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Technical Report Overview

Report: Fording River Operations Local Aquatic Effects Monitoring Program 2017 Report

Overview: This report presents the 2017 results of the local aquatic effects monitoring program (LAEMP) developed for Teck's Fording River Operations (FRO). The report presents data and evaluation of current condition and collects baseline data to support future evaluation of changes related to commissioning of an active water treatment facility that will be treating waters from Cataract, Swift, and Kilmarnock creeks at FRO.

This report was prepared for Teck by Minnow Environmental Inc.

For More Information

If you have questions regarding this report, please:

• Phone toll-free to 1.855.806.6854

• Email **feedbackteckcoal@teck.com**

Future studies will be made available at **teck.com/elkvalley**

Fording River Operations
Local Aquatic Effects Monitoring Program (LAEMP) Report, 2017

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A Trinity Consultants Company

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Fording River Operations Local Aquatic Effects Monitoring Program (LAEMP) Report, 2017

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EXECUTIVE SUMMARY

Discharges from Teck's coal mines to the Elk River watershed are authorized by the British Columbia Ministry of Environment and Climate Change Strategy (ENV, formerly MOE) through permits that are issued under provisions of the *Environmental Management Act.* Permit 107517 specifies the terms and conditions associated with those discharges. Permit 107517 also requires that Teck develop a local aquatic effects monitoring program (LAEMP) related to continued development of Fording River Operation (FRO) and the future commissioning of an active water treatment facility (AWTF) that will be treating waters from Cataract, Swift and Kilmarnock creeks at FRO.

The FRO LAEMP study design for 2016 to 2019 was submitted in accordance with the Permit requirement on June 1, 2016 (Minnow 2016) and subsequently approved by ENV on October 24, 2016. In consideration of potential existing and future mine-related influences at FRO, the following key questions were developed in consultation with the EMC in 2015 to guide the 2016-2019 study design development:

1. Are nitrate concentrations increasing, and if so, are they adversely affecting biota?
2. Is active water treatment affecting biological productivity downstream in the Fording River?
3. Are tissue selenium concentrations reduced downstream from the AWTF?
4. Is AWTF operation affecting aquatic biota through thermal effects or concentrations of treatment-related constituents other than nutrients or selenium?
5. Is re-direction of water potentially affecting biota in the Fording River?

The first annual report was submitted on May 31, 2017 (Minnow 2017a), and data interpretation showed a spatial and temporal decrease in percent (%) Ephemeroptera in the upper Fording River extending from upstream of Kilmarnock Creek to upstream of Ewin Creek that could not be attributed to nitrate alone. As such, updated monitoring tables were submitted in September, 2017, outlining additional monitoring to investigate other factors potentially influencing benthic invertebrate communities in the upper Fording River (e.g. increased spatial resolution, temperature, flow, sediment), and to address requirements related to water licensing (Minnow 2017b).

The baseline data being collected for addressing Key Questions #2 to #5 will continue in 2018, and the approach for data analysis will discussed with the EMC prior to the commissioning of the AWTF in 2020.

The evaluation of data related to Key Questions #1 (increasing nitrate concentrations and effects on biota) and changes in benthic invertebrate communities did not identify a clear, causal link with any one factor to explain the spatial and temporal reduction in % Ephemeroptera.

The previous LAEMP report identified nitrate, temperature, flow/seasonal dewatering, and calcite as possible causes of the changes in benthic invertebrate community. Nitrate concentrations are seasonally above the Level 1 and Level 2 benchmarks in the areas experiencing decreases in % Ephemeroptera; however, the highest concentrations were observed at FR_FRCP1, while the lowest % Ephemeroptera was found further downstream. Temporal trends for nitrate, other Order constituents, and nickel suggest that water quality has not changed over time commensurate with the decline in % Ephemeroptera.

Temperature in the upper Fording River also did not appear to be causing the observed changes in benthic invertebrate community structure. Temporal analysis of continuous water data from 2010 to 2017 did not identify an increasing trend. A significant positive correlation over time in June was identified at all water quality stations for which data was available from 2010 to 2017, including those having % Ephemeroptera within the normal range. This indicates that the spatial extent of the temperature increase is greater than that of the observed effects in benthic invertebrate community, and the significance of an increase in temperature in one particular month of each year on benthic invertebrate communities is not clear.

Flow in the upper Fording River has been low in the years experiencing a reduction in % Ephemeroptera compared to 2012, although temporal analysis did not identify a significant decrease over a longer time period (i.e., 1997 to 2017). When flow was analyzed by month, a significant decrease over time was observed in September, which coincided with biological sampling.

A 1.5 km section of the upper Fording River between FR_FRCP1 and FR_FRRD was identified as dewatered from December 2017 to March 2018. This area encompasses two biological monitoring areas, FRCP1SW and FRUPO, for which there are only data from 2017. Although these areas are within the reach where the decrease in % Ephemeroptera is observed (see Section 3.1), it is unlikely that dewatering is the cause as the effects on benthic invertebrate community extend both upstream and downstream of the dewatered section.

Overall, a combination of a number of mine-related and natural environmental factors may be contributing to the change in benthic invertebrate community. Water quality (based on PC-1 and PC-2), substrate size, and calcite appear to correlate the strongest with % Ephemeroptera. Other factors that may be contributing to the observed change are decreases in flow, and predation by other invertebrates (e.g., predatory Plecoptera and Trichoptera taxa) or fish.

Following consultation with the EMC, the 2018 FRO LAEMP implementation will retain all existing sampling areas, and a study design letter will be submitted to include replicate kick sampling at reference areas and mine-exposed areas to increase spatial understanding and allow for more detailed statistical comparisons between areas. Addition sampling of benthic invertebrate communities is proposed for June and August, 2018, to further understand the seasonal temporal variability in benthic invertebrate communities, including how they relate to the observed increase in temperature in the month of June.

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ACRONYMS AND ABBREVIATIONS

AMP – Adaptive Management Plan

ANOVA – Analysis of Variance

AWTF – Active Water Treatment Facility

BCWQG – British Columbia Water Quality Guidelines

CABIN – Canadian Aquatic Biomonitoring Network (Environment Canada 2010)

CI – Calcite Index

CMO – Coal Mountain Operation

CRC – Collision Reaction Cell

DO – Dissolved Oxygen

dw – Dry Weight

EMC – Environmental Monitoring Committee

EMPR - Ministry of Energy, Mines and Petroleum Resources

ENV – Ministry of Environment

EPT – Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)

EVO – Elkview Operation

EVWQP – Elk Valley Water Quality Plan

FRO – Fording River Operation

GC/MS – Gas Chromatography with Mass Spectrometric Detection

GHO – Greenhills Operation

GPS – Global Positioning System

ICP-MS – Inductively Coupled Plasma-Mass Spectrophotometry

KNC – Ktunaxa Nation Council

LAEMP – Local Aquatic Effects Monitoring Program

LCO – Line Creek Operation

LPL – Lowest Practical Level, referring to taxonomic identification of benthic invertebrates

LRL – Laboratory Reporting Limit

MOE – Ministry of Environment

NMDS – Nonmetric Multidimensional Scaling Ordination

PAH – Polycyclic Aromatic Hydrocarbon

PCA – Principal Components Analysis

PC-x – (as in PC-1) referring to one of the summary variables resulting from a Principal Components Analysis

QA/QC – Quality Assurance / Quality Control

RAEMP – Regional Aquatic Effects Monitoring Program

SQG - Sediment Quality Guideline

TOC – Total Organic Carbon

UTM – Universal Transverse Mercator system

WCT – Westslope Cutthroat Trout

1 INTRODUCTION

1.1 Background

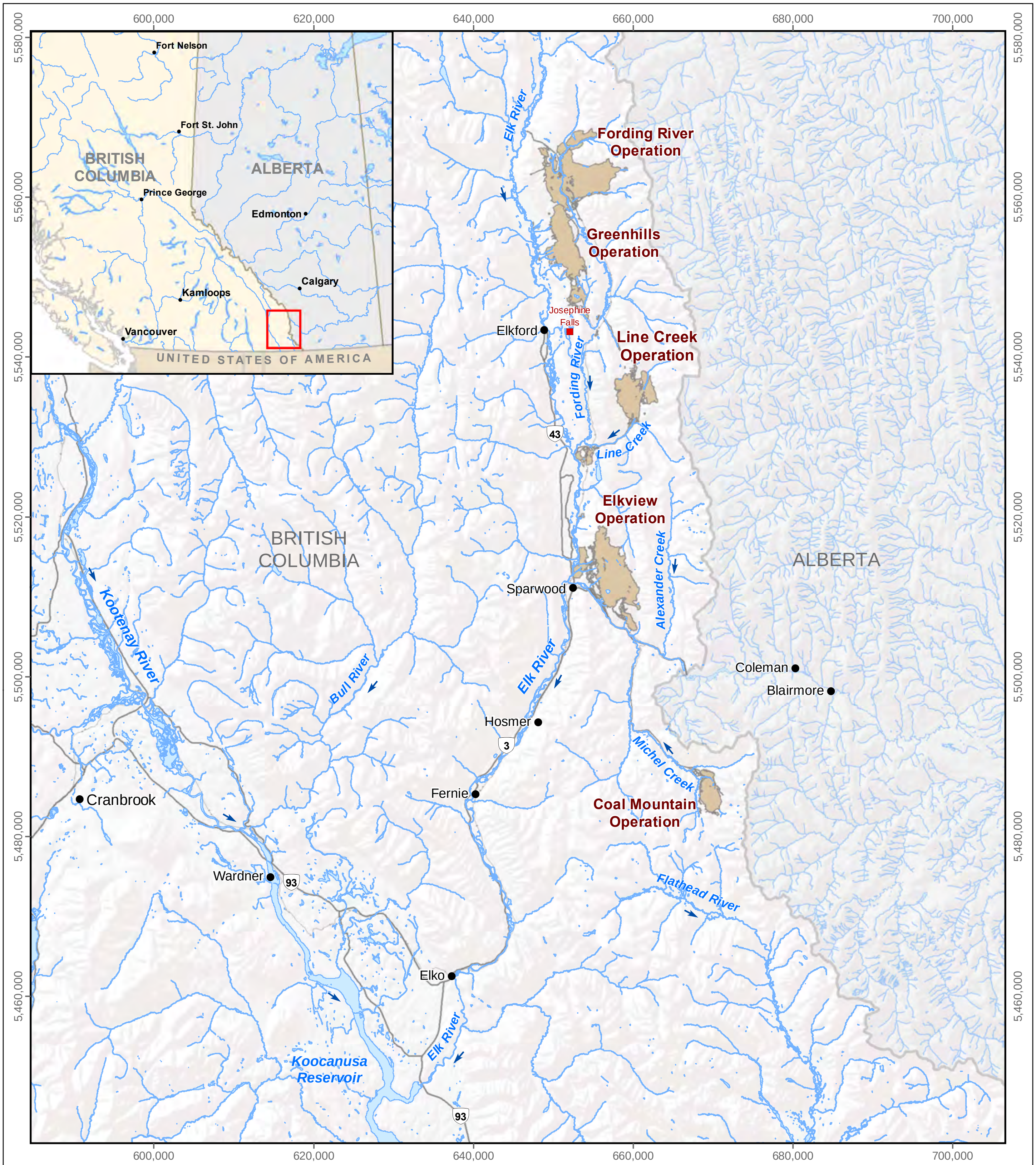
Teck Coal Limited (Teck) operates five steelmaking coal mines in the Elk River watershed, which are the Fording River Operation (FRO), Greenhills Operation (GHO), Line Creek Operation (LCO), Elkview Operation (EVO), and Coal Mountain Operation (CMO; Figure 1.1). Discharges from the mines to the Elk River watershed are authorized by the British Columbia Ministry of Environment and Climate Change Strategy (ENV) through permits that are issued under provisions of the *Environmental Management Act.* Permit 107517 was issued November 14, 2015, and is periodically amended in response to new learnings, projects, or extensions. The Permit specifies the terms and conditions associated with discharges from Teck's Elk Valley mine operations.

Teck's Regional Aquatic Effects Monitoring Program (RAEMP) is a requirement under Permit 107517, and provides comprehensive routine monitoring and assessment of potential mine-related effects on the aquatic environment downstream from Teck's mines in the Elk Valley (i.e., every three years, with the most recent cycle of reporting completed in January 2018; Minnow 2018). Teck conducts a variety of additional programs to monitor, evaluate, and/or manage the aquatic effects of mining operations within the Elk Valley at local and regional scales:

- Water Quality Monitoring
- Calcite Monitoring
- Chronic Toxicity Testing Program
- Fish and Fish Habitat Management
- Tributary Evaluation and Management Plan

Permit 107517 also required that Teck develop a local aquatic effects monitoring program (LAEMP) related to ongoing mining at FRO and the future commissioning of an active water treatment facility (AWTF) that will treat waters from Cataract, Swift, and Kilmarnock Creeks (Figure 1.2). Section 9.3.2 of Permit 107517 outlines the LAEMP requirements as follows:

> *"The Permittee must complete to the satisfaction of MOE a study design for a LAEMP which will focus on the upper Fording River for 2016-2019 by June 1, 2016. The study*



LEGEND

Teck Coal Mine Operation

Teck's Coal Mine Operations within the Elk River Watershed, Southeast British Columbia

0 10 20 40 km

N W E S

Projection: North American Datum 1983 UTM Zone 11

Date: May 2018

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Figure 1.1

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LEGEND

- Fording Swift Project Footprint
- Settling Pond
- Tailings Pond
- Teck Coal Mine Operation

Fording River Operations Future AWTF

0 0.5 1 2 km

N E S W

Projection: North American Datum 1983 UTM Zone 11

Date: May 2018
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Figure 1.2

Document Path: S:\Projects\177202\177202.0022 - Teck 2017 FRO LAEMP Implementation\GIS\Report\17-22 Fig 1.2.mxd *design must be reviewed by the EMC*[1] *and be designed to an appropriate temporal scale to capture short term, local effects to the immediate receiving environment."*

Also, Section 10.5 of Permit 107517 states:

The LAEMP Annual Reports must be reported on in accordance with generally accepted standards of good scientific practice in a written report and submitted to the Director by May 31 of each year following the data collection calendar year.

The FRO LAEMP study design was submitted in accordance with the Permit requirement on June 1, 2016 (Minnow 2016) and subsequently approved by ENV on October 24, 2016.

The first cycle of the FRO LAEMP, encompassing the 2016 to 2018 sampling years, represents a period of baseline monitoring with respect to future active water treatment. In addition to the need for baseline monitoring data prior to active water treatment, there are also concerns related to potential increases in aqueous nitrate concentrations in the Fording River prior to initiation of water treatment, as projected in the Elk Valley Water Quality Monitoring Plan (EVWQP; Teck 2014). Concern regarding the potential for effects related to increased or decreased flows in portions of the Fording River as a result of re-direction of water (i.e., re-direction of flows from Cataract, Swift, and Kilmarnock creeks for treatment or water management purposes, and consolidation of those flows into a single discharge from the AWTF) were also considered in the LAEMP design.

The goal of the FRO LAEMP is to assess site-specific issues (e.g., potential aquatic effects in the Fording River in advance of or after implementation of active water treatment) on a more frequent and localized basis, as required until sufficient data have been collected, concerns no longer exist, or relevant monitoring can be incorporated into the RAEMP. With this goal in mind, the FRO LAEMP was implemented to address the key questions described in Section 1.2.

The first annual report was submitted on May 31, 2017 (Minnow 2017a), and based on discussions with the Environmental Monitoring Committee (EMC) in 2017 regarding a temporal and spatial decrease (to below normal range) in the relative abundance of mayflies (Ephemeroptera) in the upper Fording River in the area downstream of Kilmarnock Creek to between Chauncey Creek and Ewin Creek (Minnow 2017b), updated monitoring tables were submitted in September, 2017 (Minnow 2017b, Appendix. D). Additional benthic invertebrate

[1] EMC refers to the Environmental Monitoring Committee, which Teck was required to form under Permit 107517. The EMC consists of representatives from Teck, ENV, the Ministry of Energy, Mines and Petroleum Resources (EMPR), Environment Canada, the Ktunaxa Nation Council (KNC), Interior Health Authority, and an independent scientist. Environment Canada has agreed to provide input on a case-by-case basis when requested by the other members of the EMC, but has not yet been called upon to participate. The EMC reviews submissions and provides technical advice to Teck and the ENV Director regarding monitoring programs..

community and biomass sampling was also completed to satisfy FRO water license requirements. The changes to the monitoring design consisted of the following:

- An increase in the number of biomass (Hess) sampling areas;
- addition of seven areas for analysis of benthic invertebrate community structure and tissue selenium to provide more spatial and temporal resolution within the upper Fording River;
- replicate *Parapsyche* sp. tissue selenium samples and additional samples of individual taxa for selenium analysis;
- replicate kick samples for benthic invertebrate community and tissue selenium analysis at the two biological sampling areas that most closely bracket upstream and downstream of the future AWTF discharge for quality assurance/quality control purposes;
- characterization of sediment quality at selected areas in the Fording River; and
- installation of data loggers (temperature and level) and evaluation of seasonal dewatering associated with the winter low flow period throughout the study area where changes in benthic invertebrate community structure have been observed.

Additional details can be found in Appendix D.

1.2 LAEMP Study Objectives

Study objectives are framed as key questions that were developed in consultation with the EMC during study design development (Minnow 2016):

1. Are nitrate concentrations increasing, and if so, are they adversely affecting biota?
2. Is active water treatment affecting biological productivity downstream in the Fording River?
3. Are tissue selenium concentrations reduced downstream from the AWTF?
4. Is AWTF operation affecting aquatic biota through thermal effects or concentrations of treatment-related constituents other than nutrients or selenium?
5. Is re-direction of water potentially affecting biota in the Fording River?

Key Question #1 and related investigations are being addressed through monitoring of benthic invertebrate community structure as part of annual sampling in the FRO LAEMP, and the combined LAEMP and RAEMP in 2018, as well as Teck's routine water quality monitoring for stations along the upper Fording River and in its tributaries. Additional information related to habitat (e.g., seasonal dewatering, flow, substrate type, calcite, temperature) and biological requirements for benthic invertebrate taxa are being used to support findings and discussion.

Key questions #2 to #5 relate specifically to active water treatment, which has been postponed until December 31, 2020. Therefore, the initial years of the LAEMP will include collection of baseline information, to aid in the interpretation of potential changes in aquatic conditions after water treatment commences. Effects related to changes in physical habitat, including changes in flows (i.e., Key Question #5), will be addressed through Teck's routine monitoring of flows at two stations in the upper Fording River (FR_FRNTP [continuous] and FR_FRCP1 [Permit requires monthly monitoring, and weekly from March 15th to July 15th]). Relevant information obtained under other programs, such as the regional calcite and chronic toxicity monitoring programs are also summarized in the LAEMP, as appropriate.

The results of the second year (2017) of monitoring for the FRO LAEMP are the subject of this report.

1.3 Linkages to the Adaptive Management Plan for Teck Coal in the Elk Valley

As required in Permit 107517 Section 11, Teck has developed an Adaptive Management Plan (AMP) to support implementation of the Elk Valley Water Quality Plan (EVWQP) to achieve water quality and calcite targets, ensure that human health and the environment are protected, and where necessary, restored, and to facilitate continual improvement of water quality management in the Elk Valley (Teck 2016a). Through EMC review of the 2016 AMP, it was determined that an update to the AMP was required to advance several elements that were in development at the time of the 2016 AMP submission. Teck is currently working in collaboration with the EMC to update AMP content and will submit an updated AMP for acceptance by the Director by Dec 21, 2018. Data from the RAEMP (Minnow 2018) and the various LAEMPs (including the present monitoring program) will feed into the adaptive management process to address a set of six overarching environmental Management Questions that collectively address the environmental management objectives of the AMP and the EVWQP (Teck 2014). In addition, the AMP identifies Key Uncertainties under each Management Question, which if reduced, either help confirm that Teck's current management actions are appropriate or lead to adjustments that would better satisfy EVWQP objectives.

As with the RAEMP, monitoring data and evaluations conducted within FRO LAEMP are designed primarily to provide supportive information to help answer AMP Management Question #5 (currently worded as "Does monitoring for mine-related effects indicate that the aquatic ecosystem is healthy?"), and Key Uncertainty 5.1 (currently worded as "How will monitoring data be used to identify potentially important mine-related effects on aquatic ecosystem health at a management unit scale?"). Data and analysis conducted under the LAEMP will also contribute to answering AMP Management Question #2, (currently worded as "Will aquatic ecosystem health be protected by meeting the long-term site performance objectives?) by assessing the aquatic ecosystem under a range of current conditions and identifying areas where biological effects may be occurring due to one or more mine-related constituents.

Data collected as part of the FRO LAEMP has followed and will continue to follow an adaptive management framework, and evaluation of data collected in 2016 and 2017 for the FRO LAEMP has been used to inform amendments to the FRO study design in 2017 and 2018.

2 METHODS

2.1 Overview

A conceptual site model was developed to summarize how current and future mining at FRO may affect the aquatic ecosystem and linkages to biological monitoring programs (Figure 2.1). The key study questions (Section 1.2) were developed in consideration of the potential effects identified in Figure 2.1. The general approach for the FRO LAEMP is summarized in Table 2.1, which explains the data that were collected and evaluated in relation to each of the key study questions. Monitoring locations listed in Table 2.1 are shown in Figure 2.2.

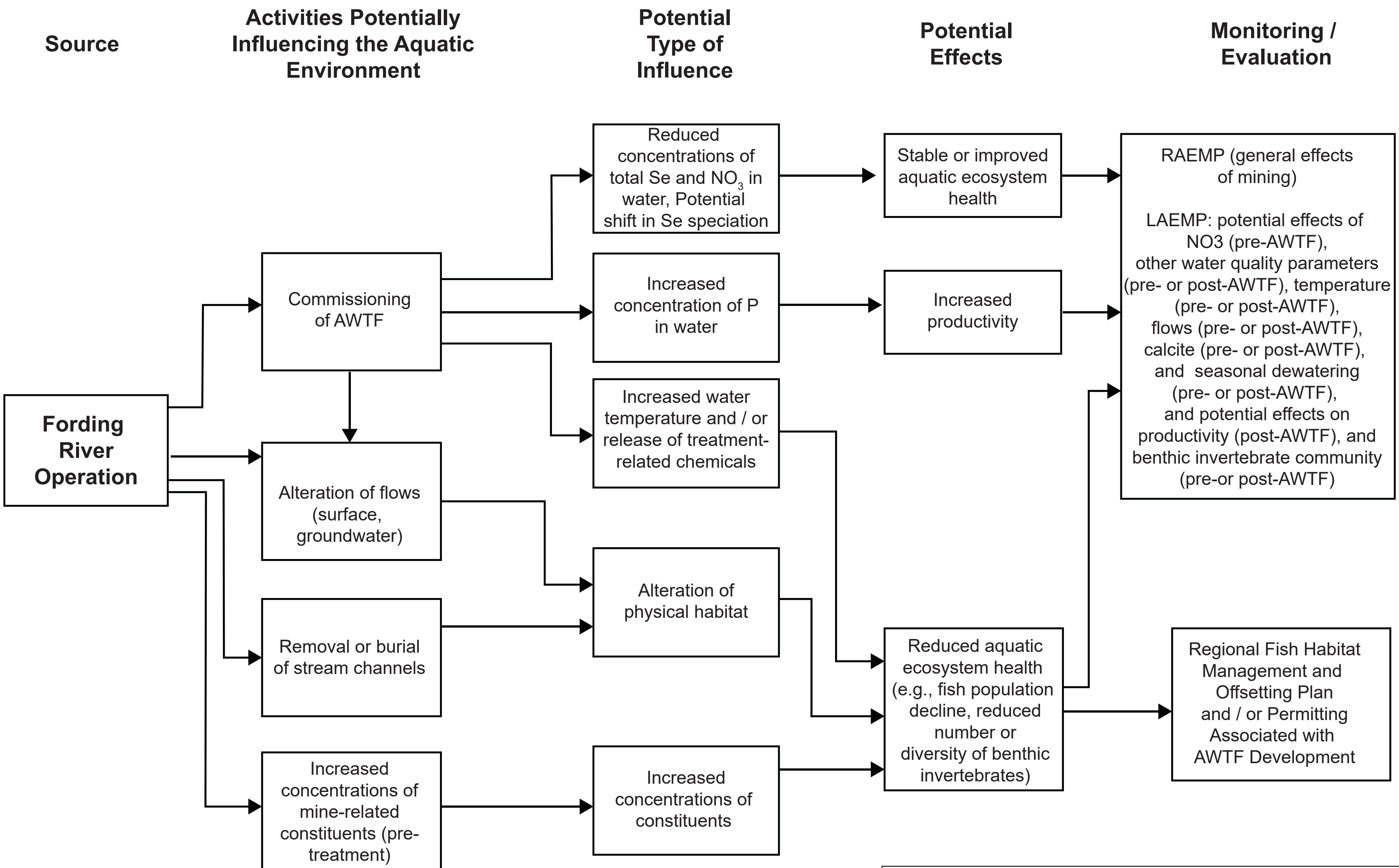
Biological samples were collected in September 2017, from locations along the Fording River extending from the headwaters of the Fording River and Henretta Creek (upstream of FRO) through FRO to downstream from Chauncey Creek (Figure 2.2). These locations bracket the location of the future AWTF and the creeks that will be diverted to the AWTF for treatment (i.e., Kilmarnock, Cataract, and Swift Creeks). Descriptions of each sampling area are provided in Table 2.2. Data were incorporated from other monitoring programs, as needed, to contribute to data evaluation and interpretation.

2.2 Benthic Invertebrates

2.2.1 Community Structure

2.2.1.1 Sample Collection

Benthic invertebrate community sampling followed the Canadian Aquatic Biomonitoring Network (CABIN) method, which involved 3-minute travelling kick sampling in riffle habitats into a net with a triangular aperture measuring 36 cm per side and mesh having 400-µm openings (Environment Canada 2012a). During sampling, the field technician moved across the stream channel (from bank to bank, depending on stream depth and width) in an upstream direction. With the net being held immediately downstream of the technician's feet, the detritus and invertebrates disturbed from the substrate were passively collected in the kick-net by the stream current. After three minutes of sampling time, the sampler returned to the stream bank with the sample. The kick-net was rinsed with water to move all debris and invertebrates into the collection cup at the bottom of the net. The collection cup was then removed and the contents poured into a labelled plastic jar and preserved to a level of 10% buffered formalin in ambient water. A single sample was collected in each monitoring area (Table 2.3) except those upstream and downstream of the future AWTF (FOUKI, FOBKS), where triplicate samples were collected.



Fording LAEMP Conceptual Site Model

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Figure 2.1

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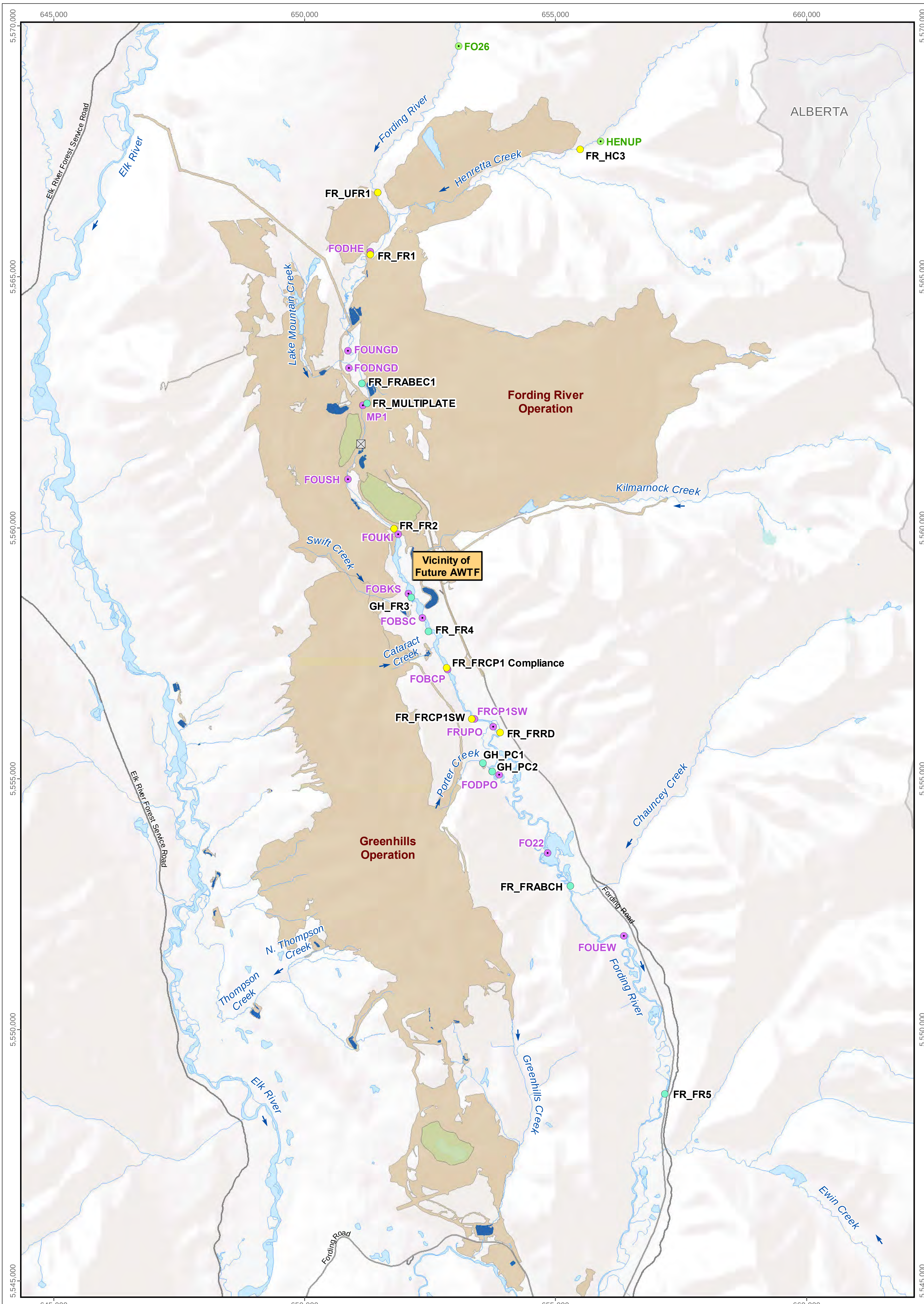
Table 2.1: Summary of the 2017 FRO LAEMP

Key Questions	Context	Assessment Endpoints	Measurement Endpoints				How Data Were Evaluated to Address Key Question
			Water	Water Sampling Stations	Biological	Biological Sampling Areas	
Are nitrate concentrations increasing and, if so, are they adversely affecting aquatic biota?	Nitrate concentrations are predicted (in the EVWQP) to increase prior to commissioning of the AWTF. Data collected during the 2016-2018 LAEMP will evaluate the potential effects of nitrate concentrations.	Benthic invertebrate community relative to nitrate concentrations in the Upper Fording River.	Nitrate concentrations in water, surface water chronic toxicity tests (quarterly and semi-annually)	FR_UFR1, FR_FR1, FR_FRABEC1, FR_MULTIPLATE, FR_FR2, GH_FR3, FR_FR4, FR_FRCP1, FR_FRCP1SW, FR_FRRD, FR_FRABCH, GH_PC2, FR_FR5; Chronic toxicity tests at FR_UFR1 and FR_FRCP1 only	Benthic invertebrate community structure (annually)	FO26 (Ref), HENUP (Ref), FODHE, FOUNGD, FODNGD, MP1, FOUSH, FOUKI, FOBKS, FOBSC, FOBCP, FRCP1SW, FRUPO, FODPO, FO22, FOUEW	1. Evaluate nitrate concentrations relative to predictions in the EVWQP. 2. Determine if benthic invertebrate community endpoints are outside of reference condition or moving away from the reference condition in accordance with observed nitrate concentrations. 3. Determine if benthic invertebrate community results correspond with expectations based on nitrate concentrations in water relative to the site-specific benchmark for nitrate.
What are the factors contributing to the variations in percent Ephemeroptera?	A consistent spatial and temporal decrease in percent Ephemeroptera has been observed in the upper Fording River. Data collected during the 2016-2018 LAEMP will evaluate potential causes.	Benthic invertebrate community relative to water quality, sediment quality, and habitat (seasonal dewatering, flow, substrate type, calcite, temperature).	Other Order constituents and nickel in waterurface water chronic toxicity tests (quarterly and semi-annually)	FR_UFR1, FR_FR1, FR_FRABEC1, FR_MULTIPLATE, FR_FR2, GH_FR3, FR_FR4, FR_FRCP1, FR_FRCP1SW, FR_FRRD, FR_FRABCH, GH_PC2, FR_FR5; Chronic toxicity tests at FR_UFR1 and FR_FRCP1 only	Benthic invertebrate community structure (annually)	FO26 (Ref), HENUP (Ref), FODHE, FOUNGD, FODNGD, MP1, FOUSH, FOUKI, FOBKS, FOBSC, FOBCP, FRCP1SW, FRUPO, FODPO, FO22, FOUEW	1. Determine if benthic invertebrate community endpoints are outside of reference condition or moving away from the reference condition in accordance with observed sulphate, selenium, and/or nickel concentrations. 2. Determine if benthic invertebrate community results correspond with expectations based on sulphate, selenium, and/or nickel concentrations in water relative to the site-specific benchmark or IC25 (nickel). 3. Investigate other potential factors affecting benthic invertebrate communities (e.g., temperature, flow, calcite, life history traits of affected taxa).
To support monitoring associated with water license needs, what is the benthic invertebrate community structure in the reach of the Fording River that goes dry, and can changes be correlated with flow conditions?	A section of the upper Fording River has been observed to dewater in the winter. The spatial and temporal extent of dewatering will be characterized, and the effects on benthic invertebrate communities will be assessed.	Benthic invertebrate community within the dewatered reach of the upper Fording River.	Field in situ water quality (in association with water chemistry sampling in the affected reach); Temperature and level data loggers.	FR_UFR1, FR_FR1, FR_FRABEC1, FR_MULTIPLATE, FR_FR2, GH_FR3, FR_FR4, FR_FRCP1, FR_FRCP1SW, FR_FRRD, FR_FRABCH, GH_PC2, FR_FR5; Chronic toxicity tests at FR_UFR1 and FR_FRCP1 only	Benthic invertebrate community structure (annually)	FO26 (Ref), HENUP (Ref), FODHE, FOUNGD, FODNGD, MP1, FOUSH, FOUKI, FOBKS, FOBSC, FOBCP, FRCP1SW, FRUPO, FODPO, FO22, FOUEW	1. Determine the spatial and temporal extent of seasonal dewatering in the upper Fording River. 2. Evaluate benthic invertebrate community enpoints in the affected reach compared to areas with continuous flow.
What are the baseline conditions for water quality, biological productivity and tissue selenium concentrations pre-AWTF?	The AWTF is not scheduled to be commissioned until 2018, so context for sampling in 2016 will be collection of baseline data so that questions can be updated after the AWTF operation commences.	Biological productivity downstream from the AWTF discharge post-compared to pre-AWTF commissioning and relative to productivity observed upstream from the discharge.	Nutrient concentrations (see Table 2.3 for sampling frequency)	FR_UFR1, FR_FR1, FR_FRABEC1, FR_MULTIPLATE, FR_FR2, GH_FR3, FR_FR4, FR_FRCP1, FR_FRCP1SW, FR_FRRD, FR_FRABCH, GH_PC2, FR_FR5	Benthic invertebrate biomass (annually starting in 2017), benthic invertebrate community structure (annually)	Community - as above; Biomass - FOUKI, FOBCP	Pre-AWTF Commissioning - Continue to collect baseline data indicative of productivity based on benthic invertebrate samples collected upstream versus downstream of the future treatment system discharge.
		Tissue selenium concentrations downstream from the AWTF discharge post- compared to pre-AWTF commissioning and relative to concentrations observed upstream from the discharge.	Total and dissolved selenium concentrations (see Table 2.3 for sampling frequency); Selenium speciation, if required, when treatment begins	FR_UFR1, FR_FR1, FR_FRABEC1, FR_MULTIPLATE, FR_FR2, GH_FR3, FR_FR4, FR_FRCP1, FR_FRCP1SW, FR_FRRD, FR_FRABCH, GH_PC2, FR_FR55; Locations for Se speciation work need to be determined	Benthic invertebrate tissue selenium (composite and single taxon samples, annually), WCT tissue samples (once every three years as part of the RAEMP)	Invertebrate tissue - FO26, HENUP, FOUKI, FOBCP, FOUEW; WCT - Fording River u/s of Josephine Falls	Pre-AWTF Commissioning - Continue to collect baseline tissue selenium data from benthic invertebrates sampled upstream and downstream of the future treatment system discharge.
		Potential thermal effects or other treatment related constituents of interest on biota downstream from the AWTF.	Chronic toxicity tests in receiving environment (quarterly); Field *in situ* water quality (in association with water chemistry sampling); Temperature data loggers (when treatment begins); Acute toxicity tests on effluent (when treatment begins)	Effluent mixing zone, FR_UFR1, FR_FR2, FR_FR4, FR_FRCP1, FR_FRRD, FR_FRABCH, FR_FR5 Chronic toxicity tests at FR_UFR1 and FR_FRCP1 only	Benthic invertebrate community structure (annually)	FOUKI, FOBKS, FOBSC, FOBCP, FODPO, FOUEW	Pre-AWTF Commissioning - Continue to collect baseline temperature data through routine monitoring stations upstream and downstream of the future treatment system discharge. Also install tidbits in the expected mixing zone of the future discharge for continuous temperature monitoring. Continue routine water quality monitoring upstream versus downstream of the future treatment system discharge. Biological data collected for other purposes (above) will also serve as baseline data for this question.
Is re-direction of water potentially affecting biota in the Fording River?	As mining development progresses, water will be re-routed and alter water flows in the Upper Fording River compared to current conditions.	Potential effects on fish populations	To be determined	To be determined	To be determined	To be determined	Evaluation of potential effects on fish populations to be harmonized with on-going monitoring through the regional fish habitat management and offsetting plans and evaluation will need to consider permitting associated with AWTF development and approvals, as well as LAEMP questions.



LEGEND

- Hydrometric Station
- Water Monitoring Station (Non-permit)
- Water Monitoring Station (Permit)

Biological Sampling Area

- Mine-exposed
- Reference
- Settling Pond
- Tailings Pond
- Teck Coal Mine Operation

Monitoring Locations in Upper Fording River

0 1 2 4
km

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Figure 2.2

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Table 2.2: **Monitoring Areas Associated with the 2017 FRO LAEMP**

Watershed	Exposure Status	Minnow Biological Monitoring Area	Biological Monitoring Area UTM Coordinates		Associated Teck Water Monitoring Station Code	Description	Water Monitoring Station UTM Coordinates	
			Easting	Northing			Easting	Northing
Fording River	Reference	FO26	653049	5569608	FR_UFR1	Fording River u/s Henretta (u/s all mines)	653064	5569601
	Reference	HENUP	655782	5567704	FR_HC3	Henretta Creek u/s all mine operations	655893	5567697
	Mine-exposed	FODHE	651311	5565421	FR_FR1	Fording River d/s Henretta Creek	651305	5565503
	Mine-exposed	FOUNGD	650993	5563529	-	Fording River u/s NGD	651138	5562882
	Mine-exposed	FODNGD	650883	5563190	FR_FRABEC1	d/s Lake Mountain Creek/ North Greenhills Diversion	651138	5562882
	Mine-exposed	MP1	651158	5562442	FR_MULTIPLATE	Fording Multiplate d/s Eagle Ponds	651238	5562482
	Mine-exposed	FOUSH	650863	5560970	FR_FRNTP	Fording River u/s Shandley Creek	651122	5561675
	Mine-exposed	FOUKI	651841	5559848	FR_FR2	Fording River u/s Kilmarnock Creek	651861	5559872
	Mine-exposed	FOBKS	652084	5558649	GH_FR3	Fording River between Kilmarnock Creek & Swift Creek	652125	5558620
	Mine-exposed	FOBSC	652340	5558197	FR_FR4	Fording River d/s Swift Creek, u/s Cataract Creek	652342	5558207
	Mine-exposed	FOBCP	652865	5557150	FR_FRCP1	Fording River between Cataract & Porter Creek	652846	5557174
	Mine-exposed	FRCP1SW	653324	5556197	FR_FRCP1SW	Fording River ~1150 m downstream of the Compliance Point	653324	5556197
	Mine-exposed	FRUPO	653899	5555938	FR_FRRD	Fording River u/s of Porter Creek	653897	5555925
	Mine-exposed	FODPO	653899	5555080	GH_PC2	Fording River d/s Porter Creek, u/s Chauncey Creek	653877	5555083
	Mine-exposed	FO22	654841	5553523	FR_FRABCH	u/s Chauncey Creek	655293	5552865
	Mine-exposed	FOUEW	656360	5551884	FR_FR5	Fording River d/s Chauncey Creek, u/s Ewin Creek	656363	5551875

Table 2.3: Samples Collected for the 2017 FRO LAEMP

Stream Name	Biological Area Code	Water Station Code	Water	Benthic Invertebrates						Sediment
			Chemistry	CABIN kick sample	Hess Biomass/ Community	Tissue Selenium Composite	Tissue Selenium *Rhyacophilidae*	Tissue Selenium *Parapsyche*	Tissue Selenium Ephemeroptera	Chemistry
Fording River	FO26	FR_UFR1	1	1	10	1	1	3	1	-
Henretta Creek	HENUP	FR_HC3	1	1	10	1	1	3	1	-
Fording River	FODHE	FR_FR1	1	1	-	1	1	3	1	-
Fording River	FOUNGD	-	1	1	-	1	1	3	1	-
Fording River	FODNGD	FR_FRABEC1	1	1	-	1	1	3	1	-
Fording River	MP1	FR_MULTIPLATE	1	1	-	1	1	3	1	-
Fording River	FOUSH	-	1	1	-	1	1	3	1	-
Fording River	FOUKI	FR_FR2	1	3	10	3	3	3	3	5
Fording River	FOBKS	GH_FR3	1	3	10	3	3	3	3	5
Fording River	FOBSC	FR_FR4, GH_FR	1	1	10	1	1	3	1	-
Fording River	FOBCP	FR_FRCP1 (Compliance)	1	1	10	5	1	5	1	5
Fording River	FRCP1SW	FR_FRCP1SW	1	1	10	1	1	3	1	-
Fording River	FRUPO	FR_FRRD	1	1	10	1	1	3	1	5
Fording River	FODPO	GH_PC2	1	1	-	1	1	3	1	-
Fording River	FO22	FR_FRABCH	1	1	10	5	1	3	1	5
Fording River	FOUEW	FR_FR5	1	1	-	1	1	3	1	-
		Total	**16**	**20**	**90**	**28**	**20**	**50**	**20**	**25**

'-' indicate that no sample was collected.
Notes: For specific sampling parameters see section 2 methods.

2.2.1.2 Laboratory Analysis

Benthic invertebrate community samples were sent to Cordillera Consulting (lead taxonomist Sue Salter), in Summerland BC, for sorting and taxonomic identification. Organisms were identified to the lowest practical level (LPL) (typically genus or species). At the beginning of the sorting process, each sample was examined and evaluated for estimation of total invertebrate numbers. If the total number was estimated to be greater than 600, then the laboratory's sub-sampling protocol was followed. A minimum of 5% of each sample was sorted, in accordance with Quality Assurance/Quality Control (QA/QC) requirements of Environment Canada (2014). Sorting efficiency and sub-sampling accuracy and precision were quantified using methods specified by Environment Canada (2012b, 2014) (data in Appendix A). Based on the QA/QC results, the benthic invertebrate community data were judged to be of acceptable quality (Appendix A).

2.2.1.3 Supporting Measures

Consistent with the requirements of the CABIN sampling protocol, supporting habitat information (i.e., water velocity and depth, *in situ* water quality [temperature, dissolved oxygen (DO), conductivity, pH], canopy cover, substrate characteristics [Wolman 100-pebble count], etc.) was collected concurrent with benthic invertebrate communities sampled in riffle habitats (Environment Canada 2012a).

2.2.1.4 Data Analysis

To address the investigation into the changes in benthic invertebrate community structure, endpoints of total sample abundance, richness (LPL taxonomy), percent (%) Ephemeroptera-Plecoptera-Trichoptera (EPT), % Ephemeroptera (E), % Plecoptera, and % Trichoptera were computed for each monitoring area from CABIN kick samples. Values were compared to normal (reference area) ranges defined as the 2.5th and 97.5th percentiles of the distribution of reference areas (pooled 2012 and 2015 data) reported in the RAEMP (Minnow 2018), and in Appendix Table A.3. Abundance, LPL richness, % EPT, and % E were plotted over time (2012, 2015, 2016, and 2017) for each area where data were available.

Non-metric multidimensional scaling (NMDS) was used to assess difference in community structure among areas in 2017 and among area and over time (2012-2017). NMDS is a multivariate method that is used to reduce the complete taxonomic data matrix to fewer dimensions. This method is used to visualize the level of similarity of samples based on the rank (e.g. sample A is more similar to Sample B than to Sample C) of the similarities (Clarke 1993). The NMDS takes the N-dimensional (here N = number of taxa) coordinates of each sample (i.e. area) and defines a set of new n-dimensional coordinates that reflect the locations (rank distances) among samples. NMDS results of non-transformed data often leads "to shallow interpretation in which only the pattern of a few, very common species is represented" (Clarke and Ainsworth 1993). A suite of transformations were applied (log_{10}, square root, fourth root, power 2, and power 4) and the resultant data matrix was assessed for normality based on the average skewness and kurtosis. The transformation with the lowest average skewness and kurtosis was deemed the preferred transformation as it reduced the influence of dominant taxa. The NMDS was conducted on the family-level taxonomic data matric using relative abundances. The analysis used the Bray-Curtis distance as the measure of relative community similarity or dissimilarity. A 2-dimensional ordination solution was used when stress was < 0.2. Additional dimensions were used only when required to reduce the stress to < 0.2. The analysis was conducted using the *vegan* package (version 2.5-1; Oksanen et al. 2018) in R (R Core Team 2017).

Spearman rank correlations were conducted to evaluate monotonic trends between benthic invertebrate endpoints and physical and chemical parameters (See sections 2.3 and 2.4). Correlations were performed using the *Hmisc* package (version 4.1-1; Harrell 2017) in R. Flow rates reported as zero were not included in the correlation analyses. Correlations with a correlation coefficient (r) with magnitude greater than 0.6 were considered moderate (Milton and Arnold 2002), and significance was tested at $\alpha = 0.05$.

2.2.2 Tissue Selenium

2.2.2.1 Sample Collection

Benthic invertebrate samples were collected for selenium analysis from all areas (Table 2.3) using the kick sampling method described in Section 2.3.1, except that the samples were not timed. A composite sample of benthic invertebrate taxa was collected, along with three taxon-specific samples including Rhyacophilidae, individual *Parapsyche*, and Ephemeroptera. Triplicate individual *Parapsyche* samples were collected wherever possible, and all samples were taken in triplicate at FOUKI and FOBKS (Table 2.3).

Invertebrates were picked free of debris in the field, placed into sterile labelled cryovials and stored in a cooler with ice packs until they were transferred to a freezer later in the day. Approximately 2 g of wet tissue were collected for each sample (except individual *Parapsyche*), where possible.

2.2.2.2 Laboratory Analysis

Benthic invertebrate tissue samples were kept in a freezer until they were shipped in coolers to SRC Environmental Analytical Laboratories (SRC) in Saskatoon, SK. At the laboratory, samples were freeze-dried and then analyzed for selenium using Inductively Coupled Plasma-Mass

Spectrophotometry (ICP-MS). Results were reported on a dry weight (dw) basis, along with moisture content (based on the difference between wet and freeze-dried sample weights).

2.2.2.3 Data Analysis

Composite-taxa benthic invertebrate tissue selenium concentrations were plotted relative to:

- the normal (reference area) range, defined as the 2.5th and 97.5th percentiles of tissue selenium concentrations measured in reference areas that have not been disturbed by mining in historical studies completed in the Elk River watershed from 2006 to 2015 (Minnow 2018);
- data from previous sampling periods from 2006 to present, where available; and
- the Level 1 EVWQP benchmarks for effects to invertebrates (13 mg/kg dw) and for dietary effects to juvenile fish (11 mg/kg dw; Golder 2014b).

Additionally, tissue selenium concentrations were paired with corresponding water selenium concentrations and compared to the EVWQP selenium bioaccumulation model (Golder 2018a).

2.2.3 Biomass

2.2.3.1 Sample Collection

Ten stations were sampled at each of nine areas (FO26, HENUP, FOUKI, FOBKS, FOBSC, FOBCP, FRCP1SW, FRUPO, and FO22) in September for analysis of benthic invertebrate biomass and community structure (Table 2.3, Figure 2.2). Benthic invertebrates were collected using a Hess sampler with 500 µm mesh, for measurement of biomass and community endpoints relative to the area sampled. Stations were located a minimum of 5 m apart so they were representative of the overall area. A single sample was collected at each station by carefully inserting the base of the Hess sampler into the substrate to a depth of approximately 5 to 10 cm. Any gravel or cobble enclosed within the Hess sampler was carefully washed while allowing the current to carry dislodged organisms into the mesh collection net. All organisms collected into the net were rinsed into the bottom of the net, and then into a labelled wide-mouth plastic jar. Samples were preserved to a level of 10% buffered formalin in ambient water within approximately 6 hours of collection to ensure that biomass was not lost through predation or decomposition of tissues before the samples were sorted at the laboratory.

2.2.3.2 Laboratory Analysis

Benthic invertebrate biomass samples were sent to ZEAS Inc. (lead taxonomist Danuta Zaranko) in Nobleton, ON, for sorting and taxonomic identification. All preserved organisms in each sample were sorted from the sample debris into groups separated at the family-level of taxonomy for weighing. Each family group of organisms was placed onto a fine cloth to drain excess surface moisture (preservative) before being weighed to the nearest 0.0001 g. Total and family-level biomass were reported for each sample (preserved wet weight).

2.3 Water Quality

2.3.1 Sample Collection

ENV's letter approving the FRO LAEMP study design included a requirement to collect water samples concurrently with biological sampling. In addition, routine water quality monitoring data collected by Teck were downloaded from Teck's EQuIS™ database for the monitoring stations that correspond with biological sampling areas in the LAEMP (Table 2.3 and Figure 2.2): Data included:

- Nutrient concentrations (i.e., nitrate, total phosphorus, and ortho-phosphate);
- Total and dissolved selenium concentrations;
- Sulphate concentrations;
- Total hardness as $CaCO_3$; and
- *In situ* water quality data (i.e., temperature, flow, pH, conductivity, and DO).

QA/QC associated with water sampling is described by Teck in annual water quality reports submitted under Permit 107517 (e.g., Teck 2018).

Water temperature and discharge measurements from Teck's continuous monitoring station, FR_FRNTP, were also downloaded from EQuIS™. Measurements are recorded in 15 minute intervals and were used to evaluate changes in temperature and discharge over time in the upper Fording River.

Additional parameters were screened against British Columbia Water Quality Guidelines (BCWQG; BCMOE 2018) as part of Teck's Annual Water Quality Monitoring Report under Permit 107517, and results for the upper Fording River were summarized and included in interpretation where appropriate (Teck 2018).

In addition to the above, screening was completed for total aqueous nickel. This additional evaluation was based on the results of 2017 quarterly chronic toxicity sampling which showed adverse effects in *Hyalella azteca* (growth) and *Ceriodaphnia dubia* (reproduction) at nickel concentrations below the BCWQG. Preliminary screening values (IC25) for nickel toxicity were determined through Toxicity Identification Evaluations (TIEs) completed by Nautilus in 2018; the preliminary nickel IC25 values developed based on the results of the TIEs were 22.4 and 10.8 µg/L for *Hyalella* and *Ceriodaphnia*, respectively. Ongoing work to evaluate potential nickel toxicity is being completed, including the development of additional screening values based on species sensitivity distribution (SSD) curves developed by Golder in 2018. As these investigations are refined, the results will be incorporated into future evaluations.

2.3.2 Data Analysis

To address the question of whether nitrate concentrations are increasing in the upper Fording River, aqueous nitrate concentrations in the Fording River were evaluated by Golder (2018b) relative to projections made in the EVWQP (Teck 2014). Nitrate concentrations in water were plotted relative to Level 1 and Level 2 effect benchmarks for benthic invertebrates that were developed as part of the EVWQP (Table 2.5; Golder 2014a, Teck 2014).

As part of the further investigation into Key Question #1 (Section 2.1), sulphate, selenium, and nickel concentrations were also plotted relative to Level 1 benchmarks. In addition, nickel was plotted relative to preliminary IC25 values for *Hyalella* (22.4 µg/L) and *Ceriodaphnia* (10.8 µg/L).

Temporal changes in key aqueous mine-related constituents (i.e., nitrate, total selenium, sulphate, and nickel) were evaluated at mine-exposed stations relative to the mean change at reference stations from 2012 to 2017. The analysis was conducted as an analysis of variance (ANOVA) in two ways, first on the difference in monthly mean concentrations ($\log_{10}$-transformed) between the mine-exposed station and the monthly means of the reference station (FR_UFR1) with Year as a factor, with up to 12 differences in monthly means calculated per year for a complete data set. Second, the same analysis was conducted on reference and mine-exposed stations separately. If the overall ANOVA was significant ($\alpha = 0.05$) then *post hoc* contrasts were conducted to test for linear and step changes according to the following hypotheses (for a mine-exposed station sampled in all five years):

- A linear change from 2012 to 2017;
- A step change after 2012 (i.e., a comparison of the mean in 2012 to the mean of 2013-2017);
- A step change after 2013 (i.e., a comparison of the mean of 2012-2013 to the mean of 2014-2017);
- A step change after 2014 (i.e., a comparison of the mean of 2012-2014 to the mean of 2015-2017); and
- A step change after 2015 (i.e., a comparison of the mean of 2012-2015 to the mean of 2016-2017).
- A step change after 2016 (i.e., a comparison of the mean of 2012-2016 to the mean in 2017).

The contrasts were conducted in Microsoft Excel, following the methods described in Oehlert (2010). When more than one contrast hypothesis was identified as statistically significant (α = 0.05), then the contrast with the best fit was used for interpretation. The contrast with the best fit was defined to be the contrast with the largest difference in the numerator of the test statistic (equivalent to selecting the contrast with the smallest p-value). The magnitude of difference for linear contrasts was calculated as:

$$\frac{10^{\bar{x}_{OBS2016exp}} - 10^{\bar{x}_{PRED2016exp}}}{10^{\bar{x}_{PRED2016exp}}} \times 100\%$$

where $\bar{x}_{OBS2016exp}$ is the observed mean for the mine-exposed station in 2017 and $\bar{x}_{PRED2016exp}$ is the predicted mean for the mine exposed station in 2016, assuming that the relative difference between reference and mine-exposed stations in 2016 is the same as the difference observed in 2012 (i.e., $\bar{x}_{PRED2016exp} = \bar{x}_{OBS2016ref} + \bar{x}_{OBS2012exp} - \bar{x}_{OBS2012ref}$). The means $\bar{x}_{OBS2016exp}$ and $\bar{x}_{PRED2016exp}$ were anti-logged prior to calculating the percent difference in order to put the concentrations in the original data units. The magnitude of difference for step change contrasts was calculated similarly as:

$$\frac{10^{\bar{x}_{OBS(Post\ Step)exp}} - 10^{\bar{x}_{PRED(Post\ Step)exp}}}{10^{\bar{x}_{PRED(Post\ Step)exp}}} \times 100\%$$

where $\bar{x}_{OBS(Post\ Step)exp}$is the observed mean for the mine-exposed station after the step change and $\bar{x}_{PRED(Post\ Step)exp}$ is the predicted mean for the mine-exposed station in 2016, assuming that the relative difference between reference and mine-exposed stations after the step change is the same as the difference observed prior to the step change (i.e., $\bar{x}_{PRED(Post\ Step)exp} = \bar{x}_{OBS(Post\ Step)ref} + \bar{x}_{OBS(Pre\ Step)exp} - \bar{x}_{OBS(Pre\ Step)ref}$).

The contrasts and magnitude of difference calculations were modified as appropriate when a mine-exposed station was not sampled in all five years to accommodate the available data.

A principal component analysis (PCA) was conducted on all water quality samples collected as part of Teck’s routine water monitoring at stations included in the FRO LAEMP. The PCA is a multivariate analysis which transforms a group of n variables into a smaller new set of uncorrelated variables (the principal components; PCs). The principal components are defined to be linear combinations of the original n variables. The method was used to identify PCs that explained the most variability in water quality among areas. The PCA was conducted on $\log_{10}$-transformed data using the correlation matrix. Analytes with 50% or more values below the laboratory reporting limit (LRL) were excluded from the analysis. The PCA was conducted using Minitab 17 software.

Temperature and discharge data were acquired from the Teck's continuous monitoring station, FR_FRNTP, located in the upper Fording River. Data were collected every 15 minutes, and were available from 1997 for discharge and 2010 for temperature. A gap exists from June 2013 to early 2014 as the monitoring station was damaged in the 2013 flood.

To further evaluate the effects of temperature on benthic invertebrate community, using data from FR_FRNTP, accumulated degree day (May to September, June to September, and July to September; using threshold 10°C), mean and maximum temperature between July and September, and mean and maximum temperature between April and June, were calculated for 2012, 2015, 2016, and 2017. Mean and maximum discharge between July and September, and mean and maximum discharge between April and June, were also calculated for 2012, 2015, 2016, and 2017 using data from FR_FRNTP.

Potential temporal trends in flow and temperature at the continuous monitoring station, FR_FRNTP, were assessed using the nonparametric seasonal Kendall test (Hirsch et al. 1982). The seasonal Kendall test assesses temporal trends separately for each season (month or quarter) and combines the results for each season into an overall test for trend. The test assesses if there is a monotonic increasing or decreasing trend over time. The test is conducted by calculating the test statistic S = the sum of the number of increases and decreases from a time period t to all time periods after t for each observation. The probability of observing the value of S for the given sample size is then calculated to determine whether it is likely to have occurred by chance if there was no trend. The seasonal Kendall test was conducted in R (R Core Team 2017) following the methods described in Hirsch et al. (1982) and are applicable for data sets with missing data and values below a LRL.

Spearman rank correlations were conducted to evaluate monotonic trends in temperature between years for each month at stations FR_UFR1, FR_HC3, FR_FR1, FR_FR2, FR_FR4, and FR_FR5 where data were available from 2010 to 2017. FR_FRCP1 and FR_FRRD were not included in this analysis as data only exists from December 2014 onwards when these stations were added upon issuance of Permit 107517. Correlations were performed using the Hmisc package (version 4.1-1; Harrell 2017) in R. Correlations with a correlation coefficient (r) with magnitude greater than 0.6 were considered moderate (Milton and Arnold 2002), and significance was tested at $\alpha = 0.05$.

To address Key Question #2, aqueous concentrations of total phosphorus and orthophosphate were plotted to illustrate the current availability of baseline data and monitoring of these analytes will continue through the baseline period.

2.4 Substrate Quality

2.4.1 Sediment

2.4.1.1 Sample Collection

Sediment quality samples were collected concurrent with benthic invertebrate samples at five areas, FOUKI, FOBKS, FOBSCP, FRUPO, and FO22 (Table 2.3). Sediment samples were collected using a stainless steel spoon and were transferred into glass jars for analysis of polycyclic aromatic hydrocarbons (PAHs), and into polyethylene bags for all other analyses (see Section 2.4.3). Samplers took care to only remove the top 1 to 2 cm of sediment, and continued to collect sediment until sufficient sample volume was retrieved. For QA/QC purposes, duplicate (split) samples were collected at a frequency of approximately 10% of the total number of samples to permit assessment of field precision (i.e., one set of field duplicate samples). Following collection, samples were placed in a refrigerator at approximately 4°C until submission to the analytical laboratory.

2.4.1.2 Laboratory Analysis

Samples for chemical analysis were sent to ALS Environmental (Calgary, AB). The laboratory was instructed to thoroughly homogenize each sediment sample (according to standard laboratory protocols), to confirm the aliquots taken for analysis were representative and comparable.

Sediment samples were analyzed using the following methods: metals by Collision Reaction Cell Inductively Coupled Plasma-Mass Spectrophotometry (CRC ICP-MS; EPA 200.2/6020A), mercury by Cold Vapour Atomic Fluorescence Spectrophotometry (CVAFS; EPA 200.2/245.7), total organic carbon (TOC) by combustion method (Bartels and Sparks 2009), and PAHs by rotary extraction using hexane/acetone (EPA 3570/8270) followed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Particle size distribution was determined by dry sieving (coarse particles), wet sieving (sand), and the pipette sedimentation method (fine particles). Moisture content was determined gravimetrically by drying the sample at 105 °C.

2.4.1.3 Data Analysis

QA/QC for sediment samples included the collection of one field duplicate at FRUPO, and assessment of laboratory duplicates, spike recoveries, and certified reference materials. Based on the results provided for QA/QC samples, the sediment data collected for the FRO LAEMP were judged to be of acceptable quality (Appendix B). Sediment quality data were compared to BC Working Sediment Quality Guidelines (SQGs), where available.

2.4.2 Calcite

Calcite measurements were collected at each of the benthic invertebrate community sampling locations in September 2017. For each of the rocks measured during the 100-pebble count (see Section 2.2.1.3), calcite presence (score = 1) or absence (score = 0) was recorded and the degree of concretion was assessed by determining if the rock was removed with negligible resistance (not concreted; score = 0), noticeable resistance (partially concreted; score = 1), or was immovable (fully concreted; score = 2). If distinct particles were not visible due to heavy calcification, values of 1 (for presence) and 2 (for concretion) were recorded. Similarly, if fines were encountered and calcite presence could not be visually confirmed, values of 0 (for presence) and 0 (for concretion) were recorded. If rocks were visible under fine material, the rock was selected for calcite characterization.

2.4.2.1 Data Analysis

A calcite index (CI) was calculated as follows (Teck 2016b):

$CI = CI_p + CI_c$

Where:

$$CI = Calcite\ Index$$

$$CI_p = Calcite\ Presence\ Score = \frac{Number\ of\ particles\ with\ calcite}{Number\ of\ particles\ counted}$$

$$CI_c = Calcite\ Concretion\ Score = \frac{Sum\ of\ particle\ concretion\ scores}{Number\ of\ particles\ counted}$$

Calcite data collected as part of the Calcite Monitoring Program (Robinson et al. 2013, Robinson and MacDonald 2014, 2015, Robinson et al. 2016, Smithson and Robinson 2017) were considered but were not used in further analyses as the calcite measurements taken concurrently with biological sampling were deemed more appropriate because they are specific to the areas sampled for benthic invertebrates.

Calcite measurements made among 40 reference areas sampled in 2015 were used to characterize the normal range as part of the previous RAEMP report (Minnow 2018), and the upper limit (97.5th percentile) was defined as CI = 1.0.

Mean pebble size was calculated as the mean of 100 pebbles collected from the 100 pebble count and used as an indicator of particle size in correlation analyses.

2.5 Hydrology

2.5.1 Seasonal Dewatering

Monthly surveys were completed to evaluate the surface flow conditions along the Fording River at eight sections. The survey area encompassed a 12.8 km long section of the Fording River from the South Tailings Pond (FR_FR2) downstream to Chauncey Creek (FR_FRABCH). Field crews walked the section during each survey and delineated wet/dry areas by marking them with a handheld Global Positioning System (GPS) unit (in Universal Transverse Mercator [UTM] coordinates, using North American Datum [NAD]83) to facilitate mapping. Characteristics of primary interest included documenting dry sections and isolated pools. Data analysis

The GPS locations collected in the field were delineated on a map to display the dewatered sub-section of the upper Fording River. These results were corroborated by water temperature and level logger records (see Section 2.5.2), and the exact dates where the sub-section was dewatered were determined. Benthic invertebrate community endpoints within the dewatered reach were assessed compared to reaches with continuous flow as part of Key Question #1 and the investigation into the decrease in % Ephemeroptera (Section 4).

2.5.2 Water Level and Temperature

Water level (i.e., stream stage) and temperature were continuously monitored at eight stations along the Fording River (Table 2.4) using Onset Hobo U-20 Level-loggers. Water level and water temperature measurements were recorded at 15-minute intervals. The loggers were installed in the deepest part of a channel cross-section, while maintaining some protection to the logger by the bank shape. Loggers were housed in a stilling well attached to angle iron, to which a staff gauge was attached. The staff gauge was installed to verify pressure transducer readings and build a stage-discharge relationship for each site. One barometric logger was installed on land at FR_FR4 to correct for changes in atmospheric pressure. Each station was visited monthly and benchmark surveys were completed as quality control to assess whether the logger and stilling wells had shifted overtime. Benchmark surveys were completed throughout the sampling period to comply with RISC standards (RISC 2009). Data were downloaded routinely from the loggers to avoid data loss. During the winter, the loggers were winterized to prevent freezing and damage.

2.5.2.1 Data Analysis

Water level data were collected and corrected for barometric pressure using Onset Hoboware Pro (version 3.7.13) and a reference water stage relative to the staff gauge. Correcting the data for atmospheric pressure created a continuous record of water stage in meters. Stage was only a locally referenced point relative to the staff gauge at a given site. It could not be used to compare water quantity between sites.

Table 2.4: Dewatering Survey Site Locations

Site Name	Location
FR_FR2	Fording River upstream of the proposed AWTF discharge
GH_FR3	Fording River immediately downstream of the proposed AWTF discharge
FR_FR4	Fording River between Swift and Cataract
FR_FRCP1	Fording River Compliance Point
FR_FRCP1SW	Fording River ~1150 m downstream of the Compliance Point
FR_FRRD	Fording River upstream Porter Creek
GH_PC2	Fording River downstream of Porter
FR_FRABCH	Fording River upstream of Chauncey Creek

Water levels and water temperatures were plotted for each site (Appendix C). The results were cross-referenced with observations made during monthly surveys. When a site was observed to have become dry between two surveys, the logger record was used to refine the date the site was dewatered.

2.5.3 Flow

Flow measurements were made when possible at all eight water level loggers (Figure 3.1) during monthly visits. Streamflow measurements followed standards provided in the Manual of British Columbia Hydrometric Standards (RISC 2009). Stream depth (m) and velocity (m/s) were measured using a Hach FH950 flow meter. Velocity measurements were collected at 60% of the total depth from the water surface. During ice covered visits, a transect was either cleared of snow and ice, or three to five holes were drilled through the ice to get an estimate for discharge. Flow measurements collected through ice are unlikely to serve as reliable data points to create a stage-discharge relationship. Flows were not possible where sites were dewatered or when conditions were unsafe to access the stream cross-section.

2.5.3.1 Data Analysis

Flow measurements provide an instantaneous pairing of water stage (as recorded on the staff gauge and by the logger) and stream discharge. Stream discharge (m^3/s) is a parameter that will allow for spatial comparisons between sites. A series of flow measurements are used to create a stage-discharge relationship. The relationship is then used to generate a continuous flow record from the continuous stage record recorded by the logger. Approximately 10-15 flow measurements collected over a range of stages are recommended to create this relationship. In the current study, however, stage-discharge relationships were not derived due to a lack of data points over a range of water stages and ice-free conditions, thus, direct comparisons between sites were not possible in 2017.

Flow data were provided from Teck for the FRO monitoring station at the North Tailings Pond (FR_FRNTP). The 2017 data are considered final; however, the 2018 data are considered preliminary at the time of this report, as QA/QC for continuous monitoring is conducted annually by Qualified Professionals based on annual surveys, manual flow measurements, and staff gauge readings. The hydrograph of the Fording River at FR_FRNTP was plotted for March 2017 to May 2018. Flows (m^3/s) recorded on the estimated date when the section of the Fording River first dewatered and re-watered were also plotted.

3 AWTF PRE-OPERATIONAL BASELINE DATA

3.1 Overview

To address Key Questions #2 through #5 (Section 1.2), baseline data are being collected prior to the commissioning of the AWTF. The Key Questions will be specifically addressed after the AWTF is commissioned in 2020.

3.2 Key Question #2: Potential Effects of AWTF on Productivity

Key Question #2 is: "Is active water treatment affecting biological productivity downstream in the Fording River?".

Concentrations of phosphorus and ortho-phosphate are routinely monitored at stations along the Fording River as part Teck's requirements under Permit 107517. Data currently being collected represent baseline conditions prior to AWTF operation (Figure 3.1). As noted in the approved study design (Minnow 2016; Minnow 2017a), benthic invertebrate biomass samples were also collected as part of the LAEMP in 2017 to provide the first of two years of pre-operational baseline biological productivity data (Table 3.1). It is currently anticipated that an approach similar to that being used in the Line Creek LAEMP will also be used in the FRO LAEMP to evaluate potential changes in productivity over time (i.e., initially, before-after control-impact until there are at least three years of data during the operating period to undertake linear contrasts using time as a covariate).

3.3 Key Question #3: Potential Effects of AWTF on Tissue Selenium Concentrations

Key Question #3 is: "Are tissue selenium concentrations reduced downstream from the AWTF?".

Selenium concentrations in composite-taxa (2006 to 2017) and individual taxa (2016 and 2017) were monitored as part of the Fording River LAEMP (Appendix Table A.1 and A.2; Appendix Figure A.1). Tissue selenium concentrations in benthic invertebrates are currently within the ranges predicted in the EVWQP (Tables 3.2) and have generally remained below the Level 1 benchmark for invertebrates and fish (Section 4.2.5). These data, combined with future LAEMP monitoring data, will be used to characterize conditions prior to AWTF operation, and will be used to compare to conditions after the AWTF is operational.

3.4 Key Question #4: Potential Effects of AWTF Related to Temperature or Treatment-Related Constituents

Key Question #4 is: "Is AWTF operation affecting aquatic biota through thermal effects or concentrations of treatment-related constituents other than nutrients or selenium?".

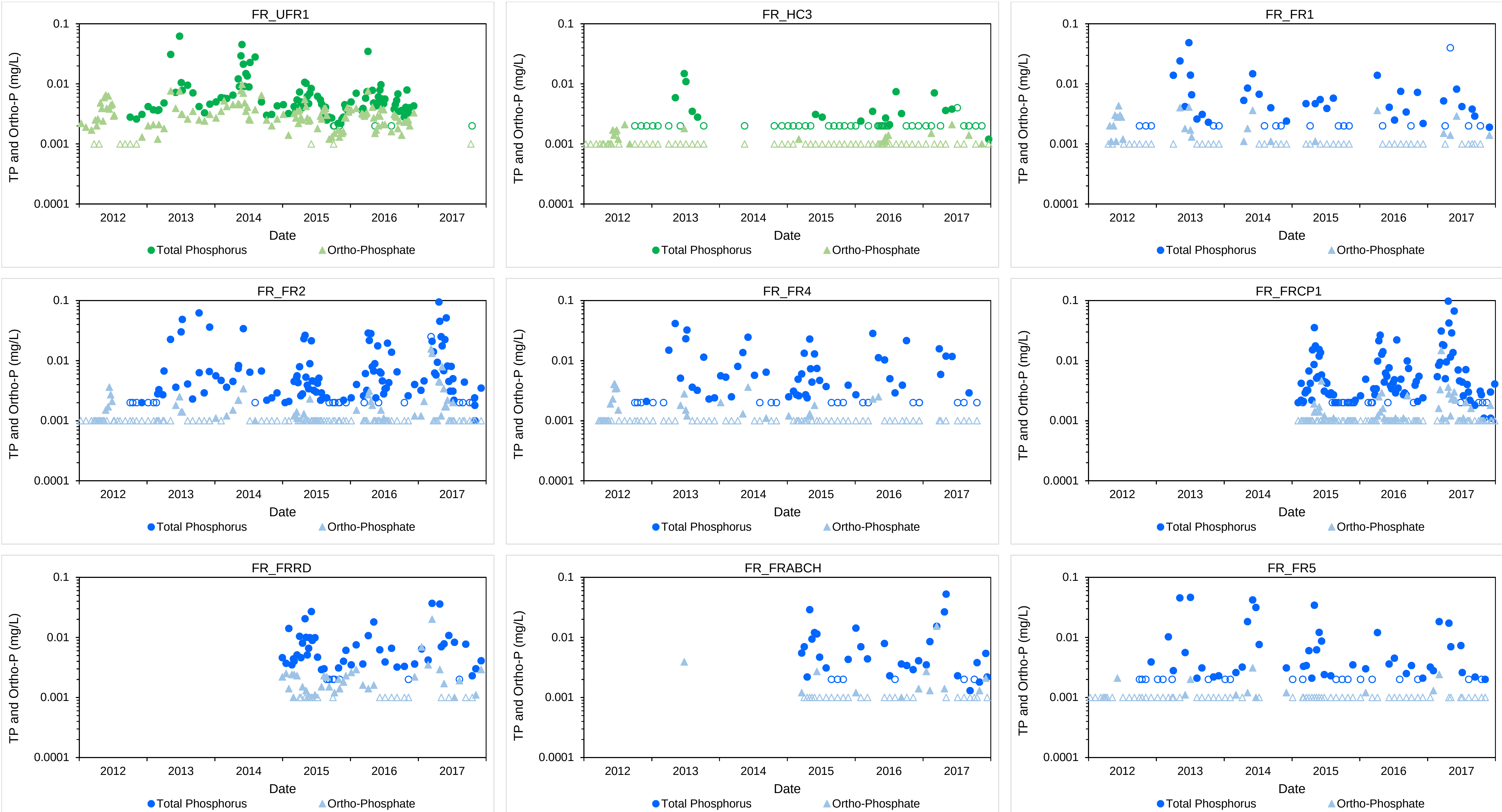


Figure 3.1: Concentrations of Total Phosphorus and Ortho-Phosphate in the Fording River, 2012 to 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL, green symbols indicate reference areas and blue symbols indicate mine-exposed areas.

Table 3.1: Total Benthic Invertebrate Biomass at Selected Areas in the Fording River, September 2017

Area		Replicate	1	2	3	4	5	6	7	8	9	10	Mean	Median	Minimum	Maximum	Standard Deviation
Reference	FO26	Total Biomass (g/m^2 ww)	22.212	27.322	21.805	27.488	22.439	52.820	32.483	7.944	14.829	6.020	23.536	22.326	6.020	52.820	13.33
	HENUP		11.672	11.184	5.248	7.820	21.142	5.762	14.508	18.800	8.871	20.410	12.542	11.428	5.248	21.142	5.93
Mine-exposed	FOUKI		9.180	6.714	6.350	20.006	8.374	10.151	9.052	6.660	5.201	13.630	9.532	8.713	5.201	20.006	4.39
	FOBKS		5.122	15.191	8.126	5.766	3.892	10.823	25.944	29.237	11.263	17.490	13.285	11.043	3.892	29.237	8.72
	FOBSC		4.780	12.227	9.843	3.933	2.678	3.606	7.106	2.979	2.282	5.604	5.504	4.357	2.282	12.227	3.30
	FOBCP		5.423	6.405	3.707	2.064	2.664	3.774	10.410	8.109	6.094	24.767	7.342	5.759	2.064	24.767	6.63
	FRCP1SW		3.586	2.786	3.464	1.679	5.292	5.704	3.623	1.389	1.372	0.939	2.983	3.125	0.939	5.704	1.66
	FRUPO		10.858	37.442	27.677	35.764	18.264	18.006	25.789	10.845	30.105	10.463	22.521	22.027	10.463	37.442	10.27
	FO22		14.384	17.964	18.559	14.920	48.324	17.484	53.676	18.238	37.881	21.894	26.332	18.399	14.384	53.676	14.65

Table 3.2: Observed versus Lower (L) and Upper (U) Predicted (EVWQP) Benthic Invertebrate (Composite) Tissue Selenium Concentrations in the Fording River

Location Code (Predictions)	Description	Biological Sampling Area Code	2013 Prediction Interval (µg/g dw)[a]		2015 Se (µg/g dw)	2016 Se (µg/g dw)	2017 Prediction Interval (µg/g dw)[a]		2017 Se (µg/g dw)
			L	U			L	U	
FR1	Fording River downstream of Henretta Creek	FODHE	3.05	23.14	6.55	-	3.16	23.96	8.10
FR2	Fording River downstream of Clode Creek	FODNGD	3.38	25.61	6.21	-	3.56	26.99	5.60
		FOUNGD			7.19	-			6.50
-	-	MP1	-	-	5.85	-	-	-	5.60
		FOUSH			6.04	-			6.50
		FOUKI			5.13	5.20			6.70
		FOBKS			6.00	-			6.60
FR3	Fording River between Swift and Cataract Creeks	FOBSC	3.78	28.64	7.51	-	4.03	30.57	5.00
-	-	FOBCP	-	-	7.68	9.70	-	-	6.40
FR3b	Fording River downstream of Porter Creek	FODPO	3.96	30.02	6.92	3.80	4.03	30.57	7.00
-	-	FO22	-	-	7.08	-	-	-	5.40
		FOUEW			6.05	5.80			6.60

[a] Approximate 95% Prediction Interval for Invertebrate Tissue Selenium Concentrations (µg/g dw).

"-" indicate that benthic invertebrate composit tissue seleneium samples were not taken.

Water temperature trends in the Fording River were identified as a factor potentially contributing to changes in benthic invertebrate communities in the 2016 LAEMP report (Minnow 2017b), however, further investigation determined that temperature was not likely responsible for the observed effects on % Ephemeroptera in the current baseline period preceding AWTF operation (Section 4.2.3.1). Water temperature will continue to be monitored in 2018, and the data will be used to characterize conditions prior to AWTF operation (Appendix Figure A.2).

3.5 Key Question #5: Potential Effects of AWTF on Water Flows

Key Question #5 is: “Is re-direction of water potentially affecting biota in the Fording River?”.

Water flow characteristics in the Fording River were identified as a factor potentially contributing to changes in benthic invertebrate communities in the 2016 LAEMP report, and were further investigated in this report (Sections 4.2.3.2 and Section 4.3.6). Water flows recorded by Teck for stations in the upper Fording River are presented in Figure 4.2. Water flows will continue to be monitored to further characterize baseline conditions prior to re-direction of flows upon commissioning of the AWTF (Appendix Figure A.2). Changes in benthic invertebrate community structure and biomass as it relates to changes in flow will be evaluated in the future to support environmental flow needs (EFN) under FRO water licensing requirements with respects to water licence withdraws.

3.6 Summary

The baseline data being collected to address Key Questions #2 to 5 will continue in 2018, and the approach for data analysis will discussed with the EMC prior to the commissioning of the AWTF in 2020.

4 CHEMICAL AND PHYSICAL EFFECTS ON BENTHIC INVERTEBRATE COMMUNITIES

4.1 Overview

To address Key Question #1 (Are nitrate concentrations increasing, and if so, are they adversely affecting biota?), chemical and biological data were collected in the upper Fording River. Following the 2016 sampling year, a spatial and temporal decline in % Ephemeroptera was identified in a reach extending from downstream of Cataract Creek to between Chauncey Creek and Ewin Creek, with values below the normal range (Minnow 2018) that could not be solely attributed to nitrate concentrations (Minnow 2017a). The study design was updated in 2017 (Minnow 2017b) to further investigate the effect, but the key questions remained the same for the current report. The following sections describe the analyses conducted to understand the observed effects on the benthic invertebrate community in the upper Fording River.

4.2 Benthic Invertebrate Structure

The 2016 FRO LAEMP report identified a temporal and spatial decreasing trend in % Ephemeroptera below the normal range in the upper Fording River, from downstream of Cataract Creek (FOBCP) to upstream of Ewin Creek (FOUEW) (Minnow 2017b). This decrease persisted in 2017, with % Ephemeroptera again below the normal range at all areas downstream of Cataract Creek (Figure 4.1, Appendix Figure A.3). Closer examination of the abundance of Ephemeroptera taxa identified two families as being the primary source of the observed decrease, Heptageniidae and Ephemerellidae (Table 4.1). The abundance of a third family present in appreciable numbers, Baetidae, did not appear to change temporally and spatially.

In addition to % Ephemeroptera, several areas also exhibited a decrease in % EPT below the normal range (Figure 4.1, Appendix Figure A.4), but this was directly related to the decrease in % Ephemeroptera, as % Plecoptera and % Trichoptera were above normal range in all areas (Figure 4.1). In fact, both % Plecoptera and % Trichoptera were highest in the areas exhibiting the lowest % Ephemeroptera.

Total abundance in the upper Fording River was within or above the normal range at all areas in 2017 (Figure 4.1, Appendix Figure A.5). The highest abundance was observed downstream of Porter Creek (FODPO), and Chauncey Creek (FO22), both areas exhibiting a decrease in % Ephemeroptera. LPL richness was also within the normal range all areas in 2017, and has remained stable over time (Figure 4.1, Appendix Figure A.6).

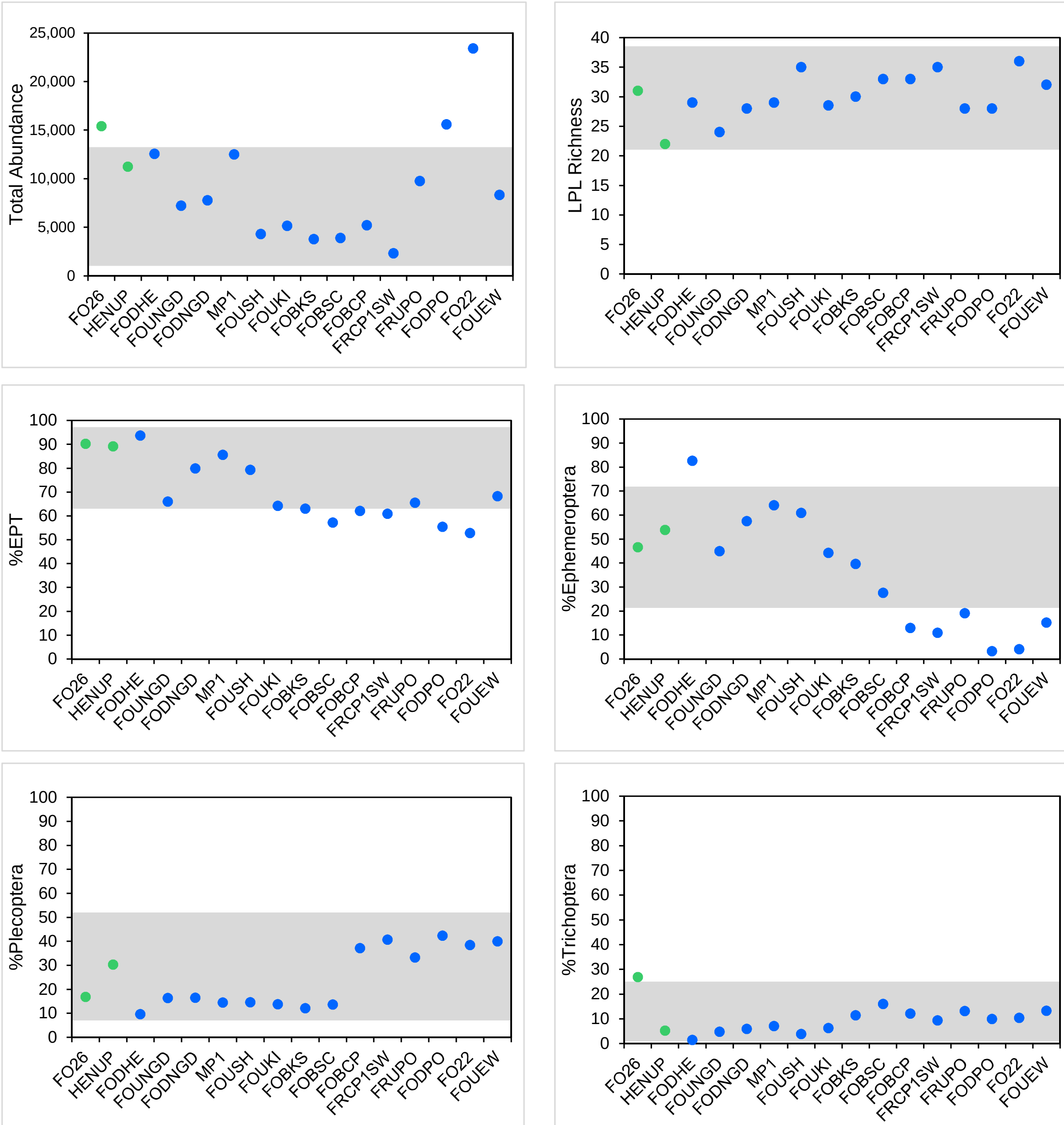


Figure 4.1: Benthic Invertebrate Community Endpoints from 3-minute Kick Samples Collected in the Upper Fording River, 2017

Note: Grey shading indicates the normal ranges. Green symbols indicate reference areas, blue symbols indicate mine-exposed areas.

Table 4.1: Total Abundance of Key Ephemeroptera Families in the Upper Fording River, 2012, 2015, 2016, and 2017

Organism Identification		Baetidae				Ephemerellidae				Heptageniidae			
		2012	2015	2016	2017	2012	2015	2016	2017	2012	2015	2016	2017
Reference	FO26	120	1,280	640	860	1,540	1,320	3,760	2,380	2,780	3,660	5,100	3,720
	HENUP	43	80	0	80	657	460	820	940	2,028	4,500	2,950	4,820
Mine-Exposed	FODHE	40	1,340	580	200	3,000	3,700	2,140	2,540	9,700	5,340	4,680	7,100
	FOUKI	340	540	96	827	280	190	88	57	8,220	1,480	320	1295
	FOBKS	345	801	326	498	155	126	376	129	2,267	1,038	976	828
	FOBSC	260	391	237	540	660	127	119	50	2,180	609	112	470
	FOBCP	40	163	133	71	2,360	138	134	14	2,860	388	160	586
	FODPO	1,060	0	960	220	2,700	140	160	20	1,660	680	540	260
	FOUEW	300	40	420	100	667	580	120	240	1,984	1,380	580	920

4.3 Potential Contributing Factors to Reductions in Ephemeroptera

4.3.1 Nitrate Concentrations in the Upper Fording River

Monitoring data collected at the FRO Compliance Point (FR_FRCP1) have indicated that surface water flow at this location is predominantly discharge water from Cataract Creek during winter low flow periods (Golder 2018b). Therefore, the location is not representative of the combined and mixed contributions of FRO discharges under all conditions, and comparison of monitored to modelled concentrations is not informative with respect to understanding prevailing conditions in the Fording River. Nitrate concentrations were also modelled in the EVWQP for the GHO Fording River Compliance Point (GH_FR1), farther downstream. Monitored concentrations at GH_FR1 have been consistently lower than model projections (Golder 2017, Golder 2018b), and updated projections for 2017 onward at this location do not suggest a continued increase in nitrate concentrations (Figure 4.2; Golder 2018b). It is important to note, however, that GH_FR1 is located downstream from the input of two reference tributaries, Chauncey Creek and Ewin Creek, which are likely contributing to lower nitrate concentrations.

Nitrate concentrations for monitoring stations in the upper Fording River reflected varying temporal patterns over the period 2012 to 2017, with increasing trends observed at the upstream reference stations (but still below the BC Water Quality Guideline of 3 µg/L), but no trends observed at the mine-exposed stations (Figures 4.3 and 4.4, Table 4.2). Temporal analysis of the difference between each mine-exposed station relative to the reference station FR_UFR1 resulted in either no change or a significant decreasing trend in nitrate (Table 4.3). This was directly related to the increasing trend observed in the reference area, and further supports no change over time in the mine-exposed areas. Note that data were limited for some stations (FR_FRCP1, FR_FRRD, and FR_FRABCH) where monitoring has only occurred over the most recent two to three years.

Nitrate concentrations have exceeded the EVWQP Level 1 and 2 benchmarks in at least one sample at most sampling areas in the Fording River downstream from mining activities, particularly at the areas downstream from Cataract Creek (FR_FRCP1, FR_FRRD, FR_FRABCH, FR_FR5; Figure 4.5). The monthly mean nitrate concentrations in 2017 were near or greater than the Level 1 benchmark at most mine-exposed stations in at least one month, but were consistently less than the Level 2 benchmark except at FR_FRRD (Figure 4.6).

Monthly mean nitrate concentrations were highest at FR_FRCP1 in 2017, which is inconsistent with the areas experiencing the lowest % Ephemeroptera in the upper Fording River (Figure 4.1). When nitrate concentrations over time were plotted together with % Ephemeroptera at each of the stations where biological data was available, no patterns were observed that would explain

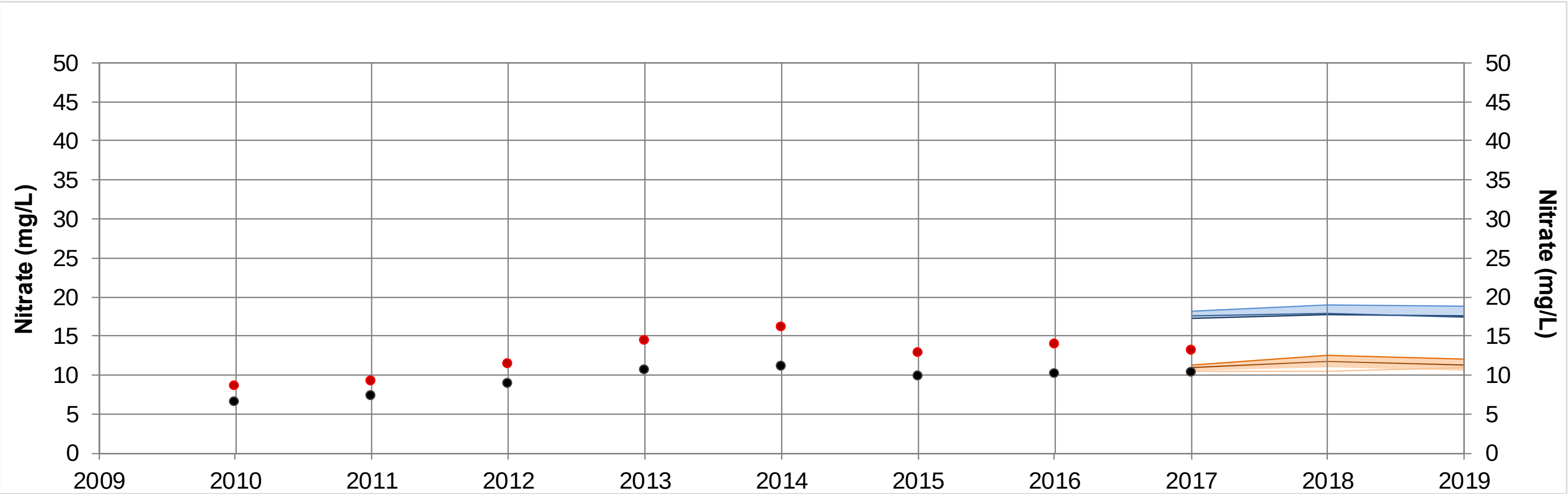


Figure 4.2: Observed (Circles) Versus Modelled (Coloured Bands) Concentrations of Nitrate at GHO Fording River Compliance Point GH_FR1 (From Golder 2018b)

Note:

Blue band = modelled range of maximum monthly concentrations.

Orange band = modelled range of annual average concentrations.

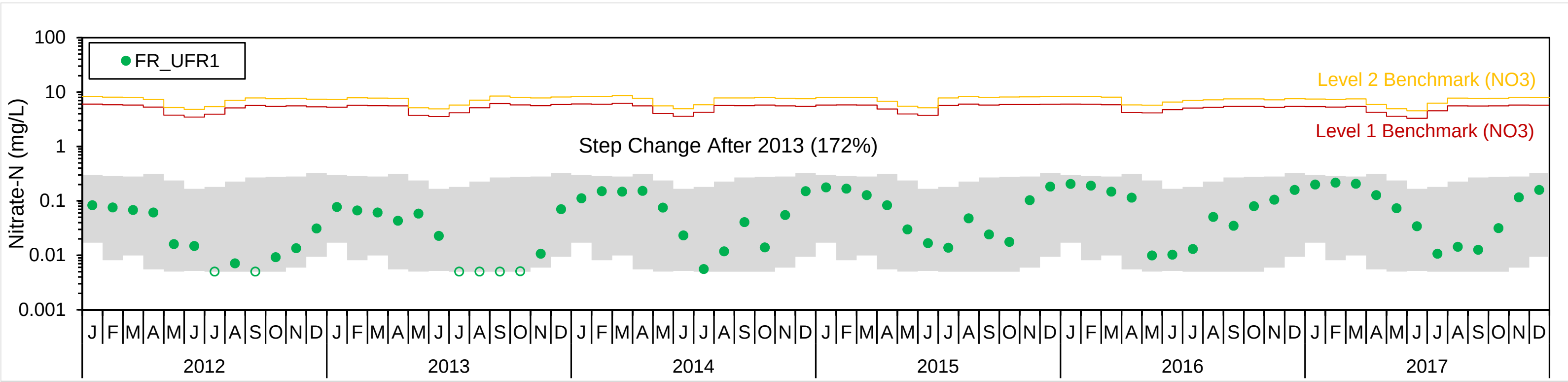
Red circles = monitored maximum monthly concentrations.

Black circles = monitored annual average concentrations.

The Model was run with the average (P50) geochemical release rate.

The predicted concentrations (the annual average and maximum) for a given year are plotted at the end of the year.

The predicted nitrate concentrations do not account for Model bias correction.



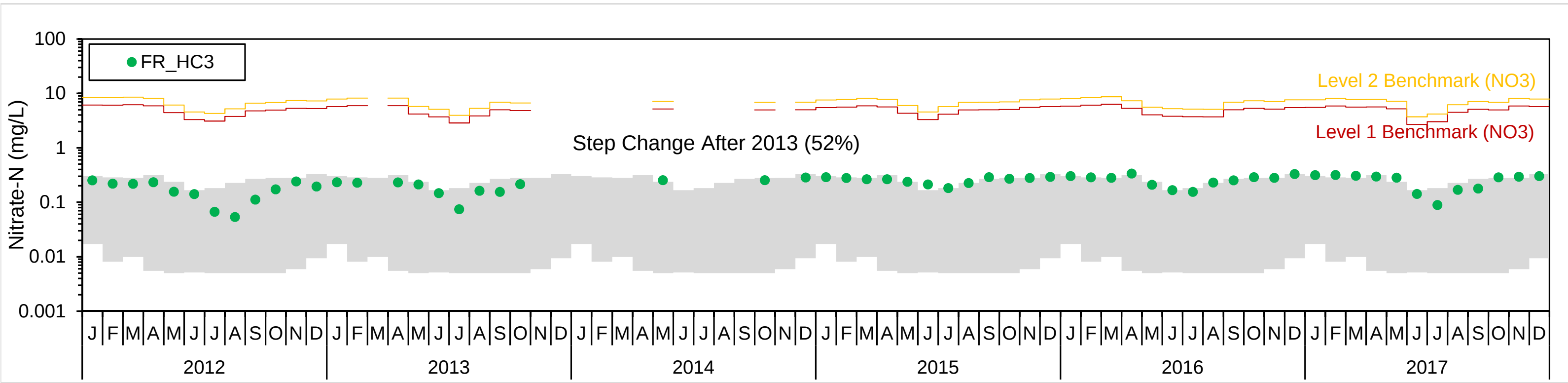
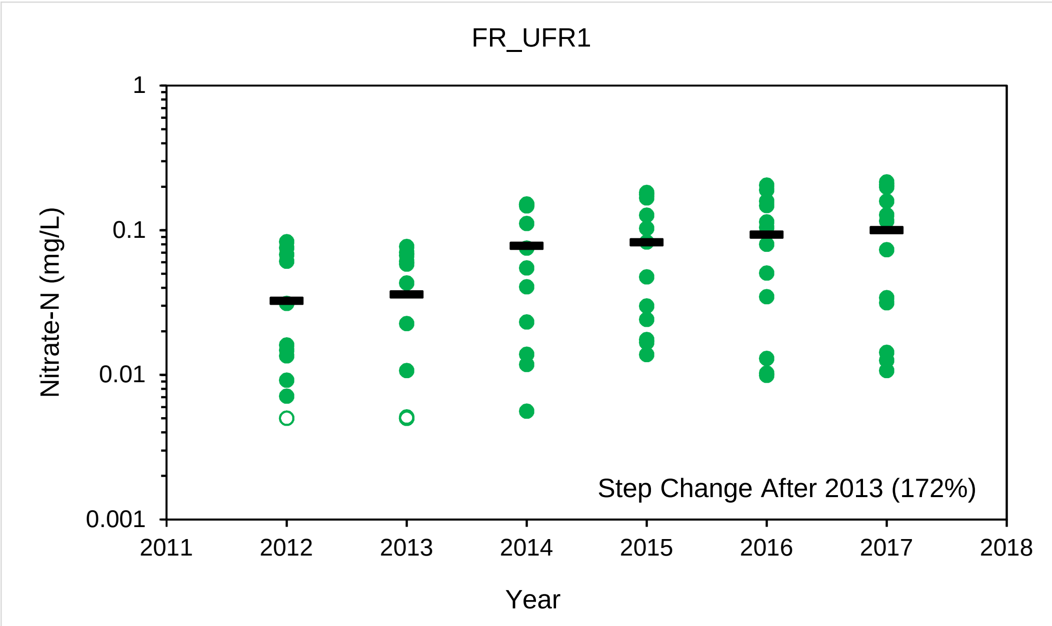


Figure 4.3: Significantly Increasing Temporal Changes for Nitrate-N, 2012 to 2017

Notes: Grey shading for nitrate represents the reference area normal range (2.5th and 97.5th percentiles of reference area monthly means from 2012-2016 in the RAEMP)
Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL



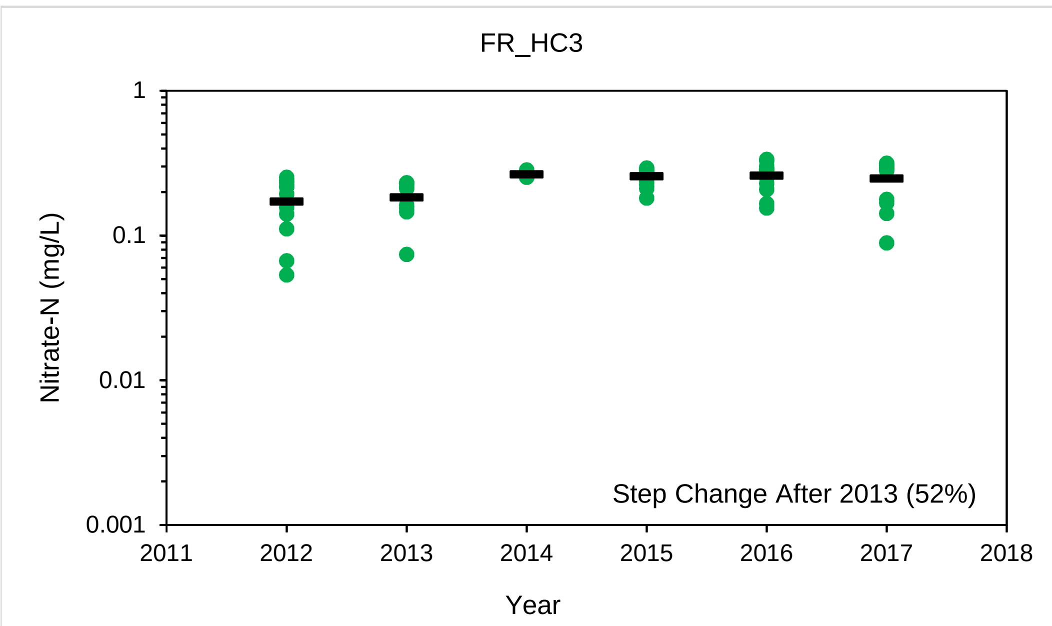


Figure 4.4: Scatterplots of Monthly Mean Concentrations of Nitrate-N for Areas With a Significant Increase Over Time

Notes: circle = monthly mean, dash = geometric mean of the monthly means for that respective year
Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL

Table 4.2: Temporal Analysis of Monthly Mean Concentrations of Nitrate-N, Total Selenium, Sulphate, and Nickel, 2012 to 2017

Analyte	Teck Water Station Code	Exposure Type	Years included in Analysis	ANOVA P-value	Linear		Step after 2012		Step after 2013		Step after 2014		Step after 2015		Step after 2016	
					P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]
Nitrate-N	FR_UFR1	Reference	2012-2017	0.033	0.002	254	0.021	131	**<0.001**	**172**	0.006	113	0.032	85	0.152	-
	FR_HC3		2012-2017	0.004	0.001	59	0.001	50	**<0.001**	**52**	0.022	28	0.117	-	0.517	-
	FR_FR1	Mine-exposed	2012-2017	0.414	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR2		2012-2017	0.252	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR4		2012-2017	0.766	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR5		2012-2017	0.347	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRABCH		2015-2017	0.438	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1		2015-2017	0.926	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD		2015-2017	0.930	-	-	-	-	-	-	-	-	-	-	-	-
Total Selenium	FR_UFR1	Reference	2012-2017	0.067	-	-	-	-	-	-	-	-	-	-	-	-
	FR_HC3		2012-2017	0.265	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR1	Mine-exposed	2012-2017	0.416	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR2		2012-2017	0.559	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR4		2012-2017	0.721	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR5		2012-2017	0.593	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRABCH		2015-2017	0.131	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1		2015-2017	0.777	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD		2015-2017	0.107	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	FR_UFR1	Reference	2012-2017	0.927	-	-	-	-	-	-	-	-	-	-	-	-
	FR_HC3		2012-2017	0.592	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR1	Mine-exposed	2012-2017	0.644	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR2		2012-2017	0.938	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR4		2012-2017	0.973	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR5		2012-2017	0.804	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRABCH		2015-2017	0.238	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1		2015-2017	0.867	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD		2015-2017	0.395	-	-	-	-	-	-	-	-	-	-	-	-
Total Nickel	FR_UFR1	Reference	2012-2017	0.372	-	-	-	-	-	-	-	-	-	-	-	-
	FR_HC3		2012-2017	0.373	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR1	Mine-exposed	2012-2017	0.005	0.377	-	0.069	-	0.140	-	0.042	-15	0.223	-	0.748	-
	FR_FR2		2012-2017	<0.001	0.026	-19	0.007	-22	<0.001	-31	0.043	-12	0.582	-	0.263	-
	FR_FR4		2012-2017	<0.001	<0.001	-41	0.006	-27	<0.001	-37	<0.001	-29	0.051	-	0.617	-
	FR_FR5		2012-2017	0.194	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRABCH		2015-2017	0.330	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1		2015-2017	0.860	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD		2015-2017	0.288	-	-	-	-	-	-	-	-	-	-	-	-

P-value < 0.05

Increase

Decrease

Contrast that best describes the data

Notes: "-" = contrast was not significant

[a] For linear change: percent change in the fitted value of a regression model in the last year, relative to the first year; For step change: percent change after the step change relative to before the step change.

Table 4.3: Temporal Analysis of the Differences in Monthly Mean Concentrations of Nitrate-N, Total Selenium, and Sulphate at Mine-exposed Areas Relative to the Reference Area (FR_UFR1), 2012 to 2017

Analyte	Teck Water Station Code	Years included in Analysis	ANOVA P-value	Linear		Step after 2012		Step after 2013		Step after 2014		Step after 2015		Step after 2016	
				P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]	P-value	Magnitude Change (%) [a]
Nitrate-N	FR_FR1	2012-2017	<0.001	<0.001	-66	0.015	-51	<0.001	-70	<0.001	-61	0.002	-55	0.155	-
	FR_FR2	2012-2017	0.040	0.010	-56	0.070	-	<0.001	-55	0.027	-38	0.149	-	0.334	-
	FR_FR4	2012-2017	0.006	0.006	-65	0.016	-47	<0.001	-60	0.006	-49	0.113	-	0.837	-
	FR_FR5	2012-2017	0.009	0.002	-67	0.026	-48	<0.001	-61	0.011	-54	0.027	-46	0.288	-
	FR_FRABCH	2015-2017	0.523	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1	2015-2017	0.915	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD	2015-2017	0.937	-	-	-	-	-	-	-	-	-	-	-	-
Total Selenium	FR_FR1	2012-2017	0.062	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR2	2012-2017	0.078	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR4	2012-2017	0.027	0.062	-	0.540	-	0.052	-	0.005	-25	0.089	-	0.846	-
	FR_FR5	2012-2017	0.005	0.081	-	0.169	-	0.359	-	0.006	-13	0.008	-12	0.462	-
	FR_FRABCH	2015-2017	0.349	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1	2015-2017	0.637	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD	2015-2017	0.088	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	FR_FR1	2012-2017	0.123	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FR2	2012-2017	0.024	0.160	-	0.614	-	0.013	-13	0.045	-10	0.386	-	0.279	-
	FR_FR4	2012-2017	0.046	0.213	-	0.606	-	0.033	-14	0.052	-	0.371	-	0.337	-
	FR_FR5	2012-2017	0.534	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRABCH	2015-2017	0.245	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRCP1	2015-2017	0.439	-	-	-	-	-	-	-	-	-	-	-	-
	FR_FRRD	2015-2017	0.112	-	-	-	-	-	-	-	-	-	-	-	-

P-value < 0.05

Increase

Decrease

Contrast that best describes the data

Notes: "-" = contrast was not significant

[a] Percent change = (observed - expected)/expected × 100%; For linear change: observed = value observed in the most recent year and expected = predicted value if the mine-exposed area followed the same linear trend as the reference area; For step change: observed = mean value observed after the step change and expected = predicted mean value after the step change if the mine-exposed area did not change relative to reference prior to the step change

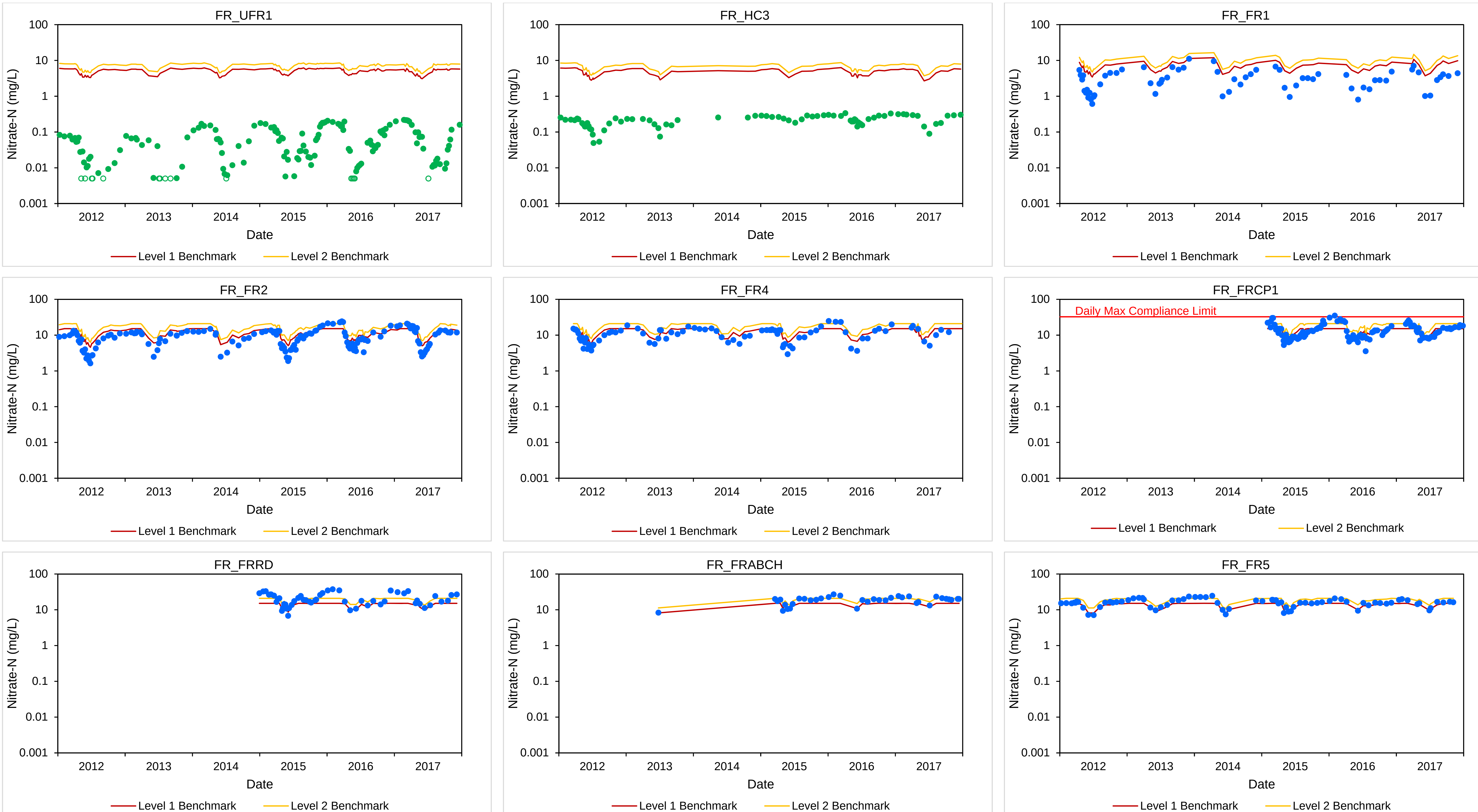


Figure 4.5: Scatterplot of Concentrations of Nitrate-N in the Fording River, 2012 to 2017

Notes: Level 1 and Level 2 Benchmarks for Nitrate-N as defined in the EVWQP. Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL

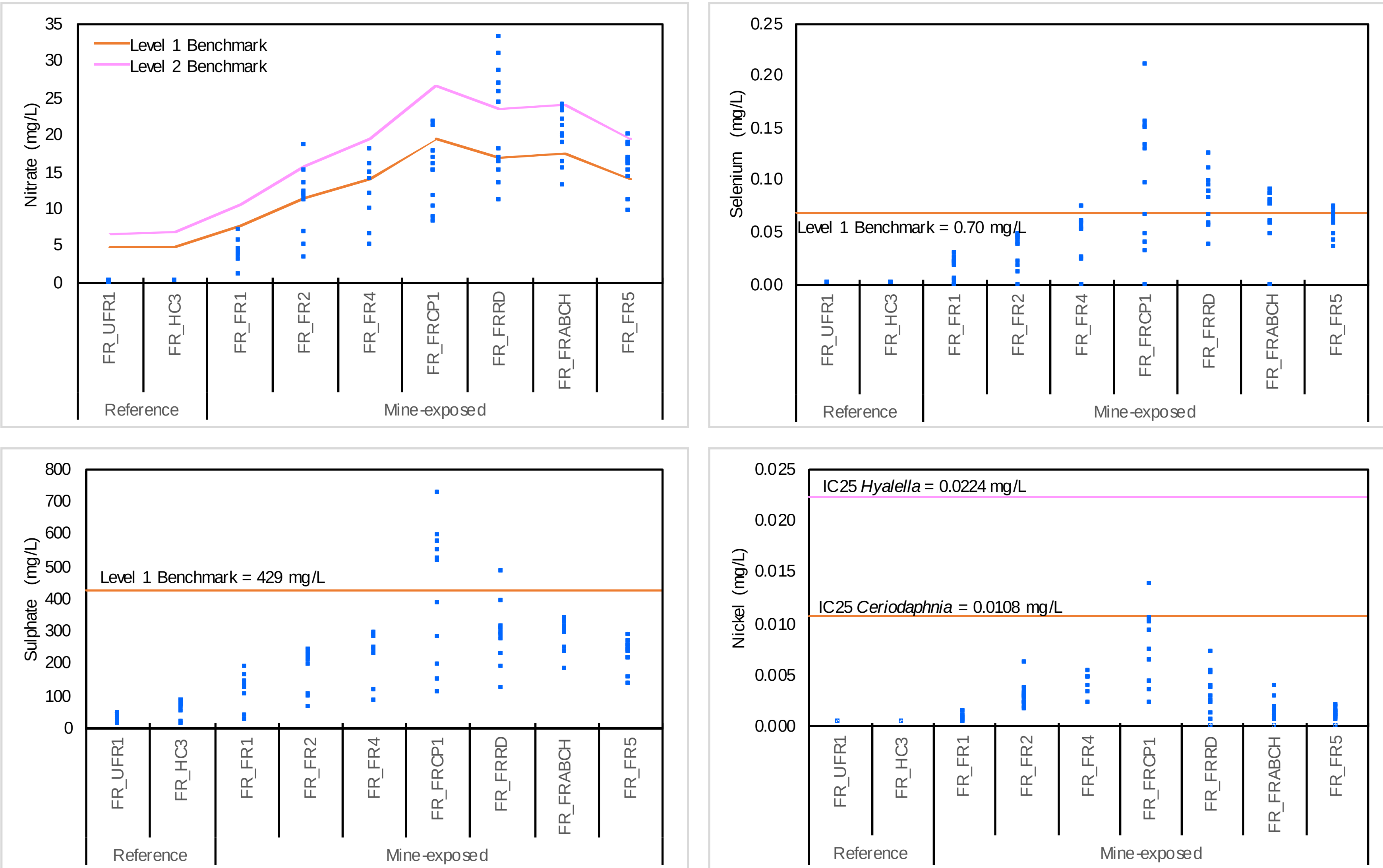


Figure 4.6: Mean Monthly Water Quality Concentrations of Selected Parameters in the Fording River, 2017

Notes: No data for January and February at FR_FR1 and FR_FR4. Monthly means were calculated when more than one sample was collected in a month.
Open circles indicate values less than the LRL.

the temporal change in % Ephemeroptera (Appendix Figure A.7). This suggests that nitrate alone is not the cause of the change in benthic invertebrate community structure.

4.3.2 Other Constituents in the Upper Fording River

4.3.2.1 Water Quality

Concentrations of selenium and sulphate in water are also above benchmarks in some areas of the upper Fording River (Figure 4.6; Appendix Figure A.8 and A.9), although not to the same extent as nitrate. Sulphate generally only exceeds the Level 1 Benchmark at FR_FRCP1, and selenium concentrations are generally below the Level 1 benchmark upstream of FR_FRCP1 where they peak, and then decrease again moving downstream. No temporal trends were observed in either constituent using monthly means (Table 4.2), with or without consideration of potential trends at the upstream reference station (Table 4.3). When plotted with % Ephemeroptera, no pattern was observed that could explain the change in community structure, indicating, as with nitrate, that these constituents alone are not causing the decrease in percent Ephemeroptera (Appendix Figures A.10 and A.11).

A recent study indicated that nickel toxicity may occur at concentrations below the current BCMOE guideline, and preliminary IC25 values for *Ceriodaphnia* (10.8 µg/L), and *Hyalella* (22.4 µg/L), respectively were developed based on additional investigations by Teck. Nickel concentrations in the upper Fording River have rarely exceeded these IC25 values, except at the compliance station, FR_FRCP1, where seasonal exceedances of one or both IC25 value occurred (Figure 4.6; Appendix Figure A.12). Temporal analysis did not indicate an increasing trend in nickel concentrations at reference or mine-exposed stations, and in fact showed a decreasing trend in a number of areas (Table 4.2). The analysis was not conducted relative to reference because nickel concentrations at the reference station were below the LRL. When plotted with % Ephemeroptera, no pattern was apparent that could help explain the change in benthic community structure (Appendix Figure A.13). Thus, nickel is unlikely to be the cause of the decrease in % Ephemeroptera.

Additional constituents measured at Teck's permitted water quality stations were screened against BCWQG (BCMOE 2018) as part of the Permit 107517 Annual Water Quality Monitoring Report (Teck 2018). Few constituents exceeded BCWQGs in the upper Fording River, with the majority of values above guideline occur during spring freshet (Table 4.4; Appendix Table A.4). The majority of instances where concentrations were measured above BCWQGs in 2017 were for total mercury (Table 4.4; Appendix Table A.4) with the percentage of instances where the sample concentration was above the guideline ranged from 21.4% at FR_FRRD to 46.9% at FR_FR2. The BCWQG for mercury is based on the percent of methyl mercury present, in which the lower the percentage of methyl mercury, the higher the BCWQG. Work is ongoing to determine the proportion of methyl mercury in samples, and in 2017, methyl mercury represented less than 8% of total mercury for all samples, indicating that a BCWQG of 0.01 µ/L is more appropriate for comparison (Teck 2018). If this value was applied, no samples would have been over the guideline in the upper Fording River. Total iron was above the BCWQG once at each of FR_FR2 and FR_FRCP1, and dissolved aluminum was above the BCWQG on one occasion at FR_FRRD. Overall, it is not expected that these exceedances contributed to the observed decrease in % Ephemeroptera.

Table 4.4: Summary of Samples Above British Columbia Water Quality Guidelines (BCWQG) in 2017 (Teck 2018)

EMS ID	Location Code	Parameter	Number of Instances	Percentage of Instances above BCWQG (%)
E216777	FR_UFR1	Total Mercury - Ultra Trace	7	25.0%
0200201	FR_FR2	Total Iron	1	3.1%
		Total Mercury - Ultra Trace	15	46.9%
E300071	FR_FRCP1	Total Iron	1	2.8%
		Total Mercury - Ultra Trace	10	27.8%
E300097	FR_FRRD	Dissolved Aluminum	1	7.1%
		Total Mercury - Ultra Trace	3	21.4%

4.3.2.2 Acute Toxicity

Two hundred and ten (210) 96-h rainbow trout 100% (single concentration) acute lethality toxicity tests and 235 48-h *Daphnia magna* 100% (single concentration) acute lethality toxicity tests were conducted throughout the Elk Valley in 2017 as a requirement of Permit 107517. Of the 235 *D. magna* acute toxicity tests, ten (4.3%) exhibited >50% mortality and as such were considered failed test results based on Permit 107517 criteria. There were no failures of rainbow trout toxicity tests in 2017 (i.e., mortality was ≤50% for all 2017 rainbow trout acute toxicity tests). Teck is currently drafting a Compliance Action Plan that identifies short-term actions and Key Performance Indicators to support the goals of 1) identifying the cause(s) of *D. magna* acute toxicity failures, and 2) meeting the Permit 107517 requirement that effluent must not be acutely toxic. As calcite is suspected to be responsible for adverse effects on *D. magna*, it is necessary to understand what factors may favor precipitate formation and determine if these factors are due to laboratory conditions. The draft Compliance Action Plan will identify additional laboratory tests that will help determine which factors may be contributing to observed *D. magna* toxicity and under what conditions toxicity may occur. Because differences in laboratory effluent handling procedures and testing protocols may have contributed to the observed variability in *D. magna* response, the draft Compliance Action Plan will also include an objective to develop and implement standardized laboratory testing protocols for use during acute toxicity testing. The draft Compliance Action Plan will also identify operational activities to be implemented to reduce and prevent calcite precipitation in some priority creeks.

4.3.3 Temperature and Discharge

4.3.3.1 Temperature

The 2016 FRO LAEMP report identified a statistically significant increase in temperature at several stations in the upper Fording River using data from 2012 to 2016 (Seasonal Kendall analysis; Minnow 2017b), leading to the hypothesis that temperature increases may be contributing to the decrease in % Ephemeroptera, possibly through the initiation of early emergence. Monthly mean water temperature was calculated and plotted over time (Figure 4.7). Seasonal-Kendall analysis did not identify a significant trend over time (Table 4.5), however, temperatures appeared to be higher in 2012 compared to other years, resulting in an overall negative slope. Monthly mean temperature was also plotted in series with year on the X-axis to visualize whether an increasing or decreasing trend existed by month (Figure 4.8), but the only significant correlation was a decrease over time in December (Table 4.6). These results suggest temperature in the upper Fording River has not increased over the 2010 to 2017 time period.

To verify the finding at the continuous monitoring station, the same analysis was conducted at the Teck water quality monitoring stations for which data was available from 2010 to 2017 (FR_UFR1, FR_HC3, FR_FR1, FR_FR2, FR_FR4, FR_FR5; Figure 4.9). A significant increase in temperature over time in June was observed at FR_FR1, FR_FR2, FR_FR4, and FR_FR5, along with a significant increase in July and August at FR_FR2 and a significant increase in April at FR_FR5 (Table 4.7). These increases in temperature occurred at mine-exposed areas with % Ephemeroptera within the normal range (FR_FR1, FR_FR2, FR_FR4) and below the normal range (FR_FR5).

To further evaluate the effects of temperature on benthic invertebrate community, using data from FR_FRNTP, accumulated degree day (May to September, June to September, and July to September; using threshold 10°C), mean and maximum temperature between July and September, and mean and maximum temperature between April and June, were calculated for 2012, 2015, 2016, and 2017 (Appendix Table A.5). A significant correlation was observed between maximum temperature from April to June and % Ephemeroptera, and between mean temperature from April to June and % EPT (Table 4.8), however, these correlations were not strong.

Emergence usually occurs in the spring/summer for the Ephemeroptera taxa experiencing declines in the upper Fording River (Appendix Table A.6), suggesting that by September any

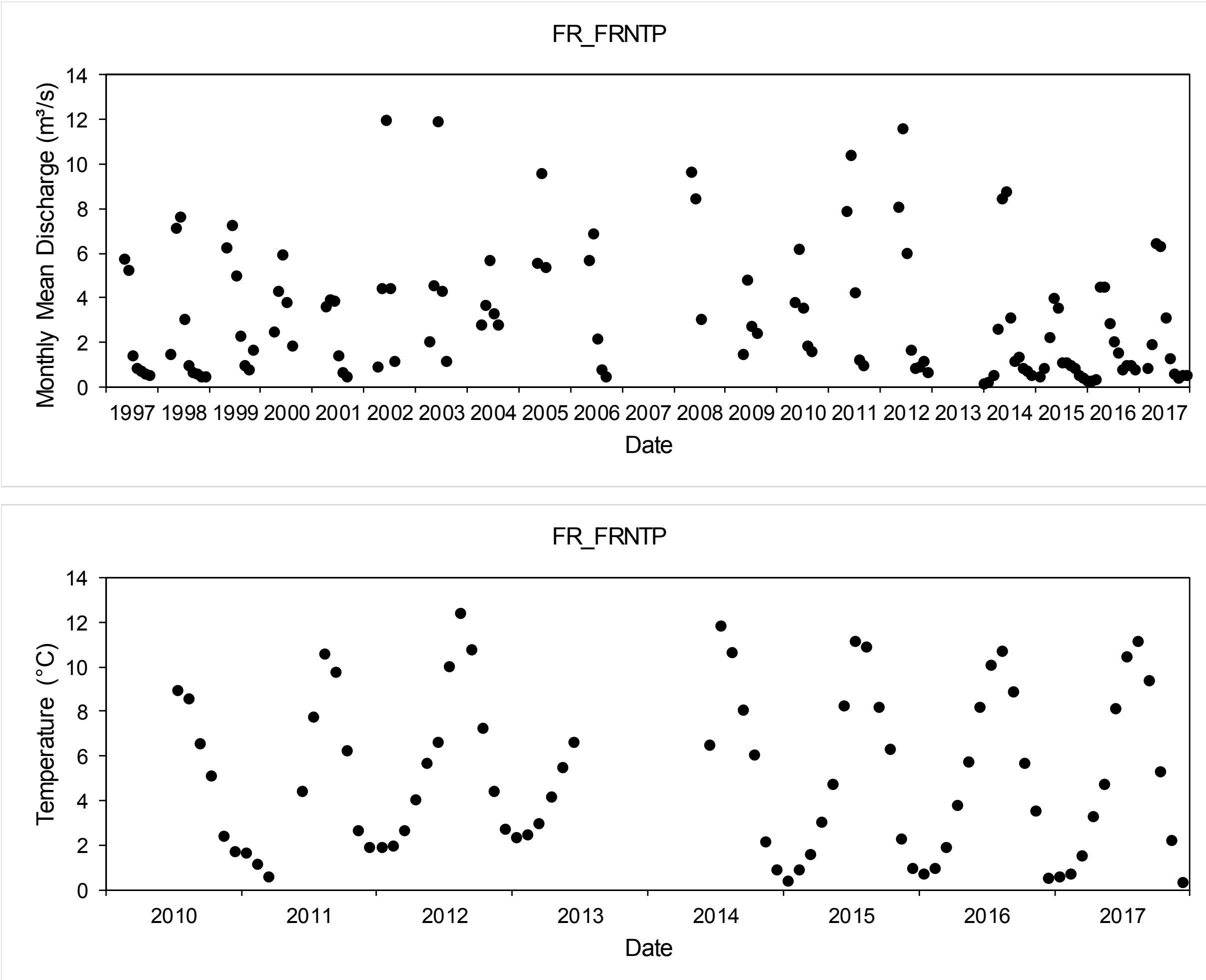
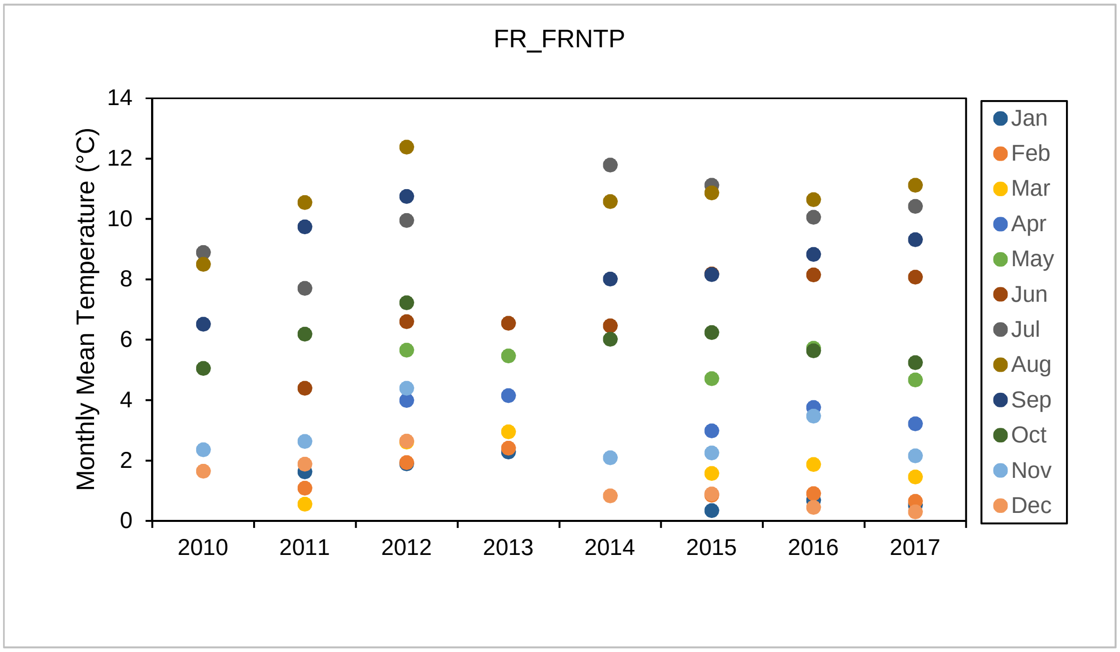


Figure 4.7: Time Series Plot of Monthly Means for Discharge and Water Temperature at Station FR_FRNTP 1997 to 2017

Table 4.5: Results of the Seasonal Kendall Test for Discharge and Water Temperature at Station FR_FRNTP, 1997 to 2017

Parameter	Units	Years	n (Total # Months with Data)	Slope (Magnitude Change / Year)	P-value
Discharge	(m^3/s)	1997-2016	127	0.00463	0.638
Temperature	(°C)	2010-2017	77	-0.02160	0.885



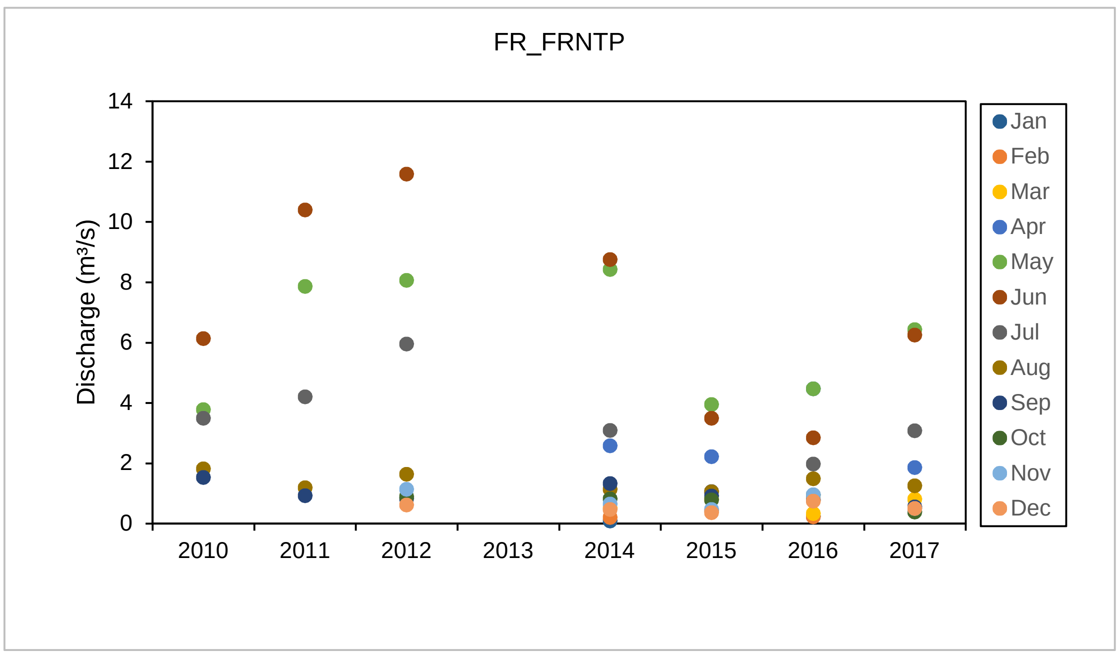


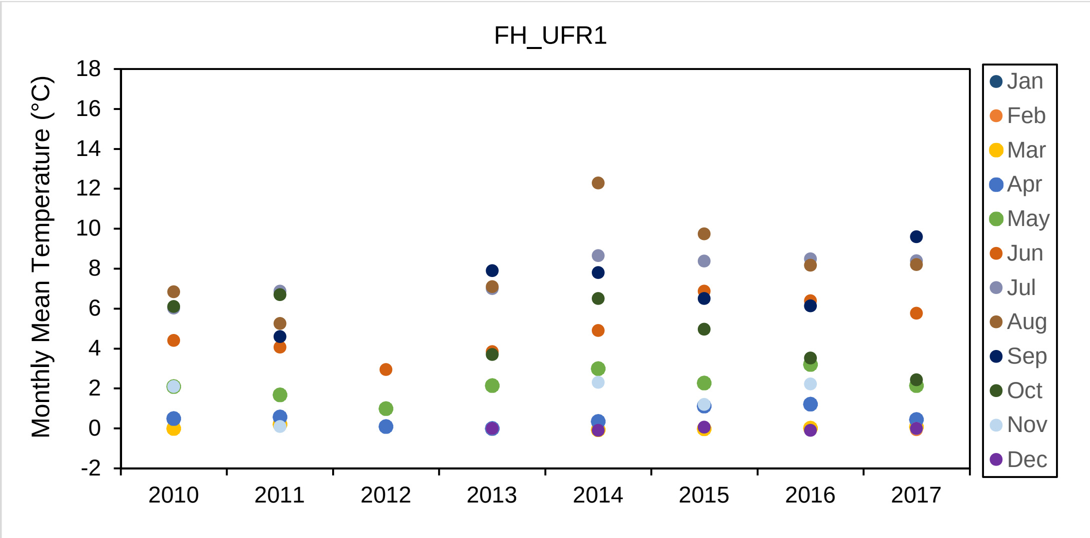
Figure 4.8: Monthly Mean Temperature and Discharge at Station FR_FRNTP, 2010 to 2017

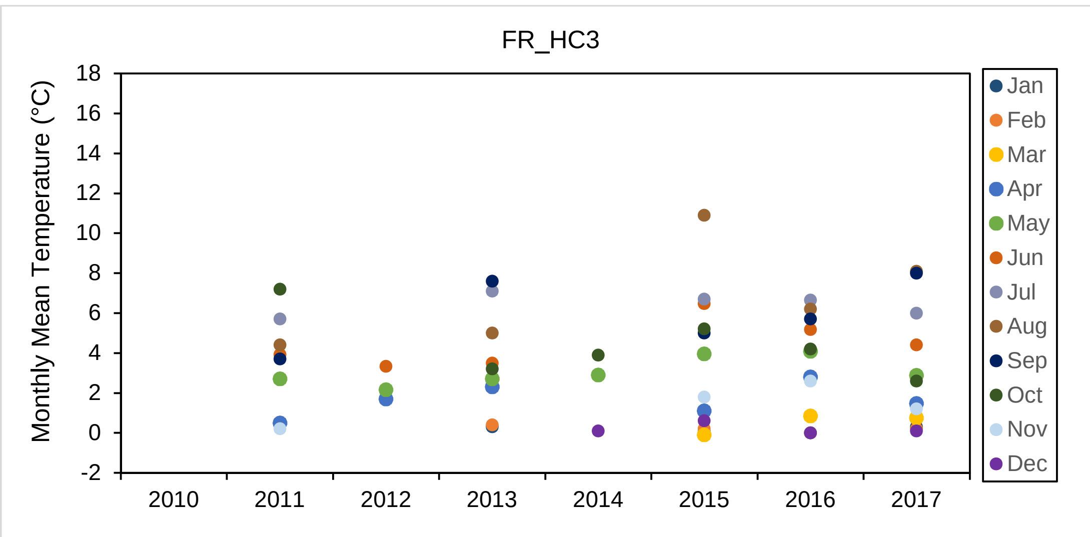
Table 4.6: Spearman Correlations of Monthly Mean Temperature and Discharge for the Continuous Monitoring Station in the Fording River (FR-NTP), 2010 to 2017

Month	Monthly Mean Temperature			Monthly Mean Discharge		
	P-value	r	Sample Size	P-value	r	Sample Size
January	0.208	-0.600	6	ND	ND	2
February	0.111	-0.714	6	0.667	0.500	3
March	0.957	-0.029	6	0.600	0.400	4
April	0.285	-0.600	5	0.600	-0.400	4
May	0.505	-0.400	5	0.939	0.036	7
June	0.071	0.714	7	0.337	-0.429	7
July	0.119	0.643	7	0.071	-0.714	7
August	0.148	0.607	7	0.432	-0.357	7
September	0.760	0.143	7	0.023	-0.821	7
October	0.879	-0.071	7	0.505	-0.400	5
November	0.535	-0.286	7	0.391	-0.500	5
December	0.023	-0.821	7	0.873	0.100	5

Note: ND indicates there were too few samples to perform the correlation (n≤2).

Shading indicates significant correlation (p-value < 0.05).





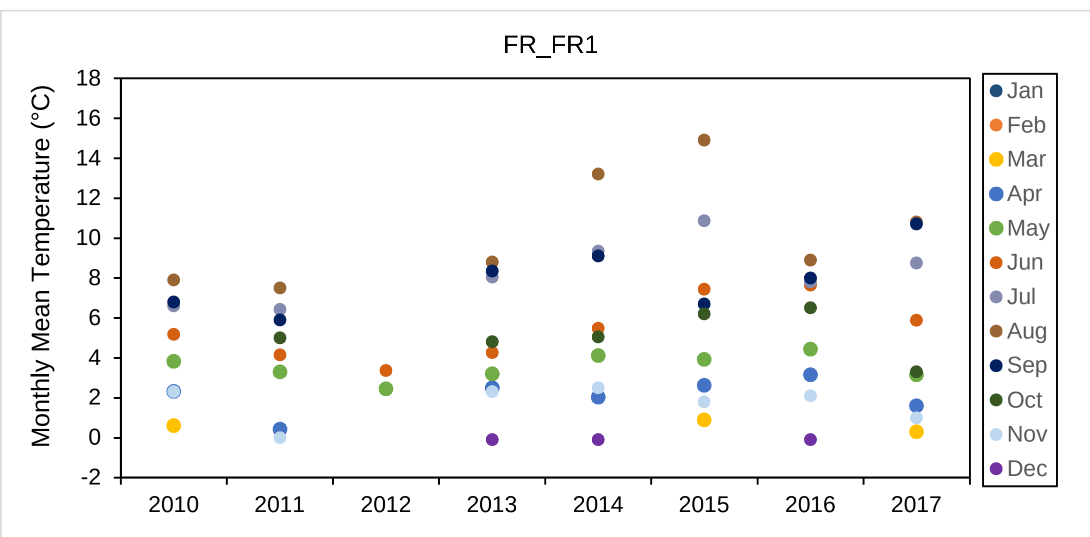


Figure 4.9: Monthly Mean Temperatures at Stations in the Fording River, 2010 to 2017

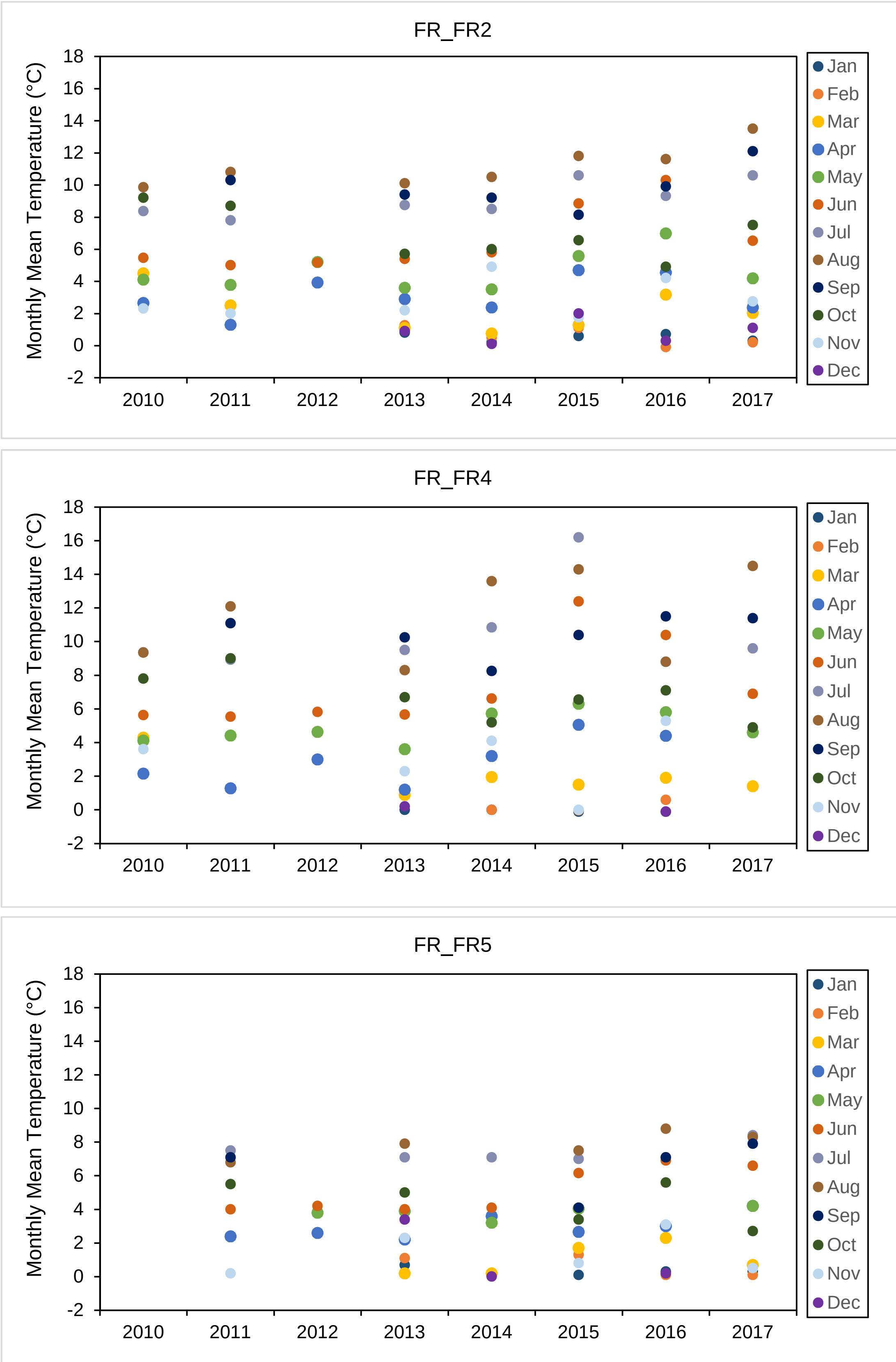


Figure 4.9: Monthly Mean Temperatures at Stations in the Fording River, 2010 to 2017

Table 4.7: Spearman Correlations of Monthly Mean Temperature for Stations in the Fording River, 2010 to 2017

Month	Monthly Mean Temperature at FH_UFR1			Monthly Mean Temperature at FR_HC3			Monthly Mean Temperature at FR_FR1			Monthly Mean Temperature at FR_FR2			Monthly Mean Temperature at FR_FR4			Monthly Mean Temperature at FR_FR5		
	P-value	r	n	P-value	r	n	P-value	r	n	P-value	r	n	P-value	r	n	P-value	r	n
Jan	ND	ND	5	0.89459	-0.105	4	ND	ND	0	0.6238	-0.3	5	0.106	-0.8944	4	0.805	-0.15	5
Feb	0.718	-0.22	5	0.368	-0.63	4	ND	ND	0	0.104	-0.80	5	0.667	0.50	3	0.219	-0.67	5
Mar	0.787	0.14	6	0.667	0.50	3	0.667	-0.50	3	0.645	-0.21	7	0.468	-0.37	6	0.219	0.67	5
Apr	0.570	0.24	8	0.468	0.37	6	0.589	0.25	7	0.509	0.28	8	0.071	0.71	7	0.036	0.79	7
May	0.086	0.64	8	0.068	0.72	7	0.610	0.21	8	0.320	0.40	8	0.139	0.57	8	0.188	0.70	5
Jun	0.058	0.69	8	0.208	0.60	6	0.028	0.76	8	0.021	0.79	8	0.007	0.86	8	0.021	0.83	7
Jul	0.052	0.75	7	1.000	0.00	5	0.180	0.57	7	0.012	0.86	7	0.589	0.25	7	0.864	0.09	6
Aug	0.119	0.64	7	0.188	0.70	5	0.094	0.68	7	0.014	0.86	7	0.294	0.46	7	0.104	0.80	5
Sept	0.397	0.43	6	0.188	0.70	5	0.215	0.54	7	0.704	0.20	6	0.266	0.54	6	0.368	0.63	4
Oct	0.052	-0.75	7	0.329	-0.49	6	0.872	0.09	6	0.253	-0.50	7	0.071	-0.71	7	0.505	-0.40	5
Nov	0.878	-0.07	7	0.600	0.40	4	0.585	-0.25	7	0.482	0.32	7	0.624	0.30	5	0.624	0.30	5
Dec	1.000	0.00	5	0.684	-0.32	4	ND	ND	3	0.624	0.30	5	ND	ND	2	0.667	-0.50	3

Note: ND indicates there were too few samples to perform the correlation (n ≤2) or all values were the same

Shading indicates significant correlation (p-value < 0.05).

Table 4.8: Spearman Rank Correlations (2012, 2015, 2016, 2017)

Variable 1	Variable 2	n	Spearman r	P-Value
% E	Mean Pebble Size	51	0.317	0.023
	ADD (May 1-Sept 15)	52	0.141	0.317
	ADD (Jun 20-Sept 15)	52	-0.162	0.251
	ADD (Jul 1-Sept 15)	52	0.141	0.317
	Mean Temperature (Jul 1-Sept 15)	52	0.141	0.317
	Max Temperature (Jul 1-Sept 15)	52	0.309	0.026
	Mean Temperature (Apr-Jun)	52	-0.234	0.095
	Max Temperature (Apr-Jun)	52	-0.280	0.045
	Mean Discharge (Jul 1-Sept 15)	52	0.078	0.583
	Max Discharge (Jul 1-Sept 15)	52	0.113	0.427
	Mean Discharge (Apr-Jun)	52	0.078	0.583
	Max Discharge (Apr-Jun)	52	0.078	0.583
% EPT	Mean Pebble Size	51	0.171	0.229
	ADD (May 1-Sept 15)	52	0.028	0.843
	ADD (Jun 20-Sept 15)	52	-0.205	0.144
	ADD (Jul 1-Sept 15)	52	0.028	0.843
	Mean Temperature (Jul 1-Sept 15)	52	0.028	0.843
	Max Temperature (Jul 1-Sept 15)	52	0.226	0.107
	Mean Temperature (Apr-Jun)	52	-0.289	0.038
	Max Temperature (Apr-Jun)	52	-0.094	0.509
	Mean Discharge (Jul 1-Sept 15)	52	-0.093	0.512
	Max Discharge (Jul 1-Sept 15)	52	-0.104	0.462
	Mean Discharge (Apr-Jun)	52	-0.093	0.512
	Max Discharge (Apr-Jun)	52	-0.093	0.512

(shaded) P-value < 0.05

Notes: ADD = Accumulated degree days (using threshold of 10°C)
No discharge data for 2012

nymphs that would have emerged in that year would have already done so. In general, the results suggest that temperature has been relatively consistent over time in the upper Fording River, and there is insufficient evidence to suggest that early emergence is the cause of the decrease in % Ephemeroptera in the section of the Fording River between Cataract and Ewin Creeks.

4.3.3.2 Discharge

Monthly mean discharge from the continuous monitoring station, FR_FRNTP, was calculated for the 1997 and 2017 period and plotted over time (Figure 4.7). Seasonal-Kendall analysis did not identify a significant trend over time (Table 4.5), however, discharge appeared to be lowest in 2015 to 2017, the years where the decrease in % Ephemeroptera was observed. Monthly mean discharge was also plotted in series with year on the X-axis to visualize whether an increasing or decreasing trend existed by month (Figure 4.8), with a significant decrease over time identified for September (Table 4.6). These results suggest discharge was lower in 2015, 2016, and 2017 in the upper Fording River, and may be a contributing factor to the changes in benthic invertebrate community structure.

4.3.4 Substrate Quality

4.3.4.1 Sediment Chemistry

Suspended and bed sediments can play an important role in the transport and fate of chemicals in aquatic systems, particularly with respect to hydrophobic chemicals that adsorb to particle surfaces (Jain and Ram 1997). Settling of particles from the water column to substrates is inversely related to particle size and water velocities (Chin 2006), such that streams that are continuously or seasonally fast flowing tend to be dominated by coarse particles.

Sediment chemistry data was collected to support the questions related to benthic invertebrate community structure. Samples collected in September 2017 had cadmium, manganese, nickel, selenium, and zinc concentrations exceeding the lower and/or upper provincial sediment quality guidelines in one or more areas (Figure 4.10; Appendix Table B.1). The concentrations of these metals did not follow a pattern consistent with the reduction in % Ephemeroptera, with the highest concentrations typically observed at the compliance point (FOBCP), and decreasing with distance downstream.

Eleven PAHs exceeded the lower or upper provincial sediment quality guidelines in sediment (Appendix Figure B.1, Appendix Table B.1). Each PAH exhibited the same pattern, with the highest concentrations observed in the most upstream area (FOUKI) and concentrations decreasing with distance downstream. Similar to metals in sediment, this pattern was not consistent with the reduction in % Ephemeroptera. Overall, results suggest that sediment chemistry is not the cause of changes in benthic invertebrate community structure in the upper Fording River.

4.3.4.2 Calcite and Particle Size

Calcite index (CI) values were greater than the normal range (i.e., 1.0 or higher) at most areas downstream of Swift Creek in 2017 (Table 4.9), including the areas with a reduction in % Ephemeroptera, suggesting that calcite may be influencing the benthic invertebrate community. In contrast, the Calcite Monitoring Program did not identify any areas with a CI greater than 1.0 in 2017. The Calcite Monitoring Program assesses 100-m-long reaches which may contain a variety of habitat types (i.e., riffle, run, pool), while only riffle habitat in the immediate proximity of benthic invertebrate community sample collection is assessed for calcite under the LAEMP. Temporal increases in calcite have not been observed in either program in the areas experiencing decreases in % Ephemeroptera, suggesting that calcite is not the sole contributing

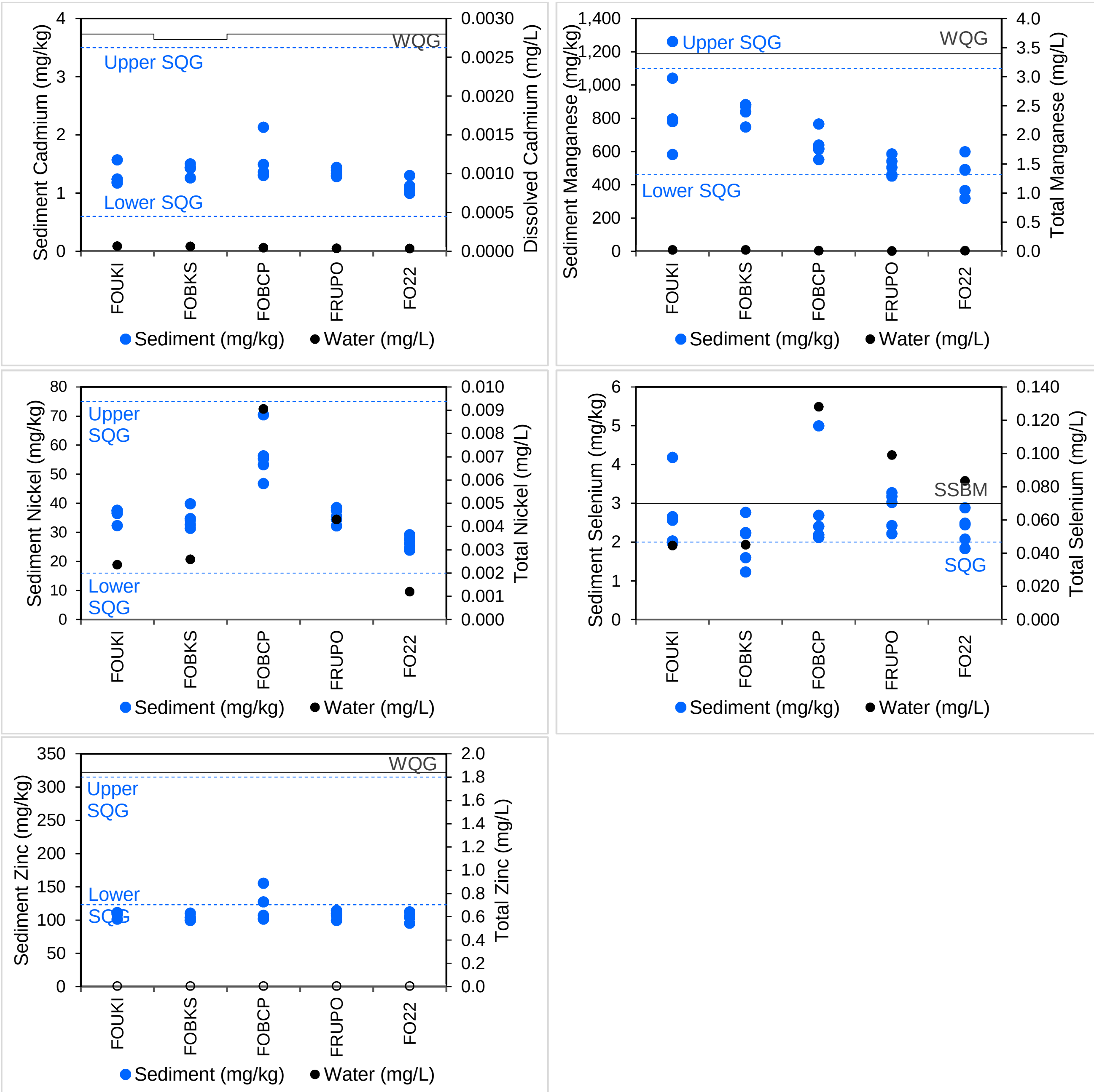


Figure 4.10: Sediment Metal Concentrations Relative to BC Sediment Quality Guidelines (SQG), 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Overlying water concentrations in concurrent water samples are plotted against the water quality guidelines (WQG) or site-specific benchmark (SSBM), except nickely because the WQG is an order of magnitude higher than the sample concentrations.

Table 4.9: Calcite Index Values in Fording River from 2013 to 2017

<table>
<tr><th rowspan="2">Biological Monitoring Area</th><th rowspan="2">Teck Water Station</th><th rowspan="2">Calcite Reach*</th><th colspan="5">Teck Regional Calcite Monitoring (Calcite Index)</th><th colspan="3">Calcite Index at Benthic Invertebrate Monitoring Areas</th></tr>
<tr><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2015</th><th>2016</th><th>2017</th></tr>
<tr><td>FO26</td><td>FR_UFR1</td><td>FORD12</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.3</td><td>-</td><td>0.9</td><td>0.8</td><td>0.6</td></tr>
<tr><td>HENUP</td><td>FR_HC3</td><td>HENR3</td><td>0.0</td><td>0.0</td><td>0.0</td><td>-</td><td>-</td><td>0.1</td><td>0.0</td><td>0.0</td></tr>
<tr><td rowspan="2">HENFO</td><td rowspan="2">-</td><td>HENR1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td rowspan="2">0.9</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>HENR2</td><td>0.0</td><td>0.0</td><td>0.0</td><td>-</td><td>0.0</td></tr>
<tr><td>FODHE</td><td>FR_FR1</td><td rowspan="2">FORD11</td><td rowspan="2">0.0</td><td rowspan="2">0.0</td><td rowspan="2">0.0</td><td rowspan="2">-</td><td rowspan="2">-</td><td>0.9</td><td>0.0</td><td>0.9</td></tr>
<tr><td>FOUNGD</td><td>-</td><td>0.8</td><td>-</td><td>0.6</td></tr>
<tr><td>FODNGD</td><td>FR_FRABEC1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>0.8</td><td>-</td><td>1.0</td></tr>
<tr><td>MP1</td><td>-</td><td rowspan="3">FORD10</td><td rowspan="3">0.0</td><td rowspan="3">0.0</td><td rowspan="3">0.0</td><td rowspan="3">-</td><td rowspan="3">-</td><td>1.0</td><td>-</td><td>1.0</td></tr>
<tr><td>FOUSH</td><td>-</td><td>1.0</td><td>-</td><td>0.9</td></tr>
<tr><td>FOUKI</td><td>FR_FR2</td><td>1.0</td><td>1.8</td><td>0.8</td></tr>
<tr><td>FOBKS</td><td>-</td><td rowspan="3">FORD9</td><td rowspan="3">0.0</td><td rowspan="3">0.0</td><td rowspan="3">0.0</td><td rowspan="3">0.0</td><td rowspan="3">0.3</td><td>0.9</td><td>2.0</td><td>0.5</td></tr>
<tr><td>FOBSC</td><td>FR_FR4</td><td>1.2</td><td>1.8</td><td>1.1</td></tr>
<tr><td>FOBCP</td><td>FR_FRCP1</td><td>1.3</td><td>1.6</td><td>1.1</td></tr>
<tr><td>FRCP1SW</td><td>FR_FRCP1SW</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>1.0</td></tr>
<tr><td>FO10</td><td>-</td><td rowspan="4">FORD8</td><td rowspan="4">0.3</td><td rowspan="4">0.5</td><td rowspan="4">0.5</td><td rowspan="4">-</td><td rowspan="4">-</td><td>0.8</td><td>-</td><td>-</td></tr>
<tr><td>FRUPO</td><td>-</td><td>-</td><td>-</td><td>1.0</td></tr>
<tr><td>FODPO</td><td>FR_ABCH</td><td>0.9</td><td>1.0</td><td>0.9</td></tr>
<tr><td>FO22</td><td>FR_FRABCH</td><td>0.8</td><td>-</td><td>1.0</td></tr>
<tr><td>FOUEW</td><td>FR_FR5</td><td>FORD7/6</td><td>0.6</td><td>0.7</td><td>1.0</td><td>0.6</td><td>0.7</td><td>1.0</td><td>1.0</td><td>1.0</td></tr>
</table>

Note: Refer to Appendix Figure B.2 for calcite reaches.

"-" indicate that no calcite monitoring was completed.

factor influencing the changes in benthic invertebrate community, however calcite was not monitored at these locations in 2012.

A significant positive correlation was found between mean pebble size and % Ephemeroptera using data from 2012, 2015, 2016, and 2017 (Table 4.8; Figure 4.11), indicating that Ephemeroptera taxa prefer larger substrate. When mean pebble size was plotted with % Ephemeroptera, a similar pattern was observed, with the smallest substrate size generally occurring in the areas with the lowest % Ephemeroptera (Figure 4.12). This pattern was similar in 2012, when % Ephemeroptera was within normal range in the upper Fording River, suggesting that although pebble size may influence % Ephemeroptera, it does not fully explain the observed decrease.

4.3.5 Tissue Selenium

Tissue selenium did not exceed the Level 1 Benchmark for effects to fish (11 mg/kg) or benthic invertebrates (13 mg/kg) in composite-taxa samples collected in September 2017, and only exceeded the upper limit of the normal range at FODHE (Figure 4.13, Appendix Table A.1, Appendix Figure A.1). Individual-taxon samples exceeded the Level 1 benchmark for effects to fish in one *Parapsyche* replicate at FOBCP and the Level 1 benchmark for effects to invertebrates, and in Ephemeroptera at FODHE (Appendix Table A.1). During winter sampling in March 2018, no samples exceeded the Level 1 benchmarks (Appendix Table A.2). The spatial pattern in tissue selenium concentrations did not correspond with the reduction in % Ephemeroptera, nor did the temporal pattern where selenium concentrations have generally remained within the normal range over time (Appendix Figure A.1).

Paired water selenium concentrations and composite-taxa tissue selenium concentrations were plotted against the one-step water to benthic invertebrate selenium bioaccumulation model (Golder 2018a), and the majority of measured values fell well below the predicted concentrations (Figure 4.14, Appendix Table A.7). Based on the observed findings, selenium accumulation in tissue does not appear to be a contributing factor in the reduction in % Ephemeroptera in the upper Fording River.

4.3.6 Seasonal Dewatering

A section of the upper Fording River near Swift and Cataract Creeks is known to dewater in the winter. In addition to the analyses outlined in Sections 4.3.1 to 4.3.5, a seasonal dewatering survey was conducted to determine the extent of dewatering as a possible explanation for the observed effects on benthic invertebrate communities. Continuous water temperature and flow were recorded between October 19/20 2017, and April 14, 2018, to support the survey results.

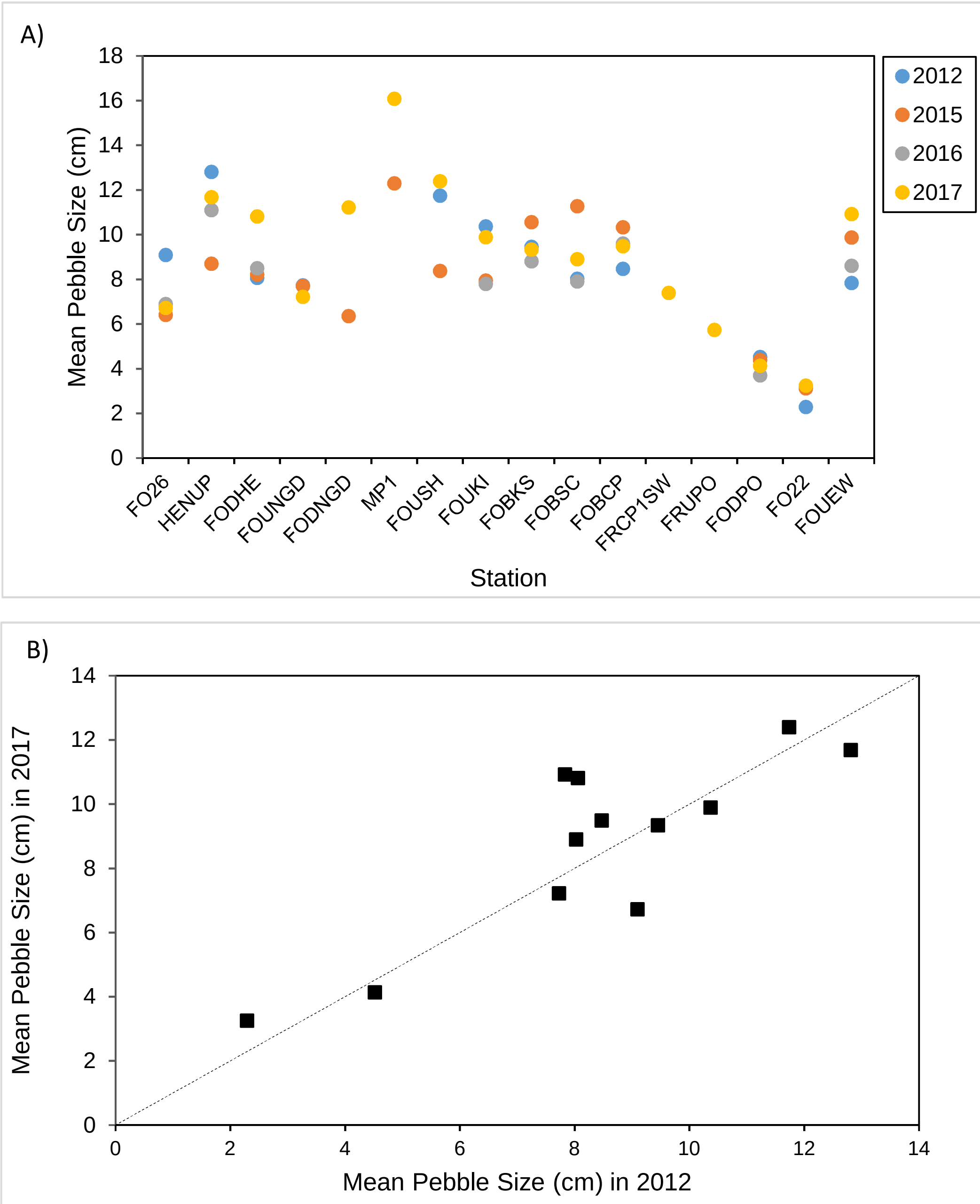


Figure 4.11: A) Mean Pebble Size in 2012, 2015, 2016, and 2017, and B) a Comparison of Mean Pebble Size between 2012 and 2017, Upper Fording River

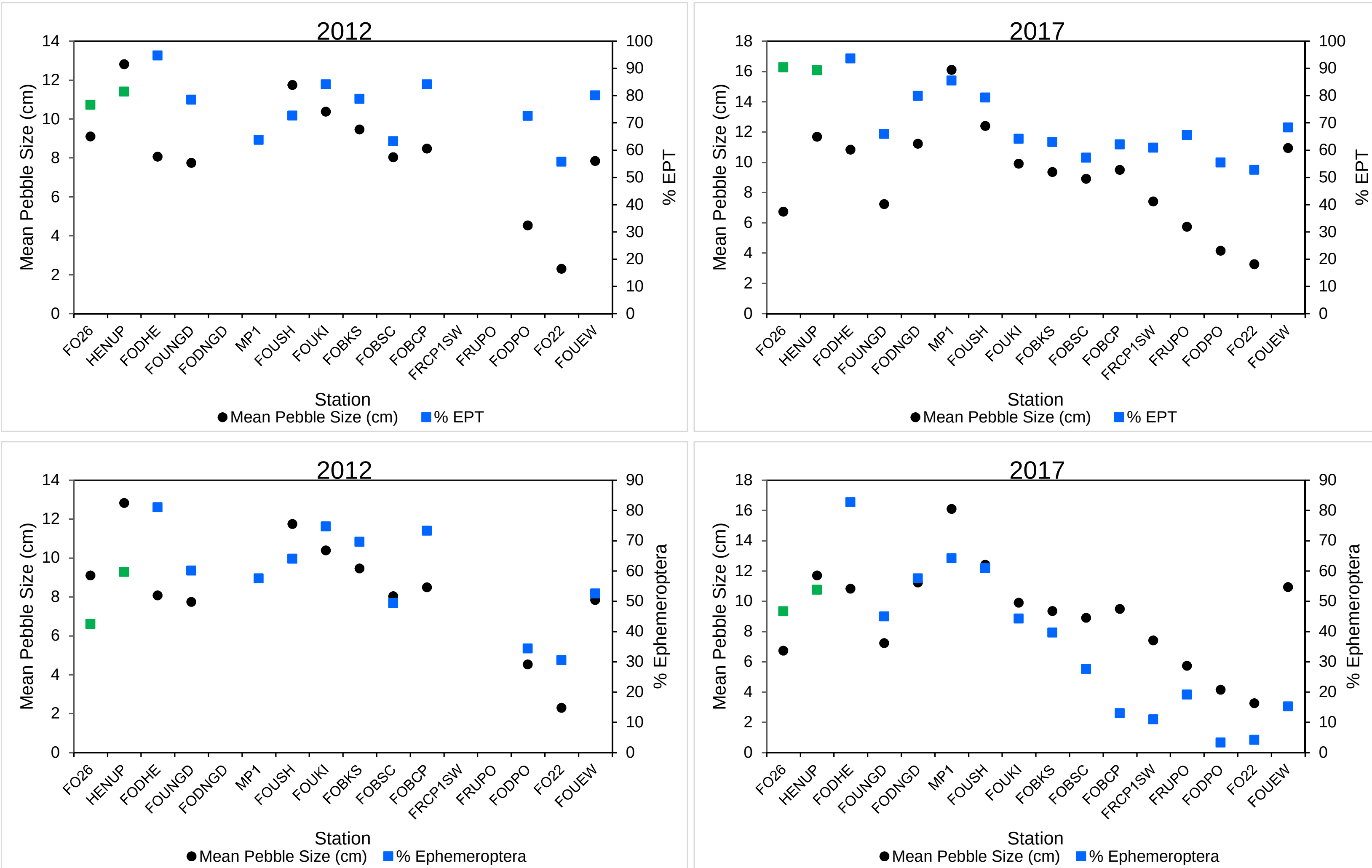


Figure 4.12: Mean Pebble Size and % EPT, % Ephemeroptera in Upper Fording River, 2012 and 2017

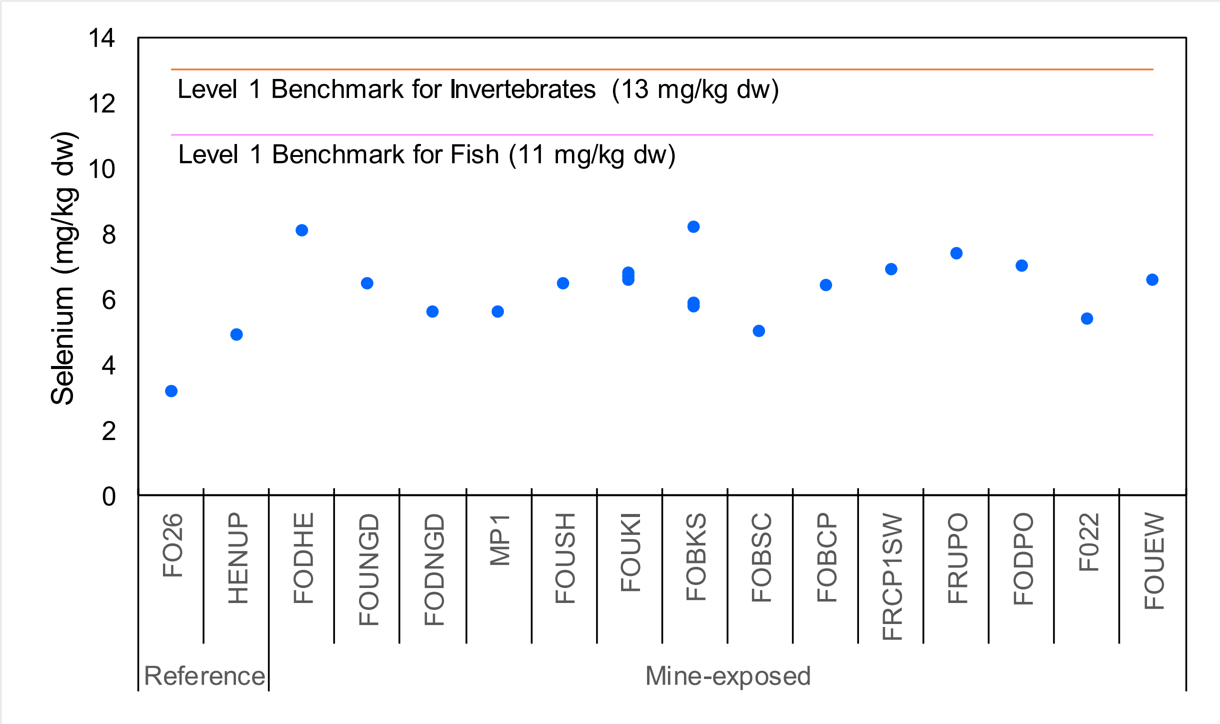


Figure 4.13: Composite-taxa Tissue Selenium Concentrations in the Upper Fording River, 2017

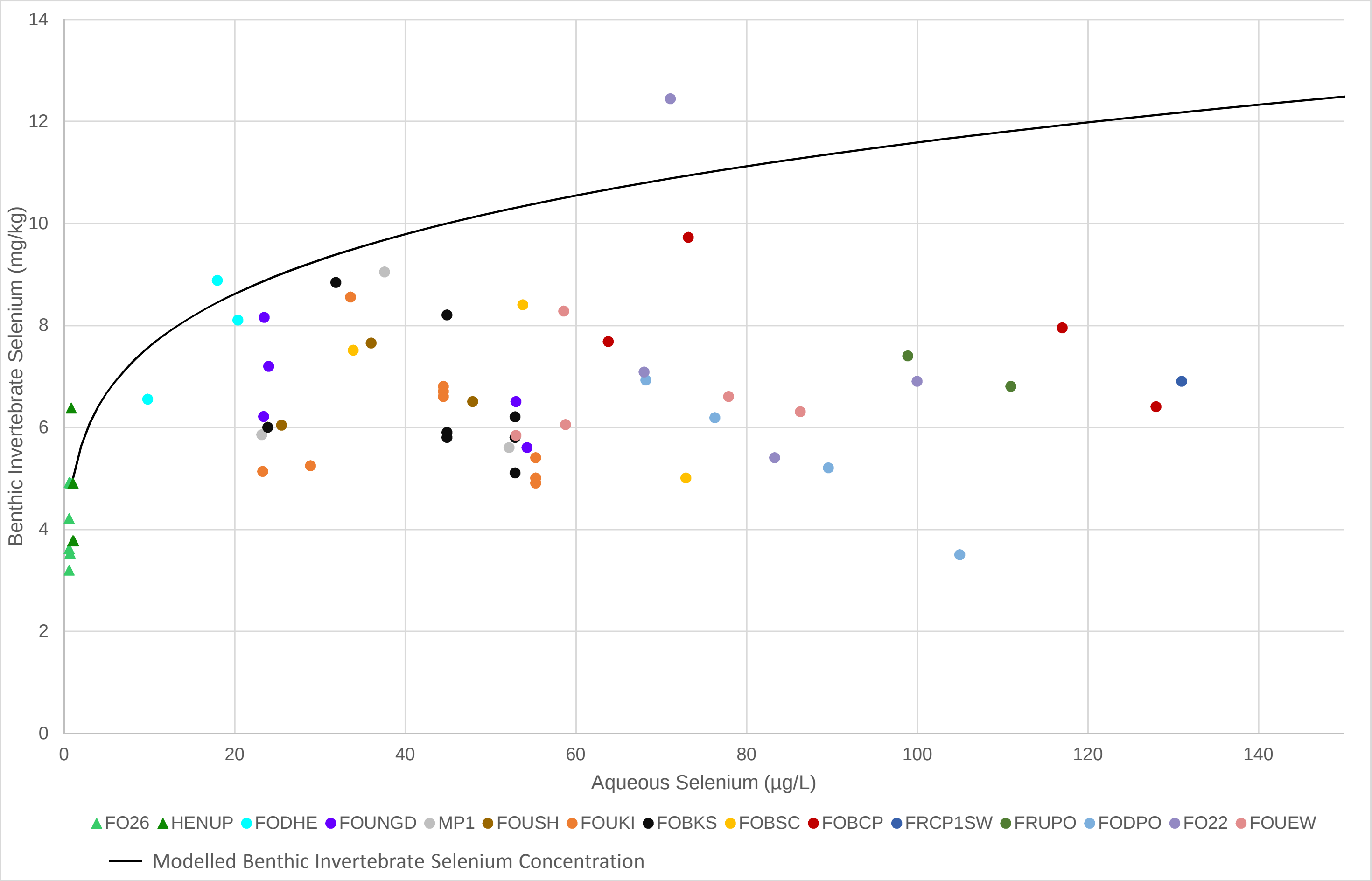


Figure 4.14: Observed and Modelled[a] Selenium Concentrations in Benthic Invertebrate Composite Samples Relative to Aqueous Selenium Concentrations At Stations Upstream and Downstream of Fording River Operations, 2012 to 2018

[a] Benthic invertebrate selenium concentrations were estimated using a one-step water to benthic invertebrate selenium accumulation model: $\log_{10}[Se]_{benthicinvertebrate}$=0.696+0.184x$\log_{10}[Se]_{aq}$ (Golder 2018a).

Note: Triangles indicate reference stations and circles indicate exposed stations.

In October 2017, the full 12.8 km section of the Fording River from Chauncey Creek (FR_FRABCH) up to the South Tailings Pond (FR_FR2) was flowing (Table 4.10). In November and December 2017, snow and ice covered sections of the river but no dewatered sections were reported. From January to March 2018, a dewatered section was observed starting 500 m downstream of FR_FRCP1 and extending to approximately 150 m upstream of FR_FRRD. The section was approximately 1.5 km long (Figure 4.15). FR_FRCP1SW was the only site to dewater. From the logger record, this site was dewatered from December 14, 2017 to March 24, 2018. In April 2018, flow was observed over the full 12.8 km section including the previously dewatered area.

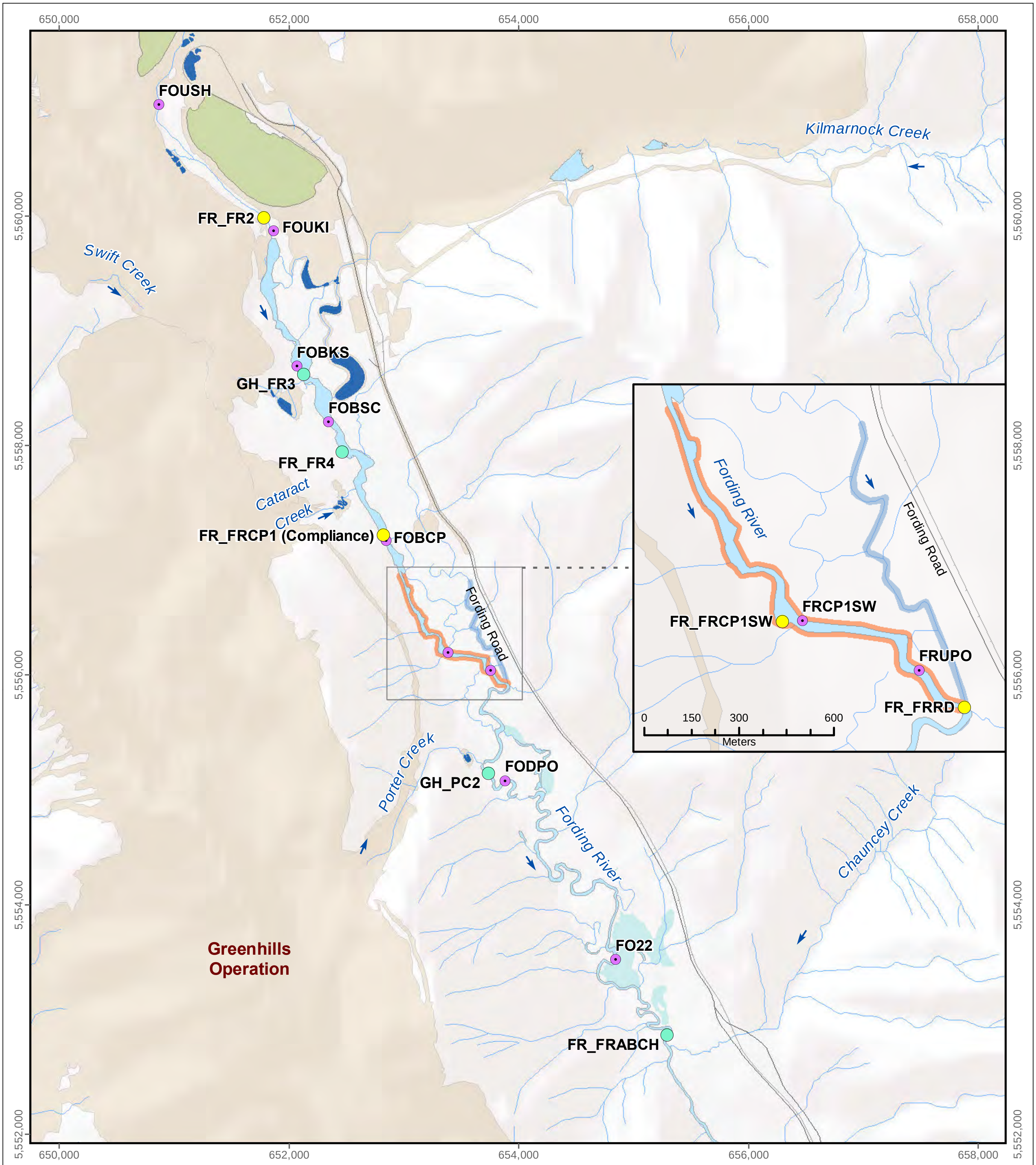
Table 4.10: Summary of Wet and Dry Areas During Dewatering Survey in the Upper Fording River

Area	October	November	December	January	February	March	April
FR_FR2							
GH_FR3							
FR_FR4							
FR_FRCP1							
FR_FRCP1SW			14-Dec-17			24-Mar-18	
FR_FRRD							
GH_PC2							
FR_FRABCH							

Note: Areas are ordered from upstream to downstream
Surface Flow
Dewatered

Logger records suggest that three distinct thermal regimes occur during winter over the surveyed section. The upper sub-section, from FR_FR2, FR_FR4, and FR_FRCP1, showed temperature patterns consistent with locations that remain wetted but have little groundwater influence, as daily temperatures approached 0°C during the winter months but never fully froze (Appendix Figure C.1 to C.3). FR_FRCP1SW was the only station within the dewatered sub-section (Appendix Figure C.4). During the winter months, the mean daily temperatures dropped below 0°C to as low as -4°C.

The furthest downstream sub-section, FR_FRRD, GH_PC2, and FR_FRABCH, showed a temperature regime indicative of groundwater-dominated sites (Appendix Figure C.5 to C.7). The water temperatures in this section typically remained constant between 2 and 5°C throughout the winter months, with only periodic drops approaching 0°C. FR_FRRD showed temperatures as low as -10°C. This was likely due to ice was forming within the stilling well.



LEGEND

- Water Monitoring Station (Non-permit)
- Water Monitoring Station (Permit)
- Mine-exposed
- Reference
- Hydrometric Station
- Greenhouse Groundwater Channel
- Dewatered Section
- Settling Pond
- Tailings Pond
- Teck Coal Mine Operation

Dewatering in the Upper Fording River, January to April 2018

0 0.75 1.5 3 km

N E S W

Datum: NAD 83 Map Projection: UTM Zone 11N
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Date: May 2018
Project 177202.0022

minnow environmental inc.

Figure 4.15

Document Path: S:\Projects\177202\177202.0022 - Teck 2017 FRO LAEMP Implementation\GIS\Report\17-22 Fig 4.15 Fording River Dewatering.mxd

Similar to water temperature, the surveyed section of the Fording River could be differentiated into three sub-sections based on hydrologic conditions. The upstream-most sub-section, FR_FR2, FR_FR4, and FR_FRCP1, showed water level patterns of locations that remain wetted and have less groundwater influence (Appendix Figure C.8 to C.10). FR_FR4 in particular showed more variable stage records, which were likely due to the detection of changes in snow and ice cover as changes in pressure, but did not represent true changes in water stage.

The middle sub-section did not sustain surface flow throughout winter. FR_FRCP1SW showed the water level record from within the dewatered section. The subsection was dewatered from December 14, 2017 to March 24, 2018, indicated by the absence of a line (Table 4.10, Appendix Figure C.11).

As with temperature, the water stage in the furthest downstream sub-section, FR_FRRD, GH_PC2, and FR_FRABCH, showed a flow regime indicative of a groundwater dominated site. Water stage remained relatively constant over the wintering period, also suggesting little influence by snow and ice cover (Appendix Figure C.12 to C.14). Stage-discharge relationships were not derived due to a lack of data points over a range of water stages and ice-free conditions, thus, direct comparisons between sites were not possible.

A hydrograph of the Fording River at FR_FRNTP was plotted for March 2017 to May 2018 (Figure 4.16). Flows (m^3/s) recorded on the estimated date when the section of the Fording River first dewatered (December 14, 2017) and re-watered (March 24, 2018) showed a mean daily discharge of 0.45 and 0.55 m^3/s, respectively. Both of these flows were representative of the base flow period for 2017 to 2018.

The 1.5 km section of the upper Fording River between FR_FRCP1 and FR_FRRD that dewatered encompassed two biological monitoring areas, FRCP1SW and FRUPO, for which there are only biological data from 2017. Although these areas are within the reach where the decrease in % Ephemeroptera was observed (see Section 4.2), it is unlikely that dewatering was the cause, as the effects on benthic invertebrate community structure extend both upstream and downstream of the dewatered section.

4.4 Influence of WQ and Habitat Factors on Benthic Invertebrate Community

To support the understanding of benthic invertebrate communities in the upper Fording River, information on life history traits was compiled for the most abundant EPT taxa, including the Ephemeroptera taxa that have decreased over time (Appendix Table A.6). This observational data did not point to any obvious habitat preferences that could explain the decrease in % Ephemeroptera, although the taxonomic resolution (of field collected samples) for the taxa of interest confounds interpretation, as the majority of Heptageniids and Ephemerellids were only

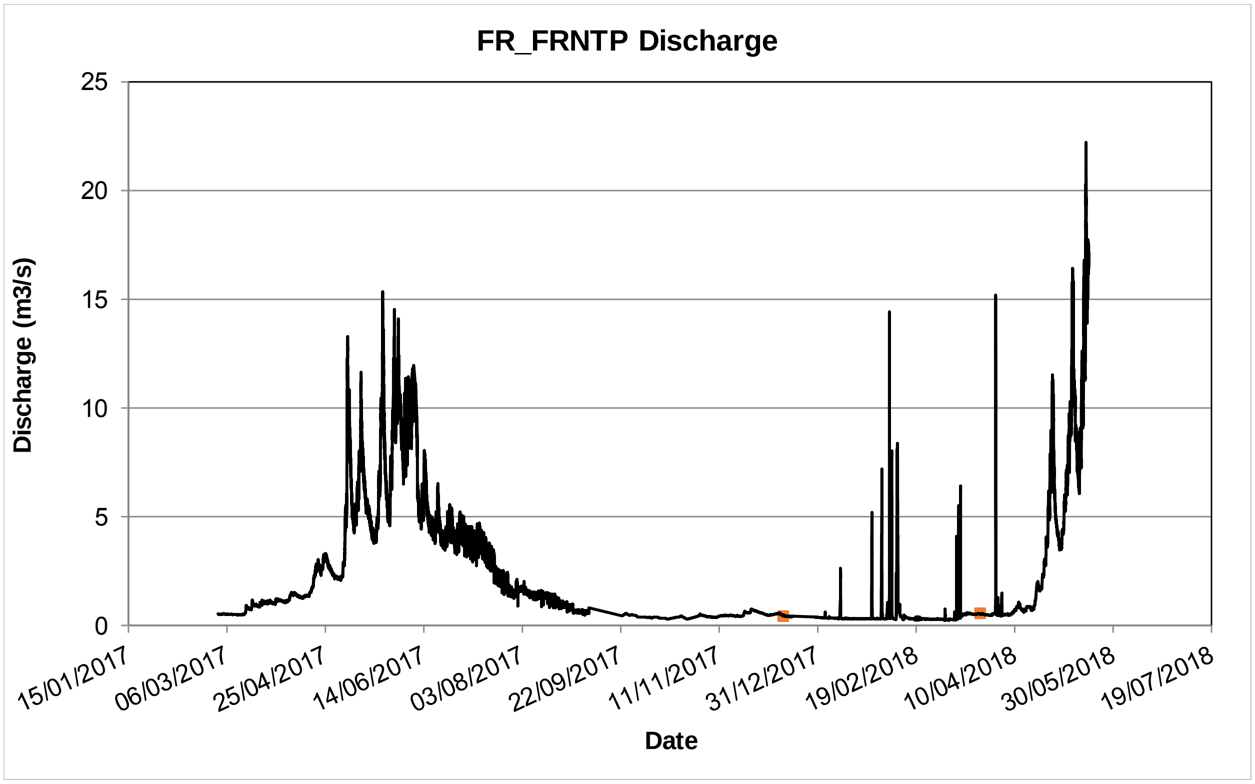

Figure 4.16: Hydrograph of Flow Data from FR_FRNTP from March 2017 to May 2018

Notes: Red symbols identify the dates when the section of the upper Fording River first de-watered and then re-watered identified to family. Individuals in the family Baetidae, which did not experience a similar spatial or temporal reduction in the upper Fording River, were primarily identified as the genus *Baetis.*

Baetis are found in erosional and depositional areas of streams where they cling to stones, aquatic vegetation, and detritus, and where they function trophically as collector-gatherers of organic matter and scrapers of the periphyton community (Merritt et al. 2008). *Drunella* mayflies, which were the most common genus in the family Ephemerellidae, have similar habitat requirements to that of *Baetis*, but function both as scrapers and as facultative engulfing predators, as well as collector-gatherers. *Epeorus* and *Rhithrogena*, the most commonly identified genera in the family Heptageniidae, are restricted to cold, swift-moving waters in erosional areas of streams, where they cling onto rocks and function as scrapers of periphyton and collector-gatherers of organic materials (Merritt et al. 2008). These two genera have requirements of meso-to-stenothermal cold waters of neutral to alkaline pH, and are considered intolerant of organic enrichment (Hubbard and Peters 1978).

There is a paucity of information on critical life stages and sensitivities to specific mine-related parameters for Ephemeroptera taxa present in the upper Fording River. That said, reduced % Ephemeroptera was observed at high elevation coal mining operations (e.g., Central Appalachian Mountains, Elk Valley, and McLeod River), and Heptageniidae and Ephemerellidae were the most sensitive taxa (Pond et al. 2008, Kuchapski and Rasmussen 2015). Mine-related changes in water quality and substrate were most strongly associated with the changes in benthic invertebrate community in these studies, but no clear cause was established and they did not have the same robust temporal dataset as is available for the upper Fording River.

The reduction in % Ephemeroptera does not co-occur with losses in specific genera; i.e. all genera are present in each area, albeit at lower abundances (Appendix Table A.8). It is possible that factors such as mayfly predation by other invertebrate taxa or fish may affect the densities of certain organisms. For example, in 2017 % Plecoptera was highest in areas with a decrease in % Ephemeroptera, and Plecoptera are known predators of Ephemeroptera. A strong year class of westslope cutthroat trout (WCT) may also be a contributing factor to the observed effect.

To aid in further understanding the benthic invertebrate communities in the upper Fording River, NMDS was conducted on family level relative abundance data (Tables 4.11 and 4.12. Figures 4.17 and 4.18). In 2017, a separation from upstream to downstream was observed along NMDS axis 1, which best explained reference versus mine-exposed benthic invertebrate communities (Figure 4.17). The taxa driving the separation on both axis 1 and axis 2 are relatively rare, or present/absent only in the most downstream mine-exposed areas (Appendix Table A.8). None of the Ephemeroptera taxa associated with the spatial and temporal decrease in the upper Fording River had relatively high or low NMDS scores (Table 4.11). The NMDS conducted using

Table 4.11: Non-metric Multi-dimensional Scaling (NMDS) Axis Scores for a 2-Dimensional NMDS of Family Level Relative Abundances (Fourth Root Transformed) for Benthic Invertebrate Communities Sampled in the Upper Fording River, September 2017

Family	NMDS Axis 1	NMDS Axis 2
Leuctridae	-0.433	-0.365
Hygrobatidae	-0.707	0.069
Pisidiidae	-0.141	-0.977
Aturidae	0.380	-0.345
Limnephilidae	-0.265	-0.592
Torrenticolidae	-0.274	0.014
Apataniidae	-0.336	0.030
Naididae	-0.080	-0.496
Simuliidae	-0.522	0.224
Uenoidae	0.352	-0.247
Enchytraeidae	-0.252	0.048
Ameletidae	0.483	0.174
Perlidae	-0.074	0.017
Elmidae	-0.290	-0.483
Brachycentridae	-0.289	0.283
Ceratopogonidae	-0.049	0.075
Empididae	-0.356	-0.043
Chloroperlidae	0.338	-0.097
Hydropsychidae	0.210	0.078
Sperchontidae	0.006	0.081
Glossosomatidae	-0.068	-0.014
Tipulidae	-0.083	-0.011
Capniidae	0.022	0.010
Nemouridae	0.046	-0.102
Perlodidae	-0.002	-0.081
Taeniopterygidae	0.150	-0.007
Psychodidae	-0.043	0.112
Lebertiidae	-0.169	-0.002
Baetidae	0.071	0.057
Ephemerellidae	0.174	0.030
Heptageniidae	0.094	0.083
Rhyacophilidae	-0.097	0.015
Chironomidae	-0.055	0.030

Area		NMDS Axis 1	NMDS Axis 2
Reference	HENUP	0.294	0.033
	FO26	0.233	-0.078
Mine-exposed	FOBCP	-0.184	0.058
	MP1	0.117	-0.127
	FODNGD	0.045	-0.011
	FODHE	0.378	0.147
	FOBSC	-0.058	0.075
	FRCP1SW	-0.279	0.001
	FO22	-0.045	-0.337
	FOBKS-1	-0.051	0.046
	FOBKS-2	-0.007	0.108
	FOBKS-3	-0.027	0.085
	FRUPO	-0.446	0.274
	FOUEW	-0.040	-0.247
	FOUKI-1	0.022	0.138
	FOUKI-3	0.114	0.081
	FOUSH	0.122	0.004
	FOUNGD	0.076	0.023
	FODPO	-0.264	-0.272

Grey: Relatively high score to axis in negative direction

Blue: Relatively high score to axis in positive direction

Table 4.12: Non-metric Multi-dimensional Scaling (NMDS) Axis Scores for a 2-Dimensional NMDS of Family Level Relative Abundances (Fourth Root Transformed) for Benthic Invertebrate Communities Sampled in the Upper Fording River, September 2012, 2015, 2016, and 2017

Family	NMDS Axis 1	NMDS Axis 2	NMDS Axis 3
Ameletidae	0.430	-0.251	-0.005
Baetidae	0.073	0.013	0.083
Brachycentridae	-0.093	-0.342	0.295
Capniidae	-0.193	0.218	0.119
Ceratopogonidae	0.072	0.146	0.209
Chironomidae	-0.050	-0.053	-0.017
Chloroperlidae	0.146	0.022	-0.156
Elmidae	-0.511	0.428	-0.262
Empididae	-0.423	-0.230	-0.155
Enchytraeidae	-0.200	-0.100	0.377
Ephemerellidae	0.155	-0.035	-0.055
Glossosomatidae	-0.451	-0.026	-0.144
Heptageniidae	0.175	-0.030	-0.022
Hydropsychidae	0.126	-0.122	0.038
Lebertiidae	-0.233	-0.110	0.048
Leuctridae	0.053	-0.318	-0.143
Limnephilidae	-0.237	0.095	-0.131
Nemouridae	-0.030	0.047	-0.032
Perlidae	-0.116	-0.064	0.222
Perlodidae	-0.045	0.080	0.017
Psychodidae	0.088	0.036	0.197
Rhyacophilidae	-0.088	0.066	0.005
Simuliidae	-0.463	-0.063	0.085
Sperchontidae	-0.045	-0.355	-0.029
Taeniopterygidae	0.080	0.104	-0.078
Tipulidae	-0.031	0.151	-0.026
Uenoidae	-0.086	0.314	-0.486

Year	Area	NMDS Axis 1	NMDS Axis 2	NMDS Axis 3
2012	FO22	-0.042	0.303	-0.123
	FOBCP	0.227	0.011	0.140
	FOBKS	0.274	0.237	0.027
	FOBSC	0.195	0.080	0.131
	FODHE	0.252	-0.018	-0.049
	FODPO	-0.102	0.132	-0.018
	FOUEW	-0.135	-0.014	-0.051
	FOUKI	0.253	0.230	0.052
	FOUNGD	0.230	0.139	0.036
	FOUSH	0.210	-0.019	0.045
	MP1	0.342	-0.145	0.076
	FO26	-0.015	-0.236	-0.093
	HENUP	-0.033	-0.245	-0.189
2015	FO22	-0.227	0.180	-0.077
	FOBCP	-0.184	0.006	0.145
	FOBKS	0.024	0.044	0.173
	FOBSC	-0.049	-0.095	0.135
	FODHE	0.166	-0.248	0.075
	FODNGD	0.085	0.210	-0.020
	FODPO	-0.254	0.245	-0.188
	FOUEW	-0.218	-0.099	-0.078
	FOUKI	0.074	0.083	0.195
	FOUNGD	0.240	0.124	-0.061
	FOUSH	0.076	-0.107	0.079
	MP1	-0.002	0.009	-0.013
	FO26	0.136	-0.203	-0.073
	HENUP	0.385	0.032	-0.190
2016	FOBCP	-0.093	0.023	0.198
	FOBKS	0.023	-0.024	0.152
	FOBSC	-0.119	-0.031	0.116
	FODHE	0.182	-0.149	0.084
	FODPO	-0.260	0.136	-0.034
	FOUEW	-0.288	0.028	-0.059
	FOUKI	-0.068	-0.111	0.046
	FO26	0.031	-0.129	-0.211
	HENUP	0.224	-0.180	-0.274
2017	FO22	-0.272	0.119	-0.157
	FOBCP	-0.257	-0.098	0.153
	FOBSC	-0.074	-0.059	0.142
	FODHE	0.283	-0.046	-0.077
	FODNGD	-0.053	-0.011	-0.038
	FODPO	-0.389	0.149	-0.084
	FOUEW	-0.228	0.019	-0.147
	FOUNGD	0.006	-0.046	-0.038
	FOUSH	0.043	0.059	-0.018
	MP1	-0.005	0.169	0.059
	FO26	0.092	0.046	-0.171
	HENUP	0.094	-0.074	-0.248
	FRCP1SW	-0.235	0.000	0.221
	FRUPO	-0.446	-0.376	-0.015
	FOBKS	-0.078	-0.033	0.105
	FOUKI	-0.021	-0.018	0.210

Relatively high score to axis in negative direction (grey shading: Ameletidae–none; Brachycentridae Axis 2; Elmidae Axes 1 and 3; Empididae Axis 1; Glossosomatidae Axis 1; Leuctridae Axis 2; Simuliidae Axis 1; Sperchontidae Axis 2; Uenoidae Axis 3)
Relatively high score to axis in positive direction (blue shading: Ameletidae Axis 1; Brachycentridae Axis 3; Elmidae Axis 2; Enchytraeidae Axis 3; Uenoidae Axis 2)

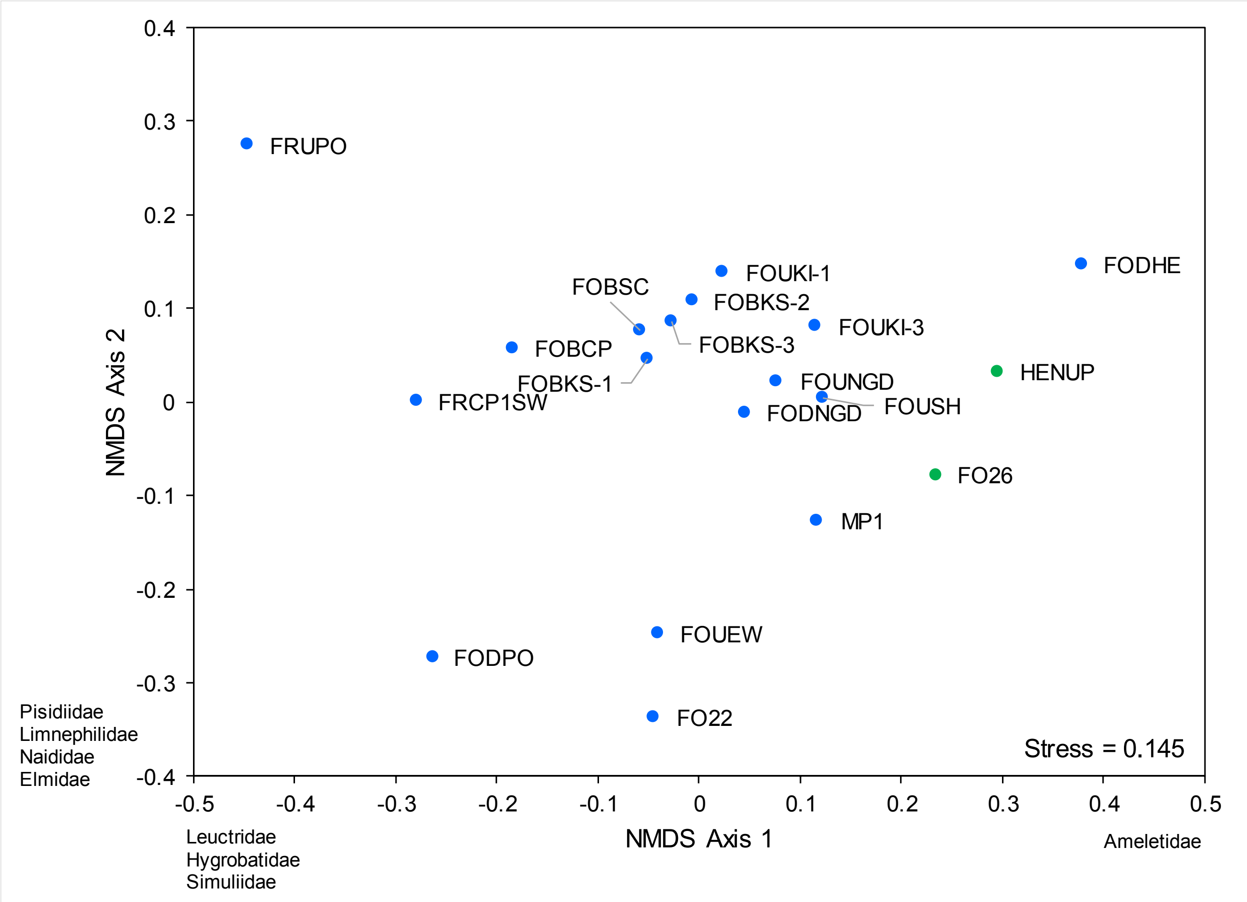

Figure 4.17: Scatterplot of Axis Scores from a 2-Dimensional Non-metric Multi-dimensional Scaling (NMDS) of Family Level Relative Abundances (Fourth Root Transformed) for Benthic Invertebrate Communities Sampled in the Upper Fording River, September 2017

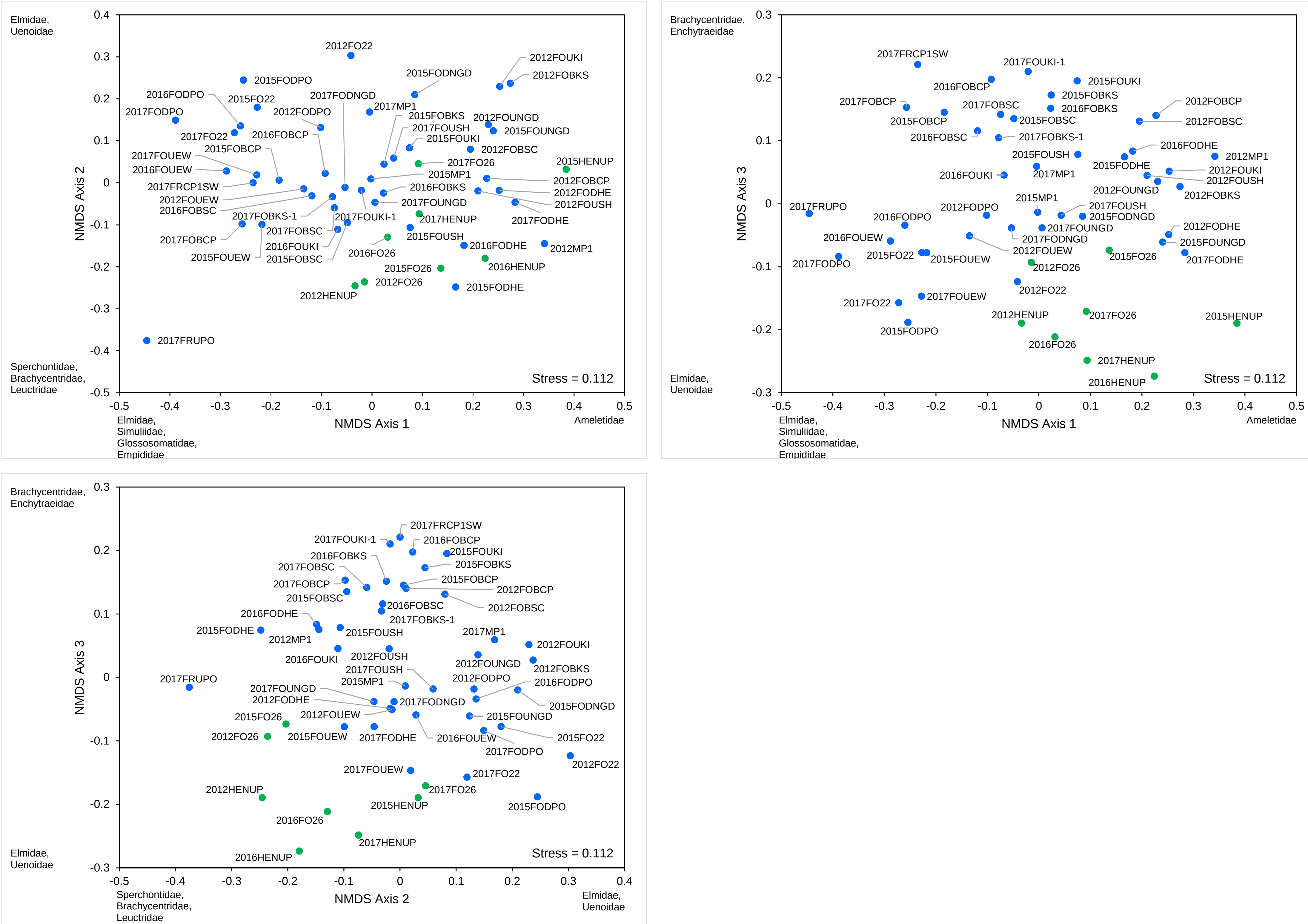

Figure 4.18: Scatterplots of Axis Scores from a 2-Dimensional Non-metric Multi-dimensional Scaling (NMDS) of Family Level Relative Abundances (Fourth Root Transformed) for Benthic Invertebrate Communities Sampled in the Upper Fording River, September 2012, 2015, 2016, and 2017

Notes: Families listed on the positive and negative Y and X-axes are the families with relatively high axis scores in the positive and negative direction all four years of data (i.e., 2012, 2015, 2016, and 2017) produced a similar result, with reference and upstream mine-exposed areas separating from downstream mine-exposed areas on axis 1. Again, most of the taxa driving the separation were rare or present/absent only in the downstream mine-exposed areas (Appendix Table A.8). NMDS axis 1 scores decreased from 2012 to 2017 at most mine-exposed areas, suggesting that communities have changed over time (Figure 4.19).

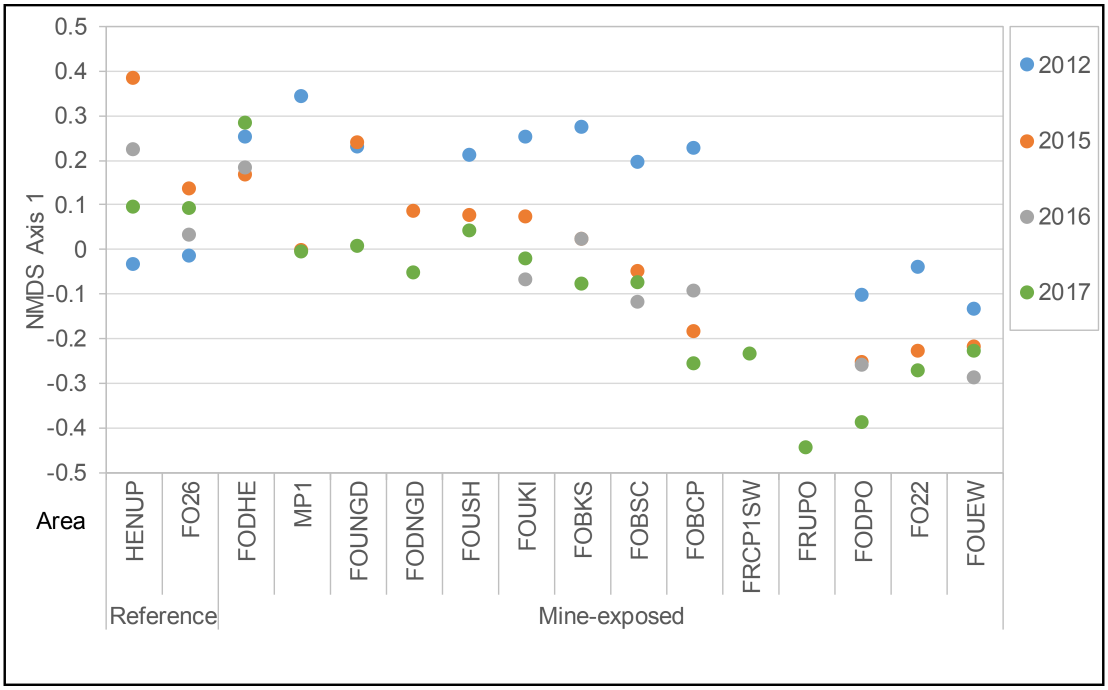

Figure 4.19: Scatterplot for NMDS Axis 1 Over Time in the Upper Fording River

PCA analysis identified the first two Principal Components explaining 56.5% and 8.5% of the variability in the data set, respectively (Figure 4.20). Pearson correlations identified that the spread in water quality data along PC-1 were associated with increased concentrations of mine-related constituents as well as other correlating analytes, specifically those representing the dissolved fraction (Table 4.13), similar to what was seen in the previous RAEMP (Minnow 2018). When PC-1 scores were compared over time, little change was seen between the years at any location (Figure 4.21). Also similar to the RAEMP, separation along PC-2 was associated with the particulate fraction (e.g. turbidity and TOC), but several dissolved analytes also correlated significantly with this axis (e.g. iron, manganese, ammonia, nitrate, and strontium). For both axes, the findings were consistent across the different timeframes tested (Table 4.13).

To assess the general influence of physical and chemical parameters on the benthic invertebrate community, correlations were conducted between benthic invertebrate endpoints (NMDS axis 1, NMDS axis 2, NMDS axis 3, % Ephemeroptera, and % EPT), and mean pebble size, calcite index,

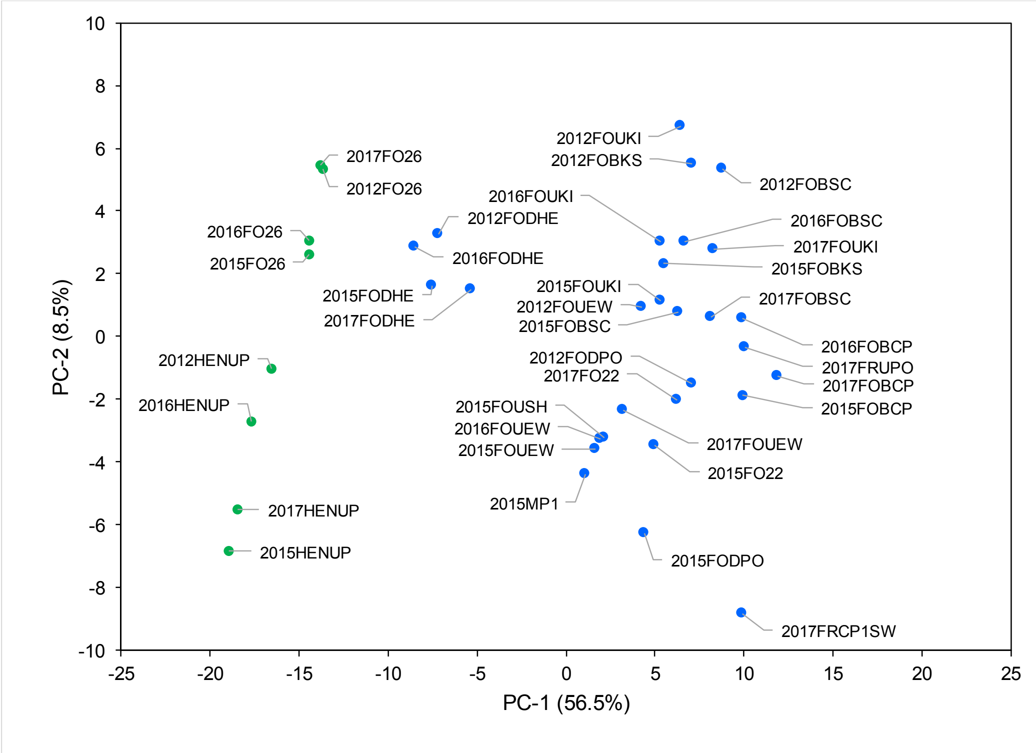

Figure 4.20: Scatterplot of PC-2 vs PC-1 from a PCA of Mean and Maximum Water Quality Parameters for Three Time Periods (Sept, Jul-Sep, and Jan-Sep), 2012, 2015, 2016, and 2017

Notes: PCA conducted on log10-transformed variables and included variables with 50% or more of the concentrations above the laboratory reporting limit. The PCA was conducted using the correlation matrix.

Table 4.13: Pearson Correlation Coefficients for Water Quality Parameters vs PC-1 and PC-2 from a PCA of Mean and Maximum Water Quality Parameters for Three Time Periods (Sept, Jul-Sep, and Jan-Sep), 2012, 2015, 2016, and 2017

Parameter	PC-1 (56.5%)						PC-2 (8.5%)					
	Sept Max	Sept Mean	Jul-Sep Max	Jul-Sep Mean	Jan-Sep Max	Jan-Sep Mean	Sept Max	Sept Mean	Jul-Sep Max	Jul-Sep Mean	Jan-Sep Max	Jan-Sep Mean
Alkalinity	0.694	0.692	0.682	0.704	0.800	0.777	-0.202	-0.202	-0.262	-0.383	-0.087	-0.261
Aluminum	0.036	0.079	0.107	0.078	0.319	0.411	0.316	0.282	0.441	0.485	0.391	0.541
Antimony	0.815	0.810	0.833	0.811	0.764	0.809	0.009	0.011	0.065	-0.055	0.168	0.042
Argon	0.151	0.138	0.083	0.193	0.353	0.509	-0.015	-0.030	0.001	0.037	0.077	0.102
Barium	0.394	0.398	0.402	0.346	0.525	0.459	-0.209	-0.206	-0.206	-0.369	-0.116	-0.273
Boron	0.600	0.594	0.581	0.568	0.726	0.654	-0.064	-0.062	-0.138	-0.252	0.036	-0.211
Cadmium	0.863	0.865	0.816	0.849	0.831	0.874	0.320	0.318	0.275	0.279	0.329	0.289
Calcium	0.862	0.854	0.844	0.748	0.856	0.813	-0.264	-0.266	-0.279	-0.430	-0.240	-0.371
Chromium	0.101	0.060	0.158	-0.003	0.350	0.279	-0.057	-0.091	0.211	0.177	0.296	0.320
Hardness	0.877	0.870	0.857	0.775	0.887	0.832	-0.243	-0.243	-0.262	-0.397	-0.206	-0.323
Iron	0.653	0.637	0.411	0.475	0.508	0.669	0.421	0.434	0.393	0.394	0.401	0.496
Lithium	0.877	0.875	0.877	0.820	0.893	0.862	-0.119	-0.116	-0.131	-0.254	0.056	-0.143
Magnesium	0.893	0.890	0.887	0.811	0.904	0.848	-0.226	-0.224	-0.231	-0.364	-0.118	-0.279
Manganese	0.791	0.791	0.821	0.809	0.714	0.791	0.398	0.398	0.376	0.368	0.483	0.400
Molybdenum	0.822	0.819	0.853	0.841	0.881	0.869	0.067	0.064	0.134	0.067	0.119	0.069
Nickel	0.941	0.941	0.949	0.931	0.924	0.928	0.036	0.035	0.010	-0.046	0.025	0.044
Nitrate (NO3)	0.683	0.681	0.687	0.621	0.764	0.690	-0.480	-0.475	-0.466	-0.560	-0.255	-0.471
Nitrite (NO2)	0.720	0.702	0.707	0.730	0.783	0.752	0.041	0.046	0.084	-0.012	0.094	0.040
Ammonia	0.246	0.224	0.319	0.317	0.360	0.353	0.434	0.442	0.559	0.529	0.480	0.410
pH	-0.242	-0.236	0.243	0.141	0.235	0.125	0.631	0.627	0.523	0.593	0.471	0.441
Potassium	0.736	0.733	0.733	0.678	0.860	0.774	0.139	0.138	0.132	0.099	0.217	0.157
Selenium	0.845	0.841	0.836	0.794	0.847	0.819	-0.368	-0.371	-0.374	-0.435	-0.340	-0.399
Sodium	0.637	0.571	0.572	0.463	0.749	0.539	-0.228	-0.168	-0.167	-0.163	0.264	0.048
Strontium	0.826	0.815	0.815	0.678	0.700	0.758	-0.383	-0.388	-0.388	-0.558	-0.270	-0.482
Total Dissolved Solids	0.863	0.867	0.856	0.774	0.867	0.825	-0.263	-0.258	-0.272	-0.400	-0.252	-0.369
Total Organic Carbon	0.660	0.658	0.621	0.717	0.235	0.505	0.430	0.437	0.394	0.426	0.719	0.714
Turbidity	0.399	0.407	0.139	0.273	0.376	0.488	0.411	0.410	0.431	0.451	0.396	0.444
Uranium	0.917	0.917	0.902	0.842	0.950	0.910	-0.244	-0.246	-0.277	-0.404	-0.073	-0.252

(shaded) P-value <0.05

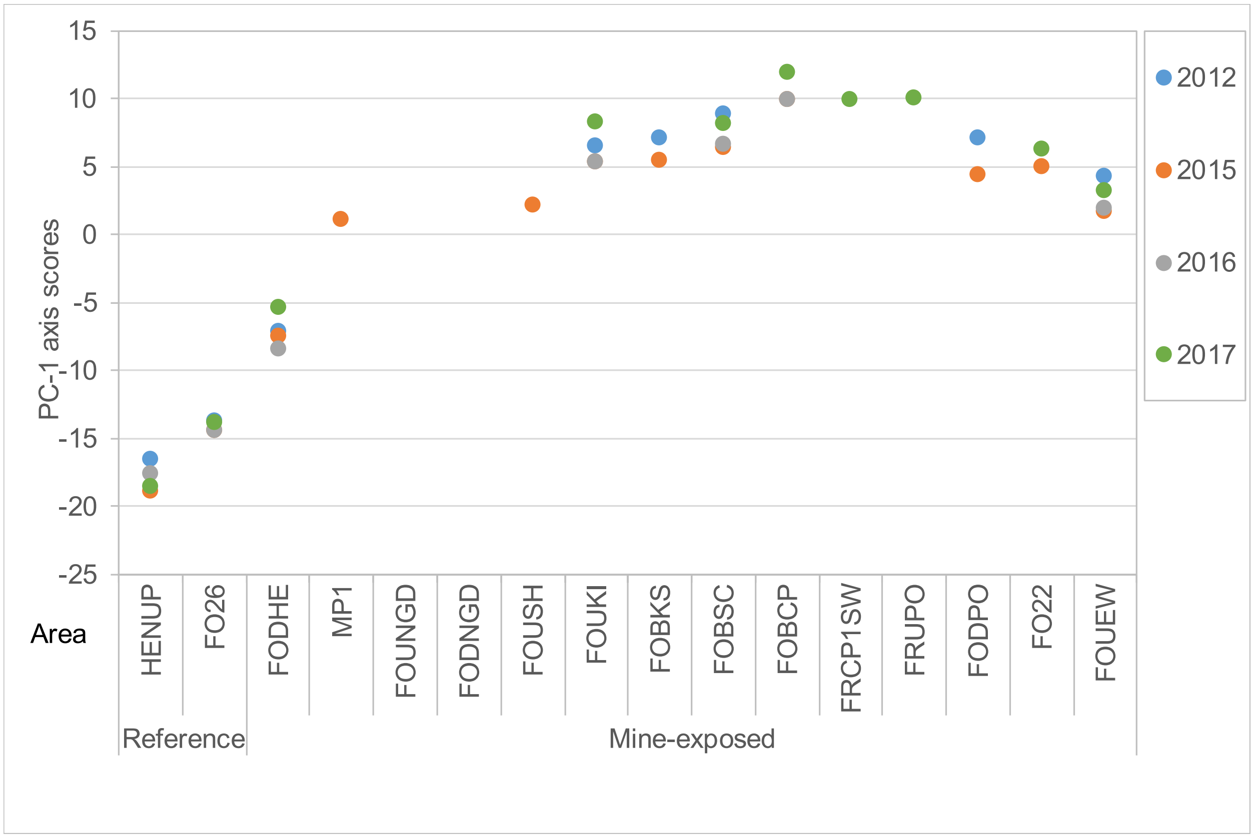

Figure 4.21: Scatterplot for PC-1 Axis Scores Over Time in the Upper Fording River

PC-1, PC-2, flow (mean and maximum in September, July to Sept, and January to September), and temperature (mean and maximum in September, July to Sept, and January to September) (Table 4.14; Appendix Figure A.14). NMDS axis 1 was positively correlated with calcite index and PC-1, and negatively correlated PC-2. This axis best identified the differences between reference and exposed areas, and these results imply that mine-related factors are driving the differences in benthic invertebrate communities among these areas, with NMDS-1 representing those taxa that are more likely to be present in in the most downstream mine-exposed areas. Percent Ephemeroptera was positively correlated with mean pebble size, but negatively correlated with calcite index, PC-1, and PC-2, which further supports both habitat and mine-influence as factors in the observed reduction. While significant correlations did exist between temperature and/or flow and NMDS axis 2, NMDS axis 3, and % EPT, neither correlated with NMDS axis 1 or % Ephemeroptera, suggesting that although temperature and flow may be influencing benthic invertebrate communities, they are not the primary factors driving the observed differences.

Table 4.14: Spearman Rank Correlations Between Benthic Invertebrate Endpoints and Physical and Chemical Parameters, 2012, 2015, 2016, and 2017

Parameter	NMDS Axis 1	NMDS Axis 2	NMDS Axis 3	% E	% EPT
Mean Pebble Size	0.259	-0.277	0.181	0.317	0.182
Calcite Index	-0.397	0.056	0.515	-0.424	-0.570
PC-1 WQ (56%)	-0.484	0.321	0.750	-0.558	-0.675
PC-2 WQ (8.5%)	0.460	-0.070	0.208	0.412	0.051
Flow (Sept max)	-0.001	0.541	0.426	-0.110	-0.399
Flow (Sept mean)	-0.003	0.539	0.423	-0.111	-0.394
Flow (Jul-Sep max)	0.021	0.223	0.272	-0.028	-0.291
Flow (Jul-Sep mean)	-0.029	0.419	0.387	-0.079	-0.400
Flow (Jan-Sep max)	-0.070	0.424	0.533	-0.212	-0.374
Flow (Jan-Sep mean)	-0.135	0.524	0.460	-0.238	-0.482
Temperature (Sept max)	0.079	-0.047	0.505	0.111	-0.271
Temperature (Sept mean)	0.059	-0.018	0.540	0.083	-0.291
Temperature (Jul-Sep max)	0.193	0.005	0.691	0.153	-0.243
Temperature (Jul-Sep mean)	0.092	-0.128	0.763	0.105	-0.303
Temperature (Jan-Sep max)	-0.024	-0.020	0.579	-0.123	-0.335
Temperature (Jan-Sep mean)	-0.168	0.106	0.651	-0.196	-0.388

[shaded] P-value < 0.05

4.5 Summary

The evaluation of data related to Key Questions #1 (increasing nitrate concentrations and effects on biota) and additional investigations into factors contributing to the changes in benthic invertebrate community structure did not identify a clear, causal link with any one factor to explain the spatial and temporal reduction in % Ephemeroptera. Results are summarized in Table 4.15.

The previous LAEMP report identified nitrate, temperature, flow/seasonal dewatering, and calcite as possible causes of the changes in benthic invertebrate community. Nitrate concentrations are seasonally above the Level 1 and Level 2 benchmarks in the areas experiencing decreases in % Ephemeroptera, however, the highest concentrations were observed at FR_FRCP1, while the lowest % Ephemeroptera was found further downstream. Temporal trends for nitrate, other Order constituents, and nickel suggest that water quality has not changed over time commensurate with the decline in % Ephemeroptera.

Temperature in the upper Fording River also did not appear to be causing the observed changes in benthic invertebrate community structure. Temporal analysis of continuous water data from 2010 to 2017 did not identify an increasing trend. A significant positive correlation over time in June was identified at all water quality stations for which data was available from 2010 to 2017,

Table 4.15: Summary of Results for the 2017 FRO LAEMP

Evaluation	Assessment Endpoint	Indicator Type	Measurement Endpoint	Evaluation Criteria	Results	Conclusion
Key Question #1 and Investigation into Decreased % Ephemeroptera	Benthic invertebrate abundance and assemblage	Direct	% Ephemeroptera	Comparison to reference areas (NR) and past observations	Below NR between Cataract Creek and Ewin Creek, lower compared to past observations in some areas (e.g. FOBCP, FODPO, FO22, FOUEW)	No single, direct cause of decrease in % Ephemeroptera identified. A combination of mine-related and natural factors likely involved. Water quality, pebble size, and calcite significantly correlated with % Ephemeroptera. Other factors such as temperature, flow, and predation may also be influencing benthic invertebrate community.
			% EPT		Below NR in some areas related to decrease in % Ephemeroptera; lower compared to past observations in some areas (e.g. FOBCP, FODPO, FO22)	
			% Plecoptera		Within NR in all areas	
			% Trichoptera		Within NR in all areas	
			Abundance		Within NR in all areas; similar compared to past observations	
			Richness		Within NR in all areas; generally increasing compared to past observations	
			Community Composition	Non-metric multidimensional scaling (NMDS) to assess difference in community structure among areas in 2017 and among area and over time (2012 to 2017).	NMDS analysis identified rare taxa and those present/absent only in the downstream mine-exposed areas as those explaining the differences among areas, but did not identify key Ephemeroptera taxa	
		Indirect	Tissue selenium concentrations	Concentrations relative to effect benchmarks and past observations	No composite-taxa tissue selenium concentrations above effects benchmarks; generally the same or lower compared to past observations	
			Surface water chemistry	Concentrations of mine-related chemicals relative to effect benchmarks and past observations.	Nitrate exceeds benchmarks seasonally at most mine-exposed areas; sulphate and selenium exceed benchmarks seasonally at FR_FRCP1 with concentrations decreasing downstream; nickel concentrations exceed the preliminary IC25 (*Ceriodaphnia*) only at FR_FRCP1; very few other consituents exceed BCWQG; no increasing trends observed in mine-exposed areas	
				Principal component analysis (PCA) to assess variability in water quality among areas	The majority of variabilty in water quality explained by PC1 (i.e. mine-related constituents and correlating analytes)	
			Temperature	Temperature compared to reference areas, other mine-exposed areas, and past observations	No overall increase in temperature over time, but significant increase at mine-exposed areas (FR_FR1, FR_FR2, FR_FR4, FR_FR5) in June	
			Flow	Flow compared to reference areas, other mine-exposed areas, and past observations	No overall decrease in flow over time, but significant decrease at mine-exposed areas (FR_FR1, FR_FR2, FR_FR4, FR_FR5) in September	
			Sediment chemistry	Concentrations relative to BC sediment quality guidelines (SQGs)	Cadmium, manganese, nickel, selenium, and zinc exceeded lower and/or upper SQG, with highest concentrations at FOBCP; eleven PAHs exceeded lower and/or upper SQG, all with concentrations decreasing from upstream to downstream	
			Substrate size	Mean pebble size compared to reference areas, other mine-exposed areas, and past observations	Mean pebble size was lowest in mine-exposed areas with decreased % Ephemeroptera; similar compared to past observations	
			Calcite	Calcite index relative to known or suspected effect levels and past observations	Calcite index was highest in mine-exposed areas with decreased % Ephemeroptera, similar compared to past observations	

Note: NR = Normal Range

including those having % Ephemeroptera within the normal range. This indicates that the spatial extent of the temperature increase is greater than that of the observed effects in benthic invertebrate community, and the significance of an increase in temperature in one particular month of each year on benthic invertebrate communities is not clear.

Flow in the upper Fording River has been low in the years experiencing a reduction in % Ephemeroptera compared to 2012, although temporal analysis did not identify a significant decrease over a longer time period (i.e., 1997 to 2017). When flow was analyzed by month, a significant decrease over time was observed in September, which coincided with biological sampling.

A 1.5 km section of the upper Fording River between FR_FRCP1 and FR_FRRD was identified as dewatered from December 2017 to March 2018. This area encompasses two biological monitoring areas, FRCP1SW and FRUPO, for which there are only data from 2017. Although these areas are within the reach where the decrease in % Ephemeroptera is observed (see Section 3.1), it is unlikely that dewatering is the cause as the effect extends both upstream and downstream of the dewatered section.

Overall, a combination of a number of mine-related and natural environmental factors may be contributing to the change in benthic invertebrate community. Water quality (based on PC-1 and PC-2), substrate size, and calcite appear to correlate the strongest with % Ephemeroptera. Other factors that may be contributing to the observed change are decreases in flow, and predation by other invertebrates (e.g., predatory Plecoptera and Trichoptera taxa) or fish.

5 CONCLUSIONS AND RECOMMENDATIONS

The results of the 2017 FRO LAEMP did not identify a single, direct cause of the decrease in % Ephemeroptera in the upper Fording River; however, findings did suggest that the observed change was likely due to a combination of both mine-related and natural factors (e.g., water quality, calcite, substrate size and flow).

To further address the observed effects, adjustments to the study design will be submitted to refine the investigation into the decrease in % Ephemeroptera. Changes will also be made to address sampling requirements associated with the FRO water licensing Operational Environmental Monitoring Program.

Following discussion with the EMC in May 2018, two additional Key Questions are proposed for the 2018 report to address the increased scope, as follows:

6. What are the factors contributing to the variations in percent Ephemeroptera?
7. To support monitoring associated with the requirements of the water license and environmental flow needs assessment, what is the benthic invertebrate community structure in the reach of the Fording River that goes dry, and can changes be correlated with flow conditions?

The 2018 sampling year will include replicate kick sampling at reference areas and mine-exposed areas to increase spatial understanding and allow for more detailed statistical comparisons between areas. Additional sampling of benthic invertebrate communities in June and August, 2018, will also be completed to further understand the seasonal temporal variability in benthic invertebrate communities, including how they relate to the observed increase in temperature in the month of June.

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APPENDIX A

BENTHIC INVERTEBRATE SUPPORTING INFORMATION

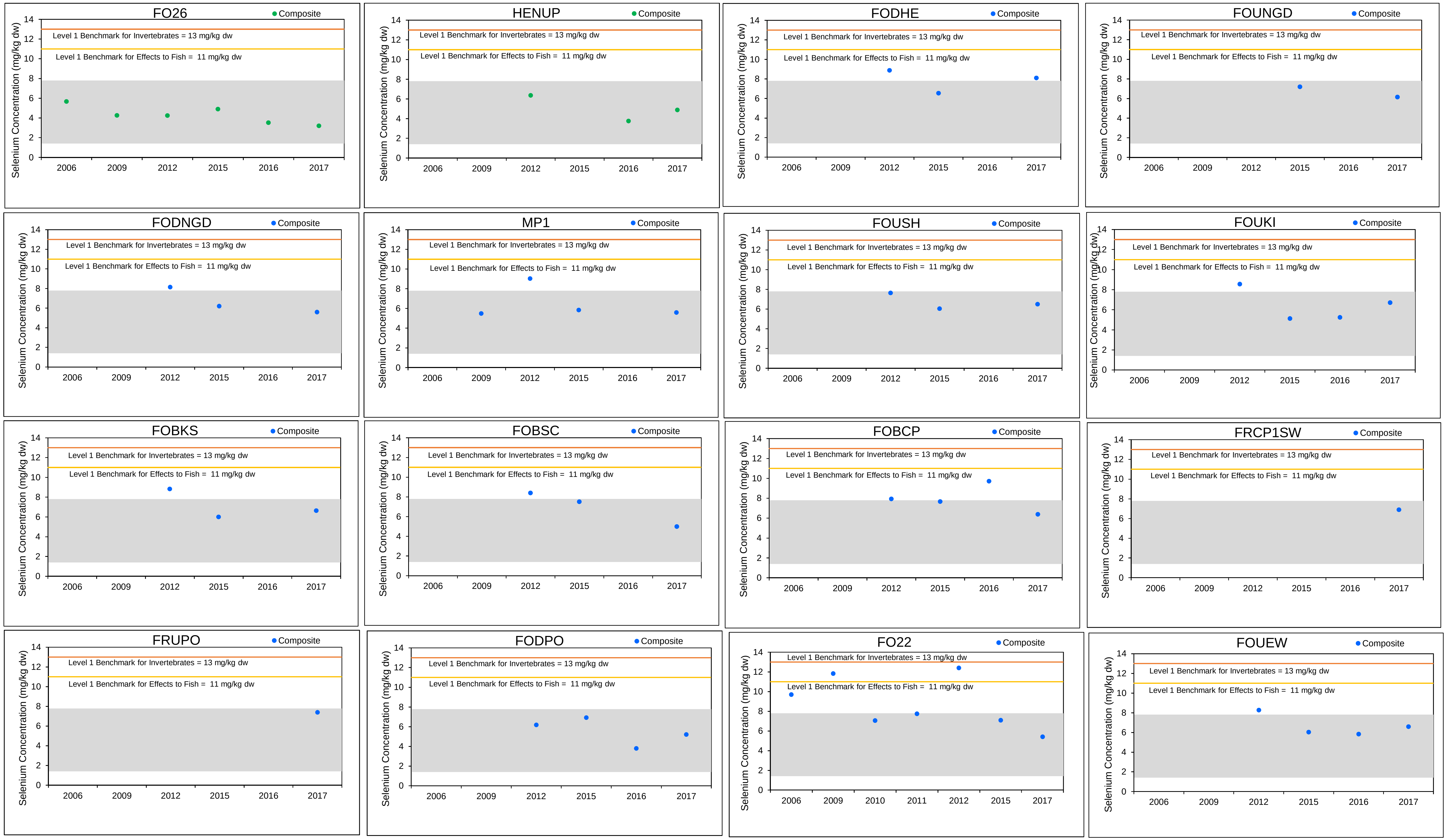

Figure A.1: Benthic invertebrate tissue selenium concentrations in Fording River, 2006 to 2017

Notes: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of reference area values from the RAEMP.

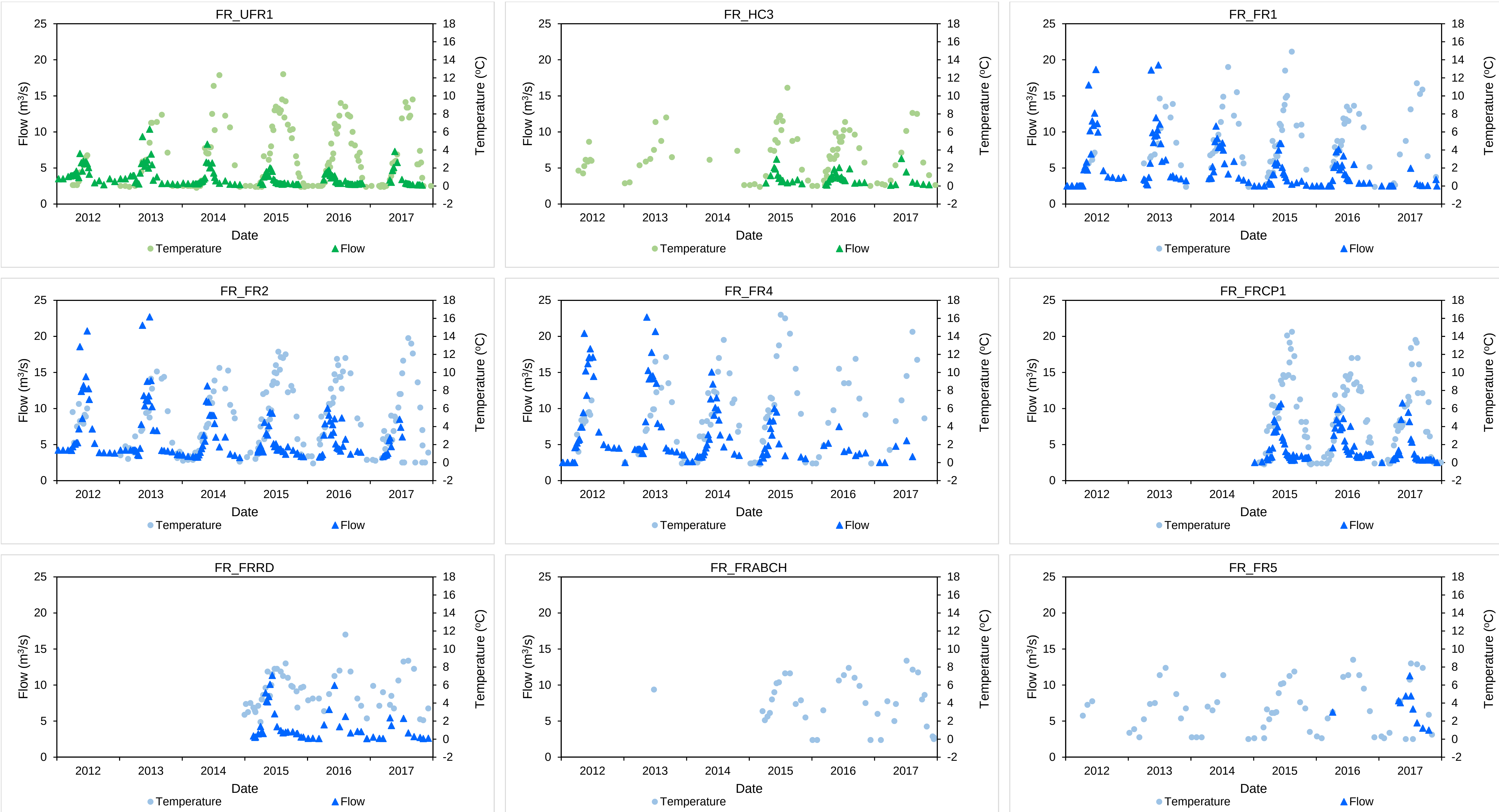

Figure A.2: Scatterplot of Flow and Water Temperature versus Time in the Fording River, 2012 to 2017

Notes: Green symbols indicate reference areas and blue symbols indicate mine-exposed areas.

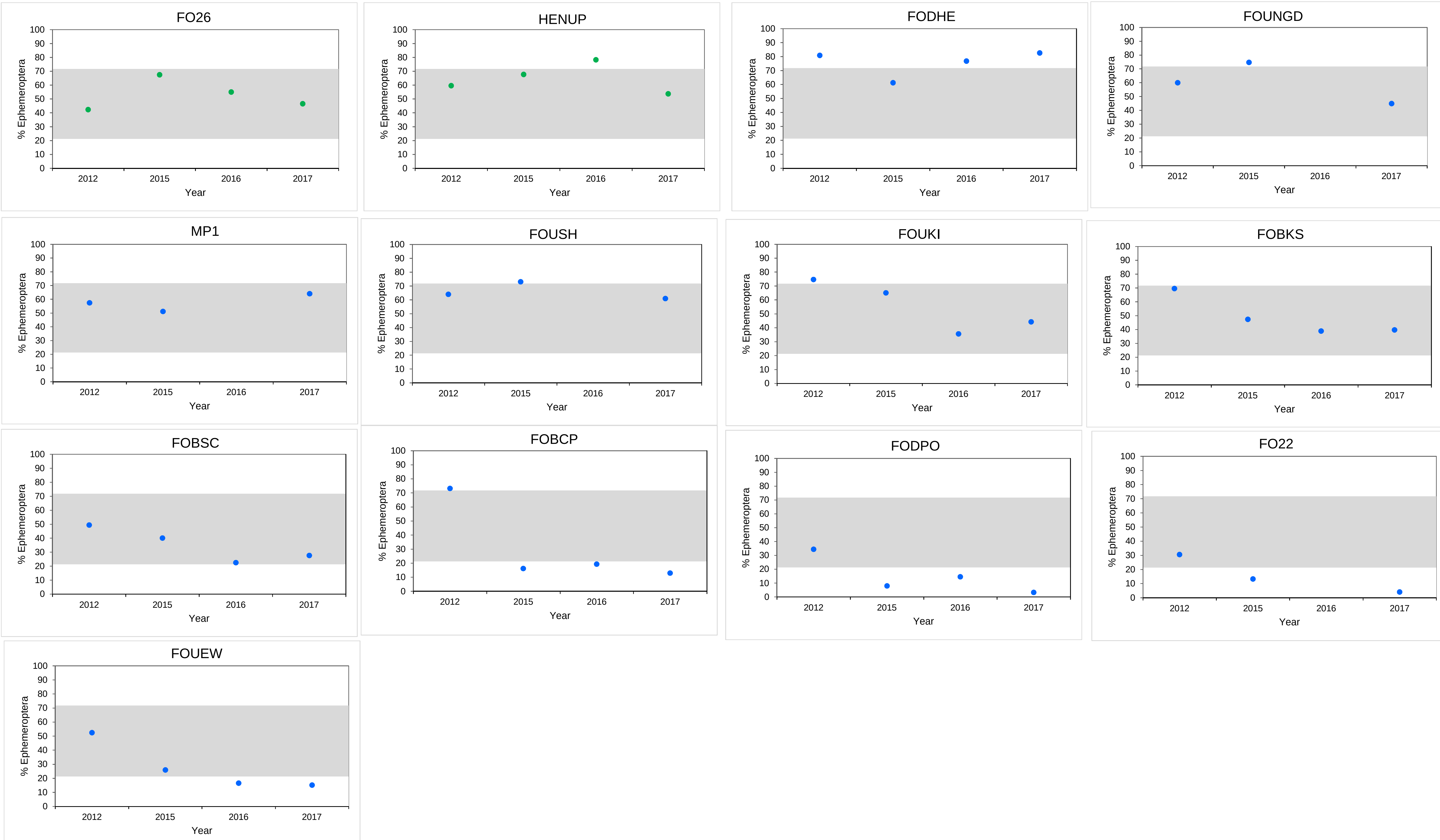

Figure A.3: Benthic Invertebrate Community % Ephemeroptera by Area from 2012 to 2017

Notes: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the RAEMP.

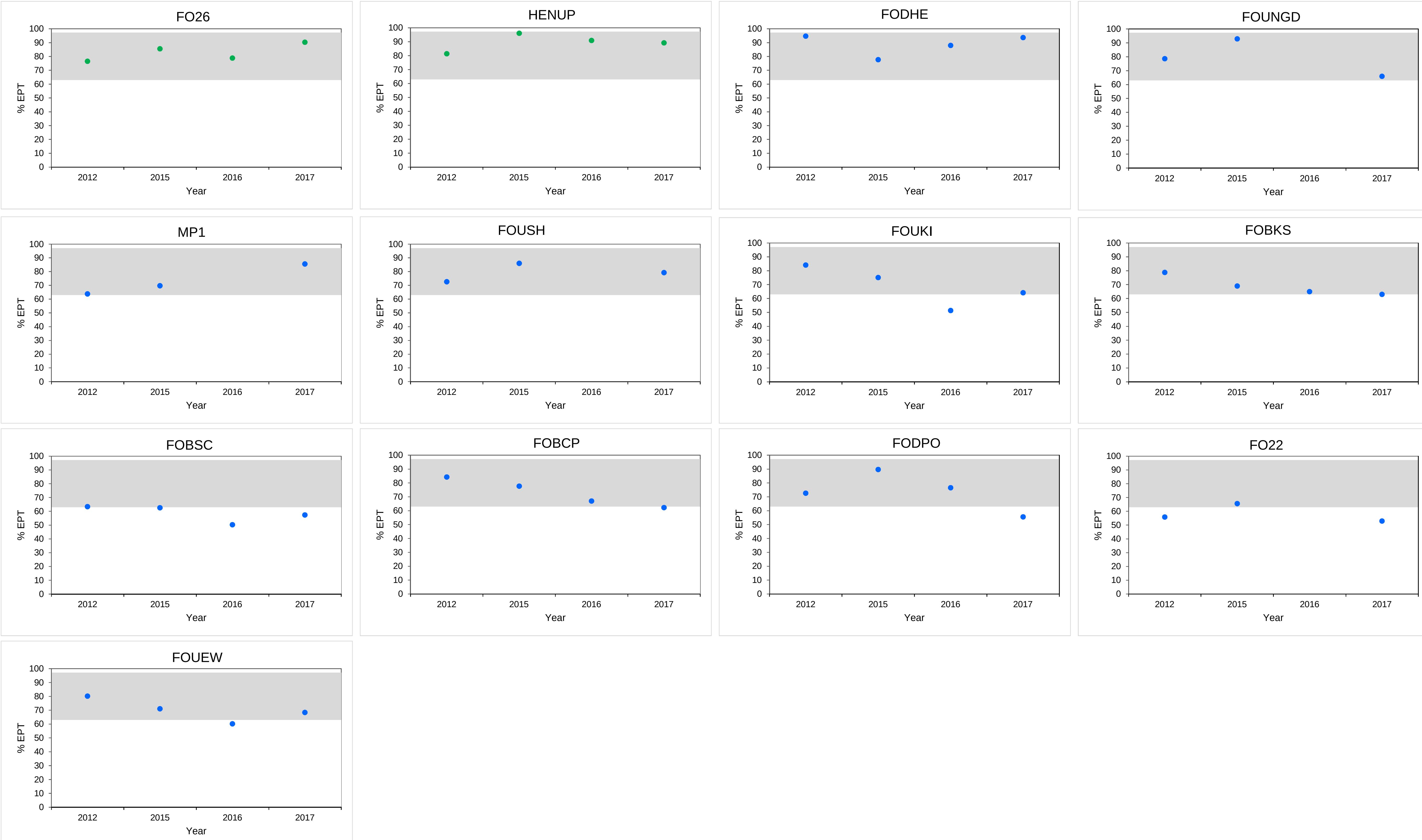

Figure A.4: Benthic Invertebrate Community % EPT by Area from 2012 to 2017

Notes: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the RAEMP.

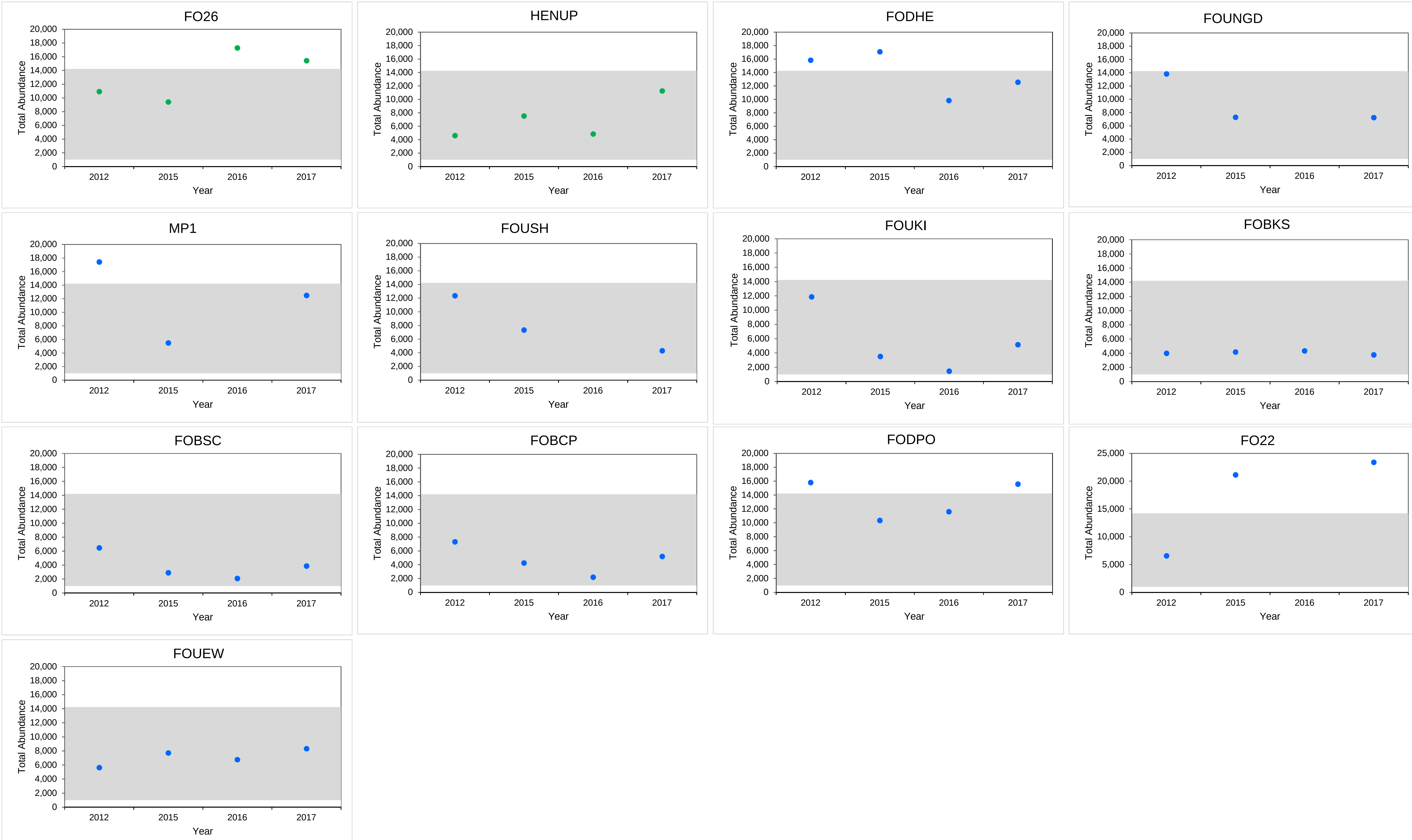

Figure A.5: Benthic Invertebrate Community Abundance by Area from 2012 to 2017

Notes: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the RAEMP.

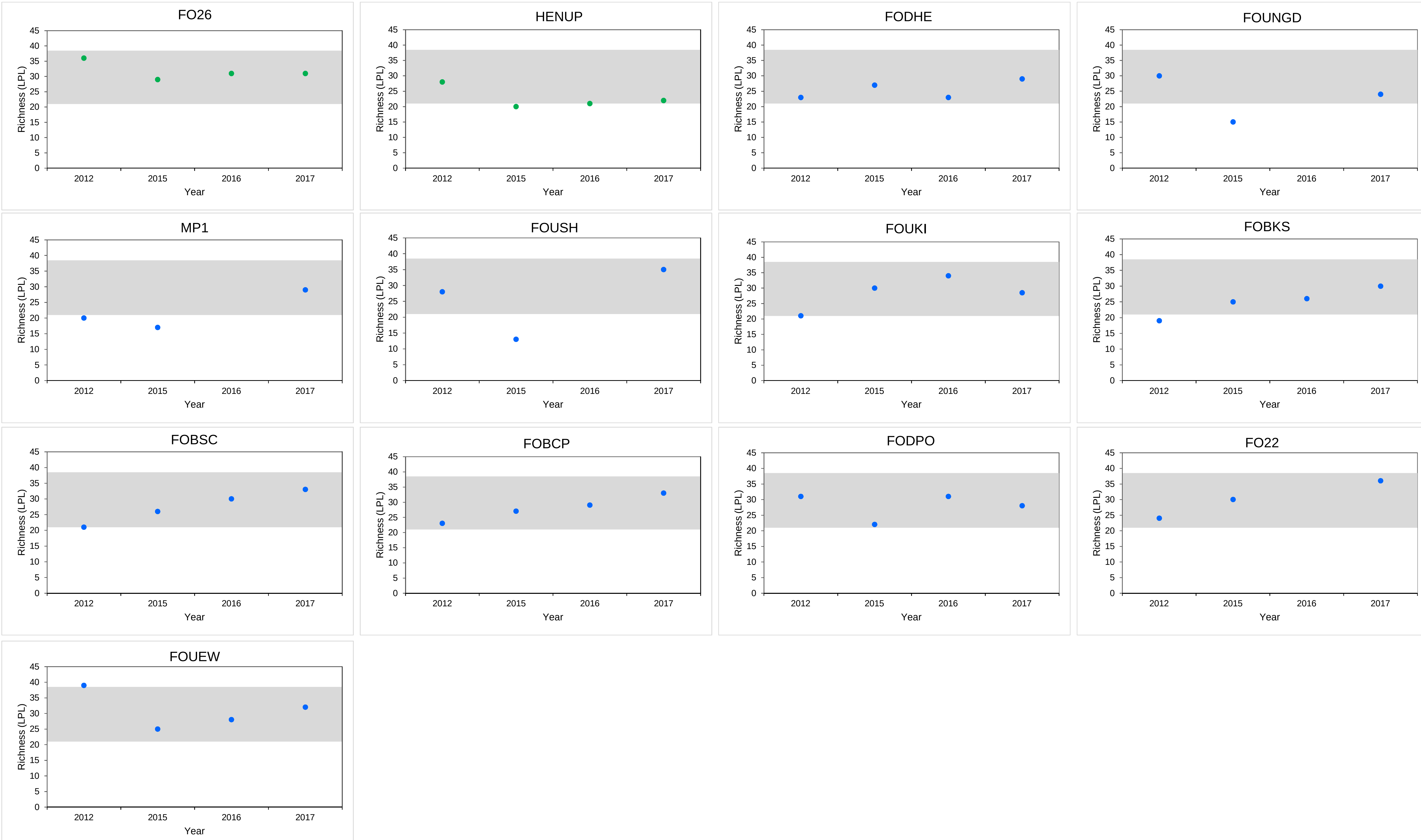

Figure A.6: Benthic Invertebrate Community Richness (LPL) by Area from 2012 to 2017

Notes: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the RAEMP.

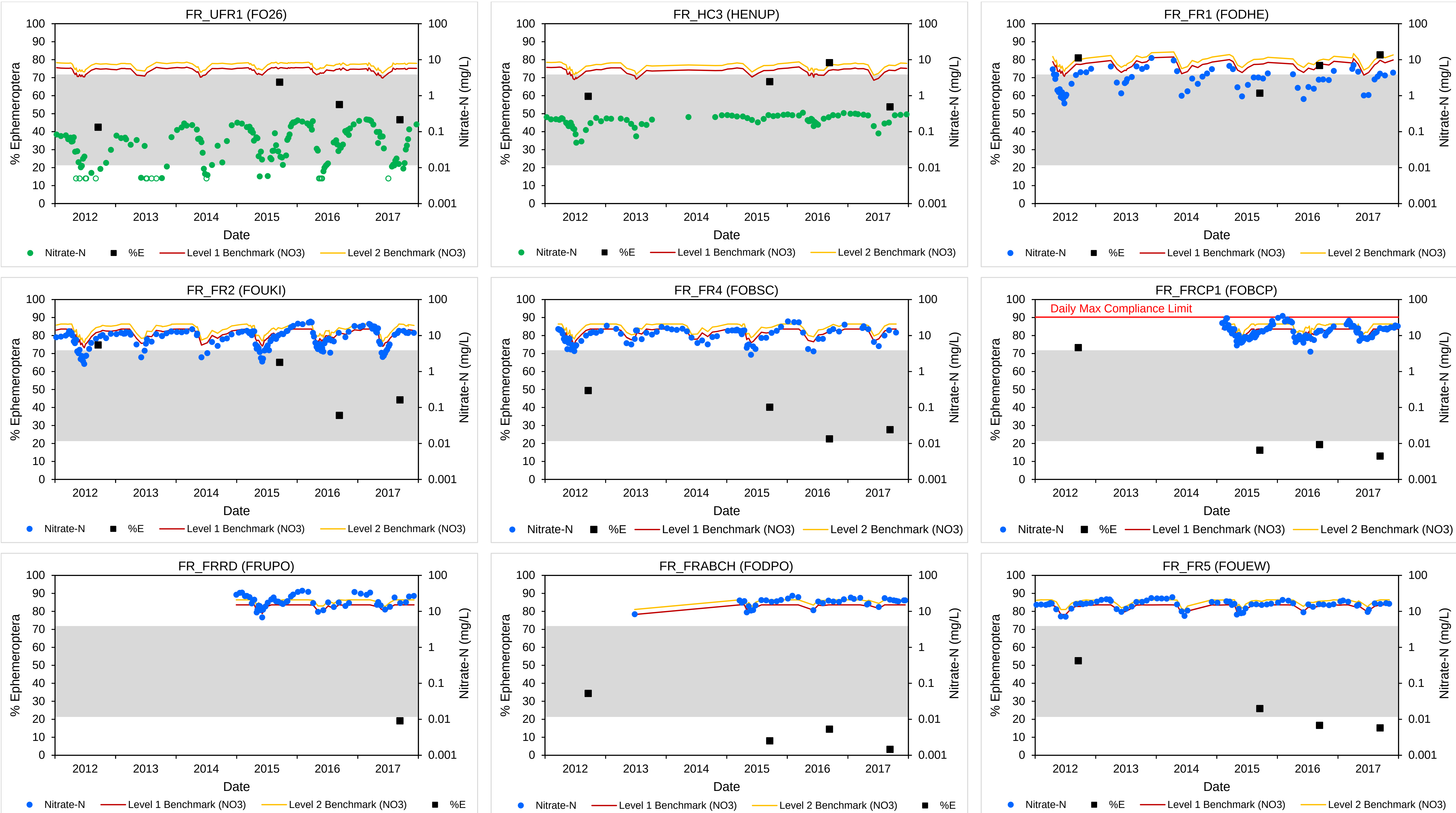

Figure A.7: Scatterplot of % Ephemeroptera versus Time with Concentrations of Nitrate-N in the Fording River, 2012 to 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Level 1 and Level 2 benchmarks for nitrate-N as defined in the EVWQP. Gray shading represents the normal range for % E defined as the 2.5th and 97.5th percentiles of the pooled 2012 and 2015 reference area data distribution from the RAEMP.

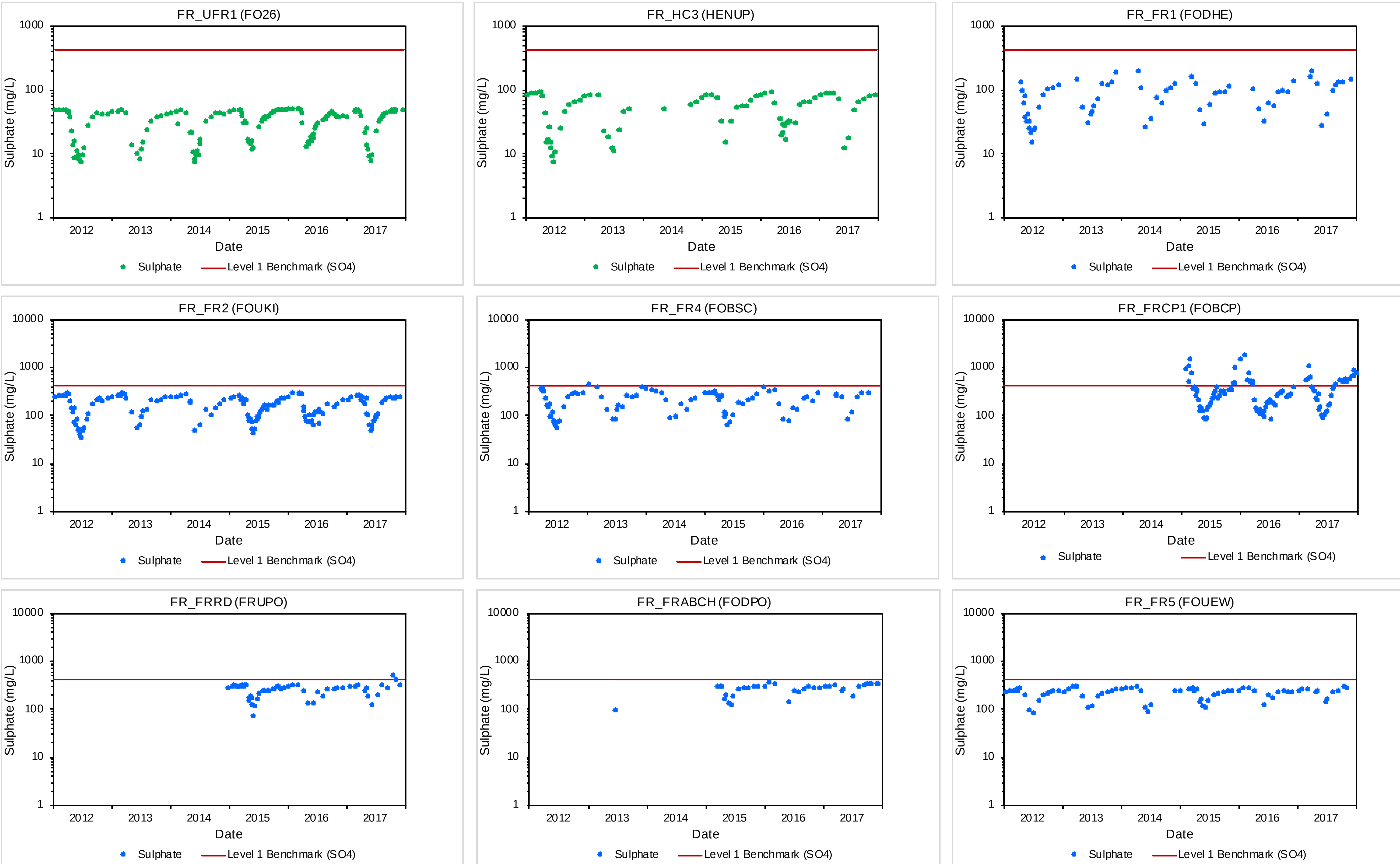

Figure A.8: Scatterplot of Concentrations of Sulphate Over Time in the Fording River, 2012 to 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Level 1 benchmark for Sulphate as defined in the EVWQP.

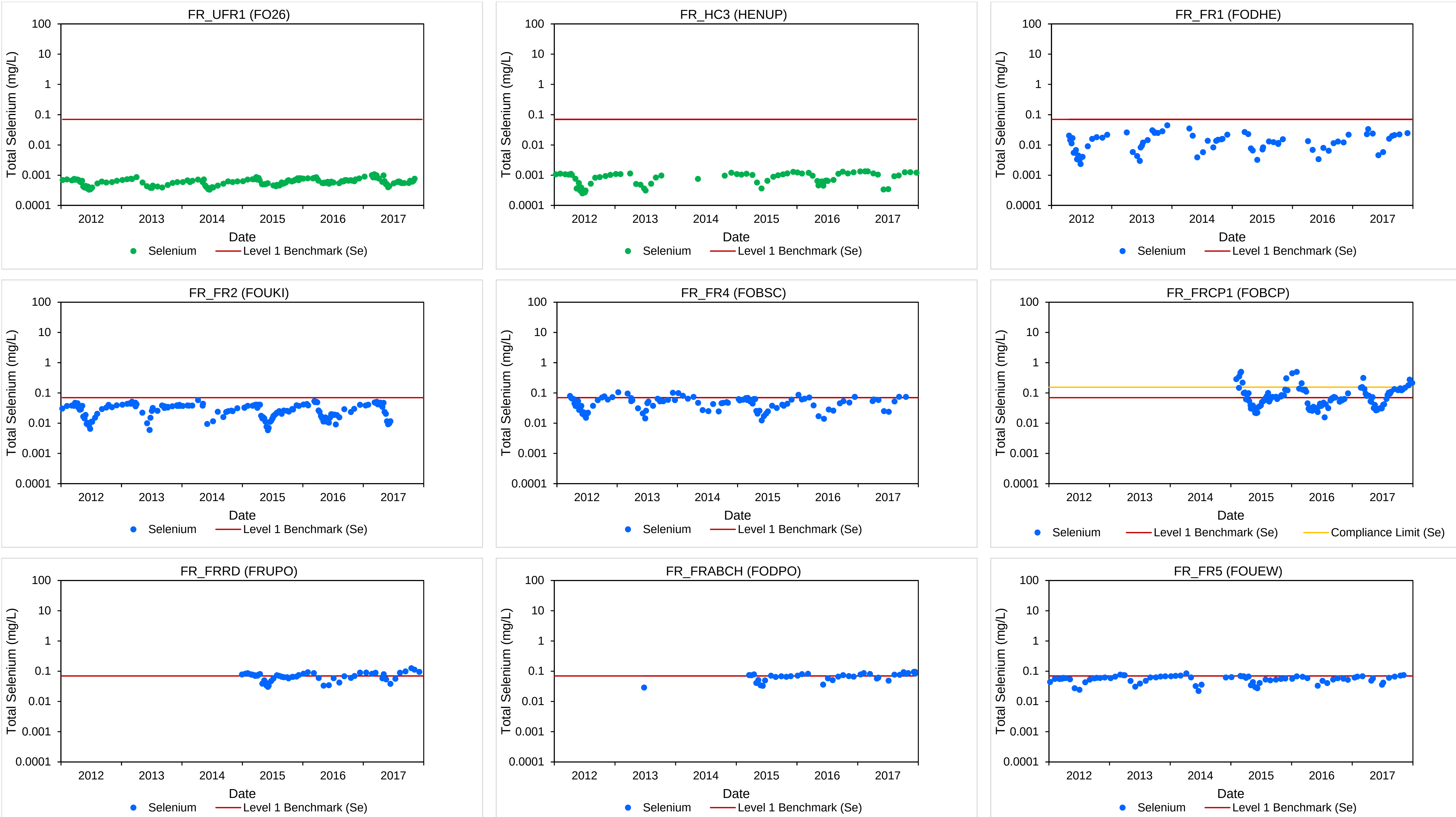

Figure A.9: **Scatterplot of Concentrations of Selenium Over Time in the Fording River, 2012 to 2017**

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Level 1 benchmarks for selenium as defined in the EVWQP.

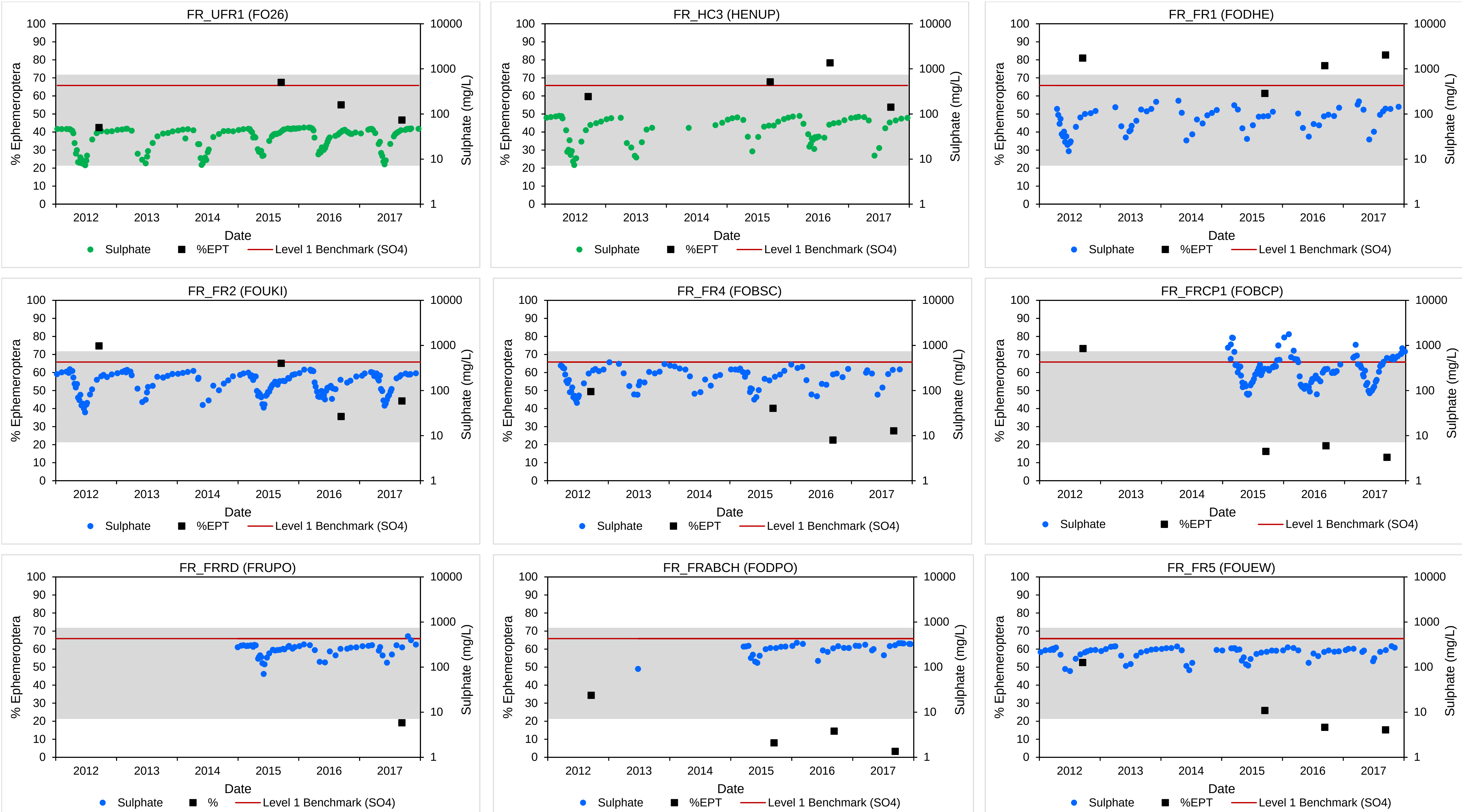

Figure A.10: **Scatterplot of % Ephemeroptera versus Time with Concentrations of Sulphate in the Fording River, 2012 to 2017**

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Level 1 benchmark for Sulphate as defined in the EVWQP. Gray shading represents the normal range for % E defined as the 2.5th and 97.5th percentiles of the pooled 2012 and 2015 reference area data distribution from the RAEMP.

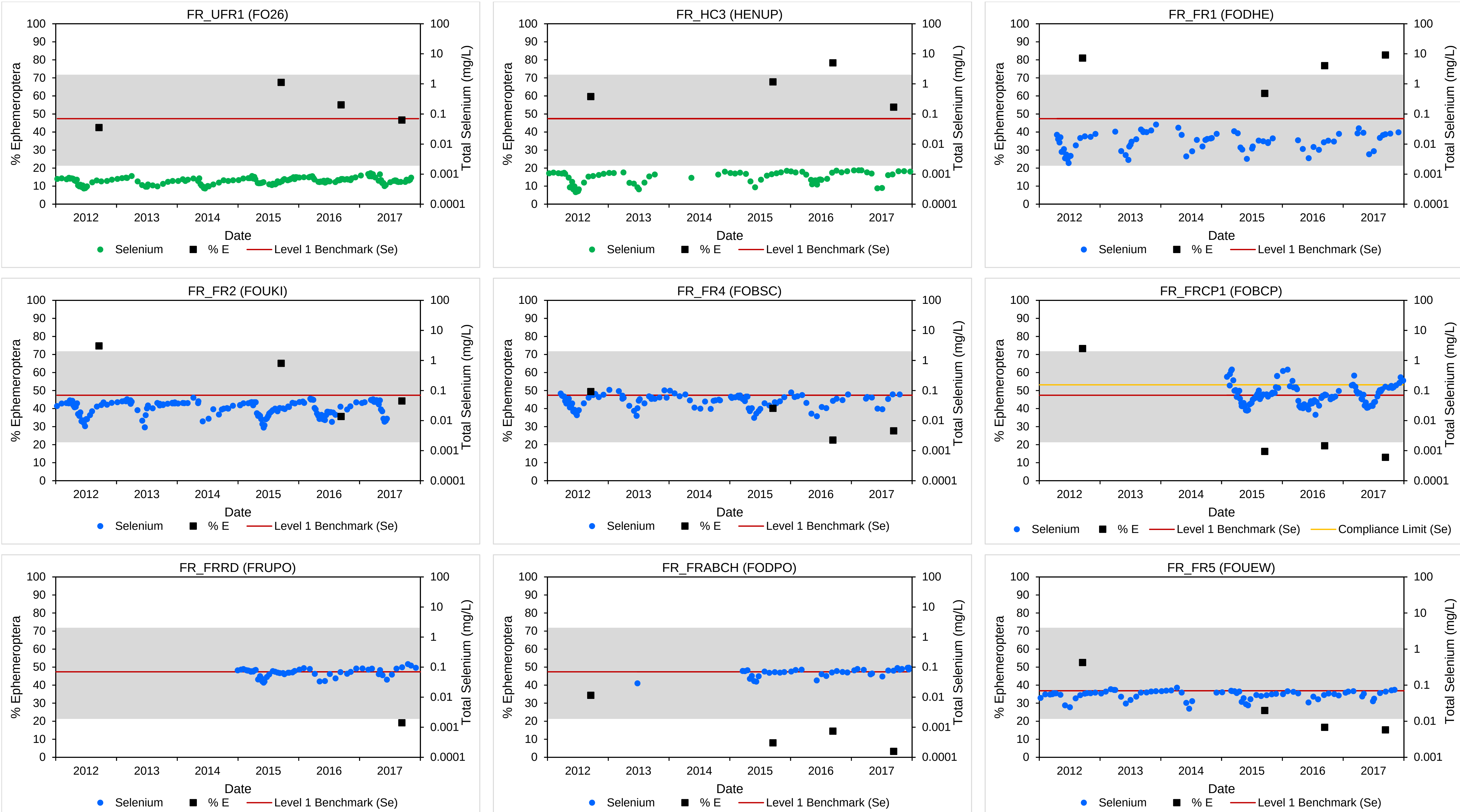

Figure A.11: Scatterplot of % Ephemeroptera Versus Time with Concentrations of Selenium in the Fording River, 2012 to 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Level 1 benchmarks for selenium as defined in the EVWQP. Gray shading represents the normal range for % E defined as the 2.5th and 97.5th percentiles of the pooled 2012 and 2015 reference area data distribution from the RAEMP.

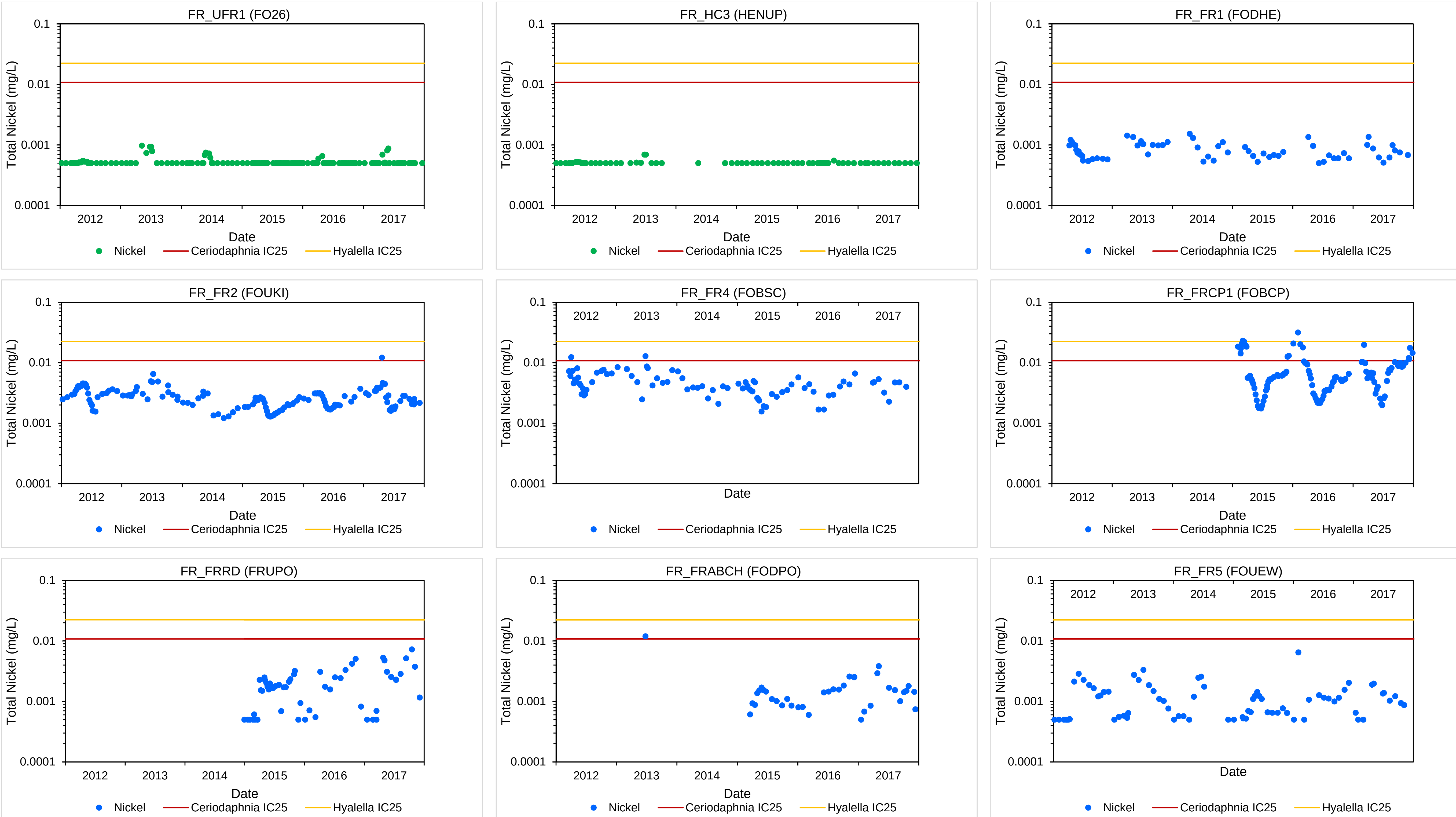

Figure A.12: Scatterplots of Concentrations of Nickel Over Time in the Fording River, 2012 to 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. IC25 benchmark for Nickel as defined in Nautilus = 0.0108 mg/L.

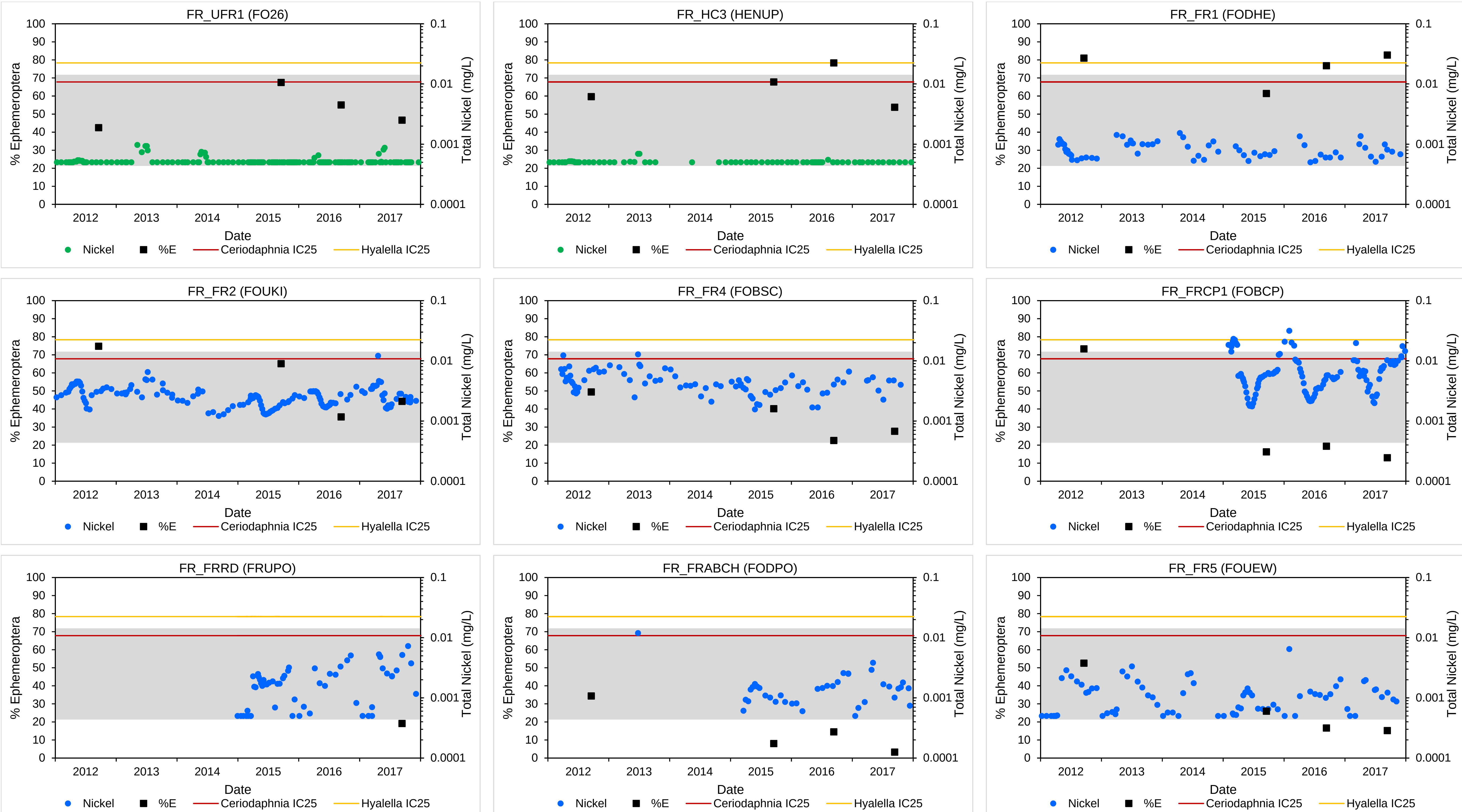

Figure A.13: Scatterplots of % Ephemeroptera versus Time with Concentrations of Nickel in the Fording River, 2012 to 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. IC25 benchmark for Nickel as defined in Nautilus = 0.0108 mg/L. Gray shading represents the normal range for % EPT defined as the 2.5th and 97.5th percentiles of the pooled 2012 and 2015 reference area data distribution from the RAEMP.

Figure A.14: Scatterplots of Spearman Rank Correlations Between Benthic Invertebrate Endpoints and Physical and Chemical Parameters in the Upper Fording River, September 2012, 2015, 2016, and 2017

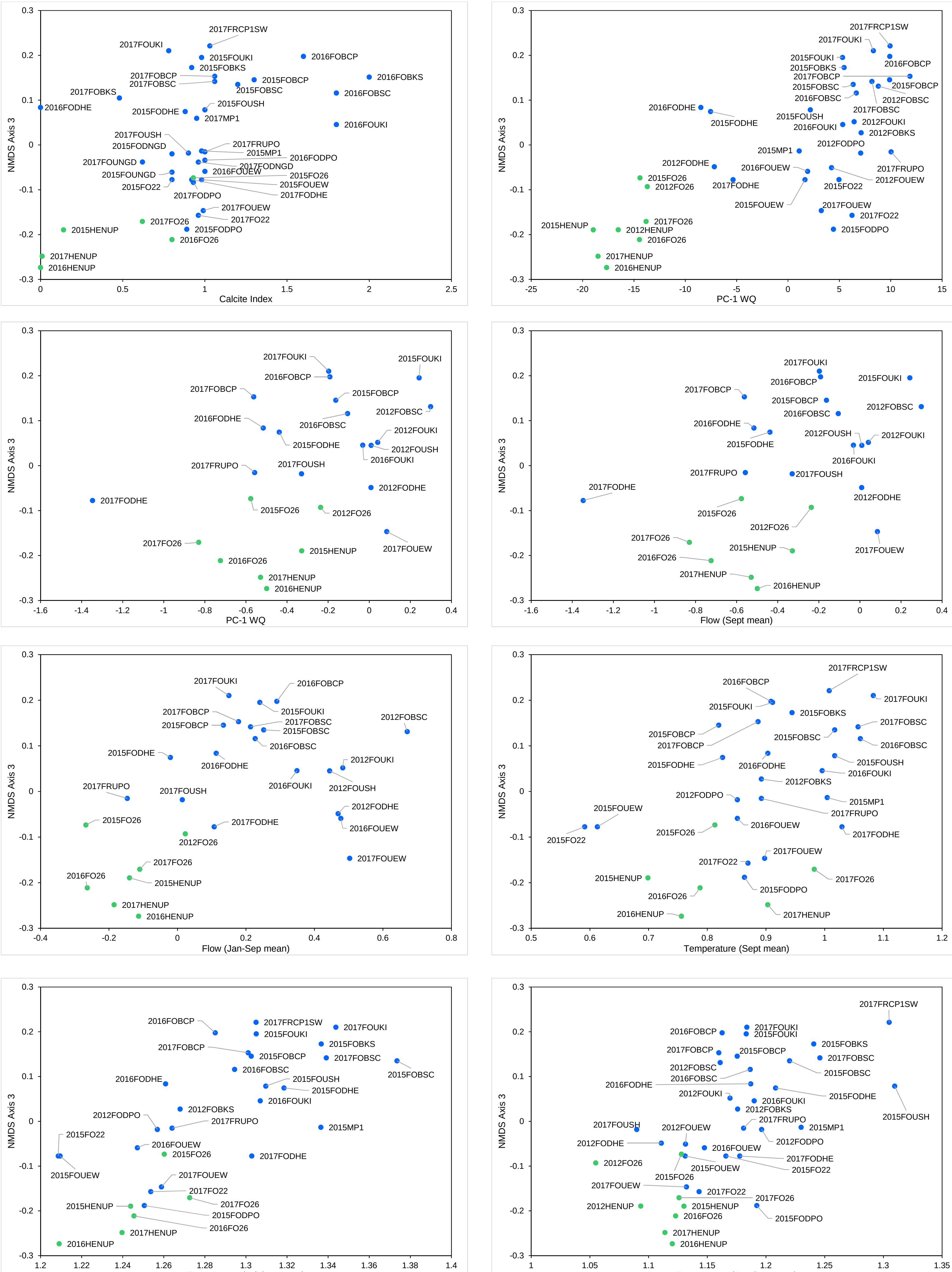

Figure A.14: Scatterplots of Spearman Rank Correlations Between Benthic Invertebrate Endpoints and Physical and Chemical Parameters in the Upper Fording River, September 2012, 2015, 2016, and 2017

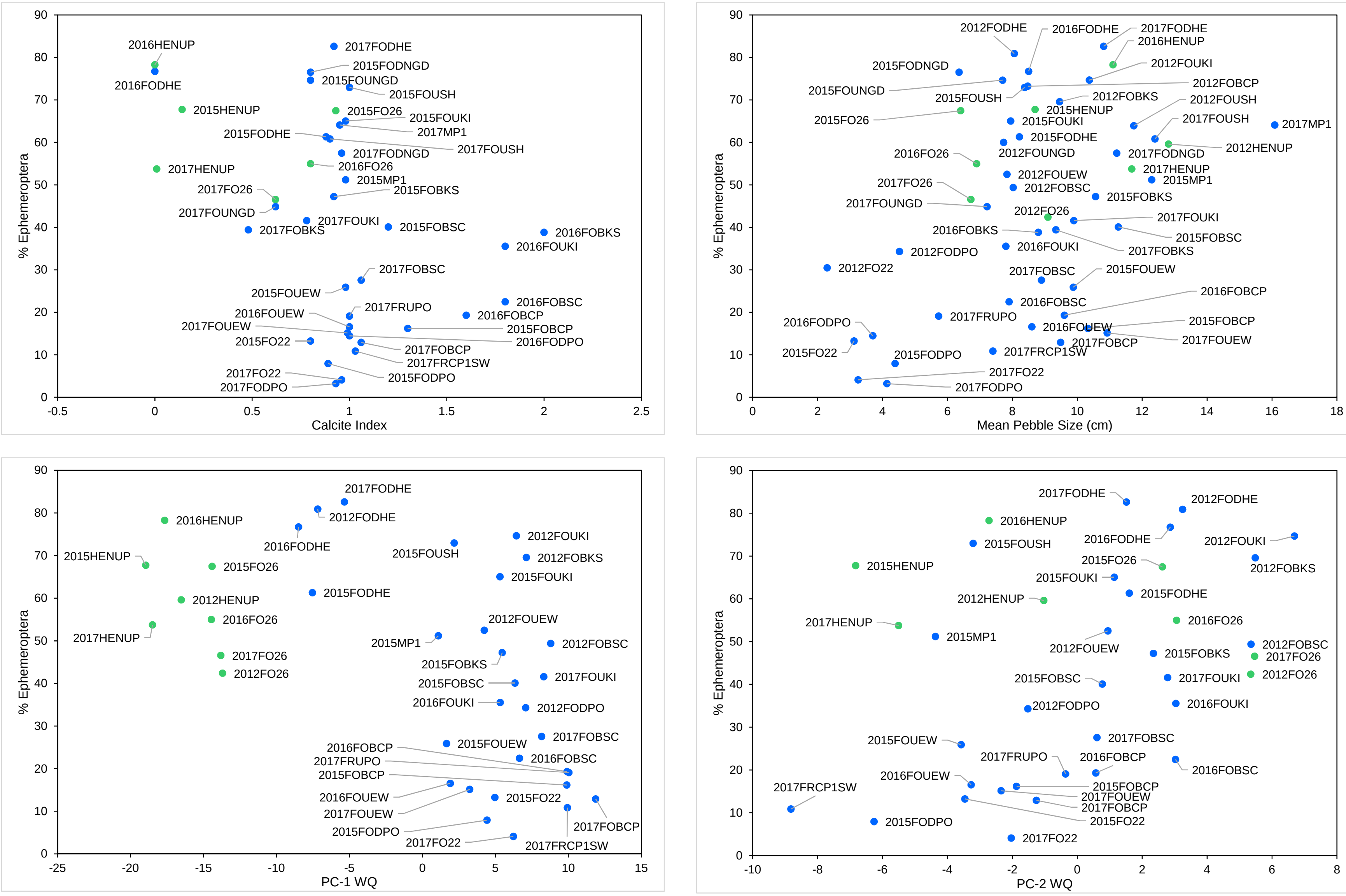

Figure A.14: Scatterplots of Spearman Rank Correlations Between Benthic Invertebrate Endpoints and Physical and Chemical Parameters in the Upper Fording River, September 2012, 2015, 2016, and 2017

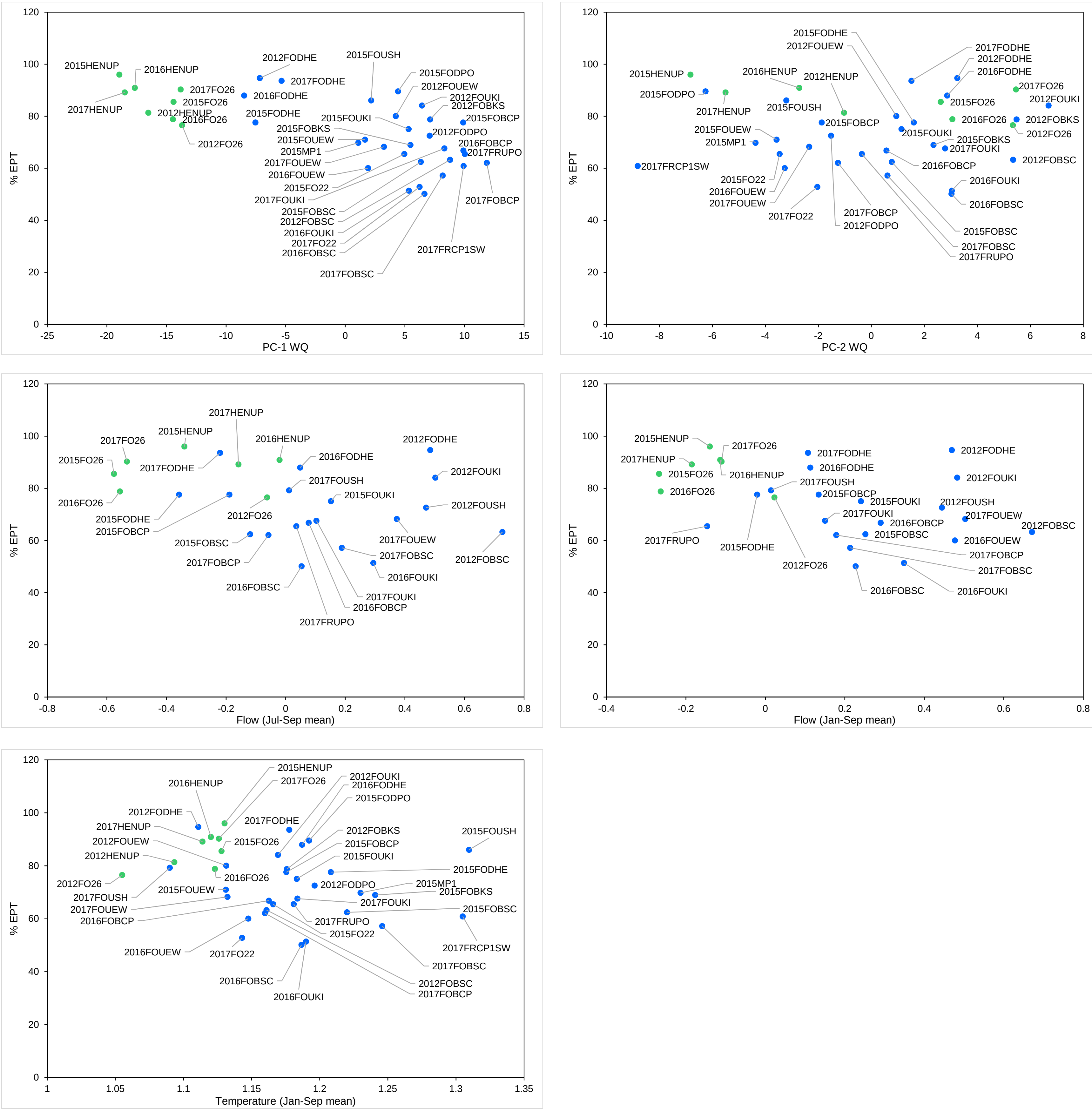

Figure A.14: Scatterplots of Spearman Rank Correlations Between Benthic Invertebrate Endpoints and Physical and Chemical Parameters Upper Fording River, September 2012, 2015, 2016, and 2017

Table A.1: Benthic Invertebrate Tissue Selenium Concentrations Measured in the 2017 FRO LAEMP

Exposure Type	Area	Taxa	Sample Name	Tissue Selenium (mg/kg dw)
Reference	FO26	**Composite**	FO26 - BIC	3.2
		Rhyacophilidae	FO26 - RHY	4.5
		Parapsyche	FO26 - PAR - 01	2.8
			FO26 - PAR - 02	3.2
			FO26 - PAR - 03	3.1
		Ephemeroptera	FO26 - MAY	6.9
	HENUP	**Composite**	HENUP-BIC	4.9
		Rhyacophilidae	HENUP-RHY	5.4
		Parapsyche	HENUP-PAR-01	5.8
			HENUP-PAR-02	5.7
			HENUP-PAR-03	3.1
		Ephemeroptera	HENUP-MAY	7.2
Mine-exposed	FODHE	**Composite**	FODHE-BIC	8.1
		Rhyacophilidae	FODHE-RHY	11
		Parapsyche	FODHE-PAR-01	8.5
			FODHE-PAR-02	6.0
			FODHE-PAR-03	8.5
		Ephemeroptera	FODHE-MAY	14
	FOUNGD	**Composite**	FOUNGD-BIC	6.5
		Rhyacophilidae	FOUNGD-RHY	9.1
		Parapsyche	FOUNGD-PAR-01	7.4
			FOUNGD-PAR-02	7.4
			FOUNGD-PAR-03	9.4
		Ephemeroptera	FOUNGD-MAY	4.9
	FODNGD	**Composite**	FODNGD-BIC	5.6
		Rhyacophilidae	FODNGD-RHY	8.9
		Parapsyche	FODNGD-PAR-01	5.7
			FODNGD-PAR-02	5.7
			FODNGD-PAR-03	7.4
		Ephemeroptera	FODNGD-MAY	5.4
	MP1	**Composite**	MP1 - BIC	5.6
		Rhyacophilidae	MP1 - RHY	8.1
		Parapsyche	MP1 - PAR	8.4
		Ephemeroptera	MP1 - MAY	6.2
	FOUSH	**Composite**	FOUSH-BIC	6.5
		Rhyacophilidae	FOUSH-RHY	7.5
		Parapsyche	-	-
		Ephemeroptera	FOUSH-MAY	7.2
	FOUKI	**Composite**	FOUKI - BIC - 01	6.7
			FOUKI - BIC - 02	6.6
			FOUKI - BIC - 03	6.8
		Rhyacophilidae	FOUKI - RHY - 01	9.6
			FOUKI - RHY - 02	9.8
			FOUKI - RHY - 03	9.8
		Parapsyche	FOUKI - PAR - 01	6.7
			FOUKI - PAR - 02	6.3
			FOUKI - PAR - 03	8.2
		Ephemeroptera	FOUKI - MAY - 01	6.4
			FOUKI - MAY - 02	7.8
			FOUKI - MAY - 03	7.9

Notes: "-" indicates taxon was not found at location.

Table A.1: Benthic Invertebrate Tissue Selenium Concentrations Measured in the 2017 FRO LAEMP

Exposure Type	Area	Taxa	Sample Name	Tissue Selenium (mg/kg dw)
Mine-exposed	FOBKS	Composite	FOBKS - BIC - 01	5.8
			FOBKS - BIC - 02	8.2
			FOBKS - BIC - 03	5.9
		Rhyacophilidae	FOBKS - RHY - 01	7.5
			FOBKS - RHY - 02	10
			FOBKS - RHY - 03	9.8
		Parapsyche	FOBKS - PAR - 01	7.0
			FOBKS - PAR - 02	7.4
			FOBKS - PAR - 03	7.0
		Ephemeroptera	FOBKS - MAY - 01	4.4
			FOBKS - MAY - 02	4.0
			FOBKS - MAY - 03	3.5
	FOBSC	Composite	FOBSC-BIC	5.0
		Rhyacophilidae	FOBSC-RHY	7.2
		Parapsyche	FOBSC-PAR-01	6.7
			FOBSC-PAR-02	7.2
			FOBSC-PAR-03	8.5
		Ephemeroptera	FOBSC-MAY	4.9
	FOBCP	Composite	FOBCP-BIC	6.4
		Rhyacophilidae	FOBCP-RHY	6.9
		Parapsyche	FOBCP-PAR-01	10
			FOBCP-PAR-02	12
			FOBCP-PAR-03	6.8
		Ephemeroptera	FOBCP-MAY	6.7
	FRCP1SW	Composite	FRCP1SW-BIC	6.9
		Rhyacophilidae	FRCP1SW-RHY	8.4
		Parapsyche	FRCP1SW-PAR-01	9.0
			FRCP1SW-PAR-02	10
			FRCP1SW-PAR-03	11
		Ephemeroptera	FRCP1SW-MAY	9.2
	FRUPO	Composite	FRUPO-BIC	7.4
		Rhyacophilidae	FRUPO-RHY	5.9
		Parapsyche	-	-
		Ephemeroptera	FRUPO-MAY	7.1
	FODPO	Composite	FODPO - BIC	7.0
		Rhyacophilidae	FODPO - RHY	6.0
		Parapsyche	-	-
		Ephemeroptera	FODPO - MAY	5.2
	F022	Composite	F022-BIC	5.4
		Rhyacophilidae	F022-RHY	6.6
		Parapsyche	-	-
		Ephemeroptera	F022-MAY	5.6
	FOUEW	Composite	FOUEW - BIC	6.6
		Rhyacophilidae	FOUEW - RHY	8.2
		Parapsyche	FOUEW - PAR - 01	8.5
			FOUEW - PAR - 02	6.4
			FOUEW - PAR - 03	6.9
		Ephemeroptera	FOUEW - MAY	6.6

Notes: "-" indicates taxon was not found at location.

Table A.2: Benthic Invertebrate Tissue Selenium Concentrations Measured in the Upper Fording River, March 2018

Exposure Type	Area	Taxa	Sample Name	Tissue selenium (mg/kg dw)
Mine-exposed	FOUKI	Composite	FOUKI-COM1	4.9
			FOUKI-COM2	5.4
			FOUKI-COM3	5.0
		Rhyacophilidae	FOUKI-RHY1	7.0
			FOUKI-RHY2	5.8
			FOUKI-RHY3	4.4
		Parapsyche	FOUKI-PAR1	4.3
			FOUKI-PAR2	8.2
			FOUKI-PAR3	6.4
		Ephemeroptera	FOUKI-EPH1	5.6
			FOUKI-EPH2	5.4
			FOUKI-EPH3	4.5
	FOBKS	Composite	FOBKS-COM1	5.8
			FOBKS-COM2	5.1
			FOBKS-COM3	6.2
		Rhyacophilidae	FOBKS-RHY1	7.2
			FOBKS-RHY2	6.8
			FOBKS-RHY3	7.3
		Parapsyche	FOBKS-PAR1	6.8
			FOBKS-PAR2	6.6
			FOBKS-PAR3	6.8
		Ephemeroptera	FOBKS-EPH1	7.6
			FOBKS-EPH2	8.1
			FOBKS-EPH3	7.3
	FRUPO	Composite	FRUPO-COM1	6.8
		Rhyacophilidae	FRUPO-RHY1	8.1
		Parapsyche	-	-
			-	-
			-	-
		Ephemeroptera	FRUPO-EPH1	9.4
	FODPO	Composite	FODPO-COM1	3.5
		Rhyacophilidae	FODPO-RHY1	4.4
		Parapsyche	-	-
			-	-
			-	-
		Ephemeroptera	FODPO-EPH1	5.6
	FO22	Composite	FO22-COM1	6.9
		Rhyacophilidae	FO22-RHY1	5.6
		Parapsyche	-	-
			-	-
			-	-
		Ephemeroptera	FO22-EPH1	6.3
	FOUEW	Composite	FOUEW-COM1	6.3
		Rhyacophilidae	FOUEW-RHY1	6.8
		Parapsyche	FOUEW-PAR1	5.3
			FOUEW-PAR2	8.7
			FOUEW-PAR3	7.5
		Ephemeroptera	FOUEW-EPH1	5.1

Notes: "-" indicates taxon was not found at location.

Table A.3: Comparison of Reference Area Data Distributions for Key Benthic

Main Watershed	Management Unit	Percentile	%P				%T			
			All Areas (No Outliers Identified)		Upper Kootenay and Flathead Areas Removed		All Areas		Outlier (n = 3) Removed Based on Distribution Plot	
		n	75		48		75		72	
		2.5	7.0		7.2		0.89		0.84	
		5	7.2		8.0		1.0		1.0	
		10	10		11		1.4		1.4	
		25	14		16		3.4		3.4	
		50	24		23		5.4		5.2	
		75	36		32		10		8.8	
		90	41		39		19		14	
		95	47		48		31		20	
		97.5	52		51		41		25	
		Area	2012	2015	2012	2015	2012	2015	2012	2015
Kootenay	N/A	ALB	46	-			3	-	3	-
	N/A	BU2	-	19			-	19	-	19
	N/A	BU40	40	13			3	13	3	13
	N/A	BUUQ	31	36			2	7	2	7
	N/A	CRUKO	41	40			7	9	7	9
	N/A	KO1	-	7			-	1	-	1
	N/A	KODCR	37	13			7	5	7	5
	N/A	KOUCR	25	24			3	7	3	7
	N/A	KOUVE	13	7			2	0	2	0
	N/A	PADAL	41	37			1	4	1	4
	N/A	PAUKO	40	36			5	5	5	5
	N/A	VEUKO	43	13			8	0	8	0
	N/A	VEUP	40	21			2	10	2	10
	N/A	WIHR	60	-			5	-	5	-
Oldman	N/A	DACK	35	21	35	21	11	9	11	9
	N/A	DUCK	44	10	44	10	8	11	8	11
	N/A	OLDDU	40	12	40	12	4	20	4	20
	N/A	OLDLI	34	24	34	24	1	5	1	5
	N/A	OLDLOW	12	11	12	11	17	33	17	33
	N/A	OLUP	28	-	28	-	5	-	5	-
	N/A	RACK	29	16	29	16	8	6	8	6
	N/A	VICK	26	27	26	27	6	3	6	3
Fording	1	CHCK	11	23	11	23	9	5	9	5
	1	DRCK	13	-	13	-	10	-	10	-
	1	EWCK	21	16	21	16	5	11	5	11
	2	LC_GRCK	-	32	-	32	-	41	-	
	1	FO26	24	16	24	16	10	2	10	2
	1	HENUP	18	27	18	27	4	1	4	1
Line	2	LI24	31	25	31	25	3	5	3	5
	2	SLINE	50	20	50	20	5	14	5	14
Michel	4	AGCK	7	25	7	25	1	4	1	4
	4	AL4	16	17	16	17	5	8	5	8
	4	ALUSM	-	9	-	9	-	19	-	19
	4	MI25	56	32	56	32	24	5	24	5
Elk	N/A	CADCK	19	26	19	26	3	2	3	2
	N/A	EL12	15	22	15	22	1	4	1	4
	3	ELUGH	38	32	38	32	3	5	3	5
	4	GRUHA	51	38	51	38	7	12	7	12
	5	MCCR	-	17	-	17	-	54	-	
	5	WWRL	35	7	35	7	7	30	7	30
	5	WWRU	-	7	-	7	-	41	-	
Flathead	N/A	FLAD	-	7	-		-	7	-	7
	N/A	FLAU	-	13	-		-	13	-	13
	N/A	FLRU	-	6	-		-	6	-	6

Note: Results were before and after the removal of potential outliers. Coloured cells show individual reference area values that were at the low (blue shade) and high (gold shade) ends of the distribution range. Green highlights the reference area data set recommended for the evaluation of communities in mine-exposed areas.

- data set was used to define the normal range (2.5th and 97.5th percentiles)
- outlier or value removed from estimation of percentiles
- value < 2.5th percentile of reference distribution
- value < 5th percentile of reference distribution
- value < 10th percentile of reference distribution
- value < 25th percentile of reference distribution
- value > 75th percentile of reference distribution
- value > 90th percentile of reference distribution
- value > 95th percentile of reference distribution
- value > 97.5th percentile of reference distribution

Table A.4: Summary of Results Above British Columbia Water Quality Guidelines in 2017 (Teck 2018)

Date	EMS ID	Location Code	Parameter	Result	Unit	Criteria (Max)	Criteria (Min)	Criteria or Guideline
5-Feb-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.00182	ug/l	0.00125	-	BCWQG Approved Average
24-Apr-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.001865	ug/l	0.00125	-	BCWQG Approved Average
16-May-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.0022275	ug/l	0.00125	-	BCWQG Approved Average
23-May-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.002392	ug/l	0.00125	-	BCWQG Approved Average
30-May-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.002338	ug/l	0.00125	-	BCWQG Approved Average
6-Jun-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.00221	ug/l	0.00125	-	BCWQG Approved Average
5-Sep-17	E216777	FR_UFR1	MERCURY - Ultra Trace	0.00241	ug/l	0.00125	-	BCWQG Approved Average
28-Aug-17	0200251	FR_FR1	DISSOLVED OXYGEN, FIELD	7.83	mg/l	-	8	BCWQG Approved Average
20-Apr-17	0200201	FR_FR2	IRON	2.3	mg/l	1	-	BCWQG Approved Max
11-Jan-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.001625	ug/l	0.00125	-	BCWQG Approved Average
5-Feb-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00297714	ug/l	0.00125	-	BCWQG Approved Average
11-Feb-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.0023	ug/l	0.00125	-	BCWQG Approved Average
20-Apr-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00242333	ug/l	0.00125	-	BCWQG Approved Average
25-Apr-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.0032	ug/l	0.00125	-	BCWQG Approved Average
16-May-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00357	ug/l	0.00125	-	BCWQG Approved Average
23-May-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00211833	ug/l	0.00125	-	BCWQG Approved Average
30-May-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00186833	ug/l	0.00125	-	BCWQG Approved Average
6-Jun-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.001815	ug/l	0.00125	-	BCWQG Approved Average
6-Jun-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.001815	ug/l	0.00125	-	BCWQG Approved Average
13-Jun-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00159667	ug/l	0.00125	-	BCWQG Approved Average
20-Jun-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00151333	ug/l	0.00125	-	BCWQG Approved Average
26-Jun-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00126667	ug/l	0.00125	-	BCWQG Approved Average
5-Aug-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.00353	ug/l	0.00125	-	BCWQG Approved Average
31-Oct-17	0200201	FR_FR2	MERCURY - Ultra Trace	0.002	ug/l	0.00125	-	BCWQG Approved Average
20-Apr-17	E300071	FR_FRCP1	IRON	1.05	mg/l	1	-	BCWQG Approved Max
5-Feb-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.003582	ug/l	0.00125	-	BCWQG Approved Average
20-Apr-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.0034675	ug/l	0.00125	-	BCWQG Approved Average
24-Apr-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.00353	ug/l	0.00125	-	BCWQG Approved Average
16-May-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.00385	ug/l	0.00125	-	BCWQG Approved Average
23-May-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.002452	ug/l	0.00125	-	BCWQG Approved Average
30-May-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.0025	ug/l	0.00125	-	BCWQG Approved Average
6-Jun-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.002776	ug/l	0.00125	-	BCWQG Approved Average
13-Jun-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.002472	ug/l	0.00125	-	BCWQG Approved Average
20-Jun-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.002366	ug/l	0.00125	-	BCWQG Approved Average
26-Jun-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.001754	ug/l	0.00125	-	BCWQG Approved Average
5-Sep-17	E300071	FR_FRCP1	MERCURY - Ultra Trace	0.003854	ug/l	0.00125	-	BCWQG Approved Average
5-Mar-17	E300097	FR_FRRD	ALUMINUM	0.151	mg/l	0.1	-	BCWQG Approved Max
5-Mar-17	E300097	FR_FRRD	MERCURY - Ultra Trace	0.00209	ug/l	0.00125	-	BCWQG Approved Average
25-Apr-17	E300097	FR_FRRD	MERCURY - Ultra Trace	0.00399	ug/l	0.00125	-	BCWQG Approved Average
18-May-17	E300097	FR_FRRD	MERCURY - Ultra Trace	0.0018325	ug/l	0.00125	-	BCWQG Approved Average

"-" Value not applicable

Table A.5: **Temperature and Discharge Calculations for the Continuous Monitoring Station, FR_NTP, in the Upper Fording River, 2012, 2015, 2016, and 2017**

Year	ADD (10°C May 1-Sept 15)	ADD (10°C Jun 20-Sept 15)	ADD (10°C Jul 1-Sept 15)	Mean Temperature (°C Jul 1-Sept 15)	Max Temperature (°C Jul 1-Sept 15)	Mean Temperature (°C Apr-Jun)	Max Temperature (°C Apr-Jun)	Mean Discharge (m^3/s Jul 1-Sept 15)	Max Discharge (m^3/s Jul 1-Sept 15)	Mean Discharge (m^3/s Apr-Jun)	Max Discharge (m^3/s Apr-Jun)
2012	-152	53.1	84.7	11.1	13.1	5.42	7.68	3.24	11.4	5.15	25.5
2015	-179	34.9	39.6	10.5	12.4	5.27	10.90	0.47	2.71	1.37	7.58
2016	-177	0.1	10.1	10.1	11.7	5.88	10.48	1.55	6.64	3.93	8.42
2017	-149	36.1	57.6	10.7	11.8	5.50	15.76	2.06	4.64	4.92	11.2

Notes: ADD: Accumulated degree day

Table A.6: Life History Traits of Select Benthic Invertebrate Taxa in the Upper Fording River (USGS 2016)

Family	*Genus/ Species*	Emergence	Primary Functional Group	Primary Feeding Methods	Current Preferance	Microhabitat	Lateral Water Column Limit	Prefered Temperature	Max Temperature (°C)	Turbidity
Baetidae	*Baetis spp.*	Spring/ Summer/Fall	Clinger	Collector/ Gatherer	Fast (Turbulent and Laminar)	Gravel, Rocks, Phytoplankton	Riffles	Cold-cool eurythermal (0-15 C)	15-20	Clear
Ephemerellidae	*Drunella coloradensis*	Summer	Clinger	Predator	Slow and Fast (Turbid)	Rocks, Boulders, LWD, and Phytoplankton	-	Cold-cool eurythermal (0-15 C)	-	Clear to Murky
	Drunella doddsii	Summer	Clinger/ Scraper	Predator	All Currrents	Sand, Gravel, Rocks Boulders, and Phytoplankton	Riffles	Cold-cool eurythermal (0-15 C)	-	Clear
	Drunella spinifera	Summer	-	Predator	Fast (Turbulent)	Rocks, Boulders, Detritus, and Algae	Riffles	Cold-cool eurythermal (0-15 C)	-	
	Drunella grandis	Summer	-	-	Fast (Turbulent and Laminar)	Gravel, Rocks, and Algae	-	Cold-cool eurythermal (0-15 C)	20	Clear
Heptageniidae	*Cinygmula spp.*	Spring/ Summer	-	Scraper/ Grazer	Slow and Fast (Turbulent and Laminar)	Gravel, Rocks, Boulders, and Detritus	Pools and Riffles	Cold-cool eurythermal (0-15 C), cold Stenothermal (4.4-10 C)	-	Clear
	Epeorus spp.	Spring/ Summer	Detrivores	Collector/ Scraper	Fast (Turbulent and Laminar)	Gravel, Rocks, Boulders, and LWD	Riffles	Cold-cool eurythermal (0-15 C)	15	-
	Rhithrogena spp.	Spring/ Summer	Clinger	Scraper/ Grazer	Fast (Turbulent and Laminar)	Gravel, Rocks, and Detritus	Riffles	Cold-cool eurythermal (0-15 C)	12.2	Clear to Silted/ Murky
Nemouridae	*Zapada spp.*	Winter/Spring	Sprawler	Shredder	-	Gravel, Rocks, Boulders, Detritus and Phytoplankton	-	Cold-cool eurythermal (0-15 C)	18	-
	Zapada oregonensis	Winter/Spring	-	-	-	Gravel, Rocks, Boulders, Detritus and Phytoplankton	-	-	-	-
	Zapada cinctipes	Winter	-	Shredder	-	Detritus	-	Cold-cool eurythermal (0-15 C)	-	-
	Zapada haysi	Winter/Spring /Summer	-	Shredder	-	Detritus	-	Cold-cool eurythermal (0-15 C)	-	
Perlodidae	*Kogotus spp.*	Spring/ Summer	-	Predator	-	Sand, Gravel, Rocks, Boulders, and Detritus	-	-	10	
	Megarcys spp.	Spring/ Summer	Clinger	Predator/ Scraper-grazer	-	-	Riffles/ Eddies	-	-	-
	Isoperla spp.	Spring/ Summer	Clinger	Predator	Fast (Laminar and Turbulent)	Sand, Gravel, Rocks, Boulders, and Detritus	Riffles	-	10-29	Clear
Taeniopterygidae	*Taenionema spp.*	Winter/Spring	-	Shredder	Slow	Sand, Gravel, Rocks, Boulders, and Detritus	Pools	-	-	-
Hydropsychidae	*Parapsyche spp.*	Spring/ Summer	Clinger	Predator / Collector-filterer / gatherer	Fast (Laminar)	Rocks and Boulders	Riffles	Cold-cool eurythermal (0-15 C)	-	No preference
Rhyacophilidae	*Rhyacophila spp.*	Spring/ Summer	Sprawler/ Clinger	Predator	Fast (Laminar and Turbulent)	Sand, Gravel, Rocks, Boulders, Detritus and Algae	Riffles	Cold-cool euythermal (0-15 C)	-	-

Table A.7: Paired Tissue and Water Selenium Concentrations for the FRO LAEMP, 2012 to 2018

Watershed	Exposure Status	Minnow Biological Monitoring Area	Associated Teck Water Monitoring Station Code	Year	Total Selenium in Water		Selenium in Tissue	
					Sample Date	µg/L	Sample Date	mg/kg dw
Fording River	Reference	FO26	FR_UFR1	2012	18-Sep-12	0.58	18-Sep-12	4.9
				2012	18-Sep-12	0.58	18-Sep-12	3.6
				2012	18-Sep-12	0.58	18-Sep-12	4.2
				2015	14-Sep-15	0.79	14-Sep-15	4.9
				2016	20-Sep-16	0.68	12-Sep-16	3.5
				2017	12-Sep-17	0.60	12-Sep-17	3.2
		HENUP	FR_HC3	2012	18-Sep-12	0.83	18-Sep-12	6.4
				2015	15-Sep-15	1.03	15-Sep-15	3.8
				2016	7-Sep-16	1.11	12-Sep-16	3.8
				2017	15-Sep-17	1.04	15-Sep-17	4.9
	Mine-exposed	FODHE	FR_FR1	2012	19-Sep-12	18.0	19-Sep-12	8.9
				2015	14-Sep-15	9.8	14-Sep-15	6.6
				2017	15-Sep-17	20.4	15-Sep-17	8.1
		FOUNGD	-	2012	12-Sep-12	23.5	12-Sep-12	8.2
				2015	15-Sep-15	24.0	15-Sep-15	7.2
				2017	16-Sep-17	53.0	16-Sep-17	6.5
		FODNGD	FR_FRABEC1	2015	14-Sep-15	23.4	14-Sep-15	6.2
				2017	16-Sep-17	54.3	16-Sep-17	5.6
		MP1	FR_MULTIPLATE	2012	18-Sep-12	37.6	18-Sep-12	9.0
				2015	15-Sep-15	23.2	15-Sep-15	5.9
				2017	12-Sep-17	52.2	12-Sep-17	5.6
		FOUSH	FR_FRNTP	2012	13-Sep-12	36.0	13-Sep-12	7.6
				2015	15-Sep-15	25.5	15-Sep-15	6.0
				2017	14-Sep-17	47.9	14-Sep-17	6.5
		FOUKI	FR_FR2	2012	14-Sep-12	33.6	14-Sep-12	8.5
				2015	16-Sep-15	23.3	16-Sep-15	5.1
				2016	8-Sep-16	28.9	12-Sep-16	5.2
				2017	12-Sep-17	44.5	12-Sep-17	6.7
				2017	12-Sep-17	44.5	12-Sep-17	6.6
				2017	12-Sep-17	44.5	12-Sep-17	6.8
				2018	6-Mar-18	55.3	06-Mar-18	4.9
				2018	6-Mar-18	55.3	06-Mar-18	5.4
				2018	6-Mar-18	55.3	06-Mar-18	5.0
		FOBKS	GH_FR3	2012	14-Sep-12	31.9	14-Sep-12	8.8
				2015	16-Sep-15	23.9	16-Sep-15	6.0
				2017	13-Sep-17	44.9	13-Sep-17	5.8
				2017	13-Sep-17	44.9	13-Sep-17	8.2
				2017	13-Sep-17	44.9	13-Sep-17	5.9
				2018	12-Mar-18	52.9	12-Mar-18	5.8
				2018	12-Mar-18	52.9	12-Mar-18	5.1
				2018	12-Mar-18	52.9	12-Mar-18	6.2
		FOBSC	FR_FR4	2012	15-Sep-12	53.8	15-Sep-12	8.4
				2015	17-Sep-15	33.9	17-Sep-15	7.5
				2017	15-Sep-17	72.9	15-Sep-17	5.0
		FOBCP	FR_FRCP1	2012	15-Sep-12	117	15-Sep-12	7.9
				2015	17-Sep-15	63.8	17-Sep-15	7.7
				2016	13-Sep-16	73.2	12-Sep-16	9.7
				2017	14-Sep-17	128	14-Sep-17	6.4
		FRCP1SW	FR_FRCP1SW	2017	14-Sep-17	131	14-Sep-17	6.9
		FRUPO	FR_FRRD	2017	15-Sep-17	98.9	15-Sep-17	7.4
				2018	7-Mar-18	111	7-Mar-18	6.8
		FODPO	GH_PC2	2012	17-Sep-12	76.3	17-Sep-12	6.2
				2015	15-Sep-15	68.2	15-Sep-15	6.9
				2017	13-Sep-17	89.6	13-Sep-17	5.2
				2018	7-Mar-18	105	7-Mar-18	3.5
		FO22	FR_FRABCH	2012	16-Sep-12	71.1	16-Sep-12	12.4
				2015	12-Sep-15	68.0	12-Sep-15	7.1
				2017	14-Sep-17	83.3	14-Sep-17	5.4
				2018	12-Mar-18	100	12-Mar-18	6.9
		FOUEW	FR_FR5	2012	16-Sep-12	58.6	16-Sep-12	8.3
				2015	13-Sep-15	58.8	13-Sep-15	6.1
				2016	8-Sep-16	53.0	12-Sep-16	5.8
				2017	13-Sep-17	77.9	13-Sep-17	6.6
				2018	7-Mar-18	86.3	7-Mar-18	6.3

Notes: No concurrent water selenium data were available for 2016 tissue samples, so concentrations from the closest sample date from each associated Teck WQ monitoring station was used. No selenium water data was available for MP1 in 2012, so the corresponding data from FR_MULTIPLATE was used for that data point only in 2012.

Table A.8: **Abundance of Ephemeroptera Taxa and Taxa with Relatively High Non-metric Multi-demensional Scaling (NMDS) Scores, Upper Fording River, September 2012, 2015, 2016, and 2017**

Order	Family	Year	Reference		Mine-exposed													
			FO26	HENUP	FODHE	FOUNGD	FODNGD	MP1	FOUSH	FOUKI	FOBKS	FOBSC	FOBCP	FRCP1SW	FRUPO	FODPO	FO22	FOUEW
Ephemeroptera	Order Total	2012	4,620	2,742	12,800	8,280	0	10,000	8,320	8,840	2,767	3,200	5,360	0	0	5,420	2,000	2,951
		2015	6,340	5,080	10,460	5,420	6,000	2,800	5,340	2,270	1,965	1,172	689	-	-	820	2,800	2,000
		2016	9,500	3,780	7,520	-	-	-	-	512	1,678	468	427	-	-	1,680	0	1,120
		2017	7,180	6,040	10,360	3,240	4,460	8,000	2,615	2,620	1,320	1,070	671	250	1,860	500	960	1,260
	Ameletidae	2012	180	14	60	0	-	150	120	0	0	100	100	-	-	0	0	0
		2015	80	40	80	60	0	50	100	60	0	45	0	-	-	0	0	0
		2016	0	10	120	-	-	-	-	8	0	0	0	-	-	20	-	0
		2017	220	200	520	0	20	0	50	20	0	10	0	10	0	0	0	0
	Baetidae	2012	120	43	40	120	-	650	240	340	345	260	40	-	-	1,060	240	300
		2015	1,280	80	1,340	860	1,360	483	2,200	540	801	391	163	-	-	0	160	40
		2016	640	0	580	-	-	-	-	96	326	237	133	-	-	960	-	420
		2017	860	80	200	700	1,800	980	351	1,080	420	540	71	5	60	220	300	100
	Ephemerellidae	2012	1,540	657	3,000	720	-	1,950	1,600	280	155	660	2,360	-	-	2,700	1,260	667
		2015	1,320	460	3,700	600	480	250	260	190	126	127	138	-	-	140	1,580	580
		2016	3,760	820	2,140	-	-	-	-	88	376	119	134	-	-	160	-	120
		2017	2,380	940	2,540	740	1,320	3,720	263	40	126	50	14	15	180	20	280	240
	Heptadeniidae	2012	2,780	2,028	9,700	7,440	-	7,250	6,360	8,220	2,267	2,180	2,860	-	-	1,660	500	1,984
		2015	3,660	4,500	5,340	3,900	4,160	2,017	2,780	1,480	1,038	609	388	-	-	680	1,060	1,380
		2016	5,100	2,950	4,680	-	-	-	-	320	976	112	160	-	-	540	-	580
		2017	3,720	4,820	7,100	1,800	1,320	3,300	1,951	1,480	774	470	586	220	1,620	260	380	920
Plecoptera	Order Total	2012	2,600	815	1,440	1,760	0	650	700	720	244	500	660	0	0	5,620	1,440	1,250
		2015	1,480	2,020	2,700	1,120	940	768	820	290	714	509	2,376	-	-	6,820	9,440	2,500
		2016	3,040	530	1,080	-	-	-	-	144	715	339	688	-	-	4,840	0	2,040
		2017	2,600	3,400	1,200	1,180	1,280	1,800	628	1,180	326	530	1,928	935	3,240	6,600	8,980	3,320
	Leuctridae	2012	60	0	0	60	-	0	0	0	0	0	0	-	-	20	0	0
		2015	20	0	40	0	0	17	0	0	0	0	0	-	-	0	0	0
		2016	20	0	0	-	-	-	-	0	0	0	0	-	-	0	-	0
		2017	0	0	0	0	0	0	0	0	0	0	14	0	0	0	20	0
Trichoptera	Order Total	2012	1,100	186	680	800	0	450	400	400	122	400	140	0	0	360	160	300
		2015	340	1,860	260	600	660	300	300	70	390	235	478	-	-	4,800	2,120	1,020
		2016	1,080	80	20	-	-	-	-	84	415	238	362	-	-	2,360	0	900
		2017	4,140	580	180	340	460	880	165	460	413	620	629	215	1,280	1,540	2,420	1,100
	Brachycentridae	2012	0	0	0	0	-	50	0	0	0	0	20	-	-	0	0	33
		2015	80	20	20	0	0	0	20	0	0	0	38	-	-	0	0	20
		2016	0	0	0	-	-	-	-	0	25	6	14	-	-	0	-	0
		2017	0	0	0	20	30	0	13	40	10	60	57	20	130	0	0	0
	Glossosomatidae	2012	0	29	0	0	-	0	0	0	0	0	0	-	-	0	0	33
		2015	20	0	0	0	0	0	0	10	25	36	0	-	-	1,200	800	680
		2016	0	20	0	-	-	-	-	48	25	19	0	-	-	1,800	-	400
		2017	0	160	0	120	70	0	13	60	35	10	14	0	45	80	760	160
	Hydropsychidae	2012	140	0	20	40	-	0	40	60	33	0	20	-	-	0	0	33
		2015	20	60	40	0	0	33	80	10	76	18	38	-	-	0	0	20
		2016	320	40	20	-	-	-	-	16	38	6	180	-	-	0	-	100
		2017	380	280	20	20	0	0	50	80	75	40	71	0	0	0	60	40
	Uenoidae	2012	0	0	0	0	-	0	0	0	0	0	0	-	-	0	20	0
		2015	0	0	0	20	0	0	0	0	0	0	0	-	-	0	40	0
		2016	540	0	0	-	-	-	-	0	0	0	0	-	-	0	-	20
		2017	3,200	0	0	100	0	340	13	0	0	0	0	0	0	0	60	120

Table A.8: Abundance of Ephemeroptera Taxa and Taxa with Relatively High Non-metric Multi-demensional Scaling (NMDS) Scores, Upper Fording River, September 2012, 2015, 2016, and 2017

Order	Family	Year	Reference		Mine-exposed													
			FO26	HENUP	FODHE	FOUNGD	FODNGD	MP1	FOUSH	FOUKI	FOBKS	FOBSC	FOBCP	FRCP1SW	FRUPO	FODPO	FO22	FOUEW
Coleoptera	Order Total	2012	0	0	0	0	0	0	20	60	33	0	0	0	0	580	1,160	350
		2015	0	0	0	0	0	17	0	10	0	0	0	-	-	40	2,500	120
		2016	0	0	0	-	-	-	-	4	0	0	0	-	-	380	0	220
		2017	20	0	0	0	20	20	13	0	0	0	0	5	60	500	5,720	800
	Elmidae	2012	0	0	0	0	-	0	20	60	33	0	0	-	-	580	1,160	350
		2015	0	0	0	0	0	17	0	10	0	0	0	-	-	40	2,500	120
		2016	0	0	0	-	-	-	-	4	0	0	0	-	-	380	-	220
		2017	20	0	0	0	20	20	13	0	0	0	0	5	60	500	5,720	800
Diptera	Order Total	2012	2,060	687	740	2,900	0	6,250	2,400	1,820	800	2,240	960	0	0	3,600	1,680	586
		2015	1,320	300	3,780	520	420	1,518	860	730	1,178	926	878	-	-	1,020	4,680	1,840
		2016	3,340	410	1,060	-	-	-	-	596	1,452	838	659	-	-	2,220	0	2,080
		2017	1,220	1,140	780	2,400	1,280	1,520	816	1,980	1,095	1,380	1,400	505	2,940	6,260	2,540	820
	Simuliidae	2012	40	0	0	0	-	0	0	0	0	0	0	-	-	0	0	17
		2015	0	0	0	0	40	0	0	0	0	118	38	-	-	40	220	0
		2016	140	0	40	-	-	-	-	0	0	0	13	-	-	80	-	20
		2017	0	0	0	0	0	20	0	100	14	0	14	0	120	20	0	0
	Empididae	2012	160	186	0	0	-	0	0	0	0	0	0	-	-	480	0	100
		2015	20	0	20	0	0	17	20	0	0	27	50	-	-	40	100	20
		2016	20	50	0	-	-	-	-	12	0	38	0	-	-	120	-	180
		2017	0	60	0	20	40	0	0	0	7	10	29	30	140	180	120	40
Trombidiformes	Order Total	2012	420	157	100	0	0	50	60	0	11	80	180	0	0	60	0	100
		2015	40	0	20	0	60	117	100	30	26	63	51	-	-	20	40	260
		2016	300	30	100	-	-	-	-	56	38	94	27	-	-	140	0	180
		2017	240	80	20	60	240	220	63	40	148	210	399	370	360	180	280	840
	Sperchontidae	2012	240	86	20	0	-	50	0	0	0	0	0	-	-	20	0	17
		2015	20	0	0	0	0	17	20	0	13	27	13	-	-	0	0	40
		2016	160	20	40	-	-	-	-	16	0	6	14	-	-	0	-	0
		2017	70	40	20	20	70	100	0	0	30	10	15	25	40	0	0	50
Tubificida	Order Total	2012	0	14	0	0	0	0	0	0	0	60	0	0	0	80	0	17
		2015	0	0	20	0	0	0	60	80	88	109	13	-	-	0	60	0
		2016	20	0	20	-	-	-	-	40	25	106	47	-	-	0	0	180
		2017	0	0	0	0	20	40	0	20	47	70	171	15	0	0	2,360	120
	Naididae	2012	0	0	0	0	-	0	0	0	0	0	0	-	-	0	0	0
		2015	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0	0
		2016	0	0	0	-	-	-	-	4	0	0	7	-	-	0	-	160
		2017	0	0	0	0	20	0	0	0	0	0	14	0	0	0	2,300	120
	Enchytraeidae	2012	0	14	0	0	-	0	0	0	0	20	0	-	-	80	0	17
		2015	0	0	20	0	0	0	60	80	88	109	13	-	-	0	60	0
		2016	20	0	20	-	-	-	-	36	25	106	40	-	-	0	-	20
		2017	0	0	0	0	0	40	0	20	47	70	157	15	0	0	60	0

Table A.9: Channel Depth and Velocity Data Associated with Mine-exposed Sampling Areas, September 2017

	Replicate	1	2	3	4	5	mean
Reference	**FO26**						
	Depth (cm)	8	9	12	14	7	10
	Velocity (m/s)	0.25	0.25	0.32	0.24	0.13	0.238
	HENUP						
	Depth (cm)	22	20	24	26	14	21.2
	Velocity (m/s)	0.19	0.34	0.36	0.49	0.32	0.34
Mine-exposed	**FODHE**						
	Depth (cm)	6	12	16	18	8	12
	Velocity (m/s)	0.14	0.18	0.22	0.17	0.09	0.16
	FOUNGD						
	Depth (cm)	10	22	20	16	10	15.6
	Velocity (m/s)	0.32	0.34	0.28	0.41	0.18	0.306
	MP1						
	Depth (cm)	18	22	12	28	26	21.2
	Velocity (m/s)	0.15	0.12	0.38	0.17	0.24	0.212
	FOUSH						
	Depth (cm)	16	24	26	24	16	21.2
	Velocity (m/s)	0.14	0.32	0.36	0.23	0.21	0.252
	FOUKI						
	Depth (cm)	10	13	18	20	17	15.6
	Velocity (m/s)	0.212	0.491	0.368	0.403	0.196	0.334
	FOBSC						
	Depth (cm)	18	19	20	10	4	14.2
	Velocity (m/s)	0.49	0.73	0.33	0.51	0.21	0.454
	FOBCP						
	Depth (cm)	16	11	25	20	10	16.4
	Velocity (m/s)	0.59	0.36	0.35	0.22	0.29	0.362
	FRCP1SW						
	Depth (cm)	10	8	12	8	4	8.4
	Velocity (m/s)	0.22	0.42	0.41	0.42	0.19	0.332
	FRUPO						
	Depth (cm)	11	9	18	17	16	14.2
	Velocity (m/s)	0.23	0.36	0.36	0.56	0.54	0.41
	FODPO						
	Depth (cm)	9	17	25	24	17	18.4
	Velocity (m/s)	0.09	0.37	0.41	0.42	0.2	0.298
	FO22						
	Depth (cm)	17	33	20	11	18	19.8
	Velocity (m/s)	0.435	0.24	0.488	0.342	0.158	0.333
	FOUEW						
	Depth (cm)	16	16	35	32	14	22.6
	Velocity (m/s)	0.26	0.23	0.16	0.42	0.27	0.268
	FODNGD						
	Depth (cm)	16	18	21	30	14	19.8
	Velocity (m/s)	0.11	0.25	0.41	0.34	0.18	0.258

Notes: Velocity measurements were taken at five randomly chosen locations throughout the kick sample area. Velocity was measured at the bottom of the water column.

Table A.10: **Pebble and Calcite Count in the Upper Fording River, September 2017**

FO26 (CI = 0.62)					FO29				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness
1	0	1	5.3	-	1	0	1	5.5	-
2	0	1	9.2	-	2	0	1	18	-
3	0	1	4.4	-	3	0	1	9.8	-
4	0	1	6.4	-	4	0	1	11	-
5	0	0	1.3	-	5	1	1	17	-
6	0	1	32.2	-	6	0	1	9.3	-
7	0	0	4.2	-	7	0	1	16	-
8	0	0	3.9	-	8	0	1	12.2	-
9	0	0	4	-	9	1	1	13	-
10	0	0	8.4	0.5	10	0	1	9.9	0.5
11	0	1	6.3	-	11	0	1	10.6	-
12	0	1	5.2	-	12	0	1	15	-
13	0	1	25.5	-	13	0	1	10.5	-
14	0	0	2.3	-	14	0	1	10.1	-
15	0	0	6.9	-	15	0	1	9.6	-
16	0	1	8.8	-	16	0	1	13.8	-
17	0	0	1.5	-	17	0	1	10.1	-
18	0	1	31.9	-	18	0	1	8.8	-
19	0	1	6.1	-	19	0	1	11.5	-
20	0	1	6.1	0.25	20	0	1	10.5	0.75
21	0	0	2.6	-	21	0	1	6.4	-
22	0	1	22.1	-	22	1	1	13	-
23	0	0	3.8	-	23	0	1	8.4	-
24	0	1	9.1	-	24	1	1	17.5	-
25	0	1	12.1	-	25	0	1	8.1	-
26	0	1	5.1	-	26	0	1	5.2	-
27	0	1	6.2	-	27	0	1	12.8	-
28	0	0	5.9	-	28	0	1	10.8	-
29	0	1	7.4	-	29	0	1	14.5	-
30	0	1	9.6	0.25	30	0	1	17	0.5
31	0	1	8.4	-	31	0	1	7	-
32	0	0	3.2	-	32	0	1	16	-
33	0	0	3.8	-	33	0	1	7.6	-
34	0	1	9.9	-	34	0	1	7.9	-
35	0	1	6.2	-	35	0	1	6.3	-
36	0	0	5.8	-	36	0	1	15.5	-
37	0	0	7.3	-	37	0	1	8.6	-
38	0	1	4.9	-	38	0	1	9.3	-
39	0	0	3.4	-	39	0	1	12.5	-
40	0	0	2.2	0	40	0	1	18	0.25
41	0	0	3.4	-	41	0	1	16	-
42	0	1	6.6	-	42	0	1	8.9	-
43	0	0	4.2	-	43	1	1	11.5	-
44	0	1	6.8	-	44	1	1	8.4	-
45	0	1	7.2	-	45	0	1	5.5	-
46	0	1	7.1	-	46	1	1	13.1	-
47	0	1	9.2	-	47	0	1	14	-
48	0	1	6.9	-	48	0	1	13.5	-
49	0	1	13.2	-	49	1	1	13.8	-
50	0	1	8.1	0.5	50	1	1	14.2	0.5
51	0	0	3.9	-	51	0	1	11.5	-
52	0	1	3.8	-	52	0	1	7.3	-
53	0	1	12.2	-	53	0	1	11.2	-
54	0	1	3.6	-	54	0	1	18	-
55	0	1	8.6	-	55	0	1	13	-
56	0	0	6.8	-	56	0	1	10.8	-
57	0	0	5.1	-	57	0	1	9.6	-
58	0	0	5.2	-	58	0	1	7.1	-
59	0	0	6.8	-	59	1	1	14.7	-
60	0	0	3.1	0.5	60	0	1	19	0.5
61	0	0	4.4	-	61	0	1	7.8	-
62	0	1	2.9	-	62	0	1	9.6	-
63	0	0	1.7	-	63	0	1	12	-
64	0	0	8	-	64	0	1	12.5	-
65	0	0	6.2	-	65	0	1	9.4	-
66	0	1	3.8	-	66	1	1	16	-
67	0	0	3.4	-	67	1	1	12.7	-
68	0	1	5.9	-	68	0	1	7	-
69	0	1	8.1	-	69	1	1	11.5	-
70	0	1	10.2	0.5	70	0	1	19	0.5
71	0	1	6	-	71	0	1	9.8	-
72	0	1	4.2	-	72	0	1	13	-
73	0	1	6.6	-	73	0	1	12.8	-
74	0	1	8.2	-	74	1	1	15	-
75	0	1	11.2	-	75	1	1	10.2	-
76	0	1	7.1	-	76	0	1	9	-
77	0	0	3.2	-	77	0	1	11.4	-
78	0	1	4.9	-	78	0	1	14	-
79	0	1	3.4	-	79	1	1	16	-
80	0	1	3.6	0.25	80	0	1	14.8	0.5
81	0	1	3.2	-	81	1	1	10.5	-
82	0	0	3.6	-	82	0	1	13.6	-
83	0	0	3.2	-	83	0	1	17	-
84	0	0	3.7	-	84	1	1	13.7	-
85	0	0	10.6	-	85	0	1	14	-
86	0	0	3.8	-	86	0	1	7.4	-
87	0	1	5.1	-	87	0	1	10.6	-
88	0	1	4.6	-	88	0	1	9.5	-
89	0	1	4.3	-	89	0	1	13	-
90	0	1	7.6	0.25	90	0	1	12.8	0.75
91	0	1	10.2	-	91	0	1	12	-
92	0	1	9.2	-	92	0	1	8.1	-
93	0	1	8	-	93	0	1	12.3	-
94	0	0	2.7	-	94	0	1	20	-
95	0	1	3.5	-	95	0	1	11.3	-
96	0	1	2.9	-	96	0	1	15.5	-
97	0	1	11.5	-	97	0	1	11.7	-
98	0	0	4.1	-	98	0	1	16.5	-
99	0	1	2.8	-	99	0	1	5.8	-
100	0	1	4.1	0	100	1	1	17.5	0.5
Minimum	**0.0**	**0.0**	**1.3**	**0**	**Minimum**	**0.0**	**1.0**	**5.2**	**0.25**
Maximum	**0.0**	**1.0**	**32.2**	**0.5**	**Maximum**	**1.0**	**1.0**	**20.0**	**0.75**
Mean	**0.0**	**0.6**	**6.7**	**0.3**	**Mean**	**0.2**	**1.0**	**11.9**	**0.5**
sd	**0.0**	**0.5**	**5.1**	**0.2**	**sd**	**0.4**	**0.0**	**3.5**	**0.1**
Geometric mean	**-**	**-**	**5.6**	**-**	**Geometric mean**	**-**	**-**	**11.4**	**-**
Median	**0.0**	**1.0**	**5.9**	**0**	**Median**	**0.0**	**1.0**	**11.6**	**1**

CI = Calcite index

Table A.10: Pebble and Calcite Count in the Upper Fording River, September 2017

FODHE (CI = 0.92)					FOUNGD (CI = 0.62)				
Rock	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embeddedness**	**Rock**	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embeddedness**
1	0	1	16	-	1	0	1	8.1	-
2	0	1	15.8	-	2	0	0	7.6	-
3	0	1	8.8	-	3	0	1	10.6	-
4	0	1	11.8	-	4	0	1	8.9	-
5	0	0	10	-	5	0	1	3.5	-
6	0	1	9.6	-	6	0	0	6.7	-
7	0	1	17.5	-	7	0	0	4.2	-
8	0	1	4.6	-	8	0	0	14	-
9	0	1	10.2	-	9	0	1	7.3	-
10	0	0	5.6	0.75	10	0	0	5.2	0.25
11	0	1	17.5	-	11	0	1	14.5	-
12	0	0	7.6	-	12	0	1	8.1	-
13	0	1	8.5	-	13	0	1	8.8	-
14	0	1	7.2	-	14	0	1	7.5	-
15	0	1	14	-	15	0	0	3.1	-
16	0	1	11.6	-	16	0	0	7.2	-
17	0	1	33	-	17	0	0	4.7	-
18	0	1	14.5	-	18	0	0	5.3	-
19	0	1	9.2	-	19	0	0	7.2	-
20	0	1	10.2	0.5	20	0	1	7.3	0.5
21	0	1	4.8	-	21	0	0	5.4	-
22	0	1	8.1	-	22	0	1	4.8	-
23	0	1	4.6	-	23	0	1	6.2	-
24	0	1	9.6	-	24	0	0	5.6	-
25	0	1	4.5	-	25	0	1	8.1	-
26	0	1	8.7	-	26	0	1	6	-
27	0	1	4.3	-	27	0	0	8.2	-
28	0	1	9.6	-	28	0	1	6.8	-
29	0	0	7.5	-	29	0	0	7.5	-
30	0	0	7.4	0.75	30	0	1	7.1	0.25
31	0	1	11.3	-	31	0	1	10.5	-
32	0	1	7.5	-	32	0	1	5.2	-
33	0	1	8.2	-	33	0	1	12.2	-
34	0	1	18	-	34	0	1	7.7	-
35	0	1	8.5	-	35	0	1	7.3	-
36	0	1	6.6	-	36	0	1	8.2	-
37	0	1	4.6	-	37	0	1	17	-
38	0	1	16.4	-	38	0	1	7.2	-
39	0	1	8.8	-	39	0	1	6	-
40	0	1	12.7	0.5	40	0	1	6.6	0.5
41	0	1	9.6	-	41	0	1	7.1	-
42	0	1	9.4	-	42	0	1	8.4	-
43	0	1	21	-	43	0	1	5.6	-
44	0	1	7.7	-	44	0	1	9.3	-
45	0	1	20	-	45	0	1	7.7	-
46	0	1	11.3	-	46	0	1	6.5	-
47	0	1	7.6	-	47	0	0	4.6	-
48	0	1	14.8	-	48	0	0	4.5	-
49	0	1	7.5	-	49	0	0	4.4	-
50	0	1	10.7	0.25	50	0	0	4.3	0.25
51	0	1	25	-	51	0	0	4	-
52	0	1	9.2	-	52	0	1	6.5	-
53	0	1	13.8	-	53	0	1	8.5	-
54	0	1	7.8	-	54	0	1	11	-
55	0	1	15.3	-	55	0	1	7.6	-
56	0	0	4.2	-	56	0	1	5.3	-
57	0	1	11	-	57	0	1	6	-
58	0	1	10.8	-	58	0	1	7.2	-
59	0	1	18	-	59	0	1	6.5	-
60	0	1	13.4	0.25	60	0	1	10	0.25
61	0	1	11.6	-	61	0	0	7.5	-
62	0	1	12.6	-	62	0	0	6.9	-
63	0	1	6	-	63	0	1	6.8	-
64	0	1	8.9	-	64	0	1	4.9	-
65	0	1	10.4	-	65	0	1	6.4	-
66	0	1	13.9	-	66	0	1	6.9	-
67	0	1	8.2	-	67	0	1	7.2	-
68	0	1	11	-	68	0	0	5.3	-
69	0	1	11.1	-	69	0	0	8.8	-
70	0	1	10.2	0.75	70	0	1	7.9	0.5
71	0	1	7.4	-	71	0	1	5.8	-
72	0	1	12	-	72	0	0	5.6	-
73	0	0	7.1	-	73	0	0	4.4	-
74	0	1	11.5	-	74	0	0	6	-
75	0	1	10.7	-	75	0	1	8.5	-
76	0	1	11.6	-	76	0	1	8.2	-
77	0	1	8	-	77	0	0	4.6	-
78	0	1	12.9	-	78	0	1	7.7	-
79	0	1	14.8	-	79	0	1	5	-
80	0	1	13.6	0.25	80	0	1	17	0.5
81	0	1	12.1	-	81	0	1	12.4	-
82	0	1	15	-	82	0	1	4.2	-
83	0	1	6.2	-	83	0	1	5.4	-
84	0	1	14.8	-	84	0	1	6.1	-
85	0	1	9.3	-	85	0	0	7.5	-
86	0	1	8.4	-	86	0	1	7.7	-
87	0	1	12.5	-	87	0	0	6.6	-
88	0	1	6.1	-	88	0	0	3.8	-
89	0	1	16	-	89	0	0	4.9	-
90	0	1	12.7	0.25	90	0	0	6.6	0.25
91	0	1	7.5	-	91	0	1	5.6	-
92	0	1	7.2	-	92	0	0	4.9	-
93	0	0	3	-	93	0	0	15.5	-
94	0	1	14.8	-	94	0	0	13.5	-
95	0	1	6.7	-	95	0	1	6.2	-
96	0	1	12.6	-	96	0	1	7.9	-
97	0	1	12.2	-	97	0	0	5.3	-
98	0	1	7.5	-	98	0	1	7.6	-
99	0	1	9.7	-	99	0	0	5.3	-
100	0	1	10.3	0.25	100	0	0	5.2	0.5
Minimum	**0.0**	**0.0**	**3.0**	**0.25**	**Minimum**	**0.0**	**0.0**	**3.1**	**0.25**
Maximum	**0.0**	**1.0**	**33.0**	**0.75**	**Maximum**	**0.0**	**1.0**	**17.0**	**0.5**
Mean	**0.0**	**0.9**	**10.8**	**0.5**	**Mean**	**0.0**	**0.6**	**7.2**	**0.4**
sd	**0.0**	**0.3**	**4.6**	**0.2**	**sd**	**0.0**	**0.5**	**2.7**	**0.1**
Geometric mean	**-**	**-**	**10.0**	**-**	**Geometric mean**	**-**	**-**	**6.8**	**-**
Median	**0.0**	**1.0**	**10.2**	**0**	**Median**	**0.0**	**1.0**	**6.9**	**0**

CI = Calcite index

Table A.10: Pebble and Calcite Count in the Upper Fording River, September 2017

FODNGD (CI = 0.96)					MP1 (CI = 0.95)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness
1	0	1	18.5	-	1	0	1	15.2	-
2	0	1	7.4	-	2	0	1	9.5	-
3	0	1	6.5	-	3	0	1	16	-
4	0	1	5.6	-	4	0	1	18.5	-
5	0	1	9.6	-	5	0	1	8.6	-
6	0	0	7.6	-	6	0	1	7.1	-
7	0	0	7.7	-	7	0	1	8.6	-
8	0	0	3.2	-	8	0	1	38	-
9	0	1	8.2	-	9	0	1	5.7	-
10	0	1	9.8	0.25	10	0	1	15.9	0.75
11	0	1	9.9	-	11	0	1	5.3	-
12	0	1	10.5	-	12	0	1	4.6	-
13	0	1	7.7	-	13	0	1	40	-
14	0	1	6.2	-	14	0	1	21	-
15	0	1	20.5	-	15	0	1	5.5	-
16	0	1	10	-	16	0	1	13.3	-
17	0	1	9.6	-	17	0	1	17.5	-
18	0	1	8.1	-	18	0	1	33	-
19	0	1	6.7	-	19	0	1	12.2	-
20	0	1	7.1	0.75	20	0	1	15.2	0.25
21	0	1	14.9	-	21	0	1	24	-
22	0	1	11	-	22	0	1	17.7	-
23	0	0	4	-	23	0	0	4	-
24	0	1	7.2	-	24	0	1	58	-
25	0	1	7.1	-	25	0	1	19.2	-
26	0	1	14	-	26	0	0	1.8	-
27	0	1	12.2	-	27	0	1	18.3	-
28	0	1	12.6	-	28	0	1	14	-
29	0	1	10.5	-	29	0	1	28.5	-
30	0	1	13.1	0.25	30	0	1	17.8	0.5
31	0	1	9.5	-	31	0	1	3.9	-
32	0	1	12.3	-	32	0	1	28	-
33	0	1	7.8	-	33	0	1	18.5	-
34	0	1	9.4	-	34	0	1	7.8	-
35	0	1	9.3	-	35	0	1	3.7	-
36	0	1	5.6	-	36	0	1	30	-
37	0	1	4.1	-	37	0	1	22	-
38	0	1	7.8	-	38	0	1	26	-
39	0	1	9.8	-	39	0	0	4.2	-
40	0	1	8.4	0.75	40	0	1	15.5	0.5
41	0	1	6.1	-	41	0	1	5.2	-
42	0	1	9.6	-	42	0	1	3.7	-
43	0	1	6.4	-	43	0	1	26	-
44	0	1	15.9	-	44	0	1	15.5	-
45	0	1	14.5	-	45	0	1	13.6	-
46	0	1	6.9	-	46	0	1	41	-
47	0	1	12	-	47	0	1	18.3	-
48	0	1	7.5	-	48	0	1	4	-
49	0	1	11.3	-	49	0	1	5.2	-
50	0	1	22	0.5	50	0	1	21	0.25
51	0	1	10	-	51	0	1	14.6	-
52	0	1	6.1	-	52	0	1	10.5	-
53	0	1	5	-	53	0	1	15.1	-
54	0	1	7.8	-	54	0	1	18	-
55	0	1	8.9	-	55	0	1	3.9	-
56	0	1	12.8	-	56	0	1	51	-
57	0	1	7.3	-	57	0	1	11.5	-
58	0	1	22	-	58	0	1	8	-
59	0	1	8.3	-	59	0	1	17	-
60	0	1	8	0.5	60	0	1	30	0.75
61	0	1	17	-	61	0	1	16.7	-
62	0	1	85	-	62	0	1	9.8	-
63	0	1	6.7	-	63	0	1	34	-
64	0	1	13.4	-	64	0	1	12.5	-
65	0	1	19	-	65	0	0	5.3	-
66	0	1	8.7	-	66	0	0	2.1	-
67	0	1	10.3	-	67	0	1	18	-
68	0	1	10.4	-	68	0	1	14	-
69	0	1	11.4	-	69	0	1	4.7	-
70	0	1	9.5	0.5	70	0	1	25	0.5
71	0	1	10.3	-	71	0	1	12.8	-
72	0	1	8.2	-	72	0	1	25	-
73	0	1	6.7	-	73	0	1	29	-
74	0	1	8.9	-	74	0	1	13.5	-
75	0	1	8.4	-	75	0	1	46	-
76	0	1	7.2	-	76	0	1	16	-
77	0	1	18.5	-	77	0	1	8	-
78	0	1	11.4	-	78	0	1	5.7	-
79	0	1	48	-	79	0	1	5.3	-
80	0	1	7.9	0.5	80	0	1	18.5	0.25
81	0	1	18	-	81	0	1	32	-
82	0	1	12.5	-	82	0	1	7.2	-
83	0	1	11	-	83	0	1	19	-
84	0	1	12.6	-	84	0	1	7	-
85	0	1	6.9	-	85	0	1	21	-
86	0	1	10.6	-	86	0	1	5	-
87	0	1	11.1	-	87	0	1	7.3	-
88	0	1	18.5	-	88	0	1	11	-
89	0	1	3.6	-	89	0	1	13	-
90	0	1	4.4	0	90	0	1	12.5	0.25
91	0	1	10	-	91	0	1	10.3	-
92	0	1	9.4	-	92	0	1	9.8	-
93	0	1	12.5	-	93	0	1	14.5	-
94	0	1	3.6	-	94	0	1	5.3	-
95	0	1	9.6	-	95	0	1	25.5	-
96	0	1	11.4	-	96	0	1	26	-
97	0	1	15	-	97	0	1	9.4	-
98	0	1	11.3	-	98	0	1	9.9	-
99	0	1	11.1	-	99	0	1	5.2	-
100	0	1	12.2	0.25	100	0	1	29	0.5
Minimum	**0.0**	**0.0**	**3.2**	**0**	**Minimum**	**0.0**	**0.0**	**1.8**	**0.25**
Maximum	**0.0**	**1.0**	**85.0**	**0.75**	**Maximum**	**0.0**	**1.0**	**58.0**	**0.75**
Mean	**0.0**	**1.0**	**11.2**	**0.4**	**Mean**	**0.0**	**1.0**	**16.1**	**0.5**
sd	**0.0**	**0.2**	**9.3**	**0.2**	**sd**	**0.0**	**0.2**	**11.1**	**0.2**
Geometric mean	**-**	**-**	**9.7**	**-**	**Geometric mean**	**-**	**-**	**12.6**	**-**
Median	**0.0**	**1.0**	**9.6**	**1**	**Median**	**0.0**	**1.0**	**14.3**	**1**

CI = Calcite index

Table A.10: Pebble and Calcite Count in the Upper Fording River, September 2017

FOUSH (CI = 0.90)					FOUKI (CI = 0.78)				
Rock	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embeddedness**	**Rock**	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embeddedness**
1	0	1	14.5	-	1	0	1	11.5	-
2	0	0	11.5	-	2	0	0	6	-
3	0	1	5.2	-	3	0	1	13	-
4	0	0	8.1	-	4	0	1	18	-
5	0	0	8.6	-	5	0	1	12	-
6	0	1	14	-	6	0	0	6	-
7	0	1	12.3	-	7	0	0	4.5	-
8	0	0	3.6	-	8	0	1	14	-
9	0	1	28	-	9	0	0	4	-
10	0	0	13.5	-	10	0	1	11.5	0
11	0	1	26	-	11	0	1	12	-
12	0	1	8.2	0.25	12	0	1	8.5	-
13	0	1	15.5	-	13	0	1	12.5	-
14	0	1	14.3	-	14	0	0	9	-
15	0	1	15	-	15	0	0	8	-
16	0	1	15	-	16	0	1	6.5	-
17	0	1	22.5	-	17	0	0	6	-
18	0	1	8.2	-	18	0	1	12	-
19	0	1	15.3	-	19	0	0	7	-
20	0	1	9.5	0.25	20	0	1	4	0
21	0	1	19.5	-	21	0	1	16.5	-
22	0	1	16.5	-	22	0	1	11.5	-
23	0	1	8.5	-	23	0	0	5	-
24	0	1	11.5	-	24	0	0	6.5	-
25	0	1	9.5	-	25	0	1	19	-
26	0	1	16	-	26	0	1	13	-
27	0	1	20	-	27	0	1	13	-
28	0	0	6.2	-	28	0	0	9.5	-
29	0	1	9.5	-	29	0	1	6	-
30	0	1	10.4	0.25	30	0	0	11	0
31	0	1	10	-	31	0	0	11.5	-
32	0	1	5.9	-	32	0	1	19	-
33	0	1	7.8	-	33	0	1	9.5	-
34	0	1	6.2	-	34	0	1	11	-
35	0	1	8.4	-	35	0	1	45	-
36	0	1	36	-	36	0	0	12	-
37	0	1	6.3	-	37	0	1	8	-
38	0	1	8.6	-	38	0	1	14	-
39	0	1	14.5	-	39	0	1	7	-
40	0	1	12.2	0.5	40	0	1	10	0
41	0	1	6.2	-	41	0	1	5	-
42	0	1	11.5	-	42	0	1	10	-
43	0	1	12.1	-	43	0	1	5	-
44	0	1	12.6	-	44	0	1	11	-
45	0	1	25	-	45	0	0	10.5	-
46	0	1	6.8	-	46	0	1	14	-
47	0	1	22	-	47	0	1	8	-
48	0	1	10.5	-	48	0	1	6	-
49	0	1	9.1	-	49	0	1	9	-
50	0	1	9.7	-	50	0	1	15	0
51	0	1	8.4	0.25	51	0	1	3.5	-
52	0	1	6.5	-	52	0	1	16.5	-
53	0	1	7	-	53	0	1	5.5	-
54	0	1	8.3	-	54	0	1	14	-
55	0	1	7.2	-	55	0	0	11	-
56	0	1	15.5	-	56	0	1	12	-
57	0	1	11.5	-	57	0	1	9	-
58	0	1	9	-	58	0	1	5	-
59	0	1	5.7	-	59	0	0	7	-
60	0	0	9.7	0.25	60	0	1	9	0.25
61	0	1	13	-	61	0	1	14	-
62	0	1	8.8	-	62	0	1	11	-
63	0	1	10.6	-	63	0	1	7	-
64	0	1	6.2	-	64	0	1	4	-
65	0	1	11.3	-	65	0	1	10	-
66	0	1	10.5	-	66	0	1	6	-
67	0	1	5.7	-	67	0	1	5	-
68	0	1	9.9	-	68	0	1	10	-
69	0	1	14	-	69	0	1	18	-
70	0	1	11.8	0.25	70	0	1	9	0.5
71	0	1	11.6	-	71	0	1	3.5	-
72	0	1	20	-	72	0	1	6	-
73	0	0	6.2	-	73	0	1	3.5	-
74	0	1	11.1	-	74	0	1	13.5	-
75	0	1	8.6	-	75	0	1	5.5	-
76	0	1	24	-	76	0	1	9.5	-
77	0	1	9.1	-	77	0	1	8	-
78	0	1	8.6	-	78	0	1	9	-
79	0	1	5.9	-	79	0	1	16	-
80	0	1	22	-	80	0	0	9	0.5
81	0	1	20.5	0.5	81	0	1	6	-
82	0	1	14.2	-	82	0	1	14	-
83	0	1	7.9	-	83	0	1	11	-
84	0	1	9.2	-	84	0	1	7	-
85	0	1	21	-	85	0	1	13	-
86	0	1	7.7	-	86	0	1	14	-
87	0	1	32	-	87	0	1	8	-
88	0	1	12	-	88	0	1	5.5	-
89	0	1	18	-	89	0	0	5	-
90	0	1	21	0.25	90	0	1	12.5	0
91	0	1	9.2	-	91	0	1	3	-
92	0	1	9.1	-	92	0	0	3.5	-
93	0	1	12	-	93	0	1	7	-
94	0	0	9.2	-	94	0	1	7.5	-
95	0	0	8.2	-	95	0	1	10.5	-
96	1	0	9.3	-	96	0	0	9	-
97	0	1	12.2	-	97	0	1	11	-
98	0	1	7.4	-	98	0	1	8	-
99	0	1	33	-	99	0	1	18	-
100	0	1	10.6	0.25	100	0	0	8	0
Minimum	**0.0**	**0.0**	**3.6**	**0.25**	**Minimum**	**0.0**	**0.0**	**3.0**	**0**
Maximum	**1.0**	**1.0**	**36.0**	**0.5**	**Maximum**	**0.0**	**1.0**	**45.0**	**0.5**
Mean	**0.0**	**0.9**	**12.4**	**0.3**	**Mean**	**0.0**	**0.8**	**9.9**	**0.1**
sd	**0.1**	**0.3**	**6.3**	**0.1**	**sd**	**0.0**	**0.4**	**5.3**	**0.2**
Geometric mean	**-**	**-**	**11.1**	**-**	**Geometric mean**	**-**	**-**	**8.9**	**-**
Median	**0.0**	**1.0**	**10.5**	**0**	**Median**	**0.0**	**1.0**	**9.0**	**0**

CI = Calcite index

Table A.10: Pebble and Calcite Count in the Upper Fording River, September 2017

FOBKS (CI = 0.48)					FOBSC (CI = 1.06)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness
1	0	0	7.1	-	1	0	1	17	-
2	0	0	3.9	-	2	0	1	10	-
3	0	1	15.7	-	3	0	1	6	-
4	0	1	5	-	4	1	1	17	-
5	0	0	8.2	-	5	0	1	10	-
6	0	0	1.5	-	6	0	1	8	-
7	0	0	3.4	-	7	0	1	8	-
8	0	0	7.5	-	8	0	1	8	-
9	0	1	8.7	-	9	0	1	6.5	-
10	0	0	7.2	0.5	10	0	1	18.5	0
11	0	1	13.2	-	11	0	1	10	-
12	0	0	3.4	-	12	0	1	9	-
13	0	0	8.1	-	13	0	1	4	-
14	0	0	9.9	-	14	0	1	8	-
15	0	0	1.3	-	15	0	1	7	-
16	0	1	19.5	-	16	0	1	8	-
17	0	0	5.2	-	17	0	1	9	-
18	0	0	11	-	18	0	1	7.5	-
19	0	1	7.2	-	19	0	1	6	-
20	0	1	11.6	0.25	20	0	1	10	0.25
21	0	1	10	-	21	0	1	4.5	-
22	0	1	12.9	-	22	0	1	10	-
23	0	0	6	-	23	0	1	6	-
24	0	0	5.4	-	24	0	1	4	-
25	0	1	10	-	25	0	1	8	-
26	0	0	5.9	-	26	0	1	9	-
27	0	1	8.3	-	27	0	1	6.5	-
28	0	0	14.4	-	28	0	1	3.5	-
29	0	0	2.2	-	29	0	1	6.5	-
30	0	0	7.6	0.25	30	0	1	6.5	0
31	0	0	6.5	-	31	0	1	20	-
32	0	0	8.1	-	32	0	1	9	-
33	0	0	6	-	33	0	1	7.5	-
34	0	1	9.1	-	34	0	1	3	-
35	0	0	2.9	-	35	1	1	6	-
36	0	0	16	-	36	0	1	13	-
37	0	0	3.5	-	37	2	1	7.5	-
38	0	0	7.2	-	38	2	1	9	-
39	0	0	6	-	39	0	1	9	-
40	0	1	12.5	0.25	40	0	1	27	0.5
41	0	0	10	-	41	0	1	6	-
42	0	1	11.1	-	42	0	1	7.5	-
43	0	1	21	-	43	0	1	5.5	-
44	0	1	9.4	-	44	0	1	6.5	-
45	0	1	5.8	-	45	0	1	10	-
46	0	0	9.4	-	46	0	1	5	-
47	0	0	9.1	-	47	0	1	10.5	-
48	0	0	3.5	-	48	0	1	7.5	-
49	0	1	11.3	-	49	0	1	5.5	-
50	0	1	20.5	0	50	0	1	11	0.25
51	0	0	5.2	-	51	0	1	11	-
52	0	0	13	-	52	0	1	11.5	-
53	0	0	7.1	-	53	0	1	6	-
54	0	1	15.3	-	54	0	1	4.5	-
55	0	1	5.9	-	55	0	1	5	-
56	0	1	15.2	-	56	0	1	3	-
57	0	1	8.7	-	57	0	1	8	-
58	0	1	11.7	-	58	0	1	10	-
59	0	1	11	-	59	0	1	4.5	-
60	0	1	12.5	0.5	60	0	1	12	0.25
61	0	1	12.2	-	61	0	1	10.5	-
62	0	1	10.9	-	62	0	1	4.5	-
63	0	0	2.3	-	63	0	1	7.5	-
64	0	0	7.1	-	64	0	1	13	-
65	0	0	9.5	-	65	0	1	18	-
66	0	0	3.9	-	66	0	1	7	-
67	0	0	15	-	67	0	1	23	-
68	0	0	2	-	68	0	1	9	-
69	0	0	1.7	-	69	0	1	7	-
70	0	0	15.2	0.5	70	0	1	6.5	0
71	0	0	6.4	-	71	0	1	9	-
72	0	0	9.1	-	72	0	1	7	-
73	0	0	8.9	-	73	0	1	9.5	-
74	0	0	11.6	-	74	0	1	18	-
75	0	0	8.9	-	75	0	1	7	-
76	0	0	8.2	-	76	0	1	6	-
77	0	0	16.5	-	77	0	1	16	-
78	0	1	14.3	-	78	0	1	7	-
79	0	1	10.1	-	79	0	1	5	-
80	0	1	20.5	0.5	80	0	1	3.5	0
81	0	1	19.1	-	81	0	1	10.5	-
82	0	1	9.2	-	82	0	1	12	-
83	0	1	10.9	-	83	0	1	9	-
84	0	1	12.2	-	84	0	1	28.5	-
85	0	0	4.4	-	85	0	1	3.5	-
86	0	1	6.7	-	86	0	1	6.5	-
87	0	1	26	-	87	0	1	5	-
88	0	1	4.5	-	88	0	1	6.5	-
89	0	1	2.6	-	89	0	1	5.5	-
90	0	1	10.5	0.25	90	0	1	6	0.25
91	0	0	5	-	91	0	1	7	-
92	0	1	23.5	-	92	0	1	6	-
93	0	1	7	-	93	0	1	5.5	-
94	0	1	7.4	-	94	0	1	13.5	-
95	0	1	11.8	-	95	0	1	13	-
96	0	1	10.4	-	96	0	1	10	-
97	0	1	8.1	-	97	0	1	9	-
98	0	1	2	-	98	0	1	7.5	-
99	0	1	15.2	-	99	0	1	5.5	-
100	0	0	7.2	0.25	100	0	1	12	0.75
Minimum	**0.0**	**0.0**	**1.3**	**0**	**Minimum**	**0.0**	**1.0**	**3.0**	**0**
Maximum	**0.0**	**1.0**	**26.0**	**0.5**	**Maximum**	**2.0**	**1.0**	**28.5**	**0.75**
Mean	**0.0**	**0.5**	**9.3**	**0.3**	**Mean**	**0.1**	**1.0**	**8.9**	**0.2**
sd	**0.0**	**0.5**	**5.0**	**0.2**	**sd**	**0.3**	**0.0**	**4.7**	**0.2**
Geometric mean	**-**	**-**	**7.9**	**-**	**Geometric mean**	**-**	**-**	**8.0**	**-**
Median	**0.0**	**0.0**	**8.8**	**0**	**Median**	**0.0**	**1.0**	**7.5**	**0**

CI = Calcite index

Table A.10: Pebble and Calcite Count in the Upper Fording River, September 2017

FOBCP (CI = 1.1)					FRCP1SW (CI = 1.03)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness
1	0	1	11.8	-	1	0	1	10.6	-
2	0	1	7	-	2	0	1	7.4	-
3	0	1	6.9	-	3	0	1	7.3	-
4	0	1	9.9	-	4	0	1	8.5	-
5	0	1	15.2	-	5	0	1	8.4	-
6	0	1	13.6	-	6	0	1	10.7	-
7	0	1	11.8	-	7	0	1	10.1	-
8	0	1	8.5	-	8	0	1	8.2	-
9	0	1	7.7	-	9	0	1	4.3	-
10	0	1	9.8	0.25	10	0	1	6.8	0.25
11	0	1	4.5	-	11	0	1	5.6	-
12	0	1	9.7	-	12	0	1	6.5	-
13	0	1	17.2	-	13	0	1	5.8	-
14	0	1	6	-	14	0	1	6.4	-
15	0	1	10.1	-	15	0	1	7.9	-
16	0	1	11	-	16	1	1	9.8	-
17	0	1	10	-	17	0	1	6.3	-
18	0	1	10.3	-	18	0	1	7.2	-
19	0	1	13.2	-	19	0	1	9.9	-
20	0	1	8.8	0.25	20	0	1	6.1	0.25
21	0	1	7.1	-	21	0	1	10	-
22	0	1	7.9	-	22	0	1	8.3	-
23	0	1	7.2	-	23	0	1	12	-
24	0	1	G	-	24	0	1	8.6	-
25	0	1	12.3	-	25	0	1	5.6	-
26	0	1	1.6	-	26	0	1	5.7	-
27	0	1	3.9	-	27	0	1	6.2	-
28	0	1	3	-	28	1	1	7.3	-
29	0	1	10.8	-	29	0	1	7.9	-
30	0	1	12.5	0.5	30	0	1	5.4	0.25
31	0	1	10.1	-	31	0	1	11	-
32	0	1	8.5	-	32	0	1	8.6	-
33	0	0	7	-	33	0	1	4.9	-
34	0	1	6.1	-	34	0	1	9.2	-
35	0	1	13	-	35	0	1	4.1	-
36	0	1	9.5	-	36	0	1	7.6	-
37	0	1	11.3	-	37	0	1	13	-
38	0	1	5	-	38	0	1	8.9	-
39	1	1	12.5	-	39	0	1	3.3	-
40	0	1	10.5	0.5	40	0	1	13.2	0.5
41	0	1	9.5	-	41	0	1	4.9	-
42	0	1	13.2	-	42	0	1	4.9	-
43	0	1	10.7	-	43	0	1	5.2	-
44	0	1	8.7	-	44	0	1	5.5	-
45	0	1	30.5	-	45	0	1	7.6	-
46	0	1	8.8	-	46	0	1	5.3	-
47	0	1	14.5	-	47	0	1	11.2	-
48	1	1	10.5	-	48	0	1	6.1	-
49	0	1	10	-	49	0	1	6.3	-
50	0	1	11	0.75	50	0	1	8.2	0.25
51	0	1	5.5	-	51	0	1	5.8	-
52	0	1	9.5	-	52	0	1	5.6	-
53	0	1	15.5	-	53	0	1	9	-
54	0	1	7.8	-	54	0	1	5.3	-
55	0	1	8.9	-	55	0	1	4.2	-
56	0	1	5	-	56	0	1	4.8	-
57	1	1	2.8	-	57	0	1	9.7	-
58	0	1	4.4	-	58	0	1	8	-
59	0	1	4.5	-	59	0	1	5.1	-
60	0	1	2.5	0	60	0	1	6.4	0.25
61	0	1	7	-	61	0	1	8.5	-
62	0	1	6.1	-	62	0	1	5.2	-
63	0	1	5.6	-	63	0	1	3.2	-
64	0	1	8.4	-	64	0	1	9.4	-
65	0	1	4.8	-	65	0	1	11.5	-
66	0	1	9.9	-	66	0	1	7.2	-
67	0	1	14	-	67	0	1	8.4	-
68	0	1	8.4	-	68	0	1	7.3	-
69	0	1	4.9	-	69	0	1	6.2	-
70	0	1	13.5	0.25	70	0	1	8.2	0.5
71	0	1	4	-	71	0	1	9.8	-
72	1	1	4	-	72	0	1	7.6	-
73	1	1	10.2	-	73	0	1	5.3	-
74	0	1	4.8	-	74	0	1	5.9	-
75	0	1	12.1	-	75	0	1	8	-
76	0	1	8	-	76	0	1	6.1	-
77	0	1	14.2	-	77	0	1	7.3	-
78	0	1	8.4	-	78	0	1	3.2	-
79	0	1	10.1	-	79	0	1	8.8	-
80	0	1	11.3	0.75	80	0	1	7.2	-
81	0	1	10.5	-	81	0	1	5.3	0.25
82	0	1	11.6	-	82	0	1	15	-
83	0	1	7.7	-	83	1	1	5.8	-
84	0	1	4.6	-	84	0	1	7.6	-
85	0	1	4	-	85	0	1	8.6	-
86	0	1	10.1	-	86	0	1	6.7	-
87	0	1	10.2	-	87	0	1	6.4	-
88	0	1	10.8	-	88	0	1	8.5	-
89	0	1	14	-	89	0	1	7.6	-
90	0	1	8.8	0.25	90	0	1	7.7	0.25
91	1	1	12.5	-	91	0	1	13	-
92	1	1	14.5	-	92	0	1	5.7	-
93	0	1	12.2	-	93	0	1	4.6	-
94	0	1	7.7	-	94	0	1	4.8	-
95	0	1	21	-	95	0	1	6	-
96	0	1	14.4	-	96	0	1	13	-
97	0	1	15.7	-	97	0	1	6.5	-
98	0	1	11.6	-	98	0	1	5.5	-
99	0	1	6.6	-	99	0	1	7	-
100	0	1	4.4	0.5	100	0	1	6.6	0.5
Minimum	**0.0**	**0.0**	**1.6**	**0**	**Minimum**	**0.0**	**1.0**	**3.2**	**0.25**
Maximum	**1.0**	**1.0**	**30.5**	**0.75**	**Maximum**	**1.0**	**1.0**	**15.0**	**0.5**
Mean	**0.1**	**1.0**	**9.5**	**0.4**	**Mean**	**0.0**	**1.0**	**7.4**	**0.3**
sd	**0.3**	**0.1**	**4.2**	**0.2**	**sd**	**0.2**	**0.0**	**2.4**	**0.1**
Geometric mean	**-**	**-**	**8.6**	**-**	**Geometric mean**	**-**	**-**	**7.0**	**-**
Median	**0.0**	**1.0**	**9.7**	**0**	**Median**	**0.0**	**1.0**	**7.2**	**0**

CI = Calcite index

Table A.10: **Pebble and Calcite Count in the Upper Fording River, September 2017**

FRUPO (CI = 1.0)					FODPO (CI = 0.93)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness
1	0	1	9.5	-	1	0	1	3.3	-
2	0	1	6.1	-	2	0	1	4	-
3	0	1	8.6	-	3	0	1	4.6	-
4	0	1	4.1	-	4	0	1	4	-
5	0	1	4.3	-	5	0	1	3.3	-
6	0	1	6.7	-	6	0	1	2.3	-
7	0	1	5.8	-	7	0	0	4.5	-
8	0	1	6.9	-	8	0	1	2.6	-
9	0	1	4.7	-	9	0	1	2.9	-
10	0	1	5	0.25	10	0	0	2.5	0.5
11	0	1	5.4	-	11	0	0	2.5	-
12	0	1	5.3	-	12	0	1	1.5	-
13	0	1	4.8	-	13	0	1	4	-
14	0	1	5.1	-	14	0	1	3.7	-
15	0	1	5.2	-	15	0	1	3.7	-
16	0	1	6.5	-	16	0	1	3.3	-
17	0	1	5.6	-	17	0	1	3.6	-
18	0	1	6.5	-	18	0	0	G	-
19	0	1	8	-	19	0	1	3.6	-
20	0	1	4.2	0.25	20	0	0	2.9	0.25
21	0	1	5.5	-	21	0	1	1.1	-
22	0	1	7	-	22	0	1	5.8	-
23	0	1	8.2	-	23	0	1	1.5	-
24	0	1	8.3	-	24	0	1	3.3	-
25	0	1	5.4	-	25	0	1	4.3	-
26	0	1	4.6	-	26	0	1	7	-
27	0	1	6.5	-	27	0	1	5.1	-
28	0	1	6.8	-	28	0	1	4.5	-
29	0	1	3.5	-	29	0	1	4.2	-
30	0	1	7.7	0.5	30	0	1	6.4	0.75
31	0	1	6.6	-	31	0	1	1.5	-
32	0	1	5.2	-	32	0	1	3.5	-
33	0	1	6.4	-	33	0	1	7.3	-
34	0	1	6.2	-	34	0	0	4.9	-
35	0	1	7.1	-	35	0	1	4.7	-
36	0	1	5.8	-	36	0	1	3	-
37	0	1	4.3	-	37	0	1	2.4	-
38	0	1	3.2	-	38	0	1	5.5	-
39	0	1	4.2	-	39	0	1	5.5	-
40	0	1	4.9	0.25	40	0	1	6.4	0.75
41	0	1	5	-	41	0	1	3.5	-
42	0	1	5.2	-	42	0	1	7.2	-
43	0	1	5.4	-	43	0	1	7.1	-
44	0	1	7.3	-	44	0	1	6.9	-
45	0	1	5.1	-	45	0	1	5.9	-
46	0	1	4.9	-	46	0	1	5.4	-
47	0	1	8.2	-	47	0	1	3.5	-
48	0	1	4.5	-	48	0	1	3.6	-
49	0	1	6.1	-	49	0	1	5.7	-
50	0	1	8.1	0.5	50	0	1	4.4	0.5
51	0	1	5	-	51	0	1	3	-
52	0	1	6	-	52	0	1	4.4	-
53	0	1	7.6	-	53	0	1	3.1	-
54	0	1	4.5	-	54	0	1	2.9	-
55	0	1	5.6	-	55	0	1	3.9	-
56	0	1	5.2	-	56	0	1	3.2	-
57	0	1	5.9	-	57	0	0	2	-
58	0	1	4.8	-	58	0	1	3	-
59	0	1	5.5	-	59	0	1	1.3	-
60	0	1	6.6	0.25	60	0	1	6.5	0.5
61	0	1	5.6	-	61	0	1	4.2	-
62	0	1	4.6	-	62	0	1	2.2	-
63	0	1	5.9	-	63	0	1	2.2	-
64	0	1	5.5	-	64	0	1	3.9	-
65	0	1	3.2	-	65	0	1	2	-
66	0	1	7.4	-	66	0	1	6.4	-
67	0	1	4.4	-	67	0	1	1.6	-
68	0	1	7.3	-	68	0	1	1.5	-
69	0	1	4.5	-	69	0	1	2.3	-
70	0	1	4.9	0.25	70	0	1	3	0.5
71	0	1	4.3	-	71	0	1	4.8	-
72	0	1	5.4	-	72	0	1	5	-
73	0	1	6.7	-	73	0	1	5.5	-
74	0	1	5.2	-	74	0	1	11.5	-
75	0	1	5.9	-	75	0	1	3.4	-
76	0	1	2.1	-	76	0	1	4	-
77	0	1	5	-	77	0	1	2	-
78	0	1	4.4	-	78	0	1	4.3	-
79	0	1	5.7	-	79	0	1	5.4	-
80	0	1	6.5	0.25	80	0	1	5.9	0.5
81	0	1	4.5	-	81	0	1	6.3	-
82	0	1	4.5	-	82	0	1	1.9	-
83	0	1	3.2	-	83	0	1	4.7	-
84	0	1	4.1	-	84	0	1	4.6	-
85	0	1	5.6	-	85	0	1	2.3	-
86	0	1	5	-	86	0	1	5.5	-
87	0	1	5.2	-	87	0	1	4.9	-
88	0	1	5	-	88	0	1	3	-
89	0	1	4.2	-	89	0	1	6.2	-
90	0	1	3.6	0.25	90	0	1	5.2	0.75
91	0	1	8.9	-	91	0	1	4.5	-
92	0	1	7.2	-	92	0	1	6.6	-
93	0	1	10.7	-	93	0	1	3.5	-
94	0	1	6.3	-	94	0	1	6.4	-
95	0	1	8.5	-	95	0	1	4.3	-
96	0	1	6.3	-	96	0	1	5.1	-
97	0	1	6.1	-	97	0	1	3.8	-
98	0	1	7.5	-	98	0	1	8.3	-
99	0	1	4.5	-	99	0	1	2.5	-
100	0	1	5.4	0.25	100	0	1	1.4	0.75
Minimum	**0.0**	**1.0**	**2.1**	**0.25**	**Minimum**	**0.0**	**0.0**	**1.1**	**0.25**
Maximum	**0.0**	**1.0**	**10.7**	**0.5**	**Maximum**	**0.0**	**1.0**	**11.5**	**0.75**
Mean	**0.0**	**1.0**	**5.7**	**0.3**	**Mean**	**0.0**	**0.9**	**4.1**	**0.6**
sd	**0.0**	**0.0**	**1.5**	**0.1**	**sd**	**0.0**	**0.3**	**1.8**	**0.2**
Geometric mean	**-**	**-**	**5.5**	**-**	**Geometric mean**	**-**	**-**	**3.7**	**-**
Median	**0.0**	**1.0**	**5.5**	**0**	**Median**	**0.0**	**1.0**	**4.0**	**1**

CI = Calcite index

Table A.10: Pebble and Calcite Count in the Upper Fording River, September 2017

FO22 (CI = 1.0)					FOUEW (CI = 0.99)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embeddedness
1	0	1	3.5	-	1	0	1	15.5	-
2	0	1	3.5	-	2	0	1	7.4	-
3	0	1	1.5	-	3	0	1	3.2	-
4	0	1	2.5	-	4	0	1	15	-
5	0	1	2	-	5	0	1	7.9	-
6	0	1	2	-	6	0	1	16.5	-
7	0	1	2	-	7	0	1	12.2	-
8	0	1	2	-	8	0	1	6.4	-
9	0	1	2.5	-	9	0	1	5.1	-
10	0	1	3	0	10	0	1	15.5	0.5
11	0	1	1	-	11	0	1	7.2	-
12	0	0	Fines	-	12	0	1	13.3	-
13	0	1	1.5	-	13	0	1	12.2	-
14	0	1	1	-	14	0	1	7.6	-
15	0	1	2.5	-	15	0	1	8.3	-
16	0	1	3	-	16	0	1	9.8	-
17	0	1	4	-	17	0	1	9.4	-
18	0	1	2	-	18	0	1	9.5	-
19	0	0	2.5	-	19	0	1	13	-
20	0	1	3	0	20	0	1	7.8	0.25
21	0	1	3	-	21	0	1	19.2	-
22	0	1	2.5	-	22	0	1	21	-
23	0	1	5	-	23	0	1	11.3	-
24	0	1	4.5	-	24	0	1	14.4	-
25	0	1	2.5	-	25	0	1	13.5	-
26	0	1	3.5	-	26	0	1	6.7	-
27	0	1	3	-	27	0	1	10.2	-
28	0	1	3	-	28	0	1	13.1	-
29	0	1	4.5	-	29	0	1	10.1	-
30	0	1	3	0.5	30	0	1	12	0.25
31	0	1	3	-	31	0	1	31	-
32	0	1	2	-	32	0	1	11.8	-
33	0	1	6	-	33	0	1	15	-
34	0	1	3	-	34	0	1	12.4	-
35	0	1	4	-	35	0	1	6.1	-
36	0	1	3	-	36	0	1	7	-
37	0	1	2.5	-	37	0	1	10.8	-
38	0	1	2.5	-	38	0	1	11.9	-
39	0	1	3.5	-	39	0	1	4.4	-
40	0	1	1.5	0.5	40	0	1	12.6	0.5
41	0	1	4	-	41	0	1	12.4	-
42	0	0	Fines	-	42	0	1	9	-
43	0	1	2	-	43	0	1	10.8	-
44	0	1	3	-	44	0	1	8.9	-
45	0	1	3	-	45	0	1	16.2	-
46	0	1	5	-	46	0	1	5.8	-
47	0	1	3	-	47	0	1	11.1	-
48	0	1	3.5	-	48	0	1	10.3	-
49	0	1	3.5	-	49	0	1	10.6	-
50	0	1	2	0	50	0	1	20	0.5
51	0	1	4	-	51	0	0	3.6	-
52	0	1	1.5	-	52	0	1	12.4	-
53	0	1	2	-	53	0	1	13	-
54	0	1	3.5	-	54	0	1	6.2	-
55	0	1	3	-	55	0	1	12.8	-
56	0	1	7	-	56	0	1	12.2	-
57	0	1	3	-	57	0	1	8.1	-
58	0	1	4	-	58	0	1	6.9	-
59	0	1	2	-	59	0	1	8.2	-
60	0	1	2	0.5	60	0	1	12.2	0.25
61	0	1	3	-	61	0	1	12.3	-
62	0	1	4	-	62	0	1	13.2	-
63	0	1	2	-	63	0	1	12.5	-
64	0	1	3	-	64	0	1	11	-
65	0	1	5	-	65	0	1	3.4	-
66	0	1	2.5	-	66	0	1	13.1	-
67	0	1	3.5	-	67	0	1	4.5	-
68	0	1	4.5	-	68	0	1	10.2	-
69	0	1	5.5	-	69	0	1	1.6	-
70	0	1	3.5	0.25	70	0	1	13.5	0.25
71	0	1	3.5	-	71	0	1	9.4	-
72	0	0	Fines	-	72	0	1	8.3	-
73	0	1	3	-	73	0	1	4.8	-
74	0	1	3.5	-	74	0	1	16.5	-
75	0	1	2.5	-	75	0	1	8.3	-
76	0	1	3	-	76	0	1	9	-
77	0	1	5.5	-	77	0	1	8.1	-
78	0	1	7	-	78	0	1	7.2	-
79	0	1	3	-	79	0	1	5.4	-
80	0	1	2	0	80	0	1	32	0.5
81	0	1	3.5	-	81	0	1	9.9	-
82	0	1	2.5	-	82	0	1	12.1	-
83	0	1	2.5	-	83	0	1	10.9	-
84	0	1	3.5	-	84	0	1	9.3	-
85	0	1	4	-	85	0	1	7.4	-
86	0	1	3	-	86	0	1	11.6	-
87	0	1	3.5	-	87	0	1	11.4	-
88	0	1	5	-	88	0	1	11.9	-
89	0	1	8	-	89	0	1	16.3	-
90	0	1	2	0	90	0	1	12.5	0.5
91	0	1	4	-	91	0	1	16	-
92	0	1	1.5	-	92	0	1	5.5	-
93	0	1	3	-	93	0	1	11.2	-
94	0	1	3	-	94	0	1	22	-
95	0	1	5	-	95	0	1	6.6	-
96	0	1	5	-	96	0	1	7.5	-
97	0	1	3	-	97	0	1	12.9	-
98	0	1	4.5	-	98	0	1	7.4	-
99	0	1	5	-	99	0	1	8.9	-
100	0	1	2.5	0	100	0	1	8.3	0.25
Minimum	**0.0**	**0.0**	**1.0**	**0**	**Minimum**	**0.0**	**0.0**	**1.6**	**0.25**
Maximum	**0.0**	**1.0**	**8.0**	**0.5**	**Maximum**	**0.0**	**1.0**	**32.0**	**0.5**
Mean	**0.0**	**1.0**	**3.2**	**0.2**	**Mean**	**0.0**	**1.0**	**10.9**	**0.4**
sd	**0.0**	**0.2**	**1.3**	**0.2**	**sd**	**0.0**	**0.1**	**4.9**	**0.1**
Geometric mean	**-**	**-**	**3.0**	**-**	**Geometric mean**	**-**	**-**	**9.9**	**-**
Median	**0.0**	**1.0**	**3.0**	**0**	**Median**	**0.0**	**1.0**	**10.8**	**0**

CI = Calcite index

Table A.11: Habitat Information Associated with Mine-exposed and Reference Areas Sampled during the Benthic Invertebrate Survey, September 2017

Station ID		Mine-exposed					
		FO22	FO26	FO29	FOBCP	FOBKS	FOBSC
Waterbody		Fording River	Fording River	Fording River	Fording River	Fording River	Fording River
Date Sampled		14/Sep/17	12/Sep/17	16/Sep/17	14/Sep/17	13/Sep/17	15/Sep/17
Zone 11 UTMs - E		654829	653039	655208	652868	652038	652346
Zone 11 UTMs - N		5553616	556934	5543683	5557155	5558704	5558195
Elevation		1,561	-	-	-	-	1,591
Samplers' Initials		TN Tw	HC MW	HC MW	HC MW	HC MW	TN TW
Habitat Characteristics							
Surrounding Land Use		Forest, Mining	Forest, Mining	Forest, Mining	Forest, Mining	Logging, Mining	Mining
Anthropogenic Influences		downstream FRO	Mining	-	-	-	downstream FRO
Length of Reach Assessed (m)		50	50	50	100	50	100
Habitat	% Riffle	-	-	-	-	-	-
	% Run	-	-	-	-	-	-
	% Rapids	-	-	-	-	-	-
	% Pool/Back Eddy	-	-	-	-	-	-
Substrate	% Bedrock	-	-	-	-	-	-
	% Boulder	-	-	-	-	-	-
	% Cobble	-	-	-	-	-	-
	% Pebble	-	-	-	-	-	-
	% Gravel	-	-	-	-	-	-
	% Sand/Finer	-	-	-	-	-	-
	% Organic	-	-	-	-	-	-
Canopy Coverage (%)		-	-	-	-	-	-
Streamside Vegetation (most dominant first)		-	-	-	-	-	-
Macrophyte Coverage (%)		-	-	-	-	-	-
Periphyton Coverage		-	-	-	-	-	-
Bank Stability		moderate	moderate	moderate	stable, no erosion	stable, no erosion	stable, no erosion
Water Colour & Clarity		no colour, clear	no colour, clear	no colour, clear	no colour, clear	no colour, clear	no colour, clear
Channel Measurements							
Bankfull Width (m)		-	-	-	-	-	-
Wetted Width (m)		-	-	-	-	-	-
Bankfull-Wetted Depth (cm)		-	-	-	-	-	-
Gradient (%)		-	-	-	-	-	-
CABIN							
Samplers' Initials		-	HC	MW	HC	HC	TW
Sampling Time (min)		3	3	3	3	3	3
Total Kick Distance (m)		-	12	-	-	-	-
Number of Replicates		1	1	1	1	3	1
Number of Jars		-	1	1	1	3	1
Number of transects		-	3	2	2	6	3
Distance from shore (m)		-	-	-	-	-	-

Table A.11: **Habitat Information Associated with Mine-exposed and Reference Areas Sampled during the Benthic Invertebrate Survey, September 2017**

Station ID		Mine-exposed					
		FODHE	FODNGD	FODPO	FOUEW	FOUKI	FOUNGD
Waterbody		Fording River	Fording River	Fording River	Fording River	Fording River	Fording River
Date Sampled		15/Sep/17	16/Sep/17	13/Sep/17	13/Sep/17	12/Sep/17	16/Sep/17
Zone 11 UTMs - E		651310	650917	653897	656360	6551854	650864
Zone 11 UTMs - N		5565419	5563163	5555076	5551888	5559820	5536525
Elevation		-	-	-	-	1,607	-
Samplers' Initials		HC MW	HC MW	HC MW	HC MW	TN TW	HC MW
Habitat Characteristics							
Surrounding Land Use		Mining	Forest, Logging, Mining	Forest, Mining	Forest, Commercial	Mining	Forest, Logging, Mining
Anthropogenic Influences		-	construction of new culvert u/s	-	-	-	-
Length of Reach Assessed (m)		50	50	50	50	50	50
Habitat	% Riffle	-	-	-	-	-	-
	% Run	-	-	-	-	-	-
	% Rapids	-	-	-	-	-	-
	% Pool/Back Eddy	-	-	-	-	-	-
Substrate	% Bedrock	-	-	-	-	-	-
	% Boulder	-	-	-	-	-	-
	% Cobble	-	-	-	-	-	-
	% Pebble	-	-	-	-	-	-
	% Gravel	-	-	-	-	-	-
	% Sand/Finer	-	-	-	-	-	-
	% Organic	-	-	-	-	-	-
Canopy Coverage (%)		-	-	-	-	-	-
Streamside Vegetation (most dominant first)		-	-	-	-	-	-
Macrophyte Coverage (%)		-	-	-	-	-	-
Periphyton Coverage		-	-	-	-	-	-
Bank Stability		moderate	moderate	moderate	unstable, substantial erosion	stable, no erosion	moderate
Water Colour & Clarity		no colour, clear	no colour, clear	no colour, clear	no colour, clear	no colour, clear	no colour, clear
Channel Measurements							
Bankfull Width (m)		-	-	-	-	-	-
Wetted Width (m)		-	-	-	-	-	-
Bankfull-Wetted Depth (cm)		-	-	-	-	-	-
Gradient (%)		-	-	-	-	-	-
CABIN							
Samplers' Initials		MW	MW	MW	MW	TW	MW
Sampling Time (min)		3	3	3	3	3	3
Total Kick Distance (m)		-	-	-	-	-	-
Number of Replicates		1	1	1	1	3	1
Number of Jars		1	1	1	1	-	1
Number of transects		4	3.5	2	1	2	3.5
Distance from shore (m)		-	-	-	-	-	-

Table A.11: **Habitat Information Associated with Mine-exposed and Reference Areas Sampled during the Benthic Invertebrate Survey, September 2017**

Station ID		Mine-exposed				Reference
		FOUSH	FRCP1SW	FRUPO	MP1	HENUP
Waterbody		Fording River	Fording River	Fording River	Fording River	Henretta Creek
Date Sampled		14/Sep/17	14/Sep/17	15/Sep/17	12/Sep/17	15/Sep/17
Zone 11 UTMs - E		650882	653387	653892	651225	655873
Zone 11 UTMs - N		5560970	5556201	5555964	5562468	5567711
Elevation		-	1,559	1,596	1,647	-
Samplers' Initials		HC MW	TN TW	TN TW	HC MW	HC MW
Habitat Characteristics						
Surrounding Land Use		Forest, Mining	Forest, Mining	Forest	Mining	Forest
Anthropogenic Influences		-	-	~7km d/s of FRO	-	-
Length of Reach Assessed (m)		50	50	100	100	50
Habitat	% Riffle	-	50	50	-	-
	% Run	-	25	30	-	-
	% Rapids	-	-	0	-	-
	% Pool/Back Eddy	-	25	20	-	-
Substrate	% Bedrock	-	0	0	-	-
	% Boulder	-	0	0	-	-
	% Cobble	-	60	50	-	-
	% Pebble	-	30	40	-	-
	% Gravel	-	10	10	-	-
	% Sand/Finer	-	0	<1	-	-
	% Organic	-	0	0	-	-
Canopy Coverage (%)		-	1-25	51-75	-	-
Streamside Vegetation (most dominant first)		-	coniferous trees, ferns/grass	coniferous trees, ferns/grass, shrubs	-	-
Macrophyte Coverage (%)		-	0	0	-	-
Periphyton Coverage		-	2	2	-	-
Bank Stability		stable, no erosion	moderate	moderate	moderate	moderate
Water Colour & Clarity		no colour, clear	no colour, clear	no colour, clear	no colour, clear	no colour, clear
Channel Measurements						
Bankfull Width (m)		-	22	23	-	-
Wetted Width (m)		-	6.7	7	-	-
Bankfull-Wetted Depth (cm)		-	50	20	-	-
Gradient (%)		-	1	1	-	-
CABIN						
Samplers' Initials		MW	TW	TW	HC	MW
Sampling Time (min)		3	3	3	3	3
Total Kick Distance (m)		-	-	28	15	-
Number of Replicates		1	1	1	1	1
Number of Jars		1	1	1	1	1
Number of transects		3.25	3	4	3	5
Distance from shore (m)		-	-	-	-	-

Table A.12: ***In Situ*** **Water Quality Taken at Biological Monitoring Areas, September 2017**

Field Parameters	Mine-exposed																Reference
	FO22	**FO26**	**FO29**	**FOBCP**	**FOBKS**	**FOBSC**	**FODHE**	**FODNGD**	**FODPO**	**FOUEW**	**FOUKI**	**FOUNGD**	**FOUSH**	**FRCP1SW**	**FRUPO**	**MP1**	**HENUP**
Date	14-Sep-17	12-Sep-17	16-Sep-17	14-Sep-17	13-Sep-17	15-Sep-17	15-Sep-17	16-Sep-17	13-Sep-17	13-Sep-17	12-Sep-17	16-Sep-17	14-Sep-17	14-Sep-17	15-Sep-17	12-Sep-17	15-Sep-17
Temperature (°C)	7.22	7.84	4.74	6.66	9.43	7.23	7.91	7.98	7.05	7.15	13.12	7.28	10.05	10.18	6.60	11.55	4.24
Dissolved Oxygen (mg/L)	12.12	9.17	10.69	11.71	9.87	11.72	10.15	9.12	10.47	10.81	10.07	8.74	9.88	10.89	12.23	9.09	11.01
Dissolved Oxygen (%)	108	77.2	83.2	96.1	86.5	97.5	85.9	72.1	86.8	89.7	96.1	72.9	87.8	97.6	100.1	84.1	84.7
Specific Conductivity (mS/cm)	1.082	0.364	0.466	0.842	0.856	0.954	0.366	0.538	0.716	0.663	0.859	0.523	0.584	0.926	1.151	0.823	0.197
Conductivity (µS/cm)	715	244	761	-	601	631	542	798	-	-	664	789	-	1290	746	612	325
pH	7.91	7.75	8.81	8.91	8.56	8.22	8.75	8.53	8.46	8.49	8.08	8.49	8.39	8.27	7.85	7.53	8.92

Methods and QC Report 2017

Project ID: Teck

Client: Minnow Environmental

Cordillera Consulting

Prepared by:
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Sample Reception

On September 22, 2017, Cordillera Consulting received 58 samples from Minnow Environmental. These samples were divided into 4 sections: Teck Line Creek, Teck Greenhills, Teck Fording Swift LAEMP and Teck RAEMP. When samples arrived to Cordillera Consulting, exterior packaging was initially inspected for damage or wet spots that would have indicated damage to the interior containers.

Samples were logged into a proprietary software database (INSTAR1) where the clients assigned sample name was recorded along with a Cordillera Consulting (CC) number for cross-reference. Each sample was checked to ensure that all sites and replicates recorded on field sheets or packing lists were delivered intact and with adequate preservative. Any missing, mislabelled or extra samples were reported to the client immediately to confirm the total numbers and correct names on the sample jars. The client representative was notified of the arrival of the shipment and provided a sample inventory once intake was completed.
See table below for sample inventory:

Table 1: Summary of sample information including Cordillera Consulting (CC) number

Teck Line Creek LAEMP					
Sample	**Site Code**	**CC#**	**Date**	**Size**	**# of Jars**
LI8-BIC	LI8-BIC	CC181023	9/8/2017	400µM	1
LISP24-BIC	LISP24-BIC	CC181024	9/11/2017	400µM	1
LIDCOM-BIC	LIDCOM-BIC	CC181025	9/10/2017	400µM	1
FO23-BIC	FO23-BIC	CC181026	9/13/2017	400µM	1
SLINE-BIC	SLINE-BIC	CC181027	9/9/2017	400µM	1

LIDSL-BIC-01	LIDSL-BIC	CC181028	9/10/2017	400µM	1
LIDSL-BIC-02	LIDSL-BIC	CC181029	9/10/2017	400µM	1
LIDSL-BIC-03	LIDSL-BIC	CC181030	9/10/2017	400µM	1
LISP23-BIC	LISP23-BIC	CC181031	9/11/2017	400µM	1
LILC3-BIC	LILC3-BIC	CC181032	9/9/2017	400µM	1
LI24-BIC	LI24-BIC	CC181033	9/11/2017	400µM	1
LCUT-BIC	LCUT-BIC	CC181034	9/10/2017	400µM	1
FRUL-BIC	FRUL-BIC	CC181035	9/13/2017	400µM	1

Teck Greenhills

Sample	Site Code	CC#	Date	Size	# of Jars
GH_ER2-BIC	GH_ER2-BIC	CC181036	9/10/2017	400µM	1
GH_ER1A-BIC	GH_ER1A-BIC	CC181037	9/8/2017	400µM	1
GH_ERSC4-BIC	GH_ERSC4-BIC	CC181038	9/8/2017	400µM	1
GH_ERSC5-BIC-1	GH_ERSC5-BIC	CC181039	9/9/2017	400µM	1
GH_ERSC5-BIC-2	GH_ERSC5-BIC	CC181040	9/9/2017	400µM	1
GH_ERSC5-BIC-3	GH_ERSC5-BIC	CC181041	9/9/2017	400µM	1

Teck Fording Swift

Sample	Site Code	CC#	Date	Size	# of Jars
FOBCP-BIC	FOBCP-BIC	CC181042	9/14/2017	400µM	1
MP1-BIC	MP1-BIC	CC181043	9/12/2017	400µM	1
FODNGD-BIC	FODNGD-BIC	CC181044	9/16/2017	400µM	1
FODHE-BIC	FODHE-BIC	CC181045	9/15/2017	400µM	1
FOBSC-BIC	FOBSC-BIC	CC181046	9/15/2017	400µM	1
FRCP1SW-BIC	FRCP1SW-BIC	CC181047	9/14/2017	400µM	1
FO22-BIC	FO22-BIC	CC181048	9/14/2017	400µM	2
FOBKS-BIC-1	FOBKS-BIC	CC181049	9/13/2017	400µM	1
FOBKS-BIC-2	FOBKS-BIC	CC181050	9/13/2017	400µM	1
FOBKS-BIC-3	FOBKS-BIC	CC181051	9/13/2017	400µM	1
FRUPO-BIC	FRUPO-BIC	CC181052	9/15/2017	400µM	1
FOUEW-BIC	FOUEW-BIC	CC181053	9/13/2017	400µM	1
FOUKI-BIC-1	FOUKI-BIC	CC181054	9/12/2017	400µM	1
FOUKI-BIC-2	FOUKI-BIC	CC181055	9/12/2017	400µM	1
FOUKI-BIC-3	FOUKI-BIC	CC181056	9/12/2017	400µM	1
HENUP-BIC	HENUP-BIC	CC181057	9/15/2017	400µM	1
FO26-BIC	FO26-BIC	CC181058	9/12/2017	400µM	1
FOUSH-BIC	FOUSH-BIC	CC181059	9/14/2017	400µM	1
FOUNGD-BIC	FOUNGD-BIC	CC181060	9/16/2017	400µM	1
FODPO-BIC	FODPO-BIC	CC181061	9/13/2017	400µM	1

Teck RAEMP

Sample	Site Code	CC#	Date	Size	# of Jars
ELUFE-BIC	ELUFE-BIC	CC181062	9/15/2017	400µM	1
MIDCO-BIC	MIDCO-BIC	CC181063	9/14/2017	400µM	1
ALUSM-BIC	ALUSM-BIC	CC181064	9/16/2017	400µM	1

MIUCO-BIC	MIUCO-BIC	CC181065	9/14/2017	400μM	1
MI2-MIC	MI2-MIC	CC181066	9/13/2017	400μM	1
ELELKO-BIC	ELELKO-BIC	CC181067	9/15/2017	400μM	1
EL19-BIC	EL19-BIC	CC181068	9/13/2017	400μM	1
CORCK-BIC	CORCK-BIC	CC181069	9/14/2017	400μM	2
MI25-BIC	MI25-BIC	CC181070	9/14/2017	400μM	1
EL20-BIC	EL20-BIC	CC181071	9/10/2017	400μM	1
MI3-BIC	MI3-BIC	CC181072	9/16/2017	400μM	1
FO29-BIC	FO29-BIC	CC181073	9/16/2017	400μM	1
HACKDS-BIC	HACKDS-BIC	CC181074	9/16/2017	400μM	1
ELH93-BIC	ELH93-BIC	CC181075	9/15/2017	400μM	1
FODGH-BIC	FODGH-BIC	CC181076	9/12/2017	400μM	1
EL1-BIC	EL1-BIC	CC181077	9/17/2017	400μM	1
LC_DCDS-BIC	LC_DCDS-BIC	CC181078	9/17/2017	400μM	1
LC_DC1-BIC	LC_DC1-BIC	CC181079	9/17/2017	400μM	1
LC_FRUS-BIC	LC_FRUS-BIC	CC181080	9/17/2017	400μM	1

Sample Sorting

- Using a gridded Petri dish, fine forceps and a low power stereo-microscope (Olympus, Nikon, Leica) the sorting technicians removed the invertebrates and sorted them into family/orders.
- The sorting technician kept a running tally of total numbers excluding organisms from Porifera, Nemata, Platyhelminthes, Ostracoda, Copepoda, Cladocera and terrestrial drop-ins such as aphids. These organisms were marked for their presence (given a value of 1) only and left in the sample. They were not included towards the 300-organism subsample count.
- Where specimens are broken or damaged, only heads were counted.
- Subsampling was conducted with the use of a Marchant Box.
- When using the Marchant box, cells were extracted at the same time in the order indicated by a random number table. If the 300^{th} organism was found part way into sorting a cell then the balance of that cell was sorted. If the organism count had not reached 300 by the 50^{th} cell then the entire sample was sorted.
- The total number of cells sorted and the number of organisms removed were recorded manually on a bench sheet and then recorded into INSTAR1
- Organisms were stored in vials containing 80% ethanol and an interior label indicating the site names, date of sampling, site code numbers and portion subsampled. This information was also recorded on the laboratory bench sheet and on INSTAR1.
- The sorted portion of the debris was preserved and labeled separately from the unsorted portion and was tested for sorting efficiency (Sorting Quality Control – Sorting Efficiency). The unsorted portion was also labeled and preserved in separate jars.

Percent sub-sampled and total countable invertebrates pulled from the samples were summarized in the table below.

Table 2: Percent sub-sample and invertebrate count for each sample

Teck Line Creek LAEMP				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
LI8-BIC	08-Sep-17	CC181023	5%	589
LISP24-BIC	11-Sep-17	CC181024	5%	575
LIDCOM-BIC	10-Sep-17	CC181025	5%	1000
FO23-BIC	13-Sep-17	CC181026	10%	417
SLINE-BIC	09-Sep-17	CC181027	5%	328
LIDSL-BIC-01	10-Sep-17	CC181028	5%	638
LIDSL-BIC-02	10-Sep-17	CC181029	5%	806
LIDSL-BIC-03	10-Sep-17	CC181030	5%	378
LISP23-BIC	11-Sep-17	CC181031	5%	579
LILC3-BIC	09-Sep-17	CC181032	5%	649
LI24-BIC	11-Sep-17	CC181033	5%	310
LCUT-BIC	10-Sep-17	CC181034	5%	512
FRUL-BIC	13-Sep-17	CC181035	5%	300
Teck Greenhills				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
GH_ER2-BIC	10-Sep-17	CC181036	5%	309
GH_ER1A-BIC	08-Sep-17	CC181037	7%	344
GH_ERSC4-BIC	08-Sep-17	CC181038	8%	343
GH_ERSC5-BIC-1	09-Sep-17	CC181039	6%	308
GH_ERSC5-BIC-2	09-Sep-17	CC181040	7%	317
GH_ERSC5-BIC-3	09-Sep-17	CC181041	7%	313
Teck Fording Swift LAEMP				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
FOBCP-BIC	14-Sep-17	CC181042	7%	364
MP1-BIC	12-Sep-17	CC181043	5%	624
FODNGD-BIC	16-Sep-17	CC181044	5%	388
FODHE-BIC	15-Sep-	CC181045	5%	627

	17			
FOBSC-BIC	15-Sep-17	CC181046	10%	388
FRCP1SW-BIC	14-Sep-17	CC181047	20%	460
FO22-BIC	14-Sep-17	CC181048	5%	1170
FOBKS-BIC-1	13-Sep-17	CC181049	15%	502
FOBKS-BIC-2	13-Sep-17	CC181050	10%	303
FOBKS-BIC-3	13-Sep-17	CC181051	7%	342
FRUPO-BIC	15-Sep-17	CC181052	5%	326
FOUEW-BIC	13-Sep-17	CC181053	5%	416
FOUKI-BIC-1	12-Sep-17	CC181054	5%	306
FOUKI-BIC-2	12-Sep-17	CC181055	100%	57
FOUKI-BIC-3	12-Sep-17	CC181056	11%	441
HENUP-BIC	15-Sep-17	CC181057	5%	562
FO26-BIC	12-Sep-17	CC181058	5%	771
FOUSH-BIC	14-Sep-17	CC181059	8%	343
FOUNGD-BIC	16-Sep-17	CC181060	5%	361
FODPO-BIC	13-Sep-17	CC181061	5%	779
Teck RAEMP				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
ELUFE-BIC	15-Sep-17	CC181062	5%	1231
MIDCO-BIC	14-Sep-17	CC181063	5%	879
ALUSM-BIC	16-Sep-17	CC181064	6%	348
MIUCO-BIC	14-Sep-17	CC181065	5%	356
MI2-MIC	13-Sep-17	CC181066	10%	429
ELELKO-BIC	15-Sep-17	CC181067	5%	373
EL19-BIC	13-Sep-17	CC181068	5%	319
CORCK-BIC	14-Sep-17	CC181069	5%	500
MI25-BIC	14-Sep-17	CC181070	5%	1260
EL20-BIC	10-Sep-17	CC181071	5%	438
MI3-BIC	16-Sep-17	CC181072	5%	482
FO29-BIC	16-Sep-17	CC181073	5%	470
HACKDS-BIC	16-Sep-17	CC181074	5%	1269
ELH93-BIC	15-Sep-17	CC181075	50%	386
FODGH-BIC	12-Sep-17	CC181076	5%	849

EL1-BIC	17-Sep-17	CC181077	5%	387
LC_DCDS-BIC	17-Sep-17	CC181078	5%	894
LC_DC1-BIC	17-Sep-17	CC181079	5%	726
LC_FRUS-BIC	17-Sep-17	CC181080	5%	323

Sorting Quality Control - Sorting Efficiency

As a part of Cordillera's laboratory policy, all projects undergo sorting efficiency checks.

- As sorting progresses, 10% of samples were randomly chosen from the group of four Teck projects by senior members of the sorting team for resorting.
- All sorters working on a project had at least 1 sample resorted by another sorter.
- An efficiency of 90 % was expected.
- If 90/95% efficiency was not met, samples from that sorter were resorted.
- To calculated sorting efficiency the following formula was used:

$$\frac{\#OrganismsMissed}{TotalOrganismsFound} * 100 = \%OM$$

Table 3: Summary of sorting efficiency

CC #	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
CC181052	326	3	99%
CC181061	779	4	99%
CC181040	318	2	99%
CC181023	589	26	96%
CC181067	373	1	100%
CC181072	482	3	99%
Average Recovery			99%

Sorting Quality Control - Sub-Sampling QC

Certain Provincial and Mining projects require additional sorting checks in the form of sub-sampling QC, (Environmental Effects Monitoring (EEM) protocol). This ensured that any fraction of the total sample that was examined was actually an accurate representation of the number of total organisms. Organisms from the additional sub-samples were not identified; rather total organism count only was compared.

Sub-Sampling efficiency was measured on 10% of the number of sub-sampled samples in the group of 4 Teck projects. Ex. In a project where 50 of 100 total samples were processed through subsampling using a Marchant box, then 10% of 50; or 5 samples were used for sub sampling efficiency. There was one sample in this group which had not been subsampled. Therefore in this group of 58 samples, 6 samples were chosen to measure sub-sample QC. The 6 samples chosen represent the variation of subsample sizes in the project.

Sub-Sampling efficiency was performed by fractioning the entire sample into sub-sample percentages. On each sub-sampled portion, a total organism count was recorded and compared to the rest of the sub-samples. In order to pass, all fractions were required to be within 20% of total organism count.

Example: If 300 organisms are found in 10% of the sample, the sorter will continue to sample in 10% fractions until the entire sample is separated. They will then count the total number of organisms in each of the 10 fractions of 10% and compare the organism count.

When divergence is >20% the sorting manager examines for the source of the problem and takes steps to correct it. With the Marchant box, the problem typically rested with how the box is flipped back to the upright position. For this reason subsampling was performed by experienced employees only. Another common source of area would be the type of debris in the sample. Samples with algae or heavy with periphyton have a higher incident of failure due to clumping than clear samples.

APPENDIX B

SEDIMENT

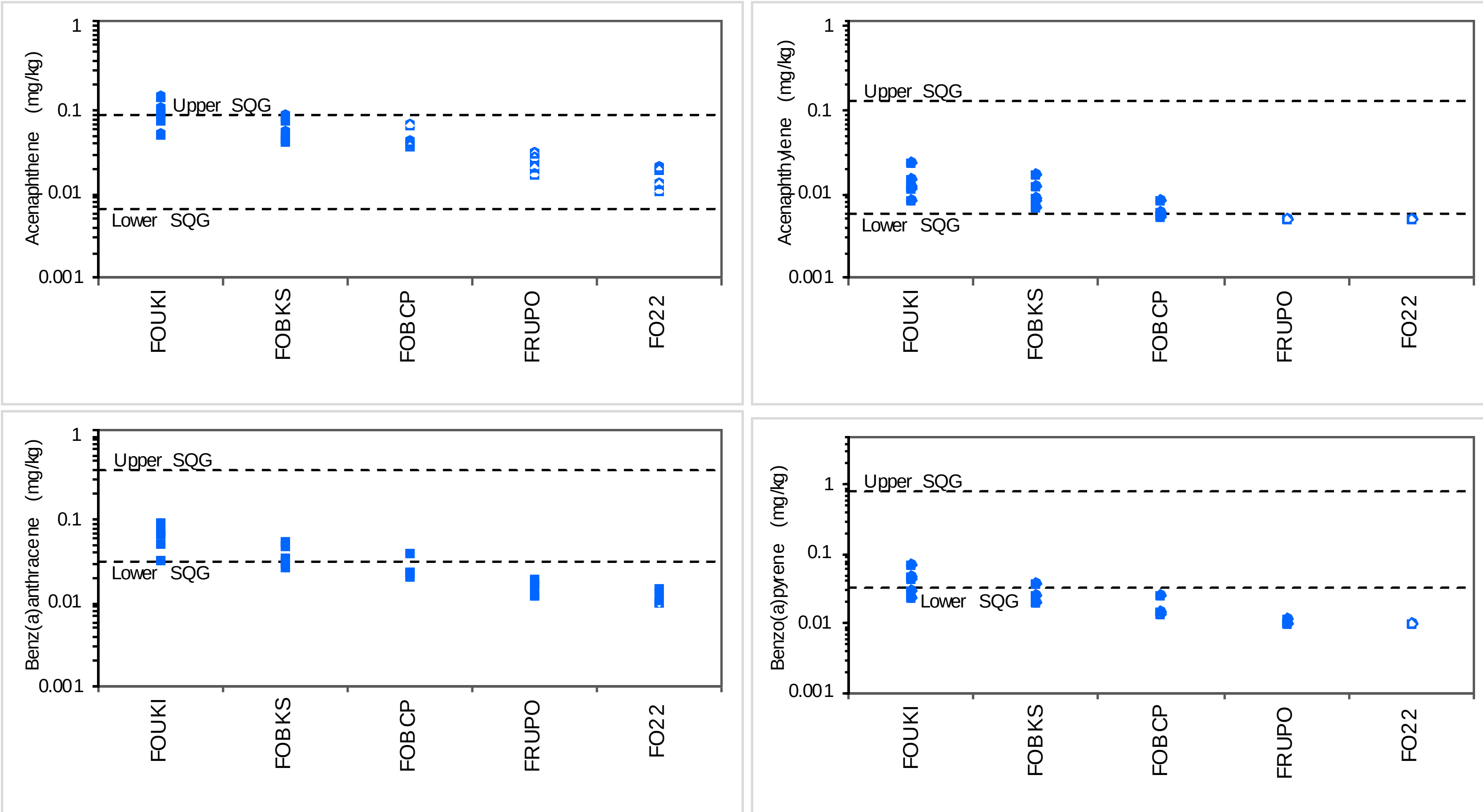


Figure B.1: Sediment Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG), 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.

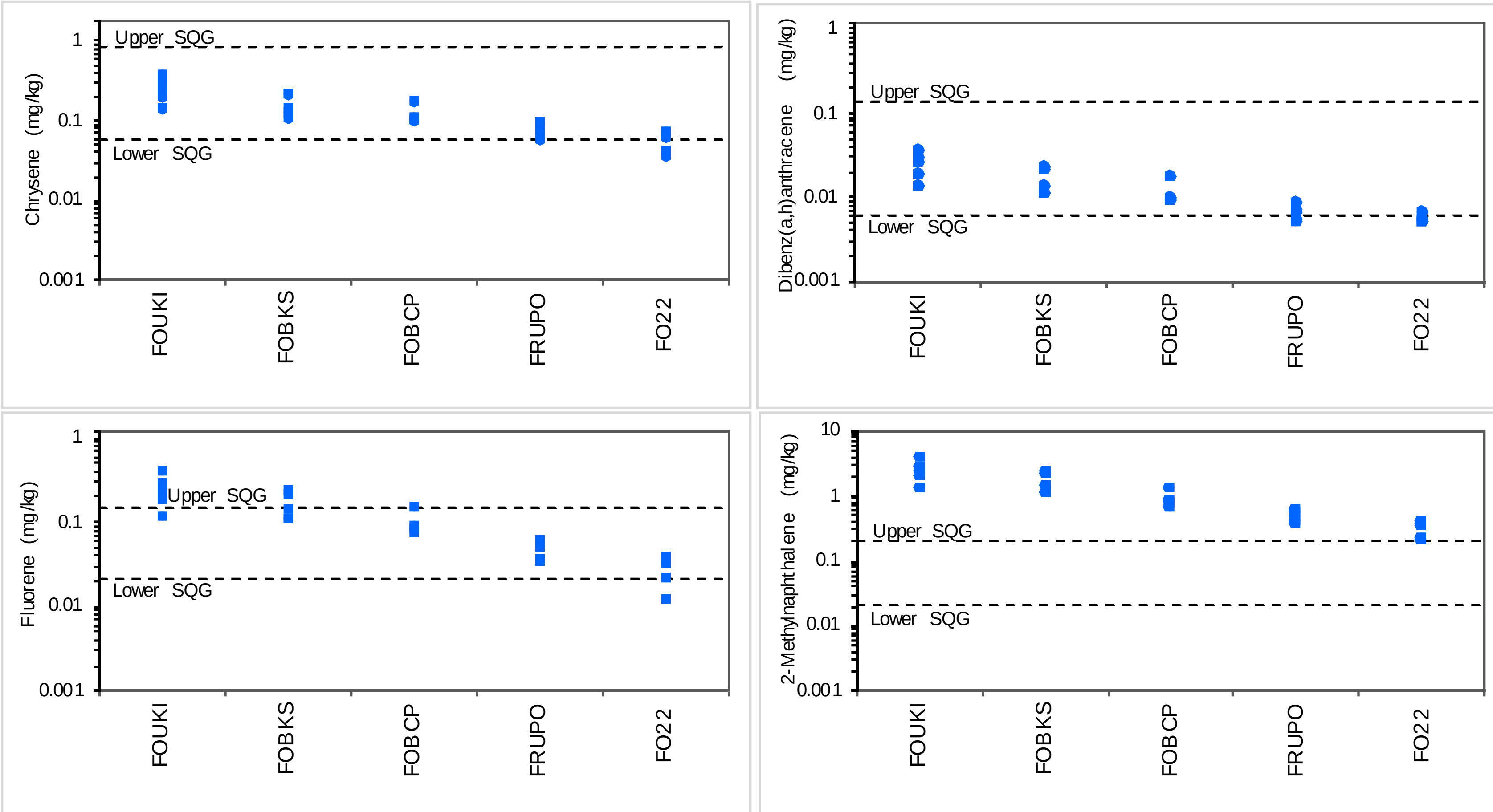
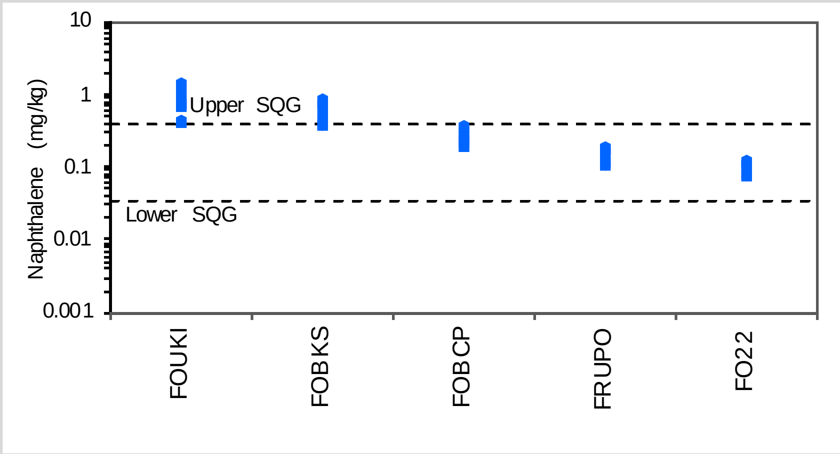
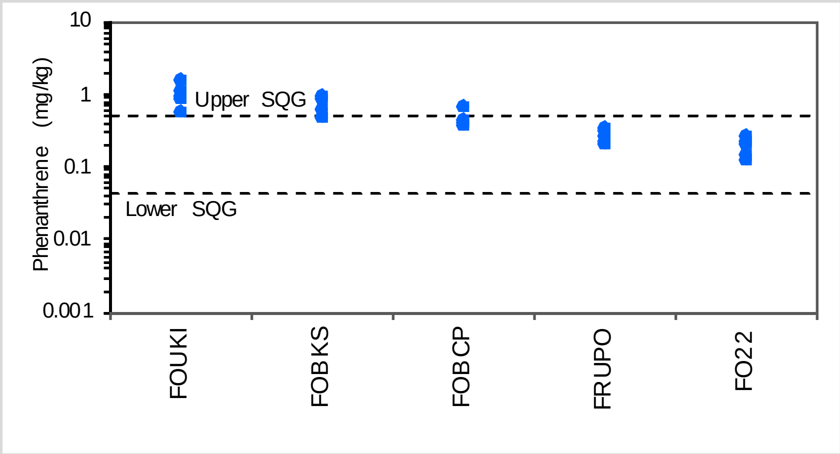


Figure B.1: Sediment Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG), 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.





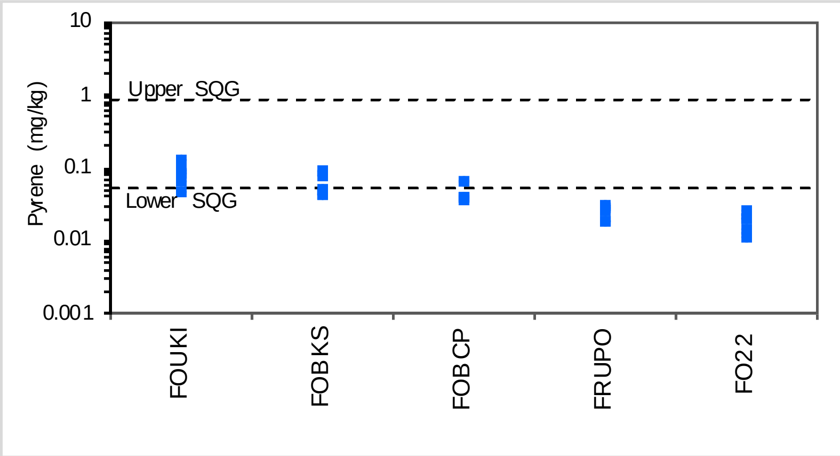
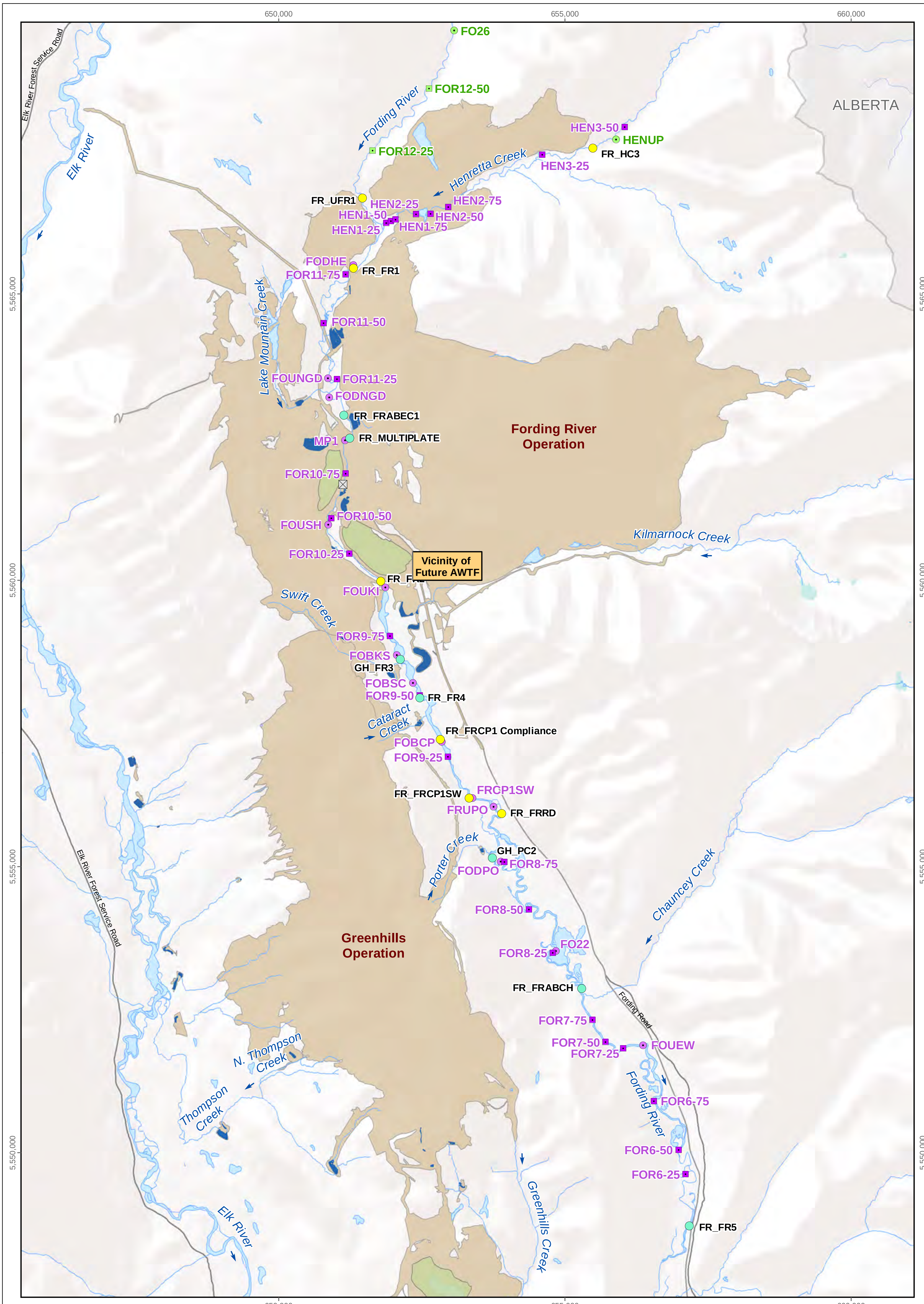


Figure B.1: Sediment Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG), 2017

Notes: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.



LEGEND

- Water Monitoring Station (Non-permit)
- Water Monitoring Station (Permit)

Teck Calcite Monitoring Station

- Exposed
- Reference

Biological Sampling Area

- Mine-exposed
- Reference
- Hydrometric Station

- Settling Pond
- Tailings Pond
- Teck Coal Mine Operation

Regional Calcite Monitoring and FRO LAEMP Biological Monitoring Locations

0 1 2 4 km

N W E S

Projection: North American Datum 1983 UTM Zone 11

Date: May 2018
Project 177202.0022

minnow environmental inc.

Figure B.2

Document Path: S:\Projects\177202\177202.0022 - Teck 2017 FRO LAEMP Implementation\GIS\Report\17-22 Fig c.2 .mxd

Table B.1: Sediment Quality in Lotic Mine-Exposed Areas and Associated Summary statistics, Fording River Operations, 2017

				FOBKS-SED-01 13-Sep-17	FOBKS-SED-02 13-Sep-17	FOBKS-SED-03 13-Sep-17	FOBKS-SED-04 13-Sep-17	FOBKS-SED-05 13-Sep-17	Minimum	Median	Maximum	Mean	Standard Deviation
Physical Tests	% Moisture	%	0.25	50.3	63.3	80.9	79.6	59.8	50.3	63.3	80.9	66.8	13.2
	pH (1:9)	pH units	0.1	-	-	-	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH units	0.1	-	-	-	-	-	-	-	-	-	-
Particle Size	% Gravel (>2mm)	%	0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (2.0mm - 0.063mm)	%	0.1	-	-	-	-	-	-	-	-	-	-
	% Sand (2.00mm - 1.00mm)	%	0.1	4.5	5.5	1.3	<1.0	3.4	<1	3.4	5.5	3.14	1.9
	% Sand (1.00mm - 0.50mm)	%	0.1	16.5	17.6	10.1	4.2	7.7	4.2	10.1	17.6	11.22	5.7
	% Sand (0.50mm - 0.25mm)	%	0.1	27.1	23.0	13.9	13.2	11.2	11.2	13.9	27.1	17.68	7.0
	% Sand (0.25mm - 0.125mm)	%	0.1	14.2	9.1	8.0	18.5	11.8	8	11.8	18.5	12.32	4.2
	% Sand (0.125mm - 0.063mm)	%	0.1	7.2	6.1	5.7	10.1	10.0	5.7	7.2	10.1	7.82	2.1
	% Silt (0.063mm - 0.004mm)	%	0.1	-	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 0.0312mm)	%	0.1	12.4	16.2	25.9	23.8	23.2	12.4	23.2	25.9	20.3	5.7
	% Silt (0.0312mm - 0.004mm)	%	0.1	15.3	19.4	29.8	25.5	27.6	15.3	25.5	29.8	23.52	6.0
	% Clay (<4μm)	%	0.1	2.90	3.1	5.30	4.3	5.10	2.9	4.3	5.3	4.14	1.1
	Texture	-	-	Sandy loam	Sandy loam	Silt loam	Sandy loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.1	5.76	7.17	10.90	9.56	9.34	5.76	9.34	10.9	8.546	2.1
Metals (1 mm) (mg/kg)	Aluminum (Al)	mg/kg	100	5,220	3,900	4,470	4,950	6,370	3,900	4,950	6,370	4,982	924
	Antimony (Sb)	mg/kg	0.2	0.37	0.35	0.37	0.44	0.46	0.35	0.37	0.46	0.398	0.049
	Arsenic (As)	mg/kg	0.2	3.85	3.38	3.31	3.72	5.59	3.31	3.72	5.59	3.97	0.93
	Barium (Ba)	mg/kg	1	183.0	165	173.0	168	193	165	173	193	176.4	11.5
	Beryllium (Be)	mg/kg	0.2	0.54	0.41	0.43	0.42	0.52	0.41	0.43	0.54	0.464	0.061
	Bismuth (Bi)	mg/kg	0.4	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	-
	Boron (B)	mg/kg	10	6.2	<5.0	5.4	6.2	7.8	<5	6.2	7.8	6.12	1.0
	Cadmium (Cd)	mg/kg	0.04	1.26	1.43	1.44	1.50	1.43	1.260	1.430	1.500	1.412	0.090
	Calcium (Ca)	mg/kg	100	73,100	77,000	75,900	80,500	74,700	73,100	75,900	80,500	76,240	2,787
	Chromium (Cr)	mg/kg	1	9.7	8.3	8.0	9.5	14.0	8.01	9.46	14	9.892	2.4
	Cobalt (Co)	mg/kg	0.2	5.14	4.99	5.09	5.38	5.73	4.99	5.14	5.73	5.27	0.30
	Copper (Cu)	mg/kg	1	11.3	10.3	10.6	10.3	12.0	10.3	10.6	12	10.9	0.74
	Iron (Fe)	mg/kg	100	12,100	10,900	11,200	10,700	12,400	10,700	11,200	12,400	11,460	750
	Lead (Pb)	mg/kg	1	7.62	7.16	6.89	7.19	7.95	6.9	7.2	8.0	7.4	0.42
	Lithium (Li)	mg/kg	4	8.4	6.8	8.0	8.0	9.7	6.8	8	9.7	8.18	1.0
	Magnesium (Mg)	mg/kg	40	10,500	11,000	9,920	12,300	12,000	9,920	11,000	12,300	11,144	1,000
	Manganese (Mn)	mg/kg	2	746	882	873	879	837	746	873	882	843.4	57.4
	Mercury (Hg)	mg/kg	0.005	0.0306	0.0320	0.0415	0.0372	0.0407	0.0306	0.0372	0.0415	0.0364	0.0050
	Molybdenum (Mo)	mg/kg	0.2	0.93	0.94	0.93	1.11	1.28	0.93	0.94	1.28	1.038	0.16
	Nickel (Ni)	mg/kg	1	32.5	34.7	34.2	31.3	39.8	31.3	34.2	39.8	34.5	3.3
	Phosphorus (P)	mg/kg	100	1,110	1,100	1,000	1,260	1,160	1000	1110	1260	1126	94.8
	Potassium (K)	mg/kg	200	1,250	890	990	1,190	1,570	890	1,190	1,570	1,178	263
	Selenium (Se)	mg/kg	0.4	1.22	1.59	2.21	2.76	2.24	1.22	2.21	2.76	2.00	0.60
	Silver (Ag)	mg/kg	0.2	0.14	0.14	0.14	0.14	0.16	0.14	0.14	0.16	0.144	0.0089
	Sodium (Na)	mg/kg	100	66	67	66	72	73	66	67	73	68.8	3.4
	Strontium (Sr)	mg/kg	1	71.3	63.6	64.5	68.4	78.0	63.6	68.4	78	69.16	5.8
	Thallium (Tl)	mg/kg	0.1	0.15	0.13	0.12	0.14	0.19	0.12	0.143	0.192	0.1466	0.028
	Tin (Sn)	mg/kg	4	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	-
	Titanium (Ti)	mg/kg	2	9.0	6.9	7.2	10.4	10.3	6.9	9	10.4	8.76	1.7
	Uranium (U)	mg/kg	0.1	0.91	0.88	0.83	0.98	0.94	0.832	0.907	0.982	0.9092	0.057
	Vanadium (V)	mg/kg	0.4	21.7	17.6	18.3	21.5	26.2	17.6	21.5	26.2	21.06	3.4
	Zinc (Zn)	mg/kg	4	99.3	99.8	103.0	103.0	110.0	99.3	103.0	110.0	103.0	4.3
	Zirconium (Zr)	mg/kg	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
Hydrocarbons (mg/kg)	Acenaphthene	mg/kg	0.005	0.0428	0.0538	0.0840	0.0770	0.0462	0.0428	0.0538	0.084	0.06076	0.019
	Acenaphthylene	mg/kg	0.005	0.0083	0.0087	0.0170	0.0120	0.0070	0.007	0.0087	0.017	0.0106	0.0040
	Anthracene	mg/kg	0.004	<0.0070	<0.010	<0.014	<0.012	<0.0050	<0.005	<0.01	<0.014	<0.01	-
	Benz(a)anthracene	mg/kg	0.01	0.027	0.034	0.056	0.048	0.030	0.027	0.034	0.056	0.039	0.012
	Benzo(a)pyrene	mg/kg	0.01	0.019	0.025	0.037	0.037	0.020	0.019	0.025	0.037	0.0276	0.0089
	Benzo(b&j)fluoranthene	mg/kg	0.01	0.054	0.069	0.109	0.103	0.058	0.054	0.069	0.109	0.0786	0.026
	Benzo(b+j+k)fluoranthene	mg/kg	0.015	-	-	-	-	-	-	-	-	-	-
	Benzo(g,h,i)perylene	mg/kg	0.01	0.021	0.027	0.038	0.039	0.021	0.021	0.027	0.039	0.0292	0.0088
	Benzo(k)fluoranthene	mg/kg	0.01	<0.010	<0.010	<0.020	<0.020	<0.010	<0.01	<0.01	<0.02	<0.02	-
	Chrysene	mg/kg	0.01	0.115	0.146	0.222	0.217	0.130	0.115	0.146	0.222	0.166	0.050
	Dibenz(a,h)anthracene	mg/kg	0.005	0.0111	0.0139	0.0230	0.0220	0.0116	0.0111	0.0139	0.023	0.01632	0.0058
	Fluoranthene	mg/kg	0.01	0.025	0.036	0.049	0.045	0.026	0.025	0.036	0.049	0.0362	0.011
	Fluorene	mg/kg	0.01	0.109	0.141	0.240	0.213	0.114	0.109	0.141	0.24	0.1634	0.060
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.01	<0.010	<0.010	<0.020	<0.020	<0.010	<0.01	<0.01	<0.02	<0.02	-
	2-Methylnaphthalene	mg/kg	0.01	1.160	1.48	2.420	2.220	1.180	1.16	1.48	2.42	1.692	0.59
	Naphthalene	mg/kg	0.01	0.387	0.492	0.805	0.708	0.365	0.365	0.492	0.805	0.5514	0.20
	Phenanthrene	mg/kg	0.01	0.476	0.60	0.964	0.888	0.495	0.476	0.602	0.964	0.685	0.23
	Pyrene	mg/kg	0.01	0.042	0.053	0.091	0.075	0.044	0.042	0.053	0.091	0.061	0.021
	Acenaphthene d10	%		85.1	80.7	79.1	83.1	77.9	77.9	80.7	85.1	81.18	2.9
	Chrysene d12	%		102.7	99.1	97	99.5	99.8	97	99.5	102.7	99.62	2.0
	Naphthalene d8	%		80.1	77.3	74.6	78.6	74.3	74.3	77.3	80.1	76.98	2.5
	Phenanthrene d10	%		88.5	82.6	83.6	85.6	79.9	79.9	83.6	88.5	84.04	3.2
	B(a)P Total Potency Equivalent	mg/kg	0.02	0.041	0.052	0.081	0.079	0.042	0.041	0.052	0.081	0.059	0.020
	IACR (CCME)	mg/kg	0.15	0.61	0.77	1.22	1.16	0.65	0.61	0.77	1.22	0.882	0.29

" - " = no data or standard deviation not estimated

(blue shading) concentration exceeds lower SQG

(grey shading) concentration exceeds upper SQG

Table B.1: Sediment Quality in Lotic Mine-Exposed Areas and Associated Summary statistics, Fording River Operations, 2017

			FOUKI-SED-01	FOUKI-SED-02	FOUKI-SED-03	FOUKI-SED-04	FOUKI-SED-05	Minimum	Median	Maximum	Mean	Standard Deviation
			12-Sep-17	12-Sep-17	12-Sep-17	12-Sep-17	12-Sep-17					
Physical Tests	% Moisture	%	64.6	64.2	52.0	78.1	79.3	52.0	64.6	79.3	67.6	11.3
	pH (1:9)	pH units	-	-	-	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH units	-	-	-	-	-	-	-	-	-	-
Particle Size	% Gravel (>2mm)	%	11.3	6.4	3.7	2.5	<1.0	<1	3.7	11.3	4.98	3.8
	% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	-	-	-
	% Sand (2.00mm - 1.00mm)	%	10.1	5.3	5.9	6.4	<1.0	<1	5.9	10.1	5.74	2.1
	% Sand (1.00mm - 0.50mm)	%	13.6	8.4	9.3	11.6	1.9	1.9	9.3	13.6	8.96	4.4
	% Sand (0.50mm - 0.25mm)	%	11.1	21.8	20.8	8.1	3.3	3.3	11.1	21.8	13.02	8.1
	% Sand (0.25mm - 0.125mm)	%	9.5	18.9	16.1	6.2	4.6	4.6	9.5	18.9	11.06	6.2
	% Sand (0.125mm - 0.063mm)	%	6.4	8.0	7.4	4.6	4.0	4	6.4	8	6.08	1.7
	% Silt (0.063mm - 0.004mm)	%	-	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 0.0312mm)	%	15.9	13.2	15.3	26.6	37.3	13.2	15.9	37.3	21.66	10.2
	% Silt (0.0312mm - 0.004mm)	%	18.6	14.9	18.0	29.6	42.4	14.9	18.6	42.4	24.7	11.4
	% Clay (<4µm)	%	3.4	3.1	3.6	4.5	5.8	3.1	3.6	5.8	4.08	1.1
	Texture	-	Sandy loam	Sandy loam	Sandy loam	Silt loam	Silt	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	8.66	7.00	7.37	12.3	13.8	7	8.66	13.8	9.826	3.1
Metals (1 mm) (mg/kg)	Aluminum (Al)	mg/kg	7,700	7,600	5,480	4,770	7,430	4,770	7,430	7,700	6,596	1,369
	Antimony (Sb)	mg/kg	0.52	0.60	0.58	0.48	0.40	0.4	0.52	0.6	0.516	0.080
	Arsenic (As)	mg/kg	4.54	4.68	4.57	3.68	4.05	3.68	4.54	4.68	4.30	0.42
	Barium (Ba)	mg/kg	190	181	176	182	164	164	181	190	178.6	9.6
	Beryllium (Be)	mg/kg	0.57	0.62	0.58	0.41	0.59	0.41	0.58	0.62	0.554	0.083
	Bismuth (Bi)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	-
	Boron (B)	mg/kg	< 7	< 8	<5.0	< 7	< 8	<5	7.3	8.4	7.14	0.50
	Cadmium (Cd)	mg/kg	1.17	1.19	1.24	1.57	1.23	1.170	1.230	1.570	1.280	0.16
	Calcium (Ca)	mg/kg	57,100	53,000	56,700	87,400	76,900	53,000	57,100	87,400	66,220	15,093
	Chromium (Cr)	mg/kg	28.8	15.4	11.0	21.4	26.0	11	21.4	28.8	20.52	7.4
	Cobalt (Co)	mg/kg	6.90	5.65	6.45	5.44	6.29	5.44	6.29	6.90	6.15	0.60
	Copper (Cu)	mg/kg	15.2	14.7	13.0	11.5	13.8	11.5	13.8	15.2	13.64	1.5
	Iron (Fe)	mg/kg	18,100	17,800	15,800	13,200	15,100	13,200	15,800	18,100	16,000	2,021
	Lead (Pb)	mg/kg	8.6	8.2	8.9	7.7	8.8	7.7	8.6	8.9	8.4	0.49
	Lithium (Li)	mg/kg	13.4	12.4	11.1	7.7	15.0	7.7	12.4	15	11.92	2.8
	Magnesium (Mg)	mg/kg	11,700	10,900	11,200	10,700	10,600	10,600	10,900	11,700	11,020	444
	Manganese (Mn)	mg/kg	779	581	796	1,260	1,040	581	796	1260	891.2	263
	Mercury (Hg)	mg/kg	0.036	0.040	0.0423	0.055	0.048	0.0355	0.0423	0.0551	0.0443	0.0076
	Molybdenum (Mo)	mg/kg	1.79	1.38	1.32	1.59	1.78	1.32	1.59	1.79	1.572	0.22
	Nickel (Ni)	mg/kg	37.0	32.3	37.4	37.5	36.4	32.3	37	37.5	36.12	2.2
	Phosphorus (P)	mg/kg	1,110	1,220	1,330	1,290	1,200	1110	1220	1330	1230	85.1
	Potassium (K)	mg/kg	1,730	1,800	1,030	1,160	1,600	1,030	1,600	1,800	1,464	347
	Selenium (Se)	mg/kg	1.97	2.02	2.65	4.18	2.56	1.97	2.56	4.18	2.68	0.90
	Silver (Ag)	mg/kg	0.16	0.15	0.16	0.14	0.15	0.14	0.15	0.16	0.152	0.0084
	Sodium (Na)	mg/kg	80	< 75	65	77	< 78	65	77	80	75	5.9
	Strontium (Sr)	mg/kg	68.7	87.3	65.1	82.3	129.0	65.1	82.3	129	86.48	25.5
	Thallium (Tl)	mg/kg	0.16	0.20	0.16	0.14	0.15	0.136	0.159	0.196	0.1598	0.022
	Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	-
	Titanium (Ti)	mg/kg	8.1	8.1	4.0	10.5	9.1	4	8.1	10.5	7.96	2.4
	Uranium (U)	mg/kg	0.83	0.93	0.92	0.97	0.83	0.829	0.915	0.965	0.894	0.062
	Vanadium (V)	mg/kg	28.4	31.3	21.3	20.2	22.9	20.2	22.9	31.3	24.82	4.8
	Zinc (Zn)	mg/kg	110	108	111	111	101	101.0	110.0	111.0	108.2	4.2
	Zirconium (Zr)	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
Hydrocarbons (mg/kg)	Acenaphthene	mg/kg	0.090	0.077	0.051	0.102	0.143	0.0513	0.0896	0.143	0.09254	0.034
	Acenaphthylene	mg/kg	0.0126	0.0114	0.0082	0.0150	0.0230	0.0082	0.0126	0.023	0.01404	0.0056
	Anthracene	mg/kg	<0.012	<0.010	<0.0070	<0.013	<0.017	<0.007	<0.012	<0.017	<0.012	-
	Benz(a)anthracene	mg/kg	0.066	0.050	0.033	0.070	0.092	0.033	0.066	0.092	0.0622	0.022
	Benzo(a)pyrene	mg/kg	0.042	0.030	0.023	0.048	0.067	0.023	0.042	0.067	0.042	0.017
	Benzo(b&j)fluoranthene	mg/kg	0.117	0.093	0.066	0.131	0.175	0.066	0.117	0.175	0.1164	0.041
	Benzo(b+j+k)fluoranthene	mg/kg	-	-	-	-	-	-	-	-	-	-
	Benzo(g,h,i)perylene	mg/kg	0.047	0.033	0.025	0.054	0.061	0.025	0.047	0.061	0.044	0.015
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	<0.010	<0.020	<0.020	<0.01	<0.01	<0.02	<0.02	-
	Chrysene	mg/kg	0.244	0.207	0.148	0.288	0.380	0.148	0.244	0.38	0.2534	0.087
	Dibenz(a,h)anthracene	mg/kg	0.0258	0.0187	0.0137	0.0300	0.0370	0.0137	0.0258	0.037	0.02504	0.0092
	Fluoranthene	mg/kg	0.049	0.037	0.028	0.059	0.071	0.028	0.049	0.071	0.0488	0.017
	Fluorene	mg/kg	0.239	0.185	0.122	0.291	0.399	0.122	0.239	0.399	0.2472	0.11
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.014	0.010	<0.010	<0.020	0.021	<0.01	0.01	0.021	0.01326667	0.0053
	2-Methylnaphthalene	mg/kg	2.470	2.11	1.34	2.970	4.12	1.34	2.47	4.12	2.602	1.0
	Naphthalene	mg/kg	0.762	0.661	0.408	0.963	1.340	0.408	0.762	1.34	0.8268	0.35
	Phenanthrene	mg/kg	0.988	0.85	0.57	1.150	1.54	0.568	0.988	1.54	1.0192	0.36
	Pyrene	mg/kg	0.085	0.066	0.045	0.094	0.128	0.045	0.085	0.128	0.0836	0.031
	Acenaphthene d10	%	84.8	82.2	79.7	74.5	85	74.5	82.2	85	81.24	4.3
	Chrysene d12	%	111	95.7	98	94	101	93.7	97.5	110.9	99.8	6.8
	Naphthalene d8	%	76.5	78.2	76.9	69.8	80	69.8	76.9	80	76.28	3.9
	Phenanthrene d10	%	92.8	82.1	80.8	77.8	84.8	77.8	82.1	92.8	83.66	5.7
	B(a)P Total Potency Equivalent	mg/kg	0.09	0.067	0.049	0.103	0.138	0.049	0.09	0.138	0.0894	0.034
	IACR (CCME)	mg/kg	1.31	1.03	0.74	1.5	1.98	0.74	1.31	1.98	1.312	0.47

" - " = no data or standard deviation not estimated

(blue) concentration exceeds lower SQG

(grey) concentration exceeds upper SQG

Table B.1: Sediment Quality in Lotic Mine-Exposed Areas and Associated Summary statistics, Fording River Operations, 2017

			FOBCP - SED - 01	FOBCP - SED - 02	FOBCP - SED - 03	FOBCP - SED - 04	FOBCP - SED - 05	Minimum	Median	Maximum	Mean	Standard Deviation
			14-Sep-17	14-Sep-17	14-Sep-17	14-Sep-17	14-Sep-17					
Physical Tests	% Moisture	%	49.9	45.9	49.8	53.8	46.1	45.9	49.8	53.8	49.1	3.3
	pH (1:9)	pH units	-	-	-	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH units	-	-	-	-	-	-	-	-	-	-
Particle Size	% Gravel (>2mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	-	-	-
	% Sand (2.00mm - 1.00mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (1.00mm - 0.50mm)	%	1.30	2.30	1.70	1.40	2.90	1.3	1.7	2.9	1.92	0.67
	% Sand (0.50mm - 0.25mm)	%	7.90	15.20	14.50	11.0	7.70	7.7	11	15.2	11.26	3.5
	% Sand (0.25mm - 0.125mm)	%	23.7	24.0	18.6	19.9	22.4	18.6	22.4	24	21.72	2.4
	% Sand (0.125mm - 0.063mm)	%	12.8	10.9	7.4	10.3	11.3	7.4	10.9	12.8	10.54	2.0
	% Silt (0.063mm - 0.004mm)	%	-	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 0.0312mm)	%	20.5	20.0	24.2	24.5	24.7	20	24.2	24.7	22.78	2.3
	% Silt (0.0312mm - 0.004mm)	%	26.6	23.0	28.8	28.7	27.0	23	27	28.8	26.82	2.4
	% Clay (<4µm)	%	7.00	4.20	4.60	4.00	3.30	3.3	4.2	7	4.62	1.4
	Texture	-	Sandy loam	Sandy loam	Silt loam	Silt loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	6.39	6.31	7.43	6.70	7.18	6.31	6.7	7.43	6.802	0.49
Metals (1 mm) (mg/kg)	Aluminum (Al)	mg/kg	8,760	8,180	5,600	4,680	6,140	4,680	6,140	8,760	6,672	1,735
	Antimony (Sb)	mg/kg	0.64	0.67	0.48	0.41	0.52	0.41	0.52	0.67	0.544	0.11
	Arsenic (As)	mg/kg	4.78	5.06	3.66	3.18	3.95	3.18	3.95	5.06	4.13	0.78
	Barium (Ba)	mg/kg	257	222	174	172	175	172	175	257	200	38.1
	Beryllium (Be)	mg/kg	0.64	0.60	0.56	0.41	0.61	0.41	0.6	0.64	0.564	0.091
	Bismuth (Bi)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	-
	Boron (B)	mg/kg	9.8	8.8	7.2	5.9	7.9	5.9	7.9	9.8	7.92	1.5
	Cadmium (Cd)	mg/kg	2.13	1.49	1.30	1.36	1.31	1.300	1.360	2.130	1.518	0.35
	Calcium (Ca)	mg/kg	108,000	69,900	85,600	124,000	78,300	69,900	85,600	124,000	93,160	22,307
	Chromium (Cr)	mg/kg	14.3	13.1	8.2	8.04	9.4	8.04	9.43	14.3	10.608	2.9
	Cobalt (Co)	mg/kg	6.70	6.30	5.11	4.62	5.34	4.62	5.34	6.70	5.61	0.86
	Copper (Cu)	mg/kg	14.5	14.0	11.7	10.3	12.1	10.3	12.1	14.5	12.52	1.7
	Iron (Fe)	mg/kg	13,400	14,400	11,100	9,720	11,600	9,720	11,600	14,400	12,044	1,863
	Lead (Pb)	mg/kg	8.32	8.97	6.89	5.97	7.15	6.0	7.2	9.0	7.5	1.2
	Lithium (Li)	mg/kg	12.20	10.70	8.80	8.00	9.70	8	9.7	12.2	9.88	1.6
	Magnesium (Mg)	mg/kg	16,700	13,300	10,700	11,300	12,500	10,700	12,500	16,700	12,900	2,354
	Manganese (Mn)	mg/kg	765	618	612	638	550	550	618	765	636.6	79.0
	Mercury (Hg)	mg/kg	0.0341	0.0347	0.0418	0.0284	0.0320	0.0284	0.0341	0.0418	0.0342	0.0049
	Molybdenum (Mo)	mg/kg	1.52	1.49	1.14	0.94	1.16	0.94	1.16	1.52	1.25	0.25
	Nickel (Ni)	mg/kg	70.4	53.2	55.2	56.3	46.7	46.7	55.2	70.4	56.36	8.7
	Phosphorus (P)	mg/kg	1,400	1,760	1,160	1,100	1,190	1100	1190	1760	1322	270
	Potassium (K)	mg/kg	2,260	2,120	1,380	1,180	1,530	1,180	1,530	2,260	1,694	472
	Selenium (Se)	mg/kg	4.99	2.68	2.40	2.18	2.11	2.11	2.40	4.99	2.87	1.2
	Silver (Ag)	mg/kg	0.21	0.18	0.15	0.13	0.15	0.13	0.15	0.21	0.164	0.031
	Sodium (Na)	mg/kg	104	87	78	78	76	76	78	104	84.6	11.7
	Strontium (Sr)	mg/kg	89.2	77.9	68.8	71.2	64.7	64.7	71.2	89.2	74.36	9.6
	Thallium (Tl)	mg/kg	0.28	0.23	0.19	0.18	0.20	0.179	0.196	0.28	0.2158	0.040
	Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	-
	Titanium (Ti)	mg/kg	15.4	10.3	7.8	9.0	9.3	7.8	9.3	15.4	10.36	3.0
	Uranium (U)	mg/kg	1.13	1.09	1.01	1.03	0.96	0.961	1.03	1.13	1.0442	0.067
	Vanadium (V)	mg/kg	37.7	34.8	24.0	19.8	25.9	19.8	25.9	37.7	28.44	7.5
	Zinc (Zn)	mg/kg	155	127.0	107.0	101.0	102.0	101.0	107.0	155.0	118.4	23.0
	Zirconium (Zr)	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
Hydrocarbons (mg/kg)	Acenaphthene	mg/kg	<0.066	<0.037	<0.040	<0.043	<0.030	<0.03	<0.04	<0.066	<0.066	-
	Acenaphthylene	mg/kg	0.0085	0.0060	0.0052	0.0056	<0.0050	<0.005	0.0056	0.0085	0.00606	0.0014
	Anthracene	mg/kg	<0.0090	<0.0040	<0.0040	< 0.004	<0.0040	<0.004	<0.004	0.004	0.004	-
	Benz(a)anthracene	mg/kg	0.040	0.021	0.023	0.024	0.017	0.017	0.023	0.04	0.025	0.0088
	Benzo(a)pyrene	mg/kg	0.025	0.013	0.014	0.014	0.011	0.011	0.014	0.025	0.0154	0.0055
	Benzo(b&j)fluoranthene	mg/kg	0.083	0.047	0.048	0.050	0.035	0.035	0.048	0.083	0.0526	0.018
	Benzo(b+j+k)fluoranthene	mg/kg	-	-	-	-	-	-	-	-	-	-
	Benzo(g,h,i)perylene	mg/kg	0.034	0.018	0.020	0.021	0.014	0.014	0.02	0.034	0.0214	0.0075
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	-
	Chrysene	mg/kg	0.183	0.101	0.107	0.112	0.078	0.078	0.107	0.183	0.1162	0.040
	Dibenz(a,h)anthracene	mg/kg	0.0180	0.0092	0.0099	0.0101	0.0073	0.0073	0.0099	0.018	0.0109	0.0041
	Fluoranthene	mg/kg	0.034	0.019	0.021	0.024	0.017	0.017	0.021	0.034	0.023	0.0067
	Fluorene	mg/kg	0.151	0.077	0.086	0.091	0.060	0.06	0.086	0.151	0.093	0.035
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.011	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	0.011	0.0102	-
	2-Methylnaphthalene	mg/kg	1.350	0.722	0.813	0.897	0.596	0.596	0.813	1.35	0.8756	0.29
	Naphthalene	mg/kg	0.358	0.191	0.233	0.267	0.175	0.175	0.233	0.358	0.2448	0.073
	Phenanthrene	mg/kg	0.691	0.376	0.423	0.437	0.312	0.312	0.423	0.691	0.4478	0.14
	Pyrene	mg/kg	0.063	0.035	0.038	0.039	0.028	0.028	0.038	0.063	0.0406	0.013
	Acenaphthene d10	%	80.9	74.6	80.4	79.0	72.9	72.9	79	80.9	77.56	3.6
	Chrysene d12	%	92.7	88	94.5	89.7	81.1	81.1	89.7	94.5	89.2	5.2
	Naphthalene d8	%	69.6	69.3	72	72	67.9	67.9	69.6	72	70.16	1.8
	Phenanthrene d10	%	86.5	79.8	88.5	85.7	76.5	76.5	85.7	88.5	83.4	5.0
	B(a)P Total Potency Equivalent	mg/kg	0.059	0.031	0.033	0.034	0.025	0.025	0.033	0.059	0.0364	0.013
	IACR (CCME)	mg/kg	0.92	0.51	0.54	0.56	0.4	0.4	0.54	0.92	0.586	0.20

" - " = no data or standard deviation not estimated

concentration exceeds lower SQG (blue shading)

concentration exceeds upper SQG (grey shading)

Table B.1: Sediment Quality in Lotic Mine-Exposed Areas and Associated Summary statistics, Fording River Operations, 2017

			FO22 - SED - 01	FO22 - SED - 02	FO22 - SED - 03	FO22 - SED - 04	FO22 - SED - 05	Minimum	Median	Maximum	Mean	Standard Deviation
			14-Sep-17	14-Sep-17	14-Sep-17	14-Sep-17	14-Sep-17					
Physical Tests	% Moisture	%	43.8	39.2	35.8	48.5	37.7	35.8	39.2	48.5	41.0	5.1
	pH (1:9)	pH units	-	-	-	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH units	-	-	-	-	-	-	-	-	-	-
Particle Size	% Gravel (>2mm)	%	<1.0	6.6	1.3	<1.0	<1.0	<1	<1	6.6	2.18	3.0
	% Sand (2.0mm - 0.063mm)	%						-	-	-	-	-
	% Sand (2.00mm - 1.00mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (1.00mm - 0.50mm)	%	1.10	1.40	2.20	2.20	2.90	1.1	2.2	2.9	1.96	0.72
	% Sand (0.50mm - 0.25mm)	%	4.00	9.60	20.40	10.00	17.10	4	10	20.4	12.22	6.5
	% Sand (0.25mm - 0.125mm)	%	10.60	25.00	41.20	14.80	31.60	10.6	25	41.2	24.64	12.4
	% Sand (0.125mm - 0.063mm)	%	5.7	16.80	17.10	11.90	14.60	5.7	14.6	17.1	13.22	4.7
	% Silt (0.063mm - 0.004mm)	%	-	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 0.0312mm)	%	33.2	18.9	8.5	26.6	15.5	8.5	18.9	33.2	20.54	9.6
	% Silt (0.0312mm - 0.004mm)	%	38.8	18.6	6.9	29.9	15.4	6.9	18.6	38.8	21.92	12.5
	% Clay (<4µm)	%	6.30	2.40	1.90	4.5	2.80	1.9	2.8	6.3	3.58	1.8
	Texture	-	Silt loam	Sandy loam	Loamy sand	Silt loam	Sandy loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	7.8	5.5	4.7	9.6	4.8	4.66	5.51	9.61	6.486	2.2
Metals (1 mm) (mg/kg)	Aluminum (Al)	mg/kg	6,750	7,570	8,400	7,060	6,880	6,750	7,060	8,400	7,332	673
	Antimony (Sb)	mg/kg	0.51	0.61	0.68	0.63	0.59	0.51	0.61	0.68	0.604	0.062
	Arsenic (As)	mg/kg	4.77	5.08	5.70	5.21	4.97	4.77	5.08	5.70	5.15	0.35
	Barium (Ba)	mg/kg	174	197	228	189	173	173	189	228	192.2	22.4
	Beryllium (Be)	mg/kg	0.49	0.73	0.87	0.58	0.64	0.49	0.64	0.87	0.662	0.15
	Bismuth (Bi)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	-
	Boron (B)	mg/kg	7	8	9	8	6	6.3	7.5	9	7.48	1.0
	Cadmium (Cd)	mg/kg	0.99	1.08	1.12	1.30	1.05	0.992	1.080	1.300	1.108	0.12
	Calcium (Ca)	mg/kg	40,500	41,600	37,400	35,900	35,700	35,700	37,400	41,600	38,220	2,694
	Chromium (Cr)	mg/kg	12.8	12.3	13.3	12.1	11.4	11.4	12.3	13.3	12.38	0.72
	Cobalt (Co)	mg/kg	4.60	5.84	6.54	6.15	5.67	4.60	5.84	6.54	5.76	0.73
	Copper (Cu)	mg/kg	11.1	13.0	13.8	14.6	11.6	11.1	13	14.6	12.82	1.5
	Iron (Fe)	mg/kg	12,500	14,500	17,600	14,200	14,200	12,500	14,200	17,600	14,600	1,853
	Lead (Pb)	mg/kg	7.0	8.4	9.4	8.3	8.0	7.0	8.3	9.4	8.2	0.86
	Lithium (Li)	mg/kg	8.7	9.7	10.5	9.1	8.9	8.7	9.1	10.5	9.38	0.73
	Magnesium (Mg)	mg/kg	12,900	10,900	10,700	9,550	11,000	9,550	10,900	12,900	11,010	1,205
	Manganese (Mn)	mg/kg	317	364	488	598	490	317	488	598	451.4	112
	Mercury (Hg)	mg/kg	0.0326	0.0343	0.0303	0.0406	0.0276	0.0276	0.0326	0.0406	0.0331	0.0049
	Molybdenum (Mo)	mg/kg	1.15	1.36	1.68	1.41	1.34	1.15	1.36	1.68	1.388	0.19
	Nickel (Ni)	mg/kg	23.8	26.1	27.6	29.1	24.6	23.8	26.1	29.1	26.24	2.2
	Phosphorus (P)	mg/kg	1,380	1,640	1,830	1,350	1,620	1350	1620	1830	1564	200
	Potassium (K)	mg/kg	1,730	1,930	2,180	1,810	1,690	1,690	1,810	2,180	1,868	197
	Selenium (Se)	mg/kg	2.88	2.5	2.07	2.4	1.8	1.83	2.44	2.88	2.34	0.40
	Silver (Ag)	mg/kg	0.14	0.17	0.16	0.19	0.15	0.14	0.16	0.19	0.162	0.019
	Sodium (Na)	mg/kg	79	80	82	78	76	76	79	82	79	2.2
	Strontium (Sr)	mg/kg	56.8	64.1	73.1	67.2	64.9	56.8	64.9	73.1	65.22	5.9
	Thallium (Tl)	mg/kg	0.18	0.19	0.21	0.19	0.18	0.179	0.187	0.208	0.1888	0.012
	Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	-
	Titanium (Ti)	mg/kg	9.5	11.2	8.1	11.4	7.1	7.1	9.5	11.4	9.46	1.9
	Uranium (U)	mg/kg	0.90	1.04	1.13	0.92	0.94	0.899	0.937	1.13	0.9848	0.098
	Vanadium (V)	mg/kg	28.6	33.1	38.5	31.9	31.2	28.6	31.9	38.5	32.66	3.7
	Zinc (Zn)	mg/kg	94.9	104	112.0	105	105.0	94.9	105.0	112.0	104.2	6.1
	Zirconium (Zr)	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
Hydrocarbons (mg/kg)	Acenaphthene	mg/kg	<0.019	<0.013	<0.011	<0.019	<0.012	<0.011	<0.013	<0.019	<0.019	-
	Acenaphthylene	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.005	<0.005	-
	Anthracene	mg/kg	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.004	<0.004	<0.004	<0.004	-
	Benz(a)anthracene	mg/kg	0.011	<0.010	<0.010	0.013	<0.010	<0.01	<0.01	0.013	0.0108	0.0011
	Benzo(a)pyrene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	-
	Benzo(b&j)fluoranthene	mg/kg	0.028	0.019	0.014	0.028	0.018	0.014	0.019	0.028	0.0214	0.0063
	Benzo(b+j+k)fluoranthene	mg/kg	-	-	-	-	-	-	-	-	-	-
	Benzo(g,h,i)perylene	mg/kg	0.011	<0.010	<0.010	0.010	<0.010	<0.01	<0.01	0.011	0.0102	0.00057
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	-
	Chrysene	mg/kg	0.064	0.043	0.037	0.065	0.041	0.037	0.043	0.065	0.05	0.013
	Dibenz(a,h)anthracene	mg/kg	0.0056	<0.0050	<0.0050	0.0052	<0.0050	<0.005	<0.005	0.0056	0.00516	0.00023
	Fluoranthene	mg/kg	0.012	<0.010	<0.010	0.012	<0.010	<0.01	<0.01	0.012	0.0108	-
	Fluorene	mg/kg	< 0.03	0.022	0.012	0.032	< 0.02	0.012	0.022	0.034	0.0236	0.0093
	Indeno(1,2,3-c,d)pyrene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	-
	2-Methylnaphthalene	mg/kg	0.370	0.239	0.221	0.357	0.221	0.221	0.239	0.37	0.2816	0.075
	Naphthalene	mg/kg	0.109	0.073	0.073	0.108	0.071	0.071	0.073	0.109	0.0868	0.020
	Phenanthrene	mg/kg	0.207	0.146	0.130	0.227	0.135	0.13	0.146	0.227	0.169	0.045
	Pyrene	mg/kg	0.02	0.01	0.01	0.02	0.01	0.011	0.014	0.021	0.0158	0.0044
	Acenaphthene d10	%	73.8	75.1	68.4	75	76.4	68.4	75	76.4	73.74	3.1
	Chrysene d12	%	85.2	89.1	79.8	87.9	91	79.8	87.9	91	86.6	4.3
	Naphthalene d8	%	71.2	73.2	66.6	69.6	72.8	66.6	71.2	73.2	70.68	2.7
	Phenanthrene d10	%	77.1	80.8	71.1	80.8	82.1	71.1	80.8	82.1	78.38	4.5
	B(a)P Total Potency Equivalent	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.02	<0.02	-
	IACR (CCME)	mg/kg	0.31	0.21	0.18	0.31	0.21	0.18	0.21	0.31	0.244	0.061

" - " = no data or standard deviation not estimated

concentration exceeds lower SQG

concentration exceeds upper SQG

Table B.1: Sediment Quality in Lotic Mine-Exposed Areas and Associated Summary statistics, Fording River Operations, 2017

			FRUPO - SED - 01	FRUPO - SED - 02	FRUPO - SED - 03	FRUPO - SED - 04	FRUPO - SED - 05	Minimum	Median	Maximum	Mean	Standard Deviation
			15-Sep-17	15-Sep-17	15-Sep-17	15-Sep-17	15-Sep-17					
Physical Tests	% Moisture	%	43.5	48.0	59.3	49.9	46.7	43.5	48.0	59.3	49.5	6.0
	pH (1:9)	pH units	-	-	-	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH units	-	-	-	-	-	-	-	-	-	-
Particle Size	% Gravel (>2mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (2.0mm - 0.063mm)	%						-	-	-	-	-
	% Sand (2.00mm - 1.00mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (1.00mm - 0.50mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
	% Sand (0.50mm - 0.25mm)	%	7.4	2.1	<1.0	3.8	4.9	<1	3.8	7.4	3.84	2.3
	% Sand (0.25mm - 0.125mm)	%	14.1	13.3	3.2	16.7	13.3	3.2	13.3	16.7	12.12	5.2
	% Sand (0.125mm - 0.063mm)	%	13.0	17.2	6.1	18.9	12.3	6.1	13	18.9	13.5	5.0
	% Silt (0.063mm - 0.004mm)	%	-	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 0.0312mm)	%	27.6	29.3	40.9	27.6	28.2	27.6	28.2	40.9	30.72	5.7
	% Silt (0.0312mm - 0.004mm)	%	31.3	32.7	44.5	28.9	33.4	28.9	32.7	44.5	34.16	6.0
	% Clay (<4μm)	%	5.70	5.30	5.00	3.80	7.30	3.8	5.3	7.3	5.42	1.3
	Texture	-	Silt loam	Silt loam	Silt	Silt loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	7.08	7.59	9.04	5.77	5.68	5.68	7.08	9.04	7.032	1.4
Metals (1 mm) (mg/kg)	Aluminum (Al)	mg/kg	6,170	7,490	6,260	7,150	7,480	6,170	7,150	7,490	6,910	650
	Antimony (Sb)	mg/kg	0.65	0.61	0.51	0.60	0.68	0.51	0.61	0.68	0.61	0.064
	Arsenic (As)	mg/kg	5.02	4.89	4.15	4.83	5.23	4.15	4.89	5.23	4.82	0.41
	Barium (Ba)	mg/kg	184	194	189	186	204	184	189	204	191.4	8.0
	Beryllium (Be)	mg/kg	0.53	0.63	0.51	0.72	0.73	0.51	0.63	0.73	0.624	0.10
	Bismuth (Bi)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	-
	Boron (B)	mg/kg	5.5	8.9	9.0	8.1	9.2	5.5	8.9	9.2	8.14	1.5
	Cadmium (Cd)	mg/kg	1.33	1.39	1.44	1.28	1.30	1.280	1.330	1.440	1.348	0.066
	Calcium (Ca)	mg/kg	48,800	54,600	55,000	49,900	44,300	44,300	49,900	55,000	50,520	4,437
	Chromium (Cr)	mg/kg	10.2	12.5	11.3	12.2	13.8	10.2	12.2	13.8	12	1.3
	Cobalt (Co)	mg/kg	6.03	6.33	5.67	5.99	6.56	5.67	6.03	6.56	6.12	0.34
	Copper (Cu)	mg/kg	14.2	14.5	14.4	13.4	14.8	13.4	14.4	14.8	14.26	0.53
	Iron (Fe)	mg/kg	14,000	14,300	12,100	14,500	14,600	12,100	14,300	14,600	13,900	1,032
	Lead (Pb)	mg/kg	8.9	9.7	7.9	8.6	8.9	7.9	8.9	9.7	8.8	0.66
	Lithium (Li)	mg/kg	9.8	11.3	9.9	10.8	11.1	9.8	10.8	11.3	10.58	0.69
	Magnesium (Mg)	mg/kg	11,700	16,500	14,400	14,600	13,900	11,700	14,400	16,500	14,220	1,720
	Manganese (Mn)	mg/kg	451	585	504	460	541	451	504	585	508.2	56.1
	Mercury (Hg)	mg/kg	0.0416	0.0421	0.0435	0.0386	0.0405	0.0386	0.0416	0.0435	0.0413	0.0018
	Molybdenum (Mo)	mg/kg	1.60	1.48	1.26	1.56	1.51	1.26	1.51	1.6	1.482	0.13
	Nickel (Ni)	mg/kg	34.4	38.5	35.5	32.2	37.5	32.2	35.5	38.5	35.62	2.5
	Phosphorus (P)	mg/kg	1,430	1,760	1,350	1,550	1,650	1350	1550	1760	1548	165
	Potassium (K)	mg/kg	1,470	1,880	1,590	1,830	1,960	1,470	1,830	1,960	1,746	207
	Selenium (Se)	mg/kg	3.02	2.42	3.27	3.17	2.21	2.21	3.02	3.27	2.82	0.47
	Silver (Ag)	mg/kg	0.20	0.21	0.20	0.20	0.21	0.2	0.2	0.21	0.204	0.0055
	Sodium (Na)	mg/kg	73	94	83	90	88	73	88	94	85.6	8.1
	Strontium (Sr)	mg/kg	65.1	63.4	57.1	63.4	65.9	57.1	63.4	65.9	62.98	3.5
	Thallium (Tl)	mg/kg	0.20	0.22	0.18	0.21	0.24	0.18	0.205	0.236	0.2072	0.021
	Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	-
	Titanium (Ti)	mg/kg	5.9	9.6	8.9	8.9	12.8	5.9	8.9	12.8	9.22	2.5
	Uranium (U)	mg/kg	1.08	1.07	1.05	1.07	1.10	1.05	1.07	1.1	1.074	0.018
	Vanadium (V)	mg/kg	28.7	33.0	27.6	31.3	33.9	27.6	31.3	33.9	30.9	2.7
	Zinc (Zn)	mg/kg	110	114	99	106	109	99.3	109.0	114.0	107.7	5.5
	Zirconium (Zr)	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	-
Hydrocarbons (mg/kg)	Acenaphthene	mg/kg	<0.020	<0.026	<0.031	<0.017	<0.020	<0.017	<0.02	<0.031	<0.026	-
	Acenaphthylene	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.005	<0.005	-
	Anthracene	mg/kg	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.004	<0.004	<0.004	<0.004	-
	Benz(a)anthracene	mg/kg	0.012	0.016	0.019	0.012	0.015	0.012	0.015	0.019	0.0148	0.0029
	Benzo(a)pyrene	mg/kg	<0.010	<0.010	< 0.01	<0.010	<0.010	<0.01	<0.01	0.01	0.01	-
	Benzo(b&j)fluoranthene	mg/kg	0.026	0.035	0.041	0.027	0.034	0.026	0.034	0.041	0.0326	0.0062
	Benzo(b+j+k)fluoranthene	mg/kg	-	-	-	-	-	-	-	-	-	-
	Benzo(g,h,i)perylene	mg/kg	<0.010	< 0.01	< 0.01	<0.010	< 0.01	<0.01	0.012	0.014	0.012	0.0012
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	-
	Chrysene	mg/kg	0.059	0.078	0.094	0.060	0.076	0.059	0.076	0.094	0.0734	0.014
	Dibenz(a,h)anthracene	mg/kg	0.0054	0.0067	0.0084	0.0050	0.0065	0.005	0.0065	0.0084	0.0064	0.0013
	Fluoranthene	mg/kg	0.010	0.016	0.019	0.012	0.014	0.01	0.014	0.019	0.0142	0.0035
	Fluorene	mg/kg	0.036	0.050	0.061	0.035	0.040	0.035	0.04	0.061	0.0444	0.011
	Indeno(1,2,3-c,d)pyrene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	-
	2-Methylnaphthalene	mg/kg	0.402	0.501	0.613	0.375	0.418	0.375	0.418	0.613	0.4618	0.097
	Naphthalene	mg/kg	0.120	0.151	0.175	0.110	0.118	0.11	0.12	0.175	0.1348	0.027
	Phenanthrene	mg/kg	0.219	0.278	0.336	0.213	0.266	0.213	0.266	0.336	0.2624	0.050
	Pyrene	mg/kg	0.019	0.027	0.030	0.019	0.026	0.019	0.026	0.03	0.0242	0.0050
	Acenaphthene d10	%	77.6	73.3	77.9	70.2	76.4	70.2	76.4	77.9	75.08	3.3
	Chrysene d12	%	89.2	87.6	92.1	83.8	89.5	83.8	89.2	92.1	88.44	3.1
	Naphthalene d8	%	74.2	69.4	73.8	66.4	73.5	66.4	73.5	74.2	71.46	3.4
	Phenanthrene d10	%	81.8	78.8	83.4	75.8	82.5	75.8	81.8	83.4	80.46	3.1
	B(a)P Total Potency Equivalent	mg/kg	<0.020	<0.020	< 0.03	<0.020	<0.020	<0.02	<0.02	0.026	0.0212	-
	IACR (CCME)	mg/kg	0.29	0.38	0.46	0.30	0.37	0.29	0.37	0.46	0.36	0.069

" - " = no data or standard deviation not estimated

(blue shading) concentration exceeds lower SQG

(grey shading) concentration exceeds upper SQG

Table B.2: Field Duplicate (Split Sample) Results for Sediment Chemistry Samples

Analyte		Units	FRUPO L1993056 FRUPO - SED - 05 11-Sep-17	FRUPO L1993056 FRUPO - SED - 05X 11-Sep-17	RPD -
Physical Tests	Moisture	%	46.7	44.2	6%
Particle Size	% Gravel (>2 mm)	%	<1.0	<1.0	0%
	% Sand (2.00 mm - 1.00 mm)	%	<1.0	<1.0	0%
	% Sand (1.00 mm - 0.50 mm)	%	<1.0	<1.0	0%
	% Sand (0.50 mm - 0.25 mm)	%	4.9	7.1	37%
	% Sand (0.25 mm - 0.125 mm)	%	13.3	18.4	32%
	% Sand (0.125 mm - 0.063 mm)	%	12.3	15.9	26%
	% Silt (0.063 mm - 0.0312 mm)	%	28.2	24.1	16%
	% Silt (0.0312 mm - 0.004 mm)	%	33.4	28.2	17%
	% Clay (<4 µm)	%	7.3	5.6	26%
	Texture	-	Silt loam	Silt loam	-
Organic Carbon	Total Organic Carbon	%	5.68	5.75	1%
Total Metals	Aluminum (Al)	mg/kg	7,480	7,040	6%
	Antimony (Sb)	mg/kg	0.68	0.61	11%
	Arsenic (As)	mg/kg	5.23	4.82	8%
	Barium (Ba)	mg/kg	204	195	5%
	Beryllium (Be)	mg/kg	0.73	0.71	3%
	Bismuth (Bi)	mg/kg	<0.20	<0.20	0%
	Boron (B)	mg/kg	9.2	8.6	7%
	Cadmium (Cd)	mg/kg	1.30	1.19	9%
	Calcium (Ca)	mg/kg	44,300	42,400	4%
	Chromium (Cr)	mg/kg	13.8	12.3	11%
	Cobalt (Co)	mg/kg	6.56	5.86	11%
	Copper (Cu)	mg/kg	14.8	13.2	11%
	Iron (Fe)	mg/kg	14,600	14,200	3%
	Lead (Pb)	mg/kg	8.9	8.4	6%
	Lithium (Li)	mg/kg	11.1	10.5	6%
	Magnesium (Mg)	mg/kg	13,900	13,000	7%
	Manganese (Mn)	mg/kg	541	474	13%
	Mercury (Hg)	mg/kg	0.0405	0.0380	6%
	Molybdenum (Mo)	mg/kg	1.51	1.49	1%
	Nickel (Ni)	mg/kg	37.5	33.5	11%
	Phosphorus (P)	mg/kg	1,650	1,510	9%
	Potassium (K)	mg/kg	1,960	1,880	4%
	Selenium (Se)	mg/kg	2.21	2.00	10%
	Silver (Ag)	mg/kg	0.21	0.17	21%
	Sodium (Na)	mg/kg	88	89	1%
	Strontium (Sr)	mg/kg	65.9	61	8%
	Sulfur (S)	mg/kg	<1000	<1000	0%
	Thallium (Tl)	mg/kg	0.236	0.217	8%
	Tin (Sn)	mg/kg	<2.0	<2.0	0%
	Titanium (Ti)	mg/kg	12.8	8.1	45%
	Tungsten (W)	mg/kg	<0.50	<0.50	0%
	Uranium (U)	mg/kg	1.10	1.00	10%
	Vanadium (V)	mg/kg	33.9	31.2	8%
	Zinc (Zn)	mg/kg	109.0	101	8%
	Zirconium (Zr)	mg/kg	<1.0	<1.0	0%
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	<0.020	<0.020	0%
	Acenaphthylene	mg/kg	<0.0050	<0.0050	0%
	Acridine	mg/kg	<0.010	<0.010	0%
	Anthracene	mg/kg	<0.0040	<0.0040	0%
	Benz(a)anthracene	mg/kg	0.015	0.013	14%
	Benzo(a)pyrene	mg/kg	<0.010	<0.010	0%
	Benzo(b&j)fluoranthene	mg/kg	0.034	0.030	13%
	Benzo(e)pyrene	mg/kg	0.031	0.028	10%
	Benzo(g,h,i)perylene	mg/kg	0.012	0.011	9%
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	0%
	Chrysene	mg/kg	0.076	0.067	13%
	Dibenz(a,h)anthracene	mg/kg	0.0065	0.0056	15%
	Fluoranthene	mg/kg	0.014	0.013	7%
	Fluorene	mg/kg	0.040	0.036	11%
	Indeno(1,2,3-c,d)pyrene	mg/kg	<0.010	<0.010	0%
	1-Methylnaphthalene	mg/kg	0.231	0.209	10%
	2-Methylnaphthalene	mg/kg	0.418	0.371	12%
	Naphthalene	mg/kg	0.118	0.106	11%
	Perylene	mg/kg	<0.010	<0.010	0%
	Phenanthrene	mg/kg	0.266	0.239	11%
	Pyrene	mg/kg	0.026	0.021	21%
	Quinoline	mg/kg	<0.010	<0.010	0%
	d10-Acenaphthene	%	76.4	74.8	2%
	d12-Chrysene	%	89.5	89.8	0%
	d8-Naphthalene	%	73.5	72.3	2%
	d10-Phenanthrene	%	82.5	83.6	1%
	B(a)P Total Potency Equivalent	mg/kg	<0.020	<0.020	0%
	IACR (CCME)	mg/kg	0.37	0.33	11%

(shaded) Relative Percent Difference greater than 40%.

Note: For calculation of the RPD, method detection limit (MDL) values were used in cases where the reported value wa

Table B.3: Benthic Invertebrates Biomass (g/0.1 m^2) , Fording River 2017

Station	FO26-BM																				FOBCP-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10		1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																																								
P. Nemata	-	-	8	0.0004	16	0.0052	8	0.0008	4	0.0004	4	0.0004	4	0.0072	4	0.0004	4	0.0024	-	-	15	0.0073	10	0.0038	10	0.0013	7	0.0037	5	0.0018	30	0.0160	6	0.0087	12	0.0077	25	0.0146	24	0.0210
FLATWORMS																																								
P. Platyhelminthes																																								
Cl. Turbellaria																																								
F. Planariidae	16	0.0136	40	0.0364	24	0.0372	36	0.0764	20	0.0404	16	0.0372	64	0.1752	28	0.0464	48	0.1052	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0011	2	0.0029	-	-
ANNELIDS																																								
P. Annelida																																								
WORMS																																								
Cl. Oligochaeta																																								
F. Enchytraeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.0020	2	0.0004	4	0.0003	2	0.0008	19	0.0086	2	0.0002	1	0.0006	-	-	12	0.0058	6	0.0028
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.0506
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	4	0.0160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS																																								
MITES																																								
Cl. Arachnida																																								
Subcl. Acari	44	0.0200	40	0.0152	168	0.0712	56	0.0248	24	0.0080	28	0.0096	76	0.0300	40	0.0096	28	0.0120	32	0.0088	45	0.0113	65	0.0175	23	0.0119	25	0.0058	22	0.0058	39	0.0091	21	0.0046	45	0.0085	30	0.0070	44	0.0158
SEED SHRIMPS																																								
Cl. Ostracoda	-	-	-	-	28	0.0080	60	0.0260	32	0.0052	8	0.0012	20	0.0052	68	0.0212	56	0.0160	8	0.0024	2	0.0003	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0006	-	-	-	-
INSECTS																																								
Cl. Insecta																																								
BEETLES																																								
O. Coleoptera																																								
F. Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0009	-	-	3	0.0008	-	-	1	0.0014	-	-	-	-	-	-	1	0.0018	-	-
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES																																								
O. Ephemeroptera																																								
F. Ameletidae	-	-	4	0.0004	16	0.0104	4	0.0004	4	0.0036	4	0.0060	-	-	4	0.0012	-	-	8	0.0224	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0003	1	0.0019	-	-
F. Baetidae	20	0.0732	24	0.0028	64	0.1088	4	0.0004	12	0.0620	8	0.0540	12	0.0020	8	0.0004	8	0.0056	8	0.0032	-	-	1	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0005	-	-
F. Ephemerellidae	116	0.2116	160	0.2980	136	0.0944	156	0.2660	88	0.1316	208	0.4688	160	0.3224	80	0.1284	96	0.1668	96	0.0976	2	0.0048	3	0.0090	11	0.0257	2	0.0040	-	-	2	0.0028	2	0.0043	3	0.0057	1	0.0039	4	0.0172
F. Heptageniidae	356	0.3384	164	0.2036	412	0.1700	456	0.3484	316	0.2640	280	0.3064	324	0.3952	292	0.1852	240	0.2028	48	0.0400	68	0.0527	64	0.0495	41	0.0226	49	0.0180	59	0.0392	56	0.0396	49	0.0313	64	0.0430	52	0.0321	118	0.0920
STONEFLIES																																								
O. Plecoptera																																								
F. Capniidae	-	-	-	-	8	0.0024	-	-	-	-	-	-	-	-	-	-	-	-	4	0.0020	5	0.0028	4	0.0028	7	0.0008	1	0.0001	3	0.0004	2	0.0008	-	-	3	0.0017	5	0.0048	6	0.0048
F. Chloroperlidae	12	0.0268	68	0.0700	52	0.0540	136	0.1676	24	0.0752	24	0.0584	28	0.0164	36	0.0300	8	0.0056	8	0.0076	1	0.0011	-	-	13	0.0051	-	-	-	-	1	0.0003	-	-	-	-	-	-	2	0.0002
F. Leuctridae	-	-	28	0.0232	8	0.0072	56	0.0408	32	0.0260	4	0.0024	12	0.0104	24	0.0088	16	0.0092	20	0.0156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Nemouridae	44	0.2580	60	0.1484	52	0.0600	36	0.1064	12	0.0912	92	0.3536	68	0.2420	4	0.0096	28	0.0832	8	0.0224	129	0.0717	48	0.0199	3	0.0010	10	0.0025	7	0.0020	37	0.0119	45	0.0125	28	0.0074	55	0.0173	68	0.0214
F. Perlidae	4	0.0044	-	-	4	0.0008	-	-	-	-	-	-	4	0.0028	-	-	-	-	-	-	4	0.0010	-	-	2	0.0047	-	-	-	-	1	0.0118	4	0.6496	2	0.4432	3	0.1028	8	0.7063
F. Perlodidae	44	0.0148	76	0.1652	80	0.1556	56	0.1456	16	0.2388	52	0.3216	64	0.0292	32	0.0156	16	0.0156	12	0.0056	91	0.0473	124	0.1914	42	0.1877	67	0.0334	56	0.0645	30	0.0486	38	0.0431	26	0.1347	27	0.0470	114	0.7266
F. Peltoperlidae	-	-	-	-	-	-	4	0.0032	4	0.0356	-	-	4	0.0012	-	-	4	0.0024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	4	0.0016	36	0.0088	-	-	4	0.0032	4	0.0004	4	0.0008	-	-	4	0.0004	4	0.0012	-	-	5	0.0008	12	0.0050	-	-	-	-	2	0.0002	6	0.0009	5	0.0008	1	0.0001	7	0.0008	4	0.0010
BUGS																																								
O. Hemiptera																																								
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																																								
O. Trichoptera																																								
F. Apataniidae	-	-	-	-	-	-	-	-	-	-	4	0.0016	-	-	-	-	-	-	-	-	-	-	1	0.0008	2	0.0038	-	-	1	0.0005	-	-	-	-	3	0.0007	-	-	-	-
F. Brachycentridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.0002	2	0.0001	-	-	-	-	-	-	1	0.0001	-	-	1	0.0001	-	-	-	-
F. Glossosomatidae	4	0.0052	4	0.0016	-	-	-	-	8	0.0024	4	0.0024	4	0.0008	4	0.0024	4	0.0024	8	0.0020	1	0.0011	4	0.0011	-	-	-	-	-	-	-	-	-	-	1	0.0002	1	0.0004	4	0.0004
F. Hydropsychidae	21	0.1804	78	0.6750	26	0.7239	32	1.2204	26	0.7192	73	2.5374	31	0.8671	1	0.0940	34	0.5800	12	0.0044	6	0.0182	6	0.0411	-	-	-	-	-	-	3	0.1426	18	0.1972	1	0.0005	4	0.0320	12	0.2594
F. Limnephilidae	-	-	4	0.0004	8	0.0036	12	0.0060	9	0.3227	-	-	-	-	24	0.0008	16	0.0028	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Rhyacophilidae	80	0.8412	80	0.8296	73	0.3648	12	0.1592	48	0.0664	81	0.8366	116	0.8148	60	0.0460	33	0.1253	48	0.1688	15	0.2314	21	0.2265	3	0.0188	6	0.1058	6	0.0531	6	0.0482	12	0.0645	12	0.1280	12	0.2543	40	0.4714
F. Uenoidae	1240	0.2028	356	0.0596	888	0.1650	744	0.1152	1036	0.1260	1620	0.2484	2040	0.2720	964	0.1064	1212	0.1316	1504	0.1588	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES																																								
O. Diptera																																								
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0097	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	-	-	-	-	-	-	-	-	4	0.0024	-	-	12	0.0044	4	0.0004	-	-	-	-	-	-	2	0.0010	3	0.0014	4	0.0020	5	0.0022	-	-	-	-	1	0.0002	2	0.0003	-	-
F. Chironomidae	44	0.0276	208	0.1164	100	0.0488	28	0.0080	20	0.0080	20	0.0212	44	0.0248	28	0.0204	8	0.0064	20	0.0224	14	0.0183	58	0.0278	24	0.0286	12	0.0117	50	0.0331	15	0.0221	8	0.0139	10	0.0087	21	0.0322	26	0.0340
F. Empididae	-	-	20	0.0620	32	0.0428	16	0.0188	4	0.0052	4	0.0076	4	0.0032	12	0.0456	8	0.0036	4	0.0040	4	0.0065	5	0.0083	2	0.0023	3	0.0036	8	0.0241	2	0.0041	-	-	4	0.0079	3	0.0039	2	0.0002
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	4	0.0016	24	0.0136	36	0.0156	12	0.0068	8	0.0020	4	0.0024	20	0.0060	4	0.0012	8	0.0028	4	0.0020	66	0.0506	47	0.0343	89	0.0348	32	0.0142	57	0.0278	31	0.0167	14	0.0088	24	0.0106	62	0.0381	96	0.0516
F. Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Stratiomyiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	-	-	8	0.0016	28	0.0308	12	0.0044	8	0.0072	8	0.0040	-	-	20	0.0200	-	-	12	0.0120	3	0.0023	-	-	3	0.0021	1	0.0008	6	0.0017	1	0.0016	1	0.0011	-	-	4	0.0050	-	-
CLAMS																																								
Cl. Gastropoda																																								
F. Lymnaeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																																								
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	2053		1490		2259		1940		1763		2550		3115		1745		1879		1864		485		479		286		221		307		265		224		246		331		582	
TOTAL NUMBER OF TAXA [a]	16		21		22		22		24		22		22		23		21		19		22		19		19		14		16		18		14		21		22		18	
TOTAL BIOMASS (g)		2.2212		2.7322		2.1805		2.7488		2.2439		5.2820		3.2483		0.7944		1.4829		0.6020		0.5423		0.6405		0.3707		0.2064		0.2664		0.3774		1.0410		0.8109		0.6094		2.4767

Notes: [a] Bold entries excluded from taxa count

Table B.3: Benthic Invertebrates Biomass (g/0.1 m^2) , Fording River 2017

Station	FOBKS-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																				
P. Nemata	4	0.0004	13	0.0031	12	0.0064	2	0.0017	6	0.0010	8	0.0042	10	0.0032	6	0.0012	10	0.0058	20	0.0160
FLATWORMS																				
P. Platyhelminthes																				
Cl. Turbellaria																				
F. Planariidae	2	0.0008	-	-	1	0.0042	1	0.0004	-	-	-	-	2	0.0030	-	-	-	-	-	-
ANNELIDS																				
P. Annelida																				
WORMS																				
Cl. Oligochaeta																				
F. Enchytraeidae	2	0.0002	5	0.0012	5	0.0009	2	0.0003	-	-	-	-	14	0.0040	2	0.0006	8	0.0034	2	0.0004
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS																				
MITES																				
Cl. Arachnida																				
Subcl. Acari	10	0.0012	7	0.0003	1	0.0018	6	0.0016	11	0.0022	18	0.0036	22	0.0042	28	0.0056	16	0.0036	24	0.0084
SEED SHRIMPS																				
Cl. Ostracoda	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0002	-	-	-	-	-	-
INSECTS																				
Cl. Insecta																				
BEETLES																				
O. Coleoptera																				
F. Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	-	-	-	-	1	0.0023	-	-	1	0.0003	-	-	2	0.0004	-	-	-	-	-	-
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES																				
O. Ephemeroptera																				
F. Ameletidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Baetidae	18	0.0818	14	0.0587	9	0.0218	20	0.0653	13	0.0393	14	0.0516	16	0.0706	26	0.0916	10	0.0284	16	0.0876
F. Ephemerellidae	6	0.0106	13	0.0400	7	0.0159	7	0.0150	5	0.0110	6	0.0162	10	0.0220	8	0.0172	8	0.0234	16	0.0086
F. Heptageniidae	112	0.0710	69	0.0470	95	0.0488	71	0.0492	64	0.0299	162	0.0698	170	0.1160	112	0.0560	82	0.0476	260	0.1510
STONEFLIES																				
O. Plecoptera																				
F. Capniidae	4	0.0020	1	0.0006	2	0.0014	-	-	-	-	2	0.0010	-	-	6	0.0074	-	-	12	0.0086
F. Chloroperlidae	-	-	-	-	-	-	-	-	-	-	2	0.0004	2	0.0062	-	-	-	-	-	-
F. Leuctridae	-	-	-	-	-	-	-	-	-	-	-	-	6	0.0062	-	-	-	-	-	-
F. Nemouridae	6	0.0026	7	0.0047	4	0.0027	1	0.0001	3	0.0008	18	0.0152	8	0.0050	40	0.0262	4	0.0006	20	0.0106
F. Perlidae	-	-	1	0.1733	-	-	1	0.0149	1	0.0101	1	0.3545	7	1.9006	10	1.7638	2	0.0220	9	0.9059
F. Perlodidae	24	0.0128	20	0.2212	22	0.4363	26	0.1233	22	0.0124	36	0.1298	24	0.0114	6	0.0006	18	0.0110	49	0.1517
F. Peltoperlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	4	0.0004	4	0.0007	8	0.0008	1	0.0002	1	0.0001	4	0.0032	2	0.0014	-	-	2	0.0008	8	0.0030
BUGS																				
O. Hemiptera																				
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																				
O. Trichoptera																				
F. Apataniidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Brachycentridae	4	0.0004	5	0.0001	-	-	-	-	7	0.0003	2	0.0002	-	-	8	0.0010	-	-	6	0.0006
F. Glossosomatidae	32	0.0156	7	0.0309	1	0.0092	34	0.0465	6	0.0029	-	-	2	0.0006	-	-	18	0.0136	16	0.0160
F. Hydropsychidae	20	0.2316	49	0.7479	8	0.0206	2	0.0073	6	0.0864	4	0.0262	26	0.1456	41	0.5129	11	0.2153	26	0.1042
F. Limnephilidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Rhyacophilidae	14	0.0032	49	0.1382	34	0.1920	20	0.1843	24	0.1321	56	0.2288	48	0.0646	72	0.2840	39	0.3224	42	0.1498
F. Uenoidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0004
TRUE FLIES																				
O. Diptera																				
indeterminate	-	-	-	-	-	-	1	0.0052	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	-	-	-	-	-	-	-	-	1	0.0001	2	0.0012	2	0.0026	-	-	-	-	4	0.0038
F. Chironomidae	12	0.0190	14	0.0086	15	0.0069	12	0.0208	12	0.0191	14	0.0100	68	0.0288	36	0.0452	20	0.0154	20	0.0414
F. Empididae	2	0.0016	4	0.0049	2	0.0043	2	0.0028	3	0.0031	-	-	2	0.0024	6	0.0114	4	0.0058	6	0.0108
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0046	-	-	-	-	-	-
F. Psychodidae	104	0.0558	48	0.0370	65	0.0327	62	0.0373	59	0.0370	196	0.1598	300	0.1842	172	0.0958	86	0.0640	95	0.0702
F. Simuliidae	-	-	1	0.0007	2	0.0036	-	-	-	-	2	0.0066	-	-	-	-	-	-	-	-
F. Stratiomyiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	2	0.0012	-	-	-	-	1	0.0004	1	0.0011	-	-	8	0.0066	10	0.0032	1	0.3432	-	-
CLAMS																				
Cl. Gastropoda																				
F. Lymnaeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																				
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	382		331		294		272		246		547		755		589		339		653	
TOTAL NUMBER OF TAXA [a]	19		19		19		19		19		18		24		17		17		20	
TOTAL BIOMASS (g)		0.5122		1.5191		0.8126		0.5766		0.3892		1.0823		2.5944		2.9237		1.1263		1.7490

Station	FOBSC-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																				
P. Nemata	2	0.0001	5	0.0034	8	0.0042	3	0.0024	-	-	4	0.0013	3	0.0019	3	0.0001	1	0.0005	6	0.0040
FLATWORMS																				
P. Platyhelminthes																				
Cl. Turbellaria																				
F. Planariidae	1	0.0006	1	0.0021	2	0.0069	1	0.0026	-	-	3	0.0028	-	-	-	-	-	-	2	0.0028
ANNELIDS																				
P. Annelida																				
WORMS																				
Cl. Oligochaeta																				
F. Enchytraeidae	4	0.0007	5	0.0021	6	0.0035	5	0.0049	11	0.0021	3	0.0017	5	0.0031	5	0.0011	3	0.0005	6	0.0031
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS																				
MITES																				
Cl. Arachnida																				
Subcl. Acari	24	0.0072	13	0.0030	23	0.0065	30	0.0110	33	0.0098	21	0.0066	10	0.0031	6	0.0009	8	0.0010	10	0.0043
SEED SHRIMPS																				
Cl. Ostracoda	-	-	1	0.0005	-	-	-	-	2	0.0004	-	-	-	-	-	-	-	-	-	-
INSECTS																				
Cl. Insecta																				
BEETLES																				
O. Coleoptera																				
F. Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	-	-	-	-	-	-	-	-	1	0.0001	-	-	3	0.0050	-	-	-	-	1	0.0007
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES																				
O. Ephemeroptera																				
F. Ameletidae	-	-	-	-	-	-	-	-	-	-	4	0.0022	1	0.0008	-	-	-	-	1	0.0003
F. Baetidae	17	0.0432	17	0.0509	23	0.0487	17	0.0269	11	0.0322	14	0.0460	22	0.0753	7	0.0293	4	0.0237	9	0.0322
F. Ephemerellidae	6	0.0283	10	0.0230	7	0.0153	2	0.0031	2	0.0064	2	0.0103	9	0.0104	1	0.0009	5	0.0056	5	0.0054
F. Heptageniidae	49	0.0464	90	0.0707	117	0.0761	56	0.0428	9	0.0095	78	0.0570	131	0.0804	44	0.0271	9	0.0037	56	0.0479
STONEFLIES																				
O. Plecoptera																				
F. Capniidae	-	-	-	-	8	0.0046	1	0.0008	-	-	3	0.0018	7	0.0036	3	0.0001	3	0.0004	-	-
F. Chloroperlidae	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0004	2	0.0025	-	-	-	-
F. Leuctridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0002	-	-	1	0.0013
F. Nemouridae	12	0.0137	14	0.0067	29	0.0122	7	0.0021	1	0.0003	2	0.0015	17	0.0093	3	0.0005	-	-	3	0.0012
F. Perlidae	4	0.0302	4	0.2180	3	0.2280	-	-	-	-	2	0.0202	-	-	-	-	-	-	2	0.1768
F. Perlodidae	14	0.0159	24	0.0472	50	0.0602	32	0.1483	20	0.0098	12	0.0374	48	0.0362	22	0.0178	19	0.0584	27	0.0675
F. Peltoperlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	-	-	1	0.0001	4	0.0011	1	0.0004	1	0.0002	1	0.0002	2	0.0002	-	-	1	0.0002	-	-
BUGS																				
O. Hemiptera																				
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																				
O. Trichoptera																				
F. Apataniidae	-	-	-	-	-	-	-	-	-	-	1	0.0004	2	0.0013	-	-	1	0.0006	-	-
F. Brachycentridae	2	0.0005	3	0.0005	4	0.0003	-	-	1	0.0001	2	0.0002	2	0.0003	-	-	-	-	1	0.0003
F. Glossosomatidae	3	0.0033	19	0.0270	3	0.0010	2	0.0010	-	-	1	0.0003	10	0.0027	2	0.0008	2	0.0022	4	0.0019
F. Hydropsychidae	12	0.0199	11	0.4666	16	0.2013	1	0.0019	-	-	-	-	7	0.0479	-	-	-	-	1	0.0038
F. Limnephilidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Rhyacophilidae	65	0.1628	41	0.2243	61	0.2313	25	0.0883	19	0.1037	7	0.0213	19	0.1216	5	0.0887	6	0.0833	8	0.0415
F. Uenoidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES																				
O. Diptera																				
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	2	0.0004	-	-	1	0.0011	1	0.0012	3	0.0012	3	0.0031	6	0.0025	10	0.0012	4	0.0005	3	0.0007
F. Chironomidae	55	0.0446	13	0.0057	26	0.0203	14	0.0160	37	0.0523	19	0.0231	23	0.0403	26	0.0678	12	0.0103	17	0.0458
F. Empididae	-	-	1	0.0031	5	0.0087	1	0.0015	16	0.0219	1	0.0042	13	0.0300	4	0.0056	3	0.0032	6	0.0162
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	92	0.0587	114	0.0653	80	0.0512	55	0.0379	41	0.0176	148	0.1190	277	0.1441	79	0.0528	48	0.0337	110	0.0746
F. Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Stratiomyiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	1	0.0015	2	0.0025	1	0.0018	1	0.0002	1	0.0002	-	-	2	0.0902	3	0.0005	2	0.0004	3	0.0281
CLAMS																				
Cl. Gastropoda																				
F. Lymnaeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																				
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	365		389		477		255		209		331		620		226		131		282	
TOTAL NUMBER OF TAXA [a]	18		20		21		19		17		21		23		18		17		22	
TOTAL BIOMASS (g)		0.4780		1.2227		0.9843		0.3933		0.2678		0.3606		0.7106		0.2979		0.2282		0.5604

Notes: [a] Bold entries excluded from ta

Table B.3: **Benthic Invertebrates Biomass (g/0.1 m^2) , Fording River 2017**

Station	FOUKI-BM																				FO22-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10		1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																																								
P. Nemata	4	0.0002	8	0.0088	2	0.0100	10	0.0030	6	0.0042	-	-	-	-	-	-	3	0.0096	4	0.0011	24	0.0080	16	0.0004	8	0.0012	16	0.0082	8	0.0004	24	0.0020	2	0.0002	12	0.0068	4	0.0004	16	0.0016
FLATWORMS																																								
P. Platyhelminthes																																								
Cl. Turbellaria																																								
F. Planariidae	6	0.0160	-	-	-	-	2	0.0056	1	0.0005	-	-	-	-	2	0.0025	2	0.0104	4	0.0103	28	0.0380	28	0.0276	36	0.0812	20	0.0262	40	0.0700	12	0.0312	6	0.0068	60	0.1368	28	0.0420	20	0.0304
ANNELIDS																																								
P. Annelida																																								
WORMS																																								
Cl. Oligochaeta																																								
F. Enchytraeidae	2	0.0002	-	-	2	0.0002	2	0.0004	1	0.0003	-	-	2	0.0012	3	0.0056	1	0.0003	-	-	4	0.0036	4	0.0012	-	-	2	0.0008	-	-	-	-	-	-	-	-	-	-	-	-
F. Lumbricidae	-	-	-	-	-	-	2	0.1172	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0086	-	-	-	-	-	-
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	2	0.0002	2	0.0019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140	0.0188	400	0.0492	104	0.0204	50	0.0110	60	0.0100	56	0.0036	16	0.0024	60	0.0112	28	0.0036	8	0.0012
ARTHROPODS																																								
MITES																																								
Cl. Arachnida																																								
Subcl. Acari	10	0.0018	17	0.0049	6	0.0010	2	0.0002	2	0.0011	28	0.0074	10	0.0016	8	0.0032	7	0.0028	5	0.0007	64	0.0124	4	0.0004	56	0.0136	86	0.0196	32	0.0036	48	0.0112	48	0.0184	76	0.0196	28	0.0084	36	0.0064
SEED SHRIMPS																																								
Cl. Ostracoda	24	0.0052	19	0.0056	4	0.0006	8	0.0004	2	0.0001	20	0.0038	8	0.0018	14	0.0050	21	0.0069	32	0.0095	-	-	-	-	-	-	2	0.0022	-	-	-	-	2	0.0002	-	-	4	0.0004	-	-
INSECTS																																								
Cl. Insecta																																								
BEETLES																																								
O. Coleoptera																																								
F. Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	520	0.4428	536	0.4648	348	0.3016	528	0.5602	660	0.7056	672	0.5684	108	0.1342	504	0.4004	528	0.6204	352	0.3552
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.0052	-	-	-	-	-	-	-	-	-	-
MAYFLIES																																								
O. Ephemeroptera																																								
F. Ameletidae	6	0.0018	16	0.0074	-	-	-	-	-	-	6	0.0254	4	0.0014	1	0.0022	13	0.0092	5	0.0006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Baetidae	24	0.0582	2	0.0102	20	0.0424	42	0.0940	10	0.0213	22	0.0626	14	0.0542	17	0.0394	5	0.0103	19	0.0700	16	0.1024	8	0.0260	12	0.0092	6	0.0534	4	0.0080	4	0.0444	8	0.0424	12	0.0820	16	0.0836	8	0.0408
F. Ephemerellidae	8	0.0422	4	0.0114	6	0.0150	14	0.0346	6	0.0251	6	0.0120	12	0.0382	4	0.0066	4	0.0155	7	0.0186	16	0.0232	8	0.0184	12	0.0120	10	0.0334	8	0.0160	8	0.0356	4	0.0108	20	0.0548	8	0.0124	16	0.0500
F. Heptageniidae	106	0.1132	48	0.0224	154	0.1218	162	0.2790	94	0.1438	132	0.0914	168	0.2386	99	0.0636	134	0.0800	168	0.2308	16	0.0020	36	0.0108	8	0.0040	26	0.0164	52	0.0168	56	0.0444	20	0.0116	40	0.0256	96	0.0392	12	0.0068
STONEFLIES																																								
O. Plecoptera																																								
F. Capniidae	6	0.0060	2	0.0020	12	0.0090	20	0.0182	6	0.0049	2	0.0022	10	0.0072	3	0.0030	1	0.0019	33	0.0403	-	-	8	0.0076	-	-	4	0.0082	24	0.0728	4	0.0128	10	0.0054	4	0.0016	16	0.0164	-	-
F. Chloroperlidae	-	-	-	-	-	-	2	0.0008	-	-	-	-	-	-	-	-	-	-	-	-	20	0.0136	8	0.0032	-	-	-	-	4	0.0004	-	-	8	0.0020	4	0.0024	28	0.0440	16	0.0240
F. Leuctridae	-	-	-	-	-	-	-	-	1	0.0004	-	-	-	-	1	0.0014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0.0128	-	-
F. Nemouridae	32	0.0172	1	0.0002	6	0.0014	96	0.0694	34	0.0266	6	0.0022	16	0.0084	5	0.0018	5	0.0066	51	0.0357	40	0.0596	80	0.0296	84	0.0388	102	0.0678	204	0.1284	516	0.3316	72	0.0502	424	0.2088	520	0.2548	348	0.1504
F. Perlidae	2	0.0376	-	-	2	0.0516	-	-	1	0.0006	-	-	-	-	-	-	-	-	1	0.0004	12	0.0156	12	0.0260	12	0.0068	6	0.0088	-	-	-	-	-	-	-	-	16	0.0160	4	0.0020
F. Perlodidae	6	0.0050	3	0.0023	8	0.0040	76	0.1048	22	0.0202	18	0.0126	27	0.0620	12	0.0201	8	0.0971	32	0.2225	104	0.0096	164	0.1744	92	0.1208	152	0.1548	188	0.2140	192	0.2112	158	0.1640	136	0.1268	344	0.4888	222	0.2568
F. Peltoperlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	-	-	1	0.0002	8	0.0012	6	0.0006	5	0.0017	4	0.0010	2	0.0004	1	0.0002	-	-	2	0.0002	8	0.0040	16	0.0056	8	0.0024	-	-	-	-	4	0.0012	4	0.0002	8	0.0028	16	0.0048	16	0.0052
BUGS																																								
O. Hemiptera																																								
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																																								
O. Trichoptera																																								
F. Apataniidae	2	0.0016	1	0.0008	-	-	-	-	1	0.0001	-	-	-	-	2	0.0037	2	0.0032	-	-	-	-	-	-	-	-	8	0.0064	4	0.0036	8	0.0012	2	0.0136	-	-	-	-	-	-
F. Brachycentridae	2	0.0004	-	-	-	-	14	0.0004	7	0.0009	-	-	6	0.0008	1	0.0002	-	-	5	0.0004	-	-	-	-	-	-	4	0.0004	-	-	-	-	-	-	4	0.0016	4	0.0008	-	-
F. Glossosomatidae	6	0.0022	2	0.0012	12	0.0080	12	0.0094	4	0.0020	6	0.0022	68	0.0536	11	0.0050	16	0.0074	5	0.0088	84	0.0292	36	0.0124	-	-	46	0.0092	8	0.0004	4	0.0008	6	0.0010	8	0.0032	8	0.0028	-	-
F. Hydropsychidae	-	-	-	-	6	0.0322	63	0.7764	20	0.1000	-	-	24	0.0494	2	0.0073	2	0.0060	12	0.1379	8	0.0068	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae	-	-	1	0.3849	-	-	-	-	-	-	1	0.3765	-	-	-	-	-	-	-	-	24	0.0060	8	0.0016	116	0.0288	54	0.0122	116	0.0372	124	0.0368	78	0.0210	100	0.0236	56	0.0184	56	0.0104
F. Rhyacophilidae	28	0.0720	3	0.0007	6	0.0176	16	0.1796	11	0.1021	6	0.0684	6	0.1070	18	0.2083	2	0.0114	2	0.0014	60	0.4024	68	0.6908	24	0.3380	26	0.2680	32	0.5248	36	0.1052	12	0.1434	41	0.2653	100	0.8120	78	0.7682
F. Uenoidae	-	-	1	0.0003	-	-	-	-	-	-	4	0.0010	4	0.0008	-	-	-	-	1	0.0001	4	0.0020	8	0.0020	100	0.0108	24	0.0026	12	0.0020	60	0.0104	8	0.0012	52	0.0072	12	0.0020	40	0.1576
TRUE FLIES																																								
O. Diptera																																								
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	-	-	2	0.0009	-	-	-	-	6	0.0023	4	0.0012	-	-	3	0.0024	1	0.0018	1	0.0004	4	0.0016	4	0.0004	-	-	-	-	-	-	-	-	-	-	8	0.0056	4	0.0024	-	-
F. Chironomidae	56	0.0508	22	0.0167	28	0.0452	32	0.0714	31	0.0442	56	0.0576	30	0.0590	38	0.0267	16	0.0304	38	0.0485	216	0.1364	280	0.2140	236	0.1332	194	0.1264	244	0.1816	368	0.2552	186	0.1370	220	0.1356	296	0.2264	364	0.2432
F. Empididae	6	0.0100	4	0.0078	-	-	-	-	1	0.0023	8	0.0134	-	-	-	-	10	0.0251	1	0.0011	20	0.0208	12	0.0096	40	0.0596	16	0.0314	4	0.0052	16	0.0308	2	0.0018	16	0.0260	8	0.0076	12	0.0188
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.0064	-	-	4	0.0272	-	-	-	-
F. Psychodidae	394	0.4640	139	0.1781	278	0.2738	172	0.1888	302	0.3287	244	0.2730	202	0.2154	220	0.2578	204	0.1842	184	0.1956	4	0.0008	-	-	24	0.0052	2	0.0046	-	-	-	-	4	0.0008	32	0.0164	12	0.0020	24	0.0056
F. Simuliidae	-	-	1	0.0013	-	-	4	0.0024	-	-	2	0.0012	2	0.0038	-	-	-	-	-	-	-	-	12	0.0088	-	-	-	-	-	-	-	-	-	-	-	-	20	0.0812	12	0.0484
F. Stratiomyiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	6	0.0122	1	0.0014	-	-	2	0.0440	4	0.0040	-	-	2	0.0004	-	-	-	-	1	0.3281	32	0.0440	8	0.0044	26	0.6627	28	0.0334	5	2.8264	8	0.0016	20	4.5708	13	0.2229	18	0.9613	12	0.0064
CLAMS																																								
Cl. Gastropoda																																								
F. Lymnaeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																																								
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	0.0348	8	0.0072	12	0.0056	10	0.0264	-	-	16	0.0024	12	0.0196	16	0.0096	16	0.0232	-	-
TOTAL NUMBER OF ORGANISMS	738		300		560		759		578		575		617		465		457		613		1492		1772		1358		1422		1713		2240		798		1874		2242		1672	
TOTAL NUMBER OF TAXA [a]	22		23		17		22		24		19		20		21		20		23		25		25		20		25		21		22		25		25		28		21	
TOTAL BIOMASS (g)		0.9180		0.6714		0.6350		2.0006		0.8374		1.0151		0.9052		0.6660		0.5201		1.3630		1.4384		1.7964		1.8559		1.4920		4.8324		1.7484		5.3676		1.8238		3.7881		2.1894

Notes: [a] Bold entries excluded from ta

Table B.3: **Benthic Invertebrates Biomass (g/0.1 m^2) , Fording River 2017**

Station	FRCP1SW-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																				
P. Nemata	4	0.0024	9	0.0012	4	0.0002	1	0.0002	6	0.0026	6	0.0052	2	0.0006	2	0.0015	2	0.0001	3	0.0001
FLATWORMS																				
P. Platyhelminthes																				
Cl. Turbellaria																				
F. Planariidae	-	-	1	0.0007	2	0.0006	2	0.0055	2	0.0072	2	0.0116	-	-	1	0.0017	1	0.0017	-	-
ANNELIDS																				
P. Annelida																				
WORMS																				
Cl. Oligochaeta																				
F. Enchytraeidae	26	0.0046	5	0.0009	4	0.0008	7	0.0021	1	0.0002	4	0.0006	8	0.0018	5	0.0016	2	0.0007	9	0.0012
F. Lumbricidae	-	-	1	0.0794	-	-	1	0.0023	1	0.0019	-	-	-	-	-	-	-	-	-	-
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS																				
MITES																				
Cl. Arachnida																				
Subcl. Acari	36	0.0088	16	0.0045	40	0.0086	21	0.0056	76	0.0153	34	0.0068	21	0.0071	12	0.0036	5	0.0023	6	0.0006
SEED SHRIMPS																				
Cl. Ostracoda	12	0.0026	2	0.0002	-	-	2	0.0005	-	-	-	-	1	0.0003	-	-	-	-	2	0.0001
INSECTS																				
Cl. Insecta																				
BEETLES																				
O. Coleoptera																				
F. Dytiscidae	2	0.0034	-	-	-	-	1	0.0043	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	12	0.0044	2	0.0007	-	-	2	0.0005	2	0.0004	2	0.0016	-	-	-	-	-	-	-	-
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES																				
O. Ephemeroptera																				
F. Ameletidae	-	-	-	-	-	-	-	-	-	-	4	0.0662	1	0.0197	2	0.0259	2	0.0025	5	0.0038
F. Baetidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0028
F. Ephemerellidae	4	0.0262	1	0.0056	4	0.0086	1	0.0028	1	0.0044	-	-	8	0.0288	-	-	3	0.0147	-	-
F. Heptageniidae	24	0.0086	3	0.0008	70	0.0220	4	0.0010	31	0.0295	64	0.0274	37	0.0136	23	0.0189	2	0.0013	1	0.0003
STONEFLIES																				
O. Plecoptera																				
F. Capniidae	20	0.0042	2	0.0001	14	0.0048	3	0.0005	4	0.0024	6	0.0028	1	0.0004	2	0.0016	5	0.0015	9	0.0051
F. Chloroperlidae	2	0.0016	-	-	2	0.0036	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Leuctridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Nemouridae	36	0.0082	7	0.0030	140	0.0406	11	0.0038	39	0.0154	76	0.0246	72	0.0192	37	0.0140	3	0.0085	-	-
F. Perlidae	-	-	-	-	-	-	-	-	11	0.2161	-	-	1	0.0277	-	-	-	-	-	-
F. Perlodidae	54	0.0908	6	0.0022	66	0.2144	7	0.0032	101	0.0681	85	0.0955	89	0.0892	21	0.0262	6	0.0562	5	0.0121
F. Peltoperlidae	-	-	-	-	2	0.0006	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	2	0.0002	-	-	-	-	-	-	5	0.0024	-	-	1	0.0001	-	-	-	-	-	-
BUGS																				
O. Hemiptera																				
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																				
O. Trichoptera																				
F. Apataniidae	-	-	13	0.0095	10	0.0082	2	0.0010	-	-	26	0.0120	5	0.0019	6	0.0030	7	0.0036	2	0.0006
F. Brachycentridae	-	-	1	0.0001	-	-	-	-	2	0.0002	-	-	-	-	-	-	-	-	-	-
F. Glossosomatidae	-	-	-	-	2	0.0008	-	-	6	0.0132	-	-	3	0.0008	2	0.0004	-	-	-	-
F. Hydropsychidae	-	-	-	-	-	-	-	-	3	0.0635	-	-	4	0.0686	-	-	-	-	-	-
F. Limnephilidae	-	-	-	-	-	-	-	-	-	-	4	0.0008	-	-	-	-	-	-	-	-
F. Rhyacophilidae	12	0.0316	1	0.0196	2	0.0002	2	0.0003	15	0.0570	4	0.0250	8	0.0651	1	0.0105	-	-	2	0.0001
F. Uenoidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES																				
O. Diptera																				
indeterminate	12	0.0034	1	0.0001	-	-	1	0.0002	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	4	0.0002	-	-	2	0.0006	1	0.0003	2	0.0007	-	-	-	-	-	-	1	0.0011	3	0.0012
F. Chironomidae	92	0.0244	26	0.0079	30	0.0092	41	0.0204	30	0.0169	24	0.0080	13	0.0103	9	0.0073	32	0.0265	28	0.0178
F. Empididae	6	0.0212	2	0.0029	16	0.0116	4	0.0027	3	0.0040	-	-	2	0.0019	-	-	2	0.0022	7	0.0054
F. Pelecorhyncidae	-	-	-	-	-	-	1	0.0002	-	-	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	180	0.0950	34	0.0168	22	0.0070	157	0.0604	21	0.0073	64	0.0318	18	0.0051	39	0.0208	27	0.0107	49	0.0304
F. Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Stratiomyiidae	-	-	1	0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	6	0.0134	2	0.0107	10	0.0040	11	0.0501	2	0.0005	5	0.2505	1	0.0001	2	0.0019	2	0.0036	4	0.0123
CLAMS																				
Cl. Gastropoda																				
F. Lymnaeidae	2	0.0034	1	0.1114	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																				
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	548		137		442		283		364		410		296		164		102		137	
TOTAL NUMBER OF TAXA [a]	21		22		19		22		22		16		20		15		16		16	
TOTAL BIOMASS (g)		0.3586		0.2786		0.3464		0.1679		0.5292		0.5704		0.3623		0.1389		0.1372		0.0939

Station	FRUPO-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																				
P. Nemata	2	0.0002	4	0.0024	4	0.0020	16	0.0156	4	0.0040	-	-	4	0.0040	2	0.0002	-	-	6	0.0014
FLATWORMS																				
P. Platyhelminthes																				
Cl. Turbellaria																				
F. Planariidae	2	0.0028	4	0.0128	4	0.0100	12	0.0188	-	-	2	0.0006	4	0.0052	2	0.0010	4	0.0020	-	-
ANNELIDS																				
P. Annelida																				
WORMS																				
Cl. Oligochaeta																				
F. Enchytraeidae	-	-	-	-	-	-	-	-	-	-	6	0.0016	4	0.0020	4	0.0006	-	-	4	0.0012
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0044	-	-	-	-
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	-	-	-	-	-	-	-	-	8	0.0028	-	-	-	-	-	-	-	-	-	-
ARTHROPODS																				
MITES																				
Cl. Arachnida																				
Subcl. Acari	40	0.0104	40	0.0140	124	0.0252	36	0.0088	148	0.0380	80	0.0288	60	0.0208	22	0.0084	28	0.0080	18	0.0058
SEED SHRIMPS																				
Cl. Ostracoda	8	0.0008	16	0.0076	-	-	-	-	-	-	-	-	4	0.0048	24	0.0068	76	0.0184	10	0.0026
INSECTS																				
Cl. Insecta																				
BEETLES																				
O. Coleoptera																				
F. Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	-	-	-	-	-	-	4	0.0060	8	0.0092	14	0.0122	12	0.0100	6	0.0066	4	0.0004	4	0.0070
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES																				
O. Ephemeroptera																				
F. Ameletidae	2	0.0428	8	0.1336	4	0.0804	-	-	4	0.0880	14	0.1980	4	0.0964	2	0.0388	8	0.0896	2	0.0366
F. Baetidae	-	-	-	-	4	0.0248	-	-	-	-	-	-	4	0.0420	-	-	-	-	-	-
F. Ephemerellidae	10	0.0064	8	0.0072	36	0.1304	12	0.0156	4	0.0352	22	0.0496	16	0.0784	8	0.0164	12	0.0596	4	0.0080
F. Heptageniidae	88	0.0330	76	0.0316	176	0.1008	40	0.0112	40	0.0288	44	0.0254	52	0.0188	24	0.0086	32	0.0084	16	0.0060
STONEFLIES																				
O. Plecoptera																				
F. Capniidae	26	0.0164	108	0.0128	24	0.0328	-	-	20	0.0012	22	0.0238	8	0.0024	22	0.0042	36	0.0140	46	0.0152
F. Chloroperlidae	8	0.0088	12	0.0128	60	0.0708	48	0.0696	4	0.0012	4	0.0030	16	0.0144	10	0.0092	16	0.0080	16	0.0132
F. Leuctridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Nemouridae	64	0.0240	96	0.0596	148	0.0904	88	0.0324	24	0.0524	14	0.0042	68	0.0212	12	0.0090	16	0.0068	18	0.0066
F. Perlidae	6	0.0970	-	-	-	-	4	0.1236	-	-	-	-	-	-	-	-	-	-	-	-
F. Perlodidae	348	0.3284	380	0.4116	716	0.7372	636	0.8904	416	0.4420	220	0.2888	388	0.3904	54	0.0344	52	0.0300	36	0.0692
F. Peltoperlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	-	-	-	-	-	-	4	0.0004	-	-	-	-	-	-	-	-	-	-	-	-
BUGS																				
O. Hemiptera																				
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																				
O. Trichoptera																				
F. Apataniidae	62	0.1568	148	0.3020	88	0.1568	20	0.0644	68	0.1672	40	0.0806	184	0.3736	110	0.1206	212	0.2860	54	0.0704
F. Brachycentridae	2	0.0002	4	0.0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0002
F. Glossosomatidae	-	-	4	0.0016	16	0.0688	36	0.0748	20	0.0132	2	0.0004	20	0.0072	2	0.0278	-	-	-	-
F. Hydropsychidae	-	-	-	-	-	-	4	0.0112	-	-	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae	4	0.0010	4	0.0008	-	-	-	-	4	0.0004	2	0.0004	8	0.0016	2	0.0002	-	-	2	0.0006
F. Rhyacophilidae	30	0.0914	36	0.0544	40	0.3476	40	0.5032	32	0.1272	58	0.0816	60	0.6344	20	0.1178	8	0.0284	8	0.0420
F. Uenoidae	-	-	4	0.0008	16	0.0040	-	-	-	-	2	0.0006	12	0.0032	2	0.0002	-	-	2	0.0002
TRUE FLIES																				
O. Diptera																				
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	-	-	-	-	-	-	-	-	4	0.0004	2	0.0010	4	0.0032	-	-	-	-	8	0.0020
F. Chironomidae	326	0.2102	328	0.2260	180	0.1452	316	0.2816	476	0.4360	196	0.0918	76	0.1516	74	0.1882	196	0.1360	210	0.3204
F. Empididae	14	0.0320	8	0.0192	12	0.0312	-	-	16	0.0208	14	0.0210	24	0.0440	4	0.0058	-	-	8	0.0078
F. Pelecorhyncidae	2	0.0002	-	-	-	-	-	-	-	-	-	-	4	0.0464	8	0.0912	-	-	4	0.0318
F. Psychodidae	44	0.0142	60	0.0344	8	0.0044	12	0.0024	28	0.0080	42	0.0220	52	0.0412	39	0.0180	76	0.0172	44	0.0082
F. Simuliidae	-	-	4	0.0160	-	-	116	0.4884	8	0.0348	2	0.0014	-	-	-	-	-	-	-	-
F. Stratiomyiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	4	0.0088	12	2.3822	11	0.7049	4	0.9580	13	0.3156	13	0.8638	10	0.5617	12	0.3661	37	2.2977	21	0.3899
CLAMS																				
Cl. Gastropoda																				
F. Lymnaeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																				
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	1092		1364		1671		1448		1349		815		1098		467		813		543	
TOTAL NUMBER OF TAXA [a]	21		22		19		19		21		22		25		24		16		23	
TOTAL BIOMASS (g)		1.0858		3.7442		2.7677		3.5764		1.8264		1.8006		2.5789		1.0845		3.0105		1.0463

Notes: [a] Bold entries excluded from ta

Table B.3: Benthic Invertebrates Biomass (g/0.1 m^2) , Fording River 2017

Station	HENUP-BM																			
Replicate	1		2		3		4		5		6		7		8		9		10	
ROUNDWORMS																				
P. Nemata	4	0.0002	-	-	-	-	-	-	-	-	1	0.0002	4	0.0036	-	-	2	0.0001	-	-
FLATWORMS																				
P. Platyhelminthes																				
Cl. Turbellaria																				
F. Planariidae	2	0.0010	6	0.0334	-	-	-	-	-	-	1	0.0019	4	0.0096	-	-	1	0.0003	-	-
ANNELIDS																				
P. Annelida																				
WORMS																				
Cl. Oligochaeta																				
F. Enchytraeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS																				
MITES																				
Cl. Arachnida																				
Subcl. Acari	6	0.0002	10	0.0078	2	0.0008	-	-	8	0.0006	4	0.0011	2	0.0014	2	0.0004	5	0.0014	2	0.0006
SEED SHRIMPS																				
Cl. Ostracoda	-	-	2	0.0004	-	-	-	-	-	-	3	0.0005	-	-	-	-	-	-	4	0.0004
INSECTS																				
Cl. Insecta																				
BEETLES																				
O. Coleoptera																				
F. Dytiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Elmidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES																				
O. Ephemeroptera																				
F. Ameletidae	10	0.0020	2	0.0002	4	0.0006	-	-	2	0.0004	16	0.0162	-	-	2	0.0028	1	0.0083	8	0.0016
F. Baetidae	2	0.0062	2	0.0008	-	-	-	-	2	0.0002	-	-	-	-	2	0.0008	-	-	-	-
F. Ephemerellidae	64	0.0124	34	0.0384	20	0.0044	60	0.0710	28	0.1726	26	0.0177	58	0.0138	18	0.0062	124	0.0425	46	0.0092
F. Heptageniidae	528	0.7618	364	0.3532	242	0.2114	364	0.4490	526	0.9620	116	0.1511	778	0.7924	402	0.6024	310	0.3802	684	0.8562
STONEFLIES																				
O. Plecoptera																				
F. Capniidae	12	0.0136	8	0.0026	10	0.0066	2	0.0006	2	0.0014	3	0.0005	4	0.0010	2	0.0006	10	0.0038	10	0.0044
F. Chloroperlidae	52	0.0742	18	0.0318	22	0.0148	72	0.0480	98	0.1532	21	0.0318	104	0.1954	82	0.2142	49	0.0666	98	0.1910
F. Leuctridae	-	-	8	0.0068	-	-	4	0.0032	2	0.0008	1	0.0001	10	0.0054	2	0.0004	6	0.0022	6	0.0008
F. Nemouridae	18	0.0212	26	0.0674	6	0.0196	2	0.0092	24	0.0790	6	0.0151	16	0.0616	18	0.0676	6	0.0103	14	0.0364
F. Perlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Perlodidae	4	0.1462	8	0.3134	4	0.1640	4	0.0552	8	0.2702	9	0.3206	8	0.1908	18	0.9354	4	0.0889	12	0.5668
F. Peltoperlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	122	0.0510	98	0.0316	34	0.0160	180	0.0474	140	0.0592	35	0.0075	84	0.0240	36	0.0114	39	0.0124	92	0.0232
BUGS																				
O. Hemiptera																				
F. Corixidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES																				
O. Trichoptera																				
F. Apataniidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Brachycentridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Glossosomatidae	6	0.0042	8	0.0444	4	0.0034	4	0.0234	8	0.0314	1	0.0019	8	0.0400	6	0.0086	5	0.0257	10	0.0454
F. Hydropsychidae	14	0.0030	18	0.0044	6	0.0022	4	0.0016	30	0.3542	1	0.0003	-	-	8	0.0018	3	0.2032	10	0.2478
F. Limnephilidae	-	-	-	-	2	0.0352	-	-	-	-	-	-	2	0.0004	-	-	-	-	-	-
F. Rhyacophilidae	4	0.0006	4	0.0818	-	-	6	0.0064	6	0.0030	-	-	6	0.0746	-	-	9	0.0113	-	-
F. Uenoidae	-	-	-	-	-	-	8	0.0004	-	-	13	0.0009	46	0.0024	8	0.0006	18	0.0008	32	0.0014
TRUE FLIES																				
O. Diptera																				
indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ceratopogonidae	2	0.0004	2	0.0010	-	-	2	0.0030	2	0.0010	-	-	4	0.0020	2	0.0018	-	-	4	0.0024
F. Chironomidae	190	0.0510	28	0.0196	34	0.0236	8	0.0130	42	0.0152	16	0.0072	48	0.0168	6	0.0088	26	0.0190	52	0.0306
F. Empididae	4	0.0174	18	0.0766	6	0.0208	12	0.0506	4	0.0098	1	0.0016	4	0.0112	4	0.0158	4	0.0098	8	0.0224
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	2	0.0006	2	0.0028	-	-	-	-	-	-	-	-	10	0.0042	2	0.0004	1	0.0003	2	0.0004
F. Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Stratiomyiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	-	-	-	-	2	0.0014	-	-	-	-	-	-	2	0.0002	-	-	-	-	-	-
CLAMS																				
Cl. Gastropoda																				
F. Lymnaeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl. Bivalvia																				
F. Sphaeriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	1046		666		398		732		932		274		1202		620		623		1094	
TOTAL NUMBER OF TAXA [a]	19		20		15		15		17		18		20		18		19		18	
TOTAL BIOMASS (g)		1.1672		1.1184		0.5248		0.7820		2.1142		0.5762		1.4508		1.8800		0.8871		2.0410

Notes: [a] Bold entries excluded from ta

MINNOW ENVIRONMENTAL INC.
ATTN: Shari Weech/Tyrell Worrall
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 18-SEP-17
Report Date: 29-SEP-17 16:22 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1993056

Project P.O. #: NOT SUBMITTED

Job Reference: 17-22

C of C Numbers:

Legal Site Desc:

Comments: ADDITIONAL 27-SEP-17 10:48
ADDITIONAL 27-SEP-17 10:08

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1993056-1 SEDIMENT 14-SEP-17 FOBCP - SED - 01	L1993056-2 SEDIMENT 14-SEP-17 FOBCP - SED - 02	L1993056-3 SEDIMENT 14-SEP-17 FOBCP - SED - 03	L1993056-4 SEDIMENT 14-SEP-17 FOBCP - SED - 04	L1993056-5 SEDIMENT 14-SEP-17 FOBCP - SED - 05
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	49.9	45.9	49.8	53.8	46.1
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	1.3	2.3	1.7	1.4	2.9
	% Sand (0.50mm - 0.25mm) (%)	7.9	15.2	14.5	11.0	7.7
	% Sand (0.25mm - 0.125mm) (%)	23.7	24.0	18.6	19.9	22.4
	% Sand (0.125mm - 0.063mm) (%)	12.8	10.9	7.4	10.3	11.3
	% Silt (0.063mm - 0.0312mm) (%)	20.5	20.0	24.2	24.5	24.7
	% Silt (0.0312mm - 0.004mm) (%)	26.6	23.0	28.8	28.7	27.0
	% Clay (<4um) (%)	7.0	4.2	4.6	4.0	3.3
	Texture	Sandy loam	Sandy loam	Silt loam	Silt loam	Silt loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	6.39	6.31	7.43	6.7	7.18
Metals	Aluminum (Al) (mg/kg)	8760	8180	5600	4680	6140
	Antimony (Sb) (mg/kg)	0.64	0.67	0.48	0.41	0.52
	Arsenic (As) (mg/kg)	4.78	5.06	3.66	3.18	3.95
	Barium (Ba) (mg/kg)	257	222	174	172	175
	Beryllium (Be) (mg/kg)	0.64	0.60	0.56	0.41	0.61
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	9.8	8.8	7.2	5.9	7.9
	Cadmium (Cd) (mg/kg)	2.13	1.49	1.30	1.36	1.31
	Calcium (Ca) (mg/kg)	108000	69900	85600	124000	78300
	Chromium (Cr) (mg/kg)	14.3	13.1	8.17	8.04	9.43
	Cobalt (Co) (mg/kg)	6.70	6.30	5.11	4.62	5.34
	Copper (Cu) (mg/kg)	14.5	14.0	11.7	10.3	12.1
	Iron (Fe) (mg/kg)	13400	14400	11100	9720	11600
	Lead (Pb) (mg/kg)	8.32	8.97	6.89	5.97	7.15
	Lithium (Li) (mg/kg)	12.2	10.7	8.8	8.0	9.7
	Magnesium (Mg) (mg/kg)	16700	13300	10700	11300	12500
	Manganese (Mn) (mg/kg)	765	618	612	638	550
	Mercury (Hg) (mg/kg)	0.0341	0.0347	0.0418	0.0284	0.0320
	Molybdenum (Mo) (mg/kg)	1.52	1.49	1.14	0.94	1.16
	Nickel (Ni) (mg/kg)	70.4	53.2	55.2	56.3	46.7
	Phosphorus (P) (mg/kg)	1400	1760	1160	1100	1190
	Potassium (K) (mg/kg)	2260	2120	1380	1180	1530
	Selenium (Se) (mg/kg)	4.99	2.68	2.40	2.18	2.11
	Silver (Ag) (mg/kg)	0.21	0.18	0.15	0.13	0.15
	Sodium (Na) (mg/kg)	104	87	78	78	76

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-6	L1993056-7	L1993056-8	L1993056-9	L1993056-10
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17
	Sampled Time					
	Client ID	FO22 - SED - 01	FO22 - SED - 02	FO22 - SED - 03	FO22 - SED - 04	FO22 - SED - 05
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	43.8	39.2	35.8	48.5	37.7
Particle Size	% Gravel (>2mm) (%)	<1.0	6.6	1.3	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	1.1	1.4	2.2	2.2	2.9
	% Sand (0.50mm - 0.25mm) (%)	4.0	9.6	20.4	10.0	17.1
	% Sand (0.25mm - 0.125mm) (%)	10.6	25.0	41.2	14.8	31.6
	% Sand (0.125mm - 0.063mm) (%)	5.7	16.8	17.1	11.9	14.6
	% Silt (0.063mm - 0.0312mm) (%)	33.2	18.9	8.5	26.6	15.5
	% Silt (0.0312mm - 0.004mm) (%)	38.8	18.6	6.9	29.9	15.4
	% Clay (<4um) (%)	6.3	2.4	1.9	4.5	2.8
	Texture	Silt loam	Sandy loam	Loamy sand	Silt loam	Sandy loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	7.83	5.51	4.66	9.61	4.82
Metals	Aluminum (Al) (mg/kg)	6750	7570	8400	7060	6880
	Antimony (Sb) (mg/kg)	0.51	0.61	0.68	0.63	0.59
	Arsenic (As) (mg/kg)	4.77	5.08	5.70	5.21	4.97
	Barium (Ba) (mg/kg)	174	197	228	189	173
	Beryllium (Be) (mg/kg)	0.49	0.73	0.87	0.58	0.64
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	6.8	7.8	9.0	7.5	6.3
	Cadmium (Cd) (mg/kg)	0.992	1.08	1.12	1.30	1.05
	Calcium (Ca) (mg/kg)	40500	41600	37400	35900	35700
	Chromium (Cr) (mg/kg)	12.8	12.3	13.3	12.1	11.4
	Cobalt (Co) (mg/kg)	4.60	5.84	6.54	6.15	5.67
	Copper (Cu) (mg/kg)	11.1	13.0	13.8	14.6	11.6
	Iron (Fe) (mg/kg)	12500	14500	17600	14200	14200
	Lead (Pb) (mg/kg)	6.99	8.43	9.38	8.33	8.03
	Lithium (Li) (mg/kg)	8.7	9.7	10.5	9.1	8.9
	Magnesium (Mg) (mg/kg)	12900	10900	10700	9550	11000
	Manganese (Mn) (mg/kg)	317	364	488	598	490
	Mercury (Hg) (mg/kg)	0.0326	0.0343	0.0303	0.0406	0.0276
	Molybdenum (Mo) (mg/kg)	1.15	1.36	1.68	1.41	1.34
	Nickel (Ni) (mg/kg)	23.8	26.1	27.6	29.1	24.6
	Phosphorus (P) (mg/kg)	1380	1640	1830	1350	1620
	Potassium (K) (mg/kg)	1730	1930	2180	1810	1690
	Selenium (Se) (mg/kg)	2.88	2.48	2.07	2.44	1.83
	Silver (Ag) (mg/kg)	0.14	0.17	0.16	0.19	0.15
	Sodium (Na) (mg/kg)	79	80	82	78	76

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1993056-11 SEDIMENT 15-SEP-17 FRUPO - SED - 01	L1993056-12 SEDIMENT 15-SEP-17 FRUPO - SED - 02	L1993056-13 SEDIMENT 15-SEP-17 FRUPO - SED - 03	L1993056-14 SEDIMENT 15-SEP-17 FRUPO - SED - 04	L1993056-15 SEDIMENT 15-SEP-17 FRUPO - SED - 05
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	43.5	48.0	59.3	49.9	46.7
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (0.50mm - 0.25mm) (%)	7.4	2.1	<1.0	3.8	4.9
	% Sand (0.25mm - 0.125mm) (%)	14.1	13.3	3.2	16.7	13.3
	% Sand (0.125mm - 0.063mm) (%)	13.0	17.2	6.1	18.9	12.3
	% Silt (0.063mm - 0.0312mm) (%)	27.6	29.3	40.9	27.6	28.2
	% Silt (0.0312mm - 0.004mm) (%)	31.3	32.7	44.5	28.9	33.4
	% Clay (<4um) (%)	5.7	5.3	5.0	3.8	7.3
	Texture	Silt loam	Silt loam	Silt	Silt loam	Silt loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	7.08	7.59	9.04	5.77	5.68
Metals	Aluminum (Al) (mg/kg)	6170	7490	6260	7150	7480
	Antimony (Sb) (mg/kg)	0.65	0.61	0.51	0.60	0.68
	Arsenic (As) (mg/kg)	5.02	4.89	4.15	4.83	5.23
	Barium (Ba) (mg/kg)	184	194	189	186	204
	Beryllium (Be) (mg/kg)	0.53	0.63	0.51	0.72	0.73
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	5.5	8.9	9.0	8.1	9.2
	Cadmium (Cd) (mg/kg)	1.33	1.39	1.44	1.28	1.30
	Calcium (Ca) (mg/kg)	48800	54600	55000	49900	44300
	Chromium (Cr) (mg/kg)	10.2	12.5	11.3	12.2	13.8
	Cobalt (Co) (mg/kg)	6.03	6.33	5.67	5.99	6.56
	Copper (Cu) (mg/kg)	14.2	14.5	14.4	13.4	14.8
	Iron (Fe) (mg/kg)	14000	14300	12100	14500	14600
	Lead (Pb) (mg/kg)	8.86	9.71	7.88	8.55	8.91
	Lithium (Li) (mg/kg)	9.8	11.3	9.9	10.8	11.1
	Magnesium (Mg) (mg/kg)	11700	16500	14400	14600	13900
	Manganese (Mn) (mg/kg)	451	585	504	460	541
	Mercury (Hg) (mg/kg)	0.0416	0.0421	0.0435	0.0386	0.0405
	Molybdenum (Mo) (mg/kg)	1.60	1.48	1.26	1.56	1.51
	Nickel (Ni) (mg/kg)	34.4	38.5	35.5	32.2	37.5
	Phosphorus (P) (mg/kg)	1430	1760	1350	1550	1650
	Potassium (K) (mg/kg)	1470	1880	1590	1830	1960
	Selenium (Se) (mg/kg)	3.02	2.42	3.27	3.17	2.21
	Silver (Ag) (mg/kg)	0.20	0.21	0.20	0.20	0.21
	Sodium (Na) (mg/kg)	73	94	83	90	88

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	
	Sample ID	L1993056-16
	Description	SEDIMENT
	Sampled Date	15-SEP-17
	Sampled Time	
	Client ID	FRUPO - SED - 05X
SOIL		
Physical Tests	Moisture (%)	44.2
Particle Size	% Gravel (>2mm) (%)	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0
	% Sand (1.00mm - 0.50mm) (%)	<1.0
	% Sand (0.50mm - 0.25mm) (%)	7.1
	% Sand (0.25mm - 0.125mm) (%)	18.4
	% Sand (0.125mm - 0.063mm) (%)	15.9
	% Silt (0.063mm - 0.0312mm) (%)	24.1
	% Silt (0.0312mm - 0.004mm) (%)	28.2
	% Clay (<4um) (%)	5.6
	Texture	Silt loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	5.75
Metals	Aluminum (Al) (mg/kg)	7040
	Antimony (Sb) (mg/kg)	0.61
	Arsenic (As) (mg/kg)	4.82
	Barium (Ba) (mg/kg)	195
	Beryllium (Be) (mg/kg)	0.71
	Bismuth (Bi) (mg/kg)	<0.20
	Boron (B) (mg/kg)	8.6
	Cadmium (Cd) (mg/kg)	1.19
	Calcium (Ca) (mg/kg)	42400
	Chromium (Cr) (mg/kg)	12.3
	Cobalt (Co) (mg/kg)	5.86
	Copper (Cu) (mg/kg)	13.2
	Iron (Fe) (mg/kg)	14200
	Lead (Pb) (mg/kg)	8.39
	Lithium (Li) (mg/kg)	10.5
	Magnesium (Mg) (mg/kg)	13000
	Manganese (Mn) (mg/kg)	474
	Mercury (Hg) (mg/kg)	0.0380
	Molybdenum (Mo) (mg/kg)	1.49
	Nickel (Ni) (mg/kg)	33.5
	Phosphorus (P) (mg/kg)	1510
	Potassium (K) (mg/kg)	1880
	Selenium (Se) (mg/kg)	2.00
	Silver (Ag) (mg/kg)	0.17
	Sodium (Na) (mg/kg)	89

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-1	L1993056-2	L1993056-3	L1993056-4	L1993056-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17
	Sampled Time					
	Client ID	FOBCP - SED - 01	FOBCP - SED - 02	FOBCP - SED - 03	FOBCP - SED - 04	FOBCP - SED - 05
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	89.2	77.9	68.8	71.2	64.7
	Sulfur (S) (mg/kg)	1400	<1000	1300	1600	<1000
	Thallium (Tl) (mg/kg)	0.280	0.230	0.194	0.179	0.196
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	15.4	10.3	7.8	9.0	9.3
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.13	1.09	1.01	1.03	0.961
	Vanadium (V) (mg/kg)	37.7	34.8	24.0	19.8	25.9
	Zinc (Zn) (mg/kg)	155	127	107	101	102
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	DLQ <0.066	DLQ <0.037	DLQ <0.040	DLQ <0.043	DLQ <0.030
	Acenaphthylene (mg/kg)	0.0085	0.0060	0.0052	0.0056	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	DLCI <0.0090	<0.0040	<0.0040	0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	0.040	0.021	0.023	0.024	0.017
	Benzo(a)pyrene (mg/kg)	0.025	0.013	0.014	0.014	0.011
	Benzo(b&j)fluoranthene (mg/kg)	0.083	0.047	0.048	0.050	0.035
	Benzo(e)pyrene (mg/kg)	0.086	0.045	0.048	0.050	0.035
	Benzo(g,h,i)perylene (mg/kg)	0.034	0.018	0.020	0.021	0.014
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.183	0.101	0.107	0.112	0.078
	Dibenz(a,h)anthracene (mg/kg)	0.0180	0.0092	0.0099	0.0101	0.0073
	Fluoranthene (mg/kg)	0.034	0.019	0.021	0.024	0.017
	Fluorene (mg/kg)	0.151	0.077	0.086	0.091	0.060
	Indeno(1,2,3-c,d)pyrene (mg/kg)	0.011	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.757	0.384	0.419	0.447	0.308
	2-Methylnaphthalene (mg/kg)	1.35	0.722	0.813	0.897	0.596
	Naphthalene (mg/kg)	0.358	0.191	0.233	0.267	0.175
	Perylene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Phenanthrene (mg/kg)	0.691	0.376	0.423	0.437	0.312
	Pyrene (mg/kg)	0.063	0.035	0.038	0.039	0.028
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	80.9	74.6	80.4	79.0	72.9
	Surrogate: d12-Chrysene (%)	92.7	88.0	94.5	89.7	81.1
	Surrogate: d8-Naphthalene (%)	69.6	69.3	72.0	72.0	67.9
	Surrogate: d10-Phenanthrene (%)	86.5	79.8	88.5	85.7	76.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-6	L1993056-7	L1993056-8	L1993056-9	L1993056-10
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17
	Sampled Time					
	Client ID	FO22 - SED - 01	FO22 - SED - 02	FO22 - SED - 03	FO22 - SED - 04	FO22 - SED - 05
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	56.8	64.1	73.1	67.2	64.9
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.179	0.187	0.208	0.190	0.180
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	9.5	11.2	8.1	11.4	7.1
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.899	1.04	1.13	0.918	0.937
	Vanadium (V) (mg/kg)	28.6	33.1	38.5	31.9	31.2
	Zinc (Zn) (mg/kg)	94.9	104	112	105	105
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	DLQ <0.019	DLQ <0.013	DLQ <0.011	DLQ <0.019	DLQ <0.012
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	0.011	<0.010	<0.010	0.013	<0.010
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.028	0.019	0.014	0.028	0.018
	Benzo(e)pyrene (mg/kg)	0.027	0.018	0.013	0.027	0.016
	Benzo(g,h,i)perylene (mg/kg)	0.011	<0.010	<0.010	0.010	<0.010
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.064	0.043	0.037	0.065	0.041
	Dibenz(a,h)anthracene (mg/kg)	0.0056	<0.0050	<0.0050	0.0052	<0.0050
	Fluoranthene (mg/kg)	0.012	<0.010	<0.010	0.012	<0.010
	Fluorene (mg/kg)	0.034	0.022	0.012	0.032	0.018
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.195	0.130	0.126	0.200	0.124
	2-Methylnaphthalene (mg/kg)	0.370	0.239	0.221	0.357	0.221
	Naphthalene (mg/kg)	0.109	0.073	0.073	0.108	0.071
	Perylene (mg/kg)	0.017	0.015	0.011	0.021	0.015
	Phenanthrene (mg/kg)	0.207	0.146	0.130	0.227	0.135
	Pyrene (mg/kg)	0.020	0.014	0.011	0.021	0.013
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	73.8	75.1	68.4	75.0	76.4
	Surrogate: d12-Chrysene (%)	85.2	89.1	79.8	87.9	91.0
	Surrogate: d8-Naphthalene (%)	71.2	73.2	66.6	69.6	72.8
	Surrogate: d10-Phenanthrene (%)	77.1	80.8	71.1	80.8	82.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-11	L1993056-12	L1993056-13	L1993056-14	L1993056-15
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	15-SEP-17	15-SEP-17	15-SEP-17	15-SEP-17	15-SEP-17
	Sampled Time					
	Client ID	FRUPO - SED - 01	FRUPO - SED - 02	FRUPO - SED - 03	FRUPO - SED - 04	FRUPO - SED - 05
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	65.1	63.4	57.1	63.4	65.9
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.198	0.217	0.180	0.205	0.236
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	5.9	9.6	8.9	8.9	12.8
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.08	1.07	1.05	1.07	1.10
	Vanadium (V) (mg/kg)	28.7	33.0	27.6	31.3	33.9
	Zinc (Zn) (mg/kg)	110	114	99.3	106	109
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	DLQ <0.020	DLQ <0.026	DLQ <0.031	DLQ <0.017	DLQ <0.020
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	0.012	0.016	0.019	0.012	0.015
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	0.010	<0.010	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.026	0.035	0.041	0.027	0.034
	Benzo(e)pyrene (mg/kg)	0.024	0.033	0.039	0.024	0.031
	Benzo(g,h,i)perylene (mg/kg)	<0.010	0.014	0.014	<0.010	0.012
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.059	0.078	0.094	0.060	0.076
	Dibenz(a,h)anthracene (mg/kg)	0.0054	0.0067	0.0084	0.0050	0.0065
	Fluoranthene (mg/kg)	0.010	0.016	0.019	0.012	0.014
	Fluorene (mg/kg)	0.036	0.050	0.061	0.035	0.040
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.213	0.261	0.322	0.202	0.231
	2-Methylnaphthalene (mg/kg)	0.402	0.501	0.613	0.375	0.418
	Naphthalene (mg/kg)	0.120	0.151	0.175	0.110	0.118
	Perylene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Phenanthrene (mg/kg)	0.219	0.278	0.336	0.213	0.266
	Pyrene (mg/kg)	0.019	0.027	0.030	0.019	0.026
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	77.6	73.3	77.9	70.2	76.4
	Surrogate: d12-Chrysene (%)	89.2	87.6	92.1	83.8	89.5
	Surrogate: d8-Naphthalene (%)	74.2	69.4	73.8	66.4	73.5
	Surrogate: d10-Phenanthrene (%)	81.8	78.8	83.4	75.8	82.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-16				
	Description	SEDIMENT				
	Sampled Date	15-SEP-17				
	Sampled Time					
	Client ID	FRUPO - SED - 05X				
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	60.8				
	Sulfur (S) (mg/kg)	<1000				
	Thallium (Tl) (mg/kg)	0.217				
	Tin (Sn) (mg/kg)	<2.0				
	Titanium (Ti) (mg/kg)	8.1				
	Tungsten (W) (mg/kg)	<0.50				
	Uranium (U) (mg/kg)	0.999				
	Vanadium (V) (mg/kg)	31.2				
	Zinc (Zn) (mg/kg)	101				
	Zirconium (Zr) (mg/kg)	<1.0				
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	DLQ <0.020				
	Acenaphthylene (mg/kg)	<0.0050				
	Acridine (mg/kg)	<0.010				
	Anthracene (mg/kg)	<0.0040				
	Benz(a)anthracene (mg/kg)	0.013				
	Benzo(a)pyrene (mg/kg)	<0.010				
	Benzo(b&j)fluoranthene (mg/kg)	0.030				
	Benzo(e)pyrene (mg/kg)	0.028				
	Benzo(g,h,i)perylene (mg/kg)	0.011				
	Benzo(k)fluoranthene (mg/kg)	<0.010				
	Chrysene (mg/kg)	0.067				
	Dibenz(a,h)anthracene (mg/kg)	0.0056				
	Fluoranthene (mg/kg)	0.013				
	Fluorene (mg/kg)	0.036				
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010				
	1-Methylnaphthalene (mg/kg)	0.209				
	2-Methylnaphthalene (mg/kg)	0.371				
	Naphthalene (mg/kg)	0.106				
	Perylene (mg/kg)	<0.010				
	Phenanthrene (mg/kg)	0.239				
	Pyrene (mg/kg)	0.021				
	Quinoline (mg/kg)	<0.010				
	Surrogate: d10-Acenaphthene (%)	74.8				
	Surrogate: d12-Chrysene (%)	89.8				
	Surrogate: d8-Naphthalene (%)	72.3				
	Surrogate: d10-Phenanthrene (%)	83.6				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-1	L1993056-2	L1993056-3	L1993056-4	L1993056-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17
	Sampled Time					
	Client ID	FOBCP - SED - 01	FOBCP - SED - 02	FOBCP - SED - 03	FOBCP - SED - 04	FOBCP - SED - 05
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	0.059	0.031	0.033	0.034	0.025
	IACR (CCME) (mg/kg)	0.92	0.51	0.54	0.56	0.40

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-6	L1993056-7	L1993056-8	L1993056-9	L1993056-10
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17	14-SEP-17
	Sampled Time					
	Client ID	FO22 - SED - 01	FO22 - SED - 02	FO22 - SED - 03	FO22 - SED - 04	FO22 - SED - 05
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	IACR (CCME) (mg/kg)	0.31	0.21	0.18	0.31	0.21

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-11	L1993056-12	L1993056-13	L1993056-14	L1993056-15
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	15-SEP-17	15-SEP-17	15-SEP-17	15-SEP-17	15-SEP-17
	Sampled Time					
	Client ID	FRUPO - SED - 01	FRUPO - SED - 02	FRUPO - SED - 03	FRUPO - SED - 04	FRUPO - SED - 05
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	0.026	<0.020	<0.020
	IACR (CCME) (mg/kg)	0.29	0.38	0.46	0.30	0.37

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993056-16				
	Description	SEDIMENT				
	Sampled Date	15-SEP-17				
	Sampled Time					
	Client ID	FRUPO - SED - 05X				
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020				
	IACR (CCME) (mg/kg)	0.33				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1993056-1	FOBCP - SED - 01	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-10	FO22 - SED - 05	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-11	FRUPO - SED - 01	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-12	FRUPO - SED - 02	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-13	FRUPO - SED - 03	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-14	FRUPO - SED - 04	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-15	FRUPO - SED - 05	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-16	FRUPO - SED - 05X	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-2	FOBCP - SED - 02	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-3	FOBCP - SED - 03	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-4	FOBCP - SED - 04	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-5	FOBCP - SED - 05	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-6	FO22 - SED - 01	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993056-9	FO22 - SED - 04	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Phosphorus (P)	MES	L1993056-1, -10, -11, -12, -13, -14, -15, -16, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.
DLQ	Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217

A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2

Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAA-CL	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

ALS Test Code	Matrix	Test Description	Method Reference**
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
MET-200.2-CCMS-CL	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

Reference Information

MOISTURE-CL	Soil	% Moisture	CWS for PHC in Soil - Tier 1

This analysis is carried out gravimetrically by drying the sample at 105 C

PAH-TMB-D/A-MS-CL	Soil	PAH by Tumbler Extraction (DCM/Acetone)	EPA 3570/8270

Polycyclic Aromatic Hydrocarbons in Sediment/Soil
This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of DCM and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

PSA-PIPET-DETAIL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

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

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

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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

Quality Control Report

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9
Contact: Shari Weech/Tyrell Worrall

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R3836087								
WG2620966-1 DUP		**L1993056-7**						
Inorganic Carbon		0.933	0.883		%	5.5	20	22-SEP-17
WG2620966-2 LCS								
Inorganic Carbon			104.2		%		80-120	22-SEP-17
WG2620966-3 MB								
Inorganic Carbon			<0.050		%		0.05	22-SEP-17
C-TOT-LECO-SK	**Soil**							
Batch R3836305								
WG2621048-1 DUP		**L1993056-10**						
Total Carbon by Combustion		5.72	5.68		%	0.7	20	21-SEP-17
WG2621048-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			99.6		%		80-120	21-SEP-17
WG2621048-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	21-SEP-17
HG-200.2-CVAA-CL	**Soil**							
Batch R3837366								
WG2623528-4 CRM		**TILL-1**						
Mercury (Hg)			93.8		%		70-130	25-SEP-17
WG2623528-9 CRM		**TILL-1**						
Mercury (Hg)			93.0		%		70-130	25-SEP-17
WG2623528-3 LCS								
Mercury (Hg)			105.0		%		80-120	25-SEP-17
WG2623528-8 LCS								
Mercury (Hg)			94.9		%		80-120	25-SEP-17
WG2623528-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	25-SEP-17
WG2623528-6 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	25-SEP-17
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-4 CRM		**TILL-1**						
Aluminum (Al)			122.7		%		70-130	26-SEP-17
Antimony (Sb)			114.8		%		70-130	26-SEP-17
Arsenic (As)			108.8		%		70-130	26-SEP-17
Barium (Ba)			106.7		%		70-130	26-SEP-17
Beryllium (Be)			108.5		%		70-130	26-SEP-17
Bismuth (Bi)			101.6		%		70-130	26-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-4 CRM		**TILL-1**						
Boron (B)			7.6		mg/kg		0-8.2	26-SEP-17
Cadmium (Cd)			112.5		%		70-130	26-SEP-17
Calcium (Ca)			122.3		%		70-130	26-SEP-17
Chromium (Cr)			110.2		%		70-130	26-SEP-17
Cobalt (Co)			117.8		%		70-130	26-SEP-17
Copper (Cu)			117.4		%		70-130	26-SEP-17
Iron (Fe)			113.2		%		70-130	26-SEP-17
Lead (Pb)			107.1		%		70-130	26-SEP-17
Lithium (Li)			123.8		%		70-130	26-SEP-17
Magnesium (Mg)			122.8		%		70-130	26-SEP-17
Manganese (Mn)			117.2		%		70-130	26-SEP-17
Molybdenum (Mo)			113.3		%		70-130	26-SEP-17
Nickel (Ni)			116.4		%		70-130	26-SEP-17
Phosphorus (P)			121.5		%		70-130	26-SEP-17
Potassium (K)			125.2		%		70-130	26-SEP-17
Selenium (Se)			0.38		mg/kg		0.11-0.51	26-SEP-17
Silver (Ag)			0.27		mg/kg		0.13-0.33	26-SEP-17
Sodium (Na)			127.4		%		70-130	26-SEP-17
Strontium (Sr)			127.4		%		70-130	26-SEP-17
Thallium (Tl)			0.139		mg/kg		0.077-0.18	26-SEP-17
Tin (Sn)			1.3		mg/kg		0-3.1	26-SEP-17
Titanium (Ti)			129.4		%		70-130	26-SEP-17
Tungsten (W)			0.16		mg/kg		0-0.66	26-SEP-17
Uranium (U)			109.5		%		70-130	26-SEP-17
Vanadium (V)			121.1		%		70-130	26-SEP-17
Zinc (Zn)			118.7		%		70-130	26-SEP-17
Zirconium (Zr)			1.0		mg/kg		0-1.8	26-SEP-17
WG2623528-9 CRM		**TILL-1**						
Aluminum (Al)			104.0		%		70-130	26-SEP-17
Antimony (Sb)			102.5		%		70-130	26-SEP-17
Arsenic (As)			98.8		%		70-130	26-SEP-17
Barium (Ba)			98.6		%		70-130	26-SEP-17
Beryllium (Be)			116.5		%		70-130	26-SEP-17
Bismuth (Bi)			96.0		%		70-130	26-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-9 CRM		**TILL-1**						
Boron (B)			4.7		mg/kg		0-8.2	26-SEP-17
Cadmium (Cd)			114.5		%		70-130	26-SEP-17
Calcium (Ca)			109.1		%		70-130	26-SEP-17
Chromium (Cr)			97.7		%		70-130	26-SEP-17
Cobalt (Co)			109.6		%		70-130	26-SEP-17
Copper (Cu)			106.8		%		70-130	26-SEP-17
Iron (Fe)			106.0		%		70-130	26-SEP-17
Lead (Pb)			101.5		%		70-130	26-SEP-17
Lithium (Li)			114.9		%		70-130	26-SEP-17
Magnesium (Mg)			110.5		%		70-130	26-SEP-17
Manganese (Mn)			105.1		%		70-130	26-SEP-17
Molybdenum (Mo)			119.8		%		70-130	26-SEP-17
Nickel (Ni)			102.9		%		70-130	26-SEP-17
Phosphorus (P)			107.9		%		70-130	26-SEP-17
Potassium (K)			113.9		%		70-130	26-SEP-17
Selenium (Se)			0.33		mg/kg		0.11-0.51	26-SEP-17
Silver (Ag)			0.23		mg/kg		0.13-0.33	26-SEP-17
Sodium (Na)			111.6		%		70-130	26-SEP-17
Strontium (Sr)			112.1		%		70-130	26-SEP-17
Thallium (Tl)			0.126		mg/kg		0.077-0.18	26-SEP-17
Tin (Sn)			1.1		mg/kg		0-3.1	26-SEP-17
Titanium (Ti)			114.0		%		70-130	26-SEP-17
Tungsten (W)			0.15		mg/kg		0-0.66	26-SEP-17
Uranium (U)			100.0		%		70-130	26-SEP-17
Vanadium (V)			108.7		%		70-130	26-SEP-17
Zinc (Zn)			101.4		%		70-130	26-SEP-17
Zirconium (Zr)			0.7		mg/kg		0-1.8	26-SEP-17
WG2623528-3 LCS								
Aluminum (Al)			116.6		%		80-120	26-SEP-17
Antimony (Sb)			102.5		%		80-120	26-SEP-17
Arsenic (As)			98.8		%		80-120	26-SEP-17
Barium (Ba)			97.1		%		80-120	26-SEP-17
Beryllium (Be)			100.7		%		80-120	26-SEP-17
Bismuth (Bi)			95.0		%		80-120	26-SEP-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-3 LCS								
Boron (B)			107.2		%		80-120	26-SEP-17
Cadmium (Cd)			95.1		%		80-120	26-SEP-17
Calcium (Ca)			102.7		%		80-120	26-SEP-17
Chromium (Cr)			90.9		%		80-120	26-SEP-17
Cobalt (Co)			100.3		%		80-120	26-SEP-17
Copper (Cu)			98.1		%		80-120	26-SEP-17
Iron (Fe)			110.9		%		80-120	26-SEP-17
Lead (Pb)			96.0		%		80-120	26-SEP-17
Lithium (Li)			101.2		%		80-120	26-SEP-17
Magnesium (Mg)			101.6		%		80-120	26-SEP-17
Manganese (Mn)			99.7		%		80-120	26-SEP-17
Molybdenum (Mo)			101.4		%		80-120	26-SEP-17
Nickel (Ni)			97.8		%		80-120	26-SEP-17
Potassium (K)			101.6		%		80-120	26-SEP-17
Selenium (Se)			95.9		%		80-120	26-SEP-17
Silver (Ag)			100.0		%		80-120	26-SEP-17
Sodium (Na)			101.2		%		80-120	26-SEP-17
Strontium (Sr)			105.0		%		80-120	26-SEP-17
Sulfur (S)			101.3		%		80-120	26-SEP-17
Thallium (Tl)			91.0		%		80-120	26-SEP-17
Tin (Sn)			97.8		%		80-120	26-SEP-17
Titanium (Ti)			91.7		%		80-120	26-SEP-17
Tungsten (W)			99.3		%		80-120	26-SEP-17
Uranium (U)			90.4		%		80-120	26-SEP-17
Vanadium (V)			101.8		%		80-120	26-SEP-17
Zinc (Zn)			97.4		%		80-120	26-SEP-17
Zirconium (Zr)			99.0		%		80-120	26-SEP-17
WG2623528-8 LCS								
Aluminum (Al)			105.6		%		80-120	26-SEP-17
Antimony (Sb)			112.6		%		80-120	26-SEP-17
Arsenic (As)			104.3		%		80-120	26-SEP-17
Barium (Ba)			106.0		%		80-120	26-SEP-17
Beryllium (Be)			102.0		%		80-120	26-SEP-17
Bismuth (Bi)			101.6		%		80-120	26-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-8 LCS								
Boron (B)			108.9		%		80-120	26-SEP-17
Cadmium (Cd)			105.5		%		80-120	26-SEP-17
Calcium (Ca)			104.4		%		80-120	26-SEP-17
Chromium (Cr)			100.3		%		80-120	26-SEP-17
Cobalt (Co)			108.5		%		80-120	26-SEP-17
Copper (Cu)			105.4		%		80-120	26-SEP-17
Iron (Fe)			119.2		%		80-120	26-SEP-17
Lead (Pb)			103.8		%		80-120	26-SEP-17
Lithium (Li)			104.6		%		80-120	26-SEP-17
Magnesium (Mg)			108.3		%		80-120	26-SEP-17
Manganese (Mn)			108.8		%		80-120	26-SEP-17
Molybdenum (Mo)			110.7		%		80-120	26-SEP-17
Nickel (Ni)			103.8		%		80-120	26-SEP-17
Potassium (K)			108.4		%		80-120	26-SEP-17
Selenium (Se)			107.2		%		80-120	26-SEP-17
Silver (Ag)			103.3		%		80-120	26-SEP-17
Sodium (Na)			106.0		%		80-120	26-SEP-17
Strontium (Sr)			106.0		%		80-120	26-SEP-17
Sulfur (S)			101.6		%		80-120	26-SEP-17
Thallium (Tl)			96.9		%		80-120	26-SEP-17
Tin (Sn)			107.1		%		80-120	26-SEP-17
Titanium (Ti)			100.6		%		80-120	26-SEP-17
Tungsten (W)			106.4		%		80-120	26-SEP-17
Uranium (U)			99.3		%		80-120	26-SEP-17
Vanadium (V)			107.8		%		80-120	26-SEP-17
Zinc (Zn)			99.4		%		80-120	26-SEP-17
Zirconium (Zr)			107.0		%		80-120	26-SEP-17
WG2623528-1 MB								
Aluminum (Al)			<50		mg/kg		50	26-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	26-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	26-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	26-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	26-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	26-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-1 MB								
Boron (B)			<5.0		mg/kg		5	26-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	26-SEP-17
Calcium (Ca)			<50		mg/kg		50	26-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	26-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	26-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	26-SEP-17
Iron (Fe)			<50		mg/kg		50	26-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	26-SEP-17
Lithium (Li)			<2.0		mg/kg		2	26-SEP-17
Magnesium (Mg)			<20		mg/kg		20	26-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	26-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	26-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	26-SEP-17
Phosphorus (P)			<50		mg/kg		50	26-SEP-17
Potassium (K)			<100		mg/kg		100	26-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	26-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	26-SEP-17
Sodium (Na)			<50		mg/kg		50	26-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	26-SEP-17
Sulfur (S)			<1000		mg/kg		1000	26-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	26-SEP-17
Tin (Sn)			<2.0		mg/kg		2	26-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	26-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	26-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	26-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	26-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	26-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	26-SEP-17
WG2623528-6 MB								
Aluminum (Al)			<50		mg/kg		50	26-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	26-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	26-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	26-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	26-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-6 MB								
Bismuth (Bi)			<0.20		mg/kg		0.2	26-SEP-17
Boron (B)			<5.0		mg/kg		5	26-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	26-SEP-17
Calcium (Ca)			<50		mg/kg		50	26-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	26-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	26-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	26-SEP-17
Iron (Fe)			<50		mg/kg		50	26-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	26-SEP-17
Lithium (Li)			<2.0		mg/kg		2	26-SEP-17
Magnesium (Mg)			<20		mg/kg		20	26-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	26-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	26-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	26-SEP-17
Phosphorus (P)			<50		mg/kg		50	26-SEP-17
Potassium (K)			<100		mg/kg		100	26-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	26-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	26-SEP-17
Sodium (Na)			<50		mg/kg		50	26-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	26-SEP-17
Sulfur (S)			<1000		mg/kg		1000	26-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	26-SEP-17
Tin (Sn)			<2.0		mg/kg		2	26-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	26-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	26-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	26-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	26-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	26-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	26-SEP-17
MOISTURE-CL	**Soil**							
Batch R3835832								
WG2621340-3 DUP		**L1993056-1**						
Moisture		49.9	50.8		%	1.8	20	22-SEP-17
WG2621340-2 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MOISTURE-CL	**Soil**							
Batch R3835832								
WG2621340-2 LCS								
Moisture			103.6		%		90-110	22-SEP-17
WG2621340-1 MB								
Moisture			<0.25		%		0.25	22-SEP-17
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3839079								
WG2626356-3 DUP		**L1993056-1**						
Acenaphthene		<0.066	<0.066	RPD-NA	mg/kg	N/A	50	25-SEP-17
Acenaphthylene		0.0085	0.0080		mg/kg	6.1	50	25-SEP-17
Acridine		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-17
Anthracene		<0.0090	<0.0090	RPD-NA	mg/kg	N/A	50	25-SEP-17
Benz(a)anthracene		0.040	0.039		mg/kg	3.8	50	25-SEP-17
Benzo(a)pyrene		0.025	0.024		mg/kg	3.3	50	25-SEP-17
Benzo(b&j)fluoranthene		0.083	0.081		mg/kg	3.4	50	25-SEP-17
Benzo(g,h,i)perylene		0.034	0.032		mg/kg	4.6	50	25-SEP-17
Benzo(k)fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-17
Benzo(e)pyrene		0.086	0.080		mg/kg	6.8	50	25-SEP-17
Chrysene		0.183	0.176		mg/kg	4.1	50	25-SEP-17
Dibenz(a,h)anthracene		0.0180	0.0184		mg/kg	2.2	50	25-SEP-17
Fluoranthene		0.034	0.033		mg/kg	1.5	50	25-SEP-17
Fluorene		0.151	0.141		mg/kg	6.6	50	25-SEP-17
Indeno(1,2,3-c,d)pyrene		0.011	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-17
1-Methylnaphthalene		0.757	0.640		mg/kg	17	50	25-SEP-17
2-Methylnaphthalene		1.35	1.24		mg/kg	8.1	50	25-SEP-17
Naphthalene		0.358	0.333		mg/kg	7.2	50	25-SEP-17
Perylene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-17
Phenanthrene		0.691	0.655		mg/kg	5.3	50	25-SEP-17
Pyrene		0.063	0.061		mg/kg	3.7	50	25-SEP-17
Quinoline		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-17
WG2626356-1 MB								
Acenaphthene			<0.0050		mg/kg		0.005	24-SEP-17
Acenaphthylene			<0.0050		mg/kg		0.005	24-SEP-17
Acridine			<0.010		mg/kg		0.01	24-SEP-17
Anthracene			<0.0040		mg/kg		0.004	24-SEP-17
Benz(a)anthracene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(a)pyrene			<0.010		mg/kg		0.01	24-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3839079								
WG2626356-1 MB								
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(e)pyrene			<0.010		mg/kg		0.01	24-SEP-17
Chrysene			<0.010		mg/kg		0.01	24-SEP-17
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	24-SEP-17
Fluoranthene			<0.010		mg/kg		0.01	24-SEP-17
Fluorene			<0.010		mg/kg		0.01	24-SEP-17
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	24-SEP-17
1-Methylnaphthalene			<0.010		mg/kg		0.01	24-SEP-17
2-Methylnaphthalene			<0.010		mg/kg		0.01	24-SEP-17
Naphthalene			<0.010		mg/kg		0.01	24-SEP-17
Perylene			<0.010		mg/kg		0.01	24-SEP-17
Phenanthrene			<0.010		mg/kg		0.01	24-SEP-17
Pyrene			<0.010		mg/kg		0.01	24-SEP-17
Quinoline			<0.010		mg/kg		0.01	24-SEP-17
Surrogate: d8-Naphthalene			80.4		%		50-130	24-SEP-17
Surrogate: d10-Acenaphthene			79.7		%		50-150	24-SEP-17
Surrogate: d10-Phenanthrene			74.4		%		60-130	24-SEP-17
Surrogate: d12-Chrysene			88.6		%		50-150	24-SEP-17
WG2626356-4 MS		**L1993056-2**						
Acenaphthene			72.0		%		50-150	25-SEP-17
Acenaphthylene			74.5		%		50-150	25-SEP-17
Acridine			101.3		%		50-150	25-SEP-17
Anthracene			82.9		%		50-150	25-SEP-17
Benz(a)anthracene			93.6		%		50-150	25-SEP-17
Benzo(a)pyrene			93.6		%		50-150	25-SEP-17
Benzo(b&j)fluoranthene			93.7		%		50-150	25-SEP-17
Benzo(g,h,i)perylene			85.8		%		50-150	25-SEP-17
Benzo(k)fluoranthene			90.5		%		50-150	25-SEP-17
Benzo(e)pyrene			94.8		%		50-150	25-SEP-17
Chrysene			92.0		%		50-150	25-SEP-17
Dibenz(a,h)anthracene			91.7		%		50-150	25-SEP-17
Fluoranthene			86.7		%		50-150	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3839079								
WG2626356-4 MS		**L1993056-2**						
Fluorene			78.6		%		50-150	25-SEP-17
Indeno(1,2,3-c,d)pyrene			79.0		%		50-150	25-SEP-17
1-Methylnaphthalene			69.0		%		50-150	25-SEP-17
2-Methylnaphthalene			74.7		%		50-150	25-SEP-17
Naphthalene			71.5		%		50-150	25-SEP-17
Perylene			100.8		%		50-150	25-SEP-17
Phenanthrene			86.6		%		50-150	25-SEP-17
Pyrene			87.9		%		50-150	25-SEP-17
Quinoline			82.3		%		50-150	25-SEP-17
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R3837770								
WG2620961-1 DUP		**L1993056-7**						
% Gravel (>2mm)		6.6	6.6		%	0.0	25	25-SEP-17
% Sand (2.00mm - 1.00mm)		<1.0	<1.0	RPD-NA	%	N/A	5	25-SEP-17
% Sand (1.00mm - 0.50mm)		1.4	1.3	J	%	0.1	5	25-SEP-17
% Sand (0.50mm - 0.25mm)		9.6	7.4	J	%	2.1	5	25-SEP-17
% Sand (0.25mm - 0.125mm)		25.0	23.2	J	%	1.8	5	25-SEP-17
% Sand (0.125mm - 0.063mm)		16.8	18.2	J	%	1.5	5	25-SEP-17
% Silt (0.063mm - 0.0312mm)		18.9	20.4	J	%	1.5	5	25-SEP-17
% Silt (0.0312mm - 0.004mm)		18.6	19.7	J	%	1.1	5	25-SEP-17
% Clay (<4um)		2.4	2.6	J	%	0.2	5	25-SEP-17
WG2620961-2 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			2.9		%		0-7.6	25-SEP-17
% Sand (1.00mm - 0.50mm)			3.8		%		0-8.9	25-SEP-17
% Sand (0.50mm - 0.25mm)			9.9		%		5.3-15.3	25-SEP-17
% Sand (0.25mm - 0.125mm)			14.1		%		10-20	25-SEP-17
% Sand (0.125mm - 0.063mm)			12.9		%		7.3-17.3	25-SEP-17
% Silt (0.063mm - 0.0312mm)			14.4		%		9.9-19.9	25-SEP-17
% Silt (0.0312mm - 0.004mm)			22.5		%		17.6-27.6	25-SEP-17
% Clay (<4um)			19.6		%		13.4-23.4	25-SEP-17

Quality Control Report

Legend:

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

Sample Parameter Qualifier Definitions:

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

Hold Time Exceedances:

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

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

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

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

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1993056-COFC

COC Number: 15 - 228

Page 1 of 2

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	Tyrell Worrall
Phone:	(905) 873-3371 ext. 234
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Form	
Select Report Format:	☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	tworrall@minnow.ca
Email 2	sweech@minnow.ca
Email 3	jtester@minnow.ca
Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	tworrall@minnow.ca
Email 2	sweech@minnow.ca

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply	
PRIORITY (Business Days)	4 day [P4] ☐	EMERGENCY: 1 Business day [E1] ☐
	3 day [P3] ☐	Same Day, Weekend or Statutory holiday [E0] ☐
	2 day [P2] ☐	
Date and Time Required for all E&P TATs:		

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information	
ALS Account # / Quote #:	Q51889
Job #:	17-22
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: Lyuda Shvets	Sampler:

Analysis Request

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PAH	[redacted]	[redacted]	moisture	metals	total organic carbon ✓	[redacted]	[redacted]	[redacted]	particle size ✓	[redacted]			Number of Containers
|	FOBCP-SED-01	14-Sep-17	—	Sediment	X			X	X	X				X				2
	FOBCP-SED-02	"	—	Sediment	X			X	X	X				X				2
	FOBCP-SED-03	"	—	Sediment	X			X	X	X				X				2
	FOBCP-SED-04	"	—	Sediment	X			X	X	X				X				2
	FOBCP-SED-05	"	—	Sediment	X			X	X	X				X				2
	FO22-SED-01	"	—	Sediment	X			X	X	X				X				2
	FO22-SED-02	"	—	Sediment	X			X	X	X				X				2
	FO22-SED-03	"	—	Sediment	X			X	X	X				X				2
	FO22-SED-04	"	—	Sediment	X			X	X	X				X				2
	FO22-SED-05	"	—	Sediment	X			X	X	X				X				2
	FRUPO-SED-01	15-Sep-17	—	Sediment	X			X	X	X				X				2
12	FRUPO-SED-02	"	—	Sediment	X			X	X	X				✓				2

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Samples ~~previously freeze dried~~

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐ No ☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated ☐			
INITIAL COOLER TEMPERATURES °C	4C - 7C	FINAL COOLER TEMPERATURES °C	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: ~~Tyrell Worrall~~ J. Tester	Date: ~~Oct 25, 2016~~ 18-SEP-17	Time: 8AM	Received by: KC	Date: 9/18/2017	Time: 13:30	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

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

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1993056-COFC

COC Number: 15 -

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	Tyrell Worrall
Phone:	(905) 873-3371 ext. 234
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax tworrall@minnow.ca

Email 2 sweech@minnow.ca

Email 3 jtester@minnow.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax tworrall@minnow.ca

Email 2 sweech@minnow.ca

...firm all E&P TATs with your AM - surcharges will apply

Regular [R] ☐ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #: Q51889

Job #: 17-22

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: | PO#

Major/Minor Code: | Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Lyuda Shvets | Sampler:

Analysis Request

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PAH	[redacted]	[redacted]	moisture	metals	total organic carbon	[redacted]	[redacted]	[redacted]	particle size	[redacted]			Number of Containers
13	FRUPO-SED-03	15-Sep-17	—	Sediment	X			X	X	X				X				2
14	FRUPO-SED-04	"	—	Sediment	X			X	X	X				X				2
15	FRUPO-SED-05	"	—	Sediment	X			X	X	X				X				2
16	FRUPO-SED-5K	"	—	Sediment	X			X	X	X				X				2
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

~~Samples previously frozen~~

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: ~~Tyrell Worrall~~ Jesi Tester	Date: ~~Oct 25, 2016~~ 18-SEP-17	Time: 8AM	Received by:	Date:	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

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

MINNOW ENVIRONMENTAL INC.
ATTN: Shari Weech/ TYRELL WORRALL
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 15-SEP-17
Report Date: 30-SEP-17 13:45 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1992230

Project P.O. #: NOT SUBMITTED
Job Reference: 17-22
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 29-SEP-17 16:14

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992230-1 SEDIMENT 13-SEP-17 FOBKS-SED-01	L1992230-2 SEDIMENT 13-SEP-17 FOBKS-SED-02	L1992230-3 SEDIMENT 13-SEP-17 FOBKS-SED-03	L1992230-4 SEDIMENT 13-SEP-17 FOBKS-SED-04	L1992230-5 SEDIMENT 13-SEP-17 FOBKS-SED-05
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	50.3	63.3	80.9	79.6	59.8
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	4.5	5.5	1.3	<1.0	3.4
	% Sand (1.00mm - 0.50mm) (%)	16.5	17.6	10.1	4.2	7.7
	% Sand (0.50mm - 0.25mm) (%)	27.1	23.0	13.9	13.2	11.2
	% Sand (0.25mm - 0.125mm) (%)	14.2	9.1	8.0	18.5	11.8
	% Sand (0.125mm - 0.063mm) (%)	7.2	6.1	5.7	10.1	10.0
	% Silt (0.063mm - 0.0312mm) (%)	12.4	16.2	25.9	23.8	23.2
	% Silt (0.0312mm - 0.004mm) (%)	15.3	19.4	29.8	25.5	27.6
	% Clay (<4um) (%)	2.9	3.1	5.3	4.3	5.1
	Texture	Sandy loam	Sandy loam	Silt loam	Sandy loam	Silt loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	5.76	7.17	10.9	9.56	9.34
Metals	Aluminum (Al) (mg/kg)	5220	3900	4470	4950	6370
	Antimony (Sb) (mg/kg)	0.37	0.35	0.37	0.44	0.46
	Arsenic (As) (mg/kg)	3.85	3.38	3.31	3.72	5.59
	Barium (Ba) (mg/kg)	183	165	173	168	193
	Beryllium (Be) (mg/kg)	0.54	0.41	0.43	0.42	0.52
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	6.2	<5.0	5.4	6.2	7.8
	Cadmium (Cd) (mg/kg)	1.26	1.43	1.44	1.50	1.43
	Calcium (Ca) (mg/kg)	73100	77000	75900	80500	74700
	Chromium (Cr) (mg/kg)	9.73	8.26	8.01	9.46	14.0
	Cobalt (Co) (mg/kg)	5.14	4.99	5.09	5.38	5.73
	Copper (Cu) (mg/kg)	11.3	10.3	10.6	10.3	12.0
	Iron (Fe) (mg/kg)	12100	10900	11200	10700	12400
	Lead (Pb) (mg/kg)	7.62	7.16	6.89	7.19	7.95
	Lithium (Li) (mg/kg)	8.4	6.8	8.0	8.0	9.7
	Magnesium (Mg) (mg/kg)	10500	11000	9920	12300	12000
	Manganese (Mn) (mg/kg)	746	882	873	879	837
	Mercury (Hg) (mg/kg)	0.0306	0.0320	0.0415	0.0372	0.0407
	Molybdenum (Mo) (mg/kg)	0.93	0.94	0.93	1.11	1.28
	Nickel (Ni) (mg/kg)	32.5	34.7	34.2	31.3	39.8
	Phosphorus (P) (mg/kg)	1110	1100	1000	1260	1160
	Potassium (K) (mg/kg)	1250	890	990	1190	1570
	Selenium (Se) (mg/kg)	1.22	1.59	2.21	2.76	2.24
	Silver (Ag) (mg/kg)	0.14	0.14	0.14	0.14	0.16
	Sodium (Na) (mg/kg)	66	67	66	72	73

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992230-6 SEDIMENT 12-SEP-17 FOUKI-SED-01	L1992230-7 SEDIMENT 12-SEP-17 FOUKI-SED-02	L1992230-8 SEDIMENT 12-SEP-17 FOUKI-SED-03	L1992230-9 SEDIMENT 12-SEP-17 FOUKI-SED-04	L1992230-10 SEDIMENT 12-SEP-17 FOUKI-SED-05
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	64.6	64.2	52.0	78.1	79.3
Particle Size	% Gravel (>2mm) (%)	11.3	6.4	3.7	2.5	<1.0
	% Sand (2.00mm - 1.00mm) (%)	10.1	5.3	5.9	6.4	<1.0
	% Sand (1.00mm - 0.50mm) (%)	13.6	8.4	9.3	11.6	1.9
	% Sand (0.50mm - 0.25mm) (%)	11.1	21.8	20.8	8.1	3.3
	% Sand (0.25mm - 0.125mm) (%)	9.5	18.9	16.1	6.2	4.6
	% Sand (0.125mm - 0.063mm) (%)	6.4	8.0	7.4	4.6	4.0
	% Silt (0.063mm - 0.0312mm) (%)	15.9	13.2	15.3	26.6	37.3
	% Silt (0.0312mm - 0.004mm) (%)	18.6	14.9	18.0	29.6	42.4
	% Clay (<4um) (%)	3.4	3.1	3.6	4.5	5.8
	Texture	Sandy loam	Sandy loam	Sandy loam	Silt loam	Silt
Organic / Inorganic Carbon	Total Organic Carbon (%)	8.66	7.00	7.37	12.3	13.8
Metals	Aluminum (Al) (mg/kg)	7700	7600	5480	4770	7430
	Antimony (Sb) (mg/kg)	0.52	0.60	0.58	0.48	0.40
	Arsenic (As) (mg/kg)	4.54	4.68	4.57	3.68	4.05
	Barium (Ba) (mg/kg)	190	181	176	182	164
	Beryllium (Be) (mg/kg)	0.57	0.62	0.58	0.41	0.59
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	7.3	7.7	<5.0	7.3	8.4
	Cadmium (Cd) (mg/kg)	1.17	1.19	1.24	1.57	1.23
	Calcium (Ca) (mg/kg)	57100	53000	56700	87400	76900
	Chromium (Cr) (mg/kg)	28.8	15.4	11.0	21.4	26.0
	Cobalt (Co) (mg/kg)	6.90	5.65	6.45	5.44	6.29
	Copper (Cu) (mg/kg)	15.2	14.7	13.0	11.5	13.8
	Iron (Fe) (mg/kg)	18100	17800	15800	13200	15100
	Lead (Pb) (mg/kg)	8.56	8.21	8.85	7.68	8.83
	Lithium (Li) (mg/kg)	13.4	12.4	11.1	7.7	15.0
	Magnesium (Mg) (mg/kg)	11700	10900	11200	10700	10600
	Manganese (Mn) (mg/kg)	779	581	796	1260	1040
	Mercury (Hg) (mg/kg)	0.0355	0.0402	0.0423	0.0551	0.0483
	Molybdenum (Mo) (mg/kg)	1.79	1.38	1.32	1.59	1.78
	Nickel (Ni) (mg/kg)	37.0	32.3	37.4	37.5	36.4
	Phosphorus (P) (mg/kg)	1110	1220	1330	1290	1200
	Potassium (K) (mg/kg)	1730	1800	1030	1160	1600
	Selenium (Se) (mg/kg)	1.97	2.02	2.65	4.18	2.56
	Silver (Ag) (mg/kg)	0.16	0.15	0.16	0.14	0.15
	Sodium (Na) (mg/kg)	80	75	65	77	78

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1992230-1	L1992230-2	L1992230-3	L1992230-4	L1992230-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	13-SEP-17	13-SEP-17	13-SEP-17	13-SEP-17	13-SEP-17
	Sampled Time					
	Client ID	FOBKS-SED-01	FOBKS-SED-02	FOBKS-SED-03	FOBKS-SED-04	FOBKS-SED-05
SOIL						
Metals	Strontium (Sr) (mg/kg)	71.3	63.6	64.5	68.4	78.0
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.152	0.126	0.120	0.143	0.192
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	9.0	6.9	7.2	10.4	10.3
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.907	0.884	0.832	0.982	0.941
	Vanadium (V) (mg/kg)	21.7	17.6	18.3	21.5	26.2
	Zinc (Zn) (mg/kg)	99.3	99.8	103	103	110
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	0.0428	0.0538	0.084 [DLHM]	0.077 [DLHM]	0.0462
	Acenaphthylene (mg/kg)	0.0083	0.0087	0.017 [DLHM]	0.012 [DLHM]	0.0070
	Acridine (mg/kg)	0.084	0.107	0.178 [DLHM]	0.163 [DLHM]	0.091
	Anthracene (mg/kg)	<0.0070 [DLCI]	<0.010 [DLCI]	<0.014 [DLCI]	<0.012 [DLCI]	<0.0050 [DLCI]
	Benz(a)anthracene (mg/kg)	0.027	0.034	0.056 [DLHM]	0.048 [DLHM]	0.030
	Benzo(a)pyrene (mg/kg)	0.019	0.025	0.037 [DLHM]	0.037 [DLHM]	0.020
	Benzo(b&j)fluoranthene (mg/kg)	0.054	0.069	0.109 [DLHM]	0.103 [DLHM]	0.058
	Benzo(e)pyrene (mg/kg)	0.055	0.070	0.112 [DLHM]	0.106 [DLHM]	0.060
	Benzo(g,h,i)perylene (mg/kg)	0.021	0.027	0.038 [DLHM]	0.039 [DLHM]	0.021
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.020 [DLHM]	<0.020 [DLHM]	<0.010
	Chrysene (mg/kg)	0.115	0.146	0.222 [DLHM]	0.217 [DLHM]	0.130
	Dibenz(a,h)anthracene (mg/kg)	0.0111	0.0139	0.023 [DLHM]	0.022 [DLHM]	0.0116
	Fluoranthene (mg/kg)	0.025	0.036	0.049 [DLHM]	0.045 [DLHM]	0.026
	Fluorene (mg/kg)	0.109	0.141	0.240 [DLHM]	0.213 [DLHM]	0.114
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.020 [DLHM]	<0.020 [DLHM]	<0.010
	1-Methylnaphthalene (mg/kg)	0.577	0.741	1.19 [DLHM]	1.11 [DLHM]	0.602
	2-Methylnaphthalene (mg/kg)	1.16	1.48	2.42 [DLHM]	2.22 [DLHM]	1.18
	Naphthalene (mg/kg)	0.387	0.492	0.805 [DLHM]	0.708 [DLHM]	0.365
	Perylene (mg/kg)	<0.010	<0.010	<0.020 [DLHM]	<0.020 [DLHM]	<0.010
	Phenanthrene (mg/kg)	0.476	0.602	0.964 [DLHM]	0.888 [DLHM]	0.495
	Pyrene (mg/kg)	0.042	0.053	0.091 [DLHM]	0.075 [DLHM]	0.044
	Quinoline (mg/kg)	<0.010	<0.010	<0.020 [DLHM]	<0.020 [DLHM]	<0.010
	Surrogate: d10-Acenaphthene (%)	85.1	80.7	79.1	83.1	77.9
	Surrogate: d12-Chrysene (%)	102.7	99.1	97.0	99.5	99.8
	Surrogate: d8-Naphthalene (%)	80.1	77.3	74.6	78.6	74.3
	Surrogate: d10-Phenanthrene (%)	88.5	82.6	83.6	85.6	79.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992230-6 SEDIMENT 12-SEP-17 FOUKI-SED-01	L1992230-7 SEDIMENT 12-SEP-17 FOUKI-SED-02	L1992230-8 SEDIMENT 12-SEP-17 FOUKI-SED-03	L1992230-9 SEDIMENT 12-SEP-17 FOUKI-SED-04	L1992230-10 SEDIMENT 12-SEP-17 FOUKI-SED-05
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	68.7	87.3	65.1	82.3	129
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	1200	1500
	Thallium (Tl) (mg/kg)	0.159	0.196	0.160	0.136	0.148
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	8.1	8.1	4.0	10.5	9.1
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.829	0.931	0.915	0.965	0.830
	Vanadium (V) (mg/kg)	28.4	31.3	21.3	20.2	22.9
	Zinc (Zn) (mg/kg)	110	108	111	111	101
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	0.0896	0.0768	0.0513	0.102 DLHM	0.143 DLHM
	Acenaphthylene (mg/kg)	0.0126	0.0114	0.0082	0.015 DLHM	0.023 DLHM
	Acridine (mg/kg)	0.195	0.150	0.101	0.224 DLHM	0.296 DLHM
	Anthracene (mg/kg)	<0.012 DLCI	<0.010 DLCI	<0.0070 DLCI	<0.013 DLCI	<0.017 DLCI
	Benz(a)anthracene (mg/kg)	0.066	0.050	0.033	0.070 DLHM	0.092 DLHM
	Benzo(a)pyrene (mg/kg)	0.042	0.030	0.023	0.048 DLHM	0.067 DLHM
	Benzo(b&j)fluoranthene (mg/kg)	0.117	0.093	0.066	0.131 DLHM	0.175 DLHM
	Benzo(e)pyrene (mg/kg)	0.123	0.094	0.067	0.138 DLHM	0.183 DLHM
	Benzo(g,h,i)perylene (mg/kg)	0.047	0.033	0.025	0.054 DLHM	0.061 DLHM
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.020 DLHM	<0.020 DLHM
	Chrysene (mg/kg)	0.244	0.207	0.148	0.288 DLHM	0.380 DLHM
	Dibenz(a,h)anthracene (mg/kg)	0.0258	0.0187	0.0137	0.030 DLHM	0.037 DLHM
	Fluoranthene (mg/kg)	0.049	0.037	0.028	0.059 DLHM	0.071 DLHM
	Fluorene (mg/kg)	0.239	0.185	0.122	0.291 DLHM	0.399 DLHM
	Indeno(1,2,3-c,d)pyrene (mg/kg)	0.014	0.010	<0.010	<0.020 DLHM	0.021 DLHM
	1-Methylnaphthalene (mg/kg)	1.27	1.19	0.691	1.59 DLHM	2.22 DLHM
	2-Methylnaphthalene (mg/kg)	2.47	2.11	1.34	2.97 DLHM	4.12 DLHM
	Naphthalene (mg/kg)	0.762	0.661	0.408	0.963 DLHM	1.34 DLHM
	Perylene (mg/kg)	<0.010	<0.010	<0.010	<0.020 DLHM	<0.020 DLHM
	Phenanthrene (mg/kg)	0.988	0.850	0.568	1.15 DLHM	1.54 DLHM
	Pyrene (mg/kg)	0.085	0.066	0.045	0.094 DLHM	0.128 DLHM
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.020 DLHM	<0.020 DLHM
	Surrogate: d10-Acenaphthene (%)	84.8	82.2	79.7	74.5	85.0
	Surrogate: d12-Chrysene (%)	110.9	95.7	97.5	93.7	101.2
	Surrogate: d8-Naphthalene (%)	76.5	78.2	76.9	69.8	80.0
	Surrogate: d10-Phenanthrene (%)	92.8	82.1	80.8	77.8	84.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992230-1	L1992230-2	L1992230-3	L1992230-4	L1992230-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	13-SEP-17	13-SEP-17	13-SEP-17	13-SEP-17	13-SEP-17
	Sampled Time					
	Client ID	FOBKS-SED-01	FOBKS-SED-02	FOBKS-SED-03	FOBKS-SED-04	FOBKS-SED-05
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	0.041	0.052	0.081	0.079	0.042
	IACR (CCME) (mg/kg)	0.61	0.77	1.22	1.16	0.65

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992230-6	L1992230-7	L1992230-8	L1992230-9	L1992230-10
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	12-SEP-17	12-SEP-17	12-SEP-17	12-SEP-17	12-SEP-17
	Sampled Time					
	Client ID	FOUKI-SED-01	FOUKI-SED-02	FOUKI-SED-03	FOUKI-SED-04	FOUKI-SED-05
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	0.090	0.067	0.049	0.103	0.138
	IACR (CCME) (mg/kg)	1.31	1.03	0.74	1.50	1.98

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Additional Comments for Sample Listed:

Samplenum	Matrix	Report Remarks	Sample Comments
L1992230-1	Soil	Note: Watey Sample	
L1992230-10	Soil	Note: Watey Sample	
L1992230-2	Soil	Note: Watey Sample	
L1992230-3	Soil	Note: Very Watey Sample	
L1992230-4	Soil	Note: Very Watey Sample	
L1992230-5	Soil	Note: Watey Sample	
L1992230-6	Soil	Note: Watey Sample	
L1992230-7	Soil	Note: Watey Sample	
L1992230-8	Soil	Note: Watey Sample	
L1992230-9	Soil	Note: Watey Sample	

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.
DLHM	Detection Limit Adjusted: Sample has High Moisture Content

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217

A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.

C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2

Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

HG-200.2-CVAA-CL	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
MET-200.2-CCMS-CL	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

MOISTURE-CL	Soil	% Moisture	CWS for PHC in Soil - Tier 1

This analysis is carried out gravimetrically by drying the sample at 105 C

PAH-TMB-D/A-MS-CL	Soil	PAH by Tumbler Extraction (DCM/Acetone)	EPA 3570/8270

Polycyclic Aromatic Hydrocarbons in Sediment/Soil
This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of DCM and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

PSA-PIPET-DETAIL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

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

Reference Information

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

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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

Quality Control Report

Workorder: L1992230 Report Date: 30-SEP-17

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9

Contact: Shari Weech/ TYRELL WORRALL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R3838413								
WG2619941-1 DUP		**L1992230-6**						
Inorganic Carbon		1.94	1.87		%	3.7	20	26-SEP-17
WG2619941-2 LCS								
Inorganic Carbon			96.9		%		80-120	26-SEP-17
WG2619941-3 MB								
Inorganic Carbon			<0.050		%		0.05	26-SEP-17
C-TOT-LECO-SK	**Soil**							
Batch R3839157								
WG2621988-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			103.3		%		80-120	25-SEP-17
WG2621988-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	25-SEP-17
HG-200.2-CVAA-CL	**Soil**							
Batch R3835117								
WG2621450-8 CRM		**TILL-1**						
Mercury (Hg)			110.9		%		70-130	21-SEP-17
WG2621450-10 DUP		**L1992230-3**						
Mercury (Hg)		0.0415	0.0304		mg/kg	31	40	21-SEP-17
WG2621450-9 LCS								
Mercury (Hg)			108.0		%		80-120	21-SEP-17
WG2621450-6 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	21-SEP-17
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-8 CRM		**TILL-1**						
Aluminum (Al)			96.9		%		70-130	25-SEP-17
Antimony (Sb)			95.9		%		70-130	25-SEP-17
Arsenic (As)			93.4		%		70-130	25-SEP-17
Barium (Ba)			93.8		%		70-130	25-SEP-17
Beryllium (Be)			100.5		%		70-130	25-SEP-17
Bismuth (Bi)			92.2		%		70-130	25-SEP-17
Boron (B)			2.7		mg/kg		0-8.2	25-SEP-17
Cadmium (Cd)			100.2		%		70-130	25-SEP-17
Calcium (Ca)			98.2		%		70-130	25-SEP-17
Chromium (Cr)			94.7		%		70-130	25-SEP-17
Cobalt (Co)			97.2		%		70-130	25-SEP-17
Copper (Cu)			97.2		%		70-130	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-8 CRM		**TILL-1**						
Iron (Fe)			90.2		%		70-130	25-SEP-17
Lead (Pb)			96.4		%		70-130	25-SEP-17
Lithium (Li)			97.3		%		70-130	25-SEP-17
Magnesium (Mg)			97.6		%		70-130	25-SEP-17
Manganese (Mn)			98.5		%		70-130	25-SEP-17
Molybdenum (Mo)			96.3		%		70-130	25-SEP-17
Nickel (Ni)			95.3		%		70-130	25-SEP-17
Phosphorus (P)			98.0		%		70-130	25-SEP-17
Potassium (K)			87.2		%		70-130	25-SEP-17
Selenium (Se)			0.31		mg/kg		0.11-0.51	25-SEP-17
Silver (Ag)			0.22		mg/kg		0.13-0.33	25-SEP-17
Sodium (Na)			85.3		%		70-130	25-SEP-17
Strontium (Sr)			92.8		%		70-130	25-SEP-17
Thallium (Tl)			0.112		mg/kg		0.077-0.18	25-SEP-17
Tin (Sn)			1.0		mg/kg		0-3.1	25-SEP-17
Titanium (Ti)			87.2		%		70-130	25-SEP-17
Tungsten (W)			0.13		mg/kg		0-0.66	25-SEP-17
Uranium (U)			96.6		%		70-130	25-SEP-17
Vanadium (V)			95.3		%		70-130	25-SEP-17
Zinc (Zn)			90.7		%		70-130	25-SEP-17
Zirconium (Zr)			0.7		mg/kg		0-1.8	25-SEP-17
WG2621450-10 DUP		**L1992230-3**						
Aluminum (Al)		4470	3530		mg/kg	24	40	25-SEP-17
Antimony (Sb)		0.37	0.41		mg/kg	9.5	30	25-SEP-17
Arsenic (As)		3.31	3.26		mg/kg	1.8	30	25-SEP-17
Barium (Ba)		173	153		mg/kg	12	40	25-SEP-17
Beryllium (Be)		0.43	0.33		mg/kg	27	30	25-SEP-17
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	25-SEP-17
Boron (B)		5.4	<5.0	RPD-NA	mg/kg	N/A	30	25-SEP-17
Cadmium (Cd)		1.44	1.42		mg/kg	1.6	30	25-SEP-17
Calcium (Ca)		75900	75100		mg/kg	1.0	30	25-SEP-17
Chromium (Cr)		8.01	7.27		mg/kg	9.6	30	25-SEP-17
Cobalt (Co)		5.09	4.72		mg/kg	7.5	30	25-SEP-17
Copper (Cu)		10.6	10.1		mg/kg	5.0	30	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-10 DUP		**L1992230-3**						
Iron (Fe)		11200	9860		mg/kg	13	30	25-SEP-17
Lead (Pb)		6.89	6.53		mg/kg	5.3	40	25-SEP-17
Lithium (Li)		8.0	6.1		mg/kg	26	30	25-SEP-17
Magnesium (Mg)		9920	9760		mg/kg	1.6	30	25-SEP-17
Manganese (Mn)		873	876		mg/kg	0.3	30	25-SEP-17
Molybdenum (Mo)		0.93	0.99		mg/kg	5.8	40	25-SEP-17
Nickel (Ni)		34.2	33.4		mg/kg	2.3	30	25-SEP-17
Phosphorus (P)		1000	924		mg/kg	8.4	30	25-SEP-17
Potassium (K)		990	780		mg/kg	24	40	25-SEP-17
Selenium (Se)		2.21	2.23		mg/kg	1.0	30	25-SEP-17
Silver (Ag)		0.14	0.13		mg/kg	3.5	40	25-SEP-17
Sodium (Na)		66	62		mg/kg	5.5	40	25-SEP-17
Strontium (Sr)		64.5	60.7		mg/kg	6.1	40	25-SEP-17
Sulfur (S)		<1000	<1000	RPD-NA	mg/kg	N/A	30	25-SEP-17
Thallium (Tl)		0.120	0.113		mg/kg	6.0	30	25-SEP-17
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	25-SEP-17
Titanium (Ti)		7.2	7.7		mg/kg	5.8	40	25-SEP-17
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	25-SEP-17
Uranium (U)		0.832	0.838		mg/kg	0.8	30	25-SEP-17
Vanadium (V)		18.3	16.7		mg/kg	9.1	30	25-SEP-17
Zinc (Zn)		103	97.6		mg/kg	5.2	30	25-SEP-17
Zirconium (Zr)		<1.0	<1.0	RPD-NA	mg/kg	N/A	30	25-SEP-17
WG2621450-9 LCS								
Aluminum (Al)			95.8		%		80-120	25-SEP-17
Antimony (Sb)			99.2		%		80-120	25-SEP-17
Arsenic (As)			95.0		%		80-120	25-SEP-17
Barium (Ba)			94.5		%		80-120	25-SEP-17
Beryllium (Be)			94.1		%		80-120	25-SEP-17
Bismuth (Bi)			89.4		%		80-120	25-SEP-17
Boron (B)			99.2		%		80-120	25-SEP-17
Cadmium (Cd)			93.9		%		80-120	25-SEP-17
Calcium (Ca)			95.8		%		80-120	25-SEP-17
Chromium (Cr)			85.1		%		80-120	25-SEP-17
Cobalt (Co)			94.0		%		80-120	25-SEP-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-9 LCS								
Copper (Cu)			91.8		%		80-120	25-SEP-17
Iron (Fe)			100.5		%		80-120	25-SEP-17
Lead (Pb)			91.5		%		80-120	25-SEP-17
Lithium (Li)			94.6		%		80-120	25-SEP-17
Magnesium (Mg)			94.0		%		80-120	25-SEP-17
Manganese (Mn)			95.7		%		80-120	25-SEP-17
Molybdenum (Mo)			97.1		%		80-120	25-SEP-17
Nickel (Ni)			92.1		%		80-120	25-SEP-17
Potassium (K)			90.2		%		80-120	25-SEP-17
Selenium (Se)			90.7		%		80-120	25-SEP-17
Silver (Ag)			84.3		%		80-120	25-SEP-17
Sodium (Na)			89.9		%		80-120	25-SEP-17
Strontium (Sr)			93.2		%		80-120	25-SEP-17
Sulfur (S)			90.3		%		80-120	25-SEP-17
Thallium (Tl)			92.8		%		80-120	25-SEP-17
Tin (Sn)			96.4		%		80-120	25-SEP-17
Titanium (Ti)			88.4		%		80-120	25-SEP-17
Tungsten (W)			94.1		%		80-120	25-SEP-17
Uranium (U)			89.7		%		80-120	25-SEP-17
Vanadium (V)			93.5		%		80-120	25-SEP-17
Zinc (Zn)			85.1		%		80-120	25-SEP-17
Zirconium (Zr)			97.2		%		80-120	25-SEP-17
WG2621450-6 MB								
Aluminum (Al)			<50		mg/kg		50	25-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	25-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	25-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	25-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	25-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	25-SEP-17
Boron (B)			<5.0		mg/kg		5	25-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	25-SEP-17
Calcium (Ca)			<50		mg/kg		50	25-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	25-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	25-SEP-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch **R3837593**								
WG2621450-6 **MB**								
Copper (Cu)			<0.50		mg/kg		0.5	25-SEP-17
Iron (Fe)			<50		mg/kg		50	25-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	25-SEP-17
Lithium (Li)			<2.0		mg/kg		2	25-SEP-17
Magnesium (Mg)			<20		mg/kg		20	25-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	25-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	25-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	25-SEP-17
Phosphorus (P)			<50		mg/kg		50	25-SEP-17
Potassium (K)			<100		mg/kg		100	25-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	25-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	25-SEP-17
Sodium (Na)			<50		mg/kg		50	25-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	25-SEP-17
Sulfur (S)			<1000		mg/kg		1000	25-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	25-SEP-17
Tin (Sn)			<2.0		mg/kg		2	25-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	25-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	25-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	25-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	25-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	25-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	25-SEP-17
MOISTURE-CL	**Soil**							
Batch **R3835853**								
WG2621485-3 **DUP**		**L1992230-1**						
Moisture		50.3	52.5		%	4.3	20	22-SEP-17
WG2621485-2 **LCS**								
Moisture			108.8		%		90-110	22-SEP-17
WG2621485-1 **MB**								
Moisture			<0.25		%		0.25	22-SEP-17
PAH-TMB-D/A-MS-CL	**Soil**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3840960								
WG2628468-1 MB								
Acenaphthene			<0.0050		mg/kg		0.005	22-SEP-17
Acenaphthylene			<0.0050		mg/kg		0.005	22-SEP-17
Acridine			<0.010		mg/kg		0.01	22-SEP-17
Anthracene			<0.0040		mg/kg		0.004	22-SEP-17
Benz(a)anthracene			<0.010		mg/kg		0.01	22-SEP-17
Benzo(a)pyrene			<0.010		mg/kg		0.01	22-SEP-17
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	22-SEP-17
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	22-SEP-17
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	22-SEP-17
Benzo(e)pyrene			<0.010		mg/kg		0.01	22-SEP-17
Chrysene			<0.010		mg/kg		0.01	22-SEP-17
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	22-SEP-17
Fluoranthene			<0.010		mg/kg		0.01	22-SEP-17
Fluorene			<0.010		mg/kg		0.01	22-SEP-17
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	22-SEP-17
1-Methylnaphthalene			<0.010		mg/kg		0.01	22-SEP-17
2-Methylnaphthalene			<0.010		mg/kg		0.01	22-SEP-17
Naphthalene			<0.010		mg/kg		0.01	22-SEP-17
Perylene			<0.010		mg/kg		0.01	22-SEP-17
Phenanthrene			<0.010		mg/kg		0.01	22-SEP-17
Pyrene			<0.010		mg/kg		0.01	22-SEP-17
Quinoline			<0.010		mg/kg		0.01	22-SEP-17
Surrogate: d8-Naphthalene			82.9		%		50-130	22-SEP-17
Surrogate: d10-Acenaphthene			81.2		%		50-150	22-SEP-17
Surrogate: d10-Phenanthrene			75.6		%		60-130	22-SEP-17
Surrogate: d12-Chrysene			101.5		%		50-150	22-SEP-17
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R3835212								
WG2619924-2 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			3.2		%		0-7.6	21-SEP-17
% Sand (1.00mm - 0.50mm)			4.0		%		0-8.9	21-SEP-17
% Sand (0.50mm - 0.25mm)			11.6		%		5.3-15.3	21-SEP-17
% Sand (0.25mm - 0.125mm)			17.2		%		10-20	21-SEP-17
% Sand (0.125mm - 0.063mm)			10.4		%		7.3-17.3	21-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R3835212								
WG2619924-2 IRM		**2017-PSA**						
% Silt (0.063mm - 0.0312mm)			13.0		%		9.9-19.9	21-SEP-17
% Silt (0.0312mm - 0.004mm)			22.1		%		17.6-27.6	21-SEP-17
% Clay (<4um)			18.6		%		13.4-23.4	21-SEP-17
Batch R3835249								
WG2619925-4 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			3.1		%		0-7.6	21-SEP-17
% Sand (1.00mm - 0.50mm)			3.7		%		0-8.9	21-SEP-17
% Sand (0.50mm - 0.25mm)			10.6		%		5.3-15.3	21-SEP-17
% Sand (0.25mm - 0.125mm)			16.0		%		10-20	21-SEP-17
% Sand (0.125mm - 0.063mm)			13.4		%		7.3-17.3	21-SEP-17
% Silt (0.063mm - 0.0312mm)			13.1		%		9.9-19.9	21-SEP-17
% Silt (0.0312mm - 0.004mm)			20.6		%		17.6-27.6	21-SEP-17
% Clay (<4um)			19.6		%		13.4-23.4	21-SEP-17

Quality Control Report

Legend:

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

Sample Parameter Qualifier Definitions:

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

Hold Time Exceedances:

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

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

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

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

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1992230-COFC

Number: 15 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	Tyrell Worrall
Phone:	(905) 873-3371 ext. 234
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: tworrall@minnow.ca

Email 2: sweech@minnow.ca

Email 3: jtester@minnow.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: tworrall@minnow.ca

Email 2: sweech@minnow.ca

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #: Q51889

Job #: 17-22

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Lyuda Shvets   Sampler: HC / MW

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PAH	moisture	metals	total organic carbon	particle size	Number of Containers
1	FOBKS-SED-01	13-Sep-17		Sediment	✓	✓	✓	✓	✓	2
2	FOBKS-SED-02	13-Sep-17		Sediment	✓	✓	✓	✓	✓	2
3	FOBKS-SED-03	13-Sep-17		Sediment	✓	✓	✓	✓	✓	2
4	FOBKS-SED-04	13-Sep-17		Sediment	✓	✓	✓	✓	✓	2
5	FOBKS-SED-05	13-Sep-17		Sediment	✓	✓	✓	✓	✓	2
6	FOUKI-SED-01	12-Sep-17		Sediment	✓	✓	✓	✓	✓	2
7	FOUKI-SED-02	12-Sep-17		Sediment	✓	✓	✓	✓	✓	2
8	FOUKI-SED-03	12-Sep-17		Sediment	✓	✓	✓	✓	✓	2
9	FOUKI-SED-04	12-Sep-17		Sediment	✓	✓	✓	✓	✓	2
10	FOUKI-SED-05	12-Sep-17		Sediment	✓	✓	✓	✓	✓	2
				Sediment						2
				Sediment						2

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Samples previously freeze dried

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [redacted] Jess Tester	Date: [redacted] 14-SEP-17	Time: 8AM	Received by:	Date: 9/15	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

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

APPENDIX C

WATER QUALITY AND QUANTITY

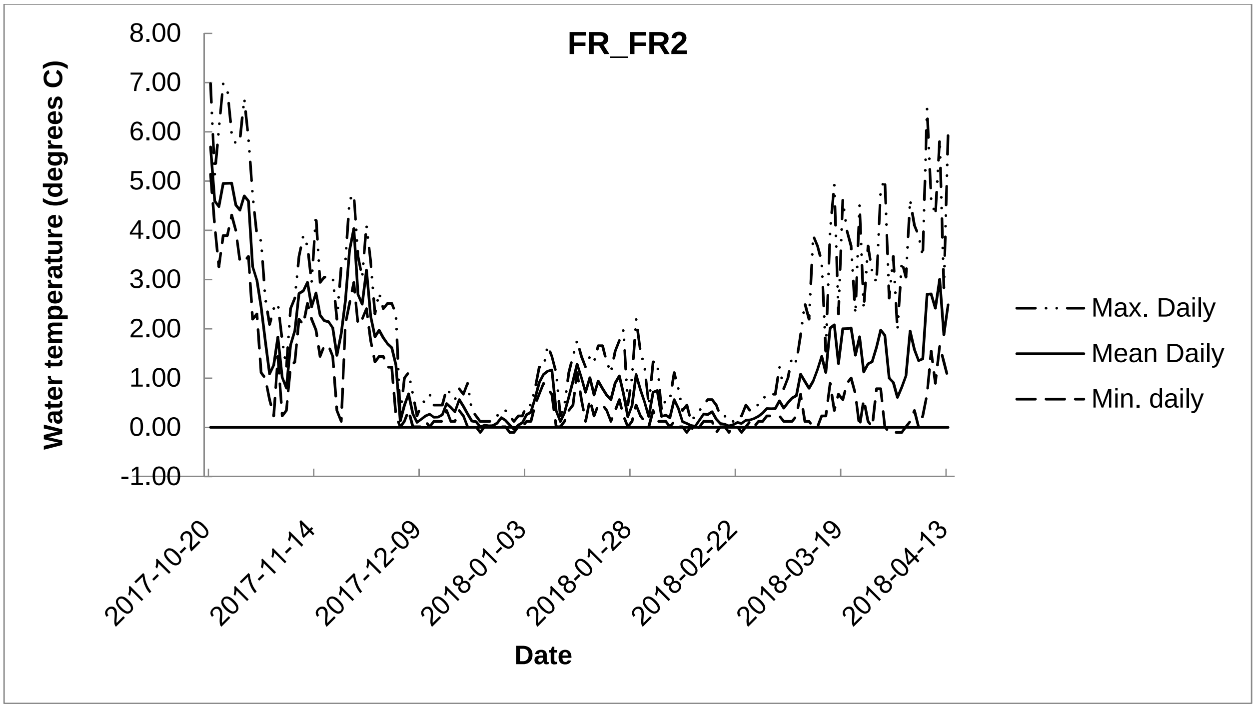


Figure C.1: Continuous Water Temperature Plot for FR_FR2

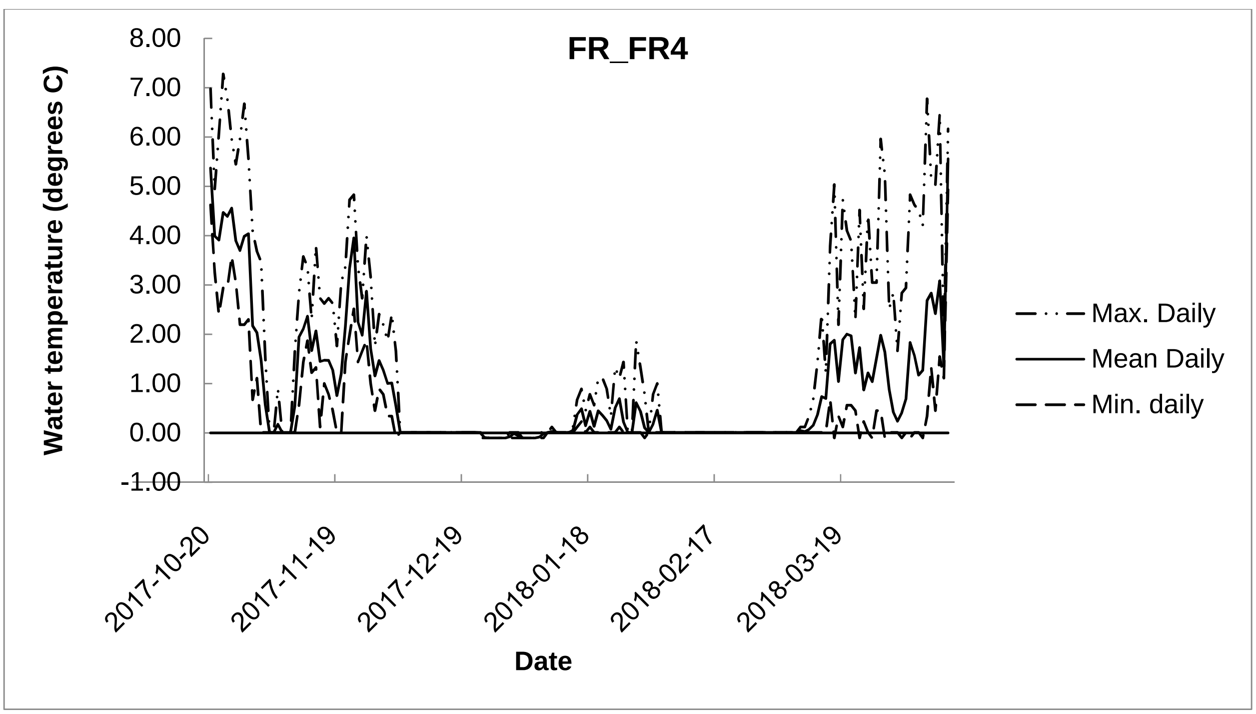


Figure C.2: Continuous Water Temperature Plot for FR_FR4

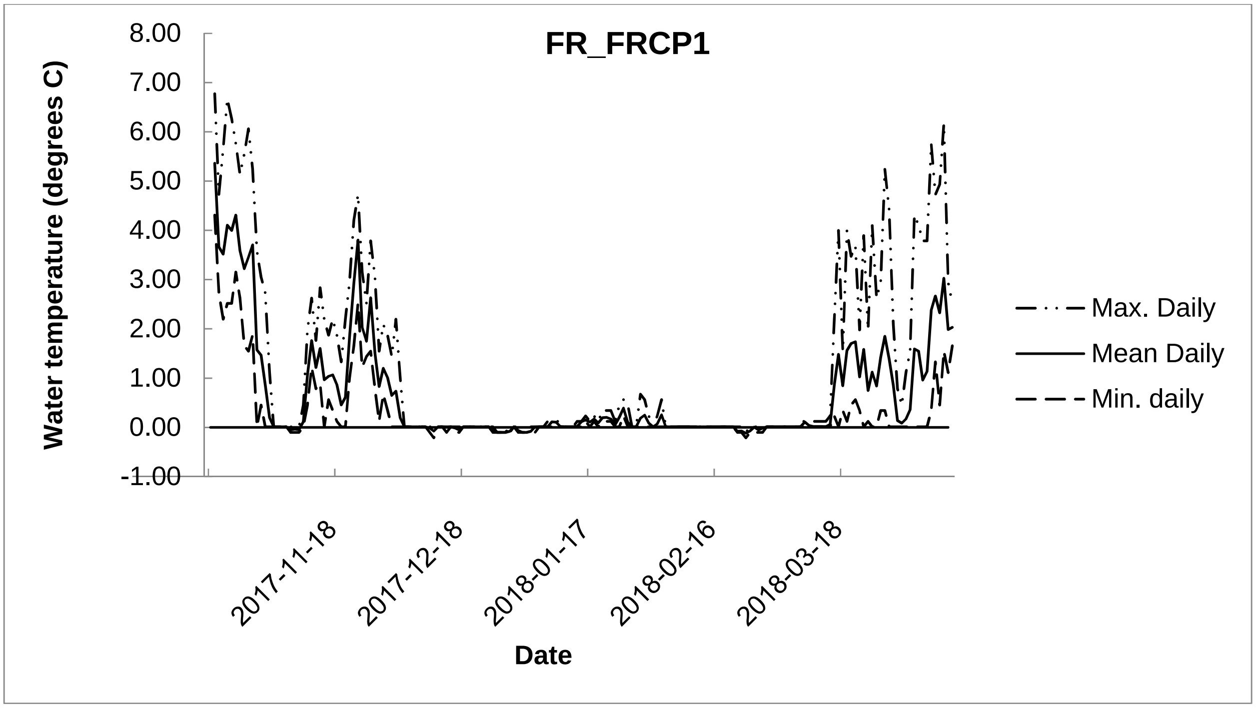


Figure C.3: **Continuous Water Temperature Plot for FR_FRCP1**

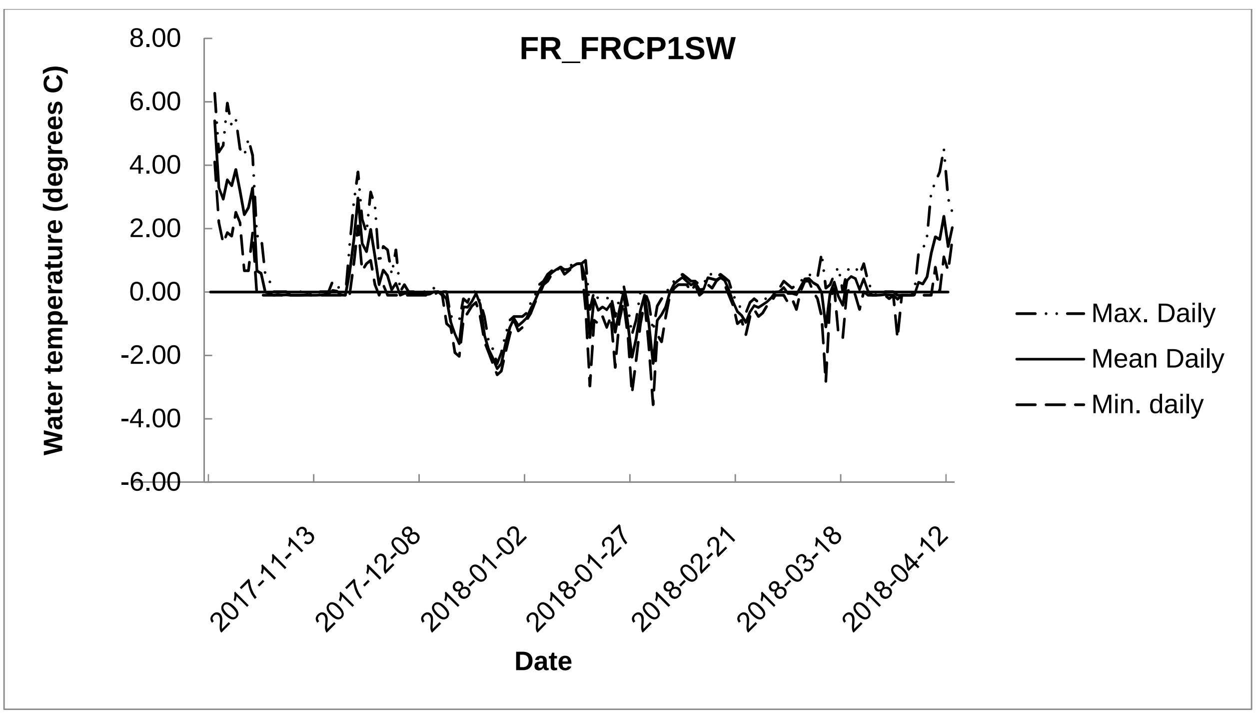


Figure C.4: **Continuous Water Temperature Plot for FR_FRCP1SW**

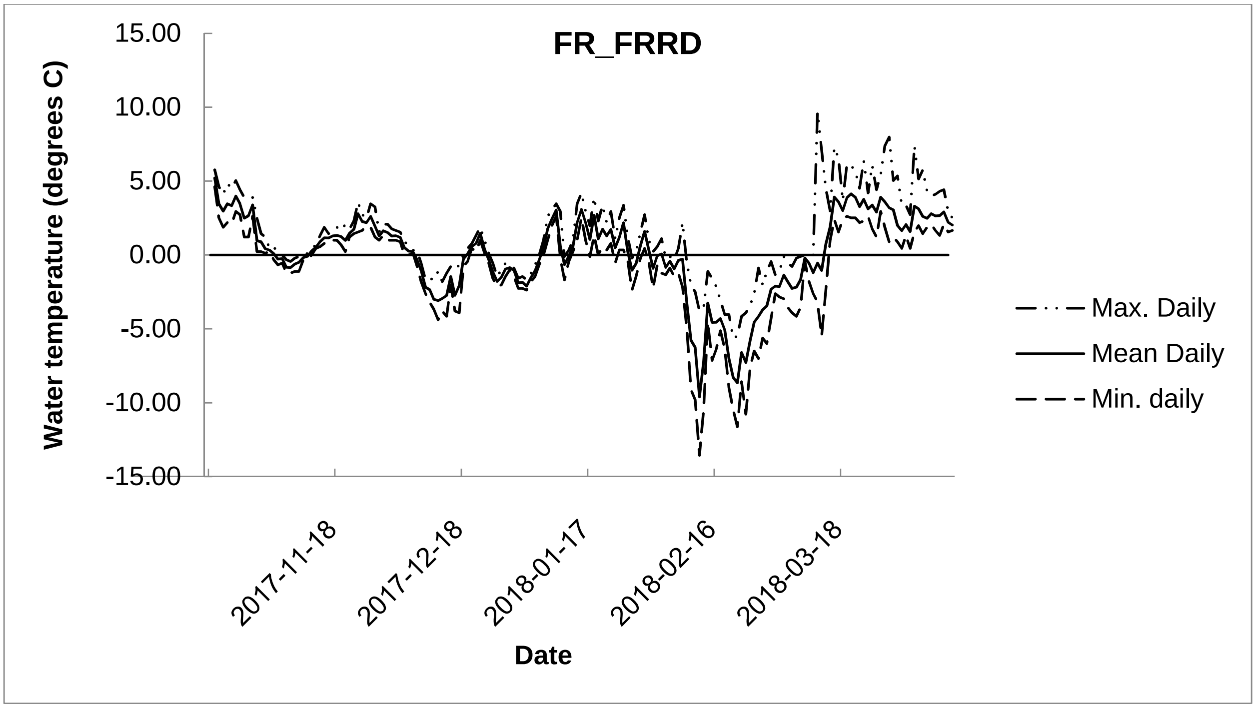


Figure C.5: Continuous Water Temperature Plot for FR_FRRD

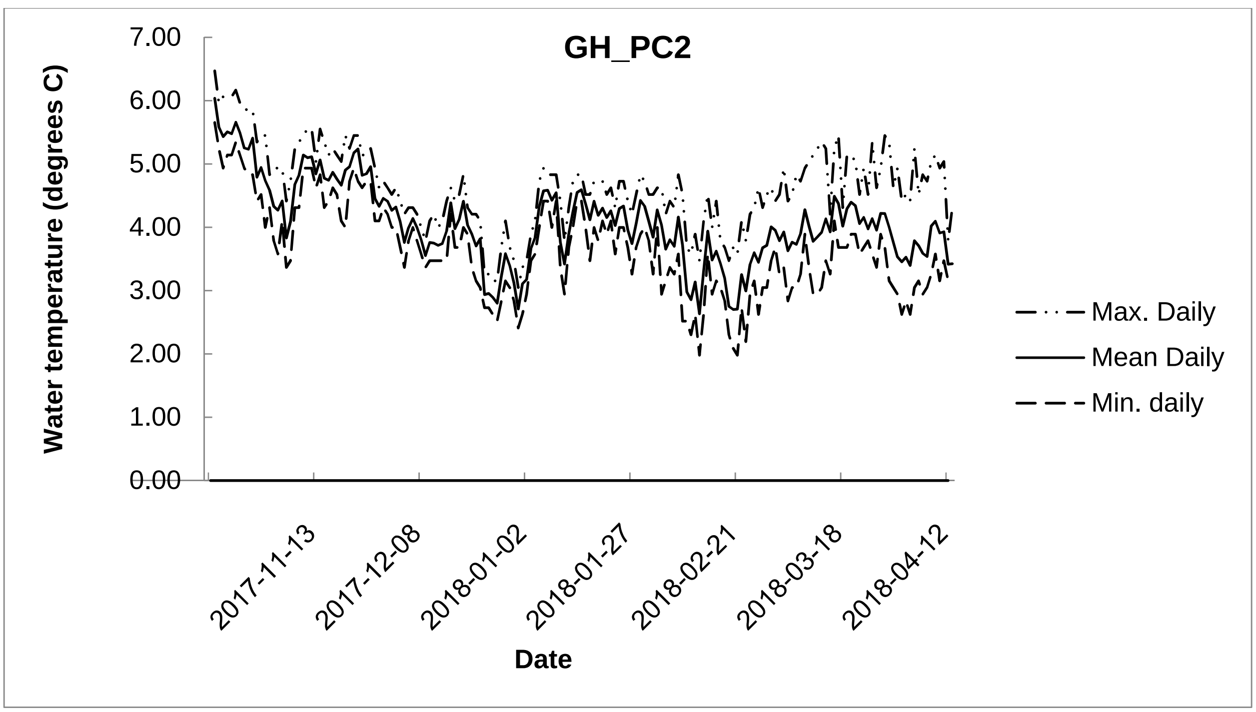


Figure C.6: Continuous Water Temperature Plot for GH_PC2

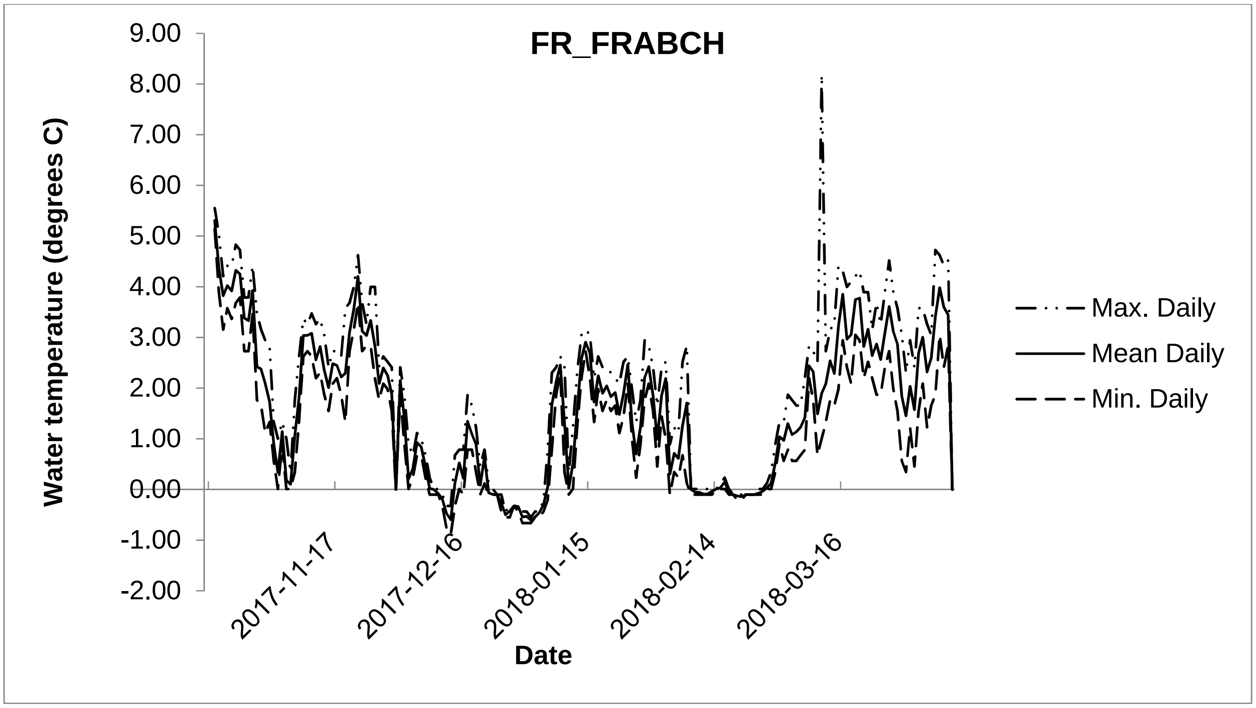


Figure C.7: **Continuous Water Temperature Plot for FR_FRABCH**

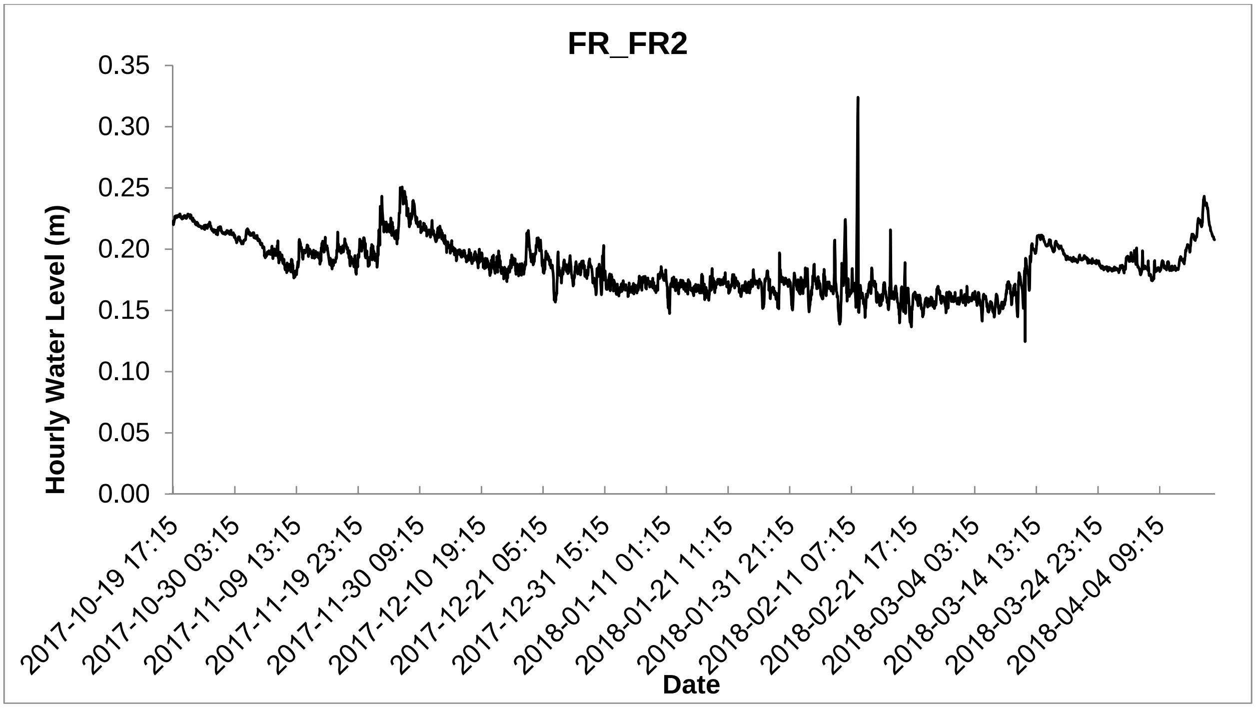


Figure C.8: **Continuous Water Level for FR_FR2**

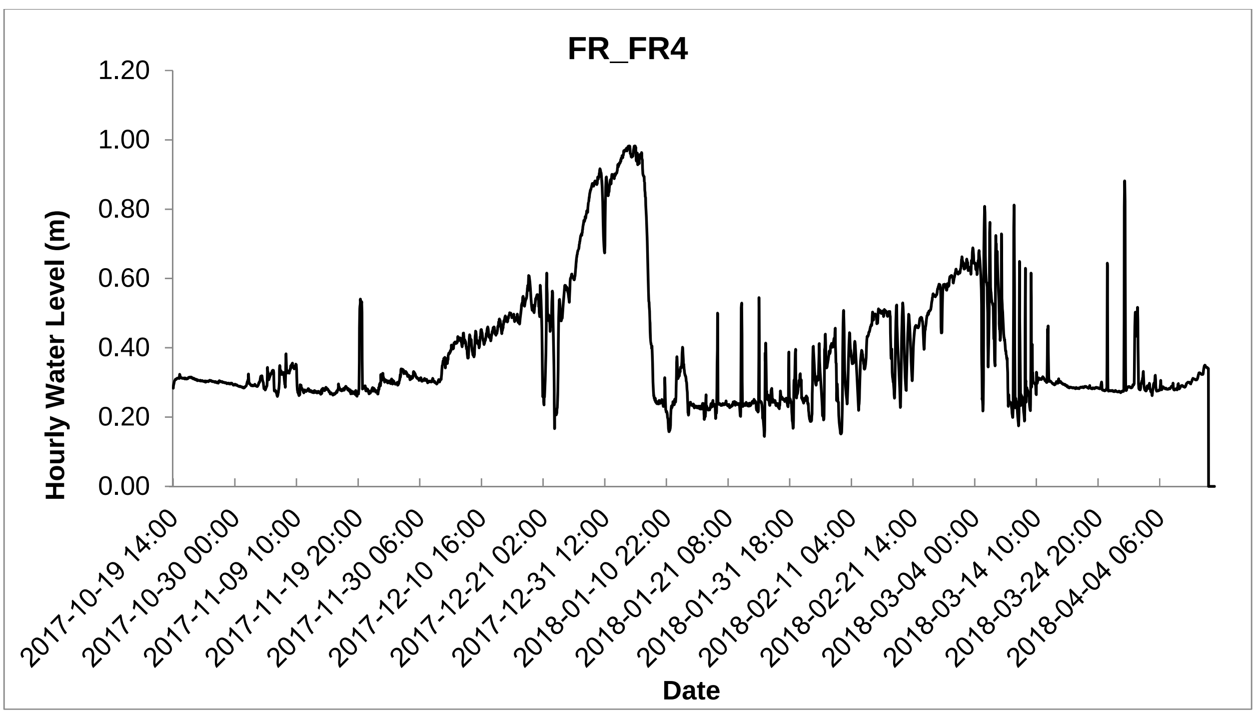


Figure C.9: **Continuous Water Level for FR_FR4**

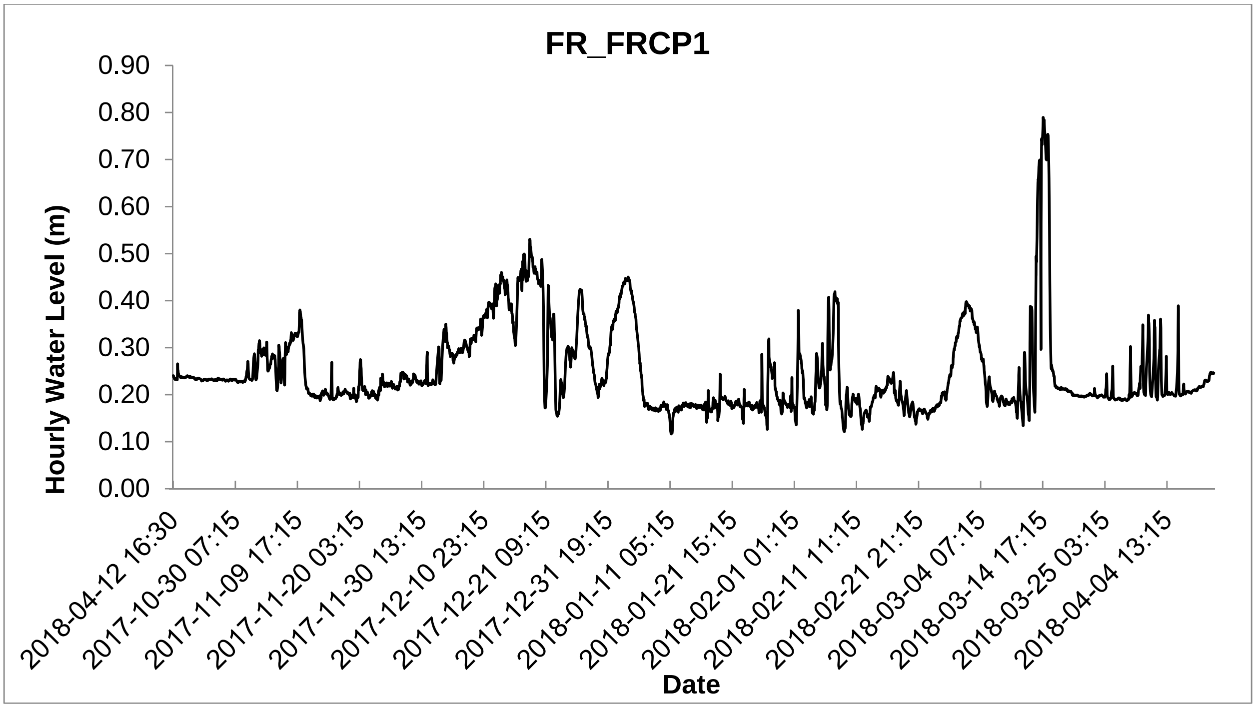


Figure C.10: **Continuous Water Level for FR_FRCP1**

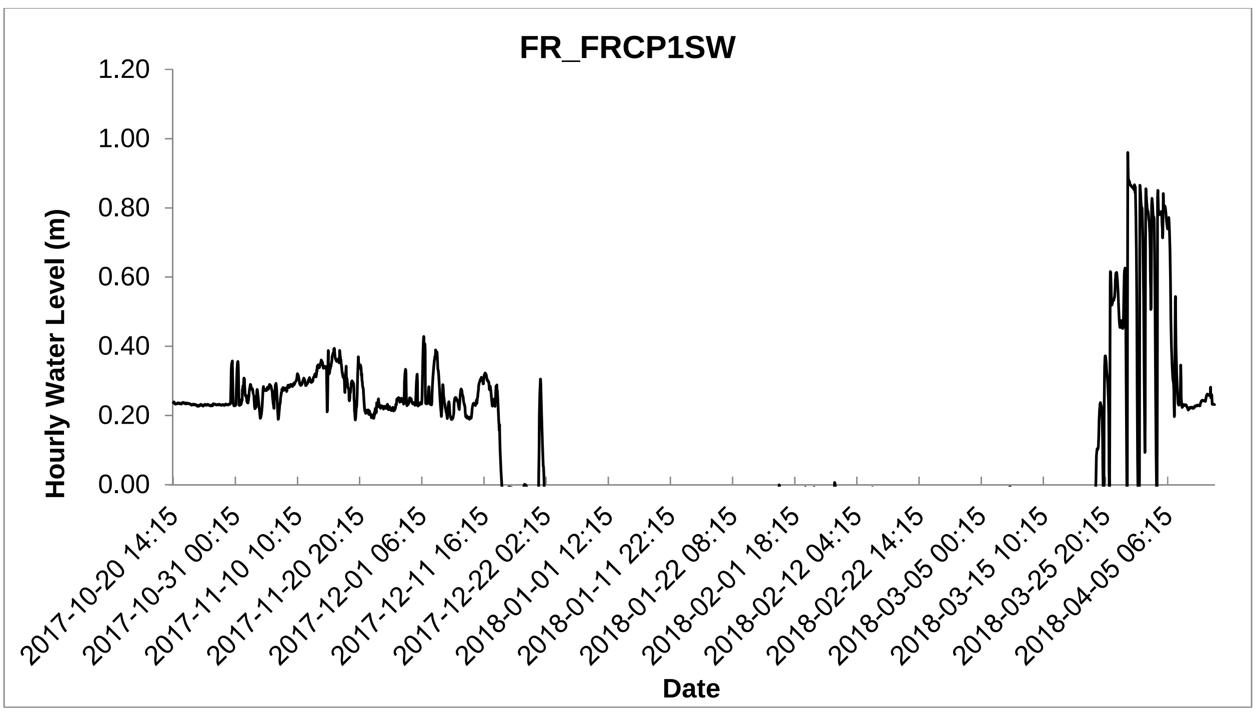


Figure C.11: **Continuous Water Level for FR_FRCP1SW**

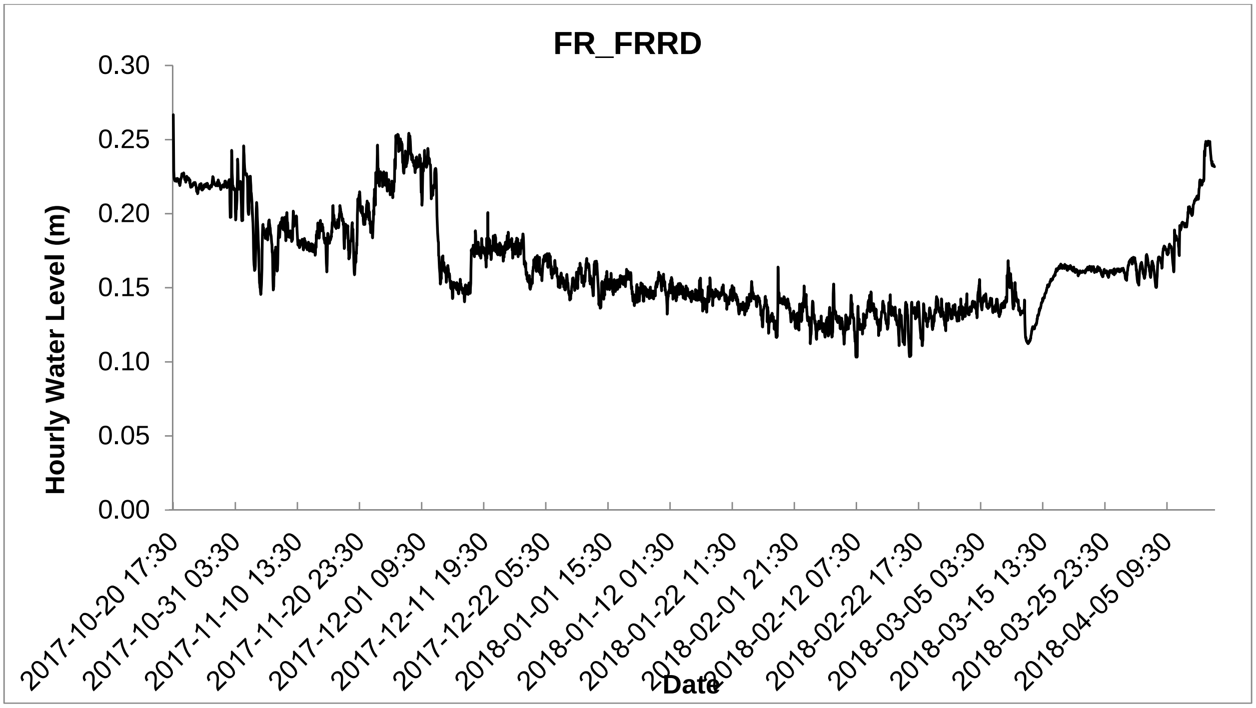


Figure C.12: Continuous Water Level for FR_FRRD

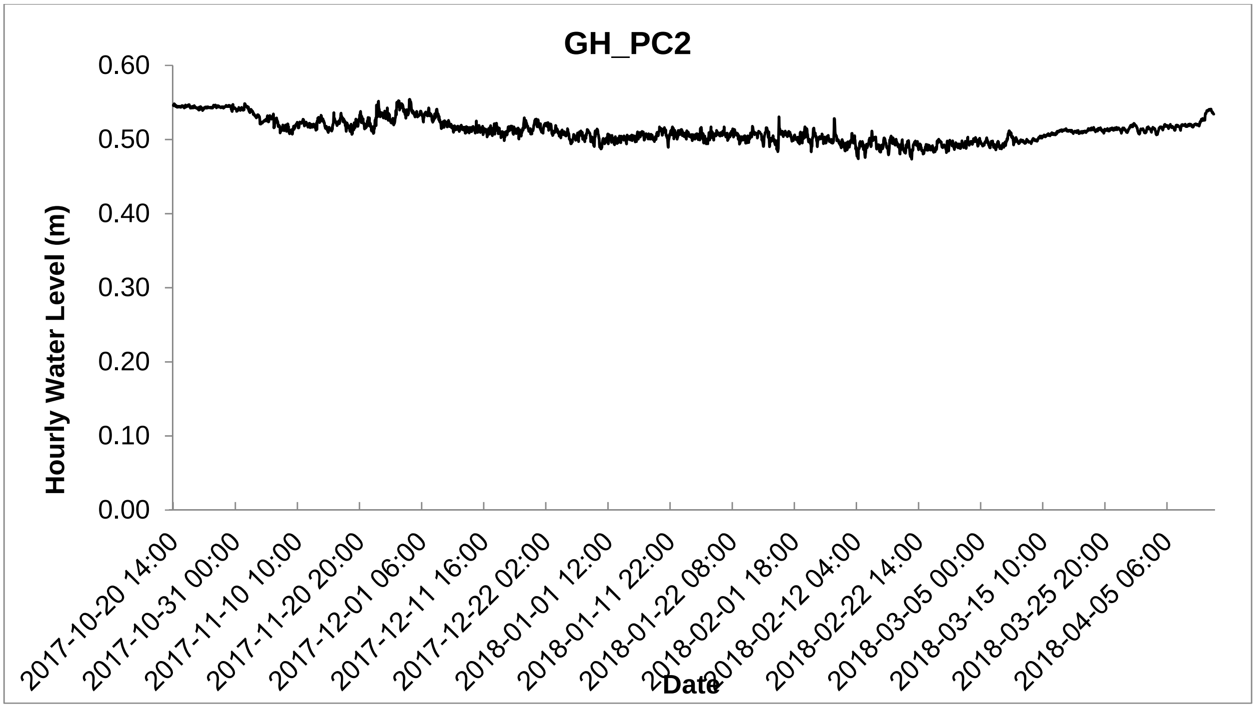


Figure C.13: Continuous Water Level for GH_PC2

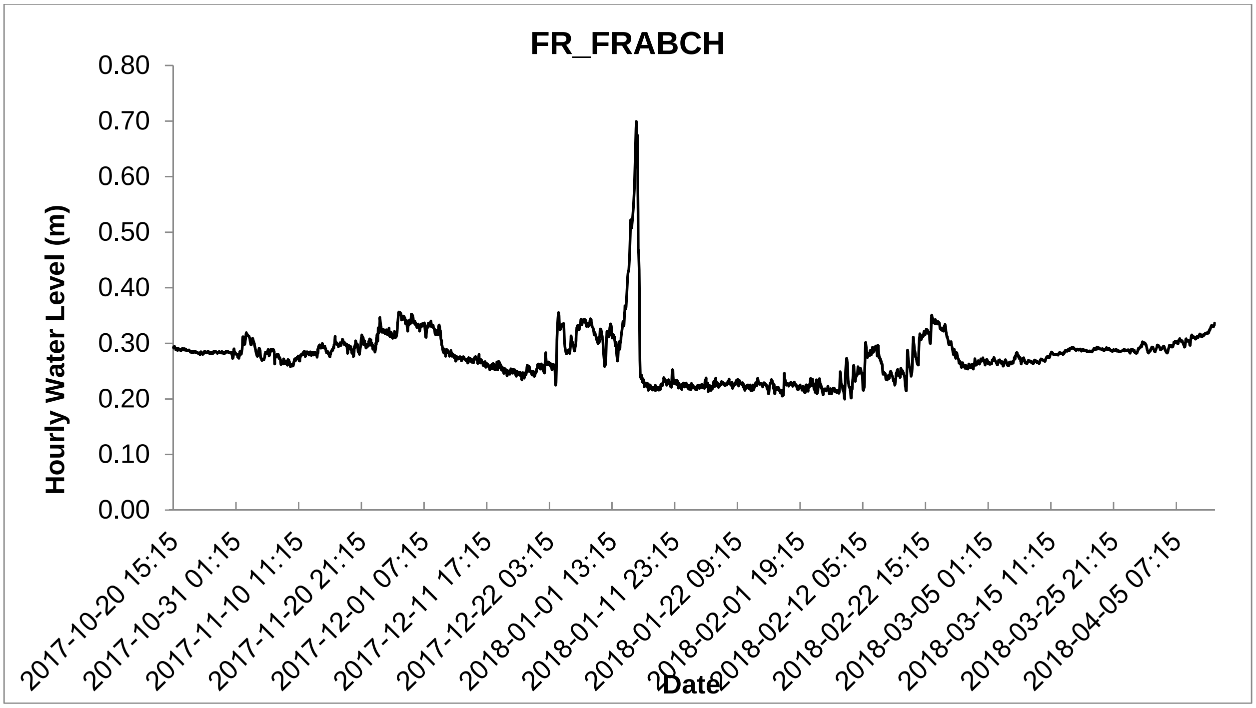


Figure C.14: Continuous Water Level for FR_FRABCH

APPENDIX D
2017 UPDATED MONITORING DESIGN

minnow environmental inc.
A Trinity Consultants Company
2 Lamb Street
Georgetown, Ontario
L7G 3M9
Tel: (905) 873-3371
Fax: (905) 873-6370

September 5, 2017

Ms. Carla Fraser
Manager, Environmental Compliance
Teck Coal Limited
124-B Aspen Drive
PO Box 1777
Sparwood BC,
V0B 2G0

Re: Updated Sampling Design for 2017 FRO LAEMP

Dear Carla,

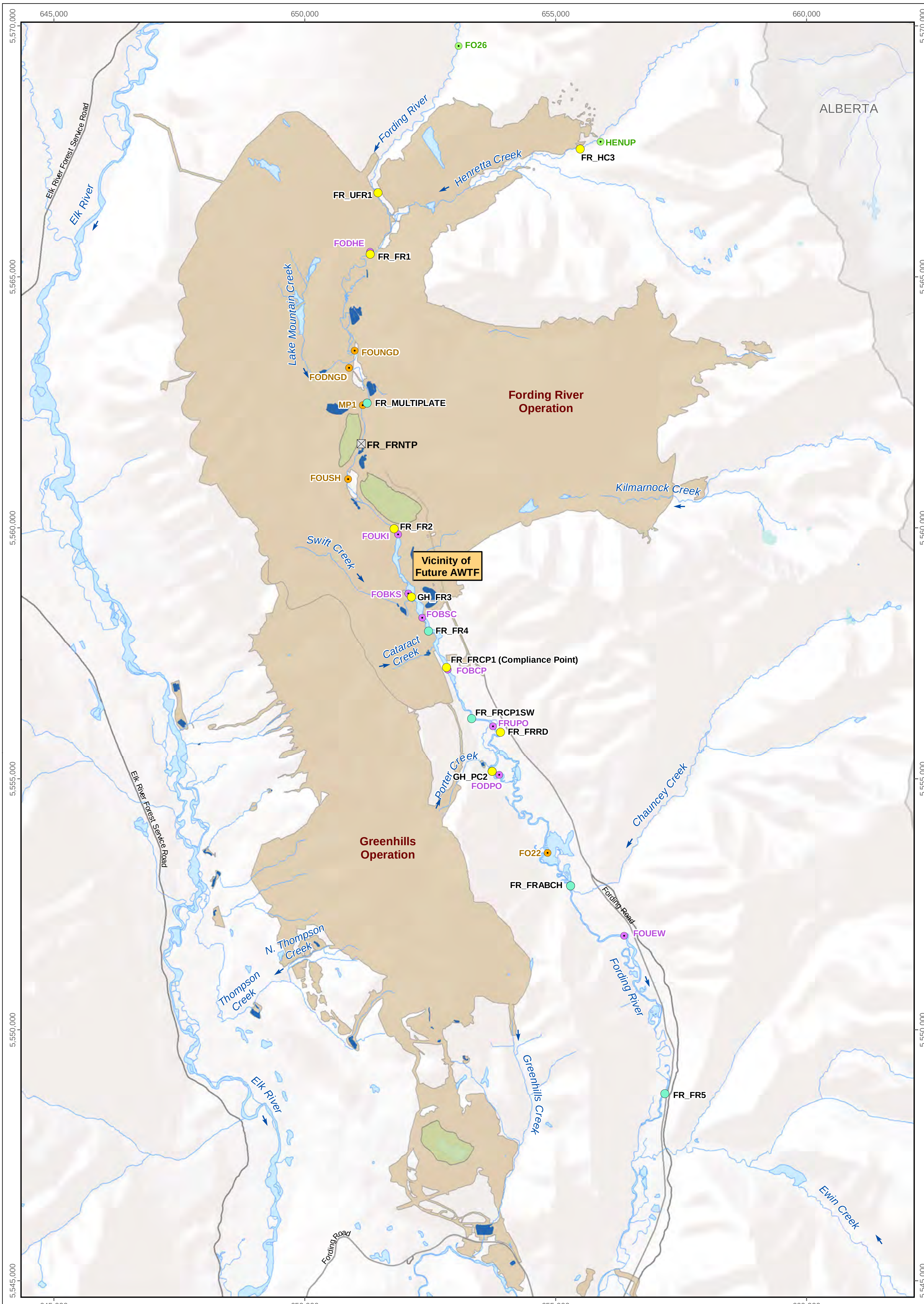
This letter has been prepared in response to discussions with the Environmental Monitoring Committee (EMC) in June regarding the need to update the 2017 Fording River Operation (FRO) Local Aquatic Effects Monitoring Program (LAEMP) sampling design based on findings from the 2016 program and the requirements of the FRO water licensing Operational Environmental Monitoring Program.

The FRO LAEMP design was developed in consultation with the EMC, submitted to the Ministry of Environment and Climate Change Strategy (ENV) in May 2016 (Minnow 2016[1]) in accordance with the requirements of Permit 107517, and subsequently approved by the ENV Director on October 24, 2016. The objective of the LAEMP is to monitor potential aquatic effects related to continued development of FRO and the future commissioning of an active water treatment facility (AWTF) that is planned to treat waters from Cataract, Swift and Kilmarnock creeks (Figure 1). Table 1 presents the scope of biological monitoring that was approved for the FRO LAEMP in 2016. Field work associated with the first cycle of implementation occurred in September, 2016, and the final report of the 2016 FRO LAEMP results was submitted May 31, 2017.

The original study design was intended to cover the 2016 to 2018 time period; however the 2016 LAEMP identified a spatial pattern of decreasing relative Ephemeroptera (mayfly) abundance in the Fording River from upstream of Kilmarnock Creek to between Chauncey and Ewin Creek. The data also suggested that invertebrate abundance and relative Ephemeroptera abundance had declined at many of the Fording River monitoring areas since 2012. The report investigated potential relationships with mine-related stressors (e.g., nitrate, sulphate, and selenium, calcite) and other factors (e.g., water temperatures and flow), but none could conclusively account for the observed patterns in invertebrate data. Based on discussion of the report results and recommendations with the EMC in May and June 2017, it was agreed that the scope of the FRO LAEMP should be modified in 2017 to improve the understanding of cause(s) for the reduced Ephemeroptera abundance.

As discussed, it is proposed that benthic invertebrate sample collection be increased in September as reflected in Table 2.

[1] Minnow Environmental Inc. 2016. Study Design for the Fording Swift Local Aquatic Effects Monitoring Program (LAEMP). Project #167202.0047



LEGEND

- ☒ Hydrometric Station
- Water Monitoring Station (Non-permit)
- Water Monitoring Station (Permit)
- Settling Pond
- Tailings Pond
- Teck Coal Mine Operation

Biological Sampling Area

- Mine-Exposed
- Reference
- RAEMP Only

Monitoring Locations in Upper Fording River

0 1 2 4
km

N E S W

Projection: North American Datum 1983 UTM Zone 11

Date: September 2017
Project 167202.0075

minnow environmental inc.

Figure 1

Document Path: S:\Projects\167202\167202.0075 - Teck FRO 2016 LAEMP\GIS Mapping\Study Design\July 2017 Amendment\16-75 Fig 1.mxd

Table 1: Summary of Biological Monitoring Associated with the FRO LAEMP Study Design Approved in 2016[a]

Location Description		Biological Sampling			September 2016 - 2018			
					Benthic Invertebrates			
		Station ID (Teck water quality Station ID in brackets)	UTM (11U)		Biomass (# of samples annually starting in 2017)	Community (# of samples annually)	Rhyacophilidae Selenium (# of samples annually)	Composite-taxon Selenium (# of samples annually)
			Easting	Northing				
Reference	Fording River upstream of FRO	FO26 (FR_UFR1)	653064	5569601	-	1	1	1
	Henretta Creek upstream of FRO	HENUP	655887	5567716	-	1	1	1
Mine-exposed	Fording River downstream of Henretta Creek	FODHE (FR_FR1)	651295	5565429	-	1	-	-
	Fording River upstream of the proposed AWTF discharge	FOUKI (FR_FR2)	651838	5559855	10	1	1	1
	Fording River immediately downstream of the proposed AWTF discharge	FOBKS	652065	5558691	-	1	-	-
	Fording River between Swift and Cataract	FOBSC (FR_FR4)	652342	5558207	-	1	-	-
	Fording River Compliance Point	FOBCP (FR_FRCP1)	652864	5557150	10	1	1	1
	Fording River downstream of Porter	FODPO (FR_ABCH1)	653901	5555074	-	1	1	1
	Fording River upstream of Ewin Creek	FOUEW (FR_FR5)	656362	5551883	-	1	1	1

[a] The approved design was intended to be applied in 2016 through 2018.

Table 2: Summary of Biological Monitoring Proposed for the 2017 FRO LAEMP

	Location Description	Biological Sampling			Water Quality Sample[a]	Sediment Quality	Benthic Invertebrates					
		Station ID (Teck water quality Station ID in brackets)	UTM (11U)				Hess	Kick and Sweep				
			Easting	Northing			Biomass and community (# of samples annually starting in 2017)	Community (# of samples annually)	Rhyacophilidae Selenium (# of samples annually)	Ephemeroptera Selenium (# of samples annually)	Parapsyche Selenium (# of samples annually)	Composite-taxon Selenium (# of samples annually)
Reference	Fording River upstream of FRO	FO26 (FR_UFR1)	653064	5569601	1	-	10	1	1	1	3	1
Reference	Henretta Creek upstream of FRO	HENUP (FR_HC3)	655887	5567716	1	-	10	1	1	1	3	1
Mine-exposed	Fording River downstream of Henretta Creek	FODHE (FR_FR1)	651295	5565429	1	-	-	1	1	1	3	1
Mine-exposed	Fording u/s North Greenhills Diversion	FOUNGD	650993	5563529	1	-	-	1	1	1	3	1
Mine-exposed	d/s Lake Mountain Creek/ North Greenhills Diversion	FODNGD	650883	5563190	1	-	-	1	1	1	3	1
Mine-exposed	Multiplate Culvert on Greenhills Access Road	MP1 (FR_MULTIPLATE)	651158	5562442	1	-	-	1	1	1	3	1
Mine-exposed	u/s Shandley Cr.	FOUSH (FR_FRNTP)	650863	5560970	1	-	-	1	1	1	3	1
Mine-exposed	Fording River upstream of the proposed AWTF discharge	FOUKI (FR_FR2)	651838	5559855	1	5	10	3	3	3	3	3
Mine-exposed	Fording River immediately downstream of the proposed AWTF discharge	FOBKS (GH_FR3; Historical)	652065	5558691	1	5	10	3	3	3	3	3
Mine-exposed	Fording River between Swift and Cataract	FOBSC (FR_FR4)	652342	5558207	1	-	10	1	1	1	3	1
Mine-exposed	Fording River Compliance Point	FOBCP (FR_FRCP1)	652864	5557150	1	5	10	1	1	1	3	1
Mine-exposed	Fording River ~1150 m downstream of the Compliance Point	FR_FRCP1SW	653324	5556197	1	-	10	1	1	1	3	1
Mine-exposed	Fording River upstream Porter Creek	FRUPO (FR_FRRD)	653899	5555938	1	5	10	1	1	1	3	1
Mine-exposed	Fording River downstream of Porter	FODPO (GH_PC2)	653901	5555074	1	-	-	1	1	1	3	1
Mine-exposed	u/s Chauncey Cr.	FO22 (FR_FRABCH)	654841	5553523	1	5	10	1	1	1	3	1
Mine-exposed	Fording River upstream of Ewin Creek	FOUEW (FR_FR5)	656362	5551883	1	-	-	1	1	1	3	1

RAEMP biological sampling area not formerly included in FRO LAEMP (see Table 1).
New biological sampling area added to the FRO LAEMP.
Additional sampling proposed for 2017 FRO LAEMP compared to design approved in 2016 (see Table 1).
[a] Water sample taken concurrently with biological data.

Table 3: Summary of Water Quality Monitoring Associated with the LAEMP

Location Description	Water Station ID (associated biological Station ID in brackets)	EMS Number	UTM (11U)		Water Quality Samples				Data Logger Install	
			Easting	Northing	Designation	Field parameters[a]	All other parameters required under mine permits[b]	Toxicity[c]	Water Level (Flow)	Temperature
Fording River upstream of FRO	FR_UFR1 (FO26)	E216777	651459	5566677	Reference	M	M	Q[d]	-	-
Henretta Creek upstream of FRO	FR_HC3 (HENUP)	E300096	655489	5567547	Reference	M	M	-	-	-
Fording River downstream of Henretta Creek	FR_FR1 (FODHE)	0200251	651304	5565451	Exposed	M	M	-	-	-
Multiplate Culvert on Greenhills Access Road	FR_MULTIPLATE[e] (MP1)	N/A	651238	5562482	Exposed	M[e]	M[e]	-	-	-
Fording River downstream of the North Tailings Pond	FR_FRNTP[e] (FOUSH)	N/A	651122	5561675	Exposed	M[e]	M[e]	-	-	-
Fording River upstream of the proposed AWTF discharge	FR_FR2 (FOUKI)	0200201	651781	5559984	Exposed	W/M	W/M	-	X	X
Fording River immediately downstream of the proposed AWTF discharge	GH_FR3[e] (FOBKS)	N/A	652125	5558620	Exposed	M[e]	M[e]	-	X	X
Fording River between Swift and Cataract	FR_FR4[e] (FOBSC)	0200311	652464	5557943	Exposed	M	M	-	X	X
Fording River Compliance Point	FR_FRCP1 (FOBCP)	E300071	652823	5557220	Exposed	W/M	W/M	Q	X	X
Fording River ~1150 m downstream of the Compliance Point	FR_FRCP1SW[e]	N/A	653324	5556197	Exposed	M[e]	M[e]	-	X	X
Fording River upstream Porter Creek	FR_FRRD (FRUPO)	E300097	653897	5555925	Exposed	M	M	-	X	X
Fording River downstream of Porter	GH_PC2[e] (FODPO)	E287431	653734	5555147	Exposed	M[e]	M[e]	-	X	X
Fording River u/s Chauncey Cr.	FR_FRABCH[e] (FO22)	N/A	655293	5552865	Exposed	M[e]	M[e]	-	X	X
Fording River upstream of Ewin Creek	FR_FR5[e] (FOUEW)	N/A	657174	5548724	Exposed	M[e]	M[e]	-	-	-

M - monthly; W/M - weekly during freshet (March 15 to July 15); Q - quarterly; S - September (once).

[a] Dissolved oxygen, water temperature, specific conductance, pH.

[b] Total and dissolved metals, total and dissolved organic carbon, nutrients, major ions, etc. as per Table 18 of Permit 107517.

[c] Chronic toxicity as per Permit 107517 requirements.

[d] Not required by Permit 107517, this locaiton is used as a reference location in the chronic toxicity program. Frequency may change depending on the needs of the program.

[e] Non permitted location, frequency may change.

(green box) Water quality sampling location not formally included in FRO LAEMP.

(pink box) Additional sampling proposed for 2017 FRO LAEMP compared to design approved in 2016.

The proposed changes are explained as follows:

- Increase the number of biomass (Hess) sampling areas from two to nine to include the two upstream reference areas (HENUP and FO26) as well as five more mine-exposed areas (FOBKS, FOBSC, FR_FRCP1SW, FRUPO, and FO22; Table 2 compared to Table 1). The proposed sampling areas include those in the original, approved FRO study design. Hess samples yield results for a defined sampling area (i.e., biomass or density per square metre) so replicate samples collected by this method allow for detailed quantification of differences among areas and over time throughout the study area.
- Include five more areas for analysis of community structure and tissue selenium endpoints based on the CABIN kick and sweep sampling method (Environment Canada 2012[2]). The additional areas were sampled as part of the Regional Aquatic Effects Monitoring Program (RAEMP) in 2012 and 2015 (FOUNGD, FODNGD, MP1, FOUSH and FO22; Table 1 and Figure 1). Data from these extra sampling areas will provide more spatial and temporal resolution of community structure and tissue selenium concentrations within the Fording River.
- Include two new area for analysis of community structure and tissue selenium endpoints based on the CABIN kick and sweep sampling method (Environment Canada 2012). These areas are, FR_FRCP1SW and FRUPO (Fording River upstream Porter Creek).
- Collect replicate *Parapsyche* tissue selenium samples at all biological monitoring areas, because these organisms are large enough to be analyzed individually.
- Collect additional samples of individual taxa at all areas for selenium analysis.
- Collect replicate kick samples for community and tissue selenium analysis at the two biological sampling areas that most closely bracket upstream and downstream of the future AWTF discharge (FOUKI and FOBKS) for quality-assurance-quality control purposes.

Also, additional supporting information will be collected by Teck about other potential abiotic stressors that might contribute to the observed biological patterns, which include:

- Measurement of calcite at all biological sampling areas. Teck will be conducting a field audit in fall 2017 to ensure that all consultants are using similar methods for calcite measurement.
- Routine water quality monitoring for permit and non-permit parameters (Table 3).
- Measurement and characterization of sediment within the Fording River at the following locations; FOUKI, FOBKS, FOBCP, FRUPO, and FO22.
- Continued measurement of water temperatures and flow measurements as per Permit 107517 requirements at all permitted water monitoring stations, as well as installation of data loggers (temperature and level) at the following locations (FR_FR2, GH_FR3, FR_FR4, FR_FRCP1, FR_FRCP1SW, FR_FRRD, GH_PC2, FR_FRABCH).
- Evaluation of seasonal dewatering associated with the winter low flow period throughout the study area where changes in benthic invertebrate community structure have been observed. Monthly surveys will begin in Q4 and occur until surface water is fully re-connected in the following March/April. This would include GPS mapping of the wet/dry extents between FR2 and FRABCH, downloading water data logger data, and conducting discharge measurements at the water data logger locations.

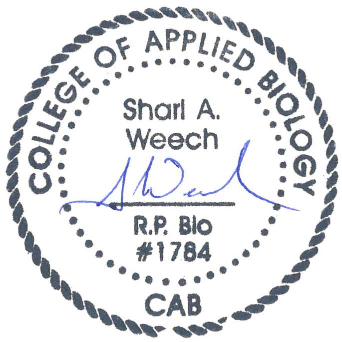
It is expected that the above modifications to the 2017 study design will contribute to better understanding of the decreased Ephemeroptera abundance reported in the 2016 FRO LAEMP study report and support the needs of the FRO water licensing Operational Environmental

[2] Environment Canada. 2012. Field Manual: Wadeable Streams. Canadian Aquatic Biomonitoring Network (CABIN).

Monitoring Program. If you have any questions or comments please do not hesitate to contact either me or Patti Orr.

Sincerely,

Minnow Environmental Inc.



Shari Weech, Ph.D., R.P.Bio.

Senior Aquatic Toxicologist

cc. Patti Orr, Senior Aquatic Scientist

Tyrell Worrall, Aquatic Ecologist