coli	<1		1	MPN/100mL		27-OCT-16	R3581817
Routine Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	413		1.2	mg/L		01-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		01-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		01-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	339		1.0	mg/L		28-OCT-16	R3584015
Chloride in Water by IC							
Chloride (Cl)	6.0		1.0	mg/L		28-OCT-16	R3584714
Conductivity							
Conductivity	744		1.0	umhos/cm		28-OCT-16	R3584015
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	78.1		0.20	mg/L	01-NOV-16	04-NOV-16	R3589097
Magnesium (Mg)-Dissolved	43.6		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Potassium (K)-Dissolved	9.18		0.10	mg/L	01-NOV-16	04-NOV-16	R3589097

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1849559-2 TH-ED-01W END							
Sampled By: CLIENT on 26-OCT-16 @ 17:30							
Matrix: Water							
Dissolved Metals by ICP-MS							
Sodium (Na)-Dissolved	32.9		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Hardness Calculated							
Hardness (as CaCO3)	375		0.54	mg/L		07-NOV-16	
Nitrate in Water by IC							
Nitrate (as N)	<0.040	DLM	0.040	mg/L		28-OCT-16	R3584714
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		01-NOV-16	
Nitrite in Water by IC							
Nitrite (as N)	<0.020	DLM	0.020	mg/L		28-OCT-16	R3584714
Sulfate in Water by IC							
Sulfate (SO4)	148		0.60	mg/L		28-OCT-16	R3584714
TDS calculated							
TDS (Calculated)	521		5.0	mg/L		07-NOV-16	
pH							
pH	7.70		0.10	pH units		28-OCT-16	R3584015

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-L-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A -DL

This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

MET-D-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A-D

This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	APHA 4500 NorgD (modified)

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
Aqueous samples are digested in a block digester with sulfuric acid and copper sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a discrete analyzer with colorimetric detection.			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2+NO3-CALC-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-WP	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-N-WP	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
P-T-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.			
P-T-L-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS-L
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorous is determined colourimetrically after persulphate digestion of the sample.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97
This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1849559 Report Date: 07-NOV-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Jason Mann

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3584015								
WG2422553-9 LCS								
Alkalinity, Total (as CaCO3)			103.8		%		85-115	28-OCT-16
WG2422553-14 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	28-OCT-16
CL-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Chloride (Cl)			101.2		%		90-110	28-OCT-16
WG2421784-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	28-OCT-16
CL-L-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Chloride (Cl)			101.2		%		90-110	28-OCT-16
WG2421784-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	28-OCT-16
EC-WP	**Water**							
Batch R3584015								
WG2422553-8 LCS								
Conductivity			96.0		%		90-110	28-OCT-16
WG2422553-14 MB								
Conductivity			<1.0		umhos/cm		1	28-OCT-16
F-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Fluoride (F)			103.1		%		90-110	28-OCT-16
WG2421784-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	28-OCT-16
MET-D-L-MS-WP	**Water**							
Batch R3589097								
WG2424655-2 LCS								
Aluminum (Al)-Dissolved			98.4		%		80-120	04-NOV-16
Antimony (Sb)-Dissolved			100.7		%		80-120	04-NOV-16
Arsenic (As)-Dissolved			99.3		%		80-120	04-NOV-16
Barium (Ba)-Dissolved			102.9		%		80-120	04-NOV-16
Beryllium (Be)-Dissolved			93.7		%		80-120	04-NOV-16
Bismuth (Bi)-Dissolved			100.9		%		80-120	04-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3589097								
WG2424655-2 LCS								
Boron (B)-Dissolved			98.6		%		80-120	04-NOV-16
Cadmium (Cd)-Dissolved			99.8		%		80-120	04-NOV-16
Calcium (Ca)-Dissolved			102.9		%		80-120	04-NOV-16
Cesium (Cs)-Dissolved			104.7		%		80-120	04-NOV-16
Chromium (Cr)-Dissolved			99.4		%		80-120	04-NOV-16
Cobalt (Co)-Dissolved			99.3		%		80-120	04-NOV-16
Copper (Cu)-Dissolved			97.9		%		80-120	04-NOV-16
Iron (Fe)-Dissolved			96.9		%		80-120	04-NOV-16
Lead (Pb)-Dissolved			103.0		%		80-120	04-NOV-16
Lithium (Li)-Dissolved			98.6		%		80-120	04-NOV-16
Magnesium (Mg)-Dissolved			101.1		%		80-120	04-NOV-16
Manganese (Mn)-Dissolved			103.9		%		80-120	04-NOV-16
Molybdenum (Mo)-Dissolved			106.9		%		80-120	04-NOV-16
Nickel (Ni)-Dissolved			99.6		%		80-120	04-NOV-16
Phosphorus (P)-Dissolved			109.1		%		80-120	04-NOV-16
Potassium (K)-Dissolved			103.9		%		80-120	04-NOV-16
Rubidium (Rb)-Dissolved			106.6		%		80-120	04-NOV-16
Selenium (Se)-Dissolved			101.0		%		80-120	04-NOV-16
Silicon (Si)-Dissolved			114.0		%		80-120	04-NOV-16
Silver (Ag)-Dissolved			102.5		%		80-120	04-NOV-16
Sodium (Na)-Dissolved			106.8		%		80-120	04-NOV-16
Strontium (Sr)-Dissolved			107.0		%		80-120	04-NOV-16
Tellurium (Te)-Dissolved			101.8		%		80-120	04-NOV-16
Thallium (Tl)-Dissolved			101.6		%		80-120	04-NOV-16
Thorium (Th)-Dissolved			101.7		%		80-120	04-NOV-16
Tin (Sn)-Dissolved			102.7		%		80-120	04-NOV-16
Titanium (Ti)-Dissolved			96.3		%		80-120	04-NOV-16
Tungsten (W)-Dissolved			100.2		%		80-120	04-NOV-16
Uranium (U)-Dissolved			104.6		%		80-120	04-NOV-16
Vanadium (V)-Dissolved			101.4		%		80-120	04-NOV-16
Zinc (Zn)-Dissolved			92.9		%		80-120	04-NOV-16
Zirconium (Zr)-Dissolved			105.4		%		80-120	04-NOV-16
WG2424655-1 MB								
Aluminum (Al)-Dissolved			<0.0020		mg/L		0.002	04-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3589097								
WG2424655-1 MB								
Antimony (Sb)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Arsenic (As)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Barium (Ba)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Beryllium (Be)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Bismuth (Bi)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	04-NOV-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	04-NOV-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	04-NOV-16
Cesium (Cs)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Chromium (Cr)-Dissolved			<0.0010		mg/L		0.001	04-NOV-16
Cobalt (Co)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	04-NOV-16
Lead (Pb)-Dissolved			<0.000090		mg/L		0.00009	04-NOV-16
Lithium (Li)-Dissolved			<0.0020		mg/L		0.002	04-NOV-16
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	04-NOV-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Molybdenum (Mo)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Nickel (Ni)-Dissolved			<0.0010		mg/L		0.001	04-NOV-16
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	04-NOV-16
Potassium (K)-Dissolved			<0.020		mg/L		0.02	04-NOV-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	04-NOV-16
Silicon (Si)-Dissolved			<0.10		mg/L		0.1	04-NOV-16
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	04-NOV-16
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Thallium (Tl)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Tin (Sn)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Titanium (Ti)-Dissolved			<0.00050		mg/L		0.0005	04-NOV-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	04-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3589097								
WG2424655-1 MB								
Vanadium (V)-Dissolved			<0.00020		mg/L		0.0002	04-NOV-16
Zinc (Zn)-Dissolved			<0.0020		mg/L		0.002	04-NOV-16
Zirconium (Zr)-Dissolved			<0.00040		mg/L		0.0004	04-NOV-16
MET-D-MS-WP	**Water**							
Batch R3589097								
WG2424655-2 LCS								
Calcium (Ca)-Dissolved			102.9		%		80-120	04-NOV-16
Magnesium (Mg)-Dissolved			101.1		%		80-120	04-NOV-16
Potassium (K)-Dissolved			103.9		%		80-120	04-NOV-16
Sodium (Na)-Dissolved			106.8		%		80-120	04-NOV-16
WG2424655-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	04-NOV-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	04-NOV-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	04-NOV-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	04-NOV-16
N-TOTKJ-WP	**Water**							
Batch R3587815								
WG2420557-10 LCS								
Total Kjeldahl Nitrogen			98.4		%		75-125	03-NOV-16
WG2420557-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	03-NOV-16
NH3-COL-WP	**Water**							
Batch R3584794								
WG2423113-6 LCS								
Ammonia, Total (as N)			100.5		%		85-115	31-OCT-16
WG2423113-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	31-OCT-16
NO2-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Nitrite (as N)			99.3		%		90-110	28-OCT-16
WG2421784-9 MB								
Nitrite (as N)			<0.010		mg/L		0.01	28-OCT-16
NO2-L-IC-N-WP	**Water**							

Quality Control Report

Workorder: L1849559 Report Date: 07-NOV-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Nitrite (as N)			99.3		%		90-110	28-OCT-16
WG2421784-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	28-OCT-16
NO3-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Nitrate (as N)			100.7		%		90-110	28-OCT-16
WG2421784-9 MB								
Nitrate (as N)			<0.020		mg/L		0.02	28-OCT-16
NO3-L-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Nitrate (as N)			100.7		%		90-110	28-OCT-16
WG2421784-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	28-OCT-16
P-T-COL-WP	**Water**							
Batch R3583236								
WG2421947-14 LCS								
Phosphorus (P)-Total			107.0		%		80-120	30-OCT-16
WG2421947-13 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	30-OCT-16
P-T-L-COL-WP	**Water**							
Batch R3585909								
WG2424506-2 LCS								
Phosphorus (P)-Total			84.6		%		80-120	02-NOV-16
WG2424506-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	02-NOV-16
PH-WP	**Water**							
Batch R3584015								
WG2422553-7 LCS								
pH			7.41		pH units		7.3-7.5	28-OCT-16
SO4-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R3584714								
WG2421784-10 LCS								
Sulfate (SO4)			102.4		%		90-110	28-OCT-16
WG2421784-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	28-OCT-16
TC,EC-QT97-WP	**Water**							
Batch R3581817								
WG2420458-2 DUP		**L1849559-1**						
Total Coliforms		24	16		MPN/100mL	41	65	27-OCT-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	27-OCT-16
WG2420458-3 DUP		**L1849559-2**						
Total Coliforms		2	2		MPN/100mL	0.0	65	27-OCT-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	27-OCT-16
WG2420458-1 MB								
Total Coliforms			<1		MPN/100mL		1	27-OCT-16
Escherichia Coli			<1		MPN/100mL		1	27-OCT-16
TURBIDITY-WP	**Water**							
Batch R3581778								
WG2420606-3 LCS								
Turbidity			102.5		%		85-115	27-OCT-16
WG2420606-1 MB								
Turbidity			<0.10		NTU		0.1	27-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	26-OCT-16 08:42	28-OCT-16 12:28	0.25	52	hours	EHTR-FM
	2	26-OCT-16 17:30	28-OCT-16 12:28	0.25	43	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	26-OCT-16 08:42	28-OCT-16 12:00	48	51	hours	EHTL
Nitrite in Water by IC (Low Level)							
	1	26-OCT-16 08:42	28-OCT-16 12:00	48	51	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1849559 were received on 27-OCT-16 11:25.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1849559-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1849559
L1846...

10- 373421

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: ✓	Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact:	Jason Mann jmann@kgsgroup.com	Select: PDF ✓	Excel ✓ Digital Fax	Priority (2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	865 Waverley St. Wpg MB	Email 1:	jmann@kgsgroup.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
		Email 2:		Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	204-896-1209 Fax:			**Analysis Request**
Invoice To	Same as Report ? (circle) (Yes) or No (if No, provide details)	**Client / Project Information**		(Indicate Filtered or Preserved, F/P)
	Copy of Invoice with Report? (circle) (Yes) or No	Job #:	16-030-006	
Company:		PO / AFE:		
Contact:		LSD:		
Address:				
Phone:	Fax:	Quote #:		
Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Round4w+HET-diss-WP	N-TOTKT-WP	NH3-COL-WP	P-T-COL-WP	TC, EC-9997	Round3-D (lab to filter + preserve)						Number of Containers
	TH-ED-01W start	26-Oct-16	08:42	water	X	X	X	X	X							4
	TH-ED-01W end	26-Oct-16	17:30	water		X	X	X	X	X						4

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by: <Original signed by>	Date: 27.10.16	Time: 11:25am	Temperature: 9.7 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

GENF 18.01 Front

KGS Group Consultants (Winnipeg)
ATTN: Jason Mann
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

Date Received: 28-OCT-16
Report Date: 08-NOV-16 14:22 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1850234

Project P.O. #: NOT SUBMITTED
Job Reference: 16-0300-006
C of C Numbers:
Legal Site Desc:

<Original signed by>

Hua Wo
Chemistry Laboratory Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1850234-1 TH - EC - 03 START							
Sampled By: CLIENT on 27-OCT-16 @ 12:20							
Matrix: WATER							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.52		0.10	mg/L		02-NOV-16	R3587250
Phosphorus (P)-Total	18.1		0.20	mg/L		01-NOV-16	R3585067
Total Kjeldahl Nitrogen	1.18		0.20	mg/L	07-NOV-16	08-NOV-16	R3590549
Total Coliform and E.coli by MPN QT97							
Total Coliforms	37		1	MPN/100mL		28-OCT-16	R3582931
Escherichia Coli	4		1	MPN/100mL		28-OCT-16	R3582931
Routine Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	533		1.2	mg/L		01-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		01-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		01-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	437		1.0	mg/L		31-OCT-16	R3584907
Chloride in Water by IC							
Chloride (Cl)	6.06		0.50	mg/L		29-OCT-16	R3589785
Conductivity							
Conductivity	747		1.0	umhos/cm		31-OCT-16	R3584907
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	69.7		0.20	mg/L	01-NOV-16	04-NOV-16	R3589097
Magnesium (Mg)-Dissolved	40.9		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Potassium (K)-Dissolved	21.6		0.10	mg/L	01-NOV-16	04-NOV-16	R3589097
Sodium (Na)-Dissolved	37.6		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Hardness Calculated							
Hardness (as CaCO3)	342		0.54	mg/L		07-NOV-16	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		29-OCT-16	R3589785
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		07-NOV-16	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		29-OCT-16	R3589785
Sulfate in Water by IC							
Sulfate (SO4)	53.1		0.30	mg/L		29-OCT-16	R3589785
TDS calculated							
TDS (Calculated)	491		5.0	mg/L		07-NOV-16	
pH							
pH	7.59		0.10	pH units		31-OCT-16	R3584907
L1850234-2 TH - EC - 03 END							
Sampled By: CLIENT on 27-OCT-16 @ 17:30							
Matrix: WATER							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.52		0.10	mg/L		02-NOV-16	R3587250
Phosphorus (P)-Total	3.52		0.20	mg/L		01-NOV-16	R3585067
Total Kjeldahl Nitrogen	0.46		0.20	mg/L	07-NOV-16	08-NOV-16	R3590549
Total Coliform and E.coli by MPN QT97							
Total Coliforms	<1		1	MPN/100mL		28-OCT-16	R3582931
Escherichia Coli	<1		1	MPN/100mL		28-OCT-16	R3582931
Routine Dissolved							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	489		1.2	mg/L		01-NOV-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1850234-2 TH - EC - 03 END							
Sampled By: CLIENT on 27-OCT-16 @ 17:30							
Matrix: WATER							
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		01-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		01-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	401		1.0	mg/L		31-OCT-16	R3584907
Chloride in Water by IC							
Chloride (Cl)	6.04		0.50	mg/L		29-OCT-16	R3589785
Conductivity							
Conductivity	736		1.0	umhos/cm		31-OCT-16	R3584907
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	69.1		0.20	mg/L	01-NOV-16	04-NOV-16	R3589097
Magnesium (Mg)-Dissolved	41.3		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Potassium (K)-Dissolved	21.1		0.10	mg/L	01-NOV-16	04-NOV-16	R3589097
Sodium (Na)-Dissolved	38.2		0.050	mg/L	01-NOV-16	04-NOV-16	R3589097
Hardness Calculated							
Hardness (as CaCO3)	343		0.54	mg/L		07-NOV-16	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		29-OCT-16	R3589785
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		07-NOV-16	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		29-OCT-16	R3589785
Sulfate in Water by IC							
Sulfate (SO4)	53.5		0.30	mg/L		29-OCT-16	R3589785
TDS calculated							
TDS (Calculated)	470		5.0	mg/L		07-NOV-16	
pH							
pH	7.57		0.10	pH units		31-OCT-16	R3584907

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L			
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.			
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.			
CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.			
Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:			
Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]			
MET-D-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A-D
This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	APHA 4500 NorgD (modified)
Aqueous samples are digested in a block digester with sulfuric acid and copper sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a discrete analyzer with colorimetric detection.			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2+NO3-CALC-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-WP	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-N-WP	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
P-T-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
		This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.	
PH-WP	Water	pH	APHA 4500H
		The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.	
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
		Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	
TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97
		This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.	

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1850234 Report Date: 08-NOV-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Jason Mann

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3584907								
WG2423376-9 LCS								
Alkalinity, Total (as CaCO3)			103.2		%		85-115	31-OCT-16
WG2423376-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	31-OCT-16
CL-IC-N-WP	**Water**							
Batch R3589785								
WG2422588-10 LCS								
Chloride (Cl)			101.8		%		90-110	29-OCT-16
WG2422588-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-16
EC-WP	**Water**							
Batch R3584907								
WG2423376-8 LCS								
Conductivity			94.3		%		90-110	31-OCT-16
WG2423376-6 MB								
Conductivity			<1.0		umhos/cm		1	31-OCT-16
MET-D-MS-WP	**Water**							
Batch R3589097								
WG2424655-2 LCS								
Calcium (Ca)-Dissolved			102.9		%		80-120	04-NOV-16
Magnesium (Mg)-Dissolved			101.1		%		80-120	04-NOV-16
Potassium (K)-Dissolved			103.9		%		80-120	04-NOV-16
Sodium (Na)-Dissolved			106.8		%		80-120	04-NOV-16
WG2424655-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	04-NOV-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	04-NOV-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	04-NOV-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	04-NOV-16
N-TOTKJ-WP	**Water**							
Batch R3590549								
WG2427571-6 LCS								
Total Kjeldahl Nitrogen			105.5		%		75-125	08-NOV-16
WG2427571-5 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	08-NOV-16
NH3-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-COL-WP	**Water**							
Batch R3587250								
WG2424820-10 LCS								
Ammonia, Total (as N)			102.3		%		85-115	02-NOV-16
WG2424820-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	02-NOV-16
NO2-IC-N-WP	**Water**							
Batch R3589785								
WG2422588-10 LCS								
Nitrite (as N)			98.8		%		90-110	29-OCT-16
WG2422588-9 MB								
Nitrite (as N)			<0.010		mg/L		0.01	29-OCT-16
NO3-IC-N-WP	**Water**							
Batch R3589785								
WG2422588-10 LCS								
Nitrate (as N)			99.8		%		90-110	29-OCT-16
WG2422588-9 MB								
Nitrate (as N)			<0.020		mg/L		0.02	29-OCT-16
P-T-COL-WP	**Water**							
Batch R3585067								
WG2423400-14 LCS								
Phosphorus (P)-Total			91.2		%		80-120	01-NOV-16
WG2423400-13 MB								
Phosphorus (P)-Total			0.011	B	mg/L		0.01	01-NOV-16
PH-WP	**Water**							
Batch R3584907								
WG2423376-7 LCS								
pH			7.41		pH units		7.3-7.5	31-OCT-16
SO4-IC-N-WP	**Water**							
Batch R3589785								
WG2422588-10 LCS								
Sulfate (SO4)			102.1		%		90-110	29-OCT-16
WG2422588-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-16
TC,EC-QT97-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT97-WP	**Water**							
Batch R3582931								
WG2421409-1 MB								
Total Coliforms			<1		MPN/100mL		1	28-OCT-16
Escherichia Coli			<1		MPN/100mL		1	28-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	27-OCT-16 12:20	31-OCT-16 11:20	0.25	95	hours	EHTR-FM
	2	27-OCT-16 17:30	31-OCT-16 11:20	0.25	90	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1850234 were received on 28-OCT-16 11:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

L1850234-COFC rm

10- 373422

L1850234

Page 1 of 1

Report To	Report Format / Distribution	Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company: KGS Group	Standard: ✓ Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact: Jason Mann	Select: PDF ✓ Excel ✓ Digital Fax	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address: 865 Waverley St. Wpg MB	Email 1: jmann@kgsgroup.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Email 2:	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone: 204-896-1209 Fax:		
Invoice To Same as Report ? (circle) Yes or No (if No, provide details)	**Client / Project Information**	**Analysis Request**
Copy of Invoice with Report? (circle) Yes or No	Job #: 16-0300-006	(Indicate Filtered or Preserved, F/P)
Company:	PO / AFE:	
Contact:	LSD:	
Address:		
Phone: Fax:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** / **Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	F/P	N-TOTKJ-WSP	NH3-cal-WSP	P-T-col-WSP	TC,EC-QT97	Rou(W)-D (lab to	pre-serve + filter						Number of Containers
	TH-EC-03 start	27-Oct-16	12:20	water	F	X	X	X	X	X							4
	TH-EC-03 end	27-Oct-16	~~05:30~~ 17:30	water		X	X	X	X	X							4

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Preserve + filter Metals for TH-EC-03 Start only. ; was not field filtered or Preserved

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
<Original signed by>	Oct 28/16	10:58	<Original signed by>	28.10.16	11:00am	°C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY GENF 18.01 Front

Date: 08-NOV-16
PO No.:
WO No.: L1851589
Project Ref: 16-0300-006
Sample ID: TH-GD-08
Sampled By: ES
Date Collected: 29-OCT-16
Lab Sample ID: L1851589-1
Matrix: GROUNDWATER

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	395		mg/L			03-NOV-16
Carbonate (CO3)	<0.60		mg/L			03-NOV-16
Hydroxide (OH)	<0.34		mg/L			03-NOV-16
*Nitrate and Nitrite as N	<0.010		mg/L	10		08-NOV-16
pH						
pH	7.79		pH units			02-NOV-16
TDS calculated						
TDS (Calculated)	483		mg/L		500	08-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	115		mg/L		500	03-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		03-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		03-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	384		mg/L		500	08-NOV-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	74.3		mg/L			07-NOV-16
Magnesium (Mg)-Dissolved	48.3		mg/L			07-NOV-16
Potassium (K)-Dissolved	10.0		mg/L			07-NOV-16
Sodium (Na)-Dissolved	35.4		mg/L		200	07-NOV-16
Conductivity						
Conductivity	732		umhos/cm			02-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.26		mg/L		250	03-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	324		mg/L			02-NOV-16
Phosphorus (P)-Total	0.081		mg/L			07-NOV-16
Ammonia, Total (as N)	0.170		mg/L			03-NOV-16
Total Kjeldahl Nitrogen	0.26		mg/L			08-NOV-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 08-NOV-16
PO No.:
WO No.: L1851589
Project Ref: 16-0300-006
Sample ID: TH-GD-08
Sampled By: ES
Date Collected: 29-OCT-16
Lab Sample ID: L1851589-1
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1851589 Report Date: 08-NOV-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: JASON MANN

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3586933								
WG2425228-9 LCS								
Alkalinity, Total (as CaCO3)			102.1		%		85-115	02-NOV-16
WG2425228-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-NOV-16
CL-L-IC-N-WP	**Water**							
Batch R3590262								
WG2425796-2 LCS								
Chloride (Cl)			99.7		%		90-110	03-NOV-16
WG2425796-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	03-NOV-16
EC-WP	**Water**							
Batch R3586933								
WG2425228-8 LCS								
Conductivity			99.0		%		90-110	02-NOV-16
WG2425228-6 MB								
Conductivity			<1.0		umhos/cm		1	02-NOV-16
MET-D-L-MS-WP	**Water**							
Batch R3590375								
WG2426389-2 LCS								
Calcium (Ca)-Dissolved			103.9		%		80-120	07-NOV-16
Magnesium (Mg)-Dissolved			106.6		%		80-120	07-NOV-16
Potassium (K)-Dissolved			105.4		%		80-120	07-NOV-16
Sodium (Na)-Dissolved			105.5		%		80-120	07-NOV-16
WG2426389-1 MB								
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	07-NOV-16
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	07-NOV-16
Potassium (K)-Dissolved			<0.020		mg/L		0.02	07-NOV-16
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	07-NOV-16
N-TOTKJ-WP	**Water**							
Batch R3590549								
WG2427571-14 LCS								
Total Kjeldahl Nitrogen			94.3		%		75-125	08-NOV-16
WG2427571-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	08-NOV-16
NH3-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-COL-WP	**Water**							
Batch R3587752								
WG2426197-10 LCS								
Ammonia, Total (as N)			100.2		%		85-115	03-NOV-16
WG2426197-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	03-NOV-16
NO2-L-IC-N-WP	**Water**							
Batch R3590262								
WG2425796-2 LCS								
Nitrite (as N)			101.9		%		90-110	03-NOV-16
WG2425796-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	03-NOV-16
NO3-L-IC-N-WP	**Water**							
Batch R3590262								
WG2425796-2 LCS								
Nitrate (as N)			100.0		%		90-110	03-NOV-16
WG2425796-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	03-NOV-16
P-T-COL-WP	**Water**							
Batch R3589508								
WG2425706-14 LCS								
Phosphorus (P)-Total			91.9		%		80-120	07-NOV-16
WG2425706-13 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	07-NOV-16
PH-WP	**Water**							
Batch R3586933								
WG2425228-7 LCS								
pH			7.41		pH units		7.3-7.5	02-NOV-16
SO4-IC-N-WP	**Water**							
Batch R3590262								
WG2425796-2 LCS								
Sulfate (SO4)			100.2		%		90-110	03-NOV-16
WG2425796-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	03-NOV-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	29-OCT-16 11:00	02-NOV-16 11:06	0.25	96	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	29-OCT-16 11:00	03-NOV-16 12:00	48	121	hours	EHTR
Nitrite in Water by IC (Low Level)							
	1	29-OCT-16 11:00	03-NOV-16 12:00	48	121	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1851589 were received on 01-NOV-16 12:10.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10- 373423

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1851589

Page 1 of 1

Report To	KGS Group	**Report Format / Distribution**	**Service Request:** (Rush subject to availability)
Company:		Standard: ✓ Other (specify):	✓ Regular (Standard)
Contact:	Jason Mann	Select: PDF ✓ Excel ✓ Digital Fax	Priority (2-4 Business Days)
Address:	865 Waverley St. Wpg MB	Email 1: jmann@kgsgroup.com	Emergency (1-2 Business Days)
		Email 2: landrese@kgsgroup.com; soffman@kgsgroup.com	Same Day or Weekend
Phone:	204-896-1209 Fax:		
Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)	**Client / Project Information**	
	Copy of Invoice with Report? (circle) Yes or No	Job #: 16-0300-006	
Company:		PO / AFE:	
Contact:		LSD:	
Address:			
Phone:	Fax:	Quote #: Q58403	
Lab Work Order # (lab use only)		**ALS Contact:** Judy D. **Sampler:** ES	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RawLW-D	lab to preserve-filter	N-TOT KJ-WP	NH3-COL-WP	P-T-COL-WP	TC, FC, QT97							Number of Containers
					(Indicate Filtered or Preserved, F/P)												
1	TH-GD-08	29-10-16	11:00 AM	Groundwater	X	X	X	X	X	X							3

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Preserve - filter metals sample was not filtered or preserved

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by: <Original signed by>	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
				1.11.16	12:10 pm	6.1 °C				

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	324		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	0.0063		mg/L	10		15-NOV-16
pH						
pH	7.83		pH units			10-NOV-16
Turbidity						
*Turbidity	0.67		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	498		mg/L		500	22-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	159		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0063		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	369		mg/L		500	22-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.483		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0212		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.709		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	67.5		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	<0.00020		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0377		mg/L			19-NOV-16
Magnesium (Mg)-	48.8		mg/L			19-NOV-16

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.0121		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00041		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	10.3		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00700		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	4.45		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	38.6		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.530		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00173		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	760		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.6		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	266		mg/L			10-NOV-16

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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GC-05
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	460		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		15-NOV-16
pH						
pH	7.64		pH units			10-NOV-16
Turbidity						
*Turbidity	205		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	461		mg/L		500	01-DEC-16
Sulfate in Water by IC						
Sulfate (SO4)	56.4		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	341		mg/L		500	01-DEC-16
Fluoride in Water by IC						
Fluoride (F)	1.04		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	0.00179		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0371		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	1.27		mg/L	5		30-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	69.9		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	<0.00020		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	0.102		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0603		mg/L			19-NOV-16
Magnesium (Mg)-	40.4		mg/L			19-NOV-16

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865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GC-05
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.00377		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00079		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	22.7		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00939		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	6.81		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	39.0		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.944		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00024		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	745		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.33		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	377		mg/L			10-NOV-16

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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GC-05
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	368		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		15-NOV-16
pH						
pH	7.72		pH units			10-NOV-16
Turbidity						
*Turbidity	1.41		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	508		mg/L		500	22-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	149		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	398		mg/L		500	22-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.821		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	0.00071		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0156		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.645		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	79.5		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	0.00026		mg/L			19-NOV-16
Copper (Cu)-Dissolved	<0.00020		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	0.154		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0326		mg/L			19-NOV-16
Magnesium (Mg)-	48.5		mg/L			19-NOV-16

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Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.0153		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00029		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	10.0		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00606		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	5.54		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	33.8		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.546		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00114		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	776		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.18		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	301		mg/L			10-NOV-16

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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	390		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		15-NOV-16
pH						
pH	7.78		pH units			10-NOV-16
Turbidity						
*Turbidity	8.91		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	483		mg/L		500	01-DEC-16
Sulfate in Water by IC						
Sulfate (SO4)	121		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	388		mg/L		500	01-DEC-16
Fluoride in Water by IC						
Fluoride (F)	0.697		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	0.00089		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0201		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.594		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	72.4		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	<0.00020		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	0.028		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0326		mg/L			19-NOV-16
Magnesium (Mg)-	50.3		mg/L			19-NOV-16

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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.00560		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00018		mg/L			30-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	10.1		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00586		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	5.55		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	31.1		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.540		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00094		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	745		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.65		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	320		mg/L			10-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved b <Original signed by>

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	391		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		15-NOV-16
pH						
pH	7.70		pH units			10-NOV-16
Turbidity						
*Turbidity	2.96		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	482		mg/L		500	22-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	120		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	391		mg/L		500	22-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.765		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0211		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.579		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	74.4		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	0.00023		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0323		mg/L			19-NOV-16
Magnesium (Mg)-	49.8		mg/L			19-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.00827		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00022		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	10.7		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00620		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	5.04		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	30.4		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.532		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00064		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	0.0049		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	751		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.62		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	320		mg/L			10-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GC-01
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	462		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	0.695		mg/L	10		15-NOV-16
pH						
pH	7.95		pH units			10-NOV-16
Turbidity						
*Turbidity	12.7		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	387		mg/L		500	22-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	10.6		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0067		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.689		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	414		mg/L		500	22-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.250		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.115		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.072		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	64.5		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	0.00094		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0134		mg/L			19-NOV-16
Magnesium (Mg)-	61.4		mg/L			19-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GC-01
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.0104		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00168		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	2.95		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00230		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	5.80		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	9.51		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.139		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	0.00021		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	0.00035		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00175		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	0.0029		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	682		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	7.61		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	379		mg/L			10-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-GC-01
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-EC-04
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-7
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	507		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	0.0245		mg/L	10		15-NOV-16
pH						
pH	7.83		pH units			10-NOV-16
Turbidity						
*Turbidity	174		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	557		mg/L		500	01-DEC-16
Sulfate in Water by IC						
Sulfate (SO4)	100		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0034		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0211		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	497		mg/L		500	01-DEC-16
Fluoride in Water by IC						
Fluoride (F)	1.60		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	0.00173		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0725		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	1.28		mg/L	5		30-NOV-16
Cadmium (Cd)-Dissolved	0.000014		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	78.2		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	0.00691		mg/L			19-NOV-16
Copper (Cu)-Dissolved	0.00051		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	2.25		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0473		mg/L			19-NOV-16
Magnesium (Mg)-	73.3		mg/L			19-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-EC-04
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-7
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.452		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.0121		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	0.0199		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	16.5		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00736		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	4.47		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	33.5		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.693		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	0.00646		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00163		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	0.0261		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	876		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.74		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	415		mg/L			10-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-EC-04
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-7
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-8
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	460		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	0.230		mg/L	10		15-NOV-16
pH						
pH	8.11		pH units			10-NOV-16
Turbidity						
*Turbidity	694		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	390		mg/L		500	22-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	21.6		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0191		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.211		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	319		mg/L		500	22-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.466		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	0.0035		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	0.00021		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	0.00034		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0275		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.184		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	38.8		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	0.00048		mg/L			19-NOV-16
Copper (Cu)-Dissolved	0.00146		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	0.010		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0193		mg/L			19-NOV-16
Magnesium (Mg)-	53.8		mg/L			19-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-8
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.0321		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.0148		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	0.0019		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	3.11		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00164		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	4.56		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	30.9		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.131		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	0.00029		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	0.00133		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00376		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	0.00048		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	616		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.6		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	377		mg/L			10-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-ED-03
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-8
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>

Hua Wo
Account Manager

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865 Waverly Street - 3rd Floor
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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-100
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-9
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	326		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
pH						
pH	7.85		pH units			10-NOV-16
Turbidity						
*Turbidity	1.44		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	508		mg/L		500	24-NOV-16
Sulfate in Water by IC						
Sulfate (SO4)	165		mg/L		500	23-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		23-NOV-16
Nitrate+Nitrite						
*Nitrate and Nitrite as N	0.0070		mg/L	10		01-DEC-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0070		mg/L	10		23-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	382		mg/L		500	22-NOV-16
Fluoride in Water by IC						
Fluoride (F)	0.573		mg/L	1.5		23-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	<0.00020		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0203		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	0.650		mg/L	5		19-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	66.5		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	<0.00020		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	<0.010		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0364		mg/L			19-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-100
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-9
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Magnesium (Mg)-Dissolved	52.3		mg/L			19-NOV-16
Manganese (Mn)-Dissolved	0.0123		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00042		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	10.5		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00727		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	4.65		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	39.9		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.521		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00164		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	757		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	14.0		mg/L		250	23-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	267		mg/L			10-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-100
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-9
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-200
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-10
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Bicarbonate (HCO3)	466		mg/L			14-NOV-16
Carbonate (CO3)	<0.60		mg/L			14-NOV-16
Hydroxide (OH)	<0.34		mg/L			14-NOV-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		16-NOV-16
pH						
pH	7.68		pH units			10-NOV-16
Turbidity						
*Turbidity	293		NTU			10-NOV-16
TDS calculated						
TDS (Calculated)	473		mg/L		500	01-DEC-16
Sulfate in Water by IC						
Sulfate (SO4)	56.6		mg/L		500	12-NOV-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		12-NOV-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		12-NOV-16
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	360		mg/L		500	01-DEC-16
Fluoride in Water by IC						
Fluoride (F)	1.04		mg/L	1.5		12-NOV-16
Dissolved Metals by ICP-MS						
Aluminum (Al)-Dissolved	<0.0020		mg/L		0.1	19-NOV-16
Antimony (Sb)-Dissolved	<0.00020		mg/L	0.006		19-NOV-16
Arsenic (As)-Dissolved	0.00184		mg/L	0.01		19-NOV-16
Barium (Ba)-Dissolved	0.0388		mg/L	1		19-NOV-16
Beryllium (Be)-Dissolved	<0.00020		mg/L			19-NOV-16
Bismuth (Bi)-Dissolved	<0.00020		mg/L			19-NOV-16
Boron (B)-Dissolved	1.37		mg/L	5		30-NOV-16
Cadmium (Cd)-Dissolved	<0.000010		mg/L	0.005		19-NOV-16
Calcium (Ca)-Dissolved	71.2		mg/L			19-NOV-16
Cesium (Cs)-Dissolved	<0.00010		mg/L			19-NOV-16
Chromium (Cr)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Cobalt (Co)-Dissolved	<0.00020		mg/L			19-NOV-16
Copper (Cu)-Dissolved	<0.00020		mg/L		1.0	19-NOV-16
Iron (Fe)-Dissolved	0.102		mg/L		0.3	19-NOV-16
Lead (Pb)-Dissolved	<0.000090		mg/L	0.01		19-NOV-16
Lithium (Li)-Dissolved	0.0575		mg/L			19-NOV-16
Magnesium (Mg)-	44.3		mg/L			19-NOV-16

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Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-200
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-10
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Dissolved						
Dissolved Metals by ICP-MS						
Dissolved Manganese (Mn)-Dissolved	0.00389		mg/L		0.05	19-NOV-16
Molybdenum (Mo)-Dissolved	0.00079		mg/L			19-NOV-16
Nickel (Ni)-Dissolved	<0.0010		mg/L			19-NOV-16
Phosphorus (P)-Dissolved	<0.030		mg/L			19-NOV-16
Potassium (K)-Dissolved	23.6		mg/L			19-NOV-16
Rubidium (Rb)-Dissolved	0.00950		mg/L			19-NOV-16
Selenium (Se)-Dissolved	<0.0010		mg/L	0.05		19-NOV-16
Silicon (Si)-Dissolved	6.93		mg/L			19-NOV-16
Silver (Ag)-Dissolved	<0.00010		mg/L			19-NOV-16
Sodium (Na)-Dissolved	41.6		mg/L		200	19-NOV-16
Strontium (Sr)-Dissolved	0.925		mg/L			19-NOV-16
Tellurium (Te)-Dissolved	<0.00020		mg/L			19-NOV-16
Thallium (Tl)-Dissolved	<0.00010		mg/L			19-NOV-16
Thorium (Th)-Dissolved	<0.00010		mg/L			19-NOV-16
Tin (Sn)-Dissolved	<0.00020		mg/L			19-NOV-16
Titanium (Ti)-Dissolved	<0.00050		mg/L			19-NOV-16
Tungsten (W)-Dissolved	<0.00010		mg/L			19-NOV-16
Uranium (U)-Dissolved	0.00024		mg/L	0.02		19-NOV-16
Vanadium (V)-Dissolved	<0.00020		mg/L			19-NOV-16
Zinc (Zn)-Dissolved	<0.0020		mg/L		5.0	19-NOV-16
Zirconium (Zr)-Dissolved	<0.00040		mg/L			19-NOV-16
Conductivity						
Conductivity	749		umhos/cm			10-NOV-16
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.37		mg/L		250	12-NOV-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	382		mg/L			10-NOV-16

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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-200
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-10
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

<Original signed by>

Approved by _____
Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: JASON MANN

Date: 01-DEC-16
PO No.:
WO No.: L1856224
Project Ref: 16-0300-006
Sample ID: TH-EC-03W
Sampled By: PL/ES
Date Collected: 09-NOV-16
Lab Sample ID: L1856224-11
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.023		mg/L			14-NOV-16

CDWQG = Health Canada Guideline Limits updated **DECEMBER 2015**

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by <Original signed by>
Hua Wo
Account Manager

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1856224 Report Date: 01-DEC-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: JASON MANN

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3594432								
WG2431818-14 LCS								
Alkalinity, Total (as CaCO3)			99.9		%		85-115	10-NOV-16
WG2431818-9 LCS								
Alkalinity, Total (as CaCO3)			99.1		%		85-115	10-NOV-16
WG2431818-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	10-NOV-16
WG2431818-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	10-NOV-16
CL-L-IC-N-WP	**Water**							
Batch R3595178								
WG2431840-11 DUP		**L1856224-8**						
Chloride (Cl)		14.6	14.7		mg/L	0.2	20	12-NOV-16
WG2431840-10 LCS								
Chloride (Cl)			101.8		%		90-110	12-NOV-16
WG2431840-14 LCS								
Chloride (Cl)			101.6		%		90-110	12-NOV-16
WG2431840-6 LCS								
Chloride (Cl)			101.5		%		90-110	12-NOV-16
WG2431840-13 MB								
Chloride (Cl)			<0.10		mg/L		0.1	12-NOV-16
WG2431840-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	12-NOV-16
WG2431840-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	12-NOV-16
WG2431840-12 MS		**L1856224-8**						
Chloride (Cl)			104.8		%		75-125	12-NOV-16
Batch R3602344								
WG2438620-2 LCS								
Chloride (Cl)			102.7		%		90-110	23-NOV-16
WG2438620-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	23-NOV-16
EC-WP	**Water**							
Batch R3594432								
WG2431818-13 LCS								
Conductivity			99.9		%		90-110	10-NOV-16
WG2431818-8 LCS								
Conductivity			99.6		%		90-110	10-NOV-16
WG2431818-11 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-WP	**Water**							
Batch R3594432								
WG2431818-11 MB								
Conductivity			<1.0		umhos/cm		1	10-NOV-16
WG2431818-6 MB								
Conductivity			<1.0		umhos/cm		1	10-NOV-16
F-IC-N-WP	**Water**							
Batch R3595178								
WG2431840-11 DUP		**L1856224-8**						
Fluoride (F)		0.466	0.454		mg/L	2.6	20	12-NOV-16
WG2431840-10 LCS								
Fluoride (F)			98.0		%		90-110	12-NOV-16
WG2431840-14 LCS								
Fluoride (F)			101.3		%		90-110	12-NOV-16
WG2431840-6 LCS								
Fluoride (F)			99.3		%		90-110	12-NOV-16
WG2431840-13 MB								
Fluoride (F)			<0.020		mg/L		0.02	12-NOV-16
WG2431840-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	12-NOV-16
WG2431840-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	12-NOV-16
WG2431840-12 MS		**L1856224-8**						
Fluoride (F)			109.1		%		75-125	12-NOV-16
Batch R3602344								
WG2438620-2 LCS								
Fluoride (F)			102.1		%		90-110	23-NOV-16
WG2438620-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	23-NOV-16
MET-D-L-MS-WP	**Water**							
Batch R3599620								
WG2432328-2 LCS								
Aluminum (Al)-Dissolved			108.3		%		80-120	19-NOV-16
Aluminum (Al)-Dissolved			108.3		%		80-120	19-NOV-16
Antimony (Sb)-Dissolved			104.3		%		80-120	19-NOV-16
Antimony (Sb)-Dissolved			104.3		%		80-120	19-NOV-16
Arsenic (As)-Dissolved			99.6		%		80-120	19-NOV-16
Arsenic (As)-Dissolved			99.6		%		80-120	19-NOV-16
Barium (Ba)-Dissolved			101.9		%		80-120	19-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3599620								
WG2432328-2 LCS								
Barium (Ba)-Dissolved			101.9		%		80-120	19-NOV-16
Beryllium (Be)-Dissolved			113.6		%		80-120	19-NOV-16
Beryllium (Be)-Dissolved			113.6		%		80-120	19-NOV-16
Bismuth (Bi)-Dissolved			96.9		%		80-120	19-NOV-16
Bismuth (Bi)-Dissolved			96.9		%		80-120	19-NOV-16
Boron (B)-Dissolved			115.1		%		80-120	19-NOV-16
Boron (B)-Dissolved			115.1		%		80-120	19-NOV-16
Cadmium (Cd)-Dissolved			98.5		%		80-120	19-NOV-16
Cadmium (Cd)-Dissolved			98.5		%		80-120	19-NOV-16
Calcium (Ca)-Dissolved			101.8		%		80-120	19-NOV-16
Calcium (Ca)-Dissolved			101.8		%		80-120	19-NOV-16
Cesium (Cs)-Dissolved			102.8		%		80-120	19-NOV-16
Cesium (Cs)-Dissolved			102.8		%		80-120	19-NOV-16
Chromium (Cr)-Dissolved			102.3		%		80-120	19-NOV-16
Chromium (Cr)-Dissolved			102.3		%		80-120	19-NOV-16
Cobalt (Co)-Dissolved			100.7		%		80-120	19-NOV-16
Cobalt (Co)-Dissolved			100.7		%		80-120	19-NOV-16
Copper (Cu)-Dissolved			99.4		%		80-120	19-NOV-16
Copper (Cu)-Dissolved			99.4		%		80-120	19-NOV-16
Iron (Fe)-Dissolved			97.9		%		80-120	19-NOV-16
Iron (Fe)-Dissolved			97.9		%		80-120	19-NOV-16
Lead (Pb)-Dissolved			100.2		%		80-120	19-NOV-16
Lead (Pb)-Dissolved			100.2		%		80-120	19-NOV-16
Lithium (Li)-Dissolved			113.9		%		80-120	19-NOV-16
Lithium (Li)-Dissolved			113.9		%		80-120	19-NOV-16
Magnesium (Mg)-Dissolved			113.2		%		80-120	19-NOV-16
Magnesium (Mg)-Dissolved			113.2		%		80-120	19-NOV-16
Manganese (Mn)-Dissolved			100.6		%		80-120	19-NOV-16
Manganese (Mn)-Dissolved			100.6		%		80-120	19-NOV-16
Molybdenum (Mo)-Dissolved			96.5		%		80-120	19-NOV-16
Molybdenum (Mo)-Dissolved			96.5		%		80-120	19-NOV-16
Nickel (Ni)-Dissolved			100.1		%		80-120	19-NOV-16
Nickel (Ni)-Dissolved			100.1		%		80-120	19-NOV-16
Phosphorus (P)-Dissolved			110.5		%		80-120	19-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3599620								
WG2432328-2 LCS								
Phosphorus (P)-Dissolved			110.5		%		80-120	19-NOV-16
Potassium (K)-Dissolved			105.0		%		80-120	19-NOV-16
Potassium (K)-Dissolved			105.0		%		80-120	19-NOV-16
Rubidium (Rb)-Dissolved			102.3		%		80-120	19-NOV-16
Rubidium (Rb)-Dissolved			102.3		%		80-120	19-NOV-16
Selenium (Se)-Dissolved			96.1		%		80-120	19-NOV-16
Selenium (Se)-Dissolved			96.1		%		80-120	19-NOV-16
Silicon (Si)-Dissolved			109.0		%		80-120	19-NOV-16
Silicon (Si)-Dissolved			109.0		%		80-120	19-NOV-16
Silver (Ag)-Dissolved			105.6		%		80-120	19-NOV-16
Silver (Ag)-Dissolved			105.6		%		80-120	19-NOV-16
Sodium (Na)-Dissolved			107.2		%		80-120	19-NOV-16
Sodium (Na)-Dissolved			107.2		%		80-120	19-NOV-16
Strontium (Sr)-Dissolved			98.6		%		80-120	19-NOV-16
Strontium (Sr)-Dissolved			98.6		%		80-120	19-NOV-16
Tellurium (Te)-Dissolved			100.3		%		80-120	19-NOV-16
Tellurium (Te)-Dissolved			100.3		%		80-120	19-NOV-16
Thallium (Tl)-Dissolved			99.4		%		80-120	19-NOV-16
Thallium (Tl)-Dissolved			99.4		%		80-120	19-NOV-16
Thorium (Th)-Dissolved			97.7		%		80-120	19-NOV-16
Thorium (Th)-Dissolved			97.7		%		80-120	19-NOV-16
Tin (Sn)-Dissolved			100.8		%		80-120	19-NOV-16
Tin (Sn)-Dissolved			100.8		%		80-120	19-NOV-16
Titanium (Ti)-Dissolved			100.7		%		80-120	19-NOV-16
Titanium (Ti)-Dissolved			100.7		%		80-120	19-NOV-16
Tungsten (W)-Dissolved			101.0		%		80-120	19-NOV-16
Tungsten (W)-Dissolved			101.0		%		80-120	19-NOV-16
Uranium (U)-Dissolved			101.0		%		80-120	19-NOV-16
Uranium (U)-Dissolved			101.0		%		80-120	19-NOV-16
Vanadium (V)-Dissolved			103.9		%		80-120	19-NOV-16
Vanadium (V)-Dissolved			103.9		%		80-120	19-NOV-16
Zinc (Zn)-Dissolved			97.7		%		80-120	19-NOV-16
Zinc (Zn)-Dissolved			97.7		%		80-120	19-NOV-16
Zirconium (Zr)-Dissolved			98.7		%		80-120	19-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3599620								
WG2432328-2 LCS								
Zirconium (Zr)-Dissolved			98.7		%		80-120	19-NOV-16
WG2432328-1 MB								
Aluminum (Al)-Dissolved			<0.0020		mg/L		0.002	19-NOV-16
Aluminum (Al)-Dissolved			<0.0020		mg/L		0.002	19-NOV-16
Antimony (Sb)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Antimony (Sb)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Arsenic (As)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Arsenic (As)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Barium (Ba)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Barium (Ba)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Beryllium (Be)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Beryllium (Be)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Bismuth (Bi)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Bismuth (Bi)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	19-NOV-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	19-NOV-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	19-NOV-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	19-NOV-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	19-NOV-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	19-NOV-16
Cesium (Cs)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Cesium (Cs)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Chromium (Cr)-Dissolved			<0.0010		mg/L		0.001	19-NOV-16
Chromium (Cr)-Dissolved			<0.0010		mg/L		0.001	19-NOV-16
Cobalt (Co)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Cobalt (Co)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	19-NOV-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	19-NOV-16
Lead (Pb)-Dissolved			<0.000090		mg/L		0.00009	19-NOV-16
Lead (Pb)-Dissolved			<0.000090		mg/L		0.00009	19-NOV-16
Lithium (Li)-Dissolved			<0.0020		mg/L		0.002	19-NOV-16
Lithium (Li)-Dissolved			<0.0020		mg/L		0.002	19-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch	**R3599620**							
WG2432328-1	**MB**							
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	19-NOV-16
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	19-NOV-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Molybdenum (Mo)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Molybdenum (Mo)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Nickel (Ni)-Dissolved			<0.0010		mg/L		0.001	19-NOV-16
Nickel (Ni)-Dissolved			<0.0010		mg/L		0.001	19-NOV-16
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	19-NOV-16
Phosphorus (P)-Dissolved			<0.030		mg/L		0.03	19-NOV-16
Potassium (K)-Dissolved			<0.020		mg/L		0.02	19-NOV-16
Potassium (K)-Dissolved			<0.020		mg/L		0.02	19-NOV-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	19-NOV-16
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	19-NOV-16
Silicon (Si)-Dissolved			<0.10		mg/L		0.1	19-NOV-16
Silicon (Si)-Dissolved			<0.10		mg/L		0.1	19-NOV-16
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	19-NOV-16
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	19-NOV-16
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Strontium (Sr)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Thallium (Tl)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Thallium (Tl)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Tin (Sn)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Tin (Sn)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Titanium (Ti)-Dissolved			<0.00050		mg/L		0.0005	19-NOV-16
Titanium (Ti)-Dissolved			<0.00050		mg/L		0.0005	19-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-WP	**Water**							
Batch R3599620								
WG2432328-1 MB								
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	19-NOV-16
Vanadium (V)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Vanadium (V)-Dissolved			<0.00020		mg/L		0.0002	19-NOV-16
Zinc (Zn)-Dissolved			<0.0020		mg/L		0.002	19-NOV-16
Zinc (Zn)-Dissolved			<0.0020		mg/L		0.002	19-NOV-16
Zirconium (Zr)-Dissolved			<0.00040		mg/L		0.0004	19-NOV-16
Zirconium (Zr)-Dissolved			<0.00040		mg/L		0.0004	19-NOV-16
NO2-L-IC-N-WP	**Water**							
Batch R3595178								
WG2431840-11 DUP		**L1856224-8**						
Nitrite (as N)		0.0191	0.0188		mg/L	1.6	20	12-NOV-16
WG2431840-10 LCS								
Nitrite (as N)			104.6		%		90-110	12-NOV-16
WG2431840-14 LCS								
Nitrite (as N)			102.4		%		90-110	12-NOV-16
WG2431840-6 LCS								
Nitrite (as N)			103.5		%		90-110	12-NOV-16
WG2431840-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	12-NOV-16
WG2431840-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	12-NOV-16
WG2431840-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	12-NOV-16
WG2431840-12 MS		**L1856224-8**						
Nitrite (as N)			106.2		%		75-125	12-NOV-16
Batch R3602344								
WG2438620-2 LCS								
Nitrite (as N)			102.7		%		90-110	23-NOV-16
WG2438620-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-NOV-16
NO3-L-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R3595178								
WG2431840-11 DUP		**L1856224-8**						
Nitrate (as N)		0.211	0.212		mg/L	0.3	20	12-NOV-16
WG2431840-10 LCS								
Nitrate (as N)			101.8		%		90-110	12-NOV-16
WG2431840-14 LCS								
Nitrate (as N)			101.9		%		90-110	12-NOV-16
WG2431840-6 LCS								
Nitrate (as N)			101.9		%		90-110	12-NOV-16
WG2431840-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	12-NOV-16
WG2431840-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	12-NOV-16
WG2431840-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	12-NOV-16
WG2431840-12 MS		**L1856224-8**						
Nitrate (as N)			104.6		%		75-125	12-NOV-16
Batch R3602344								
WG2438620-2 LCS								
Nitrate (as N)			103.2		%		90-110	23-NOV-16
WG2438620-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-NOV-16
P-T-COL-WP	**Water**							
Batch R3594562								
WG2431644-10 LCS								
Phosphorus (P)-Total			92.7		%		80-120	14-NOV-16
WG2431644-9 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	14-NOV-16
PH-WP	**Water**							
Batch R3594432								
WG2431818-12 LCS								
pH			7.42		pH units		7.3-7.5	10-NOV-16
WG2431818-7 LCS								
pH			7.42		pH units		7.3-7.5	10-NOV-16
SO4-IC-N-WP	**Water**							
Batch R3595178								
WG2431840-11 DUP		**L1856224-8**						
Sulfate (SO4)		21.6	21.6		mg/L	0.2	20	12-NOV-16
WG2431840-10 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R3595178								
WG2431840-10 LCS								
Sulfate (SO4)			101.9		%		90-110	12-NOV-16
WG2431840-14 LCS								
Sulfate (SO4)			102.0		%		90-110	12-NOV-16
WG2431840-6 LCS								
Sulfate (SO4)			101.6		%		90-110	12-NOV-16
WG2431840-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-NOV-16
WG2431840-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-NOV-16
WG2431840-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-NOV-16
WG2431840-12 MS		**L1856224-8**						
Sulfate (SO4)			102.4		%		75-125	12-NOV-16
Batch R3602344								
WG2438620-2 LCS								
Sulfate (SO4)			103.0		%		90-110	23-NOV-16
WG2438620-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	23-NOV-16
TURBIDITY-WP	**Water**							
Batch R3594238								
WG2431855-3 DUP		**L1856224-2**						
Turbidity		205	200		NTU	2.5	15	10-NOV-16
WG2431855-6 DUP		**L1856224-9**						
Turbidity		1.44	1.46		NTU	1.4	15	10-NOV-16
WG2431855-2 LCS								
Turbidity			102.5		%		85-115	10-NOV-16
WG2431855-5 LCS								
Turbidity			102.0		%		85-115	10-NOV-16
WG2431855-1 MB								
Turbidity			<0.10		NTU		0.1	10-NOV-16
WG2431855-4 MB								
Turbidity			<0.10		NTU		0.1	10-NOV-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	09-NOV-16 07:30	10-NOV-16 11:32	0.25	28	hours	EHTR-FM
	2	09-NOV-16 09:55	10-NOV-16 11:32	0.25	26	hours	EHTR-FM
	3	09-NOV-16 12:30	10-NOV-16 11:32	0.25	23	hours	EHTR-FM
	4	09-NOV-16 14:45	10-NOV-16 11:32	0.25	21	hours	EHTR-FM
	5	09-NOV-16 15:40	10-NOV-16 11:32	0.25	20	hours	EHTR-FM
	6	09-NOV-16 16:20	10-NOV-16 11:32	0.25	19	hours	EHTR-FM
	7	09-NOV-16 16:45	10-NOV-16 11:32	0.25	19	hours	EHTR-FM
	8	09-NOV-16 17:20	10-NOV-16 11:32	0.25	18	hours	EHTR-FM
	9	09-NOV-16 07:00	10-NOV-16 11:32	0.25	29	hours	EHTR-FM
	10	09-NOV-16 07:10	10-NOV-16 11:32	0.25	28	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	09-NOV-16 07:30	12-NOV-16 12:00	48	77	hours	EHTL
	2	09-NOV-16 09:55	12-NOV-16 12:00	48	74	hours	EHTL
	3	09-NOV-16 12:30	12-NOV-16 12:00	48	72	hours	EHT
	4	09-NOV-16 14:45	12-NOV-16 12:00	48	69	hours	EHT
	5	09-NOV-16 15:40	12-NOV-16 12:00	48	68	hours	EHT
	6	09-NOV-16 16:20	12-NOV-16 12:00	48	68	hours	EHT
	7	09-NOV-16 16:45	12-NOV-16 12:00	48	67	hours	EHT
	8	09-NOV-16 17:20	12-NOV-16 12:00	48	67	hours	EHT
	9	09-NOV-16 07:00	23-NOV-16 12:00	48	341	hours	EHTL
	10	09-NOV-16 07:10	12-NOV-16 12:00	48	77	hours	EHTL
Nitrite in Water by IC (Low Level)							
	1	09-NOV-16 07:30	12-NOV-16 12:00	48	77	hours	EHTL
	2	09-NOV-16 09:55	12-NOV-16 12:00	48	74	hours	EHTL
	3	09-NOV-16 12:30	12-NOV-16 12:00	48	72	hours	EHT
	4	09-NOV-16 14:45	12-NOV-16 12:00	48	69	hours	EHT
	5	09-NOV-16 15:40	12-NOV-16 12:00	48	68	hours	EHT
	6	09-NOV-16 16:20	12-NOV-16 12:00	48	68	hours	EHT
	7	09-NOV-16 16:45	12-NOV-16 12:00	48	67	hours	EHT
	8	09-NOV-16 17:20	12-NOV-16 12:00	48	67	hours	EHT
	9	09-NOV-16 07:00	23-NOV-16 12:00	48	341	hours	EHTL
	10	09-NOV-16 07:10	12-NOV-16 12:00	48	77	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1856224 were received on 10-NOV-16 10:30.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

Quality Control Report

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10- 373426

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1856224

Page 1 of 1

L1856224-COFC

Report To	**Report Format / Distribution**	**Service Request:(Rush su**
Company: KES Group	Standard: ✓ Other (specify):	✓ Regular (Standard T
Contact: Jason Mann	Select: PDF ✓ Excel ✓ Digital Fax	Priority(2-4 Business
Address: 865 Waverley St. Wpg MB	Email 1: jmann@kesgroup.com	Emergency (1-2 Bus
	Email 2:	Same Day or Weeke
Phone: 204 896-1209 Fax:		3D
Invoice To Same as Report ? (circle) Yes or No (if No, provide details)	**Client / Project Information**	**Analysis Request**
Copy of Invoice with Report? (circle) Yes or No	Job #: 16-0300-006	(Indicate Filtered or Preserved, F/P)
Company:	PO / AFE:	
Contact:	LSD:	
Address:		
Phone: Fax:	Quote #: Q58403	
Lab Work Order # (lab use only)	**ALS Contact:**	**Sampler:** PL/ES

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Rad-4hr-HET-DW	P-T-COL-WP	Number of Containers
1	TH-GD-02	09-Nov-16	07:30	water	X		2
2	TH-GC-05		09:55		X		2
3	TH-ED-01P		12:30		X		2
4	15-RD-PW1		14:45 ~~15:45~~		X		2
5	TH-GD-07		15:40		X		2
6	TH-GC-01		16:20		X		2
7	TH-EC-04		16:45		X		2
8	TH-ED-03		17:20		X		2
9	TH-100		07:00		X		2
10	TH-200		07:10		X		2
11	TH-EC-03W		16:15			X	2

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

All metals samples have been filtered in the field and preserved. Phosphorous sample preserved.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by: <Original signed by>	Date: Nov 10	Time: 10:30	Temperature: 7 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY — GENF 18.01 Front

APPENDIX D6-E2

SURFACE WATER

KGS Group Consultants (Winnipeg)
ATTN: Steve Offman
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

Date Received: 09-NOV-16
Report Date: 21-NOV-16 15:38 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1855349

Project P.O. #: NOT SUBMITTED
Job Reference: 16-0300-006
C of C Numbers:
Legal Site Desc:

<Original signed by>

Craig Riddell, B.Sc.Ag
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-1 D-3							
Sampled By: DAN LEITCH on 07-NOV-16 @ 13:22							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.150		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.031		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.020		0.010	mg/L		13-NOV-16	R3593881
Total Kjeldahl Nitrogen	1.87		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.88		0.20	mg/L		18-NOV-16	
Total Suspended Solids	2.2		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	300		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	293		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	240		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	4.78		0.10	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	564		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.113		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	335	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0051		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0067		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0016		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	85.6		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	352		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0107		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00057		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0209		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.039		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	42.5		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00038		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.021		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-1 D-3							
Sampled By: DAN LEITCH on 07-NOV-16 @ 13:22							
Matrix: SW							
Total Metals by ICP-MS							
Lithium (Li)-Total	0.0122		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	55.5		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00874		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00032		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	9.16		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00467		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	9.20		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	10.9		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.0965		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00053		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00143		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	1.15		0.10	NTU		09-NOV-16	R3592138
pH							
pH	7.88		0.10	pH units		09-NOV-16	R3592284
L1855349-2 D-4							
Sampled By: DAN LEITCH on 07-NOV-16 @ 16:00							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.018		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.040		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.025		0.010	mg/L		13-NOV-16	R3593881
Total Kjeldahl Nitrogen	1.41		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.41		0.20	mg/L		18-NOV-16	
Total Suspended Solids	6.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	341		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	280		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	7.76		0.10	mg/L		10-NOV-16	R3594580

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-2 D-4							
Sampled By: DAN LEITCH on 07-NOV-16 @ 16:00							
Matrix: SW							
Conductivity							
Conductivity	633		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.185		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	394	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	97.0		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	410		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0617		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00077		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0342		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.051		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	58.3		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00085		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.069		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0165		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	60.3		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.0108		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00052		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	8.33		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00475		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	9.33		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	10.6		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.146		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00231		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00340		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00076		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-2 D-4							
Sampled By: DAN LEITCH on 07-NOV-16 @ 16:00							
Matrix: SW							
Total Metals by ICP-MS							
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	3.39		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.15		0.10	pH units		09-NOV-16	R3592284
L1855349-3 D-1							
Sampled By: DAN LEITCH on 08-NOV-16 @ 09:05							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.042		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.032		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.0111		0.0010	mg/L		17-NOV-16	R3597189
Total Kjeldahl Nitrogen	1.06		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.06		0.20	mg/L		18-NOV-16	
Total Suspended Solids	8.8		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	1350		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	310		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	3.72		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	260		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	33.1		0.10	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	604		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.153		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	322	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	46.2		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	373		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.111		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00087		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0328		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-3 D-1							
Sampled By: DAN LEITCH on 08-NOV-16 @ 09:05							
Matrix: SW							
Total Metals by ICP-MS							
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.058		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	49.0		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00059		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.126		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	0.000097		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0172		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	48.6		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00595		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00069		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	7.98		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00403		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	8.01		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	32.5		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.150		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00472		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00188		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00094		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	0.0021		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	5.91		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.35		0.10	pH units		09-NOV-16	R3592284
L1855349-4 D-2							
Sampled By: DAN LEITCH on 08-NOV-16 @ 10:10							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.021		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.082		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.072		0.010	mg/L		13-NOV-16	R3593881
Total Kjeldahl Nitrogen	1.69		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.70		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	860		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-4 D-2							
Sampled By: DAN LEITCH on 08-NOV-16 @ 10:10							
Matrix: SW							
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	279		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	229		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	10.1		0.10	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	582		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.138		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	321	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0162		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0174		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0011		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	95.6		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	366		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0098		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00053		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0235		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.050		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	41.6		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00029		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.024		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0154		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	52.9		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00797		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00030		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	15.6		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00724		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	7.84		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-4 D-2							
Sampled By: DAN LEITCH on 08-NOV-16 @ 10:10							
Matrix: SW							
Total Metals by ICP-MS							
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	12.6		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.108		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	<0.00050		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00104		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	0.63		0.10	NTU		09-NOV-16	R3592138
pH							
pH	7.94		0.10	pH units		09-NOV-16	R3592284
L1855349-5 C-2							
Sampled By: DAN LEITCH on 08-NOV-16 @ 11:45							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	1.51		0.10	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.678		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.614		0.010	mg/L		13-NOV-16	R3593881
Total Kjeldahl Nitrogen	4.69		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	4.76		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	200		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	790		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	648		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	16.6		0.20	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	1020		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.204		0.040	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	712	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.061		0.010	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.071		0.010	mg/L		14-NOV-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-5 C-2							
Sampled By: DAN LEITCH on 08-NOV-16 @ 11:45							
Matrix: SW							
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0102		0.0020	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	16.5		0.60	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	660		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0107		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00093		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0865		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.058		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	98.9		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	0.00043		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00037		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.174		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0256		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	113		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.117		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00041		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	0.67		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	8.31		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00284		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	14.8		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	17.6		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.311		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00069		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00455		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00090		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	1.0		0.10	NTU		09-NOV-16	R3592138
pH							
pH	7.86		0.10	pH units		09-NOV-16	R3592284
L1855349-6 D-9							
Sampled By: DAN LEITCH on 08-NOV-16 @ 13:40							
Matrix: SW							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-6 D-9							
Sampled By: DAN LEITCH on 08-NOV-16 @ 13:40							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.014		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.021		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.0116		0.0010	mg/L		17-NOV-16	R3597189
Total Kjeldahl Nitrogen	1.24		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.36		0.20	mg/L		18-NOV-16	
Total Suspended Solids	7.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	211		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	5.40		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	182		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	130		0.20	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	813		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.239		0.040	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	261	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.103		0.010	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.117		0.010	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0139		0.0020	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	77.5		0.60	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	503		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0421		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00172		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0398		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.086		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	43.3		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00043		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.037		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	0.000118		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-6 D-9							
Sampled By: DAN LEITCH on 08-NOV-16 @ 13:40							
Matrix: SW							
Total Metals by ICP-MS							
Lithium (Li)-Total	0.0283		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	37.1		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00489		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00203		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	8.74		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00359		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	5.78		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	96.8		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.231		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00138		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00189		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00152		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	3.53		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.47		0.10	pH units		09-NOV-16	R3592284
L1855349-7 D-8							
Sampled By: DAN LEITCH on 08-NOV-16 @ 14:30							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.018		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.029		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.0173		0.0010	mg/L		17-NOV-16	R3597189
Total Kjeldahl Nitrogen	1.53		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.55		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	310		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	376		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	308		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	7.07		0.10	mg/L		10-NOV-16	R3594580

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-7 D-8							
Sampled By: DAN LEITCH on 08-NOV-16 @ 14:30							
Matrix: SW							
Conductivity							
Conductivity	667		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.231		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	430	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0185		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0185		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	96.1		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	436		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0357		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00064		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0327		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.064		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	63.2		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00060		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.059		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0179		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	66.1		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00712		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00054		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	7.31		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00376		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	9.25		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	11.5		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.166		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00155		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00380		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00050		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-7 D-8							
Sampled By: DAN LEITCH on 08-NOV-16 @ 14:30							
Matrix: SW							
Total Metals by ICP-MS							
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	1.31		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.18		0.10	pH units		09-NOV-16	R3592284
L1855349-8 D-7							
Sampled By: DAN LEITCH on 08-NOV-16 @ 15:00							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.063		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.020		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.0196		0.0010	mg/L		17-NOV-16	R3597189
Total Kjeldahl Nitrogen	1.41		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.41		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	410		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	341		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	280		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	3.05		0.10	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	564		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.088		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	353	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0051		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	60.6		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	353		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0250		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00064		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0300		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-8 D-7							
Sampled By: DAN LEITCH on 08-NOV-16 @ 15:00							
Matrix: SW							
Total Metals by ICP-MS							
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.020		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	56.4		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00043		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.059		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0111		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	51.5		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.0108		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00033		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	6.78		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00244		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	8.99		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	6.58		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.0966		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00105		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00352		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00053		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	0.0029		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	0.90		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.07		0.10	pH units		09-NOV-16	R3592284
L1855349-9 D-6							
Sampled By: DAN LEITCH on 08-NOV-16 @ 15:30							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.019		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.0181		0.0010	mg/L		17-NOV-16	R3597199
Phosphorus (P)-Total Dissolved	0.0170		0.0010	mg/L		17-NOV-16	R3597189
Total Kjeldahl Nitrogen	1.74		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.75		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	100		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-9 D-6							
Sampled By: DAN LEITCH on 08-NOV-16 @ 15:30							
Matrix: SW							
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	359		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	295		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	8.45		0.10	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	683		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.235		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	424	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.0173		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.0173		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	112		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	445		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0132		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00064		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0328		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.070		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	61.2		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00053		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.031		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0198		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	65.8		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00491		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00060		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	8.57		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00425		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	9.89		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-9 D-6							
Sampled By: DAN LEITCH on 08-NOV-16 @ 15:30							
Matrix: SW							
Total Metals by ICP-MS							
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	12.3		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.170		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00061		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00380		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00036		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	0.76		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.05		0.10	pH units		09-NOV-16	R3592284
L1855349-10 D-5							
Sampled By: DAN LEITCH on 08-NOV-16 @ 16:05							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.012		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.0109		0.0010	mg/L		20-NOV-16	R3598972
Phosphorus (P)-Total Dissolved	0.0062		0.0010	mg/L		20-NOV-16	R3598963
Total Kjeldahl Nitrogen	1.06		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.06		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	750		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	393		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	322		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	1.68		0.10	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	574		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.234		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	362	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		14-NOV-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-10 D-5							
Sampled By: DAN LEITCH on 08-NOV-16 @ 16:05							
Matrix: SW							
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	32.9		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	346		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0179		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00056		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0285		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.043		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	56.5		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00043		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.036		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	0.0121		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	53.6		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00746		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00028		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	2.57		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00253		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	7.23		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	5.75		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.114		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00084		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00201		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00048		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	0.77		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.27		0.10	pH units		09-NOV-16	R3592284
L1855349-11 DUP							
Sampled By: DAN LEITCH on 08-NOV-16 @ 13:40							
Matrix: SW							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-11 DUP							
Sampled By: DAN LEITCH on 08-NOV-16 @ 13:40							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.016		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.020		0.010	mg/L		13-NOV-16	R3593885
Phosphorus (P)-Total Dissolved	0.0141		0.0010	mg/L		17-NOV-16	R3597189
Total Kjeldahl Nitrogen	1.27		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	1.30		0.20	mg/L		18-NOV-16	
Total Suspended Solids	6.6		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	100		1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	100		1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	214		1.2	mg/L		10-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	5.76		0.60	mg/L		10-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		10-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	185		1.0	mg/L		09-NOV-16	R3592284
Chloride in Water by IC (Low Level)							
Chloride (Cl)	128		0.20	mg/L		10-NOV-16	R3594580
Conductivity							
Conductivity	814		1.0	umhos/cm		09-NOV-16	R3592284
Fluoride in Water by IC							
Fluoride (F)	0.238		0.040	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	248	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	0.022		0.010	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.027		0.010	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0051		0.0020	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	76.7		0.60	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	491		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0357		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	0.00166		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	0.0396		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	0.083		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	40.4		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	0.00038		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	0.036		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	0.000113		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-11 DUP							
Sampled By: DAN LEITCH on 08-NOV-16 @ 13:40							
Matrix: SW							
Total Metals by ICP-MS							
Lithium (Li)-Total	0.0262		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	35.8		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	0.00476		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	0.00185		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	8.34		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	0.00351		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	5.58		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	91.0		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.213		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	0.00126		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	0.00180		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	0.00145		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	3.72		0.10	NTU		09-NOV-16	R3592138
pH							
pH	8.48		0.10	pH units		09-NOV-16	R3592284
L1855349-12 FB							
Sampled By: DAN LEITCH on 08-NOV-16 @ 16:30							
Matrix: SW							
Miscellaneous Parameters							
Ammonia, Total (as N)	<0.010		0.010	mg/L		15-NOV-16	R3596075
Phosphorus (P)-Total	0.0045		0.0010	mg/L		17-NOV-16	R3597199
Phosphorus (P)-Total Dissolved	0.0011		0.0010	mg/L		20-NOV-16	R3598963
Total Kjeldahl Nitrogen	<0.20		0.20	mg/L	16-NOV-16	18-NOV-16	R3598037
Total Nitrogen	<0.20		0.20	mg/L		18-NOV-16	
Total Suspended Solids	<2.0		2.0	mg/L		11-NOV-16	R3594516
Total and E. coli to endpoint by QT97							
Total Coliforms	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
Escherichia Coli	<100	DLA	1	MPN/100mL		09-NOV-16	R3592636
ROU4W with Total Metals							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	<1.2		1.2	mg/L		14-NOV-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		14-NOV-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		14-NOV-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	<1.0		1.0	mg/L		10-NOV-16	R3594432
Chloride in Water by IC (Low Level)							
Chloride (Cl)	<0.10		0.10	mg/L		10-NOV-16	R3594580

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-12 FB							
Sampled By: DAN LEITCH on 08-NOV-16 @ 16:30							
Matrix: SW							
Conductivity							
Conductivity	<1.0		1.0	umhos/cm		10-NOV-16	R3594432
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		10-NOV-16	R3594580
Hardness Calculated							
Hardness (as CaCO3)	0.25	HTC	0.25	mg/L		19-NOV-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		10-NOV-16	R3594580
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		14-NOV-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		10-NOV-16	R3594580
Sulfate in Water by IC							
Sulfate (SO4)	<0.30		0.30	mg/L		10-NOV-16	R3594580
TDS calculated							
TDS (Calculated)	<5.0		5.0	mg/L		19-NOV-16	
Total Metals by ICP-MS							
Aluminum (Al)-Total	<0.0050		0.0050	mg/L	10-NOV-16	18-NOV-16	R3598364
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Arsenic (As)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Barium (Ba)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Boron (B)-Total	<0.010		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	10-NOV-16	18-NOV-16	R3598364
Calcium (Ca)-Total	0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Copper (Cu)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Iron (Fe)-Total	<0.010		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Lead (Pb)-Total	<0.000090		0.000090	mg/L	10-NOV-16	18-NOV-16	R3598364
Lithium (Li)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Magnesium (Mg)-Total	<0.010		0.010	mg/L	10-NOV-16	18-NOV-16	R3598364
Manganese (Mn)-Total	<0.00030		0.00030	mg/L	10-NOV-16	18-NOV-16	R3598364
Molybdenum (Mo)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Phosphorus (P)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Potassium (K)-Total	<0.020		0.020	mg/L	10-NOV-16	18-NOV-16	R3598364
Rubidium (Rb)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Selenium (Se)-Total	<0.0010		0.0010	mg/L	10-NOV-16	18-NOV-16	R3598364
Silicon (Si)-Total	<0.10		0.10	mg/L	10-NOV-16	18-NOV-16	R3598364
Silver (Ag)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Sodium (Na)-Total	<0.030		0.030	mg/L	10-NOV-16	18-NOV-16	R3598364
Strontium (Sr)-Total	0.00013		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Thorium (Th)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Tin (Sn)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364
Titanium (Ti)-Total	<0.00050		0.00050	mg/L	10-NOV-16	18-NOV-16	R3598364
Tungsten (W)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Uranium (U)-Total	<0.00010		0.00010	mg/L	10-NOV-16	18-NOV-16	R3598364
Vanadium (V)-Total	<0.00020		0.00020	mg/L	10-NOV-16	18-NOV-16	R3598364

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1855349-12 FB							
Sampled By: DAN LEITCH on 08-NOV-16 @ 16:30							
Matrix: SW							
Total Metals by ICP-MS							
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	10-NOV-16	18-NOV-16	R3598364
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	10-NOV-16	18-NOV-16	R3598364
Turbidity							
Turbidity	<0.10		0.10	NTU		09-NOV-16	R3592138
pH							
pH	5.98		0.10	pH units		10-NOV-16	R3594432

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-N-TOT-ANY-WP	Water	Total Nitrogen Calculated	Calculated
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-T-L-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-TL

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	APHA 4500 NorgD (modified)
Aqueous samples are digested in a block digester with sulfuric acid and copper sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a discrete analyzer with colorimetric detection.			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
P-T-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.			
P-T-L-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS-L
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorous is determined colourimetrically after persulphate digestion of the sample.			
P-TD-COL-WP	Water	Phosphorus, Total Dissolved	APHA 4500 P PHOSPHORUS
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.			
P-TD-L-COL-WP	Water	Phosphorus, Total Dissolved	APHA 4500 P PHOSPHORUS-L
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorous is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
SOLIDS-TOTSUS-LR-WP	Water	Total Suspended Solids	APHA 2540 D (modified)
Total suspended solids in aquesous matrices is determined gravimetrically after drying the residue at 103 105°C.			
TC,EC-QT97-ENDPT-WP	Water	Total and E. coli to endpoint by QT97	APHA 9223B QT97
Analysis is carried out using procedures adapted from APHA 9223 "Enzyme Susbtrate Coliform Test". Total coliforms and Escherichia coli bacteria are simultaneously determined by mixing serial dilutions of sample with a product containing hydrolyzable substrates and sealing in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1855349 Report Date: 21-NOV-16

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Steve Offman

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3592284								
WG2430130-15 DUP		**L1855349-2**						
Alkalinity, Total (as CaCO3)		280	277		mg/L	0.8	20	09-NOV-16
WG2430130-14 LCS								
Alkalinity, Total (as CaCO3)			99.9		%		85-115	09-NOV-16
WG2430130-9 LCS								
Alkalinity, Total (as CaCO3)			101.1		%		85-115	09-NOV-16
WG2430130-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	09-NOV-16
WG2430130-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	09-NOV-16
Batch R3594432								
WG2431818-4 LCS								
Alkalinity, Total (as CaCO3)			100.1		%		85-115	10-NOV-16
WG2431818-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	10-NOV-16
CL-L-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-3 DUP		**L1855349-12**						
Chloride (Cl)		<0.10	<0.10	RPD-NA	mg/L	N/A	20	10-NOV-16
WG2430724-2 LCS								
Chloride (Cl)			99.8		%		90-110	10-NOV-16
WG2430724-6 LCS								
Chloride (Cl)			100.4		%		90-110	10-NOV-16
WG2430724-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	10-NOV-16
WG2430724-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	10-NOV-16
WG2430724-4 MS		**L1855349-12**						
Chloride (Cl)			108.9		%		75-125	10-NOV-16
EC-WP	**Water**							
Batch R3592284								
WG2430130-15 DUP		**L1855349-2**						
Conductivity		633	635		umhos/cm	0.3	10	09-NOV-16
WG2430130-13 LCS								
Conductivity			99.7		%		90-110	09-NOV-16
WG2430130-8 LCS								
Conductivity			98.5		%		90-110	09-NOV-16
WG2430130-11 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-WP	**Water**							
Batch R3592284								
WG2430130-11 MB								
Conductivity			<1.0		umhos/cm		1	09-NOV-16
WG2430130-6 MB								
Conductivity			<1.0		umhos/cm		1	09-NOV-16
Batch R3594432								
WG2431818-3 LCS								
Conductivity			99.2		%		90-110	10-NOV-16
WG2431818-1 MB								
Conductivity			<1.0		umhos/cm		1	10-NOV-16
F-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-3 DUP		**L1855349-12**						
Fluoride (F)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	10-NOV-16
WG2430724-2 LCS								
Fluoride (F)			100.2		%		90-110	10-NOV-16
WG2430724-6 LCS								
Fluoride (F)			103.6		%		90-110	10-NOV-16
WG2430724-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	10-NOV-16
WG2430724-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	10-NOV-16
WG2430724-4 MS		**L1855349-12**						
Fluoride (F)			111.3		%		75-125	10-NOV-16
MET-T-L-MS-WP	**Water**							
Batch R3598364								
WG2430186-2 LCS								
Aluminum (Al)-Total			106.9		%		80-120	18-NOV-16
Antimony (Sb)-Total			101.6		%		80-120	18-NOV-16
Arsenic (As)-Total			102.3		%		80-120	18-NOV-16
Barium (Ba)-Total			105.9		%		80-120	18-NOV-16
Beryllium (Be)-Total			100.0		%		80-120	18-NOV-16
Bismuth (Bi)-Total			95.5		%		80-120	18-NOV-16
Boron (B)-Total			104.2		%		80-120	18-NOV-16
Cadmium (Cd)-Total			100.9		%		80-120	18-NOV-16
Calcium (Ca)-Total			100.6		%		80-120	18-NOV-16
Cesium (Cs)-Total			103.5		%		80-120	18-NOV-16
Chromium (Cr)-Total			104.8		%		80-120	18-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3598364								
WG2430186-2 LCS								
Cobalt (Co)-Total			99.3		%		80-120	18-NOV-16
Copper (Cu)-Total			99.5		%		80-120	18-NOV-16
Iron (Fe)-Total			100.5		%		80-120	18-NOV-16
Lead (Pb)-Total			100.6		%		80-120	18-NOV-16
Lithium (Li)-Total			99.8		%		80-120	18-NOV-16
Magnesium (Mg)-Total			106.1		%		80-120	18-NOV-16
Manganese (Mn)-Total			104.6		%		80-120	18-NOV-16
Molybdenum (Mo)-Total			100.3		%		80-120	18-NOV-16
Nickel (Ni)-Total			102.1		%		80-120	18-NOV-16
Phosphorus (P)-Total			111.0		%		80-120	18-NOV-16
Potassium (K)-Total			105.8		%		80-120	18-NOV-16
Rubidium (Rb)-Total			106.1		%		80-120	18-NOV-16
Selenium (Se)-Total			96.7		%		80-120	18-NOV-16
Silicon (Si)-Total			106.9		%		80-120	18-NOV-16
Silver (Ag)-Total			105.0		%		80-120	18-NOV-16
Sodium (Na)-Total			105.5		%		80-120	18-NOV-16
Strontium (Sr)-Total			106.9		%		80-120	18-NOV-16
Tellurium (Te)-Total			96.5		%		80-120	18-NOV-16
Thallium (Tl)-Total			98.2		%		80-120	18-NOV-16
Thorium (Th)-Total			101.9		%		80-120	18-NOV-16
Tin (Sn)-Total			104.0		%		80-120	18-NOV-16
Titanium (Ti)-Total			103.3		%		80-120	18-NOV-16
Tungsten (W)-Total			104.7		%		80-120	18-NOV-16
Uranium (U)-Total			106.9		%		80-120	18-NOV-16
Vanadium (V)-Total			105.3		%		80-120	18-NOV-16
Zinc (Zn)-Total			94.4		%		80-120	18-NOV-16
Zirconium (Zr)-Total			101.6		%		80-120	18-NOV-16
WG2430186-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	18-NOV-16
Antimony (Sb)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Arsenic (As)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Barium (Ba)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Beryllium (Be)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	18-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3598364								
WG2430186-1 MB								
Boron (B)-Total			<0.010		mg/L		0.01	18-NOV-16
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	18-NOV-16
Calcium (Ca)-Total			<0.10		mg/L		0.1	18-NOV-16
Cesium (Cs)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Chromium (Cr)-Total			<0.0010		mg/L		0.001	18-NOV-16
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Copper (Cu)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Iron (Fe)-Total			<0.010		mg/L		0.01	18-NOV-16
Lead (Pb)-Total			<0.000090		mg/L		0.00009	18-NOV-16
Lithium (Li)-Total			<0.0020		mg/L		0.002	18-NOV-16
Magnesium (Mg)-Total			<0.010		mg/L		0.01	18-NOV-16
Manganese (Mn)-Total			<0.00030		mg/L		0.0003	18-NOV-16
Molybdenum (Mo)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Nickel (Ni)-Total			<0.0020		mg/L		0.002	18-NOV-16
Phosphorus (P)-Total			<0.10		mg/L		0.1	18-NOV-16
Potassium (K)-Total			<0.020		mg/L		0.02	18-NOV-16
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Selenium (Se)-Total			<0.0010		mg/L		0.001	18-NOV-16
Silicon (Si)-Total			<0.10		mg/L		0.1	18-NOV-16
Silver (Ag)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Sodium (Na)-Total			<0.030		mg/L		0.03	18-NOV-16
Strontium (Sr)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Thorium (Th)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Tin (Sn)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Titanium (Ti)-Total			<0.00050		mg/L		0.0005	18-NOV-16
Tungsten (W)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Uranium (U)-Total			<0.00010		mg/L		0.0001	18-NOV-16
Vanadium (V)-Total			<0.00020		mg/L		0.0002	18-NOV-16
Zinc (Zn)-Total			<0.0020		mg/L		0.002	18-NOV-16
Zirconium (Zr)-Total			<0.00040		mg/L		0.0004	18-NOV-16
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R3598037								
WG2433189-10 LCS								
Total Kjeldahl Nitrogen			87.0		%		75-125	18-NOV-16
WG2433189-6 LCS								
Total Kjeldahl Nitrogen			98.6		%		75-125	18-NOV-16
WG2433189-5 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	18-NOV-16
WG2433189-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	18-NOV-16
NH3-COL-WP	**Water**							
Batch R3596075								
WG2433748-2 LCS								
Ammonia, Total (as N)			99.4		%		85-115	15-NOV-16
WG2433748-6 LCS								
Ammonia, Total (as N)			100.2		%		85-115	15-NOV-16
WG2433748-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	15-NOV-16
WG2433748-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	15-NOV-16
NO2-L-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-3 DUP		**L1855349-12**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	10-NOV-16
WG2430724-2 LCS								
Nitrite (as N)			98.7		%		90-110	10-NOV-16
WG2430724-6 LCS								
Nitrite (as N)			98.6		%		90-110	10-NOV-16
WG2430724-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	10-NOV-16
WG2430724-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	10-NOV-16
WG2430724-4 MS		**L1855349-12**						
Nitrite (as N)			109.8		%		75-125	10-NOV-16
NO3-L-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-3 DUP		**L1855349-12**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	10-NOV-16
WG2430724-2 LCS								
Nitrate (as N)			100.4		%		90-110	10-NOV-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-6 LCS								
Nitrate (as N)			100.8		%		90-110	10-NOV-16
WG2430724-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	10-NOV-16
WG2430724-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	10-NOV-16
WG2430724-4 MS		**L1855349-12**						
Nitrate (as N)			109.3		%		75-125	10-NOV-16
P-T-COL-WP	**Water**							
Batch R3593885								
WG2429834-10 LCS								
Phosphorus (P)-Total			94.4		%		80-120	13-NOV-16
WG2429834-9 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	13-NOV-16
P-T-L-COL-WP	**Water**							
Batch R3597199								
WG2434845-2 LCS								
Phosphorus (P)-Total			85.5		%		80-120	17-NOV-16
WG2434845-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	17-NOV-16
Batch R3598972								
WG2436534-2 LCS								
Phosphorus (P)-Total			90.9		%		80-120	20-NOV-16
WG2436534-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	20-NOV-16
P-TD-COL-WP	**Water**							
Batch R3593881								
WG2429809-2 LCS								
Phosphorus (P)-Total	Dissolved		97.5		%		80-120	13-NOV-16
WG2429809-6 LCS								
Phosphorus (P)-Total	Dissolved		96.2		%		80-120	13-NOV-16
WG2429809-1 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	13-NOV-16
WG2429809-5 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	13-NOV-16
P-TD-L-COL-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-TD-L-COL-WP	**Water**							
Batch R3597189								
WG2434841-2 LCS								
Phosphorus (P)-Total	Dissolved		88.4		%		80-120	17-NOV-16
WG2434841-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	17-NOV-16
Batch R3598963								
WG2436522-3 DUP		**L1855349-10**						
Phosphorus (P)-Total	Dissolved	0.0062	0.0055		mg/L	12	20	20-NOV-16
WG2436522-2 LCS								
Phosphorus (P)-Total	Dissolved		90.3		%		80-120	20-NOV-16
WG2436522-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	20-NOV-16
WG2436522-4 MS		**L1855349-12**						
Phosphorus (P)-Total	Dissolved		90.7		%		70-130	20-NOV-16
PH-WP	**Water**							
Batch R3592284								
WG2430130-15 DUP		**L1855349-2**						
pH		8.15	8.15	J	pH units	0.00	0.2	09-NOV-16
WG2430130-12 LCS								
pH			7.41		pH units		7.3-7.5	09-NOV-16
WG2430130-7 LCS								
pH			7.41		pH units		7.3-7.5	09-NOV-16
Batch R3594432								
WG2431818-2 LCS								
pH			7.43		pH units		7.3-7.5	10-NOV-16
SO4-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-3 DUP		**L1855349-12**						
Sulfate (SO4)		<0.30	<0.30	RPD-NA	mg/L	N/A	20	10-NOV-16
WG2430724-2 LCS								
Sulfate (SO4)			100.7		%		90-110	10-NOV-16
WG2430724-6 LCS								
Sulfate (SO4)			101.0		%		90-110	10-NOV-16
WG2430724-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	10-NOV-16
WG2430724-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	10-NOV-16
WG2430724-4 MS		**L1855349-12**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R3594580								
WG2430724-4 MS		**L1855349-12**						
Sulfate (SO4)			108.6		%		75-125	10-NOV-16
SOLIDS-TOTSUS-LR-WP	**Water**							
Batch R3594516								
WG2430116-2 LCS								
Total Suspended Solids			100.7		%		85-115	11-NOV-16
WG2430116-1 MB								
Total Suspended Solids			<2.0		mg/L		2	11-NOV-16
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R3592636								
WG2429827-2 DUP		**L1855349-1**						
Total Coliforms		300	100	DUPM	MPN/100mL	100	65	09-NOV-16
Escherichia Coli		<100	<100	RPD-NA	MPN/100mL	N/A	65	09-NOV-16
WG2429827-1 MB								
Total Coliforms			<1		MPN/100mL		1	09-NOV-16
Escherichia Coli			<1		MPN/100mL		1	09-NOV-16
TURBIDITY-WP	**Water**							
Batch R3592138								
WG2430274-3 DUP		**L1855349-2**						
Turbidity		3.39	3.47		NTU	2.3	15	09-NOV-16
WG2430274-6 DUP		**L1855349-10**						
Turbidity		0.77	0.78		NTU	0.8	15	09-NOV-16
WG2430274-2 LCS								
Turbidity			101.0		%		85-115	09-NOV-16
WG2430274-5 LCS								
Turbidity			100.5		%		85-115	09-NOV-16
WG2430274-1 MB								
Turbidity			<0.10		NTU		0.1	09-NOV-16
WG2430274-4 MB								
Turbidity			<0.10		NTU		0.1	09-NOV-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	07-NOV-16 13:22	09-NOV-16 11:53	0.25	47	hours	EHTR-FM
	2	07-NOV-16 16:00	09-NOV-16 11:53	0.25	44	hours	EHTR-FM
	3	08-NOV-16 09:05	09-NOV-16 11:53	0.25	27	hours	EHTR-FM
	4	08-NOV-16 10:10	09-NOV-16 11:53	0.25	26	hours	EHTR-FM
	5	08-NOV-16 11:45	09-NOV-16 11:53	0.25	24	hours	EHTR-FM
	6	08-NOV-16 13:40	09-NOV-16 11:53	0.25	22	hours	EHTR-FM
	7	08-NOV-16 14:30	09-NOV-16 11:53	0.25	21	hours	EHTR-FM
	8	08-NOV-16 15:00	09-NOV-16 11:53	0.25	21	hours	EHTR-FM
	9	08-NOV-16 15:30	09-NOV-16 11:53	0.25	20	hours	EHTR-FM
	10	08-NOV-16 16:05	09-NOV-16 11:53	0.25	20	hours	EHTR-FM
	11	08-NOV-16 13:40	09-NOV-16 11:53	0.25	22	hours	EHTR-FM
	12	08-NOV-16 16:30	10-NOV-16 11:32	0.25	43	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	07-NOV-16 13:22	10-NOV-16 12:00	48	71	hours	EHTL
	2	07-NOV-16 16:00	10-NOV-16 12:00	48	68	hours	EHTL
	3	08-NOV-16 09:05	10-NOV-16 12:00	48	51	hours	EHTL
	4	08-NOV-16 10:10	10-NOV-16 12:00	48	50	hours	EHT
Nitrite in Water by IC (Low Level)							
	1	07-NOV-16 13:22	10-NOV-16 12:00	48	71	hours	EHTL
	2	07-NOV-16 16:00	10-NOV-16 12:00	48	68	hours	EHTL
	3	08-NOV-16 09:05	10-NOV-16 12:00	48	51	hours	EHTL
	4	08-NOV-16 10:10	10-NOV-16 12:00	48	50	hours	EHT
Bacteriological Tests							
Total and E. coli to endpoint by QT97							
	1	07-NOV-16 13:22	09-NOV-16 14:15	30	49	hours	EHTR
	2	07-NOV-16 16:00	09-NOV-16 14:15	30	46	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1855349 were received on 09-NOV-16 09:20.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10-373444

ALS Environmental

L1855349-COFC

Page 1 of 1

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Company:	PO / AFE:	
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Address:		
Phone: Fax:	Quote #: 58403	
Lab Work Order # (lab use only)	ALS Contact: Judy Sampler: Dan Leitch	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROUTINE-WP	N-TOT-KJ-WP	P-T-COL-WP	NH3-COL-WP	ETL-N-TOT-ANY-WP	P-TD-COL-WP	SO4-IDS-TOTSUS-LR-WP	TC,EC-QT97-ENDPT-WP	MET-T-L-WP				Number of Containers
	D-3	07-NOV-16	13:22	SW													6
	D-4	07-NOV-16	16:00	SW													6
	D-1	08-NOV-16	9:05	SW													6
	D-2	08-NOV-16	10:10	SW													6
	C-2	08-NOV-16	11:45	SW													6
	D-9	08-NOV-16	13:40	SW													6
	D-8	08-NOV-16	14:30	SW													6
	D-7	08-NOV-16	15:00	SW													6
	D-6	08-NOV-16	15:30	SW													6
	D-5	08-NOV-16	16:05	SW													6
	Dup	08-NOV-16	13:40	SW													6
	FB	08-NOV-16	16:30	SW	✓	✓	✓	✓	✓	✓	✓	✓	✓				6

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Bacterial samples for D-3 and D-4 are past 24-hr hold time. Please process immediately. Nutrients for D-3 and D-4 should also be processed immediately.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: <Original signed by>	Date: 9:20 Nov 9	Time:	Received by: <Original signed by>	Date: Nov 9	Time: 9:20 a.m.	Temperature: 6 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

1 = 6.4 3: 5.8°C
2: 6.4

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

APPENDIX D6-E3

ISOTOPE
(ANALYSIS BY UNIVERESITY OF WATERLOO ENVIRONMENTAL ISOTOPE LABORATORY)

Client: Friedman Hamm
KGS Group
PO#: 16-0300-006-1300.05
LMB Sampling 2016 October/November

ISO# 2016522
Location:
5 for 18O, 2H

Environmental Isotope Lab
2/8/2017
1 of 1

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	pH	EC
				H_2O	VSMOW ± 0.2‰		H_2O	VSMOW ± 0.8‰			uS/cm
1	EC01-WW2	18-Oct-16	373021	X	-14.59		X	-109.82		7.35	352
2	EC-01WW1	19-Oct-16	373022	X	-13.96	-13.81	X	-103.88	-103.42	6.64	610
3	ED-01	26-Oct-16	373023	X	-14.72	-14.89	X	-113.02	-112.97	6.51	511
4	EC-03	28-Oct-16	373024	X	-14.74	-14.72	X	-114.47	-114.81	-	614
5	ED-08	29-Oct-16	373025	X	-14.86	0.16	X	-113.64		-	*

Client's Note:
* Conductivity not recorded - same area/aquifer as other samples.

18O/2H Results from LGR Laser

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Client: Friedman Hamm
KGS Group
P.O.#: 16-0300-006-1300.06

ISO# 2016561
Location:
4 for 18O, 2H

Environmental Isotope Lab
2/8/2017
1 of 1

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	pH	EC
				H_2O	VSMOW ± 0.2‰		H_2O	VSMOW ± 0.8‰			uS/cm
1	D-1 LMB	Nov. 08, 2016	374371	X	-9.72		X	-75.68		8.05	492
2	D-9 LSM	Nov. 08, 2016	374372	X	-8.46	-8.49	X	-72.86	-73.00	8.41	691
3	D-9 LSM-DUP	Nov. 08, 2016	374373	X	-8.51		X	-72.83		8.41	691
4	D-4 Clear Lake	Nov. 07, 2016	374374	X	-11.31	-11.29	X	-80.81	-80.67	8.84	532

18O/2H Results from LGR Laser

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KGS GROUP

CONSULTING ENGINEERS

APPENDIX D

SURFACE WATER STUDY (DELIVERABLE D7)

KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D7
SURFACE WATER STUDY

FINAL - REV 0

KGS Group 16-0300-006
May 2017

PREPARED BY:

<Original signed by>

Patrice Leclercq, P.Eng.
Water Resources Engineer

REVIEWED BY:

<Original signed by>

Dave MacMillan, P.Eng.
Principal, Project Manager

APPROVED BY:

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Colin Siepman, P.Eng.
Senior Infrastructure / Project Engineer

PROFESSIONAL ENGINEERING SEAL

This report has been approved by the following Professional Engineers taking responsibility for the report in their respective disciplines as indicated:

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1.0 INTRODUCTION AND SCOPE OF WORK

1.1 INTRODUCTION

The Surface Water Study has been conducted to provide an understanding of the surface water regime to allow for an assessment of potential surface water issues for Options C and D of the Lake Manitoba Outlet Channel and to provide recommendations for design and construction. The location of these channels is shown on Plate D7-1 General Site Plan – Route C and D. The study considered existing and future (post-project) surface water hydrology, the interaction with wetlands and groundwater, as well as surface water management during construction and operation.

1.2 SCOPE OF WORK

The scope of work for the study included the following items for both Options C & D:

- Surface water monitoring and water quality testing
- Assessment of existing surface water hydrology
- Assessment of future surface water hydrology
- Assessment of existing and future surface water interaction with groundwater
- Development of a Preliminary Surface Water Management Plan (SWMP)
  - surface water drainage
  - erosion and sediment control
- Development of surface water management recommendations

This report documents the results for the scope of work identified above, with the exception of the surface water monitoring and water quality testing task, which is documented independently in Annual Monitoring Technical Data Reports (Deliverables D2 and D3), to be issued in July of 2017 and 2018. Data collected during the first monitoring event in October 2016, as well as analyses conducted during the development of the field program has, however, been considered in this report. Other project related tasks, such as the Groundwater Study and the Geotechnical Investigations and Analyses are considered in this report and documented separately.

2.0 SURFACE WATER HYDROLOGY

2.1 OPTION C

2.1.1 Existing Conditions

Option C is an approximately 11.6 km (7.2 mi) long channel located immediately south of the Pinaymootang First Nation, situated on privately held lands and leased Crown lands, joining Lake Manitoba to Lake St. Martin as shown on Plate D7-2.

The surficial geology in this region is typically calcareous loamy till while moderately to excessively stony. Bedrock is also present near or at the surface in a number of locations. The topography is relatively flat, or gently undulating. Although there is some agricultural activity in the area (mostly hay and pasture), the terrestrial environment is mostly forested, and intermixed of grasslands and small wetlands. In general, the area is poorly drained and has only a few small creeks or drainage ditches.

Overland flow in the vicinity of the Option C channel alignment is sub-divided into four small basins that either drain east to Lake St. Martin at and near Harrison Creek, or north and west to Lake Manitoba, the Fairford River and Inlet Creek. The existing drainage area of the basins surrounding Option C is shown on Plate D7-2 and summarized in Table D7-1.

TABLE D7-1
EXISTING DRAINAGE AREA OF BASINS SURROUNDING OPTION C

Basin Name	Area (ha)
Basin 1 (Inlet Creek)	1,447
Basin 2 (Fairford Contributor)	985
Basin 3 (Lake St. Martin Contributor)	1,594
Basin 2 (Harrison Creek)	3,518

A preliminary hydrologic assessment of the drainage area of Inlet Creek and Harrison Creek was conducted using the Integration Method, as established by the Province of Manitoba. This method is based on the integration of the rational method for a 5 mi^2 (1,290 ha) area and a

regional flood analysis for an area of 15 mi^2 (3,880 ha). The flows expected at the outlet of Inlet Creek during the 1:10 year and 1:100 year flood events was estimated to range between approximately 3 m^3/s and 4.5 m^3/s (100 cfs and 160 cfs). On Harrison Creek, flows at the outlet were estimated to range between approximately 8 m^3/s and 13 m^3/s (280 cfs and 460 cfs). The median annual flow (1 in 2 year flood event) was estimated at approximately 1.1 m^3/s (40 cfs) on Inlet Creek and approximately 2.4 m^3/s (85 cfs) on Harrison Creek.

On an annual basis, the largest flows typically occur in the spring during the snowmelt period. However, large storm water events may result in peak flows occurring in the summer or in the fall. In general, flows in Inlet Creek and Harrison Creek are relatively small when compared to the estimated flows on watercourses surrounding the Option D Outlet Channel (Section 2.2) and the design flow of the Lake Manitoba Outlet Channel (212 m^3/s or 7,500 cfs).

2.1.2 Future Conditions

The Option C Outlet Channel will intercept a portion of the adjacent basins identified in Section 2.1.1. This is shown on Plate D7-3. Impacts to these basins have been quantified on the basis of percent changes in drainage area, and are summarized on Table D7-2.

TABLE D7-2
PERCENT REDUCTION IN DRAINAGE AREA OF BASINS SURROUNDING OPTION C

Basin Name	Existing Area (ha)	Future Area (ha)	Percent Reduction
Basin 1 (Inlet Creek)	1,447	701	52%
Basin 2 (Fairford Contributor)	985	904	8%
Basin 3 (Lake St. Martin Contributor)	1,594	1,251	22%
Basin 2 (Harrison Creek)	3,518	3,518	0%

Although Inlet Creek has the largest percent reduction in area as a result of the project, as summarized in Table D7-2, the overall impacts of this reduction to flows in Inlet Creek are not expected to be significant. This is based on anecdotal information shared by the baseline survey team which indicated that it is the lower portion of the basin that contributes most to the flows of the creek, and also due to the basin area being relatively small and poorly drained, as

discussed in Section 2.1.1. On Harrison Creek, the Outlet Channel will not result in a change to the drainage area and, therefore, negligible surface water impacts are expected on the creek.

Should this option proceed, a surface water drainage plan will need to be developed to address the area impacted on the south and west side of the channel. This is discussed in Section 3.3.1.

2.2 OPTION D

2.2.1 Existing Conditions

Option D is an approximately 24.0 km (14.9 mi) long channel joining Watchorn Bay on Lake Manitoba to Lake St. Martin near the outlet of Birch Creek. The channel is situated on privately held and leased Crown lands adjacent to numerous marshes and small lakes, as shown on Plate D7-4.

The surficial geology in this region is similar to the area surrounding Option C, as it typically consists of calcareous loamy till that is moderately to excessively stony, but with fewer areas of bedrock present near or at the surface, particularly in proximity to the outlet channel alignment. Similarly, the topography is also relatively flat, or gently undulating. The terrestrial environment is very diverse, and includes agricultural areas (mostly hay and pasture), intermixed of grasslands, forested areas and larger regions of wetlands and small lakes. Although landowners have expressed concerns with poor drainage in the region, the existing drainage network is typically more developed compared to Option C, particularly in proximity of the proposed Option D channel alignment.

Overland flow in the vicinity of Option D generally travels in a westerly direction towards the wetlands and small lakes which include Goodison Lake, Reed Lake, Water Lake and Clear Lake. These lakes and wetlands in turn discharge into Birch Creek which flows northerly towards Lake St. Martin. Only a relatively small area near the channel inlet drains towards Lake Manitoba (Watchorn Creek). The existing drainage area of the basins surrounding Option D are shown on Plate D7-4 and summarized in Table D7-3.

TABLE D7-3
EXISTING DRAINAGE AREA OF BASINS SURROUNDING OPTION D

Basin Name	Area (ha)
Basin 1 (Watchorn Creek)	10,345
Sub-basin 2A (Reed Lake)	2,389
Sub-basin 2B (Water Lake)	7,539
Sub-basin 2C (Goodison Lake)	6,505
Sub-basin 2D (Woodale Drain)	3,591
Sub-basin 2E (Clarks Drain)	5,727
Sub-basin 2F (Lower Birch Creek)	3,727
Total Basin 2 (Birch Creek)	29,477

A preliminary hydrologic assessment of the drainage area of Birch Creek was conducted based on a regional flood analysis. For this assessment, the East Fisher River near Hodgson (WSC gauge no. 05SD004 1961 to 2014) was selected as a representative basin due to its similarity in basin characteristics and proximity to the project site. It was estimated that flows expected at the outlet of Birch Creek during the 1:10 year and 1:100 year flood events range between approximately 40 m^3/s and 75 m^3/s (1400 cfs and 2600 cfs). The median annual flow (1 in 2 year flood event) was estimated at approximately 15 m^3/s (540 cfs).

On an annual basis, the largest flows in Birch Creek typically occur in the spring after the snowmelt period. Peak water levels in the wetlands and small lakes that outlet into Birch Creek also typically occur in the spring. However, large storm water events may result in peak flows and water levels occurring in the summer or in the fall. Loggers that were installed in Reed Lake and Water Lake to monitor water levels as part of the field monitoring program will be used to assess the seasonal patterns of water levels and flows in those wetlands. Results of the monitoring program will be documented independently in the Annual Monitoring Technical Data Reports (Deliverables D2 and D3), to be issued in July of 2017 and 2018.

2.2.2 Future Conditions

The Option D Outlet Channel will intercept a portion of the adjacent basins identified in Section 2.2.1. This is shown on Plate D7-5. Impacts to these basins have been quantified on the basis of percent changes in drainage area, and are summarized on Table D7-4.

TABLE D7-4
PERCENT REDUCTION IN DRAINAGE AREA OF BASINS SURROUNDING OPTION D

Basin Name	Existing Area (ha)	Future Area (ha)	Percent Reduction
Basin 1 (Watchorn Creek)	10,345	10,175	2%
Sub-basin 2A (Reed Lake)	2,389	1,311	45%
Sub-basins 2A +2B (Water Lake)	9,928	7,584	24%
Sub-basins 2A+2B+2C (Goodison Lake)	16,433	12,622	23%
Total Basin 2 (Birch Creek)	29,477	20,094	32%

As summarized in Table D7-4, the reduction in drainage area for the wetlands and small lakes due to construction of the Option D Outlet Channel was estimated to range between approximately 23% and 45%. On Birch Creek, the drainage area was estimated to be reduced by approximately 32%, whereas on Watchorn Creek, only by approximately 2%. The reduction in size of the drainage area is expected to reduce inflows to the various wetlands and small lakes, as well as flows in Birch Creek. Potential mitigation measures that address this concern are outlined in Section 3.3.2. In addition, a surface water drainage plan will developed to address the area impacted on the west side of the channel. This is also discussed in Section 3.3.2.

2.3 INTERACTION WITH GROUNDWATER

The potential for current and future (post construction) interaction of surface water with groundwater along Options C and D is discussed in Deliverable D6 and summarized in Sections 2.3.1 and 2.3.2 that follows.

2.3.1 Option C

2.3.1.1 Existing Interaction with Groundwater

The depth of the stream (Inlet Creek) originating near Station 1+000 of the proposed channel is not known, and any base flow contribution from the bedrock to the stream is also not known. However, where bedrock groundwater elevations are high, and corresponding confining surficial sediments are thin, there may be some groundwater base flow to the stream.

The stream east of the proposed channel from Station 9+000 to Lake St. Martin (Harrison Creek) is in an area of thicker till overburden and would be less likely to have interaction with the bedrock groundwater.

In general, as part of the regional flow system, in low topographic areas where there are confining tills and/or postglacial (e.g. lacustrine clays and silts) sediments covering the bedrock aquifer that are relatively thin, there may be groundwater discharges to low-lying wetlands, creeks, ponds/lakes, or discrete spring discharges of groundwater to the surface water system.

2.3.1.2 Future Interaction with Groundwater

Channel Surface Water Infiltration to bedrock Groundwater: The surface water in the Option C channel would be in direct contact with the bedrock groundwater through the channel walls and base. Downward (recharge) groundwater gradients in the central portion of the channel have been measured where the bedrock is topographically high and sediment cover is very thin. Introducing a large and direct interconnection of a surface water source within the Option C channel in an aquifer recharge area will increase the potential for downward infiltration of surface water into the bedrock, with associated water quality changes and widespread risk of bacterial contamination in the aquifer and to water supply (groundwater well) users. This has been identified as a significant concern within Deliverable D6.

Surface Water: Re-routing of local surface water drainage into the channel may affect water quality in the channel, depending on quality of water in the local drains and the amount and potential flow of water in the channel. Constituents in the local surface water drainages (e.g.

bacteria, viruses, agricultural runoff) that otherwise would not have any potential for a direct interconnection to the aquifer, could enter the bedrock groundwater aquifer system, posing a risk to the potable water supply.

Groundwater Discharge to Channel: Depending on groundwater levels, groundwater discharge will occur throughout the Option C channel. Depending on the extent of groundwater discharge and the associated water quality, volume and overall flow in the channel, this might result in a change in surface water quality in the channel before it discharges to Lake St. Martin. Typically, however, groundwater discharge quantities from the relatively low transmissivity aquifer such as in the vicinity of the Option C channel, are proportionally very low compared to through flow within the channel itself. As such, these kinds of water quality changes are nominal, and may be difficult to quantify.

2.3.2 Option D

2.3.2.1 Existing Interaction with Groundwater

Potential for Wetlands Interaction with Groundwater: Based on a drilling and pump test evaluation at Water Lake and an assessment of regional drilling logs closest to the wetlands, the risk of potential interconnection of the wetlands along Option D to the bedrock groundwater flow system is very low because of the presence of a relatively thick, continuous, and low permeability till aquitard above the bedrock aquifer. Till was present beneath the wetland on the west side of Water Lake when drilled. Till was also present in regional drilling logs along both sides of the Birch Creek Drainage system, with somewhat thinner till on the east side of the drainage system. A more detailed description of this assessment is found in Deliverable D6 Groundwater Study Report.

2.3.2.2 Future Interaction with Groundwater

Wetlands: The low permeability till beneath the wetland limits or precludes water level changes in the wetland due to any groundwater piezometric pressure drawdown that will be necessary during channel construction, or that will occur during subsequent channel operations.

Channel Surface Water infiltration to bedrock Groundwater: Mitigation measures, namely aquifer piezometric pressure reduction (depressurization) of the bedrock aquifer will be necessary in portions of the Option D channel to protect against hydraulic fracturing (blow out) of the till channel base during construction and during channel operations. If the till were to hydraulically fracture within the base of the Option D channel, a direct interconnection between the surface water in the channel and the bedrock groundwater could be established. In general, bedrock aquifer piezometric pressures in the Option D channel area favour exfiltration, or discharge to the channel. However, depending on the final optimized channel configuration and operating channel water levels, in particular where there is relatively high bedrock elevation only a few meters beneath the channel invert, this interconnection might temporarily enable surface water to locally infiltrate into the groundwater aquifer. This could have an adverse effect on groundwater quality and would pose a local risk of bacterial contamination to water supply users.

Surface Water: Re-routing local surface water drainage into the channel may affect water quality in the channel, depending on quality of water in the local drains and the amount and potential flow of water in the channel. If mitigation measures and channel optimization in areas of high bedrock beneath the channel are not carried out to address the potential against hydraulic fracturing of the till channel base, constituents in the local surface water drainage could enter the bedrock groundwater (direct interconnection of surface water and groundwater) as previously discussed.

Groundwater Discharge to Channel: Mitigation measures (bedrock aquifer depressurization) will be necessary in portions of the Option D channel to protect against hydraulic fracturing of the till channel base during construction and operation as previously discussed. This may be achieved with the construction of a passive depressurization system (i.e. without mechanical assistance) for the bedrock aquifer, which would discharge either directly to Lake St. Martin, or possibly to the Option D channel, in select areas. The goal of this system would be to mitigate the risk of hydraulic fracturing of the till in the base of the channel, thus preserving an intact, low permeability till base throughout Option D. In this scenario groundwater discharge to Option D would be via a controlled and engineered passive depressurization system. If the till were to hydraulically fracture within the base of the Option D channel, groundwater will discharge directly and in an uncontrolled manner to the channel. Depending on the extent of groundwater

discharge and the water quality, volume and flow in the channel, this could result in a change in surface water quality in the channel before discharge to Lake St. Martin. Typically, however, groundwater discharge quantities from the relatively low transmissivity aquifer such as in the vicinity of the Option D channel, are proportionally very low compared to through flow within the channel itself. As such, these kinds of water quality changes are nominal, and may be difficult to quantify. Additionally, should there be an interconnection created within the channel base due to hydraulic fracturing of the till, subcut excavation and placement of an engineered backfill is possible at an additional cost to help mitigate the direct exchange of surface and groundwater constituents within the base of the channel.

3.0 PRELIMINARY SURFACE WATER MANAGEMENT PLAN (SWMP)

3.1 OVERVIEW

3.1.1 Purpose

The purpose of the Surface Water Management Plan (SWMP) for the Lake Manitoba Outlet Channel is to minimize impacts to overland flow as a result of the Project, during construction and for long term operation. In doing so, measures will be taken to minimize and mitigate the transport and deposition of sediment beyond construction areas and into off-site receiving water bodies such as the Fairford River, Birch Creek, the wetlands upstream of Birch Creek, and Lake St. Martin.

This SWMP is preliminary and describes various proposed measures that should be considered for construction and future operation of the channel. The proposed concepts, designs and structures have been developed according to the project objectives, design criteria identified in Sections 3.1.2 and 3.1.3, and should be enhanced at the next phase of design and over the course of the project as further details are defined.

A draft of the SWMP was first developed considering both Options C and D outlet channel alternatives. However, since Option D was recommended to proceed to the next stage of design as the preferred Alternative, as documented in Deliverable D11 (Risk Assessment and Budget Quantitation Report), the SWMP was subsequently revised to focus on Option D and therefore additional details are provided for this alternative. None-the-less, preliminary information on Option C remains within the SWMP since it was part of the scope of study and was considered during the evaluation of the options.

3.1.2 Objectives

The SWMP incorporates the following objectives:

- Control of surface water sources within or in close proximity to the project area that may be impacted during construction, including surface water in adjacent water courses and

water bodies, surface water from construction dewatering activities due to seepage, depressurizing systems, etc… , surface water from rainfall and/or snow melt runoff;

- Accommodate construction staging and sequencing with consideration for ditching requirements, alignments, and risks associated with runoff and flooding;
- Accommodate surface water runoff during long-term operation with consideration given to ditching requirements, preliminary sizing of the drains and required structures.
- Sediment and Erosion Control.

Site specific treatments (i.e., engineered temporary sediment basins, dikes, etc…) should be identified on an as needed basis at the next stage of design as design details are refined.

3.1.3 SWMP Criteria

This Preliminary SWMP has been prepared considering both temporary and permanent changes to the existing drainage system for the short term (during construction) as well as for long term operation. Individual plans will be considered at the next stage of design such that the design of temporary and permanent measures can be customized according to separate and specific criteria.

The short term water management controls for this SWMP consider methods to manage potential groundwater inflow into the construction area, as well as measures to manage precipitation and surface run-off. Details of the short term measures to be developed at the next stage of design should be designed with sufficient capacity such that the measures can be constructed and maintained without damage to the constructed work or significant delay to the project completion. The storm event selected as the criteria will be identified at the next stage of design and is anticipated to be within the 1 in 5-year and the 1 in 25-year event. For comparison purposes, the temporary erosion and sediment control plan that was adopted for the Red River Floodway Expansion Project was based on a 1 in 5-year storm event. This criteria was defined based on a detailed assessment of erosion potential along the Floodway Channel during construction considering cost and risk.

The long term water management controls identified in the SWMP consider drainage re-alignments that minimize impacts to the environment. The design capacity selected as the criteria for the long term measures will be identified at the next stage of design with

consideration of environmental sensitivities, risk and long term costs, and is anticipated be within the 1 in 10-year and the 1 in 100-year flood event. Typically, provincial drains are designed with a return period of 1 in 10 years and the capacity of culvert and bridge crossings vary depending on the crossing type (e.g. Provincial roads and highways, municipal roads, local access…). For comparison purposes, the design of perimeter ditching and agricultural drains for the Red River Floodway Expansion Project was based on a 1 in 50-year runoff event. Culvert crossings for the drains were design for the 1 in 75-year runoff event, and the drop structures where the drains outlet into the Floodway Channel were design to a 1 in 100-year flood event. The capacity of the structures exceeded that of the drains to allow future drainage upgrades to be made, with recognition that the structures could not easily be upgraded in the future if the drain capacity was increased.

To prevent soil erosion and discharge of sediment bearing water runoff, erosion and sediment control measures have been identified in the SWMP. Proposed measures to be implemented will be in accordance with Provincial Best Management Practices (BMP). These should be installed and maintained until vegetation has been established on disturbed areas. The water management controls will discharge into appropriate watercourses with the methods of containment, treatment and discharge performed according to objectives outlined in the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) Regulation (Reg. 196/2011). Specifically, discharges from site should meet provincial guidelines for total suspended solids, pH, ammonia content and any other parameter that may be identified.

3.2 CONSTRUCTION STAGING AND SEQUENCING

A detailed construction staging and sequencing plan will be developed at the next stage of design considering the proposed project schedule and adopted contracting strategy. Construction is tentatively expected to occur over a period of approximately 3 years. The SWMP will require input from the construction schedule and will be updated at the next stage of design once more details are defined. The information that follows forms the basis to develop the preliminary SWMP.

Construction of the channel may be tendered in one or multiple contracts. Construction activities are likely to start at the downstream end of the channel near Lake St. Martin, however the

proposed contracting strategy and schedule may consider starting at other locations. It is anticipated that the construction method will depend on the contractors preferences and will likely consist of isolating the channel in sections, gradually moving upstream as each section is completed. It is anticipated that each section will be isolated from the next, as required for dewatering purposes. Duration of construction for each individual section is anticipated to take several weeks, however this will depend on the channel length and the total volume of excavation per section. Construction staging and sequencing will be coordinated to maximize excavation while minimizing the time of exposure of newly excavated slopes. Temporary and permanent re-vegetation activities will begin as soon as possible after finished grades are established.

Bridges and control structures are anticipated to be tendered separately. Construction at those locations may start before or after the channel immediately upstream and downstream of the structure has been excavated in the area. Duration of construction for the structures is anticipated to take up to three years depending on the structure.

As discussed in Section 2, both Options C & D will bisect existing drainage adjacent to the channel. Construction of outside drains and/or temporary ditches to redirect surface water and runoff away from the outlet channel excavation area and the control structure/bridge locations will be completed prior to proceeding with major excavation activities. Dewatering activities will also be required throughout construction. Depending on site conditions and construction sequencing, dewatering may be temporarily achieved by gravity in some locations, however active pumping will likely be required throughout the construction period. Dewatering activities will be staged in accordance with the temporary drainage plan. Further discussion on dewatering and temporary drainage is provided in Section 3.4.2.

3.3 SURFACE WATER DRAINAGE PLAN

3.3.1 Drainage Plan for Route C

As discussed in Section 2.1, and shown on Plates D7-2 and D7-3, the proposed alignment for Option C bisects three local drainage basins, resulting in the need to address surface water drainage on the south and west side of the outlet channel. Temporary drainage measures will

be required in the short term during construction and will depend on construction staging and sequencing until the permanent drainage works are completed. Construction methods for new and temporary drainage works should consider the erosion and sediment control plan discussed in Section 3.4.

Due to the presence of bedrock at or near the ground surface in the area, construction of an outside drain is not desirable along the entire length of the channel. Surface water from the Inlet Creek basin will be allowed to runoff naturally into the outlet channel with only minor provision of drainage measures to address the risk of erosion. Alternatively, surface runoff could be captured along Cook Road (existing east-west municipal road that runs parallel to the upstream portion of the outlet channel) and redirected into either Lake Manitoba or the outlet channel near its inlet with a culvert or drop structure.

Further downstream, there may be enough overburden to construct an outside drain on the west side of the channel, upstream of the PTH 6 control structure/bridge location. In this area, the land surface slopes towards Lake St. Martin, and therefore the outside drain would also direct flows towards Lake St. Martin. Flows in the drain could also be redirected into the outlet channel upstream of the control structure location with a culvert or drop structure. This would eliminate the need for a bridge/culvert structure through PTH 6 in the outside drain.

Outside drains are not anticipated to be required along the entire north and east side of the outlet channel, neither along the south side of the most downstream 3km. Considering the relatively small impacts to surface water drainage in the area, a mitigation allowance beyond what has previously been included in the Stage 2 study is likely not required for this Project. However, a budget allowance should be considered to address the potential for increased ditching or drop structure requirements. Cost allowances identified for mitigation and risk are documented separately in Deliverable D11.

3.3.2 Drainage Plan for Route D

As discussed in Section 2.2, and shown on Plates D7-4 and D7-5, the proposed alignment for Option D bisects a number of drainage basins that feed Birch Creek and upstream wetlands and small lakes, resulting in the need to address surface water drainage on the west side of the

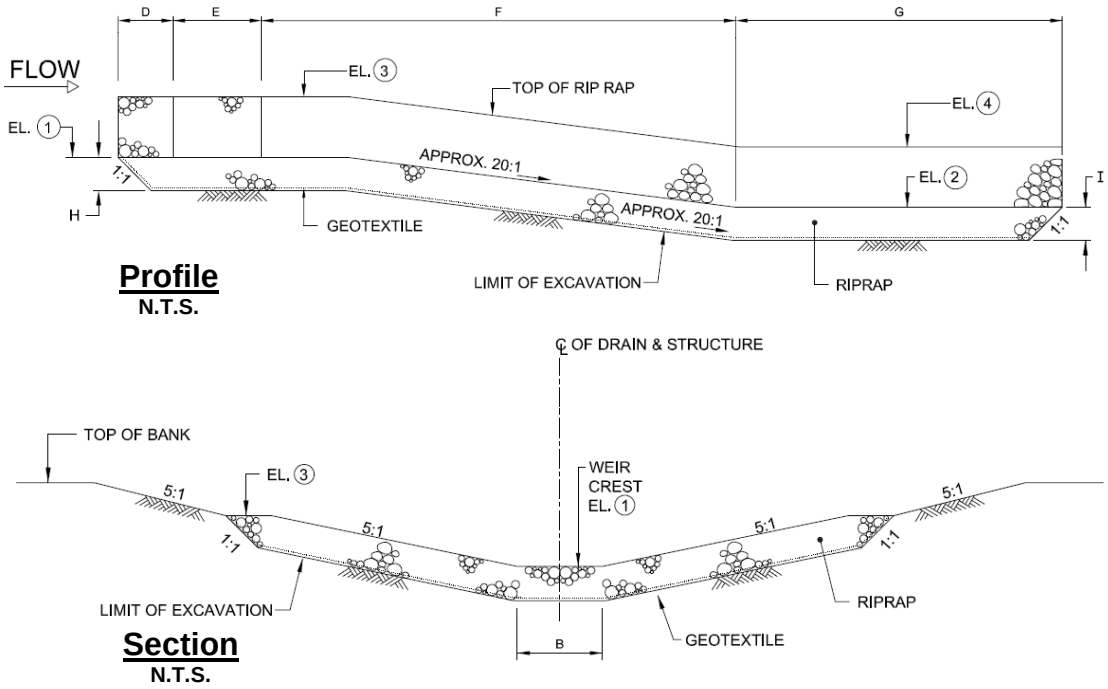
outlet channel. Based on the existing information available, a preliminary drainage plan has been developed for Option D and is shown on Plate D7-6 (Sheets 1 to 3).

Local landowners have previously expressed concerns with the existing drainage in this area and therefore detailed surveys of all existing drains, ditches, culverts and bridge crossings will be required in the area to develop a thorough drainage plan at the next phase of design. The drainage plan will be based on survey data collected and a detailed hydraulic assessment of the drainage requirements.

Temporary drainage measures will be required in the short term during construction until the permanent drainage works are completed. Details of the temporary drainage measures will depend on construction staging and sequencing. Construction methods for new and temporary drainage works will require consideration of the erosion and sediment control plan as discussed in Section 3.4. Additional details on temporary drainage measures are discussed in Section 3.4.2 (Construction Management Practices).

With the exception of a small area of the Watchorn Creek Basin near the Lake Manitoba inlet, all drainage is expected to be routed in a northern direction towards Lake St. Martin. It was assumed that an outside drain will be constructed along the west side of the outlet channel, along its entire length. The majority of the flow will then be re-directed into the channel upstream of PTH 6 with a rockfill drop structure. This structure could also be located downstream of PTH 6 but would result in the need for an additional bridge/culvert crossing under the Highway. Depending on the results of the surveys and detailed hydraulic assessment at the next phase of design, additional drop structures could also be considered at intermediate points along the outlet channel. The purpose of these additional structures would be to either reduce the construction costs of the outside drain, or alternatively to improve local drainage if deemed necessary. The drop structure is anticipated to be similar to the gradient control structures typically used by MI on drainage projects across the Province such as the one proposed for the Rempel Drain in Southern Manitoba shown on Figure D7-1.

FIGURE D7-1
EXAMPLE OF A TYPICAL DROP STRUCTURE



It is assumed that flows within the outside drain collected downstream of PTH 6 will be conveyed directly into Lake St. Martin. An alternate solution would be to re-direct the flow into the outlet channel near its Lake St. Martin outlet. The preferred method will have to consider risks of sedimentation and reduced outflow capacity, similar to existing concerns with the east outside drain of the Portage Diversion.

A preliminary hydrologic assessment of the drainage area intercepted by the outlet channel was conducted to obtain the expected range flows for the 7,345 ha area located upstream of PTH 6 (Plate D7-5). Based on the Regional Flood Discharge formula for the East Fisher River near Hodgson (WSC Gauge 05SD004 1961 to 2014), the discharge during a 1:10 year flood event is estimated to be approximately 14 m^3/s (500 cfs) and 25 m^3/s (900 cfs) for a 1:100 year flood event. The proposed design discharge for the local drainage is anticipated to be between these two flood events, but will need to be defined at the next stage of design considering project goals and objectives, and client requirements and standards, as discussed in Section 3.1.3.

The outside drain will have a minimum base width of 4m with 4H:1V side slopes. Although detailed surveys and hydraulic analyses will be required to define the final geometry of the drain, an average longitudinal slope of 0.013% was assumed appropriate at this stage of design based on the local topography. The depth of flow will range between approximately 1m to 2m resulting in average velocities below 0.5 m/s. Typical cross sections of the Option D Outlet Channel showing the preliminary details of the proposed outside drain is provided on Plate D7-7.

Although the need to address drainage along the channel was considered during the Stage 2 study, an additional mitigation allowance to supplement what has previously been included in the Project cost estimates is recommended to address the potential for increased ditching or drop structure requirements. Cost allowances identified for mitigation and risk are documented separately in Deliverable D11.

Outside drains are not anticipated to be required along the east side of the outlet channel since surface runoff slopes away from the channel on that side. However, depending on the outcome of the environmental approval process, mitigation measures may be required to address the reduction in contributing area to the wetlands and Birch Creek. Location of potential mitigation measures are shown on the Preliminary Drainage Plan (D7-6) and may include one or multiple of the following:

- Construction of a syphon under the outlet channel at Woodale Drain (and/or at other locations), near station 19+000 as noted on Sheet 3 of Plate D7-6, to maintain connectivity with Birch Creek. The syphon would be similar to the existing Seine River Syphon on the Red River Floodway, and would include an overflow structure that would discharge into the outlet channel excess runoff that exceeds the design capacity of the syphon.
- Construction of small control structure(s) at the outlet of the wetland/lakes, as shown on Sheets 2 and 3 of Plate D7-6, to maintain higher water levels during periods of low runoff. The structures would be relatively small, and could take on different forms (e.g. concrete weir, rockfill structure with sheet pile core, stop log structure, etc…) depending on objectives and site conditions.
- Pumping, and/or small water supply channel(s) from the outlet channel to Birch Creek and/or the wetlands to provide an additional source representative of the area cutoff by the outlet channel. Potential pumping locations are shown on Plate D7-6 near stations 6+000 and 13+800. These locations were identified due to their proximity to existing drains and since water levels in the outlet channel will be lower than in the adjacent

wetlands. The water supply channel would be located near station 19+000 and would have to draw water from the outlet channel upstream of the control structure where water levels are higher, and would discharge further downstream into Birch Creek at a location where water levels in Birch Creek are lower than in the outlet channel under the range of operating conditions.

Although the need and requirement for mitigation measures to be incorporated into the project are unknown at this stage of design, a budget allowance is recommended to address the surface water concerns associated with a reduction in contributing area to Birch Creek and the wetlands. Depending on the mitigation measures that may be adopted for the project, a review of hydraulic conditions at the existing PTH 6 and PR 239 road crossings over Birch Creek should be considered at the next stage of design. Upgrades to the crossings may be required if they are found to be hydraulically undersized with regard to current Provincial hydraulic design criteria for road crossings (1% event) or considering potential requirements for future fish passage. Cost allowances identified for mitigation and risk are documented separately in Deliverable D11.

3.4 EROSION AND SEDIMENT CONTROL PLAN

The erosion and sediment control plan is a component of the SWMP that identifies temporary and permanent measures that should be incorporated during construction until vegetation has been established on disturbed areas. The measures must consider the short and long term drainage plan, as discussed in Section 3.3, to ensure they achieve their intended purpose to minimize and mitigate the transport and deposition of sediment beyond construction areas and into off-site receiving water bodies.

3.4.1 Re-Vegetation

The Stage 1 and Stage 2 Studies of the outlet channel included the development of a conceptual re-vegetation plan for the outlet channels. Re-vegetation of the channels will be required to mitigate the potential for surface water erosion and the potential colonization of the channel by weeds. Re-vegetation will be a staged approach and start as soon as practical after construction commences.

Revegetation work typically includes three tasks: design, plant material procurement, and installation. Revegetation design will reflect the range of environmental conditions in the affected area. Revegetation of the channel will be divided into zones, linked to position in the channel cross section such as upland berm, mid-slope, lower slope, and wetland, where the wetland is further divided into toe-of-slope and channel bottom. Elements of the revegetation plan are illustrated on the Figure D7-2.

FIGURE D7-2
TYPICAL ELEMENTS OF REVEGETATION PLAN

According to the proposed channel design, all or portions of the channel will permanently retain water. However, due to positioning of the control structure and the operating procedures, there will inevitably be portions of the channel side slopes that will experience alternating periods of submergence and exposure as a result of long term operation and closure of the outlet channel. Under these conditions vegetation would likely not survive, thus making the slopes susceptible to erosion. It is recommended that all upland and side-slope areas be seeded with a composition of species to reflect the changing moisture conditions (drought or flooding). Additional mitigation measures may also be required to address the risk of erosion along exposed side slopes such as installing riprap or implementing constructing management practices (Section 3.4.2). Cost allowances identified for mitigation and risk are documented separately in Deliverable D11.

3.4.2 Construction Management Practices

Construction of the Lake Manitoba Outlet Channel will involve large-scale excavations posing a risk for the erosion of both the excavation and the excavated material. Various methods and techniques on the installation, monitoring, and management of erosion and sediment control measures have been incorporated in this preliminary SWMP and should be considered in more detail at the next stage of design. Implementing these types of temporary measures will help minimize soil erosion and the amount of sediment-laden water flowing from the Project area into nearby watercourses.

Drainage Ditches

Temporary drainage ditches are intended to channelize and control surface water runoff to limit the risk of erosion within excavated areas. The ditches will be constructed to provide sufficient hydraulic capacity (including freeboard) for the discharge of the average run-off resulting from the design rainfall event. When applicable, the design conditions will include any additional contribution from the proposed storm water management system (diversion, pumping etc.) taking place in adjacent work areas. Construction of temporary drainage ditches will be principally located along access roads, while overland drainage will be captured along the outside of the outlet channel excavation area. This will provide an opportunity to consider converting the temporary drainage ditches into the permanent drainage system, as described in Section 3.3 and illustrated on Plate D7-6.

The invert of the ditch networks will be graded consistently within the proposed drainage system to maintain a constant slope and thereby minimize backwater and ponding, as permitted by the local topography. Maximum water depths and flow velocities in the ditches will be calculated by iteration for the design conditions using the Manning's formula:

$$V = \frac{1}{n} \cdot {R_h}^{2/3} \cdot S^{1/2}$$

Where,

V: cross-sectional average velocity (m)
n: Manning's coefficient
R_h: Hydraulic radius (m)
S: Channel slope (m/m)

To avoid excessive Total Suspended Solids (TSS) concentrations and the degrading of infrastructure, some erosion protection will be installed, as deemed necessary during construction. This will include for example, but will not be limited to, temporary re-vegetation techniques, ditch checks, riprap lining, erosion control blankets, silt fences and sediment ponds.

Check Dams

Construction of check dams (or ditch checks) are a temporary measure that may be required to control the flow velocity resulting from the concentration of run-off in the drainage ditches to reduce the potential for erosion and accumulation of suspended sediment in the surface water.

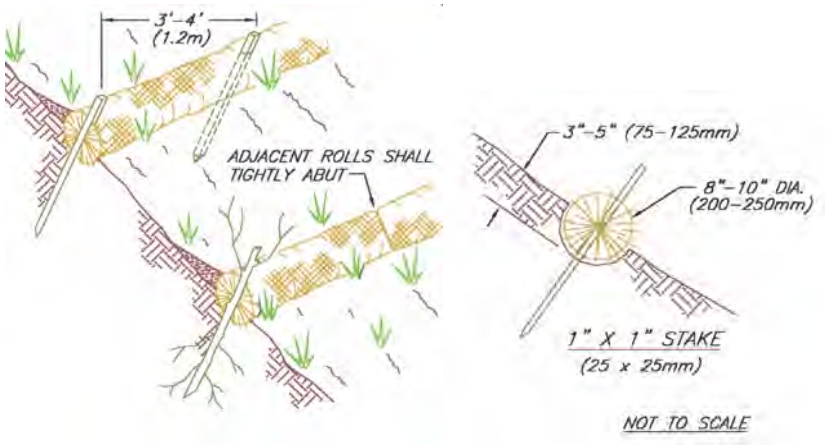
Check dams will be installed in straight sections of ditches to minimize erosion due to curves and an uneven flow distribution. The height of the check dam is determined according to the design flow, the ditch geometry and the required freeboard and would be selected to minimize the number of checks and increase distances between each one of them.

Spacing between check dams will be determined by the channel slope and the height of the ditch check, such that the downstream toe of a ditch check is at the same elevation as the crest of the subsequent check in the downstream direction. For example, with a channel slope of 1V:50H (or 0.02), the maximum distance between 0.3m tall check dams would be 15m.

Check dams will be constructed with material available on site such as rockfill or materials such as riprap or straw/coconut rolls. The typical installation detail for a straw/coconut roll is provided on Figure D7-3.

Within the outside drain of Option D, ditch checks may not be required due to the relatively mild slope that is proposed (0.00013), as described in Section 3.3.2.

FIGURE D7-3
DETAILS OF A STRAW ROLL INSTALLATION



Silt Fences

The installation of silt fences are a temporary measure that will be installed, as deemed necessary, to control sediment transport, particularly to establish and maintain a perimeter around exposed areas, such as staging areas, material stockpiles, parking lots, construction areas etc. Location and placement of the silt fences will be carefully selected to prevent additional erosion due to undercutting or end-cutting of the fence.

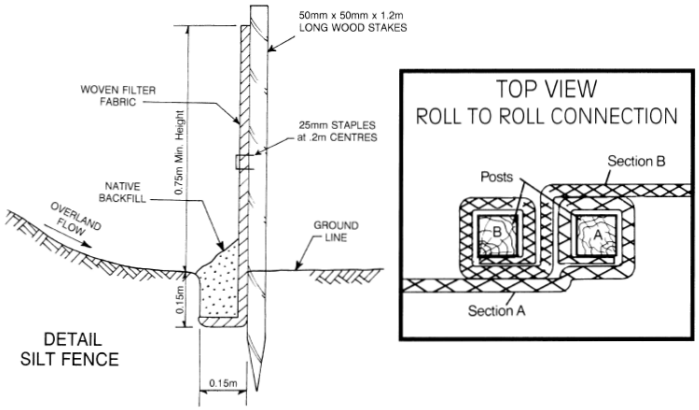
Installation of the silt fences would typically follow the following specifications and details shown in Figures D7-4 and D7-5:

- The silt fence material will be trenched in, 100 mm wide and at least 150mm deep, with vertical sides;
- The trench will be backfilled and compacted;
- J-hooks will be used to reduce the drainage area that any segment will impound;
- Silt fences placed at the toe of a slope will be set at least 1.8 m from the toe in order to increase ponding volume;
- The height of a silt fence will not exceed 0.9 m. Storage height and ponding height will never exceed 0.5 m.;
- The ends of the fence should be turned uphill;

- Steel or wooded support posts (approved by Manitoba Infrastructure) should be utilized, properly spaced and driven into compacted soil., with the posts on the downstream side of the fabric;
- Post spacing should not exceed 1.8 m.; and
- The filter fabric is wire-tied directly to the posts with three diagonal ties.

FIGURE D7-4
SUGGESTED INSTALLATION OF SILT FENCES

FIGURE D7-5
DETAILS OF SILT FENCE INSTALLATION



Sediment Ponds

The construction of temporary sediment ponds will be considered to provide additional surface water storage capacity for the design rainfall event, and to allow sediment-laden water (from runoff and/or dewatering activities) sufficient time for excess sediment to settle.

The location of the sediment ponds will be selected so that they intercept the largest possible amount of run-off from the disturbed area. The exact number of ponds and location would be defined once the construction staging and sequencing plan is developed and the design of temporary drainage measures is finalized. Potential sediment pond locations for Option D are shown on Plate D7-6 at approximately Stations 1+200, 6+000, 8+300, 13+700, 17+000, 18+700, 21+300 and 23+200. The potential locations were identified based on their proximity to existing drains for discharge into the Birch Creek basin after the sedimentation process.

The storage capacity of any sediment pond in the SWMP should be defined according to the total run-off volume calculated over the entirety of the design rainstorm event.

To improve sediment trapping efficiency in the basin, a length to width ratio of 2 to 1 or greater is proposed, as local topography and site conditions permit. Baffles to divert the flow within the basin may be considered to increase the flow path and overall detention time.

If the sediment pond includes an embankment, it will be constructed with well compacted soil and stable slopes. Design details for the sediment ponds will be developed on an as needed basis following MI's approval of the pond location and design criteria.

Dewatering of the sediment ponds is proposed to be carried out by pumping or by gravity via a culvert or an overflow weir. Dewatering will primarily be done by skimming the surface water without removing the sediment laden water found deeper in the basin. The dewatering rate should be adjusted and monitored to allow settlement of the suspended particles. The theoretical sedimentation time for different particle size is identified in Table D7-5.

TABLE D7-5
THEORETICAL SEDIMENTATION TIME OF PARTICLES

Sediment Type	Sedimentation time in 1m water
Gravel	n/a
Coarse Sand	17s
Medium Sand	50s
Fine Sand	2 min
Silt	Up to 15 hours
Clay	> 6 days

Note: based on laminar (non turbulent) flow conditions

The sediment pond performance (trapping efficiency) can be estimated from its area, and a trapping coefficient, determined as a function of the basin shape, using the following equation:

$$R = 1 - \left(1 + \frac{1}{n} \cdot \frac{V_p}{Q/A}\right)^{-n}$$

Where,

R: Basin performance or trapped fraction of target sediment
n: turbulence parameter, defined as $n = 1/(1-\lambda)$ with λ hydraulic efficient coefficient determined from the basin shape
Vp: Vertical fall velocity of particles (m/s)
Q: Discharge rate (m³/s)
A: Surface area (m²)

The hydraulic efficiency coefficient can range from 0.1 for a pond with a length to width ratio of 2 or less, up to 0.9 for a basin built in an agricultural ditch. The higher the hydraulic coefficient, the more effective will be the sediment pond.

Temporary Slope Stabilization

The stabilization and the implementation of erosion protection measures may be recommended for all temporary and permanent slopes located within the construction areas. Typical cross sections of Option D illustrating the proposed side slopes of the channel are provided on Plate D7-7. Unprotected excavated slopes may lead to erosion, development of preferential pathways and gullies, and material instabilities, which ultimately could lead to a slope failure.

Erosion control blankets will be considered for temporary protection. The type of erosion control blanket will be selected according to the manufacturer's specifications, based on the anticipated longevity required, slopes, permissible shear stress and maximum flow velocity. Erosion control blankets may also be combined with silt fences or berms.

The site preparation for the installation of the erosion control blankets should be as follows:

- Proper site preparation to ensure complete contact of the protection matting with the soil;

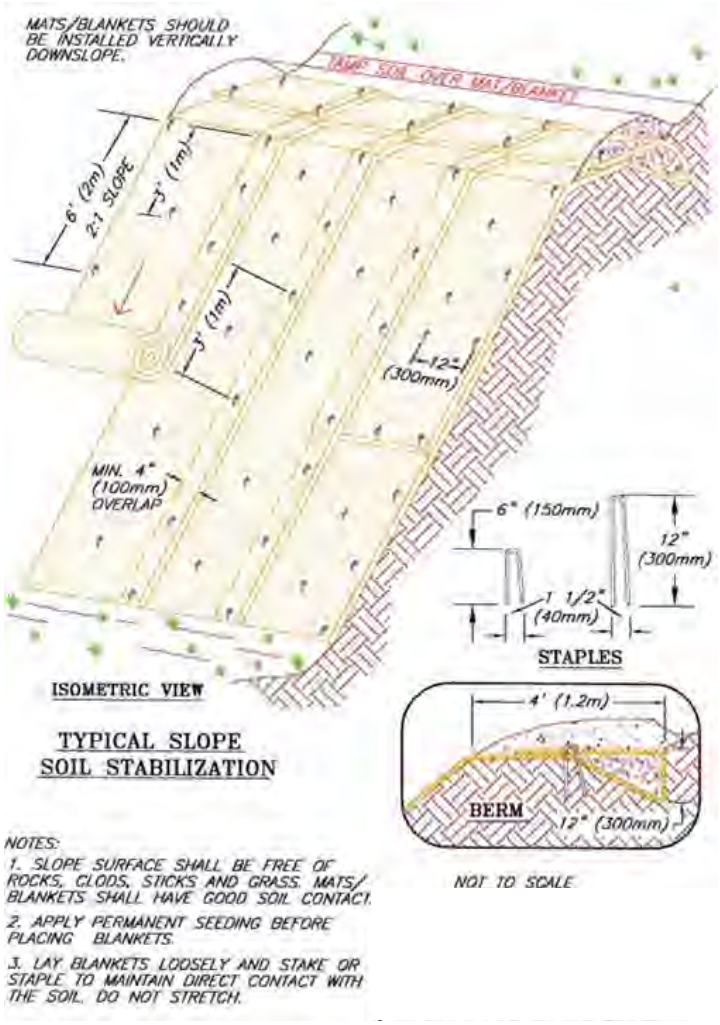
- Grade and shape area of installation; and
- Remove all rocks, clods, vegetative or other obstructions so that the installed blankets, or mats will have direct contact with the soil.

Anchoring of the blankets to the ground surface will be done with U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes. Wire staples should be a minimum of 11 gauge. Metal stake pins should be 4.8 mm (3/16 inch) diameter steel with a 38.1 mm (1 1/2 inch) steel washer at the head of the pin. Wire staples and metal stakes should be driven flush to the soil surface. All anchors should be 0.2-0.5 m (6-8 inches) long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils.

Erosion control blankets will be keyed in a small trench at the top of the slope and folded underneath themselves to insure that water flows over the top of them. Blankets will be unrolled downslope in the direction of the flow. The edges of adjacent parallel rolls should be overlapped 50-75 mm (2-3 inches) and be stapled every 0.9 m (3 feet). Blankets should be stapled sufficiently to anchor the blanket and maintain contact with the soil. Staples shall be placed down the centre and staggered with the staples placed along the edges. Steep slopes, 1:1 to 2:1, require 2 staples per square meter. Moderate slopes, 2:1 to 3:1, require 1-2 staples per square meter. Gentle slopes require 1 staple per square meter.

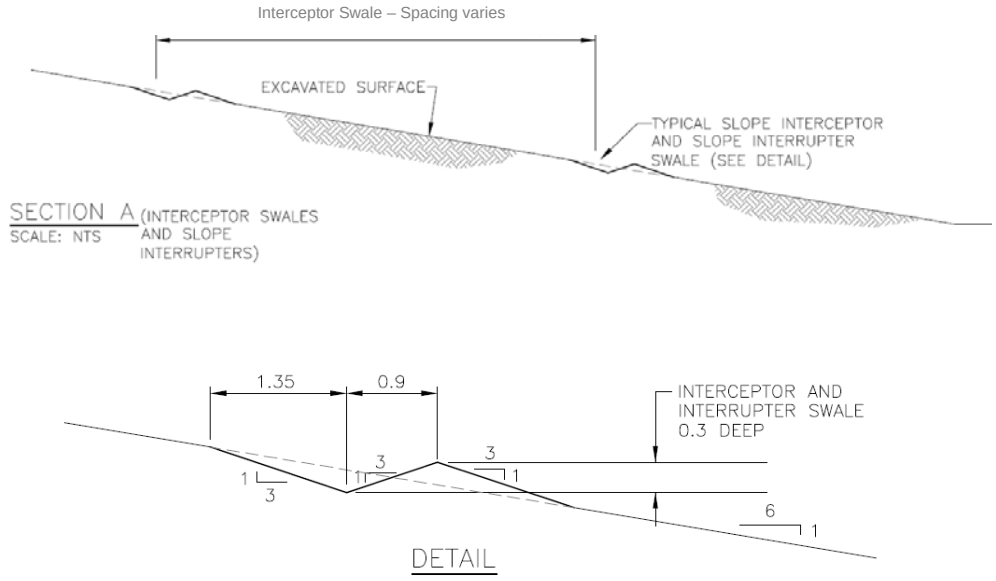
Erosion control blankets should be inspected periodically and after a rainstorm to identify undermining or imminent signs of failure. Typical details of the installation of erosion control blankets are shown on Figure D7-6.

FIGURE D7-6
DETAILS OF EROSION CONTROL BLANKET INSTALLATION



Other measures such as the construction of flow interceptor swales will be considered. The swales would be constructed at regular intervals along the cross-slope (parallel to contours) to capture and reduce the energy of the runoff and guide downslope runoff to a central swale. The runoff would then be controlled on the central swales with erosion control blanket material, ditch checks, and/or other methods previously identified in this section. This type of measure was used extensively on the Red River Floodway Expansion Project. Typical construction details of an interceptor swale are shown on Figure D7-7.

FIGURE D7-7
DETAILS OF INTERCEPTOR SWALE CONSTRUCTION



Turbidity Curtains

In locations where in-water works is required, turbidity curtains will be considered where the flow velocity is low or non-existent to contain sediment disturbance within a designated area. Potential locations where these would be employed include the channel inlet and outlet areas within Lake Manitoba and Lake St. Martin, where construction of cofferdams and/or groins will be required for the project.

The type of turbidity curtain will be selected according to the manufacturer's specifications, based on the expected site conditions. Installation details, including number and spacing of anchors will follow manufacturer recommendations, considering current velocities and potential wind and wave action acting on the barrier. Installation of the turbidity curtain will extend from the water surface to the lake bottom and will be deployed prior to commencing any in-water works.

3.4.3 Water Quality Monitoring and Follow-up Requirements

A surface water quality monitoring program will be developed for assessing any changes that may result from channel construction activities and assess the effectiveness of the proposed mitigation, and of the Erosion and Sediment Control Plan. A baseline program has already been developed for the current study and will be ongoing until 2018. Results of the baseline program will be documented in subsequent Deliverables D2 and D3, the Annual Monitoring TDRs (due in July 2017 and July 2018). The program outlines the proposed water quality parameters to be monitored, as well as the proposed locations. A groundwater quality monitoring program will also be developed as part of the project, however, these are considered separately and discussed in Deliverable D6.

The long term surface water monitoring plan will be adapted from the baseline program and updated based on the detailed and final design of the project as well as the outcome of the environmental approval process. Water quality monitoring is proposed as a minimum at the same locations as the baseline program as well as additional locations. In general, monitoring is proposed at the following locations:

- Lake Manitoba upstream of the outlet channel inlet.
- Outlet channel upstream of local drainage discharge locations.
- Outlet channel upstream of pump stations / water supply channels.
- Outlet channel upstream of the Lake St. Martin outlet.
- Lake St. Martin downstream of the outlet channel outlet.
- Outlet of all temporary sediment ponds during construction.
- Drainage ditches upstream of all outlet locations.
- Adjacent water bodies, streams and major drains that may be impacted by the project or contribute significant flow to another watercourse or waterbody that may be impacted.

Preliminary surface water monitoring locations have been identified for Option D and are shown on Plate D7-6. In summary, a total of approximately 21 monitoring sites are proposed. Monitoring activities and location, however, will depend on the flow conditions and construction progress. For example, until construction activities begin, there will be no sampling required

within the outlet channel or at the outlet of sediment ponds. Likewise, during dry conditions, if any of the adjacent streams of drainage ditches are not flowing, then they will not be sampled.

Based on input received regarding environmental considerations for the project, there is a concern that there could be poor water quality in the channel when it is not in operation due to stagnant water conditions, including lack of oxygen. As part of the project, a budget allowance is recommended to address this concern. Provision of riparian flow through the control structure would likely be an effective measure to mitigate the risk. Cost allowances identified for mitigation and risk are documented separately in Deliverable D11.

3.4.4 Adaptive Management Strategies

Adaptive management is designed to create opportunity to use the initial designs while managing the risk, to learn from field performance and to incorporate new knowledge into subsequent steps. Although the methods and recommendations outlined in the SWMP will be developed based on site specific expectations and conditions, it is accepted that these conditions are subject to change. Weather conditions, for one, will inevitably drive some of the design decisions during implementation and long term operation. By employing adaptive management principles, assumptions used in the initial design should be evaluated and management practices modified in response to the outcomes during the project construction period based on baseline investigations, follow-up monitoring and reporting.

Adaptive management inherently presumes that the initial design and follow-up monitoring are needed to evaluate whether the initial management practices have accomplished what is intended and if outcomes are consistent with expectations.

3.4.5 Contingency and Emergency Response Planning and Controls

Contingency and emergency response planning will be developed in the event that the “base” erosion and sediment control measures do not meet the water quality objectives or if the prescribed measures are overwhelmed during a severe runoff event greater than the design. Contingency planning will also be incorporated for unexpected events such as, but not limited to, an uncontrolled breach of a settling pond, or the failure of a pumping system for dewatering.

Mitigation measures will be identified in the “base” plan and may include, for example, choosing final locations of settling ponds to minimize direct surface runoff to aquatic environments, or incorporating secondary containment cells at each of the main settling ponds. Contingency measures that would be implemented in the event of an emergency will also be identified and may include, for example, the deployment of straw rolls/wattles, erosion control blankets, rapid stabilization techniques, supplementary seeding, temporary settling ponds etc…

In the event of an emergency, the Contractor would be notified and advised as to which of the contingency and emergency control measures would be implemented. These contingency and emergency control measures would be carried out within a predetermined time period depending on the site conditions and nature of the emergency. As part of the project, a construction budget allowance should be considered to cover the cost of these types of measures, as these would likely be considered above and beyond the base cost that would have been assumed by the Contractor. Cost allowances identified for mitigation and risk are documented separately in Deliverable D11.

4.0 OUTLET CHANNEL AND ROADWAY ALIGNMENT

Based on the preliminary surface water management plan, modifications to the proposed Options C and D alignments are not considered necessary to address surface water drainage in the area. For Option D, the proposed outlet channel alignment was previously shifted to the west during the previous Stage 2 study to avoid directly impacting the adjacent wetlands. Although more costly due to increased length and excavation quantities, the revised alignment has significantly contributed to reducing potential environmental impacts of the alignment.

The final channel alignment will therefore be based on the land acquisition process, any proposed bridge and road re-alignments, as well as channel design optimization. For example, a buyout of existing structures and property adjacent to the outlet channel near Stations 3+000 may be considered to straighten the channel alignment. Optimization of the channel alignment will also be necessary where the outlet channel crosses the Bipole transmission line to accommodate the existing towers.

There is a short reach of Birch Creek that is approximately 200 to 300 m in length which meanders close to the proposed Option D outlet channel alignment near Lake St. Martin (approximately Station 21+700). Mitigation and/or optimization of the channel design and alignment should be considered at this location to address this concern. This will depend on the outcome of the environmental approval and land acquisition processes. At the current stage of design, re-alignment of Birch Creek outside of the proposed project ROW has been tentatively assumed as this could be incorporated into the Project offsetting plans. This is shown on Plate D7-6.3. Alternatively, a buyout of existing structures and property on the west side of the outlet channel may be considered to re-align the channel away from Birch Creek.

Options to re-align the PTH 6 and PR 239 roadways are being considered by MI to minimize cost and improve constructability of the control and bridge structures. In general, moving the control structure downstream is better from a groundwater perspective due to higher upstream water levels which is beneficial where the existing overburden thickness between the bedrock and channel invert is small (as discussed in Deliverable D8). Shifting the channel alignment to accommodate roadway re-alignments and the two crossings in this area may also be considered if necessary, as long as the channel does not encroach on Birch Creek or Goodison Lake.

5.0 RECOMMENDATIONS OF THE SURFACE WATER STUDY

The following recommendations have been identified throughout this report and should be considered as part of the project:

- To address the impacts to existing surface water drainage, the outlet channel design should incorporate on its west side an outside drain for Option D, and on its south side for Option C. An outside drain on the opposite side of the outlet channel is not required.
- Detailed surveys of all existing drains, ditches, culverts and bridge crossings should be conducted on the west side of the proposed Option D outlet channel alignment to develop a thorough understanding of the existing condition and capacity of the drainage network, such that an appropriate and customized drainage plan can be developed at the next phase of design.
- With the exception of a small area near Lake Manitoba for both the Options C and D Outlet Channels, flow intercepted by project should be routed towards Lake St. Martin, with an intermediate discharge location into the outlet channel upstream of PTH 6 with a culvert/drop structure. Future analyses should consider additional culvert / drop structures at intermediate points to reduce construction costs or improve local drainage if deemed necessary.
- For Option D, mitigation and/or optimization of the channel design and alignment should be considered to address the 200 to 300 m length of Birch Creek near Lake St. Martin which meanders close to the proposed outlet channel alignment. This will depend on the outcome of the environmental approval and land acquisition processes.
- For Option D, mitigation measures should be considered to address the reduction in contributing area to the wetlands and Birch Creek. Potential mitigation measures have been identified and include: construction of a syphon under the outlet channel at Woodale Drain (and/or at other locations) to maintain connectivity with Birch Creek; construction of small control structure(s) at the outlet of the wetland/lakes to maintain higher water levels during periods of low runoff; pumping, and/or small water supply channel(s) from the outlet channel to Birch Creek and/or the wetlands to provide an additional source representative of the area cutoff by the outlet channel.
- For Option D, a review of hydraulic conditions at the existing PTH 6 and PR 239 road crossings over Birch Creek should be considered at the next stage of design. Upgrades to the crossings may be required if they are found to be hydraulically undersized with regard to current Provincial hydraulic design criteria for road crossings (1% event) or considering potential requirements for future fish passage.
- The outlet channel re-vegetation plan should consider requirements for additional mitigation measures, such as riprap, to address the risk of poor vegetation growth on portions of the channel banks that are submerged as a result of long term operation.
- The design of the Outlet Channel Control Structure should consider a riparian flow structure to address the concern that there could be poor water quality in the channel,

including lack of oxygen, due to stagnant water conditions when it is not in operation. Other mitigation methods should be considered if deemed necessary.

- The Surface Water Management Plan, which includes the Erosion and Sediment Control Plan, should be customized at the next stage of design for the preferred channel alignment. This will allow the short and long term objectives of controlling surface water sources within or in close proximity to the project area that may be impacted during construction and future operation to be achieved. The methods and measures identified in the Surface Water Management Plan should be implemented in accordance with Provincial Best Management Practices.

- The design capacity selected as the criteria for the temporary and long term water management plan should be identified at the next stage of design with consideration of environmental sensitivities, risk and long term costs. Temporary measures are anticipated to be designed within the 1 in 5-year and the 1 in 25-year events. Permanent measures are anticipated to be designed within the 1 in 10-year and the 1 in 100-year flood events.

6.0 STATEMENT OF LIMITATIONS AND CONDITIONS

6.1 THIRD PARTY USE OF REPORT

This report has been prepared for the Manitoba Infrastructure to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report. This report has been prepared for the Client to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

6.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

KGS Group prepared the geo-environmental conclusions and recommendations for this memorandum in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this report is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of the Manitoba Infrastructure. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

PLATES

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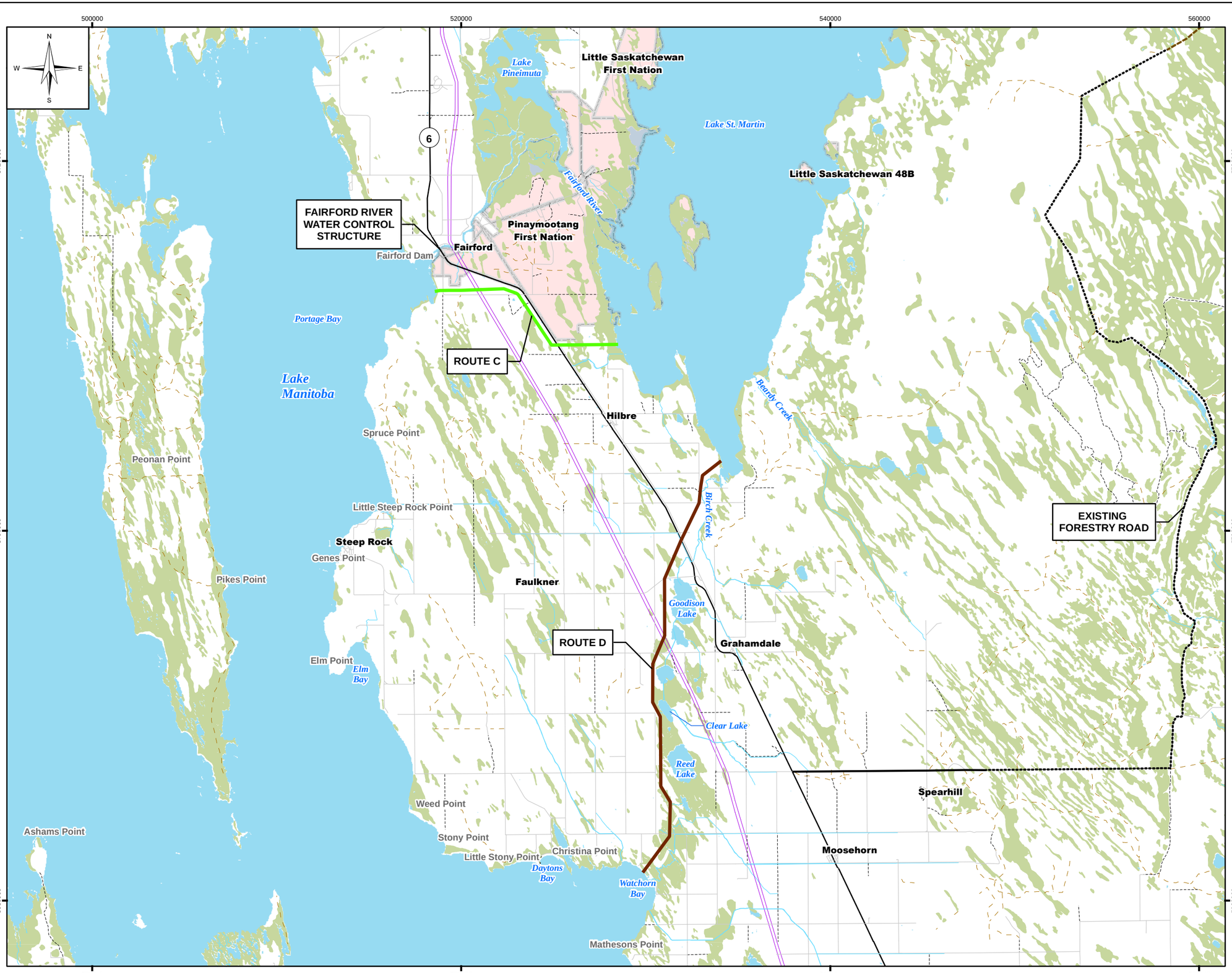

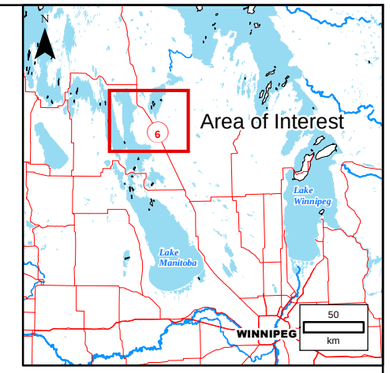

LEGEND:

- LMB Channel Option C
- LMB Channel Option D
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Wetlands
- Waterbody
- First Nation

NOTES:

1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8
Kilometres
SCALE: 1:200,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GENERAL SITE PLAN
ROUTE C AND D

MAY 2017 | PLATE D7-1 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D7\16-0300-006_Plate_D7-1_Rev0.mxd
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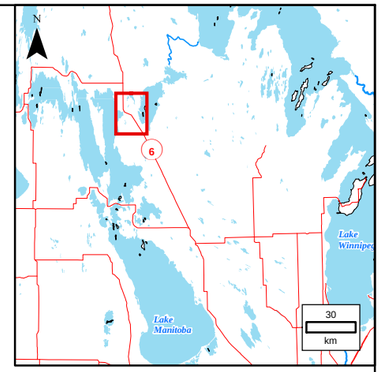

LEGEND:

- Flow Direction
- LMB Channel Option C
- Existing Transmission Line
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Waterbody
- First Nation
- Existing Drainage Area

NOTES:

1. The image shown was obtained from ESRI base map.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

1 0 1 2 3

Kilometres

SCALE: 1:75,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

EXISTING DRAINAGE AREA – OPTION C

MAY 2017 | PLATE D7–2 | REV: 0

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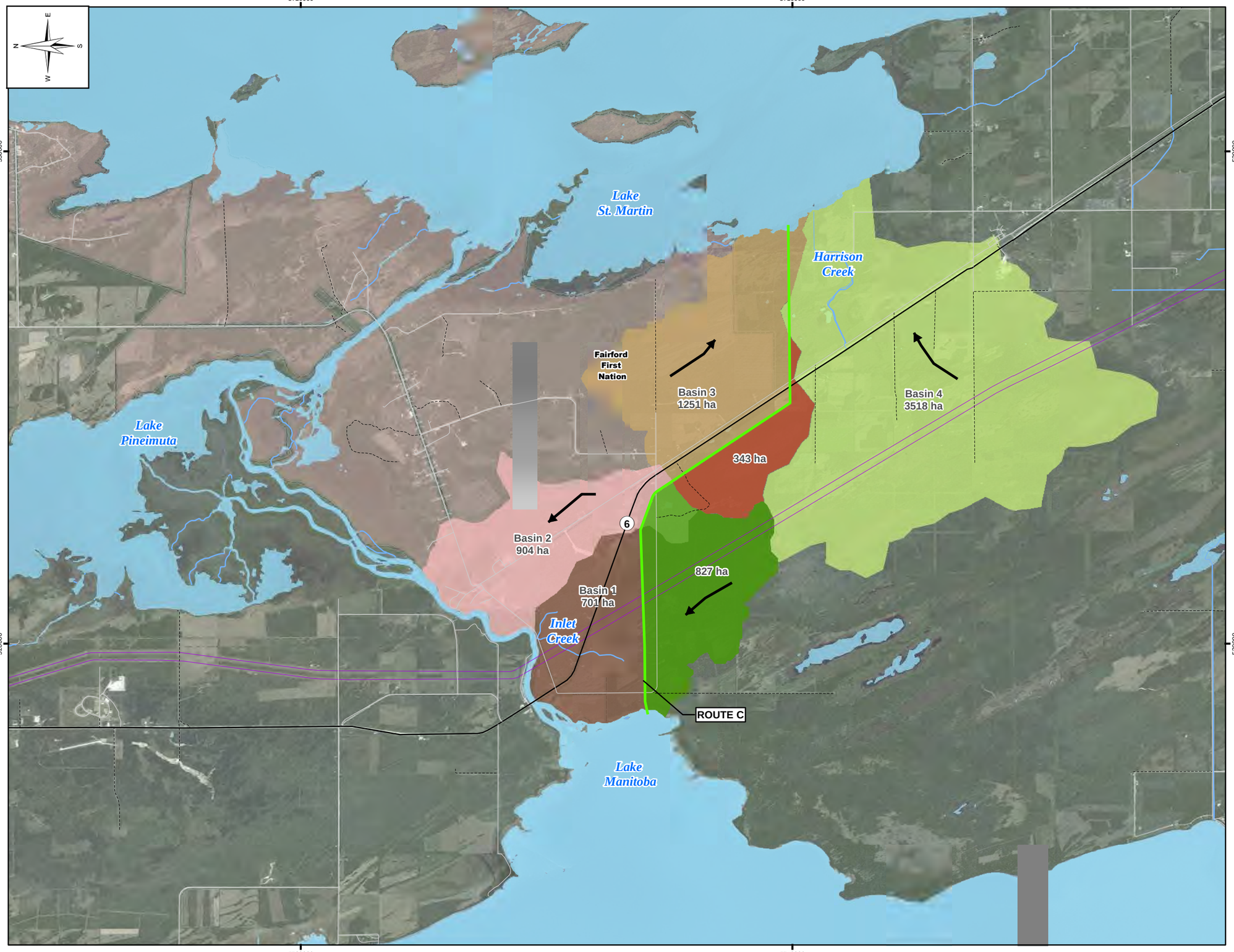

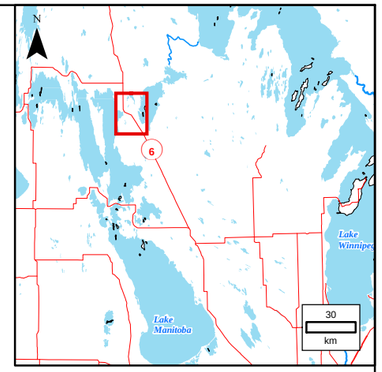

LEGEND:

- LMB Channel Option C
- Existing Transmission Line
- Municipal Road
- Highway
- Limited Use Road
- Watercourse
- Waterbody
- First Nation

NOTES:

1. The image shown was obtained from ESRI base map.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

1 0 1 2 3

Kilometres

SCALE: 1:75,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

FUTURE DRAINAGE AREA – OPTION C

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5710000 5700000 5690000 5680000

550000 540000 530000

Basin 1
10,345 ha

Basin 2E
5,727 ha

Basin 2B
7,539 ha

Basin 2F
3,727 ha

Basin 2C
6,505 ha

Basin 2A
2,389 ha

Basin 2D
3,591 ha

A6= 57 ha

ROUTE D

PTH 6

237

6

239

Lake St. Martin

Lake Manitoba

Fairford First Nation

Clarks Drain

Birch Creek

Goodison Lake

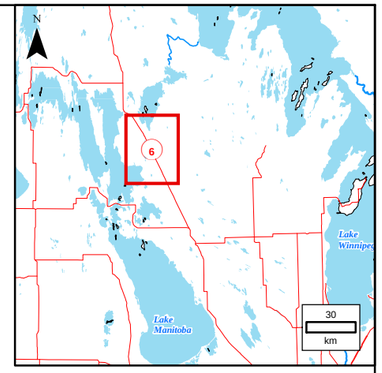
Reed Lake

Watchorn Creek

Woodale Drain

Water Lake

Clear Lake



LEGEND:

- Flow Direction
- LMB Channel Option D
- Existing Transmission Line
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Waterbody
- First Nation
- Existing Drainage Area

NOTES:

1. The image shown was obtained from ESRI base map.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

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Kilometres
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EXISTING DRAINAGE AREA – OPTION D

MAY 2017 | PLATE D7-4 | REV: 0

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5710000 5700000 5690000 5680000

550000 540000 530000

N E S W

Basin 1
10,175 ha

Basin 2
20,094 ha

2038 ha

7345 ha

170 ha

ROUTE D

PTH 6

237

6

239

Lake St. Martin

Lake Manitoba

Clarks Drain

Birch Creek

Goodison Lake

Reed Lake

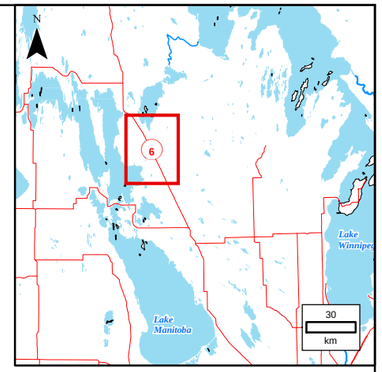
Watchorn Creek

Woodale Drain

Clear Lake

Water Lake

Fairford First Nation



LEGEND:

- Flow Direction
- LMB Channel Option D
- Existing Transmission Line
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Waterbody
- First Nation

NOTES:

1. The image shown was obtained from ESRI base map.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

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Kilometres
SCALE: 1:125,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

FUTURE DRAINAGE AREA – OPTION D

MAY 2017 | PLATE D7–5 | REV: 0

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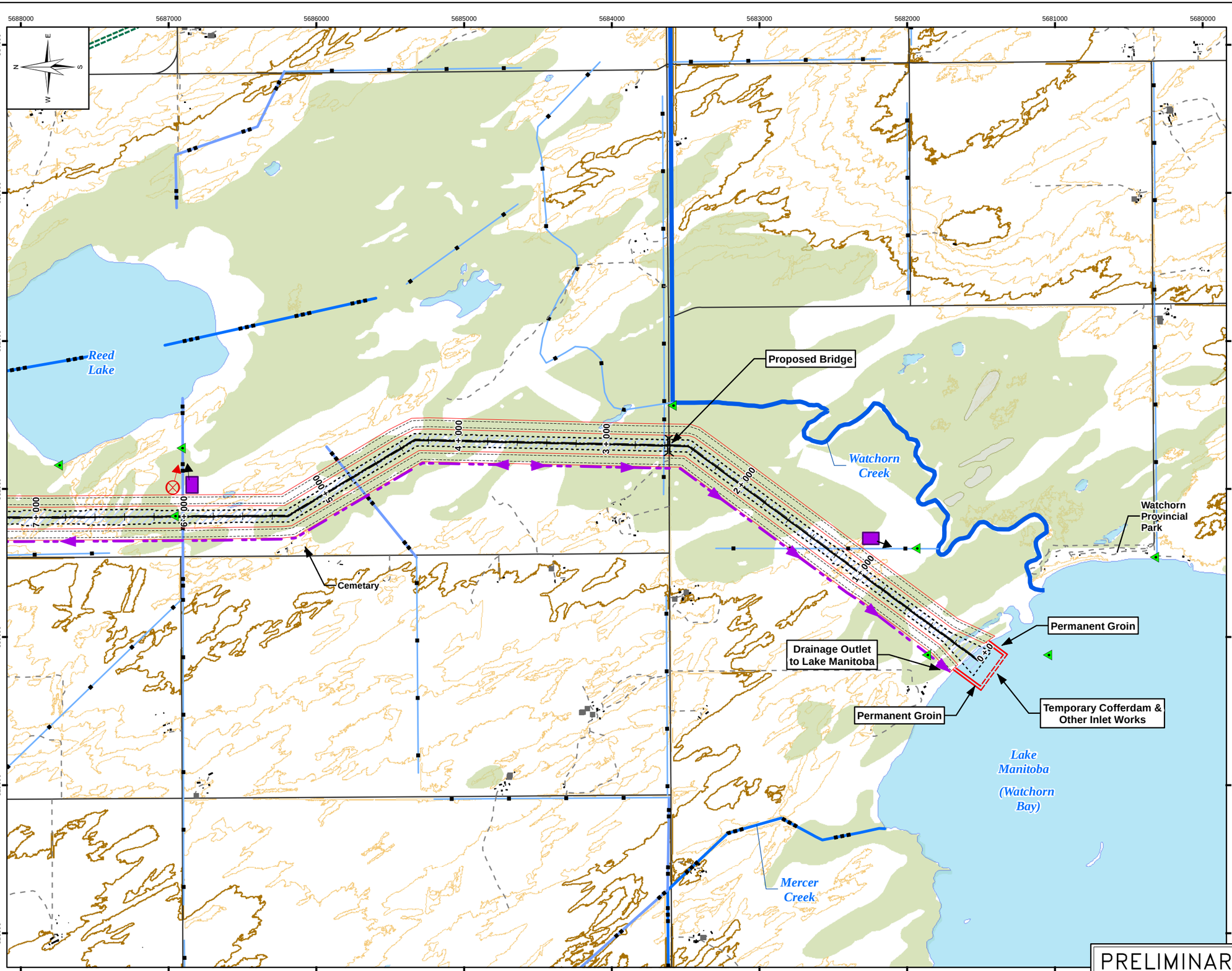

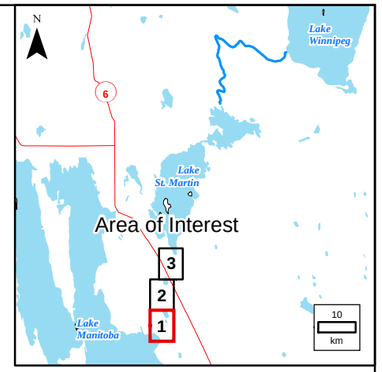

LEGEND:

- Proposed Channel Linework
  - Channel Alignment
  - Cofferdam
  - Permanent Rock Groin
  - Spoil Footprint
  - Top of Channel Footprint
- Utility Lines
  - Transmission Line (Existing)
- Roads
  - Paved Road/Street (1 or more lanes)
  - Gravel Road
  - Dry Season Road
- Water Features
  - 1st Order
  - 2nd Order
  - 3rd Order
  - 4th Order
  - Lake
- LIDAR
  - 1m Contour
  - 5m Index Contour
- Proposed Drainage and Mitigation Measures
  - Potential Water Supply and Pumping Location
  - Proposed Surface Water Monitoring Location
  - Potential Control Structure Location
  - Preliminary Drainage Alignment
  - Potential Sedimentation Pond Location

NOTES:

1. Existing Drainage based on Manitoba Watershed #111 (Birch Creek and adjacent Area)
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:25,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

PROPOSED DRAINAGE PLAN ROUTE D (SHEET 1 OF 3)

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D7-6.1 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D7\16-0300-006_Plate_D7-6_Rev0.mxd
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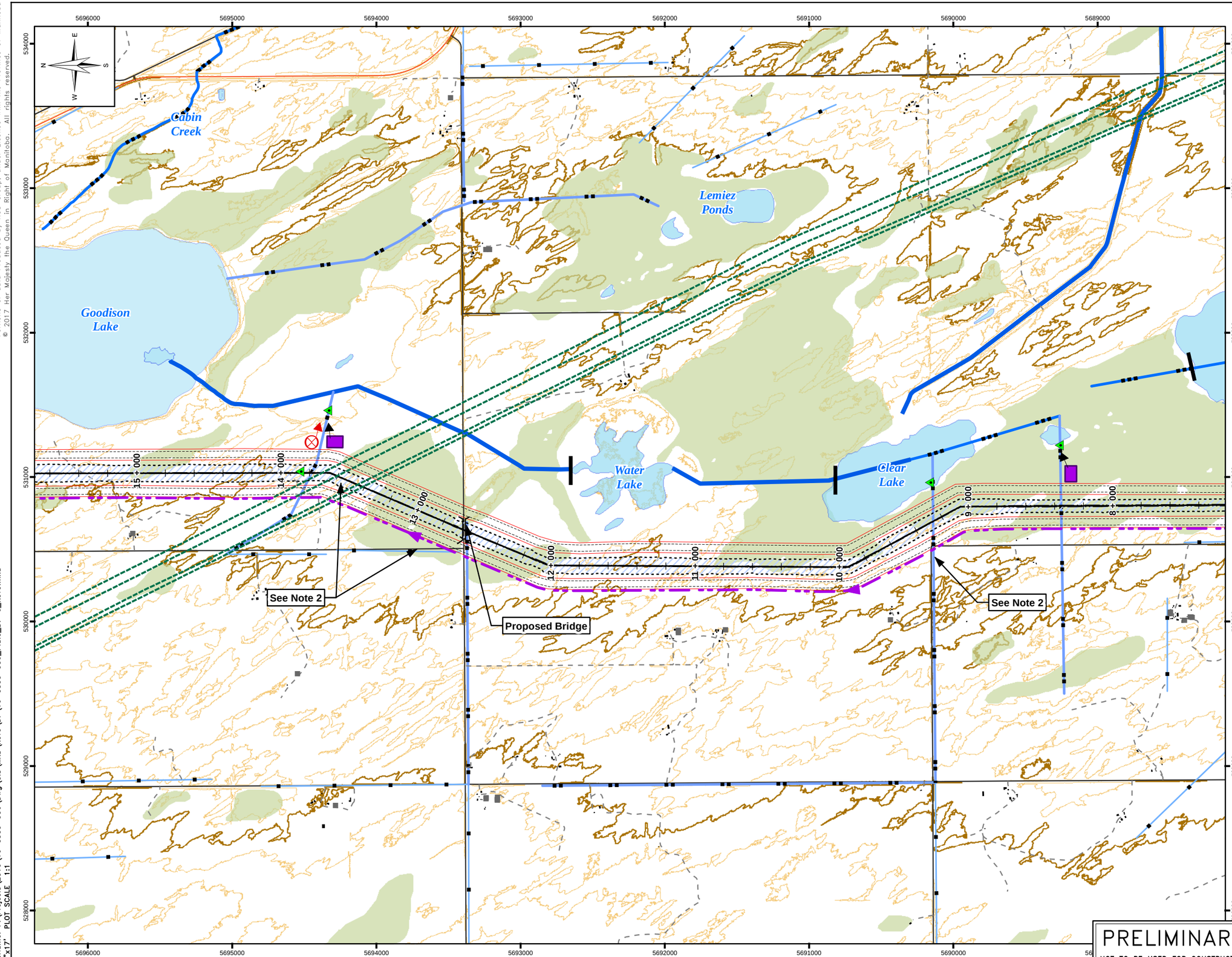

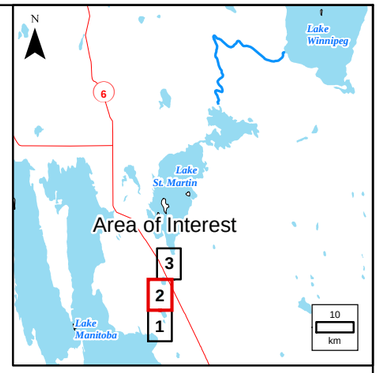

LEGEND:

Proposed Channel Linework
- Channel Alignment
- Cofferdam
- Permanent Rock Groin
- Spoil Footprint
- Top of Channel Footprint

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road

Water Features
- 1st Order
- 2nd Order
- 3rd Order
- 4th Order
- Lake

LIDAR
- 1m Contour
- 5m Index Contour

Proposed Drainage and Mitigation Measures
- Potential Water Supply and Pumping Location
- Proposed Surface Water Monitoring Location
- Potential Control Structure Location
- Preliminary Drainage Alignment
- Potential Sedimentation Pond Location

NOTES:
1. Existing Drainage based on Manitoba Watershed #111 (Birch Creek and adjacent Area)
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.2 0 0.2 0.4 0.6 0.8 1
Kilometres
SCALE: 1:25,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

PROPOSED DRAINAGE PLAN ROUTE D (SHEET 2 OF 3)

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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Temporary Cofferdam & Other Outlet Works

Lake St. Martin

Birch Creek

Potential Birch Creek Re-alignment if required.

See Note 2

Drainage Outlet to Lake St. Martin

Proposed Bridge

See Note 2

Proposed Road Re-alignment

Clarks Drain

PTH 6 & PR 239 Crossing Upgrade over Birch Creek if required.

Potential water supply channel if required.

Birch Creek

Control Structure & Bridge

See Note 2

Proposed Road Re-alignment

Woodale Drain

Drainage outlet into channel with drop structure or potential sypon location if required.

Proposed Bridge & Road Re-alignment

Area of Interest

Lake Winnipeg

Lake St. Martin

Lake Manitoba

LEGEND:

Proposed Channel Linework
- Channel Alignment
- Cofferdam
- Permanent Rock Groin
- Spoil Footprint
- Top of Channel Footprint

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- 1st Order
- 2nd Order
- 3rd Order
- 4th Order
- Lake

LiDAR
- 1m Contour
- 5m Index Contour

Proposed Drainage and Mitigation Measures
- Potential Water Supply and Pumping Location
- Proposed Surface Water Monitoring Location
- Potential Control Structure Location
- Preliminary Drainage Alignment
- Potential Sedimentation Pond Location

NOTES:
1. Existing Drainage based on Manitoba Watershed #111 (Birch Creek and adjacent Area)
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

0.2 0 0.2 0.4 0.6 0.8 1
Kilometres
SCALE: 1:25,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

PROPOSED DRAINAGE PLAN ROUTE D (SHEET 3 OF 3)

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D7-6.3 | REV: 0

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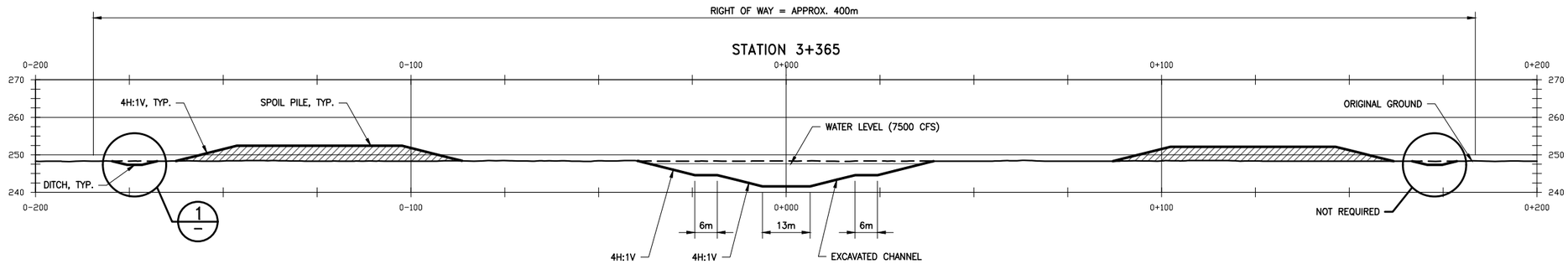
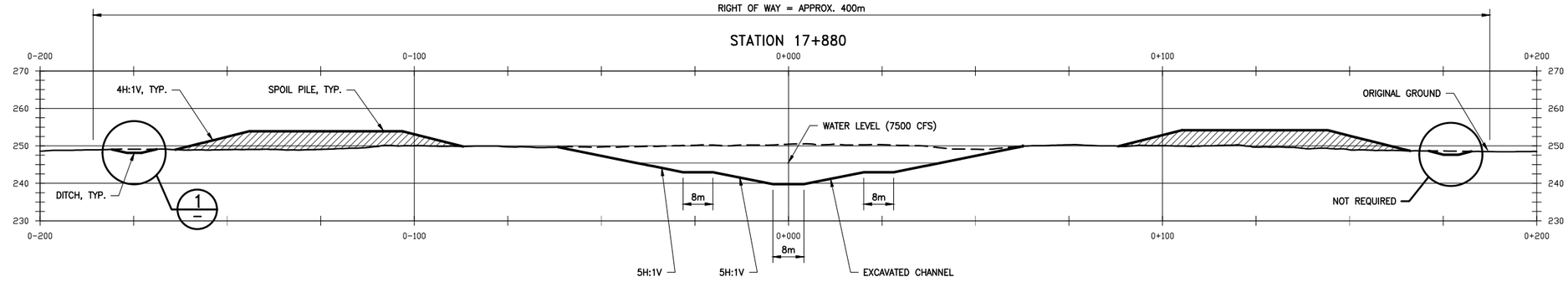
11x17



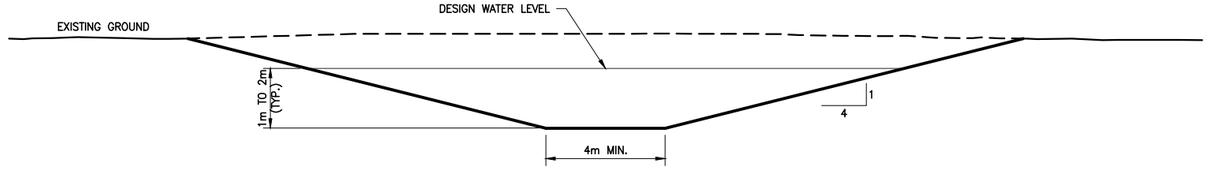
ROUTE D – CROSS SECTION 8m CUT OR LESS

SCALE: 1:750



ROUTE D – CROSS SECTION >8m CUT

SCALE: 1:750



1 – ROUTE D – TYPICAL OUTSIDE DRAIN

SCALE: N.T.S.

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D7	DEA	PAL

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

TYPICAL CROSS SECTIONS AND DETAILS OF OUTSIDE DRAIN FOR OPTION D

MAY 2017 | PLATE D7-7 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE: 1"=2"

KGS GROUP

CONSULTING ENGINEERS

APPENDIX E

GEOTECHNICAL INVESTIGATIONS AND ANALYSES (DELIVERABLE D8)

KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D8
GEOTECHNICAL INVESTIGATIONS AND ANALYSES

FINAL – REV 0

KGS Group 16-0300-006
May 2017

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1.0 INTRODUCTION

In 2011, record widespread flooding occurred across much of southwestern Manitoba, resulting in unprecedented inflows into Lake Manitoba (LMB) and Lake St. Martin (LSM). These high flows extended well into the summer and overwhelmed the capacity of the existing flood control and protection infrastructure. Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by Manitoba Infrastructure (MI) to develop a two-stage process to advance the Lake Manitoba & Lake St. Martin Outlet Channels Conceptual Design Study. One of the fundamental scope items in the Stage 1 study was to identify outlet options for Lake Manitoba (LMB) and Lake St. Martin (LSM). Six Lake Manitoba outlet options were identified in Stage 1 (Options A through F).

Based on screening criteria and economic analyses (among other tasks) completed for each of the 6 options identified within the Stage 1 study (detailed review of preferred alternatives), Options C and D were put forward for further review within Stage 2. The Province of Manitoba announced in the fall of 2014 that it was proceeding with the Stage 2 conceptual design of the preferred Lake Manitoba Outlet Channel alternatives (Options C and D) with a design capacity of 212 m^3/s (7,500 cfs) for the Lake Manitoba Outlet Channel. The location of these channels is shown on Plate D8-1. The Stage 2 study was initiated in January of 2015, and finalized the conceptual design of the Options C and D preferred alternatives for the Lake Manitoba Outlet Channel. The current study involves preliminary engineering assessments, additional geotechnical and hydrogeological investigations, and associated data analyses to identify a preferred route (Option C or D), to move forward with the next stage of design and construction.

For the purposes of the current study, which culminates with the selection of a preferred route between Option C and D, a broader look at all available data from all investigations (including new investigations and testing within the current study) was necessary to evaluate in detail the geological, hydrogeological, and geotechnical aspects of the Routes .

This report summarizes the investigation program and details the preliminary stability analysis and foundations in light of the 2016 investigations along Routes C and D.

2.0 INVESTIGATION PROGRAM

2.1 DRILLING PROGRAM

The investigation program in 2016 (this study) focused on Routes C and D, between Lake Manitoba and Lake St. Martin. Boreholes and 125 mm diameter test wells were advanced for geotechnical, environmental, and hydrogeological purposes. In addition to the 2016 investigations, the previous 2011 and 2015 investigations completed along Routes C and D have been included in Appendix F.

2.1.1 Route C

The borehole drilling and sampling program for the environmental and geotechnical field investigations along Route C was completed from October 5 through November 1, 2016. Hatch Ltd. assisted with the geotechnical program as a sub-consultant to KGS Group. Maple Leaf Drilling Ltd. of Winnipeg, Manitoba provided the drilling services using 125 mm (5 in) solid stem augers and HQ coring. Within the four (4) geotechnical test holes (TH-GC-01, 02, 04, and 05), Standard Penetration Tests (SPT) were performed at 0.75 m (2.5 ft) intervals within the overburden deposits to determine the relative density of the soil. Quality representative soil samples were obtained for soil logging and laboratory testing with the selected drilling and excavating methods. The two (2) environmental test holes (TH-EC-01WW1 and TH-EC-01WW2) and three (3) hydrogeological test holes (TH-EC-01P, 02P, and 04P) were advanced to desired depth for the purposes of installation of groundwater monitoring wells within the overburden deposits and bedrock. The investigation program was completed under the continuous supervision of Hatch Ltd. personnel and at the direction of KGS Group. The locations of the test holes have been provided in plan on Plate D8-4. Detailed test hole logs incorporating field observations are included in Appendix D8-A. Photos of representative overburden and bedrock units sampled during the 2016 investigations programs are provided in Appendix D8-C.

Groundwater Monitoring – Route C

Within each of the test holes, a series of vibrating wire and slotted and screened standpipes were installed for the purposes of monitoring the groundwater conditions along Route C. Details of the well installations and depths are provided on the test hole logs and summarized in Appendix D8-D (Table D6-1).

2.1.2 Route D

The borehole drilling and sampling program for the geotechnical field investigation along Route D at the LMB Outlet Channel was completed from October 17 to 30, 2016. Hatch Ltd. assisted with the geotechnical program as a sub-consultant to KGS Group. Maple Leaf Drilling Ltd. of Winnipeg, Manitoba provided the drilling services using 125 mm (5 in) solid stem augers and HQ coring. Within the five (5) geotechnical test holes (TH-GD-02, 05, 06, 07, and 08), Standard Penetration Tests (SPT) were performed at 0.75 m (2.5 ft) to 1.5 m (5 ft) intervals in the overburden deposits to determine the relative density of the soil. Quality representative soil samples were obtained for soil logging and laboratory testing with the selected drilling and excavating methods. The two (2) environmental test holes (TH-ED-01P and TH-ED-03P) and one (1) hydrogeological hole (TH-ED-01W) were advanced to desired depths for the purposes of installation of groundwater monitoring wells within the overburden deposits and bedrock. Two (2) shallow test holes were installed in the wetlands (TH-ED-01PP1 and TH-ED-01PP2) for monitoring the groundwater regime within the wetlands along Route D. The investigation program was completed under the continuous supervision of Hatch Ltd. personnel and at the direction of KGS Group. Locations of the test holes have been provided in plan on Plates D8-5. Detailed test hole logs incorporating field observations are included in Appendix D8-B. Photos of representative overburden units sampled during the 2016 investigations programs are provided in Appendix D8-C.

Groundwater Monitoring – Route D

Within each of the test holes a series of vibrating wire and slotted and screened standpipes were installed for the purposes of monitoring the groundwater conditions along Route D. Details

of the well installations and depths are provided on the test hole logs and summarized in Table D6-15 that is included in Appendix D8-D .

2.2 LABORATORY TESTING PROGRAM

A laboratory program consisting of grain size analyses, Atterberg limits, Proctor tests, and direct shear tests was completed with composite – reconstituted samples of till materials from both Routes C and D. Laboratory test results are included in Appendix D8-E.

3.0 INVESTIGATION RESULTS

For simplicity, this deliverable discusses the geotechnical interpretation of the investigation results only. The Regional Geological Setting Report (Deliverable D5) presents the bedrock topography and overburden thickness in detail along the Routes C and D channels, along with the longitudinal geological sections for the Route C and Route D channel alignments. The general stratigraphy and geological conditions along each route are also presented in Deliverable D5.

3.1 GROUNDWATER CONDITIONS – GENERAL

The bedrock aquifers in the study area are comprised of the Paleozoic rock sequence commonly referred to in Manitoba as the “Carbonate Aquifer System”. Pervious bedrock strata are separated by argillaceous (clayey or shaley) aquitards or aquicludes. A relatively fresh groundwater quality mound is found in the Interlake area. This area is a major zone of fresh water recharge to the carbonate aquifer, due to the relatively thin sediment cover comprised predominantly of till, with bedrock outcrops common. In these recharge areas, the bedrock aquifer is in an unconfined condition exposed to the atmosphere, with vertically downward gradients. Where interconnections with surface water are present through high permeability sediments or fractures, localized flow systems discharge from the aquifer (as seepage and flow) into streams, marshes, and lakes found throughout the Interlake. The unconfined aquifer transitions into a confined aquifer condition in areas where the carbonate bedrock is capped by a low permeability layer of till, clay or shale and siltstone, and the groundwater level/piezometric pressure is above the confining layer. Groundwater discharge areas are characterized by generally low topography, confined bedrock aquifer conditions capped by till and postglacial sediments, and upward hydraulic gradients (in places under a flowing artesian aquifer condition). Although upward gradients may be present groundwater will not physically move from the aquifer to the surface unless an area of interconnection is present. Areas of thick low permeability deposits above groundwater with upward gradients will have limited discharge locally, but will flow towards regional discharge points such as larger lakes. A secondary, perched groundwater system is expected in localized areas within overburden sediments (postglacial silts, sands, and underlying tills), where the strata overlying the bedrock are of sufficient thickness.

3.2 STRATIGRAPHY – ROUTE C

In general, the stratigraphy at Route C consisted of a thin layer of topsoil overlying till materials including silt and clay till, silt till, clay till, and then bedrock.

Topsoil – A thin layer of topsoil was encountered at the surface and extended to approximately 0.2 m. The topsoil was black to grey in colour, moist, firm and contained organics.

Silt and Clay Till / Clay Till / Silt Till – Varying till deposits were encountered beneath the topsoil containing varying amounts of clay, silt, sand and gravel. The predominant grain size within the till varied spatially and with depth. The thickness of the till ranged from approximately 1.0 m± at TH-EC-01P and up to 9.4 m± at TH-EC-03P. The till was grey in colour, moist to wet, compact to hard and contained occasional cobbles and boulders. Based on eleven (11) SPT tests performed in the till, the uncorrected SPT blow counts (N) in the till ranged from a minimum of 7 in borehole TH-GC-05 to 91 at TH-GC-02. A total of three (3) of the 11 SPT tests performed in the till encountered refusal (i.e. blow counts within any one of the three sets with 50 blows or greater). An approximate 3.0 m± thick layer of cobbles was encountered in test hole TH-GC-02, which was separating the till and bedrock.

Bedrock – Dolomitic limestone bedrock was encountered in all boreholes at approximate depths ranging from 1.0 m± to 9.4 m±. A detailed description of the rock mass characteristics, such as permeability, Rock Quality Designation (RQD) Index and drill core recovery are presented in the regional geological setting of Deliverable D5. Generally, the limestone was highly fractured, showed karstic characteristics, and recoveries of the individual core runs typically varied between approximately 40% and 100%, but in a few limited cases were as poor as 0%. The bedrock overall, based on core recoveries and Rock Quality Designation (RQD), appeared to be in fair condition. RQD rankings varied between approximately 0% and 100%, ranging from very poor to excellent rock quality designation.

Detailed borehole logs are included in Appendix D8-A.

3.3 GROUNDWATER CONDITIONS – ROUTE C

Based on the measured groundwater bedrock aquifer piezometric pressures and overburden (till) water levels along Route C, water levels within the till deposits were generally found to be at or slightly below (1.0 m±) the ground surface. The confined bedrock aquifer piezometric pressures also were generally measured to be at or slightly below (1.0 m±) the ground surface. In general, within the upstream 1/3 of the Route C channel, the bedrock piezometric pressures are confined by relatively thick overlying till strata, with bedrock piezometric pressures near ground surface. Within approximately the central 1/3 of the channel alignment, the bedrock surface rises in elevation, and is characterized by relatively thin overburden cover. Within this area of the channel, the confined bedrock aquifer is characterized by recharge conditions, where the vertical gradients are downward, and water levels are very close to ground surface. Within the downstream 1/3 of the channel, the bedrock surface declines in elevation, along with the topography towards Lake St. Martin. Here, the aquifer is again confined by the overlying tills, with upward gradients that indicate groundwater discharge toward Lake St. Martin. In this area, the ground surface is low enough such that the bedrock aquifer is under a flowing artesian condition.

Along the proposed invert of the channel (El. 243.0 m± to El. 240.5 m±), measured bedrock aquifer piezometric pressures vary from approximately 6.5 m± above the channel invert at the inlet to the channel, to approximately 13.5 m± above the channel invert at Sta. 5+000, which is situated within the relatively high bedrock elevation, groundwater recharge area along the Route C channel.

Groundwater levels will fluctuate seasonally and following precipitation or runoff events, hence the actual groundwater level at the time of construction could differ from those that have been monitored to date.

Detailed hydrogeological data and analysis is contained in the Groundwater Study Report (Deliverable D6) and a discussion of the regional hydrogeological overview is provided in the Regional Geological Setting Report (Deliverable D5). As such, interpretation of the results will not be discussed further within this report.

3.4 STRATIGRAPHY – ROUTE D

In general, the stratigraphy at Route D consisted of a thin layer of topsoil overlying till materials including clay till, silty clay till, silt till, or sandy clay till, and then bedrock.

Topsoil – A thin layer of topsoil was encountered at the surface and ranged in thickness from 0.1 to 0.3 m. The topsoil was black in colour, moist, firm and contained organics.

Clay Till / Silty Clay Till / Silt Till – A range of till deposits were encountered beneath the topsoil containing varying amounts of clay, silt, sand and gravel. The predominant grain size within the till varied spatially and with depth. The till extended to bedrock at an approximate depth of 16.0 m± in test hole TH-GD-07 (located at the proposed control structure) and up to approximately 25.0 m± at test hole TH-ED-01W. The till was grey in colour, moist to wet, hard and contained occasional cobbles and boulders. Based on 61 SPT tests performed in the till, the uncorrected SPT blow counts (N) in the till ranged from a minimum of 0 in test hole TH-GD-05 to 96. A total of 10 of the 61 SPT tests performed in the till encountered refusal (i.e. blow counts within any one of the three sets with 50 blows or greater). In general, blow counts increased with depth. Based on the SPT data, it has been interpreted that there are two layers within the till an upper softer till layer with blow counts ranging from 0 to 30 and a lower dense to very dense till with blow counts ranging from 30 to 96. This transition was encountered at approximately El. 243 m± but was variable based on available drilling.

Test holes TH-GD-07 and TH-GD-08 encountered layers of sand or silty sand within the till. The sand layers were up to 3.2 m± thick. The sand was grey to brown in colour, wet, dense, fine to medium grained and contained varying amounts of silt. Based on five SPT tests performed in the sand and silty sand, the uncorrected SPT blow counts (N) ranged from 37 to greater than 50 with an overall average of 46. Intertill granular zones are typically confined by the tills that surround them, and saturated. When exposed in excavation, often they will drain; though depending on regional continuity and interconnectivity to the overall groundwater flow system, intertill zones may seep groundwater for extended periods of time, if exposed within excavations.

Bedrock – Dolomitic limestone bedrock was encountered in test holes TH-ED-01P, TH-GD-02, and TH-GD-07 at approximate depths of 23.5 m±, 19.7 m±, and 16.1 m± respectively. A detailed description of the rock mass characteristics, such as permeability, Rock Quality Designation (RQD) Index and drill core recovery are presented in the Regional Geological Setting Report (Deliverable D5). Generally, the limestone was highly fractured and showed karstic characteristics. The bedrock overall, based on core recoveries and Rock Quality Designation (RQD), appeared to be in very poor to poor condition. RQD rankings varied between approximately 0% and 48%, ranging from very poor to poor rock quality.

Detailed borehole logs are included in Appendix D8-B.

3.5 GROUNDWATER CONDITIONS – ROUTE D

Along Route D, the bedrock aquifer is confined by continuous and relatively thick overlying till deposits. The bedrock aquifer is thus in a confined condition along the entirety of Route D. Confined piezometric pressures within the bedrock are greater than the water levels measured within the overlying tills, indicating an upward hydraulic gradient groundwater condition from the bedrock aquifer throughout. In addition, the till groundwater pressure levels and in particular confined bedrock aquifer piezometric pressures, extend above ground surface (i.e. under a potential flowing artesian condition).

Based on the measured groundwater levels along Route D, water levels within the till deposits were generally found to be at or up to 5.0 m± above ground surface. Bedrock piezometric pressures were generally measured to be at or up to 8.0 m± above the ground surface. Relative to the proposed invert of the channel (El. 242.0 m± to El. 239.0 m±), groundwater piezometric levels were from approximately 6.0 m± above the invert at the inlet to the channel, to approximately 15.0 m± above the invert at Sta. 21+400.

Groundwater levels will fluctuate seasonally and following precipitation or runoff events, hence the actual piezometric groundwater level at the time of construction could differ from those that have been monitored to date.

Detailed hydrogeological data and analysis is contained in the Groundwater Study Report (Deliverable D6) and a discussion of the regional hydrogeological overview is provided in the Regional Geological Setting Report (Deliverable D5). As such, interpretation of the results will not be discussed further within this report.

3.6 LABORATORY TESTING RESULTS

As previously stated, composite – reconstituted samples of the till were sent to the laboratory for testing. Testing included, proctor tests, grain size analyses, Atterberg limit tests and direct shear tests. Table D8-1 summarizes the test results for the combined till samples from Routes C and D. Four (4) direct shear samples were completed on reconstituted till samples compacted to 98% Standard Proctor Maximum Dry Density (SPMDD).

At final design, sulphate and resistivity testing should be completed in order to determine requirements for cement type and corrosion protection.

TABLE D8-1
COMPOSITE TILL SAMPLE TEST RESULTS
ROUTES C AND D

Route	Grain Size Analysis				Atterberg Limits			Proctor Test[1] (SPMDD) (kg/m^3)	MC @ SPMDD (%)	Direct Shear Test[2]	
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI			Cohesion (kPa)	Friction Angle (Φ')
C	9.6	25.3	45.9	19.2	19	13	6	2120	9.1	20	31
	3.5	30.8	47.5	18.2	18	13	5			10	31
D	12.1	32.1	41.1	14.7	18	13	5	2133	9.5	26	34
	3.5	32.5	45.5	18.5	17	12	5	2122	9.3	2	33

Note: 1. Only enough sample from Route C to complete one proctor test.
2. Direct shear samples tested on samples compacted to 98% of SPMDD

4.0 STABILITY ANALYSIS

Based on the results of the investigations program provided in Section 3.0, stability analyses of the proposed outlet channel geometry for both Routes C and D were conducted to advance the Conceptual Design developed during the Stage 2 Study to a Preliminary Design Level. KGS Group utilized the finite element (FE) numerical modeling package of GeoStudio developed by GeoSlope International Inc. of Calgary, Alberta. The slope stability model was a fully coupled model where the measured groundwater regime was input into the FE seepage model, Seep/W, to calculate the in-situ effective stress state. The resulting stress state was then input into the slope stability model Slope/W to estimate stability conditions.

The following design criteria were used in conjunction with the measured groundwater conditions, stratigraphy and material properties in order to establish side slope requirements for the channel excavation. Four stability cases were examined to determine the side slope requirements:

Case 1 Long Term Condition (after construction) with a minimum estimated factor of safety (FS) of 1.5: under full channel flow condition, or no flow condition with water at lake levels.

Case 2 Short Term Condition (during construction) with a minimum estimated factor of safety (FS) of 1.3: under dry excavated channel condition.

Case 3 Short Term Condition with a minimum estimated factor of safety (FS) of 1.2: under rapid drawdown conditions during channel operation with Open Gate Upstream conditions.

Case 4 Short Term Condition with a minimum estimated factor of safety (FS) of 1.2: under rapid drawdown conditions during channel operation with Closed Gate Downstream conditions.

4.1 ROUTE C

Typical cross sections of the proposed geometry of the Route C channel are shown on Plate D8-2 and are based on the following recommendations developed as part of the Stage 2 Conceptual Design Study:

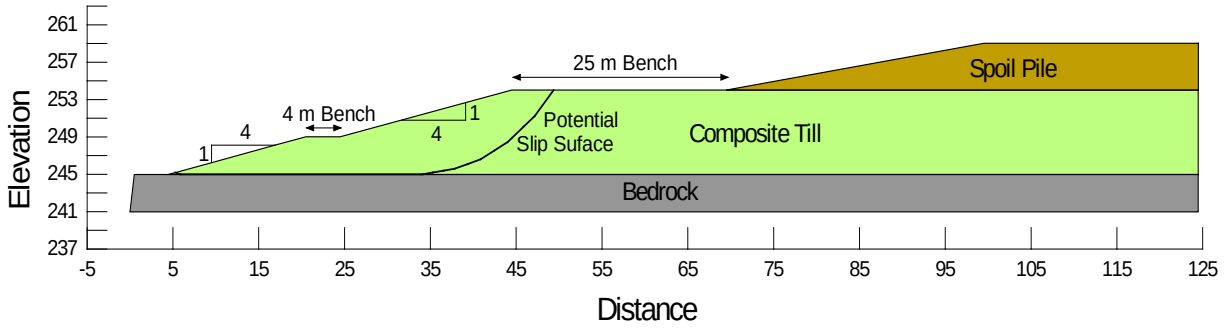
- For channel ‘height of excavation’ in overburden less than 8 m (26.3 ft), channel side slopes of 4H:1V are recommended.

- For channel 'height of excavation' in overburden between 8 m to 12 m (26.3 ft to 13.4 ft), channel side slopes of 4H:1V with a 4 m (13.1 ft) bench at height of excavation of 8 m (26.3 ft) are recommended.
- For channel excavation in bedrock, a minimum slope of 1H:8V is recommended. Various rock stabilization measures may be required depending on the in-situ joint orientation.
- For channel excavation within a combination of bedrock and overburden, a channel side slope of 1H:8V within the bedrock portion is recommended, then a 4 m wide bench, and then a 4H:1V slope within the overburden.
- Spoil pile / dike or topsoil stockpile should be placed a minimum distance of 25 m (82 ft) back from the top of the outlet channel, at a slope of 4H:1V, subject to final design review.

In summary, excavation along Route C will predominantly occur through the varying thicknesses of overburden till materials and in the upstream approximately 2/3 of the channel route, well into the underlying bedrock. The proposed Route C channel has an invert of El. 242.75 m at LMB and El. 240.6 m at LSM. The depth of excavation below ground surface will vary between approximately 4 m and 14 m, with the deepest cut located in the bedrock, between approximately Sta. 4+000 and Sta. 5+000. The highest till cut slope will be approximately 8 m at Sta. 6+800, with a bedrock cut of approximately 4.5 m. Cut slopes within the till will be 4H:1V with a 4 m wide bench at a height of excavation of 8 m from the invert of the channel.

Measured groundwater piezometric pressure conditions in the bedrock in the vicinity of Sta. 6+800 were approximately at El. 255.4 m±. In order to model the end-of-construction scenario, this boundary pressure condition was applied to the bedrock and assumes that there is no depressurization taking place prior to construction commencing. The overburden soil portion consisted of topsoil overlying till materials including silt and clay till, clay till and silt till. All types of till materials were modeled as "composite till". A friction angle, ϕ', within the till material of 31^{o} (as determined from the direct shear testing) and a cohesion of 4 kPa was used in all of the analyses along Route C. Figure D8-1 shows the cross section at Sta. 6+800 used in the stability analysis.

FIGURE D8 - 1
Route C – Sta. 6+800 – Typical Slope Stability Cross Section



Assuming these conditions occur during construction, the estimated factor of safety (FS) for overall stability within the overburden is below 1.0. The analysis shows that as excavation progresses towards the bedrock through the overburden materials, the effective stresses approach zero due to the high observed bedrock groundwater pressures. The cut slopes in the till materials do not have any support at the toe of the overburden slope (zero effective stress) resulting in the estimated failure of the slope due to the observed groundwater pressures. In order to achieve the design FS of 1.3 during construction, the lower confined groundwater pressures in the bedrock are estimated to be lowered to approximately El. 251.4 m± or a lowering of 4.0 m±, but will depend on site specific conditions at the time of construction. Further discussion on the requirement to lower groundwater pressures is included in Section 5.0. A summary of estimated FS for various cases on Route C is presented in Table D8-2.

For the long term scenario, it was assumed that the bedrock cut will act as a drain and the groundwater levels will drawdown passively equilibrating to channel surface water levels, El. 244.1 m± generally below the bedrock surface. To be conservative, it was assumed in the analysis that the extent of the drawdown cone for the groundwater pressures would occur only within the limits of the channel excavation. Beyond the limits of the channel excavation, there was assumed to be no drawdown of groundwater level (i.e. assumed that pre-construction groundwater levels would still occur away from the channel excavation). Under this scenario, the assumed geometry of 4H:1V met the design criteria of an FS of 1.5 with an estimated FS of 1.61. The short term rapid drawdown scenarios both had an estimated FS of 1.98 and 2.29 for Cases 3 and 4 respectively.

4.2 ROUTE D

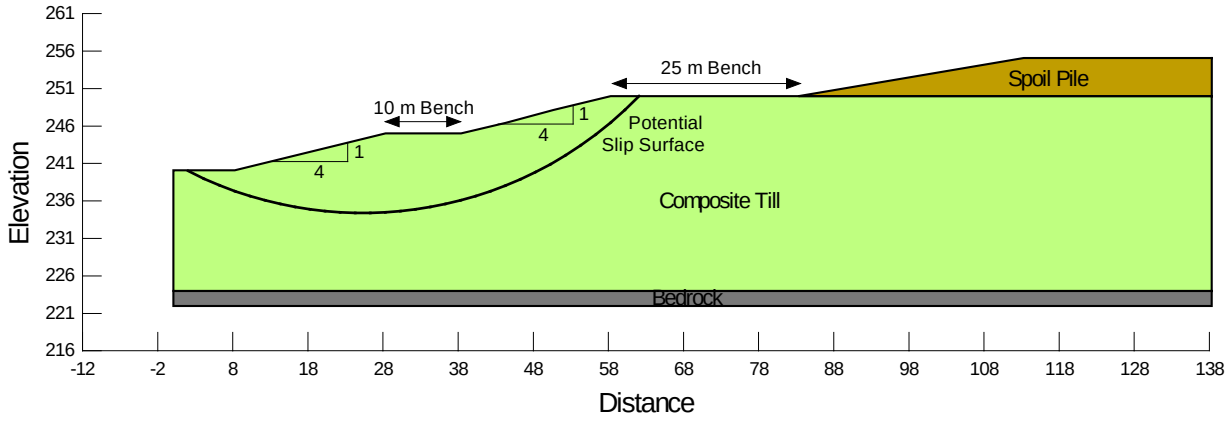
Typical cross sections of the proposed geometry of the Route D channel are shown on Plate D8-3 and are based on the following recommendations developed as part of the Stage 2 Study:

- For channel 'height of excavation' between 6 m to 8 m (19.7 to 26.2 ft), the channel configuration of "2 sections at - 4H:1V of 1/2 height (H) slope with a 6 m to 8 m (19.7 to 26.2 ft), wide mid bench for an effective slope of 5H:1V" is recommended.
- For channel 'height of excavation' between 8 m to 12 m (26.2 to 39.4 ft), the channel configuration of "2 sections at - 5H:1V of 1/2 height (H) slope with a 8 m to 12 m (26.2 to 39.4 ft), wide bench for an effective slope of 6H:1V" is recommended.
- Spoil pile / dike or topsoil stockpile should be placed at a minimum distance of 25 m (82 ft) from the top of the outlet channel.

In summary, excavation will occur entirely within the varying thicknesses of overburden till materials along Route D based on available drilling. The anticipated thinnest section of till remaining below the proposed channel invert, and above the underlying bedrock, is approximately 4 m based on available drilling, and occurs in the vicinity of Sta. 19+000 (approximately at Highway 6). The proposed Route D channel has an invert of El. 242.75 m at LMB and El. 240.6 m at LSM. The depth of excavation below ground surface will vary between approximately 6 m and 12 m. Two sections were analyzed as a part of the preliminary design, a section at Sta. 11+600, which coincides with the location of the thickest till materials below the invert of the channel, and Sta. 19+000, which is where the till is thinnest below the channel invert. Cut slopes within the till will be 4H:1V with a bench at mid-height to create an effective slope of 5H:1V.

Sta. 11+600 – The measured confined bedrock aquifer groundwater conditions at this location are approximately at El. 255.1 m±. In order to model the end-of-construction scenario, this boundary condition was applied to the bedrock and, for the extreme condition, assumes that there is no bedrock aquifer depressurization taking place prior to construction commencing. The overburden soil portion consisted of topsoil overlying till materials including silt and clay till, clay till, and silt till. All types of till materials were modeled as "composite till". A friction angle, ϕ', within the till material of 33^{o} (as determined from the direct shear testing) and a cohesion of 4 kPa was used in all of the analyses along Route D. Figure D8-2 shows the cross section at Sta. 11+600 used in the stability analysis.

FIGURE D8 - 2
Route D – Sta. 11+600 – Typical Slope Stability Cross Section



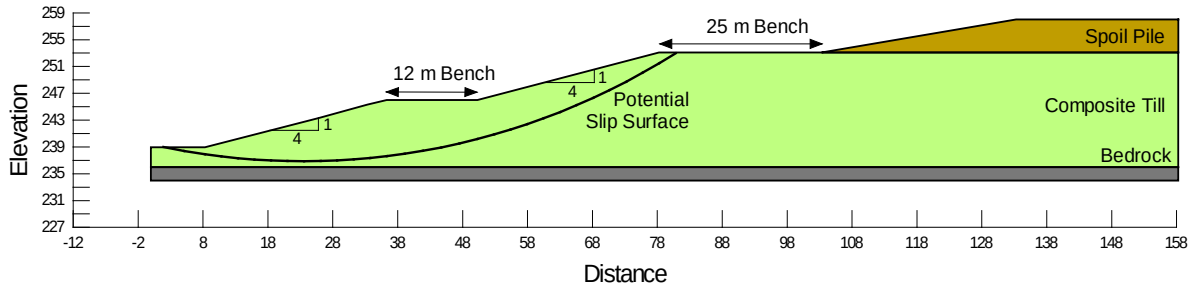
Assuming these groundwater and soil conditions are characteristic during construction, the estimated factor of safety (FS) is below 1.0. As with Route C, the analysis indicates that as excavation progresses towards the proposed channel invert through the overburden tills, the effective stresses approach zero due to the high observed confined groundwater pressures within the underlying bedrock aquifer. The cut slopes in the till materials do not have any support at the toe of the overburden slope (zero effective stress) resulting in the estimated failure of the slope due to the observed groundwater pressures. In order to achieve the design FS of 1.3 during construction, the lower confined groundwater pressures in the bedrock are estimated to be lowered to approximately El. 249.1 m± or a lowering of 6 m±, but will depend on site specific conditions at the time of construction. A discussion of mitigation measures to address the requirement to lower groundwater pressures is included in Section 5.0. A summary of estimated FS for various cases on each of the Route D sections analyzed are presented in Table D8-2.

To be conservative, it was assumed for the long term condition that the groundwater levels would be drawn down to the channel surface water elevation (El. 244.1 m±) along the channel invert and that the extents of the drawdown cone for the groundwater pressures would occur only within the limits of the channel excavation. Beyond the limits of the channel excavation there was assumed to be no drawdown of groundwater level (i.e. assumed that pre-construction groundwater levels would still occur away from the channel excavation). Under this scenario, the assumed geometry of 4H:1V with a bench met the design criteria of an FS of 1.5 with an

estimated FS of 1.61. As Sta. 11+600 is on the upstream side of the control structure, only Case 3 was considered for the short term rapid drawdown scenario. The channel had an estimated FS of 1.93 under the rapid drawdown scenario.

Sta. 19+000 – The measured groundwater conditions within the confined bedrock aquifer at this location are approximately at El. 253.8 m±. In order to model the end-of-construction scenario, this boundary condition was applied to the bedrock and assumes that there is no depressurization taking place prior to construction commencing. The overburden soil portion consisted of topsoil overlying till materials including silt and clay till, clay till and silt till. All types of till materials were modeled as "composite till". A friction angle, ϕ', within the till material of 33^{o} (as determined from the direct shear testing) and a cohesion of 4 kPa was used in all of the analyses along Route D. Figure D8-3 shows the cross section at Sta. 19+000 used in the stability analysis, and the overall critical slip surface.

FIGURE D8 - 3
Route D – Sta. 19+000 – Typical Slope Stability Cross Section



Assuming these groundwater and soil conditions are characteristic during construction, the estimated factor of safety (FS) for an overall slip surface is well below 1.0. Similar to Sta. 11+600 on Route D and Route C (Sta. 6+800), the analysis shows that as excavation progresses towards the proposed channel invert through the overburden materials, the effective stresses approach zero due to the high observed confined bedrock aquifer piezometric pressures, upward gradient and artesian pressures in the till. The cut slopes in the till materials do not have any support at the toe of the overburden slope (zero effective stress) resulting in the estimated failure of the slope due to the observed groundwater pressures. The reason for the much lower estimated FS is also due to the very thin till layer present below the channel invert (approximately 4 m±) and the high piezometric pressures in the bedrock and till. In order to achieve the design FS of 1.3 during

construction, the lower confined bedrock aquifer groundwater pressures are estimated to be lowered to approximately El. 242.8 m± or by 11 m±, but will depend on site specific conditions at the time of construction. A discussion of mitigation measures to address the requirement to lower groundwater pressures is included in Section 5.0. A summary of estimated FS for Route D are presented in Table D8-2.

To be conservative, it was assumed for the long term condition that the confined bedrock groundwater levels below the channel invert would be drawn down to the channel surface water elevation (El. 244.1 m±) and in the analysis that the extents of the drawdown cone for the groundwater pressures would extend to the limits of the channel excavation. Beyond the limits of the channel excavation there was assumed to be no drawdown of groundwater level (i.e. assumed that pre-construction groundwater levels would still occur beyond the channel excavation limits). Under this scenario, the assumed geometry of 4H:1V with a bench met the design criteria of an FS of 1.5 with an estimated FS of 1.50. As Sta. 19+000 is on the downstream side of the control structure, only Case 4 was considered for the short term rapid drawdown scenario. The channel had an estimated FS of 2.32 under the rapid drawdown scenario.

4.3 SUMMARY OF CHANNEL DESIGN CONSIDERATIONS

Based on the results of the slope stability analysis, the proposed channel geometry for both Routes C and D, as described in Sections 4.1 and 4.2 and as shown on Plates D8-2 and D8-3, are recommended to proceed to the next stage of design with 4H:1V slope with a mid-height bench. Temporary depressurization will be required for both Routes C and D during construction in order to maintain safe excavation. Along Route C, long term drainage will occur naturally through the fractured, exposed bedrock cut to the water level in the channel. Along Route D, depressurization is also required for the long term conditions by pumping and/or gravity drainage from the bedrock to the channel water level, as discussed in Section 5.0. With the potential for intertill granular deposits along Route D, it is recommended that additional investigations be undertaken at the critical structures, bridges abutments and piers and control structures, as well as along the channel, in order to help delineate potential granular deposits, their extents and potential mitigation measures that may be necessary. These additional investigations will also help confirm the soil conditions assumed in the stability analysis and potential optimization of the channel cross section.

5.0 GROUNDWATER DEPRESSURIZATION

5.1 TEMPORARY DEPRESSURIZATION MEASURES DURING CONSTRUCTION

As discussed in Sections 4.1 and 4.2, depressurization of the confined bedrock aquifer is required to achieve the required factor of safety criteria for both Routes C and D during construction. On Route C during construction, it is assumed that active dewatering will occur to the channel invert or below as required, in channel areas where the bedrock surface is at or below the channel invert (such as at Station 0+000 to 0+500 and Station 9+500 to the Outlet). This would likely be facilitated via active groundwater pumping wells.

For Route C, dewatering where the channel is deeply incised within the bedrock into the confined aquifer may be handled by a combination of dewatering wells and a pilot channel cut for gravity drainage. While dewatering of the channel to the invert through deep bedrock cut areas will be necessary to facilitate construction, it is anticipated that the groundwater would primarily be handled within the channel using a series of sumps, and/or gravity drainage to downstream channel areas, as practicable, depending on the contractor's program. There will be a seepage face within the bedrock wall of the channel cut. Based on the bedrock permeability conditions measured along Route C, it is estimated that during the relatively short-term duration of construction, the channel wall in bedrock may not completely dewater to the channel invert. For the majority of the Route C channel where excavation occurs through the bedrock, an estimate of about half of the exposed rock face is assumed to dewater, where the groundwater piezometric pressure at the top of the seepage face (H) is equal to the elevation of the seepage face on the bedrock channel wall (Z) (i.e. H = Z). On this basis, a depressurization system will not be required during construction as this groundwater discharge from the bedrock channel wall seepage face will occur naturally into the channel. However, as mentioned above, continuous dewatering will be required and may be achieved by gravity or with active pumping depending on site conditions, construction sequencing, and the contractor's program. For Route C, the channel invert elevation was optimized primarily reflecting hydraulic considerations, since requirements for groundwater dewatering and blowout considerations do not govern the invert design along Route C. A Preliminary Surface Water Management Plan (SWMP), which considers dewatering requirements, has been developed as part of the current assignment and is provided with the Surface Water Study Report (Deliverable D7).

On Route D, an active depressurization system will be required in the bedrock aquifer during construction, as well as for the long term operation, along the channel to protect against blowout of the till channel base, in particular on the northern third of the channel (from approximately Sta. 17+000 to Lake St. Martin), due to the high bedrock flowing artesian pressures beneath the channel. The preferred method for active depressurization is likely a series of drilled groundwater wells, with submersible pumps. A series of wells would be required on both sides of the channel, most likely on the mid slope bench. The extent of the active depressurization well system necessary is site specific and will have to be refined to reflect variations in the limestone fracture permeability, which should be expected to be extremely variable over very short distances due to the karstic nature of the limestone bedrock. The groundwater evaluation will have to be done by a senior, experienced hydrogeologist, preferably with pertinent experience in karstic aquifers to provide input to optimize the detailed design of the channel and final location of the control structure, as these design elements may affect the active depressurization needed during construction, as well as for the long term operation.

Importantly, the active well system would be designed (as practicable) also to act as a long-term passive bedrock aquifer depressurization system. The long term depressurization condition will be necessary (along with channel invert and control structure location optimization) to protect the channel long-term from basal heave and blowout concerns. Maintaining the intact till channel base protects the regional aquifer system from any potential environmental and water quality concerns that could arise from Route D construction and operations, long term.

Requirements for depressurization and dewatering during construction have been incorporated into the project Risk Assessment and Budget Quantification Report (Deliverable D11). Additional details on groundwater conditions along both Routes C and D are also provided in the Groundwater Study Report (Deliverable D6).

5.2 LONG TERM DEPRESSURIZATION MEASURES FOR ROUTES C AND D

Long-term, the bedrock aquifer groundwater levels along the Route C channel will re-equilibrate to the surface water levels within the channel itself. Seepage will occur to the channel via the direct interconnection of the bedrock aquifer, and the channel, due to the fact that it is incised directly into the bedrock aquifer along nearly the entire Route C channel.

As discussed in Sections 4.2 and 5.1 (above), on Route D, long-term depressurization will also be necessary to protect against blowout of the till channel base on the northern third of the channel, due to the bedrock flowing artesian piezometric pressures beneath the channel. Ideally, the active well system used during construction would be configured to allow for use long-term, as a passive system. The passive system could utilize the same drilled wells, with no submersible pumps installed, and with individual well discharge connections possibly to a buried header pipe running within the channel, to final discharge downstream of the control structure, to the water level at Lake St. Martin. During channel and depressurization optimization, the wells could be located on the mid slope bench. The optimization should address details of well spacing and well interconnection. It should also assess the need for trenching for the discharge header downstream of the control structure, to achieve drainage to Lake St. Martin water levels. In addition, locating the wells on the bench may allow for long-term access subject to final design details.

Final design should address optimization of the channel geometry, which will control the depressurization design. This optimization may include raising of the channel invert in key areas to increase the thickness of overburden between the bedrock and channel invert, and/or moving the control structure further downstream, to benefit from Lake Manitoba higher channel surface water elevation over larger extents of the upstream portions of the Route D channel. Based on typical Lake St. Martin water levels, passive depressurization of the bedrock aquifer to El. 244 m +/- would be the preliminary target. It is possible, with extreme drought conditions on Lake St. Martin, that re-activation of an active depressurization system via temporary installation of submersible pumps in the existing well system, could be necessary to protect the till channel invert from blowout conditions in the extreme case. This scenario should be evaluated during final design and optimization, and if necessary incorporated into the operations manual for the Route D flood control channel.

Requirements for de-pressurization and dewatering during construction have been incorporated into the project Risk Assessment and Budget Quantification Report (Deliverable D11). Additional details on groundwater conditions along both Routes C and D are also provided in the Groundwater Study Report (Deliverable D6).

5.3 SEEPAGE RATE ESTIMATES

Basic seepage estimate calculations for the bedrock on Route C were completed using mathematical models for confined aquifer flow from a line source to a trench excavation. For the area of deepest bedrock cut along Route C, and highest static groundwater piezometric pressures (i.e near Sta. 4+500), inputs were as follows:

- Seepage face height within the bedrock at the channel excavation estimated at 8 m (it is assumed that some of this rock cut face of approximately 10 m to 12 m will dewater to a level below the bedrock surface during construction);
- Bedrock permeability used ranged between $2X10^{-4}$ m/s and $2X10^{-6}$ m/s, which are generally representative of the most conservative conditions along Route C;
- A driving head differential of approximately 7 m (El. 255 m to El. 248 m); and
- A cross section length of approximately 125 m orthogonal to the channel cut along which the head differential occurs.

Based on the calculations above, estimated seepage from the bedrock to the channel excavation may range from approximately 155 L/day/lineal m of channel, to approximately 15,500 L/day/lineal m of channel. These estimated seepage rates will vary widely, based on variable aquifer transmissivity conditions, bedrock piezometric pressures, and the exposed area of bedrock within the channel cuts (which varies extensively along the Route C channel). The estimates above are for order of magnitude approximations of seepage within the largest bedrock cut areas on Route C during construction, and are for information only. It may be that in key areas, such as downstream of approximately Sta. 7+500, drilled depressurization wells might be temporarily necessary to facilitate controlled excavation, until such time that gravity drainage of groundwater seepage is feasible from the excavation. These details would be derived during the detailed design stage.

At Route D, there are two potential groundwater seepage sources to the channel. One is from wells drilled into the confined bedrock aquifer that would be either used actively (i.e. pumped) during channel construction, or passively (i.e. ideally by gravity drainage) in the long term to mitigate blowout conditions. The second is seepage from the till. During 2016 exploration drilling and testing, water well TH-ED-01 was pumped at approximately 12 USgpm (65,400 L/day), achieving approximately 11 m of drawdown as monitored within the bedrock aquifer at the

adjacent (7.5 m offset) piezometer. This range of bedrock aquifer depressurization is approximately what is estimated to be necessary for construction of the channel while mitigating blowout conditions.

Assuming the current channel geometric design and outlet structure location, this type of bedrock aquifer depressurization during construction is estimated to be necessary along the lower 1/3 of the route (i.e. at approximately Sta. 17+000 and beyond), via a series of bedrock depressurization wells. Each well would contribute a groundwater flow as part of an active bedrock aquifer depressurization system.

Note that the number of bedrock depressurization wells and their spacing is contingent on the aquifer transmissivity and variability, associated distance drawdown profiles, and the total amount of depressurization necessary to protect against blowout during channel excavation and in the long term. The aquifer transmissivity estimated at TH-ED-01 was quite low, at approximately 400 USgpd/ft, resulting in a relatively tight drawdown cone, and relatively low well production rate. Drilling at TH-GD-08 resulted in a significant flowing artesian well condition, with a flow estimated in the range of 100 USgpm (545,000 L/day), which is at the upper limit of well capacities observed from the water well database in the region. While this type of flow is relatively high, it indicates a much higher transmissivity of the aquifer at this location. As such, there is potential for a single well with high flows such as this to affect drawdown over a much larger channel area, potentially reducing the total number of wells necessary for bedrock aquifer depressurization.

Optimization of final channel geometry and location of the control structure (including control structure foundation design) on Route D will directly affect the limits and magnitude of bedrock aquifer depressurization required for construction, and also for long-term phases of the project. This in turn drives the number and spacing of wells that may be necessary for bedrock aquifer depressurization, in both construction and long-term scenarios.

Seepage from the till, or inter-till granular zones, is estimated to be relatively nominal. The inter-till zones are interpreted to be discontinuous, and as such, these zones would tend to drain, resulting in limited seepage contributions. Basic seepage estimate calculations for the tills/intertills were completed for the construction case (i.e. empty channel) using mathematical

models for unconfined aquifer flow from a line source to a trench excavation. Inputs were as follows:

- Seepage face height along the wall of channel excavation estimated at 5 m (it is assumed that some of this effective till cut face height of approximately 10 m will partially drain during construction);
- Permeabilities used range between $5X10^{-6}$ m/s and $1X10^{-7}$ m/s, which are generally representative of intertill to till permeabilities;
- A driving head differential of approximately 6 m (El. 250 m to El. 244 m); and
- A cross section length of approximately 125 m orthogonal to the channel cut along which the head differential occurs.

Based on the calculations above, estimated seepage from the tills/intertills to the Route D channel excavation may range from approximately 400 L/day/lineal m of channel, to approximately 20,000 L/day/lineal m of channel, in an extreme case where all the tills/intertills exposed in the channel cut exhibit high permeability. The intertill granular pockets are anticipated to be discontinuous, however, and drain out quickly. The estimates above are for order of magnitude estimates of seepage within the largest till cuts along Route D during construction, and are for information only.

5.4 BLOWOUT ESTIMATES

Heave of silt/clay soils or blowout of cohesionless soils can occur in the channel invert when the differential hydrostatic uplift pressure in the confined aquifer (i.e. artesian hydrostatic head minus water level in channel or dry channel invert) exceeds the weight of the overlying soil. Blowout calculations for the base of the channel due to the confined piezometric pressures within the underlying bedrock aquifer may be conservative in that they do not account for any shear strength or cohesion within the soil column (often discounted due to vertical fracturing). At locations along the channel where drilling and groundwater data exist, the relative weight of the column of soil that exists between the invert of the channel and bedrock surface, is compared to the column of water acting on the overlying soils, to determine the factor of safety against blowout. For a channel operating case, the column of surface water which represents the minimum operating level of surface water above the channel invert is added to the estimate for the column of soil that exists below the channel invert.

5.5 CHANNEL OPTIMIZATION

There will be opportunity during the final design to modify the channel geometry, including changes in the channel invert in key areas, to optimize the magnitude of bedrock aquifer depressurization required for both the construction and long-term scenarios. During this optimization process, the variability in the estimated number, layout, and relative costs of wells for bedrock aquifer depressurization will be compared to the costs of excavation (and associated changes in infrastructure costs with a possibly wider channel section in key areas, if any). An additional critical component to the process is finalizing the location and foundation design of the control structure. Changes in location and foundations of the control structure may allow for a reduction in the magnitude of passive depressurization necessary for Route D in the long-term.

6.0 FOUNDATION CONSIDERATIONS

As with the conceptual design stage, several foundation types were considered at this preliminary phase of analysis for bridges and control structures and are discussed below. The preferred foundation type for each structure will have to be determined at the next stage of design and will depend on site conditions at the selected structure locations and the final design of the structures.

6.1 ROUTE C

Control Structure Foundations

The Control structure will be founded on limestone bedrock. The bedrock conditions around the proposed invert elevation (El. 241.2 m) varied from 'Poor' with a Rock Quality Designation (RQD) of 27% at El. 243.5 m to 'Poor' with a Rock Quality Designation (RQD) of 22% at El. 242.0 m. For preliminary design, a factored Serviceability Limit State (SLS) and Ultimate Limit State (ULS) bearing capacity of 600 kPa and 800 kPa for intact competent limestone bedrock may be assigned for the Limit State Design (LSD), respectively, with no settlement concerns. Seepage control measures such as grouting of the upper fractured bedrock should be considered in the next stage of design. Seepage should be expected to occur where the invert of the channel is within the bedrock due to the highly fractured nature of the bedrock. If seepage is left uncontrolled through the bedrock at the control structure, this seepage may result in piping and undermining of the structural integrity of the control structure.

Note that, depending on the final location of the control structure and foundation design, active bedrock aquifer depressurization is likely necessary in key structure foundation areas, to control temporary excavation stability as well as for channel stability, to protect against basal heave/blowout, and groundwater seepage conditions during foundation construction.

Bridge Structure Shallow Foundations

Shallow foundations may be considered to support the structures at the site with the provision that all footings are to be placed at 2.4 m (8 ft) or deeper below the finished grade, which is the

recommended design depth for frost penetration. For shallow footings at 2.4 m or deeper below grade, a factored Ultimate Limit State (ULS) bearing capacity of 280 kPa for stiff till and 800 kPa for intact competent limestone bedrock may be assigned for limit state design (LSD). A factored Serviceability Limit State (SLS) bearing capacity of 225 kPa for stiff till and 600 kPa for intact competent limestone bedrock may be assigned. The minimum concrete footing dimension should be 900 mm.

Bridge Structure Cast-in-Place Concrete Friction Piles

Cast-in-place (CIP) concrete friction piles may be used to support the proposed structures depending on the design structural loads. Suitable CIP piling methods for the site include the continuous flight auger (CFA) method and the plain bored method depending on the pile diameters. Temporary casing may be required for bored piles due to the potential caving of the overburden soils along the depth. The factored Serviceability Limit State (SLS) and Ultimate Limit State (ULS) skin friction value of 18 kPa and 22 kPa may be assigned for limit state design (LSD), respectively. If insufficient capacity can be realized due to limited overburden thickness, end bearing shallow foundations should be utilized to support the structure as previously discussed.

Bridge Structure Driven Steel Piles

Based on the above, driven steel piles (H-piles or pipe piles) to practical refusal could occur within the very hard till layers. Due to limitations on the drivability of the pile imposed by the yield strength of the pile, it is recommended that the maximum design 'SLS' compressive resistance value of a steel pile be limited to $0.25F_yA_s$ (i.e., a fraction of the unfactored structural yield capacity of the pile). Note that F_y is the nominal yield stress of the steel, and A_s is the cross-sectional area of steel in the pile. The purpose of this restriction is to mitigate the risk of statically designing a pile that cannot be driven with enough energy or force to overcome dynamic soil resistance and subsequently develop the design static load resistance without yielding or damaging the pile.

Dynamic pile testing using pile driving analyzer (PDA Testing) and CAPWAP analysis should be performed during pile installation to verify the pile capacity. Driving shoes should be used for all

types of driven steel piles, H-piles or pipe piles. The steel pipe pile may be left open or filled with concrete. The pile filled with concrete will have higher bending capacity and lower potential for local buckling of the thin wall and should be strongly considered as this will have a relatively low cost with respect to the overall project costs for better long term performance.

6.2 ROUTE D

Control Structure Foundations

The Control structure will be founded on the stiff till or intertill deposits at the proposed invert elevation of El. 239.5 m. The uncorrected SPT blow count (N) values were greater than 50 (refusal) at El. 239.5 m (at proposed invert elevation). Based on the SPT blow count results, a factored Serviceability Limit State (SLS) and Ultimate Limit State (ULS) bearing capacity of 200 kPa and 250 kPa for stiff till may be assigned for the Limit State Design (LSD), respectively. Minor settlement is anticipated and should be investigated further as part of the next stage of design. Final design of the structure should also incorporate seepage control measures such as French drains where granular layers are encountered within the till. This seepage if left uncontrolled can result in the migration of soils through piping and may undermine the integrity of the control structure. Consideration for excavation within granular intertill units should also be further investigated as these units will be water bearing and the extents can be unpredictable.

Note that, depending on the final location of the control structure and foundation design, active bedrock aquifer depressurization is likely necessary in key structure foundation areas, to control temporary excavation stability as well as for channel stability in the long term, to protect against basal heave/blowout, and groundwater seepage conditions during foundation construction.

Bridge Structure Shallow Foundations

Shallow foundations may be considered for lightly loaded structures at the site with the provision that all footings are to be placed at 2.4 m (8 ft) or deeper below finished grade, which is the recommended design depth for frost penetration. For shallow footings at 2.4 m (8 ft) or deeper below grade, a factored Serviceability Limit State (SLS) and Ultimate Limit State (ULS) bearing

capacity of 200 kPa and 250 kPa for stiff till may be assigned for limit state design (LSD), respectively. The minimum concrete footing dimension should be 900 mm (3 ft).

Bridge Structure Cast-in-Place Concrete Friction Piles

Cast-in-place (CIP) concrete friction piles may be used to support the proposed structures depending on the design structural loads. Suitable CIP piling methods for the site include the continuous flight auger (CFA) method and plain bored method depending on the pile diameters. Temporary casing may be required for bored piles due to the potential caving of the overburden soils along the depth. The factored Serviceability Limit State (SLS) and Ultimate Limit State (ULS) skin friction value of 18 kPa and 22 kPa may be assigned for the limit state design (LSD), respectively.

Bridge Structure Driven Steel Piles

Based on the above, driven steel piles (H-piles or pipe piles) to practical refusal could occur within the very hard till layers. Due to limitations on the drivability of the pile imposed by the yield strength of the pile, it is recommended that the maximum design 'SLS' compressive resistance value of a steel pile be limited to $0.25F_yA_s$ (i.e., a fraction of the unfactored structural yield capacity of the pile). Note that F_y is the nominal yield stress of the steel, and A_s is the cross-sectional area of steel in the pile. The purpose of this restriction is to mitigate the risk of statically designing a pile that cannot be driven with enough energy or force to overcome dynamic soil resistance and subsequently develop the design static load resistance without yielding or damaging the pile.

Dynamic pile testing using pile driving analyzer (PDA Testing) and CAPWAP analysis should be performed during pile installation to verify the pile capacity. Driving shoes should be used for all types of driven steel piles. The steel pipe pile may be left open or filled with concrete. The pile filled with concrete will have higher bending capacity and lower potential for local buckling of the thin wall and should be strongly considered as this will have a relatively low cost with respect to the overall project costs for better long term performance.

7.0 RISK

Risk for both Routes C and D are similar in terms of understanding the soil and groundwater conditions along both of the preferred routes. However, the methods of construction and control of groundwater conditions will differ. Fundamentally, Route C is for the most part incised within the bedrock, and Route D is constructed entirely within the till, with a strong basal groundwater pressure originating from the confined bedrock aquifer below. Understanding locations of potential granular intertill zones and their extents, in particular along Route D, will have a potential impact on construction as they will most likely be water bearing, which will need to be considered / controlled (drained) during excavation activities. Further investigations, including drilling or geophysical methods can be used to help delineate these zones. Extensive granular zones may also result in "design growth" as there may be difficulties in designing remedial options should these zones be encountered and may result in increased quantities than originally allowed for in the construction cost. These granular zones, depending on their location, may necessitate some sort of cutoff / grout curtain / French drain should they occur in close proximity to the control structure, channel invert or slopes, again resulting in "design growth" and increased construction costs.

Further investigations at the piers and abutments for all bridges will also help with the optimization of the foundations once abutment and pier locations are known.

Seepage of water up bridge foundation piles should be expected. This seepage would be expected to be uncontrolled and may flood excavations should flow rates be significant, which again would affect construction costs. Depressurization wells may be necessary to help mitigate these flows, which would increase construction cost and design costs. Potential long-term seepage controls such as seepage "boots" around the piers or grouting around the foundations can be considered to allow the seepage to occur up the foundations and into the channel is also a viable option.

Seepage control through the bedrock will also need to be considered at the control structure, which may necessitate a more significant grout curtain / cutoff depending on flows encountered and size of the pervious zones.

8.0 RECOMMENDATIONS

Based on the results of the geotechnical investigations and information examined to date, the following recommendations have been developed for the project, and are as follows:

- Monitoring of the groundwater wells and the artesian pressures along the preferred channel alignment should continue through to the next stage of design. As determined from the existing data, depressurization of the bedrock aquifer is necessary for both Routes C and D in order for the channel slope stability to meet the design criteria and in order to construct the channel. At the preliminary stage, a depressurization of 4 m is estimated to be required for Route C and from 6 m to 11 m is required along Route D. A bedrock/till depressurization system will have to be developed at the next stage of design in order to complete construction of the selected Route.
- Supplemental drilling investigations should be completed at each of the bridge (piers and abutments) and control structure locations. This will allow for optimization of the bridge and control structure foundations and any mitigation measures necessary such as depressurization wells, grout curtains, etc. Supplemental drilling investigations along the preferred route will also help confirm soil conditions assumed in the stability analysis and potential optimization of the channel cross section.
- The cost allowances for risk and mitigation should consider the potential for increased excavation quantities as a result of “design growth” (i.e. as a result of the increased level of details added to the design from conceptual phase to detailed design and until construction) and should be updated at the next stage of design as project details are refined, with inputs from additional investigations, analyses and monitoring.
- The potential for seepage to occur across the control structure foundation through the rock (Option C) or through a pervious zone (Option D) must be addressed at the detailed design stage. Mitigation options could include but not be limited to grout curtains.
- Along Route D, the extent of the active depressurization well system necessary is site specific and will have to be refined to reflect variations in the limestone fracture permeability, which should be expected to be extremely variable over very short distances due to the karstic nature of the limestone bedrock. The groundwater evaluation will have to be done by a senior, experienced hydrogeologist, preferably with pertinent experience in karstic aquifers to provide input to optimize the detailed design of the channel and final location of the control structure, as these design elements may affect the active depressurization needed during construction, as well as for the long term operation.
- The potential for seepage occurring along the piles of the bridge foundations needs to be addressed at the next stage of design.
- Along Route C, additional monitoring and/or mitigation in the event of damages due to rock blasting activities will need to be addressed.

- The proposed channel geometry for both Routes C and D, are recommended to proceed to the next stage of design with 4H:1V slope and a mid-height bench.
- At final design, sulphate and resistivity testing should be completed in order to determine requirements for cement type and corrosion protection.

TABLE D8 – 2
ESTIMATED FACTOR OF SAFETY
ROUTES C AND D

ROUTE	STATION	ESTIMATED FACTOR OF SAFETY				
		Case 1	Case 2	GWL to Meet Estimated FS = 1.3 (Case 2)	Case 3	Case 4
C	6+800	1.61	<1.0 (0.56)	El. 251.6 m	1.98	2.29
D	11+600	1.61	<1.0 (0.85)	El. 249.5 m	1.93	NA
	19+000	1.51	<<1.0 (0.10)	El. 243.0 m	NA	2.32

Notes:
1. Composite Till Shear Strength Route C - c' = 4 kPa and ϕ' = 31^{o}
2. Composite Till Shear Strength Route D - c' = 4 kPa and ϕ' = 33^{o}
3. Refer to Section 4.1 for Design Criteria

PLATES

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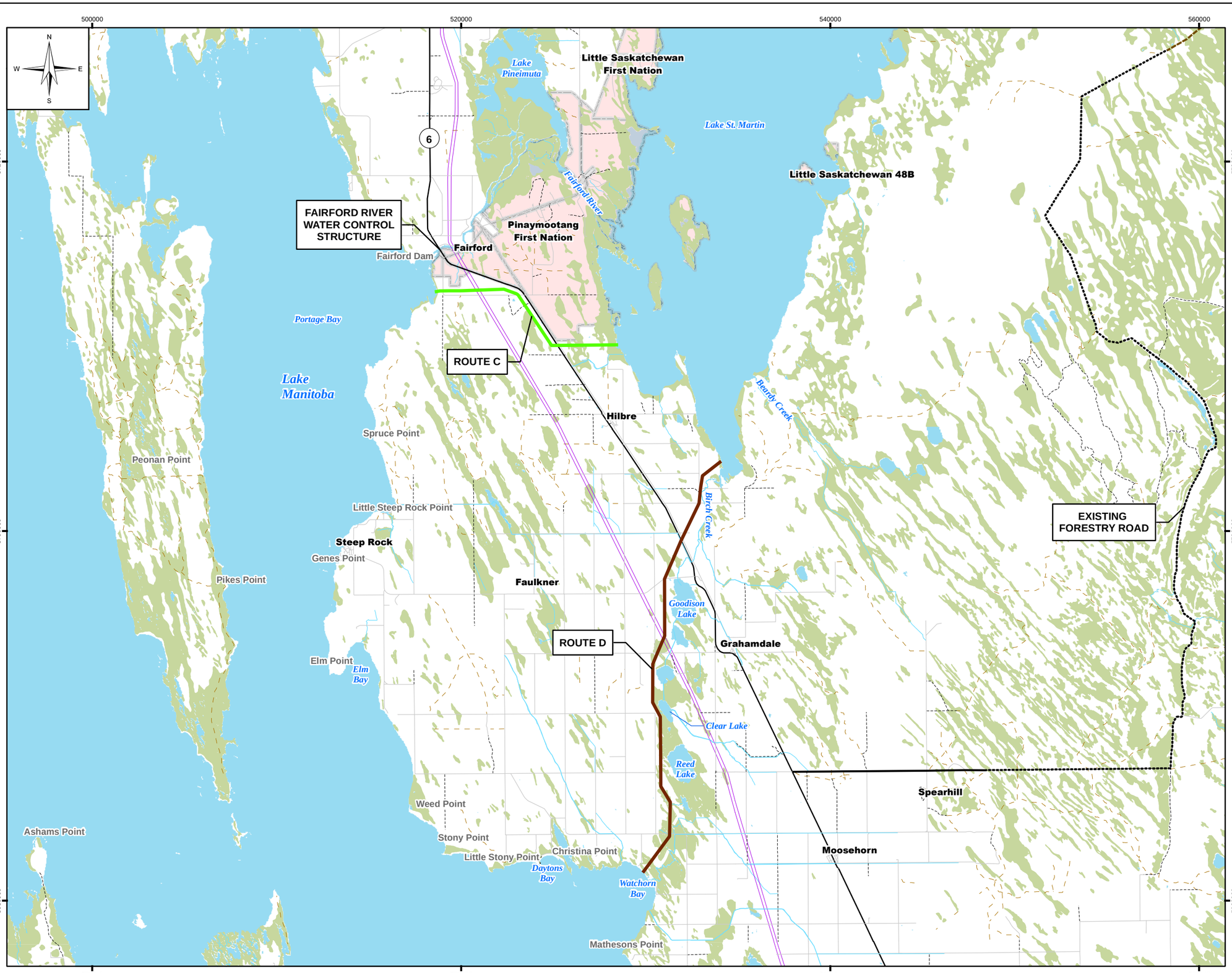

LEGEND:

- LMB Channel Option C
- LMB Channel Option D
- Existing Transmission Line
- Forestry Road
- Access Road
- Municipal Road
- Highway
- Limited Use Road
- Trail
- Watercourse
- Wetlands
- Waterbody
- First Nation

NOTES:

1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

2 0 2 4 6 8
Kilometres
SCALE: 1:200,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

GENERAL SITE PLAN ROUTE C AND D

MAY 2017 | PLATE D8–1 | REV: 0

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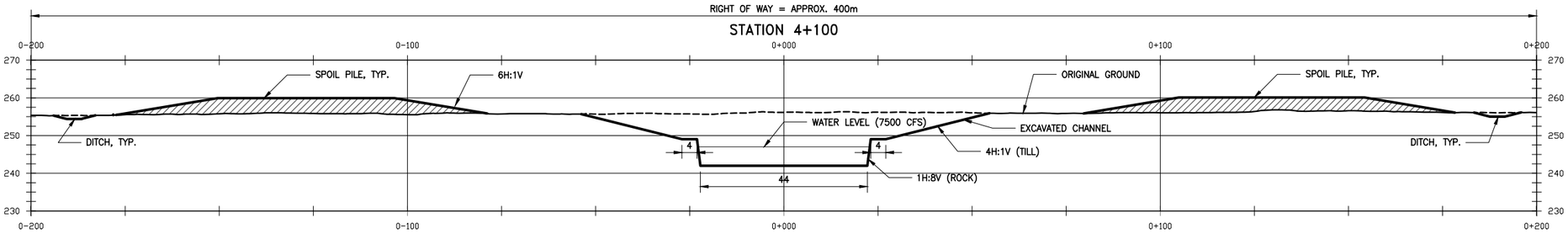
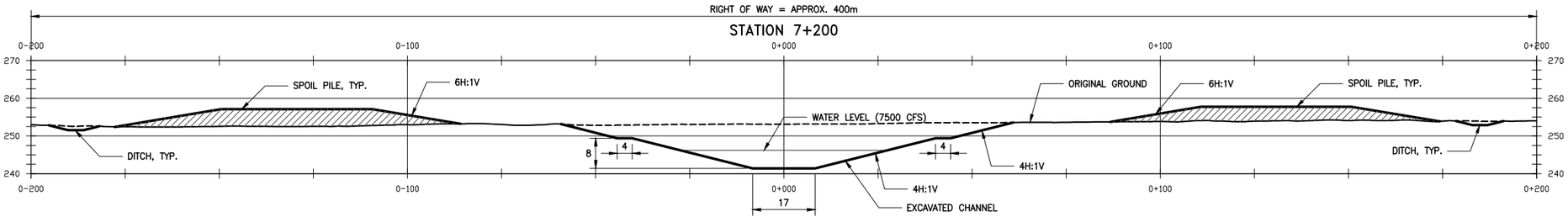
11x17



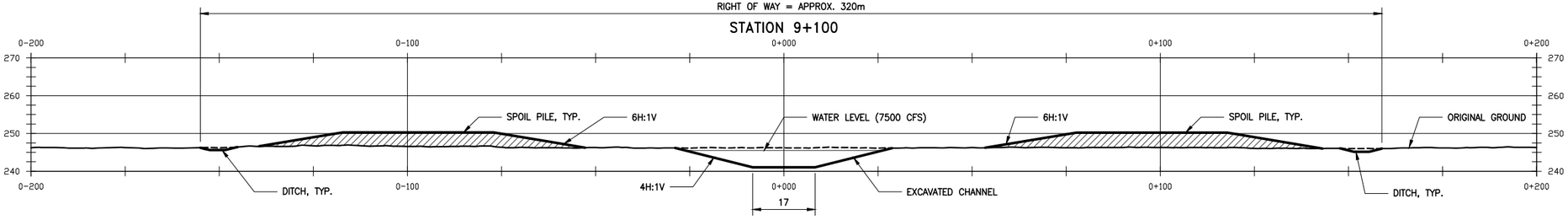
ROUTE C – CROSS SECTION IN ROCK

SCALE: 1:750



ROUTE C – CROSS SECTION > 8m CUT

SCALE: 1:750



ROUTE C – CROSS SECTION 8m CUT OR LESS

SCALE: 1:750

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

TYPICAL CROSS SECTIONS OF LAKE MANITOBA OUTLET CHANNEL ROUTE C

MAY 2017 | PLATE D8-2 | REV: 0

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

FileName: U:\FMS\16-0300-006\16-0300-006_Plate D8-2.dwg - Tab: Layout1 Plotted By: kcopek 17/05/08 [Mon 1:53pm]
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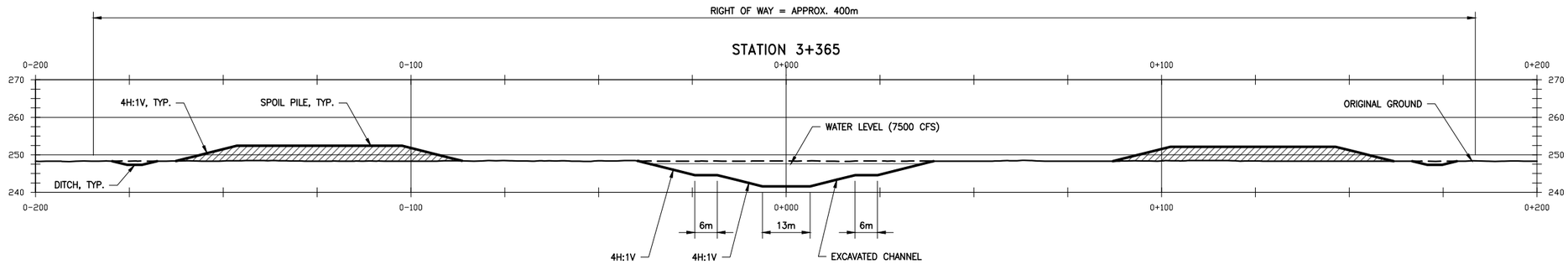
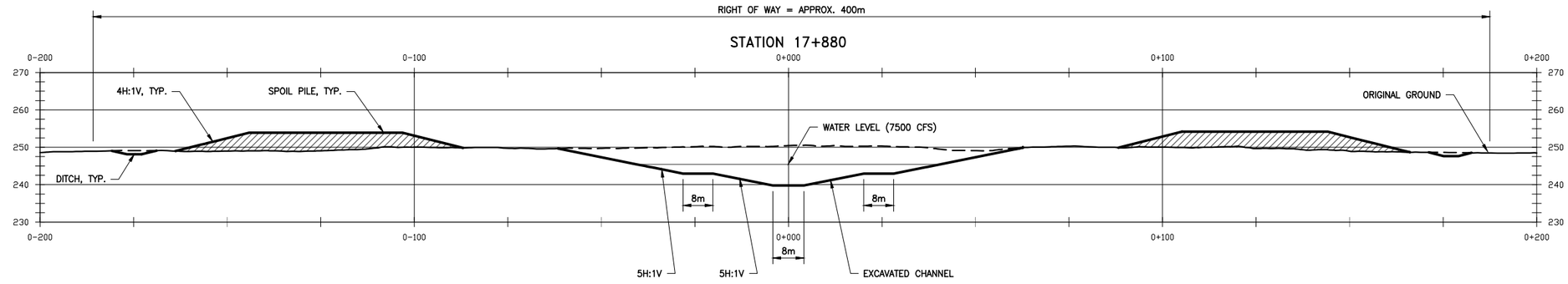


ROUTE D – CROSS SECTION 8m CUT OR LESS

SCALE: 1:750



ROUTE D – CROSS SECTION >8m CUT

SCALE: 1:750

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D8	DEA	PAL

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

TYPICAL CROSS SECTIONS OF LAKE MANITOBA OUTLET CHANNEL ROUTE D

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D8-3 | REV: 0

11x17

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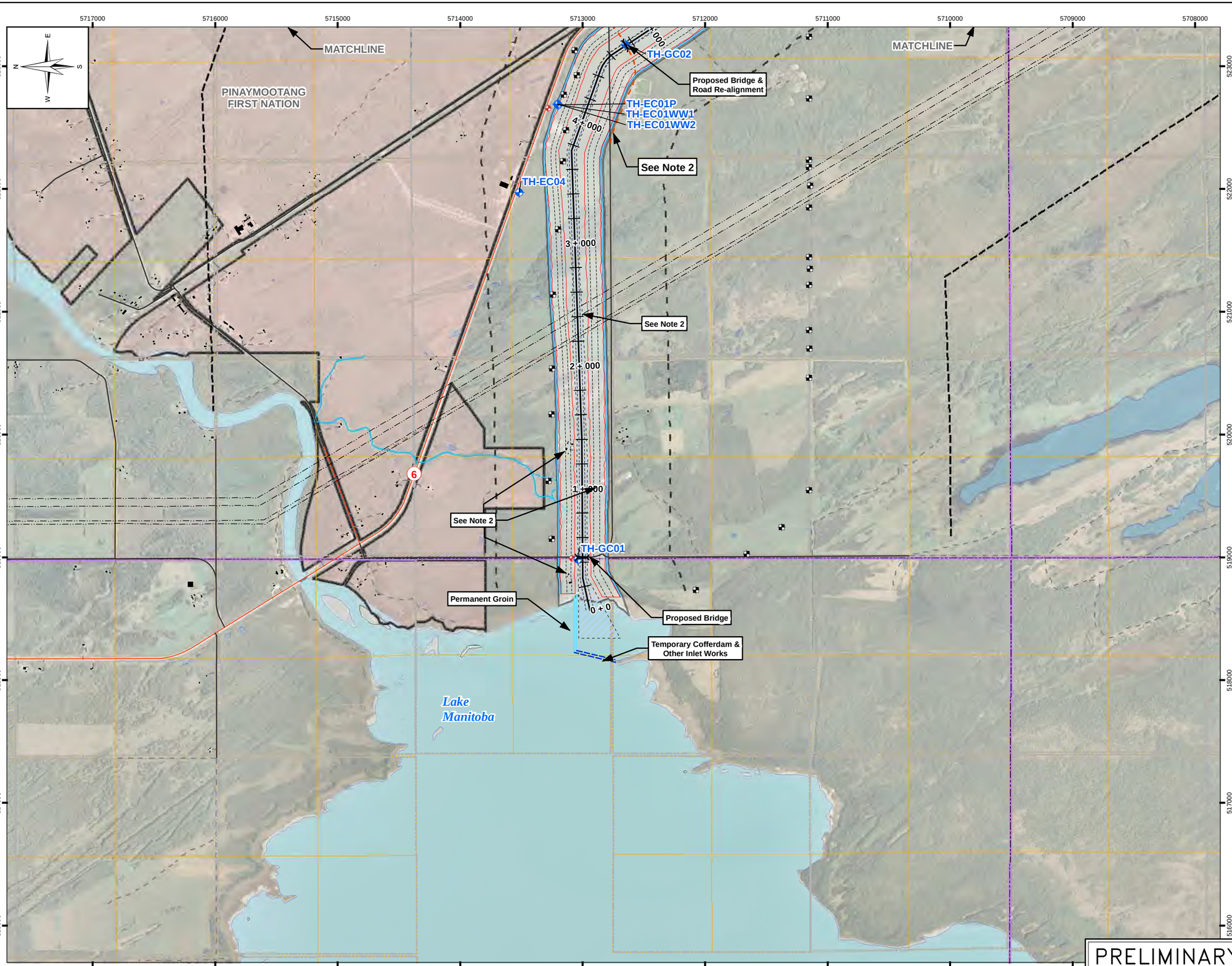

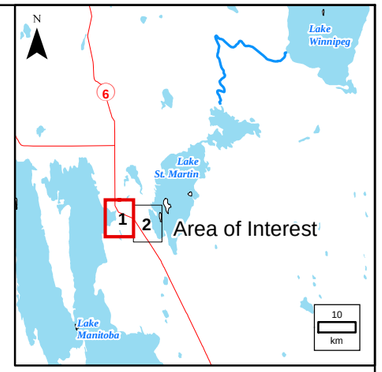

LEGEND:

- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- River (Intermittent)
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

NOTES:
1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers,
3. Surface Water Sample D9 from Route D represents outlet Water Quality for Route C and Route D. road realignments, privately owned structures, etc.
4. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

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Kilometres
SCALE: 1:30,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

TEST HOLE LOCATIONS ROUTE C

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D8-4.1 | REV: 0

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11"x17" PLOT SCALE 1:1

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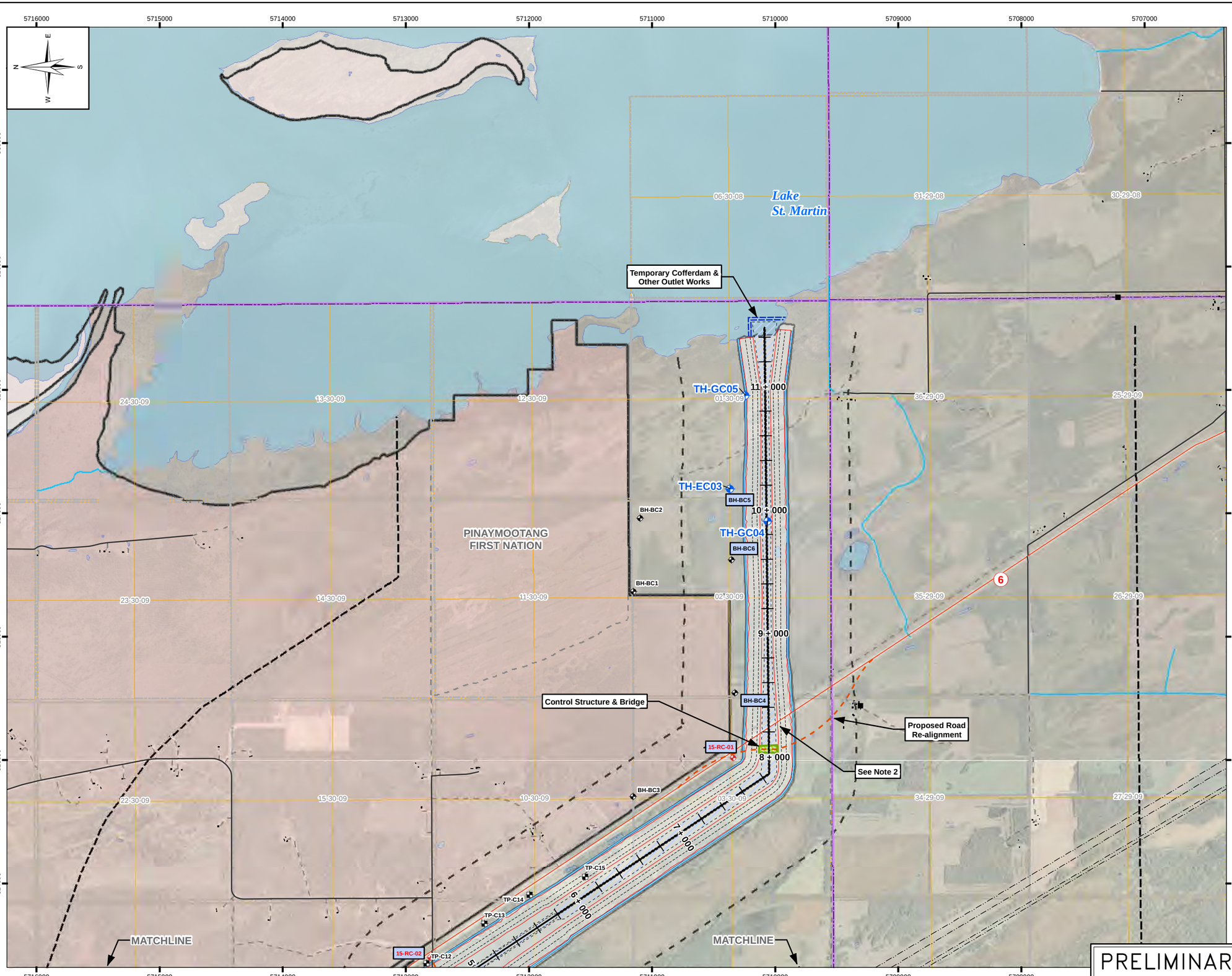

LEGEND:

- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km distance from channel centreline
- 500m distance from Channel ROW

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Kilometres
SCALE: 1:30,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

TEST HOLE LOCATIONS ROUTE C

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

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MATCHLINE

MATCHLINE

Lemiez Ponds

Reed Lake

Water Lake

Clear Lake

TH-ED01PP2

TH-ED01PP1

TH-ED01P

TH-ED01W

D3

D4

TH-GD02

Proposed Bridge

15-RD-01

Watchorn Creek

Watchorn Provincial Park

See Note 2

Cemetery

Permanent Groin

Temporary Cofferdam & Other Inlet Works

Permanent Groin

Lake Manitoba (Watchorn Bay)

Mercer Creek

Lake Winnipeg

Lake St. Martin

Lake Manitoba

Area of Interest

10 km

LEGEND:

- Logger (November, 2016)
- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:
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0.5 0 0.5 1 1.5 2

Kilometres

SCALE: 1:50,000 METRIC 11"x17"

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INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

TEST HOLE LOCATIONS
ROUTE D

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D8-5.1 | REV: 0

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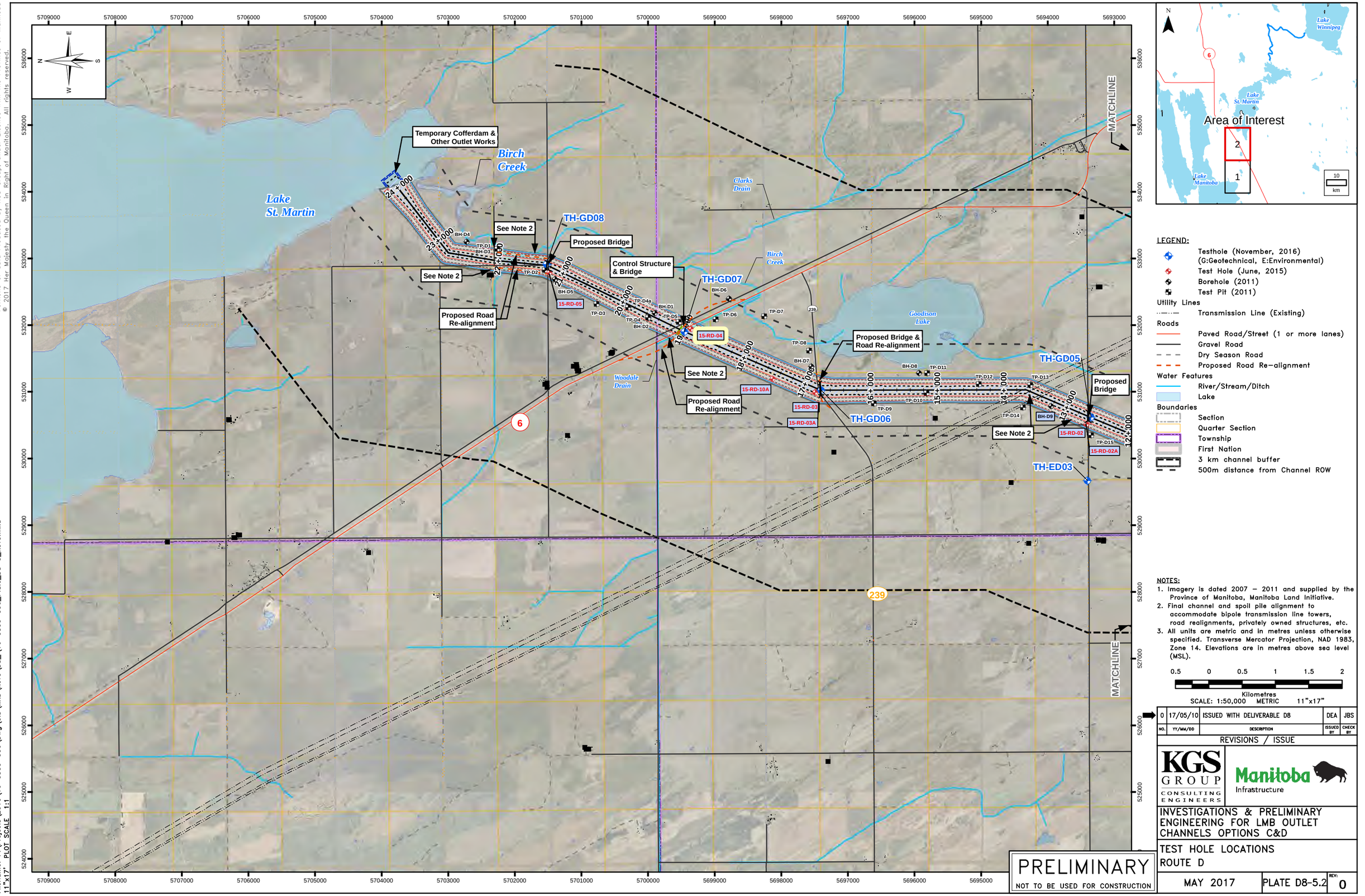

LEGEND:

- Testhole (November, 2016) (G:Geotechnical, E:Environmental)
- Test Hole (June, 2015)
- Borehole (2011)
- Test Pit (2011)

Utility Lines
- Transmission Line (Existing)

Roads
- Paved Road/Street (1 or more lanes)
- Gravel Road
- Dry Season Road
- Proposed Road Re-alignment

Water Features
- River/Stream/Ditch
- Lake

Boundaries
- Section
- Quarter Section
- Township
- First Nation
- 3 km channel buffer
- 500m distance from Channel ROW

NOTES:
1. Imagery is dated 2007 – 2011 and supplied by the Province of Manitoba, Manitoba Land Initiative.
2. Final channel and spoil pile alignment to accommodate bipole transmission line towers, road realignments, privately owned structures, etc.
3. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

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Kilometres
SCALE: 1:50,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/05/10	ISSUED WITH DELIVERABLE D8	DEA	JBS

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Manitoba Infrastructure

INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

TEST HOLE LOCATIONS ROUTE D

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D8-5.2 | REV: 0

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D8_\16-0300-006_Plate_D8-5_Rev0.mxd
11"x17" PLOT SCALE 1:1

APPENDIX D8-A

DETAILED TEST HOLE LOGS AND SUMMARY – ROUTE C

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-01P**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C + 4+050
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **255.59**
TOP OF PVC ELEV. **256.24 m**
WATER ELEV.
DATE DRILLED **05/10/2016**
UTM (m) N **5,713,201**
E **522,686**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
255			OVERBURDEN	**OVERBURDEN**							
254.6	1	5	LIMESTONE	**DOLOMITIC LIMESTONE** - Massive, tan to pink with orange alteration on fracture surfaces. Multiple close to moderate spaced, horizontal to near horizontal, bedding joints. Small vesicular/vuggy zone between 2.21 m to 2.59 m. Open joint on large rusty vug at 2.67 m. Weak to moderate reaction with HCl. - Run 1 from 0.97 m to 2.34 m. 7% RQD. - Run 2 from 2.34 m to 3.86 m. 0% RQD.				R1	7		
254	2										
253	3	10						R2	0		
252				- Run 3 from 3.86 m to 5.38 m. 29% RQD.							
252	4			- Tan to orange with moderate amount of small vugs from 3.81 m to 4.88 m. Intense orange staining associated with vugs. Trace remnants of coral. Moderate to wide spaced jointing. 0.1 m broken zone at lower contact. Lower contact at 4.88 m is an abrupt charge.							
251		15						R3	29		
250	5			- Similar to sub-unit above with fervent swollen vugs from 4.88 m to 7.85 m. Some sections are massive. Upper contact is slightly brecciated and has grey-green shale within the limestone at 5.08 m. The limestone is tan to light pink and quite massive. Vesicals and vugs appear once again at 5.69 m the orange staining re-appears. Trace grey shale stringers between 4.88 m and 6.38 m.							
249	6	20		- Run 4 from 5.38 m to 7.01 m. 84% RQD.				R4	84		
248	7			- Run 5 from 7.01 m to 8.44 m. 75% RQD.							
248		25						R5	75		
247	8			- Tan with yellow/orange hue from 7.85 m to 13.01 m. Vugs throughout. Upper contact (7.85 m to 8.00 m), a section in the middle of the unit (11.00 m to 11.83 m), and bottom of unit (12.88 m to 13.10 m) are very vuggy and have a pronounced orange alteration. The reminder of the unit varies from trace vesicular to moderately vuggy.							
246	9	30		- Run 6 from 8.44 m to 10.05 m. 57% RQD.				R6	57		

SAMPLE TYPE ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-01P**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
245	11	35		- Run 7 from 10.05 m to 11.61 m. 69% RQD.				R7	69		
244	12	40		- Run 8 from 11.61 m to 13.03 m. 85% RQD.				R8	85		
243	13	45		- Run 9 from 13.03 m to 14.57 m. 55% RQD. - Massive, tan, hard, moderate to widely spaced jointing from 13.01 m to 14.58 m. Good quality rock. Occasional vug.	VW VW VW	12.5 12.6		R9	55		
242	14	45									
241	15	50		- Run 10 from 14.57 m to 16.11 m. 64% RQD. - Tan to light brown, moderate to widely spaced joints from 14.58 m to 17.43 m. Vuggy throughout. Orange alterations where there are a higher concentration of vugs. Lower contact (17.33 m to 17.43 m) consists of soft red-brown clayey shale (moderate plasticity). Abrupt change below 17.43 m.				R10	64		
240	16	50									
239	17	55		- Run 11 from 16.11 m to 17.64 m. 70% RQD.				R11	70		
238	18	60		- Run 12 from 17.64 m to 19.27 m. 38% RQD. - Massive, very light tan, minor vugs at top 0.36 m of unit from 17.43 m to 19.85 m. Weak to moderate reaction with dilute HCl. Virtually all joints are perpendicular to core axis except one joint running sub-parallel to core axis from 19.26 m to 19.74 m.		17.4 17.7 18.3		R12	38		
237	19	60									
236	19	65		- Run 13 from 19.27 m to 19.86 m. 98% RQD.		19.8		R13	98		
235.7	20	65		**END OF HOLE AT 19.85 m.**		19.8					
235	21	70		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 18.29 m to 19.82 m. 2. Installed vibrating wire piezometer VW 1602936 to a depth of 12.50 m below grade. 3. Hole backfilled with sand to 17.7 m, and then cement bentonite grout to surface. 4. Lugeon testing was conducted on bedrock from 4.88 m to bottom of hole.							
234											

SAMPLE TYPE ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-01WW1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C - STA 4+050 NEXT TO TH-EC-01P
DRILLING METHOD DR 150

JOB NO. **16-0300-006**
GROUND ELEV. **255.57**
TOP OF PVC ELEV. **256.57 m**
WATER ELEV.
DATE DRILLED **13/10/2016**
UTM (m) N **5,713,200**
E **522,686**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
255				**SILT TILL**						20 40 60	20 40 60 80
254.7	1	5		**DOLOMITIC LIMESTONE** - Massive, tan to pink with orange alteration on fracture surfaces. Multiple close to moderate spaced, horizontal to near horizontal, bedding joints. Small vesicular/vuggy zone between 2.21 m to 2.59 m. Open joint on large rusty vug at 2.67 m. Weak to moderate reaction with HCl.		1.2					
254	2										
253	3	10									
252	4										
251	5	15									
250	6	20									
249	7										
248	8	25									
247	9										
246		30									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-EC-01WW1

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
245	11	35								20 40 60	20 40 60 80
244	12	40									
243											
242.5	13			**END OF HOLE AT 13.11 m.**		13.1					
242		45		Notes:							
241	14			1. Detailed stratigraphic descriptions can be found in TH-EC-01P. 2. Installed well casing (125 mm ø PVC Pipe) encased in bentonite chips to a depth of 1.2 m below grade and open below to the end of the hole.							
240	15	50									
239	16										
238		55									
237	17										
236	18	60									
235	19										
234	20	65									
	21	70									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-01WW2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C
DRILLING METHOD DR 150

JOB NO. **16-0300-006**
GROUND ELEV. **255.58**
TOP OF PVC ELEV. **256.58 m**
WATER ELEV.
DATE DRILLED **14/10/2016**
UTM (m) N **5,713,205**
E **522,692**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
255				**SILT TILL**
254.7	1	5		**DOLOMITIC LIMESTONE** - Massive, tan to pink with orange alteration on fracture surfaces. Multiple close to moderate spaced, horizontal to near horizontal, bedding joints. Small vesicular/vuggy zone between 2.21 m to 2.59 m. Open joint on large rusty vug at 2.67 m. Weak to moderate reaction with HCl.
254	2			
253	3	10		
252	4			
251	5	15		
250	6	20		
249	7			
248	8	25		
247	9	30		
246				

PIEZ. LOG | DEPTH (m) | SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR **Maple Leaf Enterprises**
INSPECTOR **E. SALTER**
APPROVED DRAFT
DATE 13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-EC-01WW2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
245	11	35								20 40 60	20 40 60 80
244	12	40									
243	13										
242	14	45				14.3					
241	15	50									
240	16										
239	17	55									
238	18										
237.3		60		**END OF HOLE AT 18.29 m.**		18.3					
237	19			Notes:							
236		65		1. Detailed stratigraphic descriptions can be found in TH-EC-01P.							
235	20			2. Installed well casing (125 mm ø PVC Pipe) encased in bentonite chips to a depth of 14.3 m below grade and open below to the end of the hole.							
234	21	70									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-03**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C - STA 10+200
DRILLING METHOD Mud Rotary

JOB NO. **16-0300-006**
GROUND ELEV. **245.68**
TOP OF PVC ELEV. **246.90 m**
WATER ELEV.
DATE DRILLED **16/10/2016**
UTM (m) N **5,710,367**
E **527,199**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
245	1	5		**SILTY CLAY TILL** - Grey, moist, low plasticity, compact, trace angular to sub-angular gravel up to 10 mm, trace sand, some silt.						20 40 60	20 40 60 80
244	2										
243	3	10									
242	4										
241	5	15									
240	6										
239	7	20									
238	8										
237	9	25									
236.2		30		**DOLOMITE** - Buff to pale orange, moderately jointed, fine grained, vuggy. Vugs are sparse over most of unit with an increase in the density of vugs below 5.34 m; open iron-stained fracture at 5.34 m.		9.8					
236											

SAMPLE TYPE

CONTRACTOR **Maple Leaf Enterprises** | INSPECTOR **E. SALTER** | APPROVED DRAFT | DATE 13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-EC-03

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
235	11	35										
234	12	40										
233	13	45										
232	14	50										
231	15	55										
230	16	60										
229	17	65										
228	18	70										
227	19											
226	20											
225	21											
224												
229.8				**END OF HOLE AT 15.85 m.**		15.5 15.8						

Notes:

1. Detailed stratigraphic descriptions can be found in TH-EC-01P.
2. Installed well casing (125 mm ø PVC Pipe) encased in bentonite chips to a depth of 9.8 m below grade and open below to the end of the hole.
3. Sloughed in at 15.5 m depth below grade.

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-04**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C - STA 3+400
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **254.97**
TOP OF PVC ELEV. **255.65 m**
WATER ELEV.
DATE DRILLED **11/10/2016**
UTM (m) N **5,713,518**
E **521,974**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
254.7				**TOP SOIL**					
254.4				**SILTY CLAY** - Grey, moist, trace sand, trace gravel.					
254	1			**SILT TILL** - With sand, some clay.					
		5							
253	2								
252	3	10							
				- Cobbles and boulders below 3.66 m.					
251	4								
		15							
250	5								
249	6	20				6.2 6.3			
248	7								
247.6				**CLAY SHALE**					
		25							
247	8								
246	9	30							
245									

SAMPLE TYPE ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-EC-04**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
244	11	35								20 40 60	20 40 60 80
243	12	40									
242	13										
241	14	45		- Dolomite boulder 900 mm. - Dark red-brown silty sand, trace clay, dense. Cored well with only minor wash-away of material. A total of 2.0 m core recovered.							
240	15	50				15.2 15.3 15.6		R1	58		
239	16										
238 237.8	17	55				17.1		R1	51		
237	18	60		**END OF HOLE AT 17.15 m.** Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 15.24 m to 17.15 m. 2. Installed vibrating wire piezometer VW 1602925 to a depth of 6.25 m below grade. 3. Hole backfilled with sand to 50.3 m, and then cement bentonite grout to surface.							
236	19										
235	20	65									
234	21	70									

SAMPLE TYPE ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GC-01**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C - STA 0+400
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **250.00**
TOP OF PVC ELEV. **250.87 m**
WATER ELEV.
DATE DRILLED **01/11/2016**
UTM (m) N **5,713,040**
E **518,985**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %
249.8				**TOPSOIL**					
				CLAYEY SILT TILL - Grey, moist, low plasticity, compact, some clay, fine gravel, fine-grained sand.					
				- Softer, cobbles below 2.13 m.					
249	1	5							
248	2								
247	3	10		- Auger refusal. Switched to coring at 3.10 m.				1	
246	4			- Hard drilling below 3.96 m, high sand content.				2	
		15							
245	5								
244	6	20						3	
243	7								
		25		- Easy drilling below 7.62 m.		7.6			
242	8					7.7			
241.9				**DOLOMITE** - Vuggy, variably fractured with abundant vugs, red to orange staining throughout two broken core zones above 8.84 m.					
				- Run 1 from 8.10 m to 9.20 m. 0% RQD.				R1	0
241	9	30		- Run 2 from 9.20 m to 10.72 m. 33% RQD.					
				- Light brown to buff, micro crystalline, moderately fractured, little to no stainity on fractures from 9.58 m to 10.59 m.				R2	
240									

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GC-01**

ELEVATION (m)	DEPTH (m)	(ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
									33	20 40 60	20 40 60 80
239	11	35		- Vuggy, orange to light brown, very few fractures from 10.59 m to 11.05 m.							
				- Run 3 from 10.72 m to 11.94 m. 43% RQD.				R3	43		
				- Buff to light brown, widely-spaced fractures. A few vugs below 11.64 m. light orange hue, associated with vugs from 11.05 m to 12.73 m.		11.4					
						11.7					
238	12	40		- Run 4 from 11.94 m to 13.57 m. 59% RQD.		12.0					
								R4	59		
237	13			- Vuggy, orange, moderately jointed, moderately weathered where vug density is greatest. Some clay observed in weathered/fractured zone between 13.26 m and 13.44 m.							
236.4						13.6					
		45		**END OF HOLE AT 13.57 m.**							
236	14			Notes: 1. Lugeon testing was conducted from 10.98 m to 12.34 m and 12.65 m to 13.56 m. 2. Installed standpipe (25 mm ø) piezometer slotted from 12.04 m to 13.57 m. 3. Installed vibrating wire piezometer VW 1602941 to a depth of 7.62 m below grade. 4. Hole backfilled with sand to 11.74 m, and then cement bentonite grout to surface.							
235	15	50									
234	16										
		55									
233	17										
232	18	60									
231	19										
		65									
230	20										
229	21	70									

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GC-02**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D

SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS

LOCATION ROUTE C - STA 4+750 AT PROPOSED BRIDGE

DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **256.06**
TOP OF PVC ELEV. **256.90 m**
WATER ELEV.
DATE DRILLED **13/10/2016**
UTM (m) N **5,712,649**
E **523,180**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION
256			**SILTY CLAY TILL** - Grey, moist, low plasticity, dense, trace to some rounded to sub-angular gravel up to 25 mm, trace sand, some silt.
255	1		
		5	
254.1	2		
254			**COBBLES** - Dense, some gravel, cobbles and boulders encountered. - Auger refusal. switched to coring at 1.98 m.
253	3	10	
252	4		- Silty clay inclusions, trace gravel below 4.42 m.
		15	
251	5		
250.7			**DOLOMITE** - Broken, buff, sub rounded to sub angular. - Run 1 from 5.33 m to 6.86 m. 27% RQD.
250	6	20	
249	7		- Run 2 from 6.86 m to 8.38 m. 100% RQD. - Vuggy Dolomite, buff to pale orange, moderately fractured, silt seam from 7.16 m to 7.47 m.
		25	- Fractured Dolomite with clay seams from 7.47 m to 9.76 m, buff, moderately fractured, moderately vuggy, with red-brown clay seams up to 75 mm wide at 9.35 m, 9.55 m, and 9.68 m.
248	8		- Run 3 from 8.38 m to 9.88 m. 96% RQD.
247	9	30	- Vuggy Dolomite, buff to pale orange, moderately fractured from 9.68 m to 10.75 m. - Run 4 from 9.88 m to 11.41 m. 52% RQD.

PIEZ. LOG

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △
		1	100	10, 17, 14	
		2	100	26, 41, 50	
		3	17		
		4	100	20, 26, 14	
		5	80	6, 15, 50	
		R1	27		
		R2	100		
		R3	96		

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GC-02**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
246										20 40 60	20 40 60 80
245	11	35		- Rubble with minor core recovery, badly broken core and rubble, 10 mm to 50 mm pieces of sub rounded dolomite. Most rubble has orange staining. Trace clay from 10.75 m to 14.25 m. - Run 5 from 11.41 m to 12.93 m. 0% RQD.				R4	52		
244	12	40						R5	0		
243	13			- Run 6 from 12.93 m to 14.46 m. 27% RQD.	VW	12.8 12.9					
242	14	45						R6	27		
241	15	50		- Run 7 from 14.46 m to 15.98 m. 62% RQD.				R7	62		
240	16			- Buff, moderately fractured with some broken core from 15.37 m to 15.90 m. In the broken zone there is a grey-green clay seam that appears to be near vertical (parallel to core axis from 15.65 m 15.88 m). - Run 8 from 15.98 m to 17.51 m. 48% RQD.							
239	17	55		- Broken Dolomite to Dolomite rubble from 16.67 m to 18.22 m, buff to orange, badly broken dolomite with some ground up rubble zones, some vugs, core has a mottled appearance.		16.9 17.2 17.5		R8	48		
238	18	60		- Run 9 from 17.51 m to 19.03 m. 70% RQD. - Buff, moderate- to widely-spaced fractures, very few vugs from 18.22 m to 19.03 m.				R9	70		
237.0 237	19			**END OF HOLE AT 19.03 m.**		19.1					
236	20	65		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 17.53 m to 19.05 m. 2. Installed vibrating wire piezometer VW 1602927 to a depth of 12.80 m below grade. 3. Hole backfilled with sand to 17.2 m, and then cement bentonite grout to surface.							
235	21	70									

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GC-04**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C - STA 9+900
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **248.25**
TOP OF PVC ELEV. **249.08 m**
WATER ELEV.
DATE DRILLED **16/10/2016**
UTM (m) N **5,710,061**
E **526,936**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)
248				**SILTY CLAY TILL** - Grey, moist, low plasticity, compact, trace angular to sub-angular gravel up to 10 mm, trace sand, some silt.		
	1			- Moist to dry, trace gravel up to 20 mm from 0.76 m to 1.52 m.		
247		5		- Dense, trace gravel up to 25 mm from 1.52 m to 2.29 m.		
	2			- Trace gravel up to 35 mm below 2.29 m.		
246						
	3	10		- Dry below 3.01 m.	VW	3.4
245				- Auger refusal at 3.66 m. Switched to coring.	VW	3.5
244.6				**DOLOMITE** - Buff to pale orange, moderately jointed, fine grained, vuggy. Vugs are sparse over most of unit with an increase in the density of vugs below 5.34 m; open iron-stained fracture at 5.34 m.		
	4			- Run 1 from 3.66 m to 4.93 m. 0% RQD.		
244		15				
	5			- Run 2 from 4.93 m to 6.45 m. 22% RQD.		
243						
				- Tan to light grey to buff, cryptocrystalline from 5.72 m to 7.93 m. Moderately-spaced fractures, many of which are drill breaks. Shale seam from 6.02 m to 12.32 m.		5.8
	6	20				6.1
242						6.4
				- Run 3 from 6.45 m to 7.93 m. 10% RQD.		
	7					
241		25				
240.3				**END OF HOLE AT 7.93 m.**		7.9
	8					
240				Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 6.40 m to 7.93 m. 2. Installed vibrating wire piezometer VW 1602930 to a depth of 3.35 m below grade. 3. Hole backfilled with sand to 6.1 m, and then cement bentonite grout to surface.		
	9	30				
239						

SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆
	1	83	4, 6, 10	
	2	100	9, 14, 16	
	3	100	5, 15, 18	
	4	100	11, 21, 37	
	5			
R1		0		
R2		22		
R3		10		

PL MC LL %

SAMPLE TYPE ☒ Split Spoon ▨ Auger Grab ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GC-05**

SHEET 1 of 1

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE C - STA 10+900
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **244.84**
TOP OF PVC ELEV. **245.75 m**
WATER ELEV.
DATE DRILLED **15/10/2016**
UTM (m) N **5,710,242**
E **527,957**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
244	1	5		**SILTY CLAY TILL** - Grey, moist, low plasticity, loose, trace angular to sub-angular gravel up to 25 mm, trace sand, some silt.				1	100	▲3 ▲3 ▲4	
243	2			- Compact below 1.52 m.				2	94	▲4 ▲4 ▲7	
242	3	10		- Dry to damp from 2.29 m to 3.01 m.				3	94	▲4 ▲7 ▲8	
241	4			- Moist below 3.01 m.	VW 1602926	3.7		4	100	▲3 ▲6 ▲9	
240.3		15		- Auger refusal at 4.57 m. Switched to coring.		3.8		5	72	▲4 ▲50 (Rebound on coarse-grain gravel)	
240	5			**DOLOMITE** - Buff, fine to very fine grained, moderately-spaced fractures - most due to drill action. - Run 1 from 4.57 m to 5.18 m. 0% RQD.				R1	0		
239	6	20		- Run 2 from 5.18 m to 6.55 m. 26% RQD. - Badly broken from drill action but not stained from 5.18 m to 5.34 m. - Red-brown Shale zone from 5.44 m to 5.54 m. - No solid piece of core over 5.64 m to 6.53 m.		5.5 5.8 6.1		R2	26		
238	7			- Some grey-green and red-brown Shale from 6.53 m to 7.16 m. Moderately weathered on fractured surfaces. - Run 3 from 6.55 m to 7.62 m. 0% RQD.				R3	0		
237.2		25		- Buff, competent Dolomite from 7.34 m to 7.62 m.		7.6					
237	8			**END OF HOLE AT 7.62 m.**							
236	9	30		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 6.10 m to 7.62 m. 2. Installed vibrating wire piezometer VW 1602926 to a depth of 3.66 m below grade. 3. Hole backfilled with sand to 5.79 m, and then cement bentonite grout to surface.							
235											

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

APPENDIX D8-B

DETAILED TEST HOLE LOGS AND SUMMARY – ROUTE D

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-ED-01P**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 11+600
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **249.43**
TOP OF PVC ELEV. **250.36 m**
WATER ELEV.
DATE DRILLED **20/10/2016**
UTM (m) N **5,692,376**
E **530,503**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
249	0			**SILTY CLAY TILL** - Grey, dry to moist, low plasticity, dense, trace sand, trace gravel up to 20 mm, angular to sub angular.						20 40 60	20 40 60 80	20 40 60 80
248	1	5										
247	2											
246	3	10		- Moist between 3.01 m to 6.02 m.				1				
245	4											
244	5	15										
243	6	20		- Wet, trace gravel up to 50 mm from 6.02 m to 12.2 m.		6.1 6.2		2				
242	7											
241	8	25										
240	9	30						3				

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-ED-01P

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
239	11	35				10.7				20 40 60	20 40 60 80
						10.8					
238											
	12	40		- Moist from 12.2 m to 16.46 m.				4			
237											
	13										
236		45									
	14										
235											
	15	50						5			
234											
	16										
233				- Dolomitic cobbles/boulders between 16.46 m and 17.38 m.							
232.7		55		**SILT TILL** - Brown to grey brown, moist, low plasticity, dense, with granitic and dolomitic gravel/cobbles throughout.				6			
	17										
232											
	18	60						7			
231											
	19										
230		65									
	20										
229											
	21										
228		70						8			

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-ED-01P

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %
227	22								
	23	75							
226									
225.9				**DOLOMITE** - Buff to very light brown, cryptocrystalline dolomite, moderate to wide spaced fractures to 25.63 m.					
	24			- Run 1 from 23.6 m to 24.4 m. 20% RQD.				R1	20
225		80		- Run 2 from 24.4 m to 25.9 m. 35% RQD.				9	
	25							R2	35
								10	
224						25.3			
						25.6			
	26	85		- Buff, moderate spaced fractures from 25.63 m to 27.44 m. Most vugs are quite small (1 mm). Pale green clayey seam from 26.09 m to 26.14 m.		25.9			
223				- Run 3 from 25.9 m to 27.4 m. 0% RQD.				R3	0
	27								
				- Broken by drill action from 27.13 m to 27.44 m.					
222.0 222		90				27.4			
	28			**END OF HOLE AT 27.44 m.**					
221				Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 25.91 m to 27.44 m. 2. Installed two vibrating wire piezometers, - VW 1602932 to a depth of 6.10 m below grade - VW 1602939 to a depth of 10.67 m below grade 3. Hole backfilled with sand to 25.6 m, and then cement bentonite grout to surface.					
	29	95							
220									
	30								
219		100							
	31								
218									
	32	105							
217									
	33								
216		110							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-ED-01PP1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 11+600
DRILLING METHOD Gas Powered Hand Auger

JOB NO. **16-0300-006**
GROUND ELEV. **248.72**
TOP OF PVC ELEV. **249.69 m**
WATER ELEV.
DATE DRILLED **25/10/2016**
UTM (m) N **5,692,379**
E **530,536**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.4				**PEAT** - Black, damp, trace clay.		0.0		1			
248.1				**SILTY CLAY** - Grey, damp, some to with sand.				2			
248				**SILT TILL** - Beige, some sand, trace clay.				3			
247.8	1			**CLAY TILL** - Beige, some sand, some clay.		1.2					
247.5				**END OF HOLE AT 1.22 m.**							
247		5		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 0.00 m to 1.22 m. 2. Hole filled with sand 6" below ground surface, then bentonite plug.							
246	2										
245	3	10									
244	4										
243	5	15									
242	6	20									
241	7										
240	8	25									
239	9	30									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-ED-01PP2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 11+600
DRILLING METHOD Gas Powered Hand Auger

JOB NO. **16-0300-006**
GROUND ELEV. **248.46**
TOP OF PVC ELEV. **249.52 m**
WATER ELEV.
DATE DRILLED **25/10/2016**
UTM (m) N **5,692,380**
E **530,550**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆
248.0	0	0		**PEAT** - Black, damp, trace clay.		0.0		1			
248				**SANDY SILT** - Beige, damp, some fine-grained sand.				2			
247.5	1	5		**SILT TILL**- Beige, damp, some sand, trace clay.		1.2					
247.2				**END OF HOLE AT 1.22 m.**							
247	2	10		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 0.00 m to 1.22 m. 2. Hole filled with sand 6" below ground surface, then bentonite plug.							
246	3	15									
245	4	20									
244	5	25									
243	6	30									
242	7										
241	8										
240	9										
239											

SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △: 20 40 60

Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆: 20 40 60 80

PL MC LL

%: 20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-ED-01W

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 11+600
DRILLING METHOD Mud Rotary

JOB NO. **16-0300-006**
GROUND ELEV. **249.49**
TOP OF PVC ELEV. **250.53 m**
WATER ELEV.
DATE DRILLED **20/10/2016**
UTM (m) N **5,692,378**
E **530,495**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
249	1	5		**SILT TILL** - Grey, dry to moist, trace sand, trace gravel (angular to sub-angular).						20 40 60	20 40 60 80	20 40 60 80
248	2											
247	3	10										
246	4											
245	5	15										
244	6	20										
243	7											
242	8	25										
241	9											
240		30										

SAMPLE TYPE

CONTRACTOR **Maple Leaf Enterprises** | INSPECTOR **E. SALTER** | APPROVED DRAFT | DATE 13/3/17

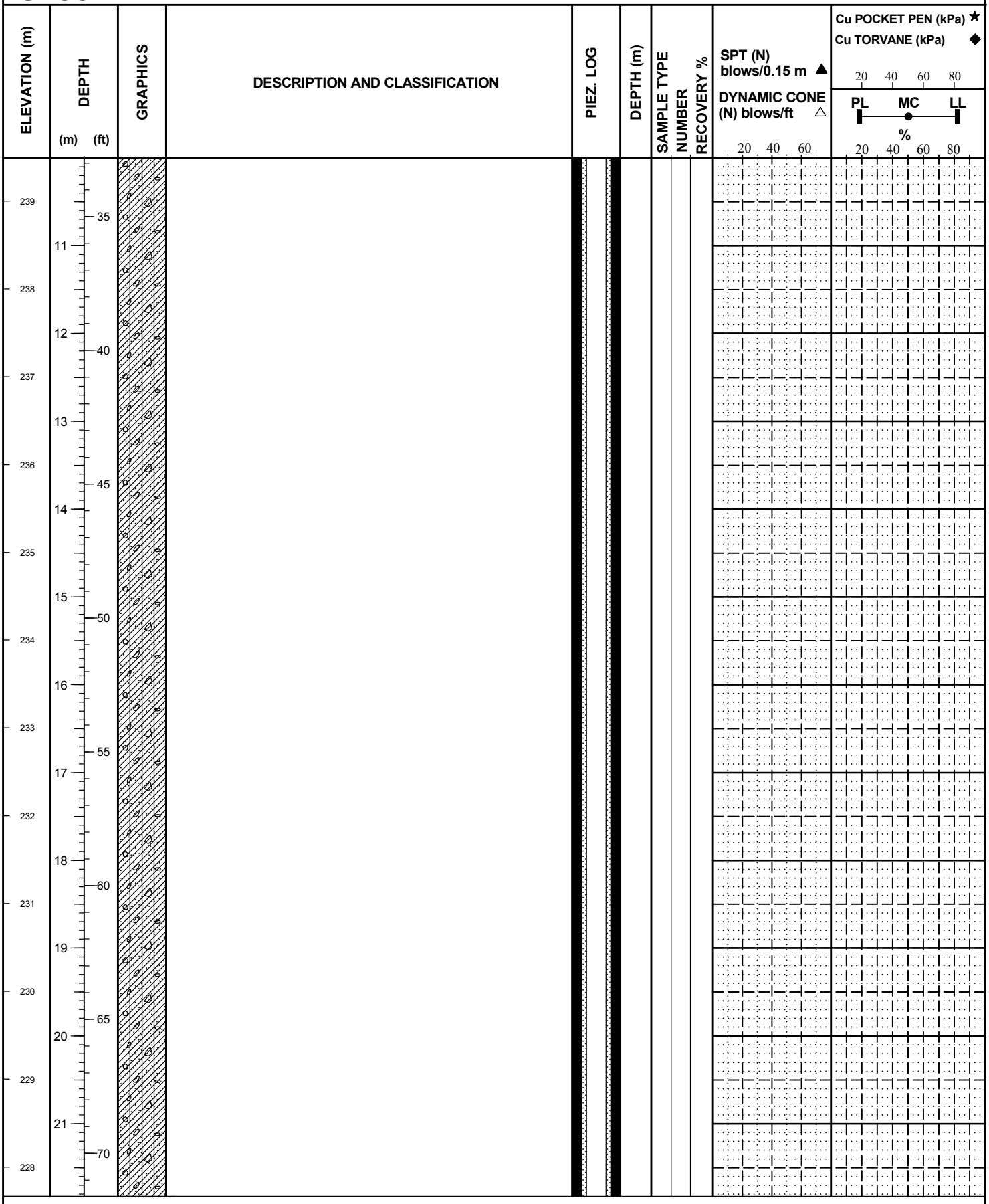
GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-ED-01W



SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	**E. SALTER**	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-ED-01W

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
227	22									20 40 60	20 40 60 80
	23	75									
226											
	24										
225		80									
224.5	25			**DOLOMITE** - Buff to very light brown.							
224						25.6					
	26	85									
223											
	27										
222		90									
	28										
221											
	29	95									
220											
	30										
219		100									
	31										
218											
217.8				**END OF HOLE AT 31.71 m.**		31.7					
	32	105		Notes:							
217				1. Detailed stratigraphic descriptions can be found in TH-ED-01P.							
	33			2. Installed well casing (125 mm ø PVC Pipe) encased in bentonite chips to a depth of 25.6 m below grade and open below to the end of the hole.							
216		110									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-ED-03**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 12+400 ±1 KM WEST OF CENTRELINE OF CHANNEL
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **252.22**
TOP OF PVC ELEV. **253.10 m**
WATER ELEV.
DATE DRILLED **18/10/2016**
UTM (m) N **5,693,404**
E **529,671**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
252				**SILTY CLAY TILL** - Light grey, dry, low plasticity, dense, trace angular to sub-angular gravel up to 10 mm, trace sand.						20 40 60	20 40 60 80
251	1	5									
250	2										
249	3	10		- Moist, trace angular gravel up to 30 mm from 3.01 m to 6.02 m.				1			
248	4										
247	5	15									
246	6	20		- Grey, trace angular gravel up to 25 mm below 6.02 m.		6.1 6.2		2			
245	7										
244	8	25									
243	9	30						3			

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-ED-03

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
242	11	35				11.3				20 40 60	20 40 60 80
241						11.6					
	12	40				11.9					
240								4			
	13										
239		45				13.4					
	14										
238 237.9				**END OF HOLE AT 14.33 m.**		14.3		5			
	15	50		Notes: 1. Rods got jammed when removing and hole slough off to 13.41 m depth. 1. Installed standpipe (25 mm ø) piezometer slotted from 11.89 m to 13.41 m. 2. Installed vibrating wire piezometer VW 1602931 to a depth of 6.10 m below grade. 3. Hole backfilled with sand to 11.6 m, and then cement bentonite grout to surface.						
237											
	16										
236		55									
	17										
235											
	18	60									
234											
	19										
233		65									
	20										
232											
	21										
231		70									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-02**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 2+600 AT PROPOSED BRIDGE
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **248.62**
TOP OF PVC ELEV. **249.48 m**
WATER ELEV.
DATE DRILLED **30/10/2016**
UTM (m) N **5,683,632**
E **531,290**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.5				**TOPSOIL**							
248.2				**SILT TILL** - Beige, damp, low plasticity, loose, fine-grained sand, trace to some clay.							
248	1	5		**CLAY TILL** - Beige, damp, low plasticity, compact, fine-grained sand, some clay.							
247	2										
246	3	10					S	S1			
245	4										
244	5	15									
243	6	20									
242						6.9					
241.6	7					7.0					
				SILT TILL - Beige, dry, low plasticity, dense, some fine-grained sand, trace gravel, trace clay.							
241	8	25									
240	9	30		- Water encountered between 9.14 m and 10.67 m.			S	S2			
239											

SAMPLE TYPE S Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-02**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
238	11	35		- Cobbles/boulders, hard slow drilling below 10.00 m. - Auger refusal, switched to coring at 10.67 m.								
237	12	40										
236	13											
235	14	45										
234	15											
233	16	50										
232	17											
231	18	55										
230	19	60		- Cobbles/boulders from 18.29 m to 19.82 m. - Run 1 from 18.29 m to 19.82 m.				R1				
229												
228.8	20	65		- Run 2 from 19.82 m to 21.34 m. 48% RQD. **DOLOMITIC LIMESTONE** - Tan to orange, moderate- to widely-spaced fractures, small vugs, weak to moderate weathering on fractures. Minor green/grey clay seams between 19.82 m to 20.22 m. Very few large vugs. Hydraulic conductivity is not expected to be very high across this zone.		20.0 20.3 20.6		R2	48			
228	21											
227		70		- Run 3 from 21.34 m to 22.76 m. 0% RQD.								

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-GD-02

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
226	22	75					R3		0	20 40 60	20 40 60 80
225.9				**END OF HOLE AT 22.76 m.**		22.8					
225	23			Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 20.63 m to 22.76 m. 2. Installed vibrating wire piezometer VW 1602935 to a depth of 6.91 m below grade. 3. Hole backfilled with sand to 20.3 m, and then cement bentonite grout to surface.						
224	24	80									
223	25										
222	26	85									
221	27										
220	28	90									
219	29										
218	30	95									
217	31										
216	32	100									
215	33	105									
		110									

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-05**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 12+600 AT PROPOSED BRIDGE
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **248.66**
TOP OF PVC ELEV. **249.52 m**
WATER ELEV.
DATE DRILLED **17/10/2016**
UTM (m) N **5,693,351**
E **530,617**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆
248.4	0			**PEAT** - Black, wet, with organics.							
248	1	5		**SILTY CLAY TILL** - Grey, wet, low plasticity, loose, trace gravel up to 10 mm, trace sand. - Dark grey, some sand from 0.76 m to 1.52 m.				1	94	2, 3, 4	
247	2			- Light grey, with gravel from 1.52 m to 2.29 m.				2	88	5, 4, 5	
246	3	10		- Grey from 3.01 m to 4.57 m.				3	100	4, 5, 5	
245	4			- Very loose from 3.66 to 5.18 m.				4	100	2, 3, 3	
244	5	15		- Some gravel up to 25 mm from 4.57 m to 5.34 m.				5	100	0, 0, 0 (SPT just pushed down through material.)	
243	6	20		- Wet, loose from 5.34 m to 6.02 m.				6	100	0, 0, 0	
242	7			- Moist, very dense, trace gravel up to 25 mm below 6.71 m.		6.7 6.8		7	100	2, 3, 4	
241	8	25		- Trace gravel up to 35 mm below 7.62 m, very dense.				8	67	3, 4, 5	
240	9	30		- Some gravel up to 75 mm, trace cobbles up to 80 mm from 9.15 m to 9.75 m. - Auger refusal, switched to coring at 9.75 m.				9	94	15, 44, 42	
239				**SANDY TILL** - Grey, wet, dense, low to non-plastic.				10	72	32, 48, 42	
								11	77	11, 22, 26	
								12	67	21, 50	
								13			

SAMPLE TYPE ☒ Split Spoon ⊡ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-05**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
238	11	35		- Boulders from 9.76 m to 11.28 m.							
237	12	40		- With coarse sand from 11.28 m to 14.08 m.							
236	13			- Very dense.				14	72	▲40 ▲50	
235		45									
234.6	14			**SILTY CLAY TILL** - Grey, moist, very dense, trace gravel.				15	72	▲7 ▲2 ▲9	
234	15	50				15.4					
233				- Very dense.		15.7		16	67	▲17 ▲40 ▲45	
232	16					16.0					
231	17	55		- Very dense.		16.9		17	67	▲9 ▲28 ▲28	
230	18	60		- Moist to wet below 18.65 m. Very dense.		18.9		18	77	▲16 ▲34 ▲50	
229	19	65									
228	20			- Very dense.				19	100	▲20 ▲46 ▲50	
227	21	70									

SAMPLE TYPE ☒ Split Spoon ⚿ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-05**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
226	22	75		- Very dense.						▲16 ▲44 ▲32	
225.4	23					23.2	☒	20	77		
				END OF HOLE AT 23.22 m.			☒	21			
225	24	80		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 16.00 m to 16.92 m. 2. Installed vibrating wire piezometer VW 1602924 to a depth of 6.71 m below grade. 3. Hole backfilled with sand to 18.9 m, and then bentonite to 16.9 m, and then sand to 15.7 m and then cement bentonite grout to surface.							
224	25										
223	26	85									
222	27										
221	28	90									
220	29	95									
219	30										
218	31	100									
217	32	105									
216	33	110									

SAMPLE TYPE ☒ Split Spoon ☒ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-06**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 16+800 AT PROPOSED BRIDGE
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **251.92**
TOP OF PVC ELEV. **252.87 m**
WATER ELEV.
DATE DRILLED **24/10/2016**
UTM (m) N **5,697,401**
E **531,025**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
251	1	5		**SILTY CLAY TILL** - Grey, moist, low plasticity, dense, trace angular gravel up to 25 mm, trace sand. - Dry below 0.1 m.			☒	1	100	▲12 ▲21 ▲22	
250	2			- Moist, very dense, trace gravel up to 35 mm below 1.52 m.			☒	2	100	▲33 ▲47 ▲46	
249	3	10					☒	3	100	▲33 ▲46 ▲46	
248	4						☒	4	77	▲33 ▲50	
		15		- Auger refusal at 4.27 m. Switched to coring.			☒	5	100	▲40 ▲50	
247	5						⊠	6			
				- Dense below 5.34 m.			☒	7	77	▲14 ▲19 ▲19	
246	6	20									
245	7						☒	8	44	▲11 ▲19 ▲23	
244	8	25									
				- Cobbles at 8.38 m.			☒	9	67	▲13 ▲24 ▲16	
243	9	30									
242											

SAMPLE TYPE ☒ Split Spoon ⊠ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-06**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
				CLAY TILL - Grey, moist, low plasticity, dense, trace gravel, trace sand. Trace to some clay.		10.7		10A	100	▲19 16 15	
						10.8		10B	100		
241	11	35									
240.5				**SILTY CLAY TILL** - Grey, moist, dense, with gravel up to 40 mm, trace sand.				11	44	▲14 ▲23 ▲14	
240	12	40									
239	13			- Some cobbles, trace angular gravel up to 40 mm below 12.96 m.		13.2		12	28	▲12 ▲13 ▲9	
		45				13.5					
238	14					13.8					
				- Dense				13	33	▲18 ▲20 ▲23	
237	15	50				15.3					
236	16			- Dense				14A	83	▲17 ▲22	
								14B	83	▲22	
235	17	55									
				- Dense				15	50	▲13 ▲30 ▲14	
234	18	60									
				- Cobbles/boulders, clay inclusions from 18.60 m to 21.34 m.							
233	19										
232	20	65									
231	21										
230.5		70				21.4					
				END OF HOLE AT 21.39 m.							
				Notes:							

SAMPLE TYPE ☒ Split Spoon ⊠ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH-GD-06

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
230	22	75		1. Auger refusal at 2.1 m depth below grade on a boulder. Hole moved 2 m and re-drilled. 1. Installed standpipe (25 mm ø) piezometer slotted from 13.77 m to 15.30 m. 2. Installed vibrating wire piezometer VW 1602923 to a depth of 10.67 m below grade. 3. Hole backfilled with bentonite to 15.3 m, and then sand to 13.5 m, and then cement bentonite grout to surface.						20 40 60	20 40 60 80
229	23										
228	24	80									
227	25										
226	26	85									
225	27										
224	28	90									
223	29										
222	30	95									
221	31	100									
220	32										
219	33	105									
		110									

SAMPLE TYPE ☒ Split Spoon ⚿ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-07**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 19+000 AT PROPOSED CONTROL STRUCTURE
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **252.05**
TOP OF PVC ELEV. **252.88 m**
WATER ELEV.
DATE DRILLED **26/10/2016**
UTM (m) N **5,699,454**
E **531,901**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △
252			**TOPSOIL** - Black, moist, with organics.				
251.7			**SILTY CLAY TILL** - Grey, moist, low plasticity, loose, trace gravel up to 25 mm, trace sand.				
			- Some gravel from 0.76 m to 1.52 m.				
251	1				1	100	▲4 4 5
		5	- Compact below 1.52 m.				
	2				2	83	▲8 13 12
250			- Trace angular gravel to 15 mm from 2.29 m to 3.01 m.				
					3	100	▲7 9 10
249	3	10	- Wet, and fine-grained sand from 3.01 m to 3.81 m.				
					4	33	▲9 13 13
248	4		- Moist, trace sand below 3.81 m.				
					5	77	▲12 13 14
		15					
					6	72	▲11 14 14
247	5						
					7	77	▲10 11 13
246	6	20	- Trace gravel up to 40 mm below 6.10 m.				
					8	72	▲11 13 12
245	7						
		25	- Very dense at 7.62 m: Auger refusal, switched to coring.				
244	8						
243.2							
243	9	30	**SAND** - Grey, wet, poorly graded, dense, trace gravel up to 40 mm, trace clay.		10	100	▲19 24 25
					11		▲18

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ☒ Split Spoon ⚿ Auger Grab ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-07**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
242											
241.2		35									
241	11			**SILTY CLAY TILL** - Grey, moist, low plasticity, very dense, trace gravel, trace sand.							
240	12	40			VW	12.2					
239.2						12.3		12	94	17, 23, 34	
239	13			**SAND** - Grey, wet, dense to very dense, coarse-grained, poorly graded, some gravel up to 5 mm, trace clay.				13	11	50	
238	14	45						14			
237	15	50									
236.9	16			**DOLOMITE** - Run 1 from 16.11 m to 17.23 m. 14% RQD. - Buff, moderately fractured, some vugs throughout. Does not appear altered or stained. Low permeable zone from 16.11 m to 17.84 m.				R1	14		
235	17	55		- Run 2 from 17.23 m to 18.75 m. 25% RQD.		17.2					
234	18	60		- Buff, fractured with red shale lens from 17.99 m to 18.09 m, and grey/green silt-filled fractures from 18.32 m to 18.42 m. Most fractures appear fairly fresh and tight. Low permeable zone from 17.84 m to 18.42 m. - Run 3 from 18.75 m to 19.36 m. 0% RQD. - Buff to white with moderately-spaced sub horizontal fractures and one vertical fracture running the length from 18.42 m to 19.36 m. Fracture faces are fresh. Low permeability.		17.5 17.8		R2	25		
233	19							R3	0		
232.7		65				19.4					
232	20			**END OF HOLE AT 19.36 m.**							
231	21	70		Notes: 1. Lugeon testing was performed from 17.68 m to 19.21 m. 2. Installed standpipe (25 mm ø) piezometer slotted from 17.68 m to 19.21 m. 3. Installed vibrating wire piezometer VW 1602937 to a depth of 12.20 m below grade. 4. Hole backfilled with sand to 17.53 m, and then cement bentonite grout to surface.							

SAMPLE TYPE ☒ Split Spoon ▣ Auger Grab ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-08**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT LAKE MANITOBA OUTLET CHANNEL OPTIONS C & D
SITE LAKE MANITOBA - LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION ROUTE D - STA 21+250 AT PROPOSED BRIDGE
DRILLING METHOD Mobile B54X -Track Rig

JOB NO. **16-0300-006**
GROUND ELEV. **246.81**
TOP OF PVC ELEV. **247.76 m**
WATER ELEV.
DATE DRILLED **28/10/2016**
UTM (m) N **5,701,522**
E **532,917**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
246.8				**TOPSOIL** - Black, moist, with organics.							
				SILTY CLAY TILL - Light grey, moist to dry, low plasticity, compact, trace gravel up to 10 mm, trace sand, trace clay.							
246	1							1	100	3, 7, 8	
		5		- Moist below 1.52 m.							
245	2							2	83	7, 7, 9	
				- Trace angular gravel up to 15 mm from 2.29 m to 3.01 m.				3	94	3, 5, 6	
244	3	10		- Trace angular gravel up to 40 mm below 3.01 m.				4	72	4, 5, 6	
243	4			- Wet from 3.81 m to 4.57 m.				5	94	6, 8, 10	
		15									
242	5							6	86	8, 12, 16	
				- Moist from 4.57 m to 6.10 m.				7	94	7, 11, 11	
241	6	20		- Dense below 6.10 m.				8	100	5, 15, 20	
240	7			- Wet below 6.86 m.				9	100	18, 23, 24	
						7.3					
		25				7.4					
239	8							10	100	13, 15, 18	
238	9							11	100	14, 16, 16	
		30		- Very dense below 9.14 m.				12	72	20, 25, 30	
237								13			

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL-SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH-GD-08**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △
				- Boulders from 10.37 m to 11.28 m. - Auger refusal at 10.36 m. Switched to coring.					53	▲38 ▲50
235.2	11	35		**SAND** - Very dense.	VW	11.6				
235	12	40			VW	11.7	☒	14	17	▲44 ▲50
234.3				**SILTY CLAY TILL** - Grey, moist, low plasticity, very dense, trace gravel, some silt, trace sand.						
234	13	45					☒	15	39	▲37 ▲41 ▲50
233	14									
232	15	50				14.9	☒	16	50	▲15 ▲19 ▲38
						15.2				
231	16			- Soft at 15.85 m.		15.5				
230	17	55		- Dense below 16.77 m.		17.1	☒	17	83	▲7 ▲5 ▲13
229.4				**END OF HOLE AT 17.38 m.**		17.4				
229	18	60		Notes: 1. Installed standpipe (25 mm ø) piezometer slotted from 15.55 m to 17.07 m. 2. Installed two vibrating wire piezometers: - VW 1602938 to a depth of 7.32 m below grade; - VW 1602940 to a depth of 11.59 m below grade. 3. Hole backfilled with sand to 15.24 m, and then cement bentonite grout to surface.						
228	19									
227	20	65								
226	21	70								
225										

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	E. SALTER/G.MEDIWAKE	DRAFT	13/3/17

GEOTECHNICAL - SOIL LOG U:\FMS\16-0300-006\LMB OUTLET CHANNELS C & D LOGS.GPJ

APPENDIX D8-C

TYPICAL PHOTOS OF REPRESENTATIVE OVERBURDEN AND BEDROCK UNITS SAMPLED DURING THE 2016 INVESTIGATION PROGRAMS – ROUTES C & D

Photo D8-C1 – Example of typical vuggy core, and shale infill zone within bedrock along Route C (TH-EC01-P). Core diameter is 63.5 mm.

Photo D8-C2 – Extensive shale infill zone within bedrock along Route C (TH-EC04). Core diameter is 63.5 mm; length of core box approximately 1.5 m.

Photo D8-C3 – Example of broken core/rubble zone within bedrock along Route C (TH-GC02). Core diameter is 63.5 mm.

Photo D8-C4 – Example of good quality bedrock along Route C (TH-GC04). Core diameter is 63.5 mm; length of core box approximately 1.5 m.

Photo D8-C5 – Example of reasonable quality bedrock along Route D (TH-GD07). Core diameter is 63.5 mm; length of core box approximately 1.5 m.

Photo D8-C6 – Example of cored and well-cemented basal till along Route D (TH-ED01). Core diameter is 63.5 mm.

APPENDIX D8-D

TABLES D6-1 AND D6-15 GROUNDWATER ELEVATIONS – ROUTES C & D

TABLE D6-1
TESTHOLE DATA SUMMARY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Groundwater Depth (m)	Groundwater Elevation (m)	VW Reading (Hz)	Groundwater Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-GC-01	Next to RC-04	5713039.768	518984.551		till	VW #1602941		249.995	7.62	242.375	-	-	08-Nov-16	-	-	-	2785.6	249.56	no	
					Limestone	STP	25	249.995	13.56	236.435	0.86	250.855	08-Nov-16	-	1.254	249.601	-	-	no	
TH-GC-02	Bridge at RC-02	5712649.169	523179.628		Limestone	VW #1602927		256.06	12.8	243.26	-	-	08-Nov-16	-	-	-	2775.9	255.48	no	
					Limestone	STP	20	256.06	18.9	237.16	0.78	256.84	08-Nov-16	-	1.322	255.518	-	-	no	
TH-GC-04		5710060.991	526935.826	9+600	till	VW #1602930		248.246	3.35	244.896	-	-	08-Nov-16	-	-	-	2977.2	247.57	no	
					Limestone	STP	25	248.246	7.92	240.326	0.83	249.076	08-Nov-16	-	1.775	247.301	-	-	no	
TH-GC-05		5710241.636	527956.468	11+200	till	VW #1602926		244.837	3.66	241.177	-	-	08-Nov-16	-	-	-	2904.5	244.46	no	
					Limestone	STP	25	244.837	7.62	237.217	0.80	245.637	08-Nov-16	-	0.058	245.579	-	-	yes	
TH-EC-01P	Next to TH-EC-01WW1	5713201.412	522685.673	3+875	Limestone	VW #1602936		255.589	12.50	243.089	-	-	08-Nov-16	-	-	-	2643.8	254.87	no	
					Limestone	STP	25	255.589	19.81	235.779	0.62	256.209	08-Nov-16	-	-	-	-	-	no	Standpipe was blocked, so could not get true DTW. (now unblocked)
TH-EC-01WW1	Water Well	5713200.004	522685.692	3+875	Limestone	STP	125	255.566	13.11	242.456	0.99	256.556	08-Nov-16	-	1.430	255.126	-	-	no	
TH-EC-01WW2	Water Well	5713204.866	522692.415	3+875	Limestone	STP	125	255.584	18.29	237.294	0.91	256.494	08-Nov-16	-	1.460	255.034	-	-	no	
TH-EC-03W	Water Well	5710366.863	527199.247	10+250	Limestone	STP	125	245.682	15.54	230.142	1.22	246.902	08-Nov-16	-	-1.220	248.122	-	-	yes	Flowing over top of casing.
TH-EC-04	N of channel near TH-EC-01	5713517.955	521973.821		till	VW #1602925		254.973	6.10	248.873	-	-	08-Nov-16	-	-	-	2918.3	254.29	no	
					Limestone	STP	25	254.973	17.37	237.603	0.64	255.613	08-Nov-16	-	1.475	254.138	-	-	no	
15-RC-04				0+464	Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	16-Jul-15	-	1.93	248.70	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	04-Aug-15	-	1.55	249.08	-	-	no	
					Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	09-Nov-15	-	1.21	249.42	-	-	no	
					Clay Till	STP	25	249.69	5.5	244.19	0.94	250.63	07-Nov-16	-	0.875	249.755	-	-	yes	
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	16-Jul-15	-	1.91	248.68	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	04-Aug-15	-	1.67	248.92	-	-	no	
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	09-Nov-15	-	1.30	249.29	-	-	no	
					Clay Till	STP	25	249.69	10.7	238.99	0.9	250.59	07-Nov-16	-	0.922	249.668	-	-	no	
15-RC-06				4+200	Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	16-Jul-15	-	-	253.37			no	Water level at bottom of hole upon completion of drilling
					Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	04-Aug-15	-	-	253.62			no	Water level at bottom of hole upon completion of drilling
					Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	09-Nov-15	-	-	254.59			no	
					Limestone	VW #1404250		254.97	5.2	249.77	-	254.97	07-Nov-16	-	-	-	2705.1	255.21	yes	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	16-Jul-15	-	2.14	253.86	-	-	no	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	04-Aug-15	-	2.70	253.31	-	-	no	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	09-Nov-15	-	1.68	254.32	-	-	no	
					Limestone	STP	25	254.97	13.5	241.47	1.03	256	07-Nov-16	-	1.255	254.745	-	-	no	
15-RC-02				5+168	Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	16-Jul-15	-	2.02	254.33	-	-	no	
					Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	04-Aug-15	-	1.72	254.63	-	-	no	
					Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	09-Nov-15	-	1.38	254.97	-	-	no	
					Topsoil, Cobbles, Limestone	STP	25	255.46	1.5	253.96	0.89	256.35	08-Nov-16	-	1.108	255.242	-	-	no	
15-RC-01				8+100	Silt	STP	25	252.62	4.6	248.02	0.82	253.44	16-Jul-15	-	1.87	251.57	-	-	no	
					Silt	STP	25	252.62	4.6	248.02	0.82	253.44	04-Aug-15	-	2.19	251.25	-	-	no	
					Silt	STP	25	252.62	4.6	248.02	0.82	253.44	09-Nov-15	-	1.53	251.91	-	-	no	
					Silt	STP	25	252.62	4.6	248.02	0.82	253.44	08-Nov-16	-	1.163	252.277	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	16-Jul-15	-	2.21	251.30	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	04-Aug-15	-	2.31	251.20	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	09-Nov-15	-	1.65	251.86	-	-	no	
					Limestone	STP	25	252.61	11.9	240.71	0.9	253.51	08-Nov-16	-	1.087	252.423	-	-	no	

TABLE D6-1
TESTHOLE DATA SUMMARY - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

TABLE D6-1
GROUNDWATER ELEVATION RESULTS - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Groundwater Depth (m)	Groundwater Elevation (m)	VW Reading (Hz)	Groundwater Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
BH-BC6		5710352.022	526616.717		Limestone	STP	25	246.071	7.6	238.471	0.88	246.951	21-Jul-12	-	-	-	-	-	yes	No water depths taken due to artesian conditions.
					Limestone	STP	25	246.071	7.6	238.471	0.88	246.951	29-Aug-12	-	-	247.58	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					Limestone	STP	25	246.071	7.6	238.471	0.88	246.951	08-Nov-16	1.8	-1.27	248.2175	-	-	yes	
BH-BC5		5710366.741	527198.084		Limestone	STP	25	245.543	13.6	231.943	0.91	246.453	21-Jul-12	-	-	-	-	-	yes	No water depths taken due to artesian conditions.
					Limestone	STP	25	245.543	13.6	231.943	0.91	246.453	29-Aug-12	-	-	246.87	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					Limestone	STP	25	245.543	13.6	231.943	0.91	246.453	08-Nov-16	1.5	-1.06	247.51	-	-	yes	

VW = Vibrating Wire
STP = Standpipe

Notes:
1. BH-BC series drilled and surveyed in 2011.
2. 15-RC series drilled in 2015. Ground elevations were estimated using LiDAR.
3. TH-GC and TH-EC series drilled and surveyed in 2016.
4. Transducers Installed December 8, 2016 at:
TH-ED-01W
TH-EC-03W
TH-EC-01WW1
TH-EC-01WW2

TABLE D6-15
TESTHOLE DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
TH-GD-02		5683632.07	531290.40		till	VW #1602935		248.625	6.91	241.715	-	-	09-Nov-16	-	-	-	2887.4	249.17	yes	
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	09-Nov-16	-	>-0.85	>250.33	-	-	yes	Flowing at TOC; no extension available >1.7m ags
TH-GD-05		5693350.95	530617.18		till	VW #1602924		248.66	6.71	241.95	-	-	09-Nov-16	-	-	-	2772.2	249.83	yes	
					till	STP	20	248.66	16.92	231.74	0.80	249.461	09-Nov-16	-	>-0.8	>250.261	-	-	yes	Flowing at TOC; no extension available
TH-GD-06		5697400.98	531025.08		till	VW #1602923		251.918	10.67	241.248	-	-	10-Nov-16	-	-	-	2738.5	251.56	no	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	10-Nov-16	-	0.02	252.791	-	-	yes	
TH-GD-07		5699453.66	531900.65		till	VW #1602937		252.045	12.19	239.855	-	-	09-Nov-16	-	-	-	2726.0	253.08	yes	
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	09-Nov-16	-	>-0.79	>253.626	-	-	yes	Flowing at TOC; no extension available >1.6m ags
TH-GD-08		5701521.62	532917.21		till	VW #1602938		246.807	7.32	239.487	-	-	09-Nov-16	-	-	-	2721.1	250.41	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	09-Nov-16	-	-	-	2590.2	227.26	no	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	09-Nov-16	-	>-7.92	>254.75	-	-	yes	Flowing at TOC; only able to extend by 7.92 m safely >7.9m ags
TH-ED-01P		5692376.38	530502.82	11+625	till	VW #1602932		249.431	6.10	243.331	-	-	09-Nov-16	-	-	-	2830.4	249.47	yes	
					till	VW #1602939		249.431	10.67	238.761	-	-	09-Nov-16	-	-	-	2771.9	250.36	yes	
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	09-Nov-16	2.1	-1.48	>251.826	-	-	yes	Flowing at TOC; no extension available >2.4m ags
TH-ED-01W		5692378.37	530495.27	11+625	bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	09-Nov-16	-	-4.57	255.1	-	-	yes	Artesian at 5.6m ags
TH-ED-01PP1		5692378.65	530536.08		till	STP	25	248.717	1.22	247.497	0.97	249.688	09-Nov-16	-	1.130	248.558	-	-	no	
TH-ED-01PP2		5692380.13	530549.75		till	STP	25	248.456	1.22	247.236	1.06	249.519	09-Nov-16	-	1.03	248.493	-	-	yes	
TH-ED-03		5693404.42	529670.69		till	VW #1602931		252.218	6.10	246.118	-	-	09-Nov-16	-	-	-	2854.2	251.54	no	
					till	STP	25	252.218	13.41	238.808	0.86	253.076	09-Nov-16	-	0.580	252.496	-	-	yes	
BH-D109		5682844.41	530474.731		till	STP	20	249.716	12.85	236.866	0.96	250.676	21-Jul-12	-	-	250.68	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	29-Aug-12	-	-	250.68	-	-	yes	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	09-Nov-16	-	1.11	249.571	-	-	no	
15-RD-01				2+672	Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	16-Jul-15	1	-0.70	250.00	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	04-Aug-15	1	-0.70	250.00	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	09-Nov-15	1	-0.70	250.00	-	-	yes	
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	09-Nov-16	1.1	-0.77	250.07	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	16-Jul-15	3.5	-2.46	251.73	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	04-Aug-15	2.9	-2.04	251.31	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	09-Nov-15	3	-2.11	251.38	-	-	yes	
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	09-Nov-16	3.8	-2.67	251.94	-	-	yes	
BH-D101		5684505.014	530628.736		till	STP	25	249.251	8.94	240.311	1.12	250.371	21-Jul-12	-	-	248.09	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	29-Aug-12	-	-	247.69	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.251	8.94	240.311	1.12	250.371	09-Nov-16	-	1.33	249.04	-	-	no	
BH-D106		5682844.413	530474.731		till	STP	50	249.917	11.23	238.687	0.89	250.807	21-Jul-12	-	-	248.06	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.917	11.23	238.687	0.89	250.807	29-Aug-12	-	-	247.58	-	-	no	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	09-Nov-16	-	0.86	249.951	-	-	yes	

TABLE D6-15
TESTHOLE DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
BH-D107		5691570.348	530533.122		till	STP	50	249.81	8.69	241.12	0.86	250.67	21-Jul-12	-	-	248.97	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	29-Aug-12	-	-	248.65	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	50	249.81	8.69	241.12	0.86	250.67	09-Nov-16	-	-	-	-	-	-	No permission for access
15-RD-02				12+776	Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	16-Jul-15	7.1	-5.00	254.45	-	-	yes	
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	04-Aug-15	7.1	-5.00	254.45	-	-	yes	
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	09-Nov-15	7.7	-5.42	254.87	-	-	yes	
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	09-Nov-16	7.4	-5.21	254.66	-	-	yes	
15-RD-02A				12+776	Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	16-Jul-15	-	0.91	248.39	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	04-Aug-15	-	0.98	248.33	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	09-Nov-15	-	0.65	248.65	-	-	yes	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	09-Nov-16	-	>-0.67	>249.97	-	-	yes	Flowing at TOC; no extension available
BH-D9		5693949.149	530788.559		till	STP	25	249.495	12.376	237.119	0.90	250.395	21-Jul-12	-	-	248.96	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	29-Aug-12	-	-	248.77	-	-	no	Groundwater elevations from Summary Field Investigation Report, August, 2012 (KGS), Table 2.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	09-Nov-16	-	1.23	249.161	-	-	no	
15-RD-03				17+032	Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	16-Jul-15	-	1.75	250.99	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	04-Aug-15	-	1.68	251.06	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	09-Nov-15	-	1.30	251.44	-	-	no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	09-Nov-16	-	1.238	251.502	-	-	no	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	16-Jul-15	-	0.36	252.39	-	-	yes	Water level 0.9 m below grade upon completion of drilling
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	04-Aug-15	-	0.32	252.42	-	-	yes	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	09-Nov-15	-	0.00	252.74	-	-	yes	Water level at Top Of Casing (TOC)
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	09-Nov-16	-	>-0.9	>253.64	-	-	yes	Flowing at TOC; no extension available
15-RD-03A				17+032	Sand	VW #1403291		251.86	10.4	241.46	-	-	16-Jul-15	-	-	250.52	-	-	no	Water level at bottom upon completion of drilling
					Sand	VW #1403291		251.86	10.4	241.46	-	-	04-Aug-15	-	-	251.18	-	-	no	Water level at bottom upon completion of drilling
					Sand	VW #1403291		251.86	10.4	241.46	-	-	09-Nov-15	-	-	251.94	-	-	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	09-Nov-16	-	-	-	2816.1	251.93	yes	
15-RD-04				19+256	Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	16-Jul-15	-	1.03	251.73	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	04-Aug-15	-	2.51	250.255	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	09-Nov-15	-	0.75	252.01	-	-	yes	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	09-Nov-16	-	0.54	252.216	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	16-Jul-15	1.6	-1.13	253.89	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	04-Aug-15	1.1	-0.77	253.53	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	09-Nov-15	2.5	-1.76	254.52	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	09-Nov-16	-	>-1	>253.76	-	-	yes	Flowing at TOC; no extension available

TABLE D6-15
TESTHOLE DATA SUMMARY - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Test Hole	Description	UTM Location		Station	Soil Type	Instrumentation		Ground Elevation (m)	Tip Depth (m)	Tip Elevation (m)	Stick-up Height (m)	Top of Casing Elevation (m)	Date	Pressure Gauge Reading (psi)	Ground-water Depth (m)	Ground-water Elevation (m)	VW Reading (Hz)	Ground-water Elevation (m)	Artesian Conditions	Comments
		Northing	Easting			Type	Diam. (mm)													
15-RD-10A				17+800	Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	16-Jul-15	-	-	-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	04-Aug-15	-		-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	09-Nov-15	-	-	-	-	-	-	Was not read
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	09-Nov-16	-	-	-	2727.5	249.60	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	16-Jul-15	-	-	-	-	-	-	Water level at bottom of hole upon completion of drilling
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	04-Aug-15	-	-	-	-	-	-	No Access
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	09-Nov-15	-	0.1	249.77	-	-	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	09-Nov-16	-	>-1	>250.87	-	-	yes	Flowing at TOC; no extension available
15-RD-05				21+464	Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	16-Jul-15	-	1.90	246.14			no	Water level 0.9 m below grade upon completion of drilling
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	04-Aug-15	-	1.89	246.15			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	09-Nov-15	-	1.37	246.67			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	09-Nov-16	-	-	-	-	-	-	Blocked at 0.61 m.
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	16-Jul-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	04-Aug-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	09-Nov-15	-	>-0.93	>248.95			yes	Flowing at TOC; no extension available
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	09-Nov-16	-	0.23	247.791			yes	

VW = Vibrating Wire
STP = Standpipe

Notes:
1. BH-BC series drilled and surveyed in 2011.
2. 15-RC series drilled in 2015. Ground elevations were estimated using LiDAR.
3. TH-GC and TH-EC series drilled and surveyed in 2016.
4. Transducers installed December 8, 2016:
   TH-ED-01W
   15-RD-PW1

APPENDIX D8-E

LABORATORY TEST RESULTS – ROUTE C AND D

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg MB R3Y 1G4

January 27, 2017
File: 123312912

Attention: Mr. David Anderson
KGS Group Inc.
3rd Floor – 865 Waverley St.
Winnipeg, Manitoba R3T 5P4

Dear David,

Reference: Lake Manitoba Channel (16-0300-006)

On December 16, 2016, a total of four (4) soil samples were submitted to our laboratory for analysis. The following tests were conducted on selected soil samples:

- Standard Proctor (ASTM 698)
- Particle-Size Analysis (ASTM D422)
- Liquid Limit (multi-point), plastic limit, and plasticity index (ASTM D4318)
- Direct Shear (ASTM D3080)

We appreciate the opportunity to assist you in this project. Please call if you have any questions regarding this report.

Regards,

STANTEC CONSULTING LTD.

<Original signed by>

Nestor Abarca
Geotechnical Technologist
Phone: (204) 488-6999
nestor.abarca@stantec.com

<Original signed by>

Jason Thompson, C.E.T.
Senior Associate – Team Lead
Manager, Materials Testing Services
Phone: (204) 928-4004
jason.thompson@stantec.com

Attachment: Table 1 – Particle Size Analysis and Atterberg Limits Test Data
4 x Particle Size Analysis Test Reports
4 x Atterberg Limits Test Reports
3 x Proctor Density Test Reports
4 x Direct Shear Test Reports

Reference: Lake Manitoba Channel (16-0300-006)

TABLE 1
PARTICLE SIZE ANALYSIS AND ATTERBERG LIMITS TEST DATA

Testhole	Particle Size Analysis							Atterberg Limits		
	Gravel (%) 75 to 4.75 mm	Sand (%)			Silt (%) <0.075 to 0.002 mm	Clay (%) <0.002 mm	Colloids (%) < 0.001 mm	Liquid Limit	Plastic Limit	Plasticity Index
		Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm						
"C" Series	9.6	4.0	8.9	12.4	45.9	19.2	14.7	19	13	6
"C" Series	3.5	4.4	12.6	13.8	47.5	18.2	13.5	18	13	5
"D" Series	3.5	5.2	12.0	15.3	45.5	18.5	14.3	18	13	5
"D" Series	12.1	4.4	12.3	15.4	41.1	14.7	11.4	17	12	5

Notes:
1. A high speed stirring device was used for 1 minute to disperse the test sample for particle size analysis
2. The soil samples were air-dried during sample preparation for Atterberg limits and particle size analysis

LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

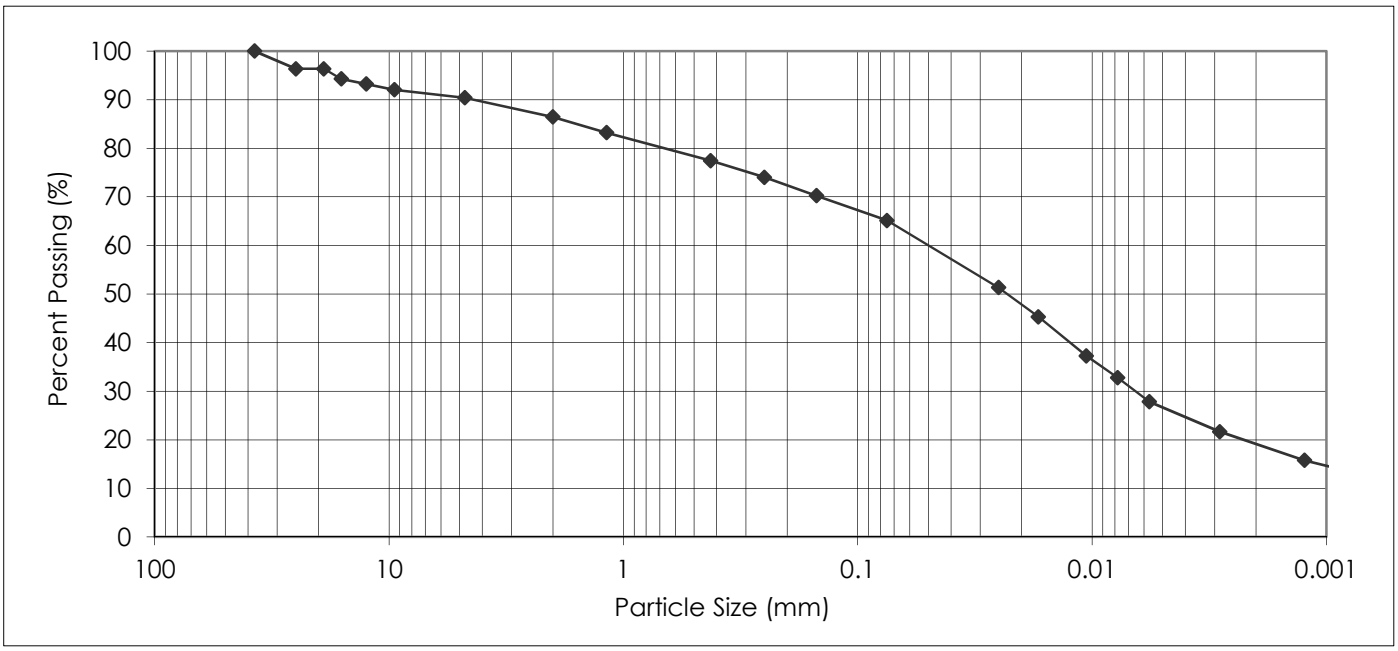
PROJECT: Lake MB Channel
(16-0300-006)

Attention: David Anderson

PROJECT NO.: 123312912

SAMPLED BY: Client
SAMPLE ID: "C" Series

DATE RECEIVED: December 16, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	96.4
19.00 mm	96.4
16.00 mm	94.3
12.50 mm	93.2
9.50 mm	92.1
4.75 mm	90.4
2.00 mm	86.4

PARTICLE SIZE	PERCENT PASSING
1.18 mm	83.2
0.425 mm	77.5
0.250 mm	74.0
0.150 mm	70.2
0.075 mm	65.1
0.005 mm	26.7
0.002 mm	19.2
0.001 mm	14.7

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
9.6	4.0	8.9	12.4	45.9	19.2	14.7

<Original signed by>

REPORT DATE: December 22, 2016

REVIEWED BY. [illegible] E.T.

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LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

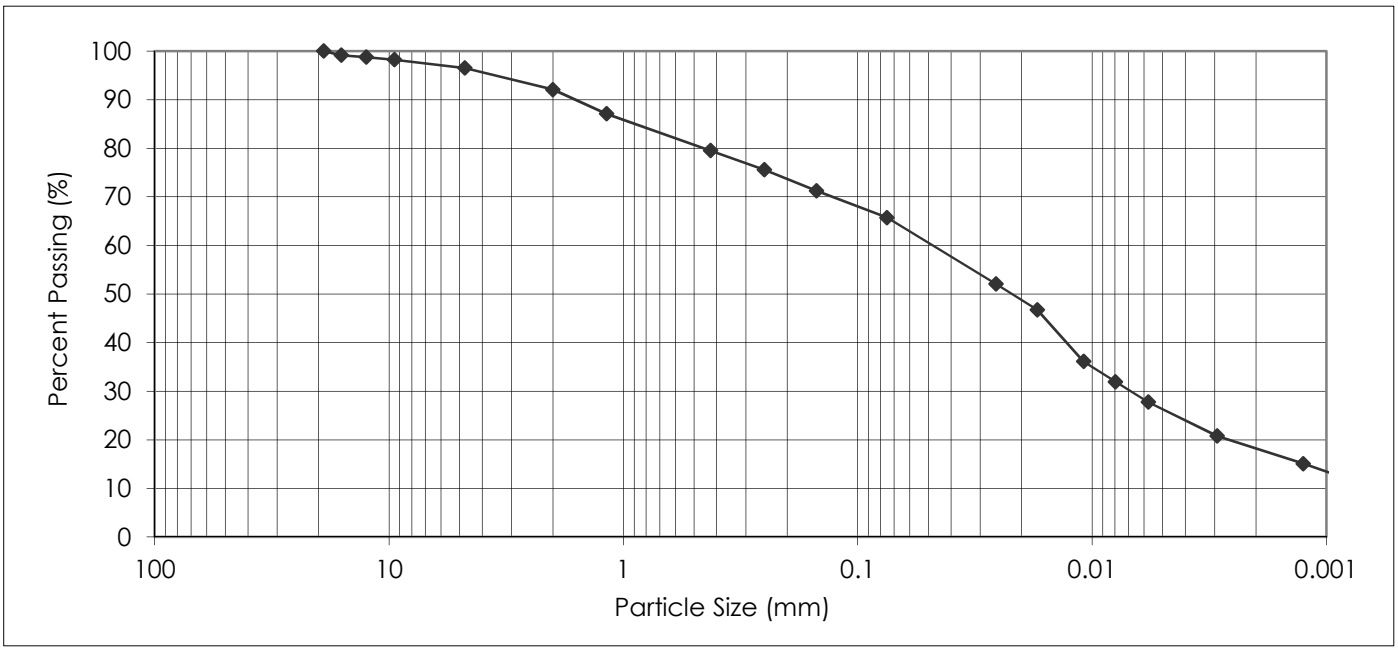
PROJECT: Lake MB Channel
(16-0300-006)

Attention: David Anderson

PROJECT NO.: 123312912

SAMPLED BY: Client
SAMPLE ID: "C" Series

DATE RECEIVED: December 16, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	99.2
12.50 mm	98.8
9.50 mm	98.2
4.75 mm	96.5
2.00 mm	92.1

PARTICLE SIZE	PERCENT PASSING
1.18 mm	87.1
0.425 mm	79.5
0.250 mm	75.6
0.150 mm	71.3
0.075 mm	65.7
0.005 mm	26.3
0.002 mm	18.2
0.001 mm	13.5

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
3.5	4.4	12.6	13.8	47.5	18.2	13.5

<Original signed by>

REPORT DATE: December 22, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

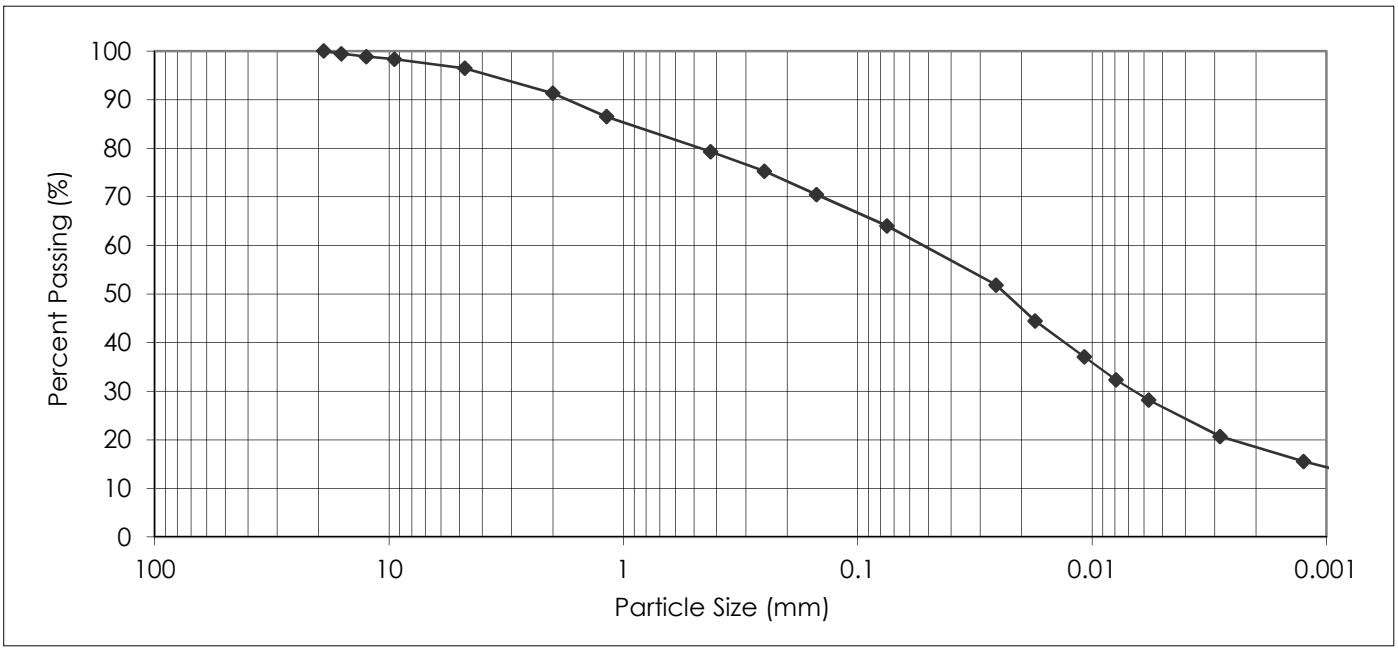
PROJECT: Lake MB Channel
(16-0300-006)

Attention: David Anderson

PROJECT NO.: 123312912

SAMPLED BY: Client
SAMPLE ID: "D" Series

DATE RECEIVED: December 16, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	99.4
12.50 mm	98.9
9.50 mm	98.3
4.75 mm	96.5
2.00 mm	91.3

PARTICLE SIZE	PERCENT PASSING
1.18 mm	86.5
0.425 mm	79.3
0.250 mm	75.3
0.150 mm	70.5
0.075 mm	64.0
0.005 mm	26.7
0.002 mm	18.5
0.001 mm	14.3

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
3.5	5.2	12.0	15.3	45.5	18.5	14.3

<Original signed by>

REPORT DATE: December 22, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

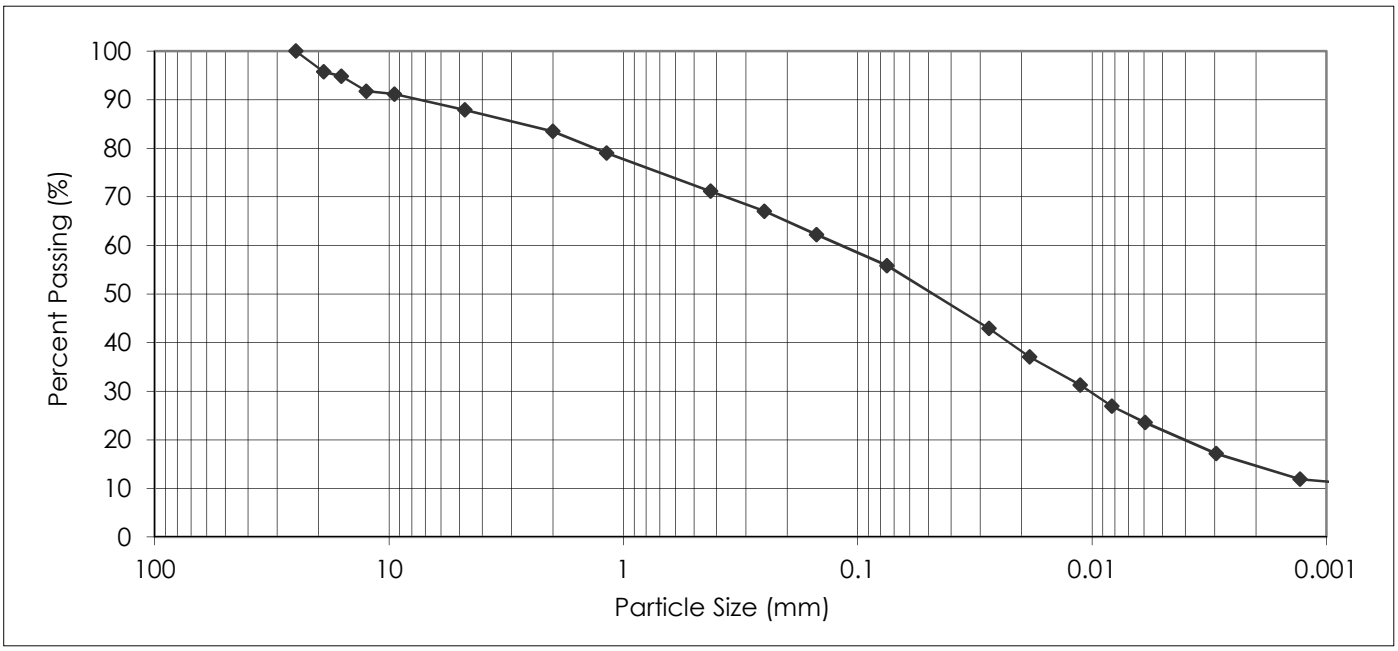
PROJECT: Lake MB Channel
(16-0300-006)

Attention: David Anderson

PROJECT NO.: 123312912

SAMPLED BY: Client
SAMPLE ID: "D" Series

DATE RECEIVED: December 16, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	95.7
16.00 mm	94.8
12.50 mm	91.8
9.50 mm	91.1
4.75 mm	87.9
2.00 mm	83.5

PARTICLE SIZE	PERCENT PASSING
1.18 mm	79.0
0.425 mm	71.2
0.250 mm	67.1
0.150 mm	62.3
0.075 mm	55.8
0.005 mm	22.0
0.002 mm	14.7
0.001 mm	11.4

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
12.1	4.4	12.3	15.4	41.1	14.7	11.4

REPORT DATE: December 22, 2016

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REVIEWEL , C.E.T.

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LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

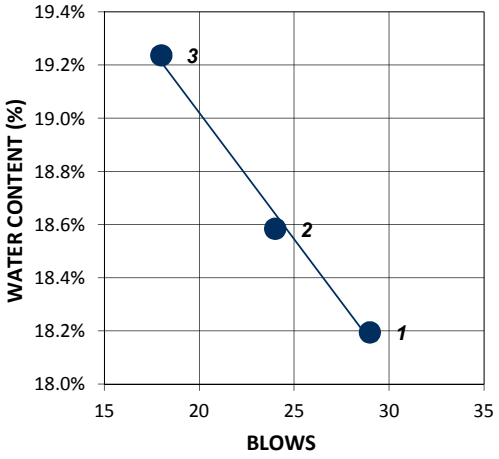
Atterberg Limits
ASTM D4318
Method A- Multi-Point

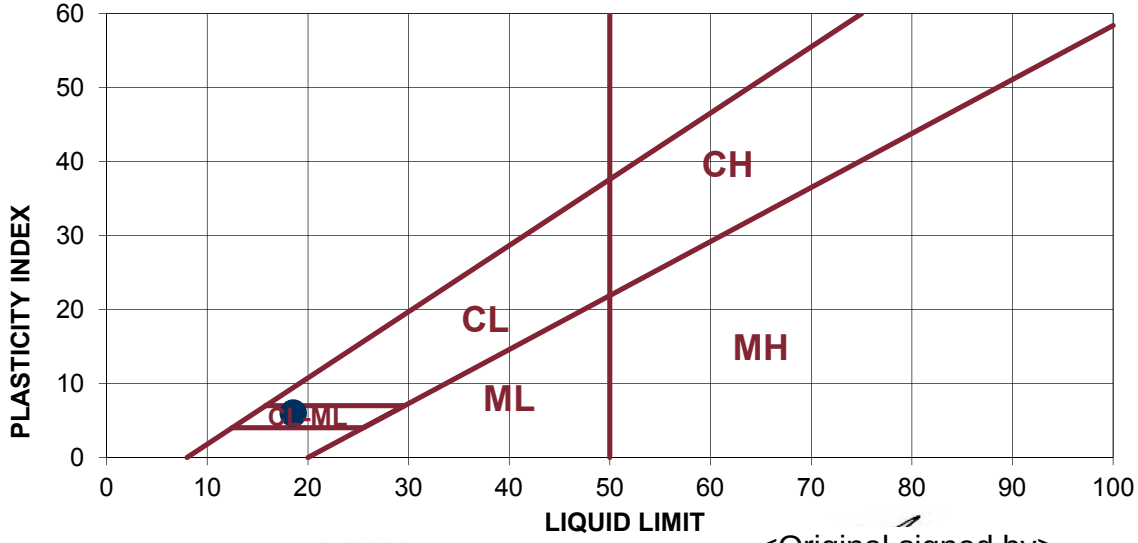
Client:	KGS Group Inc.
Project Name:	Lake MB Channel (16-0300-006)
Project No:	123312912
Date Received:	December 16, 2016
Date Tested:	December 21, 2016
Tested By:	Nestor Abarca

Sample : "C" Series

LIQUID LIMIT				PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	29	24	18			
Tare No.	162	204	260	Tare No.	289	303
Wt. Sa. (wet+tare)(g)	45	45	43	Wt. Sa. (wet+tare)(g)	39.19	41.75
Wt. Sa. (dry+tare)(g)	42	41	39	Wt. Sa. (dry+tare)(g)	36.90	39.35
Wt. Tare (g)	20	19	20	Wt. Tare (g)	19.27	20.95
Wt. Dry Soil (g)	21.6	22.3	19.1	Wt. Dry Soil (g)	17.6	18.4
Wt. Water (g)	3.9	4.2	3.7	Wt. Water (g)	2.3	2.4
Water Content (%)	18.2%	18.6%	19.2%	Water Content (%)	13.0%	13.0%

RESULTS	
LL	**19**
PL	**13**
PI	**6**





<Original signed by>

Reviewed By: Jason Thompson, C.E.T.

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LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

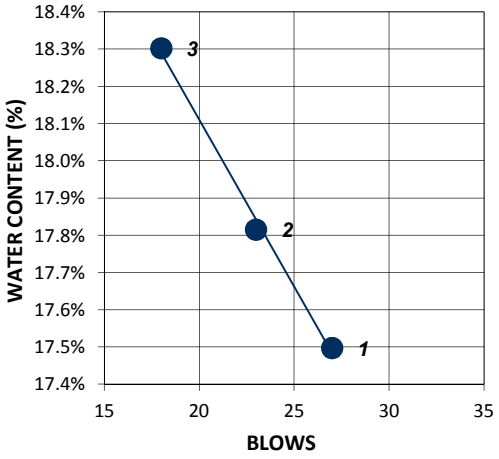
Atterberg Limits
ASTM D4318
Method A- Multi-Point

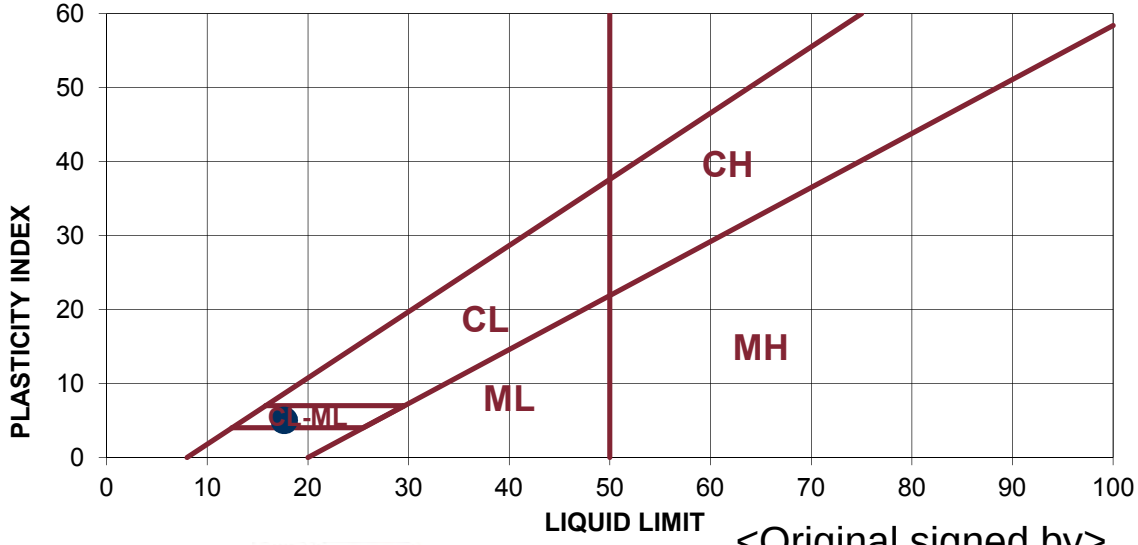
Client:	KGS Group Inc.
Project Name:	Lake MB Channel (16-0300-006)
Project No:	123312912
Date Received:	December 16, 2016
Date Tested:	December 21, 2016
Tested By:	Nestor Abarca

Sample : "C" Series

LIQUID LIMIT				PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	27	23	18			
Tare No.	158	165	226	Tare No.	229	230
Wt. Sa. (wet+tare)(g)	42	45	44	Wt. Sa. (wet+tare)(g)	40.32	43.8
Wt. Sa. (dry+tare)(g)	39	41	40	Wt. Sa. (dry+tare)(g)	38.08	41.2
Wt. Tare (g)	20	20	20	Wt. Tare (g)	20.88	21.06
Wt. Dry Soil (g)	18.5	21.1	20.4	Wt. Dry Soil (g)	17.2	20.1
Wt. Water (g)	3.2	3.8	3.7	Wt. Water (g)	2.2	2.6
Water Content (%)	17.5%	17.8%	18.3%	Water Content (%)	13.0%	12.9%

RESULTS	
LL	18
PL	13
PI	5





<Original signed by>

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LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

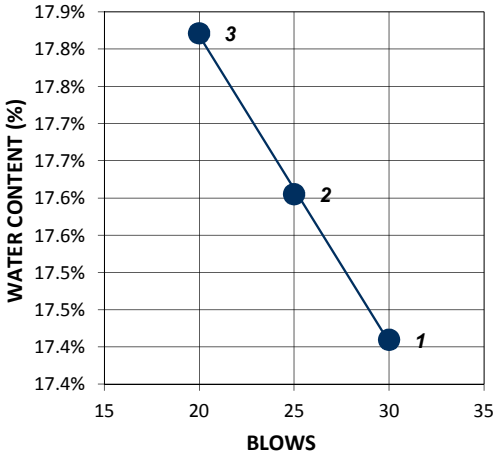
Atterberg Limits
ASTM D4318
Method A- Multi-Point

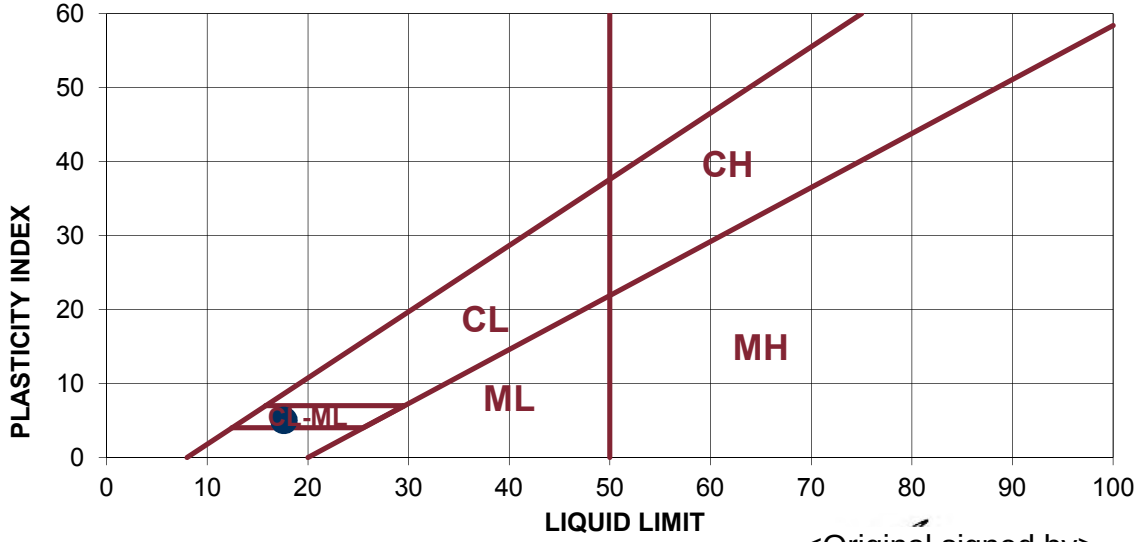
Client:	KGS Group Inc.
Project Name:	Lake MB Channel (16-0300-006)
Project No:	123312912
Date Received:	December 16, 2016
Date Tested:	December 21, 2016
Tested By:	Nestor Abarca

Sample : "D" Series

LIQUID LIMIT				PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	30	25	20			
Tare No.	147	163	210	Tare No.	238	243
Wt. Sa. (wet+tare)(g)	42	43	43	Wt. Sa. (wet+tare)(g)	39.48	44.68
Wt. Sa. (dry+tare)(g)	39	39	40	Wt. Sa. (dry+tare)(g)	37.35	41.98
Wt. Tare (g)	20	19	20	Wt. Tare (g)	20.64	20.96
Wt. Dry Soil (g)	18.8	19.7	19.9	Wt. Dry Soil (g)	16.7	21.0
Wt. Water (g)	3.3	3.5	3.6	Wt. Water (g)	2.1	2.7
Water Content (%)	17.4%	17.6%	17.8%	Water Content (%)	12.7%	12.8%

RESULTS	
LL	18
PL	13
PI	5





<Original signed by>

Reviewed By: Jason Thompson, C.E.T.

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LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

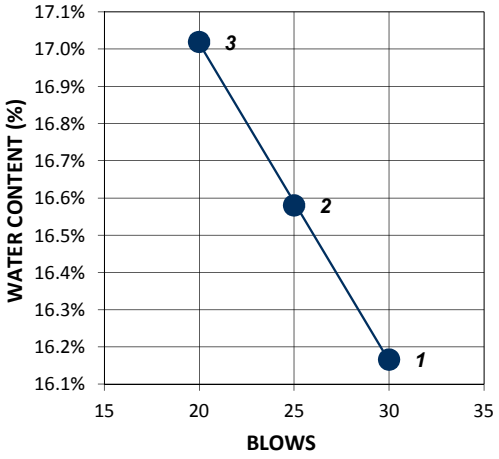
Atterberg Limits
ASTM D4318
Method A- Multi-Point

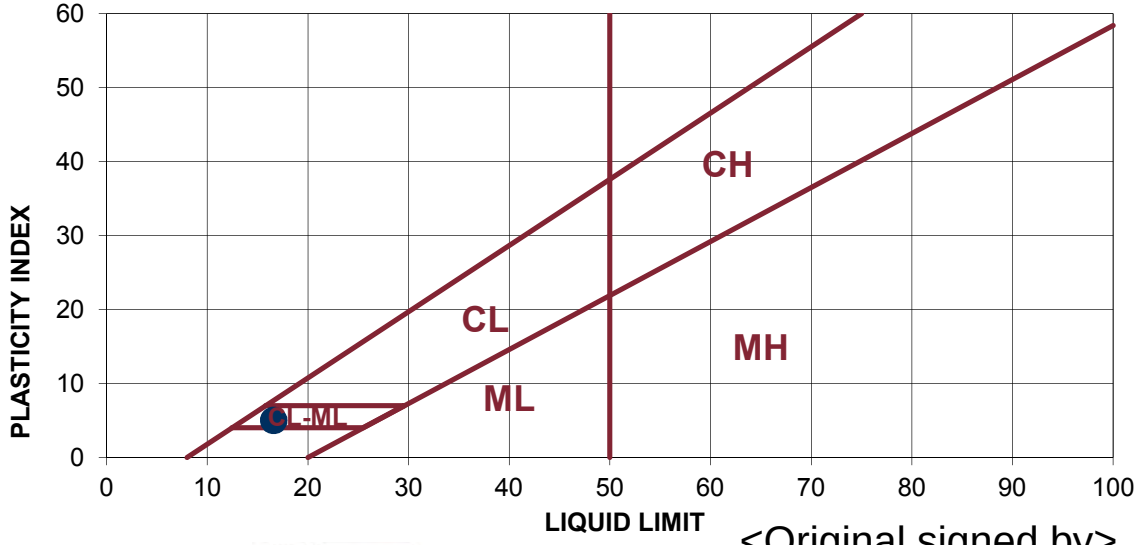
Client:	KGS Group Inc.
Project Name:	Lake MB Channel (16-0300-006)
Project No:	123312912
Date Received:	December 16, 2016
Date Tested:	December 21, 2016
Tested By:	Nestor Abarca

Sample : "D" Series

LIQUID LIMIT				PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	30	25	20			
Tare No.	134	160	178	Tare No.	235	310
Wt. Sa. (wet+tare)(g)	42	46	47	Wt. Sa. (wet+tare)(g)	39.10	40.28
Wt. Sa. (dry+tare)(g)	39	42	43	Wt. Sa. (dry+tare)(g)	37.14	38.18
Wt. Tare (g)	20	19	20	Wt. Tare (g)	20.54	20.5
Wt. Dry Soil (g)	19.0	23.2	23.2	Wt. Dry Soil (g)	16.6	17.7
Wt. Water (g)	3.1	3.8	3.9	Wt. Water (g)	2.0	2.1
Water Content (%)	16.2%	16.6%	17.0%	Water Content (%)	11.8%	11.9%

RESULTS	
LL	**17**
PL	**12**
PI	**5**





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Stantec
199 Henlow Bay
Winnipeg, Manitoba
R3Y 1G4
Tel: (204) 488-6999

CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

PROCTOR TEST REPORT

TO KGS Group Inc.
3rd Floor - 865 Waverley St
Winnipeg, MB
R3T 5P4

ATTN: David Anderson

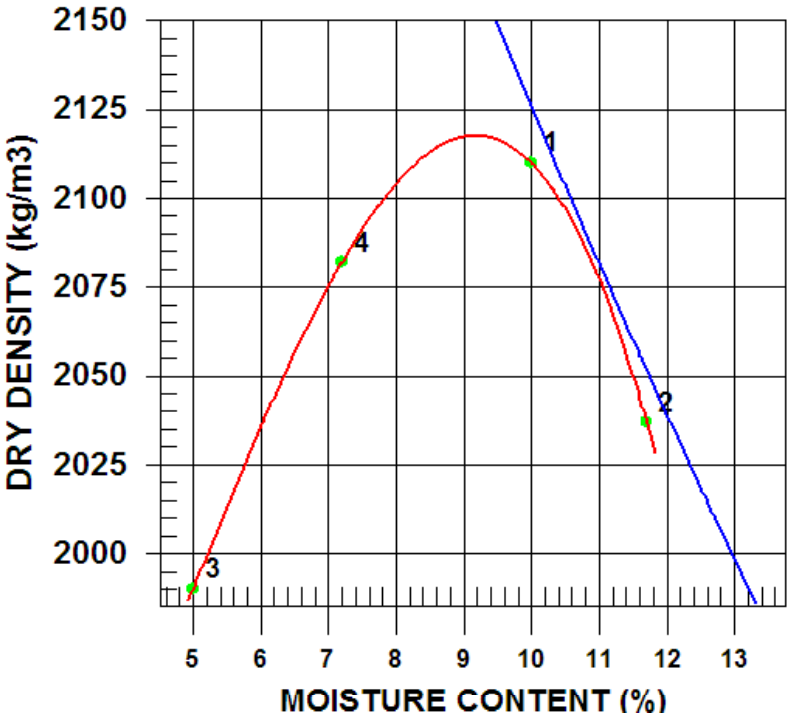
CLIENT KGS Group Inc.
C.C. KGS Group Inc.

PROJECT Lake Manitoba Channel (16-0300-006)

PROJECT NO.
PROCTOR NO. 1 DATE SAMPLED 2016.Dec.16 DATE RECEIVED 2016.Dec.16 DATE TESTED 2016.Dec.21

INSITU MOISTURE N/A %
TESTED BY JT
MATERIAL IDENTIFICATION
MATERIAL USE
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay Till
SUPPLIER
SOURCE In-Sity Materials

COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE C: 152.4mm Mold, Passing 19mm
RAMMER TYPE Manual
PREPARATION Moist
OVERSIZE CORRECTION METHOD None
RETAINED 19mm SCREEN



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	2321	2110	10.0
2	2275	2037	11.7
3	2089	1990	5.0
4	2232	2082	7.2

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	2120	9.1
OVERSIZE CORRECTED		

COMMENTS
Sample identified as "C" Series and is a composite of the samples obtained from TH-GC-01, TH-GC-02, TH-GC-04, and TH-GC-05.

<Original signed by>

Page 1 of 1 2017.Jan.03

REVIEWED BY Jason Thompson, C.E.T.

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Stantec
199 Henlow Bay
Winnipeg, Manitoba
R3Y 1G4
Tel: (204) 488-6999

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

PROCTOR TEST REPORT

TO KGS Group Inc.
3rd Floor - 865 Waverley St
Winnipeg, MB
R3T 5P4

ATTN: David Anderson

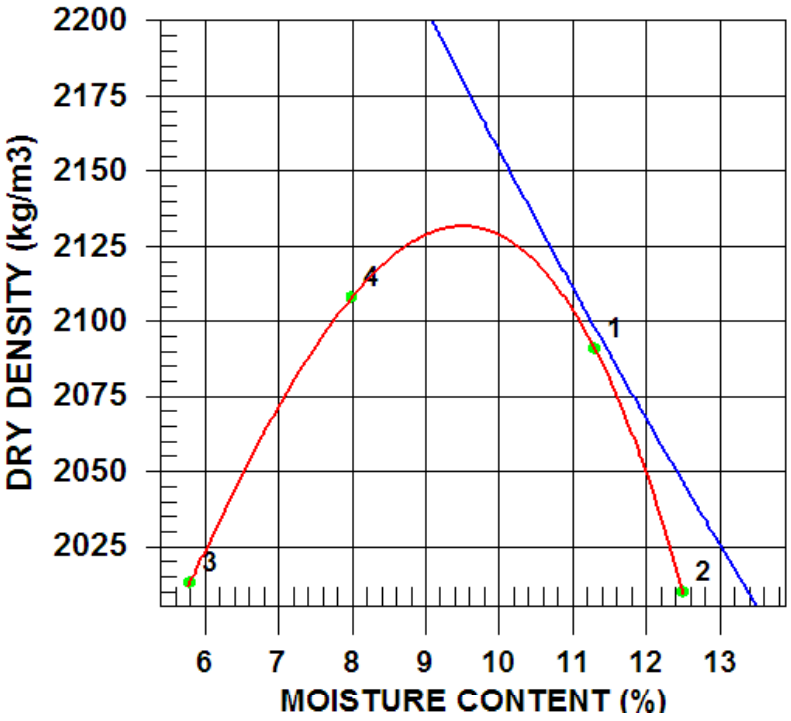
CLIENT KGS Group Inc.
C.C. KGS Group Inc.

PROJECT Lake Manitoba Channel (16-0300-006)

PROJECT NO.
PROCTOR NO. 2 DATE SAMPLED 2016.Dec.16 DATE RECEIVED 2016.Dec.16 DATE TESTED 2016.Dec.21

INSITU MOISTURE N/A %
TESTED BY JT
MATERIAL IDENTIFICATION
MATERIAL USE
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay Till
SUPPLIER
SOURCE In-Situ Materials

COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE C: 152.4mm Mold, Passing 19mm
RAMMER TYPE Manual
PREPARATION Moist
OVERSIZE CORRECTION METHOD None
RETAINED 19mm SCREEN



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	2327	2091	11.3
2	2261	2010	12.5
3	2130	2013	5.8
4	2277	2108	8.0

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED OVERSIZE CORRECTED	2133	9.5

COMMENTS
Sample identified as "D" Series Trial #1 and is a composite of the samples obtained from TH-ED-01P, TH-ED-03, TH-GD-02,TH-GD-05, TH-GD-06, TH-GD-07, and TH-GD-08.

<Original signed by>

REVIEWED BY Jason Thompson, C.E.T.

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Report System Software Registered to Stantec Consulting Ltd., Winnipeg

Stantec
199 Henlow Bay
Winnipeg, Manitoba
R3Y 1G4
Tel: (204) 488-6999

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

PROCTOR TEST REPORT

TO KGS Group Inc.
3rd Floor - 865 Waverley St
Winnipeg, MB
R3T 5P4

ATTN: David Anderson

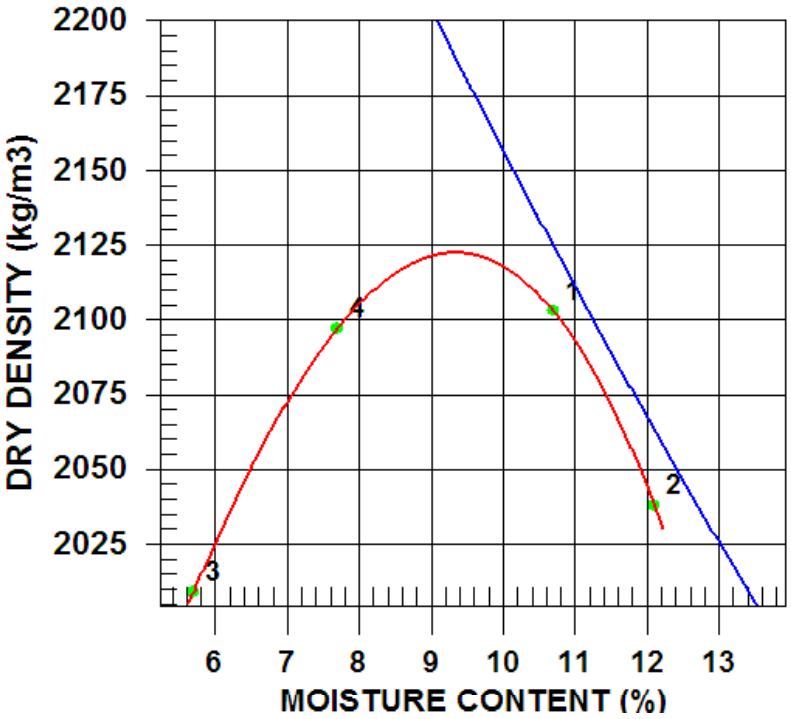
CLIENT KGS Group Inc.
C.C. KGS Group Inc.

PROJECT Lake Manitoba Channel (16-0300-006)

PROJECT NO.
PROCTOR NO. 3 DATE SAMPLED 2016.Dec.16 DATE RECEIVED 2016.Dec.16 DATE TESTED 2016.Dec.21

INSITU MOISTURE N/A %
TESTED BY JT
MATERIAL IDENTIFICATION
MATERIAL USE
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay Till
SUPPLIER
SOURCE In-Situ Materials

COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE C: 152.4mm Mold, Passing 19mm
RAMMER TYPE Manual
PREPARATION Moist
OVERSIZE CORRECTION METHOD None
RETAINED 19mm SCREEN



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	2328	2103	10.7
2	2285	2038	12.1
3	2123	2009	5.7
4	2259	2097	7.7

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	2122	9.3
OVERSIZE CORRECTED		

COMMENTS
Sample identified as "D" Series Trial #2 and is a composite of the samples obtained from TH-ED-01P, TH-ED-03, TH-GD-02, TH-GD-05, TH-GD-06, TH-GD-07, and TH-GD-08.

<Original signed by>

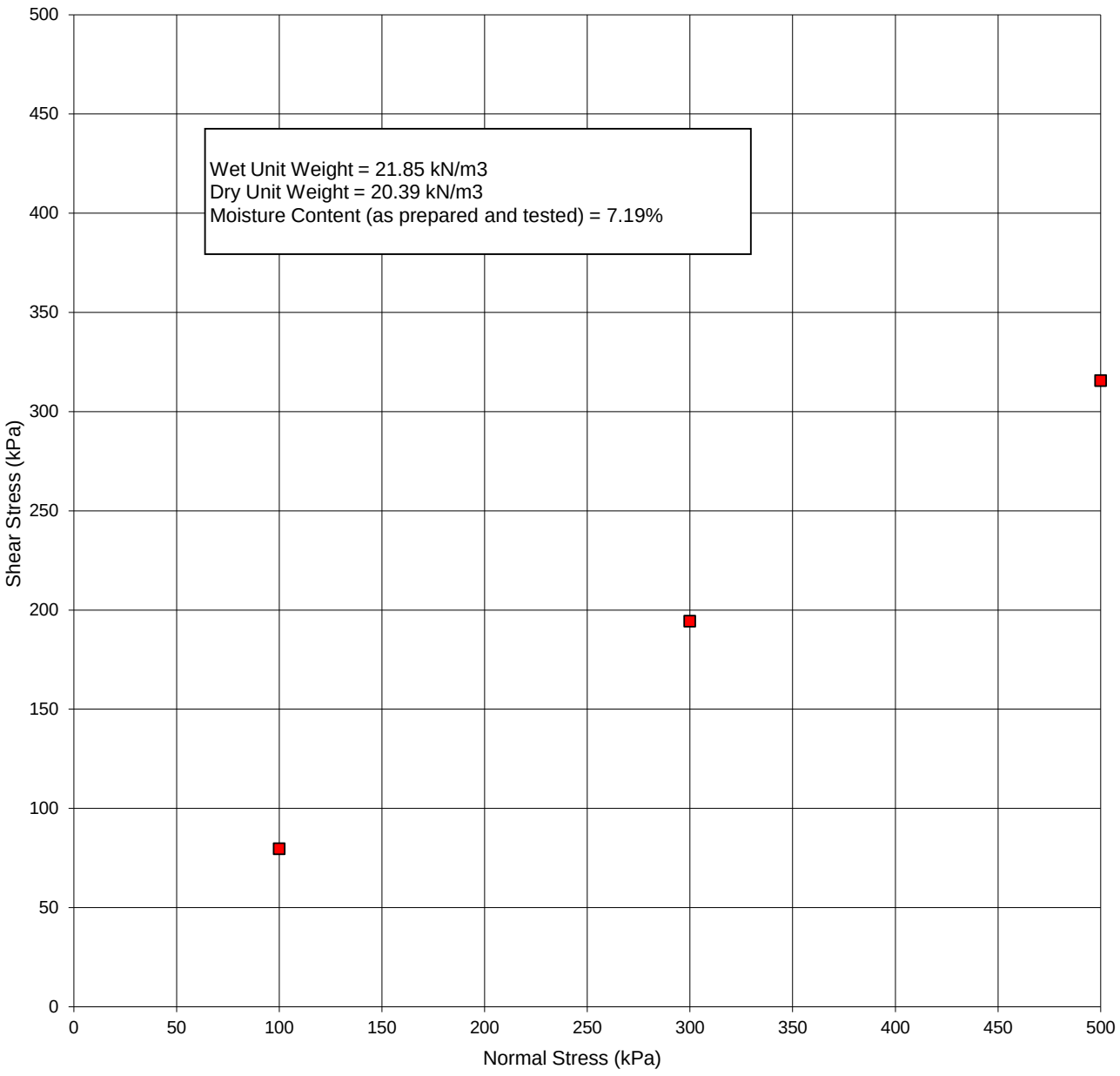
Page 1 of 1 2017.Jan.03

REVIEWED BY Jason Thompson, C.E.T.

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided on written request. The data presented is for sole use of client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.
Report System: Software Registered to: Stantec Consulting Ltd., Winnipeg

DIRECT DRAINED SHEAR TEST

EFFECTIVE STRESS FAILURE ENVELOPE



Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

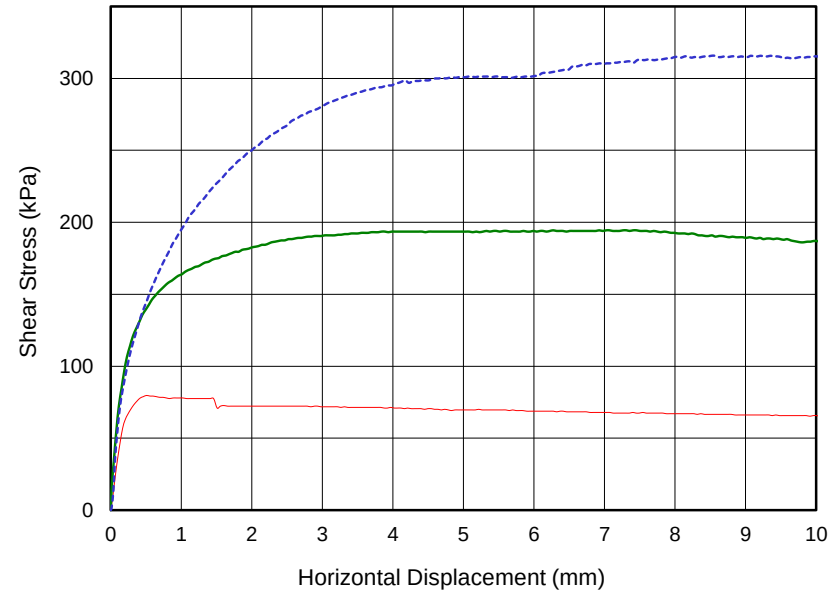
Lake Manitoba Channel (16-0300-006)
"C" Series - Trial 1

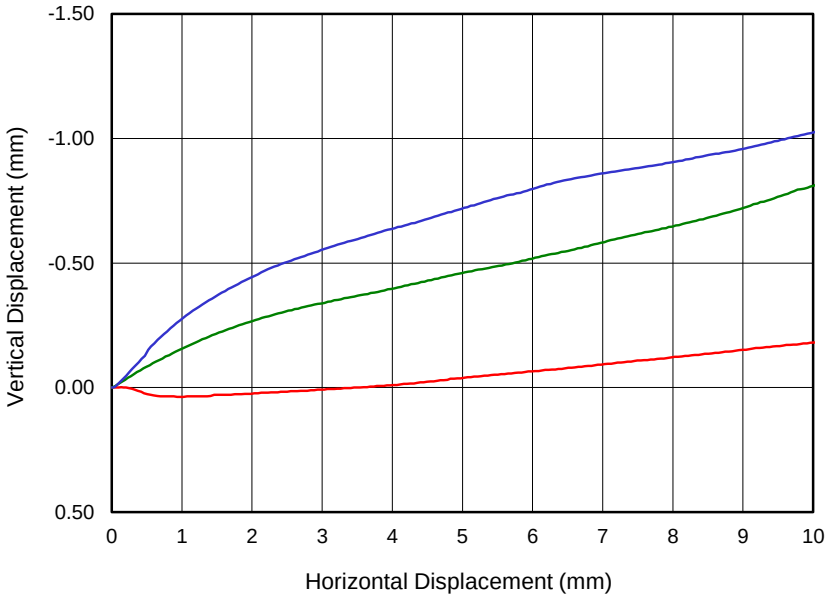
Stantec

DIRECT DRAINED SHEAR TEST

SHEAR STRESS and VERTICAL DISPLACEMENT

vs. HORIZONTAL DISPLACEMENT





Normal Stress: 100 kPa Normal Stress: 300 kPa Normal Stress: 500 kPa

Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

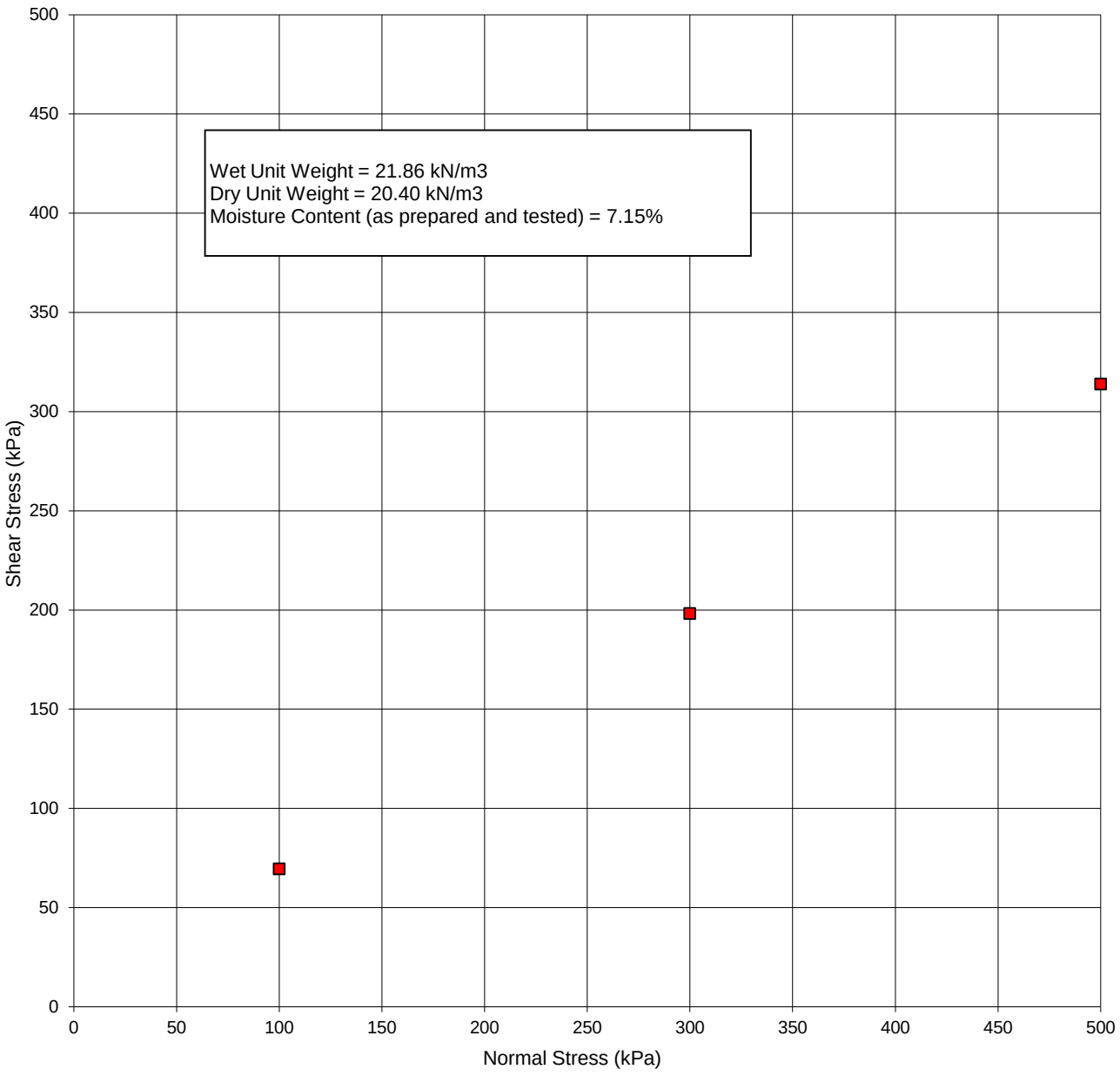
Lake Manitoba Channel (16-0300-006)

"C" Series - Trial 1

Stantec

DIRECT DRAINED SHEAR TEST

EFFECTIVE STRESS FAILURE ENVELOPE



Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

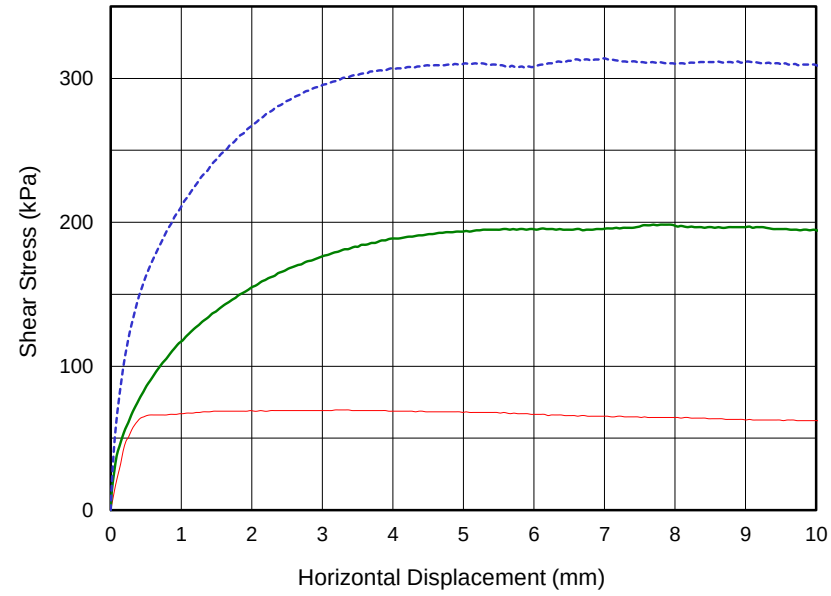
Lake Manitoba Channel (16-0300-006)
"C" Series - Trial 2

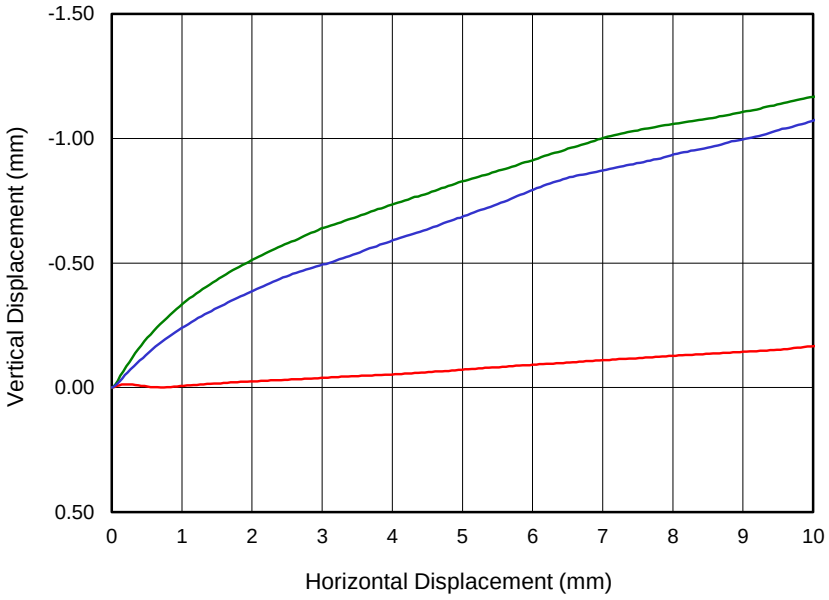
Stantec

DIRECT DRAINED SHEAR TEST

SHEAR STRESS and VERTICAL DISPLACEMENT

vs. HORIZONTAL DISPLACEMENT





Normal Stress: 100 kPa Normal Stress: 300 kPa Normal Stress: 500 kPa

Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

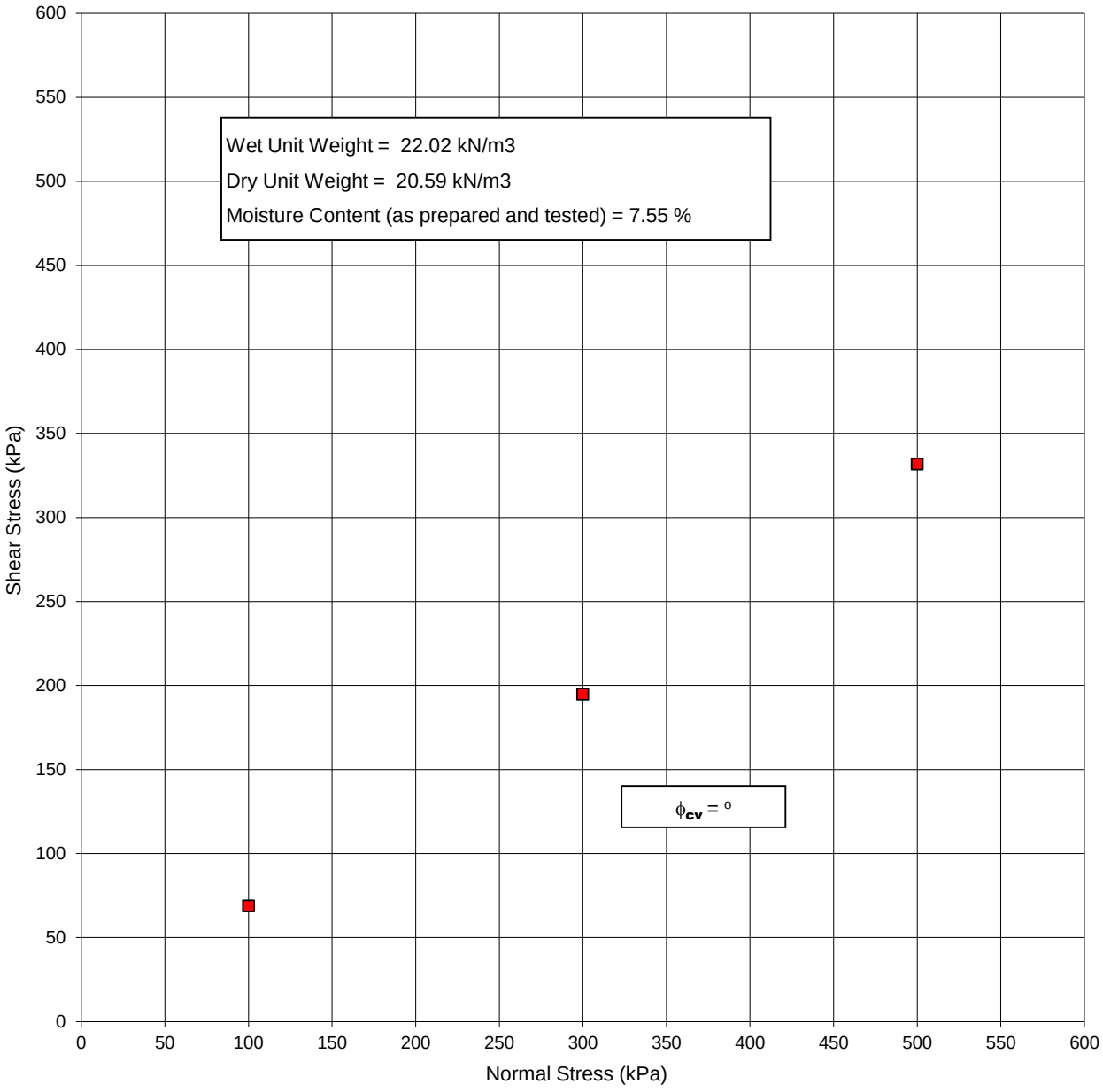
Lake Manitoba Channel (16-0300-006)

"C" Series - Trial 2

Stantec

DIRECT DRAINED SHEAR TEST

EFFECTIVE STRESS FAILURE ENVELOPE



Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

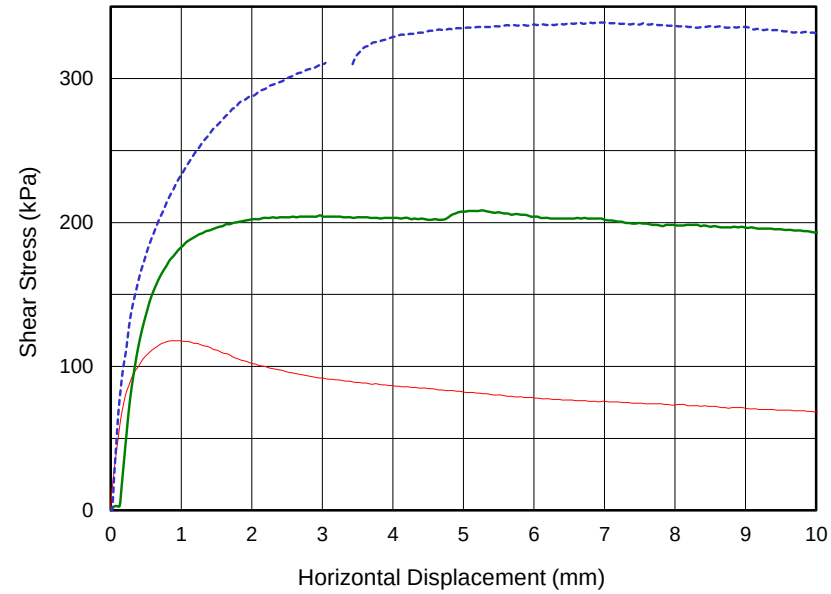
Lake Manitoba Channel (16-0300-006)
"D" Series - Trial 1

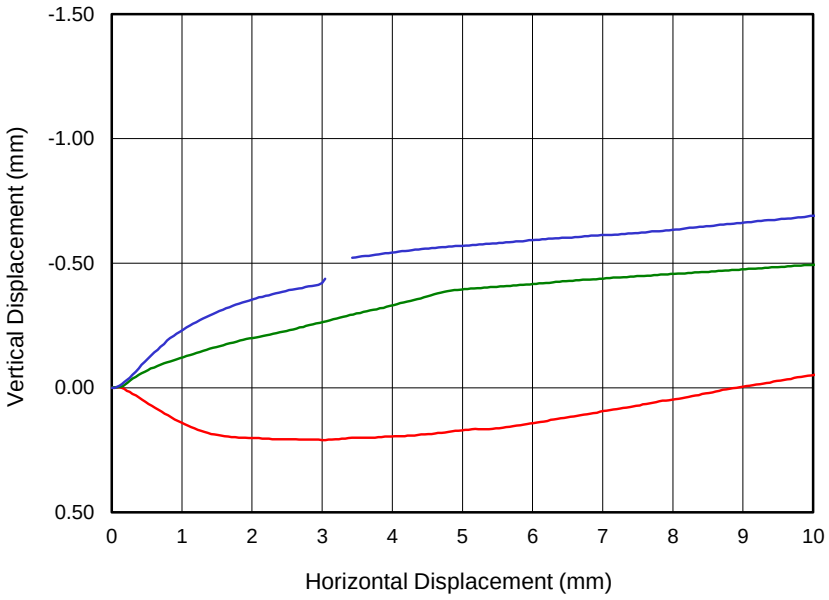
Stantec

DIRECT DRAINED SHEAR TEST

SHEAR STRESS and VERTICAL DISPLACEMENT

vs. HORIZONTAL DISPLACEMENT





Normal Stress: 100 kPa Normal Stress: 300 kPa Normal Stress: 500 kPa

Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

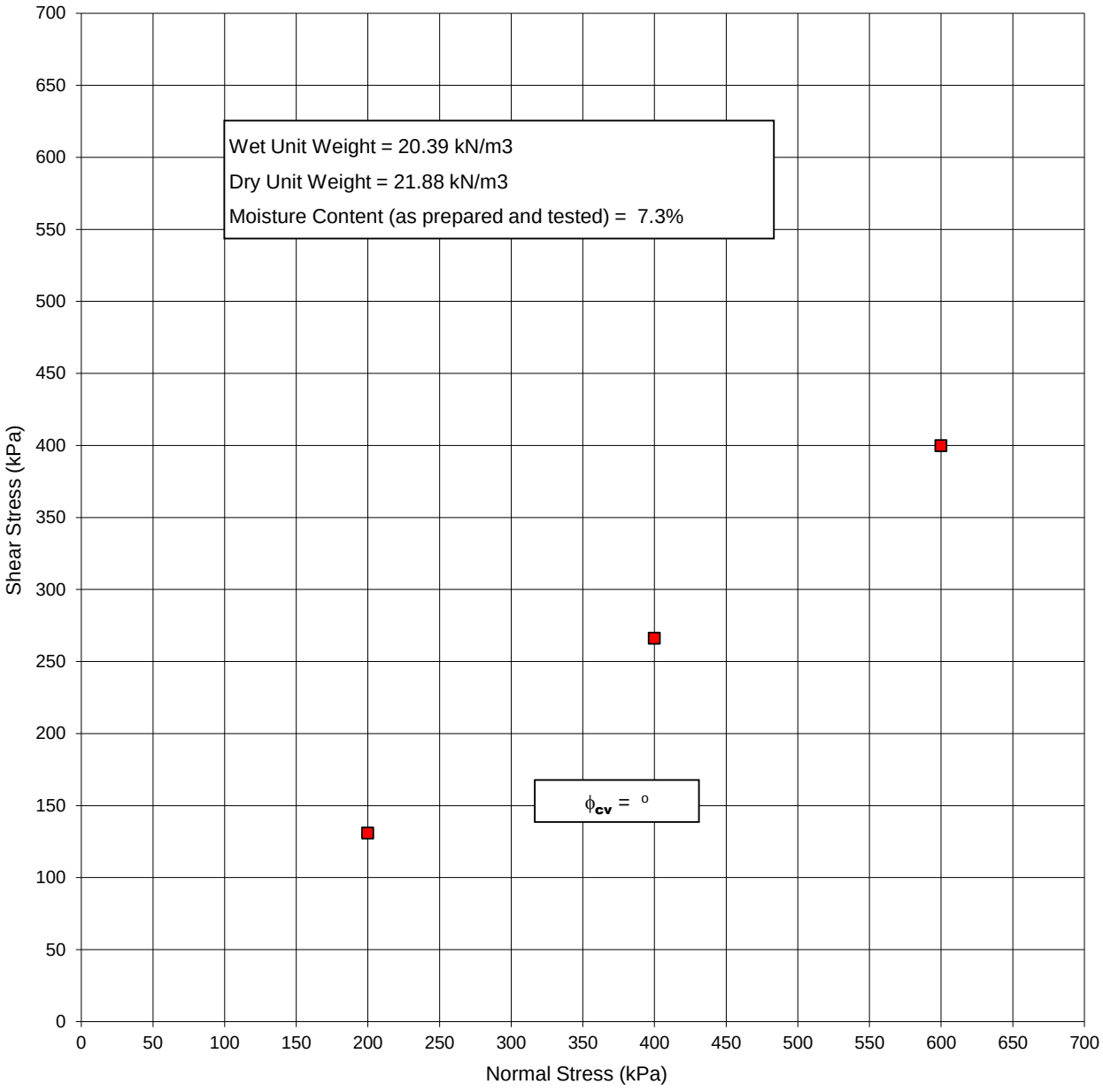
Lake Manitoba Channel (16-0300-006)

"D" Series - Trial 1

Stantec

DIRECT DRAINED SHEAR TEST

EFFECTIVE STRESS FAILURE ENVELOPE



Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

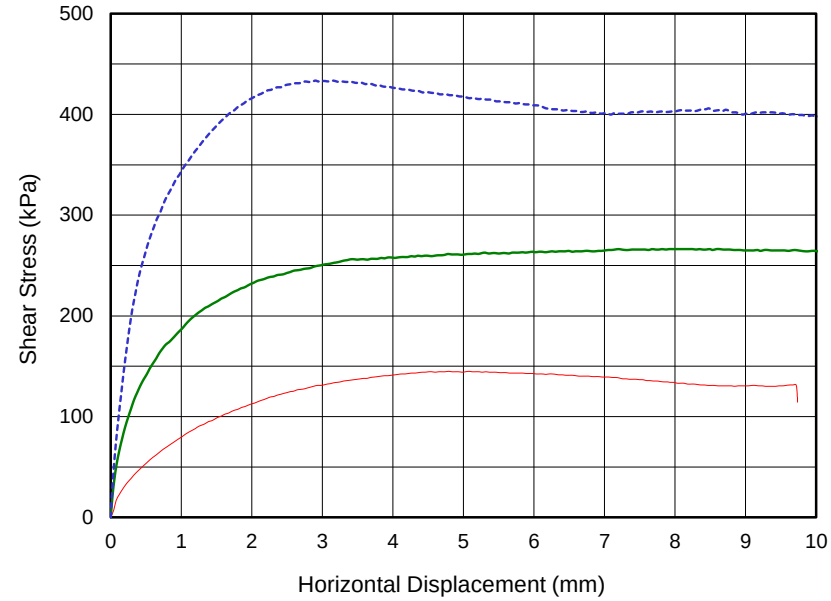
Lake Manitoba Channel (16-0300-006)
"D" Series - Trial 2

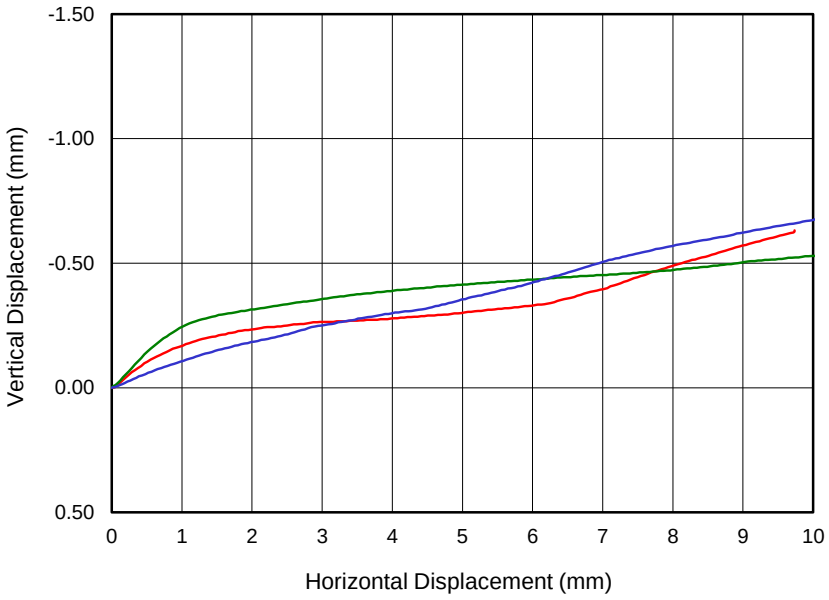
Stantec

DIRECT DRAINED SHEAR TEST

SHEAR STRESS and VERTICAL DISPLACEMENT

vs. HORIZONTAL DISPLACEMENT





Normal Stress: 200 kPa Normal Stress: 400 kPa Normal Stress: 600 kPa

Tested By: MVG Date: Jan.2017 Checked By: HMW Date: Jan.2017

Lake Manitoba Channel (16-0300-006)

"D" Series - Trial 2

Stantec

APPENDIX D8-F

TEST HOLE LOGS FROM PREVIOUS STUDIES

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-01**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 8+100, ROUTE C
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. 12-0300-011
GROUND ELEV. 252.61 m
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/15/2015
UTM (m) N 5,710,341
E 525,018

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
252.3				**TOPSOIL** - Black, moist.							
				SILT AND CLAY TILL - Light grey, moist, hard, trace sand, trace angular fine grained to coarse grained gravel (up to 25 mm).							
252	1										
		5								▲7 ▲21 ▲32	
251	2						S1		100		
250											
	3	10		- Grain size distribution at 3.3 m: Gravel (14%), Sand (37%), Silt (38%), Clay (11%).							
249						3.7				▲69 spoon refusal	
				SILT TILL - Light grey, dry, trace sand.			S2		78		
	4						S2A				
248		15		- Grey, moist, hard, some clay, trace fine grained gravel (up to 10 mm) below 4.6 m.		4.6				▲39 ▲47 spoon refusal	
	5			- Grain size distribution at 4.8 m: Gravel (8%), Sand (40%), Silt (45%), Clay (7%).			S3		67		
247											
246.5	6	20		**SAND** - Brown, moist, fine grained.			S4A		22	▲35 ▲50 spoon refusal	
246.4				**LIMESTONE** - Yellowish brown, moderately weathered. - Run 1 from 6.2 m to 7.8 m. 26% RQD.			S4B		67		
246											

SAMPLE TYPE ☒ Split Spoon ▨ Auger Grab ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
245	8	25		- Run 2 from 7.8 m to 9.0 m. 22% RQD.
				- Clay inclusion at 8.0 m.
244	9	30		- Run 3 from 9.0 m to 10.5 m. 53% RQD.
243	10	35		- Run 4 from 10.5 m to 12.0 m. 32% RQ.
242	11			- Silt inclusion and clay seam at 11.0 m.
241				
240.6	12	40		**END OF TEST HOLE at 12.0 m**
240	13			Notes: 1. Installed 2 standpipe (1" ø) piezometers, one slotted from 11.0 m to 11.9 m and one slotted from 3.7 m to 4.6 m. 2. Water level in test hole not encountered upon completion of drilling on June 15, 2015.
239		45		
	14			
238				
	15	50		

PIEZ. LOG: 11.0 – 11.9

SAMPLE TYPE / NUMBER / RECOVERY %: R1, R2, R2, R4

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ☒ Split Spoon ⊠ Auger Grab ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-02**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 5+168, ROUTE C
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. 12-0300-011
GROUND ELEV. 255.46 m
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/16/2015
UTM (m) N 5,712,800
E 523,402

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION
255			**TOPSOIL** - Grey.
254.5	1	5	**COBBLES** - Some fine grained to coarse grained sand, trace fine grained to coarse grained sand. - Switched from solid stem to coring below 0.9 m.
254.1			**LIMESTONE** - Yellowish brown, moderately weathered.
254	2		- Run 1 from 1.5 m to 3.0 m. 26% RQD.
253			
	3	10	- Run 2 from 3.0 m to 4.6 m. 52% RQD.
252			
	4		
251			
250.9		15	**END OF TEST HOLE at 4.6 m**
	5		Notes: 1. Installed standpipe (1" ø) piezometer, slotted from 0.6 m to 1.5 m.
250			
	6	20	
249			

PIEZ. LOG: 0.6 to 1.5

SAMPLE TYPE / NUMBER / RECOVERY %: R1 100; R2 90

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ■ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-04**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 0+464, ROUTE C
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **249.69 m**
TOP OF PVC ELEV.
WATER ELEV. **248.79 m**
DATE DRILLED **6/16/2015**
UTM (m) N **5,713,086** E **518,993**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249											
248.9				**TOPSOIL** - Black, moist to wet, with organics.							
	1			**SILT AND CLAY TILL** - Grey, moist, hard, trace fine grained gravel (up to 25 mm).							
248		5					S1		56	▲11 ▲23 ▲33	
	2			- Trace cobbles (>100 mm) at 2.1 m.							
247											
246.6	3	10		**CLAY TILL** - Greenish grey, wet, hard, some sand, trace fine grained to coarse grained gravel (up to 75 mm). - Grain size distribution at 3.3 m: Gravel (11%), Sand (37%), Silt (42%), Clay (10%).			S2		94	▲34 ▲44 spoon refusal	
246											
	4					4.6					
245		15					S3		72	▲13 ▲14 ▲23	
	5			- Grain size distribution at 4.8 m: Gravel (13%), Sand (41%), Silt (38%), Clay (8%).		5.5					
244											
	6	20					S4		94	▲16 ▲22 spoon refusal	
243											

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-04**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
242	8	25		- Very stiff below 7.6 m. - Grain size distribution at 7.8 m: Gravel (35%), Sand (32%), Silt (26%), Clay (7%).			S5		67	▲16 ▲16 ▲13	
241	9	30					S6		39	▲10 ▲11 ▲13	
240	10					9.8					
239	11	35		- Stiff below 10.7 m. - Grain size distribution at 10.9 m: Gravel (25%), Sand (31%), Silt (35%), Clay (9%).		10.7	S7		44	▲4 ▲5 ▲7	
238.6				**END OF TEST HOLE at 11.1 m**							
238	12	40									
237	13										
236	14	45									
235	15	50									

Notes:
1. Installed 2 standpipe (1" ø) piezometers, one slotted from 10.7 m to 9.8 m and one slotted from 5.5 m to 4.6 m.
2. Water level in test hole at 0.9 m below grade upon completion of drilling on June 16, 2015.

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-06**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 4+200, ROUTE C
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. 12-0300-011
GROUND ELEV. 254.97 m
TOP OF PVC ELEV.
WATER ELEV. 241.25 m
DATE DRILLED 6/17/2015
UTM (m) N 5,713,281
E 522,658

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
254.4				**TOPSOIL** - Black, moist, with organics.							
254	1			**SILT AND CLAY TILL** - Grey, dry to moist, trace fine grained to coarse grained gravel (up to 25 mm).							
253.3		5		- Switched from solid stem to coring below 1.5 m.			S	1	22	▲50 spoon refusal	
253	2			**LIMESTONE** - Grey, faintly weathered (machine breaks). - Run 1 from 1.6 m to 3.0 m. 10% RQD.				R1	100		
252	3	10		- Run 2 from 3.0 m to 4.6 m. 27% RQD. - Fractures at 3.4 m and 4.0 m.				R2	63		
251	4										
		15		- Run 3 from 4.6 m to 6.1 m. 37% RQD.							
250	5				VW	5.1 5.2		R3	88		
249	6	20		- Run 4 from 6.1 m to 7.6 m. 50% RQD.							
248								R4	100		

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RC-06**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
247	8	25		- Run 5 from 7.6 m to 9.1 m. 50% RQD.				R5	100		
246	9	30		- Run 6 from 9.1 m to 10.7 m. 68% RQD.				R6	100		
245	10	35		- Run 7 from 10.7 m to 12.2 m. No recovery, 76 mm clay inclusion.				R7	0		
244	11										
243	12	40		- Run 8 from 12.2 m to 13.7 m. 62% RQD, faintly weathered.		12.6		R8	100		
242	13					13.5					
243		45		**END OF TEST HOLE at 13.7 m**	▼						
241	14										
240	15	50									

Notes:
1. Installed standpipe (1" ø) piezometer slotted from 12.6 m to 13.5 m.
2. Installed water saturated vibrating wire piezometer to a depth of 5.2 m below grade.
3. Water level in test hole at bottom of hole upon completion of drilling on June 17, 2015.

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE C\ROUTE C_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-01**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 2+672, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **248.30 m**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **6/8/2015**
UTM (m) N **5,683,639** E **531,292**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.0				**TOPSOIL** - Black, moist, firm, trace organics.							
248				**SILT AND CLAY TILL** - Grey, frozen, stiff, some fine grained gravel (up to 5 mm), trace sand, trace silt pockets.							
	1										
247		5		- Wet, trace organics below 1.5 m.			S1		100	▲2 ▲5 ▲7	
	2										
246											
	3	10		- Moist, firm, very stiff, trace angular fine grained gravel (up to 10 mm) below 3.0 m.			S2		100	▲5 ▲8 ▲17	
245											
	4										
244											
243.7		15		**SILT TILL**							
	5			- Firm from 4.0 m to 5.5 m. - Grain size distribution at 4.8 m: Gravel (1%), Sand (45%), Silt (41%), Clay (13%).			S3		72	▲2 ▲3 ▲3	
243											
	6	20		- Wet, hard, some angular fine grained gravel (up to 10 mm), some silt below 6.1 m.			S4		100	▲3 ▲7 ▲28	
242				- Cobbles encountered at 6.7 m.							

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
241	8	25		- Light grey, moist, some sub-rounded fine grained gravel (up to 10 mm) below 7.6 m. - Grain size distribution at 7.8 m: Gravel (7%), Sand (34%), Silt (50%), Clay (9%).			S5		100	▲ 28 ▲ 35 ▲ 35	
240				- Cobbles encountered at 8.5 m.							
239	9	30		- Grey, wet, some fine grained to coarse grained sand below 9.1 m.		9.4	S6		100	▲ 28 ▲ 24 ▲ 18	
238	10					10.4					
237.6		35		**SAND** - Brown, wet, compact, medium grained.			S7		72	▲ 15 ▲ 13 ▲ 13	
237	11										
236.1	12	40		**SAND AND SILT TILL** - Grey, wet. - Grain size distribution at 12.4 m: Gravel (7%), Sand (50%), Silt (33%), Clay (10%). - Solid stem refusal at 12.5 m. Switched to coring below 12.5 m.			S8		67	▲ 50 spoon refusal	
236											
235	13	45									
234	14										
233.1	15	50									

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	16	55		**SILT AND CLAY TILL** - Light grey, moist, with boulders. - Grain size distribution at 15.5 m: Gravel (2%), Sand (43%), Silt (42%), Clay (13%).
232				
	17			- With fine grained to coarse grained gravel (up to 20 mm) below 16.8 m. - Boulders (up to 300 mm) encountered at 16.8 m.
231				
	18	60		
230				- Grain size distribution at 18.5 m: Gravel (14%), Sand (50%), Silt (30%), Clay (6%).
	19			
229		65		
	20			- Grain size distribution at 19.9 m: Gravel (4%), Sand (29%), Silt (56%), Clay (11%).
228				
227.6				**LIMESTONE** - Faintly weathered.
	21	70		
227				
	22			
226.0				**END OF TEST HOLE at 22.3 m**
226				Notes: 1. Installed 2 standpipe (1" ø) piezometers, one slotted from 19.5 m to 20.4 m and one slotted from 9.4 m to 10.4 m. Installed pressure gauges in both standpipes. 2. Water level in test hole at 3.2 m below grade following drilling on June 8, 2015. 3. Water level in standpipe installed in silty clay at 0.7 m above grade (artesian) upon completion of drilling on June 10, 2015.
	23	75		
225				

PIEZ. LOG: 19.5 – 20.4

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆
		S9	22	▲50 spoon refusal	
		S9A	100		
		S10	100		
		S11	56	▲50 spoon refusal	
		S11A	100		
		S12	100		
		S13	100		

SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △: 20 40 60

Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆: 20 40 60 80

PL MC LL

%: 20 40 60 80

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
224	24	80		4. Water level in standpipe installed in clay till at 2.8 m above grade (artesian) upon completion of drilling on June 10, 2015.					
223	25								
222	26	85							
221	27	90							
220	28								
219	29	95							
218	30	100							
217	31								

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-02**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 12+776, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **248.65 m**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **6/11/2015**
UTM (m) N **5,693,417** E **530,519**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248	1	5		**TOPSOIL** - Black, moist, with organics.							
247.4				**SILT AND CLAY TILL** - Grey, frozen, stiff, trace silt pockets, trace fine grained to coarse grained gravel.			S1		100	▲3 ▲4 ▲6	
247	2										
246	3	10		- Wet, trace fine grained to coarse grained sand below 3.0 m. - Grain size distribution at 3.3 m: Gravel (7%), Sand (32%), Silt (48%), Clay (13%).			S2		100	▲4 ▲4 ▲5	
245	4										
244	5	15		- Very stiff, some sub-angular coarse grained gravel (up to 40 mm) below 4.6 m.			S3		100	▲4 ▲8 ▲8	
243	6	20		- Grain size distribution at 6.3 m: Gravel (9%), Sand (41%), Silt (40%), Clay (10%).			S4		100	▲4 ▲7 ▲11	
242											

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
15-RD-02

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
241	8	25		- Moist, hard, with fine grained to coarse grained gravel (up to 50 mm) below 7.6 m. - Grain size distribution at 7.8 m: Gravel (26%), Sand (29%), Silt (35%), Clay (10%).
240	9	30		- Solid stem refusal at 9.1 m. Switched to coring below 9.1 m.
239	10			
238	11	35		- With cobbles (up to 300 mm) at 10.7 m. - Grain size distribution at 10.9 m: Gravel (9%), Sand (35%), Silt (44%), Clay (12%).
237	12			
236	13	40		
235	14	45		- Grain size distribution at 13.8 m: Gravel (5%), Sand (37%), Silt (49%), Clay (9%).
234	15			
233.4		50		

PIEZ. LOG: 14.0 – 14.9

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △
	S5		67	▲11, ▲53, ▲82
	S6		78	▲50, ▲65 spoon refusal
	S7		100	▲36, ▲50, ▲46
	S8		100	
	S9		100	
				▲6

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80

PL MC LL
%
20 40 60 80

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-02**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
233	15	50		**SAND** - Grey, wet, fine grained, dense.				S10		▲14 ▲22	
				END OF TEST HOLE at 15.7 m							
	16			Notes: 1. Installed standpipe (1" ø) piezometer slotted from 14.0 m to 14.9 m. Installed pressure gauge in standpipe. 2. Water level in standpipe installed in silty clay till at 2.8 m above grade (artesian) upon completion of drilling on June 11, 2015.							
232		55									
	17										
231											
	18	60									
230											
	19										
229		65									
	20										
228											
	21	70									
227											
	22										
226		75									
	23										

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-02A**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 12+776, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **248.63 m**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **6/12/2015**
UTM (m) N **5,693,419**
E **530,519**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
248	1	5		**TOPSOIL** - Black, moist, with organics.						20 40 60	20 40 60 80
247.4				**SILT AND CLAY TILL** - Grey, frozen, stiff, trace silt pockets, trace fine grained to coarse grained gravel.							
247											
246	2										
245	3	10									
244	4	15									
243	5										
242	6	20				6.7					

SAMPLE TYPE

CONTRACTOR **Maple Leaf Enterprises** | INSPECTOR **G. Mediwake** | APPROVED TNg | DATE 1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
15-RD-02A

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
241	8	25				7.6				20 40 60	20 40 60 80
240.7				**END OF TEST HOLE at 7.9 m**							
240	9	30		Notes: 1. Installed standpipe (1" ø) piezometer slotted from 6.7 m to 7.6 m.							
239	10										
238		35									
237	11										
236	12	40									
235	13	45									
234	14										
	15	50									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	**G. Mediwake**	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-03**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 17+032, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **251.84 m**
TOP OF PVC ELEV.
WATER ELEV. **250.94 m**
DATE DRILLED **6/12/2015**
UTM (m) N **5,697,485**
E **530,996**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
251.5				**TOPSOIL** - Black, moist, trace organics.							
				SILT AND CLAY TILL - Grey, moist, very stiff, trace fine grained to coarse grained gravel (up to 25 mm), trace sand, trace organics.							
	1	5					S1		78	▲5 ▲6 ▲10	
250	2										
249	3	10		- Hard, trace fine grained to coarse grained gravel (up to 40 mm) below 3.0 m. - Grain size distribution at 3.3 m: Gravel (32%), Sand (28%), Silt (30%), Clay (10%).			S2		100	▲12 ▲13 ▲21	
248	4										
		15		- Very dense, coarse grained gravel ends below 4.6 m.			S3		100	▲8 ▲10 ▲13	
247	5			- Boulder (450 mm) encountered at 5.5 m.							
246	6	20		- Stiff, trace coarse grained gravel (up to 40 mm) below 6.1 m. - Solid stem refusal at 6.1 m. Switch to coring below 6.1 m. - Grain size distribution at 6.3 m: Gravel (29%), Sand (28%), Silt (34%), Clay (9%).			S4		72	▲13 ▲12 ▲11	
245						6.7					

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
15-RD-03

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
242.1	9.4	30		- Grain size distribution at 9.4 m: Gravel (30%), Sand (30%), Silt (31%), Clay (9%).
242	10			**SAND** - Grey, wet, fine grained, compact, trace silt.
241	10.7	35		- No core recovery between 10.7 m and 11.1 m.
240	12			
239	12.2	40		- No core recovery between 12.2 m and 12.6 m.
238.1	13.9	45		**SILT AND CLAY TILL** - Dark grey, moist, hard, trace angular fine grained to coarse grained gravel (up to 25 mm). - Grain size distribution at 13.9 m: Gravel (31%), Sand (22%), Silt (38%), Clay (9%).
236.6	15	50		

PIEZ. LOG: 7.6 m; 14.0 m; 14.9 m

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △
7.6	S5		6	11, 10, 10	
	S5A		100		
	S6		44	9, 17, 11	
	S6A		100		
			0	8, 12, 7	
	S6B		100		
			0	13, 14, 12	
14.0	S7		67	21, 77, 68	
14.9	S8		100		

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-03**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
236	16			**END OF TEST HOLE at 15.2 m**								
				Notes: 1. Installed 2 standpipe piezometers, one slotted from 14.0 m to 14.9 m and one slotted from 6.7 m to 7.6 m. 2. Water level in test hole at 0.9 m below grade upon completion of drilling on June 13, 2015.							
235	17	55										
234	18	60										
233	19											
232	20	65										
231	21	70										
230	22											
229	23	75										

SAMPLE TYPE ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-03A**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 17+032, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **251.86 m**
TOP OF PVC ELEV.
WATER ELEV. **241.19 m**
DATE DRILLED **6/19/2015**
UTM (m) N **5,697,489**
E **530,991**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
251.6				**TOPSOIL** - Black, moist, trace organics.						20 40 60	20 40 60 80
				SILT AND CLAY TILL - Grey, moist, very stiff, trace fine grained to coarse grained gravel (up to 25 mm), trace sand, trace organics.							
251	1	5									
250	2										
249	3	10		- Hard, trace fine grained to coarse grained gravel (up to 40 mm) below 3.0 m.							
248	4										
247	5	15									
246	6	20									
245											

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-03A**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
244	8	25									
243	9	30									
242.1				**SAND** - Grey, wet, fine grained, compact, trace silt.							
242	10				VW	10.3 10.4					
241.2		35		**END OF TEST HOLE at 10.7 m**							
241	11										
240	12	40									
239	13										
238	14	45									
237	15	50									

Notes:
1. Installed water saturated vibrating wire piezometer to a depth of 10.4 m below grade.
2. Water level in test hole at bottom of hole upon completion of drilling on June 19, 2015.

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-04**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 19+256, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **251.76 m**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **6/13/2015**
UTM (m) N **5,699,450**
E **531,894**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
251											
250.8	0			**TOPSOIL** - Black, moist, trace organics.							
	1	5		**SILT AND CLAY TILL** - Grey, very stiff, trace silt, trace sand, trace fine grained to coarse grained gravel (up to 25 mm).			S1		83	▲5 ▲7 ▲12	
250	2										
249	3	10		- Trace coarse grained gravel (up to 40 mm) between 3.0 m and 4.6 m.			S2		100	▲3 ▲9 ▲14	
248	4										
247		15		- Hard below 4.6 m.			S3		100	▲6 ▲14 ▲17	
	5			- Grain size distribution at 4.8 m: Gravel (10%), Sand (28%), Silt (49%), Clay (13%).							
246											
	6	20		- Greenish grey, Dry to moist, fine grained gravel ends below 6.1 m.		6.7	S4		78	▲10 ▲16 ▲19	
245											

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
15-RD-04

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
244	8	25		- With silt, trace fine grained to coarse grained gravel (up to 40 mm) below 7.6 m. - Grain size distribution at 7.8 m: Gravel (12%), Sand (25%), Silt (56%), Clay (7%).
243	9			
242.6		30		**SILTY SAND** - Grey, wet, very dense, and silt, some clay. - Solid stem refusal at 9.1 m. Switch to coring below 9.1 m.
242				
241.7	10			**SAND** - Grey, wet, medium grained, trace clay, trace fine grained to coarse grained gravel.
241.1		35		**SILT AND CLAY TILL** - Grey, wet, trace fine grained to coarse grained gravel, trace sand. - Grain size distribution at 10.9 m: Gravel (9%), Sand (31%), Silt (55%), Clay (5%).
241	11			
240				
	12	40		- Hard, trace fine grained gravel (up to 10 mm) below 12.2 m.
239				
	13			
238		45		
	14			
237				
	15	50		

PIEZ. LOG: 7.6 m; 13.6 m; 14.5 m

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
7.6	S5		100	▲28 ▲35 ▲35	◆ ■
	S6		100	▲22 ▲28 ▲43	●
	S6A		44		●
	S7		100		●
13.6	S8		33	▲50 spoon refusal	●
14.5					

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-04**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
236.2				- Moist below 15.4 m.				S9	33	▲50 spoon refusal	
				END OF TEST HOLE at 15.5 m							
236	16										
235	17	55									
234	18	60									
233	19										
232	20	65									
231	21	70									
230	22										
229	23	75									

Notes:
1. Installed 2 standpipe (1" ø) piezometers, one slotted from 13.6 m to 14.5 m and one slotted from 6.7 m to 7.6 m. Installed pressure gauge in standpipe at 14.5 m below grade.
2. Water level in standpipe installed in silty clay till at 1.4 m above grade (artesian) upon completion of drilling on June 14, 2015.

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-05**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 21+464, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel, Acker Renegade

JOB NO. 12-0300-011
GROUND ELEV. 247.09 m
TOP OF PVC ELEV.
WATER ELEV. 246.19 m
DATE DRILLED 6/14/2015
UTM (m) N 5,701,483
E 532,787

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
247				**TOPSOIL** - Black, moist, with organics.							
246.8				**SILT AND CLAY TILL** - Light grey, moist, stiff, trace angular fine grained to coarse grained gravel (up to 30 mm).							
246	1	5					S1		100	▲4 ▲7 ▲8	
245	2										
244	3	10		- Grey, very stiff, some angular fine grained to coarse grained gravel (up to 40 mm) below 3.0 m. - Grain size distribution at 3.3 m: Gravel (12%), Sand (30%), Silt (45%), Clay (13%).			S2		100	▲5 ▲10 ▲13	
243	4	15		- Some sand, coarse grained gravel ends below 4.6 m.			S3		94	▲13 ▲11 ▲68 spoon refusal	
242	5										
241	6	20		- Hard, trace coarse grained gravel (up to 30 mm) below 6.1 m. - Grain size distribution at 6.3 m: Gravel (15%), Sand (31%), Silt (43%), Clay (11%).		6.7	S4		94	▲25 ▲22 ▲27	

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-05**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
240										20 40 60	20 40 60 80
	8	25		- Dry to moist below 7.6 m.		7.6	S5		100	▲18 ▲25 ▲28	●
239											
238	9	30		- Trace sand below 9.1 m. - Grain size distribution at 9.4 m: Gravel (12%), Sand (29%), Silt (46%), Clay (13%).			S6		100	▲44 ▲28 ▲26	●
237	10										
		35		- Light grey below 10.7 m.		11.0	S7		100	▲19 ▲26 ▲26	●
236	11										
235	12					11.9					
234.9		40		**SAND AND SILT TILL** - Grey, wet, hard, some sand, trace fine grained to coarse grained gravel (up to 50 mm). - Grain size distribution at 12.4 m: Gravel (31%), Sand (46%), Silt (18%), Clay (5%).			S8		67	▲34 ▲44 spoon refusal	●
234.4				**END OF TEST HOLE at 12.6 m**							
234	13										
		45									
233	14										
232	15	50									

Notes:
1. Installed 2 standpipe (1" ø) piezometers, one slotted from 11.0 m to 11.9 m and one slotted from 6.7 m to 7.6 m.
2. Water level in test hole at 0.9 m below grade upon completion of drilling on June 14, 2015.

SAMPLE TYPE ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-10A**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT ASSINIBOINE RIVER & LAKE MB FLOOD STUDY
SITE LAKE ST. MARTIN EMERGENCY CHANNELS
LOCATION STA. 17+800, ROUTE D
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker Renegade

JOB NO. **12-0300-011**
GROUND ELEV. **248.87 m**
TOP OF PVC ELEV.
WATER ELEV. **230.13 m**
DATE DRILLED **6/18/2015**
UTM (m) N **5,698,130**
E **531,200**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
248.6	0	0		**TOPSOIL** - Black, moist, with organics.							
				SILT AND CLAY TILL - Grey, moist, very stiff, trace silt pockets, trace oxidation, trace organics, trace fine grained gravel (up to 15 mm).							
248	1	5									
247	2						S1		100	▲4 ▲13 ▲12	
246	3	10		- Moist to wet, stiff below 3.0 m.			S2		67	▲9 ▲7 ▲6	
245	4	15		- Greenish grey, moist, firm, some angular fine grained and coarse grained gravel (up to 40 mm) below 4.6 m. - Grain size distribution at 4.8 m: Gravel (16%), Sand (29%), Silt (44%), Clay (11%).			S3		94	▲2 ▲3 ▲5	
244	5										
243	6	20		- Soft below 6.1 m.			S4		89	▲1 ▲1 ▲1	
242											

SAMPLE TYPE ☒ Split Spoon ⚒ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-10A**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
241.3	8	25		**SAND AND SILT TILL** - Grain size distribution at 7.8 m: Gravel (18%), Sand (41%), Silt (32%), Clay (9%).	VW	7.5 7.6	S5		39	▲1 ▲1 ▲1	
240	9	30		**SILT AND SAND TILL** - Grey, dry, very dense, trace fine grained gravel (up to 10 mm). - Grain size distribution at 9.4 m: Gravel (8%), Sand (38%), Silt (42%), Clay (12%).			S6		83	▲74 spoon refusal	
239	10	35		- Trace coarse grained gravel (up to 50 mm) below 10.7 m.			S7		67	▲78 spoon refusal	
238	11										
237	12	40		- Decreasing coarse grained gravel below 12.2 m. - Grain size distribution at 12.4 m: Gravel (1%), Sand (31%), Silt (54%), Clay (14%).			S8		67	▲70 spoon refusal	
236	13										
235	14	45					S9		67	▲50 spoon refusal	
234	15										
		50								▲50 spoon refusal	

SAMPLE TYPE ☒ Split Spoon ⚿ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **15-RD-10A**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
233	16	55		- Grain size distribution at 15.5 m: Gravel (4%), Sand (34%), Silt (50%), Clay (12%).				S10	50		
232	17							S11			
231	18	60		- Greenish grey, dry to moist, hard, some clay below 18.3 m.		17.4					
230.1				- Grain size distribution at 18.5 m: Gravel (11%), Sand (30%), Silt (48%), Clay (11%).		18.3		S12		▲26 ▲46 ▲42	
230	19			**END OF TEST HOLE at 18.7 m**							
229	20	65									
228	21	70									
227	22										
226	23	75									

Notes:
1. Installed standpipe (1" ø) piezometer slotted from 17.4 m to 18.3 m.
2. Installed water saturated vibrating wire piezometer to a depth of 10.4 m below grade.
3. Water level in test hole at bottom of hole upon completion of drilling on June 18, 2015.

SAMPLE TYPE ☒ Split Spoon ⊠ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	G. Mediwake	TNg	1/5/16

GEOTECHNICAL-SOIL LOG \\K-FILE-4\P-DATA\PROJECTS\2012\12-0300-011\DESIGN\GEO\LOGS\ROUTE D\ROUTE D_LOGS.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-BC1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B/C

LOCATION In quarter section NE-2-30-09

DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.99 m**
TOP OF PVC ELEV. **249.80 m**
DATE DRILLED **7/5/2011**
UTM (m) N **5,711,147**
E **526,368**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
248.9				**TOPSOIL** - Brown, dry.						
				SILT TO SILTY CLAY TILL - Brown to grey, damp to moist, stiff, some to with subangular to angular gravel (up to 25 mmin diameter), trace to some sand, some cohesion - trace clay.						
248	1	5					S1			
247	2									
							S2			
246	3	10								
245	4									
		15								
244	5						S3			
243	6	20								
242	7									
		25								
241	8									
240	9	30								
239	10									
		35		- Drilling became easier from 10.67 m to 12.19 m.						
238	11									
237										

SAMPLE TYPE Auger Grab Auger Cuttings Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	S. BEAUDRY	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
BH-BC1

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %
236	13	40		- Light grey, wet, soft to firm, some to with sand, some gravel - up to 12.5 mm diameter below 12.19 m.		13.1	S4		
		45				13.7			
235	14								
234.5				**AUGER REFUSAL AT 14.48m** - Switched to HQ Coring. 305 mm diameter limestone boulder from 14.48 to 14.78 m.					
234	15	50		**SILTY CLAY TILL** - Grey, damp, hard, some to with fine to course grained gravel - subangular up to 25 mm diameter, some sand, trace to some cobbles. **R1 (14.48 to 15.24 m)**: Recovered a limestone boulder and silty clay till.			R1		80
233	16			**R2 (15.24 to 16.76 m)**: Washed out till - Broken cobbles and gravel with trace silty clay.			R2		20
232.2		55				16.8			
232	17			**END OF HOLE IN SILTY CLAY TILL AT 16.76 m.**					
231	18	60		Notes: 1. Hole open to 16.76 m immediately after drilling. 2. Boulders visible at surface adjacent to BH-BC1. 3. 25 mm (1") diameter PVC standpipe installed: - Screened from 16.76 m to 13.72 m - Backfilled above 13.72 m with a cement-bentonite grout to surface					
230	19								
229	20	65							
228	21	70							
227	22								
226	23	75							
225	24								
224	25	80							
223	26	85							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ▨ Auger Grab ▩ Auger Cuttings ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	S. BEAUDRY	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-BC2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B/C

LOCATION In quarter section NE-2-30-09

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 245.40 m
TOP OF PVC ELEV. 246.14 m
DATE DRILLED 7/6/2011
UTM (m) N 5,711,098
E 526,965

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
245.3				**TOPSOIL** - Brown to grey, dry.								
245				**SILT TO SILTY CLAY TILL** - Light to dark grey, dry to damp, stiff, some sand, some cohesion, trace to some clay, trace angular to subangular gravel, trace roots.								
	1											
244		5		- Brown to light grey, intermediate to high plasticity below 1.5 m.				S1				
	2											
243						2.7						
	3	10		- Intermediate plasticity below 3.0 m.				S2				
242				- Moist below 3.4 m.								
	4			- Light grey below 4 m.								
241		15		- Low plasticity below 4.57 m.				S3				
	5											
240												
	6	20		- Trace cobbles below 6.1 m.								
239												
	7											
238		25		- Brown to light grey, dry below 7.6 m.								
	8											
237												
	9	30				9.1		S4				
236												
	10											
235		35										
	11											
234												

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
BH-BC2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
233	12	40		- Light brown to brown, moist below 12.2 m.							
232	13	45									
231	14										
230	15	50									
229	16										
228	17	55		- Brown to grey, dry below 16.8 m.							
227	18	60		- Brown, moist to wet below 18.29 m.							
226	19										
225	20	65		- Light brown to brown, trace gravel below 19.8 m.							
224	21	70		- Light grey below 21.3 m.							
223	22										
222.5	23	75		**END OF HOLE IN SILT TILL TO SILTY CLAY TILL AT 22.9 m.**		22.9					
222	24										
221	25	80									
220	26	85									

Notes:
1. 25 mm (1") diameter PVC standpipe installed:
   - Screened from 9.14 m to 2.74 m.
   - Backfilled above 2.74 m with bentonite chips to surface.

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-BC3**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B/C

LOCATION In quarter section SE-10-30-09

DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **251.68 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,158**
E **524,704**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
251.5				**TOPSOIL** - Brown to black, stiff, trace roots.			
251	1			**SILTY CLAY** - Brown to grey, moist, stiff, high plasticity.			
250.2		5		- Light grey, trace roots below 1.2 m.			
250	2			**SILT** - Brown, dry, stiff, low plasticity.			
249							
248.6	3	10		**SILT TILL** - Brown to reddish, dry to moist, firm to stiff, trace gravel, trace fine sand.			
248				- Light grey below 3.4 m.			
247.7	4			- Reddish, moist below 3.7 m.			
				AUGER REFUSAL AT 3.96 m - Switched to HQ coring.			
247		15		**BASAL TILL**		C1	
	5			**C1 (3.96 to 4.57m)** - White to yellow limestone boulder, hard.			
				C2 (4.57 TO 6.1m) - Brown to reddish boulders mixed with gravel, cobbles and clay pieces.		C2	90
246	6	20		**C3 (6.1 to 6.73m)** - Brown to yellowish, broken boulders and cobbles.		C3	52
245							
244.8	7			**C4 (6.73 to 7.62m)** - Brown to yellowish broken boulders and cobbles to 6.86 m. Weathered limestone below 6.86 m.		C4	
244		25		**LIMESTONE** - White to brown, weathered and fractured, soft material in fractures, soft to hard.			
	8			**C5 (7.62 to 9.14m)** - White to brown limestone, weathered, fractured, soft material in fractures - RQD = 81%		C5	
243							
	9	30		**C6 (9.14 to 10.67m)** - White to brown limestone, weathered, fractured, soft material in fractures - RQD = 55%.		C6	
242	10						
241.0		35		**END OF HOLE AT 10.7 m.**			
241	11						
240				Notes: 1. Hole backfilled with bentonite to surface.			

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ■ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-BC4**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B/C

LOCATION In quarter section SW-2-30-09

DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.27 m**
TOP OF PVC ELEV.
DATE DRILLED **7/7/2011**
UTM (m) N **5,710,322**
E **525,546**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
248.1				**TOPSOIL** - Black, trace roots and grass.						
248				**SILTY CLAY** - Brown, moist, soft, intermediate plasticity, trace gravel.						
	1					S1			★	
247										
246.7		5		**SILT TO SILTY CLAY TILL** - Brown, dry, soft to firm, low plasticity, trace rootlets, trace gravel, trace fine sand.						
	2					S2			★	
246										
	3	10		- Light brown to brown, moist, soft below 3.05 m.						
245										
	4									
244		15								
	5									
243										
	6	20		- Dark grey, dry below 6.1 m.		S3				
242										
	7									
241		25								
	8									
240										
	9	30		- Stiff below 9.1 m.		S4				
239										
	10									
238		35				S5				
	11									
237										

SAMPLE TYPE Auger Grab | Auger Cuttings | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
BH-BC4

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
236		40		- Grey, dry to damp below 12.2 m.					
	13								
235		45							
	14								
234				- Moist below 14.3 m.					
	15	50							
233									
	16								
232		55							
	17								
231									
	18								
230		60							
229.8				**AUGER REFUSAL AT 18.44 m** - Switched to HQ Coring					
229.3	19			**BASAL TILL**	C1				
229				**C1 (18.44 to 19.08m)** - Grey to white boulders and cobbles mixed with sand.					
				LIMESTONE - White, hard, intensely bedded, slightly weathered and fractured.	C2				
		65		**C2 (19.08 TO 19.81m)** - White limestone, slightly weathered, moderately to highly fractured.					
228	20								
				C3 (19.81 to 21.34m) - White limestone, slightly weathered, moderately to highly fractured, hard - RQD = 56%	C3				
227	21	70							
	22			**C4 (21.34 to 22.86m)** - White limestone, slightly weathered, moderately fractured, hard - RQD = 80%.	C4				
226									
225.4		75							
	23			**END OF HOLE AT 22.9 m.**					
225									
				Notes: 1. Water level in hole at 1.52 m below grade after removing augers. 2. Flowing artesian conditions encountered during coring of bedrock. Static water level measurment through the core steel was 2.90 m above ground level (July 7, 2011) 3. Hole backfilled with a cement/bentonite mixture to surface.					
	24								
224		80							
	25								
223									
		85							
	26								

SAMPLE TYPE: Auger Grab | Auger Cuttings | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-BC5**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B/C

LOCATION In quarter section SW-1-30-09

DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel

KGS JOB NO.	11-0300-18
AECOM JOB NO.	60212781
GROUND ELEV.	245.54 m
TOP OF PVC ELEV.	246.45 m
DATE DRILLED	7/8/2011
UTM (m)	N 5,710,367
	E 527,198

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %
245.4				**TOPSOIL** - Black, moist, soft.					
245	1			**SILTY CLAY** - Brown to black, moist, soft, intermediate plasticity, some sand.				S1	
244.0									
244	2	5		**SILT TILL** - Brown, dry, non-plastic to low plasticity, trace to some sand, trace gravel.					
243	3	10						S2	
242	4								
241	5	15						S3	
240	6	20							
239	7								
238	8	25							
237	9	30				8.8			
236.1				**AUGER REFUSAL AT 9.45 m** - Switched to HQ Coring.					
236	10			**LIMESTONE BEDROCK** - Rubble zone. **C1 (9.45 to 10.67 m)** - Highly weathered and fractured. RQD = 35%.				C1	
235	11	35		**C2 (10.67 to 12.19 m)** - Light grey to white, highly weathered and fractured, clay infill in fractures. RQD = 25%.		10.5		C2	
234									

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP | AECOM

SUMMARY LOG

HOLE NO.
BH-BC5

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
233	13	40		**C3 (12.19 to 13.72 m)** - Grey to white, highly weathered and fractured, clay infill in fractures. RQD = 30 %.			C3			20 40 60	20 40 60 80
232						13.6					
231.8	14	45		**END OF HOLE AT 13.72 m.**		13.7					
231	15	50		Notes: 1. Flowing artesian conditions encountered during coring of bedrock. Static water level measurment through the core steel was 1.98 m above ground level (July 7, 2011) 2. Hole backfilled with a cement/bentonite mixture to surface.							
230	16										
229		55									
228	17										
227	18	60									
226	19										
225	20	65									
224	21	70									
223	22										
222	23	75									
221	24										
220	25	80									
	26	85									

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	M. AKHTAR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-BC6**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B/C

LOCATION In quarter section SE-2-30-09

DRILLING METHOD 125 mm ø Solid Stem Auger, HQ Core Barrel

KGS JOB NO.	11-0300-18
AECOM JOB NO.	60212781
GROUND ELEV.	246.07 m
TOP OF PVC ELEV.	246.95 m
DATE DRILLED	7/9/2011
UTM (m)	N 5,710,352
	E 526,617

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %
246				**TOPSOIL** - Black, moist, trace sand.					
245.9				**SILT** - Light grey, moist to wet, soft, some cohesion, some sand, trace to with clay, trace gravel.					
245.3				**SILTY CLAY** - Brown, moist, stiff, high plasticity, trace oxidized silt.					
245.2				**SILT TO SILTY CLAY TILL** - Brown/tan, moist, stiff, some cohesion, low to intermediate plasticity, with sand, trace to some angular to subangular limestone gravel.					
245	1	5		- Light grey/brownish below 1.4 m.					
244	2			- Some gravel (subangular limestone), trace granitic stones below 1.8 m.			S	S1	
243	3	10							
242	4								
241.1	5	15		**Auger Refusal at 5.11 m** - Switched to HQ coring.					
241.0				**LIMESTONE**			R	R1	82
240	6	20		- Possible void at 5.92 m.		5.9			
239	7			- Possible void at 7.01 m.		6.1		R2	93.3
238.5		25		**END OF HOLE AT 7.62 m.**		7.6			
238	8			Notes: 1. Hole open to 7.62 m after drilling. 2. 25 mm (1") diameter PVC standpipe installed: - Screened from 7.62 m to 5.94 m - Backfilled with a cement-bentonite grout to surface 3. Artesian conditions encountered in the bedrock. Water flowing at approximately 70 gal/min from the top of hole after drilling was completed.					
237	9	30							
236	10								
235	11	35							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE S Auger Grab R Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	S.BEAUDRY	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-4-29-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.35 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,699,898**
E **532,178**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
250	0			**TILL** - Light brown, dry to damp, dense, trace stones, trace silt, trace clay.		20 40 60	20 40 60 80
249	1	5					
248	2						
247	3	10					
246	4	15					
245	5						
244	6	20					
243	7						
242	8	25					
241	9	30		- Drilling hard below 9.1 m.			
240	10						
239	11	35					
238.2	12	40		**END OF HOLE AT 12.2 m.**			
238							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D100**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-17-27-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.03 m**
TOP OF PVC ELEV. **249.94 m**
DATE DRILLED **7/11/2011**
UTM (m) N **5,684,315**
E **530,855**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)
248.9				**TOPSOIL**		
				SILT TO SILTY CLAY TILL - Light brown, moist to wet, intermediate plasticity, some pebbles and sand, trace to some clay, trace clay lenses up to 10 cm thick.		
248	1	5				
247	2					
246	3	10		- Damp, very stiff to hard, low plasticity below 3.05 m.		
245	4					
		15		- Grey, moist, firm, low to intermediate plasticity below 4.6 m.		4.6
244	5					
243	6	20		- Stiff below 6.1 m.		
242	7					7.3
		25		- Some clay, trace cobbles below 7.6 m.		7.6
241	8					
240	9	30		- Low plasticity below 9.1 m.		
239	10					
238.4		35		**END OF HOLE AT 10.7 m.**		10.7
238	11					
237	12	40				

SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)

Notes:
1. 25 mm (1") diameter PVC standpipe installed:
   - Cassagrande tip from 7.3 to 7.6 m.
   - Sand from 4.6 to 7.6 m.
   - Backfilled with bentonite to surface.
2. Land owner indicated that 3 wells on the property encountered bedrock between approximately 18.9 to 19.8 m below surface.

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BURNS/N. HANNESON	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D101**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-17-27-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO.	11-0300-18
AECOM JOB NO.	60212781
GROUND ELEV.	249.25 m
TOP OF PVC ELEV.	250.37 m
DATE DRILLED	7/11/2011
UTM (m)	N 5,684,505
	E 530,629

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)
249				**TOPSOIL**		
				SILT TO SILTY CLAY TILL - Light brown, moist, firm, low plasticity, trace clay, trace gravel.		
248	1	5		- Trace cobbles at 1.5 m.		
247	2					
	3	10		- Grey, soft, low to intermediate plasticity below 3.05 m.		
246	4					4.1
245		15		- Intermediate plasticity, trace cobbles below 4.6 m.		
244	5					
	6	20		- Moist to wet below 6.1 m.		
243	7			- Firm below 7.0 m.		7.3
242		25		- Moist, soft below 7.6 m.		7.6
241	8					
	9	30		- Firm, low to intermediate plasticity below 9.1 m.		
240	10					
239						
238.6		35		**END OF HOLE AT 10.7 m.**		10.7
238	11					
	12	40				
237						

SAMPLE TYPE | SAMPLE NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲

DYNAMIC CONE (N) blows/ft △

20 40 60

Cu POCKET PEN (kPa) ★

Cu TORVANE (kPa) ◆

20 40 60 80

PL MC LL

%

20 40 60 80

Notes:
1. 25 mm (1") diameter PVC standpipe installed:
   - Cassagrande tip from 7.3 to 7.6 m.
   - Sand from 4.1 to 7.6 m.
   - Backfilled with bentonite to surface.

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N. HANNESON	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D102**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-20-27-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.59 m**
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,685,373**
E **530,589**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249.4				**TOPSOIL**
249				**SILT TILL** - Brown, dry, stiff, some gravel, some cobbles.
	1			- Trace to some clay below 0.9 m.
248		5		- Dry to damp below 1.5 m.
	2			
247				
	3	10		- Moist below 3.05 m.
246				
	4			
245		15		- Grey, damp, low plasticity below 4.6 m.
	5			
244				
	6	20		- Soft to firm, low plasticity to non-plastic, trace clay below 6.1 m.
243				
	7			
242		25		
	8			
241				
	9	30		
240				- Firm below 9.8 m.
	10			
239.2				**AUGER REFUSAL ON SUSPECTED BOULDER AT 10.4 m.**
239		35		
	11			
238				
	12	40		
237				

SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
			20 40 60	20 40 60 80	20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N. HANNESON	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D104**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-29-27-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.62 m**
TOP OF PVC ELEV. **249.53 m**
DATE DRILLED **7/12/2011**
UTM (m) N **5,688,209**
E **530,625**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.3				**TOPSOIL**						20 40 60	20 40 60 80
248				**SILT TO SILTY CLAY TILL** - Brown, moist to wet, soft, trace gravel, trace cobbles.							
	1	5		- Grey, mottled, low plasticity from 0.91 to1.52 m.							
247				- Brown, dry below 1.52 m.							
	2										
246											
	3	10		- Damp, trace cobbles, trace gravel, trace clay below 3.05 m.							
245											
	4			- Moist below 4.3 m.		4.6					
244		15		- Damp to wet, soft, intermediate plasticity, some clay, trace cobbles, trace gravel below 4.6 m.		5.2					
	5										
243											
	6	20		- Intermediate to high plasticity below 6.1 m.							
242											
	7										
241		25									
	8					8.2					
240											
239.5	9	30		**END OF HOLE AT 9.1 m.**		9.1					
239				Notes: 1. 50 mm (2") diameter PVC standpipe installed: - Screened from 5.18 to 8.23 m. - Sand from 4.57 to 8.23 m. - Backfilled with bentonite to surface.							
	10										
238		35									
	11										
237											
	12	40									
236											

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N. HANNESON	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D105**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-29-27-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.42 m**
TOP OF PVC ELEV.
DATE DRILLED **7/12/2011**
UTM (m) N **5,686,937**
E **530,592**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249.3				**TOPSOIL**
249				**SILT TO SILTY CLAY TILL** - Brown, dry to damp, very dense, trace cobbles, trace gravel, trace clay.
	1	5		
248				
	2			
247		10		
	3			
246				
	4	15		- Grey, damp below 4.3 m.
245				
	5			- Moist, firm, low plasticity to non-plastic below 5.5 m.
244				
	6	20		- Soft below 6.1 m.
243				
	7			
242		25		- Intermediate plasticity below 7.6 m.
	8			
241				
	9	30		
240				
	10			
239		35		
	11			
238				
237.2	12	40		**END OF HOLE AT 12.2 m.**
237				

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR **Paddock Drilling Ltd.**
INSPECTOR **N. HANNESON**
APPROVED **DRAFT**
DATE 10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D106**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-32-27-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO.	11-0300-18
AECOM JOB NO.	60212781
GROUND ELEV.	249.92 m
TOP OF PVC ELEV.	250.81 m
DATE DRILLED	7/12/2011
UTM (m)	N 5,688,543
	E 530,605

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249.8				**TOPSOIL**						20 40 60	20 40 60 80
249	1	5		**SILT TO SILTY CLAY TILL** - Grey, damp, soft, low plasticity, trace gravel, trace cobbles. - Brown, and sand from 0.30 to 0.76 m. - Moist, firm, trace clay below 0.76 m.							
248	2										
247	3	10		- Damp, soft to firm below 3.05 m.							
246	4	15									
245	5										
244	6	20		- Grey, soft, intermediate plasticity below 6.1 m.							
243	7					7.0 7.3					
242	8	25		- Wet below 7.6 m.							
241	9	30									
240	10					10.4					
239.2		35		**END OF HOLE AT 10.7 m .**		10.7					
239	11										
238	12	40		Notes: 1. 50 mm (2") diameter PVC standpipe installed: - Screened from 7.3 to 10.4 m. - Sand from 7.0 to 10.4 m. - Backfilled with bentonite to surface.							
237											

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N. HANNESON	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D107**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-5-28-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.81 m**
TOP OF PVC ELEV. **250.67 m**
DATE DRILLED **7/12/2011**
UTM (m) N **5,691,570**
E **530,533**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)
249.7				**TOPSOIL**		
				SILT TO SILTY CLAY TILL - Brown, damp, firm, trace gravel, trace cobbles, trace clay.		
249	1	5		- Stiff below 1.5 m.		
248	2			- Intermediate plasticity from 2.29 to 2.59 m m.		
				- Some clay below 2.7 m.		
247	3	10				3.7
246	4					
		15		- Soft, intermediate plasticity below 4.6 m.		4.6
245	5					
244	6	20				
				- Wet, soft to firm below 6.4 m.		
243	7					
		25				7.6
242	8			- Moist, firm, low to intermediate plasticity below 7.6 m.		
241	9	30				
240	10					
239.1		35				10.7
239	11			**END OF HOLE AT 10.7 m.**		
238	12	40				
237						

SAMPLE TYPE | SAMPLE NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

Notes:
1. 50 mm (2") diameter PVC standpipe installed:
   - Screened from 4.6 to 7.6 m.
   - Sand from 3.7 to 7.6 m.
   - Backfilled with bentonite to surface.

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N. HANNESON	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D108**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NE-7-28-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO.	11-0300-18
AECOM JOB NO.	60212781
GROUND ELEV.	249.98 m
TOP OF PVC ELEV.	250.86 m
DATE DRILLED	7/12/2011
UTM (m)	N 5,692,583
	E 530,190

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249.8				**TOPSOIL**						20 40 60	20 40 60 80
249	1	5		**SILT TO SILTY CLAY TILL** - Brown, moist, soft, intermediate plasticity, some clay, trace cobbles, trace gravel.							
248	2			- Firm, low to intermediate plasticity below 1.2 m. - Dry to moist, trace clay below 1.5 m.							
247	3	10		- Grey below 3.05 m.							
246	4	15									
245	5										
244	6	20		- Stiff below 6.1 m.							
243	7					7.0					
242	8	25		- Damp to moist, firm below 7.6 m.							
241	9	30									
240	10					10.1					
239.3		35				10.7					
239	11			**END OF HOLE AT 10.7 m.**							
238	12	40		Notes: 1. 50 mm (2") diameter PVC standpipe installed: - Screened from 7.0 to 10.1 m. - Backfilled with bentonite to surface.							
237											

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N. HANNESON	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D109**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NE-31-26-08

DRILLING METHOD 125 mm ø Solid Stem Auger - Acker MP 8

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.72 m**
TOP OF PVC ELEV. **250.68 m**
DATE DRILLED **7/13/2011**
UTM (m) N **5,682,844**
E **530,475**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
249.6				**TOPSOIL** - Black, damp, organics.					
249	1	5		**SILT TILL** - Brown, damp, some cohesion, trace to some sand, trace to some gravel (subangular limestone).					
248	2			- Cobbles and boulders between 1.5 m and 3.05 m.					
247	3	10							
246	4								
245	5	15							
244	6								
243	7	20							
242	8								
241	9	25		- Greyish-brown below 8.5 m.		8.8			
240	10	30		- Damp to moist below 9.1 m.		9.1			
239.0		35							
239	11			**SILTY CLAY TILL** - Greyish-brown, moist, intermediate plasticity, trace sand, trace fine gravel.					
238									
237.5	12	40				12.2			
237				**END OF HOLE AT 12.2 m.**					
236	13	45		Notes: 1. 50 mm (2") diameter PVC standpipe installed: - Screened from 9.1 to 12.2 m. - Sand from 8.8 to 12.2 m. - Backfilled with bentonite to surface. 2. Free water in bottom of hole immediately after removing solid stem augers.					
235	14								

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	S. BEAUDRY/N.HANNESON	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-4-29-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.64 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,700,003**
E **532,111**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
250	1	5		**TILL** - Light brown, dry, dense, with silt, trace stones, trace clay.					
249	2								
248	3	10							
247	4								
246	5	15							
245	6	20							
244	7								
243.0 243	7.6	25		**END OF HOLE AT 7.6 m.**					
242	8								
241	9	30							
240	10								
239	11	35							
238	12	40							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D3**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SE-9-29-08
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **246.40 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,702,263**
E **533,143**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
246	0	0				20 40 60	20 40 60 80
245	1	5		**TILL** - Light brown, dry, dense, trace stones, trace silt, trace clay.			
244	2						
243	3	10					
242	4	15					
241	5						
240	6	20					
239	7						
238.0 238	8	25		**AUGER REFUSAL AT 8.4 m.**			
237	9	30					
236	10						
235	11	35					
234	12	40					

SAMPLE TYPE

CONTRACTOR **Paddock Drilling Ltd.** | INSPECTOR **A. SINCLAIR** | APPROVED **DRAFT** | DATE 10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D4**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NE-9-29-08
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 246.46 m
TOP OF PVC ELEV.
DATE DRILLED 7/11/2011
UTM (m) N 5,702,721
E 533,266

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %
246.3				**TOPSOIL** - Dark brown, dry, some organics.	
246				**SILTY CLAY** - Grey, dry to damp, hard, low plasticity, trace angular and subangular gravel.	
	1			- Light brown, trace stones below 1.2 m.	
245		5			
244.6	2			**SILT** - Light grey, dry to damp, trace clay.	
244					
	3	10			
243.1				**SILT TILL** - Grey, dry, trace stones.	
243	4				
242		15			
	5			**AUGER REFUSAL AT 5.2 m** - Switched to HQ Coring.	
241.3				**BASAL TILL** - Boulders, hard drilling.	
241				**R1 (5.18 to 6.10 m** - Mix of gravel, large boulders and pieces of cemented silt till.	R1
	6	20		**R2 (6.10 to 7.62 m)** - Mix of cemented till and boulders.	
240					R2
	7				
239		25		**R3 (7.62 to 9.14 m)** - Mix of cemented till and boulders.	
	8				R3
238					
237.3	9	30		**SAND**	
237				- Free water below 9.8 m.	R4
	10				
236					
235.8		35		**END OF HOLE AT 10.7 m.**	
	11				
235					
	12	40			
234					

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

Notes:
1. Artesian conditions encountered with core steel advanced to 10.67 m.
2. Static water level measurment in the core steel was approximately 6.1 m above ground surface at the time of drilling.
3. Hole backfilled with a cement/bentonite grout to surface.

SAMPLE TYPE ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D5**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-4-29-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.51 m**
TOP OF PVC ELEV.
DATE DRILLED **7/12/2011**
UTM (m) N **5,701,399**
E **532,687**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248				**SILT** - Light grey, dry, dense, trace clay, trace stones.
247.7	1	5		**SILT TILL** - Light grey, dry, hard, trace clay, trace stones.
247	2			
246				- Light brown below 2.44 m.
	3	10		
245				
	4	15		
244				
	5			
243				
	6	20		
242				
	7			
241		25		- Moisture increases at 7.62 m.
	8			
240				
	9	30		
239				
	10			- Gravel and boulders encountered at 10.06 m.
238				
237.8		35		**END OF HOLE IN SUSPECTED SILT TILL AT 10.67 m.**
	11			
237				
	12	40		
236				

SAMPLE TYPE | SAMPLE NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80

PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D6**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-33-28-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.99 m**
TOP OF PVC ELEV.
DATE DRILLED **7/12/2011**
UTM (m) N **5,698,777**
E **532,400**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248	1	5		**TILL** - Light grey, dry, stiff, trace clay, trace gravel.
247	2			
246.9	3	10		**SILT TILL** - Light brown, trace gravel.
245	4	15		
244	5			
243	6	20		
242	7			
241	8	25		
240	9			
239.8		30		**END OF HOLE AT 9.14m.**
239	10			
238	11	35		
237	12			
236		40		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D7**

SHEET 1 of 1

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NE-29-28-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.54 m**
TOP OF PVC ELEV.
DATE DRILLED **7/12/2011**
UTM (m) N **5,697,545**
E **531,387**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.1				**TOPSOIL** - Black, moist, soft, organics.
248				**SILTY CLAY** - Light grey, soft.
	1	5		
247				
246.4	2			**TILL** - Light brown, firm, trace clay.
246				
	3	10		- Moist below 3.05 m.
245				
	4			
244.0		15		**SILTY CLAY TILL** - Light grey, moist to wet, soft.
244	5			- Increased moisture content with depth.
243				
	6	20		
242				
	7			
241		25		
	8			
240				
	9	30		
239				
	10			
238.0		35		**END OF HOLE AT 10.67 m.**
	11			
237				
	12	40		
236				

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D8**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-20-28-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.24 m**
TOP OF PVC ELEV.
DATE DRILLED **7/12/2011**
UTM (m) N **5,695,932**
E **531,279**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249				**SILT TO SILTY CLAY TILL** - Light grey, damp, soft, trace stone.
248	1	5		
247	2			- More dense below 2.44 m.
246	3	10		
245	4	15		
244	5			
243	6	20		- Dry below 6.10 m.
242	7	25		
241	8			
240	9	30		
239	10			
238.6		35		**END OF HOLE AT 10.67 m.**
238	11			
237	12	40		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-D9**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-17-28-08

DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.49 m**
TOP OF PVC ELEV. **250.39 m**
DATE DRILLED **7/12/2011**
UTM (m) N **5,693,949**
E **530,789**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)
249.2				**TOPSOIL** - Black, damp, organcs.		
249				**SILTY CLAY TILL** - Light grey, dry to damp, soft, low plasticity, trace gravel.		
248	1	5				
247	2					
246	3	10				
245	4					
244	5	15				
243	6	20		- Damp, intermediate plasticity below 6.10 m.		
242	7	25				
241	8					
240	9	30				9.1
239	10					
238	11	35				
237.3	12	40		**END OF HOLE AT 12.19 m.**		12.2
237	13			Note: 1. 25 mm (1") diameter PVC standpipe installed: - Screened from 9.1 to 12.2 m. - Backfilled with bentonite to surface.		
236		45				

SAMPLE TYPE | SAMPLE NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	A. SINCLAIR	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 100 mm ø Solid Stem Auger/75 mm ø Air Hammer - B20 Skid Mounted Rig

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **244.76 m**
TOP OF PVC ELEV.
DATE DRILLED **7/21/2011**
UTM (m) N **5,741,845**
E **554,688**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
244.0				**PEAT** - Organics					
244				- Free water below 0.30 m.					
243.7	1			**CLAYEY SILT TILL** - Light grey, moist to wet, soft, some sand, some gravel.		S1			
		5		**SILT TILL** - Light brown/tan, low plasticity, some to with sand, trace gravel, generally limestone, sub-angular.		S2			
243	2					S3			
242	3	10		**AUGER REFUSAL AT 2.74 m** - Switched to Air Hammer. - Drilled through boulder 200-250 mm ø boulder encountered at 2.74 m.					
241	4	15							
240	5								
239									
238.7	6	20		**END OF HOLE IN SUSPECTED SILT TILL AT 6.10 m**					
238	7								
237		25							
	8								
236									
	9	30							
235									
	10								
234		35							
	11								
233									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	S. BEAUDRY	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 100 mm ø Solid Stem Auger/75 mm ø Air Hammer with Water Injection - B20 Skid Mounted Rig

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **238.80 m**
TOP OF PVC ELEV.
DATE DRILLED **7/21/2011**
UTM (m) N **5,745,441**
E **562,070**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
238.4				**PEAT** - Organics				
				- Wet below 0.30 m.				
237.9	1	5		**SILTY CLAY** - Black/grey, moist, soft to firm, intermediate plasticity, with sand, trace gravel. Grain Size: Gravel (8%), Sand (24%), Silt (24%), Clay (45%) between 0.30 to 0.90 m. - Transitioning to grey below 0.61 m.	S1			
					S2			
237	2			**SILT TILL** - Light brown/tan, damp to moist, firm, low plasticity, with sand, fine to coarse grained, trace gravel, generally limestone, angular to subangular. Grain Size: Gravel (7%), Sand (25%), Silt (30%), Clay (30%) at 1.20 m. Grain Size: Gravel (5%), Sand (32%), Silt (39%), Clay (24%) between 1.80 to 2.40 m.	S3			
236	3	10		- Slight color change to grey/tan, some gravel, moisture content increases below 2.74 m.				
				Grain Size: Gravel (15%), Sand (27%), Silt (33%), Clay (25%) between 3.05 to 4.00 m.	S4			
235	4	15						
234	5			- Gravel content increasing with depth below 5.18 m.				
				Grain Size: Gravel (27%), Sand (20%), Silt (25%), Clay (28%) between 5.20 to 5.80 m.	S5			
233	6	20		- Some cobbles, limestone, subangular below 5.79 m.				
				Grain Size: Gravel (56%), Sand (10%), Silt (15%), Clay (19%) between 6.10 to 6.70 m.	S6			
232	7			**AUGER REFUSAL AT 6.71 m** - Switched to Air Hammer with water injection.				
231	8	25						
230	9	30			S7			
229.0				**END OF HOLE IN SUSPECTED SILT TILL AT 9.75 m**				
229	10			Note: 1. Sample S1 was screened from return water during drilling.				
228		35						
227	11							

SAMPLE TYPE Auger Grab Wash

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	S. BEAUDRY	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L3**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 75 mm ø Air Hammer with Water Injection - B20 Skid Mounted Rig

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **241.65 m**
TOP OF PVC ELEV.
DATE DRILLED **7/22/2011**
UTM (m) N **5,744,880**
E **556,496**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
241.6				**PEAT** - Organics				
				- Sand gravel seam at 0.61 m.				
240.9				- Wet below 0.15 m.				
240.7	1	5		**SILTY CLAY** - Black/drak grey, moist to wet, soft to firm, with sand.				
				SILT TILL				
240	2			- Drill action indicative of gravel and cobbles below 0.91 m.				
239	3	10			S1			
238	4							
237	5	15						
236	6	20						
235	7			- Approximately 150 to 200 mm ø boulder encountered at 7.01 m.	S2			
234		25		**S2 (7.01 to 7.62 m)** - Pieces of clay, intermediate to high plasticity located in washed drill screenings.				
233	8							
232	9	30						
231	10	35						
230	11				S3			
229.0	12	40						
228	13	45		**END OF HOLE IN SUSPECTED SILT TILL AT 12.8 m**				

Note:
1. Samples S1, S2, and S3 were screened from return water during drilling.

SAMPLE TYPE Wash

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	S. BEAUDRY	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L3A**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 100 mm ø Solid Stem Auger/75 mm ø Air Hammer - B20 Skid Mounted Rig

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **241.67 m**
TOP OF PVC ELEV.
DATE DRILLED **7/22/2011**
UTM (m) N **5,744,879**
E **556,496**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
241.67				Ground Surface				20 40 60	20 40 60 80
241.1				**PEAT** - Organics - Sand gravel seam at 0.61 m.					
241	1			**SILTY CLAY** - Black/drak grey, moist to wet, intermediate plasticity, with organics, some sand, trace limestone gravel. - Brown, soft, trace gravel below 0.76 m. Grain Size: Gravel (4%), Sand (15%), Silt (23%), Clay (58%) between 0.90 to 1.40 m.		S1			
240.3		5		**SILT TILL** - Light brown/tan, wet, soft, low plasticity, some sand, trace gravel. Grain Size: Gravel (8%), Sand (24%), Silt (36%), Clay (32%) between 1.50 to 2.00 m.		S2			
240									
239.7	2			**AUGER REFUSAL IN SUSPECTED TILL AT 1.98 m.**					
239	3	10							
238	4								
237		15							

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	S. BEAUDRY	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L4**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 75 mm ø Air Hammer with Water Injection - B20 Skid Mounted Rig

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 241.71 m
TOP OF PVC ELEV.
DATE DRILLED 7/23/2011
UTM (m) N 5,743,814
E 556,908

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
241.0				**PEAT** - Organics					
240.8				- Wet below 0.30 m.					
	1	5		**SILTY CLAY** - Black/dark grey, wet, intermediate plasticity, soft, with sand, fine to coarse grained, trace gravel.					
240	2			**SILT TILL** - Light grey, wet, soft, low plasticity, some to with sand, some gravel, subangular.					
		10		- Light brown/tan, moist, firm to stiff below 1.37 m.		S1			
239	3								
238	4	15							
237	5								
236		20							
	6								
235	7	25				S2			
234	8								
233		30							
232.0	9			**END OF HOLE IN SUSPECTED SILT TILL AT 9.75 m**					
	10	35		Notes: 1. Soil descriptions are based on BH-L4A, drilled adjacent to BH-L4 using solid stem augers. 2. Samples S1 and S2 were screened from return water during drilling.					
231	11								
230									

SAMPLE TYPE Wash

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	S. BEAUDRY	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L4A**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 100 mm ø Solid Stem Auger - B20 Skid Mounted Rig

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 241.60 m
TOP OF PVC ELEV.
DATE DRILLED 7/23/2011
UTM (m) N 5,743,918
E 556,928

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
241				**PEAT** - Organics					
				- Wet below 0.30 m.					
240.8									
240.7				**SILTY CLAY** - Black/dark grey, wet, intermediate plasticity, soft, with sand, fine to coarse gained, trace gravel. Grain Size: Gravel (4%), Sand (26%), Silt (19%), Clay (51%) at 0.80 m.		S1			
	1			**SILT TILL** - Light grey, wet, soft, low plasticity, some to with sand, trace to some gravel, subangular. Grain Size: Gravel (13%), Sand (18%), Silt (28%), Clay (41%) between 0.90 to 1.40 m.		S2			
		5		- Light brown/tan, moist, firm to stiff below 1.37 m. Grain Size: Gravel (7%), Sand (23%), Silt (39%), Clay (31%) at 1.40 m.		S3			
240									
	2			Grain Size: Gravel (2%), Sand (31%), Silt (42%), Clay (25%) at 2.10 m.		S4			
239.3				**END OF HOLE 2.29 m**					
239									
	3	10							
238									
	4								
237		15							

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	S. BEAUDRY	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **BH-L5**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake St. Martin Emergency Channel System - Route L

LOCATION

DRILLING METHOD 75 mm ø Air Hammer with Water Injection - B20 Skid Mounted Rig

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **246.88 m**
TOP OF PVC ELEV.
DATE DRILLED **7/24/2011**
UTM (m) N **5,741,002**
E **553,446**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
246.0				**PEAT** - Organics					
				- Wet below 0.3 m.					
245.7	1			**BOULDERS AND COBBLES** - Mix of limestone and granite.		S1			
						S2			
		5		**SILT TILL** - Grey, wet, soft, intermediate plasticity, some to with sand, trace gravel.					
245	2			- Drilling indicative of dense till to 9.75 m.					
244	3	10							
						S3			
243	4								
		15							
242	5								
241	6	20							
						S4			
240	7								
		25							
239	8					S5			
238	9								
237.7		30		**END OF HOLE IN SUSPECTED SILT TILL AT 9.75 m**					
237	10			Notes: 1. Samples S1 and S2 taken from blast hole adjacent to BH-L5. 2. Samples S3, S4 and S5 were screened from return water during drilling.					
		35							
236	11								
235									

SAMPLE TYPE Auger Grab Wash

CONTRACTOR **Maple Leaf Enterprises** | INSPECTOR **S. BEAUDRY** | APPROVED **DRAFT** | DATE 10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-01**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.86 m**
TOP OF PVC ELEV.
DATE DRILLED **9/13/2011**
UTM (m) N **5,715,187**
E **518,507**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
249.7				**TOPSOIL**					
				SILT TILL - Tan, damp, soft, non to low plastic, some clay, trace coarse grained sand.					
249	1								
		5			S1				
248				- Increased sand, trace subangular gravel below (up to 25 mm Ø) below 1.83 m.					
	2								
247									
	3	10							
246									
	4			- Damp to moist below 4.28 m.	S2				
		15							
245									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-01

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
244	6	20		- Subangular gravel (up to 50 mm Ø) below 5.49 m.				20 40 60	20 40 60 80
					S3				
				- Moist below 6.1 m.					
243	7								
		25							
242	8								
241.5				**AUGER REFUSAL AT 8.38 m.**					
				Notes: 1. Test hole dry at end of drilling. 2. Water level at 1.86 m below ground level after 72 hours. 3. Test hole sloughed in to 3.96 m below ground level after 72 hours. 4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface after 72 hours.				
241	9	30							
240	10								
		35							
239									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-02**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.50 m**
TOP OF PVC ELEV.
DATE DRILLED **9/13/2011**
UTM (m) N **5,715,291**
E **518,486**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
250.3				**TOPSOIL**				
				SILT TILL - Tan, dry to damp, soft, non to low plastic, some clay, trace coarse grained sand.				
250	1							
					S1			
249		5						
	2			- Boulder encountered at 1.98 m.				
248								
				- Trace clay, some to with subangular gravel (up to 20 mm Ø)	S2			
	3	10						
247								
	4			- Damp below 4.28 m.				
246		15						

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-02

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
245										
	6	20		- Increased clay below 5.79 m.		S3				
244										
	7									
243		25								
	8			- Hard drilling below 7.92 m, auger cuttings spinning up grey.						
242										
	9	30				S4				
241.0				**AUGER REFUSAL AT 9.45 m.**						
241				Notes: 1. Test hole dry at end of drilling. 2. Test hole relocated adjacent to original TH11-02 to avoid boulder encountered at 1.98 m. 3. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.						
	10									
240		35								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-03**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.42 m**
TOP OF PVC ELEV.
DATE DRILLED **9/13/2011**
UTM (m) N **5,715,384**
E **518,483**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
250.4				**TOPSOIL**			20 40 60	20 40 60 80
250				**SILT TILL** - Tan, dry to damp, soft, crumbles, non-plastic, trace fine grained sand, some subrounded to subangular gravel (up to 35 mm Ø), roots mixed in to 1.22 m.				
	1				S1			
249		5						
	2							
248					S2			
	3	10						
247								
	4				S3			
246		15						

SAMPLE TYPE Auger Grab

CONTRACTOR **Paddock Drilling Ltd.** | INSPECTOR **C. ROBAK** | APPROVED **DRAFT** | DATE 10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-03

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
245										
	6	20								
244										
	7									
243		25								
	8			- Hard drilling below 7.92 m, auger cuttings spinning up grey.						
242										
	9	30								
241										
240.7				**AUGER REFUSAL AT 9.75 m.**		S4				
	10			Notes: 1. Test hole dry at end of drilling. 2. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.						
240		35								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-04**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 250.27 m
TOP OF PVC ELEV.
DATE DRILLED 9/13/2011
UTM (m) N 5,715,489
E 518,482

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
250.2				**TOPSOIL**						
250				**SILT** - Tan, dry to damp, soft, crumbles, non to low plastic, some clay, trace fine grained sand, trace fine subrounded to subangular gravel (up to 5 mm Ø).						
249.7				**ORGANIC CLAY** - Black, damp to moist, soft, low plastic, with roots, organic odour.		S1				
249.2	1			**CLAYEY SILT TILL** - Tan/Grey, moist, firm, low to intermediate plasticity, some fine to coarse grained sand, trace fine grained gravel (up to 8 mm Ø).		S2				
249		5		- Increased medium grained, subrounded to subangular gravel (up to 25 mm Ø), decreased plasticity below below 1.52 m.						
	2									
248										
	3	10				S3				
247										
	4									
246		15				S4				

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd. | INSPECTOR C. ROBAK | APPROVED DRAFT | DATE 10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-04

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
245										
	6	20		- Hard drilling between 6.1 m and 6.41 m.		S5				
244										
	7									
243		25								
	8									
242										
	9	30								
241										
	10									
240		35								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-04

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
239	11			- Grey, wet below 11.28 m.		S6				
238.7				**AUGER REFUSAL AT 11.58 m.**						
				Notes: 1. Water level at 5.6 m below ground surface at end of drilling. 2. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.						
	12	40								
238										
	13									
237		45								
	14									
236										
	15	50								
235										
	16									
234										
		55								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-05**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.09 m**
TOP OF PVC ELEV.
DATE DRILLED **9/13/2011**
UTM (m) N **5,715,596**
E **518,481**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
250				**SILT** - Brown, damp, soft/loose, non plastic, trace sand, trace gravel, some clay.		S1	
249.6				**ORGANIC CLAY** - Black, damp to moist, soft, low plastic, trace roots.		S2	
249.2	1			**SILTY CLAY** - Grey, damp to moist, firm, high plasticity, some silt includsion, laminated structure.		S3	
249				- Brown below 1.22 m.			
248.6		5		**SILT** - Tan, damp, soft, non-plastic, trace gravel, trace sand, some clay.		S4	
248.1	2			**SILTY CLAY** - Brown, damp, firm to stiff, intermediate plasticity, with silt pockets.		S5	
248							
247.3				**SILT TILL** - Tan, damp, soft, non-plastic, trace gravel, trace sand, some clay.		S6	
247	3	10		- Increased medium to coarse grained sand, increased subrounded to subangular gravel (up to 25 mm Ø) below 3.05 m.			
246	4					S7	
		15					

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-05

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
245										
	6	20		- Grey, wet below 5.79 m.		S8				
244										
	7									
243						S9				
		25								
	8									
242										
				- Increased gravel content below 8.84 m. Switched to HQ coring. - 250 mm Ø boulder encountered at 8.84 m.		S10				
	9	30								
241										
240.6				**END OF HOLE AT 9.45 m.**						
				Notes: 1. Test hole caved in to 4.57 m overnight. 2. HWT casing required to core beyond 9.45 m, test hole abandoned due to limited access to water. 3. Water entering test hole between 3.05 and 4.57 m. 4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.						
	10									
240										
		35								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-06**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 250.11 m
TOP OF PVC ELEV.
DATE DRILLED 9/14/2011
UTM (m) N 5,715,677
E 518,484

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %
250					
249.9				**SILT** - Brown, dry to damp, soft, crumbles, non-plastic, some gravel, some sand, some clay.	
249.8				**ORGANIC CLAY** - Black, damp, firm, low plasticity, some rootlets.	
				SILTY CLAY - Brown, damp, firm, intermediate to high plasticity, trace gravel (up to 15 mm Ø).	
	1				
249					S1
248.6		5		**CLAYEY SILT TILL** - Brown, damp, firm, low to intermediate plasticity, trace to some sand and gravel.	
	2				
248					
					S2
	3	10			
247					
	4				
246				- Some fine grained subangular gravel, decreased plasticity below 4.27 m.	S3
		15			

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-06

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
245							
	6	20			S4		
244							
	7						
243		25					
	8						
242							
	9						
241		30		- Cuttings spinning up grey below 9.14 m.			
	10						
240							
		35			S5		

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-06

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
239.1	11			**AUGER REFUSAL AT 10.97 m.**						
239										
				Notes: 1. Water level at 6.1 m below ground level at end of drilling. 2. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.						
	12	40								
238										
	13									
237		45								
	14									
236										
	15	50								
235										
	16									
234		55								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-07**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 249.90 m
TOP OF PVC ELEV.
DATE DRILLED 9/14/2011
UTM (m) N 5,715,745
E 518,589

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249.8				**ORGANICS**				
				SILT TILL - Tan, dry to damp, soft, crumbles, non-plastic, trace subangular gravel (up to 15 mm Ø), trace clay.				
249	1	5			S1			
248	2							
247	3	10			S2			
				- Firm, increased gravel from 3.35 m to 3.66 m.				
246	4			- Soft, crumbles below 1.98 m.				
		15			S3			
245	5			- Grey, damp to moist below 5.18 m.				
244	6	20			S4			
243	7							
		25						
242	8							
241	9	30						
				- Hard drilling below 9.75 m.				
240	10			- Grey, wet, trace gravel below 10.06 m.	S5			
239.1		35						
239	11			**AUGER REFUSAL AT 10.82 m.**				
238				Notes: 1. Water level at 8.5 m at end of drilling. 2. Water level at 2.42 m below ground level after 48 hours.				

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-07

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
		40		3. Test hole sloughed in to 7.66 m after 48 hours. 4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface after 48 hours.				20 40 60	20 40 60 80
237	13								
		45							
236	14								
235	15	50							
234	16								
		55							
233	17								
232	18	60							
231	19								
230	20	65							
229	21								
		70							
228	22								
227	23	75							
226	24								
		80							
225	25								
224	26	85							

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-09**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 248.77 m
TOP OF PVC ELEV.
DATE DRILLED 9/16/2011
UTM (m) N 5,715,808
E 518,832

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
248.6				**ORGANICS**				
				CLAYEY SILT TILL - Tan/Grey, damp to moist, firm, low plasticity, some coarse grained sand, trace fine grained subangular to subrounded gravel (up to 15 mm Ø).				
248				- 100 mm thick silty clay seam at 0.81 m.				
	1				S1			
		5		- Increased gravel, decreased clay below 1.52 m.				
247								
	2							
246					S2			
	3	10						
245								
	4				S3			
		15						
244				- Grey, moist below 4.88 m.				

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-09

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
243	6	20			S4			20 40 60	20 40 60 80
242	7	25							
241	8								
240.2				**AUGER REFUSAL AT 8.53 m.**					
240	9	30		Notes: 1. Tes thole at topographic low point (approximately 2 m lower than TH11-10). 2. Water at 8.33 m below ground level at end of drilling. 3. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.					
239	10	35							
238									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-10**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 250.23 m
TOP OF PVC ELEV.
DATE DRILLED 9/16/2011
UTM (m) N 5,715,811
E 518,878

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
250.2				**ORGANICS**					
250				**SILT TILL (ML)** - Tan, dry, soft, crumbles, non-plastic, trace coarse grained sand, trace fine grained gravel.					
249	1	5				S1			
248	2			- Brown, damp to dry below 1.83 m.		S2			
247	3	10		- Damp, increased fine grained gravel/coarse grained sand below 3.05 m.					
246	4	15		- Moist, trace to some clay below 4.57 m.		S3			
245	5								
244	6	20				S4			
243	7	25		- Auger grinding between 6.71 m and 6.86 m.					
242	8			- Hard drilling below 7.92 m.					
241	9	30							
240	10								
239.6		35		**AUGER REFUSAL IN SILT TILL AT 10.67 m.**					
239	11								

Notes:
1. Water level at 8.66 m one hour after drilling.
2. Test hole sloughed in to 10.06 m one hour after drilling.
3. Water entering test hole from 10.36 m.

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-10

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
238		40		4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.					
	13								
237		45							
	14								
236									
	15	50							
235									
	16								
234		55							
	17								
233									
	18	60							
232									
	19								
231		65							
	20								
230									
	21	70							
229									
	22								
228		75							
	23								
227									
	24	80							
226									
	25								
225		85							
	26								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-11**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 250.03 m
TOP OF PVC ELEV.
DATE DRILLED 9/16/2011
UTM (m) N 5,715,814
E 518,980

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
250				**TOPSOIL**			20 40 60	20 40 60 80
249.9				**SILT TILL** - Tan, damp, firm, non to low plastic, some coarse grained sand, some clay, trace gravel.				
249	1				S1			
		5						
248	2			- Increased max gravel size (up to 25 mm Ø) below 2.13 m.	S2			
247	3	10						
				- Dry to damp below 3.81 m.	S3			
246	4							
		15		- 300 mm thick sandy gravel seam from 4.57 m to 4.88 m.	S4			
				- Grey, damp, non-plastic, some coarse grained sand, some fine grained gravel below				

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-11

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
245				4.88 m.		20 40 60	20 40 60 80
244	6	20					
243	7						
		25					
242	8						
241	9	30					
240	10						
		35					

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-11

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
239	11					20 40 60	20 40 60 80
238.3				**AUGER REFUSAL IN SILT TILL AT 11.73 m.**			
238	12	40		Notes: 1. Water entering test hole from sandy gravel seam at 4.57 m. 2. Water at 2.18 m below ground level two hours after drilling. 3. Test hole sloughed to 7.14 m two hours after drilling. 4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.			
237	13	45					
236	14						
235	15	50					
234	16						
		55					

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-12**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.92 m**
TOP OF PVC ELEV.
DATE DRILLED **9/14/2011**
UTM (m) N **5,715,816**
E **519,071**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
249.9				**TOPSOIL**						
				SILT TILL - Tan, dry to damp, soft to firm, non to low plastic, some clay, trace subangular gravel (up to 15 mm Ø).						
249	1									
		5				S1				
248	2									
				- Increased gravel content below 2.74 m.		S2				
247	3	10								
				- Damp to moist below 3.66 m.						
246	4									
						S3				
		15								
245				- Grey/Brown, some gravel below 4.88 m.						

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-12

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
244	6	20		- Hard drilling below 5.79 m.	S4	20 40 60	20 40 60 80
243	7	25			S5		
242	8						
241	9	30			S6		
240	10						
		35			S7		

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-12

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
	11								
238.2					S	8			
				AUGER REFUSAL AT 11.73 m.					
238	12	40		Notes: 1. Water level at 11.58 m below ground level at end of drilling. 2. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.					
237	13								
		45							
236	14								
235	15	50							
234	16								
		55							

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-13**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.89 m**
TOP OF PVC ELEV.
DATE DRILLED **9/14/2011**
UTM (m) N **5,715,824**
E **519,197**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
249.8				**TOPSOIL**					
				SILT TILL - Tan, damp to moist, soft to firm, non to low plastic, trace subangular gravel (up to 10 mm Ø).					
249	1	5			S1				
248	2								
				- Trace oxidation at 2.74 m.	S2				
247	3	10							
246	4				S3				
		15		- Moist below 4.57 m.					
245									

SAMPLE TYPE Auger Grab Auger Cuttings

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-13

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
244	6	20				S4		20 40 60	20 40 60 80
243	7	25							
242	8			- Grey, moist to wet, trace coarse grained sand, trace fine grained gravel below 8.53 m.					
241	9	30				S5			
240	10								
239		35							

SAMPLE TYPE ▯ Auger Grab ▩ Auger Cuttings

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-13

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
238.5	11			- Hard drilling below 11.28 m.		20 40 60	20 40 60 80
				AUGER REFUSAL AT 11.43 m.			
238	12	40		Notes: 1. Water level at 8.1 m below ground level at end of drilling. 2. Sample S5 taken from spun up auger cuttings. 3. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.			
237	13						
		45					
236	14						
235	15	50					
234	16						
		55					

SAMPLE TYPE Auger Grab Auger Cuttings

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-14**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 249.31 m
TOP OF PVC ELEV.
DATE DRILLED 9/14/2011
UTM (m) N 5,715,827
E 519,336

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249.1				**TOPSOIL**					
249				**SILT TILL** - Tan, damp, firm, non plastic, trace clay, trace medium to coarse grained sand, trace fine grained gravel.					
	1								
248		5				S1			
	2								
247									
	3	10				S2			
246									
	4			- Boulder/Cobble or gravel seam at 5.79 m.					
245		15				S3			
	5			- Brown/Grey below 4.57 m.					
244									
	6	20				S4			
243									
	7								
242		25							
	8								
241									
	9	30							
240									
	10								
239		35							
	11			- Hard drilling below 10.97 m.					
238									

SAMPLE TYPE Auger Grab Auger Cuttings

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-14

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
237	12	40							
	13			- Grey, moist to wet silt, trace gravel from 12.8 m to 13.41 m.		S5			
236		45							
	14								
235									
	15	50		- Wet at 15.24 m.					
234									
	16								
233									
232.8		55		**AUGER REFUSAL AT 16.46 m.**					
	17			Notes: 1. Water level at 9.6 m below ground level at end of drilling. 2. Sample S5 taken from spun up cuttings. 3. Test hole sloughed to 14.1 m at end of drilling. 4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.					
232									
	18	60							
231									
	19								
230		65							
	20								
229									
	21	70							
228									
	22								
227									
	23	75							
226									
	24								
225		80							
	25								
224									
	26	85							

SAMPLE TYPE Auger Grab Auger Cuttings

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-15**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 248.49 m
TOP OF PVC ELEV.
DATE DRILLED 9/15/2011
UTM (m) N 5,715,855
E 519,505

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.3				**TOPSOIL**				
248				**SILTY CLAY** - Brown, damp, firm to stiff, trace coarse grained sand, trace silt pockets (up to 10 mm Ø).				
247.9				**SILT TILL** - Tan/Grey, moist, soft, non plastic, some subangular gravel (up to 15 mm Ø), trace medium to coarse grained sand.				
	1			- 100 mm thick silty clay seam at 1.22 m.	S1			
247		5		- Increased medium grained gravel (up to 25 mm Ø) at 1.52 m, some clay. Decreased clay content below 1.52 m.				
	2							
246					S2			
	3	10						
245								
	4				S3			
244		15		- Grey/Tan below 4.57 m.				
	5							
243								
	6	20			S4			
242								
	7							
241		25						
	8							
240								
	9	30						
239								
	10							
238								
237.7		35			S5			
	11			**AUGER REFUSAL AT 10.82 m.**				
237								

Notes:
1. Test hole dry at end of drilling.
2. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-16**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 248.95 m
TOP OF PVC ELEV.
DATE DRILLED 9/15/2011
UTM (m) N 5,715,835
E 519,595

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.9				**TOPSOIL**				
				SILT TILL - Tan, damp, soft to firm, non to low plastic, some medium to coarse grained sand, some fine grained gravel (up to 15 mm Ø).				
248	1	5			S1			
247	2			- Moist, increased fine grained gravel below 1.83 m.				
246	3	10			S2			
245	4							
		15			S3			
244	5			- Grey/Brown, damp to moist below 4.57 m.				
243	6	20			S4			
242	7							
		25						
241	8							
240	9	30						
239	10			- Hard drilling below 10.06 m.				
		35						
238.0	11			**AUGER REFUSAL AT 10.97 m.**				
237				Notes: 1. Water level at 10.85 m below ground level at end of drilling.				

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-16

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
		40		2. Some water entering test hole from 1.83 m.			
236	13			3. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.			
		45					
235	14						
		50					
234	15						
		55					
233	16						
		60					
232	17						
		65					
231	18						
		70					
230	19						
		75					
229	20						
		80					
228	21						
		85					
227	22						
226	23						
225	24						
224	25						
223	26						

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-17**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 248.35 m
TOP OF PVC ELEV.
DATE DRILLED 9/15/2011
UTM (m) N 5,715,843
E 519,721

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.3				**TOPSOIL**					
248				**CLAYEY SILT TILL** - Tan, damp, soft to firm, low to intermediate plasticity, trace fine grained gravel (up to 20 mm Ø), trace medium to coarse grained sand.					
	1			- 25 mm Ø fine grained sand pocket at 0.45 m.					
				- 300 mm thick, brown, firm to stiff, silty clay seam at 0.61 m.					
247		5				S1			
				- Decreased plasticity, increased fine to medium grained gravel (up to 25 mm Ø) below 1.52 m.					
	2								
246						S2			
	3	10							
245				- Moist below 3.35 m.					
	4								
244		15				S3			
				- Grey/Tan below 4.88 m.					
	5								
243									
						S4			
	6	20							
242									
	7								
241		25							
	8								
240				- Hard drilling between 8.23 m and 8.84 m.					
	9	30							
239									
	10					S5			
238.0				**AUGER REFUSAL AT 10.36 m.**					
238		35							
	11			Notes: 1. Water level at 9.99 m below ground level at end of drilling. 2. Water level at 0.93 m below ground level after 24 hours.					
237									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-17

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
				3. Water entering test hole at 9.15 m. 4. Test hole backfilled with mix of bentonite chips and auger cuttings to surface after 24 hours.				20 40 60	20 40 60 80
236	12	40							
235	13	45							
234	14								
233	15	50							
232	16	55							
231	17								
230	18	60							
229	19								
228	20	65							
227	21	70							
226	22								
225	23	75							
224	24	80							
	25								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-18**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 248.22 m
TOP OF PVC ELEV.
DATE DRILLED 9/15/2011
UTM (m) N 5,715,840
E 519,792

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
248.1				**TOPSOIL**						
248				**CLAYEY SILT TILL** - Tan, dry to damp, firm, low plasticity, some medium to coarse grained sand, trace fine grained gravel (subangular, up to 20 mm Ø).						
	1					S1				
247		5								
	2			- Decreased plasticity, increased gravel below 2.13 m.						
246						S2				
	3	10								
245										
	4					S3				
244		15								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-18

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
243				- Increased sand and medium grained gravel (up to 35 mm Ø) below 5.03 m.				20 40 60	20 40 60 80
						S4			
	6	20							
242									
	7								
241									
		25							
	8			- Hard drilling, grey, dry to damp, soft, crumbly silt and gravel below 7.92 m.					
240									
	9								
		30							
239									
238.3				**AUGER REFUSAL AT 9.91 m.**					
	10			Notes: 1. Test hole dry at end of drilling. 2. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.					
238									
		35							

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-19**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger & HQ Core Barrel

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.34 m**
TOP OF PVC ELEV.
DATE DRILLED **9/15/2011**
UTM (m) N **5,715,911**
E **519,951**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
248.2				**TOPSOIL**					
248				**CLAYEY SILT TILL (CL-ML)** - Tan, damp, firm, non to low plastic, some medium to coarse grained sand, trace fine grained gravel.	S1				
	1			- 100 mm thick clay seam, stiff, with gravel and sand at 1.22 m.					
247									
246.8		5		**SILT TILL(ML)** - Tan, damp, firm, non plastic, some medium to coarse grained sand, some trace below 2.44 m.					
	2				S2				
246									
	3	10							
245									
	4				S3				
244		15							

SAMPLE TYPE: Auger Grab | Core Barrel | Grab from Double Tube Core Barrel Recovered Core

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-19

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
243								20 40 60	20 40 60 80
						S4			
	6	20							
242									
						S5			
						R1	37		
	7			- Grey, very stiff, increased limestone cobbles and boulders below 7.24 m. Switched to HQ coring.					
241		25							
	8					R2	83		
240									
						S7			
	9	30							
239									
						R3	100		
	10								
238									
		35				S8			

SAMPLE TYPE Auger Grab | Core Barrel | Grab from Double Tube Core Barrel Recovered Core

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-19

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
237	11					R4	100
	12	40				S9	
236						S10	
235.8				**LIMESTONE BEDROCK** - Pale yellow, moderately fractured. 12.57 to 13.89 m - 13 joints in first run into limestone (R5), mostly horizontal, generally planar to irregular, partly open, trace weathered, trace stained, 65% RQD.		R5	100
235	13	45					
	14			13.89 to 14.94 - 7 joints in second run into limestone (R2), two vertical, 5 horizontal, partly open, trace weathered, trace stained, 45% RQD.		R6	100
234							
233.4	15	50		**END OF HOLE IN BEDROCK AT 14.94 m.**			
233				Notes: 1. Water level in solid stem auger hole at 6.35 m at end of drilling, before coring began. 2. Coring runs R1 to R4 generally contained dense basal till, grey, damp, very stiff to hard, non-plastic, with intermittent limestone boulders and cobbles. 3. Test hole backfilled with grout/cement mix.			
	16						
232		55					

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab | Core Barrel | Grab from Double Tube Core Barrel Recovered Core

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TH11-20**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route E
LOCATION Adjacent to the Fairford River
DRILLING METHOD 125 mm ø Solid Stem Auger

KGS JOB NO. 11-0300-18
AECOM JOB NO. 60212781
GROUND ELEV. 248.10 m
TOP OF PVC ELEV.
DATE DRILLED 9/15/2011
UTM (m) N 5,715,903
E 520,051

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %
248				**TOPSOIL**	
247.9				**CLAYEY SILT** - Tan, damp, firm, non to low plastic, some medium to coarse grained sand, trace fine grained gravel.	
247.0	1			**SILTY CLAY** - Brown, damp, stiff, intermediate to high plasticity, some sand, trace gravel, some silt pockets.	S1
246.6		5		**CLAYEY SILT TILL** - Tan, damp, firm, non to low plastic, some medium to coarse grained sand, trace fine grained gravel.	
246	2				S2
245	3	10			S3
244	4				
		15			

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO.
TH11-20

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
243				- Dry to damp, soft below 5.18 m.	S4	20 40 60	20 40 60 80
242	6	20					
				- Increased coarse grained sand and gravel below 6.4 m.			
241	7	25					
240	8						
239	9	30		**AUGER REFUSAL AT 9.15 m**			
238	10	35					

Notes:
1. Water level at 8.78 m at end of drilling.
2. Water entering test hole at 4.57 m and 7.62 m.
3. Test hole backfilled with mix of bentonite chips and auger cuttings to surface.

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. ROBAK	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NE-4-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **254.08 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,711,151**
E **523,240**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
254				**TOPSOIL**		20 40 60	20 40 60 80
253.9				**SILTY CLAY** - Brown, moist, firm to stiff.			
253	1						
252.9				**SILT TILL** - Grey, trace cobbles, trace boulders, trace clay.			
		5					
252	2						
		10					
251	3						
250	4						
		15					
249	5						
248.3				**REFUSAL ON SUSPECTED BEDROCK AT 5.82 m.**			
248	6	20		Note: 1. Seepage at 1.22 m from bog near test hole.			

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B10**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B

LOCATION In quarter section SW-8-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.00 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,146**
E **520,850**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
254.8				**TOPSOIL** - Rootlets.
				SILT TILL - Light grey, dense, some sand, trace clay.
254	1			
		5		- Light brown, some cobbles, some boulders below 1.12 m.
253	2			**REFUSAL ON SUSPECTED BEDROCK AT 2.03 m.**
252	3	10		
251	4			
		15		
250	5			
249	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B11**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B

LOCATION In quarter section NW-5-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **254.40 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,147**
E **520,637**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
254.2				**TOPSOIL**
254				**SILT TILL** - Brown, clayey, trace sand, trace cobbles.
253.9				- Light grey below 0.46 m.
				REFUSAL ON BEDROCK AT 0.53 m.
253	1	5		
252	2			
251	3	10		
250	4	15		
249	5			
248	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B12**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section SE-7-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **253.36 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,155**
E **520,458**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
253.2				**TOPSOIL**		20 40 60	20 40 60 80
253				**SILT TILL** - Light grey, some sand, some cobbles, some boulders, seeping at surface.			
	1						
252		5					
	2						
251							
250.8				**REFUSAL ON SUSPECTED BEDROCK OR BOULDERS AT 2.51 m.**			
				Note: 1. Water seeping into test pit from surface.			
	3	10					
250							
	4						
249		15					
	5						
248							
	6	20					
247							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B13**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NW-6-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **252.27 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,156**
E **519,543**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
252.1				**TOPSOIL** - Black.		20 40 60	20 40 60 80
252				**SILTY CLAY** - Grey, moist, firm.			
251.5	1	5		**SILT TO SILTY CLAY TILL** - Light grey, firm, low to intermediate plasticity, trace sand, trace boulders, trace cobbles.			
251							
250	2						
249.5				**REFUSAL ON SUSPECTED BEDROCK AT 2.74 m.**			
249	3	10		Notes: 1. Seepage noted at 1.22 m. 2. Suspected bedrock orange at surface, easily broken. 3. Creek located adjacent to TP-B13.			
248	4	15					
247	5						
246	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B14**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section SW-7-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **252.31 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,372**
E **519,250**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
252.1				**TOPSOIL** - Black, organics.
252				**CLAYEY TILL** - Grey, moist, stiff, trace sand, trace gravel, rootlets.
251.7				**SILT TILL** - Trace cobbles, trace sand, trace clay.
251	1	5		
250	2			- Boulders below 1.83 m.
249	3	10		
248.1	4			- Large boulders below 3.96 m.
248		15		**REFUSAL ON SUSPECTED BEDROCK OR BOULDERS AT 4.19 m.**
247	5			
246	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B15**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section SW-7-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **251.69 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,666**
E **519,028**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
251.4				**TOPSOIL** - Black, rootlets.
				SILTY CLAY - Light grey, moist, firm to soft, trace sand.
251				
250.8				- Light brown, becoming soft below 0.76 m.
	1			**SILT TILL** - Clayey.
250.2		5		- Trace cobbles below 1.52 m.
250				**SANDY SILT TILL** - Light brown, moist, some sand, some cobbles, some boulders.
	2			- Seepage at 1.98 m.
249.4				**REFUSAL ON BEDROCK AT 2.31 m.**
249				Note: 1. Bedrock flat at base of hole.
	3	10		
248				
	4			
		15		
247				
	5			
246				
	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B16**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NE-12-30-10
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.18 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,712,076**
E **518,730**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
250				
249.9				**TOPSOIL** - Black, organics, rootlets.
				CLAY TILL - Grey, moist, stiff, some silt, some sand, some gravel.
249.4				- Dark grey layer at 0.61 m.
	1			**SILTY CLAY TILL** - Light grey, moist, stiff, trace boulders.
249		5		
248.5				**REFUSAL ON SUSPECTED BEDROCK AT 1.70 m.**
	2			Notes:
248				1. Seepage at 1.07 m.
				2. Water at base of hole after excavating rock.
	3	10		
247				
	4			
246		15		
	5			
245				
	6	20		
244				

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B

LOCATION In quarter section NW-4-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.91 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,711,150**
E **522,741**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
256.8				**TOPSOIL** - Rootlets, organics.
				SAND TILL - Grey, moist, non to low plasticity, some clay, trace oxides, some cobbles with depth.
256	1			
255.7				**SILT TILL** - Grey, damp to moist, trace boulders.
		5		
255	2			- Damp, some cobbles, some boulders, trace clay below 2.03 m.
254.1				**LIMESTONE BEDROCK**
254	3	10		
253.3				**REFUSAL ON BEDROCK AT 3.58 m.**
253	4			Note: 1. Bedrock slopes in test pit - 2.80 m deep at high point sloping to 3.58 m deep at low spot.
		15		
252	5			
251	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B3**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NE-5-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.30 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,150**
E **522,242**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
256.2				**TOPSOIL** - Black, rootlets.					
256				**SILT TILL** - Brown, moist, some clay, some cobbles, gravelly.					
255.7									
255.6				**BEDROCK**					
				REFUSAL ON BEDROCK AT 0.69 m.					
	1			Note: 1. Bedrock flat on base of hole.					
255		5							
	2								
254									
	3	10							
253									
	4								
252		15							
	5								
251									
	6	20							
250									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B4**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B

LOCATION In quarter section NE-5-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.01 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,150**
E **522,190**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
255.9				**TOPSOIL** - Black, organics.						
				SILT TILL - Some clay, some gravel, trace sand.						
255.4				**REFUSAL ON BEDROCK AT 0.56 m.**						
				Note: 1. Bedrock flat at base of hole.						
255	1	5								
254	2									
253	3	10								
252	4									
		15								
251	5									
250	6	20								

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B5**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B

LOCATION In quarter section NE-5-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.63 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,142**
E **522,028**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
256.4				**TOPSOIL** - Rootlets.
256.3				**GRANULAR FILL** - 5-10 mm diameter, some sand.
				SILT TILL - Damp to moist, some clay, trace cobbles, trace boulders.
256	1			
255.3				**REFUSAL ON BEDROCK AT 1.35 m.**
255		5		
	2			
254				
	3	10		
253				
	4			
252		15		
	5			
251				
	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B6**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NE-5-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.73 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,150**
E **521,858**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
256.5				**TOPSOIL** - Black.		20 40 60	20 40 60 80
				SILT TILL - Grey, some sand, some clay, trace cobbles, trace boulders.			
256	1	5					
255	2						
254							
253.9	3	10		**REFUSAL ON SUSPECTED BEDROCK AT 2.84 m.**			
253	4						
252		15					
	5						
251							
	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B7**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NW-5-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.40 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,148**
E **521,449**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
256.2				TOPSOIL
256				SILT TILL
255.7				REFUSAL ON BEDROCK AT 0.69 m.
255	1	5		
254	2			
253	3	10		
252	4			
251	5	15		
250	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B8**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route B
LOCATION In quarter section NW-5-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **256.79 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,148**
E **521,351**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆	PL MC LL %
256.7				**TOPSOIL**						
				SILT TILL						
256	1			- Boulders below 0.91 m.						
255.5				**LIMESTONE BEDROCK**						
255.3		5		**REFUSAL ON BEDROCK AT 1.52 m.**						
255	2			Notes: 1. Bedrock excavated from 1.30 m to 1.52 m. 2. Bedrock outcrops noted at surface near TP-B08.						
254	3	10								
253	4									
		15								
252	5									
251	6	20								

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-B9**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route B

LOCATION In quarter section NW-5-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **257.49 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,711,147**
E **521,223**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80)	PL MC LL % (20 40 60 80)
257.4				**TOPSOIL**						
				SILT TILL - Grey, dry, low plasticity, some cobbles.						
257	1									
256		5		**BOULDERS** - Grey, dense, and silt.						
	2									
255.3				**REFUSAL ON BEDROCK AT 2.21 m.**						
255										
	3	10								
254										
	4									
253		15								
	5									
252										
	6	20								
251										

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SW-18-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.62 m**
TOP OF PVC ELEV.
DATE DRILLED **7/4/2011**
UTM (m) N **5,713,255**
E **519,151**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249.2	0	0		**TOPSOIL** - Dark brown, organic-rich, with roots.
249	1	5		**SILT TILL** - Light grey, moist, slightly oxidized, low plasticity, trace clay.
248	2			- Large boulders below 1.5 m.
247.5				**BASAL TILL** - Dense, some limestone fragments, some cobbles, some boulders, subround.
247	3	10		**END OF HOLE IN SUSPECTED BASAL TILL AT 3.1 m.**
246.5				
246	4	15		
245	5			
244	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	J. BURNS	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C10**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SW-16-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.85 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,713,044**
E **522,929**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
255.6				**TOPSOIL**					
				REFUSAL ON BEDROCK AT 0.25 m.					
255	1								
		5							
254	2								
253	3	10							
252	4								
		15							
251	5								
250	6	20							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C11**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SE-16-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.49 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,713,059**
E **523,126**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
255.4				TOPSOIL				20 40 60	20 40 60 80
				REFUSAL ON BEDROCK AT 0.08 m.					
255	1	5							
254	2	10							
253	3	15							
252	4	20							
251	5								
250	6								
249									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C12**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SE-16-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.58 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,712,832**
E **523,364**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
255.4				TOPSOIL					
				SILT TILL					
255									
254.8				REFUSAL ON BEDROCK AT 0.76 m.					
254	1	5							
253	2								
252	3	10							
251	4	15							
250	5								
	6	20							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C13**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route C
LOCATION In quarter section NE-9-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **254.95 m**
TOP OF PVC ELEV.
DATE DRILLED **7/7/2011**
UTM (m) N **5,712,363**
E **523,681**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
254.7				**TOPSOIL** - Black, rootlets.					
				GRAVEL - Some sand.					
254.5				**SILT TILL** - Grey, damp, dense, trace cobbles, trace boulders, trace clay.					
				- Dry below 0.61 m.		G1			
254	1								
		5							
253	2								
252									
251.9	3	10		- Becoming orange below 3.05 m.					
				REFUSAL ON BEDROCK AT 3.07 m.					
251	4								
		15							
250	5								
249	6	20							

SAMPLE TYPE ⋈ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C14**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section NW-10-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **254.23 m**
TOP OF PVC ELEV.
DATE DRILLED **7/7/2011**
UTM (m) N **5,711,996**
E **523,908**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
254.0				**TOPSOIL** - Black, rootlets.					
254				**SILT** - Grey, moist, loose to compact, some clay, trace sand.					
253.2	1			**SILT TILL** - Grey, dry, dense.		G2			
253				- Some cobbles, some boulders, trace clay below 1.22 m.					
		5							
252	2								
		10							
250.9	3			**REFUSAL ON BEDROCK AT 3.28 m.**					
250	4								
		15							
249	5								
		20							
248	6								

SAMPLE TYPE ⋈ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C15**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SW-10-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **253.39 m**
TOP OF PVC ELEV.
DATE DRILLED **7/7/2011**
UTM (m) N **5,711,548**
E **524,057**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
253.2				**TOPSOIL** - Black, rootlets.				20 40 60	20 40 60 80
253				**SILT TILL** - Grey, moist, dense to compact, some sand, trace gravel, trace clay.					
	1								
252		5		- Light brown, dry, silt, increasing boulders and cobbles with depth below 1.22 m.					
	2								
251				- Seepage at 2.44 m.					
	3	10							
250									
	4								
249									
248.7		15		**REFUSAL ON SUSPECTED BOULDERS AT 4.70 m.**					
	5								
248									
	6	20							
247									

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route C
LOCATION In quarter section SW-18-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.63 m**
TOP OF PVC ELEV.
DATE DRILLED **7/4/2011**
UTM (m) N **5,713,278**
E **519,619**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.3				**TOPSOIL** - Dark brown, wet, soft, organic-rich.
248				**SILT** - Light grey, moist to wet, soft.
247.7	1	5		**SILTY CLAY** - Brown silty clay interlayed with light grey silt layers up to 15 cm thick.
247.0	2			**CLAYEY SILT TILL** - Light brown, moist to wet, some stones, occassional boulders.
246				
245	3	10		
	4			- Water at 4 m.
244.2				**BASAL TILL** - Oxidized sand, gravel, and cobbles, boulders (some rounded) of varying composition.
244.1		15		**REFUSAL ON SUSPECTED BEDROCK AT 4.5 m.**
244	5			Note: 1. Oxidized limestone fragments were observed at base of hole.
243	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	J. BURNS	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C3**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route C
LOCATION In quarter section SE-18-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.01 m**
TOP OF PVC ELEV.
DATE DRILLED **7/4/2011**
UTM (m) N **5,713,257**
E **520,176**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.8				**TOPSOIL** - Dark brown, damp, organic-rich, clayey silt.
248.1				**SILT** - Light grey, moist to wet, soft, loose, trace clay.
248	1			**SILTY CLAY TILL** - Brown, wet, intermediate plasticity, with cobbles.
		5		
247.3				**REFUSAL ON BEDROCK AT 1.7 m.**
247	2			Notes: 1. Bedrock observed as limestone, white with oxidized areas. 2. Water seepage observed along bedrock surface.
246	3	10		
245	4			
		15		
244	5			
243	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	J. BURNS	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C4**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SE-18-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.85 m**
TOP OF PVC ELEV.
DATE DRILLED **7/4/2011**
UTM (m) N **5,713,245**
E **520,525**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249.7				**TOPSOIL** - Dark brown, organic-rich, peaty.		20 40 60	20 40 60 80
				SILT - Light brown, moist to wet, low plasticity, some stones, trace clay.			
249	1						
248.3		5		**SILT TILL** - Light brown, very stoney, with boulders.			
248	2						
247	3	10					
246	4						
		15					
245							
244.8	5			**REFUSAL ON SUSPECTED BOULDER AT 5.03 m.**			
244	6	20		Note: 1. Some wall caving encountered during excavation.			

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	J. BURNS	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C5**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route C
LOCATION In quarter section SW-17-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **252.02 m**
TOP OF PVC ELEV.
DATE DRILLED **7/6/2011**
UTM (m) N **5,713,242**
E **521,135**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
251.9				**TOPSOIL**
				SILTY CLAY - Grey, dry, firm.
251.6				
				SILT - Dry, loose to compact.
251.1				
251	1			**REFUSAL ON BEDROCK AT 0.91 m.**
		5		
250	2			
		10		
249	3			
248	4			
		15		
247	5			
		20		
246	6			

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C6**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SE-17-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **252.75 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,713,212**
E **521,670**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
252.6				**TOPSOIL**		20 40 60	20 40 60 80
				CLAYEY SILT TO SILT - Stiff, damp.			
252	1						
		5					
250.9				**SILT TILL** - Some boulders.			
	2			- Boulder content increasing with depth.			
250							
	3	10		- Dry, some cobbles below 3.05 m.			
249							
	4						
248.3				**REFUSAL ON SUSPECTED BEDROCK AT 4.47 m.**			
		15					
248							
	5						
247							
	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C7**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route C
LOCATION In quarter section SE-17-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.23 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,713,156**
E **522,225**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
255.1				**TOPSOIL**
255				**SILT** - Moist, stiff, some clay to clayey, some sand, trace gravel.
254.6				**SILT TILL** - Moist, compact, some sand, trace to some gravel, trace clay.
254	1	5		- Some boulders below 1.22 m. - Boulder content increases with depth.
253	2			
252.3	3	10		**REFUSAL ON SUSPECTED BEDROCK AT 2.95 m.**
252				
251	4	15		
250	5			
249	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C8**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route C
LOCATION In quarter section SW-16-30-09
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.55 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,713,126**
E **522,484**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
255.4				**TOPSOIL** - Dark brown, damp, organic-rich silty soil.
				CLAYEY SILT TILL - Grey, damp to moist, low plasticity, some small stones, trace cobbles.
255				
254.6	1			**BASAL TILL** - Orange/brown, dense, some gravel, some cobbles, some boulders up to 40 cm.
254		5		
	2			
253.3				**REFUSAL ON BEDROCK AT 2.21 m.**
253				Note: 1. Slow water seepage into hole at till-bedrock interface.
	3	10		
252				
	4			
251		15		
	5			
250				
	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	J. BURNS / M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-C9**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route C

LOCATION In quarter section SW-16-30-09

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **255.68 m**
TOP OF PVC ELEV.
DATE DRILLED **7/5/2011**
UTM (m) N **5,713,149**
E **522,774**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
255	1	5		**BEDROCK ENCOUNTERED AT SURFACE**		20 40 60	20 40 60 80
254	2						
253	3	10					
252	4						
251	5	15					
250	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D1**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SE-9-29-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **246.34 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,702,265**
E **533,146**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
246.0				**TOPSOIL** - Rootlets.			
246				**SILT** - Grey, dry, dense to compact, non-plastic, trace gravel.			
	1						
245.2				**SILT TILL** - Trace cobbles, some clay.			
245		5					
	2			- Grey, dry, with boulders, with cobbles below 2.13 m.			
244							
	3	10		- Moist, large boulders, trace clay below 3.35 m.			
243				- Intermediate plasticity below 3.66 m.			
242.2	4			**REFUSAL ON BEDROCK AT 4.09 m.**			
242		15					
	5						
241							
	6	20					
240							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D10**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-20-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.01 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,695,820**
E **530,985**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.8				**TOPSOIL** - And silt, some rootlets.
				SILT - Brown, damp, firm, non-plastic.
248.4				**SILT TILL** - Grey, moist, some clay, some boulders, some cobbles.
248	1			
		5		
247	2			- Moist, firm to stiff, large boulders, some gravel below 1.83 m.
246	3	10		
245	4			
		15		
244	5			
243.5				**END OF HOLE IN SILT TILL AT 5.51 m.**
				Note: 1. No seepage observed.
243	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D11**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-20-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.54 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,695,811**
E **531,280**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.3				**TOPSOIL** - Black.		20 40 60	20 40 60 80
248				**SILT TO SILTY CLAY TILL** - Intermediate plasticity, some clay, some sand, trace gravel.			
	1						
247		5		- Some boulders and cobbles below 1.52 m.			
	2						
246							
	3	10		- Increasing boulders and cobbles with depth below 3.05 m.			
245				- Seepage at 3.66 m.			
	4			- Sloughing below 3.96 m.			
244		15					
	5						
243 242.9				**END OF HOLE IN SILT TO SILTY CLAY TILL AT 5.61 m.**			
	6	20		Notes: 1. Seepage observed at 3.66 m. 2. Test pit sloughing below 3.96 m during excavation.			

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D12**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-20-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.98 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,695,034**
E **531,118**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.8				**TOPSOIL** - Black, organics, rootlets.		20 40 60	20 40 60 80
				SILTY CLAY - Dark grey, moist, firm, intermediate to high plasticity, trace to some clay.			
248.2				**SILT TO SANDY SILT TILL** - Light grey, moist, firm, trace clay.			
248	1			- Dark grey, moist, stiff, sandy, trace clay below 1.22 m.			
		5					
247	2			- Boulders and cobbles below 1.83 m.			
246	3	10		- Seepage at 3.66 m.			
245	4						
		15					
244	5						
243.7				**END OF HOLE IN SILT TO SANDY SILT TILL AT 5.26 m.**			
243	6	20		Notes: 1. Seepage observed at 3.66 m. 2. Caving of test pit wall below 2.94 m during excavation.			

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D13**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-17-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.82 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,694,266**
E **531,115**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.7				**TOPSOIL** - Black, silty, rootlets.					
				SILT - Light grey, moist, firm, oxides, trace sand, trace clay.					
248.2				**SILTY SAND** - Light brown, moist, compact, medium grained.					
248									
247.9	1			**CLAY TILL** - Grey, some silt, some sand.					
		5							
247	2								
246.4				**SILT TO SILTY CLAY TILL** - Light grey, wet, compact, low to intermediate plasicity, some boulders, some cobbles, trace silt, trace sand.					
246									
	3	10							
245									
	4								
		15							
244									
	5			- Seepage at 4.88 m.					
243.4				**END OF HOLE IN SILT TO SILTY CLAY TILL AT 5.41 m.**					
				Note: 1. Seepage observed at 4.88 m.					
243	6	20							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D14**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-17-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.92 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,694,378**
E **530,760**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.7				**TOPSOIL** - Black, rootlets.
				SILT TILL - Light grey, moist to damp, some sand, trace to some clay, trace gravel.
248	1			
		5		- Increased boulders and cobbles below 1.52 m.
247	2			
246	3	10		
245	4			
		15		
244.0				**END OF HOLE IN SILT TILL AT 4.88 m.**
244	5			
243	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D15**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NE-7-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.99 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,693,341**
E **530,349**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.8				**TOPSOIL** - Black, rootlets.
				SILTY CLAY - Grey, moist, firm, intermediate plasticity, some sand.
248.1				
248	1			**SILT TO SILTY CLAY TILL** - Grey, intermediate plasticity, some boulders, some cobbles.
		5		
247	2			
246	3	10		
245	4			- Wet, soft below 3.96 m.
		15		
244	5			
243.3				**END OF HOLE IN SIL TO SILTY CLAY TILL AT 5.66 m.**
243	6	20		Note: 1. No seepage observed.

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D16**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NE-7-28-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.34 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,692,581**
E **530,406**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249.1				**TOPSOIL** - Black, silty.
249				**CLAYEY SILT** - Light grey, moist, stiff, some sand, cobbles.
248.7				**SILT TILL** - Some clay, some sand.
	1			- Light brown, wet, soft, trace boulders, trace cobbles below 0.91 m.
248		5		
				- Moist below 1.83 m.
	2			
247				
	3	10		
246				
	4			
245		15		
	5			- Grey below 4.88 m.
244.1				**END OF HOLE IN SILT TILL AT 5.21 m.**
244				
	6	20		
243				

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D17**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NE-6-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.27 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,691,755**
E **530,337**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249.1				**TOPSOIL** - Black, organics, rootlets.
249				**SILT** - Light grey, moist, firm, non-plastic, trace sand.
248.4				
248	1	5		**SILT TO SILTY CLAY TILL** - Grey, some boulders, some cobbles.
247	2			- Moist, some clay to clayey, low plasticity below 1.83 m.
246	3	10		- Non-plastic, with cobbles, with boulders below 3.05 m.
245	4	15		- Intermediate plasticity, large boulder at 4.57 m.
244	5			
243.6				**END OF HOLE IN SILT TO SILTY CLAY TILL AT 5.72 m.**
243	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D18**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-5-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.80 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,691,130**
E **530,841**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.6				**TOPSOIL** - Black.
				SILT - Light grey, moist, firm, trace clay.
248	1			
247.6				**SILT TILL** - Some oxides, trace clay, trace gravel.
		5		
247	2			- Brown, moist to wet, some cobbles, some boulders, some gravel below 1.83 m.
246	3	10		
245	4			- Grey, moist to wet, stiff below 3.96 m.
		15		
244	5			- Low to intermediate plasticity, some clay below 5.18 m.
243.0				**END OF HOLE IN SILT TILL AT 5.79 m.**
243	6	20		Note: 1. No seepage observed.

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D19**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NE-6-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.30 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,690,985**
E **530,435**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
249.1				**TOPSOIL** - Black.		20 40 60	20 40 60 80
249				**SILT** - Brown, moist, firm, low to intermediate plasticity, trace clay.			
	1						
248							
247.8		5		**SILT TO SILTY CLAY TILL** - Grey, moist to wet, firm, intermediate plasticity, some sand, trace clay, trace gravel, trace cobbles, trace oxides.			
	2						
247							
	3	10					
246							
	4						
245		15					
	5						
244							
243.5				**END OF HOLE IN SILT TO SILTY CLAY TILL AT 5.82 m.**			
	6	20		Note: 1. No seepage observed.			
243							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D2**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-9-29-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **247.03 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,701,548**
E **532,835**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
247				**TOPSOIL** - Black, rootlets.
246.7				**SILT** - Grey, moist, compact, intermediate plasticity, some sand.
246	1			
245.8				**SILT TILL** - Dark grey, moist, some clay, trace gravel, trace sand.
		5		
245	2			
		10		
244	3			
243	4			- Seepage, boulders, trace cobbles below 3.96 m.
242.5		15		**END OF TEST HOLE IN SILT TILL AT 4.52 m.**
242	5			
241	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D20**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-32-27-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.15 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,690,136**
E **530,572**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
249				**TOPSOIL** - Black, rootlets.
248.7				**SILT** - Grey, moist, firm, some clay, trace oxides.
				SILT TILL - Brown, moist, firm, some clay, trace sand, trace gravel, trace oxides.
248	1	5		- Grey, non-plastic to low plasticity, some boulders, some cobbles below 1.22 m.
247	2			
	3	10		
246				
	4			
245		15		
	5			- Sloughing below 5.18 m.
244				
243.7				**END OF HOLE IN SILT TILL AT 5.43 m.**
	6	20		Note: 1. Sloughing observed at base of test pit during excavation.
243				

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D21**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-32-27-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.78 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,689,345**
E **530,684**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.6				**TOPSOIL** - Black, rootlets.
				SILT - Grey, moist, firm, low plasticity to non-plastic, trace clay, trace oxides.
248	1			
247.6				**SILT TILL** - Brown, moist, firm to stiff, some sand, trace clay, trace gravel.
		5		- Some boulders, some cobbles below 1.52 m.
247				- Stiff below 1.83 m.
	2			
				- Boulders and cobbles below 2.44 m.
246				
	3	10		
245				
	4			- Grey, moist below 3.96 m.
		15		
244				
	5			
243.4				**END OF HOLE IN SILT TILL AT 5.41 m.**
243				
	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D22**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-32-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.52 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,689,063**
E **530,602**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.4				**TOPSOIL** - Black.
				SILT - Grey, moist, firm, intermediate plasticity, trace clay.
248				
247.9				**SILT TO SILTY CLAY TILL** - Brown, moist, firm, intermediate plasticity, some oxides, trace gravel.
	1			
247		5		- Stiff, some sand, some gravel below 1.52 m.
				- Boulders and cobbles below 1.83 m.
	2			
246				
	3	10		
245				
	4			
244		15		- Firm to stiff below 4.57 m.
	5			
243.1				**END OF HOLE IN SILT TILL AT 5.43 m.**
243				
	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D23**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-29-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **249.01 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,687,984**
E **530,797**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.8				**TOPSOIL** - Black, rootlets.
				SILT - Dark grey, moist, soft to firm, trace clay.
248	1			- Light grey, moist, firm, low plasticity, some clay, some sand below 1.07 m.
247.5		5		**SILT TILL** - Brown, moist, stiff, some sand, some gravel.
247	2			- Boulders and cobbles below 1.83 m.
246	3	10		
245	4			
		15		- Grey, moist, very stiff below 4.57 m.
244	5			
243.6				**END OF HOLE IN SILT TILL AT 5.43 m.**
243	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D24**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-29-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.53 m**
TOP OF PVC ELEV.
DATE DRILLED **7/10/2011**
UTM (m) N **5,688,483**
E **530,554**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.3				**TOPSOIL** - Black, rootlets.
				SILT - Dark grey, moist, firm, non-plastic, trace sand.
248				
247.6				
	1			**SILT TILL** - Grey, moist, firm to stiff, some sand, trace clay, trace gravel.
247		5		
	2			- Boulders and cobbles below 1.83 m.
246				
	3	10		
245				
	4			
244		15		
	5			
243.2				**END OF HOLE IN SILT TILL AT 5.31 m.**
243				
	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D25**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-29-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,687,150**
E **530,589**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
				TOPSOIL - Black, silty.
				SILT TILL - Brown, moist, firm, some clay, trace gravel, trace sand.
	1			- Grey below 0.91 m.
		5		- Stiff, some cobbles, some boulders, trace clay below 1.52 m.
	2			
	3	10		- Moist, firm, some clay below 3.66 m.
	4			
		15		
	5			
	6	20		**END OF HOLE IN SILT TILL AT 6.04 m.**

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D26**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-29-27-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,687,092**
E **531,105**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	0	0		**TOPSOIL** - Black, rootlets.
				SILT - Brown, moist, firm, non-plastic, trace clay.
	1			**SILT TILL** - Brown, moist, firm, some sand, trace clay, trace gravel, trace oxides.
		5		- Grey, firm to stiff, non-plastic, some cobbles, some boulders below 1.22 m.
	2			
	3	10		
	4			
		15		- Low plasticity, seepage below 4.57 m.
	5			
				END OF HOLE IN SILT TILL AT 5.43 m.
	6	20		Note: 1. Seepage observed at 4.57 m from south side of test hole during excavation.

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D27**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-20-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,686,768**
E **531,358**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	0	0		**TOPSOIL** - Black.
				SILT - Grey, moist, firm, intermediate plasticity, some clay.
				SILT TILL - Grey, moist, firm, low to intermediate plasticity, some clay, trace to some gravel, trace sand, trace oxides.
	1	5		- Brown below 1.52 m.
	2			- Some boulders, some cobbles below 1.83 m.
	3	10		- Grey below 3.05 m.
	4	15		
	5			**END OF HOLE IN SILT TILL AT 4.93 m.**
	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

Notes:
1. Seepage observed at 3.66 m during excavation.
2. Sloughing observed at base of excavation.
3. TP-D27 was adjacent to a marsh/bog.

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D28**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NW-20-27-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,686,449**
E **530,616**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
				TOPSOIL - Black, organics.		20 40 60	20 40 60 80
				SILTY CLAY - Brown, moist, firm to soft, intermediate plasticity.			
				SILT - Grey, moist, firm, some clay.			
	1			**SILT TILL** - Brown, moist, compact, trace sand, trace gravel.			
		5		- Some cobbles, some boulders below 1.52 m.			
	2						
	3	10		- Grey, trace clay below 3.66 m.			
	4						
		15					
	5						
				END OF HOLE IN SILT TILL AT 5.33 m.			
	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D29**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-20-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,685,641**
E **530,595**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
	1	5		**TOPSOIL** - Black.		20 40 60	20 40 60 80
				SILT - Grey, moist, firm, non-plastic, some sand, trace clay.			
	2	10		**SILT TILL** - Some clay, trace sand, trace gravel.			
				- Some boulders, some cobbles below 2.13 m.			
	3						
	4	15		- Grey, moist, firm, low to intermediate plasticity, and clay, trace gravel below 4.57 m.			
	5						
				END OF HOLE IN SILT TILL AT 5.64 m.			
	6	20		Note: 1. Seepage observed at 4.57 m duirng excavation.			

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D3**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-4-29-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.55 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,700,767**
E **532,318**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
248.4				**TOPSOIL**		20 40 60	20 40 60 80
				SILT - Grey, moist, soft to firm, trace sand, trace clay.			
248	1						
				- Firm below 1.32 m.			
247.0		5		**SILT TILL** - Dry, with boulders and cobbles.			
247	2						
246							
	3	10					
245				- Grey, damp, some clay, some shale below 3.66 m.			
	4						
244.2				**END OF HOLE IN SILT TILL AT 4.39 m.**			
244		15		Notes:			
	5			1. No seepage observed.			
243							
	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D30**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-20-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,685,573**
E **530,996**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	0	0		**TOPSOIL** - Black.
				SILT TILL - Grey, moist, firm, intermediate plasticity, some clay, trace sand, trace gravel.
				- Some boulders, some cobbles below 0.61 m.
	1	5		- Brown, firm to stiff, some clay below 1.83 m.
	2			
	3	10		- Grey, low plasticity to non-plastic, some to with clay below 3.66 m.
	4			
		15		
	5			
				END OF HOLE IN SILT TILL AT 5.56 m.
	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D31**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-17-27-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV.
TOP OF PVC ELEV.
DATE DRILLED **7/11/2011**
UTM (m) N **5,684,517**
E **531,289**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	0	0		**TOPSOIL** - Black.
				CLAY TILL - Grey, moist, firm, intermediate plasticity, and silt, some sand, trace gravel.
	1			
		5		**SILT TILL** - Brown, moist, firm, low plasticity to non-plastic, some to with clay, some sand, trace gravel.
	2			
	3	10		- Grey, moist to wet below 3.66 m.
	4			
		15		
	5			**END OF HOLE IN SILT TILL AT 4.88 m.**
				Note: 1. Sloughing of test pit wall below 3.66 m during excavation.
	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D4**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-4-29-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.56 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,699,991**
E **532,116**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
250.4				**TOPSOIL** - Black, rootlets.
				SILT - Grey, moist, soft, trace gravel.
250				**SILT TILL** - Grey, moist to damp, firm, trace clay.
	1			- Boulders and cobbles below 1.22 m.
249		5		- Dry, large boulders below 1.52 m.
	2			
248				
	3	10		
247.0				**REFUSAL ON BEDROCK AT 3.53 m.**
247				
	4			
246		15		
	5			
245				
	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D4a**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section SW-4-29-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.50 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,700,289**
E **532,265**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
248.4				**TOPSOIL** - Black.		20 40 60	20 40 60 80
				SILT - Grey, moist, firm, low plasticity, trace to some clay.			
248							
247.9				**SILT TILL** - Moist, trace gravel.			
	1						
247		5		- Moist, stiff, boulders and cobbles below 1.52 m.			
	2						
246							
	3	10					
245							
	4			- Moist to wet below 4.27 m.			
244							
243.8		15		**END OF TEST HOLE AT 4.65 m.**			
	5			Note: 1. No seepage observed.			
243							
	6	20					
242							

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D5**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NE-32-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.54 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,699,523**
E **532,049**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
250.4	0			**TOPSOIL** - Black.		20 40 60	20 40 60 80
				SILT - Light grey, compact, trace sand.			
250				- Trace to some clay, low plasticity below 0.61 m.			
	1						
249.3				**SILT TILL** - Some gravel, some cobbles, trace to some clay.			
249		5					
	2			- Grey, damp to moist, dense, with cobbles and boulders below 1.83 m.			
248							
	3	10		- Damp to dry below 3.05 m.			
247							
	4						
246.3				**END OF HOLE IN SILT TILL AT 4.27 m.**			
246		15		Notes: 1. Difficulty excavating below 3.05 m. 2. No seepage observed.			
	5						
245							
	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

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KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D6**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SE-32-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.00 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,698,981**
E **532,093**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER / RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
249.7				**TOPSOIL**		20 40 60	20 40 60 80
				SILTY CLAY - Grey, firm, high plasticity, trace sand.			
249	1						
				- Seepage at 1.22 m.			
248.5		5		**SILT TILL** - Grey, dense, non-plastic, some cobbles, some boulders, trace sand.			
248	2						
247	3	10		- Incresing boulders and cobbles below 3.05 m.			
246	4						
245.7				**END OF HOLE IN SILT TILL AT 4.27 m.**			
		15		Note: 1. Sloughing at bottom of hole during excavation.			
245	5						
244	6	20					

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D7**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section SW-33-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.04 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,698,264**
E **532,150**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248				**TOPSOIL** - Black, organics.
247.4				**SILT** - Light grey, moist, oxides.
247	1			
246.5		5		**SILT TILL** - Grey, moist, and gravel, some boulders, some cobbles.
246	2			
245	3	10		- Dense below 3.05 m.
244	4			
243.7				**END OF HOLE IN SILT TILL AT 4.34 m.**
		15		
243	5			
242	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D8**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION

PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels

SITE Lake Manitoba Emergency Channel System - Route D

LOCATION In quarter section NE-29-28-08

DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **248.87 m**
TOP OF PVC ELEV.
DATE DRILLED **7/8/2011**
UTM (m) N **5,697,583**
E **531,626**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
248.6				**TOPSOIL** - Black.
248.3				**CLAYEY SILT** - Dark grey, moist, firm.
248	1			**SILT TILL** - Grey, moist, firm, trace clay, some oxides.
		5		
247	2			
246	3	10		- Trace boulders, trace cobbles below 2.74 m.
245	4			
244.5				**END OF HOLE IN SILT TILL AT 4.34 m.**
		15		Note: 1. Material at base of hole was relatively easy to excavate.
244	5			
243	6	20		

SAMPLE TYPE / NUMBER / RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

KGS GROUP AECOM

SUMMARY LOG

HOLE NO. **TP-D9**

CLIENT MANITOBA INFRASTRUCTURE AND TRANSPORTATION
PROJECT Emergency Reduction of Lake Manitoba & Lake St. Martin Water Levels
SITE Lake Manitoba Emergency Channel System - Route D
LOCATION In quarter section NW-20-28-08
DRILLING METHOD Komatsu PC 220 Backhoe Excavator

KGS JOB NO. **11-0300-18**
AECOM JOB NO. **60212781**
GROUND ELEV. **250.74 m**
TOP OF PVC ELEV.
DATE DRILLED **7/9/2011**
UTM (m) N **5,696,606**
E **530,827**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
250.6				**TOPSOIL** - Black.
				SILTY CLAY - Light grey, moist, high plasticity, trace sand.
250				
249.7	1			**SILT TILL** - Grey, moist, some sand, trace clay, trace gravel.
		5		
249				
	2			- Boulders and cobbles below 1.83 m.
248				
	3	10		
247				
	4			
		15		
246				
	5			
245.6				**END OF HOLE IN SILT TILL AT 5.13 m.**
245				Note: 1. TP-D9 located approximately 20 m away from a wet area.
	6	20		

SAMPLE TYPE | NUMBER | RECOVERY %

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
Hugh Munroe	M. ALKIKI	DRAFT	10/8/12

GEOTECHNICAL - SOIL LOG W/ AECOM LOGO P:\PROJECTS\2011\11-0300-18\DESIGN\GEO\LOGS\#ROUTE B_C_D_E_REACH 1_COMBINED\MASTER.GPJ

APPENDIX D8-G

SLOPE STABILITY SECTIONS

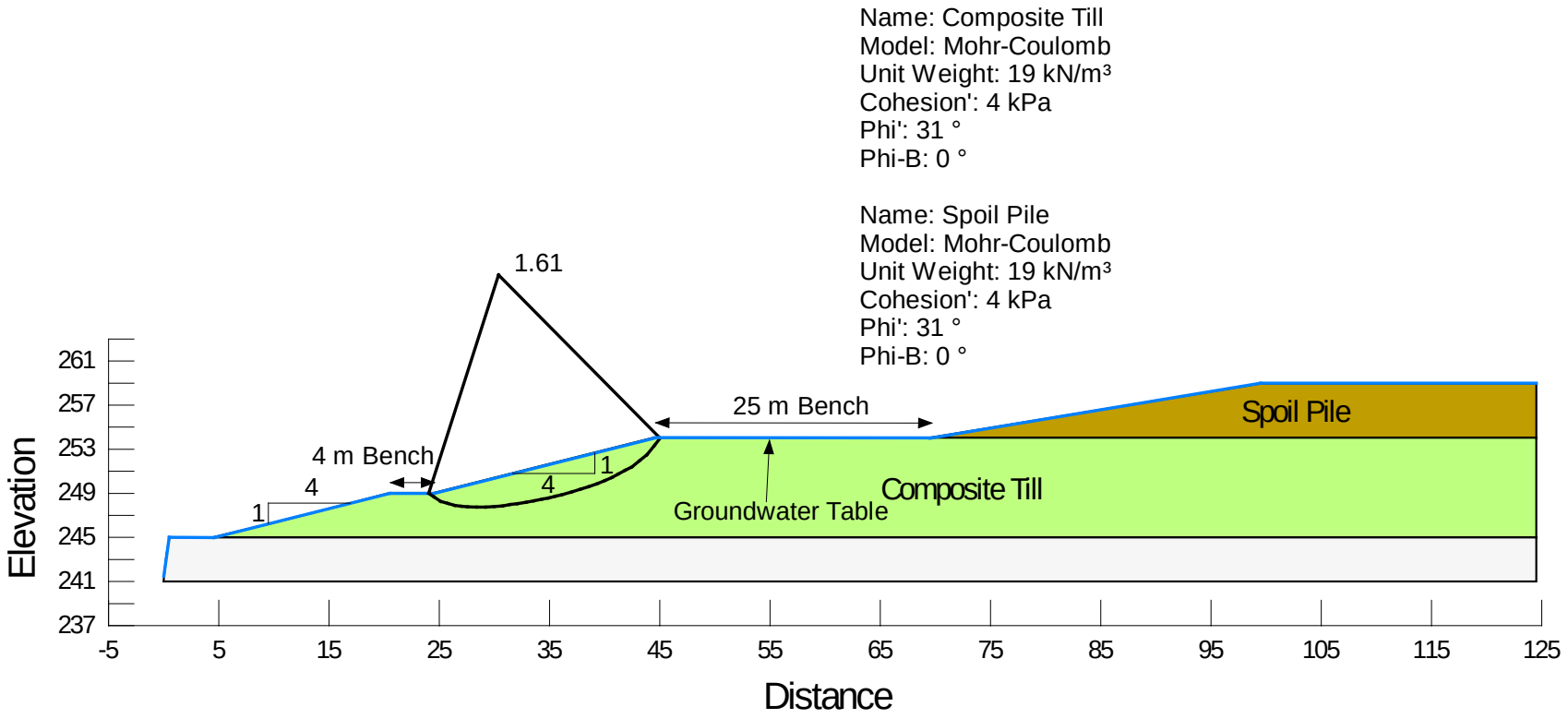

FIGURE D8-G1

ROUTE C – STATION 6+800. Case (1)

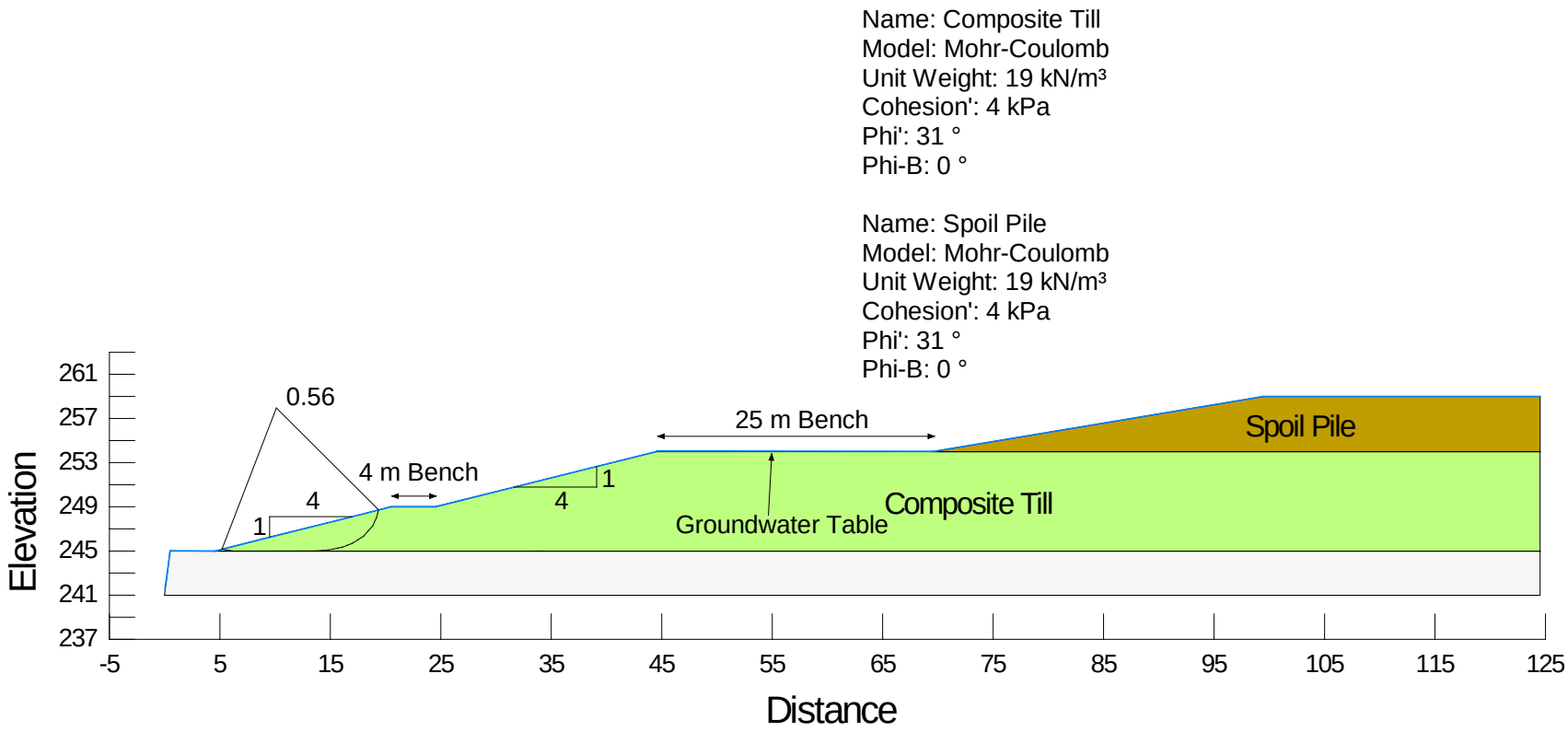

FIGURE D8-G2

ROUTE C – STATION 6+800. Case (2)

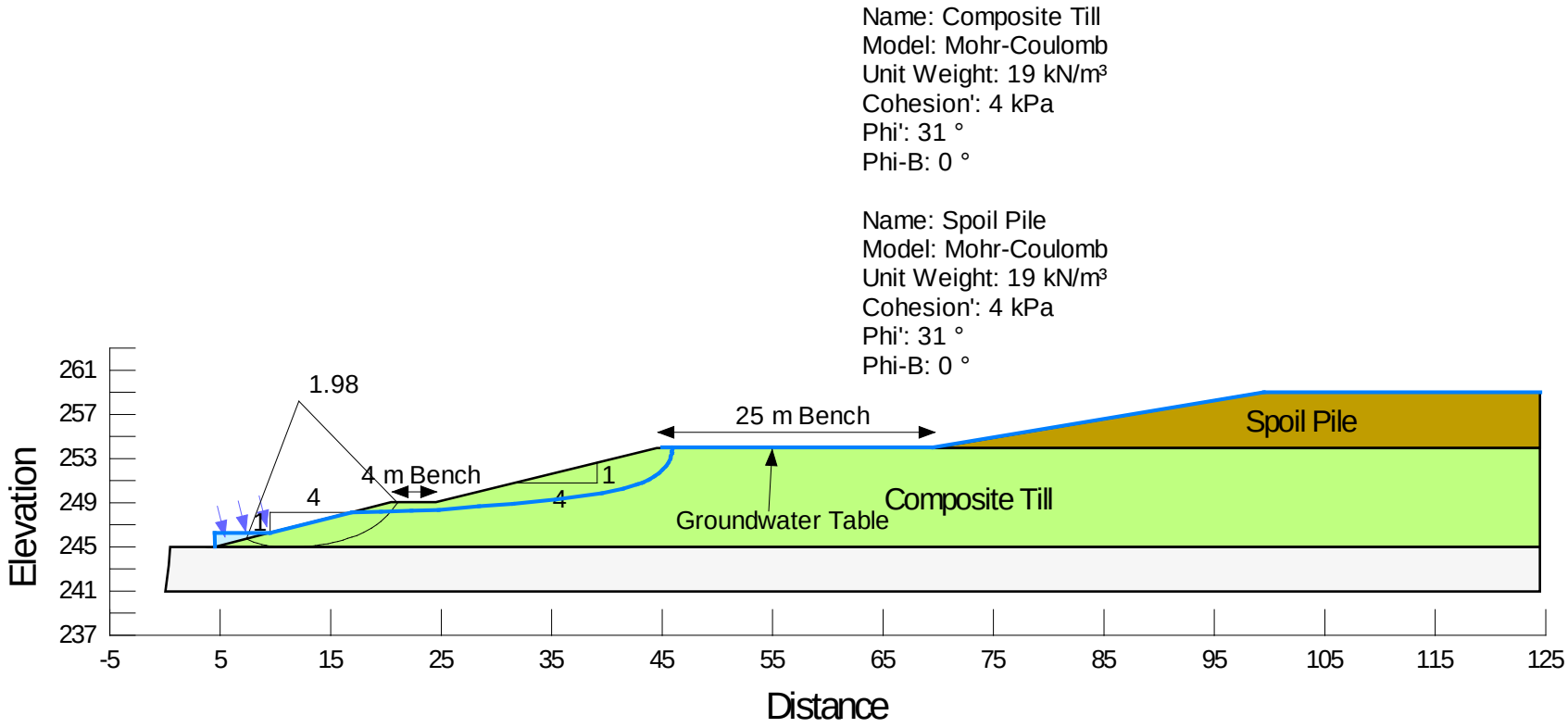

FIGURE D8-G3

ROUTE C – STATION 6+800. Case (3)

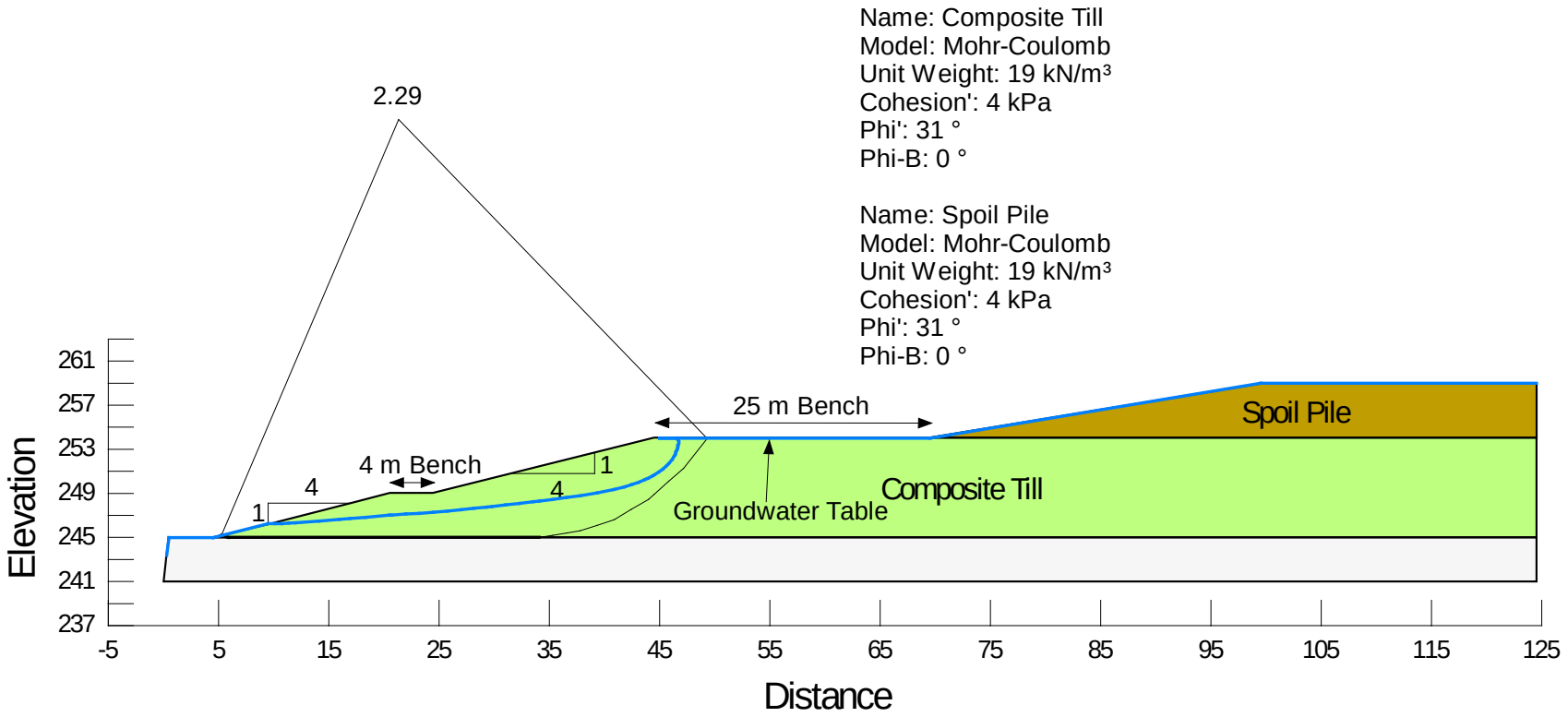

FIGURE D8-G4

ROUTE C – STATION 6+800. Case (4)

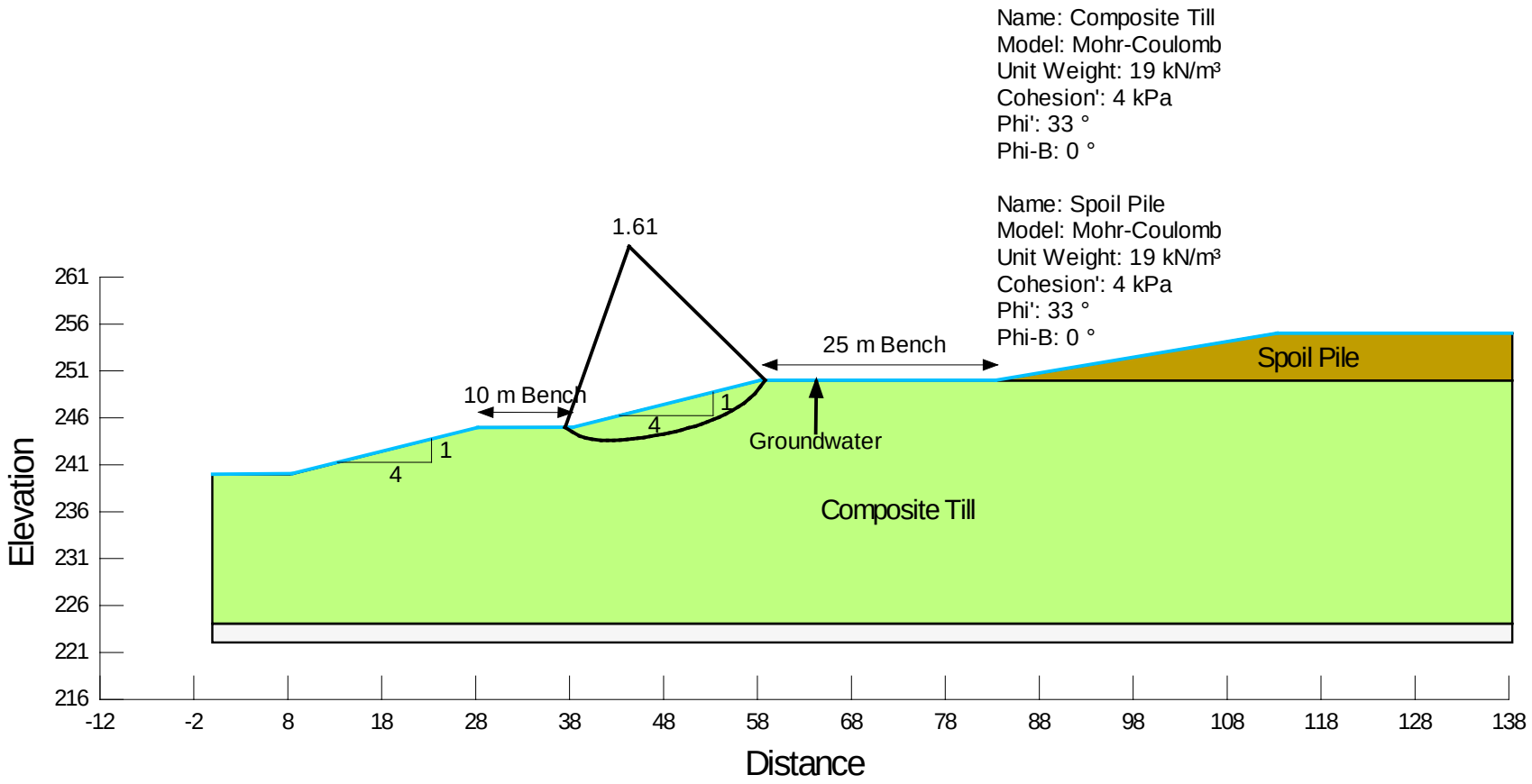

FIGURE D8-G5

ROUTE D – STATION 11+600. Case (1)

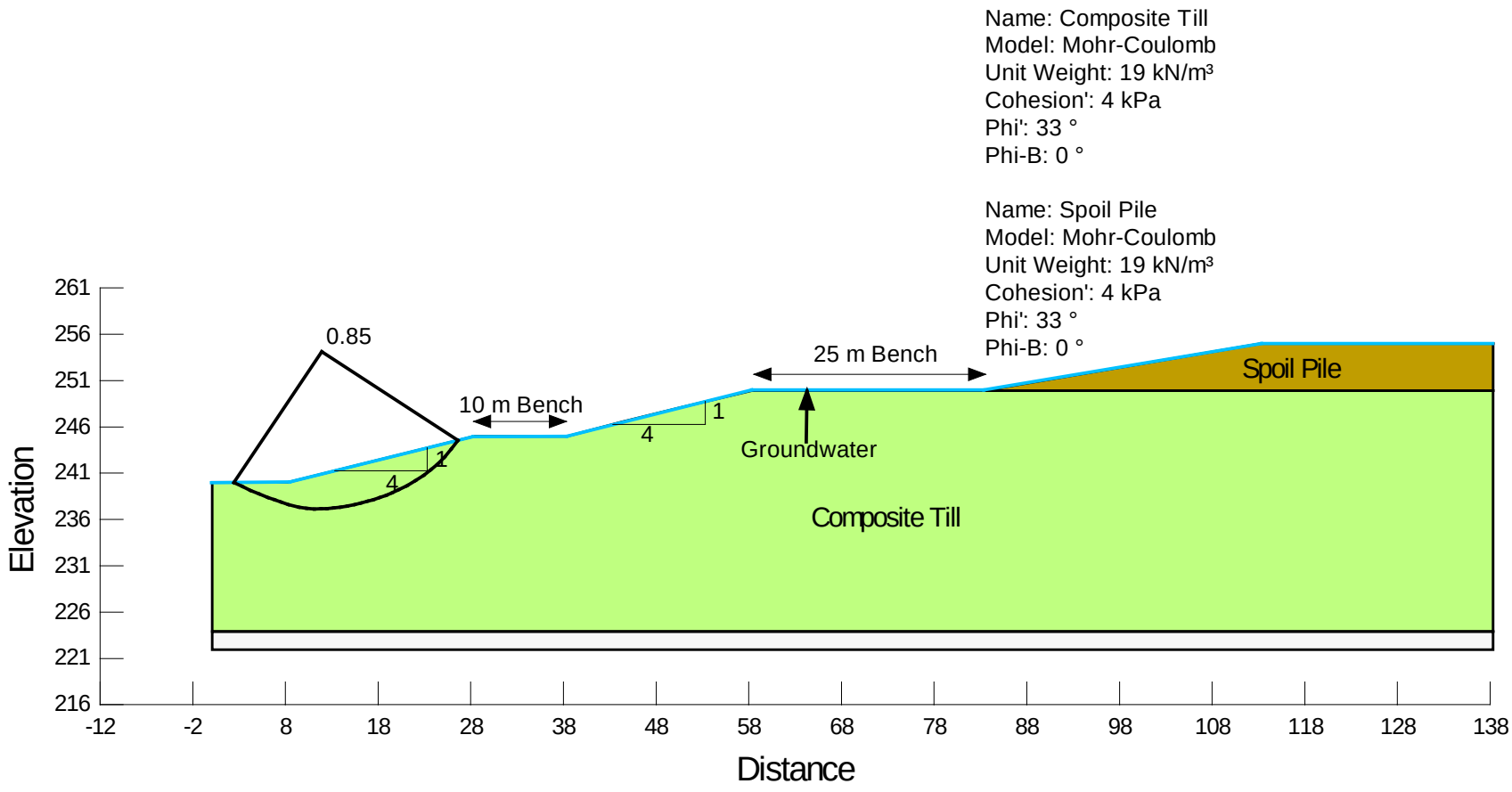

FIGURE D8-G6

ROUTE D – STATION 11+600. Case (2)

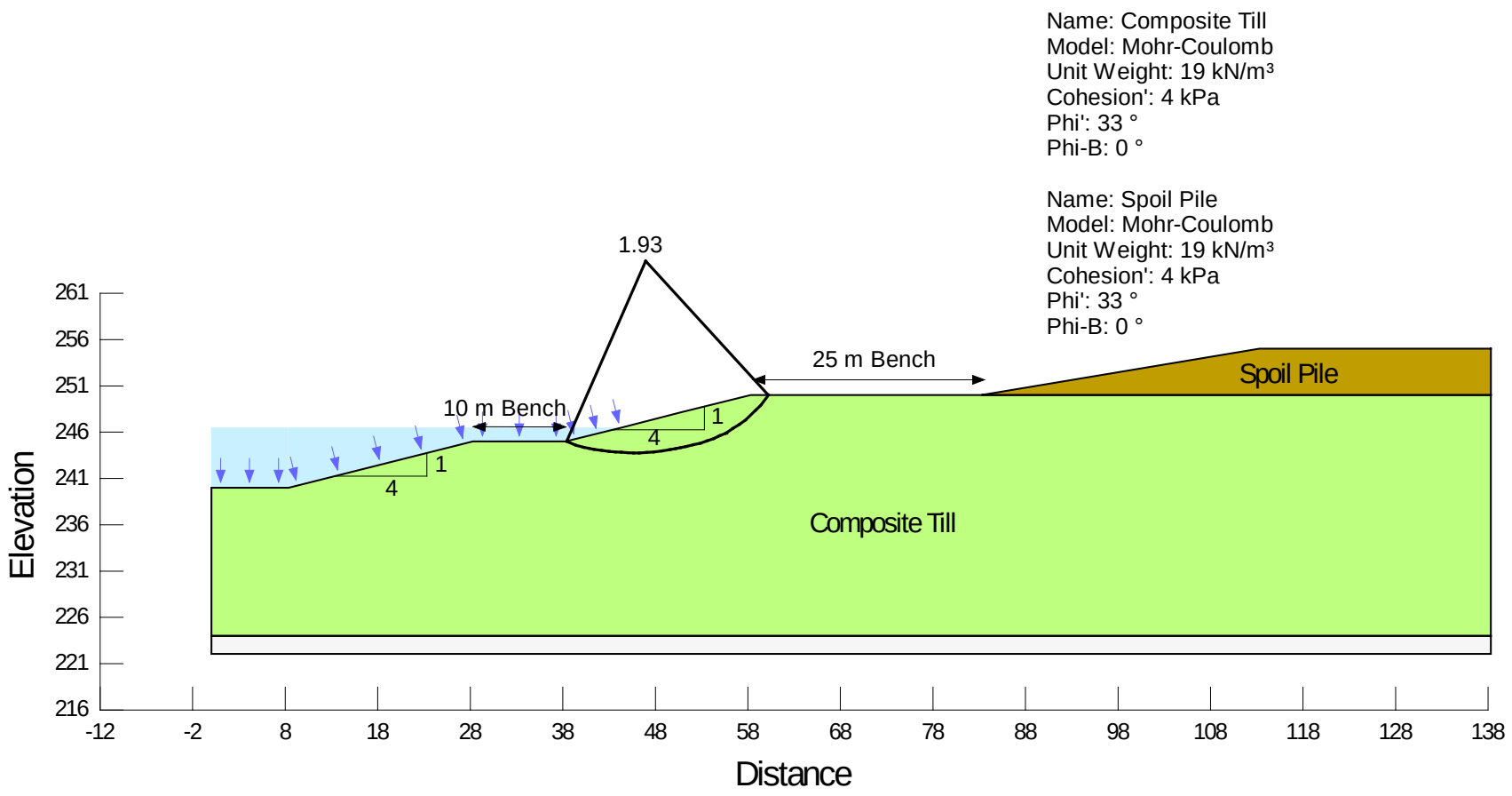

FIGURE D8-G7

ROUTE D – STATION 11+600. Case (3)

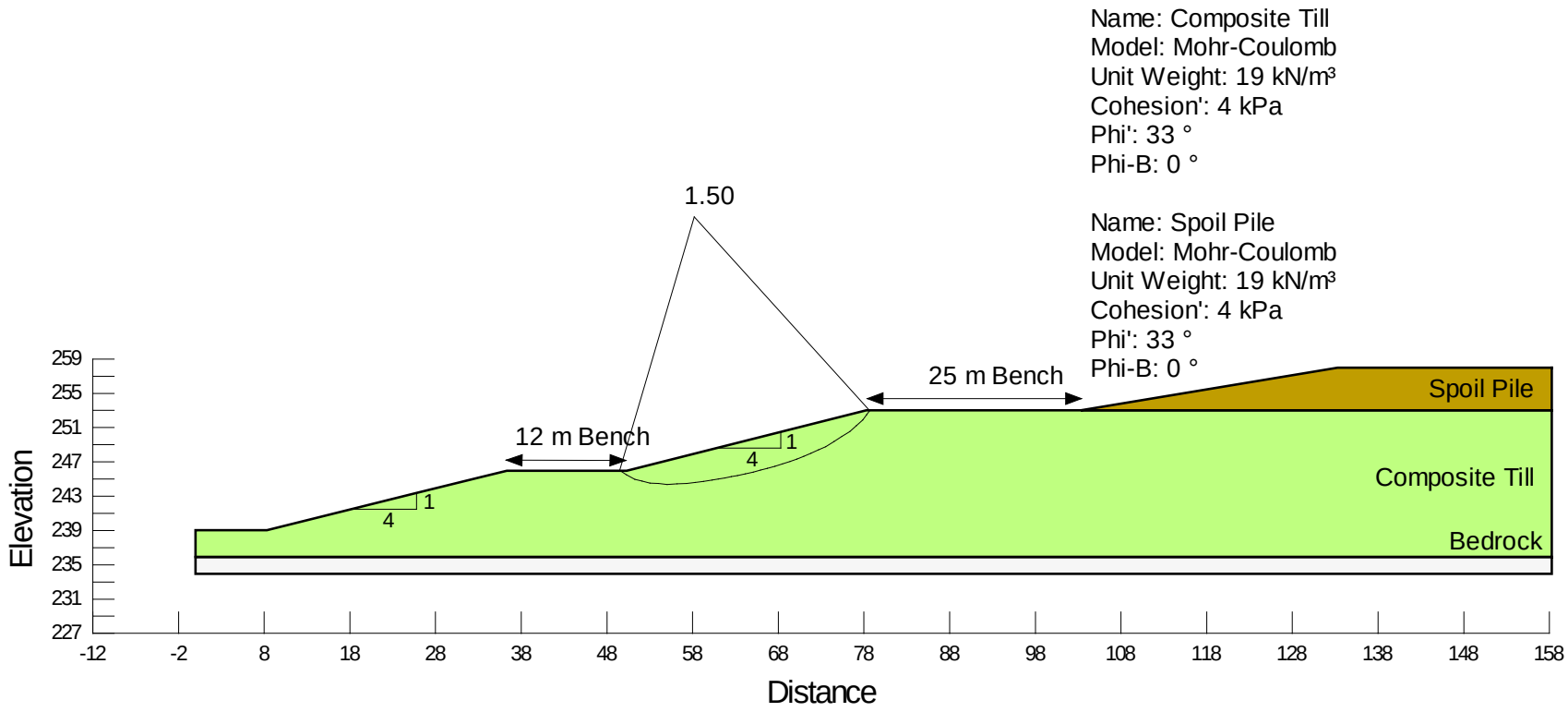

FIGURE D8-G8

ROUTE D – STATION 19+000. Case (1)

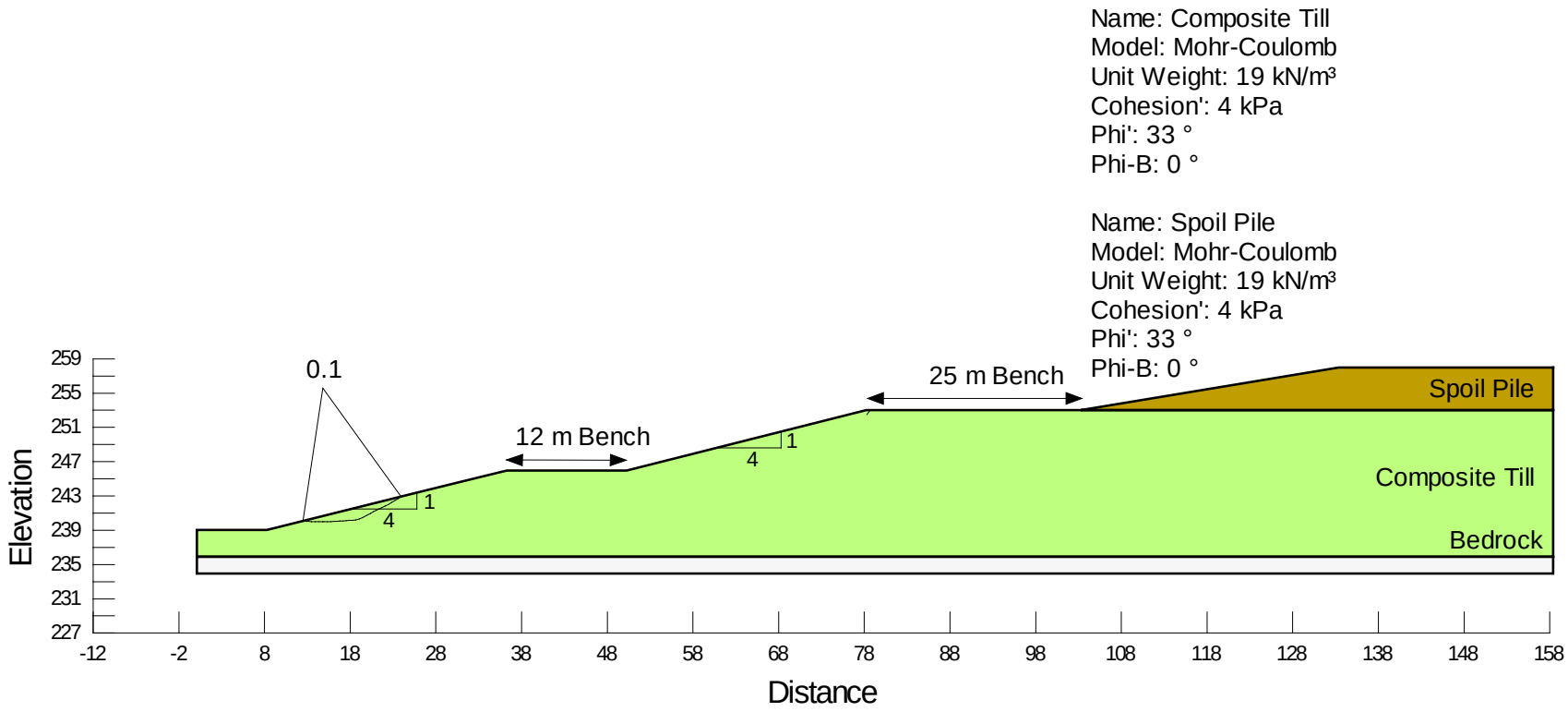

FIGURE D8-G9

ROUTE D – STATION 19+000. Case (2)

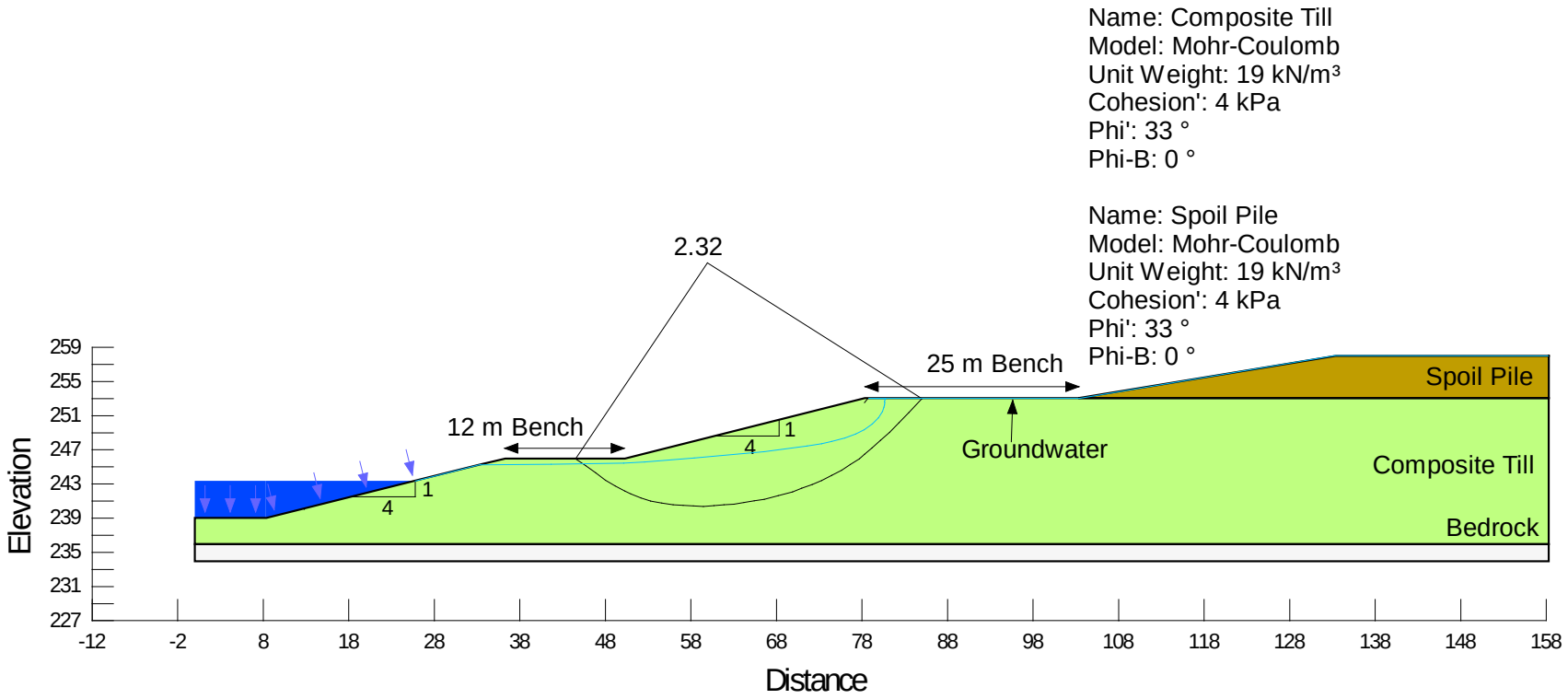

FIGURE D8-G10

ROUTE D – STATION 19+000. Case (4)

KGS GROUP

CONSULTING ENGINEERS

APPENDIX F

RISK ASSESSMENT AND BUDGET QUANTIFICATION (DELIVERABLE D11)

KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D11
RISK ASSESSMENT AND BUDGET QUANTIFICATION

FINAL – REV 0

KGS Group 16-0300-006
May 2017

PREPARED BY:

<Original signed by>

Patrice Leclercq, P.Eng.
Water Resources Engineer

REVIEWED BY:

<Original signed by>

Dave MacMillan, P.Eng.
Principal, Project Manager

APPROVED BY:

<Original signed by>

Colin Siepman, P.Eng.
Senior Infrastructure / Project Engineer

PROFESSIONAL ENGINEERING SEAL

This report has been approved by the following Professional Engineers taking responsibility for the report in their respective disciplines as indicated:

<Original signed by>

Patrice Leclercq, P.Eng.
Water Resources Engineer

<Original signed by>

Dave MacMillan, P.Eng.
Principal, Project Manager

<Original signed by>

Colin Siepman, P. Eng.
Senior Infrastructure/Project Engineer

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1.0 INTRODUCTION AND SCOPE OF WORK

1.1 INTRODUCTION

This Risk Assessment and Budget Quantification Report has been developed to provide MI information related to the engineering and environmental risks associated with Options C and D of the Lake Manitoba Outlet Channel. Consistent with our study terms of reference, the report focuses on potential groundwater, surface water and geotechnical concerns and impacts, and identifies technically and economically feasible measures to mitigate the associated risks. The costs of these measures have been estimated and the residual risks assessed to more rigorously facilitate a comparison of the two Outlet Channel Options. The results of this assessment were used to evaluate the Options at a Technical Workshop where a preferred Option was identified and recommended to proceed to the next stage of design.

1.2 SCOPE OF WORK

The scope of work for the Risk Assessment was based on our study terms of reference and focused on potential groundwater, surface water and geotechnical concerns and impacts for both Options C and D and included:

- Identification, Evaluation and Mitigation of Risks.
- Development of Recommendations for Design and Construction.
- Assessment of Residual Risks and Impacts.
- Development of Cost Allowances for Risks.
- Risk Assessment for Rating of Options.
- Technical Workshop.
- Technical Presentation.
- Risk Assessment and Budget Quantification Report.

This report documents the results for the scope of work identified above.

2.0 RISK ASSESSMENT, MITIGATION AND COST ALLOWANCES FOR RISK

2.1 RISK IDENTIFICATION, MITIGATION, AND RESIDUAL RISKS

KGS Group identified and evaluated engineering and environmental risks associated with Options C and D of the Lake Manitoba Outlet Channel. The risk assessment was based on the following information:

- Previous assessments, design, and investigations conducted during the Lake Manitoba Outlet Channels Conceptual Design Stages 1 and 2 as well as for the Analysis of Options to Reduce Lake Manitoba and Lake St. Martin Water Levels on an Emergency Basis.
- Data and findings from the drilling program and geotechnical investigations conducted in the fall of 2016.
- Data and findings from the first groundwater and surface water monitoring event also conducted in the fall of 2016.
- Analysis results and recommendations from the groundwater study, the surface water study and the geotechnical analyses, which are documented separately in Deliverables D4, D5, D6, D7 and D8.

Based on the information and assessments identified above, a comprehensive list of risk items for the Options C and D channels was developed. These are described in detail in the attached Tables D11-1 (Option C) and D11-2 (Option D). The severity and probability of each individual risk item was rated on a scale of low, medium, and high using engineering judgement. Risk response and mitigation strategies were also developed for each individual risk item.

The Risk Assessment focused on potential groundwater, surface water and geotechnical concerns and impacts. Other risks, such as, but not limited to risks related to design and construction (e.g. weather, channel inlet/outlet, bridges…), land acquisition, or socio-economic factors, were also identified and incorporated into the assessment, but were not evaluated in detail. The following list summarizes the groundwater, surface water and geotechnical risk items that were identified and included in Tables D11-1 and D11-2.

Groundwater

- Depressurization during construction – Risk of basal heave conditions (blowouts) during construction (Options C&D).
- Individual and/or community groundwater wells and systems (quantity) – Risk that water level drops below the existing pump setting or below the casing while the well is pumping due to aquifer drawdown from channel construction or operation (Options C&D).
- Individual and/or community groundwater wells and systems (quality) – Risk of groundwater under direct influence of surface water (GUDI) conditions. Potential for bacterial and virus contamination, as a result of interconnection to the aquifer in an aquifer recharge area (Options C&D).
- Groundwater interaction with wetlands – risk of lowering the wetlands water levels in the event that the wetlands are connected directly to the bedrock and extensive drawdown occurred in the aquifer (Option D).

Geotechnical

- Earth and rock excavation – Risk of increased excavation quantities as a result of "design growth" (i.e. as a result of the increased level of design information and detail between the conceptual phase to detailed design and until construction) (Options C&D).
- Control structure foundation – Risk of seepage below the structure foundation from upstream to downstream through the rock or through a pervious zone that may require mitigation such as grouting (Options C&D).
- Bridge foundation – Risk of seepage occurring upwards along the interface between the foundation piles and adjacent soil during construction that could result in additional dewatering requirements (Options C&D).
- Damages due to blasting – Risk that rock blasting activities require additional monitoring and/or mitigation due to potential damages to nearby buildings (e.g. houses) and/or other infrastructure (e.g. bridges) (Option C).

Surface water

- Revegetation – Risk of poor vegetation growth on channel banks as a result of long term operation (i.e. difficulties establishing long term erosion resistant vegetation) (Options C&D).
- Water quality in outlet channel – Risk of poor water quality in channel when it is not in operation due to stagnant water conditions, including lack of oxygen (Options C&D).
- Water quality in adjacent waterbodies – Risk of poor water quality as a result of construction activities (i.e. due to sediment erosion during construction and/or excessive runoff from construction site) (Options C&D).

- Surface water drainage – Risk that there will be a requirement for additional ditching and/or drop structures identified at the final design stage (Options C&D).
- Birch Creek flows – Risk that the reduction in flows in Birch Creek due to the loss in contributing drainage area result in the requirement for additional mitigation measures to address potential environmental impacts(Option D)
- Wetland water levels – Risk that the reduction in flows due to the loss in contributing drainage area result in reduced water levels in the wetlands that require additional mitigation measures to address potential environmental impacts (Option D).

The results of the assessment were presented to a technical panel of experts and senior engineers from KGS Group, MI and other external consultants at a one-day long Technical Workshop/Meeting that was held on December 21, 2016. The Workshop/Meeting process followed a systematic approach and included a detailed Technical Presentation of the groundwater study, surface water study, and geotechnical analyses, a comprehensive review and discussion of the Project risks and mitigation measures, as well as a rigorous comparison and evaluation of the options. Further information on the Technical Workshop process is provided in Section 3.1.

Meeting Minutes of the Technical Workshop/Meeting are attached in Appendix A and include the presentation slides that provide additional details on the Risk Assessment, as well as the groundwater study, surface water study, and geotechnical analyses. Each individual risk item was thoroughly discussed at the Workshop/Meeting and the risk severity/probability ratings, as well as the risk response/mitigation measures were refined and updated based on the collaborative input of the Workshop/Meeting attendees. Additional risk items were also identified and incorporated into the assessment as deemed necessary. Tables D11-1 and D11-2 attached incorporate the comments and input received at the Workshop /Meeting.

2.2 COST ALLOWANCE FOR RISK AND MITIGATION

For each of the individual risk items identified in Tables D11-1 and D11-2, cost allowances were developed for inclusion in the project budget. The cost allowances were developed based on:

- Results of the Risk Assessment described in Section 2.1.

- Recommendations from the groundwater study, the surface water study and the geotechnical analyses, which are documented separately in Deliverables D4, D5, D6, D7 and D8.
- Input received at the Technical Workshop/Meeting.
- Engineering judgement and past experience.

Assumptions that formed the basis of the cost allowances are included in Tables D11-1 and D11-2. The cost allowances were subdivided into the following three categories:

1. **Base Mitigation Cost –** An expenditure that was identified and included in previous Project base cost estimates to mitigate impacts of an expected environmental risk.
2. **Updated Mitigation Cost –** An allowance that replaces the all-encompassing 5% mitigation allowance included in previous project estimates to mitigate an expected environmental risk. This allowance was determined on a risk by risk basis and is an expenditure that was not specifically identified in the base cost of previous Project estimates. In some cases, the mitigation allowance was judged to be sufficient to reduce the environmental risk to an insignificant level.
3. **Residual Risk Cost –** A new allowance to be included in the Project cost estimates to address the risk that is remaining following the implementation of technically and economically feasible risk reduction measures. This allowance is representative of what is typically covered by the Project contingency, and therefore the summation of all residual risk allowances replaces the 20% contingency allowance included in previous project estimates. Items not specifically addressed in this study, such as the control structure, were added to the list of residual risks to complete the transfer of contingency items to the residual risks. Each individual Residual Risk allowance was determined by multiplying the Risk Consequence Cost with the Risk Probability.

   The Risk Consequence Cost is the potential expenditure associated with a particular risk. Each expenditure (or risk) has a theoretical probability of occurrence that may be significantly reduced with the implementation of risk reduction measures. In some cases, the Risk Consequence Cost would be higher if measures that reduce risk were not being considered.

   The Risk Probability in terms of percentage was estimated using engineering judgement and based on the Risk Severity rating (low, medium, and high) described in Section 2.1. In general, a risk with a low severity rating had a probability that ranged between 10% to 25%, a medium severity rating had a probability that ranged between 30% and 70%, and a high severity rating had a probability that ranged between 75% and 90%.

Table D11-3 summarizes the estimated cost allowance for risk and mitigation for both Options C and D. A detailed breakdown of the cost allowance for each individual risk item is included in Tables D11-1 and D11-2.

TABLE D11-3
SUMMARY OF COST ALLOWANCES FOR RISK AND MITIGATION

	BASE MITIGATION COST	UPDATED MITIGATION COST	RESIDUAL RISK COST
Option C	$3,081,000	$11,492,000	$113,649,000
Option D	$4,081,000	$10,400,000	$50,795,000

The cost allowances for risk and mitigation were used to update the project cost estimates developed during the Stage 2 study. The Stage 2 study cost estimates were considered to be an Association for the Advancement of Cost Engineering (AACE) Class 3 estimate (i.e. based on semi-detailed unit costs sufficient of budget authorization, with an accuracy range of -20% to +30%), and included a 5% allowance for Mitigation and a 20% Contingency Allowance. As described above, these previous 5% and 20% allowances were replaced with the actual Mitigation Cost and Residual Risk Cost allowances estimated as part of the Risk Assessment. The Stage 2 Study cost estimates and the updated cost estimates considering risk and mitigation are summarized in Tables D11-4 and D11-5.

TABLE D11-4
STAGE 2 STUDY PROJECT COST ESTIMATES SUMMARY

	OPTION C	OPTION D
Base Cost	$142,755,000	$173,771,000
Mitigation Cost (5%)	$7,138,000	$8,688,550
Engineering, Contract Admin. Approvals (20%)	$28,551,000	$34,754,200
Contingency Cost (20%)	$35,689,000	$43,442,800
TOTAL	$214,133,000	$260,656,550

TABLE D11-5
UPDATED PROJECT COST ESTIMATES BASED ON RISK ASSESSMENT

	OPTION C	OPTION D
Base Cost	$142,755,000	$173,771,000
Updated Mitigation Cost	$11,492,000*	$10,400,000*
Engineering, Contract Admin. Approvals (20%)	$28,551,000	$34,754,200
Residual Risk Cost	$113,649,000*	$50,795,000*
TOTAL	$296,447,000*	$269,720,200*

Note: * indicates a value that has been updated based on the Risk Assessment.

Based on the results of the Risk Assessment, the estimated project cost for Option D increased by approximately $9 million, which is within the bounds of the Class 3 estimate (-20% to +30%). However, for Option C, the estimated project cost increased by $82 million, which now makes this alignment more costly than Option D. The most significant component of the cost increase to Option C can be attributed to the likely need for a regional water treatment plant and distribution system for the First Nation Community located within the impact zone of the proposed channel. As shown on Table D11-1, it was judged that there is a high probability that the water treatment plant and distribution system would be required to address the risk of impacts to the individual and community groundwater wells in the region and due to the high potential for GUDI conditions. These groundwater conditions along the Option C alignment are discussed in detail in Deliverable D6.

The updated cost estimates identified in Table D11-5 contributed significantly to the evaluation of options process discussed in Section 3.0. The cost allowances for risk and mitigation should be updated at the next stage of design for the recommended channel alignment as project details are refined, with inputs from additional investigations, analyses and monitoring. Further assessment of risk items not included in the current study scope, and therefore not considered in as much detail, should also be undertaken for the recommended channel alignment to refine the overall estimated project cost. The process would consist of developing a detailed cost estimate for each individual risk item and the detailed design of risk reduction measures where applicable. As the level of detail increases, each risk reduction measure would be incorporated directly into the Base Cost of the Project. In some cases, the residual risk would be reduced to an insignificant level, and the estimated overall Residual Risk Cost would decrease.

3.0 EVALUATION OF OPTIONS

3.1 TECHNICAL WORKSHOP / MEETING

As discussed in Section 2.1, a one-day long Technical Workshop/Meeting was held on December 21, 2016 which included the following 3 major sessions:

1. A detailed Technical Presentation of the groundwater study, surface water study, and geotechnical analyses that provided a preliminary summary of the findings and recommendations included in Deliverables D4, D5, D6, D7 and D8.
2. A comprehensive review and discussion of the Project risks and mitigation measures, as discussed in more detail in Section 2.1 and summarized in the attached Tables D11-1 and D11-2.
3. A rigorous comparison and evaluation of the options. Information from the Technical Presentation and the Risk Assessment formed the basis to evaluate and rank the suitability of the Option C and Option D Outlet Channels and to identify a preferred option to proceed with the Preliminary Design.

Meeting Minutes of the Technical Workshop/Meeting are attached in Appendix A and include the presentation slides that provide additional details of the workshop and evaluation process. The comparison and evaluation of the options followed a systematic approach and was conducted with input from MI, and KGS Group, as well as external experts. The following categories were identified at the beginning of the evaluation process as the basis for comparing the options:

1. **Constructability –** considered construction access and monitoring; type of material and ease of excavation; dewatering requirements; extents of inlet and outlet works; and total number of bridge structures.
2. **Operation & Maintenance –** considered geotechnical performance of channel such as slope stabilities and seepage; risk of erosion and sedimentation; potential concerns with vegetation growth; long term access for maintenance; potential concerns with winter operation; signage and fencing requirements for public safety; number of structures and channel length; long term maintenance of mitigation measures (e.g. wells and water treatment plant); and overall inspection cost.
3. **Groundwater Impacts –** considered concerns associated with GUDI conditions (bacteria); potential for aquifer drawdown and impacts; the total number of well users; existing well conditions and proximity to the outlet channel; interaction of groundwater with adjacent wetlands and streams.

4. **Surface Water Impacts –** considered existing network of streams and wetlands; concerns with existing and future surface water drainage; extents of required drainage upgrades and mitigation; and potential impacts to surface water quality;

5. **Physical / Biological Environment Impacts –** considered potential impacts to terrestrial environment (e.g. vegetation, wildlife, habitat, etc…); potential impacts to aquatic environment (e.g. wetlands, streams, habitat, fish, water quality, etc.); ease and extents of environmental approval process; and potential mitigation measures.

6. **Social Economic Considerations –** considered public safety concerns and access; social implications of project impacts on groundwater quality/quantity; proximity of project to First Nation land; past litigation claims; ease and extents of approval processes; existing land use (e.g. agricultural land) and associated loss/reduction in operation (i.e. revenue); potential issues with severance of land parcels, and local acceptance.

7. **Cost –** evaluation based on the difference between options in the estimated Base Cost.

8. **Risk –** evaluation based on results of the Risk Assessment which considered Risk Consequence, Risk Probability and Residual Risk Cost.

One category at a time, the workshop attendees discussed the evaluation criteria definition and then rated the two options considering the results of the Risk Assessment discussed in Section 2.0 and the results of the various studies and analyses documented in Deliverables D4, D5, D6, D7 and D8. The rating system considered both the suitability of the options in meeting the objectives of the project, and the performance of one option relative to the other based on the following priority scale:

1. Poor
2. Mediocre
3. Satisfactory
4. Good
5. Superior

In general, the rating of Options C & D was considered at least satisfactory when compared to the four previous options that were dismissed at the end of the Stage 1 study. However, in order to better differentiate the suitability and performance of one option compared to the other, a lower or higher rating was at times assigned for some categories. Therefore, although a “Poor” or “Mediocre” rating was selected in some instances, the lower rating was typically selected to indicate that the option rated less favorably relative to the other option in that category.

As part of the workshop process, weighting factors were established for each category. A score was then calculated for each category by multiplying together the category's weight and rating. The total score was then computed and the option with the highest total score was identified as the preferred Option.

3.2 RESULTS AND RECOMMENDATION OF PREFERRED ALTERNATIVE

Based on the ratings and weightings that were determined during the workshop, the total scores for Options C & D were determined. The results of the evaluation and workshop are summarized in Table D11-6.

TABLE D11-6
OPTIONS C AND D EVALUATION RESULTS

MAIN CATEGORY	WEIGHT	OPTION C		OPTION D	
		RATING	SCORE	RATING	SCORE
1. Constructability	10	3	30	3	30
2. Operation and Maintenance	10	2	20	3	30
3. Groundwater Impacts	15	1	15	4	60
4. Surface Water Impacts	5	4	20	3	15
5. Physical / Biological Environment Impacts	15	4	60	3	45
6. Social Economic Considerations	20	1	20	3	60
7. Cost	10	4	40	3	30
8. Risk	15	1	15	3	45
TOTAL SCORE (out of 500)			**220**		**315**

As shown on the Table, Option D has the highest score. The groundwater impacts, social economic considerations and risk were the major factors that contributed to Option D being the preferred Option compared to Option C as summarized below.

- **Groundwater Impacts –** Option C rated poorly due to the concerns associated with GUDI conditions, aquifer drawdown, and the large number of well users in close proximity of the channel, whereas Option D does not have the same level of concerns. Results of the Groundwater Study are provided in Deliverable D6.
- **Social Economic Considerations –** The following factors contributed to a poor rating for Option C compared to Option D:
    - The potential Groundwater Impacts along Option C could affect the water quality and quantity of a large number of groundwater users in the region, resulting in significant socio-economic implications. Option D does not have the same level of concerns with groundwater quantity and quality and the potential impacts affect a lesser number of groundwater users.
    - Option C has Public Safety concerns and reduced access in the region due to the steep bedrock side slopes of the channel, which Option D does not have. The steep bedrock side slopes exceed 8m in depth above the water surface in the channel at some locations, posing a substantial safety threat, particularly to recreational users (e.g. ATV's and snowmobiles) in the region.
- **Risk –** Option C was assessed with higher Risk Consequences and Risk Probability compared to Option D, mostly due to the groundwater concerns that could affect water quality and quantity. This resulted in a significant Residual Risk Cost for Option C as described in Section 2.0.

Based on the results of the evaluation of Options carried out at the Technical Workshop, the Lake Manitoba Outlet Channel was initially recommended to proceed to the next stage of design with Option D as the preferred Alternative.

After the Technical Workshop and upon completing the evaluation of the options, MI held meetings with potentially affected landowners located along the proposed Option D channel alignment. Based on feedback received at the meetings, Loss of Revenue as well as Stress and Anxiety were identified as Social Economic factors that required further consideration in the evaluation of the options.

The concern with loss of revenue is primarily attributed to the loss of agricultural land as a result of channel construction and the associated purchase of Right of Way (ROW) for the project. The loss in revenue experienced by an agricultural producer is not only related to the area of arable land that is lost, but also on the type of crop in the area, the quality of the land, the overall size of the operation, and the impact of the channel construction on access and efficiency to the operation. Furthermore, where a business typically has the ability to relocate in close proximity

within the same region to make up for some or all of the loses in revenue, an agricultural producer may not have the same viable opportunity, as relocation depends on whether or not land is available in the region. Land that is available can also be more expensive, less productive, and not easily accessible depending on location, and therefore may not be a feasible solution. In addition, any loss in agricultural productivity within the region will also result in a direct and long term loss in tax-base revenue to the Rural Municipality (RM). Although some level of compensation is offered to both the producer and the RM, the exact monitory value of the losses can be difficult to quantity.

Consideration was also given to the relative effects of intangible aspects such as stress and anxiety by acknowledging the number of people affected, and the stress endured as a result of the project. The challenge in quantifying this variable is the fact that stress and anxiety and its measurement is dependent on each individual's perceptions and abilities to cope. Recent flood events in 2011/2012 and 2014 have demonstrated that stress and anxiety to families and individuals within the region is a significant socio economic impact. It is anticipated that stress and anxiety may be experienced by some individuals who are directly impacted by the construction of the Outlet Channel on their existing property.

Based on a review of existing land use along the Options C and D channels, Option D affects a much larger footprint of agricultural and forage land, including rangeland and grassland, than Option C (approximately 1,300 ha vs 400 ha based on an assumed 400m wide ROW). Also, in general, the quality of the affected agricultural land along Option D is likely better than Option C. Although the actual total area of agricultural land loss due to the project will depend on the land acquisition process and the final width of the ROW, and may increase if the purchase of a large number of isolated land parcels or bisected parcels rather than just "strips" is required, it is clear that Option D rates less favorably than Option C in this category.

Based on the concerns with Loss in Revenue and Stress and Anxiety described above, the previous rating of 3 (satisfactory) awarded to Option D in the Category of Social Economic Considerations, as previously identified in Table 11-6, is now judged to be too high. Instead, a lower rating of 2 (mediocre) or potentially 1 (poor) should be considered. The evaluation results were therefore revised assuming a low rating of 1 (poor) for Option D in the category of Social Economic Considerations and the results are shown in Table D11-7.

TABLE D11-7
REVISED OPTIONS C AND D EVALUATION RESULTS

MAIN CATEGORY	WEIGHT	OPTION C		OPTION D	
		RATING	SCORE	RATING	SCORE
1. Constructability	10	3	30	3	30
2. Operation and Maintenance	10	2	20	3	30
3. Groundwater Impacts	15	1	15	4	60
4. Surface Water Impacts	5	4	20	3	15
5. Physical / Biological Environment Impacts	15	4	60	3	45
6. Social Economic Considerations (Revised)	20	1	20	1	20
7. Cost	10	4	40	3	30
8. Risk	15	1	15	3	45
TOTAL SCORE (Revised)			**220**		**275**

As shown on the Table, with a low rating of 1 (poor), the total score for Option D is reduced from 315 to 275. Although this potential change in score is significant, Option D continues to maintain a higher score compared to Option C. On this basis, the conclusion that the Lake Manitoba Outlet Channel is recommended to proceed to the next stage of design with Option D as the preferred Alternative does not change.

4.0 STATEMENT OF LIMITATIONS AND CONDITIONS

4.1 THIRD PARTY USE OF REPORT

This report has been prepared for Manitoba Infrastructure to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

4.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

KGS Group prepared the geo-environmental conclusions and recommendations for this report in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this report is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of Manitoba Infrastructure. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

4.3 GEOTECHNICAL INVESTIGATION STATEMENT OF LIMITATIONS

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at this site. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendations can be reviewed and modified if necessary.

4.4 CAPITAL COST ESTIMATE STATEMENT OF LIMITATIONS

The cost estimates included with this report have been prepared by KGS Group using its professional judgment and exercising due care consistent with the level of detail required for the stage of the project for which the estimate has been developed. These estimates represent KGS Group's opinion of the probable costs and are based on factors over which KGS Group has no control. These factors include, without limitation, site conditions, availability of qualified labour and materials, present workload of the Bidders at the time of tendering and overall market conditions. KGS Group does not assume any responsibility to Manitoba Infrastructure, in contract, tort or otherwise in connection with such estimates and shall not be liable to Manitoba Infrastructure if such estimates prove to be inaccurate or incorrect.

TABLES

TABLE D11-1
OPTION C RISK ASSESSMENT, MITIGATION AND COST ALLOWANCES

	Risk Item	Risk Description	Severity	Risk Response / Mitigation	Base Mitigation Cost ($)	Updated Mitigation Cost ($)	Risk Consequence Cost ($)	Risk Probability (%)	Residual Risk Cost ($)
Groundwater									
1	Depressurization during construction	Blowouts / basal heave conditions during construction	Medium	Construction management (pumping + treatment due to high turbidity) included in Base Cost ($2 million). Additional measures based on assumed lump sum ($1 million plus a potential additional $5 million)	**$2,000,000**	**$1,000,000**	$5,000,000	50%	**$2,500,000**
2	Individual Groundwater wells - quantity	Water level drops below pump setting or below casing while well is pumping due to aquifer drawdown from channel construction / operation	High	Replace and lower pumps in wells $8000/well x 25 wells (i.e. assumed 25% of wells, assumed 100 wells total) including engineering and supervision		**$200,000**			
				Drill new wells and replace pump, servicing etc. $50,000/well x 75 wells (i.e. assumed 75% of wells, assumed 100 wells total) including engineering and supervision		**$3,750,000**			
3	Community Groundwater Wells and Systems - quantity	Water level drops below pump setting or below casing while well is pumping due to aquifer drawdown from channel construction / operation	High	Replace and lower pumps in wells $16,000/well x 2 systems (i.e. assumed 20% of systems, assumed 10 systems total) including engineering and supervision		**$32,000**			
				Drill new wells and replace pump, services $70,000/well x 8 systems (i.e. assumed 80% of systems, assumed 10 systems total) including engineering and supervision		**$560,000**			
4	Individual Groundwater wells - quality	Groundwater Under Direct Influence of Surface Water (GUDI), potential for bacterial and virus contamination, as a result of interconnection to the aquifer in an aquifer recharge area	High	Provide long term UV disinfection and microfiltration at individual wells - 100 wells, $12,000/system including engineering and supervision		**$1,200,000**			
				Maintenance of individual UV and microfiltration systems approximately $500/yr - 100 systems (approximate present value of 30-50 year of maintenance)		**$750,000**			
5	Community Groundwater wells - quality	Groundwater Under Direct Influence of Surface Water (GUDI), potential for bacterial and virus contamination, as a result of interconnection to the aquifer in an aquifer recharge area	High	Provide new treatment or upgrade treatment to each existing system (not including operating costs) $100,000 per system x 10 systems including engineering and supervision		**$2,000,000**			
6	Regional Groundwater wells - quality & quantity	Regional mitigation measure approach for the First Nations community instead of Individual approach	High	Water treatment plant and distribution system for entire First Nation Community (1000 to 1500 people) - assumed $20 million for water treatment plant plus $20,000 per household/building (approx. 350 total) plus present value of 30 to 50 yrs of maintenance and operation assumed (annual cost assumed at 5% of capital cost). 30% allowance included for future growth and 30% allowance for contingency.			$79,000,000	90%	**$71,100,000**
				Sub Total	**$2,000,000**	**$9,492,000**	$84,000,000		**$73,600,000**
Geotechnical									
1	Earth Excavation	Increase in quantities due to design growth	Medium	5% increase in excavation volume			$1,945,000	50%	**$972,500**
2	Rock Excavation	Increase in quantities due to design growth	Medium	20% increase in excavation volume			$9,700,000	50%	**$4,850,000**
3	Control Structure foundation	Seepage below the structure foundation from upstream to downstream through the rock	Medium	Assumed lump sum for limestone grout foundation prep			$5,000,000	50%	**$2,500,000**
4	Bridge foundation	Seepage occuring along the interface between the foundation piles and adjacent soil during construction that could result in additional dewatering requirements	Low	Included in base cost. Allowance for dewatering also included in Groundwater Risk Item #1	**included**				
5	Damages due to Rock Blasting	Rock Blasting Activities require additional monitoring and/or mitigation due to potential damages to nearby buildings (e.g. houses) and/or infrastructure (e.g. bridges)	Medium	Assumed lump sum based			$2,000,000	50%	**$1,000,000**
				Sub Total	**$0**	**$0**	$18,645,000		**$9,322,500**
Surface Water									
1	Revegetation	Poor vegetation growth on channel banks as a result of long term operation (i.e. establishing long term erosion resistant vegetation)	Medium	Revegetation included in base costs. Risk Cost based on 10% increase in revegetation cost plus riprap of channel banks to protect against erosion: 48,000 m^2 area of channel banks x 0.15m depth of riprap x $90/$m^2$	**included**		$795,300	50%	**$397,650**
2	Water quality in outlet channel (long term operation)	Poor water quality in channel when not in operation, including lack of oxygen (i.e. due to sediment erosion during construction and/or excessive runoff from construction site)	Medium	Provision of riparian flow through control structure - Assumed lump sum			$500,000	50%	**$250,000**
3	Water quality in adjacent waterbodies (construction)	Poor water quality as a result of construction activities	Medium	Enhanced surface water management measures (e.g. erosion & sediment control) - Assumed lump sum			$1,000,000	50%	**$500,000**
4	Surface water drainage	Additional requirements to address surface water drainage	low	Allowance for outside drain(s) included in base cost. Assumed lump sum for increase ditching requirements and drop structures	**included**		$3,000,000	10%	**$300,000**
				Sub Total	**$0**	**$0**	$5,295,300		**$1,447,650**
Construction / Design Risks									
1	Weather	Adverse weather conditions during construction causing delays and/or difficulties in construction	Medium	5% increase in total project cost			$7,138,000	50%	**$3,569,000**
2	Channel Inlet / Outlet	Increased construction effort at channel inlet / outlet due to design changes	Medium	50% increase in cost			$4,670,000	50%	**$2,335,000**
3	Control Structure	Increase in design scope	Medium	30% increase in cost			$7,253,400	50%	**$3,626,700**
4	Bridges	Increase in design standards to address concerns with ice	High	100% increase in cost (i.e. construction cost doubles)			$5,556,000	90%	**$5,000,400**
5	Environmental Mitigation	Increased mitigation requirements for bio-physical and or aquatic environment.	Medium	Base cost includes the Fish Passage structure at FRWCS. Additional measures based on assumed lump sum ($2 million plus a potential additional $6 million)	**$1,081,000**	**$2,000,000**	$6,000,000	50%	**$3,000,000**
6	Construction Camp	Increase in design scope	Medium	20% increase in cost			$1,021,860	50%	**$510,930**
7	Electrical Power Supply	Increase in design scope	Medium	20% increase in cost			$891,000	50%	**$445,500**
8	Fish Passage	Increase in design scope	Medium	100% increase in cost (i.e. construction cost doubles)			$1,081,000	50%	**$540,500**
9	Optimization	Reduction in cost as a result of design optimization	Medium	10% reduction in total project cost			-$14,276,000	50%	**-$7,138,000**
				Sub Total	**$1,081,000**	**$2,000,000**	$19,335,260		**$11,890,030**
Other Risks									
1	Land Acquisition	Increased cost of land acquisition	Medium	10% increase in area to purchase & 10% increase in unit cost			$515,550	50%	**$257,775**
2	Socio-economic Factors	Increase in design scope and/or delays due to concerns of affected stakeholder. Fencing and signage requirements along the steep rock sections.	High	10% increase in total project cost			$14,275,500	70%	**$9,992,850**
3	Engineering /Contract Admin. / Approvals	Increased effort as a result of design changes, complications, approval requirement.	Medium	20% increase in effort			$5,710,200	50%	**$2,855,100**
4	Constructability / Bid Climate / Labour / Fuel Costs	Increase in project cost	Medium	10% increase in total project cost			$14,275,500	30%	**$4,282,650**
				Sub Total	**$0**	**$0**	$34,776,750		**$17,388,375**
				Total Mitigation & Risk Allowance	**$3,081,000**	**$11,492,000**	$162,052,310		**$113,648,555**

Notes: Red shaded cells identify risk items included for completeness only. Study scope focused on groundwater, surface water and geotechnical risks.
Column Definitions are described in the text of Deliverable D11.

TABLE D11-2
OPTION D RISK ASSESSMENT, MITIGATION AND COST ALLOWANCES

	Risk Item	Risk Description	Severity	Risk Response / Mitigation	Base Mitigation Cost ($)	Updated Mitigation Cost ($)	Risk Consequence Cost ($)	Risk Probability (%)	Residual Risk Cost ($)
Groundwater									
1	Depressurization during construction / operation	Blowouts / basal heave conditions	Medium	Depressurization system and construction management (pumping) included in Base Cost ($3 million). Additional measures based on assumed lump sum ($2 million plus a potential additional $5 million)	**$3,000,000**	**$2,000,000**	$5,000,000	50%	**$2,500,000**
2	Individual Groundwater wells - quantity	Water level drops below pump setting or below casing while well is pumping due to aquifer drawdown from channel construction / operation	High	Replace and lower pumps in wells $8000/well x 50 wells (i.e. assumed 50% of wells, assumed 100 wells total) including engineering and supervision		**$400,000**			
			High	Drill new wells and replace pump, servicing etc. $50,000/well x 50 wells (i.e. assumed 50% of wells, assumed 100 wells total)		**$2,500,000**			
3	Individual Groundwater wells - quality	Groundwater Under Direct Influence of Surface Water (GUDI), potential for bacterial and virus contamination, as a result of interconnection to the aquifer in an aquifer recharge area	Medium	Provide long term UV disinfection and microfiltration at individual wells - 50 wells, $12,000/system including engineering and supervision (assumed 50% of wells)			$600,000	50%	**$300,000**
				Maintenance of individual UV and microfiltration systems approximately $500/yr - 50 systems (approximate present value of 30-50 year of maintenance)			$375,000	50%	**$187,500**
4	Groundwater interaction with wetlands	Lowering of wetlands water levels if wetlands are connected directly to bedrock and if extensive drawdown occurred in aquifer	Medium	Wetlands require mitigation to maintain specified water levels during dry periods. Increase flow to wetlands from other sources, or with water control structures			See surface water item 2		
				Sub Total	**$3,000,000**	**$4,900,000**	$5,975,000		**$2,987,500**
Geotechnical									
1	Earth Excavation	Increase in quantities due to design growth	Medium	10% increase in excavation volume			$10,843,300	50%	**$5,421,650**
2	Control Structure foundation	Seepage control below structure foundation from upstream to downstream through pervious zone	Low	Assumed lump sum for pervious zone foundation preparation			$3,000,000	10%	**$300,000**
3	Bridge foundation	Seepage occuring along the interface between the foundation piles and adjacent soil during construction that could result in additional dewatering requirements	Low	Included in base cost. Allowance for dewatering also included in Groundwater Risk Item #1	**included**				
				Sub Total	**$0**	**$0**	$13,843,300		**$5,721,650**
Surface Water									
1	Birch Creek flows	Reduction in flows in Birch Creek due to the loss in contributing drainage area result in the requirement for additional mitigation measures to address potential environmental impacts	Medium	Construction of syphon under outlet channel on Woodale Drain - Assumed lump sum value			$5,000,000	50%	**$2,500,000**
2	Wetland water levels	reduction in flows due to the loss in contributing drainage area result in reduced water levels in the wetlands that require additional mitigation measures to address potential environmental impacts	Medium	Construction of a pump station to provide constant source of flows into wetlands and / or inclusion of control structures at outlet of lakes - Assumed lump sum ($ 0.5 million plus a potential additional $5 million)		**$500,000**	$5,000,000	50%	**$2,500,000**
3	Revegetation	Poor vegetation growth on channel banks as a result of long term operation (i.e. establishing long term erosion resistant vegetation)	Medium	Revegetation included in base costs. Risk Cost based on 20% increase in revegetation cost plus riprap of channel banks to protect against erosion: 60,000 m^2 area of channel banks x 0.15m depth of riprap x $90/$m^2$	**included**		$1,839,600	50%	**$919,800**
4	Water quality in outlet channel (long term operation)	Poor water quality in channel when not in operation, including lack of oxygen	Medium	Provision of riparian flow through control structure - Assumed lump sum			$500,000	50%	**$250,000**
5	Water quality in adjacent wetland and creek (construction)	Poor water quality as a result of construction activities (i.e. due to sediment erosion during construction and/or excessive runoff from construction site)	Medium	Enhanced surface water management measures (e.g. erosion & sediment control) - Assumed lump sum			$1,000,000	50%	**$500,000**
6	Surface water drainage	Additional requirements to address surface water drainage	Medium	Allowance for outside drain(s) included in base cost. Additional measures based on an assumed lump sum for increase ditching requirements and drop structures ($1 million plus a potential additional $5 million)	**included**	**$1,000,000**	$5,000,000	50%	**$2,500,000**
				Sub Total	**$0**	**$1,500,000**	$18,339,600		**$9,169,800**
Construction / Design Risks									
1	Weather	Adverse weather conditions during construction causing delays and/or difficulties in construction	High	5% increase in total project cost			$8,689,000	75%	**$6,516,750**
2	Channel Inlet / Outlet	Increased construction effort at channel inlet / outlet due to design changes	Medium	50% increase in cost			$3,300,000	50%	**$1,650,000**
3	Control Structure	Increase in design scope	Medium	30% increase in cost			$7,253,400	50%	**$3,626,700**
4	Bridges	Increase in design standards to address concerns with ice	High	100% increase in cost (i.e. construction cost doubles)			$12,167,000	90%	**$10,950,300**
5	Environmental Mitigation	Increased mitigation requirements for bio-physical and or aquatic environment	Medium	Base cost includes the Fish Passage structure at FRWCS. Additional measures based on assumed lump sum ($4 million plus a potential additional $8 million)	**$1,081,000**	**$4,000,000**	$8,000,000	50%	**$4,000,000**
6	Construction Camp	Increase in design scope	Medium	20% increase in cost			$1,236,800	50%	**$618,400**
7	Electrical Power Supply	Increase in design scope	Medium	20% increase in cost			$438,000	50%	**$219,000**
8	Fish Passage	Increase in design scope	Medium	100% increase in cost (i.e. construction cost doubles)			$1,081,000	50%	**$540,500**
9	Optimization	Reduction in cost as a result of design optimization	Medium	10% reduction in total project cost			-$17,378,000	50%	**-$8,689,000**
				Sub Total	**$1,081,000**	**$4,000,000**	$24,787,200		**$19,432,650**
Other Risks									
1	Land Acquisition	Increased cost of land acquisition	Medium	10% increase in area to purchase & 10% increase in unit cost			$900,900	50%	**$450,450**
2	Socio-economic Factors	Increase in design scope and/or delays due to concerns of affected stakeholders	Medium	5% increase in total project cost			$8,688,550	50%	**$4,344,275**
3	Engineering /Contract Admin. / Approvals	Increased effort as a result of design changes, complications, approval requirement	Medium	20% increase in effort			$6,950,840	50%	**$3,475,420**
4	Constructability / Bid Climate / Labour / Fuel Costs	Increase in project cost	Medium	10% increase in total project cost			$17,377,100	30%	**$5,213,130**
				Sub Total	**$0**	**$0**	$33,917,390		**$13,483,275**
				Total Project Risk	**$4,081,000**	**$10,400,000**	$96,862,490		**$50,794,875**

Notes: Red shaded cells identify risk items included for completeness only. Study scope focused on groundwater, surface water and geotechnical risks.
Column Definitions are described in the text of Deliverable D11.

APPENDIX D11-A

MINUTES OF TECHNICAL WORKSHOP/MEETING AND PRESENTATION

KGS GROUP CONSULTING ENGINEERS

MINUTES OF MEETING

PROJECT DESCRIPTION:
Groundwater Surface Water and Geotechnical Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D

FILE NO:
16-0300-006

PREPARED BY:
Patrice Leclercq & Colin Siepman

ISSUED DATE:
Revised May 4, 2017

MEETING DATE: December 21, 2016

LOCATION: KGS Group Office
895 Waverley Street

PRESENT:

Jared Baldwin (MI)	Colin Siepman (KGS Group)
Ron Richardson (MI)	Dave MacMillan (KGS Group)
Christine Baljko (MI)	Bert Smith (KGS Group)
Maureen Forster (M. Forster Ent.)	Jason Mann (KGS Group)
Dave Morgan (Stantec)	Marci Friedman Hamm (KGS Group)
Doug McMahon (MI)*	David Anderson (KGS Group)
Mark Allard (MI)*	Patrice Leclercq (KGS Group)
*afternoon only	Steve Offman (KGS Group)

ISSUED TO: All attendees

PURPOSE:

Technical Presentation (Deliverable D10)
To present technical information pertaining to groundwater, surface water and geotechnical design that contribute to the evaluation of Options C& D.

Technical Workshop (Deliverable D9)
To evaluate and rank the suitability of the two options in meeting the objectives of the project, considering cost and risk, and identify a preferred option to proceed with Preliminary Design.

ITEM	DETAILS	ACTION BY:
1.0	**Introduction and Review of Agenda**	
	• All attendees participated in round-table introductions to open the workshop. Mark Allard and Doug McMahon were present only for the afternoon session.	
	• Dave M. reviewed the agenda for the day. The morning session was a technical presentation of the options. The afternoon session began with a presentation of the risk assessment and cost allowances for risk and mitigation, followed by the technical workshop to evaluate and rank the suitability of the two options.	

ITEM	DETAILS	ACTION BY:
2.0	**Project Background/Review of Options**	
	• Patrice L. presented project background information based on the channel concepts developed during the Stage 2 study. Jason M. presented a high level overview of the groundwater conditions within the project area. Details of the review are included in the presentation slides attached to these minutes.	
	• Although a number of recommendations were identified in the Stage 2 study report, it was emphasized that KGS Group's scope of work for the current assignment is focused on major issues related to groundwater, surface water, and geotechnical engineering.	
3.0	**Overview of Field Investigations**	
	• A summary of the field investigations that took place in the fall of 2016 were presented. Details of the summary are included in the presentation slides attached to these minutes.	
	• The surface water monitoring program included 10 water sampling locations and 2 water level monitoring locations. The next surface water monitoring event is planned for the spring of 2017.	
	• The Domestic Well inventory was a one-time sample event to establish a preconstruction baseline. Nineteen wells were sampled on Option D, however only 3 wells were sampled on Option C due to access restrictions to Pinaymootang First Nation land.	
	• The Environmental and Geotechnical Drilling Programs included the installation of 6 piezometers and 3 water wells (pump tests) on Option C, as well as 9 piezometers (2 shallow piezometers) and 1 water well (pump test) on Option D. The next groundwater level monitoring event is planned for the winter of 2017 (early March).	
	• The number and location of water wells and piezometers installed was modified during the program compared to what was originally planned based on field conditions, access permission and scheduling. It was concluded at the meeting, based on the information that was presented, that conducting additional drilling was no longer required for the current assignment. Post Meeting Follow up: • KGS Group has reviewed the status of the project budget for the field activities. Although the number of piezometers and water well installation differed slightly from what was originally planned, the field activities remain on budget. The savings from reducing the number of drilling locations has been used to offset the additional effort attributed to difficult weather conditions (very wet conditions), unforeseen drilling circumstances (i.e. heavy	

ITEM	DETAILS	ACTION BY:
	flowing well at GD08) and additional effort to coordinate access permission (e.g. First Nation). Additional desktop research was also performed to gain an understanding of the PFN wells due to the lack of access and lack of communication with PFN representatives. The majority of the remaining budget is required for the long term monitoring program until spring 2018.	
4.1	**Preliminary Findings – Surface Water**	
	• Patrice L. presented the preliminary findings of the surface water study. Details are included in the presentation slides attached to these minutes. A copy of the handouts that were provided at the meeting, showing the existing and future drainage area along Options C & D, is included in the presentation.	
	• Option C was judged to have lesser surface water concerns than Option D as it affects a relatively small area.	
	• It was noted that addressing the surface water drainage on the south side of the Option C channel will need to consider that rock is located near or at the surface is some locations and that constructing an outside drain should be considered where there is sufficient till at the surface.	
	• On Option D, the channel will result in 30% loss to the drainage area of Birch Creek, and 20% to 45% loss to the drainage area of the wetlands and small lakes. This may require some form of mitigation, such as syphon(s), small control structure(s) at the outlet of the wetland/lakes, pumping, and/or small supply drainage channel(s) from the outlet channel to Birch Creek.	
	• Surface water drainage on the west side of the Option D channel (agricultural land) will also have to be addressed as part the design.	
4.2	**Preliminary Findings – Assessment of Existing Well Use and Suitability as Drinking Water**	
	• Marci H. presented the preliminary findings of the existing well use assessment. Details are included in the presentation slides attached to these minutes. A copy of the handouts that were provided at the meeting, are included in the Draft Report Deliverable D4; Assessment of Existing Well Use and Suitability as Drinking Water Report – issued after the meeting on December 23, 2016.	
	• Groundwater from the bedrock aquifer is the sole source of potable drinking water for both routes.	
	• Option C has +/- 100 individual wells within 3km. Wells also service several water systems (residential subdivisions, bottling plant, school…). MI noted that the First Nation have commented about a potential future subdivision planned for their land.	
	• Although no field studies could be conducted on wells within the	

ITEM	DETAILS	ACTION BY:
	First Nation area near Option C for the current study (access not permitted), including water quality data or field pump tests, the overall impact of the Route C is predictable based on other existing regional data.	
	• Mitigation for drawdown for Option C will be required in a number of locations (channel invert in bedrock is below well casings for half the well records examined). Mitigation will also be required to address the high risk of surface water infiltration and bacterial contamination to aquifer (GUDI), which may include individual treatment or a community treatment and distribution system.	
	• Option D also has +/- 100 individual wells within 3km, but no community supplies were identified.	
	• The well casings near Option D are deeper and less sensitive to drawdown and easier to mitigate. Flowing conditions and upward gradients protect against infiltration of surface water in the event of a blowout in the base of the channel.	
4.3	**Preliminary Findings – Geotechnical Assessment**	
	• David A. presented the preliminary findings of the Geotechnical Assessment. Details are included in the presentation slides attached to these minutes.	
	• On Route C, there is 1 to 9m of overburden over the bedrock. In general, the confined groundwater level is at ground surface and up to 2m above grade (up to 14m above channel invert). Calculations indicate that the channel invert in overburden would blow out under existing groundwater levels during construction. Lowering groundwater levels by approximately 3.5m is required to achieve a design Factor of Safety against blow out of 1.3. Long term stability of 4H to 1V slopes to the design invert elevation meet the design criteria.	
	• On Route D, there is 16 to 26m of overburden over the bedrock. In general, the confined groundwater level is at ground surface and up to 6m above grade (up to 16m above channel invert). The channel invert in overburden would blow out under existing groundwater levels during construction. Lowering groundwater levels by approximately 4.5 m near station 11+600 and 11m near station 19+000 is required to achieve design Factor of Safety against blow out of 1.3. Long term stability of 4H to 1V slopes (with bench) to the design invert elevation meets the design criteria.	
4.4	**Preliminary Findings – Groundwater Study**	
	• Jason M. presented the preliminary findings of the Groundwater Study. Details are included in the presentation slides attached to these minutes. Detailed stratigraphic profiles and cross sections of both channel alignments were presented at a large scale.	**KGS**

ITEM	DETAILS	ACTION BY:
	Sketches were also drawn on the white board as an aid to the presentation. KGS Group will include a copy of the profiles and cross-sections with Deliverables D5/D6 to be issued within the next few weeks.	
	• Both Options C & D will require depressurization of the bedrock aquifer.	
	• Option C will result in a direct interconnection of surface water to the bedrock aquifer in an aquifer along the channel recharge area, resulting in potential GUDI conditions. Shallow well casings near Route C also contribute to GUDI concerns.	
	• The means and methods for dewatering excavation for Option C are different compared to Option D and may involve more risk.	
	• Option D requires controlled aquifer depressurization for construction, and in the long-term, to maintain an intact till channel invert. Optimization of the channel configuration to balance excavation and depressurization costs is required at the next stage of design. The depressurization may be a passive system. (i.e. no maintenance required).	
	• Depressurization for Option D would begin prior to construction, and would likely only take weeks (i.e. less than a month) to establish target groundwater levels. To avoid the risk of channel invert blowout, depressurization would have to be continuous once construction begins, even if construction activities pause depending on seasonal factors / scheduling.	
	• It was noted that relocating the control structure for Option D away from the high bedrock location could be considered at the next stage of design to address blowout concerns and depressurization requirements. MI noted that bedrock degradation is occurring at the FRWCS due to groundwater gradients and flows.	
	• Current results illustrate no interconnection of the deep bedrock aquifer to Water Lake – suggesting that there is no direct seepage pathway between the confined groundwater and the small shallow lakes adjacent to Option D.	
5.0	**Environmental Considerations**	
	• Patrice L. presented a high level overview of environmental considerations for Option C & D, largely based on the recent baseline work performed by M. Forster. Details are included in the presentation slides attached to these minutes.	
	• It was noted that clearing for construction will likely have to occur in the winter prior to nesting, etc. Construction activities will also have to consider DFO restrictions, expected to be between April 30 and June 15.	
	• Risk of stagnant conditions in the channel when not in operation can be mitigated with surface drainage, groundwater infiltration and mostly by maintaining nominal flow through the control structure.	

ITEM	DETAILS	ACTION BY:
	• Overall, Option C is less of an environmental concern relative to Option D from a biological perspective, due to the proximity of Option D to the wetlands. Appropriate design mitigation will be included to provide compensation for impacts. Post Meeting Follow up: • It should be noted that the alignment of Option D was previously shifted to the west during the Stage 2 study to avoid directly impacting the wetlands. Although more costly due to increased length and excavation quantities, the revised alignment is now on the fringe or adjacent to the wetlands, which will significantly contribute to reducing potential environmental impacts of the alignment.	
6.0	**Risk Assessment, Mitigation and Cost Allowances**	
	• Dave M. presented the preliminary results of the risk assessment. Two tables, one for Option C and the other for Option D, that described the risks and risk response, as well as summarizing the cost allowances for risk and mitigation, were provided as handouts.	
	• Although the risk assessment for the current study is focused on groundwater, surface water and geotechnical risks, other risk items (e.g. design / construction) were identified for completeness.	
	• The group addressed each risk item one by one. Proposed modifications, updates, and additions to the risk items and costs were discussed. Revised drafts of the two Cost Allowances for Risk & Mitigation Tables, which incorporate the comments from the meeting/workshop, are attached to these minutes.	
	• Option C includes an allowance for a water treatment plant and distribution system for the entire First Nation Community to address both water quality (GUDI) and quantity (drawdown) concerns. It was concluded that provision of this treatment system was the only reliable means of mitigating these risks and the risk associated with getting FN approvals. Post Meeting Follow up: • Costs associated with the Water Treatment and distribution system are substantial. KGS Group has reviewed and updated the estimate and assumptions included in the Risk Matrix. The risk cost is now estimated to be $ 79 million, and is similar to the previous estimate. The rationale and basis of this estimate will be summarized in future Deliverable D11 – Risk Assessment and Budget Quantification Report.	
	• On Option C, although groundwater contamination in the area could occur due to other reasons not related to the construction / operation of the outlet channel, the project could still be held responsible as a key source of the problem.	

ITEM	DETAILS	ACTION BY:
	• Doug M. noted that a new treatment plant would have to consider future expansion of the First Nation Community as well as long-term operation and maintenance cost.	
	• It was noted that the new water treatment plant for the Dauphin River First Nation is being paid for by INAC, and is different than what would be proposed for Option C, where the responsibility would fall to the province.	
	• The group discussed bridge design criteria concerns associated with the impact of ice flowing down the channel during operation. Ron indicated that based on discussions he has had at MI, the unit cost for the bridges should be in the range of \$4,800/m^2 per square meter area of deck. Doug was concerned that the unit price could be more. KGS has therefore adopted a revised unit price for the bridges of \$5,000/m^2 and incorporated this value in the Cost Allowance for Risk and Mitigation Matrix. This value corresponds to the average between the original unit price value of \$2,500/m^2 that was suggested by MI for Provincial/Municipal type bridges and the value of \$7,500/m^2 for PTH type bridges. MI is to confirm that they are in agreement with this approach.	**MI**
7.0	**Evaluation and Ranking of the Options**	
	• The evaluation and ranking process was based on a Decision Matrix, incorporating a weighting and rating system. Each option is then scored by multiplying the rating by the weighting and the option with the highest total score is identified as the preferred alternative.	
	• The group evaluated and ranked the Option C and Option D Outlet Channels based on the following list of categories: 1. Constructability 2. Operation & Maintenance 3. Groundwater Impacts 4. Surface water Impacts 5. Physical / Biological Environment Impacts 6. Socio-economic Considerations 7. Cost 8. Risk	
	• One category at a time, the group discussed the evaluation criteria definition and then ranked the two options based on the following scale: 1. Poor 2. Mediocre 3. Satisfactory 4. Good 5. Superior	
	• It was noted that when Option C & D are compared to the four previous options that were dismissed at the end of the Stage 1 study, Options C & D should in general be considered at least satisfactory.	

<table>
<tr><th>ITEM</th><th>DETAILS</th><th>ACTION BY:</th></tr>
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- On Option C, it was discussed that the Operation & Maintenance category should consider First Nation water treatment as well as the need for fencing/security.

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- It was noted that the Socio Economic category should also consider existing land use (e.g. agricultural land), potential issues with severance of land parcels, reductions in operations (revenue), and local acceptance of the preferred alignment.

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- After completing the rating process, the group proceeded to assign a weight to each category.

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- Based on the rankings and weightings that were determined during the workshop, the total scores for Options C & D were determined. The results were presented at the workshop for review prior to selecting the preferred alternative. The results are summarized below.

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Main Category	Weight	Option C		Option D	
		Rating	Score	Rating	Score
1. Constructability	10	3	30	3	30
2. Operation and Maintenance	10	2	20	3	30
3. Groundwater Impacts	15	1	15	4	60
4. Surface water Impacts	5	4	20	3	15
5. Physical / Biological Environment Impacts	15	4	60	3	45
6. Social Economic Consideration	20	1	20	3	60
7. Cost	10	4	40	3	30
8. Risk	15	1	15	3	45
Total Score (out of 500)			**220**		**315**

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- Based on the results, Option D was identified as the preferred alternative. It was noted that water treatment was a major new factor that made Option C much less feasible.

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<tr><td>8.0</td><td>Wrap-up / Next Steps</td><td></td></tr>
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- Based on the outcome of the workshop, **Option D has been recommended as the preferred option to proceed to the next stage of Design.**

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- Meeting Minutes (this document) will be used to document the results of the Workshop. A more detailed description of the process and results will be included in Deliverable D11.

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ITEM	DETAILS	ACTION BY:
	Post Meeting Follow up: • A letter that contains KGS's recommendation that is signed and sealed by the Project Manager will be issued to MI to support the request for approval of the preferred option from senior levels of government. The letter will reference the Technical Workshop and will append the Meeting Minutes.	**KGS**
	• KGS Group will start submitting draft deliverables documenting the study findings starting before Christmas. Post Meeting Follow up: • Deliverable D4; *Assessment of Existing Well Use and Suitability as Drinking Water Report* was issued on December 23, 2016. • Several other deliverables are nearly complete and will be submitted within the next few weeks. • KGS Group and MI discussed the proposed structure of the final report after the meeting. It was agreed that the final report will consist of a detailed Executive Summary style report, and that the final copy of each of the main deliverables would be attached to the report. Each of the deliverables will be issued in a report format similar to Deliverable D4 that has already been issued.	**KGS**

It is believed that these minutes accurately reflect the discussion held in the meeting. Please advise if there are errors or omissions.

Prepared By:

<Original signed by>

Patrice Leclercq, P.Eng.
Water Resources Engineer

PAL/mlb
Enclosure

KGS GROUP
CONSULTING ENGINEERS

Groundwater Surface Water and Geotechnical Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D

Technical Meeting/ Workshop

December 21, 2016

Science | Imagination | Collaboration

Introduction

KGS GROUP
CONSULTING ENGINEERS

- Welcome
- Housekeeping
- Round Table Introductions

Agenda

8:30 AM - Start

1.0 Goals & Objectives

2.0 Project Background / Review of Options

3.0 Overview of Field Investigations

4.0 Preliminary Findings

- Surface Water Study
- Well Use Assessment
- Geotechnical Study
- Groundwater Study
- Brief Re-cap at end

12:00 PM – Lunch

Agenda

12:30 PM – Afternoon Session

5.0 Environmental Considerations

6.0 Risk Assessment, Mitigation and Cost Allowances

7.0 Evaluation of Options

- Weighting
- Rating

8.0 Wrap up / Next Steps

Goals & Objectives

- Present technical information pertaining to groundwater, surface water and geotechnical design that will contribute to the evaluation of Options C & D
- Evaluate and rank the suitability of the options in meeting the objectives of the project, considering cost and risk.
- Identify a preferred option to proceed with Preliminary Design.

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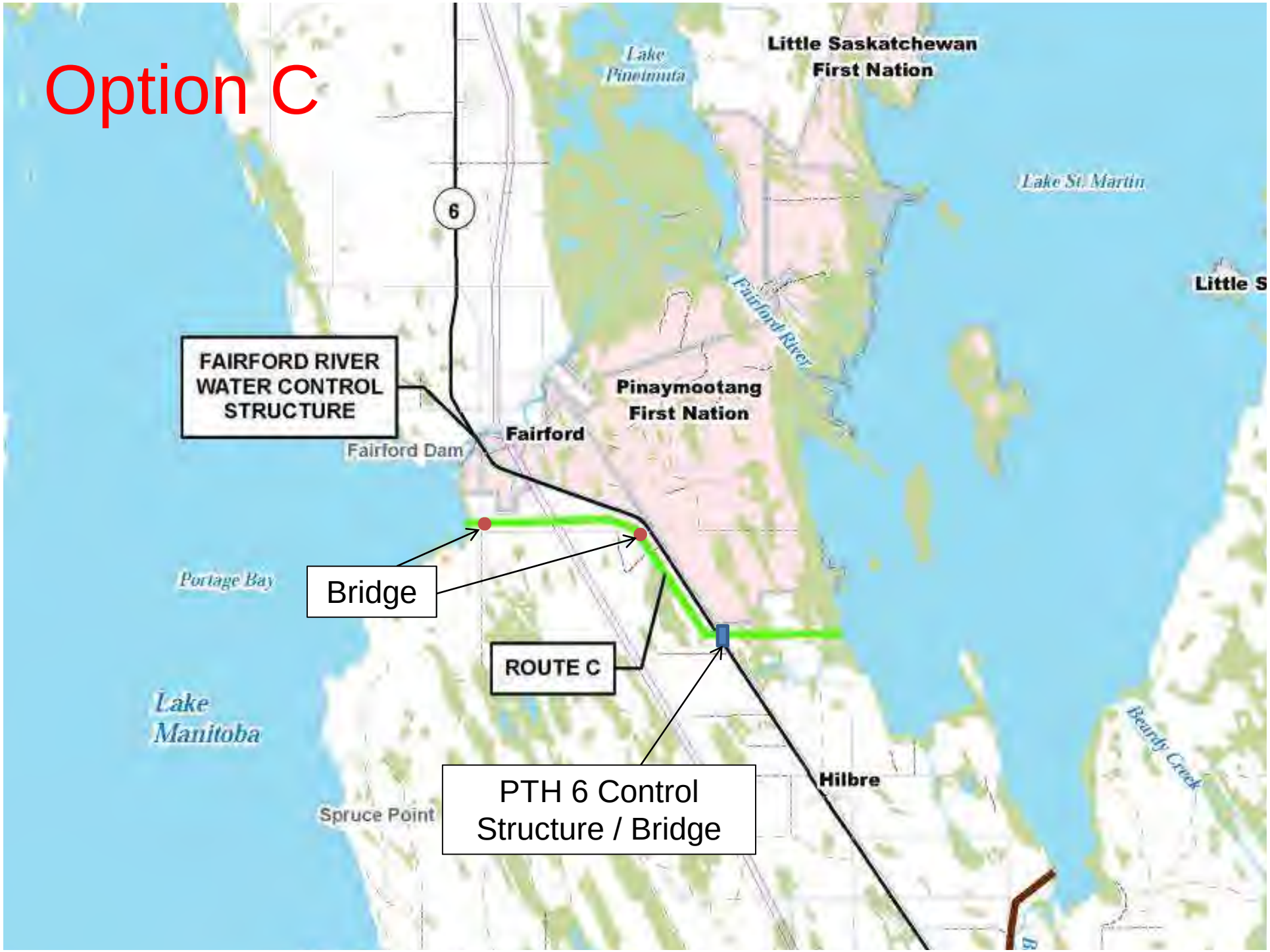
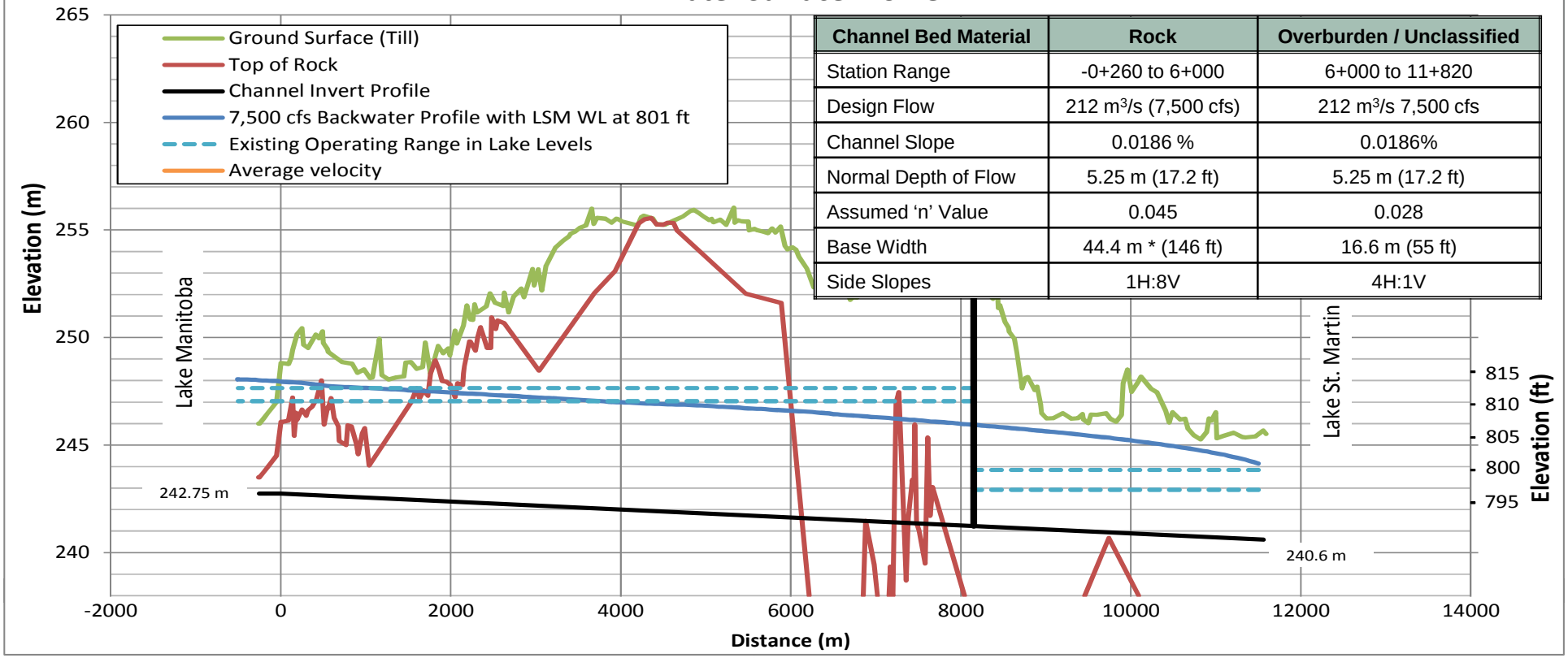
2. Project Background

REACH 3 (WILLOW POINT OPTION)
REACH 3 (JOHNSON BEACH OPTION)
REACH 2 OPTION 1 & 2
REACH 2 OPTION 3
REACH 2 OPTION 4
ACCESS ROAD ALIGNMENT
END OF FORESTRY ROAD
EXISTING FORESTRY ROAD
REACH 2 DIKE
REACH 1 EXTENSION
REACH 1 CHANNEL
PROPOSED 24 kV POWER LINE
EXISTING DEWALD ROAD
OPTION D
OPTION C
FAIRFORD RIVER WATER CONTROL STRUCTURE
Dauphin River 48A
Big Rock Campground
The Narrows 49B
Little Saskatchewan 49E
Lake St. Martin
The Narrows 49
Little Saskatchewan First Nation
Gypsumville
Fairford First Nation
Fairford
St. Martin Junction
Steep Rock
Spearhill
Rathern
Moosehorn
Grahamdale
Hebra
Faulkner
Area of Interest
DRAFT
PRELIMINARY
KGS GROUP
Manitoba Infrastructure
PRELIMINARY DESIGN FOR REACH 2 OF THE LSM OUTLET CHANNEL
GENERAL SITE PLAN
OCTOBER 2018
FIGURE 1
A

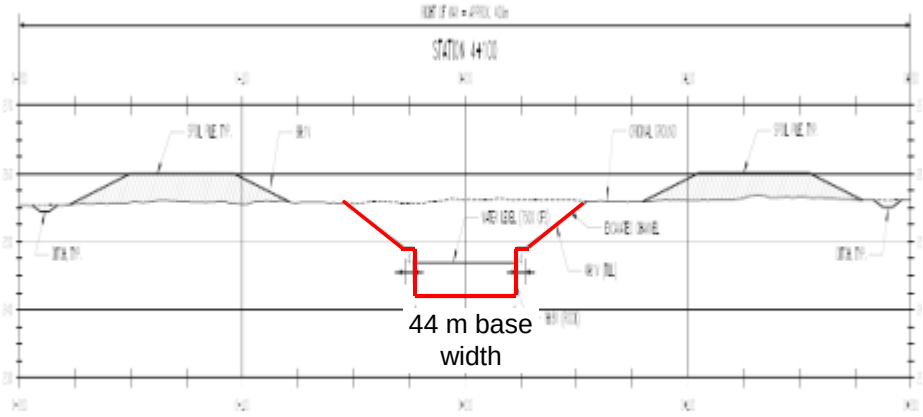
Option C


Lake Pineimuta
Little Saskatchewan First Nation
Lake St. Martin
6
Fairford River
Little S
FAIRFORD RIVER WATER CONTROL STRUCTURE
Pinaymootang First Nation
Fairford
Fairford Dam
Portage Bay
Bridge
ROUTE C
Lake Manitoba
Hilbre
Beardy Creek
Spruce Point
PTH 6 Control Structure / Bridge

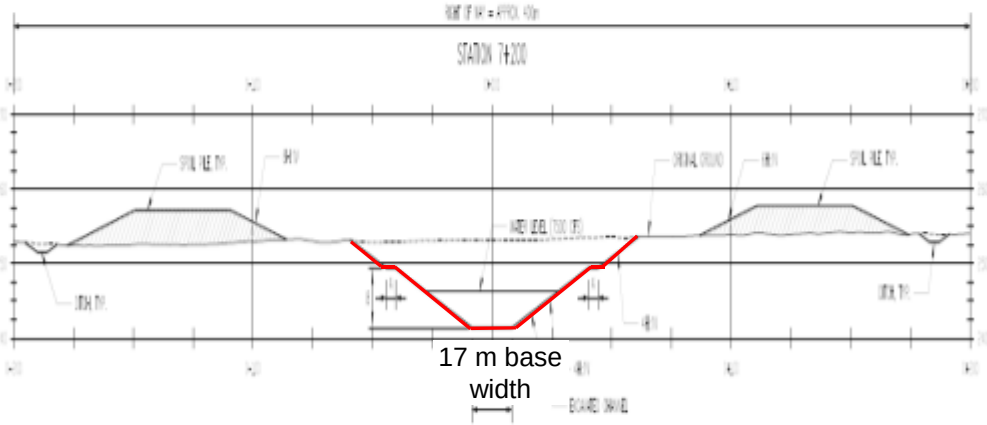
Water Surface Profile



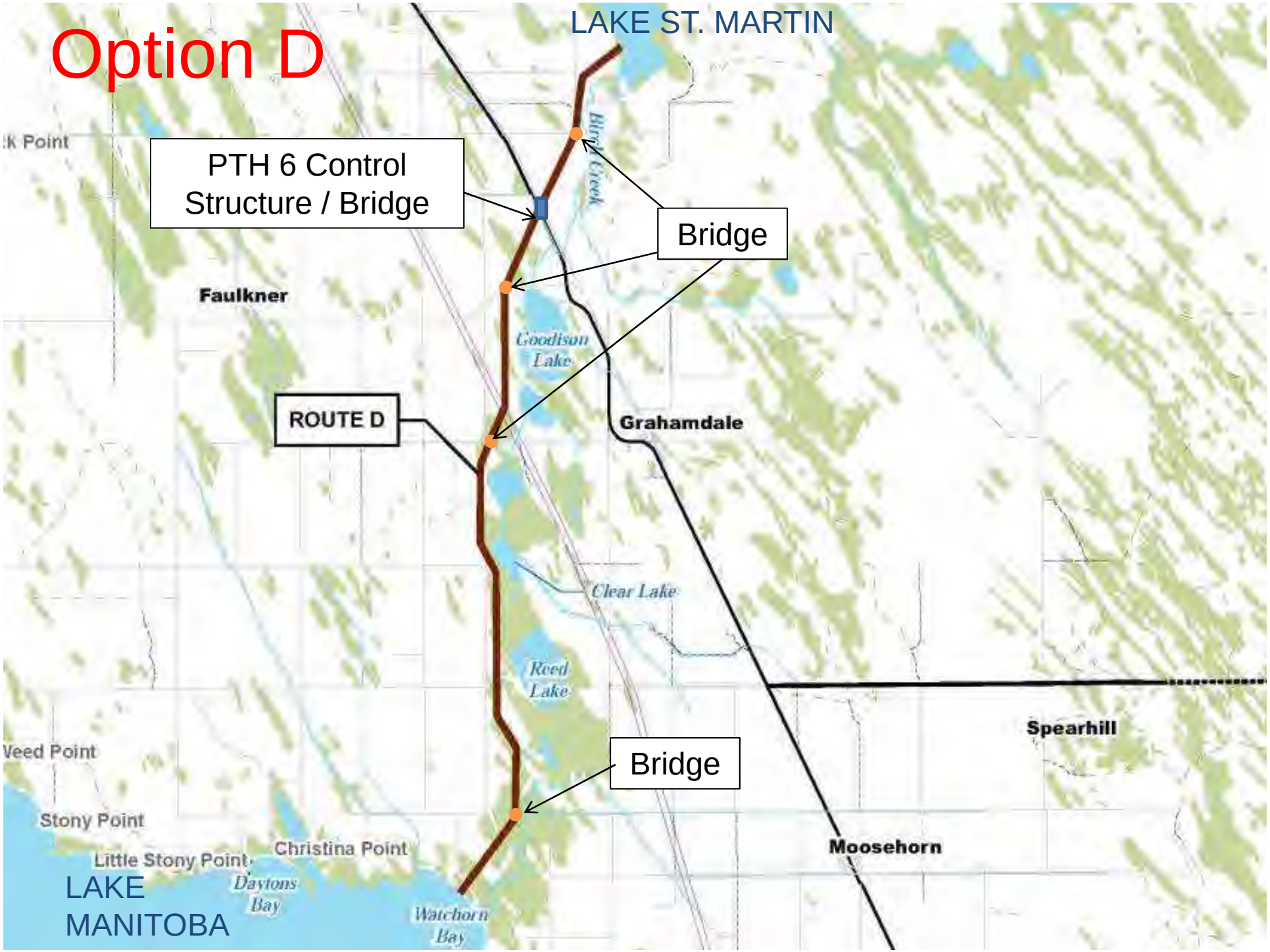
Channel Bed Material	Rock	Overburden / Unclassified
Station Range	-0+260 to 6+000	6+000 to 11+820
Design Flow	212 m^3/s (7,500 cfs)	212 m^3/s 7,500 cfs
Channel Slope	0.0186 %	0.0186%
Normal Depth of Flow	5.25 m (17.2 ft)	5.25 m (17.2 ft)
Assumed 'n' Value	0.045	0.028
Base Width	44.4 m * (146 ft)	16.6 m (55 ft)
Side Slopes	1H:8V	4H:1V



ROUTE C - CROSS SECTION IN ROCK

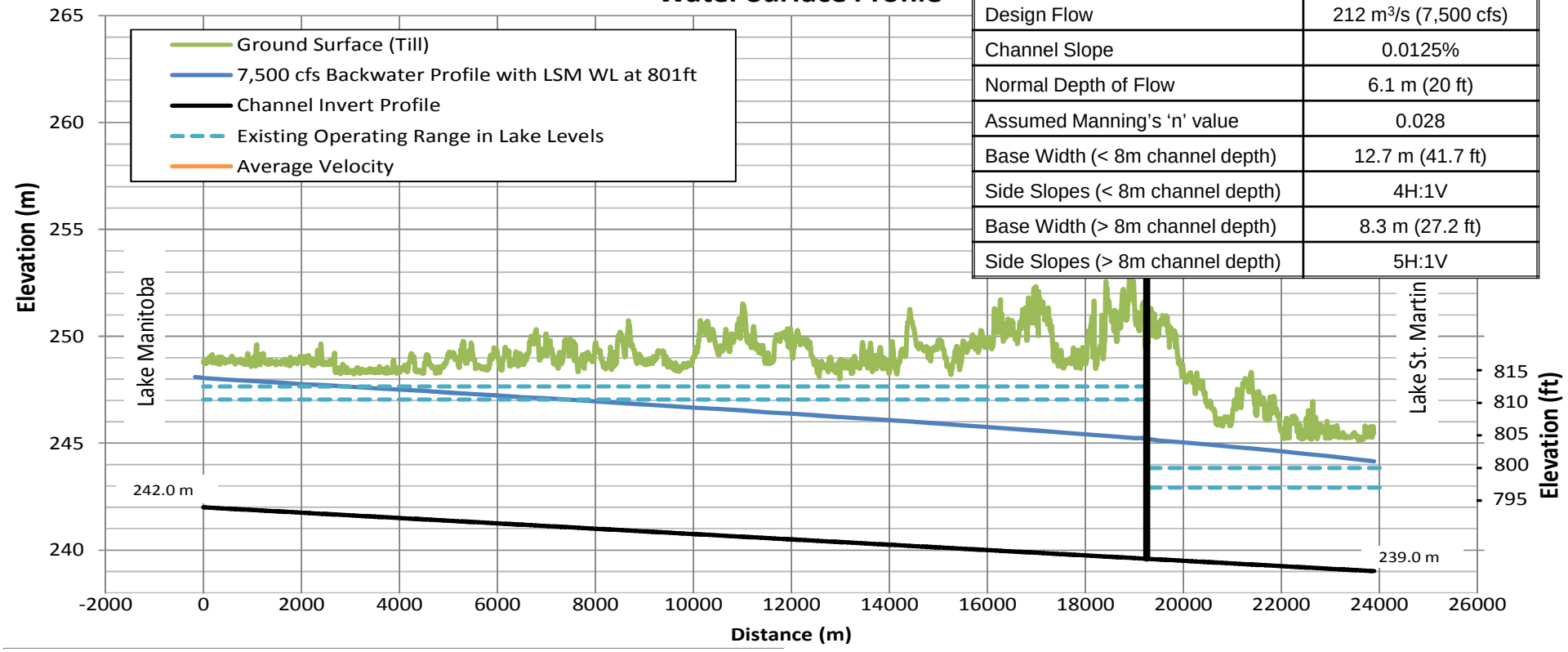


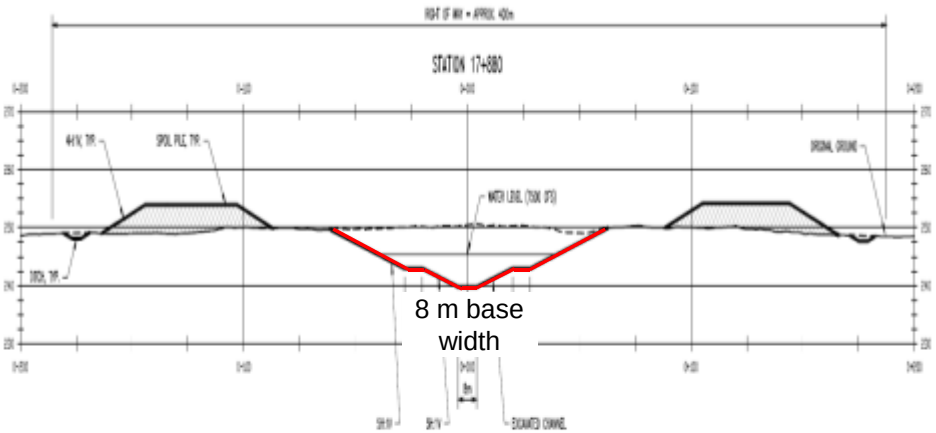
ROUTE C - CROSS SECTION > 8m CUT


Option D
LAKE ST. MARTIN
PTH 6 Control Structure / Bridge
Bridge
Bridge
ROUTE D
Faulkner
Grahamdale
Spearhill
Moosehorn
Birch Creek
Goodison Lake
Clear Lake
Reed Lake
Stony Point
Little Stony Point
Christina Point
Daytons Bay
Watchorn Bay
LAKE MANITOBA

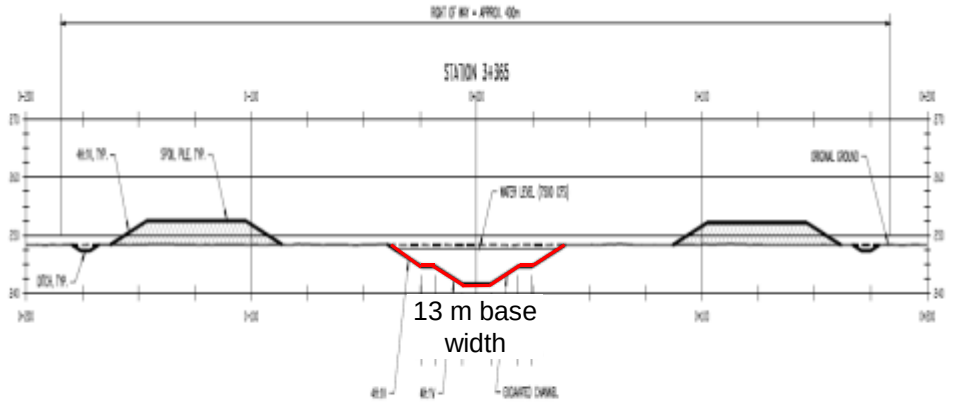
Water Surface Profile

Design Flow	212 m^3/s (7,500 cfs)
Channel Slope	0.0125%
Normal Depth of Flow	6.1 m (20 ft)
Assumed Manning's 'n' value	0.028
Base Width (< 8m channel depth)	12.7 m (41.7 ft)
Side Slopes (< 8m channel depth)	4H:1V
Base Width (> 8m channel depth)	8.3 m (27.2 ft)
Side Slopes (> 8m channel depth)	5H:1V





ROUTE D - CROSS SECTION >8m CUT



ROUTE D - CROSS SECTION 8m CUT OR LESS

Generalized Groundwater Conditions

- **Perched upper water table within postglacial silts and clays, tills, and intertills; till K is low**
- **Confined, bedrock aquifer; depth to bedrock variable**
- **Bedrock aquifer has paleokarst features**
- **Where bedrock is high elevation with thin overburden – recharge area**
- **Where bedrock is deep with thick overburden cover – discharge areas**
- **Where ground elevation is low, such as adjacent to lakes – flowing artesian well conditions showing strong discharge gradients**
- **Bedrock permeability is generally low**

Stage 2 Study Recommendations
Options C & D

- Key recommendations addressed in current assignment:
  - Water well survey and field investigations
  - Groundwater monitoring
  - Geotechnical investigations and Laboratory soils testing

- Other recommendations:
  - Optimization of channel design
  - Study of shoreline processes / inlet outlet design

Major Issues

- Potential impacts on groundwater users
  - Individuals & First Nation
- Potential impacts of groundwater on design, construction, and operation
  - Geotechnical design
- Potential impacts on surface water movement
- Potential impacts on wetlands
- Erosion potential as a result of construction or operation
- Management of groundwater / surface water during construction and operation
- Proximity of First Nation Land

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3. Overview of Field Investigations

Surface Water Monitoring

- 10 location sampled along Options C&D (Nov. 2016; see handouts)
  - In situ and analytical data
- Water level monitoring at 2 locations (Reed Lake and Water Lake)
- Continued seasonal monitoring until spring 2018
  - Next event planned for Spring 2017

Domestic Well Inventory

- Domestic wells sampled Oct./Nov. 2016; see handouts:
  - **Option C** – 3 wells (Limited due to access restrictions to Pinaymootang FN)
  - **Option D** – 19 wells

Proposed sampling program 40 wells (20 from each of Options C & D).

One-time sample event to establish baseline

Environmental and Geotechnical Drilling Programs

Option C (Oct./Nov. 2016; see handouts)

- 2 environmental piezometers
- 4 geotechnical piezometers
- 3 water wells (pump tests)

Eliminated:

- 1 enviro piezometer
- 1 geotechnical piezometer
- 1 water well

Environmental and Geotechnical Drilling Programs

Option D (Oct./Nov. 2016; see handouts)

- 2 environmental piezometers
- 2 shallow piezometers (Water Lake)
- 5 geotechnical piezometers
- 1 water well (pump tests)

Eliminated:

- 4 geotechnical piezometer

October Field Program

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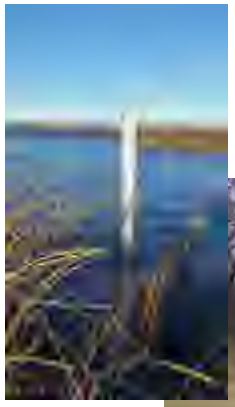

Groundwater Level Monitoring and Quarterly Water Quality Sampling

- Sampled new and existing GW wells (October & November 2016)
- 6 quarterly events proposed
- In situ and analytical data for groundwater quality

- Continued seasonal monitoring until spring 2018
  - Next event planned for Winter (early March) 2017

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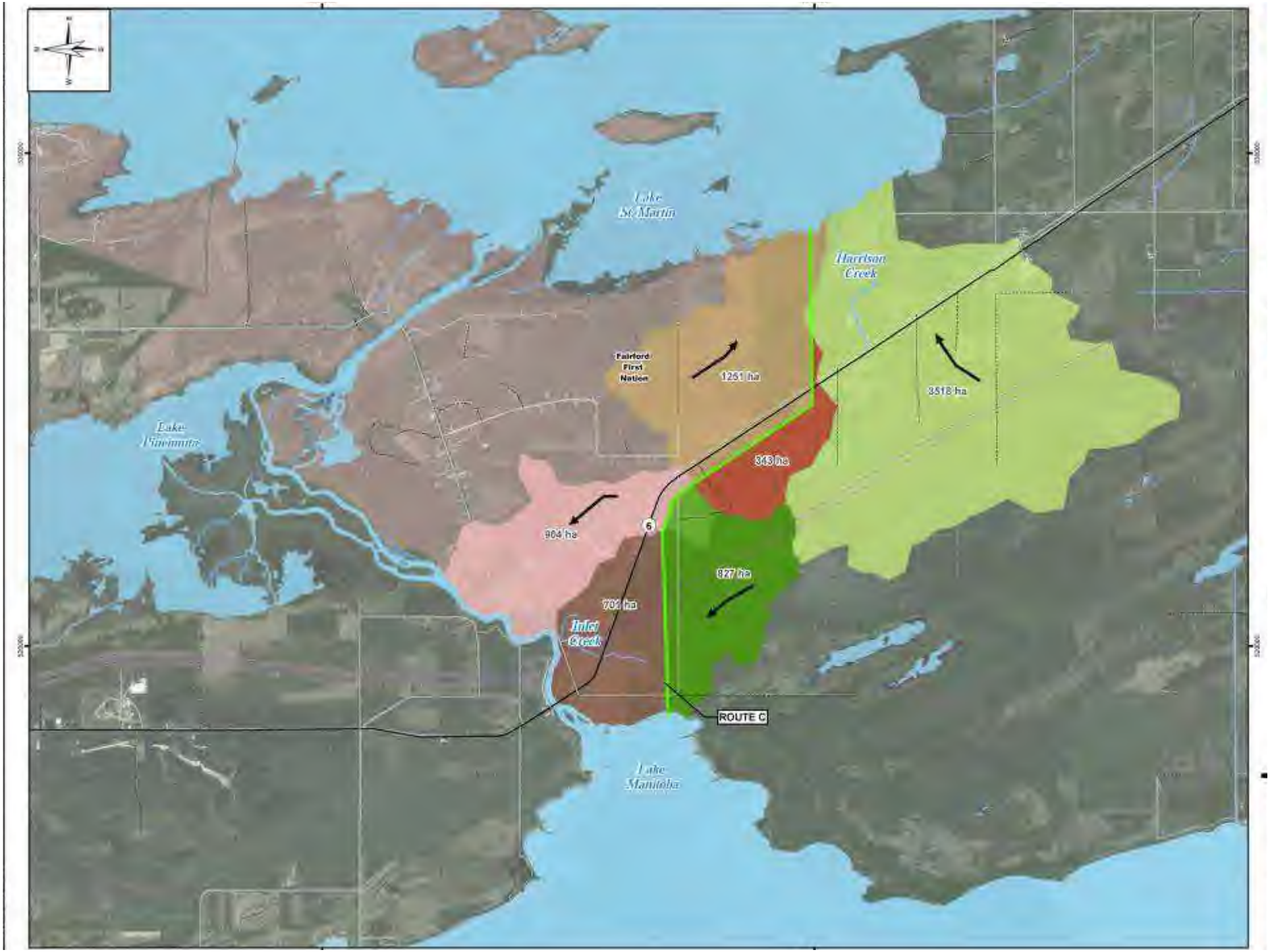
4.1 Preliminary Findings – Surface Water

Surface Water Study

- Surface water monitoring & testing
  - ongoing
- Assessment of surface water hydrology
  - Existing and future surface water hydrology
  - Interaction with groundwater addressed separately
- Preliminary surface water management plan
  - Future surface water drainage
  - Erosion control and surface water management

Lake
St. Martin
Harrison
Creek
Fairford
First
Nation
1694 ha
3518 ha
Lake
Pineimuta
985 ha
6
1447 ha
Inlet
River
ROUTE C
Lake
Manitoba


Lake St. Martin
Harrison Creek
Fairford First Nation
1251 ha
3518 ha
Lake Pineimuta
343 ha
6
904 ha
827 ha
704 ha
Inlet Creek
ROUTE C
Lake Manitoba

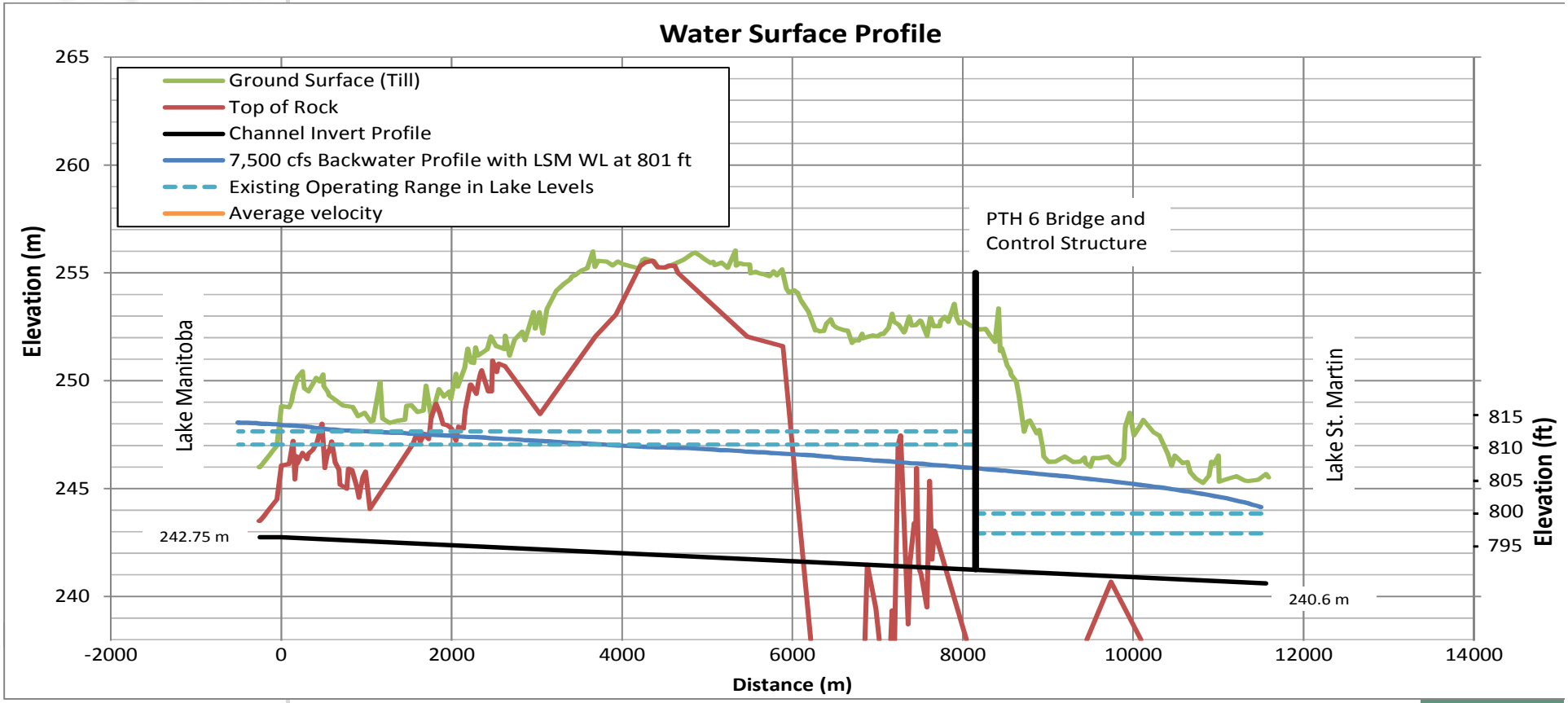
Option C – Hydrology Summary

- 50 % loss to the drainage area of Inlet Creek
  - Small basin with poor existing drainage
  - Impacts not expected to be significant
- Insignificant change to Harrison Creek surface drainage

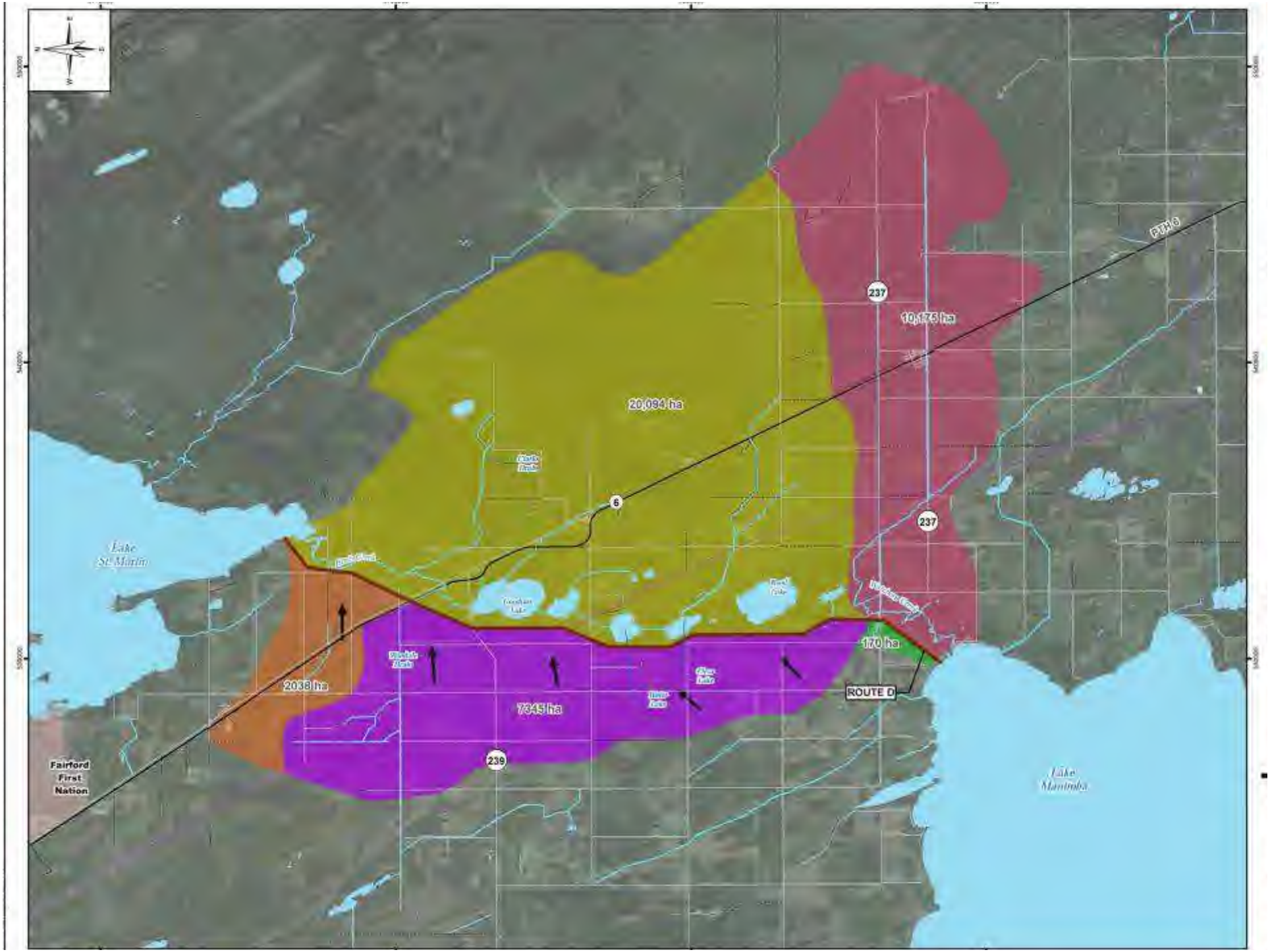
Option C – Future Drainage Plan

- Need to address surface water drainage on south side of channel
  - Rock near surface in some locations
  - Outside drain
  - may need small drop structure upstream of PTH 6 crossing

Option C


Water Surface Profile
Ground Surface (Till)
Top of Rock
Channel Invert Profile
7,500 cfs Backwater Profile with LSM WL at 801 ft
Existing Operating Range in Lake Levels
Average velocity
PTH 6 Bridge and
Control Structure
Lake Manitoba
Lake St. Martin
242.75 m
240.6 m
Elevation (m)
Elevation (ft)
Distance (m)
265
260
255
250
245
240
815
810
805
800
795
-2000
0
2000
4000
6000
8000
10000
12000
14000

Drainage Name | Area (ha)
A1 - Watchorn Creek | 10345
A2 - Reed Lake | 2389
A3 - Clear Lake - Water Lake | 7539
A4 - Goodison Lake | 6505
A5 - Clarks Drain | 5727
A6 - Woodale Drain | 3591
A7 - Birch Creek | 3727
A2 to A7 - Total Birch Creek | 39822
A1= 10345 ha
A5= 5727 ha
A3= 5272 ha
A4= 5038 ha
A7= 1690 ha
A2= 1311 ha
A6= 57 ha
A1a= 170 ha
A7a= 2035 ha
A4a= 1457 ha
A2a= 1077 ha
A3a= 1267 ha
A6a= 3524 ha
ROUTE D
Lake St. Martin
Lake Manitoba
Fairford First Nation
PTH 6
237
239
6


20,094 ha
10,175 ha
2038 ha
7345 ha
170 ha
237
237
6
239
PTH 6
ROUTE D
Lake St. Martin
Lake Manitoba
Fairford First Nation

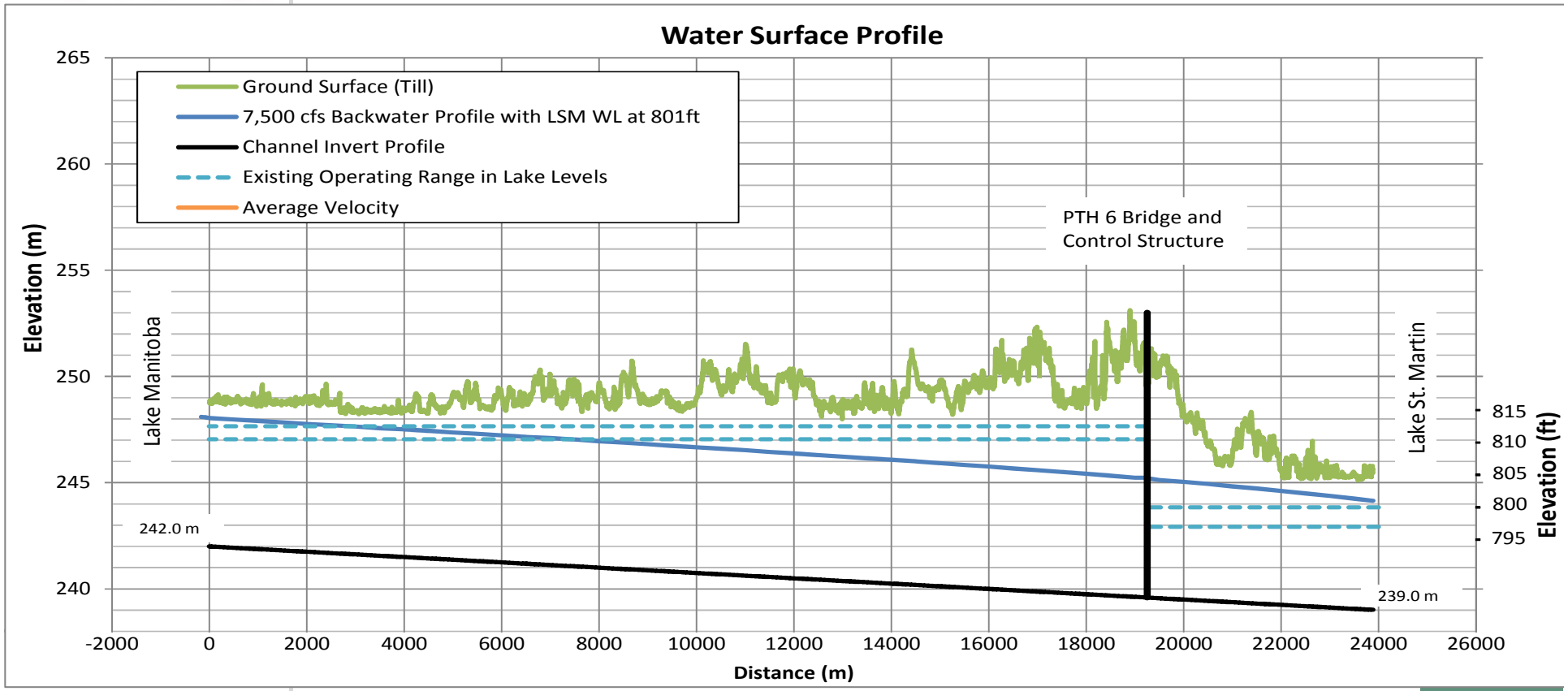
Option D – Hydrology Summary

- ~30 % loss to the drainage area of Birch Creek
- ~20 % to 45 % loss to the drainage area of the wetlands and small lakes
- Insignificant change to drainage area of Watchorn Creek

Option D – Future Drainage Plan

- Need to address surface water on north side of channel
  - Construction of outside drain
  - Construction staging
- Relatively flat topography
  - Need detailed surveys of existing drains & ditches

Option D


Water Surface Profile
Ground Surface (Till)
7,500 cfs Backwater Profile with LSM WL at 801ft
Channel Invert Profile
Existing Operating Range in Lake Levels
Average Velocity
PTH 6 Bridge and
Control Structure
Lake Manitoba
Lake St. Martin
242.0 m
239.0 m
Elevation (m)
Elevation (ft)
Distance (m)
265
260
255
250
245
240
815
810
805
800
795
-2000
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
24000
26000

Option D – Future Drainage Plan

- Assumed flow diverted into channel with drop structure
  - Upstream vs downstream of PTH 6 crossing
  - Multiple smaller structures and or divert directly into LSM / LMB are alternatives
- Mitigating impacts to Birch Creek flows & wetland water levels
  - Syphon(s)
  - Control structure(s)
  - Pumping and/or small supply channel(s)

Other Considerations

- Birch Creek re-alignment
  - Optimization of Option D channel alignment at next stage of design to minimize impact
- Risk of poor vegetation growth on channel side slopes
  - Risk concentrated in proximity of control structures
- Impacts to water quality
  - Construction & long term operation

4.2 Preliminary Findings – Assessment of Existing Well Use and Suitability as Drinking Water

Location of Residences and GW Drill Records

Potential Well locations based on Air Photo Imagery

- Route C
  - Plate D4-2 Estimated 100 (within 3 km)
- Route D
  - Plate D4-6 Estimated 75 (within 3 km)

Location of Residences and GW Drill Records

GW Drill Logs (may include old wells 1900, 1920's not in use)

- Route C
  - Plate D4-3 96 logs
- Route D
  - Plate D4-7 135 logs

Regional Water Supply Use

Groundwater is ***only*** source identified for water supply

ROUTE C

Outside of Pinaymootang First Nation

- Domestic
- Domestic and Livestock

Pinaymootang First Nation (Information from Public Sources)

- Homes are on individual domestic wells

Community systems serve:

- 38 home development (2 wells)
- 7 well development (1 well)
- Water Treatment Bottling plant (treatment system)

Regional Water Supply Use

ROUTE C – continued

Pinaymootang First Nation (Information from Public Sources) - continued

Plus individual wells at:

- Arena
- Gas Station
- School (treatment System)
- Resort and Campground
- Other public businesses buildings

Regional Water Supply Use

ROUTE D- Rural area

- Domestic Use
- Domestic/Livestock
- Livestock Use
- Local Population centres lie outside of 3 km distance from channel (Grahamdale, Hilbre)

General Stratigraphy

Route C

- Topsoil
- Till (thicker at the inlet and outlet, thin in the centre with bedrock near surface)
- Bedrock

Route D

- Topsoil
- Till (thicker along channel alignment and just west of the alignment, thinner east of the Birch Creek wetland system and west at approximately 2 km distance)
- Bedrock

Aquifer Systems and Piezometric Levels

Carbonate Aquifer Main Source on Both Routes

- Some other aquifers are noted in GWDrill logs
- Sand and gravel, shale, sandstone Not clear if these are being used presently

Aquifer Systems and Piezometric Levels

Route C

- Shallow depth to Groundwater (0 to 4 m bgs)
- Deepest in central section (1 to 4 m below groundwater surface) recharge area with downward gradients
- Flowing wells- Artesian at outlet

Route D

- Many areas with flowing wells- Artesian along alignment (0 to +6 m above ground surface)
- Shallow depth to groundwater away from channel 0 to -3 m bgs

Well Construction

Casing Depth important factor for evaluating adverse impacts and possible mitigation

Route C Plate D4-4

- Casing depths 0- 10 m in many areas will be above GW drawdown during construction

Route D Plate D4-8

- Casing depths are deeper closer to the channel because bedrock is deep
- Less potential for affecting water supplies if drawdown occurs

Well Capacities and Estimated Transmissivity

Affect how drawdown is transmitted in aquifer

- Route C Plate D4-5
- Route D Plate D4-9

On both routes generally low aquifer transmissivity based on well capacity

- <5000 USgpd/ft in 90% of wells
- A few wells to 15,000 USgpd/ft
- Very few higher and over >50,000 USgpd/ft
- Variability expected as flow is in fractures and solution channels

Aquifer Vulnerability

***Route C*- High Aquifer vulnerability due to:**

- Shallow depth to bedrock along alignment, particularly in central section
- Groundwater near surface
- Thin till cover
- Fractured bedrock
- Downward vertical gradients in bedrock (as found in investigation program)
- Proposed channel invert would be in the bedrock

Aquifer Vulnerability

Route D- Low Aquifer vulnerability due to:

- Greater depth to bedrock and thick till along alignment
- Flowing conditions, upward gradients
- Proposed channel invert will be in the till many metres above the bedrock

Well Inventory and Water Quality Results

Route C 3 homes- south of channel

- 1 near inlet reported either sediment and had high nitrate and elevated chloride
  - could be septic influence
- 1 near outlet reported odour and E. coli and boils water before drinking
  - had copper, iron and lead above CDWQ
  - copper and lead not confirmed in duplicate
- 1 near outlet had total coliform 1 count in this sampling
  - Not enough of a sample to define regional water quality.

Well Inventory and Water Quality Results

Route D 19 homes

- Potable water quality
- 3 wells had total coliform (2 to 3 counts) no E. coli detected
- Nitrates notably very low as are chloride and sodium
- Sulphate present in water
- Only 3 wells above 500 mg/L TDS
- Iron above CDWQ in 5 wells
- Some use of softeners or other filters

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4.3 Preliminary Findings – Geotechnical Study

Stratigraphy

- Route C
  - 1 to 9 m of overburden over bedrock
  - Overburden typically consisted of compact to very dense clayey silt till to silty clay till
  - Bedrock typically was dolomite to dolomitic limestone to limestone
  - Invert of channel typically in the bedrock
- Instrumentation
  - Vibrating wire piezometers in the till and standpipes in the bedrock

Stratigraphy

- Route D
  - 16 to 26 m of overburden over bedrock
  - Overburden typically consisted of compact to very dense clayey silt till to silty clay till
  - Bedrock typically was dolomite to dolomitic limestone to limestone
  - Invert of channel in the glacial till
- Instrumentation
  - Vibrating wire piezometers in the till and standpipes in the bedrock

Soils and Groundwater

- Laboratory Soils Testing
  - Grain size analyses, Atterberg Limits, Proctor tests, and Direct shear tests on reconstituted till samples
- Groundwater Conditions
  - Route C – near ground surface up to 2 m above grade (up to 14 m above channel invert)
  - Route D – near ground surface up to 6 m above grade (up to 16 m above channel invert)

Foundations

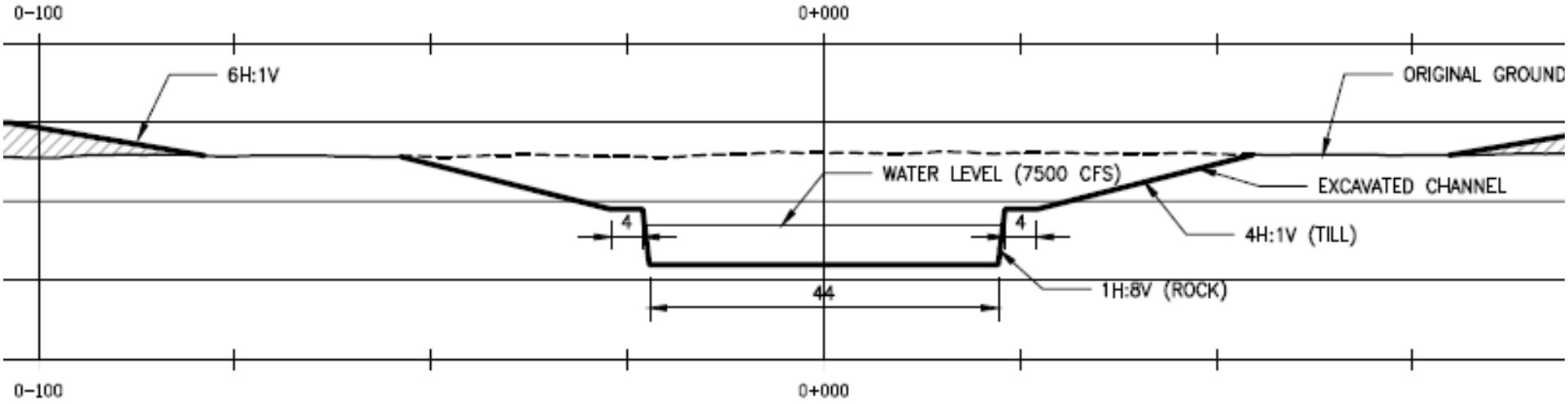
- Bridges and Control Structures
  - Suitable foundation strata - dense tills or bedrock for all bridges and control structures along both Routes C or D
    - Shallow footings, steel piles, cast-in-place piles
  - Seepage should be expected up any pile foundations (Route C and D)
  - Seepage control (grout curtain) will be necessary at the Control Structure on Route C

Stability Analysis

- Design Criteria
  - Factor of Safety (FS) of 1.3 End of Construction and FS of 1.5 Long Term
- Material Properties
  - Glacial Till Shear Strength $c' = 4$ kPa and $\phi' = 27^o$ to 35^o
- Groundwater Conditions
  - Incorporated by including a seepage analysis where boundary conditions set as the observed bedrock levels

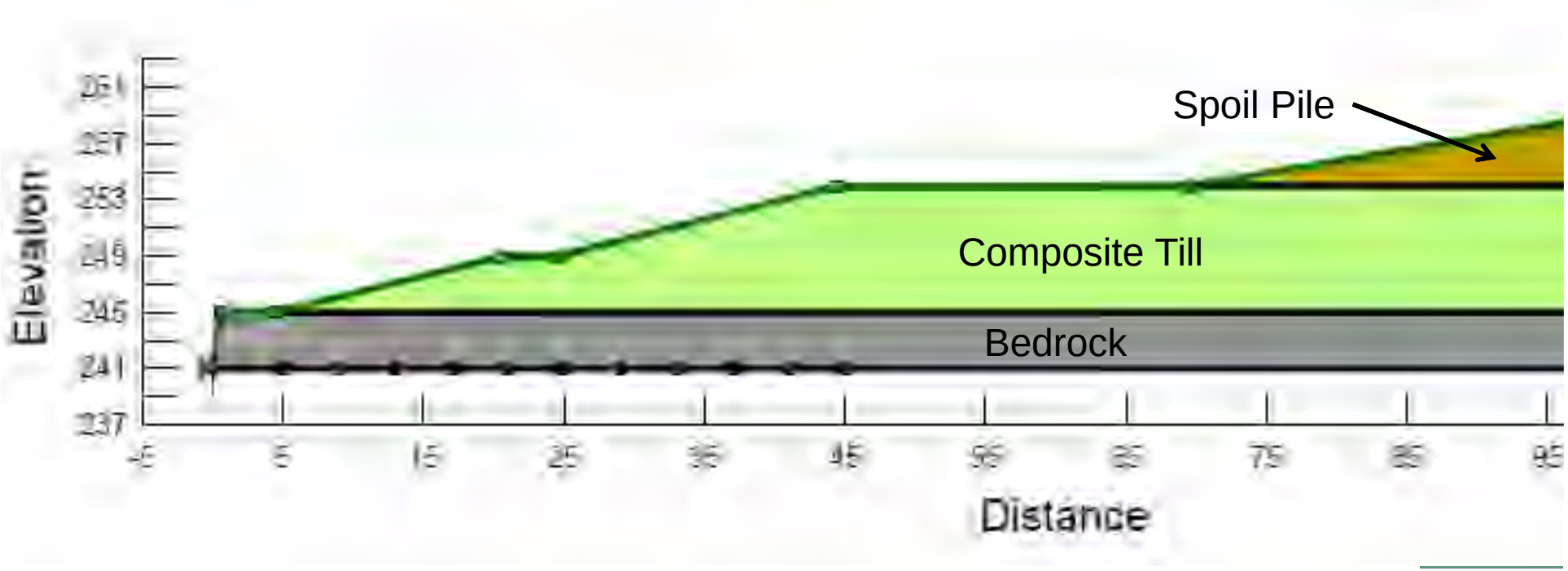
Route C

- Composite slope consisting of bedrock cut and overburden slopes
  - 1H to 8V in Bedrock
  - 4H or 5 H to 1V in overburden
  - Maximum overburden thickness of 9 m



Route C

- Sta. 6+800
  - 9 m of overburden
  - Groundwater level at Elev. 255.5 m



Stability Analysis Results

- Route C
  - End of Construction Channel to design invert elevation with existing groundwater conditions no water in channel

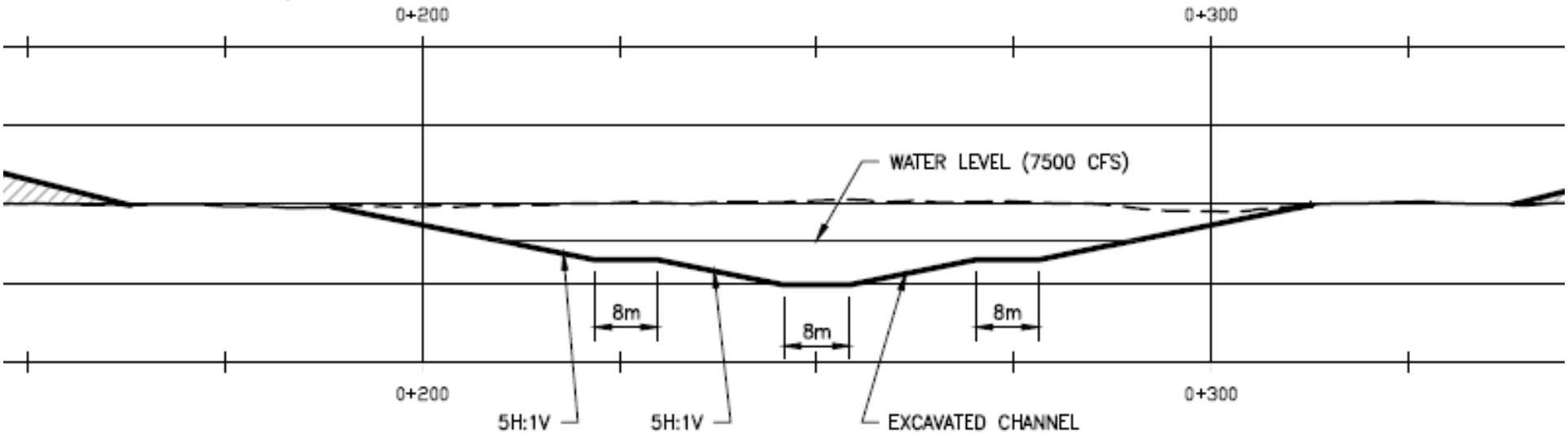
    FS < 1.0 – blowout
  - In order to achieve design EoC FS of 1.3 need to lower groundwater level 3.5 m (Elev. 252m)
  - Long Term Stability to design invert elevation 4H to 1V meets design criteria of 1.5 (FS=1.8)
    - Drawdown of GWL within limits of channel excavation

Route D

- Entire slope within overburden soils

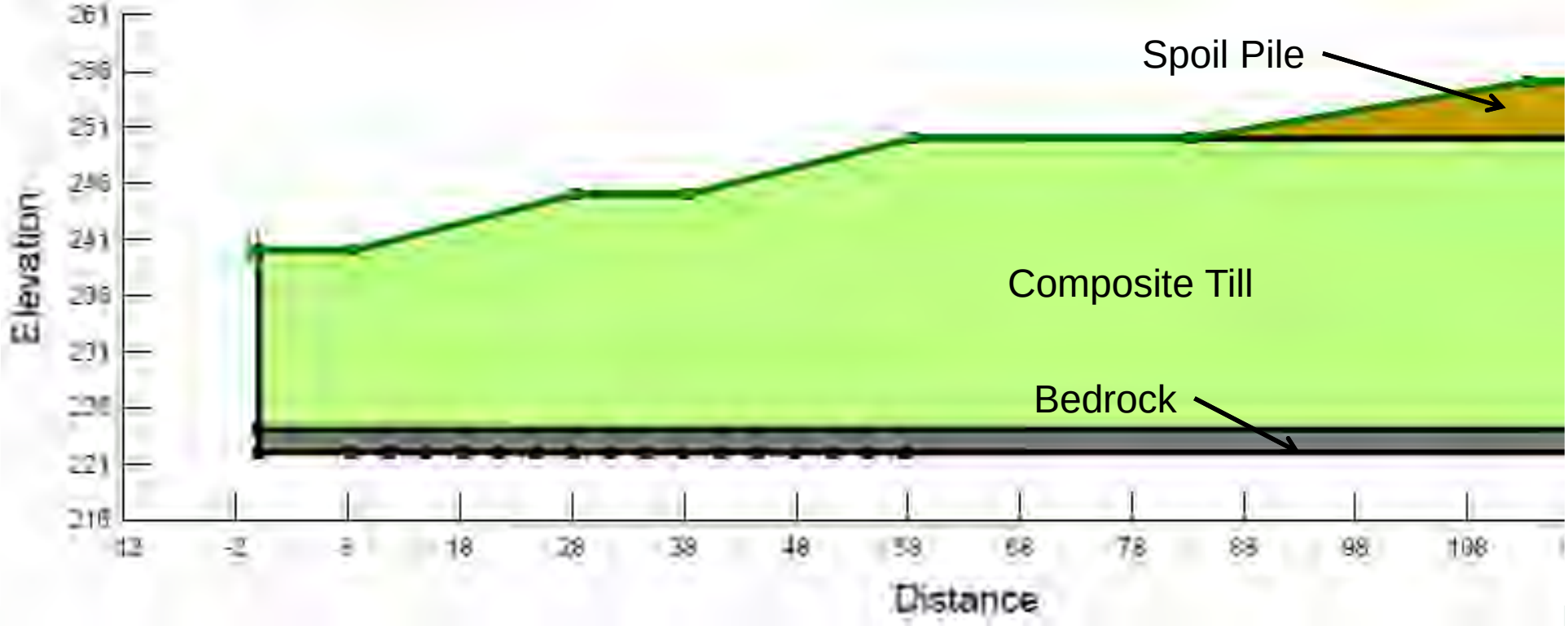
  4H or 5 H to 1V with bench

  Sections 11+600 and 19+000 were analyzed



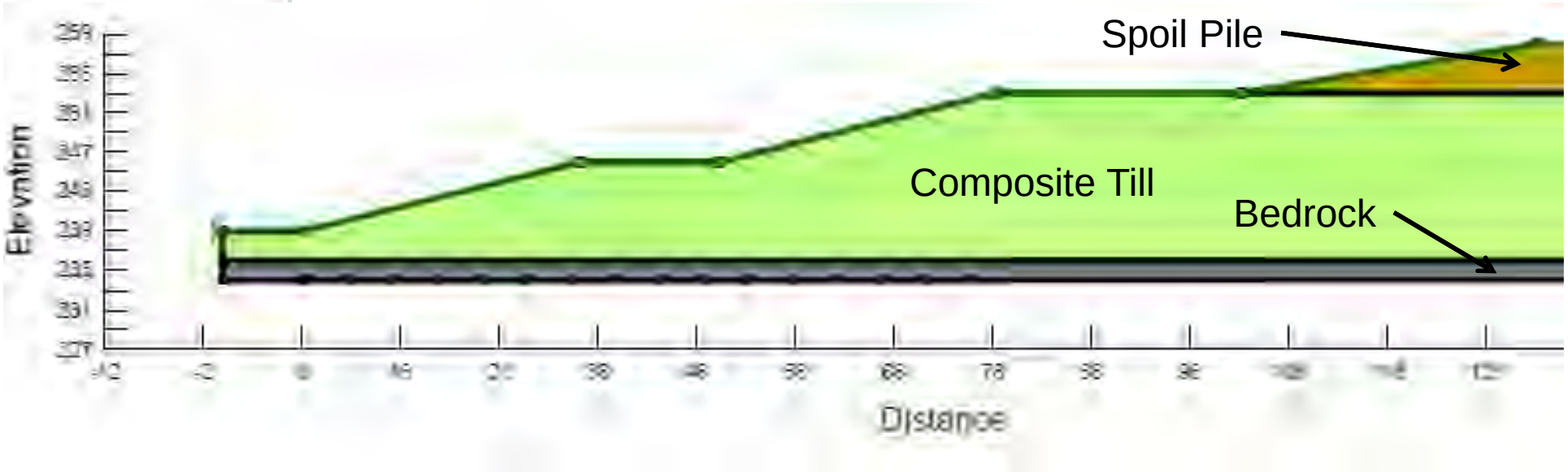
Route D

- Sta. 11+600
  - 26 m of overburden
  - Groundwater level at Elev. 255.5 m



Route D

- Sta. 19+000
  - 15 m of overburden
  - Groundwater level at Elev. 254 m



Stability Analysis Results

- Route D
  - End of Construction Channel to design invert elevation with existing groundwater conditions no water in channel

    FS < 1.0 – blowout
  - In order to achieve design EoC FS of 1.3 need to lower groundwater level:

    4.5 m (Elev. 251 m) at 11+600

    11 m (Elev. 243 m) at 19+000
  - Long Term Stability to design invert elevation 4H to 1V with bench meets design criteria of 1.5 at each section (FS=1.7 and FS=1.6)

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Break

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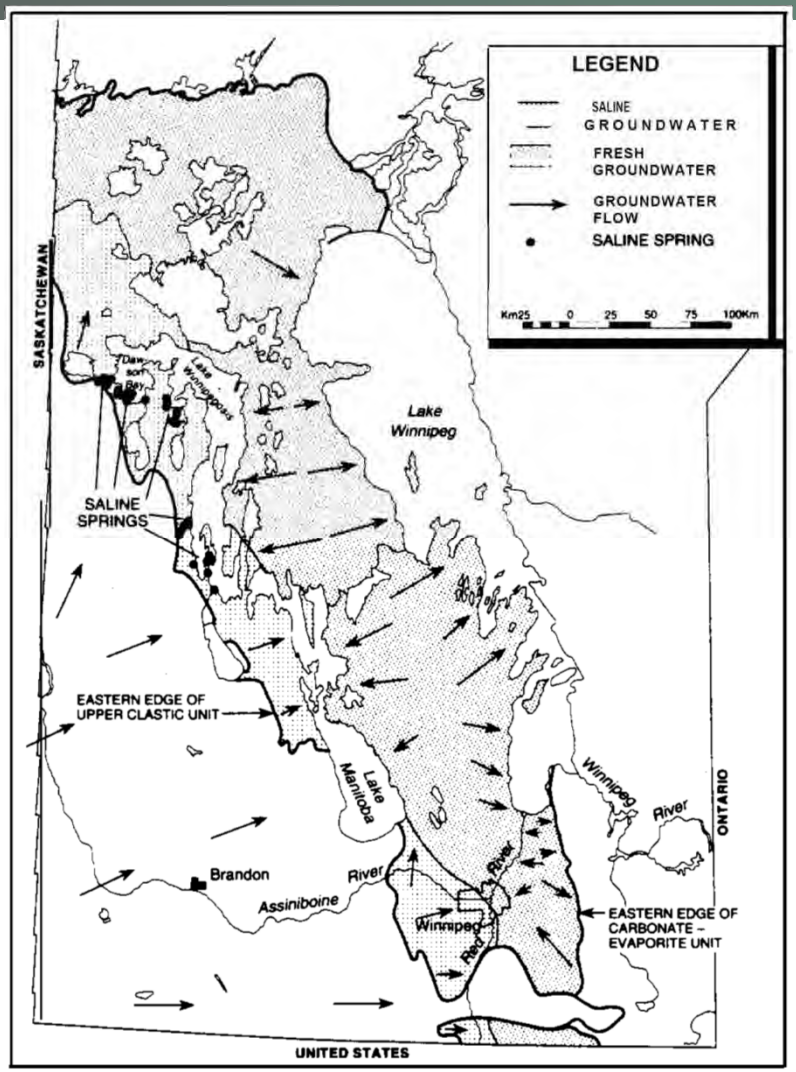
4.4 Preliminary Findings – Groundwater Study

Summary of Regional Geology

- **Overburden - sandy silt tills and discontinuous inter-till granular zones; low-lying areas - glaciolacustrine silts and clays**
- **Scattered discontinuous relict beach ridges have been used for aggregate sources**
- **Bedrock - Silurian Interlake Group, to Devonian Ashern Formation (inlet Route D)**
- **Dolomite with argillaceous (shale) zones; thickness varies between 15 m and 45 m**
- **Upper bedrock truncated by erosional surface; paleo-karst features are common; especially upland bedrock ridges**
- **Some karst features infilled with Cretaceous aged shales, and carboniferous sediments**

Summary of Regional Hydrogeology



- **Central portion of Interlake – major freshwater bedrock aquifer recharge area**
- **Recharge mound exists Between the lakes – eastward and westward flows**
- **Recharge in bedrock outcrop areas, high elevation bedrock areas with thin overburden**
- **Discharges as seepage and spring flows to lakes, streams, marshes – confined Aquifer system**
- **Also a shallow perched system in till and postglacial**

Summary of Regional Groundwater Conditions

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Depth of Bedrock Groundwater Piezometric Pressure Relative to Grade

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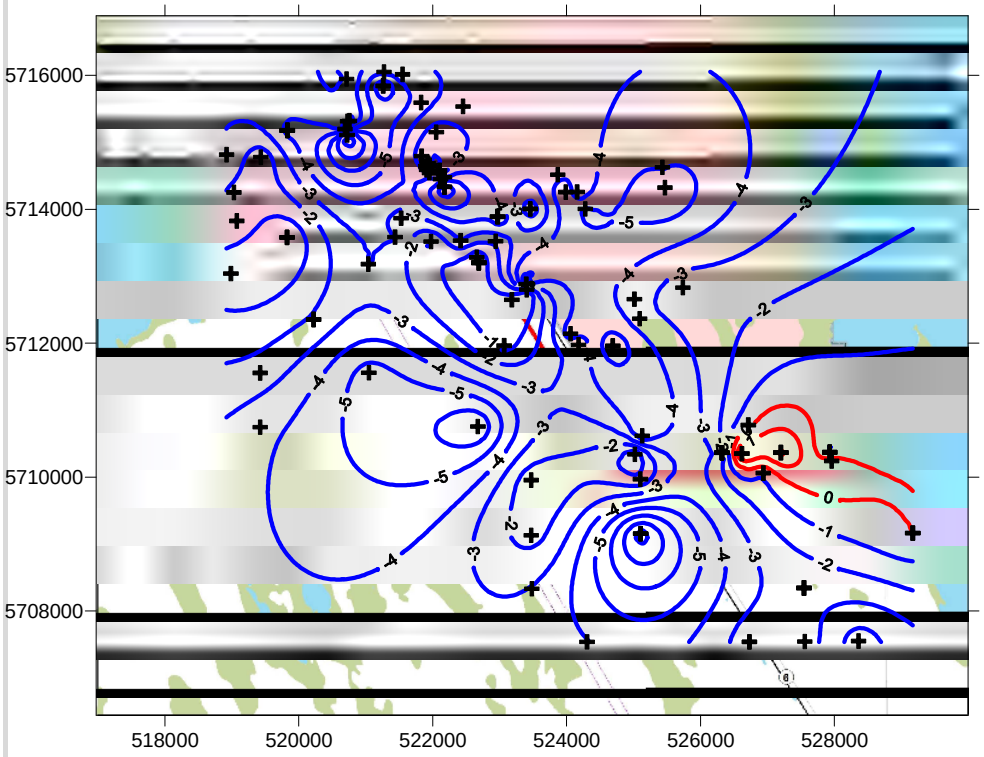

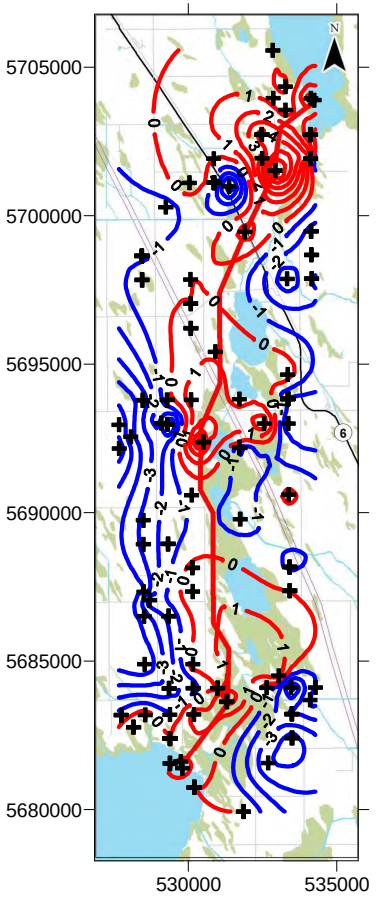

October Drilling Program

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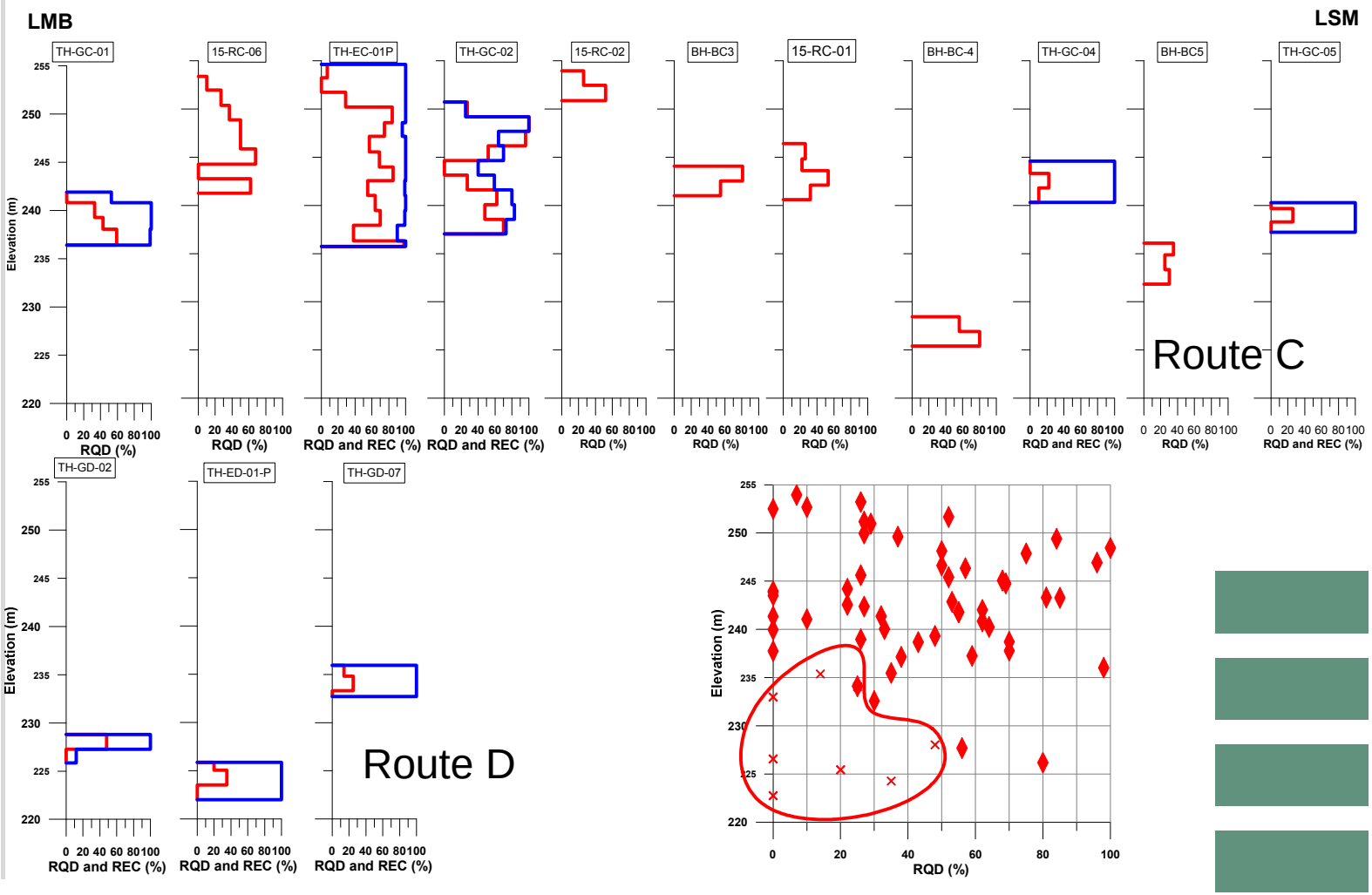
Rock Quality Designation (RQD)



Route D Topography

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Route D Bedrock Surface

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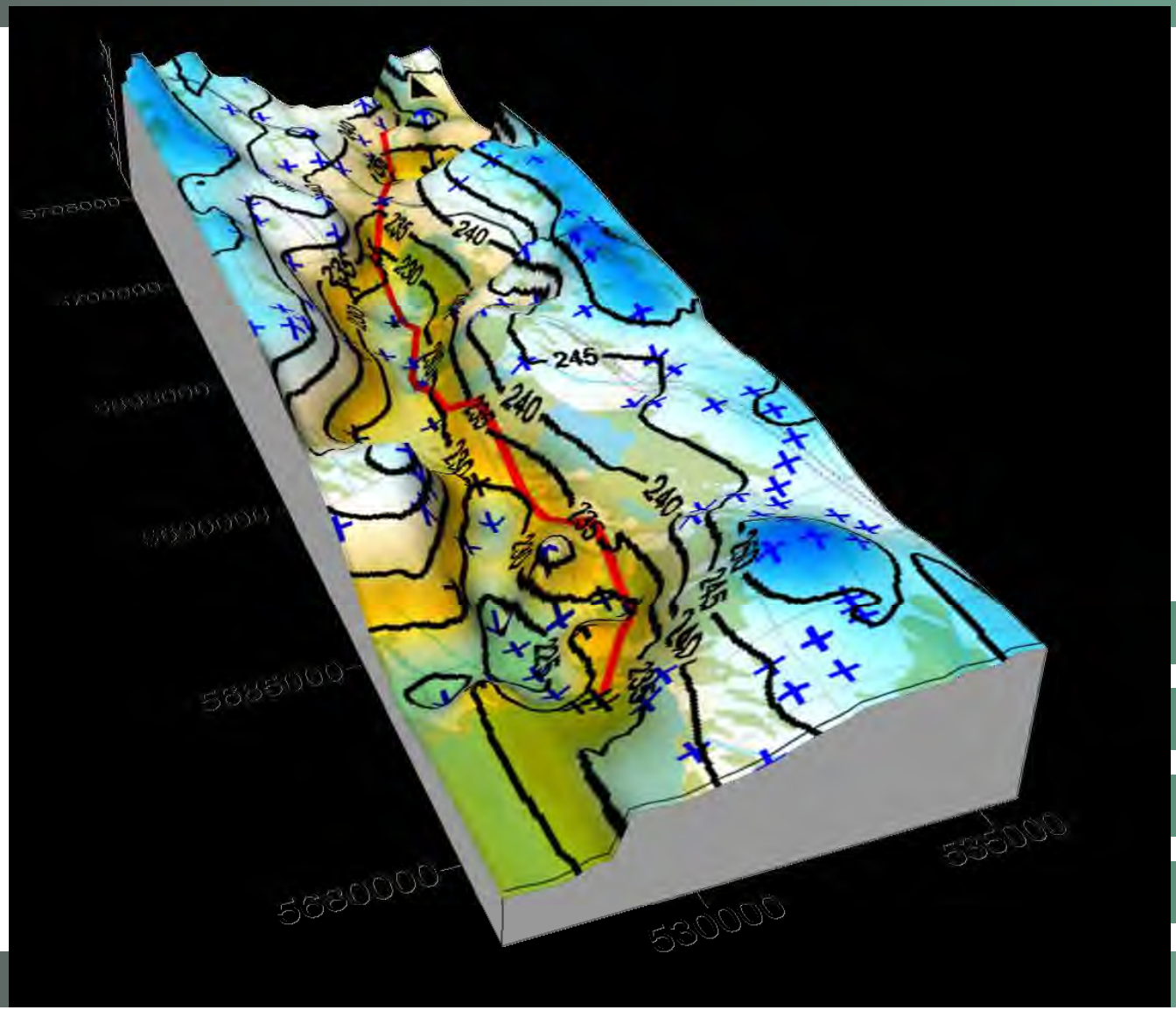

Route D Overburden Thickness

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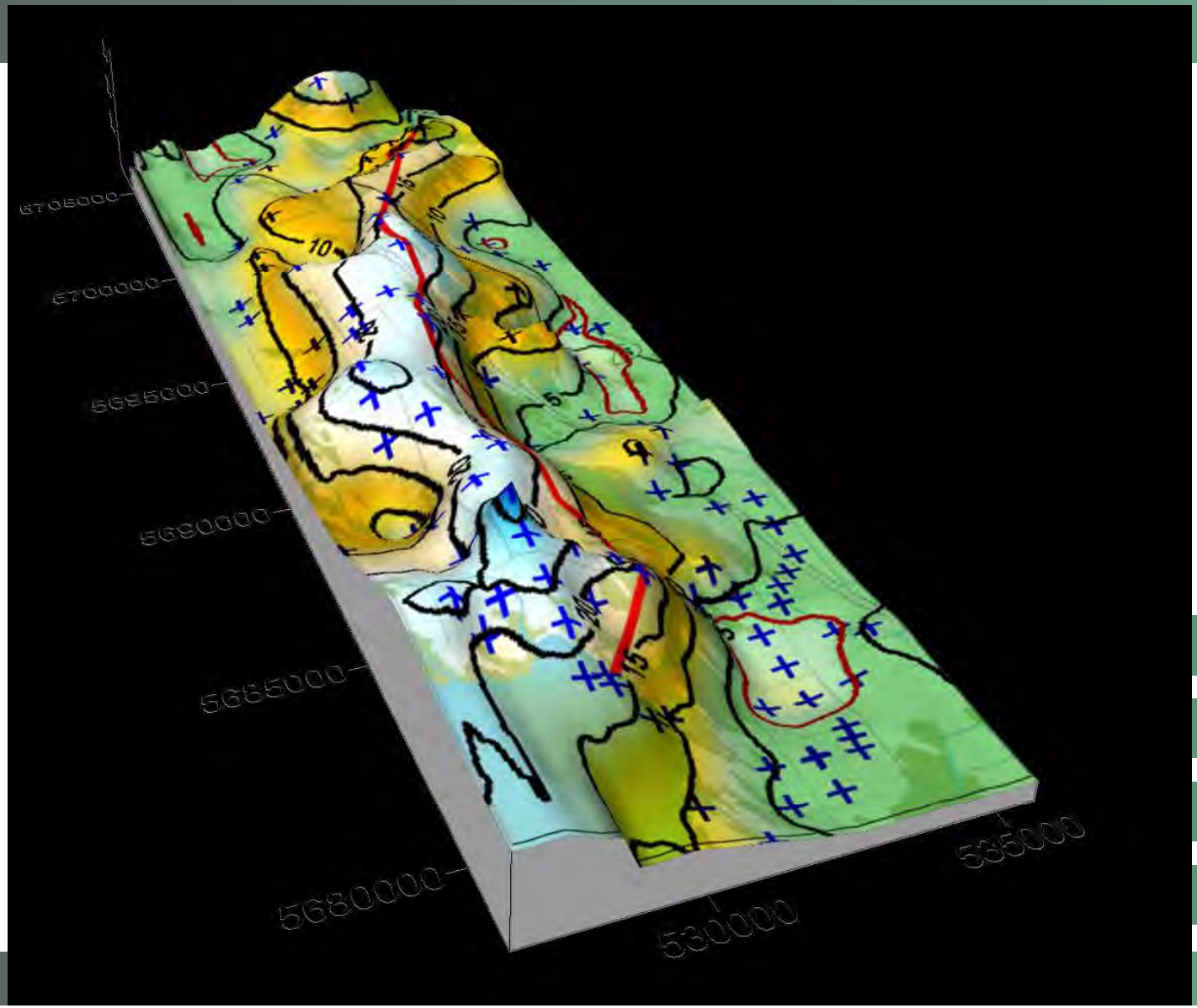

Route C Topography

Route C Bedrock Surface

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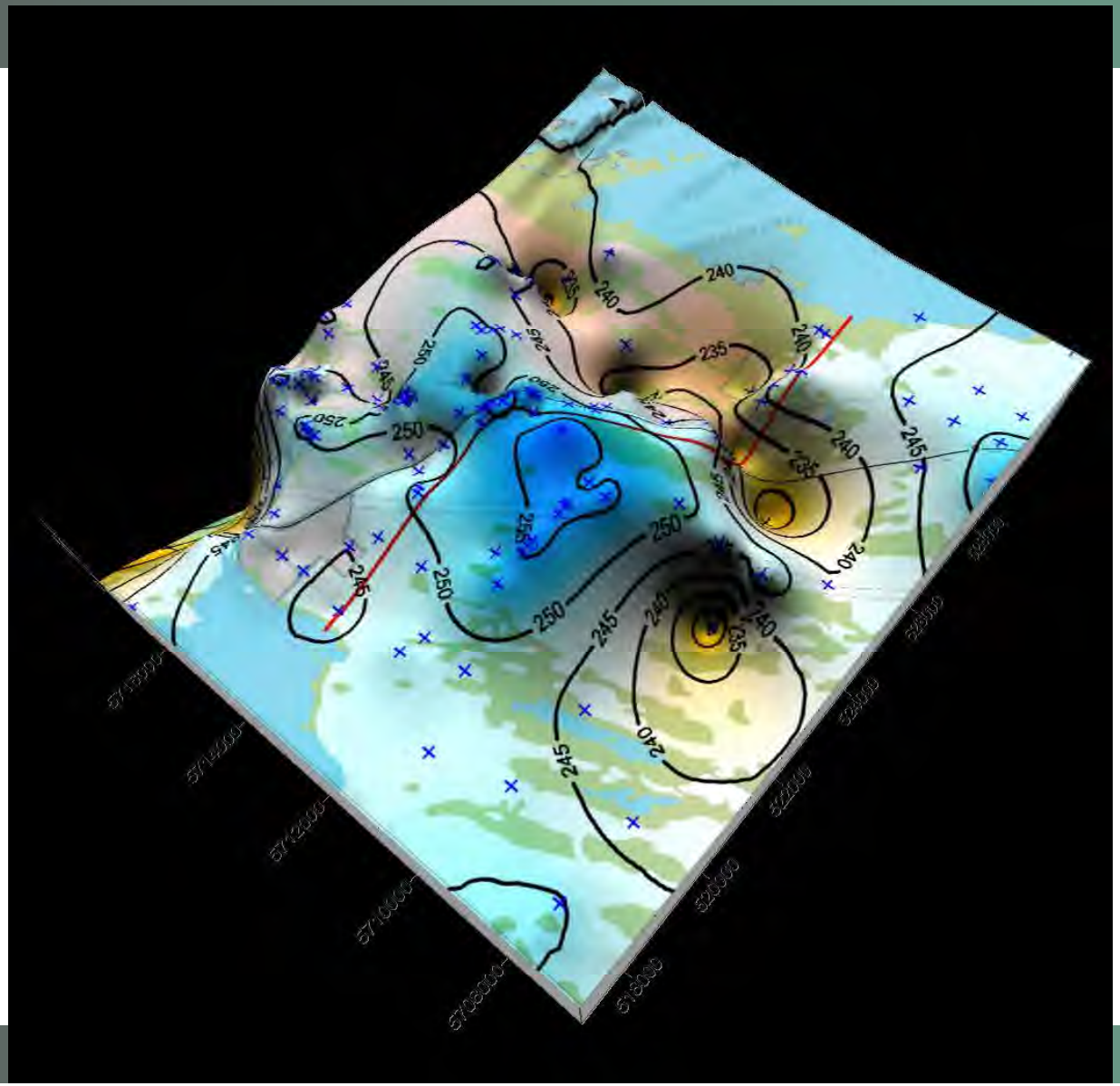

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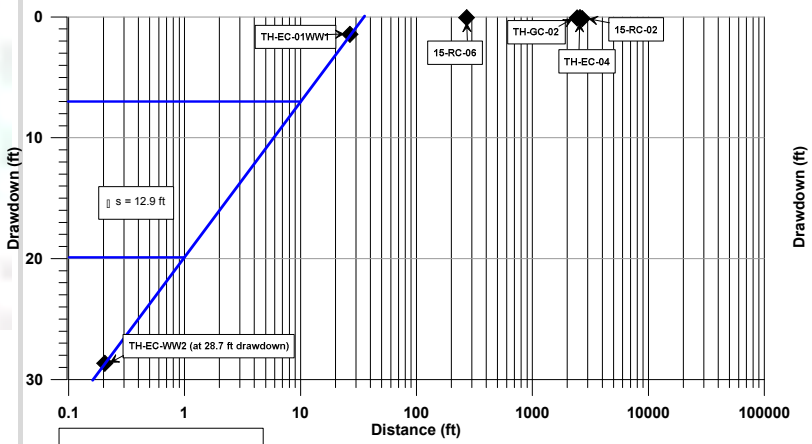
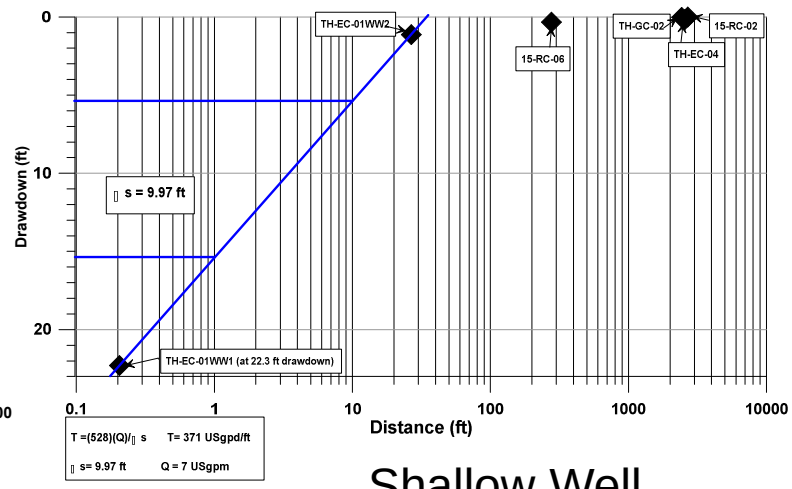
Example Pumping Tests - Route C



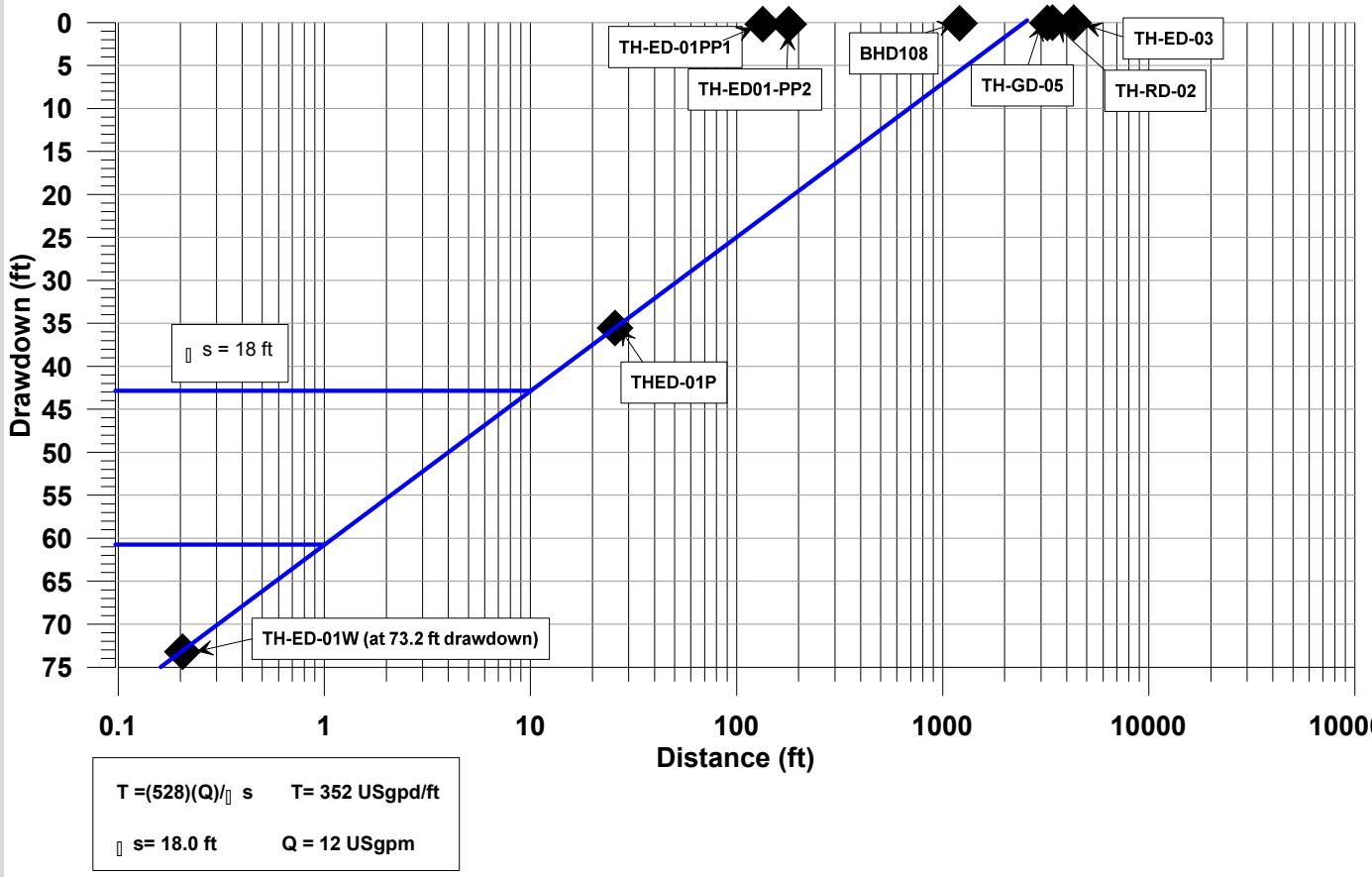
Deep Well



Shallow Well

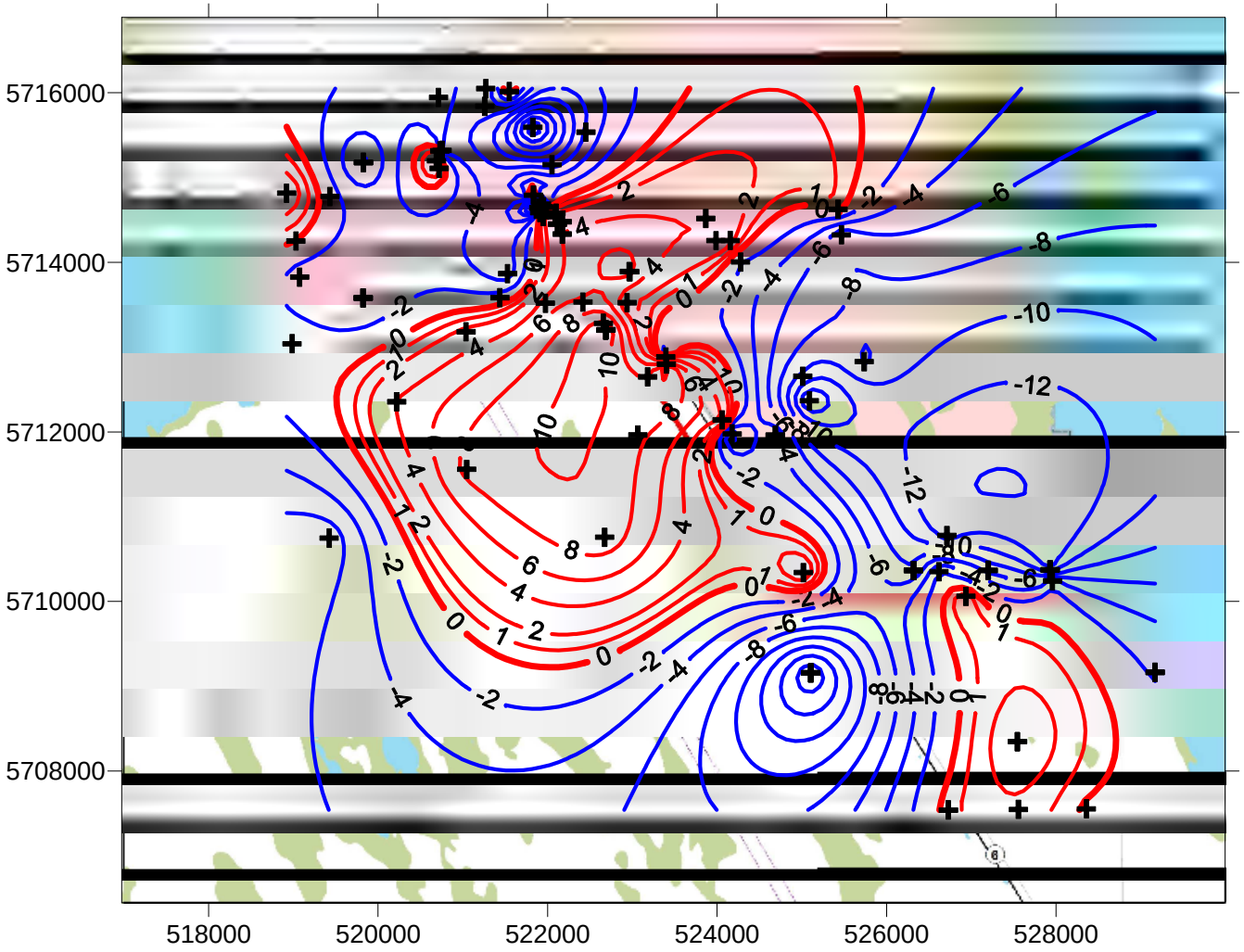
- **Similar distance drawdown responses for deep and shallow well**
- **Approximately 7 to 10 m of drawdown in well**
- **0.3 m to 0.5 m drawdown in adjacent well, less than 10 m distance**
- **Piezometers beyond 60 m distance registered nominal response**

Example Pumping Test – Route D Near Water Lake



- **Drawdown in bedrock did not induce change in overburden (till) or peat/Water Lake water levels**

Well Casing Completions Relative to Channel Invert Route C - GUDI



Drawdown Estimates at Channels

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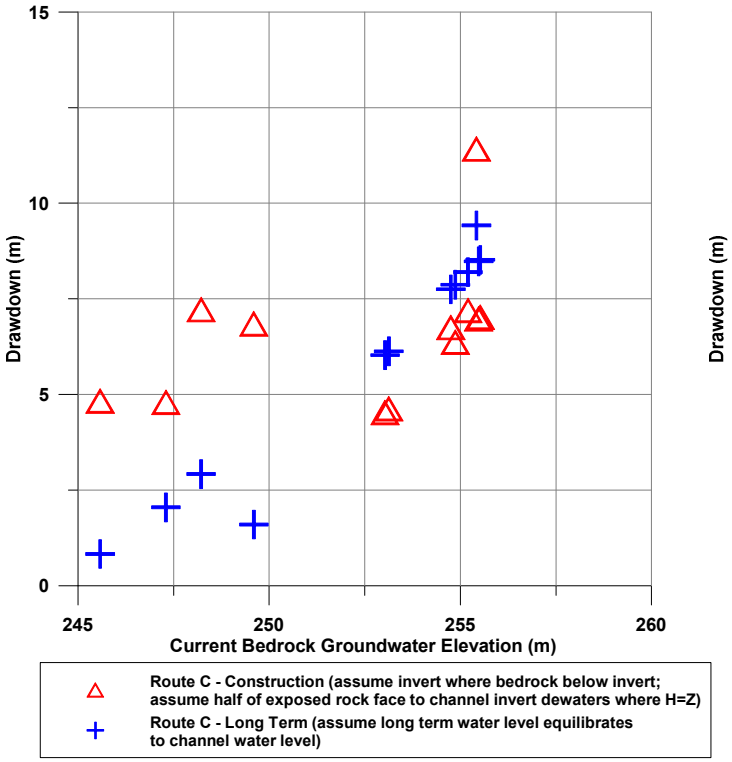
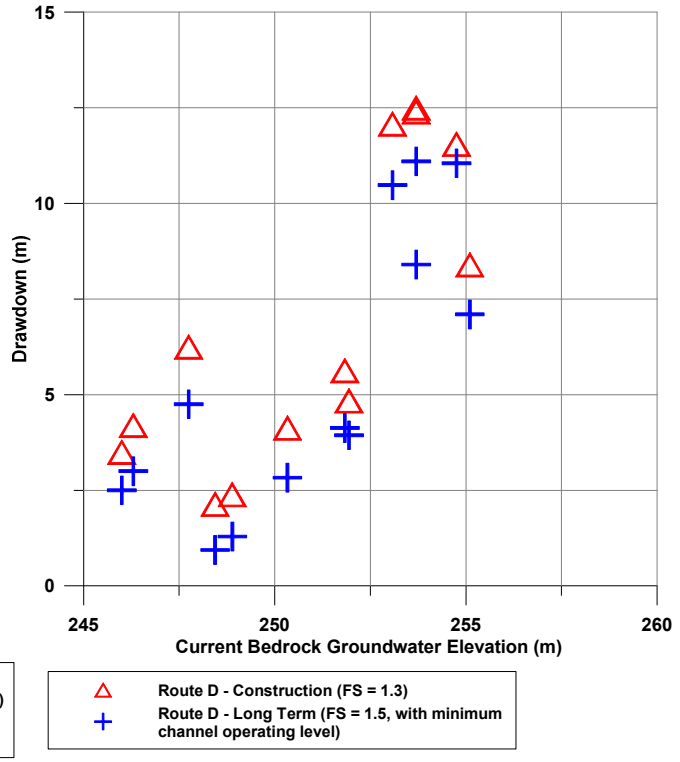
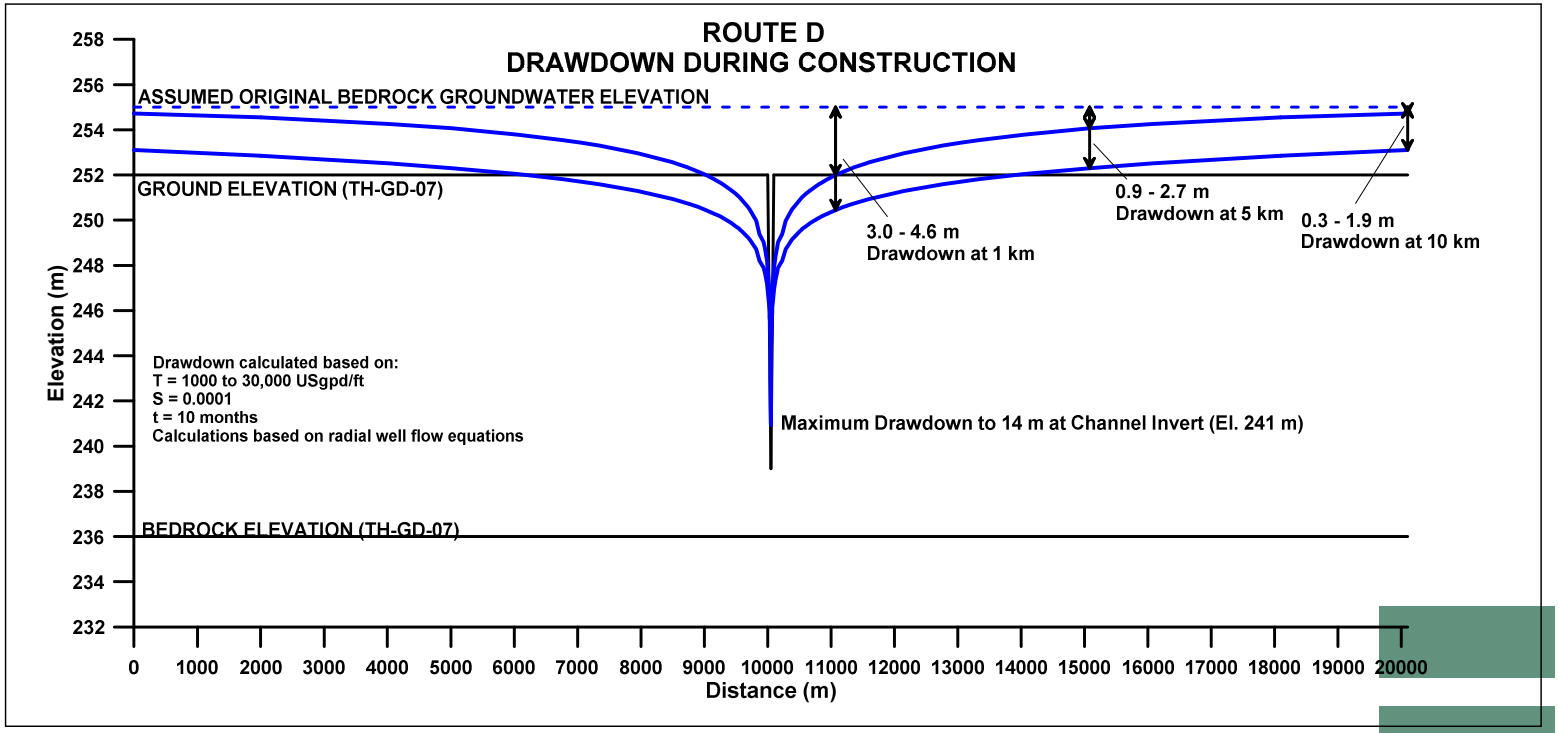
Route C



Route D

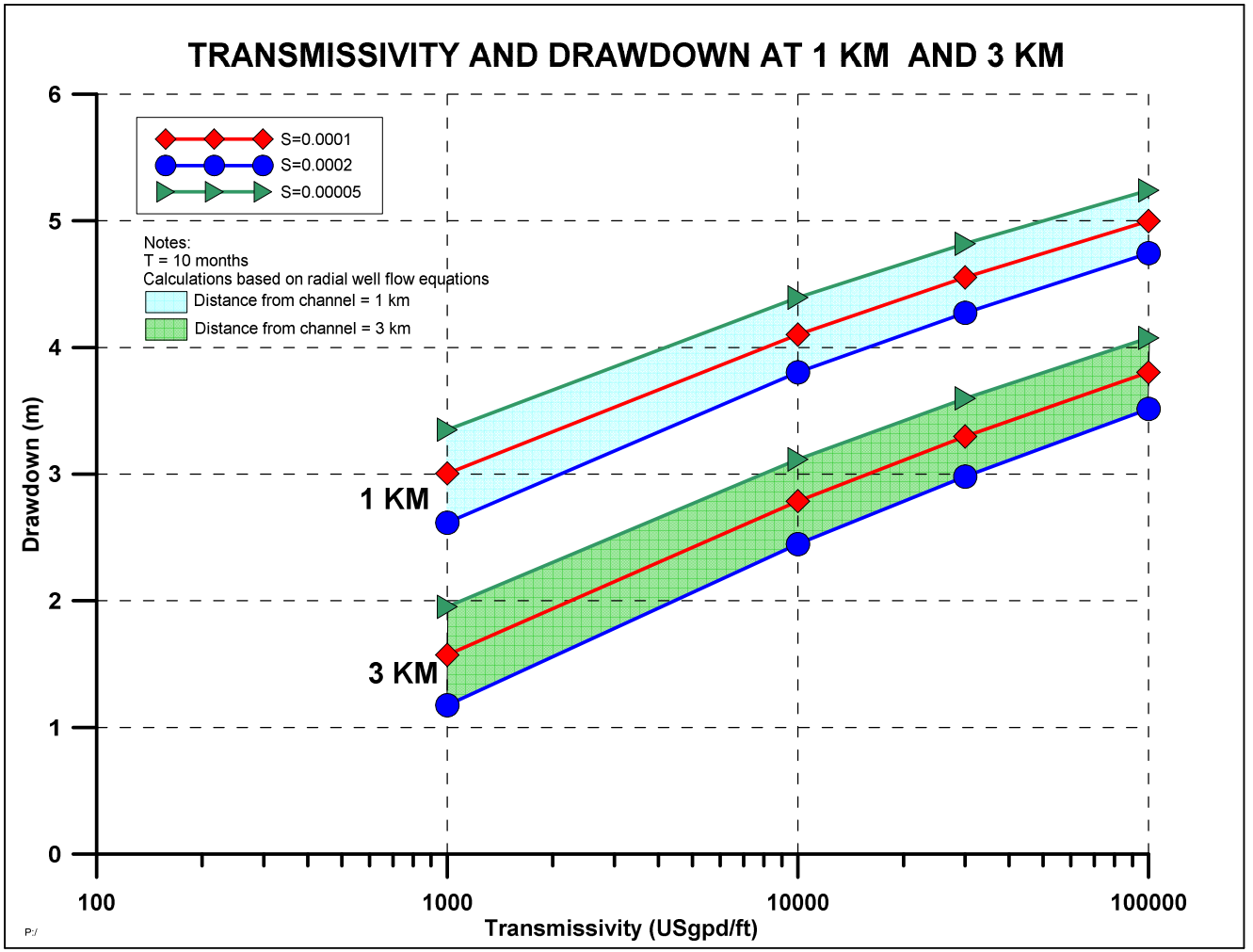


Drawdown Estimates With Distance Route D



- **Analysis does not account for boundary conditions (lakes, rivers, etc.), nor for complex bedrock surface topography and till infill condition at channel**

Drawdown Estimates With Distance Route D



Summary

- **Either route will result in depressurization of bedrock aquifer**
- **Route C will induce a direct interconnection of surface water to the aquifer in an aquifer recharge area - GUDI**
- **Well casings near Route C are shallow - GUDI**
- **Means and methods for dewatering excavation at route C are different and may involve more risk**
- **Route D requires controlled aquifer depressurization for construction, and in long-term, to maintain intact till channel**
- **Deep dense till illustrates isolation of deep bedrock aquifer from Water Lake – Route D; though irregular bedrock surface – regional groundwater pressures and wetland areas may require further water quality assessment and/or using longer-term monitoring data**

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Lunch

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4.5 Re-cap of Preliminary Findings

Surface Water

- Option C:
  - Need to address surface water drainage on south side of channel
  - Relatively small area

- Option D:
  - ~30 % loss to the drainage area of Birch Creek
  - ~20 % to 45 % loss to the drainage area of the wetlands and small lakes
  - Need to address surface water drainage on north side of channel

Well Use Assessment

- Groundwater from bedrock aquifer is sole source of potable drinking water (both routes)
  - Limited field survey on Route C. Transmissivity is low in aquifer, but can be variable

Well Use Assessment

Route C +/- 100 individual wells within 3 km

- Several water systems
  - residential subdivisions, bottling plant, school, etc.
- Channel invert in bedrock below well casings
  - half the well records examined
  - mitigation for drawdown require new wells
- High risk of surface water infiltration and bacterial contamination to aquifer (GUDI).
  - Mitigation include individual treatment, or community treatment and distribution system.

Well Use Assessment

Route D +/- 100 individual wells within 3 km, but no community supplies identified

- Channel invert in till with greater depth to bedrock and thicker till along alignment
- Well casings deeper
  - less sensitive to drawdown
  - easier to mitigate by lowering pumps
- Flowing conditions and upward gradients
  - protect against infiltration of surface water in the event of a blowout in the base

Geotechnical Summary

- Route C
  - 1 to 9 m of overburden over bedrock
  - Groundwater at ground surface and up to 2 m above grade (up to 14 m above channel invert)
  - Channel blows out under existing GWL during construction
  - In order to achieve design EoC FS of 1.3 need to lower groundwater level 3.5 m (Elev. 252m)
  - Long Term Stability to design invert elevation 4H to 1V meets design criteria

Geotechnical Summary (cont'd)

- Route D
  - 16 to 26 m of overburden over bedrock
  - Groundwater at ground surface up to 6 m above grade (up to 16 m above channel invert
  - Channel blows out under existing GWL during construction
  - In order to achieve design EoC FS of 1.3 need to lower groundwater level:

    4.5 m (Elev. 251 m) at 11+600

    11 m (Elev. 243 m) at 19+000
  - Long Term Stability to design invert elevation 4H to 1V with bench meets design criteria

Groundwater Summary

- **Either route will result in depressurization of bedrock aquifer**
- **Route C will induce a direct interconnection of surface water to the aquifer in an aquifer recharge area - GUDI**
- **Well casings near Route C are shallow - GUDI**
- **Means and methods for dewatering excavation at route C are different and may involve more risk**
- **Route D requires controlled aquifer depressurization for construction, and in long-term, to maintain intact till channel**
- **Deep dense till illustrates isolation of deep bedrock aquifer from Water Lake – Route D; though irregular bedrock surface – regional groundwater pressures and wetland areas may require further water quality assessment and/or using longer-term monitoring data**

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5. Environmental Considerations

Environmental Considerations

- Considered for risk assessment, mitigation and cost allowances
- Component of evaluation / comparison of options
- Meeting with Christine & Maureen on December 1 on Baseline information
- Excludes surface water and groundwater
  - Dealt with separetely
- Socio-Economic Concerns
  - Addressed later

Aquatic Habitat – Inlet / Outlet

Option C:

- Inlet area least productive
- Outlet area most productive
  - Proximity to Harrison Creek and adjacent coastal wetlands

Option D:

- Inlet area slightly more productive than Option C inlet
  - Proximity of Fishline Drain and Spearhill Drain
- Outlet area productive (Birch Creek)

Aquatic Habitat - Channel

- Concern with un-inhabitable conditions in the channel when not in operation
  - Lack of dissolved oxygen
  - Risks magnified in Option D, since its longer than Option C
  - Solutions should be incorporated into final design

Terrestrial Habitat

- Option C:
  - No significant concerns
- Option D:
  - Diverse habitat supports many species at-risk (SARA) and migratory birds
  - Construction will need to adhere to timing windows and set-back distances
- Seneca root prevalent in the entire Interlake region - valued by FN

Summary
Physical & Biological Environment

- Option C less of a concern relative to Option D from a biological perspective

- Appropriate design mitigation provides compensation for impacts

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6. Risk Assessment, Mitigation and Cost Allowances

Risk Assessment

- Risk assessment focused on
  - Groundwater
  - Surface water
  - Geotechnical risks
- Other risks considered (e.g. design / construction)
- Cost allowance for mitigation and risk
  - Replaces mitigation allowance (5%) and contingency (20%) allowance from Stage 2 Study estimates

Stage 2 Study Cost Estimates

	Option C	Option D
Base Cost	$142,755,000	$173,771,000
Mitigation Cost (5%)	$7,138,000	$8,688,550
Engineering, Contract Admin. Approvals (20%)	$28,551,000	$34,754,200
Contingency Cost (20%)	$35,689,000	$43,442,800
Total	**$214,133,000**	**$260,656,550**

Cost Allowances for Risk & Mitigation

- Summary table provided as handout
- Focus of risk assessment:
  - Groundwater risks
  - Surface water risks
  - Geotechnical risks
- Other risks identified in red

Cost Allowances for Risk & Mitigation

- Severity / probability
  - Based on judgement
- Base cost
  - Actual allowance identified and included in previous estimates
- Mitigation cost
  - Updated allowance

Cost Allowances for Risk & Mitigation

- Risk cost
  - Preliminary cost – assumptions listed
- Risk probability
  - Low risk 10-25%
  - Medium risk ~50% (typical value without detailed assessments)
  - High risk 75-90%
- Residual Risk
  - Included in future cost estimates
  - Replaces contingency for items assessed

Option C

	Risk Item	Risk Description	Severity / Probability	Base Cost ($)	Mitigation Cost ($)	Risk Cost ($)	Risk Probability (%)	Residual Risk ($)
Groundwater								
1	Dewatering during construction	Blowouts / basal heave conditions during construction	Medium	$2,000,000	$1,000,000	$5,000,000	50%	$2,500,000
2	Individual Groundwater wells - quantity	Water level drops below pump setting or below casing while well is pumping due to aquifer drawdown from channel construction / operation	High		$200,000			
					$3,750,000			
3	Community Groundwater Wells and Systems - quantity	Water level drops below pump setting or below casing while well is pumping due to aquifer drawdown from channel construction / operation	High		$32,000			
					$560,000			
4	Individual Groundwater wells - quality	Groundwater Under Direct Influence of Surface Water (GUDI), potential for bacterial and virus contamination, as a rsult of interconnection to the aquifer in an aquifer recharge area	High		$1,200,000			
					$750,000			
5	Community Groundwater wells - quality	Groundwater Under Direct Influence of Surface Water (GUDI), potential for bacterial and virus contamination, as a rsult of interconnection to the aquifer in an aquifer recharge area	High		$2,000,000			
6	Regional Groundwater wells - quality & quantity	Regional mitigation measure approach for the First Nations community instead of Individual approach	High			$82,250,000	90%	$74,025,000
			Sub Total	**$2,000,000**	**$9,492,000**	**$87,250,000**		**$76,525,000**

Option C

	Risk Item	Risk Description	Severity / Probability	Base Cost ($)	Mitigation Cost ($)	Risk Cost ($)	Risk Probability (%)	Residual Risk ($)
Geotechnical								
1	Earth Excavation	Increase in quantities due to design growth	Medium			$3,890,000	50%	$1,945,000
2	Rock Excavation	Increase in quantities due to design growth	Medium			$4,850,000	50%	$2,425,000
3	Control Structure foundation	Seepage control across structure through rock	Medium			$5,000,000	50%	$2,500,000
4	Bridge foundation	Seepage control up the piles	Medium	included				
			Sub Total	**$0**	**$0**	**$13,740,000**	**50%**	**$6,870,000**
Surface water								
1	Revegetation	Poor vegetation growth on channel banks as a result of long term operation &/or increase in cost due to design changes	Medium			$942,600	50%	$471,300
2	Water quality in outlet channel (long term operation)	Poor water quality in channel when not in operation, including lack of oxygen	Medium			$500,000	50%	$250,000
3	Water quality in adjacent waterbodies (construction)	Poor water quality as a result of construction	Medium			$1,000,000	50%	$500,000
4	Surface water drainage	Additional requirements to address surface water drainage	low	included		$3,000,000	10%	$300,000
			Sub Total	**$0**	**$0**	**$5,442,600**	**28%**	**$1,521,300**

Option C

Risk Item		Risk Description	Severity / Probability	Base Cost ($)	Mitigation Cost ($)	Risk Cost ($)	Risk Probability (%)	Residual Risk ($)
Construction / Design Risks								
1	Weather	Adverse weather conditions during construction causing delays and/or difficulties in construction	Medium			$7,138,000	50%	$3,569,000
2	Channel Inlet / Outlet	Increased construction effort at channel inlet / outlet due to design changes	Medium			$4,670,000	50%	$2,335,000
3	Control Structure	Increase in design scope	Medium			$2,417,800	50%	$1,208,900
4	Bridges	Increase in design scope	High			$5,556,000	90%	$5,000,400
5	Environmental Mitigation	Increased mitigation requirements for bio-physical and or aquatic environment.	Medium		$2,000,000	$6,000,000	50%	$3,000,000
6	Construction Camp	Increase in design scope	Medium			$1,021,860	50%	$510,930
7	Electrical Power Supply	Increase in design scope	Medium			$891,000	50%	$445,500
8	Fish Passage	Increase in design scope	Medium			$1,081,000	50%	$540,500
9	Optimization	Reduction in cost as a result of design optimization	Medium			-$7,138,000	50%	-$3,569,000
			Sub Total	**$0**	**$2,000,000**	**$21,637,660**		**$13,041,230**
Other Risks								
1	Land Acquisition	Increased cost of land acquisition	Medium			$515,550	50%	$257,775
2	Socio-economic Factors	Increase in design scope and/or delays due to concerns of affected stakeholders	High			$14,275,500	70%	$9,992,850
3	Engineering /Contract Admin. / Approvals	Increased effort as a result of design changes, complications, approval requirement.	Medium			$5,710,200	50%	$2,855,100
4	Constructability / Bid Climate / Labour / Fuel Costs	Increase in project cost	Medium			$14,275,500	30%	$4,282,650
			Sub Total	**$0**	**$0**	**$34,776,750**		**$17,388,375**
			Total Mitigation & Risk Allowance	**$2,000,000**	**$11,492,000**	**$162,847,010**		**$115,345,905**

Option D

Risk Item		Risk Description	Severity / Probability	Base Cost ($)	Mitigation Cost ($)	Risk Cost ($)	Risk Probability (%)	Residual Risk ($)
Groundwater								
1	Dewatering during construction / operation	Blowouts / basal heave conditions	Medium	$3,000,000	$2,000,000	$5,000,000	50%	$2,500,000
2	Individual Groundwater wells - quantity	Water level drops below pump setting or below casing while well is pumping due to aquifer drawdown from channel construction / operation	High		$400,000			
			High		$2,500,000			
3	Individual Groundwater wells - quality	Groundwater Under Direct Influence of Surface Water (GUDI), potential for bacterial and virus contamination, as a rsult of interconnection to the aquifer in an aquifer recharge area	Low			$600,000	25%	$150,000
						$375,000	25%	$93,750
4	Groundwater interaction with wetlands	Lowering of wetlands water levels if wetlands are connected directly to bedrock and if extensive drawdown occurred in aquifer	Low			See surface water item 2		
			Sub Total	**$3,000,000**	**$4,900,000**	**$5,975,000**		**$2,743,750**

Option D

	Risk Item	Risk Description	Severity / Probability	Base Cost ($)	Mitigation Cost ($)	Risk Cost ($)	Risk Probability (%)	Residual Risk ($)
Geotechnical								
1	Earth Excavation	Increase in quantities due to design growth	Medium			$10,843,300	50%	$5,421,650
2	Control Structure foundation	Seepage control across structure through rock	Low			$3,000,000	10%	$300,000
3	Bridge foundation	Seepage control up the piles	Low	included				
			Sub Total	**$0**	**$0**	**$13,843,300**		**$5,721,650**
Surface water								
1	Birch Creek flows	Reduction of flows in Birch Creek as a result of a loss in contributing drainage area	Low			$5,000,000	10%	$500,000
2	Wetland water levels	Reduction of flows into wetlands as a result of a loss in contributing drainage area	Low		$500,000	$5,000,000	10%	$500,000
3	Revegetation	Poor vegetation growth on channel banks as a result of long term operation &/or increase in cost due to design changes	Medium			$1,839,600	50%	$919,800
4	Water quality in outlet channel (long term operation)	Poor water quality in channel when not in operation, including lack of oxygen	Medium			$500,000	50%	$250,000
5	Water quality in adjacent wetland and creek (construction)	Poor water quality as a result of construction	Medium			$1,000,000	10%	$100,000
6	Surface water drainage	Additional requirements to address surface water drainage	Medium	included	$1,000,000	$5,000,000	50%	$2,500,000
			Sub Total	**$0**	**$1,500,000**	**$18,339,600**		**$4,769,800**

Option D

	Risk Item	Risk Description	Severity / Probability	Base Cost ($)	Mitigation Cost ($)	Risk Cost ($)	Risk Probability (%)	Residual Risk ($)
Construction / Design Risks								
1	Weather	Adverse weather conditions during construction causing delays and/or difficulties in construction	High			$8,689,000	75%	$6,516,750
2	Channel Inlet / Outlet	Increased construction effort at channel inlet / outlet due to design changes	Medium			$3,300,000	50%	$1,650,000
3	Control Structure	Increase in design scope	Medium			$2,417,800	50%	$1,208,900
4	Bridges	Increase in design scope	High			$12,167,000	90%	$10,950,300
5	Environmental Mitigation	Increased mitigation requirements for bio-physical and or aquatic environment	Medium		$4,000,000	$8,000,000	50%	$4,000,000
6	Construction Camp	Increase in design scope	Medium			$1,236,800	50%	$618,400
7	Electrical Power Supply	Increase in design scope	Medium			$438,000	50%	$219,000
8	Fish Passage	Increase in design scope	Medium			$1,081,000	50%	$540,500
9	Optimization	Reduction in cost as a result of design optimization	Medium			-$8,689,000	50%	-$4,344,500
			Sub Total	**$0**	**$4,000,000**	**$28,640,600**		**$21,359,350**
Other Risks								
1	Land Acquisition	Increased cost of land acquisition	Medium			$900,900	50%	$450,450
2	Socio-economic Factors	Increase in design scope and/or delays due to concerns of affected stakeholders	Medium			$8,688,550	50%	$4,344,275
3	Engineering /Contract Admin. / Approvals	Increased effort as a result of design changes, complications, approval requirement	Medium			$6,950,840	50%	$3,475,420
4	Constructability / Bid Climate / Labour / Fuel Costs	Increase in project cost	Medium			$17,377,100	30%	$5,213,130
			Sub Total	**$0**	**$0**	**$33,917,390**		**$13,483,275**
			Total Project Risk	**$3,000,000**	**$10,400,000**	**$100,715,890**		**$48,077,825**

Updated Cost Estimate with Allocation for Mitigation and Risks

	Option C	Option D
Base Cost	$142,755,000	$173,771,000
Mitigation Cost	$11,492,000	$10,400,000
Engineering, Contract Admin. Approvals	$28,551,000	$34,754,200
Residual Risk	$115,345,905	$48,077,825
Total	**$298,143,905**	**$267,003,025**
Change from Stage 2 Estimate	$84,010,905	$6,346,475

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Break

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7. Evaluation of Options

Objective

- Evaluate and rank the suitability of the options in meeting the objectives of the project.

- Identify a preferred option to proceed with Preliminary Design.

Method

- Simplified method compared as Reach 2 Workshop
  - No sub-criteria
  - Rating first

1. Define categories and rate options using priority scale
2. Establish weight factors for each category
3. Multiply rating by weight to establish score
4. Option with the highest total score is preffered

Criteria Definition

1. Constructability
2. Operation & Maintenance
3. Groundwater Impacts
4. Surfacewater Impacts
5. Physical / Biological Environment Impacts
6. Socio-economic Considerations
7. Cost
8. Risk

Rating Scale

1. Poor
2. Mediocre
3. Satisfactory
4. Good
5. Superior

Constructability

- Till vs rock excavation
- Dewatering
- Inlet / outlet works
- Construction access
- Construction monitoring
- Number of structures (bridges)

Operation & Maintenance

- Geotechnical performance
- Risk of erosion/sedimentation
- Inspection cost
- Vegetation growth
- Maintenance access
- Winter operation
- Number of structures / channel length

Groundwater Impacts

- GUDI (bacteria)
- Aquifer Drawdown
- Well users
- Interaction with wetlands

Surfacewater Impacts

- Surface water drainage
- Wetlands and creeks
- Water quality

Physical / Biological Environment Impacts

- Terrestrial Environment
- Aquatic Habitat

Socio-economic Considerations

- Groundwater Quality / Quantity
- Proximity to First Nation
- Public Safety / Access
- Approvals
- Past Litigation

Cost Estimate

- Stage 2 study Estimates:

	Option C	Option D
Base Cost	$142,755,000	$173,771,000
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Contingency Cost (20%)	$35,689,000	$43,442,800
Total	**$214,133,000**	**$260,656,550**

Risk

- Updated Cost Estimates Considering Risks

	Option C	Option D
Base Cost	$142,755,000	$173,771,000
Mitigation Cost	$11,492,000	$10,400,000
Engineering, Contract Admin. Approvals	$28,551,000	$34,754,200
Residual Risk	$115,345,905	$48,077,825
Total	**$298,143,905**	**$267,003,025**
Change from Stage 2 Estimate	$84,010,905	$6,346,475

Weighting Process

White board exercise (Mark's Method)

100 pts over 8 categories =12.5 pts each

Results

- Preliminary Scoring Results
- “Parking Lot” Items
- Discussion

Wrap up / next steps

- Consensus of the preferred Option
- Are there any follow up items identified during the course of the workshop?
- Summary documentation with Minutes
- Detailed documentation directly into final report

Wrap up / next steps

- Completion of Deliverables:
  - Early January
- Draft Report
  - February

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