Keeyask Generation Project

Sediment Management Plan for In-Stream Construction

Sediment Management Report

SMP-2015-01

Manitoba Hydro

KEEYASK

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KEEYASK GENERATING STATION PROJECT

SEDIMENT MANAGEMENT PLAN FOR IN-STREAM CONSTRUCTION

Report #SMP-2015-01

Annual Report July 2014 – April 2015: Year 1 Construction

Prepared for

Manitoba Hydro

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SUMMARY

BACKGROUND

The Keeyask Generation Project (the Project) involves the construction and operation of the Keeyask Generating Station (GS) at Gull Rapids. In order to obtain a license to construct the GS and before construction began in July 2014, the Keeyask Hydropower Limited Partnership (KHLP) prepared the Keeyask Generation Project Sediment Management Plan for In-stream Construction (SMP). The SMP has been developed for the construction phase of the Project to identify sediment increases due to in-stream construction activities in the Nelson River so that corrective actions can be taken to keep increases below target levels. The plan outlines the monitoring and management of Total Suspended Solids (TSS) inputs into the waterway that may occur as a result of shoreline erosion, in-stream construction, and commissioning of the Spillway and the Powerhouse. The introduction of excessive amounts of sediment load could change the water quality and be harmful to fish and fish habitat.

In 2014/15, the SMP was implemented during periods of in-stream work in the open-water period, the shoulder season between summer and winter, and in winter. Implementation involved the use of automated electronic sensors deployed in the Nelson River immediately upstream of the construction area within Gull Rapids and at two downstream sites (one near Gull Rapids and one further downstream). At each site turbidity sensors measure the turbidity of the water, which is a general measure of water clarity or the murkiness of the water. Turbidity data is continuously transmitted to the on-site monitoring office where it is converted to a TSS concentration. If there is an increase in TSS between the upstream site the first downstream site that is greater than the specified action levels then action is taken to identify the cause. Mitigation action would be taken to reduce sediment inputs if the increase is caused by in-stream construction. Action levels are set to ensure that mitigation action is taken soon enough to keep average daily TSS increases below the targeted maximum increase at the site that is farther downstream.

OPEN WATER PERIOD

In-stream work began on July 16, 2014, with the construction of the quarry cofferdam (Jul. 16-Aug.1). This was followed by construction of: the north channel rock groin (Aug. 5-29); powerhouse cofferdam (Sep. 6 – Oct. 2); and north channel cofferdam (Sep. 9 – Sep. 25). During this period, turbidity sensors were suspended in the water from floating platforms.

A number of times the observed TSS increases exceeded the action thresholds, however these events were typically caused by fouling of sensors (e.g., vegetation stuck on sensor) or a malfunctioning sensor. In one case, a mooring broke which allowed the sensors to move and contact the lake bottom. While one of four sensors immediately downstream detected TSS increases below the action threshold during construction of the north channel rock groin, the other three sensors showed no effect at that time. During the open water period, there were no increases above the action thresholds attributed to in-stream construction activity.

North channel rock groin under construction

SHOULDER SEASON

The shoulder season is the period between open water, when turbidity sensors can be deployed from floating platforms, and winter when they can be deployed from the ice surface. In this period it is generally not possible or safe to get onto the waterway. The sensors were placed so they were suspended above the river bottom and had a communication cable running to a station on the shore for data transmission. In-stream work during the shoulder season included construction of: a causeway to borrow pit N-5 (Oct. 18-30); central dam cofferdam (Oct. 24 – Nov. 12); a causeway to borrow pit G-3 (Dec. 4-9); and the north channel rock groin extension (Dec. 8-11).

Monitoring of in-stream work from Oct. 18 to Nov. 12 did not detect any TSS increases due to construction that exceeded the action thresholds. On Nov. 11, the sensors immediately upstream and downstream stopped operating correctly, likely due to ice effects, while the sensors placed farther downstream were noted not to be working soon after installation. Because of unsafe ice conditions, the sensors could not be replaced and were not operating when the causeway to borrow pit G-3 and the rock groin extension were installed. However, as discussed with the Department of Fisheries Oceans, the observed effects from other in-stream work suggested that installing these structures was unlikely to increase downstream TSS above action levels.

Central dam cofferdam under construction

WINTER SEASON

Winter season monitoring was performed at two sites using equipment mounted through the ice, but the third site immediately below Gull Rapids could not be monitored due to unsafe ice conditions. In-stream work during the winter season included: north channel cofferdam crest widening (Feb. 5-9); repairs to the N-5 and G-3 causeways (Feb. 17-21); spillway cofferdam (Feb 27 to mid-May); and removal of the north channel rock groin extension (April 4-15). The turbidity sensors and resulting data have been influenced by the effects of ice (slush ice, ice sticking to sensors) resulting in some inconsistent data. However, at times when ice does not appear to be significantly influencing the sensors, the differences between upstream and downstream sites have not exceeded the action thresholds or the target level for maximum increase.

CONCLUSION

During the SMP monitoring period (July 2014 to April 2015) there were no downstream TSS increases that exceeded of the SMP action levels caused by in-stream construction activities. The increases in TSS levels that were noted above the action levels were identified as resulting from fouling, equipment malfunction, ice interference and maintenance. Downstream TSS increases measured during in-stream construction were consistent with the expected effects in that the increases have typically been well below the SMP2 action levels.

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1.0 INTRODUCTION

Construction of the Keeyask Generation Project (the Project), a 695-megawatt hydroelectric generating station and associated facilities, began in July 2014. The Project is located at Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle Generating Station. The *Keeyask Generation Project: Response to EIS Guidelines*, completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. The primary effect of the Project during the construction phase was predicted to be related to increases in total suspended solids (TSS), notably in relation to shoreline erosion, in-stream construction and commissioning of the Spillway and the Powerhouse. As part of the licensing process for the Project, the *Keeyask Generation Project Sediment Management Plan for In-stream Construction* (SMP) was developed detailing how suspended sediment monitoring and mitigation will be carried out to minimize the impacts of in-stream sediment from construction activities on the Nelson River. This report summarizes the results for the sediment monitoring that took place during in-stream construction on the Nelson River from July 16, 2014 to April 30, 2015. In-stream construction activities during this time period included the construction of the Quarry Cofferdam, North Channel Rock Groin (including addition/removal of an extension), North Channel Cofferdam (including widening), Central Dam Cofferdam, Powerhouse Cofferdam, rockfill causeways to N-5 and G3 Borrow Pits (and repairs), and the Spillway Cofferdam (Figure 1).

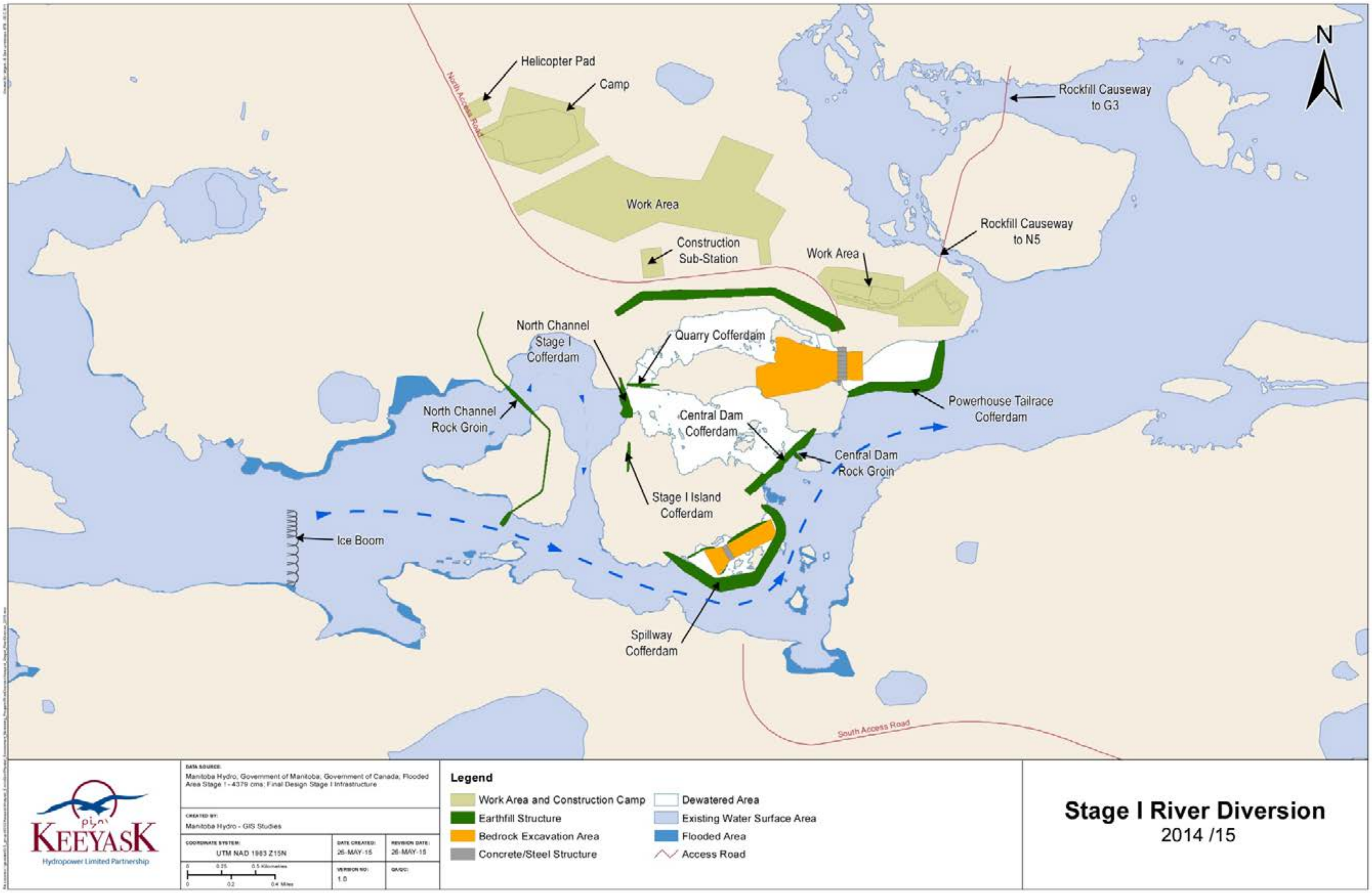

Figure 1: Stage I River Diversion Structures Constructed in 2014-2015

2.0 SEDIMENT MONITORING PROGRAM

As part of the Keeyask Generation Station Project, a detailed real-time sediment-monitoring program was developed for the Construction phase of the project to monitor the sediment impacts of the in-stream construction activities in the Nelson River. The Keeyask Generation Project Sediment Management Plan for In-stream Construction, July 2014 outlines the monitoring and management of Total Suspended Solids (TSS) that may occur as a result of shoreline erosion, in-stream construction and commissioning of the Spillway and the Powerhouse.

Turbidity (Tu) was monitored through the use of automated, electronic turbidity loggers at three locations (with a total of five monitoring stations). The loggers measure turbidity, which is reported in nephelometric turbidity units (NTU), and transmit the data to the environmental monitoring office on site. There the Tu data is converted to an equivalent TSS concentration, in milligrams per Litre (mg/L), using the following site-specific relationship between Tu and TSS (as described in the SMP):

$$TSS = 0.79 * Tu - 2.86$$

The monitoring locations are consistent with the baseline monitoring sites that were used in the Keeyask GS Environmental Impact Assessment. However, the actual locations varied during construction for reasons such as the safety, accessibility, and ambient conditions (e.g., high river flow, high water velocity, unsafe ice). Monitoring locations are discussed in more detail in Section 2.1, 2.2 and Section 2.3.

2.1 OPEN WATER MONITORING STATIONS

During the month of June 2014, five monitoring stations (SMP-1, SMP-2L & SMP-2R, SMP-3L & SMP-3R) were installed on the Nelson River, as illustrated in Figure 2. At each station, a catamaran was anchored and used as a platform on which data loggers and sensors were installed. Surface sensors (designated TSSS) were suspended 2.0 meters below the water's surface and bottom sensors (designated TSSB) were located 2.0 meters above the bottom of the channel at each location. In summary:

- SMP-1 was located upstream of construction activities on the Nelson River and monitors on-going background Tu/TSS;
- SMP2L and SMP2R were located approximately 1.5km downstream of the future Powerhouse and positioned on the left and right side of the channel, respectively. This location was chosen as it is a near-field location within the mixing zone prior to the fully mixed conditions.

SMP-3L & SMP3Rwere located approximately 9 km downstream of the construction site, on the left and right side, in the fully mixed zone of the primary flow channel along the deepest part of the river. The location was chosen as the majority of the flow passes through this south channel and where increase in TSS will mostly occur.

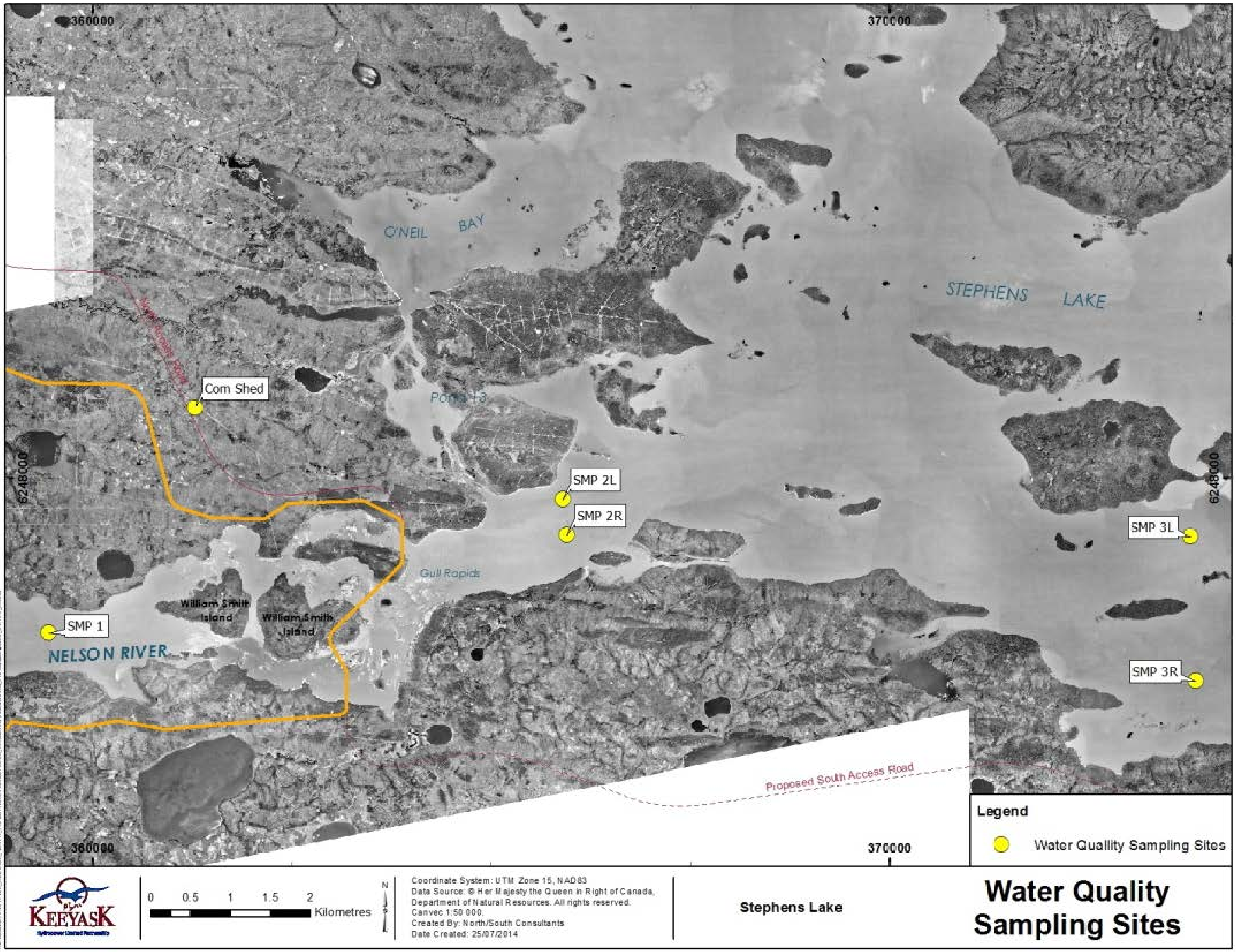

Figure 2: Open Water Monitoring Stations

2.2 SHOULDER SEASON MONITORING STATIONS

As described in Section 3.4.1 of the SMP some modifications to the SMP may be required to monitor the TSS variations in Nelson River during the in-stream activities extending through the shoulder season (transition period between open-water and ice).

The modified SMP was implemented in October 2014 and included deployment of submersible monitoring stations after the removal of the catamarans used during the open water period. The submersible system consisted of turbidity sensors installed above the river bottom, using an anchor and a buoy, and a communication cable to transmit Tu readings to a data logger located at the shore. The data were transmitted to the on-site environmental office in real-time, as in the summer monitoring program.

The shoulder season monitoring sites were designated SMP-1W, SMP-2LW, SMP-2RW, SMP-3LW, and SMP-3RW (Figure 3). The monitoring locations had to be adjusted from the open-water locations because of limitations on the length of communication cables that could be used to connect from the shore-based data loggers to the sensors in the water.

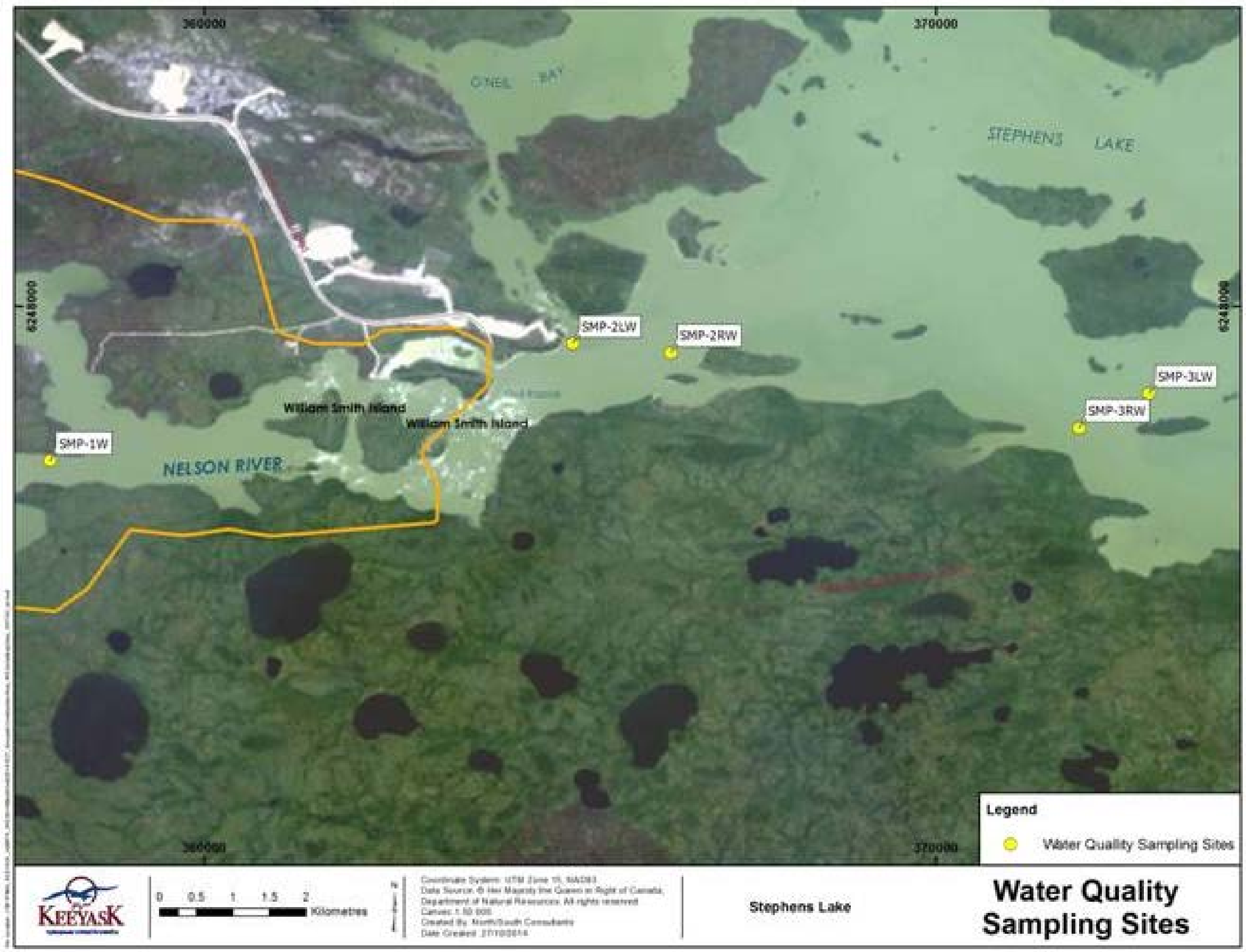

Figure 3: SMP Shoulder Season Water Monitoring Stations

2.3 WINTER MONITORING STATIONS

The SMP describes modifications to the open-water SMP program would be required with the onset of winter and associated ice formation. On January 7, 2015, SMP Winter Monitoring Station catamarans were installed on the ice surface. Turbidity loggers were deployed through the ice, 2 meters below the water's surface, at SMP-1WC, SMP-3LWC, and SMP-3RWC (Figure 4). All three monitoring stations transmitted data in real-time for construction monitoring purposes. The SMP-2 monitoring stations could not be been installed due to unsafe ice conditions.

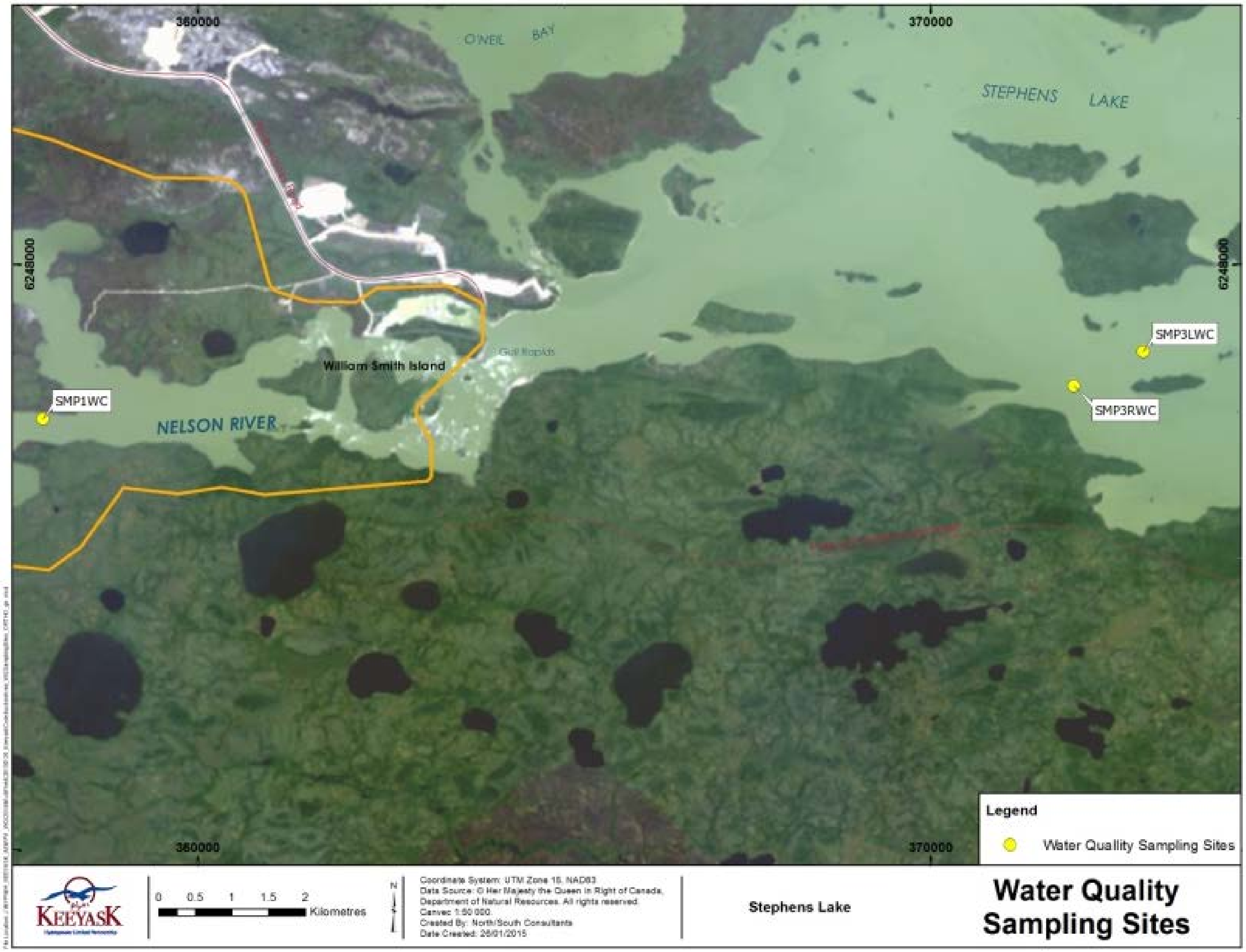

Figure 4: SMP Winter Monitoring Stations

2.4 ACTION AND TARGET LEVELS

As outlined in the SMP (July 2014) the management of TSS levels during construction incorporates two action levels measured in the mixing zone at SMP-2:

1. four consecutive 15-minute averaged measurements over 25 mg/L above background TSS at monitoring site SMP-1, and
2. one 15-minute averaged increase of 200 mg/L above background TSS at monitoring site SMP-1.

Both action levels are below acutely lethal thresholds of TSS for freshwater fish, which range from the hundreds to hundreds of thousands of mg/L. The action levels at SMP2 are set so that action is initiated to mitigate sediment inputs due to construction in order to maintain a 24-hour moving average increase of 25 mg/L or less at SMP3 relative to SMP1. In winter, when SMP-2 could not be installed, the action levels were applied to the SMP-3 readings.

Exceedence of the action levels will initiate an action plan to identify the source of the TSS and secondary mitigation strategies for unanticipated events and/or a modification to in-stream construction activities procedure, including commissioning of Spillway and Powerhouse, which are outlined in the SMP.

2.5 TRANSECT SAMPLING

To ensure that the SMP 2 stations (i.e. left and right locations) were adequately positioned to measure TSS concentration increase in the sediment plume passing the site, manual transect measurements were performed. Transect measurements were obtained at the beginning of construction and when the first in-stream work commenced. Turbidity measurements were collected using a Tu logger towed behind a boat across the river at a cross section at the SMP 2 monitoring site. Transact data was collected on July 17, 2014, which was the start of the in-stream work for the construction of the Quarry Cofferdam. Table 1 summarizes the turbidity and calculated TSS data that were recorded. The results showed that the turbidity was consistent across the width of the river at this location.

Table 1: Turbidity Transect Data for July 17, 2014

Depth from surface (m)	Distance from right bank	Time (CST)	Turbidity (NTU)	Calculated TSS (mg/L)
2	50	12:44	n/a	n/a
2	100	12:57	27.7	19.0
2	150	13:01	27.6	18.9
2	200	13:07	27.7	19.0
2	250	13:12	27.6	18.9
2	300	13:16	27.7	19.0
2	350	13:22	28	19.3
2	400	13:28	28	19.3
2	450	13:32	28	19.3
2	500	13:37	28	19.3
2	550	13:41	28	19.3
2	600	13:46	28	19.3
2	650	13:51	28	19.3
2	700	13:55	28	19.3
2	750	13:59	28	19.3
2	800	14:03	28.1	19.3
2	850	14:08	28.1	19.3
2	900	14:12	28.1	19.3
2	950	14:18	28.1	19.3
2	1000	14:22	28.1	19.3
2	1050	14:32	9.2	4.4
2	1100	14:35	9.2	4.4
2	50	15:06	46.3	33.7
2	100	15:11	46.3	33.7
2	150	15:16	46.3	33.7
2	200	15:20	46.3	33.7
2	250	15:24	46.3	33.7
2	300	15:28	46.3	33.7
2	350	15:32	46.3	33.7
2	400	15:36	46.3	33.7
2	450	15:40	27.9	19.2
2	500	15:44	27.9	19.2
2	550	15:48	27.9	19.2
2	600	15:52	27.9	19.2
2	650	15:56	28	19.3
2	700	16:00	28	19.3
2	750	16:04	28	19.3

2.6 ANNUAL SAMPLING

As outlined in the SMP (July 2014) the in-situ turbidity logger data would be supplemented through manual monitoring of turbidity using handheld loggers and collecting water samples. Turbidity measurements and samples were collected from near-surface and near-bottom positions within the water column along a river cross section in the vicinity of the SMP monitoring sites during the reporting period.

Table 2: Manual Turbidity and TSS Monitoring Results

Year	Station ID	Description	Sample Date & Time	Turbidity (NTU)	Lab TSS (mg/L)
2014	SMP-1	2m from Bed	8/21/2014 15:00		15
2014	SMP-1	2m from Surface	8/21/2014 15:00		17
2014	SMP-1	2m from Surface	8/21/2014 15:00		19
2014	SMP-1	2m from Bed	8/21/2014 15:00		19
2014	SMP-2L	2m from Surface	8/20/2014 15:59	29.5	19
2014	SMP-2L	2m from Surface	8/20/2014 16:02	29.8	19
2014	SMP-2L	2m from Bed	8/20/2014 16:08	30	21
2014	SMP-2L	2m from Bed	8/20/2014 16:10	29.8	27
2014	SMP-2L	2m from Surface	9/21/2014 10:00		11
2014	SMP-2L	2m from Surface	9/21/2014 10:00		11
2014	SMP-2L	2m from Bed	9/21/2014 10:09		11
2014	SMP-2L	2m from Bed	9/21/2014 10:09		10
2014	SMP-2R	2m from Surface	8/20/2014 14:50	30.8	21
2014	SMP-2R	2m from Surface	8/20/2014 14:53	30.6	21
2014	SMP-2R	2m from Bed	8/20/2014 14:56	30.9	23
2014	SMP-2R	2m from Bed	8/20/2014 14:58	30.9	21
2014	SMP-2R	2m from Surface	9/21/2014 9:45		9
2014	SMP-2R	2m from Surface	9/21/2014 9:45		9
2014	SMP-2R	2m from Bed	9/21/2014 9:54		10
2014	SMP-3L	2m from Surface	7/29/2014 17:45		15
2014	SMP-3L	2m from Surface	7/29/2014 17:45		10
2014	SMP-3L	2m from Bed	7/30/2014 17:20		22
2014	SMP-3L	2m from Bed	7/30/2014 17:20		19
2014	SMP-3L	2m from Surface	8/20/2014 12:24	30.3	20
2014	SMP-3L	2m from Surface	8/20/2014 12:27	30.7	20
2014	SMP-3L	2m from Bed	8/20/2014 12:35	31.3	21
2014	SMP-3L	2m from Bed	8/20/2014 12:37	30.9	14
2014	SMP-3L	2m from Surface	9/21/2014 12:12		13
2014	SMP-3L	2m from Surface	9/21/2014 12:12		12
2014	SMP-3L	2m from Bed	9/21/2014 12:13		11
2014	SMP-3L	2m from Bed	9/21/2014 12:13		12
2014	SMP-3R	2m from Surface	8/20/2014 13:45	28.8	17
2014	SMP-3R	2m from Surface	8/20/2014 13:52	28.6	18
2014	SMP-3R	2m from Bed	8/20/2014 13:55	30.2	19
2014	SMP-3R	2m from Bed	8/20/2014 13:56	29.8	18
2014	SMP-3R	2m from Surface	9/21/2014 9:17		24
2014	SMP-3R	2m from Surface	9/21/2014 9:17		9
2014	SMP-3R	2m from Bed	9/21/2014 9:23		9

3.0 IN-STREAM WORK

3.1 OPEN WATER MONITORING

3.1.1 QUARRY COFFERDAM CONSTRUCTION

The Quarry Cofferdam (Figure 5) was the first cofferdam to be constructed on the Keeyask Generation Project. The in-stream portion of the cofferdam construction occurred over the course of 12 days from July 16 to July 20 and July 25 to August 1, 2014. No in-stream work occurred on July 21, 22, 23 or July 24, 2014.

Figure 5: Construction of the Quarry Cofferdam

Figure 6 shows the daily 15 minute average TSS values compared with the action levels, which are outlined in red and light blue on the graph. No exceedances of the action levels occurred at SMP2 during the construction of the Quarry Cofferdam. TSS levels at SMP2L were observed to spike on July 23, 2014. However, no in-stream work took place from July 21 to July 24; therefore, the sudden spike was not a result of construction activities but was likely a result of debris passing by the sensor. Slight increases in TSS levels were noted at 12:00hrs (Greenwich

Mean Time) on July 30, 2014. Although increases in TSS levels were noted, TSS levels were still well below the SMP action levels.

TSS values recorded at SMP2L and SMP2R were consistent with the daily background 20mg/L TSS readings that were recorded at SMP1 (both at the surface and bottom sensors) during the duration of the construction of the Quarry Cofferdam.

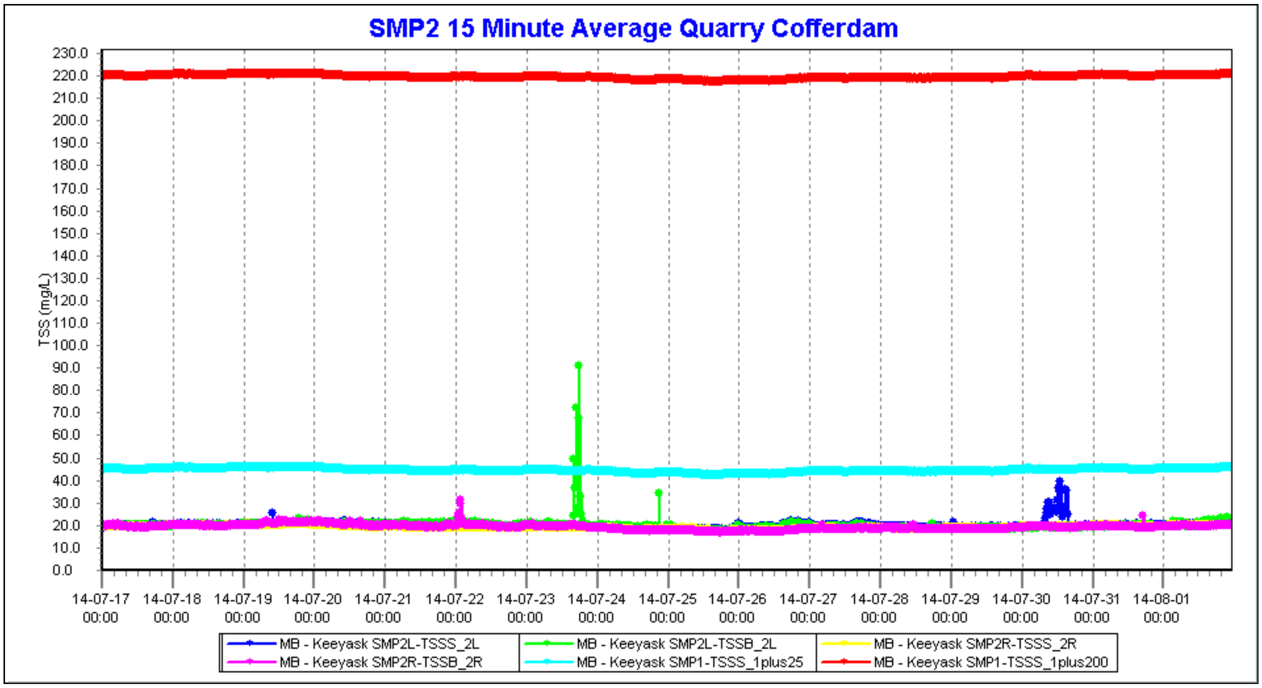

Figure 6: Quarry Cofferdam TSS values at SMP2L and SMP2R (15 min average)

Figure 7 shows the TSS values averaged at SMP3 monitoring stations over the previous 24 hours compared with the target level, which is shown in dark blue on the graph. No in-stream work was conducted from July 21, to July 24, 2014. There was an increase in TSS levels above the target level on July 28 and 29, at SMP3R. A site visit conducted on July 30 confirmed that the increase in TSS levels was a result of the sensor hitting the bottom substrate and not a result of the construction activities.

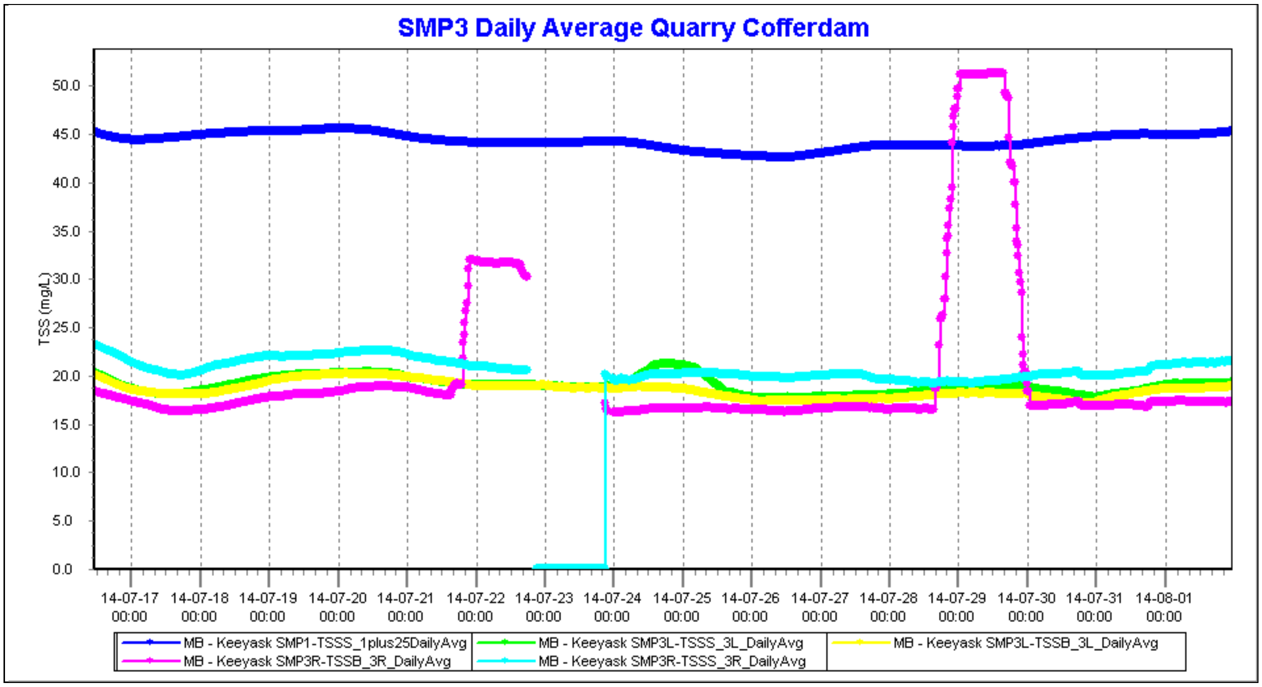

Figure 7: Quarry Cofferdam TSS values at SMP3L and SMP3R (24 hour moving average).

3.1.2 NORTH CHANNEL ROCK GROIN

The in-stream work portion for the construction of the North Channel Rock Groin (Figure 8) commenced on August 5, 2014 and was completed on August 29, 2014.

Figure 8: North Channel Rock Groin

Figure 9 shows the daily 15 minute average TSS values compared with the action levels, which are shown in red and light blue on the graph. Increases in TSS concentrations above the SMP action levels were observed from August 18 to August 28. The spikes in TSS levels were a likely a result of debris drifting by the sensor, as well as from maintenance activities that were conducted on the sensor during this time frame and not a result of the in-stream construction activities. Elevated TSS was observed at the SMP2L-TSSS sensor (SMP2 left surface sensor); however, the increase did not exceed the SMP action levels during this time. This general increase resulted from water level increases upstream of the groin as it was constructed across the channel toward the island, which caused some over land flow on the island. During this time, the other three sensors at SMP2 had calculated TSS concentrations within about +/-1 mg/L of the background concentration at SMP1.

Aside from the noted increase at one sensor, the TSS values recorded at SMP2L and SMP2R during the construction of the North Channel Rock Groin were consistent with the daily background of about 20mg/L TSS that were recorded at SMP1 (both at the surface and bottom sensors).

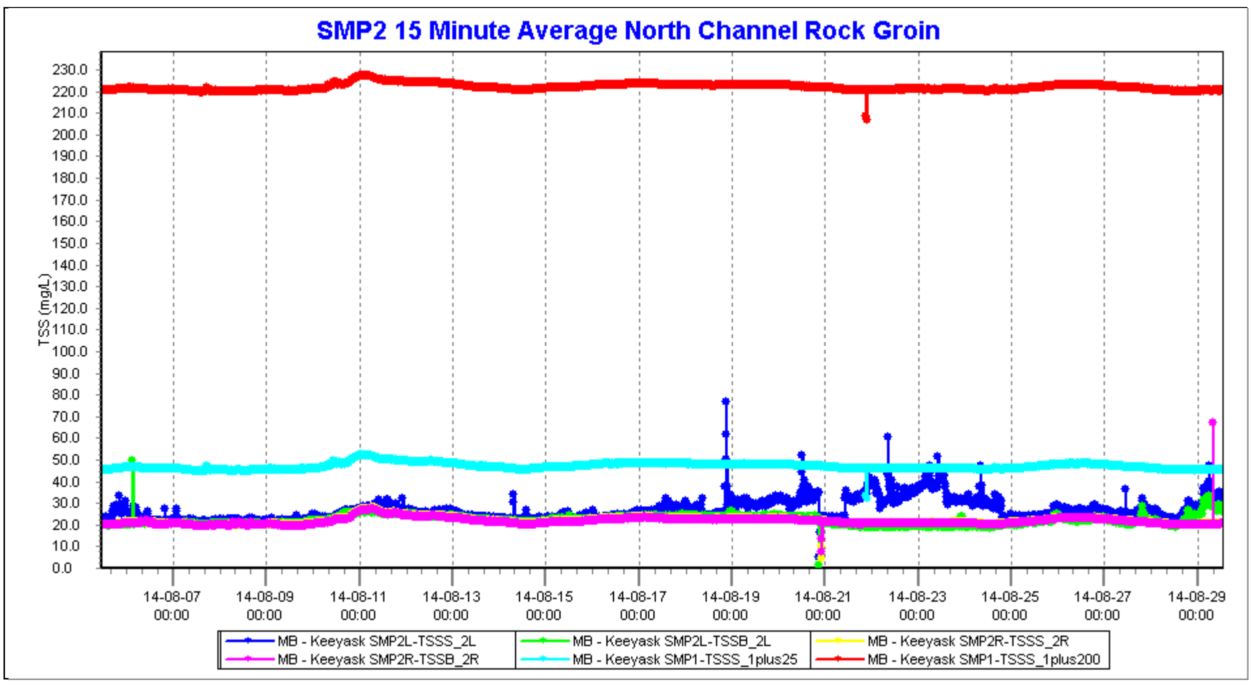

Figure 9: North Channel Rock Groin TSS values at SMP2L and SMP2R (15 min average)

Figure 10 shows the SMP1 and SMP3 TSS values averaged over the previous 24 hours compared with the target level, which is shown in dark blue on the graph. There were no exceedences of target level at the SMP3 monitoring stations during the construction of the North Channel Rock Groin.

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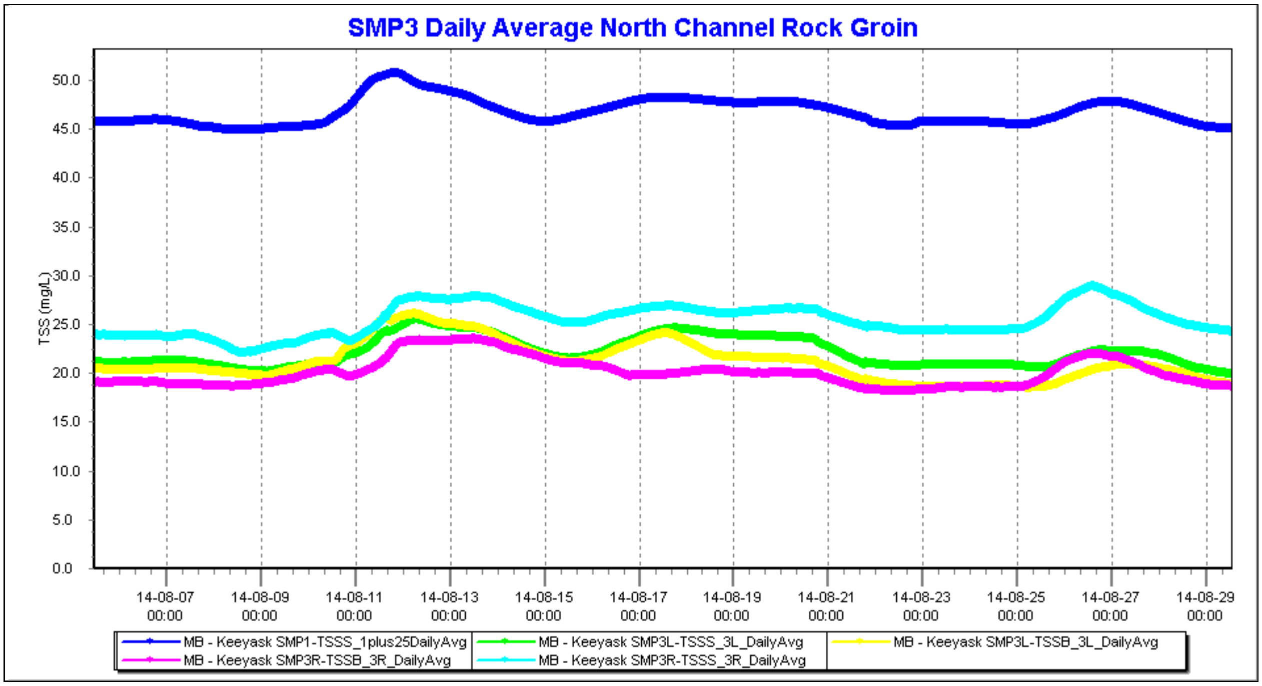

Figure 10: North Channel Rock Groin TSS values SMP3L and SMP3R (24 hour moving average)

3.1.3 POWERHOUSE AND NORTH CHANNEL COFFERDAMS

The construction of the Powerhouse Stage 1 Cofferdam (Figure 11) commenced on September 6, 2014 and consisted of a total of 26 days of in-stream work. The construction of the cofferdam was completed on October 2, 2014.

In-stream work for the construction of the North Channel Cofferdam (Figure 12) commenced on September 9, 2014 and was completed on September 25, 2014, a total of 17 days of in-stream construction.

Figure 13 shows the daily 15 minute average TSS values compared with the action levels, which are shown in red and light blue on the graph. An increase in TSS levels above the SMP action levels was observed at SMP2R on September 23 and 24, 2014. A site visit was conducted and it was found that the anchor cable for the catamaran at SMP2R had broken. This caused the catamaran to drift 2 km downstream, resulting in the bottom sensor resting on the river bottom. The catamaran was towed to shore for maintenance. Therefore, the apparent exceedence of the action levels in Figure 13 was caused by sensor interference. No other abnormalities were noted for the remaining sensors on September 23, 2014. The erratic readings captured by both the top and bottom SMP2R sensors reflect the maintenance that took place at the shore and were not caused by in-stream construction.

TSS values recorded at SMP2R were otherwise consistent with the daily background 20mg/L TSS readings that were recorded at SMP1 (both by the surface and bottom sensors) for the duration of the construction of the Powerhouse Cofferdam and North Channel Cofferdam.

Figure 11: Powerhouse Cofferdam Placement of Impervious Material

Figure 12: North Channel Cofferdam

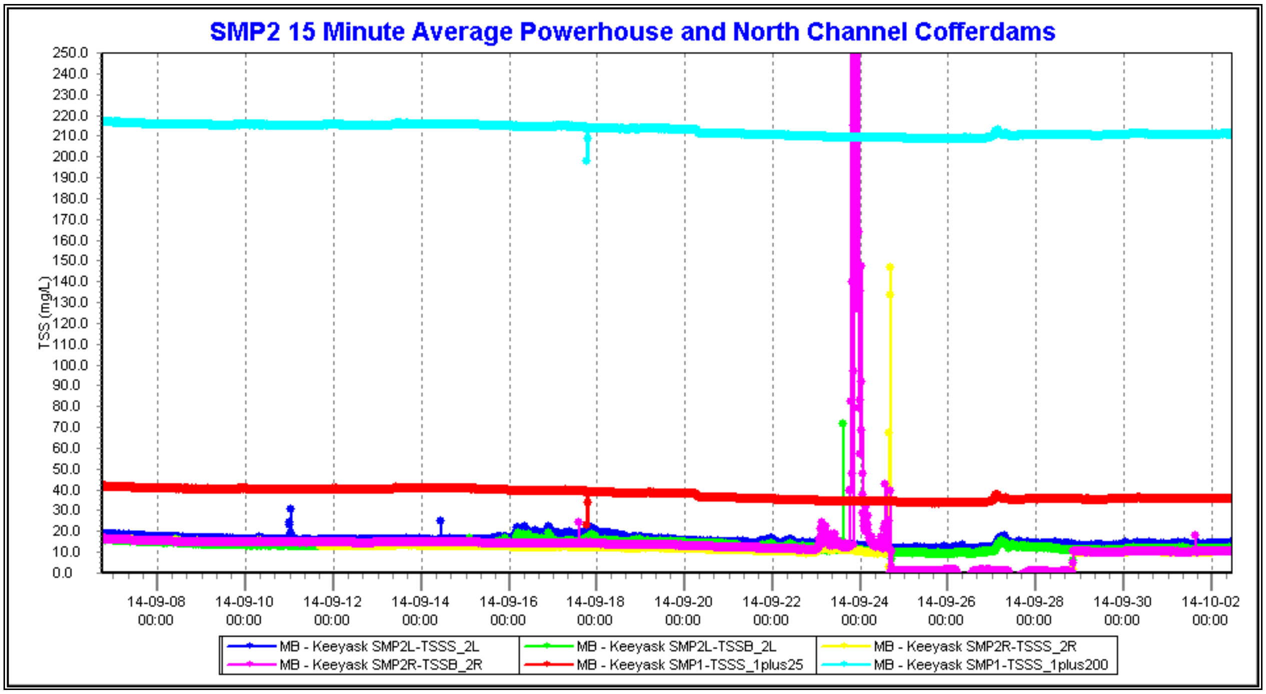

Figure 13: Powerhouse and North Channel Cofferdam TSS values SMP2L and SMP2R (15 min average)

Figure 14 shows the TSS values averaged over the previous 24 hours compared with the target level, which is shown in dark blue on the graph. No exceedences of the SMP target level occurred at either of the SMP3 monitoring stations during the construction of the Powerhouse Cofferdam and North Channel Cofferdam.

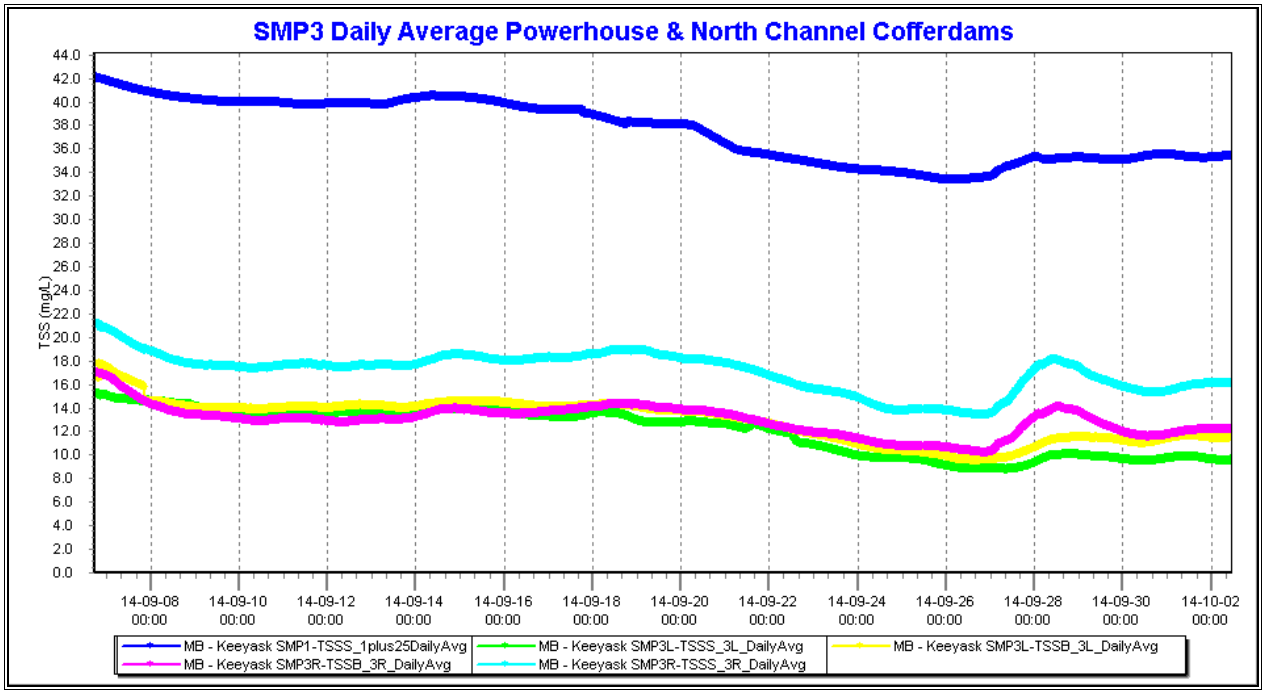

Figure 14: Powerhouse and North Channel Cofferdam TSS values at SMP3L and SMP3R (24 hour moving average)

3.2 SHOULDER SEASON MONITORING

3.2.1 N-5 BORROW PIT CAUSEWAY AND CENTRAL DAM

N-5 BORROW PIT CAUSEWAY

The construction of the N-5 Causeway (Figure 15) was conducted over the course of 14 days from October 18 to October 30, 2014.

Figure 15: Causeway to N-5 Borrow Pit

CENTRAL DAM COFFERDAM

The in-stream construction for the Central Dam Cofferdam (Figure 16) commenced on October 24, 2014 and occurred over the course of 14 days. The cofferdam construction was completed on November 12, 2014. However, no in-stream work was conducted on the cofferdam from November 5 to November 12, 2014.

Figure 16: Central Dam Cofferdam

Figure 17 shows the daily 15-minute average TSS values for the SMP monitoring stations compared with the action levels, which are shown in red and light purple. There were no exceedences of SMP action levels. SMP1 started malfunctioning on November 11, 2014 due to ice hitting the sensor.

As illustrated in Figure 17, TSS readings recorded at SMP2L and SMP2R (for both the surface and bottom sensors) did not exceed SMP action levels for the duration of constructing the N-5 Borrow Pit Causeway and Central Dam.

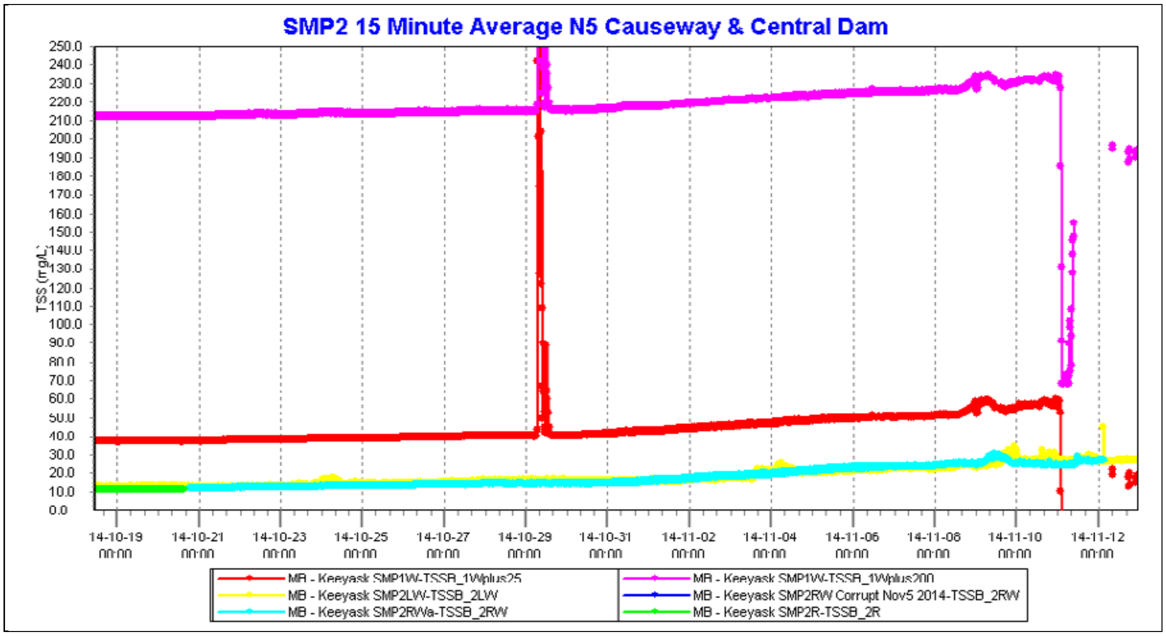

Figure 17: N-5 Causeway and Central Dam TSS values at SMP2L and SMP2R (15-minute average)

Figure 18 shows the TSS values averaged over the previous 24 hours compared with the target level, which is shown in dark blue. There were was exceedence of the target level during the construction of the N-5 Causeway and the Central Dam Cofferdam. SMP1 started malfunctioning on November 11, 2014 due to ice hitting the sensor.

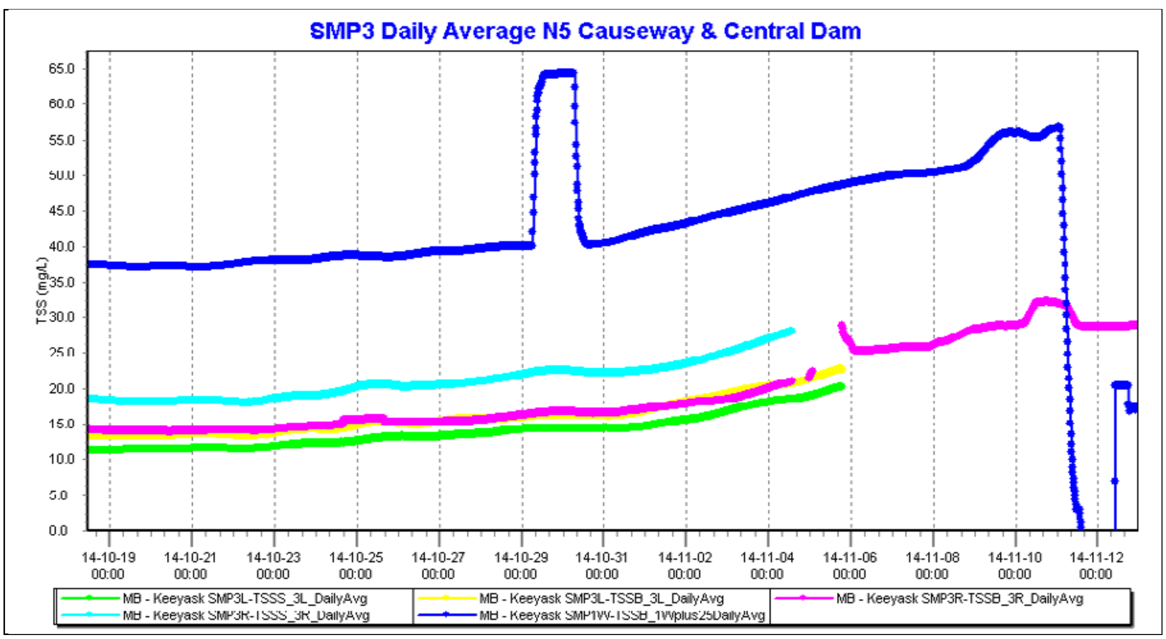

Figure 18: N-5 Causeway and Central Dam TSS values at SMP3L and SMP3R (24 hour moving average)

3.2.2 NORTH CHANNEL ROCK GROIN EXTENSION AND G-3 BORROW PIT CAUSEWAY

NORTH CHANNEL ROCK GROIN EXTENSION

The North Channel Rock Groin Extension (Figure 19) construction commenced on December 5 and was completed on December 17, 2014. However, no in-stream work was conducted on the rock groin extension from December 8 to December 11, 2014.

Figure 19: North Channel Rock Groin Extension

G-3 BORROW PIT CAUSEWAY

Construction of the of G-3 Borrow Pit Causeway (Figure 20) occurred over the course of 5 days and commenced on December 4, 2014 with the in-stream portion completed on December 9, 2014.

Figure 20: Causeway to G-3 Borrow Pit

On November 11, 2014, data collected from SMP1W and SMP2RW indicated that the sensors were not operating correctly and had stopped collecting turbidity data. SMP2LW continued to collect data until November 15 at which point the sensor stopped collecting reliable data. The SMP3 shoulder season stations were installed on November 5, but were noted to not be transmitting data since the time of installation. Due to the unsafe ice conditions repairs to the shoulder season stations or deployment of the winter monitoring stations could not occur.

The Causeway to G-3 and the North Channel Rock Extension were constructed from clean blast rock and did not take more than one week to construct. In-stream construction activities prior to the construction of this causeway and rock groin extension had not resulted in exceedences of TSS action levels within the Nelson River. As a result, it was anticipated that the construction of the Causeway to Borrow G-3 and the North Channel Rock Groin Extension would not exceed the SMP TSS limits within the Nelson River.

An update on the SMP monitors was provided to Mr. Richard Janusz from the Department of Fisheries Oceans on November 25, 2014 via email.

As a result of the sensors being damaged at the SMP monitoring stations, shoulder season monitoring data was not collected during the construction of the G3 causeway and the north channel rock groin extension.

3.3 WINTER SEASON MONITORING

3.3.1 REPAIRS TO N-5 AND G-3 CAUSEWAYS

Water levels at the entrance to Stephens Lake increased in winter due to the accumulation of ice and formation of a hanging ice dam downstream of Gull Rapids. This resulted in high water levels adjacent to the causeways to borrow areas N-5 and G-3, which caused the causeways to be partially washed out. Repairs to the N-5 and G-3 causeways were required due to the increase in water levels that occurred in the Nelson River and took place from February 17, 2015 until February 21, 2015.

Figure 21 shows the TSS values averaged over the previous 24 hours compared with the action level shown in red on the graph. Since SMP-2 was not in place during the winter, the action levels applicable at SMP-2 were instead applied to the SMP-3 readings. There were no exeedences of the SMP action levels during the repairs to the Causeways.

On February 18, 2015, field crews installed a new aluminum pipe through the ice at SMP1WC. Prior to this maintenance frazil ice was interfering with the sensor mounted in the pipe that was originally in place, resulting in very high and incorrect turbidity readings. The new pipe was 2ft longer so that it could extend below the frazil ice.

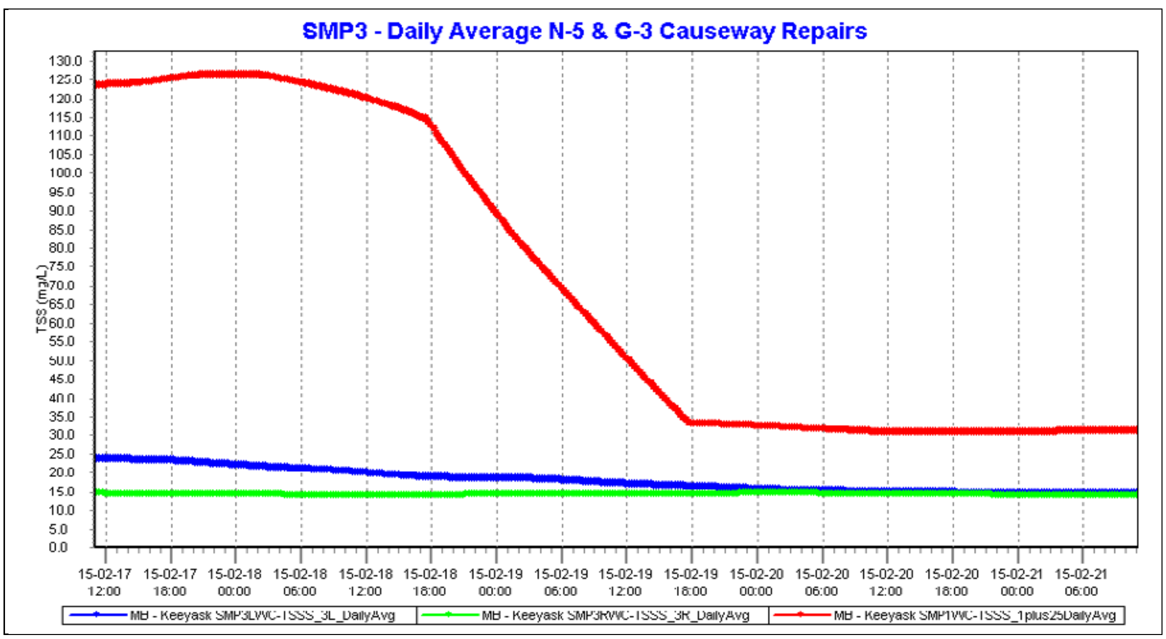

Figure 21: N-5 and G-3 Causeway Repairs TSS Values at SMP3 (24 hour moving average)

3.3.2 SPILLWAY COFFERDAM

In-stream work for the construction of the Spillway Cofferdam Rock Groins (Figure 22) commenced on February 27, 2015 and is on-going. The rock groins will be completed before May 15, 2015, to avoid the spring restriction on in-stream work during the sturgeon-spawning season as per Fisheries Authorization.

Figure 22: Spillway Cofferdam

Figure 23 shows the daily TSS values averaged over the previous 24 hours compared with the action levels, which are shown in red and light blue. Increases in the TSS levels above the SMP actions levels occurred between April 10 to April 24, 2015. The increase in TSS levels was a result of ice and slush build up around the sensors.

On April 13, 2015 due to the ice melting upstream, SMP1 Winter monitoring station was removed.

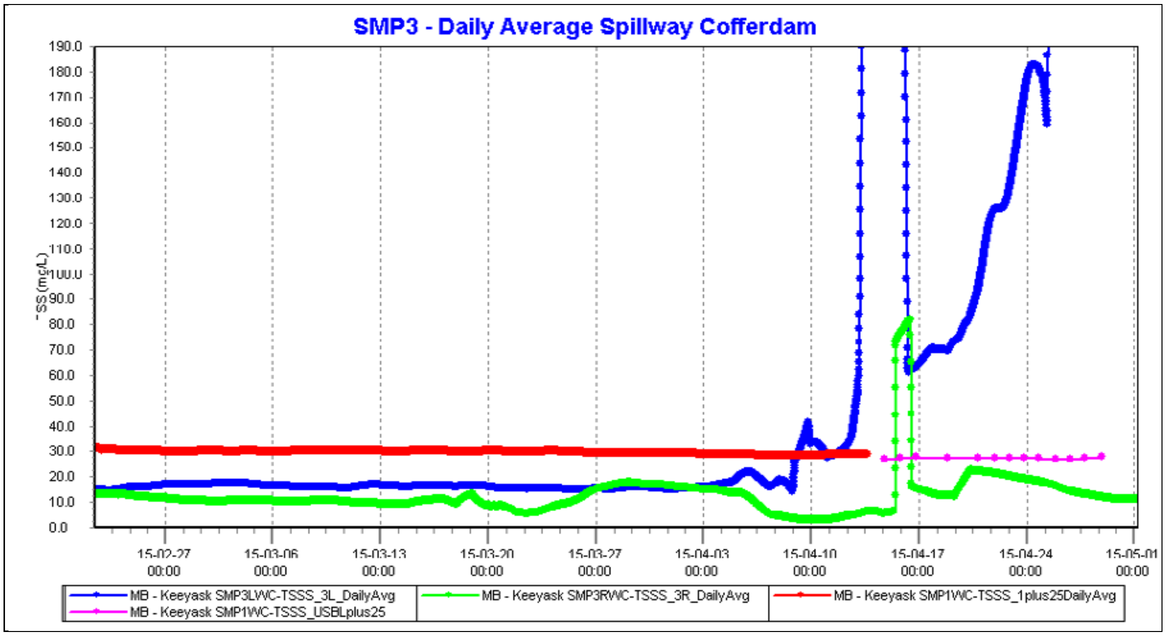

Figure 23: Spillway Cofferdam TSS Values at SMP3 (24 hour moving average)

3.3.3 NORTH CHANNEL ROCK GROIN EXTENSION REMOVAL

The removal of the rock groin extension commenced on April 4 and was completed on April 15, 2015. Figure 24 shows the TSS values averaged over 24 hours during the removal of the rock groin extension compared with the action levels, which are shown in red and light blue on the graph. There was an increase in TSS levels above the action levels on April 9, 2015, which was due to ice and slush build-up around the sensors and not a result of the construction activities.

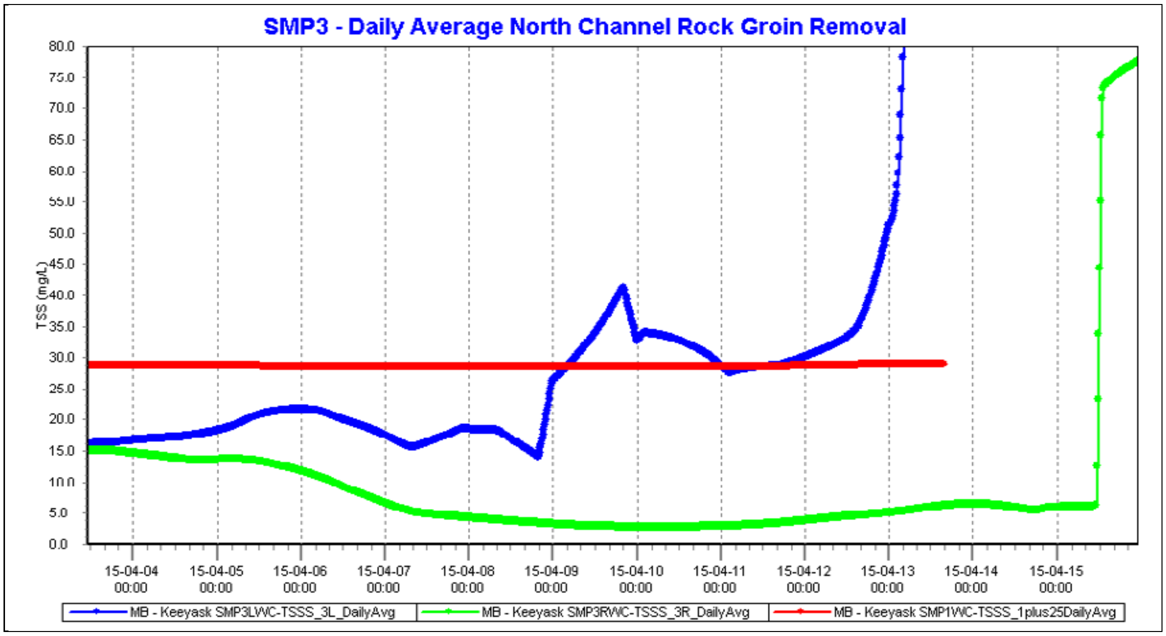

Figure 24: North Channel Rock Groin Extension Removal TSS Values at SMP3L and SMP3R (24 hour moving average)

3.3.4 NORTH CHANNEL COFFERDAM CREST WIDENING

Figure 25 shows the daily TSS values averaged over the previous 24 hours compared with the action levels, which are shown in red and light blue. Slush and ice interference caused the sensors at stations SMP1 and SMP3L to have high TSS values.

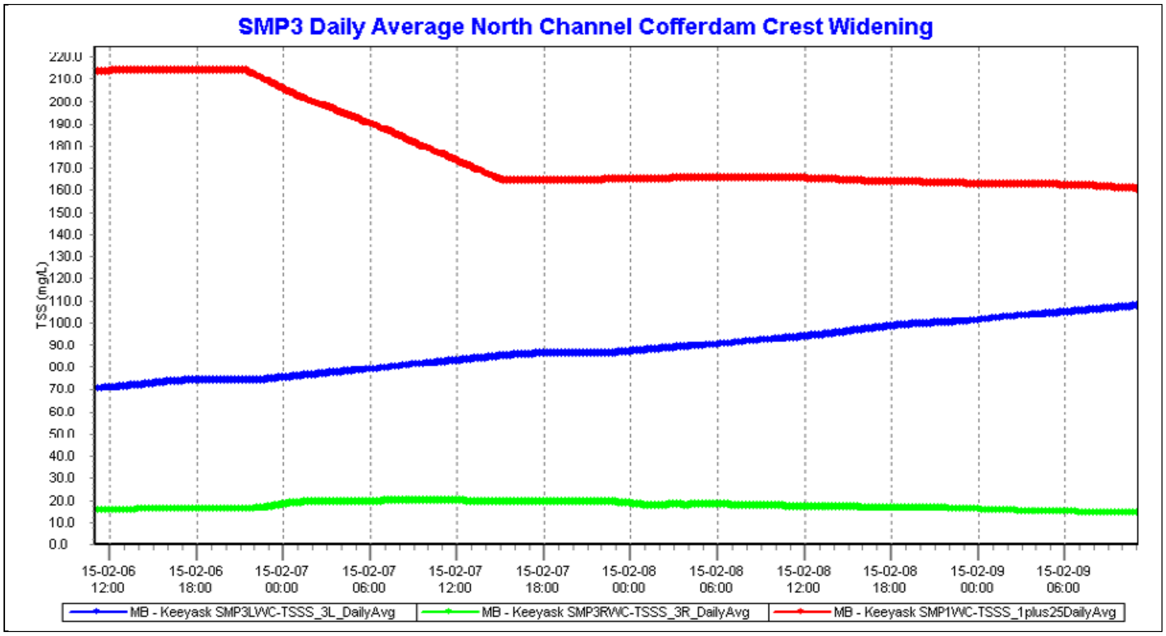

Figure 25: North Channel Cofferdam Crest Widening TSS values at SMP3L and SMP3R (24 hour moving average)

3.4 PREDICTED TSS LEVELS VS. MONITORING RESULTS

As described in the SMP, construction activities during river management will introduce additional sediment into the Nelson River due to shoreline erosion, construction and removal of cofferdams, and commissioning of the Spillway and the Powerhouse. The predicted effects of in-stream construction presented in the SMP and reproduced in Figure 26 were based on the proposed construction timeline at the time that the analyses were performed. The proposed schedule showed the quarry cofferdam, powerhouse stage I cofferdam, north channel rock groin and north channel stage 1 cofferdam being constructed from mid-July to mid-October. These structures were actually finished about two weeks earlier than anticipated.

Construction of the powerhouse cofferdam was somewhat different than expected when the TSS analysis was performed. The cofferdam was extended to enclose the entire spillway area rather than enclosing the full spillway area later with the tailrace summer-level cofferdam, which was shown as taking place in 2018 in Figure 26 but will not occur now due to this change. Additionally, construction of the central dam stage 1 cofferdam took place in November 2014 while the spillway cofferdam was constructed between the end of February and mid-May in 2015. Both of these structures were completed in advance of the timing shown in the SMP, which showed them being constructed in summer 2015. The extension of the north channel rock groin into the south channel was not a planned activity and therefore is not shown in the predicted effects.

3.4.1 PREDICTED CONSTRUCTION EFFECTS

Several numerical and empirical modeling methods were used to predict increases in downstream TSS concentrations during construction. Due to the analytical methods employed, the analyses assumed that sediment entering the river was fully mixed within the river flow and did not predict the larger local increases that would occur within the mixing zone, with increases being greatest near the source and diminishing downstream as mixing occurs. For the in-stream work completed in 2014/15, the predicted effects of construction on downstream TSS may be generally summarized as:

- From mid-July to mid-October, fully mixed TSS increases of up to 4 mg/L, but generally increasing 2 mg/L over most of the period
- Short duration increase of about 8 mg/L during spillway cofferdam construction but increases generally varying from about 2-4 mg/L during spillway and central dam cofferdam construction.

3.4.2 OBSERVED CONSTRUCTION EFFECTS

Using the raw data collected at the three SMP monitoring sites, comparisons were made between the calculated TSS at SMP2 versus SMP1, and between SMP3 versus SMP1 and SMP2. For each sensor, the 24-hour moving average TSS was calculated based on the 15-minute average turbidity data. The average TSS at each SMP location was then calculated by averaging the TSS values from the sensors at each site. All calculation were run using the raw turbidity data without removing any anomalies like high readings due to interference, such as vegetation getting caught on a sensor. The only exception is that data for the September 23-28 period for SMP2R were omitted to remove erroneous data obtained when the sensors broke free and had to be removed for a few days before being replaced at the correct location.

From the start of construction in July until mid-October the average TSS at SMP2 was typically no more than 3 mg/L greater than the average TSS at SMP1 (Figure 27) and was less than 5 mg/L for the majority of the time. Larger deviations in TSS were noted during construction of the north channel rock groin, primarily as a result of elevated turbidity that was observed at the SMP2L-TSSS sensor (SMP2 left surface sensor). Figure 27 shows that deviations between SMP2L-TSSS and SMP1 were larger than the deviations for the site as a whole, but did not exceed the SMP action or target levels during this time. This general increase resulted from water level increases upstream of the groin as it was constructed across the channel toward the island, causing some over land flow on the island. During this time, the other three sensors at SMP2 had calculated TSS concentrations within about +/-1 mg/L of the background concentration at SMP1. After the end of September, the average TSS at the SMP2L-TSSS sensor was about 3 to 4 mg/L above the average TSS at SMP1.

At SMP3, which is considered the fully mixed zone, the TSS was generally within 1-2 mg/L of the TSS measured at SMP1 until approximately mid-September, and was about 2-3 mg/L above

SMP1 from then until mid-October (Figure 28). Similar differences are observed between SMP3 and SMP2 over this period. Overall, the observed difference between upstream and downstream TSS is consistent with predicted effects in that increases were expected to be generally small and would not exceed target 24-hour moving average increase of 25 mg/L.

Because the SMP monitoring sites were installed before July 16, 2014, Figures 27 and 28 both show calculated TSS for the two weeks leading up to the start of construction. Results from this period show that the average downstream TSS was initially about 4-5 mg/L higher at SMP2 and SMP3 than at SMP1, and over a couple of days just before construction the downstream TSS was 10-20 mg/L higher than SMP1. Thus, the observed deviations between upstream and downstream TSS in the two weeks prior to construction are generally greater than effects observed during construction up to mid-October. The elevated TSS levels observed downstream are likely due to sustained high winds at the end of June and over a few days prior to construction. High winds can stir up sediment in shallow water and along shorelines, particularly in lake areas where large waves can develop, causing an increase in suspended sediment. These results highlight the variability that can occur independently of any construction activity.

Winter monitoring started with installation of sensors at SMP1 and SMP3 in January, but SMP2 could not be monitored because of unsafe ice conditions. Slush ice and ice buildup resulted in poor quality data prior to February 18 when loggers were re-installed to move the sensors lower in the water column to get them below the slush ice and reduce the potential influence of ice on the turbidity data. Construction of the spillway cofferdam began 9 days later. During this time, calculated TSS at SMP3 was generally 4-8 mg/L above SMP1, and increased to 10-13 mg/L above SMP1 in the last few days of March (Figure 29). The peak increase predicted during the environmental assessment process was approximately 8 mg/L, with typical increases of 2-4 mg/L. The differences observed through SMP monitoring are generally two to three times greater than the predicted effects if it is conservatively assumed that neither the SMP1 nor the SMP3 sensors were being influenced by ice effects.

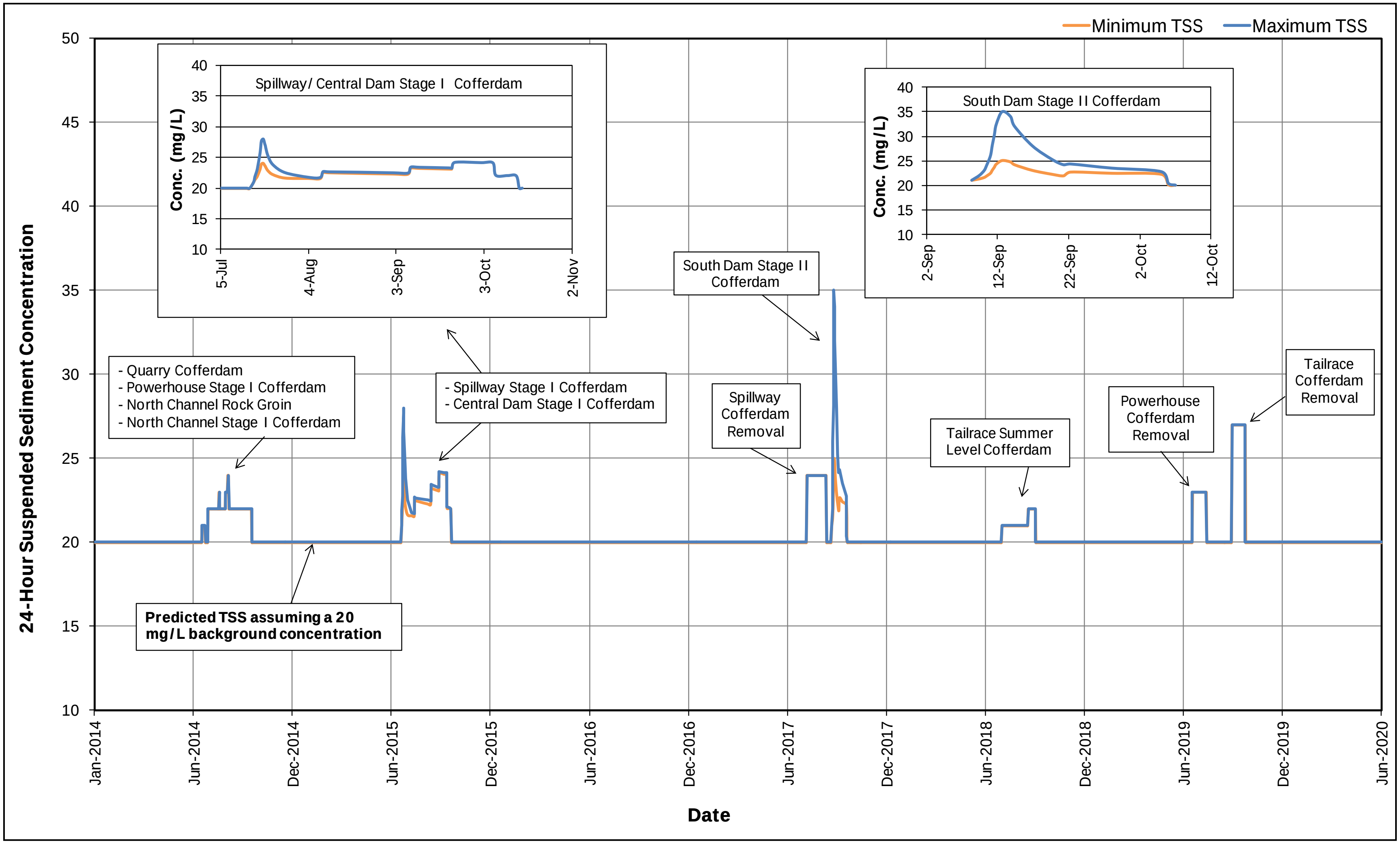

Figure 26: Fully Mixed 24-Hour Average TSS Concentration Predicted in the Proximity of Site SMP2 (mixing zone) During Construction of the Keeyask GS

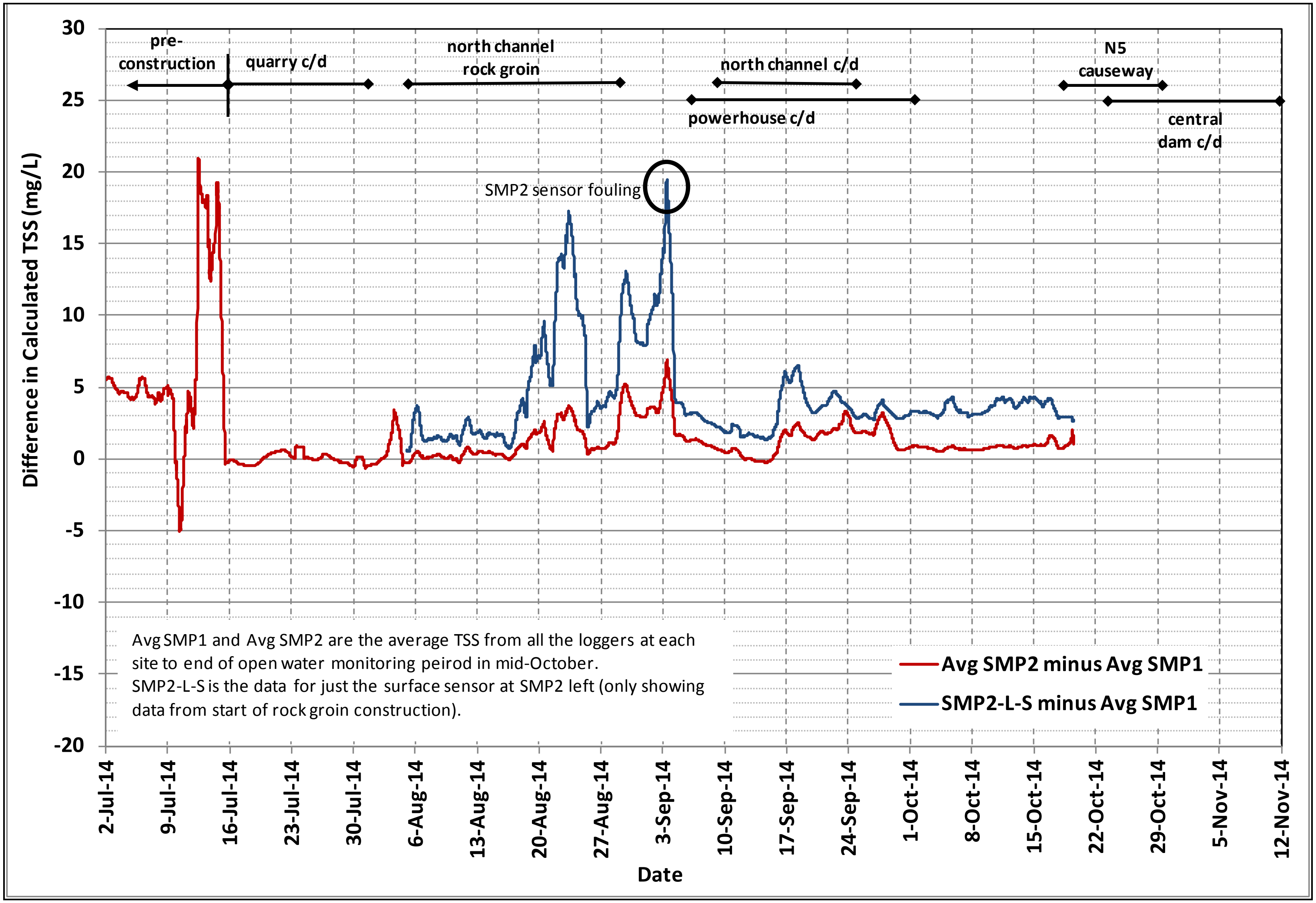

Figure 27: 24 Hour Moving Average of the Difference between Average TSS levels at SMP 1 and SMP 2

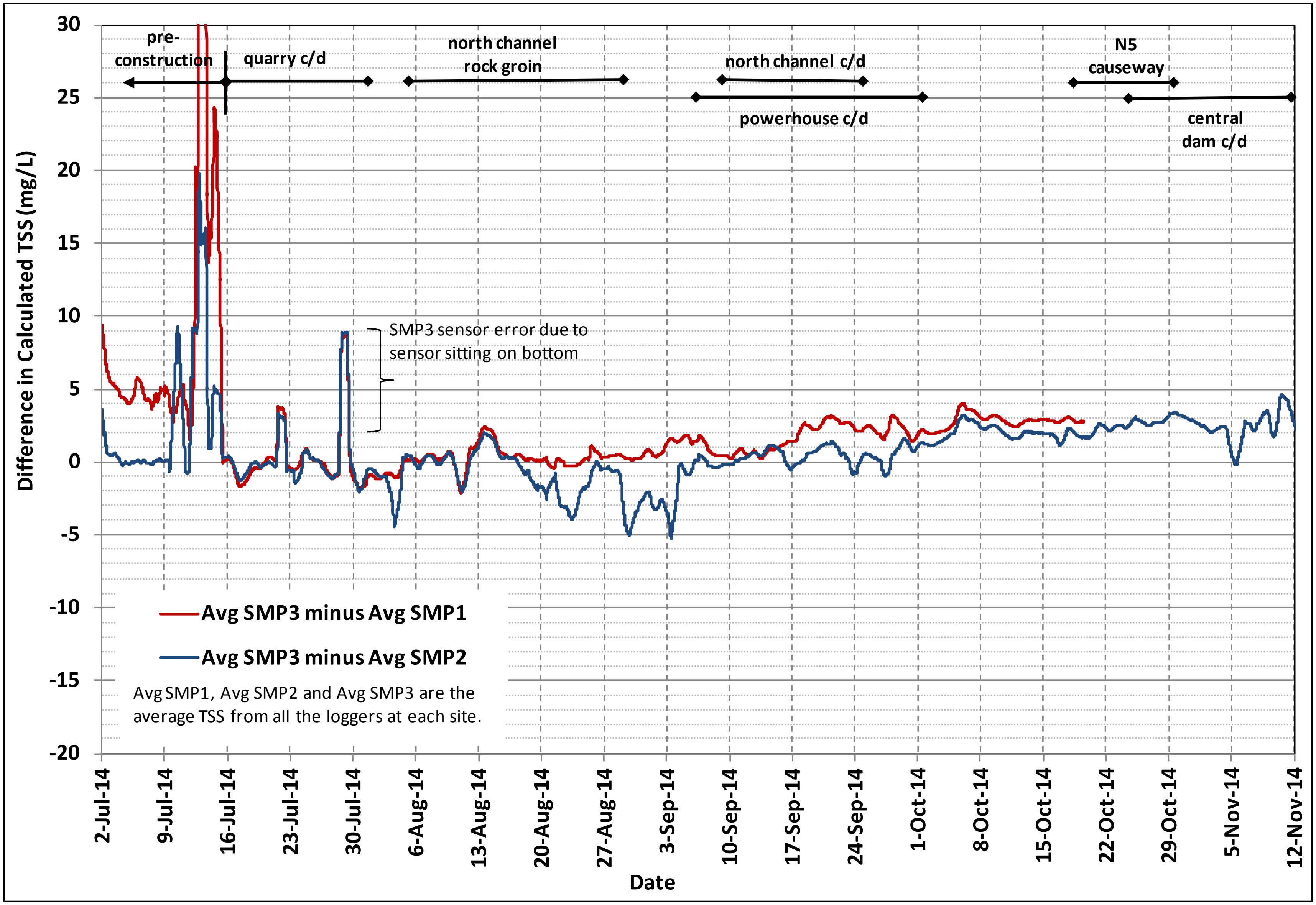

Figure 28: 24 Hour Moving Average of the Difference between Average TSS at SMP3 and Average TSS at SMP1 and SMP2

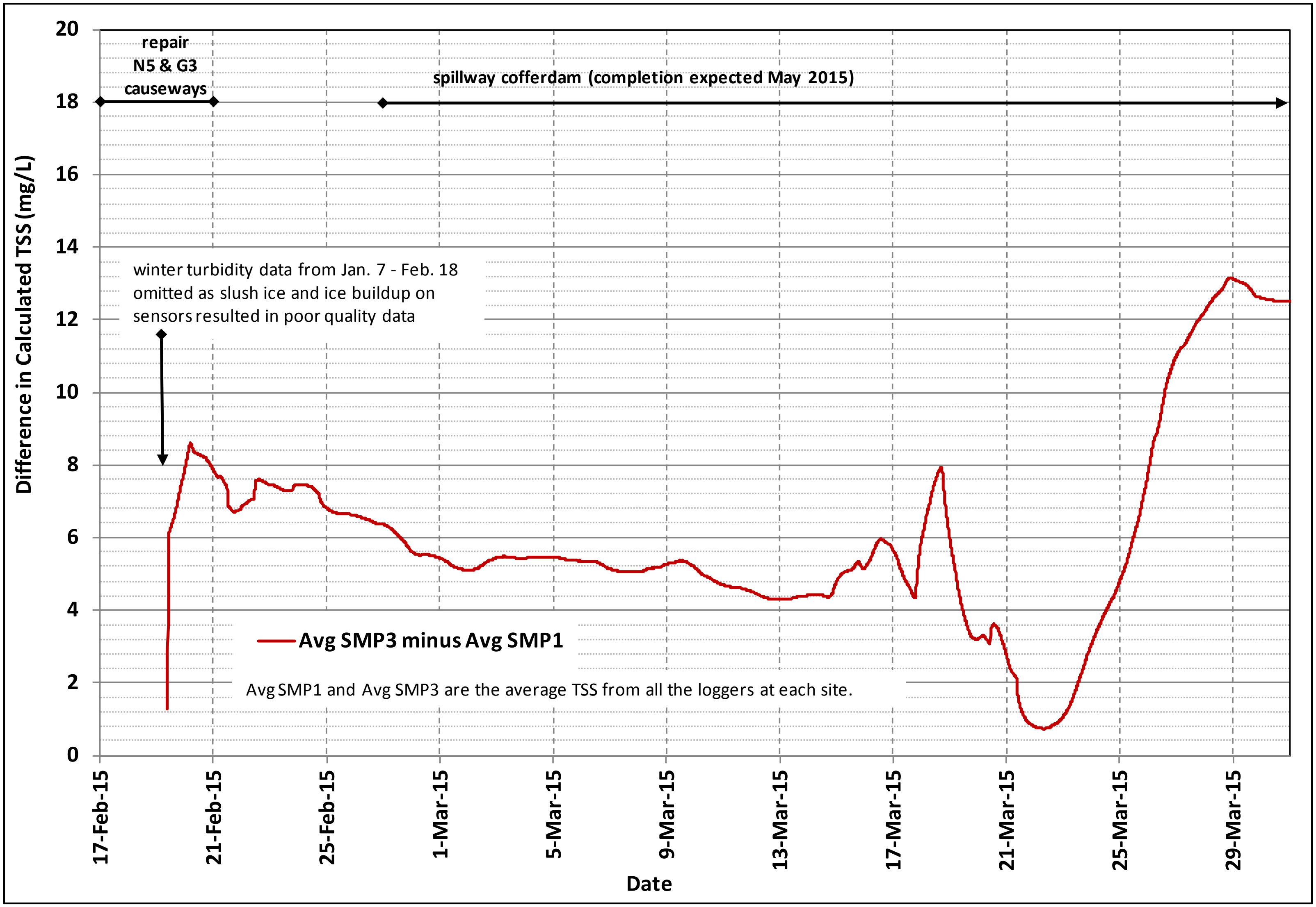

Figure 29: 24 Hour Moving Average of the Difference between Average TSS at SMP3 and Average TSS at SMP1 (Winter)

4.0 CONCLUSION

During the SMP monitoring period (July 2014 to April 2015) there were no exceedences of the SMP action levels caused by in-stream construction activities that took place. The increases in TSS levels that were noted above the action levels were identified as resulting from equipment malfunction, slush ice interference on the sensors or from maintenance activities that took place during the monitoring period.

Downstream TSS increases measured during in-stream construction in the open water period were consistent with predictions for fully mixed conditions. TSS increases measured during the winter period when the spillway cofferdam was under construction were two to four times greater than the predicted TSS increases during construction of this cofferdam. However, construction of the spillway cofferdam took place in winter rather than the summer period, when it was originally scheduled, so effects due to ice may contribute to the observed TSS increase downstream. The observed effects are consistent with the expected effects in that the downstream TSS increases have typically been less than 5 mg/L above background, well below the SMP2 action levels for TSS change and much less than the target of no more than a 25 mg/L increase above background at SMP3 over a 24-hour averaging period.

5.0 LITERATURE CITED

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Keeyask Hydropower Limited Partnership. 2014. Keeyask Generation Project, Application for Authorization Under Paragraph 35(2)(b) of the Fisheries Act Regulation. Winnipeg, Manitoba. June 2014