Site C Clean Energy Project

Offset Effectiveness Monitoring for River Road Rock Spurs and Upper Site 109L – 2017

Peace River Fish Community Monitoring Program (Mon-2, Task 2d)
Peace River Physical Habitat Monitoring Program (Mon-3, Task 2c)

Construction Year 3 (2017)

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6 April 2018

REPORT

Site C Clean Energy Project
Offset Effectiveness Monitoring

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Peace River Physical Habitat Monitoring Program (Mon-3, Task 2c)

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Executive Summary

Fish and fish habitat are valued components of the Peace River that are considered important by BC Hydro, Aboriginal groups, the public, the scientific community, and government agencies. The Site C Clean Energy Project (the Project), including Project construction, reservoir filling, and operation, could affect fish and fish habitat via three key pathways: changes to fish habitat (including nutrient concentrations and lower trophic biota), changes to fish health and fish survival, and changes to fish movement.

BC Hydro submitted an application to Fisheries and Oceans Canada (DFO) for an authorization under Section 35(2)b of the *Fisheries Act* for several components of the Project associated with Site Preparation. The application included an Offsetting Plan, which proposed the creation of rock spurs along River Road, channel modifications at Upper Site 109L, and channel modifications at Side Channel Site 108R, which were designed to offset unavoidable serious harm to fish as a result of Site Preparation by providing the following (as detailed in the application; BC Hydro 2015):

- increase the quantity and quality of available, permanently wetted habitat to support primary and secondary production as food production for fish and provide rearing, feeding, overwintering, and potential spawning habitats for fish.
- reduce fish stranding risk.
- increase the complexity and variability of fish habitat to support a variety of life stages for local fish populations.

DFO approved the Offsetting Plan and issued a *Fisheries Act* Authorization (FAA; No. 15-HPAC-00170) for site preparation works on September 30, 2015. The FAA requires BC Hydro undertake monitoring and reporting of the implementation of offsetting measures. The objectives of Site C Offset Effectiveness Monitoring are to identify the following (as detailed in the application; BC Hydro 2015):

- that the offsets have been implemented as designed and approved.
- that the offsets maintain their design and purpose over time.
- that the offsets are biologically effective (i.e., support ongoing productivity).

Construction of two habitat offset areas, the River Road rock spurs and channel modifications at Upper Site 109L, began in 2015 and were completed in 2016. The third habitat offset area (channel modifications at Side Channel Site 108R) is yet to be built.

Monitoring the effectiveness of the two constructed habitat offset areas began in 2017. This report presents the results of the first of three years of proposed offset effectiveness monitoring for these two offsets.

In 2017, effectiveness monitoring of offset areas focused on three components; physical habitat, general fish use, and Mountain Whitefish (*Prosopium williamsoni*) spawning.

Physical habitat was visually assessed to confirm that the rock spurs provided a diversity of hydraulic conditions that were unique to that reach of the Peace River. Water velocity patterns (i.e., speed and direction) were also assessed using an Acoustic Doppler Current Profiler (ADCP). Where possible, water depth data collected during boat-based and ground-based ADCP surveys were compared to data that were similarly collected in 2015. ADCP surveys were conducted on 27 May 2017 at five previously established transect locations (Golder 2015), which are also assessed as part of BC Hydro's Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program (FAHMFP), and at three new locations established for the purposes of this study.

General fish use was assessed by conducting boat electroshocking sampling in each offset area. Sampling was conducted at three previously established sites that are also assessed as part of the Site C FAHMFP. Two additional sites were established and sampled within Upper Site 109L for the purposes of this study. Boat electroshocking was conducted between 26 August and 3 October 2017. These data were combined with data collected in 2016 and compared to a 2-year block of data collected before the offsets were constructed (i.e., 2014 and 2015).

The use of Upper Site 109L for spawning by Mountain Whitefish was monitored using artificial substrate mats that rested on the river bottom to trap eggs that drifted downstream. These samplers were deployed continuously between 24 October and 14 December and were checked approximately once per week.

A visual assessment of the rock spur structures and associated bank armouring along River Road indicated that the near-channel area provides more turbulent and variable flow patterns with slower mean water column velocities when compared to the more laminar flows observed towards the mid-channel and along adjacent Peace River shorelines. Water vector assessments showed that flow directions were affected by the rock spurs, with velocity vectors pointing randomly in different directions. At Upper Site 109L, ADCP data generally indicated higher water speeds near the upstream end of the site and lower water speeds near the downstream end of the site. Water speeds were also higher along the mid-channel side (i.e., south side) of Upper Site 109L when compared to the north side. Non-laminar and variable water velocities within the site, coupled with excavated channel depressions, appeared to increase habitat complexity and suitability for the target species when compared to habitats present in the area prior to recontouring. In addition, the excavation of the Upper Site 109L to an elevation of less than 407 metres above sea level (masl) is intended to ensure that the area remains permanently wetted even under minimum operating flows for the Project (409 masl), increasing the quantity of permanently wetted habitat available for primary and secondary productivity while reducing fish stranding risk. Upper Site 109L remained wetted under all water levels observed over the duration of the 2017 field program.

Fish use data collected during the two years immediately prior to the construction of the rock spurs and data collected during the two years immediately after construction of the rock spurs indicated increased use of the area by Arctic Grayling, Bull Trout, and Rainbow Trout and decreased use of the area by Walleye, Northern Pike [*Esox lucius*], and the three sucker species (Largescale Sucker [*Catostomus macrocheilus*], Longnose Sucker [*Catostomus catostomus*], and White Sucker [*Catostomus commersonii*]). The number of Mountain Whitefish recorded in the rock spur area declined after the construction of the offsets; however, Mountain Whitefish catches were lower throughout the Peace River in 2016 and 2017. Two Burbot (*Lota lota*) were recorded along the rock spurs, which represented the first two occurrences for this species along these two sites of the Peace River in 12 years of near continuous monitoring conducted by BC Hydro. Sparse data for all other species during all study years limit analysis and interpretation for these species.

Fish use data collected during the two years immediately prior to the construction of Upper Site 109L and data collected during the two years immediately after construction of Upper Site 109L did not indicate substantial changes in use of this area for any fish species or life stages.

Over 13,000 mat-hours were expended during a seven week long Mountain Whitefish spawn monitoring survey within Upper Site 109L. No Mountain Whitefish eggs were trapped by the mats during this period.

Overall, monitoring documented the effectiveness of the offsets relative to the objectives for the monitoring. First, the River Road rock spurs and channel modifications at Upper Site 109L were constructed as described in Section 6.2.1 (Mitigation Measures Downstream of Site C Dam Site) of the Project's Fisheries and Aquatic Habitat Management Plan[1]. Second, physical habitat data collected in 2017 show that the offsets provide a variety of habitats unique to that reach of the Peace River that are suitable for use by a variety of fish species and life stages, while reducing stranding risk. Finally, a variety of fish species and life stages were recorded in the offset areas after their construction.

[1] Available for download at: https://www.sitecproject.com/sites/default/files/Fisheries_and_Aquatic_Habitat_Management_Plan.pdf.

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1.0 INTRODUCTION AND BACKGROUND

Fish and fish habitat are valued components of the Peace River that are considered important by BC Hydro, Aboriginal groups, the public, the scientific community, and government agencies. The Site C Clean Energy Project (the Project), including Project construction, reservoir filling, and operation, could affect fish and fish habitat via three key pathways: changes to fish habitat (including nutrient concentrations and lower trophic biota), changes to fish health and fish survival, and changes to fish movement. These paths are examined in Volume 2 of the Project's Environmental Impact Statement (EIS)[2].

BC Hydro submitted an application to Fisheries and Oceans Canada (DFO) for an authorization under Section 35(2)b of the *Fisheries Act* for several components of the Project associated with Site Preparation (BC Hydro 2015). The application included an Offsetting Plan, which proposed the creation of rock spurs along the River Road, channel modifications at Upper Site 109L, and channel modifications at Side Channel Site 108R, which were designed to offset unavoidable serious harm to fish as a result of Site Preparation by providing the following (BC Hydro 2015):

- increasing the quantity and quality of available, permanently wetted habitat to support primary and secondary production as food production for fish and provide rearing, feeding, overwintering, and potential spawning habitats for fish.
- reducing fish stranding risk.
- increasing the complexity and variability of fish habitat to support a variety of life stages for local fish populations.

The design of the offsets is described in the Project's Fisheries and Aquatic Habitat Management Plan[3]. BC Hydro's *Fisheries Act* Authorization Application for site preparation (BC Hydro 2015) provides the following summary with regards to the construction of the River Road rock spurs:

> *Twenty rock spurs will be constructed along a 2.4 km length of River Road that extend from River Road into the river to enhance fish habitat by providing a diversity of water velocities, depths, and predation refuges. These spurs were proposed in the EIS for the Project and are a common enhancement method to induce eddies or shear zones, which are frequently used as resting and feeding areas by fish (Slaney and Zaldokas 1997). The rock spurs will be constructed either entirely of riprap from Wuthrich Quarry or a combination of river cobble/gravels and armoured with Wuthrich riprap as River Road construction progresses. The rock spurs will be 15 m long and 4 m wide at the crest. The spacing between the spurs will be 60 m, four times their length. The rock spurs will alter 0.19 ha of instream area beyond the River Road footprint. In addition to the rock spurs, this portion of River Road will be stabilized with large riprap and boulders, which will also provide more substrate variability and interstitial cover for rearing fish when compared to existing conditions.*
>
> *Flow conditions associated with the rock spurs (i.e., flow streamlines, water levels, and depth averaged velocities) were modelled using River 2D. Modelling predicted that the spurs would be effective at moving the higher velocities away from the bank, and therefore provide a range of velocities between them that is more suitable for fish use. Substrata between the spurs will initially consist of gravel and cobble that is suitable for supporting benthos. At discharges below 1000 m^3/s, the modelling predicted low velocity depositional areas*

[2] Available for download at: http://www.ceaa-acee.gc.ca/050/document-eng.cfm?document=85328.

[3] Available for download at: https://www.sitecproject.com/sites/default/files/Fisheries_and_Aquatic_Habitat_Management_Plan.pdf

will form between the spurs that will result in some sediment deposition. At higher flows, recirculation between the spurs is predicted, which will limit fine sediment deposition and potentially scour out previously deposited fines…

The rock spurs are expected to enhance fish productivity by diversifying water velocities and depths in the area, as well as providing predation refugia for juvenile large-bodied fish and all life stages of small-bodied fish. Current hydraulic conditions along this section of the river bank are homogenous due to a lack of physical habitat (such as log jams or depositional fans), limited undulations in the shoreline, and a consistent bank slope. The eddies that will form behind each rock spur will benefit most life stages of the cold-water target fish species. Migrating Bull Trout (Salvelinus confluentus) will use the slack water within the eddies for resting. Adult Arctic Grayling (Thymallus arcticus), Bull Trout, Mountain Whitefish (Prosopium williamsoni), and Rainbow Trout (Oncorhynchus mykiss) can hold in the eddies, dart into the adjacent main current to capture prey items drifting downstream, and quickly return to the eddy. Juvenile Rainbow Trout are known to prefer the interstitial areas created within the large riprap substrate (Tabor and Wurtsbaugh 1991; ONA et al. 2014).

Riprap substrate was placed between the rock spurs and adjacent to River Road to armour the newly constructed bank (BC Hydro 2015). The riprap substrate was larger than the substrate found in the area prior to construction (Golder 2016) and is expected to provide additional interstitial cover for small fish. Throughout this report, assessments of fish use consider the combined influence of the River Road rock spurs themselves and the associated bank armouring along the length of River Road.

With regards to Upper Site 109L, BC Hydro (2015) provides the following summary:

The approach is to use a 'cut and fill' excavation and deposition approach in shallow water habitats that are dewatered during Project operations. Areas will be excavated to below low flow levels, and this material will be used to 'fill' adjacent shallow areas to an elevation above high water. Alternatively, at some locations, excavated material from shallow water habitats can be moved and used as Project construction material. The area proposed for excavation during Site Preparation comprises 15.43 ha of instream area and 0.04 ha of riparian area…

The works are expected to increase the potential use of the area for Mountain Whitefish spawning by providing suitable depth and velocity characteristics. The excavation should provide clean gravels and cobbles that will increase interstitial spaces, thereby providing additional cover for eggs and larvae that in turn, may benefit survival of these life stages. The increased wetted surface area and wetted duration of the habitat at Upper Site 109L is also expected to result in an overall increase in primary and secondary productivity…

In addition, channel depressions will be excavated within Upper Site 109L. These depressions and their associated monitoring form part of BC Hydro's adaptive management strategy, and monitoring results on the physical and biological effectiveness of these depressions will guide future channel enhancements. There is substantial biological precedent for the use of structures that alter depth and velocity to increase habitat suitability in rivers, and this approach will be used to increase fish use at this site. These depressions will include both longitudinal (parallel to flow) and transverse (perpendicular to flow) types to create a variety of hydraulic conditions. The depressions proposed are 5 to 25 m in length and width (at the top), and vary in depth from 1 m to 2 m deeper than the adjacent bed. The depressions will be spaced to maintain uniform hydraulics across the area. The depressions will be located and spaced across the area to optimize fish habitat features.

These depressions will provide areas of greater depth (up to 3 m at minimum flows) and increase the habitat suitability and complexity in the area by providing more appropriate depths and velocities as well as complex flow patterns and velocity refugia, while not interfering with the overall flow-through of the main current. The additional habitat complexity provided by the proposed depressions is expected to increase the number of fish that use the area for feeding and holding functions. Hydraulic modelling of 109L shows the velocities of up to exceed preferences of Mountain Whitefish during peak operating flows over most of the 109L area. Under these conditions the proposed depressions will provide lower velocities across 109L, increasing habitat suitability over a range of flows for Mountain Whitefish. The depressions are also expected to provide shear zones at higher flows and deeper pool areas for cover and holding at lower flows. These features will provide additional habitat for species such as Walleye (Sander vitreus), Mountain Whitefish and Bull Trout, which make use of deeper habitats.

The third offset area (i.e., Side Channel Site 108R) is yet to be built and thus monitoring was not conducted at this offset area in 2017. A summary of the construction and resulting habitat at this location is included in the *Fisheries Act* Authorization Application for Site Preparation (BC Hydro 2015). Further description is not provided in this report.

DFO approved the Offsetting Plan and issued a *Fisheries Act* Authorization (FAA; No. 15-HPAC-00170) for Site Preparation works[4]. The FAA requires BC Hydro undertake monitoring and reporting of the implementation of offsetting measures, in accordance with Section 5.1 of the FAA. This report supports this requirement.

Construction of the River Road rock spurs and the channel modifications at Upper Site 109L began in 2015 and were completed in 2016. Monitoring the effectiveness of these two offset areas began in 2017, the year following construction of the offsets, as described in the monitoring plan. Offset effectiveness monitoring includes data collection that supplements existing monitoring of fish and fish habitat that has been ongoing. This report presents the results of the first year of three years of proposed offset effectiveness monitoring.

1.1 Objectives

The Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program (FAHMFP) states that the objective of Offset Effectiveness Monitoring is to determine the biological effectiveness of the offsets (i.e., to support ongoing productivity) by monitoring fish abundance and community composition at both a site- (i.e., 100's m) and reach-scale (i.e., 10's km). Reach-scale monitoring will be encompassed within the entirety of the Site C FAHMFP and summaries of the reach-scale effectiveness of offset areas will be provided in select Site C FAHMFP reports issued during future study years. The current report is intended to provide a summary of the effectiveness of offset areas at a site-scale.

Site-scale offset effectiveness monitoring as detailed in this report represents a summary of activities conducted under two different components of the Site C FAHMFP: the Peace River Physical Habitat Monitoring Program (Mon-3) and the Peace River Fish Community Monitoring Program (Mon-2).

Within Mon-3, BC Hydro notes that uncertainties remain regarding the effectiveness of the offset components in terms of potential rates of sediment deposition and changes in physical configuration over time. The objective of Offset Effectiveness Monitoring (Task 2c) under Mon-3 is to determine if offset areas maintain their structure and function over time and to evaluate the suitability of habitat for fish.

[4] Available at:
https://www.sitecproject.com/sites/default/files/authorization-site-preparation-15-HPAC-00170_0.pdf

BC Hydro (2015) states that there is relatively high confidence (low uncertainty) that the offset measures are likely to be effective. However, uncertainties remain regarding the effectiveness of these offsets in terms of fish use. As a result, fish use of offset areas by indicator species and Mountain Whitefish spawning at the offset areas will be monitored under Task 2d (Offset Effectiveness Monitoring) of Mon-2.

Monitoring techniques, as detailed in Section 2.0, follow the methods and requirements detailed in the *Fisheries Act* Authorization and are intended to meet the following objectives (BC Hydro 2015):

- are the offsets implemented as designed as approved.
- do the offsets maintain their design and purpose over time.
- are the offsets biologically effective (i.e., support ongoing productivity).

The offsets were constructed as described in Section 6.2.1 (Mitigation Measures Downstream of Site C Dam Site) of the Project's Fisheries and Aquatic Habitat Management Plan[5].

Determining whether the offsets maintain their design and purpose over time will be tested by Hypothesis #3 of Mon-3, which is stated as follows:

> H_3: Site C offset habitat areas in the Peace River maintain their design and purpose over time.

The biological effectiveness of the offsets will be tested by Hypothesis #6 of Mon-2, which is stated as follows:

> H_6: Indicator fish species will use the Site C offset habitat areas in the Peace River between the Project and the Many Islands area in Alberta for rearing, feeding, and/or spawning as shown in Table [1].

The indicator fish species referenced in the Site C FAHMFP are Arctic Grayling, Bull Trout, Burbot (*Lota lota*), Goldeye (*Hiodon alosoides*), Mountain Whitefish, Rainbow Trout, and Walleye (BC Government 2011); however, the offset areas were not predicted to yield measurable improvements to habitats preferred by Burbot and Goldeye. As such, these two species are not presented in Table 1. Table 1 has been modified relative to the one presented in the Site C FAHMFP to only include offset areas that are applicable to the Project's Site Preparation FAA.

Table 1: Expected use of proposed habitat offsets located in the Peace River between the Project and the Many Islands area in Alberta by indicator fish species. Modified from Table 2 of the Peace River Fish Community Monitoring Program (Mon-2) of the Site C FAHMFP.

Location	Species				
	Arctic Grayling	Bull Trout	Mountain Whitefish	Rainbow Trout	Walleye
River Road Rock Spurs	R[a], F	F	R, F	R, F	
Upper Site 109L	R	F	R, F, S	R, F	F
Side Channel Site 108R	R, F		R, F	R, F	

[a] R = rearing; F = feeding; and S = habitat suitable for spawning.

Periodically throughout this report, indicator species are classified as being members of either the coldwater or coolwater fish groups. Information regarding these classifications are summarized in the Project's EIA[6]. Arctic Grayling, Bull Trout, Mountain Whitefish, and Rainbow Trout belong to the coldwater fish group and Burbot, Goldeye, and Walleye belong to the coolwater fish group.

[5] Available for download at: https://www.sitecproject.com/sites/default/files/Fisheries_and_Aquatic_Habitat_Management_Plan.pdf#page=27.

[6] Site C Clean Energy Project Environmental Impact Statement, Volume 2, Section 12.3.2.1.

2.0 METHODS

Peace River discharge data presented in this report are from the Water Survey of Canada's Peace River at Pine River station (Station Number 07FA004)[7], which is located approximately 3 km downstream of Upper Site 109L. Unless stated otherwise, discharge values are daily average values presented in cubic metres per second (m^3/s).

Effectiveness monitoring of offset areas at the site-scale has three components; physical habitat, general fish use, and Mountain Whitefish spawning. A site-scale overview map of the study area is provided in Appendix A, Figure A1.

2.1 Physical Habitat

The study design for physical habitat at the River Road rock spurs and Upper Site 109L included assessing water depths and water velocities using an Acoustic Doppler Current Profiler (ADCP) at channel cross section transects and visual assessments of the offsets and the hydraulic features around the offsets. ADCP measurements were obtained by boat or foot depending on water depths (see below). Physical habitat was visually assessed at the rock spurs to determine if they provide a diversity of hydraulic conditions that are less common in that reach of the Peace River. The physical habitat survey was conducted on 27 May 2017. Where possible, water depth data were compared to data collected in 2015 (Golder 2016).

ADCP surveys were conducted at five previously established transect locations (Golder 2015), which are also assessed as part of the Site C FAHMFP's Peace River Physical Habitat Monitoring Program (Mon-3), and at three new locations established for the purposes of this study (Table 2; Appendix A Figure A2). Overall, measurements of channel cross sections were recorded at nine transects across the main channel of the Peace River (Table 2), which includes one existing transect (DS8) that was situated downstream of both offset areas and was surveyed to collect additional baseline data for the area prior to the development of other proposed offsets associated with the Project (i.e., Lower Site 109L).

Table 2: Physical habitat transect locations surveyed on 27 May 2017 as part of Site C Offset Effectiveness Monitoring. All transects are located within UTM Zone 10.

Transect Identifier	New or Existing Transect	Offset Location	Left Bank[a] (Transect Start)		Right Bank[a] (Transect End)	
			Easting (m)	Northing (m)	Easting (m)	Northing (m)
DS03	Existing	Rock Spurs	630856	6229716	630577	6228620
DS04	Existing	Rock Spurs	631314	6229624	631318	6228389
DS05	Existing	Rock Spurs	631894	6229580	632071	6228420
DS06a	New	Upper Site 109L	632275	6229669	632676	6228529
DS06	Existing	Upper Site 109L	632409	6229718	632843	6228578
DS06b	New	Upper Site 109L	632544	6229773	632996	6228659
DS07	Existing	Upper Site 109L	632669	6229861	633151	6228740
DS07b	New	Upper Site 109L	632830	6229854	633283	6228819
DS08	Existing	n/a[b]	633504	6230441	633976	6229267

[a] As viewed facing downstream.

[b] Transect DS08 is downstream of Upper Site 109L and was surveyed to collect additional baseline data.

[7] https://wateroffice.ec.gc.ca/search/real_time_e.html.

Cross section data were collected using two methods:

1) **GPS Total Station Surveys.** A Trimble R10 (GPS RTK) system and benchmark system were used to measure ground elevations on the banks and elevations in shallow areas of the Peace River near the shorelines that could be accessed safely by field staff wearing chest waders. Water surface elevations were also collected. Topographic elevations were measured along the established cross sections and extended away from the wetted channel to the top of the bank as allowed by terrain access. Large floods were not recorded on the Peace River between surveys conducted in July 2015 (i.e., the previous year that the transects were surveyed; Golder 2016) and the current study[8]; therefore, the shoreline above the bankfull elevations was not surveyed and was assumed to have remained unchanged between 2015 and 2017. The maximum wadeable depth during the 2017 survey was approximately 0.6 m.
2) **River Depth Surveys.** A SonTek RiverSurveyor® M9 dual-beam ADCP system was used to perform depth surveys and to measure riverbed bathymetry. The transducer of the ADCP was mounted 0.20 m below the water surface with a minimum measurable depth of 0.14 m below the transducer. Thus, the minimum measurable water depth was 0.4 m during surveys. Both water depth and water speed data were collected.

During river depth surveys, the Trimble R10 (GPS RTK) system was attached to the ADCP system and the local coordinates were transmitted to the ADCP unit and incorporated into the raw data by the ADCP data collection software. The two survey methods were referenced to the same datum and had overlap where possible so they could be spliced together to produce a single dataset. For Upper Site 109L, water velocity and water depth figures were created using a ‘natural neighbour’ interpolation method using a benchmark water surface elevation of 409.26 metres above sea level (masl). Alternative interpolations of velocity and depth data were generated for Upper Site 109L (i.e., kriging, Inverse Distance Weighting [IDW], spline, and Topo to Raster); however, these interpolations were uninformative due to the linear nature of the transects. Results of these alternative interpolations are not presented in this report.

Visual surveys were scheduled to assess the substrate characteristics at each offset area at the time of the ADCP surveys, using methods similar to those detailed in Section 2.2. However, high turbidity levels coupled with high water depths limited substrate visibility and rendered the visual surveys ineffective. Substrate characteristics were not effectively documented during the 2017 survey.

Cross section data from 2017 and 2015[9] (Golder 2016) were available for all transects except DS06a, DS06b, and DS07b (these three transects were not surveyed prior to 2017). Transect data were plotted, overlain, and visually assessed to identify changes in elevations over time.

2.2 General Fish Use

The study design for fish use consisted of monitoring each of the two offset areas (i.e., River Road rock spurs and Upper Site 109L) during the late August to early October period. This timing corresponds with the timing of historical surveys conducted by BC Hydro (e.g., Mainstream 2010, 2011, 2013, Mainstream and Gazey 2004-2014; Golder and Gazey 2015-2016). By aligning the study period with historical datasets, more accurate comparisons between the two datasets were possible. In addition, during the late summer to early fall period, sampling conditions in the Peace River were appropriate in terms of water clarity, water temperature, and

[8] The highest daily average discharge for the Peace River at Water Survey of Canada gauging station 07FA004 between the two survey periods was 2010 m^3/s on 4 September 2015.

[9] For some transects, data were available for years prior to 2015; however, these data were not analyzed as part of the current study. See Church (2015) for a summary of these data.

discharge, and the species and life stages that are expected to use the offset areas were expected to be present. Sampling during other seasons was considered, but ultimately abandoned due to expected inefficiencies, largely associated with ice formation and cold weather in the winter and high water levels and high turbidity during the spring and early summer.

Multiple fish capture and observation techniques were considered for assessing general fish use of the River Road rock spurs and Upper Site 109L, including gillnets, minnow traps, boat electroshocking, backpack electrofishing, beach seining, visual surveys (both snorkel-based and boat-based), and sonar surveys. Due to the physical characteristics of the offset areas (i.e., high water depths, water velocities, and turbidity), most methods were considered unsafe or impractical. For the 2017 survey, field crews assessed general fish use using boat-based visual surveys, sonar surveys, and boat electroshocking.

Visual surveys consisted of one crew member directing a boat over the study area while a second crew member assessed fish use using a view tube. The view tube consisted of an approximately 0.5 m long by 0.25 m wide piece of dark-coloured PVC pipe fitted with a piece of clear acrylic sealed on one end. The average Secchi depth recorded on the day of the survey (23 September 2017) was 1.08 m, while water depths recorded on the same day were as deep as 3.8 m. During visual surveys, the bottom substrate was rarely observed and fish were not observed. The low visibility hindered the effectiveness of this technique; therefore, its use as an assessment method was abandoned and results are not discussed further in this report.

Fish use of the area was further assessed by manoeuvring the boat over the study area while general observations of fish distribution were noted based on the boat's on-board sonar display. At Upper Site 109L, crew members noted the undulating river bottom associated with the excavated channel depressions (Section 1.0); however, fish use of these areas, even anecdotal descriptions, could not be ascertained. Results of the sonar-based survey are not presented or discussed further in this report.

For the above reasons, general fish use of the River Road rock spurs and Upper Site 109L was assessed using data collected by boat electroshocking exclusively.

Boat electroshocking techniques were consistent with techniques used during baseline studies (e.g., Golder and Gazey 2015-2016) and followed industry standard methods (e.g., Nielsen and Johnson 1992). Sampling consisted of a three-person crew operating a Smith-Root Inc. high-output Generator Powered Pulsator (GPP 5.0) electroshocker from a 5.5 m outboard jet-drive riverboat. The electroshocking procedure generally consisted of manoeuvring the boat downstream along the shoreline of each sample site; however, Sites 109LOFA and 109LOFB (Appendix A, Figure A3), were located further from the shoreline to ensure adequate coverage of Upper Site 109L. Two crew members, positioned on a netting platform at the bow of the boat, netted stunned fish, while the third individual operated the boat and electroshocking unit. The two netters attempted to capture all fish that were stunned by the electrical field. Captured fish were immediately placed into a 175 L onboard live-well equipped with a freshwater pump. To prevent electroshocking-induced injuries, fish were netted one at a time (i.e., fish were not double-netted). Fish that were positively identified but avoided capture were enumerated and recorded as "observed". The electroshocking unit was operated at a frequency of 30 Hz with pulsed direct current. Amperage was adjusted as needed to achieve the desired effect on fishes, which was the minimum level of immobilization that allowed efficient capture, and did not cause undesired outcomes such as immediate tetany or visible haemorrhaging (Martinez and Kolz 2009). An amperage of 3.2 A typically produced the desired effect on fishes; however, the amperage was set as low at 2.2 A and as high as 4.1 A at some sites based on local water conditions. Electroshocker settings were based on information provided by Golder (2004, 2005) that resulted in less electroshocking-induced injuries on large-bodied Rainbow Trout in the Columbia River. These settings also align with recommendations by Snyder (2003) for pulsed direct current and low frequencies for adult salmonids.

2.2.1 River Road Rock Spurs

Data from two boat electroshocking sites (Site 0505 and 0506; Appendix A, Figure A3) situated along River Road and sampled as part of the Site C Peace River Large Fish Indexing Survey (Mon-2, Task 2a) were assessed to determine general fish use of the rock spurs. These two sites were previously surveyed each year between 2007 and 2017 under various BC Hydro projects, and provide a baseline dataset for the River Road area. Under Mon-2, Task 2a, each of these two sites were sampled six times in 2017, approximately once per week, between 26 August and 3 October. Additional sampling was not required for the River Road area as part of offset effectiveness monitoring.

2.2.2 Upper Site 109L

Data from three boat electroshocking sites (Site 0509, 109LOFA, and 109LOFB) were situated within Upper Site 109L (Appendix A, Figure A3). Site 0509 was sampled six times in 2017, approximately once per week, between 26 August and 3 October as part of the Site C Peace River Large Fish Indexing Survey (Mon-2, Task 2a). This site is located along the downstream portion of Upper Site 109L. Approximately half of Site 0509 is situated outside of the recontoured area. Site 0509 was sampled each year between 2007 and 2017 under various BC Hydro projects (e.g., Golder and Gazey 2016). Sites 109OFA and 109OFB were sampled once in 2017 (23 September). These two sites are not index sites that are sampled as part of Mon-2, Task 2a, but were sampled specifically in 2017 to gather additional information on fish use of Upper Site 109L as part of offset effectiveness monitoring. These two sites were situated within Upper Site 109L, but were located further offshore when compared to Site 0509 (Appendix A, Figure A3).

2.3 Mountain Whitefish Spawning

The study design for Mountain Whitefish spawning consisted of deploying artificial substrate mats throughout Upper Site 109L (Appendix A, Figure A4) to collect eggs that were deposited in the area over the expected Mountain Whitefish spawning season (i.e., late October to mid-December), based on Peace River water temperatures and data collected in other systems (e.g., Northcote and Ennis 1994; Golder 2014). Any eggs collected would be considered as evidence that Mountain Whitefish used the area for spawning. Habitat in the vicinity of the River Road rock spurs was not predicted to provide potential Mountain Whitefish spawning habitats (Table 1); therefore, this area was not surveyed, per the monitoring plan (BC Hydro 2015). Mountain Whitefish spawn monitoring was conducted between 24 October and 14 December (Table 3).

Mountain Whitefish spawn monitoring followed industry-accepted methods (e.g., Golder 2014, 2017). Artificial substrate mats consisted of a 0.76 by 0.76 m iron frame that enclosed two layers of filter material (latex-coated animal hair). When deployed, the mats rested on the river bottom to trap eggs that drift downstream. Two different set types were used during the 2017 survey. Shore-sets were secured to the shore using a shore line with a float line attached to the mat to provide a secondary means of retrieval in case the shore line failed or became snagged. Mid-channel sets consisted of an anchor system and a 10 m long steel cable that connected the anchor system to the egg collection mat. A float line with approximately 15 m of rope was attached to the mat to enable retrieval by boat. Another float line with approximately 15 m of rope was also attached to the anchor system to allow for removal of the anchor system at the end of the survey. A total of eight mid-channel sets and two shore sets were used during the 2017 survey. Mats were positioned throughout Upper Site 109L and were repositioned periodically over the study period to ensure adequate coverage of the offset. Carabiners were used at all shore line and float line attachment points to allow quick removal of the mats. Once the mat was detached, the float line was attached to the anchor cable to allow the cable to be retrieved when the mats were ready for redeployment. For each deployment, the current date, time, water temperature, water depth, and location (UTMs) were recorded.

Table 3: Summary of Mountain Whitefish spawn monitoring conducted as part of Site C Offset Effectiveness Monitoring, 2017.

Date(s)	Activity
24 October	Deployment of egg collection mats
31 October; 7, 14, 23, 29 November	Retrieval, inspection, and redeployment of egg collection mats
14 December	Retrieval, inspection, and removal of egg collection mats

The egg collection mats were retrieved by either untying the shore line or retrieving the float line. The mats were then pulled off the river bottom (either by hand or by an electric winch mounted on the starboard side of the boat) and brought on board the boat. Each egg collection mat was inspected by two different people, and if eggs were collected, they were to be removed using forceps and placed in preservative for later staging. During the collection process, the number of eggs collected on each mat, set time and date, retrieval time and date, and depth (determined by the boat-mounted echo sounder) were recorded on standardized field forms.

A total of 10 egg collection mats were deployed each week. Mats were not always deployed at the same locations and not all locations were sampled continuously over the study period. Over the 2017 study period, 16 different locations were surveyed (Table 4; Appendix A, Figure A4). Egg mats within the study area were retrieved, checked, cleaned, and redeployed on a weekly basis. Prior to each deployment, mats were inspected and the filter material was replaced as required.

Table 4: Locations sampled as part of the Mountain Whitefish spawning survey for Site C Offset Effectiveness Monitoring, 2017.

Site Name[a]	UTM Zone	UTM Easting	UTM Northing
M01	10V	632282	6229580
M02	10V	632458	6229598
M03	10V	632560	6229598
M04	10V	632690	6229675
M05	10V	632668	6229631
M06	10V	632751	6229704
M07	10V	632753	6229623
M08	10V	632778	6229670
M09	10V	632291	6229552
M10	10V	632438	6229548
M11	10V	632574	6229544
M12	10V	632900	6229690
M13	10V	632699	6229573
M14	10V	632658	6229598
S01	10V	632929	6229754
S02	10V	633059	6229758

[a] M = Mid-channel set; S = Shoreline set.

3.0 RESULTS

3.1 Physical Habitat

River cross section profiles were measured at nine transects in 2017 to provide channel profile data. Survey transect locations are provided in Appendix A, Figure A2, and cross section profiles are presented in Appendix B, Figures B1 to B9. Six of the channel cross sections were previously surveyed in July 2015 (Golder 2016) and where possible, these data were compared to results from the current survey.

3.1.1 River Road Rock Spurs

Transects DS03, DS04, and DS05 are located along the length of the Peace River where River Road and associated bank armouring, as well as the rock spurs, were constructed between 2015 and 2016. These activities resulted in the left bank (i.e., north shore) shifting south towards the river when comparing 2015 to 2017 data. This result is evident in Appendix B, Figures B1 to B3. The main river thalweg (line with the lowest channel elevations) moved towards the middle of the river (i.e., towards the right bank/south shore). Between 2015 and 2017, Transect DS03, the most upstream transect surveyed in 2017, experienced substantial changes across the channel profile, with elevation of some portions of the channel bed changing by over 2 m during the approximate 2 year period between surveys. The remaining two transects (DS04 and DS05) experienced similar channel changes (erosion and deposition) but with a lower magnitude. The cross-sectional areas (for the same water level elevations, below bankfull) increased by approximately 10% at transect DS03, decreased by approximately 10% at transect DS04, and decreased by approximately 20% at transect DS05.

Water direction and speed data were collected at Transects DS03, DS04, and DS05 and are presented in Appendix B, Figures B10, B11, and B12, respectively. At each surveyed transect, the same general water velocity patterns were observed. For approximately 20 m from the shoreline, the rock spurs created a more turbulent flow pattern, when compared to the more laminar flows observed towards the mid-channel consistent with River 2D model results (BC Hydro 2015). These results are supported by photographs taken during the study period (Plate 1 and 2) and by aerial photographs taken of the area before (Plate 3) and after (Plate 4) the construction of River Road and the rock spurs.

The majority of water speeds around the rock spurs were measured at 0.4 m/s or less (average velocities over the entire water column), which was approximately 1.6 m/s slower than the average water velocities recorded at these transects in the mid-channel area (approximately 2.0 m/s). The water vector directions measured for these velocities show that flow directions were affected by the rock spurs, with vectors pointing randomly in different directions (towards the river bank, upstream, downstream, and towards the mid channel).

Further south (i.e., towards mid-channel and away from the influence of the rock spurs), measured water speeds increased, and became typical for this reach of the Peace River. The majority of the flow away from the rock spurs was laminar with the water vector directions pointed downstream.

Plate 1 View of non-laminar flow observed around rock spurs located along River Road. Photo taken 10 September 2017 at approximately 9:30 am.

Plate 2 View of non-laminar flow observed around rock spurs located along River Road. Photo taken 10 September 2017 at approximately 9:30 am.

Plate 3 Aerial view of the River Road area prior to the construction of the road. Photo taken on 16 July 2015. Photo from Google Earth.

Plate 4 Aerial view of the River Road area after the construction of River Road and rock spurs. Photo taken on 26 April 2016.

3.1.2 Upper Site 109L

Upper Site 109L was recontoured to have a channel bed elevation of less than 407 masl, ensuring that the area remains permanently wetted, even under the minimum operating flows for the Project (409 masl; BC Hydro 2015). This permanently wetted area increases the quantity of habitat available for primary and secondary production, increases the area available for fish eggs to incubate without risk of dewatering, and reduces fish stranding risk in this area.

Five transects were located within Upper Site 109L (Transects DS06A, DS06, DS06B, DS07, and DS07b). Transects DS06A, DS06B, and DS07B were surveyed for the first time in 2017; baseline data do not exist for these three transects. Results from Transects DS06 (Appendix B, Figure B5) and DS07 (Appendix B, Figure B7) indicated that most of the profile changes occurred along the left bank where River Road was constructed. Data from these transects also indicate a more variable channel bottom when compared to 2015 results. This variability is likely due to the excavated channel depressions, which were also noted by the crew during sonar surveys (see Section 2.2; data not presented). Similar to Transects DS03, DS04, and DS05 (Appendix B, Figures B1 to B3), the left banks near DS06 and DS07 shifted towards mid-river between 2015 and 2017 due to the construction of River Road.

The most downstream transect (DS08) was located downstream of Upper Site 109L and exhibited negligible change between 2015 (Golder 2016) and 2017, indicating a relatively stable channel between surveys (Appendix B, Figure B9). This transect is located within the boundaries of offset area Lower Site 109L.

ADCP mean water column velocity data (Appendix B, Figure B13) generally indicate higher speeds near the upstream end of Upper Site 109L and lower speeds near the downstream end of the site. Water speeds were also higher along the mid-channel side (i.e., south side) of Upper Site 109L when compared to the north side. The non-laminar and variable water velocities within the site coupled with excavated channel depressions likely increase habitat complexity and suitability for the target species when compared to habitats available prior to recontouring.

Excavated depressions were visible in ADCP transect data (see Appendix B, Figure B5 as an example); however, the low number of transects within Upper Site 109L (n = 5) reduced the resolution of the interpolation analysis (Appendix B, Figure B14). The locations of individual excavated depressions are not visible in the image..

During future study years, the Wetted Useable Area (WUA) within Upper Site 109L that is available to adult and juvenile Rainbow Trout, adult Bull Trout, and spawning and feeding adult Mountain Whitefish will be derived from relevant habitat suitability indices. Currently, the range of water depths (1.0 to 3.8 m), water speeds (0.13 to 1.8 m/s), and substrates (dominantly gravels with cobbles subdominant; Golder 2016) within Upper Site 109L are similar to criteria preferred by these species and life stages (e.g., CEMA 2009; Golder 2014).

3.2 General Fish Use

Sites 0505, 0506, and 0509 were sampled in 2005 (Mainstream and Gazey 2006) and 2006 (Mainstream and Gazey 2007) and from 2008 to 2017 inclusive (Mainstream and Gazey 2008-2014; Golder and Gazey 2015-2016; Golder and Gazey in prep.) as part of various BC Hydro studies. These studies include the Large River Fish Indexing Program (2001 to 2007), the Peace Project Water Use Plan (2008 to 2014), and the Peace River Large Fish Indexing Survey (2015 to 2017; Mon-2, Task 2a). While sample collection methods employed each year were relatively consistent between 2005 and 2013, a few changes were implemented in 2014 and 2015 that should be considered when drawing conclusions across study years.

In 2014, electroshocker settings were modified to reduce the likelihood of electroshocker-induced injuries to large-bodied fish. As a result of this change, catchability (i.e., the fraction of the population that is caught in a given unit of effort) was lower from 2014-2017 when compared to 2005-2013. A summary of these electroshocker setting changes is provided in Golder and Gazey (2015).

In 2015, the objectives of sampling were modified to ensure collected data met the needs of the Site C Clean Energy Project. One of these changes included the size of fish targeted by the netters. Prior to 2015, netters focused effort on fish that had fork lengths (FL) greater than approximately 150 mm. From 2015 onward, netters targeted all size classes of fish. As a result of this change to the methods, small-bodied fish species (e.g., Redside Shiner [*Richardsonius balteatus*]) and younger age-classes of large-bodied fish species were inconsistently recorded prior to 2015.

To more readily allow comparisons across study years, before-after comparisons in the following sections were limited to data collected during the two years immediately prior to offset construction (i.e., 2014 and 2015; before) and data collected during the two years immediately after offset construction (i.e., 2016 and 2017; after).

Activities associated with the construction of the Project were ongoing during the 2017 field season. These activities were largely limited to locations upstream of the two offset areas and may have altered water quality, and therefore fish use of the offset areas at the time of sampling.

3.2.1 River Road Rock Spurs

The efficiency of sampling the River Road area was negatively impacted in 2016 and 2017 by the construction of the rock spurs themselves. Variable water depths, velocities, and flow directions around the rock spurs made it more difficult to manoeuvre the boat and resulted in an inconsistent electrical field. These changes caused less predictable responses by fish and a more difficult netting environment.

During 2016 and 2017 surveys, a total of 261 fish were captured at Sites 0505 and 0506 combined (Table 5; Appendix C, Tables C1 and C2). These numbers do not include fish that were observed but avoided capture. The total number of fish captured after the construction of the offsets (n = 261) was substantially lower than the total number of fish captured during the two years immediately before offset construction (n = 844). The largest change in composition before and after the construction of the rock spurs was attributed to the three sucker species (Largescale Sucker [*Catostomus macrocheilus*], Longnose Sucker [*Catostomus catostomus*], and White Sucker [*Catostomus commersonii*]). Combined, these three species represented 64% of the total catch before the construction of the rock spurs and only 37% of the total catch after the construction of the rock spurs. The portion of coldwater indicator species (i.e., Arctic Grayling, Bull Trout, Mountain Whitefish, and Rainbow Trout) in the catch increased from 33% prior to offset construction to 53% after offset construction. For these species, Bull Trout and Rainbow Trout showed the largest increases, at 8.8% and 6.9%, respectively.

Two Burbot and a single Lake Chub (*Couesius plumbeus*) were recorded in 2017. These encounters represent the first time either of these species were recorded in Sites 0505 or 0506 during 13 years of systematic sampling.

Overall, data collected during the two years immediately prior to the construction of the offset (2014 and 2015) and data collected during the two years immediately after construction of the offset (2016 and 2017) suggest increased use of the area for most coldwater indicator species (i.e., Arctic Grayling, Bull Trout, and Rainbow Trout) and decreased use by coolwater indicator species (i.e., Walleye and Northern Pike [*Esox lucius*]) and sucker species. The number of Mountain Whitefish (a coldwater indicator species) recorded in the study area declined after the construction of the offsets; however, Mountain Whitefish catches were lower throughout the

Peace River in 2016 and 2017 (Golder and Gazey in prep.). Lower catch rates for this species at Site 0505 and 0506 in 2016 and 2017 were likely due to lower overall abundances for this species and not a reflection of poorer preference for the habitat created by the rock spurs. Sparse data for all other species during all study years limit analysis and interpretation for these species.

The River Road rock spurs are intended to provide additional rearing habitat for immature Arctic Grayling, Mountain Whitefish, and Rainbow Trout (Table 1). Both immature Mountain Whitefish and immature Rainbow Trout were recorded within Sites 0505 and 0506 after the construction of the offset (Appendix C, Table C3). Immature Arctic Grayling were not recorded within Sites 0505 or 0506 after the construction of the offset, but were also rare in these sites before offset construction (1 immature Arctic Grayling in 2014 and 1 immature Arctic Grayling in 2015).

Overall, data suggest increased use of the River Road rock spur area by the target species and that this area may provide more preferable habitats for some species that had not previously been captured at these sites (e.g., Burbot and Lake Chub).

Table 5: Number of fish caught by boat electroshocking and their frequency of occurrence in Sites 0505 and 0506 of the Peace River, 2014 to 2017.

Species	Year											
	Before						After					
	2014		2015		Both		2016		2017		Both	
	n[a]	%[b]	n[a]	%[b]	n[a]	%[b]	n[a]	%[b]	n[a]	%[b]	n[a]	%[b]
Indicator Species												
Arctic Grayling	1	<1	1	<1	2	<1	3	2	1	1	4	2
Bull Trout	4	1	6	1	10	1	12	9	14	11	26	10
Burbot									2	2	2	1
Mountain Whitefish	170	50	90	18	260	31	33	26	57	43	90	34
Rainbow Trout			3	1	3	<1	9	7	10	8	19	7
Walleye	11	3	3	1	14	2	2	2	1	1	3	1
Indicator Spp. Subtotal	**186**	**55**	**103**	**20**	**289**	**34**	**59**	**100**	**85**	**100**	**144**	**55**
Non-Indicator Species												
Kokanee									1	1	1	<1
Lake Chub									1	1	1	<1
Largescale Sucker	20	6	61	12	81	10	4	3	3	2	7	3
Longnose Sucker	117	35	288	57	405	48	46	36	31	23	77	30
Northern Pike	2	1			2	<1						
Northern Pikeminnow	2	1	10	2	12	1	4	3	7	5	11	4
Redside Shiner			2	<1	2	<1	5	4	3	2	8	3
Slimy Sculpin			1	<1	1	<1						
White Sucker	9	3	42	8	51	6	10	8	2	2	12	5
Sucker spp.[c] (Catostomidae)	1	<1			1	<1						
Non-Indicator Spp. Subtotal	**151**	**45**	**404**	**80**	**555**	**66**	**69**	**100**	**48**	**100**	**117**	**45**
All species	**337**	**100**	**507**	**100**	**844**	**100**	**128**	**12**	**133**	**12**	**261**	**100**

[a] Includes fish captured and identified to species; does not include fish that were positively identified but avoided capture.

[b] Percent composition of the total catch.

[c] Not identified to species.

Length-frequency histograms were generated for all species for all years between 2014 and 2017, but were uninformative for all species except Mountain Whitefish due to the low number of individuals measured within each year. For all of these species, the range of fork lengths recorded after the construction of the rock spurs were similar to the ranges recorded before the construction of the rock spurs (Appendix C, Table C3).

Length-frequency data for Mountain Whitefish (Figure 1) indicate that fewer small (i.e., less than approximately 220 mm FL) Mountain Whitefish were captured in the River Road rock spur area after the construction of the rock spurs when compared to pre-offset years (2014 and 2015). Fish less than approximately 220 mm FL correspond to the age-0 and age-1 cohorts (Golder and Gazey 2016). Age-0 and age-1 Mountain Whitefish were recorded in adjacent areas in 2017 as part of the Peace River Large Fish Indexing Survey (Golder and Gazey in prep.), but also in lower numbers when compared to previous study years.

Body condition values recorded at Sites 0505 and 0506 in 2016 and 2017 were similar to values recorded at these sites in 2014 and 2015 for all species. These data are not graphically presented, but are provided in Appendix C, Table C3.

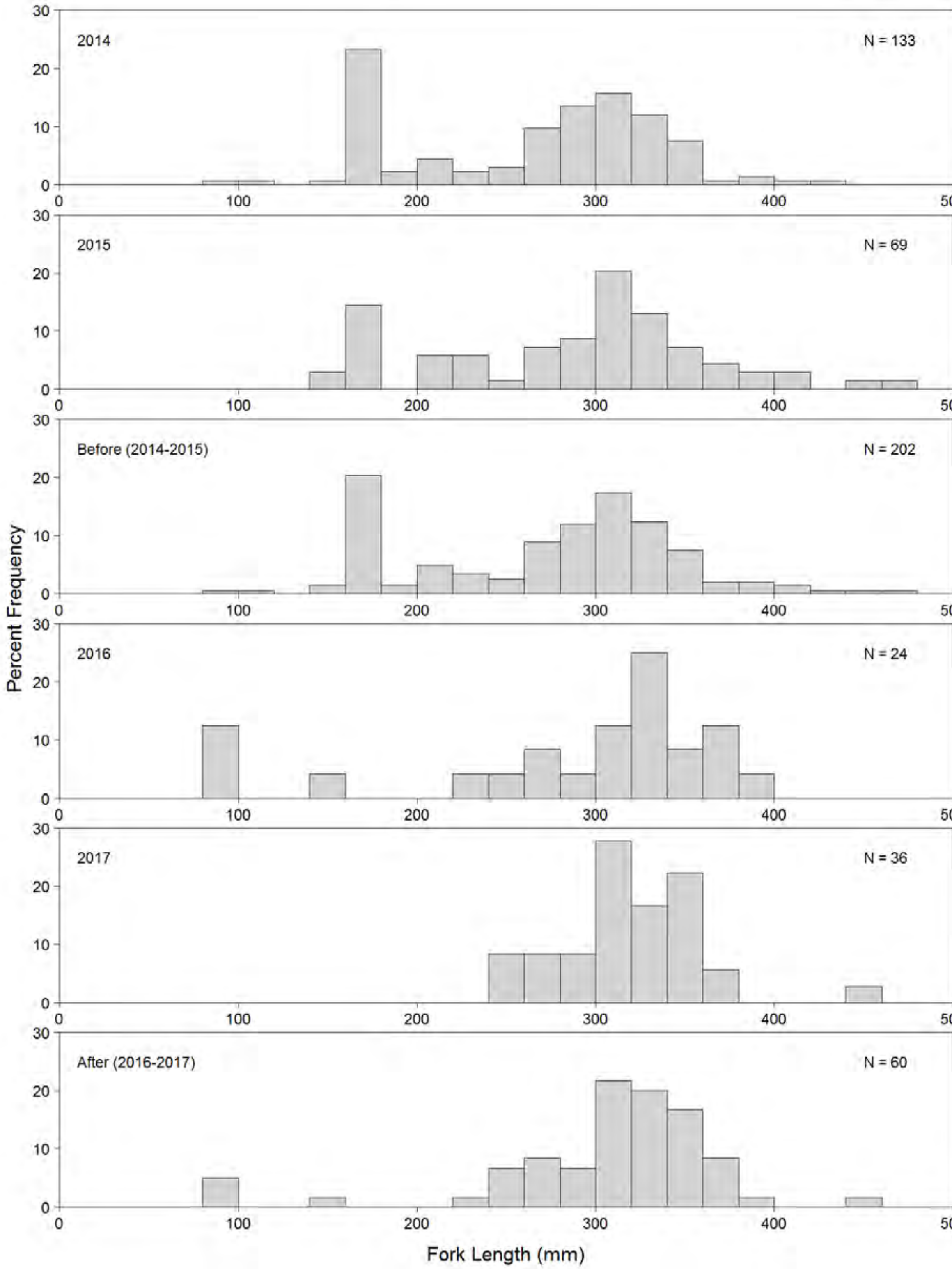

Figure 1: Length-frequency distributions for Mountain Whitefish captured by boat electroshocking in Sites 0505 and 0506 of the Peace River as part of the Peace River Large Fish Indexing Survey (Site C FAHMFP Mon-2, Task 2a), 2014 and 2015, both separate and combined, and 2016 and 2017, both separate and combined.

3.2.2 Upper Site 109L

During 2016 and 2017 surveys, a total of 330 fish were captured at Sites 0509 109OSA, and 109OSB combined (Table 5; Appendix C, Tables C1 and C2); only Site 0509 was sampled in 2016. These numbers do not include fish that were observed but avoided capture. The total number of fish captured after the construction of the offset (*n* = 330) was approximately 33% lower when compared to the total number of fish captured during the two years immediately prior to offset construction (*n* = 492). This decline is largely due to a decline in the Mountain Whitefish catch. Arctic Grayling have not been recorded in Upper Site 109L since its construction; this species was rarely encountered prior to Upper Site 109L's development. There were no other substantial changes in the composition of the catch before and after the construction of this offset.

Table 6: Number of fish caught by boat electroshocking and their frequency of occurrence in Sites 0509, 109OSA, and 109OSB of the Peace River, 2012 to 2017. Data courtesy of BC Hydro's Peace River Large Fish Indexing Survey (Mon-2, Task 2a).

Species	Year											
	Before						After					
	2014[a]		2015[a]		Both		2016[a]		2017		Both	
	n[b]	%[c]	n[b]	%[c]	n[b]	%[c]	n[b]	%[c]	n	%[c]	n[b]	%[c]
Indicator Species												
Arctic Grayling			2	1	2	<1						
Bull Trout			5	2	5	1	2	2	3	2	5	2
Burbot												
Mountain Whitefish	223	91	162	66	385	78	87	95	133	97	220	67
Rainbow Trout			6	2	6	1	3	3			3	1
Walleye	1	<1			1	<1			1	1	1	<1
Indicator Spp. Subtotal	**224**	**91**	**175**	**71**	**399**	**81**	**92**	**100**	**137**	**100**	**229**	**69**
Non-Indicator Species												
Largescale Sucker	5	2	2	1	7	1	7	17	13	22	20	6
Longnose Sucker	16	7	64	26	80	16	31	76	43	72	74	22
Northern Pike												
Northern Pikeminnow			2	1	2	<1	1	2	1	2	2	1
Redside Shiner							2	5	3	5	5	2
Slimy Sculpin			2	1	2	<1						
White Sucker	1	<1	1	<1	2	<1						
Non-Indicator Spp. Subtotal	**22**	**9**	**71**	**29**	**93**	**19**	**41**	**100**	**60**	**100**	**101**	**31**
All species	**246**	**100**	**246**	**100**	**492**	**100**	**133**	**9**	**197**	**14**	**330**	**100**

[a] Only includes data from Site 0509; Sites 109OSA and 109OSB were not sampled during this study year.
[b] Includes fish captured and identified to species; does not include fish that were positively identified but avoided capture.
[c] Percent composition of the total catch.

Upper Site 109L was predicted to provide additional rearing habitat for immature Arctic Grayling, Mountain Whitefish, and Rainbow Trout, and additional feeding habitat for adult Bull Trout, Mountain Whitefish, Rainbow Trout, and Walleye (Table 1). Immature Mountain Whitefish were common at these sites in 2016 and 2017 and represented more than 24% of the combined 2016-2017 Mountain Whitefish catch. These data are consistent with previous study years. Three immature Rainbow Trout were recorded after the construction of Upper Site 109L. All three were recorded in 2016 (Appendix C, Table C3). Immature Arctic Grayling were not recorded within Upper Site 109L after construction; this species was rarely encountered in this area prior to construction. The adult Bull Trout, Mountain Whitefish, and Walleye catch was low in 2016 and 2017 and similar to 2014 and 2015 results. Adult Rainbow Trout were not recorded at the sites during the 2016 and 2017 surveys.

Length-frequency histograms were generated for all species for all years between 2014 and 2017, but were uninformative for all species except Mountain Whitefish due to the low number of individuals measured within each year. For all of these species, the range of fork lengths recorded after the construction of Upper Site 109L were similar to the ranges recorded before the construction of Upper Site 109L (Appendix C, Table C3).

Length-frequency data for Mountain Whitefish (Figure 2) indicate that the Upper Site 109L area is used by all life stages of Mountain Whitefish. Fewer young Mountain Whitefish were recorded in the area in 2017 when compared to other study years. This result is consistent with data collected along River Road (Figure 1) and is likely a reflection of lower overall Peace River Mountain Whitefish abundance in 2017.

Body condition values recorded in the Upper Site 109L area in 2016 and 2017 were similar to values recorded in these sites between 2014 and 2015 for all species. These data are not graphically presented, but are provided in Appendix C, Table C3.

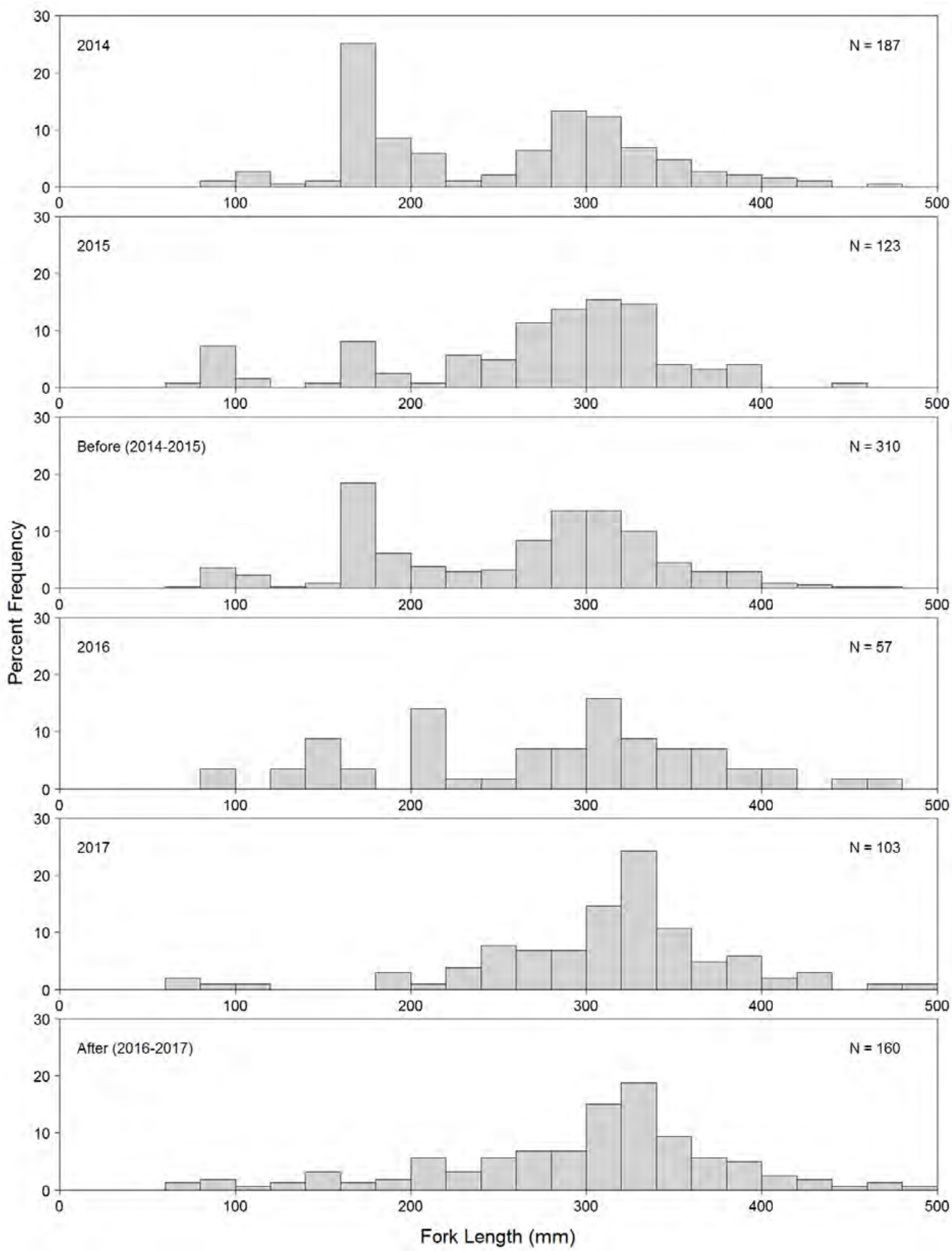

Figure 2: Length-frequency distributions for Mountain Whitefish captured by boat electroshocking in Sites 0509, 109OSA, and 109OSA of the Peace River as part of the Peace River Large Fish Indexing Survey (Site C FAHMFP Mon-2, Task 2a), 2014 and 2015, both separate and combined, and 2016 and 2017, both separate and combined.

3.3 Mountain Whitefish Spawning

Artificial substrate mat sampling in Upper Site 109L occurred from October 24 to December 14 (Table 3). Over this time period, mats were deployed at 16 different locations at water depths that ranged between 0.9 and 4.1 m (average = 2.3 m). Water temperature declined from a high of 8.9°C to a low of 2.6°C over the monitoring period. In total, 13,681 mat-hours were expended during the 2017 survey (Appendix D, Table D1). Despite this effort, no Mountain Whitefish eggs were trapped by the mats.

Over the 2017 study period, daily average Peace River discharges ranged between 1272 and 1684 m^3/s (average = 1484 m^3/s; WaterOffice 2018). The minimum instantaneous discharge recorded over the study period was 620 m^3/s (recorded on 27 November; not presented). Based on the lowest water level observed by the crew while on site (807 m^3/s on 29 November), it is unlikely that any of Upper Site 109L dewatered over the course of the study period as mean water depths at that time were greater than 2.0 m.

4.0 DISCUSSION

This report summarizes results collected during Year 1 of a proposed 3-year monitoring period for the River Road rock spurs and Upper Site 109L. This monitoring supplements other monitoring components that have been ongoing in this portion of the Peace River. Year 1 results were compared to baseline conditions, when possible, and will be used as benchmark data for comparisons during future study years.

This report is also intended to summarize the effectiveness of the offsets at a site-scale. The effectiveness of the offset areas at a reach-scale, as outline in the *Fisheries Act* Authorization, will be monitored over time under other components of the Site C FAHMFP, most notably the Peace River Physical Habitat Monitoring Program (Mon-3) and the Peace River Fish Community Monitoring Program (Mon-2; e.g., Golder and Gazey 2016).

4.1 Physical Habitat

4.1.1 River Road Rock Spurs

The River Road rock spurs were designed to provide variability in water depths, water velocities, and substrate sizes (through the use of riprap and boulders), as well as lower nearshore water velocities, resulting in more suitable rearing and feeding habitat for most coldwater fish species. ADCP data collected in 2017 indicate substantial variability in water velocities immediately upstream, downstream, and above the rock spurs. In addition, increased flow variability was observed in the areas immediately adjacent to the rock spurs (i.e., towards mid-channel). These results are consistent with River 2D model results detailed by BC Hydro (2015). Flow variability surrounding the rock spurs contrasts with adjacent Peace River shorelines, which typically consist of few bank irregularities and more laminar flows. Nearshore water speeds were lower than would be expected in the absence of the rock spurs.

Although substrate data were not collected in 2017, the rock spurs were armoured with rip-rap and larger boulders during construction. These substrates are substantially larger than the substrate sizes present in the area prior to the construction of the rock spurs (dominantly fines to cobbles; Golder 2016) and would be expected to provide increased interstitial areas and predation refugia for juvenile large-bodied fish and all life stages of small-bodied fish.

Overall, the construction of the rock spurs and associated bank armouring provide physical habitat that is consistent with predictions made by BC Hydro (2015). The construction of the offset resulted in lower, and more variable water velocities, and lower water depths compared to adjacent areas. In addition, the offset provides velocity and interstitial refugia for small fish. The habitat present along River Road is suitable for feeding and rearing for coldwater species like Arctic Grayling, Bull Trout, Mountain Whitefish, and Rainbow Trout.

4.1.2 Upper Site 109L

Upper Site 109L was designed and constructed to meet several objectives, including increasing the quantity and quality of permanently wetted habitat available to support primary and secondary productivity, providing rearing, feeding, overwintering, and potential spawning habitats for fish, reducing fish stranding risk, and increasing the complexity and variability of fish habitat to support a variety of life stages for local fish populations.

ADCP data collected in 2017 indicate variability in water velocities, flow directions, and water depths associated with the constructed channel depressions. This variability results in increased habitat complexity when compared to pre-Project conditions.

Upper Site 109L was recontoured with an elevation of less than 407 masl, with the intent of ensuring that the area remains permanently wetted under the minimum operating flows for the Project (409 masl; BC Hydro 2015). Recontouring aimed to increase the quantity of permanently wetted habitat available for primary and secondary production, an area where eggs could incubate without risk of dewatering, and reduce fish stranding risk. The area was observed to remain wetted even at low discharges in 2017 (i.e., a low of 620 m^3/s on 27 November).

4.2 General Fish Use

The use of several different fish capture techniques was considered during the 2017 field program and three different assessment methods were ultimately implemented during the field season; boat electroshocking, visual surveys, and sonar surveys. With the exception of boat electroshocking, all other methods were considered impractical, unsafe, or ineffective due to local conditions. High water speeds, high water depths, and high turbidity were the main factors influencing the effectiveness of alternative techniques. The feasibility of implementing alternative assessment techniques should be re-assessed at the start of each field season based on local conditions at the time of sampling. As examples, shallower water depths relative to those recorded during the 2017 survey may allow the use of backpack electrofishing near the rock spurs, and lower water turbidity relative to 2017 would increase the effectiveness of visual surveys.

Successful boat electroshocking surveys were conducted in both offset areas, providing a reliable index of fish use for the sample period (August-October); however, smaller life stages of fish are typically underrepresented in boat electroshocking catches. Both offset areas are intended to increase the amount of rearing habitat available for Arctic Grayling, Mountain Whitefish, and Rainbow Trout. Direct observations of these smaller life stages using boat electroshocking is difficult.

4.2.1 River Road Rock Spurs

Boat electroshocking was less efficient along River Road after the construction of the rock spurs (2016 and 2017). The eddies formed by the rock spurs resulted in less effective netting and made manoeuvring the boat more onerous when compared to the straight shoreline and laminar flows that were present in the area prior to the construction of the rock spurs. This decline in efficiency likely contributed to the lower catch rates recorded in 2016 and 2017, but was likely consistent across species and size classes.

The large riprap substrate installed along River Road resulted in additional interstitial cover for small-bodied fish in 2016 and 2017. The additional cover may have partially contributed to the lower catches observed for small Mountain Whitefish during latter study years; however, this result is confounded by overall lower numbers for this species in the area in 2016 and 2017 (Golder and Gazey in prep.).

Data from 2017 suggests increased species diversity along the River Road area compared to historical studies. This increase is likely due to the increased habitat complexity associated with the rock spurs; however, additional data are required to confirm this finding. The two Burbot captured along the River Road rock spurs were the first two encountered along this portion of the Peace River. This area of the Peace River has been surveyed 73 times over the last 12 years as part of other BC Hydro monitoring programs (Golder and Gazey 2016). Between 2004 and 2016, 13 Burbot were recorded in the approximately 12 km long portion of the Peace River immediately downstream of the Moberly River confluence (i.e., Section 5 under the Site C FAHMFP) during these same surveys (Golder and Gazey 2016). Golder has frequently recorded Burbot associated with similarly constructed rock spurs during boat electroshocking surveys conducted on the Columbia River (Golder 2005, 2006) and

McPhail (2007) notes that juvenile Burbot strongly associate with riprap jetties and natural boulder areas. Based on these data, Burbot use of this area of the Peace River may increase as a result of the construction of the rock spurs. Lake Chub were also recorded along the River Road for the first time during 2017 sampling; however, this species has been recorded in immediately adjacent areas in recent study years (e.g., Golder and Gazey 2015, 2016).

Catch data suggest increased use of the River Road and rock spur area for most coldwater indicator species (i.e., Arctic Grayling, Bull Trout, and Rainbow Trout) and decreased use by coolwater indicator species (i.e., Walleye and Northern Pike) and sucker species (Largescale Sucker, Longnose Sucker, and White Sucker). Use of the area by Mountain Whitefish declined, but the decline was consistent with an overall decline in Mountain Whitefish catch throughout the Peace River (Golder and Gazey in prep.). Additional years of data will further inform the use of the rock spurs area by target fish species.

The River Road rock spurs are intended to provide additional rearing habitat for immature Arctic Grayling, Mountain Whitefish, and Rainbow Trout (Table 1). Both immature Mountain Whitefish and immature Rainbow Trout were recorded within Sites 0505 and 0506 since the construction of the offset (Appendix C, Table C3). Immature Arctic Grayling were not recorded within Sites 0505 or 0506 after the construction of the offset, but were also rare in these sites before offset construction (1 immature Arctic Grayling in 2014 and 1 immature Arctic Grayling in 2015).

Overall, the data collected in 2017 suggest increased use of the River Road rock spur area by the target species and that this area may provide more preferable habitats for some species that had not previously been captured at these sites (e.g., Burbot and Lake Chub).

4.2.2 Upper Site 109L

Data suggest similar uses of Upper Site 109L in 2017 when compared to previous study years, with no apparent changes in use by fish species or life stage. An apparent decline in use of the area by young Mountain Whitefish was consistent with an overall decline in young Mountain Whitefish abundance throughout this reach of the Peace River (Golder and Gazey in prep.). Additional years of data are required to adequately determine use of the offset area by the target fish species.

4.3 Mountain Whitefish Spawning

Collected data did not indicate that Mountain Whitefish spawned immediately upstream or within Upper Site 109L in 2017. Samplers were deployed for the duration of what was expected to be the bulk of the Mountain Whitefish spawning season (i.e., late October to mid-December when water temperatures declined from a high of 8.9°C to a low of 2.6°C). In other systems, water temperatures at the onset of Mountain Whitefish spawning range between 6.0°C and 10°C (Golder 2014; Northcote and Ennis 1994 cited in Mainstream and Gazey 2014; McPhail 2007). Samplers were deployed at a variety of water depths and locations within Upper Site 109L; adequate spatial and temporal coverage of the area was assumed with the study design. The intensity of sampling was expected to capture eggs, if spawning occurred. The site provided a potential area for egg incubation, as the area did not dewater over the range of discharges observed. Additional years of data are required to determine use of the area for spawning by Mountain Whitefish.

5.0 CONCLUSION

The FAA lists three offset effectiveness criteria. The Offset Effectiveness Monitoring's progress towards addressing each of these three criteria are briefly addressed below.

1) Offsets will be constructed according to designs. Information gathered during implementation monitoring will inform this assumption.

The offsets were constructed as described in Section 6.2.1 (Mitigation Measures Downstream of Site C Dam Site) of the Project's Fisheries and Aquatic Habitat Management Plan[10].

1) Offsets maintain their structure and function. For example, the depressions maintain their structure and function (i.e., infilling does not reduce physical function) and substrate at 109L is suitable for spawning by Mountain Whitefish. This will be assessed in the physical component of the effectiveness monitoring program.

Physical habitat data as well as visual assessment of the offset in 2017 indicate that the offsets have generally maintained their structure since their construction. The physical characteristics of water depths and water velocities occur as predicted (BC Hydro 2015). The construction of the rock spurs and associated bank armouring along River Road has increased habitat complexity and provides habitats that are uncommon in this reach of the Peace River. Upper Site 109L effectively increases the amount of permanently wetted habitat available to support primary and secondary productivity, while reducing stranding risk, and increasing the complexity of habitat available to fish. Overall, the two offset areas increase the quantity and quality of rearing, feeding, overwintering, and potential spawning habitats available to fish and are capable of supporting a variety of life stages.

Physical habitat data collected in 2017 will serve as a baseline dataset for monitoring physical changes at the River Road rock spurs and Upper Sites 109L over the proposed 3-year monitoring period. Habitat characteristics measured at Upper Site 109L in 2017 were similar to habitat characteristics measured in other known Mountain Whitefish spawning areas (e.g., Golder 2014).

1) Fish will use the offset areas. Information collected on fish use will inform this assumption.

The River Road rock spurs were designed to provide additional rearing habitat for Arctic Grayling, Mountain Whitefish, and Rainbow Trout. Young Mountain Whitefish and Rainbow Trout were recorded along the River Road after the rock spurs were constructed. However, young Arctic Grayling were not recorded in this area after the rock spurs were constructed, but were also rarely recorded before the rock spurs were constructed.

The River Road rock spurs were also designed to provide additional feeding habitat for Arctic Grayling, Bull Trout, Mountain Whitefish, and Rainbow Trout. The adult life stages of these species represented a larger portion of the total catch after the rocks spurs were constructed, indicating that the area provides suitable feeding habitat for these species.

Upper Site 109L was designed to provide additional rearing habitat for Arctic Grayling, Mountain Whitefish, and Rainbow Trout; both immature Mountain Whitefish and immature Rainbow Trout were recorded in the area in

[10] Available for download at: https://www.sitecproject.com/sites/default/files/Fisheries_and_Aquatic_Habitat_Management_Plan.pdf#page=27.

2017 after Upper Site 109L's development. Young Arctic Grayling were not recorded in this area after Upper Site 109L was constructed, but they were also rarely recorded before the Upper Site 109L was constructed.

Upper Site 109L was designed to provide additional feeding habitat for Bull Trout, Mountain Whitefish, Rainbow Trout, and Walleye. The adult life stages of these species were recorded after Upper Site 109L's construction at numbers that were similar to those recorded before Upper Site 109L's construction.

After its construction, Upper Site 109L provided habitat conditions that were similar to habitats known to successfully incubate Mountain Whitefish eggs in other systems (e.g., Golder 2014). Mountain Whitefish eggs were not recorded in the area during the 2017 survey.

Additional years of data will further inform the assessment of the effectiveness of the constructed offsets.

6.0 CLOSURE

We trust the information contained in this report is sufficiently detailed for your review purposes. Please do not hesitate to contact us should you have any questions or require clarification.

Golder Associates Ltd.

Dustin Ford, BSc, RPBio
Project Manager

Shawn Redden, RPBio
Project Director

DF/SR/nnv

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7.0 LITERATURE CITED

BC Government. 2011. DRAFT Fish, Wildlife and Ecosystem resources and Objectives for the Lower Peace River Watershed – Site C Project Area. 25 pages + appendices.

BC Hydro. 2015. DFO - Application for Authorization - Site Preparation - Site C Clean Energy Project. Report prepared by BC Hydro. Submitted to DFO on 23 February 2015. 80 pages + 15 appendices.

CEMA (Cumulative Environmental Management Association). 2009. Summary of the Lower Athabasca River Fish Habitat Suitability Criteria Workshop (April 22 to 23, 2009). Report prepared by Golder Associates Ltd. Copyright #1071379. 67 pages + 5 appendices.

Church, M. 2015. The Regulation of Peace River: A Case Study for River Management. The University of British Columbia. Vancouver, Canada. Wiley Blackwell. 278 pages.

Golder Associates Ltd. 2004. Large River Fish Indexing Program – Lower Columbia River 2003 Phase 3 Investigations. Report prepared for B.C. Hydro, Burnaby, BC. Golder Report No. 03-1480-021F: 54 pages + 6 appendices.

Golder Associates Ltd. 2005. Large River Fish Indexing Program – Lower Columbia River 2004 Phase 4 Investigations. Report prepared for B.C. Hydro, Burnaby, BC. Golder Report No. 04-1480-047F: 57 pages + 6 appendices.

Golder Associates Ltd. 2006. Large River Fish Indexing Program – Lower Columbia River 2005 Phase 5 Investigations. Report prepared for B.C. Hydro, Burnaby, BC. Golder Report No. 05-1480-034F: 56 pages + 6 appendices.

Golder Associates Ltd. 2015. Site C Mon-3 Peace River Physical Habitat Monitoring Proposed Transect Locations. Prepared for BC Hydro, Vancouver, BC. Technical Memo. 4 pages + attachments.

Golder Associates Ltd. 2014. Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program: Year 5 Interpretive Report. Report prepared for BC Hydro, Castlegar, BC. Golder Report No. 11-1492-0111F: 102 pages + 5 appendices.

Golder Associates Ltd. 2016. Site C Mon-3 Peace River Physical Habitat Monitoring Program – 2015. Prepared for BC Hydro, Vancouver, BC. Technical Memo submitted on 17 October 2016. 55 pages + maps and appendices.

Golder Associates Ltd. 2017. Waneta White Sturgeon Egg Predation and Spawn Monitoring at Waneta: 2016 (Year 5) Investigations. Report prepared for Columbia Power Corporation, Castlegar, BC by Golder Associates Ltd., Castlegar, BC. Golder Report No. 1523138: 40 pages.

Golder and Gazey (Golder Associates Ltd. and W.J. Gazey Research). 2015. GMSMON-2 Peace Project Water Use Plan – Peace River Fish Index - 2014 Investigations. Report prepared for BC Hydro, Burnaby, British Columbia. Golder Report No. 1400753: 68 pages + 6 appendices.

Golder Associates Ltd. and W.J. Gazey Research. 2016. Peace River Large Fish Indexing Survey - 2015 investigations. Report prepared for BC Hydro, Vancouver, British Columbia. Golder Report No. 1400753: 97 pages + 7 appendices.

Mainstream Aquatics Ltd. 2010. Site C fisheries studies – Peace River Fish Inventory. Prepared for BC Hydro Site C Project, Corporate Affairs Report No. 09008AF: 90 p. + plates (Volume 1) and appendices (Volume 2).

Mainstream Aquatics Ltd. 2011. Site C fisheries studies – 2010 Peace River Fish Inventory. Prepared for B.C. Hydro Site C Project, Corporate Affairs Report No. 10005F: 102 p. + plates and appendices.

Mainstream Aquatics Ltd. 2013. Site C fisheries studies – 2011 Peace River Fish Inventory. Prepared for B.C. Hydro Site C Project, Corporate Affairs Report No. 11005F: 98 p. + plates and appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2004. Peace River Fish Community Indexing Program Phase 3 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 3008F: 104 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2005. Peace River Fish Community Indexing Program Phase 4 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 04008F: 135 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2006. Peace River Fish Community Indexing Program Phase 5 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 05016F: 118 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2007. Peace River Fish Community Indexing Program Phase 6 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 06011F: 116 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2008. Peace River Fish Community Indexing Program Phase 7 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 07011F: 116 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2009. Peace River Fish Community Indexing Program - 2008 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 08011F: 93 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2010. Peace River Fish Index Project - 2009 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 09011F: 79 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2011. Peace River Fish Index Project - 2010 Studies. Report Prepared for BC Hydro by Mainstream Aquatics Ltd. Mainstream Report No. 1011F: 96 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2012. Peace River Fish Index Project - 2011 Studies. Prepared for B.C. Hydro. Report No. 11011F: 86 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2013. Peace River Fish Index Project - 2012 Studies. Prepared for B.C. Hydro. Report No. 12011F: 84 pages + appendices.

Mainstream and Gazey (Mainstream Aquatics Ltd. and W.J. Gazey Research). 2014. Peace River Fish Index Project - 2013 Studies. Prepared for B.C. Hydro. Report No. 13011F: 82 pages + appendices.

Martinez, P.J. and A.L. Kolz. 2009. Evaluating the power output of the Smith-Root GPP 5.0 electrofisher to promote electrofishing fleet standardization. North American Journal of Fisheries Management 29: 570-575.

McPhail, J.D. 2007. The Freshwater Fishes of British Columbia. University of Alberta Press, Edmonton, AB. 620 pages.

Nielsen, L.A. and Johnson, D.L. 1992. Fisheries Techniques: 4th Printing. American Fisheries Society. Bethesda, Maryland. ISBN 0-913235-00-8. 468 pages.

Northcote, T. G. and G. L. Ennis. 1994. Mountain Whitefish biology and habitat use in relation to compensation and improvement possibilities. Reviews in Fisheries Science 2: 347-371.

Okanagan Nation Alliance (ONA), Golder Associates Ltd., and Poisson Consulting Ltd. 2014. CLBMON-16 Middle Columbia River Fish Population Indexing Survey. Report prepared for BC Hydro Generation, Water License Requirements. Revelstoke, BC.

Slaney, P.A. and D. Zaldokas. 1997. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. BC Ministry of Environment, Lands and Parks, Vancouver BC. 313 pages.

Snyder, D.E. 2003. Electrofishing and its harmful effects on fish, Information and Technology Report USGS/BRD/ITR--2003-0002: U.S. Government Printing Office, Denver, CO. 149 pages.

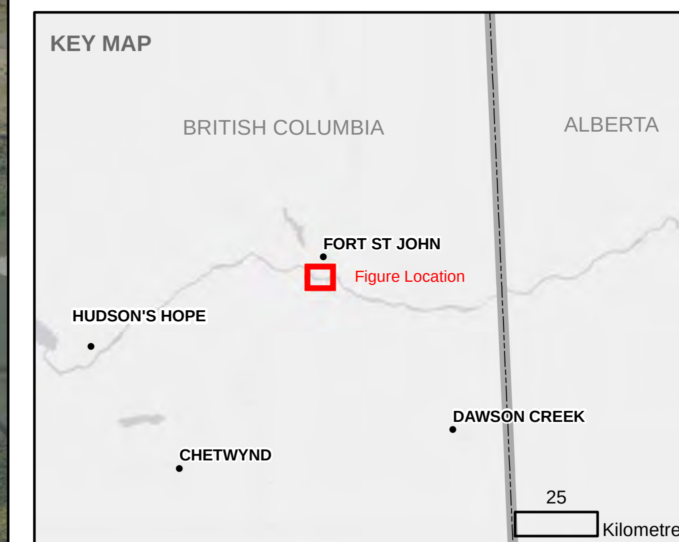
Tabor, R.A. and W.A. Wurtsbaugh. 1991. Predation risk and the importance of cover for juvenile rainbow trout in lentic systems. Transactions of the American Fisheries Society 120: 728-738.

APPENDIX A

Maps and UTM Locations

LEGEND

- APPROXIMATE LOCATION OF ROCK SPUR
- RIVER KILOMETRE AS MEASURED DOWNSTREAM FROM W.A.C. BENNETT DAM
- ROAD
- OUTLINE OF SITE C PERMANENT COMPONENTS
- UPPER SITE 109L
- FLOW DIRECTION



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REFERENCES

1. RIVER KILOMETER MARKERS OBTAINED FROM BC HYDRO.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.
3. INSET MAP OBTAINED BY ESRI, HERE, DELORME, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

DATUM: NAD83 PROJECTION UTM10

CLIENT

BC HYDRO

PROJECT

SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE

OVERVIEW OF STUDY AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DB
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
1670320	3010	0	A1

LEGEND

- APPROXIMATE LOCATION OF ROCK SPUR
- RIVER KILOMETRE AS MEASURED DOWNSTREAM FROM W.A.C. BENNETT DAM
- ADCP HABITAT TRANSECT LOCATION
- ROAD
- OUTLINE OF SITE C PERMANENT COMPONENTS
- UPPER SITE 109L
- FLOW DIRECTION

0 250 500 750 1,000 m

1:25,000

REFERENCES

1. RIVER KILOMETER MARKERS OBTAINED FROM BC HYDRO.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.

DATUM: NAD83 PROJECTION UTM10

CLIENT
BC HYDRO

PROJECT
SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE
OVERVIEW OF PHYSICAL HABITAT SAMPLE LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DB
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
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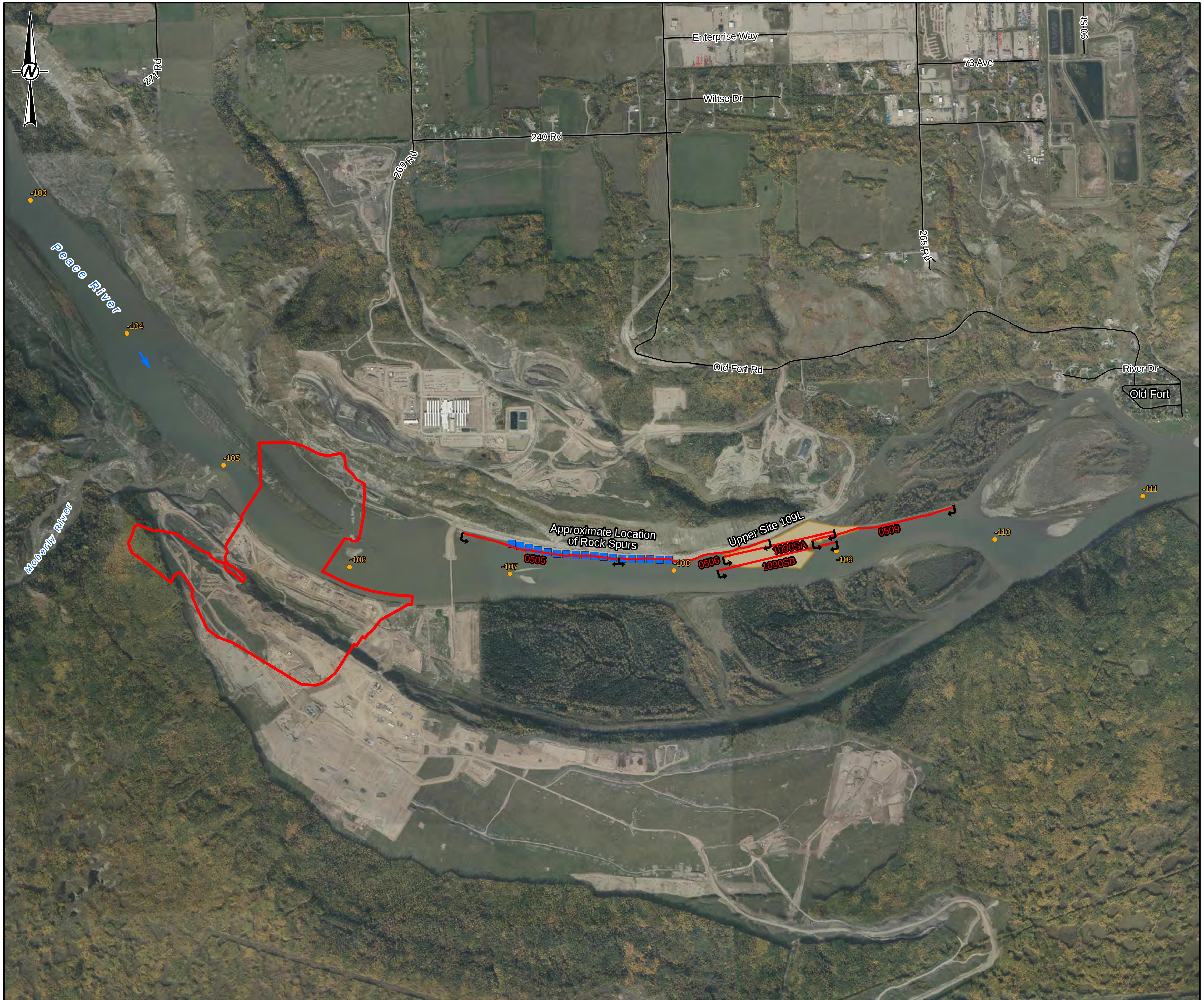

LEGEND

- APPROXIMATE LOCATION OF ROCK SPUR
- RIVER KILOMETRE AS MEASURED DOWNSTREAM FROM W.A.C. BENNETT DAM
- ROAD
- OUTLINE OF SITE C PERMANENT COMPONENTS
- UPPER SITE 109L
- 0110 BOAT ELECTROSHOCKING SITE
- FLOW DIRECTION

0 250 500 750 1,000 m

1:25,000

REFERENCES

1. RIVER KILOMETER MARKERS OBTAINED FROM BC HYDRO.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.

DATUM: NAD83 PROJECTION UTM10

CLIENT

BC HYDRO

PROJECT

SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE

OVERVIEW OF GENERAL FISH USE SAMPLE LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DB
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
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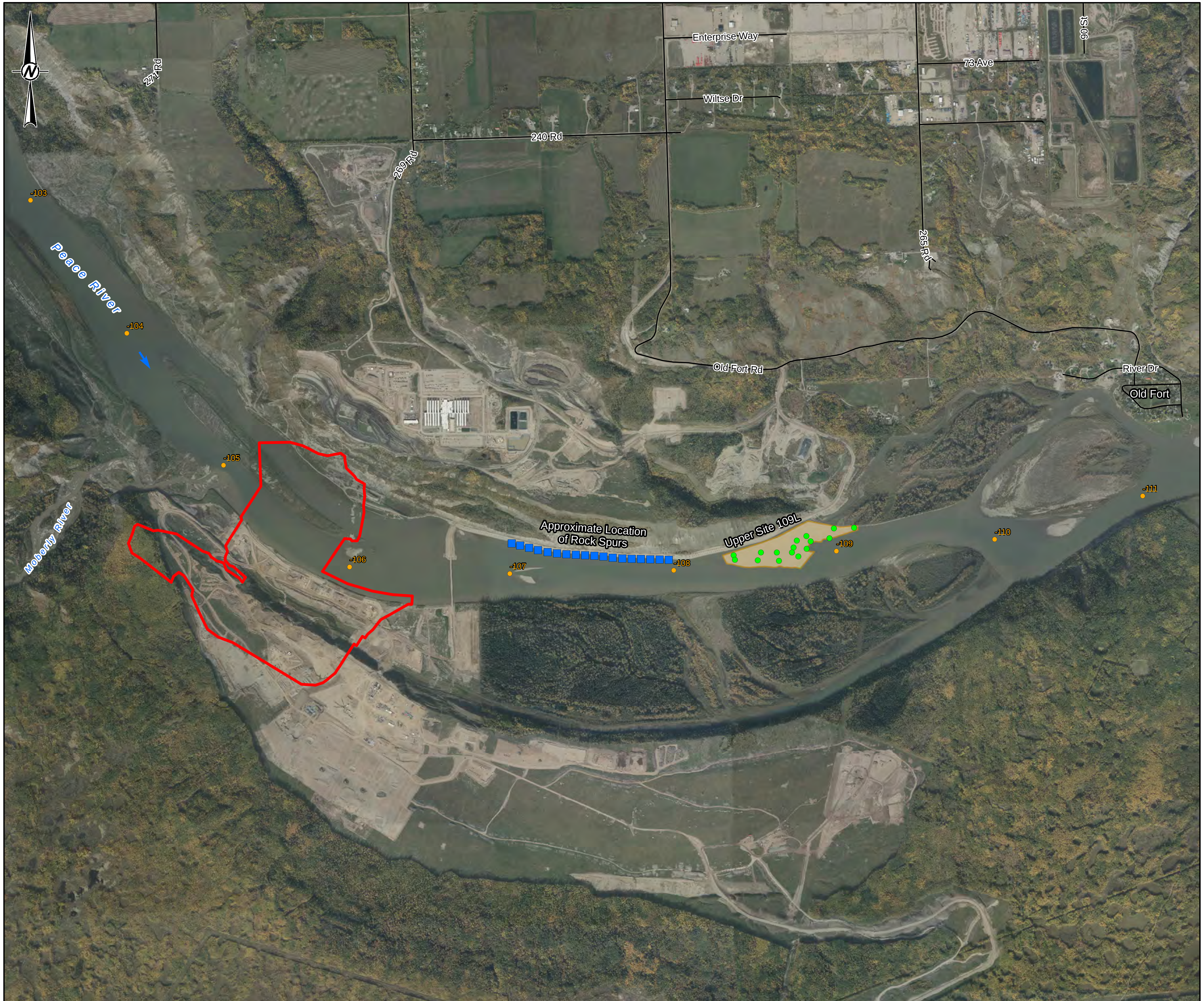

LEGEND

- MOUNTAIN WHITEFISH SPAWN MONITORING LOCATION
- APPROXIMATE LOCATION OF ROCK SPUR
- RIVER KILOMETRE AS MEASURED DOWNSTREAM FROM W.A.C. BENNETT DAM
- ROAD
- OUTLINE OF SITE C PERMANENT COMPONENTS
- UPPER SITE 109L
- FLOW DIRECTION

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1:25,000

REFERENCES

1. RIVER KILOMETER MARKERS OBTAINED FROM BC HYDRO.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.

DATUM: NAD83 PROJECTION UTM10

CLIENT

BC HYDRO

PROJECT

SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE

OVERVIEW OF MOUNTAIN WHITEFISH SPAWN MONITORING LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2016-02-16
DESIGNED	DB
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
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APPENDIX B

Physical Habitat Data

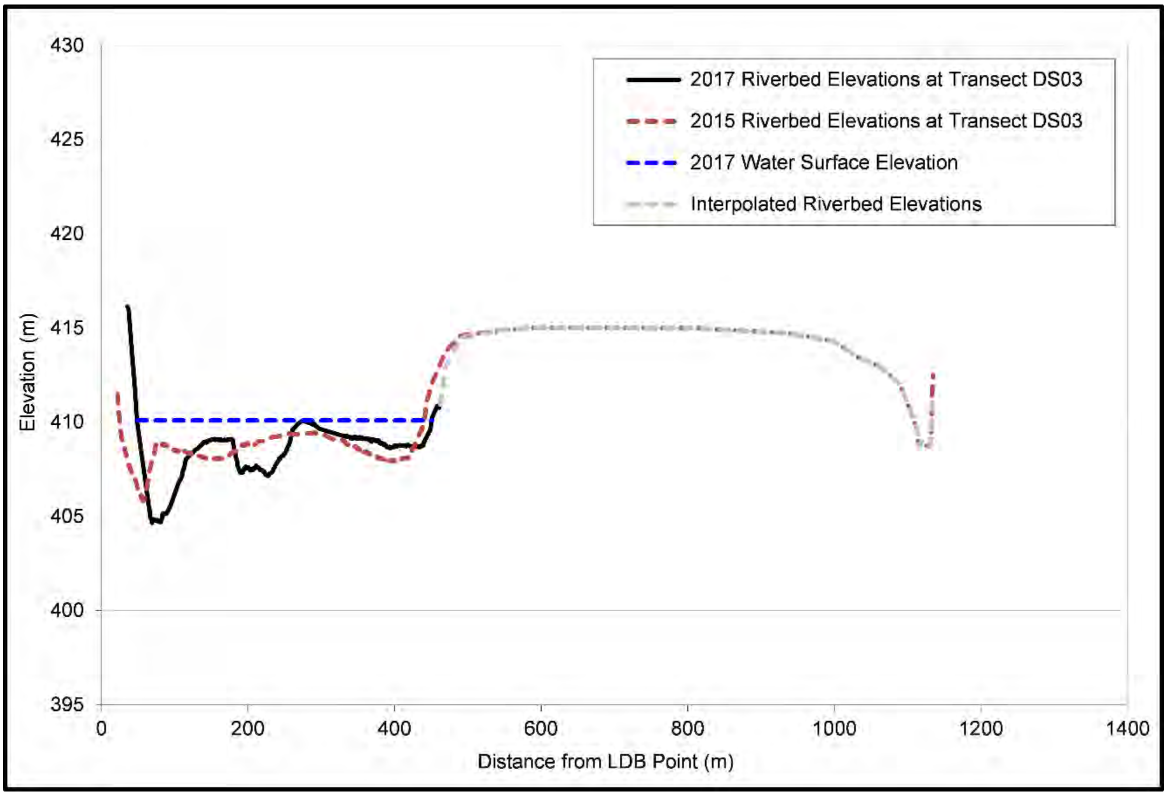


Figure B1: Cross section results for Transect DS03. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.

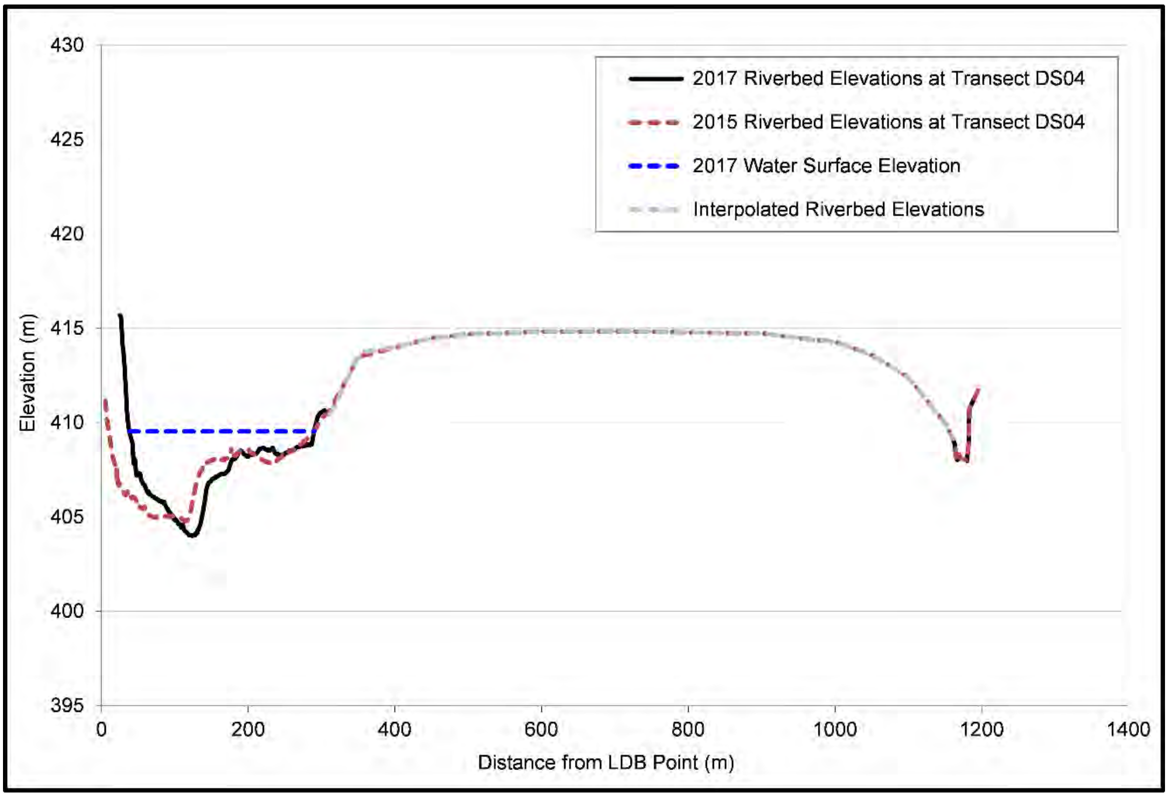


Figure B2: Cross section results for Transect DS04. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.

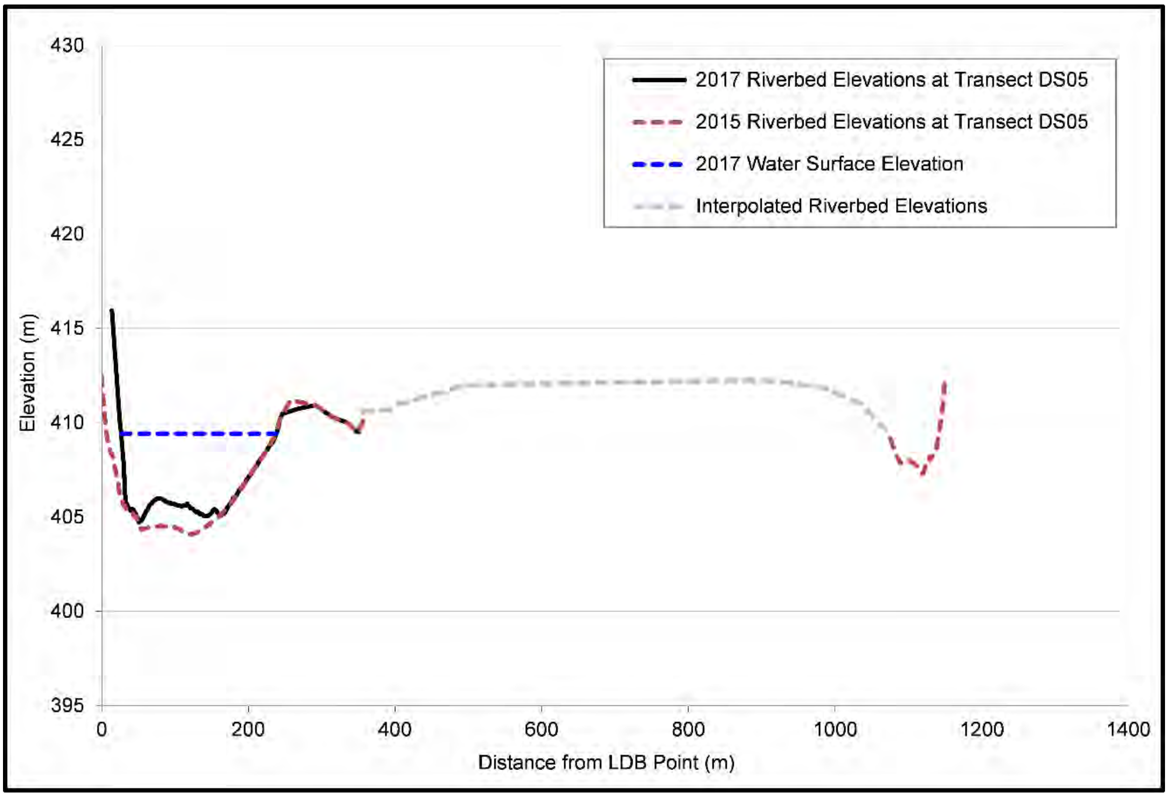


Figure B3: Cross section results for Transect DS05. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.

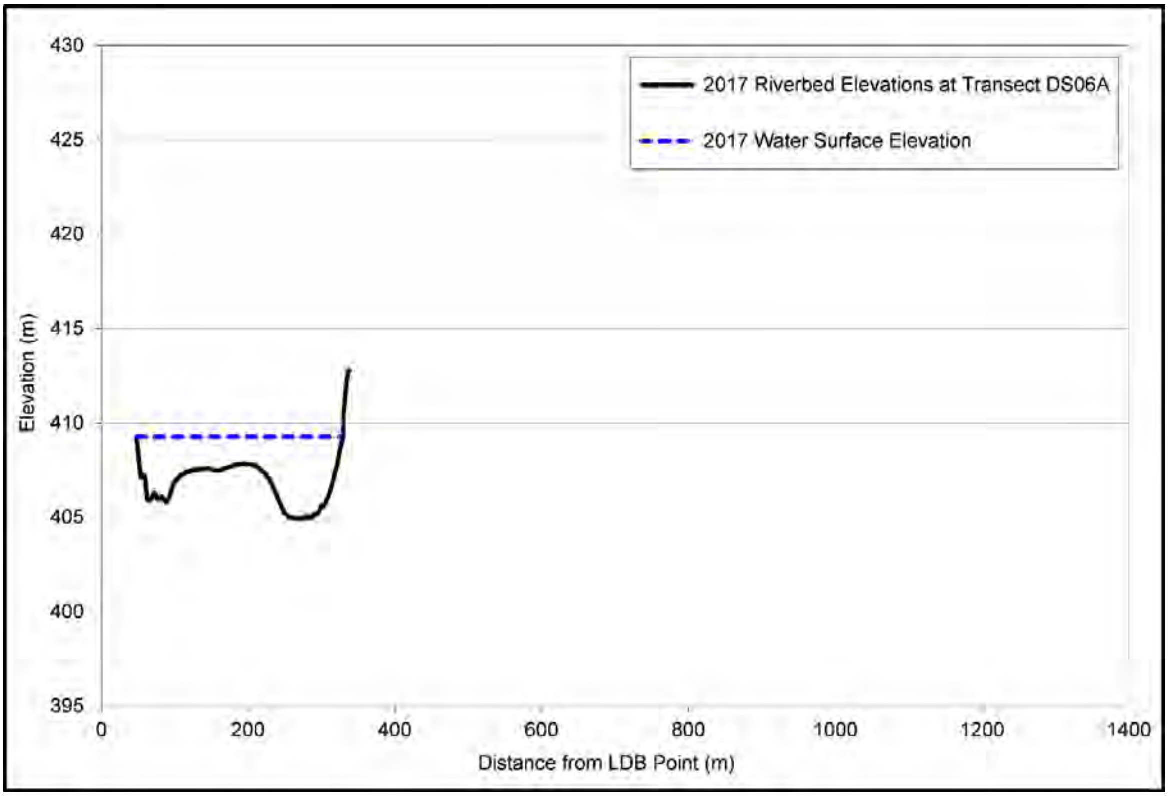


Figure B4: Cross section results for Transect DS06A. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.

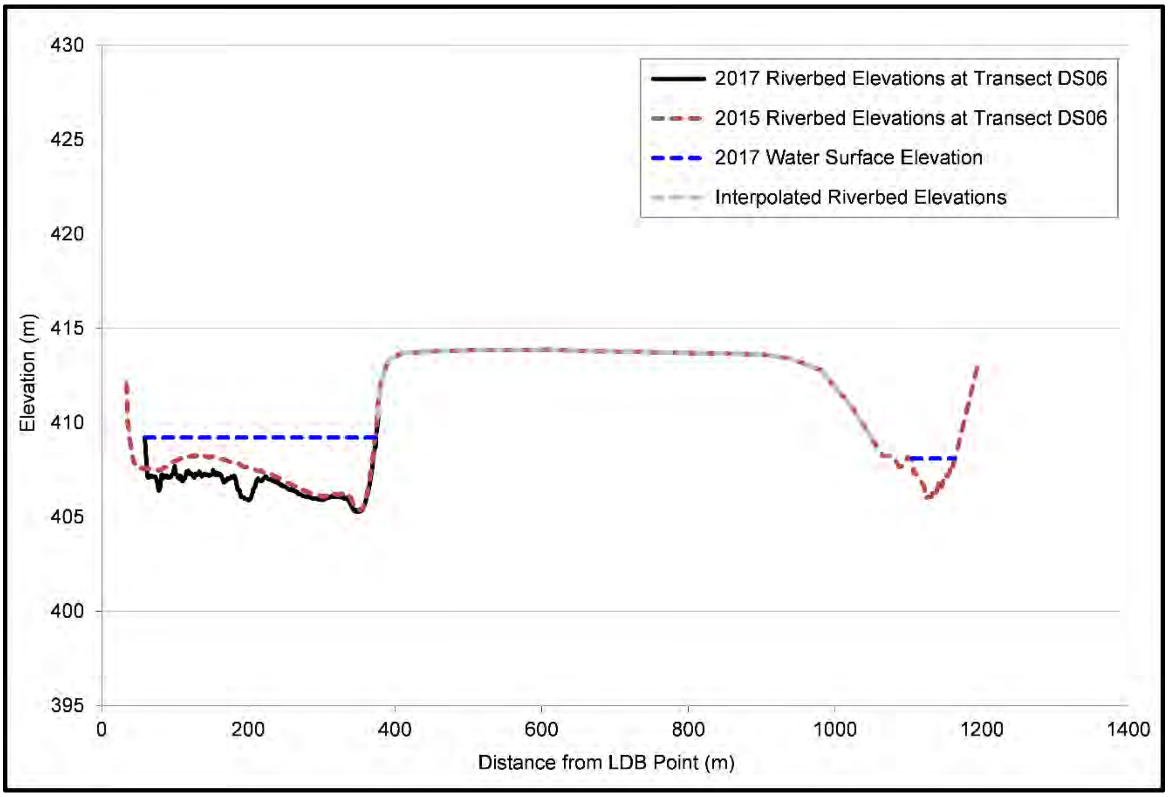


Figure B5: **Cross section results for Transect DS06. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.**

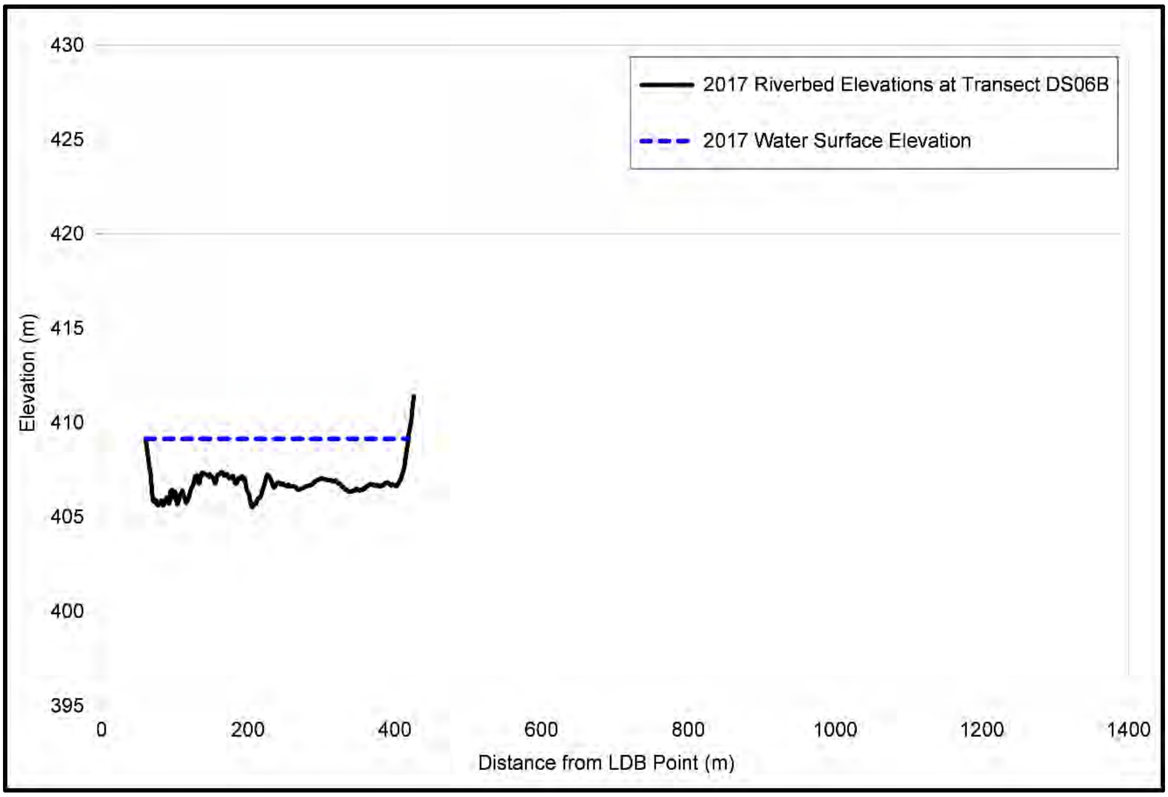


Figure B6: **Cross section results for Transect DS06B. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.**

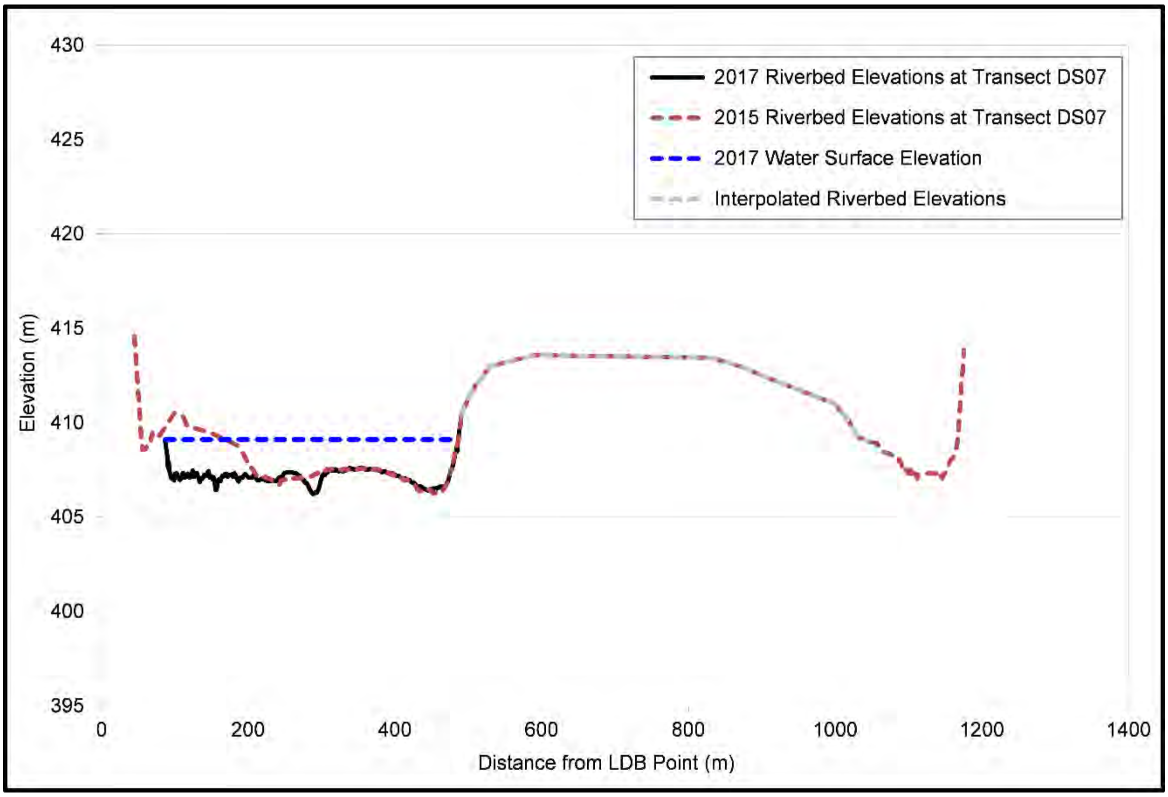


Figure B7: **Cross section results for Transect DS07. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.**

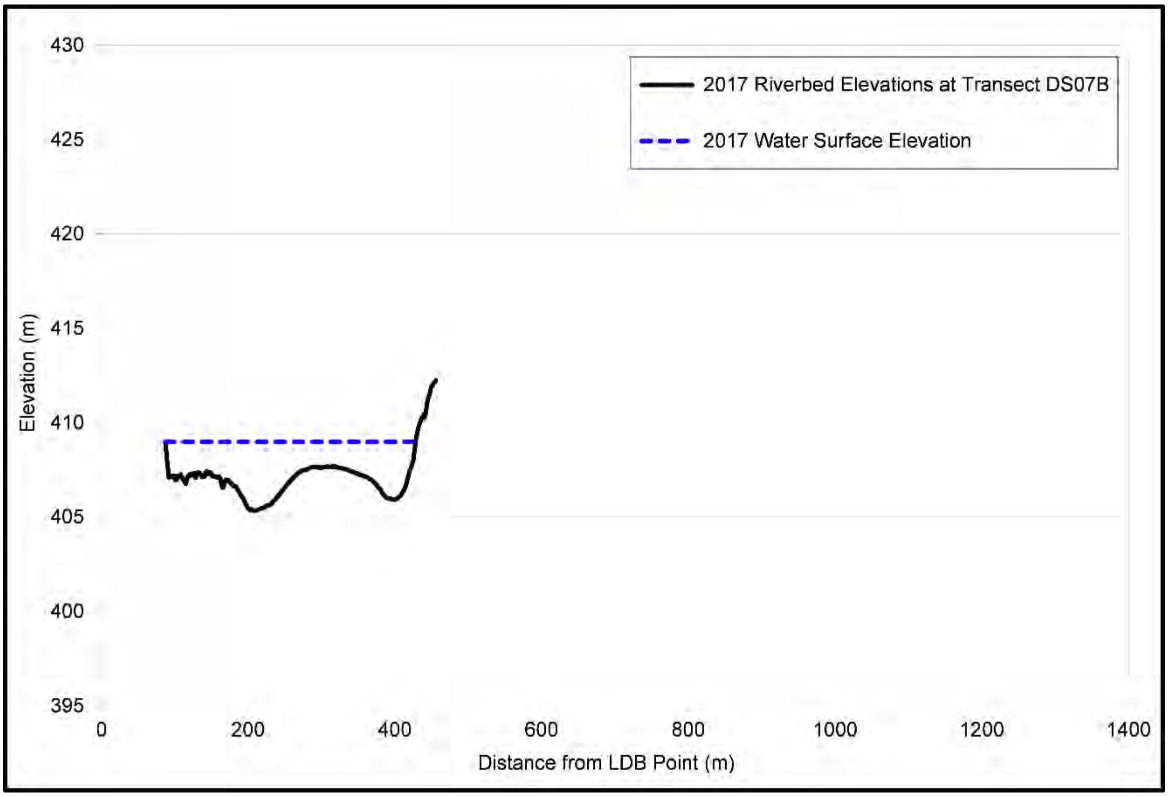


Figure B8: **Cross section results for Transect DS07B. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.**

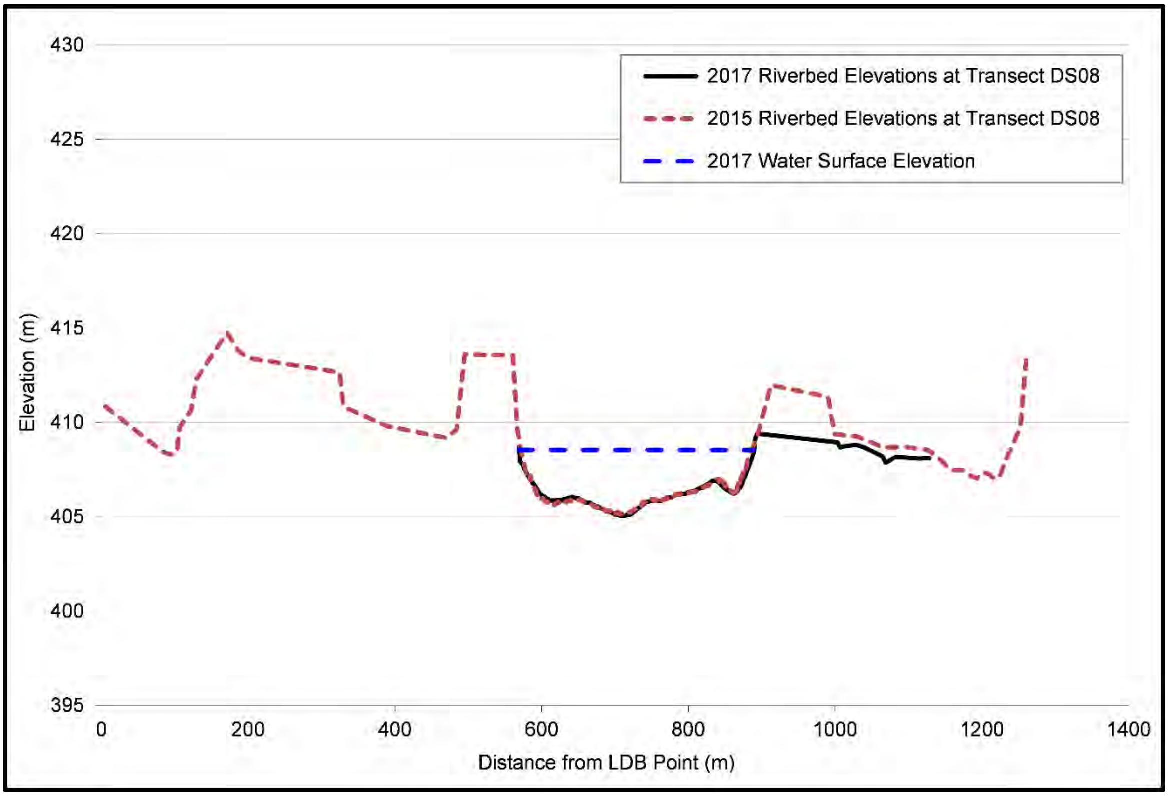


Figure B9: Cross section results for Transect DS08. Transect was surveyed as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 27 May 2017.

LEGEND

WATER SPEED AND DIRECTION VECTOR

- <= 0.4 m/s
- 0.4 - 0.8 m/s
- 0.8 - 1.2 m/s
- 1.2 - 1.6 m/s
- 1.6 - 2.3 m/s

SPUR STRUCTURE

0 2.5 5 7.5 10 m

1:300

REFERENCES

1. SPUR STRUCTURE DIGITISED FROM BING IMAGERY.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.
3. TRANSECT SURVEY DATA OBTAINED BY GOLDER ASSOCIATES LTD. 27 MAY 2017.

DATUM: NAD83 PROJECTION UTM10

CLIENT
BC HYDRO

PROJECT
SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE
WATER VELOCITY VECTORS FOR TRANSECT DS03

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DC
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
1670320	3010	0	**B10**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

LEGEND

WATER SPEED AND DIRECTION VECTOR

- <= 0.4 m/s
- 0.4 - 0.8 m/s
- 0.8 - 1.2 m/s
- 1.2 - 1.6 m/s
- 1.6 - 2.3 m/s
- SPUR STRUCTURE

0 2.5 5 7.5 10 m

1:300

REFERENCES

1. SPUR STRUCTURE DIGITISED FROM BING IMAGERY.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.
3. TRANSECT SURVEY DATA OBTAINED BY GOLDER ASSOCIATES LTD. 27 MAY 2017.

DATUM: NAD83 PROJECTION UTM10

CLIENT

BC HYDRO

PROJECT

SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE

WATER VELOCITY VECTORS FOR TRANSECT DS04

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DC
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
1670320	3010	0	B11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

LEGEND

WATER SPEED AND DIRECTION VECTOR

- <= 0.4 m/s
- 0.4 - 0.8 m/s
- 0.8 - 1.2 m/s
- 1.2 - 1.6 m/s
- 1.6 - 2.3 m/s
- SPUR STRUCTURE

0 2.5 5 7.5 10 m

1:300

REFERENCES

1. SPUR STRUCTURE DIGITISED FROM BING IMAGERY.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.
3. TRANSECT SURVEY DATA OBTAINED BY GOLDER ASSOCIATES LTD. 27 MAY 2017.

DATUM: NAD83 PROJECTION UTM10

CLIENT
BC HYDRO

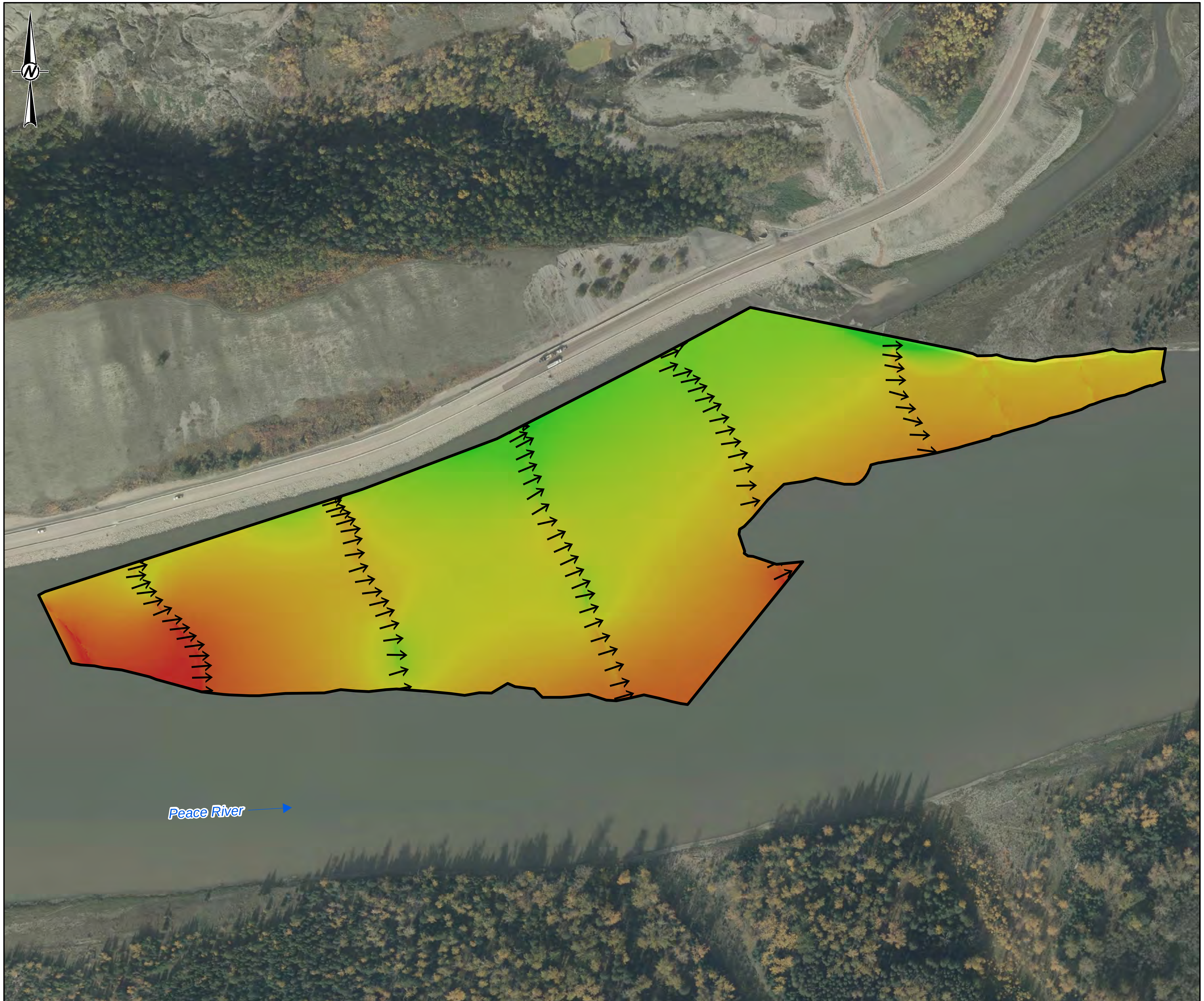
PROJECT
SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE
WATER VELOCITY VECTORS FOR TRANSECT DS05

CONSULTANT
GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DC
PREPARED	JP / CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
1670320	3010	0	**B12**



LEGEND

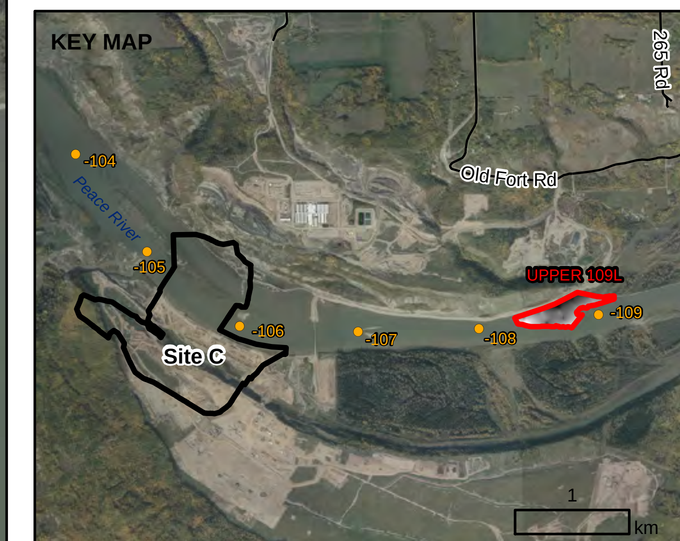
FLOW DIRECTION

UPPER109L

WATER VELOCITY

HIGH (1.8 m/s)

LOW (0.13 m/s)



0 25 50 75 100 m

1:3,000

REFERENCES

1. SPUR STRUCTURE DIGITISED FROM BING IMAGERY.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.
3. TRANSECT SURVEY DATA OBTAINED BY GOLDER ASSOCIATES LTD. 27 MAY 2017.

DATUM: NAD83 PROJECTION UTM10

CLIENT

BC HYDRO

PROJECT

SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE

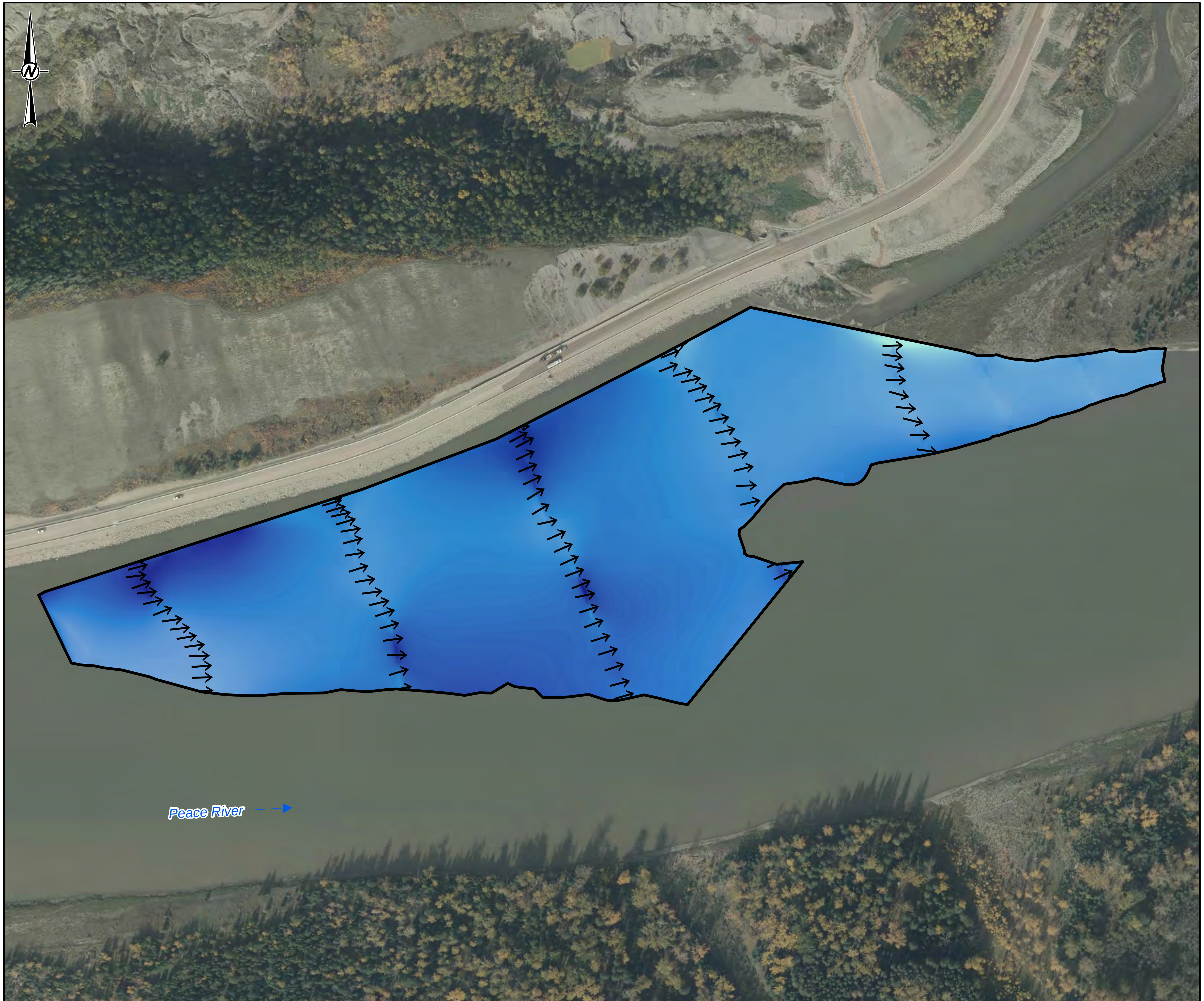
WATER VELOCITY VECTORS FOR UPPER SITE 109L

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DC
PREPARED	CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
1670320	3010	0	**B13**



LEGEND

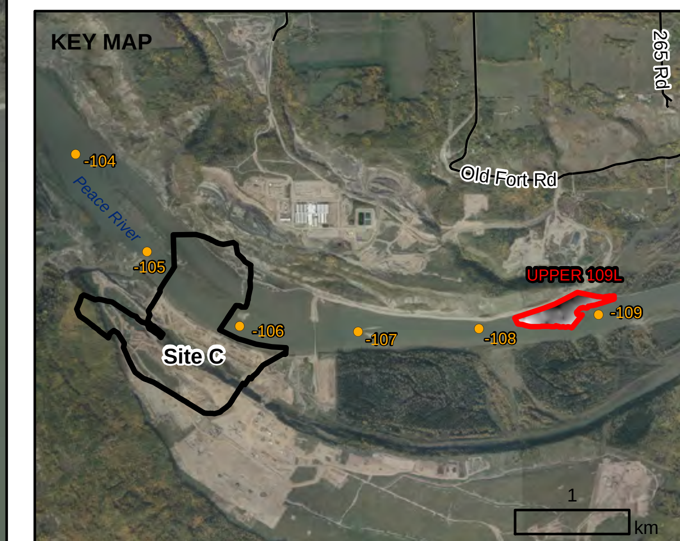
FLOW DIRECTION

UPPER109L

WATER DEPTH

HIGH (4.3m)

LOW (0.3)



0 25 50 75 100 m

1:3,000

NOTE(S)

1. WATER ELEVATION IS 409.26 M GEODETIC AT THE UPSTREAM TRANSECT

REFERENCES

1. SPUR STRUCTURE DIGITISED FROM BING IMAGERY.
2. IMAGERY PROVIDED BY CLIENT 2017-05-10. IMAGE DATE: 2016-11-10.
3. TRANSECT SURVEY DATA OBTAINED BY GOLDER ASSOCIATES LTD. 27 MAY 2017.

DATUM: NAD83 PROJECTION UTM10

CLIENT

BC HYDRO

PROJECT

SITE C OFFSET EFFECTIVENESS MONITORING PROGRAM - 2017

TITLE

SUMMARY OF WATER DEPTHS RECORDED DURING ADCP SURVEYS CONDUCTED ON 27 MAY, 2017

CONSULTANT

GOLDER

YYYY-MM-DD	2018-02-16
DESIGNED	DC
PREPARED	CD
REVIEWED	DF
APPROVED	SR

PROJECT NO.	PHASE	REV.	FIGURE
1670320	3010	0	**B14**

APPENDIX C

General Fish Use Data

Table C1 Summary of habitat variables recorded at boat electroshocking sites surveyed during BC Hydro's Site C Offset Effectiveness Monitoring Program, 2017.

Offset Area	Site Name[a]	Sample Date	Sample Time	Sample Session	Air Temp. (°C)	Water Temp. (°C)	Water Cond. (µs/cm)	Sechi Depth (m)	Cloud Cover[b]	Boat Model	Electroshocker Settings				Length Sampled (m)	Time Sampled (s)	Mean Depth (m)	Max Depth (m)
											Range	Percent	Amperes	Mode				
Rock Spurs	0505	26-Aug-2017	11:42	1	15.0	10.0	190	0.70	Mostly Cloudy	18H (Cas)	High	20	3.8	30DC	1000	960	1.6	3.2
Rock Spurs	0506	26-Aug-2017	13:45	1	15.0	10.5	190	0.80	Mostly Cloudy	18H (Cas)	High	20	4.0	30DC	1000	661	1.6	4.9
Upper Site 109L	0509	26-Aug-2017	15:15	1	15.0	10.8	200	0.60	Partly Cloudy	18H (Cas)	High	20	4.0	30DC	975	492	1.2	1.7
Rock Spurs	0505	3-Sep-2017	8:00	2	5.0	11.2	210	1.40	Mostly Cloudy	18H (Cas)	High	21	4.1	30DC	1000	1036	2.5	2.8
Rock Spurs	0506	3-Sep-2017	9:55	2		11.1	210	1.40	Clear	18H (Cas)	High	20	4.0	30DC	1000	758	2.2	3.0
Upper Site 109L	0509	3-Sep-2017	11:16	2	15.0	11.2	190	1.40		18H (Cas)	High	21	4.0	30DC	975	633	1.1	1.3
Rock Spurs	0505	12-Sep-2017	12:30	3	10.0	10.5		1.50	Mostly Cloudy	18H (Cas)	High	20	4.0	30DC	1000	1145	1.6	2.0
Rock Spurs	0506	12-Sep-2017	13:47	3	14.0	10.8	190	1.10	Mostly Cloudy	18H (Cas)	High	21	4.0	30DC	1000	743	2.0	2.3
Upper Site 109L	0509	12-Sep-2017	14:27	3	15.0	11.0	190	1.50	Mostly Cloudy	18H (Cas)	High	20	3.9	30DC	975	605	1.6	2.0
Rock Spurs	0505	17-Sep-2017	10:57	4		9.7	210	1.50		18H (Cas)	High	20	4.0	30DC	1000	1088	2.0	3.6
Rock Spurs	0506	17-Sep-2017	11:15	4	9.0	9.7			Mostly Cloudy	18H (Cas)	High	20	4.0	30DC	1000	900	2.0	2.4
Upper Site 109L	0509	22-Sep-2017	14:19	4	14.0	10.9	200	0.95	Partly Cloudy	18H (Cal)	High	30	2.2	30DC	975	552	1.3	1.7
Upper Site 109L	109OSA	23-Sep-2017	14:10	5	12.0	10.5	180		Clear	18H (Cal)	High	38	2.2	30DC	730	388	2.0	3.8
Upper Site 109L	109OSB	23-Sep-2017	14:19	5	12.0	10.3	180		Clear	18H (Cal)	High	38	2.2	30DC	780	426	1.0	1.9
Rock Spurs	0505	27-Sep-2017	9:53	5	12.0	10.7	180	1.70	Overcast	18H (Cal)	High	39	2.2	30DC	1000	1054	2.0	3.8
Rock Spurs	0506	27-Sep-2017	11:29	5	20.0	18.8	170	1.70	Partly Cloudy	18H (Cal)	High	39	2.2	30DC	1000	996	1.6	2.6
Upper Site 109L	0509	27-Sep-2017	12:45	5	20.0	11.0	170	1.70	Partly Cloudy	18H (Cal)	High	40	2.2	30DC	975	230	1.4	1.6
Rock Spurs	0505	3-Oct-2017	12:14	6	5.0	10.0	210	1.60	Mostly Cloudy	18H (Cal)	High	39	2.2	30DC	1000	1042	1.7	3.8
Rock Spurs	0506	3-Oct-2017	12:47	6	10.0	10.0	210	1.60		18H (Cal)	High	39	2.2	30DC	1000	820	1.7	2.8
Upper Site 109L	0509	3-Oct-2017	14:00	6	13.0	10.1	210	1.60	Mostly Cloudy	18H (Cal)	High	39	2.2	30DC	975	595	1.3	2.0

[a] See Appendix B, Figure B3 for sample site locations.

[b] Clear = <10%; Partly Cloudy = 10-50%; Mostly Cloudy = 50-90%; Overcast = >90%.

Table C2 Summary of boat electroshockinging catch recorded during BC Hydro's Site C Offset Effectiveness Monitoring Program, 2017.

Offset Area	Site Name[a]	Sample Date	Sample Session	Species Name	Size Class	Total Number Caught
Rock Spurs	0505	26-Aug-2017	1	Arctic Grayling	>250	1
				Bull Trout	>250	2
				Lake Chub	-	1
				Largescale Sucker	>250	1
				Longnose Sucker	>250	8
				Mountain Whitefish	>250	1
				Northern Pikeminnow	<250	1
				Rainbow Trout	>250	3
				Redside Shiner	-	3
				Walleye	>250	1
				White Sucker	>250	1
		Session Total				**23**
		3-Sep-2017	2	Bull Trout	>250	1
				Largescale Sucker	>250	1
				Longnose Sucker	<250	3
				Longnose Sucker	>250	3
				Mountain Whitefish	>250	3
				Rainbow Trout	>250	1
				White Sucker	>250	1
		Session Total				**13**
		12-Sep-2017	3	Bull Trout	>250	1
				Kokanee	<250	1
				Longnose Sucker	<250	1
				Longnose Sucker	>250	3
				Mountain Whitefish	>250	3
				Northern Pikeminnow	>250	1
				Rainbow Trout	>250	3
		Session Total				**13**
		17-Sep-2017	4	Bull Trout	>250	1
				Mountain Whitefish	>250	4
				Northern Pikeminnow	>250	1
				Rainbow Trout	>250	1
		Session Total				**7**
		27-Sep-2017	5	Bull Trout	>250	2
				Mountain Whitefish	>250	4
		Session Total				**6**
		3-Oct-2017	6	Bull Trout	>250	3
				Longnose Sucker	200-299	1
				Mountain Whitefish	>250	1
				Mountain Whitefish	>300	1
				Mountain Whitefish	200-299	3
				Rainbow Trout	>250	1
		Session Total				**10**
	Site Total					**72**
	0506	26-Aug-2017	1	Longnose Sucker	<250	1
				Longnose Sucker	>250	3
				Mountain Whitefish	>250	2
		Session Total				**6**
		3-Sep-2017	2	Bull Trout	>250	1
				Longnose Sucker	<250	1
				Longnose Sucker	>250	2
				Mountain Whitefish	<250	1
				Mountain Whitefish	>250	4
		Session Total				**9**

…continued.

Table C2 Continued.

Offset Area	Site Name[a]	Sample Date	Sample Session	Species Name	Size Class	Total Number Caught
Rock Spurs	0506	12-Sep-2017	3	Longnose Sucker	>250	2
				Mountain Whitefish	>250	8
				Rainbow Trout	>250	1
		Session Total				**11**
		17-Sep-2017	4	Bull Trout	>250	2
				Largescale Sucker	>250	1
				Longnose Sucker	<250	1
				Mountain Whitefish	>250	3
				Northern Pikeminnow	>250	4
		Session Total				**11**
		27-Sep-2017	5	Bull Trout	>250	1
				Burbot	>250	1
				Longnose Sucker	200-299	1
				Mountain Whitefish	>250	2
				Mountain Whitefish	>300	8
				Mountain Whitefish	200-299	2
		Session Total				**15**
		3-Oct-2017	6	Burbot	>250	1
				Longnose Sucker	>300	1
				Mountain Whitefish	>300	5
				Mountain Whitefish	200-299	2
		Session Total				**9**
	Site Total					**61**
Rock Spurs Total						**133**
Upper Site 109L	0509	26-Aug-2017	1	Largescale Sucker	<250	2
				Largescale Sucker	>250	3
				Longnose Sucker	<250	1
				Longnose Sucker	>250	5
				Mountain Whitefish	<250	3
				Mountain Whitefish	>250	10
				Northern Pikeminnow	<250	1
		Session Total				**25**
		3-Sep-2017	2	Bull Trout	>250	1
				Largescale Sucker	<250	1
				Largescale Sucker	>250	1
				Longnose Sucker	>250	11
				Mountain Whitefish	>250	22
				Redside Shiner	-	3
				Walleye	>250	1
		Session Total				**40**
		12-Sep-2017	3	Bull Trout	>250	1
				Largescale Sucker	<250	1
				Longnose Sucker	<250	1
				Longnose Sucker	>250	9
				Mountain Whitefish	<250	4
				Mountain Whitefish	>250	18
		Session Total				**34**
		22-Sep-2017	4	Largescale Sucker	>250	2
				Longnose Sucker	>250	11
				Mountain Whitefish	<250	2
				Mountain Whitefish	>250	17
		Session Total				**32**

...continued.

Table C2 Concluded.

Offset Area	Site Name[a]	Sample Date	Sample Session	Species Name	Size Class	Total Number Caught
		27-Sep-2017	5	Bull Trout	>250	1
				Longnose Sucker	>300	2
				Mountain Whitefish	<250	1
				Mountain Whitefish	>250	3
				Mountain Whitefish	>300	4
				Mountain Whitefish	150-199	1
				Mountain Whitefish	200-299	7
		Session Total				**19**
		3-Oct-2017	6	Largescale Sucker	>300	2
				Largescale Sucker	200-299	1
				Longnose Sucker	>300	1
				Longnose Sucker	200-299	1
				Mountain Whitefish	<150	2
				Mountain Whitefish	>250	3
				Mountain Whitefish	>300	6
				Mountain Whitefish	150-199	2
				Mountain Whitefish	200-299	8
		Session Total				**26**
	Site Total					**176**
	109OSA	23-Sep-2017	5	Longnose Sucker	>250	1
				Mountain Whitefish	>250	8
	Site Total					**9**
	109OSB	23-Sep-2017	5	Mountain Whitefish	<250	6
				Mountain Whitefish	>250	6
	Site Total					**12**
Rock Spurs Total						**197**
Survey Total						**330**

Table C3 Summary of life history data collected in the Peace River during boat electroshocking surveys conducted as part of BC Hydro's Site C Offset Effectiveness Monitoring Program, 2017.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0505	26-Aug-17	860	Redside Shiner	99	10	1.031			
		861	Largescale Sucker	444	1130	1.291	900228000586363		
		862	White Sucker	363	716	1.497	900228000585946		
		863	Longnose Sucker	430	979	1.231	900228000587793		
		864	Longnose Sucker	261	222	1.249	900228000586889		
		865	Northern Pikeminnow	201	92	1.133			
		866	Redside Shiner	72	4	1.072			
		867	Mountain Whitefish	314	344	1.111	965000000068482	900228000585786	
		868	Longnose Sucker	400	696	1.088	900228000586258		
		869	Longnose Sucker	464	944	0.945	900230000127149		
		870	Longnose Sucker	437	991	1.187	900228000585750		
		871	Lake Chub	57					
		872	Redside Shiner	85	4	0.651			
		873	Longnose Sucker	429	957	1.212	900228000586970		
		874	Longnose Sucker	371	574	1.124	900228000587965		
		875	Longnose Sucker	377					
		876	Arctic Grayling	355	506	1.131	900228000587421		1
		877	Bull Trout	371	509	0.997	900228000587517		5
		878	Bull Trout	255	155	0.935	900228000587317		5
		879	Rainbow Trout	299	292	1.092	900228000587516		5
		880	Rainbow Trout	363	595	1.244	900228000586638		5
		881	Rainbow Trout	284	282	1.231	900228000586790		5
		882	Walleye	371	612	1.198	900228000587987		5
	03-Sep-17	1968	Longnose Sucker	443	1148	1.32	900230000054606		
		1969	Largescale Sucker	440	696	0.817			
		1970	Longnose Sucker	162	60	1.411			
		1971	Longnose Sucker	192	86	1.215			
		1972	Longnose Sucker	461	1169	1.193	900230000054624		
		1973	Longnose Sucker	203	109	1.303	900228000540956		

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0505	03-Sep-17	1974	Longnose Sucker	416	930	1.292	900230000054406		
		1975	White Sucker	374	677	1.294	900230000056389		
		1976	Mountain Whitefish	351	433	1.001	900026000063269	900026000063269	
		1977	Mountain Whitefish	316	311	0.986	981098104941882	981098104941882	
		1978	Mountain Whitefish	296	298	1.149	900228000295496		
		1979	Rainbow Trout	366	592	1.207	900228000586638		
		1980	Bull Trout	436	763	0.921	900230000054622		3
	12-Sep-17	3388	Northern Pikeminnow	504	1321	1.032			
		3389	Longnose Sucker	445	1128	1.28			
		3390	Longnose Sucker	432	1122	1.392	900230000056965		
		3391	Longnose Sucker	452	1118	1.211	900230000056961		
		3392	Mountain Whitefish	296	247	0.952	900228000349109		
		3393	Mountain Whitefish	311	303	1.007	900230000056827		
		3394	Mountain Whitefish	346	344	0.83	900230000127205		
		3395	Longnose Sucker	186	72	1.119			
		3396	Bull Trout	315	277	0.886	900230000056892		3
		3397	Rainbow Trout	384	687	1.213	900230000033618		1
		3398	Rainbow Trout	305	322	1.135	900230000056866		1
		3399	Rainbow Trout	390	561	0.946	900230000033221		1
		3400	Kokanee	212	98	1.029			
	17-Sep-17	4620	Northern Pikeminnow	534	1527	1.003			
		4621	Mountain Whitefish	309	288	0.976	900230000057526		
		4622	Mountain Whitefish	312	375	1.235	981098104942978	900230000057511	
		4623	Mountain Whitefish	254	185	1.129	900228000349304		
		4624	Mountain Whitefish	264	203	1.103	900228000349283		
		4625	Rainbow Trout	331	429	1.183	900228000294447		
		4626	Bull Trout	408	634	0.933	900230000057450		5
	27-Sep-17	5404	Mountain Whitefish	319	308	0.949	900026000053661	900230000057854	
		5405	Mountain Whitefish	324	362	1.064	965000000110226	900230000057899	

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0505	27-Sep-17	5406	Mountain Whitefish	255	180	1.086	900228000541134		
		5407	Mountain Whitefish	343	332	0.823	965000000007109	900230000057634	
		5408	Bull Trout	441	738	0.86	900230000054622		
		5409	Bull Trout	255	172	1.037	900228000349650		5
	03-Oct-17	5678	Bull Trout	440	797	0.936	900230000057106		
		5679	Mountain Whitefish	312	290	0.955	900230000057526		
		5680	Bull Trout	409	688	1.006	900228000349219		3
		5681	Bull Trout	367	453	0.916	900228000349614		3
		5682	Rainbow Trout	311	353	1.174	900230000056866		
0506	26-Aug-17	884	Mountain Whitefish	450	964	1.058	900228000585866		
		885	Mountain Whitefish	323	389	1.154	900228000585784		
		886	Longnose Sucker	405	868	1.307	900228000586574		
		887	Longnose Sucker	254			900228000587472		
		888	Longnose Sucker	430	938	1.18	900228000586156		
		889	Longnose Sucker	150	29	0.859			
	03-Sep-17	2015	Mountain Whitefish	303	288	1.035			
		2016	Mountain Whitefish	277	221	1.04	900228000295428		
		2017	Mountain Whitefish	294	267	1.051	900228000294584		
		2018	Bull Trout	376	491	0.924	900230000126355		
		2019	Mountain Whitefish	344	398	0.978	900026000060672	900230000054321	
		2020	Mountain Whitefish	240	143	1.034	900228000295280		
		2021	Longnose Sucker	430	928	1.167	900230000054290		
		2022	Longnose Sucker	411	820	1.181	900230000056316		
		2023	Longnose Sucker	186	90	1.399			
	12-Sep-17	3401	Mountain Whitefish	354	399	0.899	900230000056767		
		3402	Mountain Whitefish	376	475	0.894	900230000056786		
		3403	Mountain Whitefish	329	369	1.036	900230000056979		
		3404	Mountain Whitefish	368	448	0.899	900230000032264		
		3405	Mountain Whitefish	343	392	0.971	965000000090040	900230000056769	

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0506	12-Sep-17	3406	Mountain Whitefish	336	396	1.044	900230000056941		
		3407	Mountain Whitefish	353	455	1.034	900230000056837		
		3408	Mountain Whitefish	306	293	1.023	900230000056897		
		3409	Longnose Sucker	412	941	1.346	900230000056981		
		3410	Longnose Sucker	313	362	1.181	900230000056992		
		3411	Rainbow Trout	324	394	1.158	900230000056991		1
	17-Sep-17	4628	Northern Pikeminnow	496	1589	1.302			
		4629	Northern Pikeminnow	451	1073	1.17			
		4630	Largescale Sucker	515	1417	1.037	900230000032316		
		4631	Northern Pikeminnow	431	1008	1.259			
		4632	Longnose Sucker	196	87	1.155			
		4633	Mountain Whitefish	303	332	1.193	900230000057251		
		4634	Mountain Whitefish	321	397	1.2	900230000057528		
		4635	Mountain Whitefish	356	478	1.059	900230000057469		
		4636	Northern Pikeminnow	311	363	1.207			
		4637	Bull Trout	442	814	0.943	900230000057106		5
		4638	Bull Trout	525	1650	1.14	981098104791874	900230000057135	5
	27-Sep-17	5420	Burbot	388	458	0.784	900230000057852		5
		5421	Bull Trout	451	814	0.887	900230000057974		5
		5422	Mountain Whitefish	323	387	1.148	900230000055460		
		5423	Mountain Whitefish	267	209	1.098	900228000294975		
	03-Oct-17	5684	Burbot	326	186	0.537	900228000349541		5
0509	26-Aug-17	914	Mountain Whitefish	320	323	0.986	900228000586990		
		915	Mountain Whitefish	333	383	1.037	900026000147888	900228000586544	
		916	Mountain Whitefish	236	137	1.042	900228000585950		
		917	Mountain Whitefish	193	88	1.224			
		918	Mountain Whitefish	335	374	0.995	900228000587627		
		919	Mountain Whitefish	334	289	0.776	900026000146273	900228000586435	
		920	Mountain Whitefish	359	369	0.798	900228000587269		

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0509	26-Aug-17	921	Mountain Whitefish	421	685	0.918	900228000587796		
		922	Mountain Whitefish	288	310	1.298	900228000585795		
		923	Mountain Whitefish	336	346	0.912	900026000053443	900228000587852	
		924	Mountain Whitefish	324	367	1.079	900228000586958		
		925	Mountain Whitefish	372	400	0.777	900228000586591		
		926	Northern Pikeminnow	217	122	1.194			
		927	Mountain Whitefish	72					
		928	Largescale Sucker	304	346	1.232	900228000587258		
		929	Longnose Sucker	392	749	1.243	900228000587189		
		930	Largescale Sucker	312	358	1.179	900228000587456		
		931	Longnose Sucker	145	39	1.279			
		932	Largescale Sucker	297	319	1.218	900228000586277		
		933	Largescale Sucker	171	54	1.08			
		934	Longnose Sucker	422	904	1.203	900228000587959		
		935	Longnose Sucker	397	758	1.211	981098104942685	900228000586272	
		936	Longnose Sucker	462	1176	1.193	900230000126838		
		937	Longnose Sucker	350	533	1.243	900228000585924		
		938	Largescale Sucker	108	14	1.111			
	03-Sep-17	2045	Mountain Whitefish	371	488	0.956	900230000054543		
		2046	Mountain Whitefish	395	731	1.186	900230000054542		
		2047	Mountain Whitefish	331	394	1.086	900230000054554		
		2048	Mountain Whitefish	311	312	1.037	981098104933773	900230000054575	
		2049	Mountain Whitefish	306	323	1.127	900230000056352		
		2050	Mountain Whitefish	303	318	1.143	900230000056286		
		2051	Mountain Whitefish	317	347	1.089	900026000060696	900230000054010	
		2052	Mountain Whitefish	279	245	1.128	900228000294210		
		2053	Mountain Whitefish	273	215	1.057	900228000295147		
		2054	Mountain Whitefish	293	328	1.304	900228000587281		
		2055	Mountain Whitefish	348	404	0.959	900230000056427		

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0509	03-Sep-17	2056	Mountain Whitefish	351	465	1.075	900230000054301		
		2057	Mountain Whitefish	327	353	1.01	900230000054132		
		2058	Mountain Whitefish	390	559	0.942	900230000056214		
		2059	Redside Shiner	86	8	1.258			
		2060	Mountain Whitefish	330	385	1.071	900230000126361		
		2061	Redside Shiner	80	6	1.172			
		2062	Mountain Whitefish	281	230	1.037	900228000541553		
		2063	Mountain Whitefish	311	322	1.07	900230000056243		
		2064	Mountain Whitefish	396	531	0.855	900230000056418		
		2065	Longnose Sucker	386	760	1.321	981098104942378	900230000054629	
		2066	Largescale Sucker	370	634	1.252	900230000054616		
		2067	Walleye	551	1859	1.111	900230000054217		
		2068	Mountain Whitefish	336	345	0.909	900230000033794		
		2069	Mountain Whitefish	330	362	1.007	900230000054604		
		2070	Longnose Sucker	302	309	1.122	900230000054149		
		2071	Longnose Sucker	396	808	1.301	900230000056248		
		2072	Longnose Sucker	398	732	1.161	900230000054546		
		2073	Longnose Sucker	374	676	1.292	900230000054438		
		2074	Longnose Sucker	376	648	1.219	900230000056398		
		2075	Longnose Sucker	361	598	1.271	900230000054175		
		2076	Largescale Sucker	234	153	1.194	900228000295405		
		2077	Longnose Sucker	266	254	1.35	900228000294225		
		2078	Longnose Sucker	312	414	1.363	900230000056457		
		2079	Bull Trout	360	482	1.033	900230000054641		3
		2080	Mountain Whitefish	271	236	1.186	900228000587930		
		2081	Redside Shiner	99	14	1.443			
		2082	Longnose Sucker	439	940	1.111	900230000054540		5
		2083	Longnose Sucker	340	451	1.147	900230000056217		5
		2084	Mountain Whitefish	252	164	1.025	900228000294849		5

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0509	12-Sep-17	3413	Mountain Whitefish	384	505	0.892	900230000056835		
		3414	Mountain Whitefish	369	455	0.906	965000000071683	900230000056710	
		3415	Mountain Whitefish	280	230	1.048	900228000349137		
		3416	Mountain Whitefish	387	552	0.952	900230000056667		
		3417	Mountain Whitefish	335	327	0.87	900228000587852		
		3418	Mountain Whitefish	330	372	1.035	900230000056530		
		3419	Mountain Whitefish	354	439	0.99	900230000056718		
		3420	Mountain Whitefish	365	484	0.995	900230000032695		
		3421	Mountain Whitefish	335	377	1.003	900230000056585		
		3422	Mountain Whitefish	289	261	1.081	900228000349119		
		3423	Mountain Whitefish	256	206	1.228	900228000349131		
		3424	Mountain Whitefish	310	312	1.047	900230000056652		
		3425	Mountain Whitefish	354	441	0.994	900230000056653		
		3426	Mountain Whitefish	321	321	0.97	900230000056707		
		3427	Mountain Whitefish	243	138	0.962	900228000349063		
		3428	Mountain Whitefish	309	294	0.996	900230000056611		
		3429	Mountain Whitefish	312	359	1.182	900230000056883		
		3430	Mountain Whitefish	238	140	1.038	900228000349107		
		3431	Mountain Whitefish	72					
		3432	Mountain Whitefish	321	307	0.928	900230000056812		
		3433	Mountain Whitefish	335	342	0.91	900230000056689		
		3434	Longnose Sucker	425	1001	1.304	900230000056766		
		3435	Longnose Sucker	421	924	1.238	900230000056793		
		3436	Longnose Sucker	409	899	1.314	900230000056606		
		3437	Longnose Sucker	452	1047	1.134	900230000056776		
		3438	Longnose Sucker	400	740	1.156	900230000056943		
		3439	Longnose Sucker	419	1028	1.397	900230000056642		
		3440	Longnose Sucker	426	883	1.142	900230000056996		
		3441	Longnose Sucker	357	560	1.231	900230000056772		

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0509	12-Sep-17	3442	Largescale Sucker	246	181	1.216	900228000592039		
		3443	Longnose Sucker	239	151	1.106	900228000349169		
		3444	Mountain Whitefish	190	65	0.948			
		3445	Longnose Sucker	396	788	1.269	900230000056773		
		3446	Bull Trout	380	461	0.84	900230000056771		3
	22-Sep-17	4815	Mountain Whitefish	356	477	1.057	965000000085527	900230000057023	
		4816	Mountain Whitefish	336	340	0.896	900230000057539		
		4817	Mountain Whitefish	411	726	1.046	900230000057049		
		4818	Mountain Whitefish	332	440	1.202	900230000057611		
		4819	Mountain Whitefish	325	358	1.043	900230000127088		
		4820	Mountain Whitefish	341	456	1.15	900230000057089		
		4821	Mountain Whitefish	342	355	0.887	900230000057767		
		4822	Mountain Whitefish	329	388	1.09	900230000057966		
		4823	Mountain Whitefish	311	344	1.144	900230000057018		
		4824	Mountain Whitefish	436	786	0.948	900230000057030		
		4825	Mountain Whitefish	314	291	0.94	900026000188215	900230000057213	
		4826	Mountain Whitefish	269	231	1.187	900228000349660		
		4827	Mountain Whitefish	348	378	0.897	900230000057203		
		4828	Mountain Whitefish	288	255	1.067	900228000348926		
		4829	Mountain Whitefish	316	372	1.179	900230000057131		
		4830	Mountain Whitefish	309	306	1.037	900230000057689		
		4831	Mountain Whitefish	328	441	1.25	900230000057042		
		4832	Mountain Whitefish	231	125	1.014	900228000349981		
		4833	Longnose Sucker	371	700	1.371	900230000057092		
		4834	Longnose Sucker	348	536	1.272	900230000057291		
		4835	Longnose Sucker	444	1138	1.3	900230000057228		
		4836	Longnose Sucker	436	1125	1.357	900230000055241		
		4837	Longnose Sucker	431	976	1.219	900230000057044		
		4838	Longnose Sucker	454	1116	1.193	900230000057029		

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
0509	22-Sep-17	4839	Longnose Sucker	339	475	1.219	900230000057019		
		4840	Longnose Sucker	399	807	1.27	900230000054594		
		4841	Longnose Sucker	428	1006	1.283	900230000057038		
		4842	Longnose Sucker	424	970	1.273	900230000057220		
		4843	Longnose Sucker	388	689	1.18	900230000057138		
		4844	Largescale Sucker	398	725	1.15	900230000056587		
		4845	Largescale Sucker	369	647	1.288	900230000057222		
		4846	Mountain Whitefish	99	12	1.237			
	27-Sep-17	5432	Mountain Whitefish	242	168	1.185	900228000348621		
		5433	Mountain Whitefish	303	313	1.125	981098104939057	900230000057579	
		5434	Mountain Whitefish	282	282	1.257	900230000057716		
		5435	Mountain Whitefish	354	499	1.125	965000000282668	900230000057557	
		5436	Bull Trout	530	1690	1.135	900230000032092		
	03-Oct-17	5698	Mountain Whitefish	337	406	1.061	900026000147910	900228000349535	
		5699	Mountain Whitefish	311	378	1.257	900026000155317	900228000349235	
		5700	Mountain Whitefish	389	613	1.041	900230000056214		
109OSA	23-Sep-17	5112	Mountain Whitefish	343	356	0.882	900230000057493		
		5113	Mountain Whitefish	374	519	0.992	900230000057013		
		5114	Mountain Whitefish	250	177	1.133	900228000349754		
		5115	Mountain Whitefish	259	189	1.088	900228000349857		
		5116	Mountain Whitefish	277	222	1.045	900228000349949		
		5117	Mountain Whitefish	464	1123	1.124	965000000070589	900230000057026	
		5118	Mountain Whitefish	332	379	1.036	900230000057186		
		5119	Longnose Sucker	285	282	1.218	900228000349644		
		5120	Mountain Whitefish	487	1479	1.281	900230000057093		
109OSB		5122	Mountain Whitefish	246	171	1.149	900228000349846		
		5123	Mountain Whitefish	279	239	1.1	900228000349811		
		5124	Mountain Whitefish	260	212	1.206	900228000349836		
		5125	Mountain Whitefish	236	162	1.232	900228000349799		

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

Table C3 Continued.

Site Name	Date	Sample Number	Species	Length (mm)	Weight (g)	Condition (K)	Tag 1 Number	Tag 2 Number	Preserve Code[a]
109OSB	23-Sep-17	5126	Mountain Whitefish	196	90	1.195			
		5127	Mountain Whitefish	405	636	0.957	900230000057690		
		5128	Mountain Whitefish	312	311	1.024	900230000057713		3
		5129	Mountain Whitefish	427	825	1.06	900230000057050		
		5130	Mountain Whitefish	326	342	0.987	900230000057525		
		5131	Mountain Whitefish	208	124	1.378	900228000349769		
		5132	Mountain Whitefish	240	159	1.15	900228000349905		
		5133	Mountain Whitefish	109	13	1.004			3

[a] 1 = Stomach contents (gastric lavage); 3 = DNA Sample; 5 = Mercury and SIA (biopsy)

APPENDIX D

Mountain Whitefish Spawn Monitoring Data

Table D1 Summary of egg collection mat data collected during a Mountain Whitefish spawn monitoring data conducted under BC Hydro's Site C Offset Effectiveness Monitoring Program, 2017.

Station Name[a]	Number of Samplers Deployed	Set		Pull		Effort (h)	Water Temperature (°C)		Water Depth (m)	Number of Mountain Whitefish Eggs
		Date	Time	Date	Time		Set	Pull		
M1	1	18-Oct-17	10:54	24-Oct-17	10:09	143.25	8.9	8.7	2.8	0
M2	1	18-Oct-17	11:41	24-Oct-17	10:23	142.70	8.9	8.7	2.4	0
M3	1	18-Oct-17	12:05	24-Oct-17	10:30	142.42	8.9	8.7	2.6	0
M4	1	18-Oct-17	12:36	24-Oct-17	10:37	142.02	8.9	8.7	2.3	0
M5	1	18-Oct-17	10:58	24-Oct-17	10:43	143.75	8.9	8.7	1.9	0
M6	1	18-Oct-17	11:26	24-Oct-17	10:48	143.37	8.9	8.7	1.9	0
M7	1	18-Oct-17	11:47	24-Oct-17	10:56	143.15	8.9	8.7	1.5	0
M8	1	18-Oct-17	12:16	24-Oct-17	11:02	142.77	8.9	8.7	2.1	0
S1	1	18-Oct-17	10:01	24-Oct-17	11:08	145.12	8.9	8.7	1.5	0
S2	1	18-Oct-17	13:07	24-Oct-17	10:23	141.27	8.9	8.7	1.9	0
M1	1	24-Oct-17	10:10	31-Oct-17	10:39	168.48	8.7	8.0	2.0	0
M2	1	24-Oct-17	10:24	31-Oct-17	11:08	168.73	8.7	8.0	1.9	0
M3	1	24-Oct-17	10:31	31-Oct-17	11:28	168.95	8.7	8.0	2.1	0
M4	1	24-Oct-17	10:37	31-Oct-17	11:46	169.15	8.7	8.0	2.0	0
M5	1	24-Oct-17	10:43	31-Oct-17	13:15	170.53	8.7	8.0	1.9	0
M6	1	24-Oct-17	10:50	31-Oct-17	13:20	170.50	8.7	8.0	2.0	0
M7	1	24-Oct-17	10:57	31-Oct-17	13:26	170.48	8.7	8.0	1.7	0
M8	1	24-Oct-17	11:03	31-Oct-17	13:32	170.48	8.7	8.0	2.4	0
S1	1	24-Oct-17	11:18	31-Oct-17	13:40	170.37	8.7	8.0	1.5	0
S2	1	24-Oct-17	11:27	31-Oct-17	13:54	170.45	8.7	8.0	1.7	0
M1	1	31-Oct-17	10:41	07-Nov-17	13:34	170.88	8.0	6.1	2.6	0
M2	1	31-Oct-17	11:15	07-Nov-17	14:02	170.78	8.0	6.1	2.8	0
M3	1	31-Oct-17	11:37	07-Nov-17	11:32	167.92	8.0	6.1	2.4	0
M4	1	31-Oct-17	11:46	07-Nov-17	12:43	168.95	8.0	6.1	2.0	0
M5	1	31-Oct-17	13:16	07-Nov-17	11:39	166.38	8.0	6.1	1.9	0
M6	1	31-Oct-17	13:21	07-Nov-17	13:11	167.83	8.0	6.1	2.0	0
M7	1	31-Oct-17	13:28	07-Nov-17	11:50	166.37	8.0	6.1	1.7	0
M8	1	31-Oct-17	13:33	07-Nov-17	11:45	166.20	8.0	6.1	2.5	0
S1	1	31-Oct-17	13:48	07-Nov-17	11:59	166.18	8.0	6.1	1.6	0
S2	1	31-Oct-17	14:02	07-Nov-17	12:10	166.13	8.0	6.1	1.8	0
M9	1	07-Nov-17	13:51	14-Nov-17	11:25	165.57	6.1	4.8	2.1	0
M10	1	07-Nov-17	14:28	14-Nov-17	11:31	165.05	6.1	4.8	1.6	0
M3	1	07-Nov-17	11:33	14-Nov-17	11:38	168.08	6.1	4.8	3.1	0
M11	1	07-Nov-17	12:58	14-Nov-17	11:45	166.78	6.1	4.8	3.0	0
M12	1	07-Nov-17	11:46	14-Nov-17	11:54	168.13	6.1	4.8	2.5	0
M13	1	07-Nov-17	13:26	14-Nov-17	11:59	166.55	6.1	4.8	2.6	0
M7	1	07-Nov-17	11:51	14-Nov-17	12:06	168.25	6.1	4.8	2.1	0
M8	1	07-Nov-17	11:40	14-Nov-17	12:11	168.52	6.1	4.8	1.8	0

[a] M = Mid-channel set; S = Shoreline set.

…continued.

Table D1 Concluded.

Station Name[a]	Number of Samplers Deployed	Set		Pull		Effort (h)	Water Temperature (°C)		Water Depth (m)	Number of Mountain Whitefish Eggs
		Date	Time	Date	Time		Set	Pull		
S1	1	07-Nov-17	12:04	14-Nov-17	12:17	168.22	6.1	4.8	1.7	0
S2	1	07-Nov-17	12:17	14-Nov-17	12:26	168.15	6.1	4.8	1.7	0
M9	1	14-Nov-17	11:26	23-Nov-17	12:05	216.65	4.8	3.8	2.4	0
M10	1	14-Nov-17	11:33	23-Nov-17	12:17	216.73	4.8	3.8	2.0	0
M3	1	14-Nov-17	11:39	23-Nov-17	12:28	216.82	4.8	3.8	4.1	0
M11	1	14-Nov-17	11:46	23-Nov-17	13:37	217.85	4.8	3.8	3.6	0
M12	1	14-Nov-17	11:54	23-Nov-17	14:00	218.10	4.8	3.8	3.3	0
M13	1	14-Nov-17	12:02	23-Nov-17	13:42	217.67	4.8	3.8	3.0	0
M7	1	14-Nov-17	12:07	23-Nov-17	13:48	217.68	4.8	3.8	2.3	0
M8	1	14-Nov-17	12:13	23-Nov-17	13:54	217.68	4.8	3.8	2.8	0
S1	1	14-Nov-17	12:22	23-Nov-17	13:09	216.78	4.8	3.8	1.9	0
S2	1	14-Nov-17	12:31	23-Nov-17	13:26	216.92	4.8	3.8	2.0	0
M9	1	23-Nov-17	12:07	29-Nov-17	12:12	144.08	3.8	2.9	2.5	0
M10	1	23-Nov-17	12:23	29-Nov-17	12:19	143.93	3.8	2.9	2.0	0
M3	1	23-Nov-17	12:30	29-Nov-17	12:26	143.93	3.8	2.9	3.0	0
M11	1	23-Nov-17	13:37	29-Nov-17	12:32	142.92	3.8	2.9	3.8	0
M14	1	23-Nov-17	14:20	29-Nov-17	12:37	142.28	3.8	2.9	3.6	0
M13	1	23-Nov-17	13:43	29-Nov-17	12:42	142.98	3.8	2.9	3.0	0
M7	1	23-Nov-17	13:50	29-Nov-17	12:46	142.93	3.8	2.9	2.4	0
M8	1	23-Nov-17	13:55	29-Nov-17	12:50	142.92	3.8	2.9	2.9	0
S1	1	23-Nov-17	13:14	29-Nov-17	13:00	143.77	3.8	2.9	1.7	0
S2	1	23-Nov-17	13:33	29-Nov-17	13:08	143.58	3.8	2.9	2.3	0
M9	1	29-Nov-17	12:13	14-Dec-17	11:06	358.88	2.9	2.6	1.6	0
M10	1	29-Nov-17	12:20	14-Dec-17	11:26	359.10	2.9	2.6	0.9	0
M3	1	29-Nov-17	12:27	14-Dec-17	11:44	359.28	2.9	2.6	3.3	0
M11	1	29-Nov-17	12:32	14-Dec-17	12:02	359.50	2.9	2.6	2.8	0
M14	1	29-Nov-17	12:37	14-Dec-17	13:42	361.08	2.9	2.6	3.0	0
M13	1	29-Nov-17	12:43	14-Dec-17	13:37	360.90	2.9	2.6	2.6	0
M7	1	29-Nov-17	12:47	14-Dec-17	13:32	360.75	2.9	2.6	1.6	0
M8	1	29-Nov-17	12:51	14-Dec-17	13:28	360.62	2.9	2.6	2.0	0
S1	1	29-Nov-17	13:02	14-Dec-17	10:46	357.73	2.9	2.6	1.2	0
S2	1	29-Nov-17	13:14	14-Dec-17	10:54	357.67	2.9	2.6	1.2	0
Total						**13681**				**0**

[a] M = Mid-channel set; S = Shoreline set.

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