KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C AND D
DELIVERABLE D2
ANNUAL MONITORING REPORT TO JULY 1, 2017

FINAL – REV 0

KGS Group 16-0300-006
July 2017

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July 1, 2017

File No. 16-0300-006

Manitoba Infrastructure
Water Management and Structures
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ATTENTION: Mr. Jared Baldwin, P.Eng.
Project Manager

RE: Investigations & Preliminary Engineering for Lake Manitoba Outlet Channels Options C & D Deliverable D2, Final – Rev 0

Dear Mr. Baldwin:

KGS Group is pleased to submit an electronic copy on the FTP site of our Final Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C and D Deliverable D2. Three hard copies of the report will follow by courier.

If you have any questions or comments regarding the enclosed report, please contact the undersigned.

Sincerely <Original signed by>

Colin Siepman, P.Eng.
Senior Infrastructure/Project Engineer

MFH/jr
Enclosure

cc: Mr. Mark Allard, P.Eng. Project Director (MI)
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TABLE OF CONTENTS

LIST OF TABLES

ROUTE D

LIST OF PLATES

ROUTE D

LIST OF APPENDICES

ROUTE C

ROUTE D

1.0 INTRODUCTION AND SCOPE OF WORK

1.1 INTRODUCTION

Manitoba Infrastructure retained KGS Group to complete Investigations and Preliminary Engineering for Lake Manitoba Outlet Channels Options C and D. The "Summary Report" for the project was issued in May 2017. This annual monitoring report is required under WBS 1010.04 and WBS 1010.05 monitoring plan as described in Deliverable D1 Groundwater Level Monitoring and Quarterly Water Quality Sampling. Annual monitoring of groundwater and surface water is included in the project, with interim reports required July 1, 2017 (Deliverable D2) and July 1, 2018 (Deliverable 3).

This annual monitoring report summarizes groundwater and surface water monitoring activities from December 2016 through July 1, 2017. The report documents seasonal data collection activities and provides comments regarding surface and groundwater conditions, building on Deliverable D6 Groundwater Study (included as Appendix C of the Summary Report). Deliverable D6 Groundwater Study contains detailed background information on the project that is not repeated here, and should be used for reference. Manitoba Infrastructure directed that no further monitoring on Route C be conducted, with the exception of transducer downloads at Route C, beginning in May 2017.

1.2 SCOPE OF WORK

The Scope of Work for Deliverable D2 includes the following:

1. Route C Field Programs:
   - Transducer Download May 2017.

2. Route D Field Programs:
   - Groundwater Elevation, Sampling and Transducer Download Winter - March; 2017 and Spring May 2017
   - Surface Water Sampling and Transducer Download May 2017.

3. Summary comments and conclusions relating to seasonal changes in groundwater and surface water levels and quality.

2.0 ROUTE C

2.1 WATER ELEVATION, TEMPERATURE AND TRANSDUCER DOWNLOADS

2.1.1 Field Program Activities

The locations of instruments are shown on the plan set in Appendix D2-A. Rubber mechanical packers were installed where wells were under a flowing artesian condition. The packers were installed in flowing wells needed for long-term continuous monitoring and water quality sampling. They prevent water from entering the casing above ground, which could freeze and damaging the casing. A flexible tube with a valve was installed through a port in the packer to allow sampling without removal of the packer. A Heron DipperLog transducer for long-term measurement of water elevation and temperature was installed below each packer, with the cables running through ports in the packer to surface. Ports were sealed around the sample tubing and cables to prevent leakage of water into the casing. Transducers installed in these wells were purchased for and are owned by Manitoba Infrastructure (MI). Installation of packers and transducers was completed on December 8, 2016. Transducers along Route C were downloaded in May 2017, with data plotted in Appendix D2-B Figure D2-B1 through Figure D2-B3.

Packers and transducers were installed at:

- TH-EC-01WW1 shallow bedrock groundwater well (open bedrock monitoring zone El. 254.37 m to 242.5 m)
- TH-EC-01WW2 (Appendix F Photo 1) deeper bedrock well (open bedrock monitoring zone El. 241.28 m to 237.3 m)
- TH-EC-03 (open bedrock monitoring zone El. 235.88 to 229.8 m)

The elevations of the packers and transducers are summarized in Appendix Table D2-B-4. The transducer for TH-EC-01 WW1 is installed 0.1 m above the base of the well casing close to the top of the open bedrock monitoring zone, while the transducers for TH-EC-01 WW2 and TH-EC-03 are installed 12.6 m and 8.3 m respectively above the base of the well casing, therefore they are not close to the open bedrock monitoring zone. Although installation of the transducers in

the casing above the open bedrock monitoring zone does not have an effect on the pressure (and thus elevation readings) it may influence temperature readings, as the transducer tip is not in contact with actively flowing groundwater in the aquifer.

Results of the transducer download are shown in Appendix D2-B for Route C. Transducer data was corrected for barometric pressure using data from the Environment Canada Fisher Branch Station. Average daily precipitation and average daily air temperature was added to the plots for each well, based on the Environment Canada Fisher Branch weather station. Environment Canada Real-Time Hydrometric data graphs for the monitoring period for Lake Manitoba (Fairford River near Fairford - 05LM001) and for Lake St. Martin (Lake St. Martin near Hilbre - 05LM005) are shown in Appendix D2-B-5. A regional hydrograph for bedrock provincial observation well G05LM001 Steep Rock #1 current to January 2017 is included in Appendix D2-B6. This well is located in NW19-28-08 W, approximately 4 km west of Steep Rock Junction and approximately 2 km west of the proposed Route D Right-of-Way.

Shallow bedrock well TH-EC01-WW1 is confined, but not artesian, and has only a shallow overburden till thickness of 0.9 m over bedrock. The groundwater elevation (Figure D2-B-1) decreased throughout the winter from approximately El. 254.8 m on December 8, 2017 to 254.1 m on February 14, 2017. Groundwater elevation began to increase on March 27, 2017 (254.3 m) increasing by 0.7 m to El. 255.0 m on April 2, in a period of 6 days. Groundwater elevation remained relatively stable through the end of May 2017 with a slight decline of 0.2 m.

The piezometric pressure in confined aquifers can respond to regional changes in surrounding hydrogeologic boundaries such as Lakes Manitoba and Lake St. Martin because the hydraulic pressure is transmitted through the sediments and till beneath the lakes to the bedrock aquifer. The extent of the pressure response will depend on the location of instrumentation in relation to the lakes, the change in water level in the lakes, and the extent of interconnection between the well and the aquifer, and the connection between the lake and the aquifer.

The change in lake level; however, does not appear to be the main cause of the groundwater elevation increase in the well at TH-EC-01WW1. The water level in Lake Manitoba (Appendix D2-B-5 Fairford River) did not begin to rise until approximately April 1, 2017, after the piezometric pressure response had already started at well TH-EC-01WW1. The increased water

level in Lake Manitoba between April 1 and April 2 was less than 0.1 m, much less than the 0.7 m groundwater elevation decrease in the well. Furthermore, Lake Manitoba continued to rise another 1 m from 246.1 m on April 1 to 247.1 m on May 1, but the well groundwater elevation did not rise. Based on the lack of correlation between the timing and magnitude of water level changes in Lake Manitoba and well TH-EC-01WW1, local and regional spring recharge to the groundwater appears to be the driving factor in the groundwater water elevation increase. This is consistent with the well's location in an area of high bedrock with thin to absent overburden, which is a regional recharge area. The timing of the recharge response corresponded with the increase in average daily air temperature to above 0°C in mid-March 2017 (Appendix D2 Figure D2-B-1).

The groundwater elevation change in the deeper bedrock well at TH-EC-01WW2 followed the same general pattern as the shallow well TH-EC-01WW1. Groundwater elevation decreased throughout the winter from El. 254.7 m on December 8, 2017 to El. 253.6 m on March 18. 2017. Water elevation began to increase on March 24, 2017 to El. 253.7 m, three days earlier than the shallow well. Groundwater elevations increased by 1.3 m to El. 255.0 m in 9 days (April 2, 2017) and remained at a similar elevation through the end of May, with a slight decline of 0.3 m. The greater rise in groundwater elevation in the deeper well was due to a lower initial water level at the start of the rise, as both wells peaked at an elevation of 255.0 m on April 2, 2017.

Groundwater temperatures decreased over the winter at both wells. At TH-EC-01WW1, where the transducer was installed close to the open bedrock zone, a sharper temperature decrease began from 4°C in early February, and continued to 1.5°C by mid-April, and increasing to 7°C by late May 2017. This response may reflect colder temperatures at the top of water column as the ground temperature continued to drop in the late winter during the February to mid-April period. Since the groundwater temperature in the well is already below normal, the effect of early spring snowmelt (which would typically depress temperatures) is dampened. The temperature increase beginning two weeks after groundwater elevations rise in mid-April is attributed to local recharge, including effects of larger precipitation events that clustered around April 15, 2017 as shown on Figure D2-B-1.

The deeper bedrock well TH-EC-01WW2 also showed a slow decrease in temperature over the winter, but temperature did not go below 4°C until a steep decline to 2°C in mid-March.

Temperatures remained low until an increase in mid-April, returning to nearly 7°C by late May 2017. The temperature changes indicate local and regional recharge of cold snowmelt, followed by a return to normal groundwater temperatures, with some influence of major precipitation events in mid-April. This interpretation is preliminary as the transducer in the deeper bedrock well is set shallow and within the well casing therefore it likely is not directly measuring the temperature of the actively flowing groundwater in the open bedrock zone which is 12.6 m below the transducer.

Well TH-EC-03 is confined, flowing artesian, and has a overburden till cover of 9.4 m. Water elevation decreased through the winter from El. 247.3 m on December 8, 2017 to El. 246.8 m on March 22, 2017, increasing slightly to El. 246.9 m on March 29. The groundwater elevation response began on March 29, with an increase of only 0.2 m from 246.9 m to 247.1 m between March 29 and April 2, much lower than at TH-EC01WW1. In contrast to the other wells, groundwater elevation continued to increase through April 27 to El. 247.7 m (a rise of 0.8 m) before slowly decreasing to El. 247.5 on May 23, 2017.

The total rise in water level of 0.8 m in the well TH-EC-03 was larger than the increase in water levels in either Lake Manitoba (0.4 m from El. 246.7 to El. 247.1 m) or Lake St. Martin (0.1 m from El. 244.6 m to El. 244.7) from March 29 to April 27, 2017. In addition, water levels in Lake St. Martin continued to rise further to May 15 El. 244.9 m), but piezometric pressures did not rise further in the well. The water elevation changes in this well appear to be related to a delayed response to regional recharge in the upland areas, which are located approximately 5 km west of the well.

The temperature profile in TH-EC-03 showed a decrease in temperature from 5°C in mid-March to 1°C, continuing to early May before temperatures rose back to 5°C. The thick till cover above the well; however, indicates that this effect is not from local recharge. Furthermore, the temperature decrease occurred before water elevations rose at the well. The position of the transducer at the top of the water column, 8.3 m above the casing open bedrock zone is likely influencing this data. Colder temperatures measured within the well casing at the top of the water column may be due to a ground temperature influence. The increasing water temperature begins in mid-May, almost 1 month after it was seen at TH-EC-01WW1. This may be due to a delayed effect of regional recharge combined with the warming ground temperatures.

Alternately, the cold temperatures recorded at TH-EC-03 may persist longer than at TH-EC-01WW1 because the transducer is set within the casing (and at shallow depths influenced by surrounding ground temperatures), rather than in contact with the groundwater within the aquifer, which at the same time is increasing in temperature to normal levels of approximately 6 to 7°C. Further observation of the seasonal data is needed to explain the role of regional recharge in these temperature changes.

Water quality information was not collected on Route C in 2017, and thus is not available to be used to further interpret the recharge effects in the area.

3.0 ROUTE D

3.1 WATER ELEVATION, TEMPERATURE AND TRANSDUCER DOWNLOADS

3.1.1 Field Program Activities

The locations of instruments are shown on the plan set in Appendix D2-C on Table D2-1. Installation of packers and transducers is described in section 2.1.1. Packers and transducers were installed at:

- TH-ED-01 (Appendix F Photo 3) bedrock well (open zone El. 223.89 to m to 217.8 m)
- 15 RD-PW1 bedrock well (Appendix H Photo 4) (open zone El. 234.96 m to 228.6 m)

The elevations of the packers and transducers are summarized in Appendix Table D2-D-4. The transducer for TH-ED-01 is installed 24 m above the open bedrock zone. The transducer for 15-RD-PW1 is set 15 m above the top of the open bedrock monitoring zone. The transducer in 15-RD-PW1 did not connect in the March or May 2017 sampling program. The instrument will be removed for diagnosis and/or repair.

Foam inserts were installed in all other flowing wells to prevent water from rising above ground surface in the casing and freezing in winter, which would cause the casing to break and result in uncontrolled groundwater flow. Foam inserts consisted of an aluminum rod surrounded by a foam packer. These inserts were frozen in almost all wells during the March 2017 sampling as indicated on Table D-2-1. The inserts in several wells were not able to be removed during the May 2017 sampling, however, there was no evidence of casing damage, and inserts were able to be removed for all wells designated for water sampling. Vibrating wire piezometers were read in March and May 2017.

In March 2017 the borehole annulus above the mechanical packers installed at 15-RD-PW1 and TH-ED-01W was filled with water and needed to be bailed out to reach the sample tubing at the base. The sample tubing; however, was frozen and samples could not be retrieved. In May 2017 there was no water in the casing and the sample tubing was accessible, with no indication of leakage. In May, 2017 the outer casing on well TH-GD-08 was placed inside the inner casing

and grouted to complete the installation. 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.

Transducers were installed at two surface water locations: Reed Lake (D3) (Appendix F Photo 4) 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 can be uploaded 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 boards will be inspected, re-surveyed and re-calibrated with the transducer in summer 2017. Repair is required at the staff gauge board at Clear Lake, which is dislodged.

3.1.2 Results

Results of the groundwater monitoring program on Route D are shown on Table D2-1 showing all instrumentation monitored, instrument details and depth to groundwater level, pressure or vibrating wire readings and appropriate conversions to geodetic elevations. Transducer hydrographs are shown in Appendix D2-D.

Well TH-ED-01W is confined and flowing artesian and has a deep overburden till cover of 25 m. Groundwater elevations decreased slightly through the winter from El. 254 m on December 8, 2017 to El. 253.5 m on March 28, 2017 when they began to rise through April 27, 2017 to 254.2 m, decreasing slightly through the end of May 2017. Groundwater elevations showed a slight increase in April 2017, but were only 0.2 m, higher than elevations in December 2016. The water elevation rise is attributed to a piezometric response to the regional groundwater system and may include a response to Lake Manitoba water levels which began to rise on April 1 as well as transmission of the piezometric response from a regional recharge in upland areas. The low profile of the elevation rise at TH-ED-01W is more similar to well TH-EC-03 on Route C, which has a 9.4 m till cover, than it is to Route C wells TH-EC-01WW1 or TH-EC-01-WW2, where local recharge is a factor and spring water levels rose more steeply and wells have less

than 1 m of till cover. Well TH-ED-01 is located in the deep bedrock valley that is beneath most of the channel alignment. Regional recharge occurs at a distance from the valley in upland bedrock areas, and not though the local 25 m till to the bedrock.

Temperature at TH-ED-01 decreased throughout the winter, from 6 °C to 4 °C with a steeper decrease in early March to 1 °C and remained low throughout the monitoring period. The timing of the temperature decrease, well before the groundwater elevation increase in early April, may indicate an early signal of colder water from early spring intermittent melting in regional recharge areas to the east in higher bedrock areas. Temperatures remained low throughout the monitoring period. The transducer is 24 m above the bedrock open hole, so is not in contact with aquifer groundwater, therefore temperature results may not be representative of true aquifer response and may be influenced by surrounding ground temperatures.

A comparison of water quality results from October 2016 and May 2016 as discussed in Section 3.2.2 (Table D-2-4), also does not show any changes in water quality changes further supporting that the bedrock beneath the buried valley is isolated from local recharge.

Well 15-RD-01W is confined and flowing artesian and has a deep overburden till cover of 16.3 m. Data from this well will be downloaded during the July/August 2017 sampling.

At Reed Lake (Appendix D2-D-2), water elevation remained constant through the spring melt. A very slight elevation increase was seen beginning in Late March 2017 from 248.60 m on March 29 to 248.80 m on April 6, 2017. The water elevation increase began at the same time air temperatures rose above zero and water temperature fluctuations began, coincident with the spring melt. Water temperatures rose from 3 °C to 12 °C by the end of May 2017.

At Clear Lake (Appendix D2-D-3) the transducer was frozen in the ice in January 2017 as shown by the sub-zero temperatures. This affected the elevation readings which are not considered representative until early April 2017. Temperature increased from 0 °C in early April, to 15 °C in late May 2017.

3.2 GROUNDWATER AND SURFACE WATER QUALITY

3.2.1 Field Program Methodology

Nine sites were sampled for surface water along Route D on May 25, 2017. Locations and site descriptions are 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

- ***D1 (Lake Manitoba)* –** 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)* –** along P.R.237.
- ***D3 (Reed Lake)* –** accessed by walking approximately 700 m from a gravel road through a pasture and was sampled on the west side of the lake.
- ***D4 (Clear Lake)* –** accessed by walking approximately 500 m along an old road allowance. The sample was collected on the west side of the lake.
- ***D5 (Clark's Drain) – sampled*** where the drain crossed the road.
- ***D6 (Birch Creek at PTH6)* –**upstream of Highway #6.
- ***D7 (Woodale Drain)* –** sampled approximately 150 m west of Hwy 6.
- ***D8 (Birch Creek)* –** sampled 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.

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.

Groundwater

Groundwater samples along Route D were taken at six locations on May 23 to 24, 2017:

- 15-RD-PW1 (Appendix F, Photo 2)
- TH-ED-01W (Appendix F, Photo 3)
- TH-ED-01P
- TH-ED-03
- TH-GD-02
- TH-GD-07

Sampling tubing was opened and groundwater was allowed to purge from the well under artesian conditions until groundwater parameters (conductivity and temperature) stabilized. Stable groundwater parameters were achieved at all sample locations within 20 minutes.

Field measurements for pH, conductivity and dissolved oxygen were taken for 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. 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 in May 2017.

Field Equipment – Field equipment such as field chemistry meters were calibrated prior to use or installation.

3.2.2 Results

Groundwater - Groundwater quality samples in May 2017 were similar to October and November 2016 and seasonal differences were not observed.

Surface Water- Minor seasonal changes were noted in most surface water samples including an increase or decrease in sulphate, alkalinity, hardness and conductivity.

Bacteria Sampling (Surface water only) - Total coliform (maximum value 2420 MPN/100 mL) and *E. coli* (maximum value185 MPN/100mL) were detected in all samples.

Water Quality Plot

A Durov plot was prepared for water quality using the software program Aquachem. This plot can be used to differentiate water types as well as to compare seasonal water quality changes. 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.

Surface water locations are shown with numbers in black, while groundwater locations are shown with letter symbols in red. Groundwater samples plot to the left of all surface water samples except sample D-2 (Watchorn Creek). The distinct geochemical composition of Lake St. Martin sample D9 (symbol 9) and Lake Manitoba sample D1 (symbol 1) can be seen on the plot, due to its elevated sodium and chloride relative to the other samples. This continues to confirm the movement of very high quality groundwater from the recharge areas to the regional discharge areas of Lake Manitoba and Lake St. Martin. The position of the samples are similar in the plots, except that the May 2017 sample for Lake Manitoba is more typical of regional Lake Manitoba quality than the November 2016 sample.

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 wells TH-ED-01W, 15-RD-PW1, as well as Lake Manitoba (D1), Clear Lake (D4), and at Lake St. Martin (D9). Sample results are shown on Table D2-2 and are plotted on Plate D2-2. 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.

Groundwater samples are in a similar position to the November 2016 samples as shown in Deliverable D6 Plate D6-10. Samples for Clear Lake in May 2017 plot strongly to the right of the meteoric water line in May, in contrast to November 2016 where they plotted slightly to the left of the line. Isotope ratios at Clear Lake are distinct from groundwater.

4.0 CONCLUSIONS

The following conclusions regarding seasonal effects can be made from the data collected in 2017 to July 1:

1. Water elevation changes in spring 2017 at bedrock wells in the recharge area of Route C (TH-EC-01WW1 and WW2) showed evidence of local annual spring recharge. Changes in the well with till overburden (TH-EC-03) were much less pronounced; however, they also resulted from a regional aquifer response to spring recharge.

2. Temperature responses seen at TH-EC-01WW1 may be related to local recharge. Responses at other wells on Route C may be related to regional recharge, or may not be representative, due the transducer placement high above the open bedrock zone, thus being influenced by ground temperatures surrounding the wells.

3. Water elevation changes at Route D at TH-ED-01 are minor, and may be related to a combination of lake level rise and aquifer piezometric response, in combination with regional recharge from upland areas outside of the Route D buried bedrock valley area.

4. Seasonal differences in groundwater quality on Route D were not observed between November 2016 and May 2017 in the wells sampled.

5. Minor seasonal differences in surface water quality (sulphate, alkalinity, hardness, conductivity) between November 2016 and May 2017 were observed at most locations in the Birch Creek watershed.

6. The water type and isotopic signature signatures for Lake Manitoba and Lake St. Martin differ from the rest of the surface and groundwater samples confirming the regional groundwater flow system from the upland bedrock recharge areas to discharge at the regional lakes.

7. The water type signature for the groundwater samples continues to differ from surface water samples along most locations sampled along the Birch Creek drainage; however, the sample from Watchorn Creek is more similar to the groundwater samples.

8. The stable isotope signature for bedrock groundwater (TH-ED-01W and 15-RD-PW1) and surface water (Clear Lake) samples is widely different suggesting negligible if any contribution of groundwater discharge to Clear Lake.

5.0 RECOMMENDATIONS

1. The 2017 to 2018 monitoring program should be continued.

2. Repairs to staff gauge at Clear Lake and re-survey of Reed Lake and Clear Lake staff gauge should be conducted.

3. Removal of the packer and transducer in 15-RD-PW1 should be carried out in order to download the transducer and investigate the malfunction.

4. Additional efforts should be made to dislodge foam inserts in several wells where they could not be removed in May 2017.

5. Expanded isotope monitoring is recommended for groundwater and surface water samples for the remainder of the program (September 2017 and May 2018) as results have proven useful to differentiate groundwater and surface water sources.

6. To obtain more accurate measurements of temperature in groundwater wells, measurements should be taken close to or within the bedrock monitoring zone.

6.0 STATEMENT OF LIMITATIONS AND CONDITIONS

6.1 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.

6.2 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 D2-1
TESTHOLE AND GROUNDWATER 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	Left on road #237 (Township Line) just north of Moosehorn	5683632.07	531290.40		till	VW #1602935		248.625	6.91	241.715	-	-	9-Nov-16	-	-	-	2887.4	249.17	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	30-Mar-17	-	-	-	2874.3	250.16	yes	
					till	VW #1602935		248.625	6.91	241.715	-	-	24-May-17	-	-	-	2869.8	250.48	yes	
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	9-Nov-16	-	>-0.85	>250.33	-	-	yes	Flowing at TOC; used bailer as extension to measure GW elevation.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					bedrock	STP	25	248.625	22.76	225.865	0.85	249.48	24-May-17	4.6	-3.24	252.72	-	-	yes	Removed foam insert - ice on foam 2 m down from top of rod to end of rod; sampled; pressure reading is approx.- seal not tight. Flow rate approx. 6.7 L/min.
TH-GD-05	Carne Ridge Road	5693350.95	530617.18		till	VW #1602924		248.66	6.71	241.95	-	-	9-Nov-16	-	-	-	2772.2	249.83	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	30-Mar-17	-	-	-	2749.6	251.29	yes	
					till	VW #1602924		248.66	6.71	241.95	-	-	24-May-17	-	-	-	2751.2	251.18	yes	
					till	STP	20	248.66	16.92	231.74	0.80	249.461	9-Nov-16	-	>-0.8	>250.26	-	-	yes	Flowing at TOC; no extension available
					till	STP	20	248.66	16.92	231.74	0.80	249.461	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	20	248.66	16.92	231.74	0.80	249.461	24-May-17	-	>-1.05	>249.71	-	-	yes	Used bailer as extension for GW elevation measurement. Removed foam insert; STP loose pulls up while removing foam.
TH-GD-06	On left side of road #239 to Steep Rock	5697400.98	531025.08		till	VW #1602923		251.918	10.67	241.248	-	-	10-Nov-16	-	-	-	2738.5	251.56	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	30-Mar-17	-	-	-	2744.1	251.19	no	
					till	VW #1602923		251.918	10.67	241.248	-	-	24-May-17	-	-	-	2740.2	251.45	no	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	10-Nov-16	-	0.02	252.79	-	-	yes	
					till	STP	25	251.918	21.34	230.578	0.89	252.809	30-Mar-17	-	0.02	252.79	-	-		Foam insert frozen; could not remove.
					till	STP	25	251.918	21.34	230.578	0.89	252.809	24-May-17	-	1.495	251.31	-	-	yes	Water was near TOC before removing foam insert; was still rising slowly after monitoring.
TH-GD-07	Cluster of wells on west side of Hwy 6 (heading north)	5699453.66	531900.65		till	VW #1602937		252.045	12.19	239.855	-	-	9-Nov-16	-	-	-	2726.0	253.08	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	31-Mar-17	-	-	-	2720.0	253.48	yes	
					till	VW #1602937		252.045	12.19	239.855	-	-	24-May-17	-	-	-	2715.4	253.79	yes	
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	9-Nov-16	-	>-0.79	>253.63	-	-	yes	Flowing at TOC; no extension available >1.6m ags
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					bedrock	STP	25	252.045	19.20	232.845	0.79	252.836	24-May-17	1.8	-1.27	254.10	-	-	yes	Removed foam insert; sampled. Flow rate approx. 0.8 L/min.
TH-GD-08	Intersection of Iverson Road and Birch Bay Loop	5701521.62	532917.21		till	VW #1602938		246.807	7.32	239.487	-	-	9-Nov-16	-	-	-	2721.1	250.41	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	30-Mar-17	-	-	-	2689.4	252.03	yes	
					till	VW #1602938		246.807	7.32	239.487	-	-	24-May-17	-	-	-	2681.6	252.54	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	9-Nov-16	-	-	-	2590.2	251.97	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	30-Mar-17	-	-	-	2587.5	252.15	yes	
					sand	VW #1602940		246.807	11.58	235.227	-	-	24-May-17	-	-	-	2579.2	252.67	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	9-Nov-16	-	>-7.92	>254.75	-	-	yes	Flowing at TOC; only able to extend by 7.92 m safely >7.9m ags. Installed pressure gauge.
					till	STP	25	246.807	17.07	229.737	0.91	247.717	30-Mar-17	5.2	-3.66	251.38	-	-	yes	
					till	STP	25	246.807	17.07	229.737	0.91	247.717	24-May-17	4.2	-2.96	250.67	-	-	yes	

TABLE D2-1
TESTHOLE AND GROUNDWATER 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-ED-01P	Farm off Werster Road (off Carne Ridge Road)	5692376.38	530502.82	11+625	till	VW #1602932		249.431	6.10	243.331	-	-	9-Nov-16	-	-	-	2830.4	249.47	yes	
					till	VW #1602932		249.431	10.67	238.761	-	-	30-Mar-17	-	-	-	2841.9	248.61	no	
					till	VW #1602932		249.431	6.10	243.331	-	-	23-May-17	-	-	-	2830.7	249.42	no	
					till	VW #1602939		249.431	10.67	238.761	-	-	9-Nov-16	-	-	-	2771.9	250.36	yes	
					till	VW #1602939		249.431	10.67	238.761	-	-	30-Mar-17	-	-	-	2788.6	249.18	no	
					till	VW #1602939		249.431	10.67	238.761	-	-	23-May-17	-	-	-	2778.9	249.86	yes	
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	9-Nov-16	-	-	>251.16	-	-	yes	Flowing at TOC; used bailer as extension to measure GW elevation.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					bedrock	STP	25	249.431	27.74	221.691	0.92	250.348	23-May-17	3.9	-2.74	253.09	-	-	yes	Removed foam insert; sampled. Flow rate approx. 4 L/min.
TH-ED-01W	Farm off Werster Road (off Carne Ridge Road)	5692378.37	530495.27	11+625	bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	9-Nov-16	-	-4.57	255.10	-	-	yes	Artesian at 5.6 m above ground surface.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	30-May-17	-	-	-	-	-	yes	Mechanical packer installed in December, 2016. Sampling port frozen. Downloaded transducer.
					bedrock	STP	125	249.492	31.70	217.792	1.04	250.53	23-May-17	-	-	-	-	-	yes	Downloaded transducer and sampled. Flow rate from well sampling tube approx. 2 L/min.
TH-ED-01PP1	Farm off Werster Road (off Carne Ridge Road)	5692378.65	530536.08		till	STP	25	248.717	1.22	247.497	0.97	249.688	9-Nov-16	-	1.130	248.56	-	-	no	
					till	STP	25	248.717	1.22	247.497	0.97	249.688	30-Mar-17	-	1.855	247.83	-	-	no	Foam insert removed and then reinstalled.
					till	STP	25	248.717	1.22	247.497	0.97	249.688	23-May-17	-	1.470	248.22	-	-	no	Foam insert removed.
TH-ED-01PP2	Farm off Werster Road (off Carne Ridge Road)	5692380.13	530549.75		till	STP	25	248.456	1.22	247.236	1.06	249.519	9-Nov-16	-	1.03	248.49	-	-	yes	
					till	STP	25	248.456	1.22	247.236	1.06	249.519	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	25	248.456	1.22	247.236	1.06	249.519	23-May-17	-	1.47	248.05	-	-	no	Foam insert removed.
TH-ED-03	Carne Ridge Road	5693404.42	529670.69		till	VW #1602931		252.218	6.10	246.118	-	-	9-Nov-16	-	-	-	2854.2	251.54	no	
					till	VW #1602931		252.218	6.10	246.118	-	-	30-Mar-17	-	-	-	-	-	-	VW reading error.
					till	VW #1602931		252.218	6.10	246.118	-	-	23-May-17	-	-	-	-	-	-	VW reading error.
					till	STP	25	252.218	13.41	238.808	0.86	253.076	9-Nov-16	-	0.580	252.50	-	-	yes	
					till	STP	25	252.218	13.41	238.808	0.86	253.076	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	25	252.218	13.41	238.808	0.86	253.076	23-May-17	-	1.915	251.16	-	-	no	Foam insert removed; sampled.
BH-D109	Walk south on farmer's field from Township Line	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	9-Nov-16	-	1.11	249.57	-	-	no	
					till	STP	20	249.716	12.85	236.866	0.96	250.676	30-Mar-17	3	-2.11	252.79	-	-	yes	Foam insert removed and then reinstalled.
					till	STP	20	249.716	12.85	236.866	0.96	250.676	23-May-17	-	-	>250.68	-	-	yes	Foam insert removed; water rose to TOC within a few minutes.

TABLE D2-1
TESTHOLE AND GROUNDWATER 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-01	Beside TH-GD-02	5683639	531292	2+672	Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	16-Jul-15	1	-0.70	250.00	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	4-Aug-15	1	-0.70	250.00	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	9-Nov-15	1	-0.70	250.00	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	9-Nov-16	1.1	-0.77	250.07	-	-	yes	Pressure gauge installed.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	248.3	10.4	237.9	1	249.3	24-May-17	-	1.080	248.22	-	-	no	Removed foam insert; possibly artesian - water level may be low because foam was just removed.
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	16-Jul-15	3.5	-2.46	251.73	-	-	yes	Handheld pressure gauge
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	4-Aug-15	2.9	-2.04	251.31	-	-	yes	Handheld pressure gauge
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	9-Nov-15	3	-2.11	251.38	-	-	yes	Handheld pressure gauge
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	9-Nov-16	3.8	-2.67	251.94	-	-	yes	Handheld pressure gauge
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	30-Mar-17	1	-0.70	249.97	-	-	yes	Handheld pressure gauge
					Clay Till	STP	25	248.3	20.4	227.9	0.97	249.27	24-May-17	3.9	-2.74	252.01	-	-	yes	Handheld pressure gauge
BH-D101	East side of Bayton Road	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	9-Nov-16	-	1.33	249.04	-	-	no	
					till	STP	25	249.251	8.94	240.311	1.12	250.371	23-May-17	-	-	-	-	-	-	Foam remained stuck in STP; could not remove; could not monitor.
BH-D106	East side of Bayton Road	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	9-Nov-16	-	0.86	249.95	-	-	yes	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	30-Mar-17	-	2.56	248.25	-	-	no	
					till	STP	50	249.917	11.23	238.687	0.89	250.807	23-May-17	-	1.31	approx. 249.50	-	-	yes	STP rose or casing fell approx. 5 cm while monitoring water level; needs to be resurveyed.
BH-D107	Access by quad from TH-ED-01 farm	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	9-Nov-16	-	-	-	-	-	-	No permission for access
					till	STP	50	249.81	8.69	241.12	0.86	250.67	23-May-17	-	1.137	249.53	-	-	no	Pressure gauge installed.
15-RD-02	Corner of Burnett and Carne Ridge Road	5693417	530519	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	Pressure gauge installed.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	4-Aug-15	7.1	-5.00	254.45	-	-	yes	Pressure gauge installed.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	9-Nov-15	7.7	-5.42	254.87	-	-	yes	Pressure gauge installed.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	9-Nov-16	7.4	-5.21	254.66	-	-	yes	Pressure gauge installed.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	30-Mar-17	2.0	-1.41	250.86	-	-	yes	Pressure gauge installed.
					Silty Clay Till	STP	25	248.65	14.9	233.75	0.8	249.45	24-May-17	1.0	-0.70	250.15	-	-	yes	Pressure gauge installed; leaking a bit around pressure gauge.
15-RD-02A	Corner of Burnett and Carne Ridge	5693419	530519	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	4-Aug-15	-	0.98	248.33	-	-	no	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	9-Nov-15	-	0.65	248.65	-	-	yes	
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	9-Nov-16	-	>-0.67	>249.97	-	-	yes	Flowing at TOC; no extension available

TABLE D2-1
TESTHOLE AND GROUNDWATER 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)													
	Road				Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	248.63	7.6	241.03	0.67	249.3	24-May-17	-	1.91	247.39	-	-	no	Removed foam insert.
BH-D9	East side of Burnett, walk from road	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	9-Nov-16	-	1.23	249.16	-	-	no	
					till	STP	25	249.495	12.376	237.119	0.90	250.395	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					till	STP	25	249.495	12.376	237.119	0.90	250.395	24-May-17	-	2.12	248.28	-	-	no	
15-RD-03	On trail in woods across ditch on road #239, opposite side from TH-GD-06	5697485	530996	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	4-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	9-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	9-Nov-16	-	1.238	251.50	-	-	no	
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	30-Mar-17	-	2.150	250.59	-	-	no	
					Silty Clay Till	STP	25	251.84	7.6	244.24	0.9	252.74	24-May-17	-	2.090	250.65	-	-	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	4-Aug-15	-	0.32	252.42	-	-	yes	
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	9-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	9-Nov-16	-	>-0.9	>253.64	-	-	yes	Flowing at TOC; no extension available
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	30-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Clay till	STP	25	251.84	14.9	236.94	0.9	252.74	24-May-17	-	0.852	251.89	-	-	yes	Removed foam insert; water still rising after monitoring.
15-RD-03A	On trail in woods across ditch on road #239, opposite side from TH-GD-06	5697489	530991	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	-	-	4-Aug-15	-	-	251.18	-	-	no	Water level at bottom upon completion of drilling
					Sand	VW #1403291		251.86	10.4	241.46	-	-	9-Nov-15	-	-	251.94	-	-	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	9-Nov-16	-	-	-	2816.1	251.93	yes	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	30-Mar-17	-	-	-	2823.9	251.44	no	
					Sand	VW #1403291		251.86	10.4	241.46	-	-	24-May-17	-	-	-	2818.4	251.78	no	
15-RD-04	Cluster of wells on west side of Hwy 6 (heading north)	5699450	531894	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	4-Aug-15	-	2.51	250.26	-	-	no	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	9-Nov-15	-	0.75	252.01	-	-	yes	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	9-Nov-16	-	0.54	252.22	-	-	yes	
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	251.76	7.6	244.16	1	252.76	24-May-17	-	1.92	250.84	-	-	no	
					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	4-Aug-15	1.1	-0.77	253.53	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	9-Nov-15	2.5	-1.76	254.52	-	-	yes	
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	9-Nov-16	-	>-1	>253.76	-	-	yes	Flowing at TOC; no extension available
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silty Clay Till	STP	25	251.76	14.5	237.26	1	252.76	24-May-17	1	-0.70	253.46	-	-	yes	Flowing at TOC; no extension available

TABLE D2-1
TESTHOLE AND GROUNDWATER 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-PW1	Cluster of wells on west side of Hwy 6 (heading north)	5699447	531897	19+256	bedrock	STP	125	251.76	23.16	228.6	0.94	252.70	9-Nov-16	-	-	-	-	-	yes	Conducted pump test (flow rate approx. 9.5 L/min); sampled; installed packer with transducer.
					bedrock	STP	125	251.76	23.16	228.6	1.94	253.70	31-Mar-17	-	-	-	-	-	yes	Transducer would not connect.
					bedrock	STP	125	251.76	23.16	228.6	2.94	254.70	24-May-17	-	-	-	-	-	yes	Transducer would not connect; sampled. Flow rate from well sampling tube approx. 1.3 L/min.
15-RD-10A	Use quad from old house on Burnett - watch for ditch in middle of field	5698130	531200	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	-	-	4-Aug-15	-		-	-	-	-	No Access
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	9-Nov-15	-	-	-	-	-	-	Was not read
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	9-Nov-16	-	-	-	2727.5	249.60	yes	
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	31-Mar-17	-	-	-	2732.3	249.29	yes	
					Silty Clay	VW #1404249		248.87	7.6	241.27	-	-	24-May-17	-	-	-	2728.0	249.54	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	4-Aug-15	-	-	-	-	-	-	No Access
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	9-Nov-15	-	0.1	249.77	-	-	yes	
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	9-Nov-16	-	>-1	>250.87	-	-	yes	Flowing at TOC; no extension available
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	31-Mar-17	-	-	-	-	-	-	Foam insert frozen; could not remove.
					Silt Till	STP	25	248.87	18.3	230.57	1	249.87	24-May-17	-	1.613	248.26	-	-	no	Removed foam insert. Possibly artesian; water still rising after monitoring.
15-RD-05	Across road from TH-GD-08	5701483	532787	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	4-Aug-15	-	1.89	246.15			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	9-Nov-15	-	1.37	246.67			no	
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	9-Nov-16	-	-	-	-	-	-	Blocked at 0.61 m.
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	30-Mar-17	-	-	-	-	-	-	Foam insert and rod stuck at 0.46 m below TOC - cannot remove.
					Silty Clay	STP	25	247.09	7.6	239.49	0.95	248.04	24-May-17	-	-	-	-	-	-	Foam insert stuck at 0.46 m below TOC - cannot remove.
					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	4-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	9-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	9-Nov-16	-	0.23	247.79			yes	
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	30-Mar-17	-	-	-			-	Foam insert frozen; could not remove.
					Silty Clay	STP	25	247.09	11.9	235.19	0.93	248.02	24-May-17	-	0.15	247.87			yes	Removed foam insert; water still rising after monitoring (rose 1 m in 20 min).

VW = Vibrating Wire
STP = Standpipe
* Pressure gauges were installed on standpipes at: TH-GD-08; 15-RD-01 (10.4 m STP); and 15-RD-02. Pressure readings at other standpipes were taken with a handheld gauge.
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 were installed December 8, 2016 in wells TH-ED-01W and 15-RD-PW1.

TABLE D2-2
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
	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
	23-May-17	7.4	813.1	4.7	133.2	3.07	none	none	none	purged 60 L; flow rate approx. 2 L/min.
TH-ED-01P	09-Nov-16	-	868	9.1	-185.1	1.21	none to very low	none	none	pH not calibrating
	23-May-17	7.3	818	7.0	122.2	1.92	none	none	none	purged 40L; flow rate approx. 4 L/min.
TH-ED-03	09-Nov-16	-	616	9.7	-172.9	9.02	none to very low	none	none	pH not calibrating
	24-May-17	8.1	547.6	8.7	77.1	6.52	none	none	none	purged dry after 8 L; recharge after 28 hours - 1 L
TH-GD-02	09-Nov-16	-	796	5.7	-24.6	1.54	none to very low	none	none	pH not calibrating
	24-May-17	7.4	815	5.8	153.0	0.97	none	none	none	purged 150L; flow rate approx. 6.7 L/min.
TH-GD-07	09-Nov-16	-	782	7.4	-296.5	1.15	none to very low	none	none	pH not calibrating
	24-May-17	7.2	813	7.3	112.3	1.46	none	none	none	purged 30 L; flow rate approx. 0.8 L/min.
15-PW-1	24-May-17	7.3	817	6.3	97.0	1.24	none	none	none	purged 40 L; flow rate approx. 1.3 L/min.

Notes:
Mechanical packers installed in wells TH-ED-01W and 15-PW-1 in December, 2016.

"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D2-3
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 / 0.60*	*1 / 0.34*	*1*	*0.5*	*0.02*	*0.5*	*0.01*	*0.03*	*0.01 / 0.0051*	*0.01 / 0.005*	*0.01/0.02/0 .001*	*0.03*	*0.005*	*0.001*	*0.05*	*2 / 5*	*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-ED-01W	23-May-17		-	7.71	768	328	400	<0.60	<0.34	398	5.76	-	142	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	514	-	-	-
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-01P	23-May-17		-	7.71	771	319	390	<0.60	<0.34	390	6.12	-	148	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	518	-	-	-
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-ED-03	25-May-17		-	8.34	514	332	399	2.88	<0.34	162	17	-	43.2	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	372	-	-	-
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-02	23-May-17		-	7.84	744	276	336	<0.60	<0.34	359	12.9	-	156	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	496	-	-	-
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	-	-	-
TH-GD-07	23-May-17		-	7.74	739	334	407	<0.60	<0.34	384	5.3	-	117	-	-	<0.0051	<0.0050	<0.0010	-	-	-	-	487	-	-	-
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	-	-
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	-	-	-
15-RD-PW1	23-May-17		-	7.75	736	339	414	<0.60	<0.34	371	5.29	-	115	-	-	<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-oligotrophi <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 D2-4
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-ED-01W	23-May-17	-	-	-	-	-	-	-	-	81.5	-	-	-	-	-	-	-	47.2	-	-
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-01P	23-May-17	-	-	-	-	-	-	-	-	79.5	-	-	-	-	-	-	-	46.5	-	-
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-ED-03	25-May-17	-	-	-	-	-	-	-	-	20.8	-	-	-	-	-	-	-	26.8	-	-
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-02	23-May-17	-	-	-	-	-	-	-	-	68	-	-	-	-	-	-	-	45.9	-	-
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
TH-GD-07	23-May-17	-	-	-	-	-	-	-	-	75.2	-	-	-	-	-	-	-	47.8	-	-
TH-GD-08	29-Oct-16	-	-	-	-	-	-	-	-	74.3	-	-	-	-	-	-	-	48.3	-	-
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
15-RD-PW1	23-May-17	-	-	-	-	-	-	-	-	70.9	-	-	-	-	-	-	-	47.2	-	-
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

TABLE D2-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

TABLE D2-4
GROUNDWATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

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-ED-01W	23-May-17	-	-	9.65	-	-	-	-	31.5	-	-	-	-	-	-	-	-	-	-'	-
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-01P	23-May-17	-	-	9.82	-	-	-	-	36	-	-	-	-	-	-	-	-	-	-'	-
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-ED-03	25-May-17	-	-	2.43	-	-	-	-	62.1	-	-	-	-	-	-	-	-	-	-'	-
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-02	23-May-17	-	-	9.88	-	-	-	-	37.5	-	-	-	-	-	-	-	-	-	-'	-
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
TH-GD-07	23-May-17	-	-	10.2	-	-	-	-	31.4	-	-	-	-	-	-	-	-	-	-'	-
TH-GD-08	29-Oct-16	-	-	10	-	-	-	-	35.4	-	-	-	-	-	-	-	-	-	-	-
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
15-RD-PW1	23-May-17	-	-	10	-	-	-	-	30.3	-	-	-	-	-	-	-	-	-	-'	-
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 D2-4
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 D2-5
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
	25-May-17	8.3	936	14.1	205.5	7.33	5.04	none	none	sampled adjacent to Watchorn Prov. Park approx. 75 m from shoreline at depth of 0.1 m; very windy; light rain
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
	25-May-17	7.4	603.2	13.8	175.6	3.59	1.59	none	none	sampled approx. 40 m south of PR 237 from side road using reacher pole; very windy; light rain
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
	25-May-17	7.7	540.3	14.1	152.0	6.16	2.70	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; windy; light rain
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
	25-May-17	8.3	696	12.8	131.4	5.63	1.09	none	none	sampled beyond staff gauge/edge of reeds using reacher pole; windy; light rain
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
	25-May-17	8.1	622.5	14.4	118.0	7.07	3.21	none	none	sampled on E side of road in front of middle culvert; water approx. 0.2 m deep; windy
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
	25-May-17	8.0	876	14.0	133.9	6.42	3.37	none	none	sampled on W side of Hwy 6 where Woodale Drain joins Birch Creek using reacher pole; water approx. 0.35 m deep; windy
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
	25-May-17	7.7	541.4	13.2	125.2	5.21	0.97	none	none	sampled on N side of Ira Pontius Rd., 100 m west of Hwy 6; water approx. 0.15 m deep; windy
D8 - Birch Creek	07-Nov-16	8.3	566.8	5.5	-54.4	9.83	1.89	none	none	sampled upstream of bridge
	25-May-17	8.4	788	14.6	130.8	7.96	5.04	none	none	sampled upstream of bridge on Bittner Bay Rd. off end of culvert; water approx. 1 m deep; windy
D9 - LSM	07-Nov-16	8.4	691.4	6.6	-26.1	10.58	5.15	none	none	sampled at prov. hydrometric station
	25-May-17	8.2	932	14.2	150.2	7.29	3.27	none	none	sampled south of prov. hydrometric station approx. 10 m from shoreline at depth of 1 m; windy; lake high - covering approach road to shoreline

Notes:
"-" = No Data
NA = Not Applicable
EC = Electrical Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-Reduction Potential

TABLE D2-6
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	Phosphorous, Total Particulate	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-1	Lake Manitoba	25-May-17		2.5	8.5	886	193	222	6.6	<0.34	250	141	0.148	82.7	<0.010	<0.010	<0.0020	0.87	0.87	0.0054	0.022	-	<0.010	0.0007	532	3.8	<1	74
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-2	Watchorn Creek	25-May-17		1.2	7.82	561	272	332	<0.60	<0.34	329	13.3	0.221	129	<0.010	<0.010	<0.0020	1.51	1.51	0.037	**0.046**	-	<0.010	0.0002	426	<2.0	20	1990
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-3	Reed Lake	25-May-17		2	7.98	508	239	292	<0.60	<0.34	291	4.32	0.109	66.2	<0.0051	<0.0050	<0.0010	1.54	1.54	0.02	**0.042**	-	<0.010	0.0002	318	3.8	33	236
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-4	Clear Lake	25-May-17		0.9	8.45	645	337	393	8.88	<0.34	418	6.83	0.171	74	<0.0051	<0.0050	<0.0010	1.15	1.15	0.02	**0.028**	-	<0.010	0.0006	419	<2.0	2	42
D-4	Clear Lake	25-May-17	Dup	0.9	8.46	642	338	393	9.6	<0.34	405	6.81	0.178	73.9	<0.0051	<0.0050	<0.0010	1.39	1.39	0.02	**0.027**	-	<0.010	0.0006	416	<2.0	1	38
			RPD	*0.0%*	*0.1%*	*0.5%*	*0.3%*	*0.0%*	*7.8%*	-	*3.2%*	*0.3%*	*4.0%*	*0.1%*	-	-	-	*18.9%*	*18.9%*	*0.0%*	*3.6%*		-	*0.0%*	*0.7%*	-	*66.7%*	*10.0%*
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-5	North Clarks Drain	25-May-17		2.93	8.27	585	368	448	<0.60	<0.34	375	0.78	0.244	18.1	0.0346	0.0295	0.0051	0.92	0.89	0.021	**0.03**	-	0.05	0.0023	364	4	49	2420
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-6	South Birch Creek	25-May-17		2.39	8.22	810	416	508	<0.60	<0.34	526	9.25	0.246	110	0.011	0.011	<0.0020	1.36	1.34	0.0102	0.0162	0.006	<0.010	0.0004	549	2.4	185	1730
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-7	Woodale Drain	25-May-17		0.79	7.99	511	303	370	<0.60	<0.34	311	0.8	0.08	20.7	<0.0051	<0.0050	<0.0010	1.29	1.29	0.04	**0.043**	-	<0.010	0.0002	308	<2.0	68	1550
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-8	Birch Creek	25-May-17		3.43	8.49	720	396	455	13.4	<0.34	480	6.82	0.243	78.1	<0.0051	<0.0050	<0.0010	1.3	1.3	0.0134	**0.029**	-	<0.010	0.0008	485	3.2	39	1990
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%*	-	-	-
D-9	Lake St. Martin	25-May-17		2.41	8.24	864	208	253	<0.60	<0.34	270	142	0.125	64	0.011	0.011	<0.0020	0.82	0.81	0.0096	**0.027**	-	<0.010	0.0004	532	3.6	1	387
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
FB		25-May-17		<0.10	6.27	1	1.1	1.3	<0.60	<0.34	<0.25	<0.10	<0.020	<0.30	<0.0051	<0.0050	<0.0010	<0.20	<0.20	<0.0010	<0.0010	<0.0028	<0.010	-	<5.0	<2.0	<1	<1
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 D2-7
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-1	Lake Manitoba	25-May-17	-	-	-	-	-	-	-	-	43.6	-	-	-	-	0.025	-	-	34.2	0.00461	-
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-2	Watchorn Creek	25-May-17	-	-	-	-	-	-	-	-	47.5	-	-	-	-	0.037	-	-	51	0.0446	-
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-3	Reed Lake	25-May-17	-	-	-	-	-	-	-	-	37	-	-	-	-	0.025	-	-	48.3	0.0146	-
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-4	Clear Lake	25-May-17	-	-	-	-	-	-	-	-	45.2	-	-	-	-	0.021	-	-	74	0.00546	-
D-4 Dup	Clear Lake	25-May-17	-	-	-	-	-	-	-	-	44.8	-	-	-	-	0.014	-	-	71.2	0.00514	-
		RPD	-	-	-	-	-	-	-	-	*0.9%*	-	-	-	-	*40.0%*	-	-	*3.9%*	*6.0%*	-
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-5	North Clarks Drain	25-May-17	-	-	-	-	-	-	-	-	63.2	-	-	-	-	0.116	-	-	52.7	0.0318	-
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-6	South Birch Creek	25-May-17	-	-	-	-	-	-	-	-	74.2	-	-	-	-	0.073	-	-	82.7	0.0308	-
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-7	Woodale Drain	25-May-17	-	-	-	-	-	-	-	-	46.7	-	-	-	-	0.084	-	-	47.2	0.0407	-
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
D-8	Birch Creek	25-May-17	-	-	-	-	-	-	-	-	70.8	-	-	-	-	0.11	-	-	73.7	0.0438	-
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%*
D-9	Lake St. Martin	25-May-17	-	-	-	-	-	-	-	-	48.6	-	-	-	-	0.031	-	-	36.2	0.00518	-
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
FB		25-May-17	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	<0.010	-	-	<0.010	<0.00030	-
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

TABLE D2-7
SURFACE WATER METALS - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

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-1	Lake Manitoba	25-May-17	-	-	9.26	-	-	-	-	106	-	-	-	-	-	-	-	-	-	-	-
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-2	Watchorn Creek	25-May-17	-	-	10.2	-	-	-	-	11.5	-	-	-	-	-	-	-	-	-	-	-
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-3	Reed Lake	25-May-17	-	-	8.56	-	-	-	-	9.88	-	-	-	-	-	-	-	-	-	-	-
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-4	Clear Lake	25-May-17	-	-	3.27	-	-	-	-	13.4	-	-	-	-	-	-	-	-	-	-	-
D-4 Dup	Clear Lake	25-May-17	-	-	3.23	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-
		RPD	-	-	*1.2%*	-	-	-	-	*3.0%*	-	-	-	-	-	-	-	-	-	-	-
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-5	North Clarks Drain	25-May-17	-	-	2.26	-	-	-	-	5.77	-	-	-	-	-	-	-	-	-	-	-
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-6	South Birch Creek	25-May-17	-	-	6.66	-	-	-	-	16.3	-	-	-	-	-	-	-	-	-	-	-
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-7	Woodale Drain	25-May-17	-	-	4.7	-	-	-	-	6.06	-	-	-	-	-	-	-	-	-	-	-
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
D-8	Birch Creek	25-May-17	-	-	5.33	-	-	-	-	13.2	-	-	-	-	-	-	-	-	-	-	-
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%*	-	-
D-9	Lake St. Martin	25-May-17	-	-	8.57	-	-	-	-	108	-	-	-	-	-	-	-	-	-	-	-
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
FB		25-May-17	-	-	<0.020	-	-	-	-	<0.030	-	-	-	-	-	-	-	-	-	-	-
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 D2-7
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.

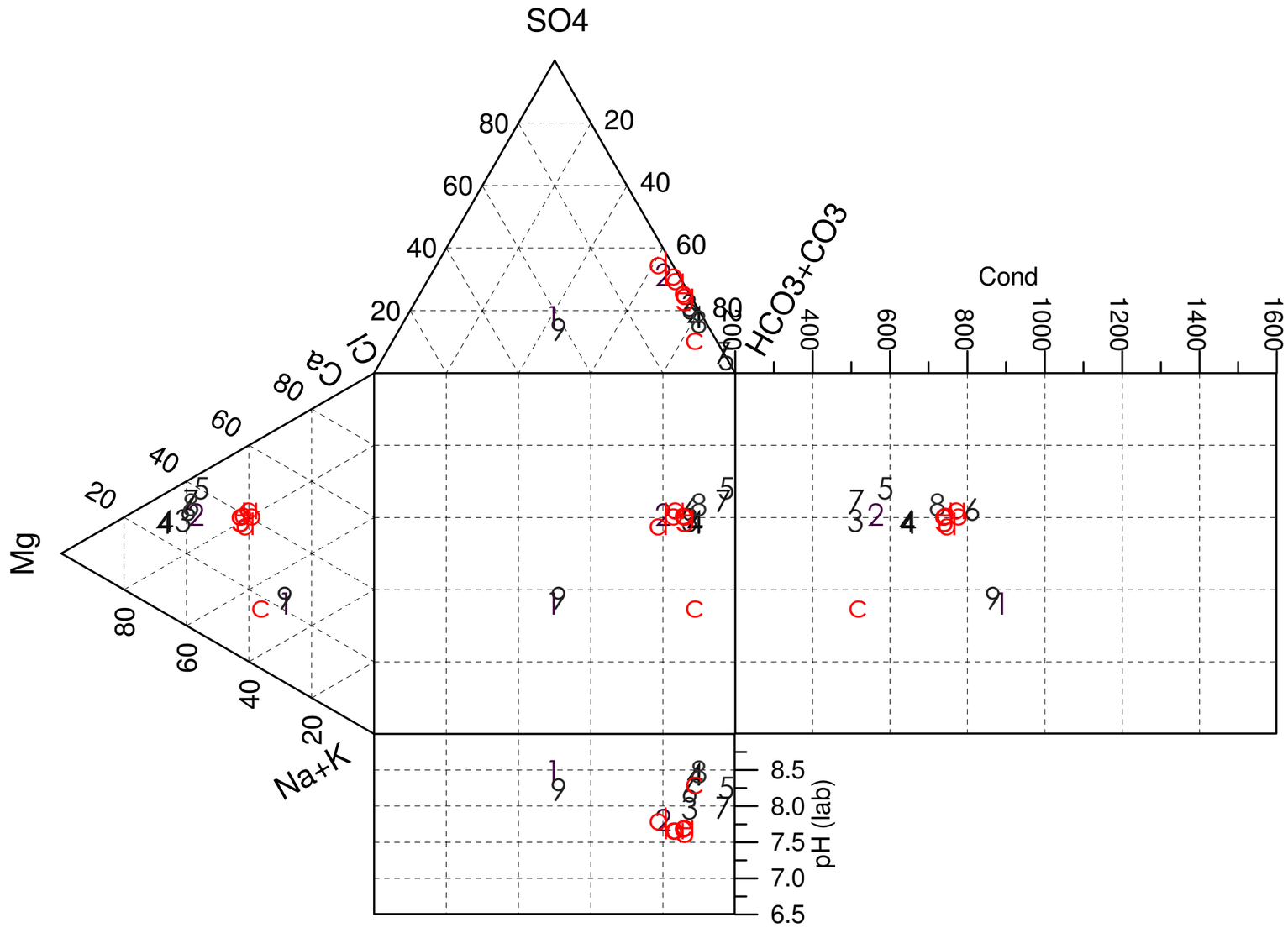
Trigger ranges (µg/L):				
	ultra-oligotrophic	<4	meso-eutrophic	20-35
	oligotrophic	4-10	eutrophic	35-100
	mesotrophic	10-20	hyper-eutrophic	>100

	- Exceedance of CCME Guidelines
BOLD	- Exceedance of MWQSOG Guidelines

TABLE D2-8
STABLE ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

Sample	Date	Lab#	$\delta 18O$	Result	Repeat	δ^2H	Result	Repeat	pH	Conductivity
			H_2O	VSMOW		H_2O	VSMOW			µS/cm
Ground Water										
TH-ED-01W	26-Oct-16	373023	X	-14.72	-14.89	X	-113.02	-112.97	6.51	511
TH-ED-01W	23-May-17	381957	X	-15.14	-15.11	X	-114.18	-113.99	7.38	813
TH-GD-08	29-Oct-16	373025	X	-14.86	0.16	X	-113.64	-	-	*
15-RD-PW1	24-May-17	381958	X	-15.30	-	X	-115.05	-	7.33	817
Surface Water										
D-1 LMB	08-Nov-16	374371	X	-9.72	-	X	-75.68	-	8.05	492
D-4 Clear Lake	08-Nov-16	374374	X	-11.31	-11.29	X	-80.81	-80.67	8.84	532
D-9 LSM	08-Nov-16	374372	X	-8.46	-8	X	-72.86	-73.00	8.41	691
D-9 LSM-DUP	08-Nov-16	374373	X	-8.51	-	X	-72.83	-	8.41	691
D-1 LMB	25-May-17	381959	X	-8.83	-8.81	X	-75.80	-75.55	8.32	936
D-4 Clear Lake	25-May-17	381960	X	-10.67	-	X	-90.14	-	8.33	696
D-4 Clear Lake DUP	25-May-17	381962	X	-10.68	-10.75	X	-89.83	-89.67	8.33	696
D-9 LSM	25-May-17	381961	X	-9.00	-	X	-77.15	-	8.18	932

PLATES



a TH-ED-01W 2017/05/23
b TH-ED-01P 2017/05/23
c TH-ED-03 2017/05/25
d TH-GD-02 2017/05/23
e TH-GD-07 2017/05/23
g 15-RD-PW1 2017/05/23
1 D-1 2017/05/25
2 D-2 2017/05/25
3 D-3 2017/05/25
4 D-4 2017/5/25
5 D-5 2017/05/25
6 D-6 2017/05/25
7 D-7 2017/05/25
8 D-8 2017/05/25
9 D-9 2017/05/25

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01		MFH	JDM

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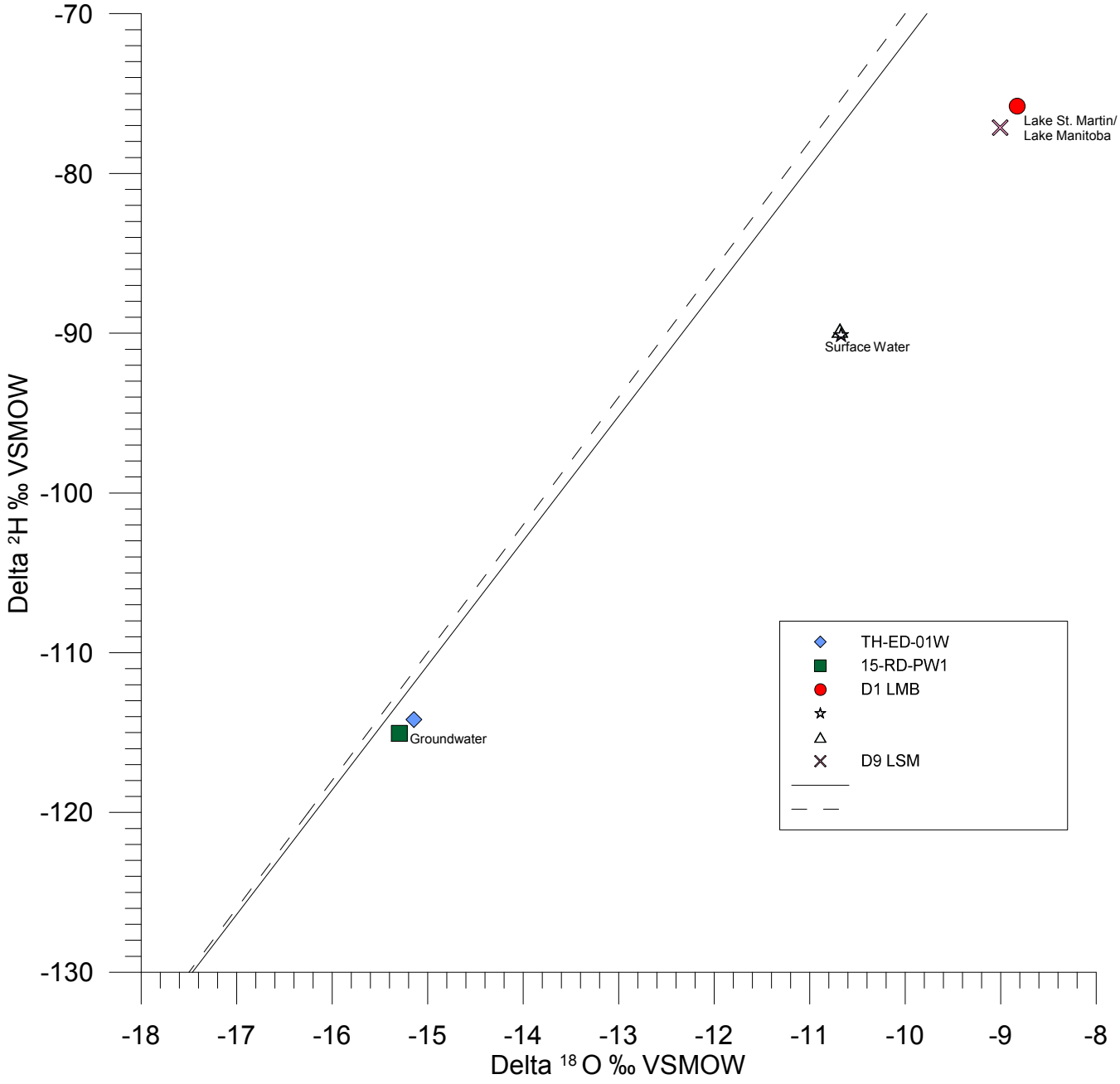
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C & D

GROUNDWATER AND SURFACE WATER QUALITY - HYDROGEOCHEMICAL PLOTS - ROUTE D

JULY 2017 | PLATE D2-1 | 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

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01		MFH	JDM

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

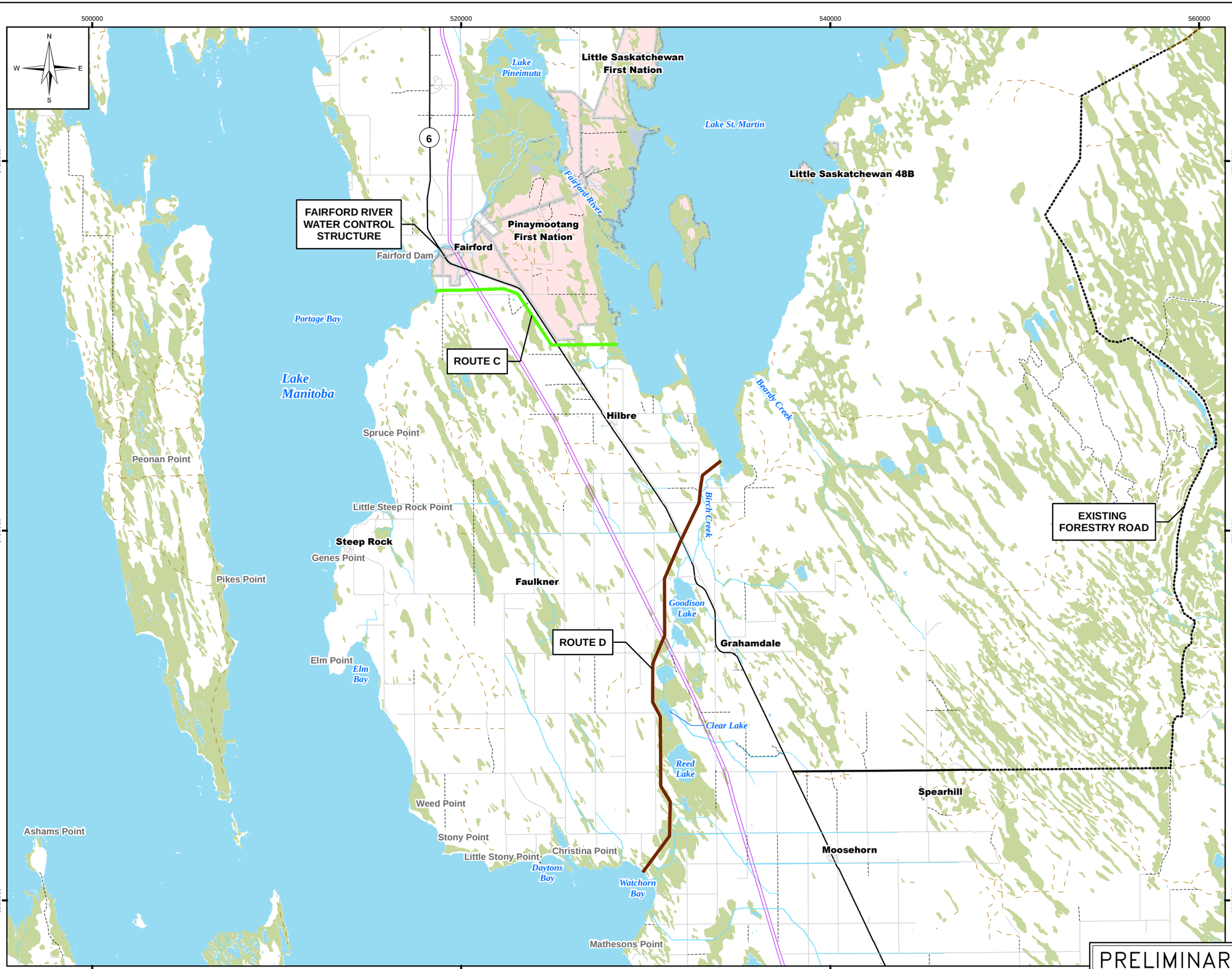
ISOTOPES IN GROUNDWATER AND SURFACE WATER - ROUTE D

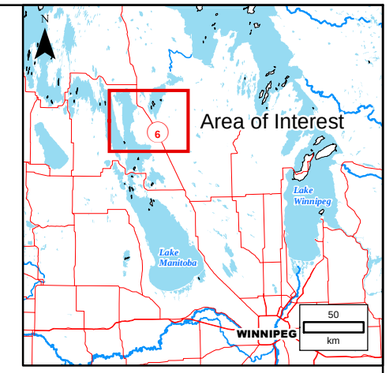
JULY 2017	PLATE D2-2	REV: 0

P:\Projects\2016\16-0300-006\Design\Env\Tables\D2 Tables\Isotopes\Route D_isotopes 2017 May 25.pdf

APPENDIX D2-A

LOCATION PLANS FROM: INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LAKE MANITOBA OUTLET CHANNELS OPTIONS C AND D SUMMARY REPORT, MAY 2017. APPENDIX A, DELIVERABLE 4 ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER – ROUTE C





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

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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

5717000 5716000 5715000 5714000 5713000 5712000 5711000 5710000 5709000 5708000

523000 522000 521000 520000 519000 518000 517000 516000

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

6

1 + 000

See Note 2

TH-GC01

Permanent Groin

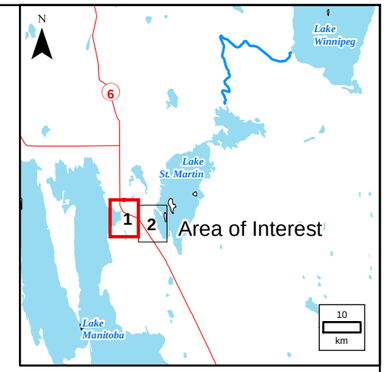
0 + 0

Proposed Bridge

Temporary Cofferdam & Other Inlet Works

Lake Manitoba

INSET A



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.
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"

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

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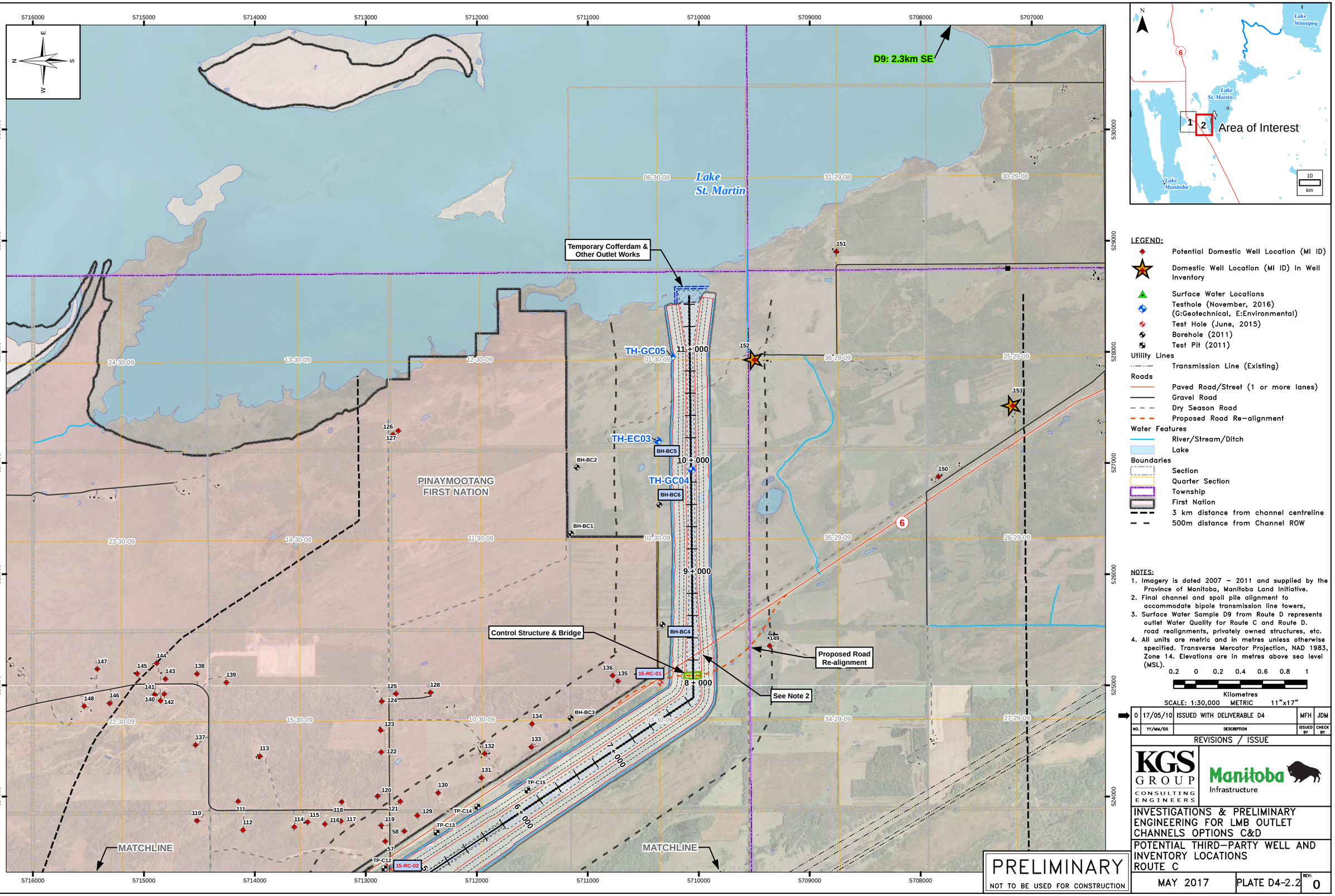
INVESTIGATIONS & PRELIMINARY ENGINEERING FOR LMB OUTLET CHANNELS OPTIONS C&D

POTENTIAL THIRD–PARTY WELL AND INVENTORY LOCATIONS ROUTE C

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

MAY 2017 | PLATE D4-2.1 | 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



LEGEND:

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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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- 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

NOTES:
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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"

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

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE C

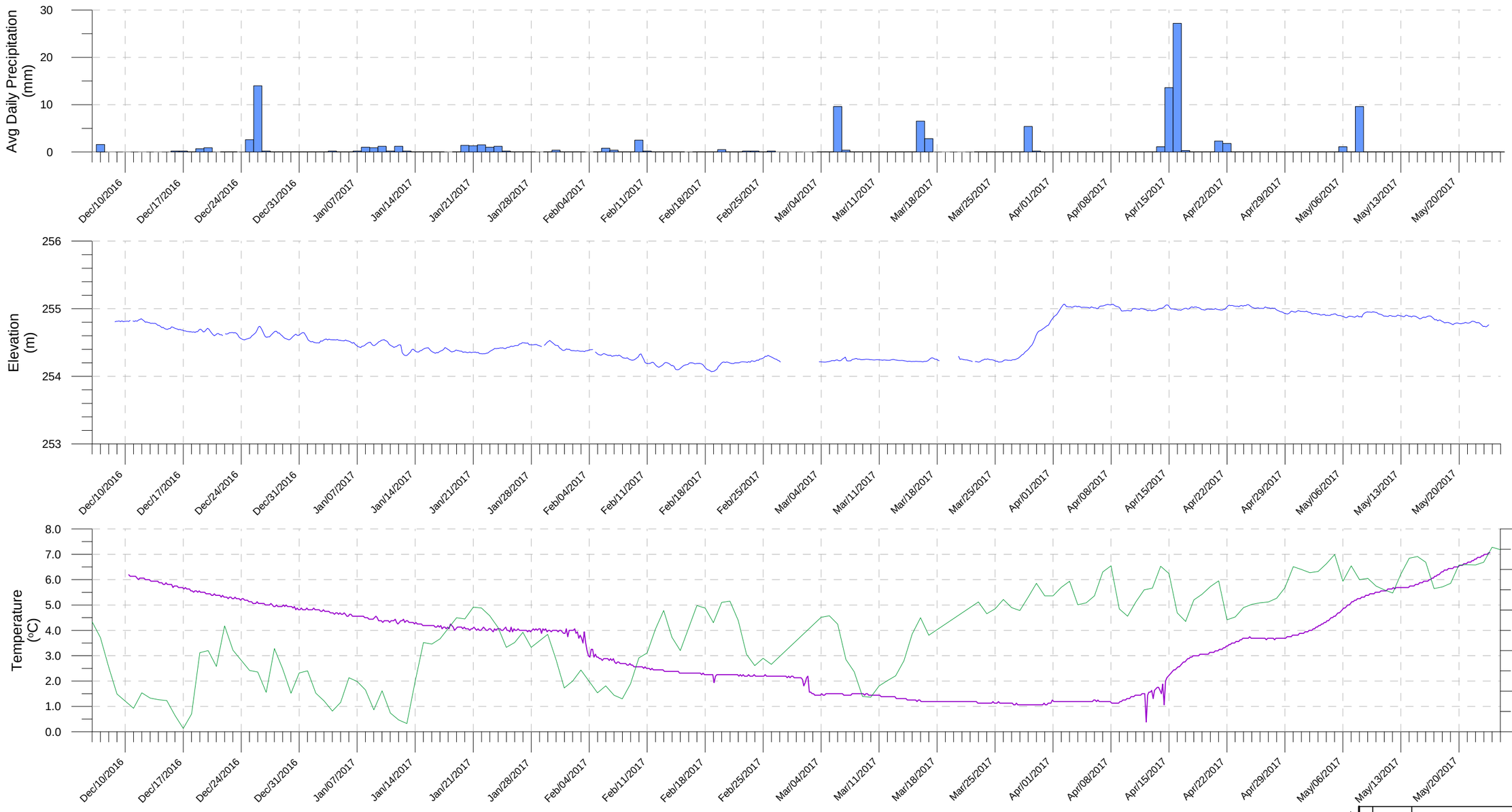
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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

APPENDIX D2-B

CONTINUOUS WATER ELEVATION AND TEMPERATURE DATA



Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

Temperature
- Water Temperature (Transducer)
- Avg. Daily Air Temperature (Fisher Branch)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01	ISSUED WITH DELIVERABLE D2	PJL	MFH

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LAKE MANITOBA CHANNEL D
GROUNDWATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT WELL TH-EC-01WW1

JULY 2017 | FIGURE D2-B-1 | REV: 0

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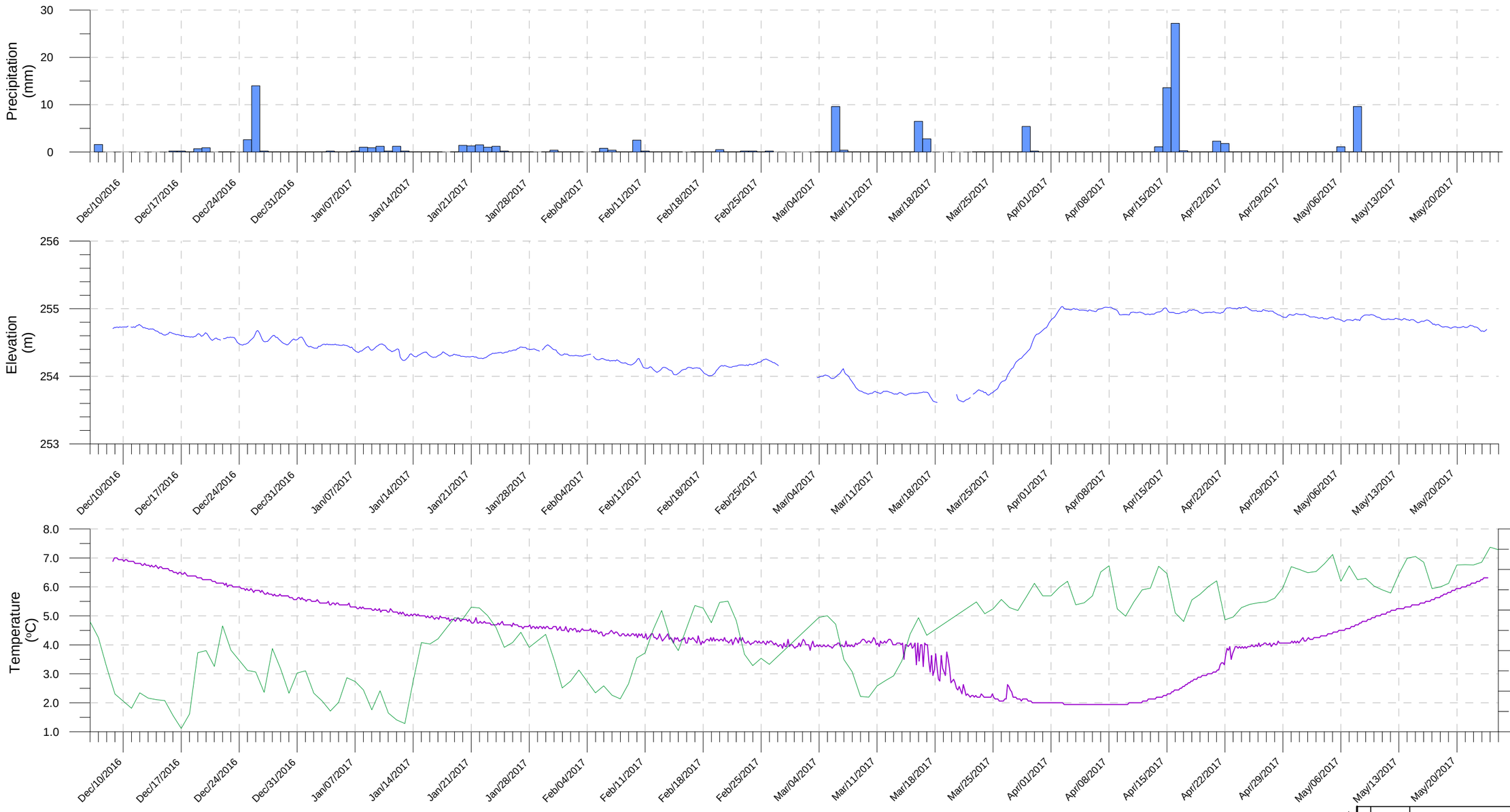

Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

Temperature
- Water Temperature (Transducer)
- Avg. Daily Air Temperature (Fisher Branch)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01	ISSUED WITH DELIVERABLE D2	PJL	MFH

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LAKE MANITOBA CHANNEL D
GROUNDWATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT WELL TH-EC-01WW2

JULY 2017 | FIGURE D2-B-2 | REV: 0

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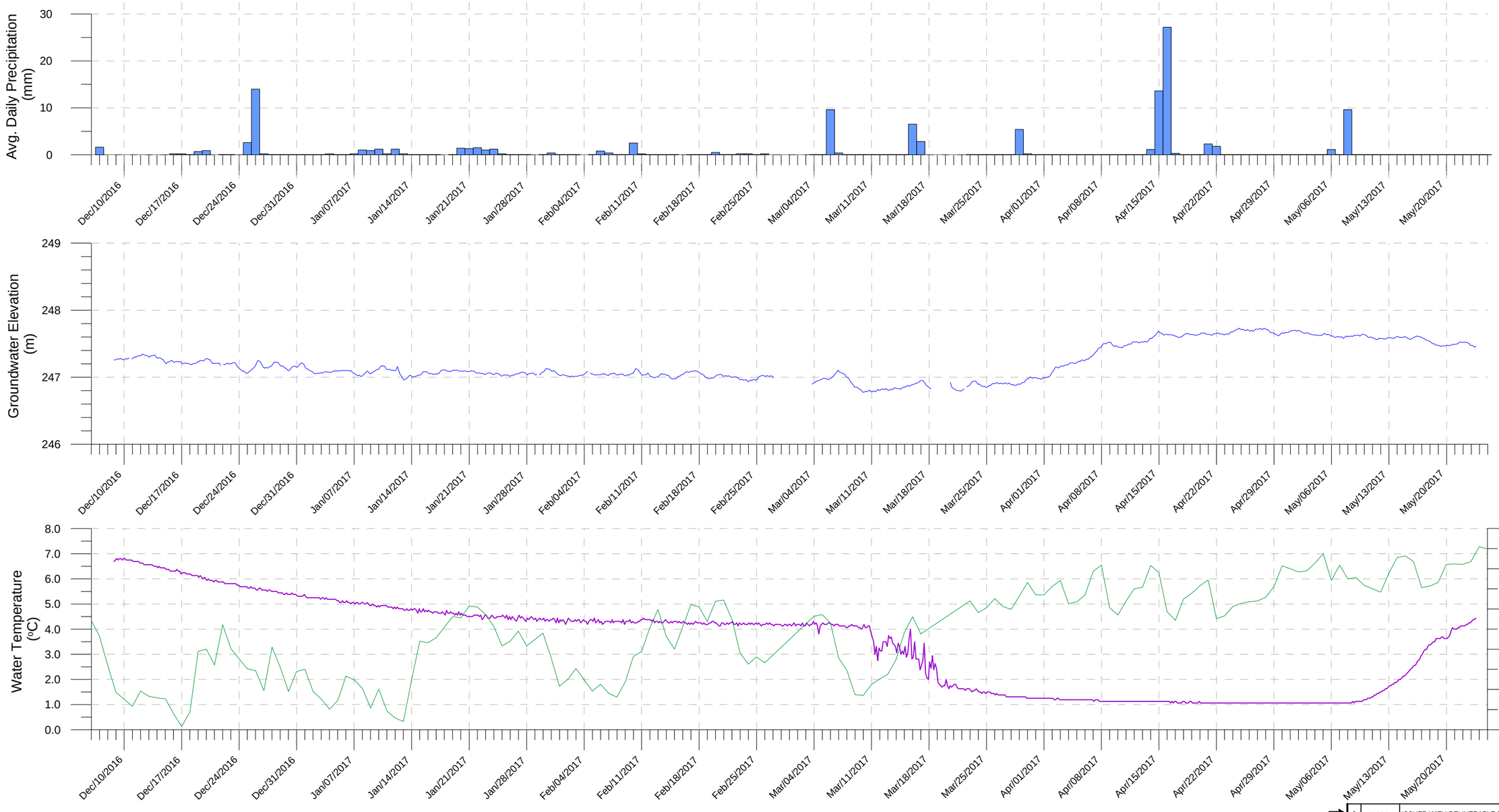

Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

Temperature
- Water Temperature (Transducer)
- Average Daily Air Temperature (Fisher Branch)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01	ISSUED WITH DELIVERABLE D2	PJL	MFH

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LAKE MANITOBA CHANNEL D
GROUNDWATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT WELL TH-EC-03

JULY 2017 | FIGURE D2-B-3 | REV: 0

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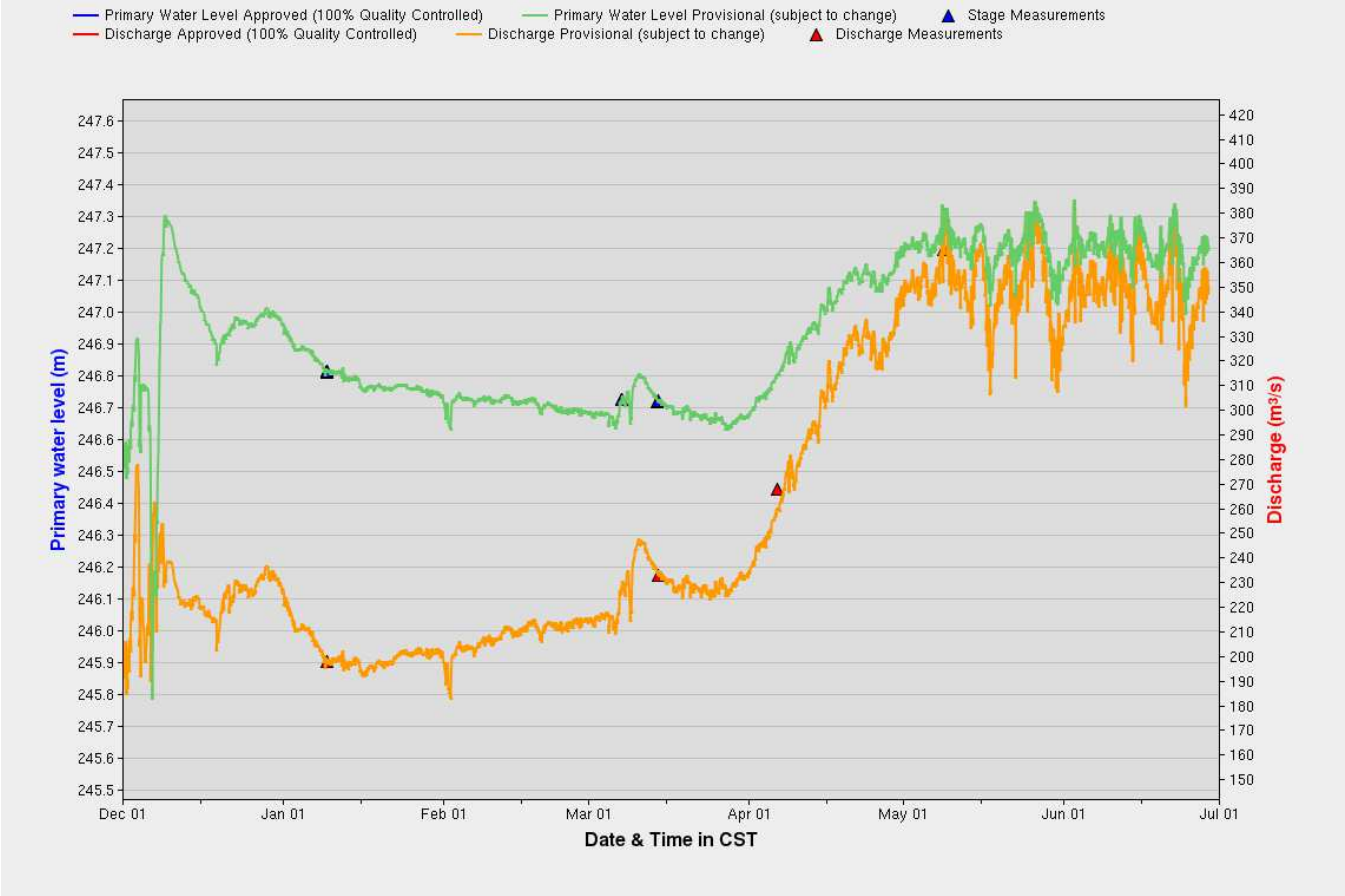
TABLE D2-B-4
MECHANICAL PACKER AND TRANSDUCER INSTALLATION - ROUTE C
LAKE MANITOBA OUTLET CHANNELS

ID	TOC El. (m)	Grnd El. (m)	Packer El. (m)	Transducer Tip El. (m)	Bedrock Open Zone Elevation
TH-EC-03W	246.90	245.68	245.01	244.17	El. 235.88 to 229.8 m)
TH-EC-01WW1	256.56	255.57	255.26	254.47	El. 254.37 m to 242.5 m
TH-EC-01WW2	256.56	255.58	254.68	253.91	El. 241.28 m to 237.3 m

Government of Canada Gouvernement du Canada

Real-Time Hydrometric Data Graph for FAIRFORD RIVER NEAR FAIRFORD (05LM001) [MB]



Timeliness of the real-time data

Station Information

Active or discontinued:	Active
Province / Territory:	Manitoba
Latitude:	51° 35' 14" N
Longitude:	98° 42' 42" W
Gross drainage area:	79800 km²
Effective drainage area:	N/A
Record length:	74 Years
Period of record:	1881 - 2017
Regulation type:	Regulated
Regulation length:	N/A

Real-time data available:	Yes
Sediment data available:	No
Type of water body:	River
RHBN:	No
EC Regional Office:	WINNIPEG
Data contributed by:	N/A
Datum of published data:	GEODETIC SURVEY OF CANADA DATUM (LOCAL 1962 ADJ.)

Data Collection History

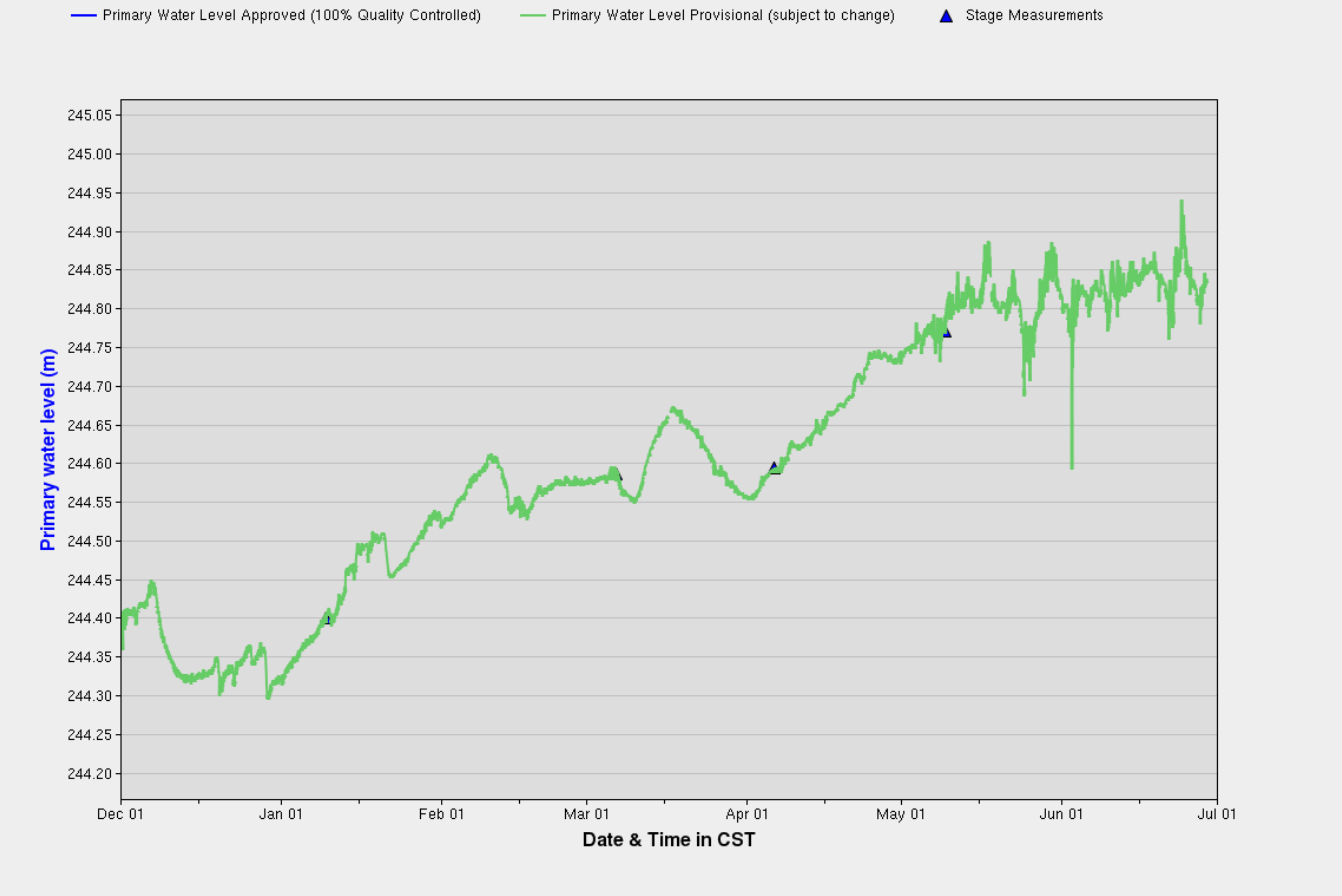
This table contains information pertaining to the historical changes of defined elements in the operation of a station.

Period of operation	Type	Operation schedule	Gauge type
1881 - 1881	Flow	Miscellaneous	N/A
1908 - 1908	Flow	Miscellaneous	N/A
1912 - 1919	Flow	Continuous	Manual
1920 - 1920	Flow	Seasonal	Manual
1955 - 1960	Flow	Continuous	Manual
1961 - 2001	Flow	Continuous	Recorder
2002 - 2017	Flow & Level	Continuous	Recorder

Date modified:
2016-06-17

Government of Canada Gouvernement du Canada

Real-Time Hydrometric Data Graph for LAKE ST. MARTIN NEAR HILBRE (05LM005) [MB]



Timeliness of the real-time data

Station Information

Active or discontinued:	Active
Province / Territory:	Manitoba
Latitude:	51° 30' 31" N
Longitude:	98° 31' 44" W
Gross drainage area:	82200 km^2
Effective drainage area:	N/A
Record length:	52 Years
Period of record:	1966 - 2017
Regulation type:	Regulated
Regulation length:	N/A

Real-time data available:	Yes
Sediment data available:	No
Type of water body:	Lake
RHBN:	No
EC Regional Office:	WINNIPEG
Data contributed by:	N/A
Datum of published data:	GEODETIC SURVEY OF CANADA DATUM (LOCAL 1964 ADJ.)

Data Collection History

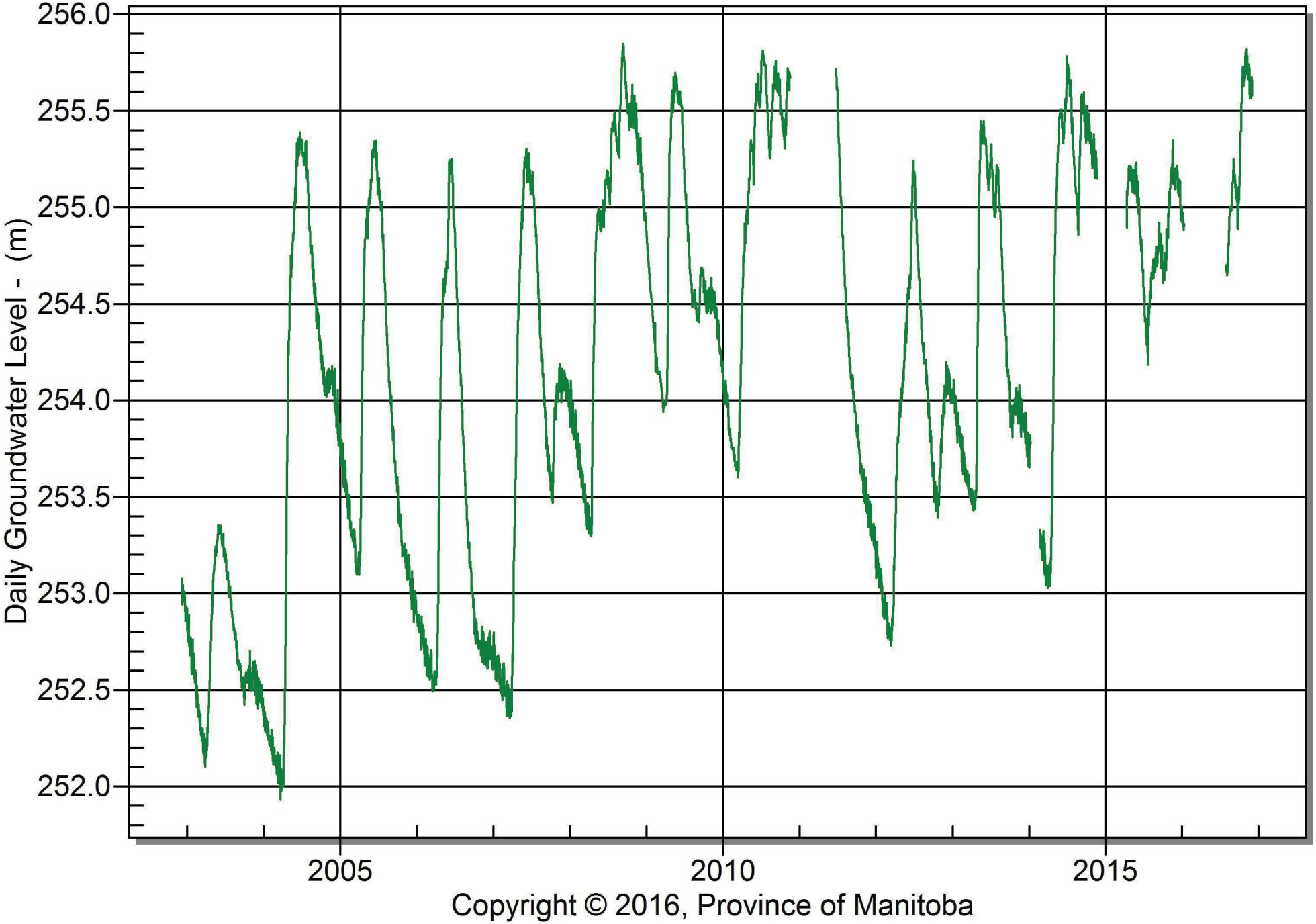
This table contains information pertaining to the historical changes of defined elements in the operation of a station.

Period of operation	Type	Operation schedule	Gauge type
1966 - 1970	Level	Continuous	Manual
1971 - 2017	Level	Continuous	Recorder

Date modified:
2016-06-17

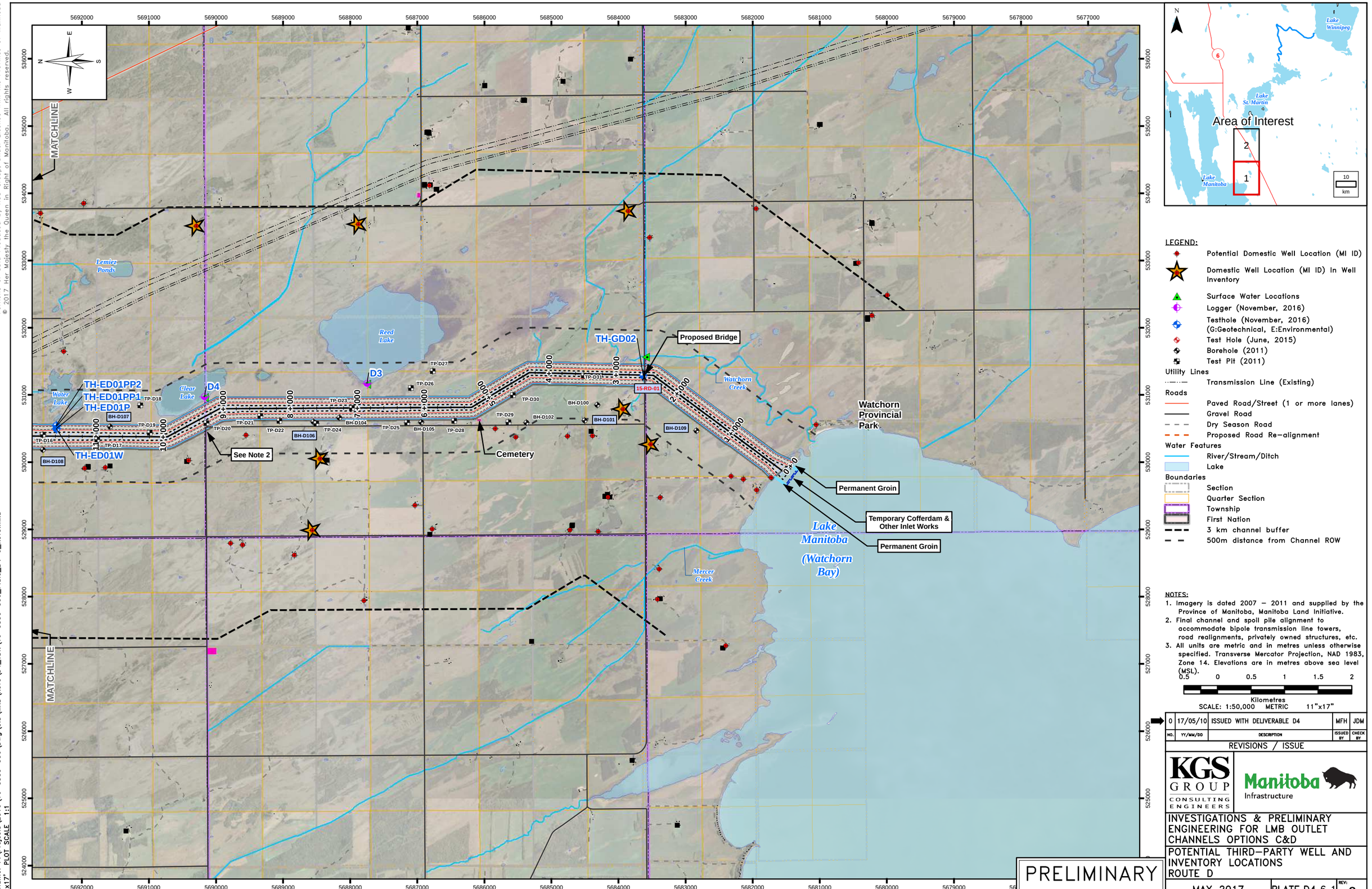
G05LM001 STEEP ROCK #1 NW19-28-08W

GROUND LEVEL ELEVATION 255.826 METRES (839.32 FT)



APPENDIX D2-C

LOCATION PLANS FROM: INVESTIGATIONS AND PRELIMINARY ENGINEERING FOR LAKE MANITOBA OUTLET CHANNELS OPTIONS C AND D SUMMARY REPORT, MAY 2017. APPENDIX A, DELIVERABLE 4 ASSESSMENT OF EXISTING WELL USE AND SUITABILITY AS DRINKING WATER – ROUTE D



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:
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"

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

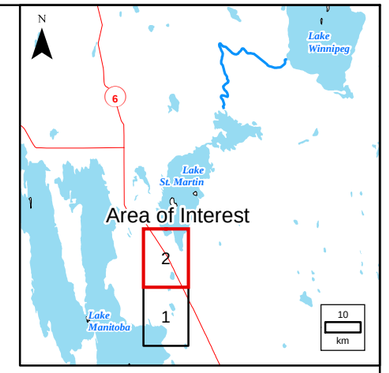
POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

MAY 2017 | PLATE D4-6.1 | 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_D4-6_Rev0.mxd
11"x17" PLOT SCALE 1:1

Temporary Cofferdam & Other Outlet Works
Birch Creek
Lake St. Martin
TH-GD08
See Note 2
Proposed Bridge
Control Structure & Bridge
TH-GD07
Proposed Road Re-alignment
TH-GD06
Proposed Bridge & Road Re-alignment
TH-GD05
Proposed Bridge
TH-ED03
MATCHLINE
Clarks Drain
Goodison Lake
Woodale Drain
D5
D6
D7
D8
D9
15-RD-02
15-RD-02A
15-RD-03
15-RD-03A
15-RD-04
15-RD-05
15-RD-10A
6
239



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

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"

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

POTENTIAL THIRD-PARTY WELL AND INVENTORY LOCATIONS ROUTE D

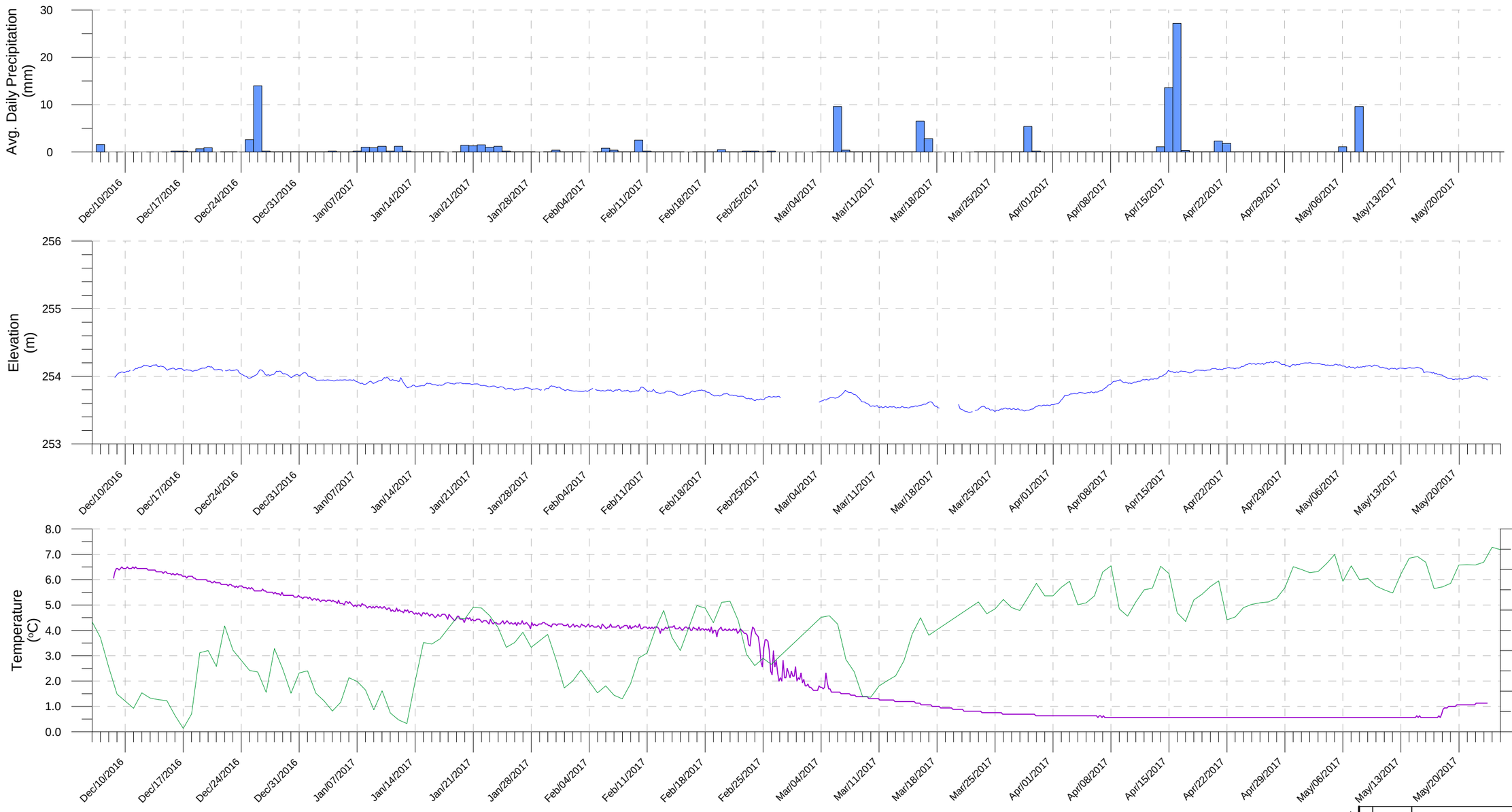
MAY 2017 | PLATE D4-6.2 | REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

FileName: P:\Projects\2016\16-0300-006\Dwg\GIS\MXD\Rev0\D4_TDR\16-0300-006_Plate_D4-6_Rev0.mxd
11"x17" PLOT SCALE 1:1

APPENDIX D2-D

CONTINUOUS WATER ELEVATION AND TEMPERATURE DATA



Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

Temperature
- Water Temperature (Transducer)
- Avg. Daily Air Temperature (Fisher Branch)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01	ISSUED WITH DELIVERABLE D2	PJL	MFH

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KGS GROUP CONSULTING ENGINEERS

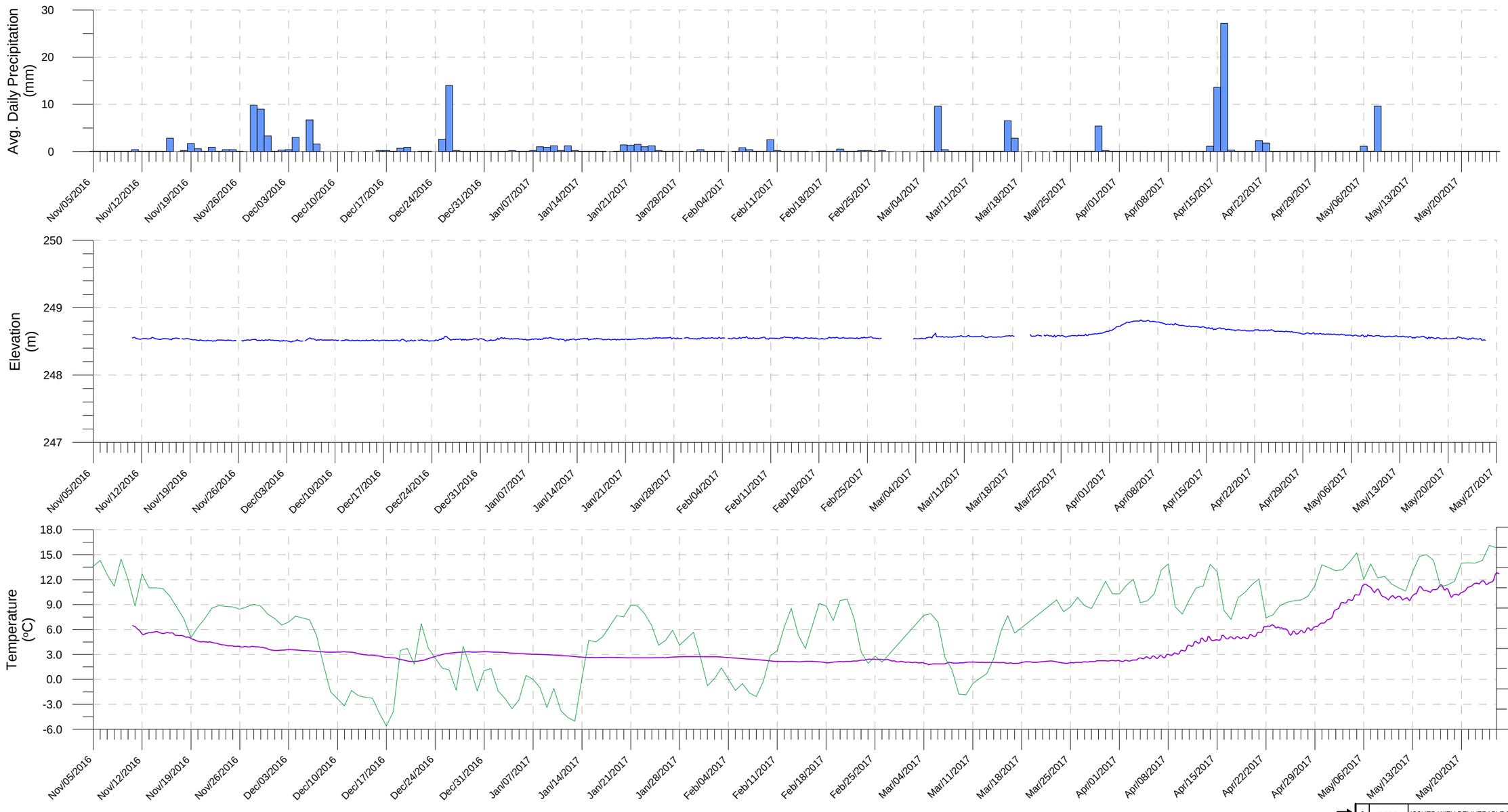
Manitoba Infrastructure

LAKE MANITOBA CHANNEL D
GROUNDWATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT WELL TH-ED-01W

JULY 2017 | FIGURE D2-D-1 | REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Transducer Data\LMB_Dec 2016 to 2018_TD Data\D\TH-ED-01W.grf



Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01	ISSUED WITH DELIVERABLE D2	PJL	MFH

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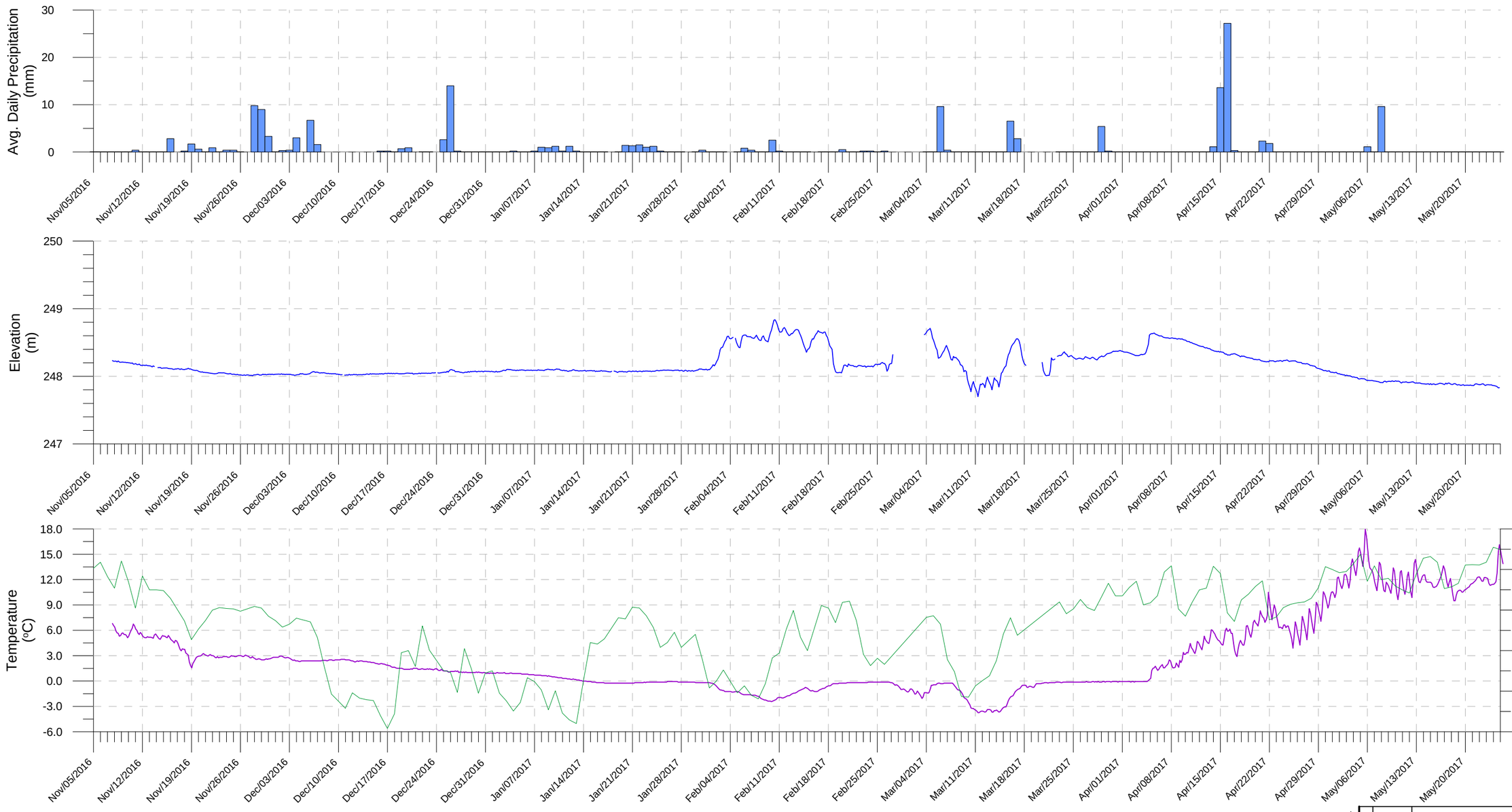
Manitoba Infrastructure

LAKE MANITOBA CHANNEL D
SURFACE WATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT D3, REED LAKE

JULY 2017 | FIGURE D2-D-2 | REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Transducer Data\LMB_Dec 2016 to 2018_TD Data\D\D3 Reed Lake.grf



Notes:
1. Transducer groundwater elevation data compensated with barometric pressure data from Fisher Branch, MB weather station.
2. Breaks in groundwater elevation data occur where barometric data is unavailable.
3. Average daily air temperature and precipitation data was collected from Fisher Branch (AUT) weather station.

Temperature
- Water Temperature (Transducer)
- Avg. Daily Air Temperature (Fisher Branch)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/07/01	ISSUED WITH DELIVERABLE D2	PJL	MFH

REVISIONS / ISSUE

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Manitoba Infrastructure

LAKE MANITOBA CHANNEL D
SURFACE WATER MONITORING

WATER ELEVATION AND TEMPERATURE READINGS AT D4, CLEAR LAKE

JULY 2017 | FIGURE D2-D-3 | REV: 0

P:\Projects\2016\16-0300-006\Design\Env\1010.04 GW Level & Qual Mon\Transducer Data\LMB_Dec 2016 to 2018_TD Data\D\D4 Clear Lake.grf

TABLE D2-D-4
MECHANICAL PACKER AND TRANSDUCER INSTALLATION - ROUTE D
LAKE MANITOBA OUTLET CHANNELS

ID	TOC El. (m)	Ground El. (m)	Packer El. (m)	Transducer Tip El. (m)	Bedrock Open Zone Elevation
TH-ED-01W	250.53	249.49	248.65	247.89	223.89 m to 217.8 m
15-RD-PW1	252.67	251.76	250.79	250.03	234.96 m to 228.6 m
Reed Lake	-	-	-	247.619 (1)	-
Clear Lake	-	-	-	247.678 (1)	-

Note:
1. Tip Elevation for transducer at Reed Lake and Clear Lake surveyed.

APPENDIX D2-E

LABORATORY REPORTS ROUTES C AND D

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-1
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	222		mg/L			29-MAY-17
Carbonate (CO3)	6.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		29-MAY-17
pH						
pH	8.50		pH units			26-MAY-17
Turbidity						
*Turbidity	2.50		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	43.6		mg/L			29-MAY-17
Iron (Fe)-Total	0.025		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	34.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00461		mg/L		0.05	29-MAY-17
Potassium (K)-Total	9.26		mg/L			29-MAY-17
Sodium (Na)-Total	106		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	532		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	82.7		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	250	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.148		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	886		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	141		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	193		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0054		mg/L			01-JUN-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-1
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.022		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	0.87		mg/L			02-JUN-17
Total Nitrogen	0.87		mg/L			02-JUN-17
Total Suspended Solids	3.8		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	74		MPN/100mL	0		26-MAY-17
Escherichia Coli	<1		MPN/100mL	0		26-MAY-17

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

Judy Dalmaijer
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-2
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	332		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.010		mg/L	10		29-MAY-17
pH						
pH	7.82		pH units			26-MAY-17
Turbidity						
*Turbidity	1.20		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	47.5		mg/L			29-MAY-17
Iron (Fe)-Total	0.037		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	51.0		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0446		mg/L		0.05	29-MAY-17
Potassium (K)-Total	10.2		mg/L			29-MAY-17
Sodium (Na)-Total	11.5		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	426		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	129		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	329	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.221		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	561		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	13.3		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	272		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.037		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-2
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.046		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.51		mg/L			06-JUN-17
Total Nitrogen	1.51		mg/L			06-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1990		MPN/100mL	0		26-MAY-17
Escherichia Coli	20		MPN/100mL	0		26-MAY-17

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

Judy Dalmajer
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-3
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	292		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.98		pH units			26-MAY-17
Turbidity						
*Turbidity	2.00		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	37.0		mg/L			29-MAY-17
Iron (Fe)-Total	0.025		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	48.3		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0146		mg/L		0.05	29-MAY-17
Potassium (K)-Total	8.56		mg/L			29-MAY-17
Sodium (Na)-Total	9.88		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	318		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	66.2		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	291	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.109		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	508		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	4.32		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	239		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-3
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-3
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.042		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.54		mg/L			06-JUN-17
Total Nitrogen	1.54		mg/L			06-JUN-17
Total Suspended Solids	3.8		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	236		MPN/100mL	0		26-MAY-17
Escherichia Coli	33		MPN/100mL	0		26-MAY-17

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

Judy Dalmaijer
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-4
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	393		mg/L			29-MAY-17
Carbonate (CO3)	8.88		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.45		pH units			26-MAY-17
Turbidity						
*Turbidity	0.90		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	45.2		mg/L			29-MAY-17
Iron (Fe)-Total	0.021		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	74.0		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00546		mg/L		0.05	29-MAY-17
Potassium (K)-Total	3.27		mg/L			29-MAY-17
Sodium (Na)-Total	13.4		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	419		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	74.0		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	418	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.171		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	645		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.83		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	337		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			29-MAY-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-4
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-4
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.028		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.15		mg/L			02-JUN-17
Total Nitrogen	1.15		mg/L			02-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	42		MPN/100mL	0		26-MAY-17
Escherichia Coli	2		MPN/100mL	0		26-MAY-17

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

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Approved by

Judy Dalmaijer
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-5
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	448		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	0.0346		mg/L	10		29-MAY-17
pH						
pH	8.27		pH units			26-MAY-17
Turbidity						
*Turbidity	2.93		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	63.2		mg/L			29-MAY-17
Iron (Fe)-Total	0.116		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	52.7		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0318		mg/L		0.05	29-MAY-17
Potassium (K)-Total	2.26		mg/L			29-MAY-17
Sodium (Na)-Total	5.77		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	364		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	18.1		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0051		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0295		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	375	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.244		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	585		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.78		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	368		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.021		mg/L			29-MAY-17

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Project Ref: 16-0300-006
Sample ID: D-5
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.030		mg/L			29-MAY-17
Ammonia, Total (as N)	0.050		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	0.89		mg/L			06-JUN-17
Total Nitrogen	0.92		mg/L			06-JUN-17
Total Suspended Solids	4.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		26-MAY-17
Escherichia Coli	49		MPN/100mL	0		26-MAY-17

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Approved by

Judy Dalmajer
Account Manager

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Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-6
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	508		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	0.011		mg/L	10		29-MAY-17
pH						
pH	8.22		pH units			26-MAY-17
Turbidity						
*Turbidity	2.39		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	74.2		mg/L			29-MAY-17
Iron (Fe)-Total	0.073		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	82.7		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0308		mg/L		0.05	29-MAY-17
Potassium (K)-Total	6.66		mg/L			29-MAY-17
Sodium (Na)-Total	16.3		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	549		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	110		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.011	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	526	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.246		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	810		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	9.25		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	416		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0102		mg/L			01-JUN-17

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Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-6
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.0162		mg/L			01-JUN-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Phosphorus (P)-Total Particulate	0.0060		mg/L			01-JUN-17
Total Kjeldahl Nitrogen	1.34		mg/L			02-JUN-17
Total Nitrogen	1.36		mg/L			02-JUN-17
Total Suspended Solids	2.4		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1730		MPN/100mL	0		26-MAY-17
Escherichia Coli	185		MPN/100mL	0		26-MAY-17

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Approved by

Judy Dalmaijer
Account Manager

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Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-7
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	370		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.99		pH units			26-MAY-17
Turbidity						
*Turbidity	0.79		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	46.7		mg/L			29-MAY-17
Iron (Fe)-Total	0.084		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	47.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0407		mg/L		0.05	29-MAY-17
Potassium (K)-Total	4.70		mg/L			29-MAY-17
Sodium (Na)-Total	6.06		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	308		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	20.7		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	311	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.080		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	511		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	0.80		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	303		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.040		mg/L			29-MAY-17

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Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-7
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.043		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.29		mg/L			02-JUN-17
Total Nitrogen	1.29		mg/L			02-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1550		MPN/100mL	0		26-MAY-17
Escherichia Coli	68		MPN/100mL	0		26-MAY-17

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Approved by _____
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Account Manager

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ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-8
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	455		mg/L			29-MAY-17
Carbonate (CO3)	13.4		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.49		pH units			26-MAY-17
Turbidity						
*Turbidity	3.43		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	70.8		mg/L			29-MAY-17
Iron (Fe)-Total	0.110		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	73.7		mg/L			29-MAY-17
Manganese (Mn)-Total	0.0438		mg/L		0.05	29-MAY-17
Potassium (K)-Total	5.33		mg/L			29-MAY-17
Sodium (Na)-Total	13.2		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	485		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	78.1		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	480	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.243		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	720		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.82		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	396		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0134		mg/L			01-JUN-17

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PO No.:
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Project Ref: 16-0300-006
Sample ID: D-8
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.029		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.30		mg/L			06-JUN-17
Total Nitrogen	1.30		mg/L			06-JUN-17
Total Suspended Solids	3.2		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	1990		MPN/100mL	0		26-MAY-17
Escherichia Coli	39		MPN/100mL	0		26-MAY-17

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Account Manager

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Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-9
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	253		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	0.011		mg/L	10		29-MAY-17
pH						
pH	8.24		pH units			26-MAY-17
Turbidity						
*Turbidity	2.41		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	48.6		mg/L			29-MAY-17
Iron (Fe)-Total	0.031		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	36.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00518		mg/L		0.05	29-MAY-17
Potassium (K)-Total	8.57		mg/L			29-MAY-17
Sodium (Na)-Total	108		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	532		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	64.0		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.011	DLM	mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	270	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.125		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	864		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	142		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	208		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.0096		mg/L			01-JUN-17

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Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: D-9
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.027		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	0.81		mg/L			02-JUN-17
Total Nitrogen	0.82		mg/L			02-JUN-17
Total Suspended Solids	3.6		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	387		MPN/100mL	0		26-MAY-17
Escherichia Coli	1		MPN/100mL	0		26-MAY-17

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Account Manager

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ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	393		mg/L			29-MAY-17
Carbonate (CO3)	9.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.46		pH units			26-MAY-17
Turbidity						
*Turbidity	0.90		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	44.8		mg/L			29-MAY-17
Iron (Fe)-Total	0.014		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	71.2		mg/L			29-MAY-17
Manganese (Mn)-Total	0.00514		mg/L		0.05	29-MAY-17
Potassium (K)-Total	3.23		mg/L			29-MAY-17
Sodium (Na)-Total	13.0		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	416		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	73.9		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	405	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	0.178		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	642		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.81		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	338		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	0.020		mg/L			29-MAY-17

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ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: S-100
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-10
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	0.027		mg/L			29-MAY-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Total Kjeldahl Nitrogen	1.39		mg/L			06-JUN-17
Total Nitrogen	1.39		mg/L			06-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	38		MPN/100mL	0		26-MAY-17
Escherichia Coli	1		MPN/100mL	0		26-MAY-17

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

Judy Dalmaijer
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: FB
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W total low range						
Bicarbonate (HCO3)	1.3		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	6.27		pH units			26-MAY-17
Turbidity						
*Turbidity	<0.10		NTU			26-MAY-17
Total Metals by ICP-MS						
Calcium (Ca)-Total	<0.10		mg/L			29-MAY-17
Iron (Fe)-Total	<0.010		mg/L		0.3	29-MAY-17
Magnesium (Mg)-Total	<0.010		mg/L			29-MAY-17
Manganese (Mn)-Total	<0.00030		mg/L		0.05	29-MAY-17
Potassium (K)-Total	<0.020		mg/L			29-MAY-17
Sodium (Na)-Total	<0.030		mg/L		200	29-MAY-17
TDS calculated						
TDS (Calculated)	<5.0		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	<0.30		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	<0.25	HTC	mg/L		500	30-MAY-17
Fluoride in Water by IC						
Fluoride (F)	<0.020		mg/L	1.5		26-MAY-17
Conductivity						
Conductivity	1.0		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	<0.10		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	1.1		mg/L			26-MAY-17
Phosphorus (P)-Total Dissolved	<0.0010		mg/L			01-JUN-17

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: STEVE OFFMAN

Date: 07-JUN-17
PO No.:
WO No.: L1931744
Project Ref: 16-0300-006
Sample ID: FB
Sampled By: DL/ES
Date Collected: 25-MAY-17
Lab Sample ID: L1931744-11
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Phosphorus (P)-Total	<0.0010		mg/L			01-JUN-17
Ammonia, Total (as N)	<0.010		mg/L			26-MAY-17
Phosphorus (P)-Total Particulate	<0.0028		mg/L			01-JUN-17
Total Kjeldahl Nitrogen	<0.20		mg/L			06-JUN-17
Total Nitrogen	<0.20		mg/L			06-JUN-17
Total Suspended Solids	<2.0		mg/L			29-MAY-17
Total and E. coli to endpoint by QT97						
Total Coliforms	<1		MPN/100mL	0		26-MAY-17
Escherichia Coli	<1		MPN/100mL	0		26-MAY-17

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>
Judy Dalmaijer
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

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 R3733144								
WG2536090-19 LCS								
Alkalinity, Total (as CaCO3)			103.5		%		85-115	26-MAY-17
WG2536090-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	26-MAY-17
CL-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Chloride (Cl)			99.3		%		90-110	26-MAY-17
WG2535719-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-MAY-17
EC-WP	**Water**							
Batch R3733144								
WG2536090-18 LCS								
Conductivity			99.1		%		90-110	26-MAY-17
WG2536090-16 MB								
Conductivity			<1.0		umhos/cm		1	26-MAY-17
F-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Fluoride (F)			100.5		%		90-110	26-MAY-17
WG2535719-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	26-MAY-17
MET-T-L-MS-WP	**Water**							
Batch R3735288								
WG2536780-2 LCS								
Calcium (Ca)-Total			98.3		%		80-120	29-MAY-17
Iron (Fe)-Total			97.1		%		80-120	29-MAY-17
Magnesium (Mg)-Total			103.8		%		80-120	29-MAY-17
Manganese (Mn)-Total			101.8		%		80-120	29-MAY-17
Potassium (K)-Total			101.5		%		80-120	29-MAY-17
Sodium (Na)-Total			103.8		%		80-120	29-MAY-17
WG2536780-1 MB								
Calcium (Ca)-Total			<0.10		mg/L		0.1	29-MAY-17
Iron (Fe)-Total			<0.010		mg/L		0.01	29-MAY-17
Magnesium (Mg)-Total			<0.010		mg/L		0.01	29-MAY-17
Manganese (Mn)-Total			<0.00030		mg/L		0.0003	29-MAY-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-WP	**Water**							
Batch R3735288								
WG2536780-1 MB								
Potassium (K)-Total			<0.020		mg/L		0.02	29-MAY-17
Sodium (Na)-Total			<0.030		mg/L		0.03	29-MAY-17
N-TOTKJ-WP	**Water**							
Batch R3738838								
WG2537915-10 LCS								
Total Kjeldahl Nitrogen			98.0		%		75-125	02-JUN-17
WG2537915-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	02-JUN-17
Batch R3740973								
WG2541328-14 LCS								
Total Kjeldahl Nitrogen			90.7		%		75-125	06-JUN-17
WG2541328-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	06-JUN-17
NH3-COL-WP	**Water**							
Batch R3732779								
WG2535542-6 LCS								
Ammonia, Total (as N)			99.6		%		85-115	26-MAY-17
WG2535542-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	26-MAY-17
NO2-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Nitrite (as N)			99.2		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-MAY-17
NO3-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Nitrate (as N)			100.1		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-MAY-17
P-T-COL-WP	**Water**							
Batch R3733584								
WG2536383-10 LCS								
Phosphorus (P)-Total			98.8		%		80-120	29-MAY-17
WG2536383-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-WP	**Water**							
Batch R3733584								
WG2536383-6 LCS								
Phosphorus (P)-Total			96.2		%		80-120	29-MAY-17
WG2536383-5 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	29-MAY-17
WG2536383-9 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	29-MAY-17
WG2536383-12 MS		**L1931744-1**						
Phosphorus (P)-Total			91.7		%		70-130	29-MAY-17
P-T-L-COL-WP	**Water**							
Batch R3737171								
WG2539132-2 LCS								
Phosphorus (P)-Total			103.1		%		80-120	01-JUN-17
WG2539132-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	01-JUN-17
P-TD-COL-WP	**Water**							
Batch R3733584								
WG2536381-2 LCS								
Phosphorus (P)-Total	Dissolved		96.0		%		80-120	29-MAY-17
WG2536381-1 MB								
Phosphorus (P)-Total	Dissolved		<0.010		mg/L		0.01	29-MAY-17
P-TD-L-COL-WP	**Water**							
Batch R3737171								
WG2539130-2 LCS								
Phosphorus (P)-Total	Dissolved		106.5		%		80-120	01-JUN-17
WG2539130-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0010		mg/L		0.001	01-JUN-17
PH-WP	**Water**							
Batch R3733144								
WG2536090-17 LCS								
pH			7.42		pH units		7.3-7.5	26-MAY-17
SO4-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Sulfate (SO4)			99.5		%		90-110	26-MAY-17
WG2535719-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	26-MAY-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TOTSUS-LR-WP	**Water**							
Batch R3735321								
WG2536438-2 LCS								
Total Suspended Solids			91.3		%		85-115	29-MAY-17
WG2536438-1 MB								
Total Suspended Solids			<2.0		mg/L		2	29-MAY-17
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R3732730								
WG2535527-1 DUP		**L1931744-1**						
Total Coliforms		74	60		MPN/100mL	20	65	26-MAY-17
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	26-MAY-17
WG2535527-2 MB								
Total Coliforms			<1		MPN/100mL		1	26-MAY-17
Escherichia Coli			<1		MPN/100mL		1	26-MAY-17
TURBIDITY-WP	**Water**							
Batch R3735486								
WG2535465-2 LCS								
Turbidity			100.0		%		85-115	26-MAY-17
WG2535465-1 MB								
Turbidity			<0.10		NTU		0.1	26-MAY-17

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	25-MAY-17 08:00	26-MAY-17 12:00	0.25	28	hours	EHTR-FM
	2	25-MAY-17 08:30	26-MAY-17 12:00	0.25	28	hours	EHTR-FM
	3	25-MAY-17 09:45	26-MAY-17 12:00	0.25	26	hours	EHTR-FM
	4	25-MAY-17 11:45	26-MAY-17 12:00	0.25	24	hours	EHTR-FM
	5	25-MAY-17 16:15	26-MAY-17 12:00	0.25	20	hours	EHTR-FM
	6	25-MAY-17 15:50	26-MAY-17 12:00	0.25	20	hours	EHTR-FM
	7	25-MAY-17 15:20	26-MAY-17 12:00	0.25	21	hours	EHTR-FM
	8	25-MAY-17 13:55	26-MAY-17 12:00	0.25	22	hours	EHTR-FM
	9	25-MAY-17 14:40	26-MAY-17 12:00	0.25	21	hours	EHTR-FM
	10	25-MAY-17 12:00	26-MAY-17 12:00	0.25	24	hours	EHTR-FM
	11	25-MAY-17 15:20	26-MAY-17 12:00	0.25	21	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 L1931744 were received on 26-MAY-17 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.

ALS Environmental

L1931744-COFC

10- 232386

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:	Steve Uffman	Select: PDF ✓	Excel ✓ Digital Fax		Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	<Personal information removed>	Email 1:	<Personal information removed>		Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Winnipeg, MB	Email 2:	<Personal information removed>		Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	<Personal information removed> 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 #:	16-0300-001		
Company:		PO / AFE:			
Contact:		LSD:			
Address:					
Phone:	Fax:	Quote #:	58403		
Lab Work Order # (lab use only)		ALS Contact:	Judy/Craig	Sampler:	DL/ES

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROUTW-T-L-WP	F	N-TOTKS-WP	F	NH3-COL-WP	F	P-T-COL-WP	F	ETL-N-TOT-ANV-WP	F	P-TD-COL-WP	F	SOLIDS-TOTSUS-LR-WP	F	TC, EC-DT97-ENVPT-WP					Number of Containers
1	D-1	25-MAY-17	08:00	SW	✓		✓		✓		✓		✓		✓		✓		✓					7
2	D-2	↓	08:30	↓																				7
3	D-3		09:45																					7
4	D-4		11:45																					7
5	D-5		16:15																					7
6	D-6		15:50																					7
7	D-7		15:20																					7
8	D-8		13:55																					7
9	D-9		14:40																					7
10	S-100		12:00																					7
11	FB	↓	15:20	↓	↓		↓		↓		↓		↓		↓		↓		↓					7

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

For P-TD lab should filter and preserve

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>	25-MAY-17	19:30		MAY 26 2017		°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: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-1
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	400		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.71		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	514		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	142		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	398		mg/L		500	30-MAY-17
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	81.5		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	47.2		mg/L			29-MAY-17
Potassium (K)-Dissolved	9.65		mg/L			29-MAY-17
Sodium (Na)-Dissolved	31.5		mg/L		200	29-MAY-17
Conductivity						
Conductivity	768		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.76		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	328		mg/L			26-MAY-17

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

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01W
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-1
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.

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Approved by

Shannon Sawatzky
Account Manager

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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-2
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	390		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.71		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	518		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	148		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	390		mg/L		500	30-MAY-17
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	79.5		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	46.5		mg/L			29-MAY-17
Potassium (K)-Dissolved	9.82		mg/L			29-MAY-17
Sodium (Na)-Dissolved	36.0		mg/L		200	29-MAY-17
Conductivity						
Conductivity	771		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	6.12		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	319		mg/L			26-MAY-17

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Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-01P
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-2
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.

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Account Manager

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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-3
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	336		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.84		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	496		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	156		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	359		mg/L		500	30-MAY-17
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	68.0		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	45.9		mg/L			29-MAY-17
Potassium (K)-Dissolved	9.88		mg/L			29-MAY-17
Sodium (Na)-Dissolved	37.5		mg/L		200	29-MAY-17
Conductivity						
Conductivity	744		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	12.9		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	276		mg/L			26-MAY-17

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Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-02
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-3
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.
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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-4
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	407		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.74		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	487		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	117		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	384		mg/L		500	30-MAY-17
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	75.2		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	47.8		mg/L			29-MAY-17
Potassium (K)-Dissolved	10.2		mg/L			29-MAY-17
Sodium (Na)-Dissolved	31.4		mg/L		200	29-MAY-17
Conductivity						
Conductivity	739		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.30		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	334		mg/L			26-MAY-17

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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-GD-07
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-4
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
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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-5
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	414		mg/L			29-MAY-17
Carbonate (CO3)	<0.60		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	7.75		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	483		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	115		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	371		mg/L		500	30-MAY-17
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	70.9		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	47.2		mg/L			29-MAY-17
Potassium (K)-Dissolved	10.0		mg/L			29-MAY-17
Sodium (Na)-Dissolved	30.3		mg/L		200	29-MAY-17
Conductivity						
Conductivity	736		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	5.29		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	339		mg/L			26-MAY-17

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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: 15-RD-PW1
Sampled By: ES/DL
Date Collected: 23-MAY-17
Lab Sample ID: L1931757-5
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.
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Approved by

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Account Manager

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

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-03 (LIMITED SAMPLE-WELL DRY)
Sampled By: ES/DL
Date Collected: 25-MAY-17
Lab Sample ID: L1931757-6
Matrix: WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Low Range						
Bicarbonate (HCO3)	399		mg/L			29-MAY-17
Carbonate (CO3)	2.88		mg/L			29-MAY-17
Hydroxide (OH)	<0.34		mg/L			29-MAY-17
*Nitrate and Nitrite as N	<0.0051		mg/L	10		29-MAY-17
pH						
pH	8.34		pH units			26-MAY-17
TDS calculated						
TDS (Calculated)	372		mg/L		500	30-MAY-17
Sulfate in Water by IC						
Sulfate (SO4)	43.2		mg/L		500	26-MAY-17
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		26-MAY-17
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		26-MAY-17
Ion Balance Calculation						
Hardness Calculated						
Hardness (as CaCO3)	162		mg/L		500	30-MAY-17
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	20.8		mg/L			29-MAY-17
Magnesium (Mg)-Dissolved	26.8		mg/L			29-MAY-17
Potassium (K)-Dissolved	2.43		mg/L			29-MAY-17
Sodium (Na)-Dissolved	62.1		mg/L		200	29-MAY-17
Conductivity						
Conductivity	514		umhos/cm			26-MAY-17
Chloride in Water by IC (Low Level)						
Chloride (Cl)	17.0		mg/L		250	26-MAY-17
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	332		mg/L			26-MAY-17

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ATTN: Marci Friedman Hamm

Date: 01-JUN-17
PO No.:
WO No.: L1931757
Project Ref: 16-0300-006
Sample ID: TH-ED-03 (LIMITED SAMPLE-WELL DRY)
Sampled By: ES/DL
Date Collected: 25-MAY-17
Lab Sample ID: L1931757-6
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
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Approved by

Shannon Sawatzky
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: L1931757 Report Date: 01-JUN-17

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 R3733144								
WG2536090-24 LCS								
Alkalinity, Total (as CaCO3)			103.1		%		85-115	26-MAY-17
WG2536090-21 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	26-MAY-17
CL-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Chloride (Cl)			99.5		%		90-110	26-MAY-17
WG2535719-6 LCS								
Chloride (Cl)			99.3		%		90-110	26-MAY-17
WG2535719-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-MAY-17
WG2535719-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-MAY-17
EC-WP	**Water**							
Batch R3733144								
WG2536090-23 LCS								
Conductivity			99.4		%		90-110	26-MAY-17
WG2536090-21 MB								
Conductivity			<1.0		umhos/cm		1	26-MAY-17
MET-D-L-MS-WP	**Water**							
Batch R3735288								
WG2536740-2 LCS								
Calcium (Ca)-Dissolved			100.9		%		80-120	29-MAY-17
Magnesium (Mg)-Dissolved			101.6		%		80-120	29-MAY-17
Potassium (K)-Dissolved			101.3		%		80-120	29-MAY-17
Sodium (Na)-Dissolved			100.9		%		80-120	29-MAY-17
WG2536740-1 MB								
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	29-MAY-17
Magnesium (Mg)-Dissolved			<0.010		mg/L		0.01	29-MAY-17
Potassium (K)-Dissolved			<0.020		mg/L		0.02	29-MAY-17
Sodium (Na)-Dissolved			<0.020		mg/L		0.02	29-MAY-17
NO2-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Nitrite (as N)			100.8		%		90-110	26-MAY-17
WG2535719-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-6 LCS								
Nitrite (as N)			99.2		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-MAY-17
WG2535719-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-MAY-17
NO3-L-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Nitrate (as N)			100.4		%		90-110	26-MAY-17
WG2535719-6 LCS								
Nitrate (as N)			100.1		%		90-110	26-MAY-17
WG2535719-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-MAY-17
WG2535719-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-MAY-17
PH-WP	**Water**							
Batch R3733144								
WG2536090-22 LCS								
pH			7.42		pH units		7.3-7.5	26-MAY-17
SO4-IC-N-WP	**Water**							
Batch R3733105								
WG2535719-10 LCS								
Sulfate (SO4)			100.6		%		90-110	26-MAY-17
WG2535719-6 LCS								
Sulfate (SO4)			99.5		%		90-110	26-MAY-17
WG2535719-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	26-MAY-17
WG2535719-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	26-MAY-17

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	23-MAY-17 14:45	26-MAY-17 12:00	0.25	69	hours	EHTR-FM
	2	23-MAY-17 15:30	26-MAY-17 12:00	0.25	68	hours	EHTR-FM
	3	23-MAY-17 08:47	26-MAY-17 12:00	0.25	75	hours	EHTR-FM
	4	23-MAY-17 15:25	26-MAY-17 12:00	0.25	69	hours	EHTR-FM
	5	23-MAY-17 16:45	26-MAY-17 12:00	0.25	67	hours	EHTR-FM
	6	25-MAY-17 13:15	26-MAY-17 12:00	0.25	23	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 L1931757 were received on 26-MAY-17 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.

ALS Environmental

L1931757-COFC

10- 232384

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:	<Personal information removed>	Email 1:	<Email address removed>		Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	<Personal information removed>	Email 2:	<Email address removed>		Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	<Personal information removed> Fax: <Personal information removed>			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 #:	16-0300-006		
Company:		PO / AFE:			
Contact:		LSD:			
Address:					
Phone:	Fax:	Quote #:	58403		
Lab Work Order # (lab use only)		ALS Contact:	Judy	Sampler:	ES/DL

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ROUW-D-L-SP	Number of Containers
	TH-ED-01W	23-MAY-17	1445	water	X	2
	TH-ED-01P	23-MAY-17	1530		X	
	~~TH-ED-03~~	~~24-MAY-17~~	~~1815~~		~~X~~	
	TH-GD-02		0847		X	
	TH-GD-07		1525		X	
	15-RD-PW1		1645		X	
	TH-ED-03	25 May 17	1315	water	X	1
	↳ limited sample - well dry					

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: 25 May 17	Time: 1730	Received by: David I.	Date: 26-5-17	Time: 8:00 am	Temperature: 2.2 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

Client: Friedman Hamm
KGS Group
PO: 16-0300-006-1300.06

ISO# 2017258
Location:
6 for 18O, 2H

Environmental Isotope Lab
12/07/2017

#	Sample	Date	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	pH	EC	AZD
				H_2O	VSMOW	± 0.2‰	H_2O	VSMOW	± 0.8‰		uS/cm	
1	TH-ED-01W	23-May-17	381957	X	-15.14	-15.11	X	-114.18	-113.99	7.38	813	
2	15-RD-PW1	24-May-17	381958	X	-15.30		X	-115.05		7.33	817	
3	D1 (Lake Manitoba)	25-May-17	381959	X	-8.83	-8.81	X	-75.80	-75.55	8.32	936	
4	D4 (Clear Lake)	25-May-17	381960	X	-10.67		X	-90.14		8.33	696	
5	D9 (Lake St. Martin)	25-May-17	381961	X	-9.00		X	-77.15		8.18	932	
6	S-100 (Duplicate)	25-May-17	381962	X	-10.68	-10.75	X	-89.83	-89.67	8.33	696	

Client hopes to have results by June 23

18O/2H Results from LGR Laser

Rick Heemskerk
uwEILAB Manager
rkhmskrk@uwaterloo.ca
519 888 4567 ext 35838

To Contact uwEILAB:
519 888 4732

APPENDIX D2-F

SITE PHOTOGRAPHIC LOG

Photo 1. TH-EC-01WW2 – Showing packer, tubing and transducer installation.

Photo 2. RD15-PW1 – Showing sample purging from tube.

Photo 3. TH-ED-01 – Showing sample tubing and transducer port connection.

Photo 4. Reed Lake (D3) – Showing staff gauge (right) and transducer (left).