



Keeyask Infrastructure Project

Terrestrial and Aquatic Monitoring Plan

Water Quality Monitoring

Annual Report 2013-2014



KEYYASK INFRASTRUCTURE PROJECT

TERRESTRIAL AND AQUATIC MONITORING PLAN

Water Quality: Annual Report 2013 - 2014

Report for

MANITOBA CONSERVATION AND WATER STEWARDSHIP

Prepared on Behalf of the
Keeyask Hydropower Limited Partnership

By

North/South Consultants Inc.

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1.0 INTRODUCTION

The Keeyask Hydropower Limited Partnership is constructing the Keeyask Infrastructure Project (the Project or KIP). The Project is located approximately 40 km southwest of Gillam, extending between Provincial Road (PR) 280 and Gull Rapids on the Nelson River. The Project includes a start-up camp and associated infrastructure, a 25 km all-weather access road and the first phase of a main camp. The start-up camp is located near the intersection of PR 280 and the access road, while the first phase of the main camp is located at the end of the access road on the north side of Gull Rapids.

The predicted environmental effects of the KIP were described in the KIP Environmental Assessment Report (KHLP 2009; the EA Report). The following describes sampling methods and results from the water quality monitoring program conducted in the vicinity of two stream crossings along the KIP access road from April 1, 2013 to March 31, 2014. This work was conducted in accordance with Section 2.0 of the *Keeyask Infrastructure Project Terrestrial and Aquatic Monitoring Plan*.

Water quality monitoring was conducted at two stream crossings: Looking Back Creek and an unnamed tributary to the South Moswakot River (“unnamed tributary”) (Figure 1). Sampling occurred on July 14 (Looking Back Creek only), August 20/August 23, September 10, and October 28, 2013. Sampling could not be conducted in May or June, and only at selected sites in July and October, because of the presence of low water conditions and/or ice on the creeks. Forest fires also dominated the area in July and sampling was only conducted when and where it was safe to do so.

A permanent clear-span bridge was constructed over Looking Back Creek during 2012/early 2013 (Figure 2) and a culvert was installed in the unnamed tributary in early 2012 (Figure 3). Monitoring conducted in 2013 was intended to assess whether there were any differences in water quality upstream and downstream of each of the road crossings, post-construction. The water quality monitoring program is focussed on measurement of turbidity and total suspended solids (TSS) but also includes monitoring for nutrients during one sampling event.

Looking Back Creek supports upstream movements of Walleye (*Sander vitreus*) and Northern Pike (*Esox lucius*) at the crossing location. The Department of Fisheries and Oceans Canada deemed the installation of a culvert at the unnamed tributary to be of low risk to fish and fish habitat and no fish were observed in surveys conducted prior to 2013. During one sampling period in 2013 (August), several Brook Stickleback (*Culaea inconstans*; Figure 4) and small Northern Pike were observed at the crossing.

2.0 METHODS

Monitoring was conducted in July and October by Manitoba Hydro and in August and September by North/South Consultants Inc.

2.1 SAMPLING LOCATIONS

Water quality monitoring was conducted at transects located upstream and downstream of the two crossings (Figure 1; Table 1).

At Looking Back Creek, four transects were located as follows:

- one approximately 15 m upstream of bridge (SC1-T1);
- one immediately downstream of the bridge (SC1-T2);
- one approximately 50 m downstream of bridge (SC1-T3); and,
- one approximately 100 m downstream of the bridge (SC1-T4).

Up to three sites were sampled along each transect at Looking Back Creek; not all sites were sampled during each sampling event due to low water or ice. Sampling sites were located at mid-channel and approximately half way between mid-channel and each bank. Each transect was sampled and named starting from the left-hand bank (when facing upstream) to the right-hand bank (i.e., -1, -2, -3 corresponds left, mid, and right, respectively). Exceptions occurred in July and October. In July, low water levels only allowed for two samples to be collected across the width of the creek, labelled as A and B. At that time, the samples were also labelled in reverse such that the upstream transect was sampled last and therefore labelled as Site 4 (e.g., LBC-4). Additionally, in October, the locations of the sampling sites were determined by the extent of ice formation and ability to safely access the area. No transect sampling was conducted; rather, one site upstream of the crossing and one site directly below the crossing (instead of being immediately downstream) were sampled.

At the unnamed tributary, sampling was conducted at a single site within the main flow of the creek in the following locations:

- upstream of the road crossing and the road footprint within the natural channel of the creek (SC2-T1);
- immediately upstream of the road crossing, located alongside the roadway within the ditch (SC2-T2);
- immediately downstream of the road crossing (SC2-T3); and,
- approximately 30 m downstream of the road crossing (SC2-T4).

2.2 SAMPLING METHODS AND PARAMETERS

Both road crossings were accessed by truck. Sites located on Looking Back Creek were sampled by canoe, while sites located on the unnamed tributary were sampled from shore. During most seasons, water depth of each site was measured using either a handheld Digital Sonar system or a meter stick. Universal Transverse Mercator (UTM) coordinates were recorded using a hand-held Garmin eTrex.

At each sampling site, *in situ* measurements of turbidity were collected using an Analite NEP 160 turbidity meter. At Looking Back Creek, measurements in August and September were collected near the surface, at mid-depth and near the bottom; where water depths were < 1 m only surface and bottom measurements were taken. At the unnamed tributary measurements were taken from just below the surface. Measurements were not recorded at either crossing in July. In October, *in situ* turbidity was measured three days after samples were collected for analysis of TSS; turbidity was measured from a sample of water collected in a secondary vessel from just below the surface that was then stored three days until the turbidity meter was calibrated.

At all sites and sampling times, water samples were collected for laboratory analysis of TSS. Additionally, water samples collected from Looking Back Creek in July and in the vicinity of both crossings in September were analysed for nutrients. Nutrients measured included: nitrate-N, nitrite-N, dissolved nitrate/nitrite-N, total Kjeldahl nitrogen (TKN; September only), total nitrogen (TN), total phosphorus (TP), and dissolved phosphorus (DP). All TSS and nutrient samples were collected as grab samples from just below the water surface (i.e.,

0.3 m where water depths were sufficient). After collection, samples were kept cool and in the dark until submission to a Canadian Association for Laboratory Accreditations, Inc. (CALA) accredited laboratory (Maxxam Laboratories or ALS Laboratories, Winnipeg) for analysis. Samples collected in July for nitrite, nitrate/nitrite, and DP were analysed after the laboratory specified hold times.

2.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Standard QA/QC measures were generally followed during sample collection (e.g., use of arm length gloves, standard labelling practices, meter verifications, sampling from downstream to upstream, etc.). As part of the monitoring program, a field blank and a trip blank were also collected in August and September, and a duplicate sample was collected in October. Details on the intent and methods used to assess these QA/QC samples can be found in BCMELP (1998). All water quality data were evaluated qualitatively for potential outliers and/or transcription or analytical errors. Where one sample differed notably from the others collected along a transect, the measurement was flagged as “suspect”.

3.0 RESULTS

3.1 LOOKING BACK CREEK

Water quality monitoring results for Looking Back Creek are presented in Tables 2 to 4.

TSS concentrations and turbidity measurements in Looking Back Creek were generally higher in July and August compared to September and October. However, during each sampling event, TSS and turbidity were similar upstream and downstream of the crossing and across transects. Turbidity was also similar throughout the water column at all sites sampled. TSS concentrations downstream of the Looking Back Creek crossing were consistently below the Manitoba water quality objectives for the protection of aquatic life (Manitoba Water Stewardship [MWS] 2011; i.e., induced change in TSS of 5 mg/L from background for an averaging duration of 30 days when background concentrations are less than 25 mg/L).

At the initiation of monitoring on August 20, the sampling crew noted a sediment plume in Looking Back Creek (Figures 5 and 6). Monitoring was suspended and the Environmental Officer at the Keeyask Camp was notified. Additional rip-rap was installed on August 27 as sediment/erosion control (Figure 7). As noted above, water quality was similar upstream and downstream of the crossing following installation of the rip-rap, indicating the mitigation was effective.

Similar to measures of water clarity, there was no indication that nutrients increased in Looking Back Creek downstream of the crossing. In fact, both TN and TP were lower downstream of the crossing than upstream in September; results obtained in August were similar between upstream and downstream areas. Nitrate, nitrite, and nitrate/nitrite were not detected at any sampling site in Looking Back Creek in August. Concentrations of these parameters were either below the analytical detection limits or relatively low in September. All concentrations of nitrate and nitrate/nitrite were well below the Manitoba water quality guideline for the protection of aquatic life (2.93 mg N/L; MWS 2011).

3.2 THE UNNAMED TRIBUTARY

Water quality monitoring results for the unnamed tributary are presented in Tables 5 to 7.

Turbidity and TSS downstream of the stream crossing were generally similar to or lower than at the upstream sites. A high TSS value was measured immediately upstream of the crossing (at SC2-T2) on September 10, but the value is considered suspect as *in situ* turbidity was low and similar to the downstream sites. TSS concentrations at the downstream sites were consistently below the Manitoba water quality objectives for the protection of aquatic life (MWS 2011).

Nitrate, nitrite, and nitrate/nitrite were not detected at any sampling site along the unnamed tributary in September. All concentrations of nitrate and nitrate/nitrite were well below the Manitoba water quality guideline for the protection of aquatic life (2.93 mg N/L; MWS 2011). TKN and TN were slightly higher at the two sites downstream of the road crossing compared to these in the upstream reach. In contrast, DP was highest at upstream site (SC2-T1) but TP was similar across sites.

3.3 QA/QC RESULTS

TSS, nitrate, nitrite, nitrate/nitrite, DP, and TP were not detected in the field or trip blanks (Table 8). TKN and TN nitrogen were detected in the field blank and the trip blank in September. These results suggest that TKN and TN may have been introduced to samples from the sample bottles and/or at the analytical laboratory. In addition, introduction of nitrogen to samples in the field may have also occurred since concentrations were higher, and greater than five times the analytical detection limit, in the field blank. TSS was not detected in either of the duplicate samples collected in October.

4.0 REFERENCES

British Columbia Ministry of Environment, Lands, And Parks (BCMELP). 1998. Guidelines for interpreting water quality data. Version 1, May 1998. Prepared for the Land Use Task Force Resource Inventory Committee.

Manitoba Water Stewardship. 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. Final Draft: November 28, 2011. 67 pp.

Table 1. GPS locations (NAD 83) and sampling dates for the water quality monitoring program conducted at the two stream crossings along the KIP access road, 2013.

| Transect ID | Date | Zone | Easting | Northing | Location Description ¹ |
|---------------------------|-----------|------------------|---------|----------|---|
| <u>Looking Back Creek</u> | | | | | |
| SC1-T1 | 14-Jul-13 | 15U | 360557 | 6250032 | 15 m U/S of road crossing |
| | 23-Aug-13 | 15U | 360558 | 6250033 | |
| | 10-Sep-13 | 15U | 360553 | 6250033 | |
| | 28-Oct-13 | not recorded | | | |
| SC1-T2 | 14-Jul-13 | 15U | 360620 | 6250058 | immediately D/S of road crossing |
| | 23-Aug-13 | 15U | 360618 | 6250057 | |
| | 10-Sep-13 | 15U | 360618 | 6250062 | |
| | 28-Oct-13 | not recorded | | | |
| SC1-T3 | 14-Jul-13 | 15U | 360669 | 6250073 | 50 m D/S of the road crossing |
| | 23-Aug-13 | 15U | 360673 | 6250077 | |
| | 10-Sep-13 | 15U | 360673 | 6250079 | |
| | 28-Oct-13 | unsafe to sample | | | |
| SC1-T4 | 14-Jul-13 | 15U | 360705 | 6250058 | 100 m D/S of the road crossing |
| | 23-Aug-13 | 15U | 360709 | 6250065 | |
| | 10-Sep-13 | 15U | 360708 | 6250047 | |
| | 28-Oct-13 | unsafe to sample | | | |
| <u>Unnamed Tributary</u> | | | | | |
| SC2-T1 | 23-Aug-13 | 15U | 345591 | 6254920 | U/S of road crossing |
| SC2-T2 | 23-Aug-13 | 15U | 345687 | 6254907 | Immediately U/S of crossing, located alongside the road |
| SC2-T3 | 23-Aug-13 | 15U | 345710 | 6254929 | Immediately D/S of road crossing |
| SC2-T4 | 23-Aug-13 | 15U | 345716 | 6254952 | Approximately 30 m D/S of road crossing |

¹ U/S = upstream; D/S = downstream

Table 2. *In situ* data collected at water quality monitoring transects located near the KIP access road crossing at Looking Back Creek, 2013.

| Transect Location ¹ | Transect | | Sample Date | Sample Time | Total | | | |
|--------------------------------|-----------------|-----------|-------------|-------------|-----------------|------------------|-----------------|------|
| | ID | Site ID | | | Water Depth (m) | Sample Depth (m) | Turbidity (NTU) | |
| 100 m D/S | SC1-T4 | SC1-T4-1 | 20-Aug-13 | 14:30 | 1.1 | 0.3 | 33.1 | |
| | | | | | | 0.7 | 30.7 | |
| | | | | | | 1.0 | 34.4 | |
| 15 m U/S | SC1-T1 | SC1-T1-1 | 23-Aug-13 | 14:15 | 0.58 | 0.3 | 25.4 | |
| | | | | | | 0.5 | 25.6 | |
| | | SC1-T1-2 | 23-Aug-13 | 14:25 | 1.42 | 0.3 | 25.4 | |
| | SC1-T1-3 | 23-Aug-13 | 14:35 | 1.55 | 0.3 | 25.1 | | |
| | | | | | 0.9 | 25.8 | | |
| | | | | | 1.4 | 27.4 | | |
| | Immediately D/S | SC1-T2 | SC1-T2-1 | 23-Aug-13 | 13:50 | 0.87 | 0.3 | 26.3 |
| | | | | | | | 0.8 | 28.5 |
| | | | SC1-T2-2 | 23-Aug-13 | 14:00 | 1.27 | 0.3 | 25.1 |
| SC1-T2-3 | | 23-Aug-13 | 14:05 | 1.47 | 0.3 | 25.9 | | |
| | | | | | 0.9 | 25.7 | | |
| | | | | | 1.3 | 27.8 | | |
| 50 m D/S | SC1-T3 | SC1-T3-1 | 23-Aug-13 | 13:25 | 0.89 | 0.3 | 25.7 | |
| | | | | | | 0.8 | 26.0 | |
| | | SC1-T3-2 | 23-Aug-13 | 13:30 | 0.97 | 0.3 | 25.4 | |
| | | | | | | 0.8 | 25.5 | |
| SC1-T3-3 | 23-Aug-13 | 13:35 | 0.9 | 0.3 | 26.1 | | | |
| | | | | 0.8 | 26.2 | | | |
| | | | | 0.3 | 26.2 | | | |
| 100 m D/S | SC1-T4 | SC1-T4-1 | 23-Aug-13 | 13:00 | 0.9 | 0.3 | 26.2 | |
| | | | | | | 0.7 | 27.5 | |
| | | SC1-T4-2 | 23-Aug-13 | 13:05 | 1.05 | 0.3 | 25.3 | |
| | SC1-T4-3 | 23-Aug-13 | n/r | 1.0 | 1.0 | 27.0 | | |
| | | | | | 0.3 | 26.4 | | |
| | | | | | 0.9 | 26.9 | | |
| 15 m U/S | SC1-T1 | SC1-T1-1 | 10-Sep-13 | - | 0.48 | 0.3 | 12.8 | |
| | | | | | | 0.7 | 14.5 | |
| | | SC1-T1-2 | 10-Sep-13 | - | 1.25 | 0.3 | 12.9 | |
| | SC1-T1-3 | 10-Sep-13 | 13:49 | 1.47 | 1.1 | 14.6 | | |
| | | | | | 0.3 | 13.2 | | |
| | | | | | 0.8 | 14.7 | | |
| 1.3 | 15.2 | | | | | | | |

Table 2. Continued.

| Transect Location | Transect | | Sample Date | Sample Time | Total | | Turbidity (NTU) |
|---------------------------------|----------|-----------|------------------------|-------------|-----------------|------------------|-----------------|
| | ID | Site ID | | | Water Depth (m) | Sample Depth (m) | |
| Immediately D/S | SC1-T2 | SC1-T2-1 | 10-Sep-13 | - | 1.08 | 0.3 | 12.1 |
| | | | | | | 0.7 | 12.2 |
| | | | | | | 0.9 | 12.8 |
| | | SC1-T2-2 | 10-Sep-13 | - | 1.05 | 0.3 | 11.9 |
| | | | | | | 0.7 | 12.0 |
| | | | | | | 0.9 | 12.9 |
| | | SC1-T2-3 | 10-Sep-13 | 13:33 | 0.67 | 0.3 | 11.8 |
| | | | | | | 0.5 | 11.8 |
| | | | | | | | |
| 50 m D/S | SC1-T3 | SC1-T3-1 | 10-Sep-13 | 13:22 | 0.90 | 0.3 | 11.5 |
| | | | | | | 0.7 | 11.95 |
| | | SC1-T3-2 | 10-Sep-13 | - | 0.75 | 0.3 | 11.65 |
| | | | | | | 0.6 | 11.69 |
| 100 m D/S | SC1-T4 | SC1-T4-1 | 10-Sep-13 | 13:03 | 0.80 | 0.3 | 13.6 |
| | | | | | | 0.7 | 13.7 |
| | | | | | | SC1-T4-2 | 10-Sep-13 |
| 0.7 | 12.2 | | | | | | |
| | SC1-T4-3 | 10-Sep-13 | n/r | 0.78 | 0.3 | 13.4 | |
| | | | | | 0.7 | 12.1 | |
| 10 m U/S (LHB ²) | SC1-T1 | SC1-T1 | 28-Oct-13 ⁴ | 15:59 | n/r | 0.3 | 3.28 |
| At crossing (RHB ³) | SC1-T2 | SC1-T2 | 28-Oct-13 ⁴ | 15:51 | n/r | 0.3 | 3.70 |
| 50 m D/S | SC1-T3 | | | n/r | n/r | n/r | |
| 100 m D/S | SC1-T4 | | | n/r | n/r | n/r | |

¹U/S = upstream; D/S = downstream

²Left-hand bank

³Right-hand bank

⁴Samples collected October 28 but analysed for turbidity on October 31.

Table 3. TSS results for water samples collected at water quality monitoring transects located near the KIP access road crossing at Looking Back Creek, 2013.

| Transect Location ¹ | Transect ID | Sample ID | Laboratory ID | Date Sampled | Total Suspended Solids (mg/L) |
|-----------------------------------|-------------|-----------------------|---------------|--------------|-------------------------------|
| Analytical Detection Limit | | | | | 4.0 |
| 15 m U/S | SC1-T1 | LBC-2013-07-14-TSS-4A | GX9200 | 7/14/2013 | 10.5 |
| | | LBC-2013-07-14-TSS-4B | GX9201 | 7/14/2013 | 13.3 |
| Immediately D/S | SC1-T2 | LBC-2013-07-14-TSS-3A | GX9198 | 7/14/2013 | 12.0 |
| | | LBC-2013-07-14-TSS-3B | GX9199 | 7/14/2013 | 11.3 |
| 50 m D/S | SC1-T3 | LBC-2013-07-14-TSS-2A | GX9196 | 7/14/2013 | 12.5 |
| | | LBC-2013-07-14-TSS-2B | GX9197 | 7/14/2013 | 12.3 |
| 100 m D/S | SC1-T4 | LBC-2013-07-14-TSS-1A | GX9194 | 7/14/2013 | 14.8 |
| | | LBC-2013-07-14-TSS-1B | GX9195 | 7/14/2013 | 12.8 |
| Analytical Detection Limit | | | | | 2.0 |
| 15 m U/S | SC1-T1 | SC1-T1-1 | L1353247-10 | 8/23/2013 | 6.5 |
| | | SC1-T1-2 | L1353247-11 | 8/23/2013 | 8.8 |
| | | SC1-T1-3 | L1353247-12 | 8/23/2013 | 7.2 |
| Immediately D/S | SC1-T2 | SC1-T2-1 | L1353247-7 | 8/23/2013 | 9.2 |
| | | SC1-T2-2 | L1353247-8 | 8/23/2013 | 8.4 |
| | | SC1-T2-3 | L1353247-9 | 8/23/2013 | 8.4 |
| 50 m D/S | SC1-T3 | SC1-T3-1 | L1353247-4 | 8/23/2013 | 9.2 |
| | | SC1-T3-2 | L1353247-5 | 8/23/2013 | 10.0 |
| | | SC1-T3-3 | L1353247-6 | 8/23/2013 | 9.2 |
| 100 m D/S | SC1-T4 | SC1-T4-1 | L1353247-1 | 8/23/2013 | 7.5 |
| | | SC1-T4-2 | L1353247-2 | 8/23/2013 | 8.4 |
| | | SC1-T4-3 | L1353247-3 | 8/23/2013 | 9.6 |
| Analytical Detection Limit | | | | | 4.0 |
| 15 m U/S | SC1-T1 | SC1-T1-1 | HL7129 | 9/10/2013 | 7.0 |
| | | SC1-T1-2 | HL7130 | 9/10/2013 | 4.0 |
| | | SC1-T1-3 | HL7131 | 9/10/2013 | 5.0 |
| Immediately D/S | SC1-T2 | SC1-T2-1 | HL7132 | 9/10/2013 | 6.5 |
| | | SC1-T2-2 | HL7133 | 9/10/2013 | <4.0 |
| | | SC1-T2-3 | HL7134 | 9/10/2013 | 5.8 |
| 50 m D/S | SC1-T3 | SC1-T3-1 | HL7135 | 9/10/2013 | <4.0 |
| | | SC1-T3-2 | HL7136 | 9/10/2013 | 6.0 |
| | | SC1-T3-3 | HL7137 | 9/10/2013 | 4.3 |
| 100 m D/S | SC1-T4 | SC1-T4-1 | HL7138 | 9/10/2013 | 4.0 |
| | | SC1-T4-2 | HL7139 | 9/10/2013 | 5.8 |
| | | SC1-T4-3 | HL7140 | 9/10/2013 | 4.8 |

Table 3. Continued.

| Transect Location ¹ | Transect ID | Sample ID | Laboratory ID | Date Sampled | Total Suspended Solids (mg/L) |
|---------------------------------|-------------|---|---------------|--------------|-------------------------------|
| Analytical Detection Limit | | | | | 4.0 |
| 10 m U/S (LHB ²) | SC1-T1 | SC1-T1 | HY5897 | 10/28/2013 | 7.3 |
| At crossing (RHB ³) | SC1-T2 | SC1-T2 | HY5896 | 10/28/2013 | 4.3 |
| 50 m D/S | SC1-T3 | not sampled due to ice formation and log dams | | | |
| 100 m D/S | SC1-T4 | not sampled due to ice formation and log dams | | | |

¹ U/S = upstream; D/S = downstream

² Left-hand bank

³ Right-hand bank

Table 4. Nutrient results for water samples collected at water quality monitoring transects located near the KIP access road crossing at Looking Back Creek, 2013.

| Transect Location ¹ | Transect | | Maxxam IDs | Date Sampled | Nitrate-N (mg/L) | Nitrite-N (mg/L) | Nitrate/ Nitrite-N (mg/L) | Total | Total | Total | |
|--------------------------------|-----------|-----------------------|---------------|-----------------|---------------------|---------------------|---------------------------------|--------------------------------|-----------------------------|-----------------------------------|-------------------------------|
| | ID | Sample Ids | | | | | | Kjeldahl Nitrogen (mg/L) | Total Nitrogen (mg/L) | Dissolved Phosphorus (mg/L) | Total Phosphorus (mg/L) |
| Analytical Detection Limit | | | | | 0.020 | 0.0050 | 0.020 | | 0.020 | 0.0050 | 0.0050 |
| 15 m U/S | SC1-T1 | LBC-2013-07-14-TSS-4A | GX9200 | 7/14/2013 | <0.020 | <0.0050* | <0.020* | - | 0.581 | 0.0081* | 0.0322 |
| | | LBC-2013-07-14-NP-4A | GX9208 | | | | | | | | |
| | | LBC-2013-07-14-P-4A | GX9216 | | | | | | | | |
| | 7/14/2013 | LBC-2013-07-14-TSS-4B | GX9201 | <0.020 | <0.0050* | <0.020* | - | 0.548 | 0.0092* | 0.0310 | |
| | | LBC-2013-07-14-NP-4B | GX9209 | | | | | | | | |
| | | LBC-2013-07-14-P-4B | GX9217 | | | | | | | | |
| Immediately D/S | SC1-T2 | LBC-2013-07-14-TSS-3A | GX9198 | 7/14/2013 | <0.020 | <0.0050* | <0.020* | - | 0.514 | 0.0086* | 0.0345 |
| | | LBC-2013-07-14-NP-3A | GX9206 | | | | | | | | |
| | | LBC-2013-07-14-P-3A | GX9214 | | | | | | | | |
| | 7/14/2013 | LBC-2013-07-14-TSS-3B | GX9199 | <0.020 | <0.0050* | <0.020* | - | 0.560 | 0.0100* | 0.0318 | |
| | | LBC-2013-07-14-NP-3B | GX9207 | | | | | | | | |
| | | LBC-2013-07-14-P-3B | GX9215 | | | | | | | | |
| 50 m D/S | SC1-T3 | LBC-2013-07-14-TSS-2A | GX9196 | 7/14/2013 | <0.020 | <0.0050* | <0.020* | - | 0.577 | 0.0089* | 0.0317 |
| | | LBC-2013-07-14-NP-2A | GX9204 | | | | | | | | |
| | | LBC-2013-07-14-P-2A | GX9212 | | | | | | | | |
| | 7/14/2013 | LBC-2013-07-14-TSS-2B | GX9197 | <0.020 | <0.0050* | <0.020* | - | 0.571 | 0.0097* | 0.0298 | |
| | | LBC-2013-07-14-NP-2B | GX9205 | | | | | | | | |
| | | LBC-2013-07-14-P-2B | GX9213 | | | | | | | | |
| 100 m D/S | SC1-T4 | LBC-2013-07-14-TSS-1A | GX9194 | 7/14/2013 | <0.020 | <0.0050* | <0.020* | - | 0.596 | 0.0085* | 0.0317 |
| | | LBC-2013-07-14-NP-1A | GX9202 | | | | | | | | |
| | | LBC-2013-07-14-P-1A | GX9210 | | | | | | | | |
| | 7/14/2013 | LBC-2013-07-14-TSS-1B | GX9195 | <0.020 | <0.0050* | <0.020* | - | 0.603 | 0.0094* | 0.0323 | |
| | | LBC-2013-07-14-NP-1B | GX9203 | | | | | | | | |
| | | LBC-2013-07-14-P-1B | GX9211 | | | | | | | | |

Table 4. Continued.

| Transect Location | Transect | | Maxxam IDs | Date Sampled | Nitrate-N (mg/L) | Nitrite-N (mg/L) | Nitrate/ Nitrite-N (mg/L) | Total | Total | Total | |
|-----------------------------------|----------|------------|---------------|-----------------|---------------------|---------------------|---------------------------------|--------------------------------|-----------------------------|-----------------------------------|-------------------------------|
| | ID | Sample IDs | | | | | | Kjeldahl Nitrogen (mg/L) | Total Nitrogen (mg/L) | Dissolved Phosphorus (mg/L) | Total Phosphorus (mg/L) |
| Analytical Detection Limit | | | | | 0.020 | 0.002 | 0.020 | 0.020 | 0.020 | 0.0050 | 0.0050 |
| 15 m U/S | SC1-T1 | SC1-T1-1 | HL7129 | 9/10/2013 | <0.020 | 0.003 | <0.020 | 0.602 | 0.602 | 0.0130 | 0.0248 |
| | | SC1-T1-2 | HL7130 | 9/10/2013 | <0.020 | 0.002 | <0.020 | 0.601 | 0.601 | 0.0105 | 0.0221 |
| | | SC1-T1-3 | HL7131 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.575 | 0.575 | 0.0123 | 0.0229 |
| Immediately D/S | SC1-T2 | SC1-T2-1 | HL7132 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.596 | 0.596 | 0.0116 | 0.0215 |
| | | SC1-T2-2 | HL7133 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.619 | 0.619 | 0.0119 | 0.0216 |
| | | SC1-T2-3 | HL7134 | 9/10/2013 | <0.020 | 0.002 | <0.020 | 0.544 | 0.544 | 0.0136 | 0.0219 |
| 50 m D/S | SC1-T3 | SC1-T3-1 | HL7135 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.593 | 0.593 | 0.0116 | 0.0213 |
| | | SC1-T3-2 | HL7136 | 9/10/2013 | 0.029 | 0.002 | 0.031 | 0.376 | 0.407 | 0.0126 | 0.0221 |
| | | SC1-T3-3 | HL7137 | 9/10/2013 | <0.020 | 0.002 | <0.020 | 0.552 | 0.552 | 0.0108 | 0.0220 |
| 100 m D/S | SC1-T4 | SC1-T4-1 | HL7138 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.539 | 0.539 | 0.0121 | 0.0229 |
| | | SC1-T4-2 | HL7139 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.604 | 0.604 | 0.0122 | 0.0213 |
| | | SC1-T4-3 | HL7140 | 9/10/2013 | <0.020 | <0.002 | <0.020 | 0.604 | 0.604 | 0.0137 | 0.0232 |

[†] U/S = upstream; D/S = downstream

Table 5. *In situ* data collected at water quality monitoring transects located near the KIP access road crossing at unnamed tributary, 2013.

| Transect Location ¹ | Transect | | Sample Date | Sample | Total | Sample | Turbidity (NTU) |
|--------------------------------|----------|----------------------------------|------------------------|--------|-----------------|-----------|-----------------|
| | ID | Sample ID | | Time | Water Depth (m) | Depth (m) | |
| U/S of road crossing | SC2-T1 | SC2-T1 | 23-Aug-13 | 16:35 | 0.47 | 0.1 | 15.9 |
| Immediately U/S | SC2-T2 | SC2-T2 | 23-Aug-13 | 16:25 | 0.20 | 0.1 | 4.7 |
| Immediately D/S | SC2-T3 | SC2-T3 | 23-Aug-13 | 16:05 | 0.17 | 0.1 | 5.4 |
| 30 m D/S | SC2-T4 | SC2-T4 | 23-Aug-13 | 15:35 | 0.16 | 0.1 | 6.4 |
| U/S of road crossing | SC2-T1 | SC2-T1 | 10-Sep-13 | 15:08 | 0.50 | 0.2 | 2.0 |
| Immediately U/S | SC2-T2 | SC2-T2 | 10-Sep-13 | 15:00 | 0.40 | 0.2 | 2.2 |
| Immediately D/S | SC2-T3 | SC2-T3 | 10-Sep-13 | 14:57 | 0.40 | 0.2 | 2.4 |
| 30 m D/S | SC2-T4 | SC2-T4 | 10-Sep-13 | 14:45 | 0.30 | 0.2 | 2.9 |
| U/S of road crossing | SC2-T1 | not sampled due to ice formation | | | | | - |
| Immediately U/S | SC2-T2 | SC2-T1 ² | 28-Oct-13 ³ | 16:47 | n/r | n/r | 0.66 |
| Immediately D/S | SC2-T3 | SC2-T3 | 28-Oct-13 ³ | 16:37 | n/r | n/r | 0.90 |
| 30 m D/S | SC2-T4 | not sampled due to ice formation | | | | | - |

¹U/S = upstream; D/S = downstream

²Erroneously labelled as Site SC2-T1 but sample was collected near SC2-T2 (i.e., immediately upstream of the culvert)

³Samples collected October 28 but analysed for turbidity on October 31.

Table 6. TSS results for water samples collected at water quality monitoring transects located near the KIP access road crossing at Unnamed Tributary, 2013. Values in italics are considered suspect.

| Transect Location ¹ | Transect | | Laboratory ID | Date Sampled | Total Suspended Solids (mg/L) |
|--|----------|----------------------------------|---------------|--------------|--|
| | ID | Sample ID | | | |
| Analytical Detection Limit | | | | | 2.0 |
| U/S of road crossing | SC2-T1 | SC2-T1 | L1353247-16 | 23-Aug-13 | 8.4 |
| immediately U/S | SC2-T2 | SC2-T2 | L1353247-15 | 23-Aug-13 | 2.0 |
| Immediately D/ 30 m D/S of crossing | SC2-T3 | SC2-T3 | L1353247-14 | 23-Aug-13 | 2.4 |
| | SC2-T4 | SC2-T4 | L1353247-13 | 23-Aug-13 | 3.2 |
| Analytical Detection Limit | | | | | 4.0 |
| U/S of road crossing | SC2-T1 | SC2-T1 | HL7141 | 10-Sep-13 | 5.5 |
| Immediately U/S | SC2-T2 | SC2-T2 | HL7142 | 10-Sep-13 | <i>18.0</i> |
| Immediately D/S | SC2-T3 | SC2-T3-2 | HL7143 | 10-Sep-13 | <4.0 |
| 30 m D/S of crossing | SC2-T4 | SC2-T4 | HL7144 | 10-Sep-13 | <4.0 |
| Analytical Detection Limit | | | | | 4.0 |
| U/S of road crossing | SC2-T1 | not sampled due to ice formation | | | - |
| Immediately U/S | SC2-T2 | SC2-T1 ² | HY5899 | 28-Oct-13 | <4.0 |
| Immediately D/S | SC2-T3 | SC2-T3 | HY5898 | 28-Oct-13 | <4.0 |
| 30 m D/S of crossing | SC2-T4 | not sampled due to ice formation | | | - |

¹ U/S = upstream; D/S = downstream

² Erroneously labelled as Site SC2-T1 but sample was collected near SC2-T2 (i.e., immediately upstream of the culvert)

Table 7. Nutrient results for water samples collected at water quality monitoring transects located near the KIP access road crossing at Unnamed Tributary, 2013.

| Transect Location | Sample ID | Maxxam ID | Date Sampled | Nitrate-N (mg/L) | Nitrite-N (mg/L) | Nitrate/Nitrite-N (mg/L) | Total | Total | Total | Total |
|----------------------------|-----------|-----------|--------------|------------------|------------------|--------------------------|--------------------------|-----------------------|-----------------------------|-------------------------|
| | | | | | | | Kjeldahl Nitrogen (mg/L) | Total Nitrogen (mg/L) | Dissolved Phosphorus (mg/L) | Total Phosphorus (mg/L) |
| Analytical Detection Limit | | | | 0.020 | 0.002 | 0.020 | 0.020 | 0.020 | 0.0050 | 0.0050 |
| U/S of road crossing | SC2-T1 | HL7141 | 10-Sep-13 | <0.020 | <0.002 | <0.020 | 0.804 | 0.804 | 0.0128 | 0.0232 |
| Immediately U/S | SC2-T2 | HL7142 | 10-Sep-13 | <0.020 | <0.002 | <0.020 | 0.758 | 0.758 | 0.0069 | 0.0243 |
| Immediately D/S | SC2-T3 | HL7143 | 10-Sep-13 | <0.020 | <0.002 | <0.020 | 0.837 | 0.837 | 0.0064 | 0.0230 |
| 30 m D/S | SC2-T4 | HL7144 | 10-Sep-13 | <0.020 | <0.002 | <0.020 | 0.850 | 0.850 | 0.0085 | 0.0255 |

Table 8. Results for QA/QC samples submitted to ALS and Maxxam Laboratories in 2013. Results exceeding five times the analytical detection limit are indicated in red.

| Sample Type | Sample ID | Laboratory ID | Date Sampled | Total | | | | Total | | Total | |
|----------------------------|-----------------|---------------|--------------|-------------------------|------------------|------------------|--------------------------|--------------------------|-----------------------|-----------------------------|-------------------------|
| | | | | Suspended Solids (mg/L) | Nitrate-N (mg/L) | Nitrite-N (mg/L) | Nitrate/Nitrite-N (mg/L) | Kjeldahl Nitrogen (mg/L) | Total Nitrogen (mg/L) | Dissolved Phosphorus (mg/L) | Total Phosphorus (mg/L) |
| Analytical Detection Limit | | | | 2.0 | | | | | | | |
| Field Blank | SCL-T2-F | L1353247-17 | 23-Aug-13 | <2.0 | - | - | - | - | - | - | - |
| Trip Blank | SCL-T2-T | L1353247-18 | 23-Aug-13 | <2.0 | - | - | - | - | - | - | - |
| Analytical Detection Limit | | | | 4.0 | 0.020 | 0.002 | 0.020 | 0.020 | 0.020 | 0.0050 | 0.0050 |
| Field Blank | SJ-1 | HL7145 | 10-Sep-13 | <4.0 | <0.020 | <0.002 | <0.020 | 0.107 | 0.107 | <0.0050 | <0.0050 |
| Trip Blank | MJ-1 | HL7146 | 10-Sep-13 | <4.0 | <0.020 | <0.002 | <0.020 | 0.055 | 0.055 | <0.0050 | <0.0050 |
| Duplicate | SC2-T1 | HY5899 | 28-Oct-13 | 16:47 | <4.0 | - | - | - | - | - | - |
| Duplicate | Field Duplicate | HY5895 | 28-Oct-13 | 16:47 | <4.0 | - | - | - | - | - | - |

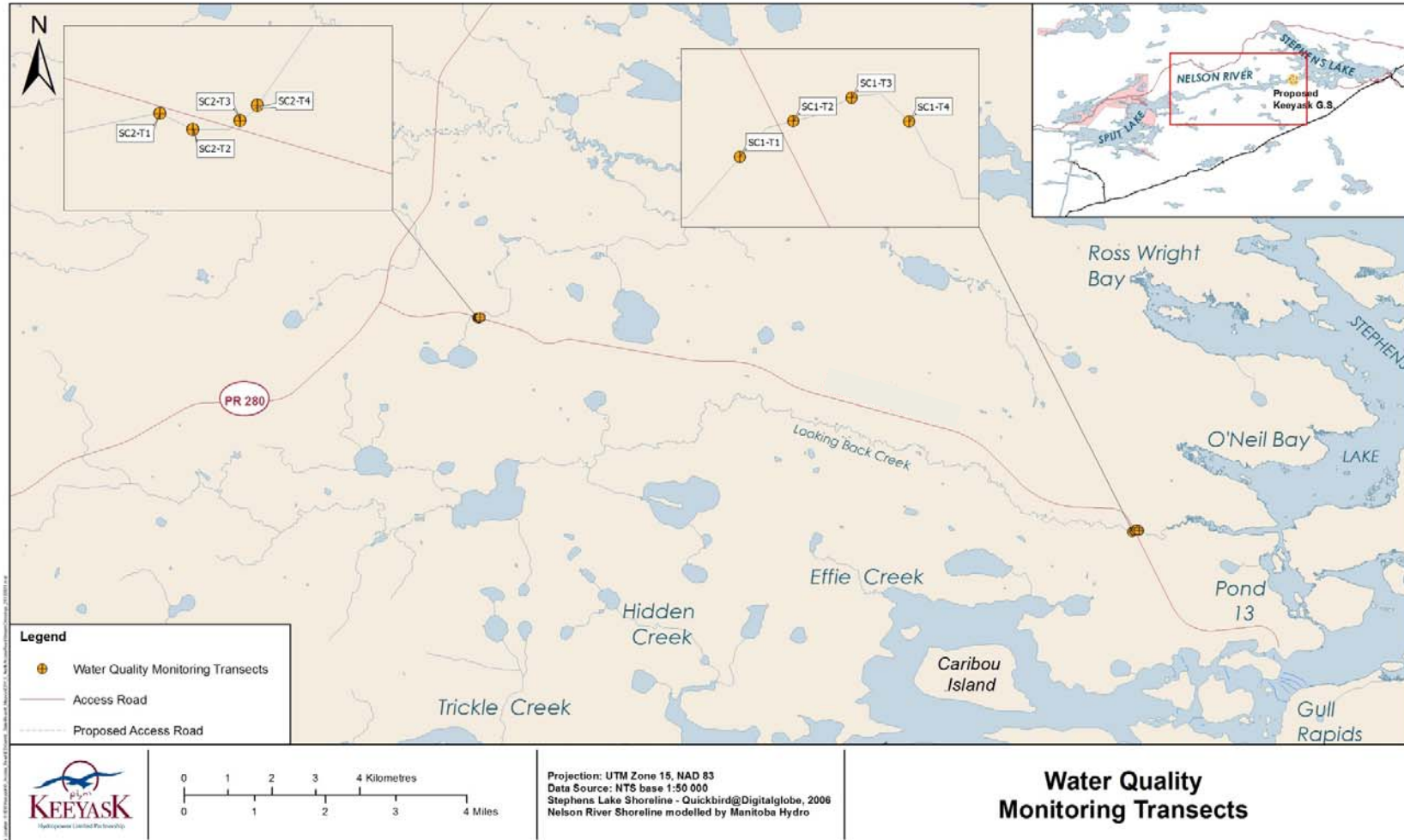


Figure 1. Location of water quality monitoring transects near stream crossings along the KIP access road, 2013.



Figure 2. Clear-span bridge over Looking Back Creek.



Figure 3. Road crossing for the unnamed tributary.



Figure 4. Brook Stickleback in the culvert at the unnamed tributary on August 20, 2013.



Figure 5. Exposed shorelines at Looking Back Creek on August 20, 2013.



Figure 6. Sediment plume entering Looking Back Creek from the left-hand bank, August 20, 2013.



Figure 7. Rip rap installation on each shore surrounding the clear-span bridge at Looking Back Creek, August 27, 2013.