Site C Clean Energy Project

Oil, Gas, and Energy Monitoring and Follow-up Program

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1. INTRODUCTION

The Site C Clean Energy Project (the "Project") near Fort St. John, British Columbia (BC) (Map 1) is the third dam and hydroelectric generating station to be built on the Peace River in northeast BC. The Project has an earth-fill dam that is approximately 1,050 m in length and 60 m high above the riverbed. The reservoir is approximately 83 km long and is, on average, two to three times the former width of the river (BC Hydro 2013). Project construction commenced on July 27, 2015 and the first turbine came into operation on October 28, 2024; the remaining turbines will come online one by one until mid-2025.

Construction of the Project required in-river work in the Peace River within and immediately upstream and downstream of the dam footprint. In-river excavation equipment and methods included aquatic excavators, excavators working from a barge or temporary constructed platform, suction dredgers, grab/bucket dredgers, and drag-line excavation. When there was active in-river work, it was expected that there would be an increase in the concentration of total suspended solids (TSS), and hence turbidity, in the Peace River downstream of the work. In-river works began on October 14, 2015 and continued through late 2024. Now that the reservoir is full and water is passing through the powerhouse, there is the potential for changes to the downstream suspended sediment and water temperature regimes in the Peace River relative to pre-construction conditions.

2. PLAN OBJECTIVES

Construction and operation of the Project requires monitoring of turbidity, TSS, and water temperature at a variety of locations to meet various monitoring requirements. One such requirement comes from Condition 32 of the Environmental Assessment Certificate (EAC) which specifies that BC Hydro must develop an Oil, Gas, and Energy Monitoring and Follow-up Program as it relates the McMahon Gas Plant's surface water intake on the Peace River ~17.6 km downstream of Site C (BC EAO 2014) (Map 1). The purpose of this document is to summarize the potential Project-related concerns around the McMahon gas plant's intake and to define what is entailed in a monitoring and follow-up program to meet Condition 32 of the EAC. We acknowledge this work is being conducted on the traditional territory of Treaty 8 First Nations of Dunne Zaa, Cree, and Tse'khene cultural descent.

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3. BACKGROUND

3.1. Environmental Impact Statement

Turbidity and TSS monitoring of the Peace River in the reach that extends from upstream of Site C to the Taylor Bridge has been ongoing since spring 2010. Water temperature monitoring of the Peace River in the reach that extends from upstream of Site C to the Taylor Bridge has been ongoing since 2008. Potential concerns around these parameters as it relates to the McMahon Gas Plant's water intake in the Peace River that were raised in the Environmental Impact Assessment are provided below.

3.1.1. Effects Assessment – Construction – Change in Land and Resource Use

The following is text that is reproduced from the Environmental Impact Statement (EIS) (BC Hydro 2013), and focusses on potential effects of Project construction on the McMahon Gas Plant. Note that when the EIS was completed, the McMahon Gas Plant was owned by Spectra Energy; it has been owned by NorthRiver Midstream since December 2019.

> "The Spectra Energy water intake in the Peace River just south of Taylor could be affected by the predicted physical changes in suspended sediment during construction, or by event driven sediment discharges during construction. The main concerns related to the construction phase raised by Spectra Energy to BC Hydro relate to the potential for increased suspended sediment that could affect their operations, as follows:
>
> - Increased suspended sediment in the water (i.e., higher turbidity) could lead to an increase in the required frequency of maintenance.
>
> Expected changes with Site C during construction, in the vicinity of the Spectra intake are described in Volume 2 Section 11.8 Fluvial Geomorphology and Sediment Transport. In summary, expected changes with Site C related to the concerns of Spectra include:
>
> - It is expected that there would be periods of increased suspended sediment / turbidity during construction.
>
> While the physical changes can be characterized, it is not clear based on what is known today that these physical changes expected due to Site C would lead to an actual adverse effect on Spectra Energy's operations. The modelling of predicted changes in water temperature and sediment transport expected during construction, along with specific information from Spectra on the relationship between these variables and its operations, can be used to inform and develop an appropriate construction monitoring program with Spectra."

3.1.2. Effects Assessment – Operations – Change in Land and Resource Use

The following is text that is reproduced from the Environmental Impact Statement (EIS) (BC Hydro 2013), and focusses on potential effects of Project operation on the McMahon Gas Plant. Note that when the EIS was completed, the McMahon Gas Plant was owned by Spectra Energy; it has been owned by NorthRiver Midstream since December 2019.

> "During operations, the Spectra Energy water intake could be affected by changes in water temperature as well as suspended sediments.
>
> - If river water temperature downstream of Site C increases, more water would have to be pumped from the river to achieve the same amount of cooling. When water temperature approaches 15 – 17°C, Spectra may need to cut back production. This typically happens, currently, on hot summer days, during daylight hours.
> - Increased suspended sediment in the water (i.e. higher turbidity) could lead to an increase in the required frequency of maintenance.
>
> Expected changes with Site C during operations, in the vicinity of the Spectra intake are described in Volume 2 Section 11.4 Surface Water Regime, Volume 2 Section 11.7 Thermal and Ice Regime, and in Volume 2 Section 11.8 Fluvial Geomorphology and Sediment Transport. In summary, expected changes with Site C related to the concerns of Spectra include:
>
> - Modelled temperatures at the Site C outlet were warmer than observed temperatures at the same location between July and January, ranging from 0.3°C in July to 1.5°C higher than existing conditions in October. The monthly modelled outlet temperatures were between 0.4 and 0.9 °C cooler from March to June, and in all months had a smaller daily range than the existing river.
> - During operation, the turbidity during the spring freshet would be substantially reduced. At other times of the year (during the first 10 years of operation) there would be a slight increase in the suspended sediment due to additional inputs to the reservoir from the erosion of shorelines. After the first 10 years the sediment input from the shorelines is expected to decrease.
>
> As during the construction phase, while the physical changes can be characterized, it is not clear based on what is known today that these physical changes expected due to Site C would lead to an actual adverse effect on Spectra Energy's operations. The modelling of predicted changes in water temperature and sediment transport expected during operations, along with specific information from Spectra on the relationship between these variables and its operations, can be used to inform and develop an appropriate construction monitoring program with Spectra."

3.2. Environmental Assessment Certificate Condition

BC Hydro conducts continuous turbidity and water temperature monitoring at the McMahon Gas Plant intake (Peace River at McMahon Gas Plant – Left Bank; Map 1) to meet EAC Condition #32 (BC EAO 2014) which specifies monitoring of the effects of increased sedimentation at the McMahon Gas Plant intake during construction, and effects of increased water temperature and sedimentation during operations. EAC Condition #32 specifies that this monitoring must be conducted for a period of 10 years after the commencement of operations. Note that Spectra Energy which is referred to in EAC Condition #32 is no longer the owner of the McMahon Gas Plant; at the time of writing it is owned by NorthRiver Midstream.

4. PLAN SCOPE

4.1. Station Description

The continuous monitoring station at the intake of the McMahon Gas Plant consists of an Observator Instruments Analite NEP395 turbidity sensor that is installed in a PVC pipe attached to the upstream wingwall of the McMahon Gas Plant intake forebay (Figure 1). The sensor is mounted below the normal annual low water level elevation. The sensor is connected via a waterproof power and communications cable to a Unidata Neon Remote Terminal data logger and cellular telemetry transmitter. The station is powered by two 12-volt, 33-amp hour batteries, which are connected to a 30-watt solar panel. The station's data logger, telemetry, and power equipment are housed within a locked aluminium case mounted on the intake structure; the solar panel is mounted adjacent to the aluminum case. Turbidity and water temperature data are logged every 15 minutes, and the logged data are transmitted hourly.

The turbidity sensor also measures the temperature of the sensor, which reflects the temperature of the water as long as the body of the sensor remains continuously and completely submerged. The temperature data collected by Analite turbidity sensors typically need to have an offset applied in order to correct the time series, and this requires substantial post-processing effort. Accordingly, a stand-alone water temperature sensor that is known to be more accurate (rarely ever requiring offsets to be applied) is installed in the same PVC pipe as the turbidity sensor. The stand-alone water temperature sensors that have been used at this station are Onset TidbiTs (model V2 Part # UTBI-001, or model MX2203). A TidbiT was first installed in 2017, and water temperature data are collected with it every 15 minutes.

Figure 1. PVC pipe attached to the upstream wingwall of the McMahon Gas Plant intake forebay which contains the Analite turbidity sensor and the TidbiT water temperature sensor.

4.2. Baseline Conditions

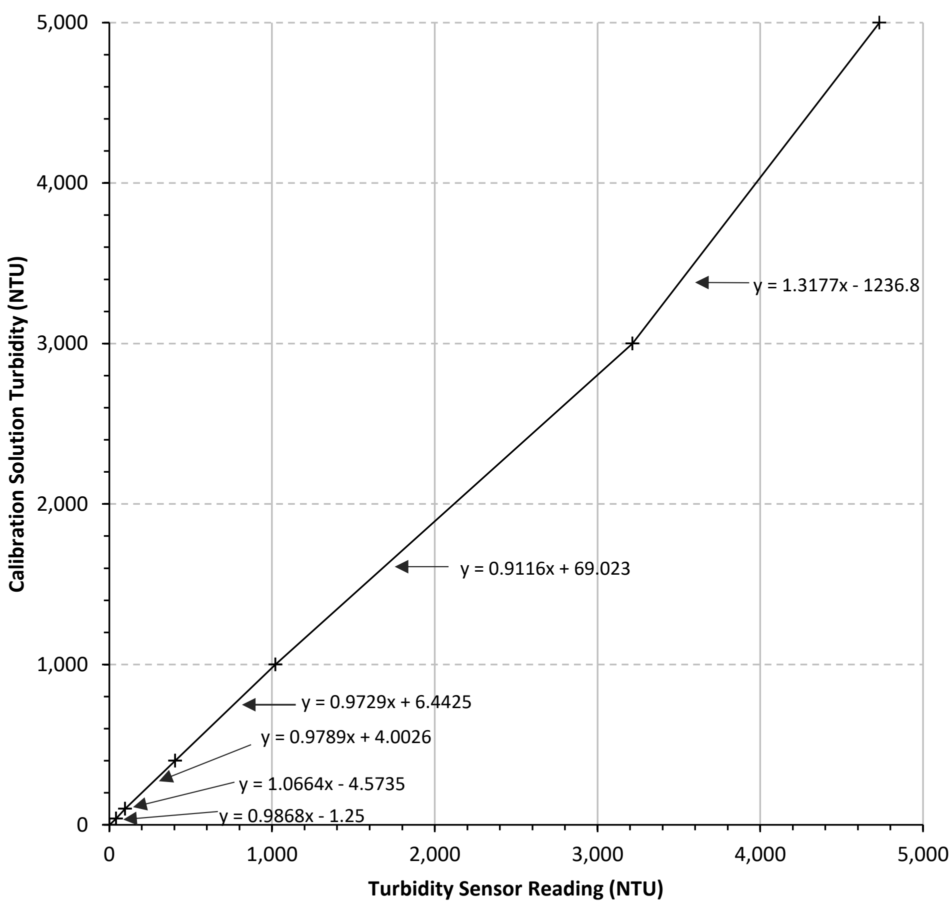
In-river works began on October 14, 2015, and continued through late 2024. Data collection began in 2010; however, prior to 2016, reliable data only exist in for a small portion of 2010 and for parts of 2013 and 2014.

4.3. Sensor Calibrations and Spot Checks

In each year of monitoring, three turbidity sensor calibrations will be performed between April to November. Additional unplanned station maintenance trips are expected to occur throughout the year to address maintenance issues as they arise, particularly during summer months when biofouling can impact data quality. Turbidity calibration solutions of 0 NTU, 40 NTU, 100 NTU, 400 NTU, 1,000 NTU, 3,000 NTU, and 5,000 NTU will be used to perform calibration checks of the instream turbidity sensors and to provide equations to convert raw turbidity data from the instream sensor to calibration-corrected turbidity data (e.g., Figure 2). Note that NTU stands for Nephelometric Turbidity Unit, and that prior to the August 2020 calibration checks, 5,000 NTU calibration solutions were not available. The sensors will not be physically calibrated to match the standards. Instead, the raw turbidity time series data recorded by the sensors will be post-processed using the AQUARIUS software (Aquatic Informatics Inc.). Calibration corrections will be applied when the sensor values differ from the calibration standard by more than 5% (2 NTU for the 0 NTU standard). The turbidity time series data will be corrected assuming a linear, piecewise relationship between the seven calibration/validation points recorded in the field (Figure 2). Following a calibration test, sensor values are aligned with measured standards by applying corrections which adjust for differences in sensor accuracy at each measured turbidity level, as well as since the previous calibration test (i.e., due to sensor drift over time). During the monitoring period, field crews will collect manual turbidity readings at the instream turbidity sensor station location during site visits where TSS lab samples are collected. Manual turbidity readings will be taken with an Observator Instruments Analite NEP-5000-LINK to ensure comparability with data from the instream Analite turbidity sensor. These data will be used for assessments of instream sensor functionality and will not be incorporated into the calibration post-processing procedure.

When turbidity calibrations are done, water temperature spot measurements will be taken as close to the TidbiT as possible using a sensor that has comparable accuracy to TidbiTs (i.e., ±0.2°C). Additional spot measurements may be taken throughout the year when station servicing is being conducted or when TSS samples are being collected.

Figure 2. Example of turbidity relationships for calibration correction.



4.4. TSS:Turbidity Relationships

The relationship between TSS and turbidity will be used to convert real-time continuous turbidity data to real-time continuous TSS data. The relationship can be dynamic, depending upon a variety of factors including snowmelt and precipitation driven changes in the relative contributions of various sediment sources, as well as hydrology driven changes in the sediment carrying capacity of the Peace River. As such, a TSS:turbidity relationship has been developed for all turbidity stations on the Peace River (currently six stations including the station at the McMahon Gas Plant) and is reassessed regularly to ensure it reflects the best available data.

For this relationship, data have been collected from 11 monitoring stations in the Peace River (the six decommissioned Peace River above Moberly River stations, a decommissioned Peace River below Moberly River station, the two Peace River above Pine River stations, Peace River at the McMahon Gas Plant Intake, and at Peace River near Taylor Wells). Real-time turbidity data are continuously collected at active stations, while TSS samples are collected for laboratory analysis periodically during station servicing visits and over the course of freshet when the Peace River experiences its full range of suspended sediment conditions.

For TSS sampling from 2017 – 2023, the procedures previously employed by KPL (2014) were followed and will be followed during operational monitoring. TSS samples will be collected as close as safely possible to the instream turbidity sensor. TSS sampling will be performed using a DH-48 sampler. The DH-48 sampler will be rapidly submerged to the turbidity sensor elevation, allowed to fill, then rapidly raised to the surface. The sampling unit was designed by the United Federal Interagency Sedimentation Project and has been used by federal agencies, including the United States Geological Survey, the United States Army Corps of Engineers, and the Water Survey of Canada (WSC). The sampler operates isokinetically, meaning that water flows into the sampler at the same velocity as the stream velocity. This ensures the suspended sediment concentration and grain size distribution are the same as that in the ambient streamflow (Edwards and Glysson 1999). Water enters the sampler through the upstream-oriented intake nozzle, while air is discharged from the sample bottle via the downstream-oriented air exhaust vent. The TSS sampling method is described in detail in Romano and Ganshorn (2017).

These TSS samples will then be lab-analyzed and paired with the corresponding turbidity data recorded at the station to determine the TSS:turbidity ratio for the individual pairings. These individual sample ratios are then plotted over time to identify major shifts in the relationship, such that an appropriate period of time can be selected for further analysis to determine the more precise relationship. Data from the selected period are combined and the TSS:turbidity ratio is determined using either a linear model with site-specific interactions (if Tukey post hoc tests shows that this ratio differs amongst sites) or if there is no clear evidence of site-specific interactions, then a single common relationship is determined for the Peace River using linear regression.

4.5. QA/QC

4.5.1. Continuous Turbidity Data

AQUARIUS Time-Series software will be used to review data on an on-going basis. Turbidity data collected at the McMahon Gas Plant intake will be compared to turbidity data from all stations on the Peace River, as well as to WSC discharge data, where available, from the following stations: Peace River above Pine River (07FA004), Halfway River near Farrell Creek (07FA006), and Moberly River near Fort St. John (07FB008).

AQUARIUS Time-Series software will be used to identify and remove periods of erroneous data. An automated spike filter will be applied to the real-time data; the filter removes spikes that deviate more than 200% from the moving average based on the three data points preceding and following the data point being assessed. Small data gaps created from the removal of erroneous data will be filled using the AQUARIUS Time-Series linear interpolation tool, and larger gaps will be filled by applying adjustments to data obtained from an applicable nearby station (e.g., the station near the District of Taylor groundwater wells on the Peace River). Adjustments to data from nearby stations will be determined by comparing overlapping portions of both turbidity time-series records, and by ensuring no negative readings remained in the time series after an offset had been applied. Data that are interpolated or based on nearby stations will be considered estimated and are graded as such in the AQUARIUS Time-Series database.

4.5.2. TSS:Turbidity Relationships

For the collection of TSS samples to be used in the development of TSS:turbidity relationships, the following best practices will be followed:

- Following collection, TSS samples will be kept in coolers containing ice packs. At the end of a field day, samples will either be refrigerated upon return to the office and taken to the ALS depot in Fort St. John the following morning or taken directly to the ALS depot in Fort St. John on the day of collection. All samples will be delivered to the laboratory as soon as possible to ensure samples were analyzed within the seven-day hold time.
- Samples will be collected in duplicate or triplicate to test sampling precision.
- All sample analyses will be completed by an accredited analytical laboratory with an ISO/IEC 17025:2017 and Canadian Association for Laboratory Accreditation certification.
- The entire sample will be used for the analysis in most cases, but this may be adjusted by the laboratory when TSS concentrations are very high (e.g., in samples collected during spring freshet).

For the purpose of developing a TSS:turbidity relationship for the stations, laboratory TSS data will be paired with turbidity data recorded from the instream turbidity sensor at the time of TSS sample collection, after the QA/QC procedures described in Section 4.5.1 are implemented.

4.5.3. Continuous TSS Data

A continuous TSS time series will be calculated using a TSS:turbidity relationship after the QA/QC procedures described in Section 4.5.1 have been implemented. Continuous TSS data will be considered as estimated when the TSS concentration is outside of the range of data used to establish the TSS:turbidity relationship.

4.5.4. Continuous Water Temperature Data

All water temperature data will be QA/QC'd to ensure that any suspect or unreliable data are excluded. Excluded data may consist of data where the sensor was out-of-water/dry, buried in sediment, being serviced, or not functioning correctly. Then, outliers from the time series will be identified and removed. This will be done by comparing water temperature data to that from sensors at the nearby stations (e.g., the station near the District of Taylor groundwater wells on the Peace River), as well as comparing the station water temperature data to local air temperature collected at the Fort St. John North Camp C_Met_60 climate station, and discharge from three WSC stations in the Peace River (07FA004, 07FD010, 07EF001). Finally, the water temperature record will be validated by comparing the data to *in situ* spot measurements of water temperature to the station sensor data. The data QA ensured that there is a good agreement between spot measurements and continuous site records.

5. REPORTING REQUIREMENTS

EAC Condition #32 specifies that the Oil, Gas, and Energy Monitoring and Follow-up Program must be developed submitted in draft to the gas plant owner within 90 days after the commencement of operations (i.e., January 25, 2025), and the final report must be filed with EAO and the gas plant owner within 150 days after the commencement of operations (i.e., March 26, 2025). Monitoring reports must be provided to owner of the McMahon Gas Plant beginning 180 days following commencement of operations (i.e., April 25, 2025), and annually thereafter. EAC Condition #32 specifies that monitoring must be conducted for a period of 10 years after the commencement of operations (i.e., October 28, 2034).

6. CLOSURE

We trust that this document meets BC Hydro's requirements with respect to an Oil, Gas, and Energy Monitoring and Follow-up Program. EAC Condition #32 specifies that this monitoring must be conducted for a period of 10 years after the commencement of operations, with annual data reports being provided to the owner of the McMahon Gas Plant.

The owner of the McMahon Gas Plant is responsible for collecting relevant data on plant operations and maintenance that would allow for the identification of effects on the McMahon Gas Plant that may be the result of the Project's influence on water temperature and sedimentation (BC Hydro 2014).

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