KGS GROUP
CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY LONG-TERM MONITORING PROGRAM
2016 PROGRAM A – ANNUAL REPORT
DELIVERABLE D1

FINAL – REV 0

KGS Group 16-0300-002
February 2017

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February 22, 2017 File No: 16-0300-002

Manitoba Infrastructure
600 – 215 Garry Street
Winnipeg, Manitoba
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ATTENTION: Ms. Jackie Dunn
Project Manager

RE: Red River Floodway Long-Term Monitoring Program
2016 Program A - Annual Report
Final – Rev 0, February 2017

Dear Ms. Dunn:

KGS Group is pleased to provide two (2) paper copies and one (1) electronic copy on DVD of the 2016 Program A – Annual Report, which is part of the Red River Floodway Long-Term Monitoring Program. This report summarizes activities for 2016.

We appreciate the opportunity to provide ongoing services to the Manitoba Infrastructure.

Sincerely,

J. Bert Smith, P.Eng.
For Project Manager

MPS/jr
Enclosure

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1.0 INTRODUCTION

1.1 ENVIRONMENT ACT LICENCE REQUIREMENTS

This 2016 Program A Annual Report, is submitted in response to the requirements for annual monitoring in accordance with Clause 27 and Clause 30 of Environmental Licence No. 2691 dated July 8, 2005 and described in the Manitoba Floodway Authority memorandum HM72 Rev 1 Post-construction and Long-term Monitoring Program, issued April 2013. Revisions to the Long-term Monitoring Program were given in HM99, the 2013 to 2014 Post-construction Monitoring Program Comprehensive Annual Report February 2015. Background information and historic data that is not included in this report can be found in the annual groundwater Monitoring Data Analysis Reports 2005 through 2015. There was no monitoring program in 2012.

1.2 SCOPE OF WORK

The objectives of the project are to carry out long term monitoring, testing and reporting on groundwater conditions within and adjacent to the Red River Floodway (Floodway) in accordance with the Provincial commitment to flood protection and as required under the Red River Floodway's Operating License (Environment Act License No. 2691). The current work program, overseen through Manitoba Infrastructure (MI) includes a monitoring period from Spring 2016 through Fall 2018, outlined in KGS Group proposal 15-000-1555. The Three Year Project Scope of Work includes the following annual activities:

- Spring and Summer Flood Monitoring Program A (or B if required);
- Inspection of Treated Groundwater Springs;
- Annual Well Disinfection, Inspection/Maintenance/Repair Programs and Channel Inspections;
- Reporting.

This report (Deliverable D1) contains reporting for Program A Annual Report (Task 1) which also includes the inspection of treated groundwater springs and the annual well disinfection. The 2016 Annual Inspection and Maintenance Report (Task 2) was submitted as Deliverable

D2. Tables and Figures are labelled using the deliverable numbers to create a unique products. For example, Appendix D1-A indicates Appendix A of the Deliverable D1 report.

In 2016, The Red River Floodway was not operated, nor was there any Red River flow into the Floodway Channel. Therefore, the requirements for Long-term Monitoring Program A (Task 1) (as outlined in proposal 15-000-1555) were initiated in Spring 2016. This included sampling of 5 instrumented wells for inorganic parameters and bacteria two times: at the peak flow of the Red River at the Inlet Control Structure; and post-melt (several weeks after peak flow) along with sampling of 7 additional core monitoring wells once during the peak flow of the Red River. Note that the timing of award of the project and early spring melt prevented incorporation of a pre-spring melt sampling program in 2016. Sampling of surface water is required once at two locations (PTH 59N Bridge and PTH 44 Bridge) during the peak flow in the Red River; however an additional sample was taken after the melt to help interpret the post-melt groundwater data.

In addition to the Spring Flood Monitoring Program A (Task 1) in 2016, KGS Group also conducted an inspection of treated groundwater springs and an annual well disinfection program as described in this report. The 2016 Annual Inspection and Maintenance Report has been submitted separately and also includes the channel bottom inspection.

The detailed 2016 program was as follows:

- Spring melt monitoring conducted on March 28 to 30, 2016. The Red River elevation remained elevated at between El. 225.2 m and El. 225.5 m during the March 28 to 30, 2016 sampling period. The peak flow was measured by the stage elevation of the Red River at the Water Survey of Canada (Station G 05OC021 Above the Red River Floodway Control Structure) which was El. 228.77 m on March 18, 2016.
- Well Pump Servicing on March 28 to 30 (in conjunction with Spring Melt Sampling);
- Follow up bacteria monitoring conducted on April 21, 2016;
- Post-melt monitoring on June 2, 2016;
- Annual Groundwater Springs Inspection on August 8 to 11, 2016;
- Annual Well Disinfection Program on September 27, 2016.

The 2016 program represents the second year of the Long-term Monitoring Program, however it is the first year falling under Manitoba Infrastructure direction. In 2016, surface water monitoring of the Floodway Channel was carried out at locations near the PTH 44 Bridge and PTH 59N Bridge. The 2016 long-term monitoring program used wells designated in the monitoring program for Program A Task 1 as shown on Figure D1-1.

1.3 AQUIFER CHARACTERIZATION

The carbonate aquifer found along the Floodway Channel is part of a regional groundwater flow system from eastern Manitoba. The confined carbonate bedrock aquifer has natural variations in water quality, with the conductivity ranging from moderate to high (1,000 to 2,000 µS/cm). Conductivity is a measure of dissolved solids, such as calcium, magnesium, chloride, sodium and sulphate. Near the Floodway Inlet, local mixing with saline groundwater found west of the Red River, results in higher conductivity groundwater (greater than 3,000 µS/cm) with increased chloride and sodium.

Lower conductivity values are found in the bedrock aquifer where it is influenced by the Birds Hill surficial granular aquifer, from CPR Keewatin Bridge to Church Road. The Birds Hill sand and gravel surficial aquifer is a local unconfined aquifer near PTH 59N Bridge. The bedrock aquifer beneath and surrounding the Birds Hill deposit has lower groundwater conductivity due to the freshwater recharge through the sand and gravel.

Natural variations in groundwater quality by location and with the seasons must be considered when the baseline and ongoing water quality results are evaluated during construction activities and Floodway operation events. One way to detect whether there is surface water intrusion into the groundwater aquifer is to monitor an indicator parameter such as conductivity which, along with other parameters, can be used to evaluate this contrast. In the vicinity of the Bird's Hill sand and gravel surficial aquifer, recharge from precipitation results in groundwater with lower conductivity (500 µS/cm to 1,000 µS/cm) than is found in other areas of the carbonate aquifer.

The intrusion of surface water into the groundwater is most readily detected when there is a contrast between the chemistry of the samples. Most groundwater conductivity values were found to be greater than surface water conductivity values measured during annual spring

Floodway operation. Red River conductivity values are historically lowest during spring flood events, such as in the spring of 2005, 2006, 2007, 2009, 2010, 2011, 2013 and 2014. In this situation, groundwater conductivity would be expected to decrease, if surface water intruded.

During summer Floodway operation in 2005, summer floodway use in 2007, and summer Floodway operation in 2010 and 2011, conductivity values of surface water from the Red River diverted in the floodway were slightly higher than in the spring, and higher than the natural groundwater conductivity levels in some areas near the CPR Keewatin Bridge, PTH 59N Bridge and Church Road. These areas have naturally low groundwater conductivity in the bedrock aquifer. Floodway Channel surface water conductivity was also higher during the summer precipitation events in June 2008, than during the spring melt, with no Floodway operation in April 2008. An increase in groundwater conductivity might occur in summer, if surface water intrudes into the groundwater at this time.

In the spring 2015 flood, one time sampling in the Floodway Channel during the spring melt on April 6, 2015 (no Floodway flow or Floodway operation) showed that the conductivity of the local surface water in the Floodway Channel was low in April, and increased in May as the surface water input decreased and the groundwater base flow became a greater percentage of the flow system.

In the spring of 2016, the conductivity during the spring melt on March 28 to 30, 2016 (no floodway flow or floodway operation) showed a low conductivity for the local surface water in the floodway channel. An increase was seen in June 2016 as the percentage of groundwater base flow increased.

2.0 METHODOLOGY

2.1 SURFACE WATER

Surface water samples in 2016 were taken in the Floodway Channel at the PTH 44 and PTH 59 Bridges. Grab samples were collected from the channel. Samples were taken directly into sample bottles attached to an extension pole. KGS Group recorded field parameters (dissolved oxygen, specific conductivity, temperature and pH) using the YSI Pro meter. Results for the field parameters are shown in Table D1-1. Laboratory analysis data are shown in Table D1-3. Original laboratory reports are given in Appendix D. Laboratory results are given in mg/L unless indicated otherwise.

2.2 WELL PUMPING METHOD MODIFICATIONS

In 2016, wells were purged using a combination of small diameter submersible pumps (either dedicated to the well or portable) and dedicated inertial pumps (Waterra tubing with foot valves). Five of the wells (K13-12321, K09-12316, K09-12012, K11-12014 and K11-12015) contained dedicated submersible pumps, previously installed in 2015. At the time of the March 2016 sampling event, operational issues were observed with all five of these pumps, most likely related to the length of time each were submerged within each well. New replacement pumps were installed in three of the wells (K13-12321, K09-12316, K09-12012). A portable small diameter submersible well pump was used for sampling at K11-12014 and K11-12015.

In the subsequent follow up bacteria sampling event in April, 2016, a dedicated small diameter submersible (Whale pump) well pump was installed in K11-12015, replacing the Waterra and foot valve installed in March.

Note that after the well disinfection program in November 2016, as approved by MI, all dedicated well pumps were removed for inside storage at KGS Group over the winter, to protect against long-term precipitation of carbonate groundwater within the pump during submergence over the winter months, prior to the next Spring Pre-melt Event.

2.3 GROUNDWATER

Monitoring well groundwater samples were taken from 12 monitoring wells in March 2016. Subsequently 5 of the 12 monitoring wells were sampled in June. All wells were located within the Floodway Right-of-Way. One of the wells sampled is a water supply well for Inlet Control Structure. Water samples are taken from an inside tap, however the water is not used for drinking. Well locations are shown on Figure D1-1. Monitoring wells are not used for drinking water supply. A supplementary groundwater sampling event was also conducted at 5 of the 12 wells in April, 2016 for bacteria, as follow up to the March sampling event.

In order to ensure groundwater samples were representative of the natural formation water, the monitoring wells were purged a minimum of three (3) well volumes, or until groundwater parameters (conductivity and temperature) stabilized. Field measurements were taken at the start of purging and at set intervals of 5 to 10 minutes. Stable groundwater parameters were achieved at all sample locations within 20 minutes.

Field measurements for pH, conductivity and dissolved oxygen were taken during each sampling period. Groundwater 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. Metal samples were filtered and acidified in the laboratory, since iron and manganese were not analyzed.

Results for the field parameters are shown in Table D1-1. Laboratory analysis data are shown in Table D1-2. Original laboratory reports are given in Appendix D. Laboratory results are given in mg/L, unless otherwise noted.

2.4 TRANSDUCER GROUNDWATER LEVEL AND QUALITY PROGRAM

Continuous measurements of groundwater elevation and temperature were collected from the previous May 2015 download to September 2016 in the 5 instrumented monitoring wells. Transducers were installed at depth so that the tips were in the open bedrock or screened zone. Transducers and pumps installed in these wells are owned by MI. Transducer results are shown

in Appendix D1-A. Historical transducer data, reported in the most recent previous Red River Floodway 2015 Long-term Monitoring Program Report (HM101) is compiled in Appendix D1-B.

2.5 WELL DISINFECTION PROGRAM

The methodology employed for the well disinfection program included the following for each location:

- Recorded water level measurement from the top of the PVC well casing;
- Temporarily removed the dedicated transducer;
- For wells with dedicated submersible pumps, the pumps were removed, labelled and placed in a dedicated bags for winter storage at KGS Group;
- Added a calculated amount of household bleach to the well to raise the chlorine level in the well water to 200 ppm;
- Operated a temporary submersible well and pumped the well until discharge water had a chlorine odour (approximately 10 minutes);
- Removed the temporary inertial pump from the well;
- Closed and locked each well.

2.6 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

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 dedicated pump outlet, which is sealed in the well. 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. Any equipment replacement in the five instrumental wells was disinfected prior to installation.

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 groundwater 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.

Field Equipment – Field equipment such as field chemistry meters and transducers (if they include conductivity) are calibrated prior to use or installation.

3.0 SURFACE WATER RESULTS AND ASSESSMENT

In 2016 Red River water did not enter the Floodway; however local surface water sources and spring melt did enter the channel.

Based on historical data collected, the cold temperature of the Red River at the beginning of the spring melt is generally useful as an indicator of surface water infiltration when the river or overland surface water runoff temperature is a few degrees above freezing and the groundwater temperature is higher. As the spring melt advances over time, water from the spring melt starts to warm, increasing in temperature as the peak passes. Historically, a decrease in temperature has been observed in groundwater with the initial onset of spring melt. For surface water sampling during the 2016 spring flood, the first surface water samples (temperatures ranging between 6.3 and 9.3°C) were collected after the peak of the flood passed, with groundwater at the time between 6.1 and 9.9°C; therefore, the initial low spring melt water temperature (historically less than 5°C) was not observed within that data set (Table D1-1).

Surface water conductivity of the channel flow was lower during the spring melt on March 30, 2016 (407 to 549 µS/cm), than after the melt on June 2, 2016 (665 to 718 µS/cm). The increase in conductivity reflects the increasing percentage of groundwater baseflow and/or post melt runoff contribution relative to a reduced contribution from lower conductivity snow melt.

The spring melt concentration of nitrate plus nitrite as nitrogen (N) measured in the Floodway Channel at PTH59 was 0.405 mg/L. After the spring melt the nitrogen concentration increased 10 times to 4.62 mg/L. Both concentrations were below the CCME criteria in drinking water of 10 mg/L for nitrate plus nitrite (as N) of 10 mg/L. Concentrations measured in 2016 at PTH44 ranged between 0.73 and 1.28 mg/L. For both PTH44 and PTH59, ammonia values during the spring melt were <0.010 to 0.072 mg/L, while TKN values were 0.75 to 1.87 mg/L.

Bacteria concentrations reflected surface water influences. Bacterial counts for total coliform increased from March (between 980 and 2,790 MPN/100 mL) to June (between 26,100 and 41,100 MPN/100 mL). Counts for *E. coli* also increased from March (between 139 and 630 MPN/100 mL) and June (1,210 and 1,440 MPN/100 mL). The increase in counts between March and June reflect a combination of increasing exposure to point sources, lower flow within

the channel and warmer temperatures. Values observed in 2016 were generally higher than historically seen in recent years.

Overall, the surface water quality parameter results highlighted above reflect the influence of the spring melt in late March and the return to post–melt conditions characterized by an increased contribution of groundwater baseflow. These changes occurred with increases in conductivity, alkalinity, hardness, and sulphate in the post-melt June 2016 results compared with the March results.

4.0 GROUNDWATER RESULTS

Groundwater quality results from wells measured in 2016 are discussed below. Results for samples collected during spring melt are compared to samples collected post-melt. In general, lower parameters observed during the spring melt period versus the post-melt period would reflect possible surface water influence on groundwater within the monitoring wells sampled. With the passing of the spring melt period, concentrations would tend to increase, reflecting a return to groundwater flow at these locations from the surrounding aquifer.

4.1 FLOODWAY OUTLET AND PTH 44

At the Floodway Outlet, monitoring wells located 65 m (K09-12316), and 350 m (K13-12321) north of the expanded channel within the Right-of-Way, showed some evidence of surface water intrusion from the floodway in 2016 at various levels. Hydrographs showed a slight rise in groundwater elevation during the spring melt with little change in temperature (Appendix D1-A-1 and D1-A-5).

Well K09-12316, closest to the channel, had the most stable water quality of the two locations (with minor changes in conductivity and hardness). In contrast, the well close to Rockhaven Road (K13-12321) had lower concentrations of many parameters in March 2016 (during the spring melt period) in comparison to values in June 2016 (post-melt), including conductivity, alkalinity, bicarbonate, hardness, TDS, calcium, magnesium, sodium and chloride and sulphate as shown on Table D1-2. Nitrate plus nitrite (as N) also showed a lower concentration at K13-12321 during the spring melt from locally elevated background values (Tables D1-2 and D1-4). The greater changes in the Rockhaven R1 well, which is further from the Floodway, points to local recharge north of the Floodway, or influence of the Red River as a source of the water quality change seen in this well.

Total Coliform were detected at both well locations during the March spring melt period (11 MPN/100 mL at K13-12321 and 22 MPN/100 mL at K09-12316), with lower counts observed after the spring melt (1 MPN/100 mL or less at K13-12321 and 4 MPN/100 mL or less at K09-12316). The fact that the total coliform concentration decreased after the spring-melt indicated potential surface water contribution to both wells. *E. coli* bacteria was not detected during the

March spring melt period, however it was detected during a resampling event in April at K09-12316 (2 MPN/100 ml). No detectable E. coli was observed in the June post-melt event.

4.2 HAY ROAD TO DUNNING ROAD

At the bedrock well within the Right-of-Way at Church Road (K09-12012), there was no observable difference in parameter concentrations between the spring melt March 2016 and post-melt June 2016 samples, indicating no of surface water intrusion. Groundwater elevation showed a small rise, while temperature remained constant (Appendix D1-A-2). Nitrate plus nitrite (as N) remained below detection. Total Coliform and *E. coli* bacteria were below detection (<1 MPN/100 mL) at these locations on all dates sampled. Dissolved oxygen values were low (below 0.2 mg/L) on all dates.

At PTH 44 Bridge (U09-13571), lower parameters concentrations were observed in 2016 during the spring melt event than during recent historical pre-melt events including conductivity, hardness, TDS, calcium, magnesium, sodium, chloride and sulphate.

At Hay, Ludwick and Dunning Roads, there was no change observed in parameter concentrations between spring melt March 2016 and pre-melt historical 2013 results.

4.3 PTH 59N BRIDGE AREA

Near Bray Road, north of PTH59N, K11-12016 showed a decreasing conductivity between the 2016 spring melt period and historical 2013 pre-melt, reflecting a change in water quality and potential surface water intrusion. Alternately the actual pre-melt concentration in 2016 may been lower than the 2013 value used for comparison. The magnitude of this possible effect is discussed in Section 5.1.

At the bedrock well located upstream of PTH 59N bridge, and 250 m west of the expanded channel at the west Right-of-Way boundary (K11-12014), a slight increase in groundwater level was seen, with no large change in temperature (Appendix D1-A-3). Parameter concentrations were generally lower in the spring melt versus post-melt monitoring, however differences were relatively small (Table D1-2 and Table D1-4). Dissolved oxygen was low (<0.5 mg/L) during all dates. A water quality change was seen in this well.

At the bedrock well located upstream of PTH 59N bridge and 60 m west of the west channel slope within the Right-of-Way (K11-12015), increases in parameters were generally observed between the March spring melt to June 2016 post-melt events, including, but not limited to conductivity, bicarbonate, hardness, TDS, sulphate, calcium, magnesium and sodium. Nitrate plus nitrite (as N) increased as the other parameters decreased during the spring melt, as was typically seen during years of Floodway operation. Dissolved oxygen was similar (between 0.99 and 1.49 mg/L) during the spring melt and post-melt sampling. The change in water quality at K11-12015 is attributed to either local recharge, or limited short-term local surface water infiltration from the channel.

Total Coliform bacteria were identified at both K11-12014 and K11-12015 during the March spring melt and June post-melt periods. For *E. coli* bacteria, a detectable count of 1 MPN/100 mL was observed at K09-12015 in March. During a resampling event in April, no *E. coli* was identified at K09-12015, however a detectable count of 1 MPN/100 mL was observed at K11-12014. *E-coli* was not detected in either location in the subsequent June 2016 sampling event.

The water level response at the well closest to the channel (K11-12015) was consistent with monitoring in previous years with local spring melt flow in the channel resulting in a short-term elevation response at this location due to recharge and the potential for surface water to infiltrate through the sand and gravel in the channel, to the bedrock (Appendix D1-A-4). However, no change in temperature was observed.

Near McGregor Farm Road at K13-12322, lower parameter concentrations were observed in 2016 during the spring melt event in comparison to the recent historical 2013 pre-melt event including but not limited to, conductivity, hardness, TDS and sulphate.

4.4 KEEWATIN BRIDGE AND AREA TO THE SOUTH

At the inlet control structure (GO50C006), lower parameter concentrations were observed in 2016 during the spring melt event in comparison to the most recent historical pre-melt event in 2011 including conductivity, hardness and chloride, suggesting potential surface water intrusion.

5.0 GROUNDWATER RESULTS AND ASSESSMENT

5.1 CONDUCTIVITY CHANGES

Conductivity changes are being used as an indicator of surface water influence on groundwater quality, as conductivity is a parameter that is readily measured. Conductivity changes reflect the changes in major ions contributing to the dissolved solids.

If surface water intrudes into the aquifer, the mixing would result in changes observed in groundwater conductivity. Groundwater conductivity decreases with the addition of surface waters in most areas. Changes are most readily observed in areas where groundwater is more mineralized and thus has higher conductivity than surface water, which is typically the case during the spring. Conversely, increases in groundwater conductivity would be seen in areas where baseline groundwater conductivity is less than that of surface waters.

In addition to the floodway, potential surface water infiltration sources in the area include ponds and open sand and gravel quarries, creeks, and the Red River (primarily near the Floodway Outlet).

The magnitude of the water quality change is described by a range in the percentage change in conductivity as follows: Type A (>50% change); Type B (25 to 50% change); Type C (10 to 25% change); Type D (5 to 10% change). Tables D1-4 and D1-5 shows the 2016 water quality assessment based on changes in conductivity. For instrumented well (Table D1-4), spring melt samples (March) were compared with post-melt samples (June) since pre-melt samples could not be collected in 2016. For the remaining 7 non-instrumented monitoring wells, (Table D1-5), spring melt samples were compared with recent historical pre-melt samples. The wells selected for sampling for the Long-Term monitoring program were in areas with higher potential for surface water intrusion due to hydrogeologic conditions, or locations near other surface water sources (such as the Floodway Outlet).

In 2016, 5 monitoring wells (wells with installed transducers) were sampled in two events for water chemistry and bacteria. From the spring melt monitoring period to the post-melt monitoring period in 2016, a change in groundwater quality was seen in 4 of the 5 wells (80%)

sampled. One location (K09-12012) near Church Road, did not have an observable change recorded. All of these wells are within the Floodway Right-of-Way.

Changes found from spring melt to post-melt were classified as follows:

- Type B (25 to 50% change) for 1 well (20% of the total) located inside of the Right-of-Way at the Outlet at Rockhaven Road (K09-12321).
- Type C (10 to 25% change) for 2 wells (40% of the total) located inside of the Right-of-Way at the Outlet (K09-12316) and PTH 59N west side (K11-12015).
- Type D (5 to 10% change) for 1 well (20%) located inside of the Right-of-Way at the PTH 59N Bridge west side at west Right-of-Way (K11-12014).

For the remaining 7 core monitoring wells, which only required measurement during the spring melt period, 4 of the wells (57%) showed an observable change as follows:

- Type C (10 to 25% change) for 3 wells (43% of the total) located inside of the Right-of-Way at the Outlet - the PTH44 bridge (U09-13571), just south of PTH59 (K09-12322) and at the outlet (G050C006).
- Type D (5 to 10% change) for 1 well (14%) located inside of the Right-of-Way at the PTH 59N Bridge west side at west Right-of-Way (K11-12016).

5.2 BACTERIA

In 2016, Total coliform bacteria was identified at five of the six sample locations tested (K13-12321, K09-12316, K11-12014, K11-12015 and the Inlet control structure), with levels generally decreasing between spring melt and post-melt events (where measured), suggesting influence of surface water intrusion and return to groundwater flow towards the channel post-melt.

Notification to Manitoba Infrastructure

During the initial March spring melt sampling event, *E. coli* was detected in one sample at K11-12015. Notification to Manitoba Infrastructure was conducted as required, in the Long Term Monitoring Plan. This detection was not considered a “change in conditions” which would

require reporting to Manitoba Sustainable Development Water Stewardship Division, for the following reasons:

- The Floodway was not operated in spring 2016, therefore any changes in groundwater quality are attributed to other sources including recharge and local runoff in the channel.
- *E. coli* has been detected previously at K11-12015 PTH 59 N west side near the channel in 2013, and 2014.

Based on a review of the other water quality parameters tested, no other change in conditions in the monitoring wells were found as defined in the sampling plan. A follow-up April sampling event was approved by MI and completed.

E. coli was detected on April 14, 2016 in 2 monitoring wells:

- Floodway outlet, near channel K09-12316 (*E. coli* 2 MPN/100 mL)
- PTH 59N near west Floodway Right of Way K11-12014 (*E. coli* 1 MPN/100 mL).

The *E. coli* previously detected at monitoring well K11-12015 in the late March sampling was not detected in this follow up sampling. As per the sampling plan, the *E. coli* detections were reported to MI. These detections were not considered a "change in conditions" which would require reporting to Manitoba Sustainable Development Water Stewardship, for the following reasons:

- The Floodway was not operated this spring, therefore any changes in groundwater quality were attributed to other sources including recharge and local runoff in the channel.
- *E. Coli* has been detected previously at K09-12316 Outlet channel in 2014, 2013 and 2011
- *E. Coli* has been detected previously at K11-12014 PTH 59 N west side near west Floodway Right of Way in 2014, and 2011

Total coliform readings were found at all 5 of the monitoring wells on March 30 from (9 to 22 CFU/100 mL), but were found at fewer locations on April 21 (three) and at lower concentrations (1 to 4 MPN/100 mL). *E. coli* was not detected in any monitoring wells during the final June post-melt sampling event.

5.3 NITRATE PLUS NITRITE AS (NITROGEN)

Nitrate plus nitrite (as N) concentrations were below the Canadian Drinking Water Quality Guidelines (CDWQG) of 10 mg/L at all monitoring wells tested. Seven (7) of the 12 sample locations had concentrations below detection (<0.0051 to <0.051 mg/L) in 2016, either for spring melt sampling only, or spring melt and post-melt events.

Higher concentrations of nitrate plus nitrite (as N) were observed during the spring melt than the post-melt (June) for K11-12014 and K11-12015, suggesting influence from surface water intrusion, as background nitrate/nitrite concentrations in groundwater in this area are generally low. In contrast, one sample within the Right-of-Way at Rockhaven Road (K13-12321) showed decreases in nitrate plus nitrite (as N) during the spring melt period versus the post-melt period. At this location, nitrate plus nitrite (as N), levels were elevated in groundwater during the spring melt. The reduction in observed values demonstrates the potential influence of lower concentration surface water intrusion relative to background.

5.4 RELATIONSHIP BETWEEN PARAMETERS

Lower conductivity values observed during the March 2016 spring melt generally correlated with the highest total coliform counts observed, with reduction in coliform after return to the June 2016 post-melt groundwater influence. *E. coli* bacteria, was generally observed to be below, or close to the detection level of 1 MPN/100 mL. Bacteria were sampled in areas where changes were expected and locations do not represent a random sample.

Changes in nitrate plus nitrite (as N) correlated with changes in water quality at 60% (3) of 5 core wells with dedicated transducers sampled within the Right-of-Way (K13-12321 at Rockhaven Road and K11-12014 / K11-12015 at PTH59N bridge) and 29% (2 of 7 remaining core monitoring wells) U09-13571 and K13-12322. Overall, higher nitrate plus nitrite (as N) concentrations were observed during spring melt versus post-melt (June) for the area near PTH59N bridge, despite the channel surface water having higher-nitrate plus nitrite (as N) concentrations in June. Where groundwater is locally affected by elevated nitrate plus nitrite (as N) near the floodway outlet, a decrease in concentrations with spring melt was observed, as

expected. Nitrate plus nitrite (as N) concentrations in all wells tested were below the Canadian Drinking Water Quality Guideline of 10 mg/L nitrate plus nitrite (as N).

Many of the monitoring wells are located on the shoulder of the Floodway Channel, or in the spoil pile, and would be expected to experience any water quality changes more quickly than domestic wells located further away, beyond the Floodway Right-of Way. Domestic wells (with the exception of the Floodway Inlet well) are not monitored in the Long-term monitoring program. Travel times from the Floodway surface water to the monitoring wells vary, depending on Floodway Channel water elevations, piezometric water elevations, interconnection pathway relative to clay and till thickness, and the hydraulic conductivity of the bedrock, which ranges from highly fractured to massive.

In general, groundwater gradients will be greater and travel rates will be faster closer to the Floodway. Gradients will decrease and travel times will lengthen further from the Floodway, such as in 2016 with no floodway operation, drier conditions, and limited channel flow.

5.5 SUMMARY ASSESSMENT OF CHANGES

The 2016 monitoring event flood represented a year with a dry early spring with no Floodway operation. Channel flow, included local contributions from streams and ditches, based on the water chemistry, however, flow was close to the edge of the low flow channel. Groundwater gradients typically remained towards the channel, with groundwater discharging to contribute to the channel baseflow. Groundwater quality changes observed from monitoring wells located within the Floodway Right-of-Way in 2016 were similar to years where the Floodway was not operated.

Bacteria were detected in more monitoring wells in 2016, than to 2015, but comparable to historic values.

The 2016 bacteria results indicate that bacteria is detected in some monitoring wells in sensitive areas during spring melt sampling even when the Floodway is not operated. However, detection of *E. coli* continues to be infrequent, not sustained, and at levels at or just above the detection limit when found.

All wells which showed groundwater quality changes in 2016 also showed changes in previous floods. Inorganic groundwater quality parameters seen in monitoring wells in 2016 did not exceed the Canadian Water Quality Guidelines for Drinking Water.

In 2016, Total coliform bacteria was identified at five of the six sample locations, with levels generally decreasing between spring melt and post-melt events, suggesting influence of local recharge or surface water intrusion and return to groundwater flow towards the channel post-melt. *E. coli* was initially detected in one sample in March 2016 and notification to MI was conducted. Follow-up sampling in April did not confirm this detection, however, *E.* coli was detected in two other wells. *E. coli* was not detected in any of the locations in the post-melt June 2016 sampling.

6.0 SPRING TREATMENT AREAS

The Spring Treatment Program mitigates surface water infiltration in the bedrock aquifer by providing sand filtration of any fines migration, by decreasing the amount of flow into the springs at the filter locations for a given flood, by reducing the potential for expansion of spring areas through piping, and by improving the bacterial quality of any infiltrating water. The constructed fine sand filters have a much lower hydraulic conductivity than an open fracture; therefore, the initial flow rate is decreased. As the low permeability silt fraction builds up above the sand filter layer during discharge into the aquifer, the infiltration rate is reduced further. The fine sand also meets criteria for slow sand filters designed to reduce bacteria passage through the filter. After the flood, when the flow direction reverses to groundwater discharge, the sand filter protects against upward piping of the foundation material (silt, sand) which otherwise could have increased the size of a fracture/hole.

Sealing the groundwater discharge areas completely is not desirable, as a pressure build-up and uncontrolled discharge in another area would likely develop. The treatments provide pressure relief, but in a controlled fashion and with a flow rate lower than was present before treatment.

Previous sampling in 2009 through 2011 showed that Total Coliform and *E. Coli* bacteria are generally present and at higher levels above the filter. The filter has been effectively reducing Total Coliform concentrations. *E. coli* has not been detected beneath the filter. Soon after the floodway drains, surface water infiltration is flushed out quickly from the system as shown by a return to groundwater quality and an absence of bacteria. A return to groundwater quality (as shown by conductivity) was seen towards the end of the flood period as shown by the transducer data in 2009, 2011 and 2013, with more limited change seen in 2014.

In 2016, monitoring of spring locations with a transducer was not included in the program. Previously in 2015 one spring discharge location was monitored with a transducer. The results from 2015 (Appendix B Figure HM66-43) showed no infiltration and no drop in conductivity or temperature during the spring melt. The water level during the spring monitoring in 2015 was at the top of the Low Flow Channel. Monitoring in prior years showed that a sufficient Floodway flow will temporarily reverse the discharge groundwater gradient to a surface water recharge

with flow direction from the channel into the bedrock beneath the spring. There is return to groundwater quality as the floodway begins to drain and groundwater is again discharged into the channel. Since there was no Red River flow into the channel these conditions did not occur in 2015 and would not have occurred in 2016. Also the total flow and water depth in the channel was insufficient to reverse the gradient in the spring in 2015 and would have been similar in 2016.

A summer inspection of 23 spring locations was conducted in August 2016 as summarized in Appendix C including description (Appendix D1-C-1) and field documentation sketches and photos (Appendix D1-C-2). Additional photos and video (Appendix D1-C-3) are provided on a separate DVD included with this report. This work documents conditions in the long-term monitoring period and can be compared with surveys completed in 2013 through 2015 (HM99).

A potential small discharge location was identified at the Low Flow Channel at UTM 648624 5547187. As the flow observed was low, less than 1 USgpm, no follow up was conducted. This location could be inspected in 2017 to confirm if discharge is continuing. If this location is to be developed further, treatment could be considered.

The constructed filters were found to be in good condition and were working as designed. Flow appeared to be coming up through the filter and discharging through the granular layer overlying the sand filter bed. No settlement or heaving of the filters was observed. No required repairs were identified.

The discharge trenches were constructed as shallow excavated trenches that were filled with riprap to grade or slightly above grade. As in previous years, it was observed that at 11 of the treated spring sites, the rip rap within the discharge trenches was infilling with sediment and spring discharge was finding alternate flow paths to the Low Flow Channel. This resulted in overland flow toward the Low Flow Channel or flow into low areas near the filter, creating wet and soft areas. No significant erosion channels were observed at any of these locations. The discharge trenches were constructed as ditches in a few locations (5A1 and 7A1). This method appeared to be more effective in directing discharge flows along the design discharge flow path, versus other trenches. Consideration to modify the 11 identified discharge trenches to create more pronounced ditches may improve control of flow towards the low flow channel.

Both high level and low level sampling pipes were found to be in good condition, with no damage observed, with the exception of the low level pipe at 5A1, in which the steel cover was missing. This cover should be replaced in 2017.

7.0 WELL DISINFECTION

The purpose of the well disinfection program is to prepare instrumented monitoring wells that are used for bacteria analysis for the pre-melt (typically March) and flood (typically March/April) monitoring programs. The program in 2016 was conducted in the Fall, as several months are required between disinfection and sampling. Disinfection was completed at the five core monitoring wells with dedicated transducers, which are used for bacteria analysis.

On September 27th, 2016 KGS Group personnel disinfected 5 wells (K11-12316. K09-12012, K13-12321, K11-12014 and K11-12015) along the Red River Floodway at PTH 59N, Church Road, Rockhaven Road and at the Outlet following the procedure outlined in Section 2.5.

Any dedicated submersible pumps were removed from the wells at the time of disinfection for winter storage at KGS Group.

8.0 LONG-TERM MONITORING

The current work program, overseen by Manitoba Infrastructure includes a monitoring period from Spring 2016 through Fall 2018. The Three Year Project Scope of Work should be continued for 2017, to include the following annual activities:

- Spring and Summer Flood Monitoring Program A (or B if required);
- Inspection of Treated Groundwater Springs;
- Annual Well Disinfection, Inspection/Maintenance/Repair Programs and Channel Inspections;
- Reporting.

9.0 STATEMENT OF LIMITATIONS AND CONDITIONS

9.1 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.

9.2 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 the Manitoba Infrastructure. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

TABLES

TABLE D1-1
2016 MONITORING WELL AND SURFACE WATER FIELD PARAMETERS

Location	Well No.	Date	E.C. (µS/cm)	Temp. (°C)	pH (Units)	DO (mg/L)	Sampling Method	Comments
Ground Water Samples								
Groundwater Monitoring Zone D								
Rockhaven Rd.	K13-12321	28-Mar-16	950	6.70	7.07	4.37	Dedicated Whale Pump	(1), (2), (3)
		21-Apr-16	1,100	6.80	7.25	3.13	Dedicated Whale Pump	-
		02-Jun-16	1,741	7.50	7.02	5.04	Dedicated Whale Pump	-
Outlet Structure	K09-12316	28-Mar-16	752	7.00	7.21	3.68	Dedicated Whale Pump	(1), (2), (3)
		21-Apr-16	823	6.90	7.43	1.96	Dedicated Whale Pump	-
		02-Jun-16	851	7.00	7.15	2.50	Dedicated Whale Pump	-
PTH 44 Bridge	U09-13571	28-Mar-16	909	7.70	7.18	1.04	Portable Tornado Pump	(5)
Hay Rd.	K11-12018	28-Mar-16	1,103	6.10	7.36	0.99	Portable Tornado Pump	(5)
Church Rd.	K09-12012	29-Mar-16	1,036	6.20	7.39	0.18	Dedicated Whale Pump	(1), (2), (3)
		21-Apr-16	1,249	6.20	7.35	0.02	Dedicated Whale Pump	-
		02-Jun-16	1,005	6.40	7.23	0.15	Dedicated Whale Pump	-
Ludwick Rd.	K09-12011	29-Mar-16	441	6.80	7.41	1.52	Portable Tornado Pump	(5)
Dunning Rd.	K11-12017	29-Mar-16	1,037	6.10	7.25	0.19	Portable Tornado Pump	(5)
Bray Rd.	K11-12016	29-Mar-16	952	6.30	6.70	0.17	Portable Tornado Pump	(5)
Groundwater Monitoring Zone C								
PTH59N Bridge	K11-12014	30-Mar-16	557	7.30	7.51	0.90	Portable Tornado Pump	(1), (2), (5)
		21-Apr-16	606	7.40	7.51	1.14	Dedicated Waterra Tubing / Foot Valve	(4)
		02-Jun-16	688	7.90	7.32	4.71	Dedicated Waterra Tubing / Foot Valve	-
	K11-12015	30-Mar-16	521	7.20	7.70	1.12	Portable Tornado Pump	(1), (2), (5)
		21-Apr-16	565	7.20	7.76	0.99	Dedicated Whale Pump	(3)
		02-Jun-16	583	7.40	7.44	1.49	Dedicated Whale Pump	-
McGregor Farm Rd.	K13-12322	30-Mar-16	737	6.20	7.56	0.09	Portable Tornado Pump	(5)
Groundwater Monitoring Zone A								
Inlet Control Structure	G050C006	30-Mar-16	2,340	9.90	8.02	1.07	Direct from Washroom Tab - Nonpotable	-
Surface Water Samples								
PTH 44 Bridge	PTH 44	28-Mar-16	415	9.30	7.77	13.80	Surface Grab Sample	-
		02-Jun-16	553	14.40	7.61	8.37	Surface Grab Sample	-
PTH59N Bridge	PTH 59N	30-Mar-16	608	6.30	7.36	8.11	Surface Grab Sample	-
		02-Jun-16	767	17.60	7.81	9.38	Surface Grab Sample	-

Notes:
"-" = No Data
E.C. = Electrical Conductivity

1. Dedicated Well Transducer Present
2. Original Dedicated Well Pump Failed
3. New Dedicated Well Pump Installed
4. New Dedicated Waterra Tubing and Foot Valve
5. Sampled with Portable Pump

TABLE D1-2
2016 GENERAL GROUNDWATER QUALITY DATA

Location	Well ID	Duplicate	Date	Parameter [1]																							
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Sulphate	Nitrate & Nitrite as N	Nitrate as N	Nitrite as N	Calcium	Magnesium	Potassium	Sodium	T.D.S. (calc.) [7]	Total Cation	Total Anion	Cation-Anion Balance (%) [8]	Ion Balance	Total Coliform (MPN/100 mL) [5]	E.coli (MPN/100 mL) [5]	Comments
			HC-CDWQ [2]																								
			Drinking Water [2]	0.3/ 1.0/ 0.1 [3]	6.5 - 8.5 (AO)	-	-	-	-	-	[4]	250 (AO)	500 (AO)	10 (MAC)	10 [6] (MAC)	1 [6] (MAC)	-	-	-	200 (AO)	500 (AO)	-	-	-	-	0 per 100 mL	0 per 100 mL	-
Rockhaven Rd.	K13-12321	-	28-Mar-2016	3.11	7.39	974	408	498	<0.60	<0.34	497	44.6	79.2	2.33	2.33	<0.0010	74.2	75.9	4.88	27.3	561	11.3	11.2	0.1	100	11	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	<1	-
		-	2-Jun-2016	0.41	7.30	1710	506	617	<0.60	<0.34	882	243	93.7	3.25	3.25	<0.0020	113	146	6.55	69.8	990	20.9	19.1	4.3	109	<1	<1	-
Outlet Structure	K09-12316	-	28-Mar-2016	0.27	7.51	775	312	381	<0.60	<0.34	372	30.6	75.6	1.56	1.56	<0.0010	62.8	52.3	4.33	24.5	444	8.61	8.79	-1	98	22	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	-
		-	2-Jun-2016	0.17	7.63	853	359	438	<0.60	<0.34	482	30.6	64.1	1.57	1.57	<0.0010	74.8	71.7	4.47	21.6	490	10.7	9.49	5.9	113	1	<1	-
PTH 44 Bridge	U09-13571	-	28-Mar-2016	0.14	7.43	940	347	423	<0.60	<0.34	427	58.2	95.4	1.64	1.64	<0.0010	69.3	61.7	4.89	38.1	543	10.3	10.7	-1.7	96.6	-	-	-
Hay Rd.	K11-12018	-	28-Mar-2016	8.20	7.23	1130	593	723	<0.60	<0.34	636	2.29	102	<0.0051	<0.0050	<0.0010	92.4	98.5	5.19	27.8	683	14.1	14	0.1	100	-	-	-
Church Rd.	K09-12012	-	29-Mar-2016	73.3	7.44	1060	350	427	<0.60	<0.34	531	23.0	237	<0.0051	<0.0050	<0.0010	94.9	71.3	4.50	45.2	686	12.7	12.6	0.4	101	<1	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-
		-	2-Jun-2016	12.8	7.56	1020	311	379	<0.60	<0.34	530	21.0	238	<0.0051	<0.0050	<0.0010	86.3	76.5	4.50	46.8	660	12.8	11.8	4.1	108	<1	<1	-
Ludwick Rd.	K09-12011	-	29-Mar-2016	0.82	8.02	454	235	286	<0.60	<0.34	230	7.98	15.4	<0.0051	<0.0050	<0.0010	47.4	27.1	2.62	9.54	251	5.08	5.23	-1.5	97	-	-	-
		MW100	29-Mar-2016	0.77	8.08	459	227	277	<0.60	<0.34	229	7.99	15.4	<0.0051	<0.0050	<0.0010	47.7	26.8	2.70	9.51	246	5.07	5.09	-0.2	99.7	-	-	-
Dunning Rd.	K11-12017	-	29-Mar-2016	3.62	7.83	1080	265	324	<0.60	<0.34	520	21.9	305	<0.0051	<0.0050	<0.0010	95.3	68.4	3.93	48.0	702	12.6	12.3	1.2	102	-	-	-
Bray Rd.	K11-12016	-	29-Mar-2016	0.11	7.75	990	299	364	<0.60	<0.34	500	16.1	236	<0.0051	<0.0050	<0.0010	94.4	64.1	4.49	33.8	629	11.6	11.3	1	102	-	-	-
PTH59N Bridge	K11-12014	-	30-Mar-2016	<0.10	7.63	573	247	301	<0.60	<0.34	299	13.6	57.6	0.252	0.252	<0.0010	59.9	36.3	3.82	6.53	327	6.36	6.53	-1.4	97.3	9	<1	-
		MW-101	30-Mar-2016	<0.10	7.67	575	249	304	<0.60	<0.34	309	13.6	57.7	0.249	0.249	<0.0010	63.2	36.6	3.85	6.57	332	6.55	6.58	-0.3	99.5	12	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	1	-
		-	2-Jun-2016	0.49	7.60	625	256	312	<0.60	<0.34	363	16.1	60.9	0.211	0.211	<0.0010	72.4	44.3	4.25	7.40	360	7.69	6.85	5.8	112	10	<1	-
	K11-12015	-	30-Mar-2016	0.32	7.78	532	222	270	<0.60	<0.34	269	16.7	50.5	0.207	0.207	<0.0010	54.2	32.4	3.89	6.72	298	5.76	5.96	-1.7	96.7	9	1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	<1	-
		MW-100	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	<1	-
		-	2-Jun-2016	0.93	7.72	596	236	288	<0.60	<0.34	337	16.9	64.6	0.076	0.0733	0.0027	66.2	41.7	4.22	7.36	343	7.16	6.55	4.5	109	5	<1	-
McGregor Farm Rd.	K13-12322	-	30-Mar-2016	0.84	7.60	741	247	302	<0.60	<0.34	356	16.1	148	<0.0051	<0.0050	<0.0010	61.9	48.8	3.36	23.3	450	8.2	8.48	-1.7	96.7	-	-	-
Inlet Control Structure	G050C006	-	30-Mar-2016	38.4	7.84	2340	206	252	<0.60	<0.34	477	539	295	<0.051	<0.050	<0.010	95.5	57.9	12.8	325	1450	24	25.5	-3	94.1	1	0	-

Notes:

E.C. = Electrical Conductivity

"-" = No Data

1. All values are expressed in milligrams per litre (mg/L) unless indicated otherwise.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated October 2014
   MAC - Maximum Acceptable Concentration
   AO - Aesthetic Objectives
3. Criteria values based on conventional treatment/ slow sand or diatomaceous earth filtration/ membrane filtration. Criteria not applicable to current study.
4. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as CaCO3) , provide acceptable balance.
5. Total Coliform and E.coli analyzed by Low Level Quantitray Method TC/EC QT97. Because coliforms are not uniformly distributed in water and are subject to considerable variation in enumeration, drinking water that fulfils the following conditions is considered to be in compliance with the total coliform MAC:

   a) No sample should contain more than 10 total coliform organisms per 100 mL, none of which should be fecal coliforms; and

   b) No consecutive samples from the same site should show the presence of coliform organisms; and

   c) For community drinking water supplies:
   - not more than 10% of the samples based on a minimum of 10 samples should show the presence of coliform organisms; and
   - not more than one sample from a set of samples taken from the community on a given day should show the presence of coliform organisms.

6. For Nitrate as Nitrogen. Where Nitrate and Nitrite are determined separately, levels of nitrite-N should not exceed 1 mg/L.
7. ALS Laboratory reports total dissolved solids (calculated) as the sum of cations plus anions.
8. Cation Balance is calculated as:

   Cation Anion balance = $\frac{\text{sum of meq of Cations - sum of meq of Anions}}{\text{sum of meq of Cations + sum of meq Anions}}$ X 100 = %

   Cation-anion balances greater than the absolute 10% are highlighted for reference only.
9. Ca, Mg, Na, K, Cl, SO4 are represented as dissolved analysis concentrations

= Exceedance of HC- CDWQ Drinking Water

TABLE D1-3
2016 GENERAL SURFACE WATER QUALITY DATA FLOODWAY CHANNEL

Location	Location Description [1]	Date	Parameter [2]																										
			Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Sulphate	Ammonia (NH_3) [3]	Nitrate+ Nitrite-N	Nitrate-N	Nitrite-N	Calcium	Magnesium	Potassium	Sodium	Total Phosphorus	T.D.S. (Calc.)	T.S.S.	T.K.N.	Anion Sum	Cation Sum	Cation - Anion Balance	Ion Balance (%)	Total Coliform MPN/100mL	E.Coli MPN/100mL
			CCME [4] - Freshwater Aquatic Life																										
			[5]	6.5-9.0	-	-	-	-	-	-	120 [6a] /640 [6b]	-	-	-	-	-	-	-	-	-	-	-	[7]	-	-	-	-	-	-	-
PTH59	RRF at PTH 59 N Spring Hill Ski	30-Mar-2016	21.2	8.13	549	193	236	<0.60	<0.34	231	45.6	39.1	0.072	0.414	0.405	0.0093	50.2	25.7	6.63	28.7	0.196	314	9.0	0.75	6	6.04	0.4	101	2790	630
PTH59	RRF at PTH 59 N Spring Hill Ski	2-Jun-2016	16.8	8.24	718	210	256	<0.60	<0.34	352	46.2	93.2	0.014	4.68	4.62	0.0606	64.4	46.4	6.53	30.4	0.285	434	15.0	1.87	7.77	8.52	4.6	110	26100	1440
PTH 44	NW side of PTH44 bridge	28-Mar-2016	42.5	7.96	407	175	213	<0.60	<0.34	198	13.5	26.2	0.054	1.28	1.25	0.0263	45.3	20.7	7.82	9.41	0.356	233	24.0	0.79	4.51	4.58	0.8	102	980 [8]	139 [8]
PTH 44	NW side of PTH44 bridge	2-Jun-2016	10.0	8.03	665	227	277	<0.60	<0.34	329	38.4	81.0	<0.010	0.727	0.704	0.0234	62.8	41.7	4.84	27.8	0.108	396	13.0	1.32	7.36	7.9	3.5	107	41100	1210

Notes:

"-" = No Data
E.C. = Electrical Conductivity
T.D.S. = Total Dissolved Solids

"*" = Detection Limit Adjusted For Sample Matrix Effects
T.K.N. = Total Kjeldahl Nitrogen
T.S.S. = Total Suspended Solids

1. See Figure D1-1 for sample locations.
2. All values are expressed in milligrams per litre (mg/L) unless indicated otherwise.
3. Guideline for un-ionized ammonia is 0.019 mg/L, which is equivalent to 16 µg ammonia-N /L (=19*14.0067 / 17.35052, rounded to two significant figures).
   Guideline for total ammonia is temperature and pH dependent, See below table for calculated total ammonia concentration.

	pH							
Temp (^{o}C)	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**10**
0	231	73	23.1	7.32	2.33	0.749	0.25	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22	6.98	2.22	0.715	0.239	0.089	0.026
20	48	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.5	2.39	0.767	0.256	0.094	0.043	0.021

4. Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Update 2014.
   Chapter 4 -Aquatic Life

BOLD - Exceedance of Criteria

5. Turbidity Guidelines Narrative (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 exposure (e.g. 30 d 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.
6. 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 tra
7. Suspended Sediments Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 25 mg/L from background levels for any short-term exposure (eg. 24 hr period).
   Maximum average increase of 5 mg/L from background levels for longer term exposures (eg. Inputs lasting between 24 hrs and 30 days).
   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.
8. Bacteria sample taken on March 29, 2016

TABLE D1-4
2016 WATER QUALITY ASSESSMENT - INSTRUMENTED WELLS

WELL ID	YEAR	PROGRAM	CONDUCTIVITY							NITRATE			E. COLI	
			SPRING MELT CONDUCTIVITY (March 28 - 30 2016)	POST-MELT CONDUCTIVITY (June 2, 2016)	% CHANGE [3]	CHANGE IS GREATER THAN 5%[2]	MAGNITUDE OF WATER QUALITY CHANGE [1]	WELL HAS POST-MELT GROUNDWATER CONDUCTIVITY VALUES SIMILAR TO THE FLOODWAY CHANNEL SURFACE WATER	CONDUCTIVITY VALUES FOR GROUNDWATER DO NOT CHANGE ASSOCIATED WITH THE SPRING MELT EVENT	SPRING MELT NITRATE PLUS NITRITE (as N) (March 28 - 30 2016)	POST-MELT NITRATE PLUS NITRITE (as N) (June 2, 2016)	% CHANGE [3]	E.COLI DETECTED IN A DISINFECTED WELL IN POST-MELT SAMPLING	E. COLI DETECTED IN A DISINFECTED WELL IN SPRING MELT PEAK SAMPLING
K13-12321	2016	Program A-1	974	1710	43	Yes	B	No	No	2.33	3.25	28	no	no
K09-12316	2016	Program A-1	755	853	11	Yes	C	No	No	1.56	1.57	1	no	no[5]
K09-12012	2016	Program A-1	1060	1020	-4	No	-	No	Yes	<0.0051	<0.0051	0	no	no
K11-12014	2016	Program A-1	573	625	8	Yes	D	Yes	No	0.252	0.211	-19	no	no
K11-12015	2016	Program A-1	532	596	11	Yes	C	Yes	No	0.207	0.076	-172	no	yes

Notes:
1. Magnitude of water quality change: Type A (50% change), Type B (25 to 50% change). Type C (10% to 25% change), Type D (5 to 10%) change
2. Changes of ≤ 5% are considered to be within the accuracy of the analysis and are considered "no change" for purposes of this analysis.
3. Negative % change values indicate higher concentrations for flood peak vs post-melt sampling.
4. Pre-melt value for previous year may not be representative of 2014; therefore, percent change may not be valid.
5. E.coli was detected in follow up April Sampling Event.

In comparison to Spring Melt Data to Post-Melt Data, highlighted values show lower values in conductivity, higher values in nitrate plus nitrite as (N) (all sites except near Lockport/Outlet) , or lower values in nitrate plus nitrite as (N) (near Lockport/Outlet only).

TABLE D1-5
2016 WATER QUALITY ASSESSMENT - INSTRUMENTED WELLS

WELL ID		CONDUCTIVITY							NITRATE		
		PRE-MELT CONDUCTIVITY PREVIOUS YEAR (2011, 2013 or 2014)	SPRING MELT CONDUCTIVITY (March 28 - 30 2016)	% CHANGE [3]	CHANGE IS GREATER THAN 5%[2]	MAGNITUDE OF WATER QUALITY CHANGE [1]	WELL HAS PRE-MELT GROUNDWATER CONDUCTIVITY VALUES SIMILAR TO THE FLOODWAY CHANNEL SURFACE WATER	CONDUCTIVITY VALUES FOR GROUNDWATER DO NOT CHANGE ASSOCIATED WITH THE SPRING MELT EVENT	PRE-MELT NITRATE PREVIOUS YEAR (2013 or 2014)	SPRING MELT NITRATE PLUS NITRITE (as N) (March 28 - 30 2016)	% CHANGE [3]
U09-13571	Program A	1170	940	24	Yes	C	No	No	1.42	1.64	15
K11-12018	Program A	1090	1130	-4	No	-	No	Yes	<0.0050	<0.0051	0
K09-12011	Program A	465	454	2	No	-	Yes	Yes	<0.0051	<0.0051	0
K11-12017	Program A	1080	1080	0	No	-	No	Yes	<0.0051	<0.0051	0
K11-12016	Program A	1050	990	6	Yes	D	No	No	<0.0050	<0.0051	0
K13-12322	Program A	880	741	19	Yes	C	Yes	No	0.0116	<0.0051	44
G050C006	Program A	2890	2340	24	Yes	C	No	No	<0.35	<0.051	0

Notes:
1. Magnitude of water quality change: Type A (50% change), Type B (25 to 50% change). Type C (10% to 25% change), Type D (5 to 10%) change
2. Changes of ≤ 5% are considered to be within the accuracy of the analysis and are considered "no change" for purposes of this analysis.
3. Negative % change values indicate higher concentrations for flood peak vs post-melt sampling.
4. Pre-melt value for previous years may not be representative of 2016; therefore, percent change may not be valid.

In comparison to Spring Melt Data to Pre-Melt Data, highlighted values show lower values in conductivity, higher values in nitrate plus nitrite as (N)

FIGURES

P:\Projects\2016\16-0300-002\Dwg\GIS\MXDs\Monitoring_Report\Rev0\16-0300-002_FigD1-1_Rev0.mxd

N W E S

RM of Rockwood
RM of St. Andrews
RM of St. Clements
RM of East St. Paul
RM of West St. Paul
City of Winnipeg
RM of Springfield
RM of Tache
RM of Ritchot
Birds Hill Provincial Park

FLOODWAY OUTLET
U 09-13571
K 13-12321
K 09-12316
HWY 44
CEMR BRIDGE
HAY ROAD
K 11-12018
CHURCH ROAD
K 09-12012
P.R. 407 LUDWICK ROAD
K 09-12011
DUNNING ROAD CROSSING
K 11-12017
K 11-12016
HWY 59 NORTH
K 11-12014
K 11-12015
K 13-12322
CPR KEEWATIN BRIDGE
CNR REDDITT BRIDGE
HWY 15
GWWD BRIDGE
HWY 1
CNR SPRAGUE BRIDGE
HWY 59 SOUTH
CPR EMERSON BRIDGE
ST. MARY'S ROAD BRIDGE
FLOODWAY INLET
G05OC006
7A1

GROUNDWATER MONITORING ZONE D
GROUNDWATER MONITORING ZONE C
GROUNDWATER MONITORING ZONE B
GROUNDWATER MONITORING ZONE A

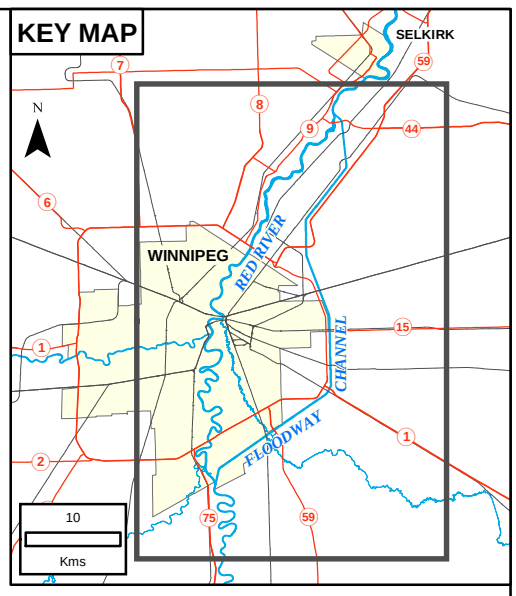
RED RIVER

49+000 48+000 47+000 46+000 45+000 44+000 43+000 42+000 41+000 40+000 39+000 38+000 37+000 36+000 35+000 34+000 33+000 32+000 31+000 30+000 29+000 28+000 27+000 26+000 25+000 24+000 23+000 22+000 21+000 20+000 19+000 18+000 17+000 16+000 15+000 14+000 13+000 12+000 11+000 10+000 9+000 8+000 7+000 6+000 5+000 4+000

	Wells Sampled	Surface Water Locations	Monitoring Well Transducers
Program A	12	2	5

GROUNDWATER MONITORING ZONE D				
WELL ID	LOCATION	UNIT	INSTALLED DEDICATED TRANSDUCER	INSTALLED DEDICATED SAMPLING EQUIPMENT
K 13-12321	Rockhaven Road	Bedrock	Yes	Whale Pump
PTH 44 Bridge	Floodway Channel	Surface Water	N/A	N/A
K 09-12316	Outlet	Bedrock	Yes	Whale Pump
U 09-13571	PTH 44 Bridge	Bedrock	No	No
K 11-12018	Hay Road	Bedrock	No	No
K 09-12012	Church Road	Bedrock	Yes	Whale Pump
K 09-12011	S. of Ludwick Road	Bedrock	No	No
K 11-12017	Dunning Road	Bedrock	No	No
K 11-12016	South of Bray Road	Bedrock	No	No
GROUNDWATER MONITORING ZONE C				
K 11-12014	PTH 59 N. West ROW	Bedrock	Yes	Waterra Tubing
K 11-12015	PTH 59 N. West	Bedrock	Yes	No
PTH 59 N.	Floodway Channel	Surface Water	N/A	N/A
K 13-12322	Mc Gregor Farm Road	Bedrock	No	No
GROUNDWATER MONITORING ZONE B				
Spring 7A	North of CNR Redditt	Spring	Permanent Installation	–
GROUNDWATER MONITORING ZONE A				
G05OC006	Floodway Inlet	Bedrock	N/A	N/A

KEY MAP



Legend

- Spring Treatment Site
- Monitoring Wells
- K11-12015 — Core Monitoring Well Location
- Instrumented Monitoring Well Location (5 Wells)
- Surface Water Sampling Location
- Proposed Groundwater Monitoring Boundary
- 4 + 000 — Floodway Channel Station
- Floodway Right of Way Limits
- RM Boundary

NOTES:
1. Instrumented monitoring well locations includes well disinfection, dedicated pumps and trandsducers, and analysis of dissolved oxygen and bacteria.
2. Imagery from the Manitoba Land Initiative website, and dated 2008-2010.

1 0 1 2 3
Kilometers

SCALE: 1:100,000 METRIC 11"x17"

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).

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/02/22	ISSUED WITH FINAL REPORT	MPS	BAT

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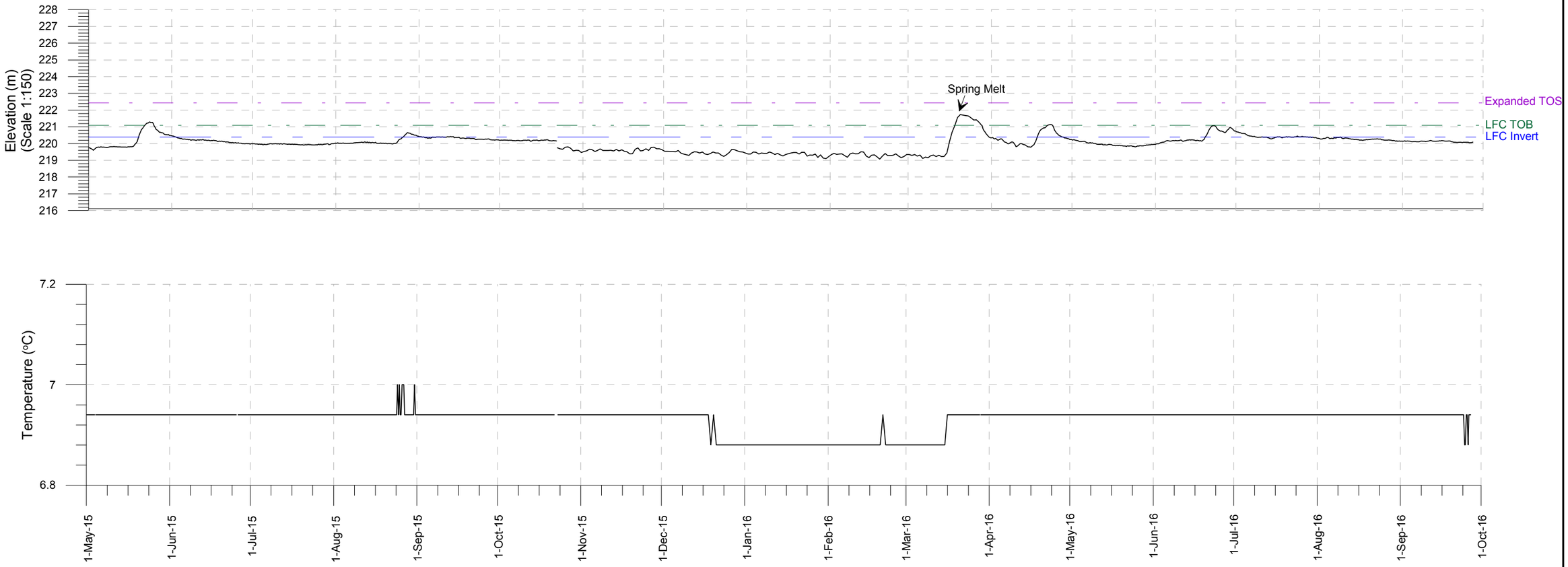
RED RIVER FLOODWAY LONG TERM MONITORING PROGRAM – 2016 PROGRAM A MONITORING REPORT

PROGRAM A MONITORING WELL LOCATIONS

FEBRUARY 2017 | FIG D1-1 | REV: 0

APPENDIX D1-A

CURRENT TRANSDUCER PROGRAM



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D1-B Figure HM66-13 Rev. 5 for historical data.

Groundwater
Transducer Data - K09-12316

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/02/21	ISSUED WITH FINAL REPORT	PJL	MFH

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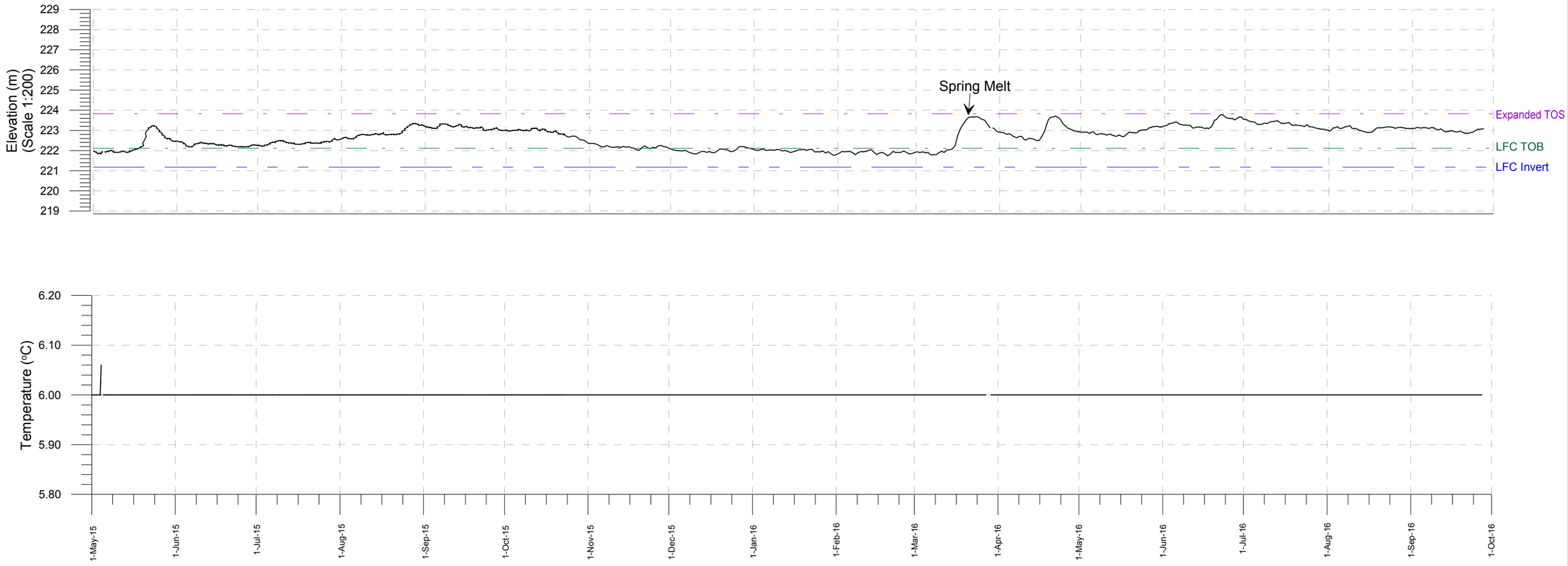
RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K09-12316 (Floodway Outlet)

FEB 2017	APPENDIX D1-A-1	REV: 0

P:\Projects\2016\16-0300-002\Design\Env\Grapher & Transducer Data\16-0300-002_Grapher Files\K09-12316 (9616)\K09-12316_(9616)_Hydrograph_16-0300-002.grf



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D1-B Figure HM66-13 Rev.5 for historical data.

Groundwater
Transducer Data - K09-12012

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/02/21	ISSUED WITH FINAL REPORT	PJL	MFH

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RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K09-12012 (Church Rd.)

FEB 2017 | APPENDIX D1-A-2 | REV: 0

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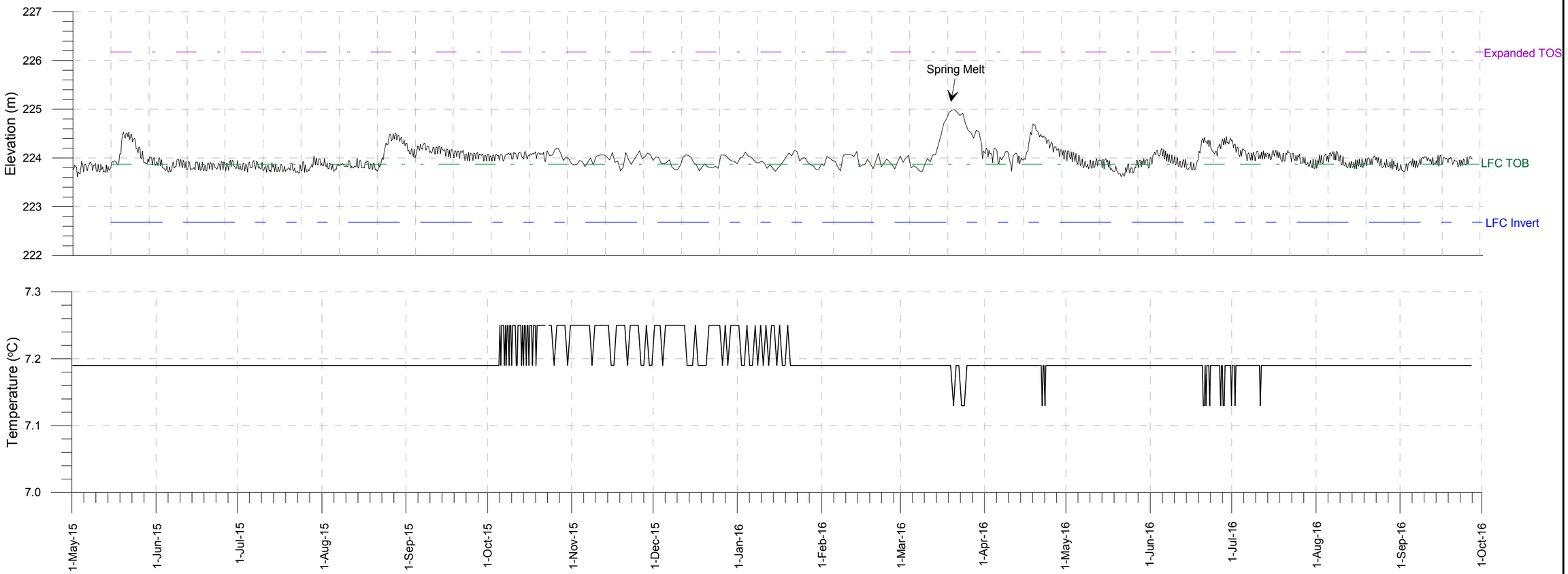

Note

TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D1-B Figure HM66-37 Rev.6 for historical data.

Groundwater
Transducer Data - K11-12014

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/02/21	ISSUED WITH FINAL REPORT	PJL	MFH

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RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K11-12014 (PTH 59N West Side)

FEB 2017 | APPENDIX D1-A-3 | REV: 0

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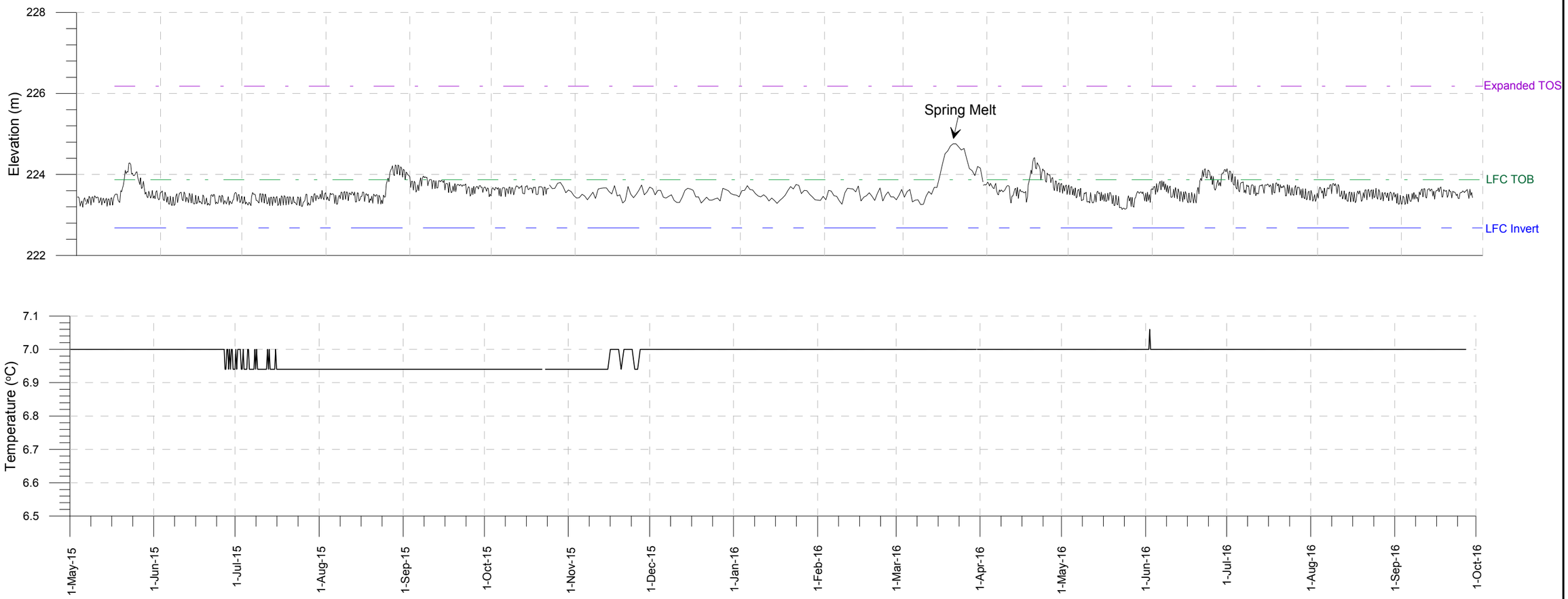

Note

TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D1-B Figure HM66-38 - Rev. 6 for historical data.

Groundwater
Transducer data - K11-12015

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/02/21	ISSUED WITH FINAL REPORT	PJL	MFH

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RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K11-12015 (PTH 59N WEST)

FEB 2017	APPENDIX D1-A-4	REV: 0

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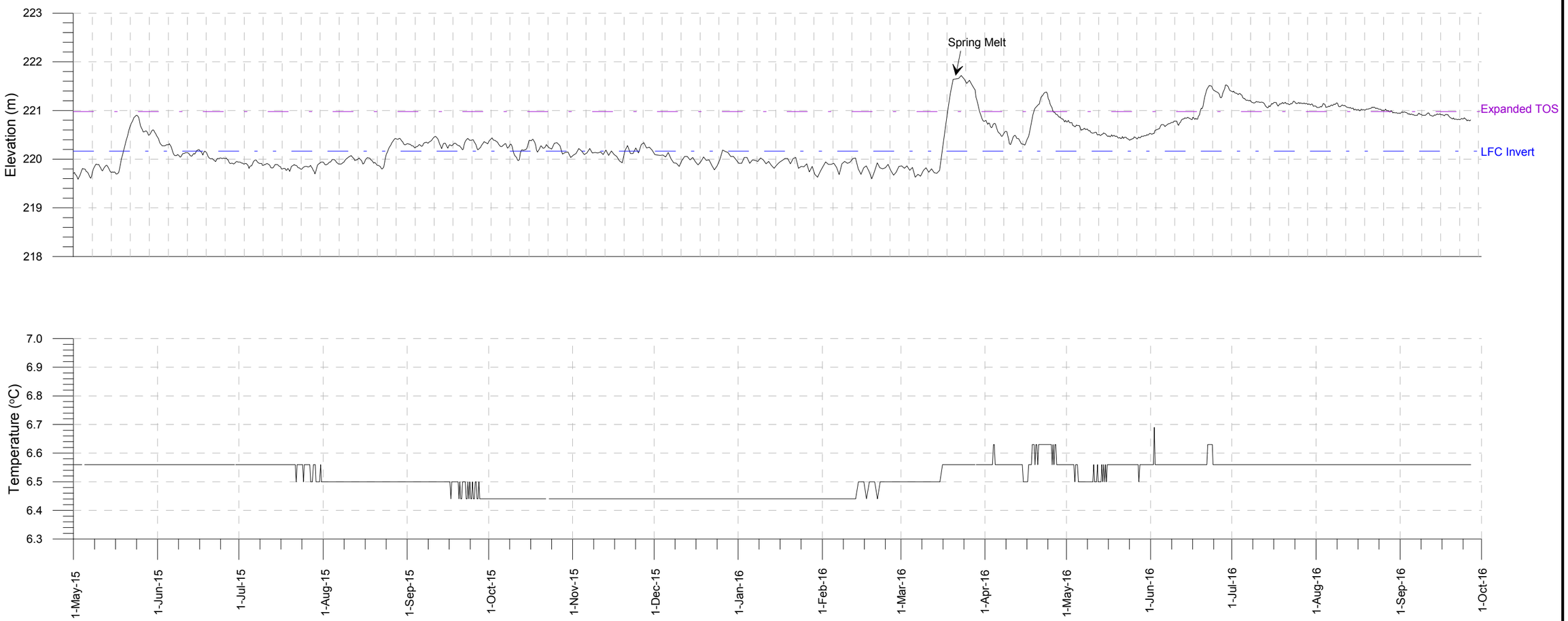

Note

TOS - Toe of Slope
TOB - Top of Bank

1. See Appendix D1-B Figure HM66-45 - Rev. 2 for historical data.

Groundwater
Transducer Data - K13-12321

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	17/02/06	ISSUED WITH FINAL REPORT	PJL	MFH

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RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
PROGRAM A ANNUAL REPORT

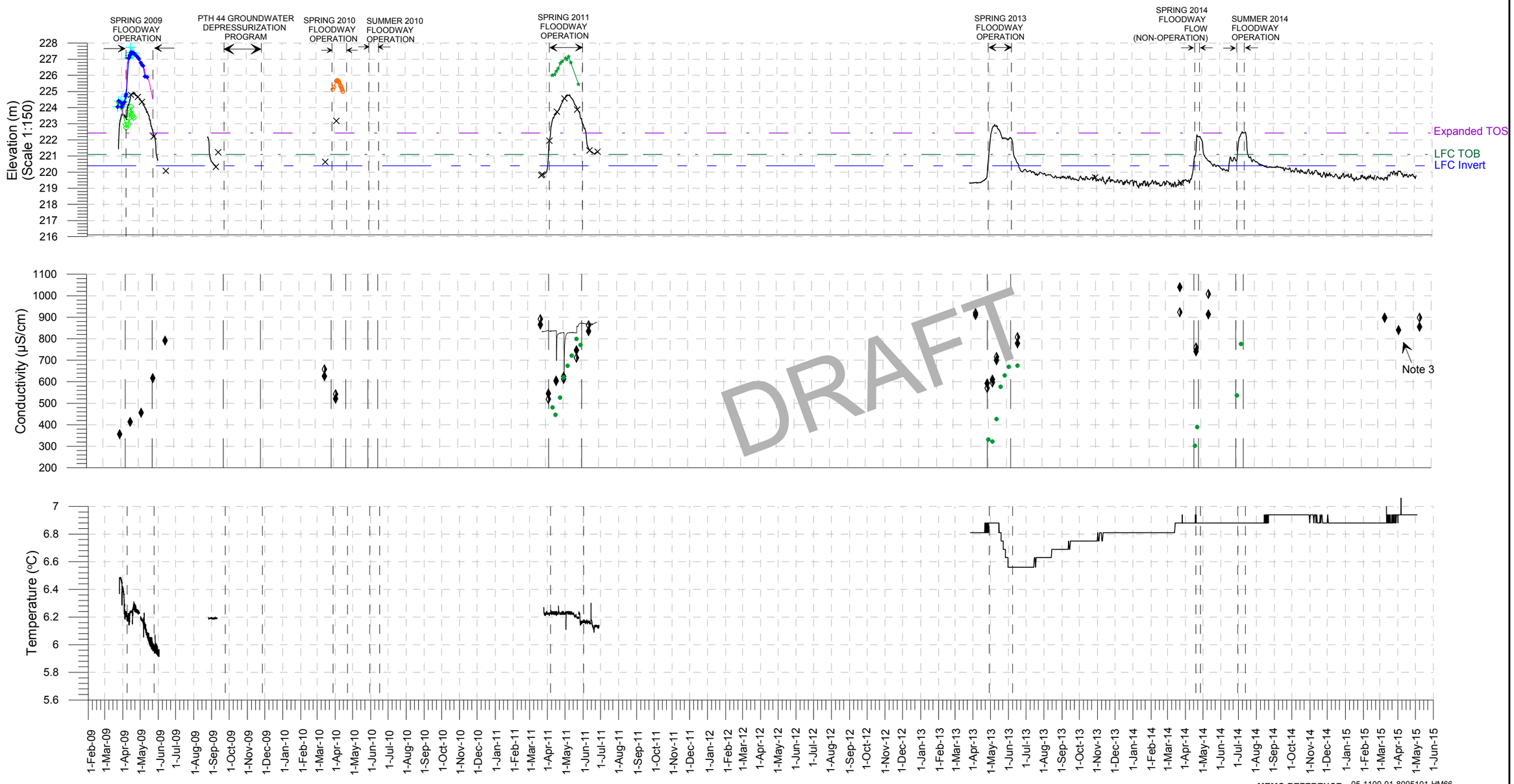
WATER ELEVATION AND
TEMPERATURE READINGS AT
K13-12321 (Rockhaven Rd.)

FEB 2017 | APPENDIX D1-A-5 | REV: 0

P:\Projects\2016\16-0300-002\Design\Env\Grapher & Transducer Data\16-0300-002_Grapher Files\K13-12321\K13_12321.grf

APPENDIX D1-B

HISTORICAL TRANSDUCER PROGRAM



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank
1. Modelled 2009 surface water levels are derived from measured water levels and discharge hydrographs at the floodway inlet. The water surface elevation is computed using the hydrodynamic version of the HEC RAS computer program.
2. Measured 2009 and 2010 surface water levels are from KGS Group data taken at locations along the channel. The measured location closest to each monitoring well was used.
3. Field measured conductivity suspect on April 6, 2015, therefore not included in plot.

Surface Water
- 2009 Floodway Water Level Modelled (Stn 50+500)
- 2009 Floodway Water Level Measured (Stn 50+437)
- 2010 Floodway Water Level Measured (Stns 50+424 to 50+437)
- 2011 Floodway Water Level Measured (Stns 50+426 to 50+427)
- Laboratory Measured Conductivity

Groundwater
- Transducer Data - K09-12316
- Outlet Water Level Measured
- Red River Water Level Measured
- Manual GW DTW
- Laboratory Measured Conductivity
- Field Measured Conductivity

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

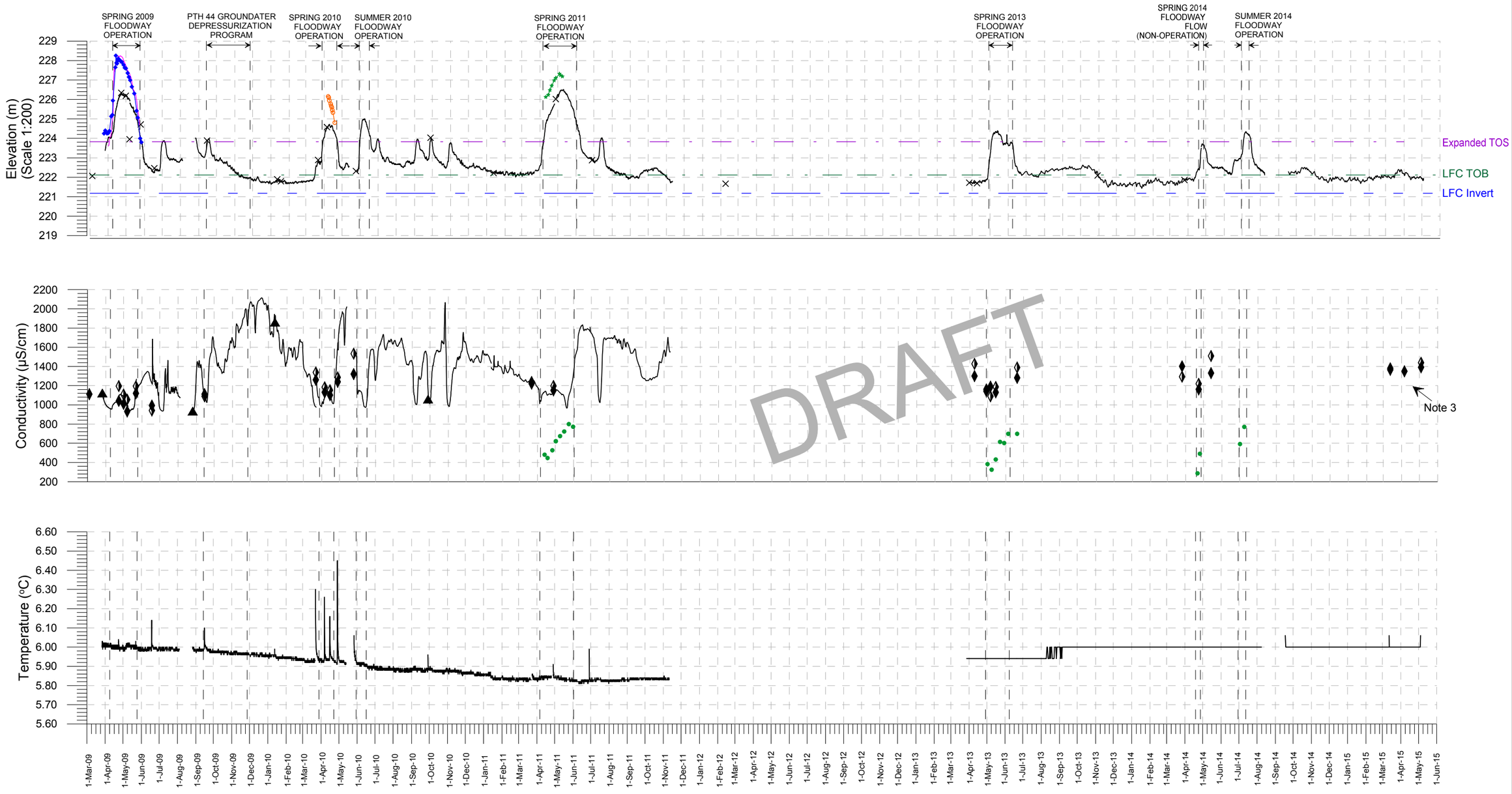
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K09-12316 (FLOODWAY OUTLET)

JUNE 2015 | FIGURE HM66-3 | REV 5

X:\projects\2003\03-1100-01\Structures & Systems\(.40) OutletStructure\Temp\Dewatering\Transducer_Data\12316 (9616)



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank
1. Modelled 2009 surface water levels are derived from measured water levels and discharge hydrographs at the floodway inlet. The water surface elevation is computed using the hydrodynamic version of the HEC RAS computer program.
2. Measured 2009 and 2010 surface water levels are from KGS Group data taken at locations along the channel. The measured location closest to each monitoring well was used.
3. Field measured conductivity suspect on April 6, 2015, therefore not included in plot.

Surface Water
- 2009 Floodway Water Level Modelled (Stn 45+000)
- 2009 Floodway Water Level Measured (Stn 47+064 (Hay Road))
- 2010 Floodway Water Level Measured (Stns 45+001 to 45+003)
- 2011 Floodway Water Level Measured (Stns 48+523 to 48+525)
- Laboratory Measured Conductivity

Groundwater
- Transducer Data - K09-12012
- × Manual Depth to Water Measurement
- ♦ Laboratory Measured Conductivity
- ◊ Field Measured Conductivity
- ▲ Field Calibrated Conductivity Date

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

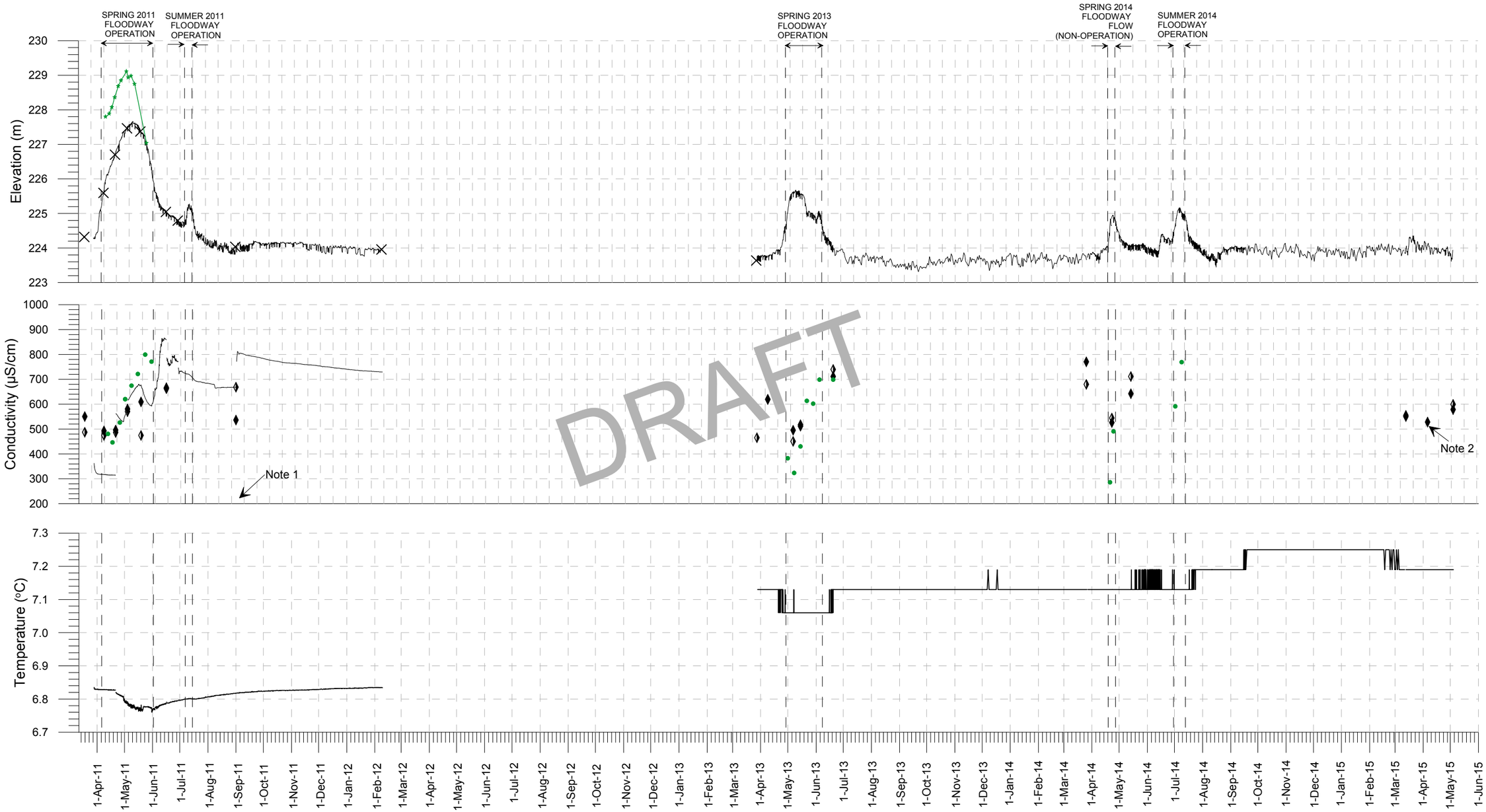
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K09-12012 (Church Road)

JUNE 2015	FIGURE HM66-13	REV 5

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K09-12012\K09-12012_



MEMO REFERENCE 05-1100-01-8005101-HM66

Note

1. Transducer fouled at bottom of well, relocated higher.
2. Field measured conductivity suspect on April 6, 2015 therefore not included.

Surface Water

- 2011 Floodway Water Level Measured (Stns 35+018 to 35+020)
- Laboratory Measured Conductivity

Groundwater

- Transducer Data - K11-12014
- Manual Depth to Water Measurement
- Field Measured Conductivity
- Laboratory Measured Conductivity

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K11-12014

KGS GROUP

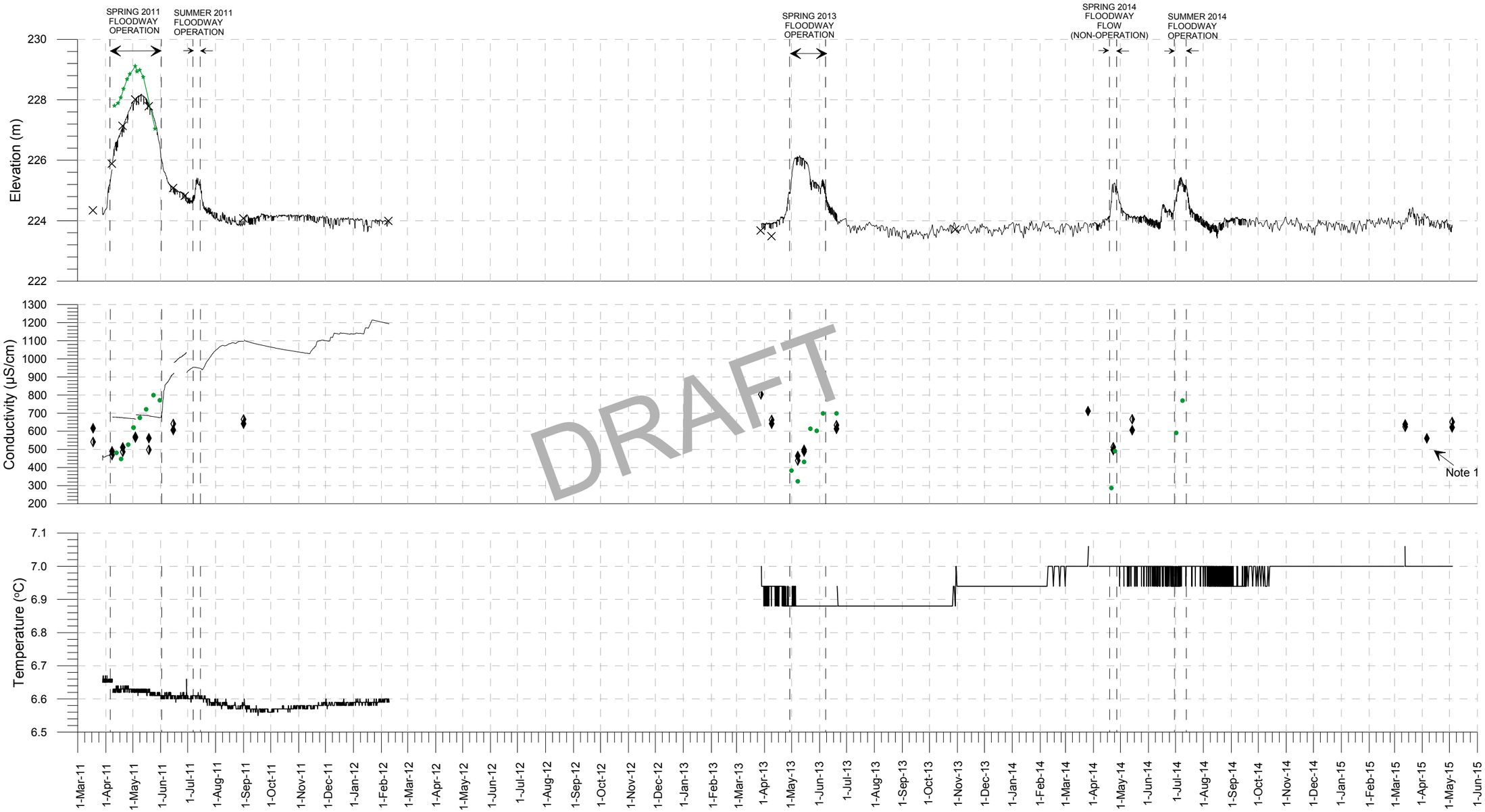
MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K11-12014 (PTH59N - WEST SIDE)

JUNE 2015	FIGURE HM66-37	REV 6



Note

1. Field measured conductivity suspect on April 6, 2015, therefore not included in plot.

Surface Water

- 2011 Floodway Water Level Measured (Stns 35+018 to 35+020)
- Laboratory Measured Conductivity

Groundwater

- Transducer data - K11-12015
- X Manual elevation
- Laboratory measured conductivity
- Field measured conductivity

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K11-12015 (PTH 59N - WEST SIDE)

JUNE 2015	FIGURE HM66-38	REV 6

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K11-12015

SPRING 2009 FLOODWAY OPERATION

SPRING 2010 FLOODWAY OPERATION

SPRING 2011 FLOODWAY OPERATION

SPRING 2013 FLOODWAY OPERATION

SPRING 2014 FLOODWAY FLOW (NON-OPERATION)

SUMMER 2014 FLOODWAY OPERATION

TRANSDUCER FOULED (JUNE 2009 TO FEBRUARY 2011)

Elevation (m)

Conductivity (µS/cm)

Temperature (°C)

Surface Water

- 2011 Floodway Water Level Measured (Stns 25+626 to 25+799)
- Laboratory Measured Conductivity

Groundwater

- Transducer Data - 7A1 Spring
- Laboratory Measured Conductivity
- Field Measured Conductivity

MEMO REFERENCE.. 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

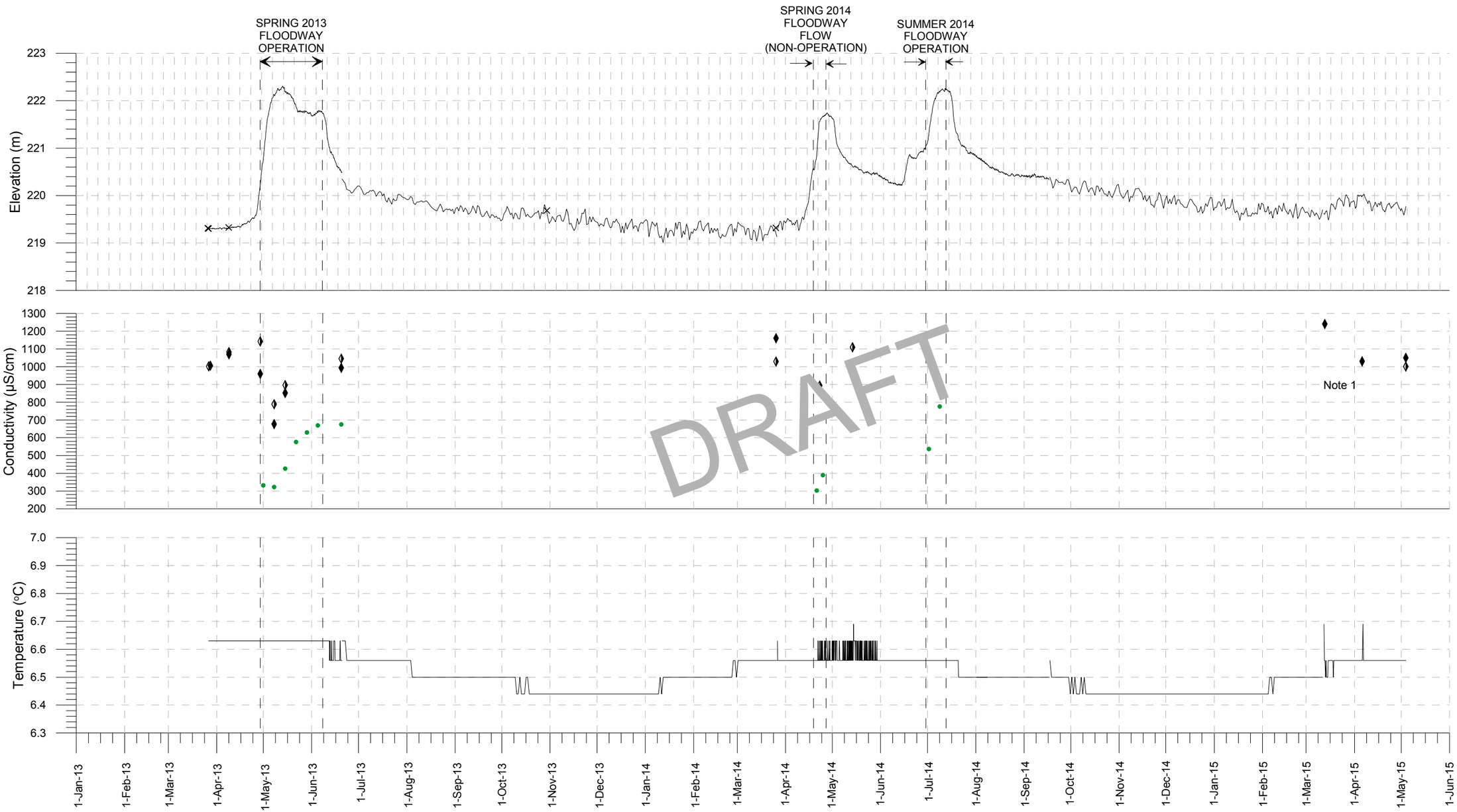
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID 7A1 SPRING (CNR REDDITT/KILDARE AREA)

JUNE 2015	FIGURE HM66-43	REV 5

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.07) ChannBaseflow_GWDischarge\Spring 7A1 Transducer Data



MEMO REFERENCE 05-1100-01-8005101-HM66

Note

1. Field measured conductivity suspect on March 13 and April 6, 2015, therefore not included in plot.

Surface Water

- 2011 Floodway Water Level Measured (Stns 50+426 to 50+427)
- Laboratory Measured Conductivity

Groundwater

- Transducer Data - K13-12321
- × Manual Depth to Water Measurement
- ♦ Laboratory Measured Conductivity
- ◊ Field Measured Conductivity

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K13-12321

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K13-12321 (ROCKHAVEN RD)

JUNE 2015	FIGURE HM66-45	REV 2

APPENDIX D1-C

2016 INSPECTION OF SPRING TREATMENT AREAS

APPENDIX D1-C1

2016 INSPECTION OF SPRING TREATMENT AREAS

APPENDIX D1-C1
2016 INSPECTION OF SPRING TREATMENT AREAS

1.0 INTRODUCTION AND SCOPE OF WORK

Annual summer inspections of the previously treated groundwater spring discharge areas are required in the Long-term monitoring program and were conducted in August 2016 by KGS Group. At total of 23 spring areas were treated as part of the program between March 2009 and February 2011. Treatment of these sites involved the construction of pervious graded sand filters to minimize potential for direct groundwater and surface water flow interconnections to develop. The filters were designed to: restrict the exfiltration rate of groundwater discharge by using the clean lower permeability sand layer while allowing for continued piezometric pressure relief; protect against ongoing piping and development of additional flow pathways under exfiltrating conditions; and satisfy requirements to restrict infiltration of silt and pathogens (e.g. bacteria) if possible.

The purpose of the 2016 inspection program was to:

- Document the condition of treated spring areas;
- Verify that additional discharge areas have not developed at the periphery of the treated area or immediately adjacent;
- Verify that the sampling standpipe is undamaged and accessible; and
- Identify any maintenance/repairs necessary.

A summary of the inspected sites is included in Appendix Table D1-C1. Inspection forms including sketches and select photos for each of the treated spring areas are included in Appendix C1-2.

Detailed maps of spring locations can be found in in the 2016 Annual Inspection and Monitoring Report Deliverable D2. Spring locations are also included in the Floodway Drilling and Instrumentation Published Map File HM80 Rev 1 (November 2013) and the Compilation of Subsurface Investigations CCO-418Y-002g Rev0 included as a PDF copy in Appendix K of HM99.

Electronic files containing additional photographs and video of each site have been included on a CD only in Appendix D1-3 of this report. This report serves as a complete documentation of baseline conditions in the Long-term monitoring period and can be compared to future conditions.

2.0 INSPECTION PROGRAM METHODOLOGY

KGS Group representatives completed the spring inspections on August 8-11, 2016. Two ATVs were used to access the treated spring sites with a handheld GPS used to identify the location of each of the sites. The inspection for each spring included:

- Photographs of the filter, discharge trench, low level and high level sampling pipes, flow paths, and any additional discharge areas;
- Videos of flowing springs;

- Assessment of any damage to the filter, discharge trench, or sampling pipes and the repairs required;
- Identification of any additional discharge areas in the vicinity (~500 m north and south) of the treated spring areas;
- Measurement of water levels within low level sampling pipes where possible;
- Overall assessment of how the filter is working relative to design.

Observations from the inspections were recorded on inspection forms (Appendix D1-C2) and the photograph and video numbers were recorded to identify the treated spring area.

3.0 SUMMARY OF INSPECTION FINDINGS

3.1 CONDITION OF FILTERS

The constructed filters were found to be in good condition and were working as designed. Flow appeared to be coming up through the filter and discharging through the granular layer overlying the sand filter bed. No settlement or heaving of the filters was observed.

3.2 ADDITIONAL DISCHARGE AREAS

A small additional discharge location was observed on the east side of the low flow channel at UTM 648624 5547187. Observed flows were low, in the range of 1 USgpm and no follow-up is required.

No other additional discharge areas were observed in the immediate vicinity of the other treated spring areas.

3.3 CONDITION OF DISCHARGE TRENCHES

The discharge trenches were constructed as shallow excavated trenches that were filled with riprap to grade or slightly above grade. It was observed that at 11 of the treated spring sites, the rip rap within the discharge trenches was infilling with sediment and spring discharge was finding alternate flow paths to the Low Flow Channel. This resulted in overland flow toward the Low Flow Channel or flow into low areas near the filter, creating wet and soft areas. No significant erosion channels were observed at any of these locations.

The discharge trenches at the 5A1 and 7A1 locations were constructed as ditches (see photos in inspection reports) which appeared to be more effective in directing discharge flows along the design discharge flow path.

3.4 CONDITION OF SAMPLING PIPES

The two high level sampling pipes, at 11A2 and 18A1, were both found to be in good condition with no damage observed.

The 10 low level sampling pipes were generally found to be in good condition. At one location, 5A1, a 30 inch steel cover was missing from the protective casing.

4.0 REPAIRS REQUIRED

4.1 FILTERS

No repairs of the filters are required. The filters appear to be operating as designed.

4.2 ADDITIONAL DISCHARGE AREAS

Additional eroded discharge areas were observed in a small area along the discharge trench at 9B2. Construction of a graded sand filter would minimize potential for direct groundwater and surface water flow interconnections to develop at this location.

4.3 DISCHARGE TRENCHES

The discharge trenches that were constructed with riprap to grade or above grade generally appeared to infill with sediment, resulting in spring flows finding alternate flow paths to the Low Flow Channel. Excavating out the existing discharge channel to create a ditch, similar to 5A1 and 7A1, would likely direct flow along the design discharge trench. Alternatively, constructing a new ditch, with riprap armouring, along the existing overland discharge path would also be effective in limiting any erosion concerns with overland flow. The discharge trenches that require some repair include:

- 5A1 – widening of the existing discharge ditch;
- 7C1 – excavating out discharge trench to create ditch, constructing new discharge ditch;
- 8B1 – excavating out discharge trench to create ditch;
- 8B2 – excavating out discharge trench to create ditch;
- 8C1 – excavating out discharge trench to create ditch;
- 9B1 – constructing new discharge ditch;
- 9B2 – excavating out discharge trench to create ditch;
- 10A1 – excavating out discharge trench to create ditch;
- 11A1 – constructing new discharge ditch;
- 18A1 – excavating out discharge trench to create ditch, constructing new discharge ditch;
- 21A1 – excavating out discharge trench to create ditch.

4.4 SAMPLING PIPES

The low level sampling pipes that require some repair include:

- 5A1 – replacing a missing 30 inch steel cover.

TABLE D-1
2016 SUMMER INSPECTION OF SPRING TREATMENT AREAS

Site No.	Channel Side	Approximate Channel Station	Low Level Sampling Pipe Installed	High Level Sampling Pipe Installed	Northing	Easting	Flow Observed Summer 2016	Condition of Filter	Additional Discharge Areas in Vicinity of Filter	Constructed Discharge Trench Operating as Designed	Low Level Sampling Pipe Repairs Required
Spring Area Treatment Sites											
2A1	West	21+000	Yes	No	5523219	647097	Yes	Good	No	Yes	No
5A1	West	26+280	Yes	No	5528520	646961	Yes	Good	No	No	Yes, missing cover
7A1	West	27+060	Yes	No	5529304	646939	Yes	Good	Yes. Very low flow discharge 10 m upstream	Yes	No
7B2	West	27+157	No	No	5529475	646951	Yes	Good	No	Yes	-
7C1	East	27+400	Yes	No	5529640	646969	Yes	Good	No	No	No
8B1	West	29+880	No	No	5531953	646023	Yes	Good	No	No	-
8B2	West	29+970	No	No	5532027	645993	Yes	Good	No	No	-
8C1	West	30+080	Yes	No	5532127	645959	Very Little	Good	No	No	No
9A6	East	30+400	No	No	5532480	645890	Yes	Good	No	Yes	-
9B1	West	30+840	No	No	5532846	645734	Very Little	Good	No	No	-
9B2	East	30+978	No	No	5532997	645715	No	Good	Yes	No	-
10A1	West	31+000	No	No	5533022	645665	Yes	Good	No	No	-
11A1	West	31+290	Yes	No	5533274	645559	Yes	Good	No	No	No
11A2	East	33+900	Yes	Yes	5535772	644767	No	Good	No	N/A (no flow)	No
16A2	West	42+180	No	No	5543145	647070	No	Good	No	No (Ponding)	-
17A2	East	42+769	Yes	No	5543545	647519	Yes	Good	No	Yes	No
18A1	West	42+800	Yes	Yes	5543620	647443	Yes	Good	No	No	No
18A2	West	42+900	No	No	5543718	647478	No	Good	No	No (Ponding)	-
20A2	East	47+030	No	No	5547417	648610	Very Little	Good	No	N/A (no flow)	-
21A1	West	47+796	No	No	5548152	648465	Very Little	Good	No	No	-
21A2	East	47+796	No	No	5548170	648545	Yes	Good	No	N/A (no flow)	-
23A1	West	49+395	No	No	5549740	648290	No	Good	No	N/A (no flow)	-
23A2	East	49+450	Yes	No	5549842	648355	Yes	Good	No	N/A (no flow)	No

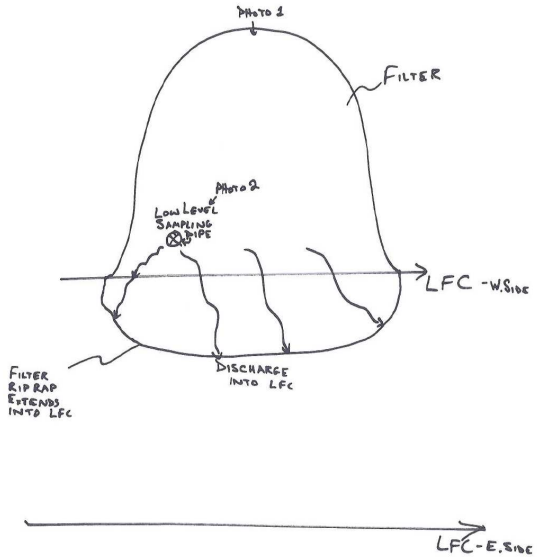
APPENDIX D1-C2

FIELD DOCUMENTATION

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 2A1 **Date:** August 8, 2016
Site Description: West side, north of HWY1 bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 2A1.

Photo 2: Discharge into LFC at 2A1.

Filter Condition: Good
Repairs Required: None

Approximate Flow: 8 USgpm

Additional Discharge Areas: No

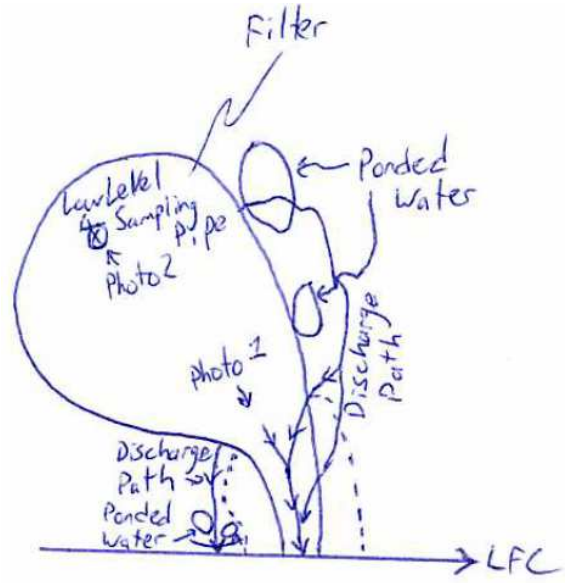
Sampling Standpipe: Yes, low level
Depth to bottom: Could not measure
Depth to water: At surface
Condition: Water above PVC, so left sealed to avoid cross contamination.
Repairs Required: None.

Other Comments: Filter appears to be working effectively.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 5A1 **Date:** August 8, 2016
Site Description: West side, north of Redditt bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 5A1 and constructed discharge trench.

Photo 2: Low level sampling pipe and protective steel casing at 5A1. Cover is missing.

Filter Condition: Good – water flowing along discharge channel as well as finding alternate flow paths to LFC. No significant erosion observed within overland discharge areas. Vegetation is quite grown over.
Repairs Required: Widening the discharge channel may focus flow along design discharge path and accommodate flows.

Approximate Flow: 10 USgpm

Additional Discharge Areas: No

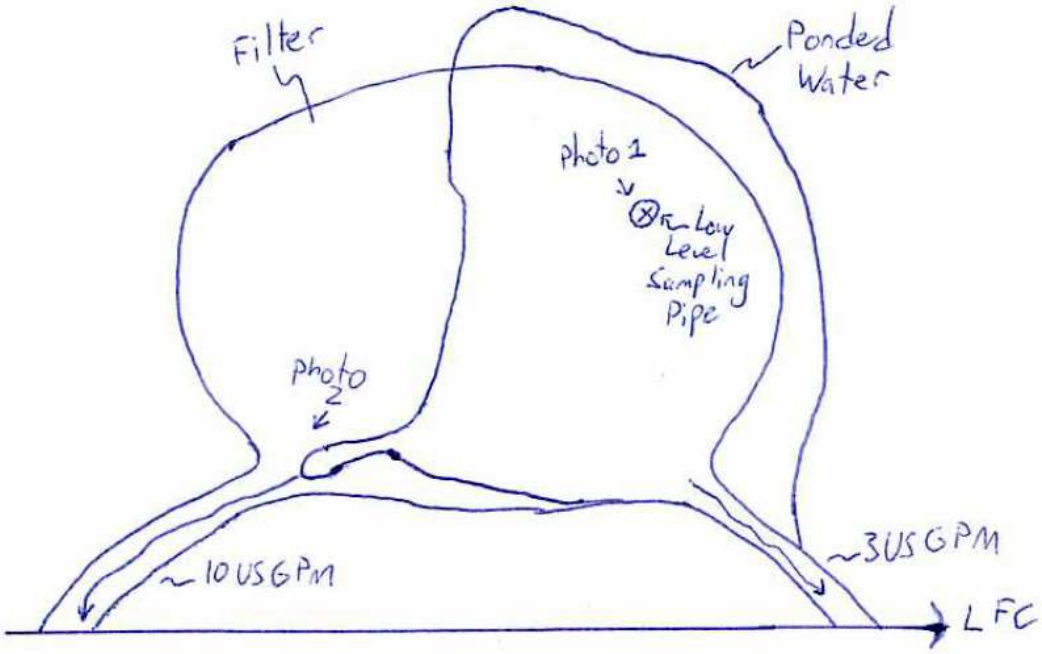
Sampling Standpipe: Yes, low level
Depth to bottom: Could not measure, 50 mm poly pipe, coiled in CMP protective casing
Depth to water: Water has filled protective steel casing
Condition: Missing a 30 inch cover
Repairs Required: Replace the 30 inch cover

Other Comments: Filter appears to be working effectively other than alternate flow paths.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 7A1 **Date:** August 8, 2016
Site Description: West side, south of 7B2.

Site Sketch and Photo Locations:



Photos:

Photo 1: Low level sampling pipe and water within protective casing.

Photo 2: Discharge ditches at 7A1 effectively direct water to LFC.

Filter Condition: Good
Repairs Required: None

Approximate Flow: 13 USgpm

Additional Discharge Areas: No

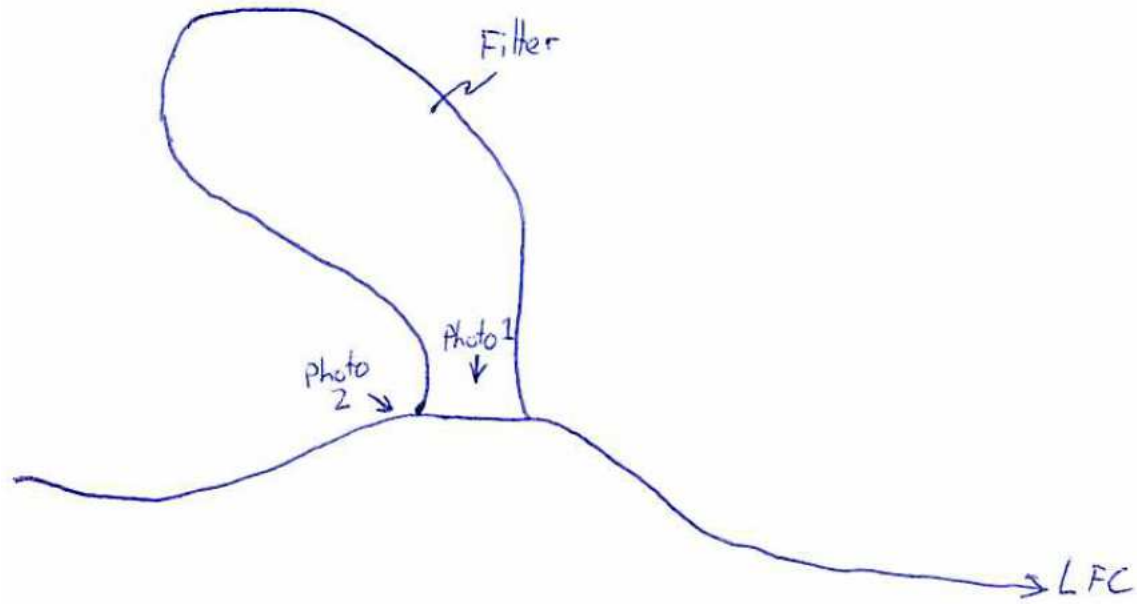
Sampling Standpipe: Yes, low level
Depth to bottom: Could not measure, 50 mm poly pipe, coiled in CMP protective casing.
Depth to water: Water has filled protective steel casing.
Condition: Good
Repairs Required: None

Other Comments: Large flow through filter, appears to be working effectively. Constructed discharge channels are formed as ditches and effectively direct discharge water to the LFC.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 7B2 **Date:** August 8, 2016
Site Description: West side, north of 7A1.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 7B2.

Photo 2: Filter discharge at 7B2 into LFC.

Filter Condition: Good
Repairs Required: None

Approximate Flow: 2 USgpm

Additional Discharge Areas: Very low flow discharge approximately 10 m upstream at LFC.

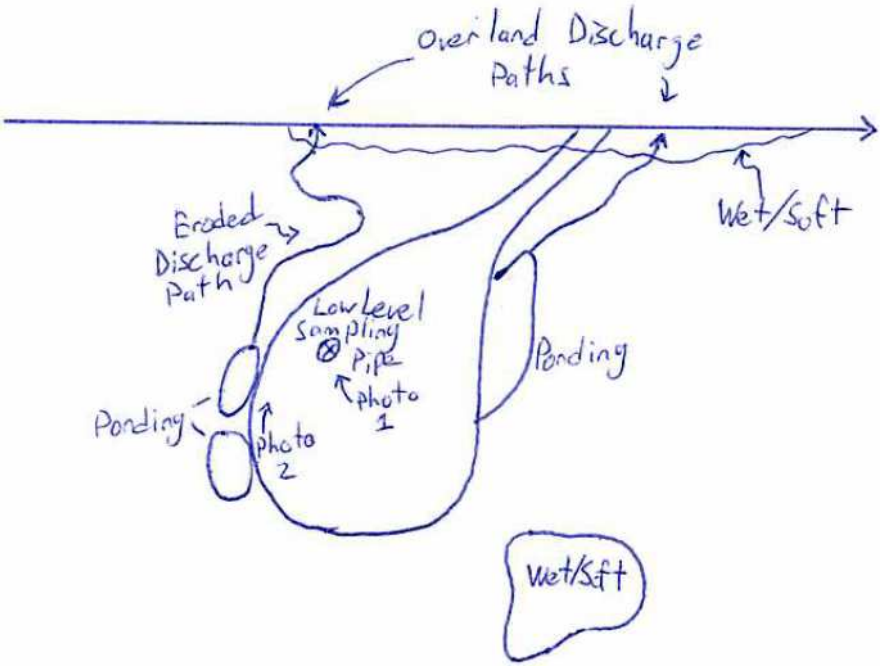
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 7C1 **Date:** August 11, 2016
Site Description: East side, between Redditt and Keewatin bridges.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 7C1.

Photo 2: Water flowing through 7C1 filter and finding alternate flow paths to LFC or ponding in low areas.

Filter Condition: Good – water finding alternate flow paths to LFC or ponding in low areas. Constructed discharge channel appears to be clogged with sediment. Eroded path on South side of filter.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 4 USgpm

Additional Discharge Areas: No

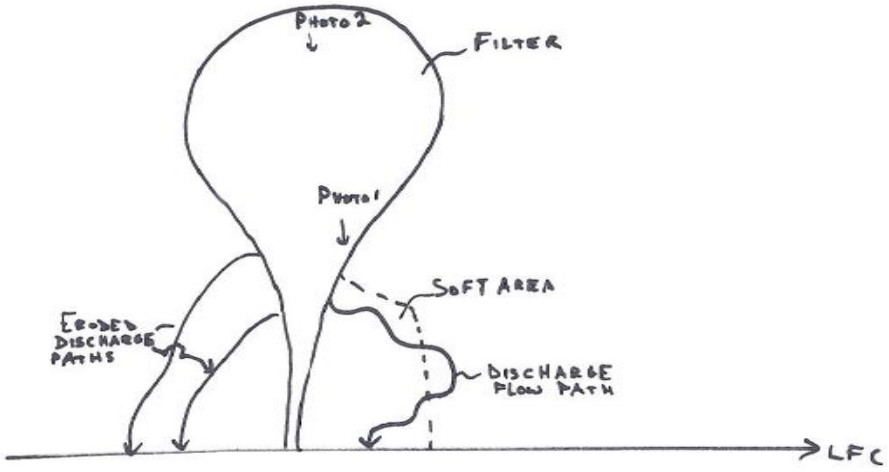
Sampling Standpipe: Yes, low level
Depth to bottom: Did not measure in order to avoid cross contamination. 2.41 m previously.
Depth to water: 0 m (at top of pipe). Artesian when opened.
Condition: Good
Repairs Required: None

Other Comments: Filter appears to be working effectively other than the discharge channel. Very soft along LFC.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 8B1 **Date:** August 8, 2016
Site Description: West side, south of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Water finding alternate flow path to LFC.

Photo 2: Spring treatment filter 8B1.

Filter Condition: Good – water finding alternate flow path to LFC. Constructed discharge channel appears to be clogged with sediment. Some erosion observed on south side in 2 paths but not currently flowing
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 6 USgpm

Additional Discharge Areas: No

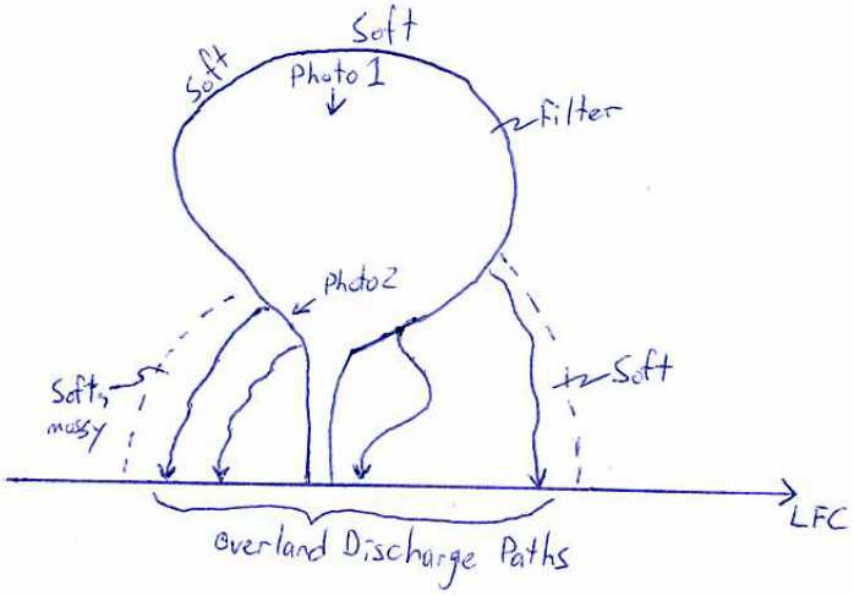
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 8B2 **Date:** August 8, 2016
Site Description: West side, south of Keewatin bridge, north of 8B1.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 8B2.

Photo 2: Water finding alternate flow path to LFC at 8B2.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge area.
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 5 USgpm

Additional Discharge Areas: No

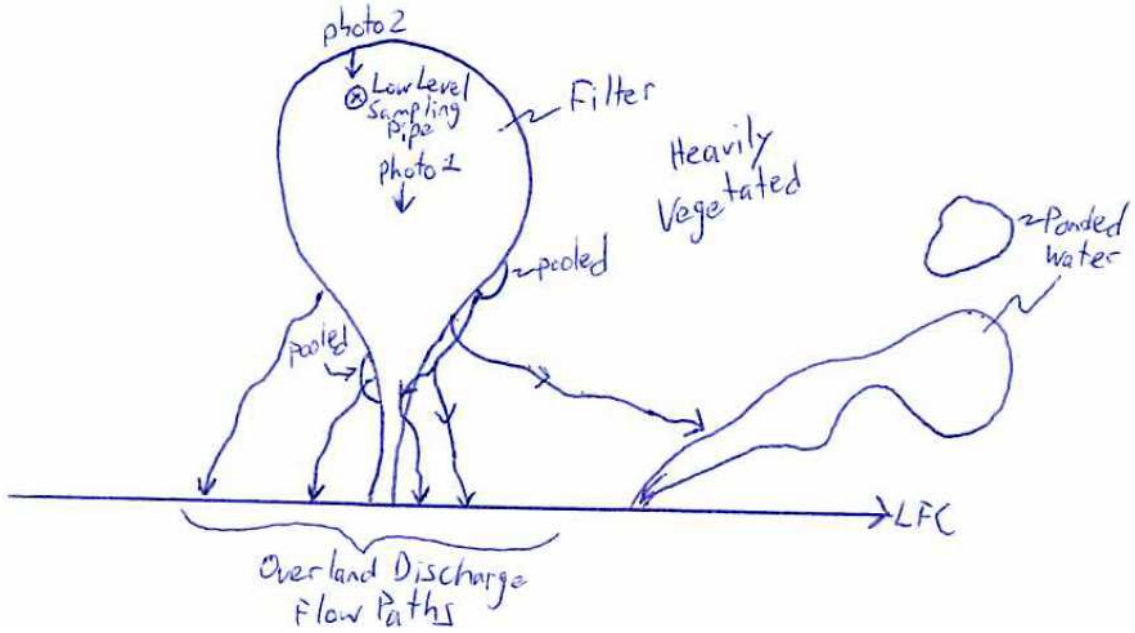
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 8C1 **Date:** August 8, 2016
Site Description: West side, south of Keewatin bridge, north of 8B2.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 8C1 and constructed discharge trench.

Photo 2: Low level sampling pipe and protective steel casing at 8C1.

Filter Condition: Good – water finding alternate flow paths to LFC. Flow paths wet and soft, but not currently flowing. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge areas.
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: >0.1USgpm

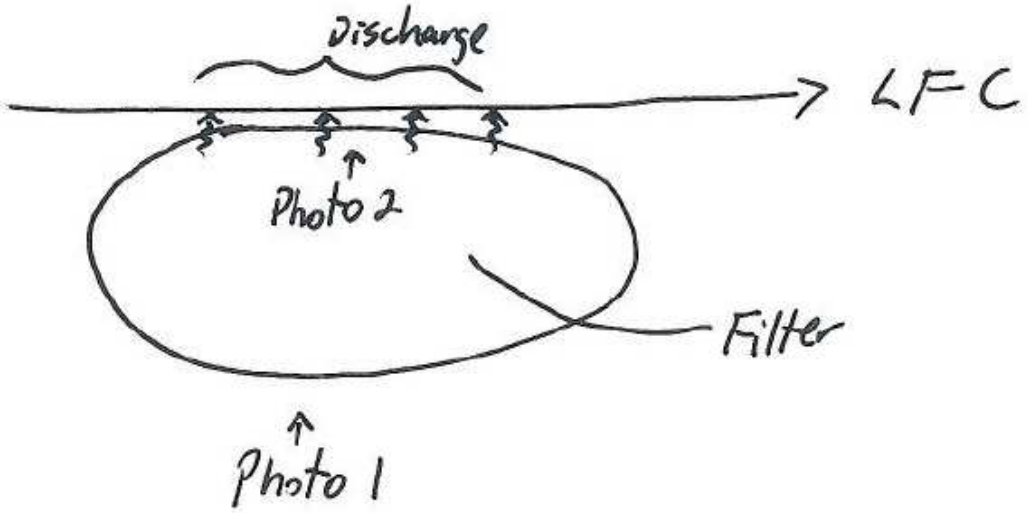
Additional Discharge Areas: No.
Sampling Standpipe: Yes, low level
Depth to bottom: 2.93 m
Depth to water: 0.15 m from steel casing.
Condition: Good
Repairs Required: None

Other Comments: Filter appears to be working effectively other than alternate flow path. Ponded area to the North of filter is discharging to LFC and appears to sourced from the filter.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 9A6 **Date:** August 23, 2016
Site Description: East side, north of CPR Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 9A6.

Photo 2: Spring 9A6 discharge into Low Flow Channel.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 4 USgpm

Additional Discharge Areas: No

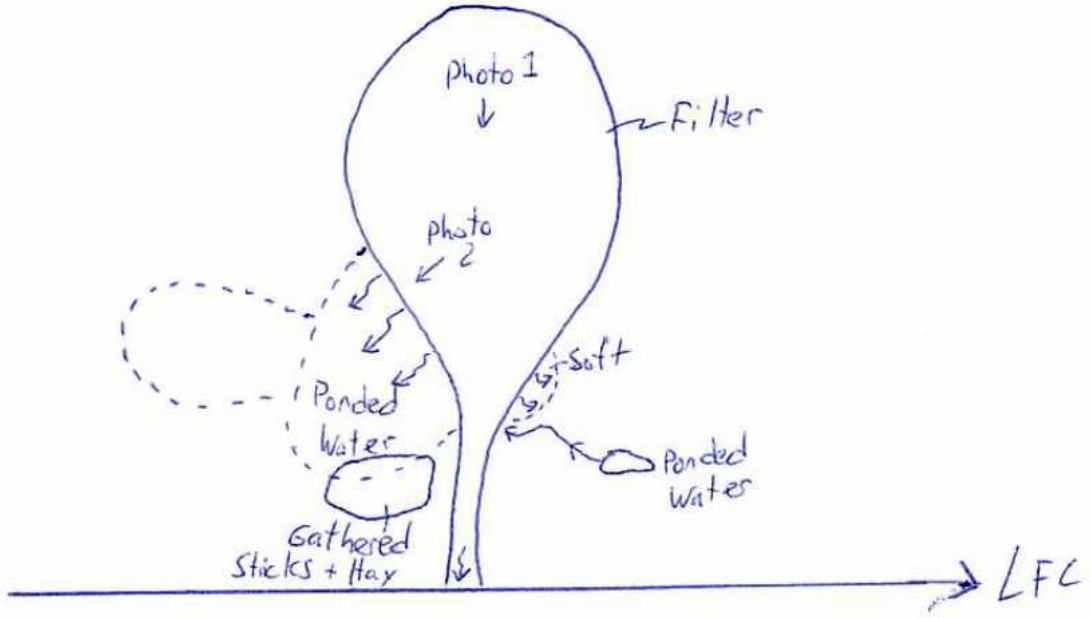
Sampling Standpipe: No

Other Comments: Flow coming through filter, appears to be working effectively.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 9B1 **Date:** August 8, 2016
Site Description: West side, north of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 9B1.

Photo 2: Water ponding to the south of 9B1 filter and finding alternate flow paths to LFC. Difficult to determine if additional springs in this area.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channel appear to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path. Alternatively, construct a new swale along existing overland discharge path.

Approximate Flow: <0.1 USgpm

Additional Discharge Areas: No, however, very difficult to tell if wet area to the south of the filter is a spring or is ponded water from discharge from the filter. Wet areas continue south, almost to Keewatin bridge.

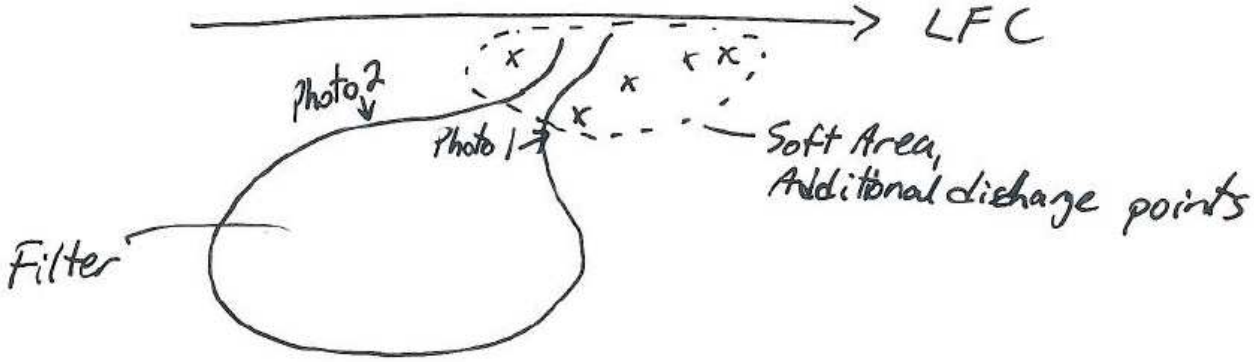
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 9B2 **Date:** August 11, 2016
Site Description: East side, north of CPR Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Additional discharge points along constructed discharge trench, very soft area.

Photo 2: Spring treatment filter 9B2.

Filter Condition: Good – water finding alternate flow paths to LFC. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 0 USgpm

Additional Discharge Areas: Yes, piping observed along constructed discharge trench, very low flows. Further investigation treatment of additional discharge areas may be required.

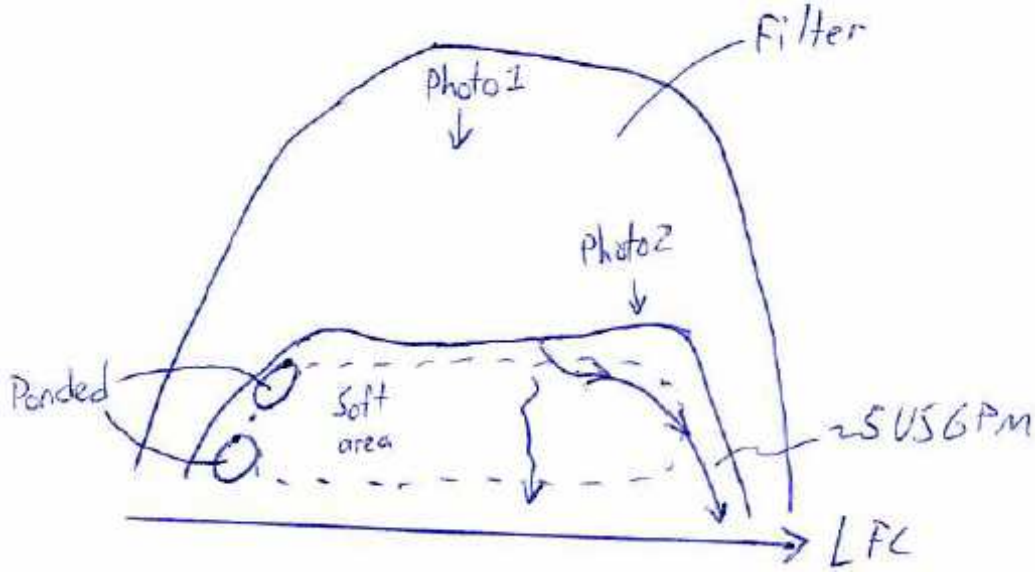
Sampling Standpipe: No

Other Comments: Wet and soft along discharge trench and near LFC.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 10A1 **Date:** August 8, 2016
Site Description: West side, north of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 10A1.

Photo 2: Water flowing through 10A1 filter and finding alternate flow paths to LFC.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channels appear to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channels and creating swales may focus flow along design discharge paths.

Approximate Flow: 5 USgpm at North discharge

Additional Discharge Areas: No

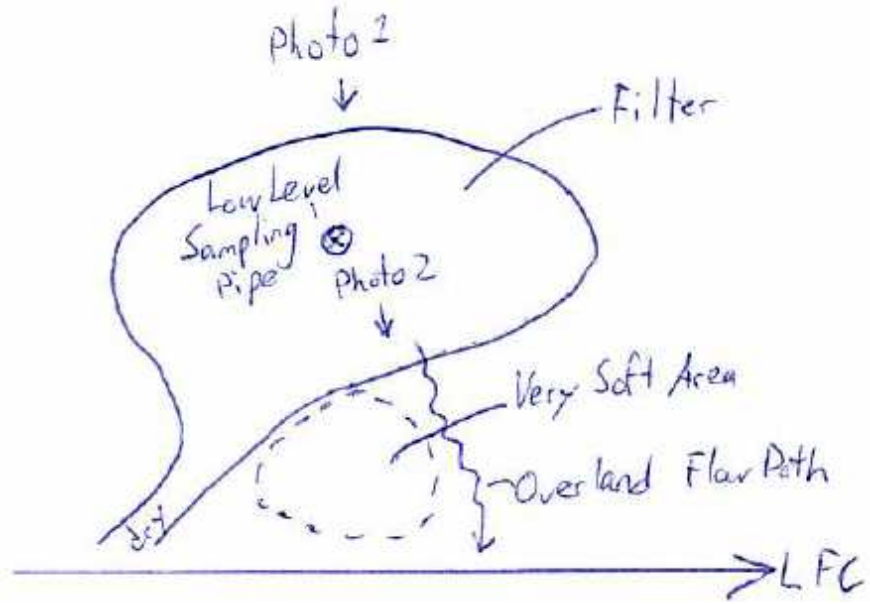
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channels.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 11A1 **Date:** August 8, 2016
Site Description: West side, north of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 11A1 and low level sampling pipe, covered by vegetation.

Photo 2: Water flowing through 11A1 filter and finding alternate flow path to LFC.

Filter Condition: Good – water finding alternate flow path to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path. Alternatively, construct a new swale along existing flow path.

Approximate Flow: 6 USgpm
Additional Discharge Areas: No

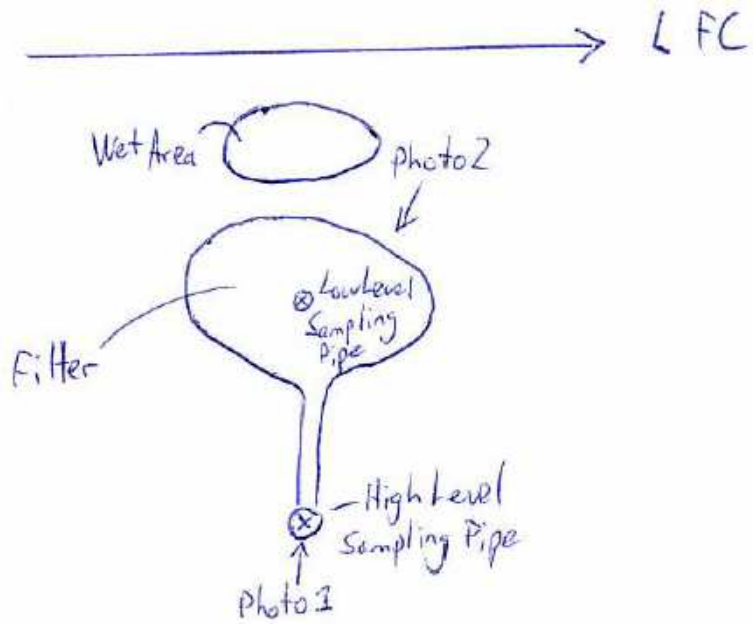
Sampling Standpipe: Yes, low level
Depth to bottom: 3.09 m
Depth to water: 0.270 m below PVC TOC
Condition: Good.
Repairs: None.

Other Comments: Filter appears to be working effectively other than alternate flow path. Water flowing over very soft soil between filter and LFC.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 11A2 **Date:** August 11, 2016
Site Description: East side of Floodway, south of PTH59N bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: High level sampling pipe and protective CMP casing.

Photo 2: Water flowing through 11A2 filter and finding alternate flow paths to LFC.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 0 USgpm

Additional Discharge Areas: No

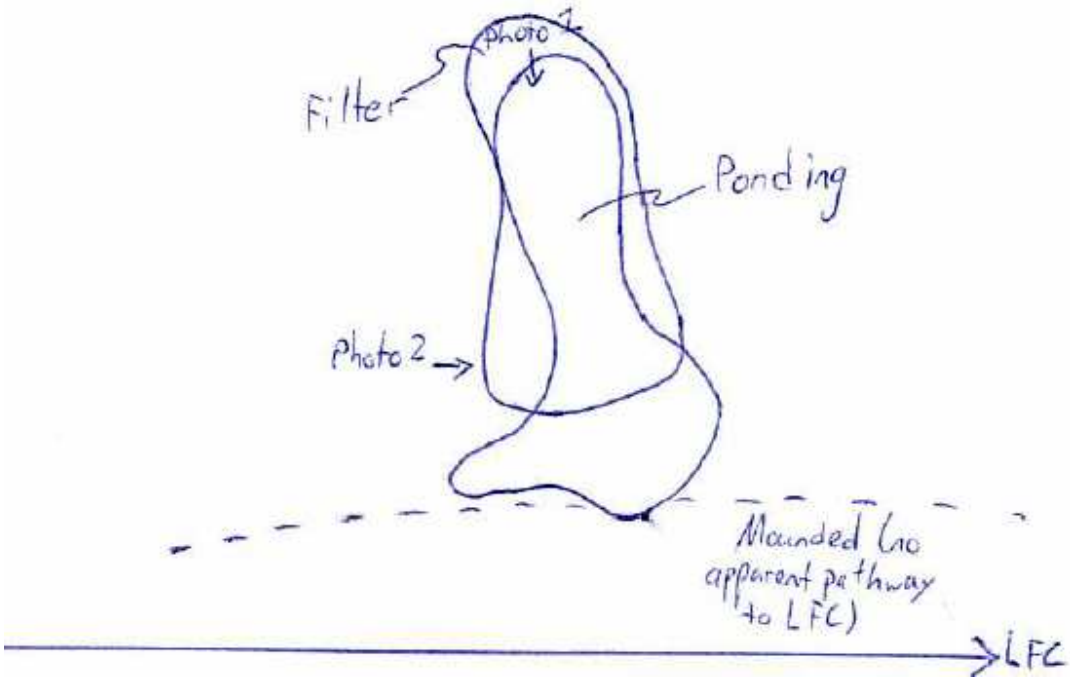
Sampling Standpipe: Yes, low level and high level
Depth to bottom: 1.93 m (low level), soft at bottom.
Depth to water: 1.11m (low level)
Condition: Good
Repairs Required: None

Other Comments: There is no discharge trench constructed to Low Flow Channel. Dry around filter. Could add mono foam around PVC at opening in steel protector at high level standpipe but is a low priority.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 16A2 **Date:** August 9, 2016
Site Description: West side, north of Dunning Road.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 16A2.

Photo 2: Spring treatment filter 16A2.

Filter Condition: Good. No apparent discharge path to drain into LFC.

Repairs Required: None.

Approximate Flow: No Flow

Additional Discharge Areas: No

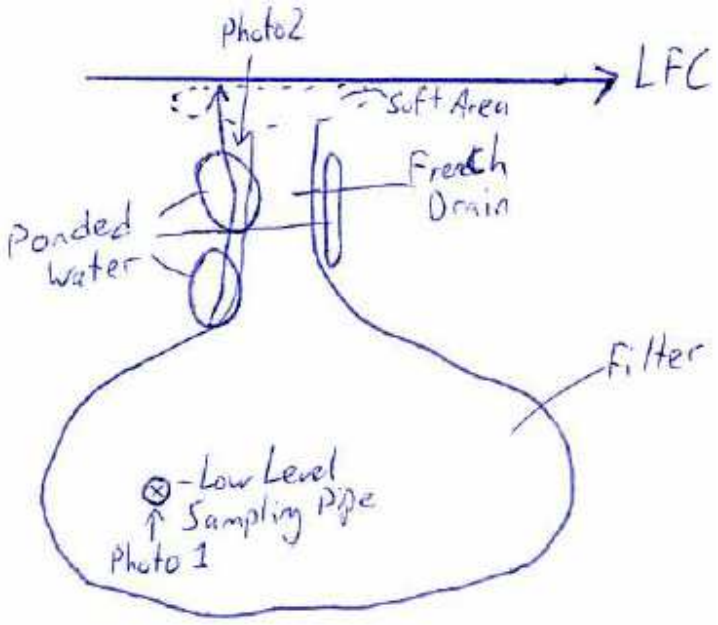
Sampling Standpipe: No

Other Comments: No flow observed. Ponding around and on filter. Heavy vegetation.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 17A2 **Date:** August 10, 2016
Site Description: East side, north of Dunning Road

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 17A2 and low level sampling pipe.

Photo 2: Water ponding beside the French drain at 17A2.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 2 USgpm

Additional Discharge Areas: Possible small discharge area along French Drain, may just be ponding water

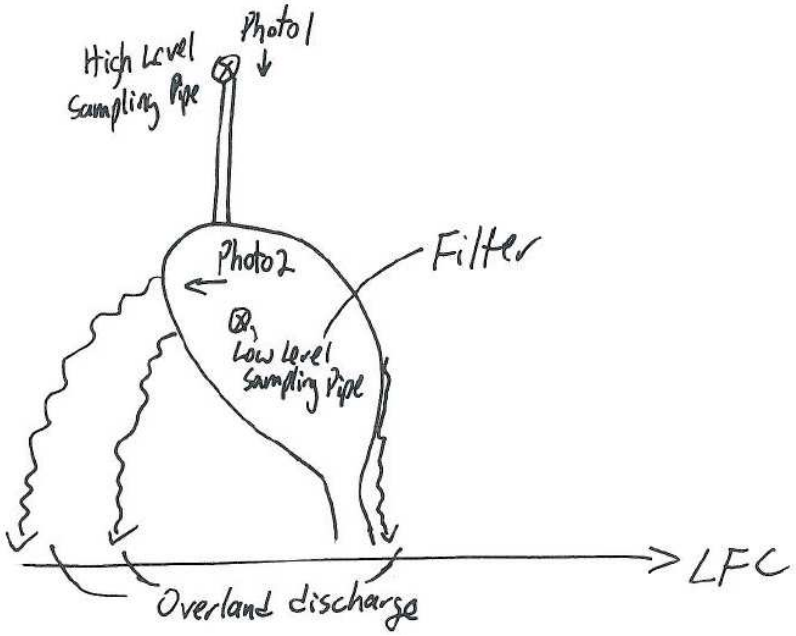
Sampling Standpipe: Yes, low level
Depth to bottom: 1.510 m
Depth to water: 0.435 m
Condition: Good
Repairs Required: None

Other Comments: Area around filter is dry, filter appears to be working well.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 18A1 **Date:** August 9, 2016
Site Description: West side, north of LFC bike/pedestrian bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: High level sampling pipe and protective CMP casing.

Photo 2: Water flowing through filter and finding alternate flow paths to LFC at 18A1.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge areas.
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: Path to South of discharge path ~ 15 USgpm. Path adjacent to discharge path ~ 3 USgpm.

Additional Discharge Areas: No

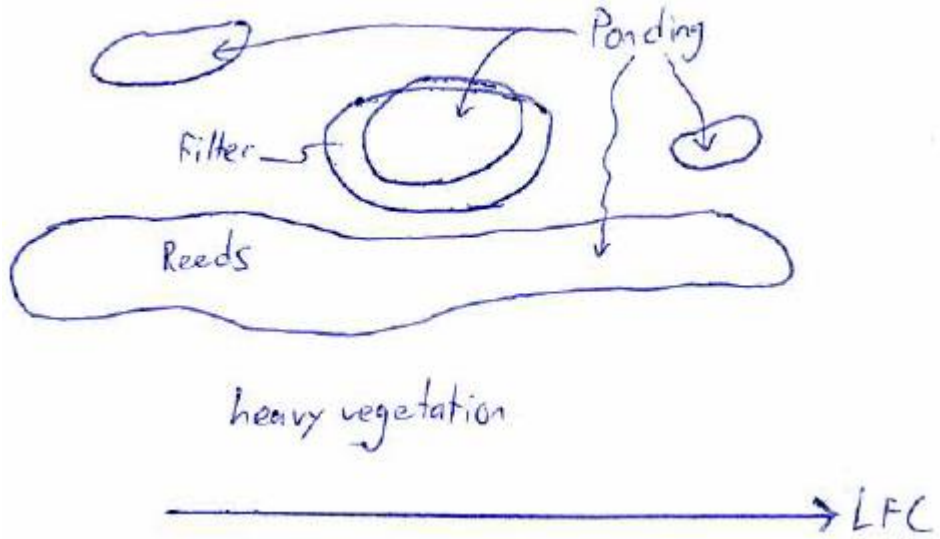
Sampling Standpipe: Yes, low level and high level
Depth to bottom: 1.94 m (low level). Very soft at bottom
Depth to water: 0.195 m (low level)
Condition: PVC has lifted up and is in contact with steel protective casing.
Repairs: None

Other Comments: Filter appears to be working effectively other than the discharge channel.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 18A2 **Date:** August 9, 2016
Site Description: West side, approximately 100 m north of 18A1.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 18A2.

Photo 2: Standing water near spring treatment filter site 18A2.

Filter Condition: Good
Repairs Required: None

Approximate Flow: No flow

Additional Discharge Areas: No

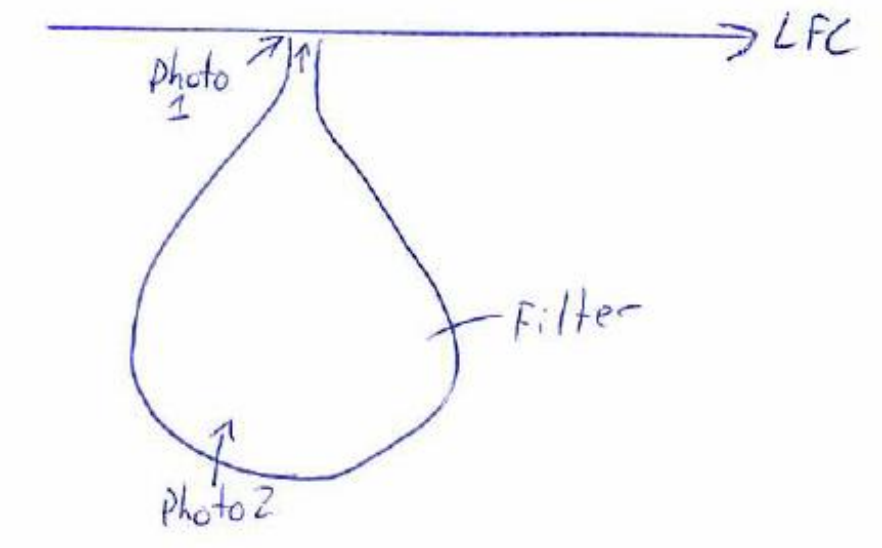
Sampling Standpipe: No

Other Comments: Soft area around filter, possibly surface water ponding.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 20A2 **Date:** August 10, 2016
Site Description: East side, south of 21A2

Site Sketch and Photo Locations:



Photos:

Photo 1: Tie-in of filter drain to Low Flow Channel.

Photo 2: Spring treatment filter 20A2.

Filter Condition: Good
Repairs Required: None

Approximate Flow: <0.1 USgpm

Additional Discharge Areas: No

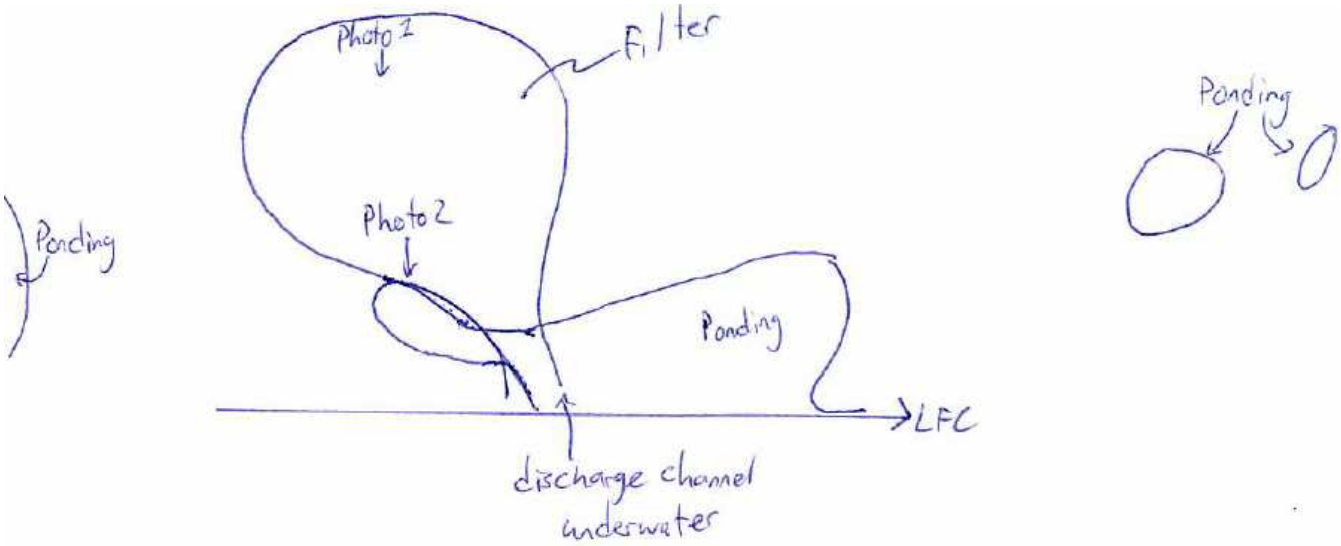
Sampling Standpipe: No

Other Comments: No flow observed, no wet or soft areas.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 21A1 **Date:** August 9, 2016
Site Description: West side, south of CEMR bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 21A1.

Photo 2: Water flowing through 21A1 filter and finding alternate flow path to LFC.

Filter Condition: Good – water finding alternate flow path to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: <0.1 USgpm

Additional Discharge Areas: No

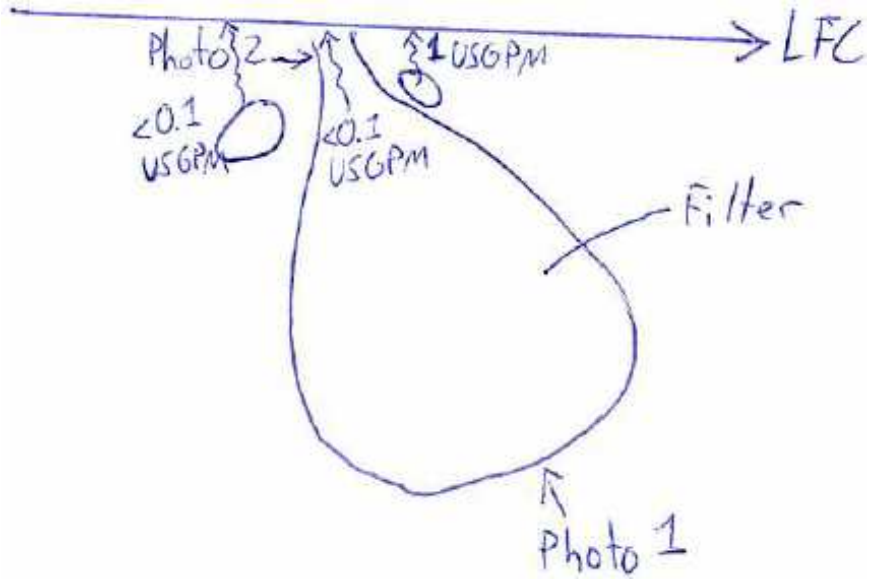
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel. LFC at filter elevation / above discharge channel.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 21A2 **Date:** August 10, 2016
Site Description: East side, north of 20A2

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 21A2.

Photo 2: Tie-in of 21A2 filter drain to Low Flow Channel.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 1 USGpm

Additional Discharge Areas: No

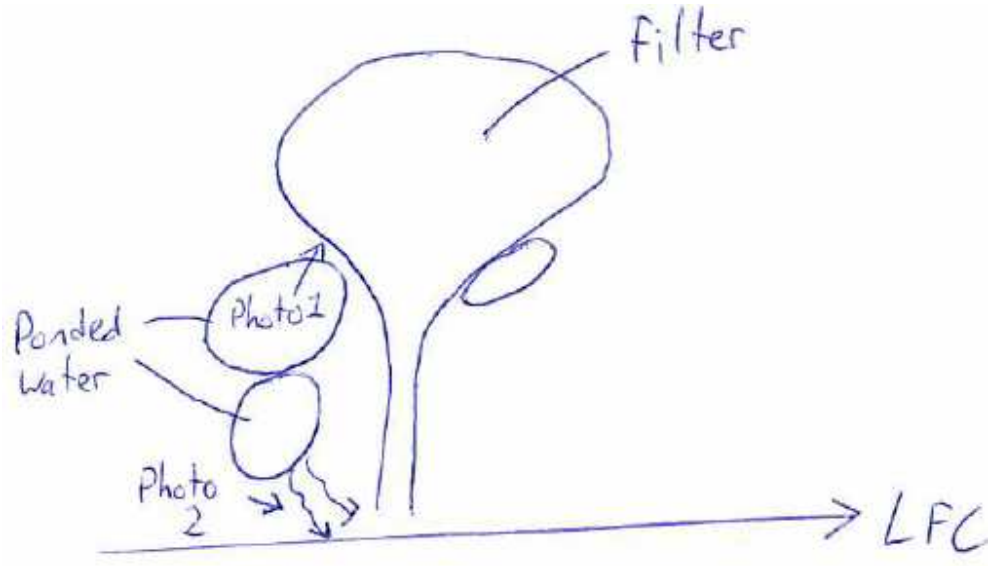
Sampling Standpipe: No

Other Comments: No flow observed, no wet or soft areas around filter.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 23A1 **Date:** August 9, 2016
Site Description: West side, south of PTH 44 bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 23A1.

Photo 2: Tie in of discharge channel to LFC at 23A1.

Filter Condition: Good

Repairs Required: None

Approximate Flow: No Flow

Additional Discharge Areas: No

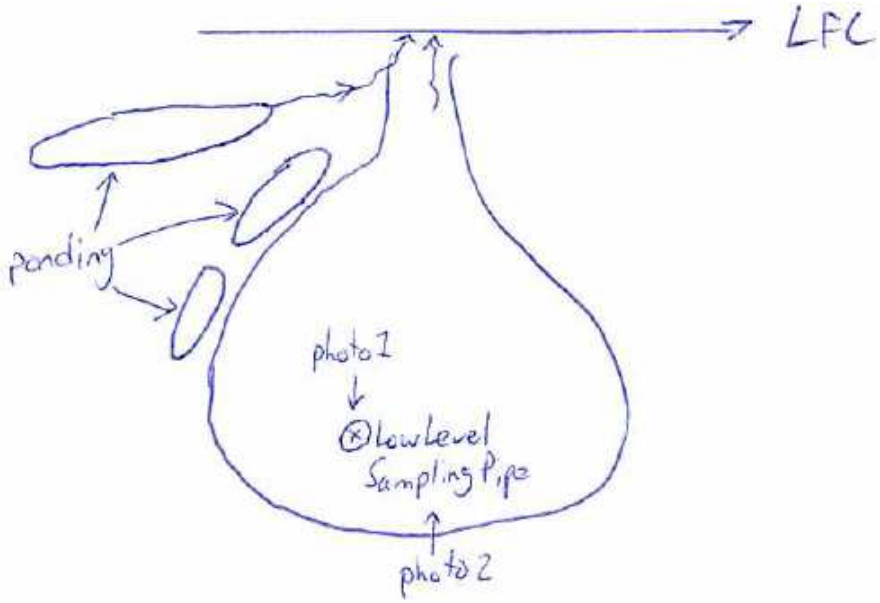
Sampling Standpipe: No

Other Comments: Rip rap is filling with sediment, hard to see filter and discharge channel. Heavy vegetation.

2016 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 23A2 **Date:** August 1, 2016
Site Description: East side, just south of PTH 44 bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Low level sampling pipe steel protective casing.

Photo 2: Spring treatment filter site 23A2.

Filter Condition: Good

Repairs Required: None

Approximate Flow: ~3 USgpm

Additional Discharge Areas: No

Sampling Standpipe: Yes, low level
Depth to bottom: 1.56 m
Depth to water: Above PVC casing/cap. 0.17 m below steel casing, 0.03 m above PVC cap.
Condition: Good.
Repairs: None.

Other Comments: No wet or soft areas around filter.

APPENDIX D1-C3

ADDITIONAL PHOTOGRAPHS AND VIDEO (INCLUDED ON DVD)

APPENDIX D1-D

LABORATORY REPORTS

MB Infra & Transport - Highway Engineering - 6th Floor
ATTN: MARCI FRIEDMAN-HAMM
865 WAVERLEY ST
3RD FL
Winnipeg MB K3T 5P4

Date Received: 29-MAR-16
Report Date: 11-APR-16 07:04 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1749125

Project P.O. #: MIT Floodway
Job Reference: 16-0300-002.1000.01
C of C Numbers:
Legal Site Desc: Floodway

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749125-1 K13-12321							
Sampled By: CLIENT on 28-MAR-16 @ 12:30							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	11		1	MPN/100mL		29-MAR-16	R3427484
Escherichia Coli	<1		1	MPN/100mL		29-MAR-16	R3427484
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	498		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	408		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	44.6		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	974		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	74.2		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	75.9		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	4.88		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	27.3		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	497		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	100			%		09-APR-16	
Cation - Anion Balance	0.1			%		09-APR-16	
Anion Sum	11.2			me/L		09-APR-16	
Cation Sum	11.3			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	2.33		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	2.33		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	79.2		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	561		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	3.11		0.10	NTU		29-MAR-16	R3428002
pH							
pH	7.39		0.10	pH units		30-MAR-16	R3427848
L1749125-2 K09-12316							
Sampled By: CLIENT on 28-MAR-16 @ 13:30							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	22		1	MPN/100mL		29-MAR-16	R3427484
Escherichia Coli	<1		1	MPN/100mL		29-MAR-16	R3427484
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	381		1.2	mg/L		31-MAR-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749125-2 K09-12316							
Sampled By: CLIENT on 28-MAR-16 @ 13:30							
Matrix: GW							
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	312		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	30.6		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	775		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	62.8		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	52.3		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	4.33		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	24.5		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	372		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	98.0			%		09-APR-16	
Cation - Anion Balance	-1.0			%		09-APR-16	
Anion Sum	8.79			me/L		09-APR-16	
Cation Sum	8.61			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	1.56		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	1.56		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	75.6		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	444		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	0.27		0.10	NTU		29-MAR-16	R3428002
pH							
pH	7.51		0.10	pH units		30-MAR-16	R3427848
L1749125-3 K09-13571							
Sampled By: CLIENT on 28-MAR-16 @ 14:30							
Matrix: GW							
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	423		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	347		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	58.2		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	940		1.0	umhos/cm		30-MAR-16	R3427848

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749125-3 K09-13571							
Sampled By: CLIENT on 28-MAR-16 @ 14:30							
Matrix: GW							
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	69.3		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	61.7		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	4.89		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	38.1		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	427		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	96.6			%		09-APR-16	
Cation - Anion Balance	-1.7			%		09-APR-16	
Anion Sum	10.7			me/L		09-APR-16	
Cation Sum	10.3			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	1.64		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	1.64		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	95.4		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	543		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	0.14		0.10	NTU		29-MAR-16	R3428002
pH							
pH	7.43		0.10	pH units		30-MAR-16	R3427848
L1749125-4 PTH 44							
Sampled By: CLIENT on 28-MAR-16 @ 15:00							
Matrix: GW							
Miscellaneous Parameters							
Ammonia, Total (as N)	0.054		0.010	mg/L		31-MAR-16	R3428671
Phosphorus (P)-Total	0.356		0.010	mg/L		04-APR-16	R3429984
Total Kjeldahl Nitrogen	0.79		0.20	mg/L	05-APR-16	05-APR-16	R3430338
Total Suspended Solids	24.0		5.0	mg/L		30-MAR-16	R3428224
ROU1W Total Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	213		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	175		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	13.5		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	407		1.0	umhos/cm		30-MAR-16	R3427848
Hardness Calculated							
Hardness (as CaCO3)	198		0.30	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	102			%		09-APR-16	
Cation - Anion Balance	0.8			%		09-APR-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749125-4 PTH 44							
Sampled By: CLIENT on 28-MAR-16 @ 15:00							
Matrix: GW							
Ion Balance Calculation							
Anion Sum	4.51			me/L		09-APR-16	
Cation Sum	4.58			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	1.25		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	1.28		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	0.0263		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	26.2		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	233		5.0	mg/L		09-APR-16	
Total Metals by ICP-MS							
Calcium (Ca)-Total	45.3		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Total	20.7		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Total	7.82		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Total	9.41		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Turbidity							
Turbidity	42.5		0.10	NTU		29-MAR-16	R3428002
pH							
pH	7.96		0.10	pH units		30-MAR-16	R3427848
L1749125-5 K11-12018							
Sampled By: CLIENT on 28-MAR-16 @ 16:00							
Matrix: GW							
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	723		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	593		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	2.29		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	1130		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	92.4		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	98.5		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	5.19		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	27.8		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	636		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	100			%		09-APR-16	
Cation - Anion Balance	0.1			%		09-APR-16	
Anion Sum	14.0			me/L		09-APR-16	
Cation Sum	14.1			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		30-MAR-16	R3427981

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749125-5 K11-12018							
Sampled By: CLIENT on 28-MAR-16 @ 16:00							
Matrix: GW							
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	102		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	683		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	8.20		0.10	NTU		29-MAR-16	R3428002
pH							
pH	7.23		0.10	pH units		30-MAR-16	R3427848

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L			
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.			
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.			
CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-HARDNESS-DIS-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-HARDNESS-TOT-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
MET-D-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A-D
This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
MET-T-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-T
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	Quickchem method 10-107-06-2-E Lachat
Samples are digested with a sulphuric acid solution, cooled, diluted with water, and analyzed for ammonia. Total Kjeldahl nitrogen is the sum of free-ammonia and organic nitrogen compounds which are converted to ammonium sulphate through this digestion process. Analysis is performed by Flow Injection Analysis (FIA). The pH of the digested sample is raised to a known, basic pH by neutralization with a concentrated buffer solution. This neutralization converts the ammonium cation to ammonia. The ammonia produced is heated with saliclyate and hypochlorite to produce blue colour which is proportional to the ammonia concentration.			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
P-T-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
SOLIDS-TOTSUS-WP	Water	Total Suspended Solids	APHA 2540 D (modified)
Total suspended solids in aquesous matrices is determined gravimetrically after drying the residue at 103 105°C.			
TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97
This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

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: L1749125 Report Date: 11-APR-16

Client: MB Infra & Transport - Highway Engineering - 6th Floor
865 WAVERLEY ST 3RD FL
Winnipeg MB K3T 5P4

Contact: MARCI FRIEDMAN-HAMM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3427848								
WG2283544-4 LCS								
Alkalinity, Total (as CaCO3)			100.1		%		85-115	30-MAR-16
WG2283544-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	30-MAR-16
CL-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-11 DUP		**L1749125-2**						
Chloride (Cl)		30.6	30.7		mg/L	0.1	20	30-MAR-16
WG2283344-7 DUP		**L1749125-1**						
Chloride (Cl)		44.6	44.5		mg/L	0.2	20	30-MAR-16
WG2283344-10 LCS								
Chloride (Cl)			100.9		%		90-110	30-MAR-16
WG2283344-6 LCS								
Chloride (Cl)			100.7		%		90-110	30-MAR-16
WG2283344-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	30-MAR-16
WG2283344-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	30-MAR-16
WG2283344-12 MS		**L1749125-2**						
Chloride (Cl)			96.7		%		75-125	30-MAR-16
WG2283344-8 MS		**L1749125-1**						
Chloride (Cl)			95.4		%		75-125	30-MAR-16
EC-WP	**Water**							
Batch R3427848								
WG2283544-3 LCS								
Conductivity			98.8		%		90-110	30-MAR-16
WG2283544-1 MB								
Conductivity			<1.0		umhos/cm		1	30-MAR-16
MET-D-MS-WP	**Water**							
Batch R3434792								
WG2283295-2 LCS								
Calcium (Ca)-Dissolved			98.4		%		80-120	08-APR-16
Magnesium (Mg)-Dissolved			95.2		%		80-120	08-APR-16
Potassium (K)-Dissolved			104.9		%		80-120	08-APR-16
Sodium (Na)-Dissolved			96.7		%		80-120	08-APR-16
WG2283295-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	08-APR-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-MS-WP	**Water**							
Batch R3434792								
WG2283295-1 MB								
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	08-APR-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	08-APR-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	08-APR-16
MET-T-MS-WP	**Water**							
Batch R3434792								
WG2283250-2 LCS								
Calcium (Ca)-Total			97.9		%		80-120	08-APR-16
Magnesium (Mg)-Total			96.2		%		80-120	08-APR-16
Potassium (K)-Total			101.2		%		80-120	08-APR-16
Sodium (Na)-Total			95.6		%		80-120	08-APR-16
WG2283250-1 MB								
Calcium (Ca)-Total			<0.20		mg/L		0.2	08-APR-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	08-APR-16
Potassium (K)-Total			<0.10		mg/L		0.1	08-APR-16
Sodium (Na)-Total			<0.050		mg/L		0.05	08-APR-16
N-TOTKJ-WP	**Water**							
Batch R3430338								
WG2285966-6 LCS								
Total Kjeldahl Nitrogen			100.0		%		75-125	05-APR-16
WG2285966-5 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	05-APR-16
NH3-COL-WP	**Water**							
Batch R3428671								
WG2284368-6 LCS								
Ammonia, Total (as N)			97.7		%		85-115	31-MAR-16
WG2284368-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	31-MAR-16
NO2-L-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-11 DUP		**L1749125-2**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	30-MAR-16
WG2283344-7 DUP		**L1749125-1**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	30-MAR-16
WG2283344-10 LCS								
Nitrite (as N)			101.2		%		90-110	30-MAR-16
WG2283344-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-6 LCS								
Nitrite (as N)			102.2		%		90-110	30-MAR-16
WG2283344-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	30-MAR-16
WG2283344-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	30-MAR-16
WG2283344-12 MS		**L1749125-2**						
Nitrite (as N)			99.1		%		75-125	30-MAR-16
WG2283344-8 MS		**L1749125-1**						
Nitrite (as N)			98.9		%		75-125	30-MAR-16
NO3-L-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-11 DUP		**L1749125-2**						
Nitrate (as N)		1.56	1.56		mg/L	0.3	20	30-MAR-16
WG2283344-7 DUP		**L1749125-1**						
Nitrate (as N)		2.33	2.33		mg/L	0.0	20	30-MAR-16
WG2283344-10 LCS								
Nitrate (as N)			101.1		%		90-110	30-MAR-16
WG2283344-6 LCS								
Nitrate (as N)			100.6		%		90-110	30-MAR-16
WG2283344-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	30-MAR-16
WG2283344-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	30-MAR-16
WG2283344-12 MS		**L1749125-2**						
Nitrate (as N)			93.0		%		75-125	30-MAR-16
WG2283344-8 MS		**L1749125-1**						
Nitrate (as N)			89.6		%		75-125	30-MAR-16
P-T-COL-WP	**Water**							
Batch R3429984								
WG2285541-10 LCS								
Phosphorus (P)-Total			104.0		%		80-120	04-APR-16
WG2285541-9 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	04-APR-16
PH-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WP	**Water**							
Batch R3427848								
WG2283544-2 LCS								
pH			7.41		pH units		7.3-7.5	30-MAR-16
SO4-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-11 DUP		**L1749125-2**						
Sulfate (SO4)		75.6	75.9		mg/L	0.4	20	30-MAR-16
WG2283344-7 DUP		**L1749125-1**						
Sulfate (SO4)		79.2	79.2		mg/L	0.0	20	30-MAR-16
WG2283344-10 LCS								
Sulfate (SO4)			101.2		%		90-110	30-MAR-16
WG2283344-6 LCS								
Sulfate (SO4)			100.5		%		90-110	30-MAR-16
WG2283344-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	30-MAR-16
WG2283344-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	30-MAR-16
WG2283344-12 MS		**L1749125-2**						
Sulfate (SO4)			90.2		%		75-125	30-MAR-16
WG2283344-8 MS		**L1749125-1**						
Sulfate (SO4)			90.0		%		75-125	30-MAR-16
SOLIDS-TOTSUS-WP	**Water**							
Batch R3428224								
WG2282315-12 LCS								
Total Suspended Solids			98.7		%		85-115	30-MAR-16
WG2282315-11 MB								
Total Suspended Solids			<5.0		mg/L		5	30-MAR-16
TC,EC-QT97-WP	**Water**							
Batch R3427484								
WG2282577-1 MB								
Total Coliforms			<1		MPN/100mL		1	29-MAR-16
Escherichia Coli			<1		MPN/100mL		1	29-MAR-16
TURBIDITY-WP	**Water**							
Batch R3428002								
WG2283292-3 DUP		**L1749125-1**						
Turbidity		3.11	2.84		NTU	9.1	15	29-MAR-16
WG2283292-2 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WP	**Water**							
Batch R3428002								
WG2283292-2 LCS								
Turbidity			98.0		%		85-115	29-MAR-16
WG2283292-1 MB								
Turbidity			<0.10		NTU		0.1	29-MAR-16

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	28-MAR-16 12:30	30-MAR-16 08:07	0.25	44	hours	EHTR-FM
	2	28-MAR-16 13:30	30-MAR-16 08:07	0.25	43	hours	EHTR-FM
	3	28-MAR-16 14:30	30-MAR-16 08:07	0.25	42	hours	EHTR-FM
	4	28-MAR-16 15:00	30-MAR-16 08:07	0.25	41	hours	EHTR-FM
	5	28-MAR-16 16:00	30-MAR-16 08:07	0.25	40	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	28-MAR-16 12:30	30-MAR-16 16:28	48	52	hours	EHT
	2	28-MAR-16 13:30	30-MAR-16 16:28	48	51	hours	EHT
	3	28-MAR-16 14:30	30-MAR-16 16:28	48	50	hours	EHT
	4	28-MAR-16 15:00	30-MAR-16 16:28	48	49	hours	EHT
Nitrite in Water by IC (Low Level)							
	1	28-MAR-16 12:30	30-MAR-16 16:28	48	52	hours	EHT
	2	28-MAR-16 13:30	30-MAR-16 16:28	48	51	hours	EHT
	3	28-MAR-16 14:30	30-MAR-16 16:28	48	50	hours	EHT
	4	28-MAR-16 15:00	30-MAR-16 16:28	48	49	hours	EHT

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1749125 were received on 29-MAR-16 07:30.

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

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.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1749125-COFC

COC Number: 14 - 502928

Page 1 of 1

Report To		Report Format / Dist		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	PDF EXCEL EDD (DIGITAL)	R Regular (Standard TAT if received by 3pm)
Contact:	Marci Friesman-Hamm	Quality Control (QC) Report with Report	Yes No	P Priority (2-4 business days if received by 3pm)
Address:	865 Waverley Street 3rd floor Winnipeg MB R3T 5P4	Criteria on Report - provide details below if box checked		E Emergency (1-2 business days if received by 3pm)
Phone:	204-896-1209	Select Distribution:	EMAIL MAIL FAX	E2 Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	Amelvin@kgsgroup.com, Plimbell@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	MFHamm@kgsgroup.com	

Invoice To		Invoice Distribution	
	Same as Report To: Yes No	Select Invoice Distribution:	EMAIL MAIL FAX
	Copy of Invoice with Report: Yes No	Email 1 or Fax	macquarrie@kgsgroup.com
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q55656	Approver ID:	Cost Center:
Job #:	16-0300-002 · 1000 · 01	GL Account:	Routing Code:
PO / AFE:	Mit Floodway	Activity Code:	
LSD:	Floodway	Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	KGS Group-D-FDW-WP	TC, EC-97-WP	KGS-Group-T-FDW-WP	P-T-Col	N-TOTKS-WP	NH3-Col-WP + Solids Tot	TC-DT-97-EndDT-WP	EC-DT-97 EndDT-WP					Number of Containers
	K13-12321	28/Mar/16	12:30	GW	X	X											3
	K09-12316	28/Mar/16	13:30	GW	X	X											3
	U09-13571	28/Mar/16	14:30	GW	X												2
	PTH 44	29/Mar/16	15:00	SW			X	X	X	X	X	X					4
	K11-12018	29/Mar/16	16:00	GW	X												2

Drinking Water (DW) Samples¹ (client use)	Special Instructions / Specify Criteria to add on report (client Use)
samples taken from a Regulated DW System? Yes No	GW Samples Not FIELD filtered Not preserved
mples for human drinking water use? Yes No	SW is preserved

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen		SIF Observations	Yes	No	
Ice packs	Yes No	Custody seal intact	Yes	No	
Cooling Initiated					

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	Mar 28/16	17:00		29 MAR 16	7:30			

CK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY

MA-FM-0378e v09 Front04 January 2014

Il 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.

e are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

MB Infra & Transport - Highway Engineering - 6th Floor
ATTN: MARCI FRIEDMAN HAMM
865 WAVERLY ST 3RD FLOOR
Winnipeg MB

Date Received: 29-MAR-16
Report Date: 11-APR-16 07:06 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1749445

Project P.O. #:	MIT Floodway
Job Reference:	16-0300-002 1000.01
C of C Numbers:	
Legal Site Desc:	Floodway

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749445-1 K09-12012							
Sampled By: AG on 29-MAR-16 @ 10:30							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	<1		1	MPN/100mL		29-MAR-16	R3427491
Escherichia Coli	<1		1	MPN/100mL		29-MAR-16	R3427491
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	427		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	350		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	23.0		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	1060		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	94.9		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	71.3		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	4.50		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	45.2		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	531		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	101			%		09-APR-16	
Cation - Anion Balance	0.4			%		09-APR-16	
Anion Sum	12.6			me/L		09-APR-16	
Cation Sum	12.7			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	237		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	686		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	73.3		0.10	NTU		30-MAR-16	R3427996
pH							
pH	7.44		0.10	pH units		30-MAR-16	R3427848
L1749445-2 K09-12011							
Sampled By: AG on 29-MAR-16 @ 11:30							
Matrix: GW							
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	286		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749445-2 K09-12011							
Sampled By: AG on 29-MAR-16 @ 11:30							
Matrix: GW							
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	235		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	7.98		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	454		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	47.4		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	27.1		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	2.62		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	9.54		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	230		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	97.0			%		09-APR-16	
Cation - Anion Balance	-1.5			%		09-APR-16	
Anion Sum	5.23			me/L		09-APR-16	
Cation Sum	5.08			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	15.4		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	251		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	0.82		0.10	NTU		30-MAR-16	R3427996
pH							
pH	8.02		0.10	pH units		30-MAR-16	R3427848
L1749445-3 K11-12017							
Sampled By: AG on 29-MAR-16 @ 12:30							
Matrix: GW							
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	324		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	265		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	21.9		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	1080		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	95.3		0.20	mg/L	30-MAR-16	08-APR-16	R3434792

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749445-3 K11-12017							
Sampled By: AG on 29-MAR-16 @ 12:30							
Matrix: GW							
Dissolved Metals by ICP-MS							
Magnesium (Mg)-Dissolved	68.4		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	3.93		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	48.0		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	520		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	102			%		09-APR-16	
Cation - Anion Balance	1.2			%		09-APR-16	
Anion Sum	12.3			me/L		09-APR-16	
Cation Sum	12.6			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	305		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	702		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	3.62		0.10	NTU		30-MAR-16	R3427996
pH							
pH	7.83		0.10	pH units		30-MAR-16	R3427848
L1749445-4 K11-12016							
Sampled By: AG on 29-MAR-16 @ 15:30							
Matrix: GW							
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	364		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	299		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	16.1		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	990		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	94.4		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	64.1		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	4.49		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	33.8		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	500		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	102			%		09-APR-16	
Cation - Anion Balance	1.0			%		09-APR-16	
Anion Sum	11.3			me/L		09-APR-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749445-4 K11-12016							
Sampled By: AG on 29-MAR-16 @ 15:30							
Matrix: GW							
Ion Balance Calculation							
Cation Sum	11.6			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	236		0.30	mg/L		30-MAR-16	R3427981
TDS calculated							
TDS (Calculated)	629		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	0.11		0.10	NTU		30-MAR-16	R3427996
pH							
pH	7.75		0.10	pH units		30-MAR-16	R3427848
L1749445-5 MW100							
Sampled By: AG on 29-MAR-16 @ 16:00							
Matrix: GW							
ROU1W Dissolved Floodway							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	277		1.2	mg/L		31-MAR-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-MAR-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-MAR-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	227		1.0	mg/L		30-MAR-16	R3427848
Chloride in Water by IC							
Chloride (Cl)	7.99		0.50	mg/L		30-MAR-16	R3427981
Conductivity							
Conductivity	459		1.0	umhos/cm		30-MAR-16	R3427848
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	47.7		0.20	mg/L	30-MAR-16	08-APR-16	R3434792
Magnesium (Mg)-Dissolved	26.8		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Potassium (K)-Dissolved	2.70		0.10	mg/L	30-MAR-16	08-APR-16	R3434792
Sodium (Na)-Dissolved	9.51		0.050	mg/L	30-MAR-16	08-APR-16	R3434792
Hardness Calculated							
Hardness (as CaCO3)	229		0.20	mg/L		09-APR-16	
Ion Balance Calculation							
Ion Balance	99.7			%		09-APR-16	
Cation - Anion Balance	-0.2			%		09-APR-16	
Anion Sum	5.09			me/L		09-APR-16	
Cation Sum	5.07			me/L		09-APR-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		30-MAR-16	R3427981
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		30-MAR-16	R3427981
Sulfate in Water by IC							
Sulfate (SO4)	15.4		0.30	mg/L		30-MAR-16	R3427981

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1749445-5 MW100							
Sampled By: AG on 29-MAR-16 @ 16:00							
Matrix: GW							
TDS calculated							
TDS (Calculated)	246		5.0	mg/L		09-APR-16	
Turbidity							
Turbidity	0.77		0.10	NTU		30-MAR-16	R3427996
pH							
pH	8.08		0.10	pH units		30-MAR-16	R3427848
L1749445-6 PTH 44							
Sampled By: AG on 29-MAR-16 @ 14:00							
Matrix: SW							
Miscellaneous Parameters							
Escherichia Coli	139		1	MPN/100mL		29-MAR-16	R3427497
Total Coliforms	980		1	MPN/100mL		29-MAR-16	R3427497

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-QT97-ENDPT-WP	Water	E. coli to endpoint by MPN QT97	APHA 9223B QT97

Analysis is carried out using procedures adapted from APHA 9223 "Enzyme Susbtrate Coliform Test". Eschericia coli bacteria are determined by mixing serial dilutions of sample with a product containing hydrolyzable substrates and sealing in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-HARDNESS-DIS-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
MET-D-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A-D

This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-WP	Water	pH	APHA 4500H

The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
		the number of positive responses to a probability table.	
TC-QT97-ENDPT-WP	Water	Total Coliforms to endpoint by MPN QT97	APHA 9223B QT97
		Analysis is carried out using procedures adapted from APHA 9223 "Enzyme Susbtrate Coliform Test". Coliform bacteria are determined by mixing serial dilutions of sample with a product containing hydrolyzable substrates and sealing in a 97-well packet. The packet is incubated for 18 hours at 44.5C and the number of wells exhibiting characteristic positive responses are counted. The final results are obtained by comparing the positive counts to a probability table.	
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
		Turbidity in aqueous matrices is determined by the nephelometric method.	

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

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: MB Infra & Transport - Highway Engineering - 6th Floor
865 WAVERLY ST 3RD FLOOR
Winnipeg MB
Contact: MARCI FRIEDMAN HAMM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3427848								
WG2283544-4 LCS								
Alkalinity, Total (as CaCO3)			100.1		%		85-115	30-MAR-16
WG2283544-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	30-MAR-16
CL-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-6 LCS								
Chloride (Cl)			100.7		%		90-110	30-MAR-16
WG2283344-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	30-MAR-16
EC-QT97-ENDPT-WP	**Water**							
Batch R3427497								
WG2283150-1 MB								
Escherichia Coli			<1		MPN/100mL		1	29-MAR-16
EC-WP	**Water**							
Batch R3427848								
WG2283544-3 LCS								
Conductivity			98.8		%		90-110	30-MAR-16
WG2283544-1 MB								
Conductivity			<1.0		umhos/cm		1	30-MAR-16
MET-D-MS-WP	**Water**							
Batch R3434792								
WG2283295-2 LCS								
Calcium (Ca)-Dissolved			98.4		%		80-120	08-APR-16
Magnesium (Mg)-Dissolved			95.2		%		80-120	08-APR-16
Potassium (K)-Dissolved			104.9		%		80-120	08-APR-16
Sodium (Na)-Dissolved			96.7		%		80-120	08-APR-16
WG2283295-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	08-APR-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	08-APR-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	08-APR-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	08-APR-16
NO2-L-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-6 LCS								
Nitrite (as N)			102.2		%		90-110	30-MAR-16
WG2283344-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	30-MAR-16
NO3-L-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-6 LCS								
Nitrate (as N)			100.6		%		90-110	30-MAR-16
WG2283344-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	30-MAR-16
PH-WP	**Water**							
Batch R3427848								
WG2283544-2 LCS								
pH			7.41		pH units		7.3-7.5	30-MAR-16
SO4-IC-N-WP	**Water**							
Batch R3427981								
WG2283344-6 LCS								
Sulfate (SO4)			100.5		%		90-110	30-MAR-16
WG2283344-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	30-MAR-16
TC,EC-QT97-WP	**Water**							
Batch R3427491								
WG2282752-1 MB								
Total Coliforms			<1		MPN/100mL		1	29-MAR-16
Escherichia Coli			<1		MPN/100mL		1	29-MAR-16
TC-QT97-ENDPT-WP	**Water**							
Batch R3427497								
WG2283150-1 MB								
Total Coliforms			<1		MPN/100mL		1	29-MAR-16
TURBIDITY-WP	**Water**							
Batch R3427996								
WG2283752-2 LCS								
Turbidity			98.5		%		85-115	30-MAR-16
WG2283752-1 MB								
Turbidity			<0.10		NTU		0.1	30-MAR-16

Quality Control Report

Legend:

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

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	29-MAR-16 10:30	30-MAR-16 08:07	0.25	22	hours	EHTR-FM
	2	29-MAR-16 11:30	30-MAR-16 08:07	0.25	21	hours	EHTR-FM
	3	29-MAR-16 12:30	30-MAR-16 08:07	0.25	20	hours	EHTR-FM
	4	29-MAR-16 15:30	30-MAR-16 08:07	0.25	17	hours	EHTR-FM
	5	29-MAR-16 16:00	30-MAR-16 08:07	0.25	16	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 L1749445 were received on 29-MAR-16 16:05.

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
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1749445-COFC

COC Number: 14 - 502927

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company: KGS group		Select Report Format: ☒ PDF ☒ EXCEL ☒ EDD (DIGITAL)		R ☒ Regular (Standard TAT if received by 3pm)
Contact: Marci Fehr/Mandi Hamm		Quality Control (QC) Report with Report ☐ Yes ☐ No		P ☐ Priority (2-4 business days if received by 3pm)
Address: 865 Waverley Street 3rd Floor Wpg MB		☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
Phone: 204-896-1209		Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX		E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax Amelia@Kgsgroup.com, MLindell@Kgsgroup.com		Specify Date Required for E2,E or P:
		Email 2 MHamm@Kgsgroup.com		Analysis Request
Invoice To Same as Report To ☒ Yes ☐ No		Invoice Distribution		Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
Copy of Invoice with Report ☒ Yes ☐ No		Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX		KGS-Poulin-D-QT97-WP; TC-EC-QT97-WP; TC-QT-97-ENDPT-WP; EC-QT-97-ENDPT-WP
Company:		Email 1 or Fax MacQuarrie@Kgsgroup.com		
Contact:		Email 2		
Project Information		Oil and Gas Required Fields (client use)		
ALS Quote #: Q55656		Approver ID:	Cost Center:	
Job #: 16-0300-002 1000.01		GL Account:	Routing Code:	
PO / AFE: Mat Floodway		Activity Code:		
LSD: Floodway		Location:		
ALS Lab Work Order # (lab use only)		ALS Contact: Jody	Sampler: AC	

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	KGS-Poulin-D-QT97-WP	TC-EC-QT97-WP	TC-QT-97-ENDPT-WP	EC-QT-97-ENDPT-WP	Number of Containers
1	K09-12012	29 Mar 16	10:30	GW	X	X			3
2	K09-12011	29 Mar 16	11:30	GW	X				2
3	K11-12017	29 Mar 16	12:30	GW	X				2
4	K11-12016	29 Mar 16	15:30	GW	X				2
5	MW100	29 Mar 16	16:00	GW	X				2
6	Pty 44	29 Mar 16	14:00	SW			X	X	2

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	Not Field Filtered or Preserved
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☐	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
				29-3-16	16:05			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

MB Infra & Transport - Highway Engineering - 6th Floor
ATTN: MARCI FRIEDMAN-HAMM
3RD FLOOR
865 WAVERLY ST
Winnipeg MB R3T5P4

Date Received: 30-MAR-16
Report Date: 11-APR-16 09:52 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1750072

Project P.O. #: MIT Floodway
Job Reference: 16-0300-002.1000.01
C of C Numbers:
Legal Site Desc: Floodway

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1750072-1 G050C006 - DOMESTIC							
Sampled By: CLIENT on 30-MAR-16 @ 09:00							
Matrix: GW							
Miscellaneous Parameters							
Bicarbonate (HCO3)	252		1.2	mg/L		06-APR-16	
Carbonate (CO3)	<0.60		0.60	mg/L		06-APR-16	
Hydroxide (OH)	<0.34		0.34	mg/L		06-APR-16	
Alkalinity, Total (as CaCO3)	206		1.0	mg/L		04-APR-16	R3430389
Chloride (Cl)	539		5.0	mg/L		01-APR-16	R3429922
Conductivity	2340		1.0	umhos/cm		04-APR-16	R3430389
Hardness (as CaCO3)	477		0.30	mg/L		09-APR-16	
Nitrate (as N)	<0.050	DLM	0.050	mg/L		01-APR-16	R3429922
Nitrate and Nitrite as N	<0.051		0.051	mg/L		04-APR-16	
Nitrite (as N)	<0.010	DLM	0.010	mg/L		01-APR-16	R3429922
Sulfate (SO4)	295		3.0	mg/L		01-APR-16	R3429922
TDS (Calculated)	1450		5.0	mg/L		09-APR-16	
Turbidity	38.4		0.10	NTU		01-APR-16	R3430190
pH	7.84		0.10	pH units		04-APR-16	R3430389
Ion Balance Calculation							
Ion Balance	94.1			%		09-APR-16	
Cation - Anion Balance	-3.0			%		09-APR-16	
Anion Sum	25.5			me/L		09-APR-16	
Cation Sum	24.0			me/L		09-APR-16	
Total Coliform and E.coli							
Total Coliforms	1		0	MPN/100mL		30-MAR-16	R3428121
Escherichia Coli	0		0	MPN/100mL		30-MAR-16	R3428121
Total Metals by ICP-MS							
Calcium (Ca)-Total	95.5		0.20	mg/L	01-APR-16	08-APR-16	R3434792
Iron (Fe)-Total	3.76		0.10	mg/L	01-APR-16	08-APR-16	R3434792
Magnesium (Mg)-Total	57.9		0.050	mg/L	01-APR-16	08-APR-16	R3434792
Manganese (Mn)-Total	0.0722		0.0010	mg/L	01-APR-16	08-APR-16	R3434792
Potassium (K)-Total	12.8		0.10	mg/L	01-APR-16	08-APR-16	R3434792
Sodium (Na)-Total	325		0.050	mg/L	01-APR-16	08-APR-16	R3434792
ROU4W Total Floodway							
Fluoride in Water by IC							
Fluoride (F)	0.41		0.20	mg/L		01-APR-16	R3429922
L1750072-2 K1B-12322 - GW							
Sampled By: CLIENT on 30-MAR-16 @ 12:00							
Matrix: GW							
Miscellaneous Parameters							
Bicarbonate (HCO3)	302		1.2	mg/L		06-APR-16	
Carbonate (CO3)	<0.60		0.60	mg/L		06-APR-16	
Hydroxide (OH)	<0.34		0.34	mg/L		06-APR-16	
Alkalinity, Total (as CaCO3)	247		1.0	mg/L		04-APR-16	R3430389
Chloride (Cl)	16.1		0.50	mg/L		01-APR-16	R3429922
Conductivity	741		1.0	umhos/cm		04-APR-16	R3430389
Hardness (as CaCO3)	356		0.20	mg/L		10-APR-16	
Nitrate (as N)	<0.0050		0.0050	mg/L		01-APR-16	R3429922
Nitrate and Nitrite as N	<0.0051		0.0051	mg/L		04-APR-16	
Nitrite (as N)	<0.0010		0.0010	mg/L		01-APR-16	R3429922
Sulfate (SO4)	148		0.30	mg/L		01-APR-16	R3429922
TDS (Calculated)	450		5.0	mg/L		10-APR-16	
Turbidity	0.84		0.10	NTU		01-APR-16	R3430190

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1750072-2 K1B-12322 - GW							
Sampled By: CLIENT on 30-MAR-16 @ 12:00							
Matrix: GW							
pH	7.60		0.10	pH units		04-APR-16	R3430389
Ion Balance Calculation							
Ion Balance	96.7			%		10-APR-16	
Cation - Anion Balance	-1.7			%		10-APR-16	
Anion Sum	8.48			me/L		10-APR-16	
Cation Sum	8.20			me/L		10-APR-16	
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	61.9		0.20	mg/L	04-APR-16	09-APR-16	R3435011
Magnesium (Mg)-Dissolved	48.8		0.050	mg/L	04-APR-16	09-APR-16	R3435011
Potassium (K)-Dissolved	3.36		0.10	mg/L	04-APR-16	09-APR-16	R3435011
Sodium (Na)-Dissolved	23.3		0.050	mg/L	04-APR-16	09-APR-16	R3435011
L1750072-3 K11-12014 - GW							
Sampled By: CLIENT on 30-MAR-16 @ 14:15							
Matrix: GW							
Miscellaneous Parameters							
Bicarbonate (HCO3)	301		1.2	mg/L		06-APR-16	
Carbonate (CO3)	<0.60		0.60	mg/L		06-APR-16	
Hydroxide (OH)	<0.34		0.34	mg/L		06-APR-16	
Alkalinity, Total (as CaCO3)	247		1.0	mg/L		04-APR-16	R3430389
Chloride (Cl)	13.6		0.50	mg/L		01-APR-16	R3429922
Conductivity	573		1.0	umhos/cm		04-APR-16	R3430389
Hardness (as CaCO3)	299		0.20	mg/L		10-APR-16	
Nitrate (as N)	0.252		0.0050	mg/L		01-APR-16	R3429922
Nitrate and Nitrite as N	0.252		0.0051	mg/L		04-APR-16	
Nitrite (as N)	<0.0010		0.0010	mg/L		01-APR-16	R3429922
Sulfate (SO4)	57.6		0.30	mg/L		01-APR-16	R3429922
TDS (Calculated)	327		5.0	mg/L		10-APR-16	
Turbidity	<0.10		0.10	NTU		01-APR-16	R3430190
pH	7.63		0.10	pH units		04-APR-16	R3430389
Ion Balance Calculation							
Ion Balance	97.3			%		10-APR-16	
Cation - Anion Balance	-1.4			%		10-APR-16	
Anion Sum	6.53			me/L		10-APR-16	
Cation Sum	6.36			me/L		10-APR-16	
Total Coliform and E.coli by MPN QT97							
Total Coliforms	9		1	MPN/100mL		30-MAR-16	R3428119
Escherichia Coli	<1		1	MPN/100mL		30-MAR-16	R3428119
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	59.9		0.20	mg/L	04-APR-16	09-APR-16	R3435011
Magnesium (Mg)-Dissolved	36.3		0.050	mg/L	04-APR-16	09-APR-16	R3435011
Potassium (K)-Dissolved	3.82		0.10	mg/L	04-APR-16	09-APR-16	R3435011
Sodium (Na)-Dissolved	6.53		0.050	mg/L	04-APR-16	09-APR-16	R3435011
L1750072-4 K11-12015 - GW							
Sampled By: CLIENT on 30-MAR-16 @ 15:15							
Matrix: GW							
Miscellaneous Parameters							
Bicarbonate (HCO3)	270		1.2	mg/L		06-APR-16	
Carbonate (CO3)	<0.60		0.60	mg/L		06-APR-16	
Hydroxide (OH)	<0.34		0.34	mg/L		06-APR-16	
Alkalinity, Total (as CaCO3)	222		1.0	mg/L		04-APR-16	R3430389

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1750072-4 K11-12015 - GW							
Sampled By: CLIENT on 30-MAR-16 @ 15:15							
Matrix: GW							
Chloride (Cl)	16.7		0.50	mg/L		01-APR-16	R3429922
Conductivity	532		1.0	umhos/cm		04-APR-16	R3430389
Hardness (as CaCO3)	269		0.20	mg/L		10-APR-16	
Nitrate (as N)	0.207		0.0050	mg/L		01-APR-16	R3429922
Nitrate and Nitrite as N	0.207		0.0051	mg/L		04-APR-16	
Nitrite (as N)	<0.0010		0.0010	mg/L		01-APR-16	R3429922
Sulfate (SO4)	50.5		0.30	mg/L		01-APR-16	R3429922
TDS (Calculated)	298		5.0	mg/L		10-APR-16	
Turbidity	0.32		0.10	NTU		01-APR-16	R3430190
pH	7.78		0.10	pH units		04-APR-16	R3430389
Ion Balance Calculation							
Ion Balance	96.7			%		10-APR-16	
Cation - Anion Balance	-1.7			%		10-APR-16	
Anion Sum	5.96			me/L		10-APR-16	
Cation Sum	5.76			me/L		10-APR-16	
Total Coliform and E.coli by MPN QT97							
Total Coliforms	9		1	MPN/100mL		30-MAR-16	R3428119
Escherichia Coli	1		1	MPN/100mL		30-MAR-16	R3428119
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	54.2		0.20	mg/L	04-APR-16	09-APR-16	R3435011
Magnesium (Mg)-Dissolved	32.4		0.050	mg/L	04-APR-16	09-APR-16	R3435011
Potassium (K)-Dissolved	3.89		0.10	mg/L	04-APR-16	09-APR-16	R3435011
Sodium (Na)-Dissolved	6.72		0.050	mg/L	04-APR-16	09-APR-16	R3435011
L1750072-5 PTH 59 - SURFACE							
Sampled By: CLIENT on 30-MAR-16 @ 15:30							
Matrix: GW							
Miscellaneous Parameters							
Bicarbonate (HCO3)	236		1.2	mg/L		06-APR-16	
Carbonate (CO3)	<0.60		0.60	mg/L		06-APR-16	
Hydroxide (OH)	<0.34		0.34	mg/L		06-APR-16	
Alkalinity, Total (as CaCO3)	193		1.0	mg/L		04-APR-16	R3430389
Ammonia, Total (as N)	0.072		0.010	mg/L		06-APR-16	R3434392
Chloride (Cl)	45.6		0.50	mg/L		01-APR-16	R3429922
Conductivity	549		1.0	umhos/cm		04-APR-16	R3430389
Escherichia Coli	630		1	MPN/100mL		30-MAR-16	R3428092
Hardness (as CaCO3)	231		0.30	mg/L		09-APR-16	
Nitrate (as N)	0.405		0.0050	mg/L		01-APR-16	R3429922
Nitrate and Nitrite as N	0.414		0.0051	mg/L		04-APR-16	
Nitrite (as N)	0.0093		0.0010	mg/L		01-APR-16	R3429922
Phosphorus (P)-Total	0.196		0.010	mg/L		04-APR-16	R3429984
Sulfate (SO4)	39.1		0.30	mg/L		01-APR-16	R3429922
TDS (Calculated)	314		5.0	mg/L		09-APR-16	
Total Coliforms	2790		1	MPN/100mL		30-MAR-16	R3428092
Total Kjeldahl Nitrogen	0.75		0.20	mg/L	07-APR-16	07-APR-16	R3433879
Total Suspended Solids	9.0		5.0	mg/L		31-MAR-16	R3429581
Turbidity	21.2		0.10	NTU		01-APR-16	R3430190
pH	8.13		0.10	pH units		04-APR-16	R3430389
Ion Balance Calculation							
Ion Balance	101			%		09-APR-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1750072-5 PTH 59 - SURFACE							
Sampled By: CLIENT on 30-MAR-16 @ 15:30							
Matrix: GW							
Ion Balance Calculation							
Cation - Anion Balance	0.4			%		09-APR-16	
Anion Sum	6.00			me/L		09-APR-16	
Cation Sum	6.04			me/L		09-APR-16	
Total Metals by ICP-MS							
Calcium (Ca)-Total	50.2		0.20	mg/L	01-APR-16	08-APR-16	R3434792
Magnesium (Mg)-Total	25.7		0.050	mg/L	01-APR-16	08-APR-16	R3434792
Potassium (K)-Total	6.63		0.10	mg/L	01-APR-16	08-APR-16	R3434792
Sodium (Na)-Total	28.7		0.050	mg/L	01-APR-16	08-APR-16	R3434792
L1750072-6 MW-101 (NOT ON COC)							
Sampled By: CLIENT on 30-MAR-16 @ 09:00							
Matrix: GW							
Miscellaneous Parameters							
Bicarbonate (HCO3)	304		1.2	mg/L		06-APR-16	
Carbonate (CO3)	<0.60		0.60	mg/L		06-APR-16	
Hydroxide (OH)	<0.34		0.34	mg/L		06-APR-16	
Alkalinity, Total (as CaCO3)	249		1.0	mg/L		04-APR-16	R3430389
Chloride (Cl)	13.6		0.50	mg/L		01-APR-16	R3429922
Conductivity	575		1.0	umhos/cm		04-APR-16	R3430389
Hardness (as CaCO3)	309		0.20	mg/L		10-APR-16	
Nitrate (as N)	0.249		0.0050	mg/L		01-APR-16	R3429922
Nitrate and Nitrite as N	0.249		0.0051	mg/L		04-APR-16	
Nitrite (as N)	<0.0010		0.0010	mg/L		01-APR-16	R3429922
Sulfate (SO4)	57.7		0.30	mg/L		01-APR-16	R3429922
TDS (Calculated)	332		5.0	mg/L		10-APR-16	
Turbidity	<0.10		0.10	NTU		01-APR-16	R3430190
pH	7.67		0.10	pH units		04-APR-16	R3430389
Ion Balance Calculation							
Ion Balance	99.5			%		10-APR-16	
Cation - Anion Balance	-0.3			%		10-APR-16	
Anion Sum	6.58			me/L		10-APR-16	
Cation Sum	6.55			me/L		10-APR-16	
Total Coliform and E.coli by MPN QT97							
Total Coliforms	12		1	MPN/100mL		31-MAR-16	R3428763
Escherichia Coli	<1		1	MPN/100mL		31-MAR-16	R3428763
Dissolved Metals by ICP-MS							
Calcium (Ca)-Dissolved	63.2		0.20	mg/L	04-APR-16	09-APR-16	R3435011
Magnesium (Mg)-Dissolved	36.6		0.050	mg/L	04-APR-16	09-APR-16	R3435011
Potassium (K)-Dissolved	3.85		0.10	mg/L	04-APR-16	09-APR-16	R3435011
Sodium (Na)-Dissolved	6.57		0.050	mg/L	04-APR-16	09-APR-16	R3435011

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-QT97-ENDPT-WP	Water	E. coli to endpoint by MPN QT97	APHA 9223B QT97

Analysis is carried out using procedures adapted from APHA 9223 "Enzyme Susbtrate Coliform Test". Eschericia coli bacteria are determined by mixing serial dilutions of sample with a product containing hydrolyzable substrates and sealing in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ETL-HARDNESS-DIS-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-HARDNESS-TOT-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
MET-D-MS-WP	Water	Dissolved Metals by ICP-MS	APHA 3030B/EPA 6020A-D

This analysis involves filtration (APHA 3030B) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

MET-T-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-T

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	Quickchem method 10-107-06-2-E Lachat

Samples are digested with a sulphuric acid solution, cooled, diluted with water, and analyzed for ammonia. Total Kjeldahl nitrogen is the sum of free-ammonia and organic nitrogen compounds which are converted to ammonium sulphate through this digestion process. Analysis is performed by Flow Injection
Analysis (FIA). The pH of the digested sample is raised to a known, basic pH by neutralization with a concentrated buffer solution. This neutralization converts the ammonium cation to ammonia. The ammonia produced is heated with saliclyate and hypochlorite to produce blue colour which is proportional to the ammonia concentration.

NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F

Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.

NO2+NO3-CALC-L-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-COL-WP	Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-WP	Water	pH	APHA 4500H

The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TOTSUS-WP	Water	Total Suspended Solids	APHA 2540 D (modified)

Total suspended solids in aquesous matrices is determined gravimetrically after drying the residue at 103 105°C.

TC,EC-QT51-WP	Water	Total Coliform and E.coli	APHA 9223B QT51

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 51-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

TC-QT97-ENDPT-WP	Water	Total Coliforms to endpoint by MPN QT97	APHA 9223B QT97

Analysis is carried out using procedures adapted from APHA 9223 "Enzyme Susbtrate Coliform Test". Coliform bacteria are determined by mixing serial dilutions of sample with a product containing hydrolyzable substrates and sealing in a 97-well packet. The packet is incubated for 18 hours at 44.5C and the number of wells exhibiting characteristic positive responses are counted. The final results are obtained by comparing the positive counts to a probability table.

TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)

Turbidity in aqueous matrices is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Workorder: L1750072 Report Date: 11-APR-16

Client: MB Infra & Transport - Highway Engineering - 6th Floor
3RD FLOOR 865 WAVERLY ST
Winnipeg MB R3T5P4

Contact: MARCI FRIEDMAN-HAMM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3430389								
WG2285531-10 DUP		**L1750072-6**						
Alkalinity, Total (as CaCO3)		249	247		mg/L	0.9	20	04-APR-16
WG2285531-9 LCS								
Alkalinity, Total (as CaCO3)			97.6		%		85-115	04-APR-16
WG2285531-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	04-APR-16
CL-IC-N-WP	**Water**							
Batch R3429922								
WG2284741-6 LCS								
Chloride (Cl)			101.7		%		90-110	01-APR-16
WG2284741-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-APR-16
EC-QT97-ENDPT-WP	**Water**							
Batch R3428092								
WG2283566-1 MB								
Escherichia Coli			<1		MPN/100mL		1	30-MAR-16
EC-WP	**Water**							
Batch R3430389								
WG2285531-10 DUP		**L1750072-6**						
Conductivity		575	570		umhos/cm	0.9	10	04-APR-16
WG2285531-8 LCS								
Conductivity			96.4		%		90-110	04-APR-16
WG2285531-6 MB								
Conductivity			<1.0		umhos/cm		1	04-APR-16
F-IC-N-WP	**Water**							
Batch R3429922								
WG2284741-6 LCS								
Fluoride (F)			106.4		%		90-110	01-APR-16
WG2284741-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-APR-16
MET-D-MS-WP	**Water**							
Batch R3435011								
WG2285366-2 LCS								
Calcium (Ca)-Dissolved			97.1		%		80-120	09-APR-16
Magnesium (Mg)-Dissolved			103.0		%		80-120	09-APR-16
Potassium (K)-Dissolved			98.1		%		80-120	09-APR-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-MS-WP	**Water**							
Batch R3435011								
WG2285366-2 LCS								
Sodium (Na)-Dissolved			101.6		%		80-120	09-APR-16
WG2285366-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	09-APR-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	09-APR-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	09-APR-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	09-APR-16
MET-T-MS-WP	**Water**							
Batch R3434792								
WG2284298-2 LCS								
Calcium (Ca)-Total			98.2		%		80-120	08-APR-16
Iron (Fe)-Total			98.2		%		80-120	08-APR-16
Magnesium (Mg)-Total			94.7		%		80-120	08-APR-16
Manganese (Mn)-Total			96.3		%		80-120	08-APR-16
Potassium (K)-Total			101.9		%		80-120	08-APR-16
Sodium (Na)-Total			94.6		%		80-120	08-APR-16
WG2284298-1 MB								
Calcium (Ca)-Total			<0.20		mg/L		0.2	08-APR-16
Iron (Fe)-Total			<0.10		mg/L		0.1	08-APR-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	08-APR-16
Manganese (Mn)-Total			<0.0010		mg/L		0.001	08-APR-16
Potassium (K)-Total			<0.10		mg/L		0.1	08-APR-16
Sodium (Na)-Total			<0.050		mg/L		0.05	08-APR-16
N-TOTKJ-WP	**Water**							
Batch R3433879								
WG2286983-6 LCS								
Total Kjeldahl Nitrogen			90.8		%		75-125	07-APR-16
WG2286983-5 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	07-APR-16
NH3-COL-WP	**Water**							
Batch R3434392								
WG2287339-2 LCS								
Ammonia, Total (as N)			104.3		%		85-115	06-APR-16
WG2287339-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	06-APR-16
NO2-L-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3429922								
WG2284741-6 LCS								
Nitrite (as N)			101.7		%		90-110	01-APR-16
WG2284741-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-APR-16
NO3-L-IC-N-WP	**Water**							
Batch R3429922								
WG2284741-6 LCS								
Nitrate (as N)			101.0		%		90-110	01-APR-16
WG2284741-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-APR-16
P-T-COL-WP	**Water**							
Batch R3429984								
WG2285541-18 LCS								
Phosphorus (P)-Total			104.0		%		80-120	04-APR-16
WG2285541-17 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	04-APR-16
PH-WP	**Water**							
Batch R3430389								
WG2285531-10 DUP		**L1750072-6**						
pH		7.67	7.67	J	pH units	0.00	0.2	04-APR-16
WG2285531-7 LCS								
pH			7.42		pH units		7.3-7.5	04-APR-16
SO4-IC-N-WP	**Water**							
Batch R3429922								
WG2284741-6 LCS								
Sulfate (SO4)			101.5		%		90-110	01-APR-16
WG2284741-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	01-APR-16
SOLIDS-TOTSUS-WP	**Water**							
Batch R3429581								
WG2283768-15 LCS								
Total Suspended Solids			96.7		%		85-115	31-MAR-16
WG2283768-14 MB								
Total Suspended Solids			<5.0		mg/L		5	31-MAR-16
TC,EC-QT51-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R3428121								
WG2283383-4 MB								
Total Coliforms			0		MPN/100mL		1	30-MAR-16
Escherichia Coli			0		MPN/100mL		1	30-MAR-16
WG2283383-5 MB								
Total Coliforms			0		MPN/100mL		1	30-MAR-16
Escherichia Coli			0		MPN/100mL		1	30-MAR-16
WG2283383-6 MB								
Total Coliforms			0		MPN/100mL		1	30-MAR-16
Escherichia Coli			0		MPN/100mL		1	30-MAR-16
TC,EC-QT97-WP	**Water**							
Batch R3428119								
WG2283414-1 MB								
Total Coliforms			<1		MPN/100mL		1	30-MAR-16
Escherichia Coli			<1		MPN/100mL		1	30-MAR-16
Batch R3428763								
WG2284133-2 MB								
Total Coliforms			<1		MPN/100mL		1	31-MAR-16
Escherichia Coli			<1		MPN/100mL		1	31-MAR-16
TC-QT97-ENDPT-WP	**Water**							
Batch R3428092								
WG2283566-1 MB								
Total Coliforms			<1		MPN/100mL		1	30-MAR-16
TURBIDITY-WP	**Water**							
Batch R3430190								
WG2286074-3 DUP		**L1750072-1**						
Turbidity		38.4	40.2		NTU	4.6	15	01-APR-16
WG2286074-2 LCS								
Turbidity			99.0		%		85-115	01-APR-16
WG2286074-1 MB								
Turbidity			<0.10		NTU		0.1	01-APR-16

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	30-MAR-16 09:00	04-APR-16 15:28	0.25	126	hours	EHTR-FM
	2	30-MAR-16 12:00	04-APR-16 15:28	0.25	123	hours	EHTR-FM
	3	30-MAR-16 14:15	04-APR-16 15:28	0.25	121	hours	EHTR-FM
	4	30-MAR-16 15:15	04-APR-16 15:28	0.25	120	hours	EHTR-FM
	5	30-MAR-16 15:30	04-APR-16 15:28	0.25	120	hours	EHTR-FM
	6	30-MAR-16 09:00	04-APR-16 15:28	0.25	126	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	30-MAR-16 09:00	01-APR-16 16:21	48	55	hours	EHT
	2	30-MAR-16 12:00	01-APR-16 16:21	48	52	hours	EHT
	3	30-MAR-16 14:15	01-APR-16 16:21	48	50	hours	EHT
	4	30-MAR-16 15:15	01-APR-16 16:21	48	49	hours	EHT
	6	30-MAR-16 09:00	01-APR-16 16:21	48	55	hours	EHT
Nitrite in Water by IC (Low Level)							
	1	30-MAR-16 09:00	01-APR-16 16:21	48	55	hours	EHT
	2	30-MAR-16 12:00	01-APR-16 16:21	48	52	hours	EHT
	3	30-MAR-16 14:15	01-APR-16 16:21	48	50	hours	EHT
	4	30-MAR-16 15:15	01-APR-16 16:21	48	49	hours	EHT
	6	30-MAR-16 09:00	01-APR-16 16:21	48	55	hours	EHT
Bacteriological Tests							
Total Coliform and E.coli by MPN QT97							
	6	30-MAR-16 09:00	31-MAR-16 17:05	30	32	hours	EHTL

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1750072 were received on 30-MAR-16 16:20.

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

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

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

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1750072-COFC

COC Number: 14 - 502929

Page 1 of 1

L1750072

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS group	Select Report Format:	PDF EXCEL EDD (DIGITAL)	R Regular (Standard TAT if received by 3pm)
Contact:	Marci Feurdman - Hamm	Quality Control (QC) Report with Report	Yes No	P Priority (2-4 business days if received by 3pm)
Address:	865 Waverley St 3rd floor Wpg MB R3T 5P4	Criteria on Report - provide details below if box checked		E Emergency (1-2 business days if received by 3pm)
Phone:	204-896-1209	Select Distribution:	EMAIL MAIL FAX	E2 Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	Amelvin@kgsgroup.ca, PLindelle@kgsgroup.ca	Specify Date Required for E2,E or P:
		Email 2	MHamm@kgsgroup.ca	

Invoice To			Invoice Distribution		
	Same as Report To	Yes No	Select Invoice Distribution:	EMAIL MAIL FAX	
	Copy of Invoice with Report	Yes No	Email 1 or Fax	wmacquarrie@kgsgroup.com	
Company:			Email 2		
Contact:			Oil and Gas Required Fields (client use)		

Project Information			
ALS Quote #:	Q55656	Approver ID:	Cost Center:
Job #:	16-0300-0027.1000.01	GL Account:	Routing Code:
PO / AFE:	Mit floodway	Activity Code:	
LSD:	floodway	Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	KGS-Routine-D-fpwp	TC,BC-Q797-wp	KGS-Routine-T-fpwp	DT-Col	N-TOTKS-wp	MH3-Col-wp+Solids Total	TC-Q797-ENDT-dp	EC-Q797-ENDT-wp	KGS-Routine-fpwp	T+TC,EC-QT-ES-wp	Number of Containers
	G050C006 (Domestic)	30-Mar-16	9:00	GW									X	X	3
	KIB-12322 (GW)	30-Mar-16	12:00	GW	X										2
	KII-12014 (GW)	30-Mar-16	14:15	GW	X	X									3
	KII-12015 (GW)	30-Mar-16	15:15	GW	X	X									3
	DH 59 (Surface)	30-mar-16	15:30	SW			X	X	X	X	X	X			5

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)	SAMPLE CONDITION AS RECEIVED (lab use only)
Are samples taken from a Regulated DW System? Yes No	GW Not filtered Not Preserved	Frozen SIF Observations Yes No
Are samples for human drinking water use? Yes No	SW ~~Filtered~~ Preserved	Ice packs Yes No Custody seal intact Yes No
	DOMGW Preserved	Cooling Initiated

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	March 30/16			30-3-16	16:20			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

ALS Canada Ltd. Form January 2014

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.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

MB Infra & Transport - Highway Engineering - 6th Floor
ATTN: MARCI FRIEDMAN-HAMM
865 Waverly St
Winnipeg MB R3T5P4

Date Received: 21-APR-16
Report Date: 22-APR-16 14:37 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1758871

Project P.O. #: MIT Floodway
Job Reference: 16-0300-002-1000-02
C of C Numbers:
Legal Site Desc: Floodway

Brennan Tingley
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1758871-1 K13-12321							
Sampled By: Ariel Melvin on 21-APR-16 @ 10:30							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	1		1	MPN/100mL		21-APR-16	R3443066
Escherichia Coli	<1		1	MPN/100mL		21-APR-16	R3443066
L1758871-2 K09-12316							
Sampled By: Ariel Melvin on 21-APR-16 @ 11:15							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	4		1	MPN/100mL		21-APR-16	R3443066
Escherichia Coli	2		1	MPN/100mL		21-APR-16	R3443066
L1758871-3 K09-12012							
Sampled By: Ariel Melvin on 21-APR-16 @ 12:15							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	<1		1	MPN/100mL		21-APR-16	R3443066
Escherichia Coli	<1		1	MPN/100mL		21-APR-16	R3443066
L1758871-4 K11-12014							
Sampled By: Ariel Melvin on 21-APR-16 @ 14:30							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	<1		1	MPN/100mL		21-APR-16	R3443066
Escherichia Coli	1		1	MPN/100mL		21-APR-16	R3443066
L1758871-5 K11-12015							
Sampled By: Ariel Melvin on 21-APR-16 @ 16:30							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	4		1	MPN/100mL		21-APR-16	R3443066
Escherichia Coli	<1		1	MPN/100mL		21-APR-16	R3443066
L1758871-6 MW-100							
Sampled By: Ariel Melvin on 21-APR-16 @ 17:00							
Matrix: GW							
Total Coliform and E.coli by MPN QT97							
Total Coliforms	5		1	MPN/100mL		21-APR-16	R3443066
Escherichia Coli	<1		1	MPN/100mL		21-APR-16	R3443066

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
TC,EC-QT97-WP	Water	Total Coliform and E.coli by MPN QT97	APHA 9223B QT97

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 97-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Workorder: L1758871 Report Date: 22-APR-16

Client: MB Infra & Transport - Highway Engineering - 6th Floor
865 Waverly St
Winnipeg MB R3T5P4
Contact: MARCI FRIEDMAN-HAMM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT97-WP	**Water**							
Batch R3443066								
WG2295198-2 DUP		**L1758871-1**						
Total Coliforms		1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
WG2295198-3 DUP		**L1758871-2**						
Total Coliforms		4	3		MPN/100mL	28	65	21-APR-16
Escherichia Coli		2	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
WG2295198-4 DUP		**L1758871-3**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
WG2295198-5 DUP		**L1758871-4**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
Escherichia Coli		1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
WG2295198-6 DUP		**L1758871-5**						
Total Coliforms		4	4		MPN/100mL	0.0	65	21-APR-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
WG2295198-7 DUP		**L1758871-6**						
Total Coliforms		5	3		MPN/100mL	52	65	21-APR-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	21-APR-16
WG2295198-8 MB								
Total Coliforms			<1		MPN/100mL		1	21-APR-16
Escherichia Coli			<1		MPN/100mL		1	21-APR-16

Quality Control Report

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

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
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1758871-COFC

COC Number: 14 - 455904

Page 1 of 1

L1758871

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS group	Select Report Format:	PDF EXCEL EDD (DIGITAL)	R Regular (Standard TAT if received by 3pm)
Contact:	Marcel Friedman-Hamm	Quality Control (QC) Report with Report	Yes No	P Priority (2-4 business days if received by 3pm)
Address:	865 waverly Street Wpg MB R3T 5P4	Criteria on Report - provide details below if box checked		E Emergency (1-2 business days if received by 3pm)
Phone:	204-896-1209	Select Distribution:	EMAIL MAIL FAX	E2 Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	Amelwin@Kgsgroup.com, Rwadell@Kgsg	Specify Date Required for E2,E or P:
		Email 2	mfHamm@Kgsgroup.com	

Invoice To		Invoice Distribution	
	Same as Report To: Yes No	Select Invoice Distribution:	EMAIL MAIL FAX
	Copy of Invoice with Report: Yes No	Email 1 or Fax	wmacquarrie@kgsgroup.com
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q55656	Approver ID:	Cost Center:
Job #:	16-0300-002 - 1000-02	GL Account:	Routing Code:
PO / AFE:	MIT Floodway	Activity Code:	
LSD:	Floodway	Location:	
ALS Lab Work Order # (lab use only)		ALS Contact: Judy Dalmaijer	Sampler: Ariel Melvin

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Analysis Request: TC, EC-QT97-wp	Number of Containers
1	K13-12321	21-Apr-16	10:30	GW	X	1
2	K09-12316	21-Apr-16	11:15	GW	X	1
3	K09-12012	21-Apr-16	12:15	GW	X	1
4	K11-12014	21-Apr-16	14:30	GW	X	1
5	K11-12015	21-Apr-16	16:30	GW	X	1
6	MW100	21-Apr-16	18:00	GW	X	1

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client use)
Are samples taken from a Regulated DW System? Yes No	Canadian Drinking water Guidelines
Are samples for human drinking water use? Yes No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen		SIF Observations	Yes	No	
Ice packs	Yes No	Custody seal intact	Yes	No	
Cooling Initiated					

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Ariel Melvin	Apr 21	18:10		21-4-16	17:10			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K13-12321
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	617		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	3.25		mg/L	10		06-JUN-16
pH						
pH	7.30		pH units			08-JUN-16
Turbidity						
*Turbidity	0.41		NTU			03-JUN-16
TDS calculated						
TDS (Calculated)	990		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	93.7		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	3.25		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	109		%			09-JUN-16
Cation - Anion Balance	4.3		%			09-JUN-16
Anion Sum	19.1		me/L			09-JUN-16
Cation Sum	20.9		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	882		mg/L		500	07-JUN-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	113		mg/L			06-JUN-16
Magnesium (Mg)-Dissolved	146		mg/L			06-JUN-16
Potassium (K)-Dissolved	6.55		mg/L			06-JUN-16
Sodium (Na)-Dissolved	69.8		mg/L		200	06-JUN-16
Conductivity						
Conductivity	1710		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	243		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	506		mg/L			08-JUN-16
Total Coliform and E.coli by MPN QT97						

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K13-12321
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		02-JUN-16
Escherichia Coli	<1		MPN/100mL	0		02-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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

Approved by

Gail Hill, B.Sc.
Account Manager

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K09-12316
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	438		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	1.57		mg/L	10		06-JUN-16
pH						
pH	7.63		pH units			08-JUN-16
Turbidity						
*Turbidity	0.17		NTU			03-JUN-16
TDS calculated						
TDS (Calculated)	490		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	64.1		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	1.57		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	113		%			09-JUN-16
Cation - Anion Balance	5.9		%			09-JUN-16
Anion Sum	9.49		me/L			09-JUN-16
Cation Sum	10.7		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	482		mg/L		500	07-JUN-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	74.8		mg/L			06-JUN-16
Magnesium (Mg)-Dissolved	71.7		mg/L			06-JUN-16
Potassium (K)-Dissolved	4.47		mg/L			06-JUN-16
Sodium (Na)-Dissolved	21.6		mg/L		200	06-JUN-16
Conductivity						
Conductivity	853		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	30.6		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	359		mg/L			08-JUN-16
Total Coliform and E.coli by MPN QT97						

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Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K09-12316
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	1		MPN/100mL	0		02-JUN-16
Escherichia Coli	<1		MPN/100mL	0		02-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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

Approved by

Gail Hill, B.Sc.
Account Manager

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K09-12012
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	379		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	<0.0051		mg/L	10		06-JUN-16
pH						
pH	7.56		pH units			08-JUN-16
Turbidity						
*Turbidity	12.8		NTU			03-JUN-16
TDS calculated						
TDS (Calculated)	660		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	238		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	108		%			09-JUN-16
Cation - Anion Balance	4.1		%			09-JUN-16
Anion Sum	11.8		me/L			09-JUN-16
Cation Sum	12.8		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	530		mg/L		500	07-JUN-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	86.3		mg/L			06-JUN-16
Magnesium (Mg)-Dissolved	76.5		mg/L			06-JUN-16
Potassium (K)-Dissolved	4.50		mg/L			06-JUN-16
Sodium (Na)-Dissolved	46.8		mg/L		200	06-JUN-16
Conductivity						
Conductivity	1020		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	21.0		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	311		mg/L			08-JUN-16
Total Coliform and E.coli by MPN QT97						

KGS Group Consultants (Winnipeg)
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ATTN: Marci Friedman Hamm

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K09-12012
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		02-JUN-16
Escherichia Coli	<1		MPN/100mL	0		02-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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

Approved by

Gail Hill, B.Sc.
Account Manager

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K11-12014
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	312		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	0.211		mg/L	10		06-JUN-16
pH						
pH	7.60		pH units			08-JUN-16
Turbidity						
*Turbidity	0.49		NTU			03-JUN-16
TDS calculated						
TDS (Calculated)	360		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	60.9		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.211		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	112		%			09-JUN-16
Cation - Anion Balance	5.8		%			09-JUN-16
Anion Sum	6.85		me/L			09-JUN-16
Cation Sum	7.69		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	363		mg/L		500	07-JUN-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	72.4		mg/L			06-JUN-16
Magnesium (Mg)-Dissolved	44.3		mg/L			06-JUN-16
Potassium (K)-Dissolved	4.25		mg/L			06-JUN-16
Sodium (Na)-Dissolved	7.40		mg/L		200	06-JUN-16
Conductivity						
Conductivity	625		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	16.1		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	256		mg/L			08-JUN-16
Total Coliform and E.coli by MPN QT97						

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K11-12014
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	10		MPN/100mL	0		02-JUN-16
Escherichia Coli	<1		MPN/100mL	0		02-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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* 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

Gail Hill, B.Sc.
Account Manager

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K11-12015
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	288		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	0.0760		mg/L	10		06-JUN-16
pH						
pH	7.72		pH units			08-JUN-16
Turbidity						
*Turbidity	0.93		NTU			03-JUN-16
TDS calculated						
TDS (Calculated)	343		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	64.6		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0027		mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0733		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	109		%			09-JUN-16
Cation - Anion Balance	4.5		%			09-JUN-16
Anion Sum	6.55		me/L			09-JUN-16
Cation Sum	7.16		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	337		mg/L		500	07-JUN-16
Dissolved Metals by ICP-MS						
Calcium (Ca)-Dissolved	66.2		mg/L			06-JUN-16
Magnesium (Mg)-Dissolved	41.7		mg/L			06-JUN-16
Potassium (K)-Dissolved	4.22		mg/L			06-JUN-16
Sodium (Na)-Dissolved	7.36		mg/L		200	06-JUN-16
Conductivity						
Conductivity	596		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	16.9		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	236		mg/L			08-JUN-16
Total Coliform and E.coli by MPN QT97						

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

Date: 09-JUN-16
PO No.: 16-0300-002
WO No.: L1777719
Project Ref:
Sample ID: K11-12015
Sampled By: AN&ADS
Date Collected: 02-JUN-16
Lab Sample ID: L1777719-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	5		MPN/100mL	0		02-JUN-16
Escherichia Coli	<1		MPN/100mL	0		02-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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

Approved by

Gail Hill, B.Sc.
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

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

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

Aesthetic Objective Concentration Levels

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

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Workorder: L1777719 Report Date: 09-JUN-16

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3475767								
WG2324124-10 DUP		**L1777719-5**						
Alkalinity, Total (as CaCO3)		236	243		mg/L	2.8	20	08-JUN-16
WG2324124-9 LCS								
Alkalinity, Total (as CaCO3)			96.4		%		85-115	08-JUN-16
WG2324124-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	08-JUN-16
CL-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Chloride (Cl)			100.5		%		90-110	03-JUN-16
WG2320702-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	03-JUN-16
EC-WP	**Water**							
Batch R3475767								
WG2324124-10 DUP		**L1777719-5**						
Conductivity		596	600		umhos/cm	0.7	10	08-JUN-16
WG2324124-8 LCS								
Conductivity			98.1		%		90-110	08-JUN-16
WG2324124-6 MB								
Conductivity			<1.0		umhos/cm		1	08-JUN-16
MET-D-MS-WP	**Water**							
Batch R3473925								
WG2320712-2 LCS								
Calcium (Ca)-Dissolved			102.2		%		80-120	06-JUN-16
Magnesium (Mg)-Dissolved			103.7		%		80-120	06-JUN-16
Potassium (K)-Dissolved			103.8		%		80-120	06-JUN-16
Sodium (Na)-Dissolved			103.2		%		80-120	06-JUN-16
WG2320712-1 MB								
Calcium (Ca)-Dissolved			<0.20		mg/L		0.2	06-JUN-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	06-JUN-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	06-JUN-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	06-JUN-16
NO2-L-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Nitrite (as N)			98.9		%		90-110	03-JUN-16
WG2320702-13 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	03-JUN-16
NO3-L-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Nitrate (as N)			100.8		%		90-110	03-JUN-16
WG2320702-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	03-JUN-16
PH-WP	**Water**							
Batch R3475767								
WG2324124-10 DUP		**L1777719-5**						
pH		7.72	7.68	J	pH units	0.04	0.2	08-JUN-16
WG2324124-7 LCS								
pH			7.42		pH units		7.3-7.5	08-JUN-16
SO4-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Sulfate (SO4)			101.0		%		90-110	03-JUN-16
WG2320702-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	03-JUN-16
TC,EC-QT97-WP	**Water**							
Batch R3471671								
WG2320278-2 DUP		**L1777719-5**						
Total Coliforms		5	4		MPN/100mL	24	65	02-JUN-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
WG2320278-3 DUP		**L1777719-4**						
Total Coliforms		10	9		MPN/100mL	12	65	02-JUN-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
WG2320278-4 DUP		**L1777719-3**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
WG2320278-5 DUP		**L1777719-2**						
Total Coliforms		1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
WG2320278-6 DUP		**L1777719-1**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT97-WP	**Water**							
Batch R3471671								
WG2320278-6 DUP		**L1777719-1**						
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-JUN-16
WG2320278-1 MB								
Total Coliforms			<1		MPN/100mL		1	02-JUN-16
Escherichia Coli			<1		MPN/100mL		1	02-JUN-16
TURBIDITY-WP	**Water**							
Batch R3473113								
WG2321668-2 LCS								
Turbidity			97.0		%		85-115	03-JUN-16
WG2321668-1 MB								
Turbidity			<0.10		NTU		0.1	03-JUN-16

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	02-JUN-16 09:00	08-JUN-16 10:16	0.25	145	hours	EHTR-FM
	2	02-JUN-16 10:00	08-JUN-16 10:16	0.25	144	hours	EHTR-FM
	3	02-JUN-16 11:30	08-JUN-16 10:16	0.25	143	hours	EHTR-FM
	4	02-JUN-16 13:00	08-JUN-16 10:16	0.25	141	hours	EHTR-FM
	5	02-JUN-16 14:00	08-JUN-16 10:16	0.25	140	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 L1777719 were received on 02-JUN-16 15:30.

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

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
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1777719-COFC

COC Number: 14 - 503129

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	PDF EXCEL EDD (DIGITAL)	R Regular (Standard TAT if received by 3pm)
Contact:	Marci Friedman - Hamm	Quality Control (QC) Report with Report	Yes No	P Priority (2-4 business days if received by 3pm)
Address:	865 Waverley Street, Winnipeg, MB	Criteria on Report - provide details below if box checked		E Emergency (1-2 business days if received by 3pm)
Phone:	204 896 1209	Select Distribution:	EMAIL MAIL FAX	E2 Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	mfhamm@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	pnguyen@kgsgroup.com	

Invoice To	Same as Report To	Yes No	Invoice Distribution		Analysis Request
	Copy of Invoice with Report	Yes No	Select Invoice Distribution:	EMAIL MAIL FAX	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
Company:	KGS Group		Email 1 or Fax	bmacquarrie@kgsgroup.com	
Contact:	Bill MacQuarrie		Email 2		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q56271	Approver ID:	Cost Center:
Job #:		GL Account:	Routing Code:
PO / AFE:	16-0300-002	Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact: Jody DeBaere	Sampler: AN & ADS

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	KGS-BOW-IN-D-FLOW-WP	+TC, EC-QT97-WP	Number of Containers
1	K13-12321	02-Jun-16	09:00	GW	X	X	2
2	K09-12316	"	10:00	"	X	X	2
3	K09-12012	"	11:30	"	X	X	2
4	K11-12014	"	13:00	"	X	X	2
5	K11-12015	"	14:00	"	X	X	2

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☑ No	
Are samples for human drinking water use? ☐ Yes ☑ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☐	No ☐		Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☐						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
10					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	June 2/16	15:30		2JUN16	15:30			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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

Date: 09-JUN-16
PO No.:
WO No.: L1777725
Project Ref: 16-0300-002
Sample ID: PTH-44
Sampled By: ADS/AN
Date Collected: 02-JUN-16
Lab Sample ID: L1777725-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	277		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	0.727		mg/L	10		06-JUN-16
pH						
pH	8.03		pH units			08-JUN-16
Turbidity						
*Turbidity	10.0		NTU			03-JUN-16
Total Metals by ICP-MS						
Calcium (Ca)-Total	62.8		mg/L			06-JUN-16
Magnesium (Mg)-Total	41.7		mg/L			06-JUN-16
Potassium (K)-Total	4.84		mg/L			06-JUN-16
Sodium (Na)-Total	27.8		mg/L		200	06-JUN-16
TDS calculated						
TDS (Calculated)	396		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	81.0		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0234		mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.704		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	107		%			09-JUN-16
Cation - Anion Balance	3.5		%			09-JUN-16
Anion Sum	7.36		me/L			09-JUN-16
Cation Sum	7.90		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	329		mg/L		500	07-JUN-16
Conductivity						
Conductivity	665		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	38.4		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	227		mg/L			08-JUN-16
Phosphorus (P)-Total	0.108		mg/L			07-JUN-16
Ammonia, Total (as N)	<0.010		mg/L			03-JUN-16

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

Date: 09-JUN-16
PO No.:
WO No.: L1777725
Project Ref: 16-0300-002
Sample ID: PTH-44
Sampled By: ADS/AN
Date Collected: 02-JUN-16
Lab Sample ID: L1777725-1
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Escherichia Coli	1210		MPN/100mL	0		02-JUN-16
Total Coliforms	41100		MPN/100mL	0		02-JUN-16
Total Kjeldahl Nitrogen	1.32		mg/L			08-JUN-16
Total Suspended Solids	13.0		mg/L			06-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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

Approved by

Craig Riddell, B.Sc.Ag
Account Manager

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

Date: 09-JUN-16
PO No.:
WO No.: L1777725
Project Ref: 16-0300-002
Sample ID: PTH-59
Sampled By: ADS/AN
Date Collected: 02-JUN-16
Lab Sample ID: L1777725-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	256		mg/L			09-JUN-16
Carbonate (CO3)	<0.60		mg/L			09-JUN-16
Hydroxide (OH)	<0.34		mg/L			09-JUN-16
*Nitrate and Nitrite as N	4.68		mg/L	10		06-JUN-16
pH						
pH	8.24		pH units			08-JUN-16
Turbidity						
*Turbidity	16.8		NTU			03-JUN-16
Total Metals by ICP-MS						
Calcium (Ca)-Total	64.4		mg/L			06-JUN-16
Magnesium (Mg)-Total	46.4		mg/L			06-JUN-16
Potassium (K)-Total	6.53		mg/L			06-JUN-16
Sodium (Na)-Total	30.4		mg/L		200	06-JUN-16
TDS calculated						
TDS (Calculated)	434		mg/L		500	09-JUN-16
Sulfate in Water by IC						
Sulfate (SO4)	93.2		mg/L		500	03-JUN-16
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0606		mg/L	1		03-JUN-16
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	4.62		mg/L	10		03-JUN-16
Ion Balance Calculation						
Ion Balance	110		%			09-JUN-16
Cation - Anion Balance	4.6		%			09-JUN-16
Anion Sum	7.77		me/L			09-JUN-16
Cation Sum	8.52		me/L			09-JUN-16
Hardness Calculated						
Hardness (as CaCO3)	352		mg/L		500	07-JUN-16
Conductivity						
Conductivity	718		umhos/cm			08-JUN-16
Chloride in Water by IC						
Chloride (Cl)	46.2		mg/L		250	03-JUN-16
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	210		mg/L			08-JUN-16
Phosphorus (P)-Total	0.285		mg/L			07-JUN-16
Ammonia, Total (as N)	0.014		mg/L			03-JUN-16

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

Date: 09-JUN-16
PO No.:
WO No.: L1777725
Project Ref: 16-0300-002
Sample ID: PTH-59
Sampled By: ADS/AN
Date Collected: 02-JUN-16
Lab Sample ID: L1777725-2
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Escherichia Coli	1440		MPN/100mL	0		02-JUN-16
Total Coliforms	26100		MPN/100mL	0		02-JUN-16
Total Kjeldahl Nitrogen	1.87		mg/L			08-JUN-16
Total Suspended Solids	15.0		mg/L			06-JUN-16

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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

Approved by

Craig Riddell, B.Sc.Ag
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

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 R3475767								
WG2324124-9 LCS								
Alkalinity, Total (as CaCO3)			96.4		%		85-115	08-JUN-16
WG2324124-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	08-JUN-16
CL-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Chloride (Cl)			100.5		%		90-110	03-JUN-16
WG2320702-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	03-JUN-16
EC-QT97-ENDPT-WP	**Water**							
Batch R3471660								
WG2320511-2 DUP		**L1777725-1**						
Escherichia Coli		1210	860		MPN/100mL	34	65	02-JUN-16
WG2320511-1 MB								
Escherichia Coli			<1		MPN/100mL		1	02-JUN-16
EC-WP	**Water**							
Batch R3475767								
WG2324124-8 LCS								
Conductivity			98.1		%		90-110	08-JUN-16
WG2324124-6 MB								
Conductivity			<1.0		umhos/cm		1	08-JUN-16
MET-T-MS-WP	**Water**							
Batch R3473925								
WG2321777-2 LCS								
Calcium (Ca)-Total			107.9		%		80-120	06-JUN-16
Magnesium (Mg)-Total			103.1		%		80-120	06-JUN-16
Potassium (K)-Total			104.0		%		80-120	06-JUN-16
Sodium (Na)-Total			107.5		%		80-120	06-JUN-16
WG2321777-1 MB								
Calcium (Ca)-Total			<0.20		mg/L		0.2	06-JUN-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	06-JUN-16
Potassium (K)-Total			<0.10		mg/L		0.1	06-JUN-16
Sodium (Na)-Total			<0.050		mg/L		0.05	06-JUN-16
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R3475017								
WG2322920-6 LCS								
Total Kjeldahl Nitrogen			98.0		%		75-125	08-JUN-16
WG2322920-5 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	08-JUN-16
NH3-COL-WP	**Water**							
Batch R3474097								
WG2321991-2 LCS								
Ammonia, Total (as N)			100.3		%		85-115	03-JUN-16
WG2321991-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	03-JUN-16
NO2-L-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Nitrite (as N)			98.9		%		90-110	03-JUN-16
WG2320702-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	03-JUN-16
NO3-L-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Nitrate (as N)			100.8		%		90-110	03-JUN-16
WG2320702-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	03-JUN-16
P-T-COL-WP	**Water**							
Batch R3474546								
WG2322229-14 LCS								
Phosphorus (P)-Total			97.7		%		80-120	07-JUN-16
WG2322229-13 MB								
Phosphorus (P)-Total			<0.010		mg/L		0.01	07-JUN-16
PH-WP	**Water**							
Batch R3475767								
WG2324124-7 LCS								
pH			7.42		pH units		7.3-7.5	08-JUN-16
SO4-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R3473400								
WG2320702-14 LCS								
Sulfate (SO4)			101.0		%		90-110	03-JUN-16
WG2320702-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	03-JUN-16
TC-QT97-ENDPT-WP	**Water**							
Batch R3471660								
WG2320511-2 DUP		**L1777725-1**						
Total Coliforms		41100	26100		MPN/100mL	44	65	02-JUN-16
WG2320511-1 MB								
Total Coliforms			<1		MPN/100mL		1	02-JUN-16
TURBIDITY-WP	**Water**							
Batch R3473113								
WG2321668-2 LCS								
Turbidity			97.0		%		85-115	03-JUN-16
WG2321668-1 MB								
Turbidity			<0.10		NTU		0.1	03-JUN-16

Quality Control Report

Legend:

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

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	02-JUN-16 11:00	08-JUN-16 10:16	0.25	143	hours	EHTR-FM
	2	02-JUN-16 14:30	08-JUN-16 10:16	0.25	140	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 L1777725 were received on 02-JUN-16 15:30.

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

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
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1777725-COFC

COC Number: 14 - 503127

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)	
Company:	KGS GROUP	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑	Regular (Standard TAT if received by 3pm)
Contact:	MARC-FRIEDMANN HAMM	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☐	Priority (2-4 business days if received by 3pm)
Address:	865 WAVERLEY ST	☐ Criteria on Report - provide details below if box checked		E ☐	Emergency (1-2 business days if received by 3pm)
		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐	Same day or weekend emergency if received by 10am – contact ALS for surcharge.
Phone:	204 896-1209	Email 1 or Fax	MFHAMM@KGSGROUP.COM	Specify Date Required for E2,E or P:	
		Email 2	PNGUYEN@KGSGROUP.COM		

Invoice To		Invoice Distribution		Analysis Request
	Same as Report To ☐ Yes ☑ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
	Copy of Invoice with Report ☑ Yes ☐ No	Email 1 or Fax	WMACQUARRIE@KASGROUP.COM	
Company:	KGS GROUP	Email 2		
Contact:	BILL MACQUARRIE	Oil and Gas Required Fields (client use)		
Project Information		Approver ID:	Cost Center:	
ALS Quote #:	Q56271	GL Account:	Routing Code:	
Job #:	16-0300-002	Activity Code:		
PO / AFE:		Location:		
LSD:				
ALS Lab Work Order # (lab use only)		ALS Contact: JUDY DALMAGER	Sampler: ADS/AN	

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	KGS-ROUTINE + Alum	WP+P-T-Col	N-TOT KJ-WP	NH3-Col-WP	SOLIDS-TOTSUS-WP	TC-QT-97-WP	END PAH-WP	EC-QT-97-EWP	< WP	Number of Containers
1	PTH-44	02-06-16	1100	SW	X	X	X	X	X	X	X	X	X	5
2	PTH-59	02-06-16	1430	SW	X	X	X	X	X	X	X	X	X	5

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)	SAMPLE CONDITION AS RECEIVED (lab use only)
Are samples taken from a Regulated DW System? ☐ Yes ☑ No		Frozen ☐ SIF Observations Yes ☐ No ☐
Are samples for human drinking water use? ☐ Yes ☑ No		Ice packs Yes ☐ No ☐ Custody seal intact Yes ☐ No ☐
		Cooling initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
10.8					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	2016/06/16	15:30		2 JUN 16	15:30			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

KGS GROUP

CONSULTING ENGINEERS