Technical Report Overview

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Teck

Report: Fording River Operations Local Aquatic Effects Monitoring Program (LAEMP) Report, 2016

Overview: This report describes the local aquatic effects monitoring program (LAEMP) being undertaken in relation to continued development of Fording River Operation (FRO) and future 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
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Future studies will be made available at **teck.com/elkvalley**

Fording River Operations Local Aquatic Effects Monitoring Program (LAEMP) Report, 2016

Prepared for:
Teck Coal Limited
Sparwood, British Columbia

Prepared by:
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May 2017

Fording River Operations Local Aquatic Effects Monitoring Program (LAEMP) Report, 2016

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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 (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.

In consideration of potential existing and future mine-related influences at FRO, the following key questions were developed in consultation with the Environmental Monitoring Committee (EMC)[1] to guide 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 key question will be addressed mainly through monitoring of benthic invertebrate community structure as part of annual sampling in the FRO LAEMP in 2016 and 2017, and the combined LAEMP and RAEMP studies in 2018, as well as through Teck's routine water quality monitoring for stations along the upper Fording River and in its tributaries. The last four key questions relate specifically to active water treatment, which is not required by permit to be operational until December 31, 2018. Therefore, the initial years of the FRO LAEMP will include collection of baseline information, to aid in the interpretation of potential changes in aquatic conditions after water treatment commences.

A study design for the FRO LAEMP was submitted in accordance with the permit requirements June 1, 2016, and subsequently approved by MOE October 24, 2016. Biological samples were collected in September, 2016, and results are reported in this document, along with relevant supporting information.

[1] Teck was required to form the EMC as a requirement of Permit 107517. It consists of representatives from the MOE, the Ministry of Energy and Mines, Environment Canada, the Ktunaxa Nation, Interior Health Authority, and the Permittee. The EMC reviews submissions and provides technical input and advice to Teck and the MOE Director on matters related to Permit 107517, including monitoring programs.

Evaluation of data related to Key Question #1 indicated that the benthic invertebrate community in the Fording River is healthy based on total abundance and richness relative to communities in local and regional reference areas. However, changes in community structure from upstream of Kilmarnock Creek to downstream from Chauncey Creek warrant further investigation. Nitrate concentrations (but not likely selenium or sulphate concentrations) may contribute to the spatial pattern of decreasing % Ephemeroptera with distance downstream, but do not explain the apparent change in benthic invertebrate community structure over time. Conversely, temperature trends (and/or associated variation in annual flows) may partially explain the temporal changes in community structure, but do not fully explain the spatial pattern of benthic invertebrate community change observed in the Fording River in 2016. Seasonal dewatering and/or calcite deposition in portions of the Fording River are additional factors potentially influencing benthic invertebrate communities. In consideration of these findings, the FRO LAEMP design will be amended to allow for further investigation of the cause(s) of benthic invertebrate community changes. This will occur in consultation with the EMC prior to implementation of field sampling in September, 2017. The baseline data being collected for addressing Key Questions #2-5 will also be discussed with the EMC, to determine the approach that will be used for data analysis once the AWTF is commissioned and, in that context, consider if any additional modifications to the FRO LAEMP are warranted during the pre-operational baseline period.

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1 INTRODUCTION

1.1 Background

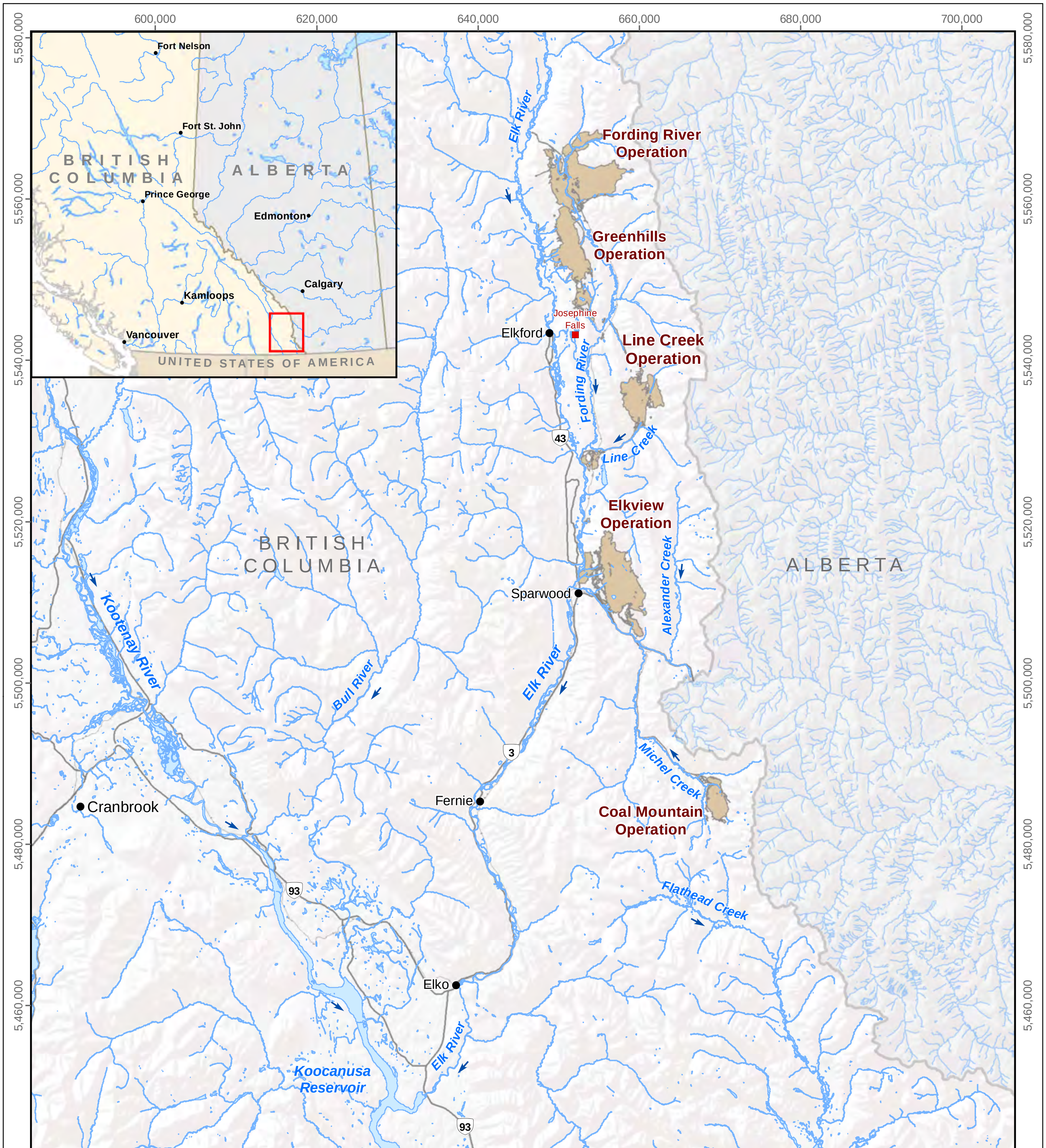
Teck Resources Limited (Teck) operates five, open pit, steelmaking coal mines in the Elk River watershed, which are the Fording River Operation (FRO), Greenhills Operation (GHO), Line Creek Operation (LCO), Elkview Operation (EVO), and Coal Mountain Operation (CMO; Figure 1.1). Discharges from the mines to the Elk River watershed are authorized by the British Columbia Ministry of Environment (BCMOE) through permits that are issued under provisions of the *Environmental Management Act.* Permit 107517, issued November 14, 2015, and recently amended March 1, 2017, specifies the terms and conditions associated with discharges from Teck's five Elk Valley coal 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 coal mines in the Elk Valley (i.e., every three years, with the most recent cycle of sampling completed in 2015). 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:

- Regional Water Quality Monitoring Program
- Regional Flow Monitoring Plan
- Regional Calcite Monitoring Program
- Chronic Toxicity Testing Program
- Regional Fish and Fish Habitat Management Program (RFFHMP)
- Tributary Evaluation and Management Plan

Permit 107517 also requires that Teck develop a local aquatic effects monitoring program (LAEMP) related to ongoing development of Fording River Operation and the future commissioning of an active water treatment facility (AWTF) that will be treating waters from Cataract, Swift and Kilmarnock creeks at FRO (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

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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

Projection: North American Datum 1983 UTM Zone 11

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Figure 1.2

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> *design must be reviewed by the EMC[2] and be designed to an appropriate temporal scale to capture short term, local effects to the immediate receiving environment."*

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

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 first cycle of the FRO LAEMP, encompassing the 2016 to 2018 period, represents a period of baseline monitoring with respect to future active water treatment. In addition to the need to collect 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., redirection 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, a study has been implemented (described herein) to address the key questions described below.

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 2016b):

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?

[2] Teck was required to form the EMC as a requirement of Permit 107517. It consists of representatives from the MOE, the Ministry of Energy and Mines, Environment Canada, the Ktunaxa Nation, Interior Health Authority, and the Permittee. The EMC reviews submissions and provides technical input and advice to Teck and the MOE Director on matters related to Permit 107517, including monitoring programs.

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 key question will be addressed mainly through monitoring of benthic invertebrate community structure as part of annual sampling in the FRO LAEMP in 2016 and 2017, 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. The last four key questions relate specifically to active water treatment, which is not required by the Permit to be operational until December 31, 2018. 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, and weekly from March 15^{th} to July 15^{th}]). Relevant information obtained under other programs, such as the regional calcite and chronic toxicity monitoring programs and the RFFHMP, will be summarized in the LAEMP, as appropriate.

The results of the first year (2016) 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 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. The AMP was submitted to the EMC and BCMOE Director July 31, 2016 as required by the Permit. Study designs for many programs were established before the AMP was submitted. The AMP is currently under review and Teck is working to incorporate input received from the EMC. Teck will work to embed elements of the AMP within each program through reviews of monitoring programs at the study design and annual report stages through implementation of the AMP. Data from the RAEMP and the various LAEMPs will feed into the adaptive management process to specifically address Big Questions #5 (Does monitoring for mine-related effects indicate that the aquatic ecosystem is healthy?) and #2 (Will aquatic ecosystem health be protected by meeting the long-term site performance objectives?). Following an adaptive management framework, evaluation of data collected in 2016 was used to inform adjustments to the 2017 FRO LAEMP study design.

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 model has been updated slightly relative to the version in the study design (Minnow 2016b). 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.

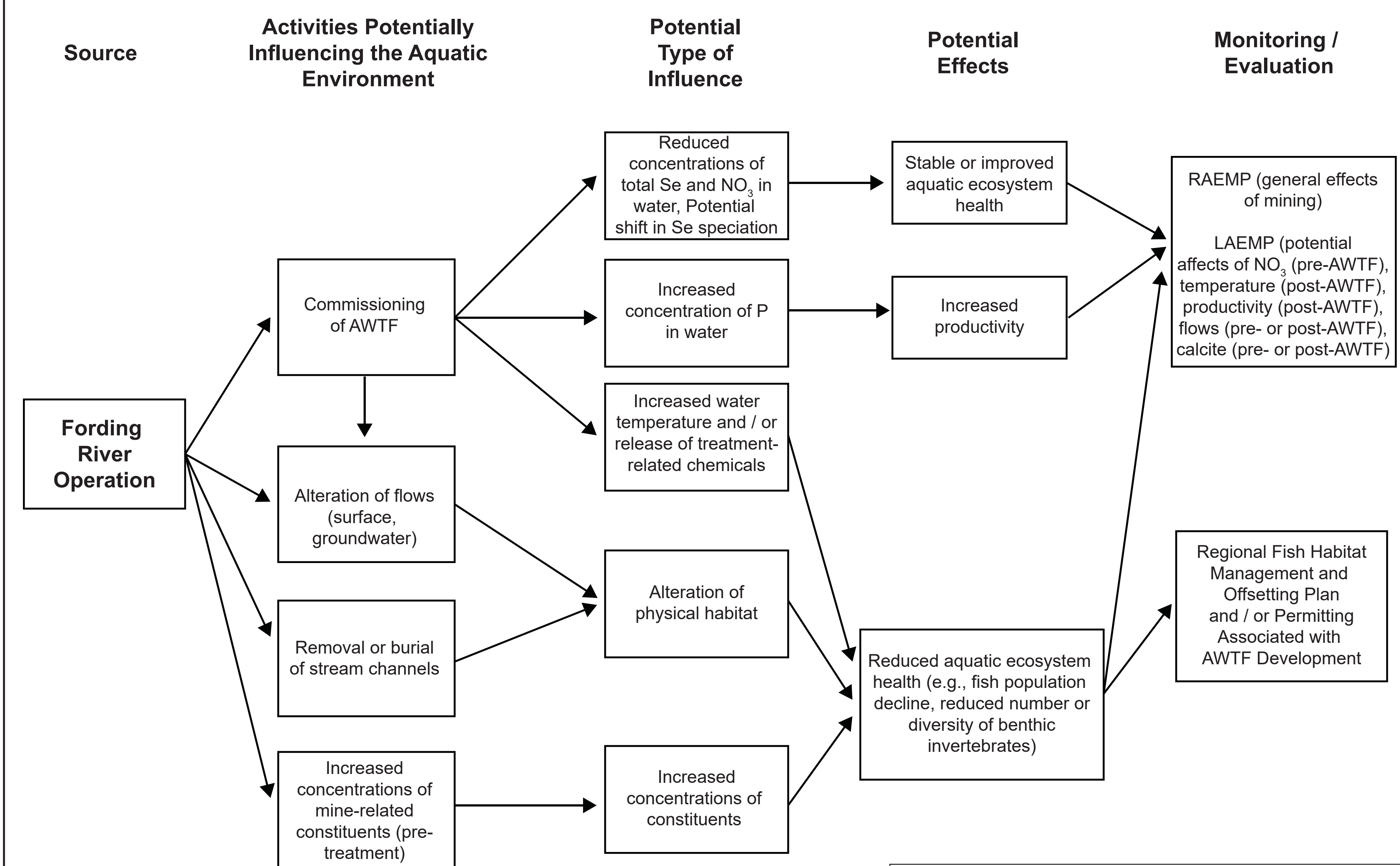
Biological samples were collected on September 12, 2016, from locations along the Fording River extending from the headwaters of Fording River and Henretta Creek (upstream of FRO) through FRO to downstream from Chauncey Creek (Figure 2.2). These locations bracket the location of the future AWTF and the 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 Water Quality and Quantity

MOE's letter approving the FRO LAEMP study design included a requirement to collect water samples concurrently with biological sampling; however, the letter was dated October 24, 2016, and received after the biological sampling was completed for the LAEMP on September 12, 2016. Consequently, concurrent water samples were not collected in 2016. Routine water quality monitoring data collected by Teck were downloaded from Teck's EQuIS^{TM} database for the monitoring stations that correspond to biological sampling areas to include as part of 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, pH, conductivity and dissolved oxygen).

Quality assurance and quality control (QA/QC) associated with water sampling were presented by Teck in annual water quality reports submitted under Permit 107517 (e.g., Teck 2017).



Fording LAEMP Conceptual Site Model

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Figure 2.1

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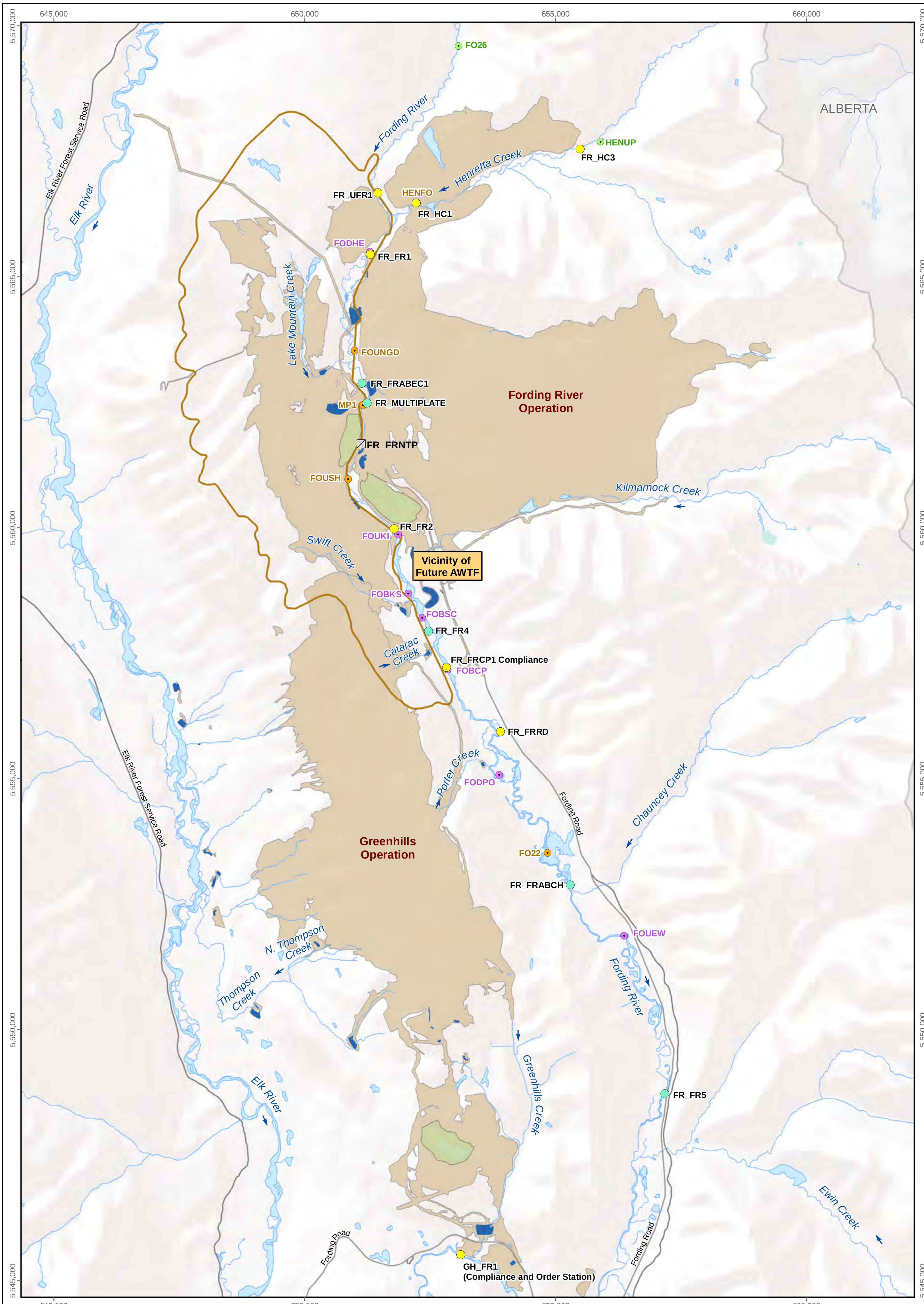
Table 2.1: Summary of the FRO 2016 LAEMP

<table>
<tr><th rowspan="2">Key Questions</th><th rowspan="2">Context</th><th rowspan="2">Assessment Endpoints</th><th colspan="4">Measurement Endpoints</th><th rowspan="2">How Data Were Evaluated to Address Key Question</th></tr>
<tr><th>Water</th><th>Water Sampling Stations</th><th>Biological</th><th>Biological Sampling Areas</th></tr>
<tr><td>Are nitrate concentrations increasing and, if so, are they adversely affecting aquatic biota?</td><td>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.</td><td>Benthic invertebrate community health relative to nitrate concentrations in the Upper Fording River.</td><td>Nitrate concentrations in water (see Table 2.3 for sampling frequency), surface water chronic toxicity tests (quarterly and semi-annually)</td><td>FR_UFR1, FR_FR1, FR_FR2, FR_FR4, FR_FRCP1, FR_FRRD, FR_FRABCH, FR_FR5; Chronic toxicity tests at FR_UFR1 and FR_FRCP1 only</td><td>Benthic invertebrate community structure (annually)</td><td>FO26 (Ref), HENUP (Ref), FODHE, FOUKI, FOBKS, FOBSC, FOBCP, FODPO, FOUEW</td><td>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.
4. (NEW) Investigate other potential factors affecting benthic invertebrate communities (e.g., water constituents, temperature, flow, calcite).</td></tr>
<tr><td rowspan="3">What are the baseline conditions for water quality, biological productivity and tissue selenium concentrations pre-AWTF?</td><td rowspan="3">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.</td><td>Biological productivity downstream from the AWTF discharge post- compared to pre-AWTF commissioning and relative to productivity observed upstream from the discharge.</td><td>Nutrient concentrations (see Table 2.3 for sampling frequency)</td><td>FR_UFR1, FR_FR2, FR_FR4, FR_FRCP1, FR_FRRD, FR_FRABCH, FR_FR5</td><td>Benthic invertebrate biomass (annually starting in 2017), benthic invertebrate community structure (annually)</td><td>Community - as above; Biomass - FOUKI, FOBCP</td><td>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.</td></tr>
<tr><td>Tissue selenium concentrations downstream from the AWTF discharge post- compared to pre-AWTF commissioning and relative to concentrations observed upstream from the discharge.</td><td>Total and dissolved selenium concentrations (see Table 2.3 for sampling frequency); Selenium speciation, if required, when treatment begins</td><td>FR_UFR1, FR_FR2, FR_FR4, FR_FRCP1, FR_FRRD, FR_FRABCH, FR_FR5; Locations for Se speciation work need to be determined</td><td>Benthic invertebrate tissue selenium (composite and single taxon samples, annually), WCT tissue samples (once every three years as part of the RAEMP)</td><td>Invertebrate tissue - FO26, HENUP, FOUKI, FOBCP, FOUEW; WCT - Fording River u/s of Josephine Falls</td><td>Pre-AWTF Commissioning - Continue to collect baseline tissue selenium data from benthic invertebrates sampled upstream and downstream of the future treatment system discharge.</td></tr>
<tr><td>Potential thermal effects or other treatment related constituents of interest on biota downstream from the AWTF.</td><td>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)</td><td>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</td><td>Benthic invertebrate community structure (annually)</td><td>FOUKI, FOBKS, FOBSC, FOBCP, FODPO, FOUEW</td><td>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.</td></tr>
<tr><td>Is re-direction of water potentially affecting biota in the Fording River?</td><td>As mining development progresses, water will be re-routed and alter water flows in the Upper Fording River compared to current conditions.</td><td>Potential effects on fish populations</td><td>To be determined</td><td>To be determined</td><td>To be determined</td><td>To be determined</td><td>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.</td></tr>
</table>



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

Biological Sampling Area

- Mine-Exposed
- Reference
- RAEMP Only

- Fording Swift Project Footprint
- 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 FRO LAEMP

Watershed	Program	Exposure Status	Minnow Biological Monitoring Area	Biological Monitoring Area UTM Coordinates		Associated Teck Water Monitoring Station Code	Description
				Easting	Northing		
Fording River	FRO LAEMP Biological Monitoring	Reference	FO26	653049	5569608	FR_UFR1	Fording River u/s Henretta (u/s all mines)
		Reference	HENUP	655782	5567704	FR_HC3	Henretta Creek u/s all mine operations
		Exposed	FODHE	651311	5565421	FR_FR1	Fording River d/s Henretta Creek
		Exposed	-	-	-	FR_FRNTP (Flow Only)	Maintenance shops near North Tailings Pond
		Exposed	FOUKI	651841	5559848	FR_FR2	Fording River u/s Kilmarnock Creek
		Exposed	FOBKS	652084	5558649	-	Fording River between Kilmarnock Creek & Swift Creek
		Exposed	FOBSC	652340	5558197	FR_FR4 [a]	Fording River d/s Swift Creek, u/s Cataract Creek
		Exposed	FOBCP	652865	5557150	FR_FRCP1[b] (Compliance)	Fording River between Cataract & Porter Creek
		Exposed	-	-	-	FR_FRRD	Fording River near Fording River Road
		Exposed	FODPO	653899	5555080	FR_FRABCH [a]	Fording River d/s Porter Creek, u/s Chauncey Creek
		Exposed	FOUEW	656360	5551884	FR_FR5 [a]	Fording River d/s Chauncey Creek, u/s Ewin Creek
	RAEMP Biological Monitoring	Exposed	HENFO	652236	5566472	FR_HC1	Henretta Creek u/s confluence with Fording River
		Exposed	FOUNGD	650993	5563529	FR_FRABEC1 [a]	Fording River u/s NGD
		Exposed	MP1	651158	5562442	FR_MULTIPLATE [a]	Fording Multiplate d/s Eagle Ponds
		Exposed	FOUSH	650863	5560970	-	Fording River u/s Shandley Creek
		Exposed	FO22	654794	5553614	-	Fording River upstream of Chauncey Creek

[a] Monitoring not required under permits.
[b] Includes flow monitoring at this station.

Table 2.3: 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			
			Easting	Northing	Designation	Field parameters[a]	Toxicity	All other parameters required under mine permits[b]
Fording River upstream of FRO	FR_UFR1 (FO26)	E216777	651459	5566677	Reference	M	Q[e]	M
Henretta Creek upstream all mine operations	FR_HC3 (HENUP)	-	655782	5567704	Reference	M[c]	-	M
Fording River downstream of Henretta Creek	FR_FR1 (FODHE)	0200251	651304	5565451	Exposed	M	-	M
Maintenance shops near North Tailings Pond	FR_FRNTP	-	651121	5561676	Exposed	Flow Only	-	-
Fording River upstream of the proposed AWTF	FR_FR2 (FOUKI)	0200201	651781	5559984	Exposed	W/M	-	W/M
Fording River between Swift and Cataract	FR_FR4[c] (FOBSC)	-	652503	5558088	Exposed	M[c]	-	M[c]
Fording River Compliance Point	FR_FRCP1[d] (FOBCP)	E300071	652823	5557221	Exposed	W/M	Q	W/M
Fording River	FR_FRRD	E300097	653897	5555925	Exposed	M	-	M
Fording River downstream of Porter and upstream of Chauncey	FR_FRABCH[c] (FODPO)	-	655293	5552865	Exposed	M[c]	-	M[c]
Fording River upstream of Ewin Creek	FR_FR5[c] (FOUEW)	-	657174	5548723	Exposed	M[c]	-	M[c]

M - monthly; W - weekly during freshet (March 15 to July 31); Q - quarterly.

[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] Not a permitted location, monthly sampling planned but frequency may change.

[d] Includes flow monitoring data.

[e] Non permited toxicity testing.

Flow data were downloaded from the Water Survey of Canada for station 08NK018, located near the mouth of the Fording River. Data were obtained for the period 2012 to 2016 to correspond with the period of biological data presented in this report.

2.3 Benthic Invertebrates

2.3.1 Community Structure

2.3.1.1 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 2.4).

2.3.1.2 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 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 B).

2.3.1.3 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, 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).

Table 2.4: Summary of Biological Monitoring Associated with the LAEMP

Location Description		Biological Sampling			September 2016		
					Benthic Invertebrates		
		Biological Area Code (Teck water quality station code in brackets)	UTM (11U)		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 (FR_HC3)	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	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	1	1	1
	Fording River downstream of Porter	FODPO (FR_FRABCH)	653901	5555074	1	1	1
	Fording River upstream of Ewin Creek	FOUEW (FR_FR5)	656362	5551883	1	1	1

An adaptation of the Wolman pebble count was used to characterize calcite deposition by also recording the presence (score = 1) or absence (score = 0) of calcite on each particle, and the degree of concretion was assessed by determining if the particle was removed with negligible resistance (not concreted; score = 0), noticeable resistance but removable (partially concreted; score = 1), or immovable (fully concreted; score = 2). Substrate that was too fine to be retrieved (e.g., sand, silt), and to visually discern calcite presence/absence was noted, and then additional particles were sampled until calcite scores were obtained for 100 particles. The results for the 100 particles were then expressed as a Calcite Index (CI) based on the following equation (Teck 2016a):

$$CI = CI_p + CI_c$$

Where:

$$CI = Calcite\ Index$$

$$CI_p = Calcite\ Presence\ Score = \frac{Number\ of\ particles\ with\ calcite}{100}$$

$$CI_c = Calcite\ Concretion\ Score = \frac{Sum\ of\ particle\ concretion\ score}{100}$$

2.3.2 Tissue Selenium

2.3.2.1 Sample Collection

Benthic invertebrate samples were collected for selenium analysis from all areas (Table 2.4) using the kick sampling method described in Section 2.3.1, except that the samples were not timed. Two samples were collected for analysis of tissue selenium, including:

- A composite sample of benthic invertebrate taxa; and
- A sample of Rhyacophilidae, which is a taxon that has been commonly observed among areas within the Elk River watershed and is easy to identify in the field without the aid of a microscope.

Invertebrates were picked free of debris in the field, placed into a sterile labelled cryovial and stored in a cooler with ice packs until they were transferred to a freezer later in the day. About 2 g of wet tissue were collected for each sample, where possible.

2.3.2.2 Laboratory Analysis

Tissue samples were kept in a freezer until they could be transported by courier in coolers with ice packs to the University of Missouri's Research Reactor Center in Columbia, Missouri, where they were freeze-dried and analyzed for selenium using Neutron Activation Analysis (NAA). Results were reported on a dry weight (dw) basis.

2.4 Data Analysis

2.4.1 Key Question #1: Potential Effects of Nitrate

Key Question #1 is: "Are nitrate concentrations increasing, and if so, are they adversely affecting biota?" To address this question, aqueous nitrate concentrations in the Fording River were evaluated by Golder (2017a) relative to projections made in the EVWQP (Teck 2014). Also, potential temporal trends in aqueous nitrate concentrations were assessed using the non-parametric 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 2016) following the methods described in Hirsch et al. (1982) and are applicable for data sets with missing data and values below analytical detection limits (DL).

Nitrate concentrations in water downloaded from Teck's EQuIS™ database and 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).

Table 2.5: Level 1 (10%) and Level 2 (20%) Effect Benchmarks Identified in the Elk Valley Water Quality Plan

<table>
<tr><th>Type</th><th>Constituent</th><th>Concentration</th><th>Units</th></tr>
<tr><td rowspan="4">Water</td><td>Selenium - total</td><td>70</td><td>µg/L</td></tr>
<tr><td rowspan="2">Nitrate-N[a]</td><td>Level 1: $10^{1.0003[\log(\text{hardness})]-1.52}$</td><td rowspan="2">mg/L</td></tr>
<tr><td>Level 2: $10^{1.0003[\log(\text{hardness})]-1.38}$</td></tr>
<tr><td>Sulphate</td><td>Level 1: 429</td><td>mg/L</td></tr>
<tr><td>Tissue</td><td>Selenium</td><td>Level 1: 13
(for effects to invertebrates)</td><td>mg/kg dw</td></tr>
</table>

[a] maximum hardness used in derivation of benchmark is 500 mg/L.

Benthic invertebrate community endpoints of total sample abundance, richness (LPL taxonomy), percent (%) Ephemeroptera-Plecoptera-Trichoptera[3] (EPT), and % Ephemeroptera were computed for each monitoring area. Values were compared to normal (reference area) ranges defined as the 2.5th and 97.5th percentiles, after outlier removal, of values observed at 40 reference areas sampled in both 2012 and 2015 as part of the RAEMP (Minnow, in preparation).

As part of the further investigation of Key Question #1 (Section 2.1), additional data (sulphate, selenium) were obtained from Teck's EQuIS™ database and plotted relative to EVWQP Level 1 benchmarks. Calcite indices associated with benthic invertebrate samples collected in the LAEMP were compared to values reported in Teck's regional calcite monitoring program 2013-2016 (Lotic Environmental 2014-2017). 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, in preparation);
- the MOE guideline for benthic invertebrate tissue of 4 mg/kg dw (BCMOE 2012); 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; Table 2.5; Golder 2014b).

2.4.2 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?" This question will be addressed after the AWTF is commissioned. In the meantime, 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. Baseline biological sampling to support future evaluation of potential effects of the AWTF on productivity will begin in 2017.

2.4.3 Key Question #3: Potential Effects of AWTF on Tissue Selenium Accumulation

Key Question #3 is: "Are tissue selenium concentrations reduced downstream from the AWTF?" This question will be addressed after the AWTF is commissioned. In the meantime, existing benthic invertebrate tissue selenium data were plotted relative to the normal (reference area) range[4], BC tissue selenium guideline (BCMOE 2014), and the EVWQP Level 1 benchmarks for

[3] Mayflies, stoneflies, and caddisflies

[4] Characterized as part of the 2015 RAEMP cycle (Minnow, in preparation). Normal ranges are defined as the 2.5th and 97.5th percentile, after outlier removal, of data from regional reference areas that are uninfluenced by mining.

effects to invertebrates (Golder 2014b) to address Key Question #1 (Section 2.4.1) and the same results will serve as baseline data for addressing Key Question #3 once the AWTF begins operation. Baseline data for tissue selenium concentrations measured in cutthroat trout in the 2015 RAEMP cycle and in previous studies were also plotted relative to the corresponding normal range, the BC tissue selenium guideline, and the Level 1 benchmark. Tissue concentrations measured in invertebrates and westslope cutthroat trout were compared to ranges predicted in the Elk Valley water quality plan (Teck 2014).

2.4.4 Key Question #4: Potential Effects of AWTF on Water Temperature

Key Question #4 is: “Is AWTF operation affecting aquatic biota through thermal effects or concentrations of treatment-related constituents other than nutrients or selenium?” This question will be addressed after the AWTF is commissioned. In the meantime, plots were prepared to illustrate the current availability of baseline data; monitoring will continue through the baseline period.

2.4.5 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?” This question will be addressed after the AWTF is commissioned. In the meantime, plots were prepared to illustrate the current availability of baseline data, and monitoring will continue through the baseline period. Also, evaluation of seasonal flows in the Fording River will continue during the baseline period in support of the investigation undertaken to address Key Question #1 (Section 3).

3 NITRATE CONCENTRATIONS AND INVERTEBRATE COMMUNITIES

This section evaluates existing data related to Key Question #1: Are nitrate concentrations increasing and, if so, are they adversely affecting aquatic biota? (Section 2.1). This question arose because, in the EVWQP, nitrate concentrations in the Fording River were projected to increase over time until treatment is implemented (Teck 2014). Permit 107517 requires the AWTF, which will reduce concentrations of both selenium and nitrate, to be operational by December 31, 2018. There is concern that, in the interim period, concentrations could rise to levels potentially affecting aquatic biota. Nitrate concentrations were evaluated spatially in the Fording River (upstream to downstream, as per locations on Figure 2.2) in 2016, and temporally (2012 to 2016) to determine if nitrate concentrations are: a) increasing over time in a manner consistent with EVWQP projections; and b) currently above levels that may potentially affect aquatic biota in areas of the Fording River, and, if so, is there evidence of biological effects, as indicated by benthic invertebrate community endpoints.

3.1 Nitrate Concentrations Relative to Projections

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 2017a). 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 were lower than model projections in 2015 and 2016 (Figure 3.1).

Nitrate concentrations for monitoring stations in the upper Fording River reflected varying temporal patterns over the period 2012 to 2016, with small increasing trends observed at the upstream reference stations (but still below the BC Water Quality Guideline of 2 μg/L), greater increasing trend at FR_FR2, and a decreasing trend at FR_FR1 (Table 3.1). At stations farther downstream, no trend was indicated, although data were limited for some stations (FR_FRCP1, FR_FRRD, and FR_FRABCH) where monitoring began only in the last 2-3 years.

Nitrate concentrations 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 3.2). The annual medians of monthly average nitrate concentrations in 2016 were near or

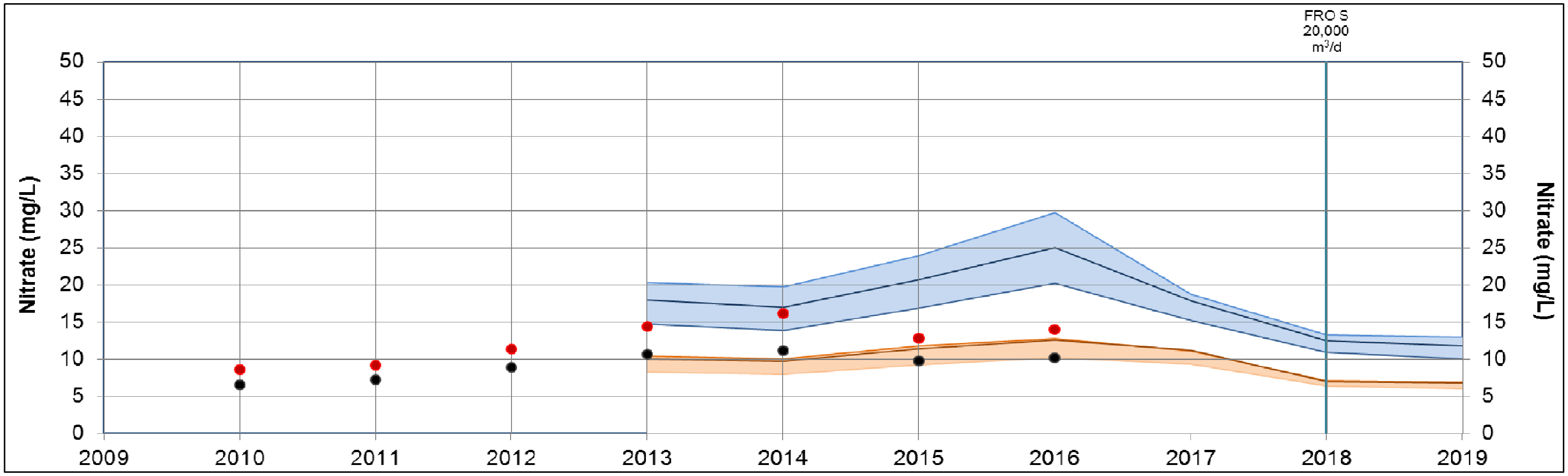

Figure 3.1: Observed (Circles) Versus Modelled (Coloured Bands) Concentrations of Nitrate at GHO Fording River Compliance Point GH_FR1 (From Golder 2017)

Note:

FRO S = FRO South AWTF.

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.

Table 3.1: Seasonal-Kendall Tests for Trends in Monthly Mean Aqueous Concentrations of Nitrate, Selenium, Sulphate, and Temperature from 2012 to 2016

Type	Station	n Samples	n Years	Nitrate			Selenium			Sulphate			Temperature		
				P-Value	Estimated Slope		P-Value	Estimated Slope		P-Value	Estimated Slope		P-Value	Sen's Slope	
					(mg/L-N) per year	(%) per year		(µg/L) per year	(%) per year		(mg/L) per year	(%) per year		°C change per year	% change per year
Reference	FR_UFR1	60	5	<0.001	0.013	91	0.012	0.023	7.1	0.016	0.92	8.3	0.037	0.06	0.0
Reference	FR_HC3	48	5	<0.001	0.022	24	<0.001	0.042	11	0.070	1.3	7.5	0.178	-	-
Mine-Exposed	FR_FR1	45	5	0.009	-0.20	-15	0.933	-	-	0.450	-	-	0.007	0.49	16.0
Mine-Exposed	FR_FR2	60	5	<0.001	0.84	17	0.944	-	-	0.888	-	-	0.063	0.31	11.0
Mine-Exposed	FR_FR4	55	5	0.187	-	-	0.103	-	-	0.244	-	-	0.019	0.41	11.0
Mine-Exposed	FR_FRCP1	23	2	1.000	-	-	0.070	-20	-25	0.228	-	-	0.752	-	-
Mine-Exposed	FR_FRRD	25	2	0.794	-	-	0.794	-	-	0.794	-	-	1.000	-	-
Mine-Exposed	FR_FRABCH	20	2	1.000	-	-	1.000	-	-	1.000	-	-	0.054	0.38	14.0
Mine-Exposed	FR_FR5	54	5	0.808	-	-	0.570	-	-	0.015	5.0	4.0	0.135	-	-

= P-value < 0.1

Figure 3.2: **Nitrate Concentrations in the Fording River Water Samples in 2012 to 2016**

Notes: Compared to Level 1 and 2 Hardness-Based Benchmarks from the EVWQP ($10^{1.0003*\log10(hardness)-1.52}$ and $10^{1.0003*\log10(hardness)-1.38}$, Respectively) greater than the Level 1 benchmark at most stations, but were consistently less than the Level 2 benchmark (Figure 3.3).

3.2 Benthic Invertebrate Communities versus Nitrate Concentrations

Although the evaluation in Section 3.1 indicated that nitrate concentrations in water have not been increasing over time at mine exposed areas, (except at FR_FR2), it showed that annual average concentrations in 2016 were near or above the Level 1 benchmark for potential effects to benthic invertebrates. Benthic invertebrate data were evaluated to determine if community characteristics have potentially been affected as part of the evaluation related to Key Question #1.

Total invertebrate sample abundance and LPL richness were generally within normal (reference area) ranges at all monitoring areas included in the Fording River LAEMP. Percent (%) EPT (mayflies, stoneflies, and caddisflies) and/or % Ephemeroptera (mayflies) were below normal ranges at some mine-exposed areas of the Fording River, suggesting potential effects on community structure at those locations (Figure 3.4). Furthermore, a distinct decline in % Ephemeroptera was indicated with distance downstream.

Overall, the data indicated that the benthic invertebrate community in the Fording River is healthy based on total abundance and richness relative to communities in local and regional reference areas; however there was a shift in the community structure indicated by decreasing % Ephemeroptera with distance downstream (Figure 3.4). This pattern of results was further investigated with respect to potential cause(s) and in consideration of implications to other components of the aquatic ecosystem in the upper Fording River. For example, the areas of the Fording River showing changes to benthic invertebrate community structure (FOUKI to FOUEW; Figure 2.2) overlap with habitats used by the upper Fording Westslope cutthroat trout population for summer rearing, overwintering, and spawning (Westslope Fisheries 2016). The westslope cutthroat trout population continues to be monitored in accordance with approaches used previously by Westslope Fisheries (2016). Specifically, snorkel surveys of sub-adults and adults, as well as 3-pass electrofishing removal depletion of fry and juveniles will occur in 2017, 2019, and 2021 to monitor trends in population characteristics. The results will be included in future LAEMP reports and discussed with the EMC as they become available.

The observed spatial pattern of benthic invertebrate community response corresponded to the increase in median nitrate concentrations with distance downstream shown in Figure 3.3, suggesting a potential relationship[5]. Laboratory chronic toxicity tests of water samples collected quarterly at the Fording River Compliance Point (FR_FRCP1) have shown evidence of adverse

[5] Also, Appendix Figures A.2 and A.3 overlay benthic invertebrate community results (%ETP and %E, respectively) on the graphs of aqueous nitrate concentraitons presented in Figure 3.2.

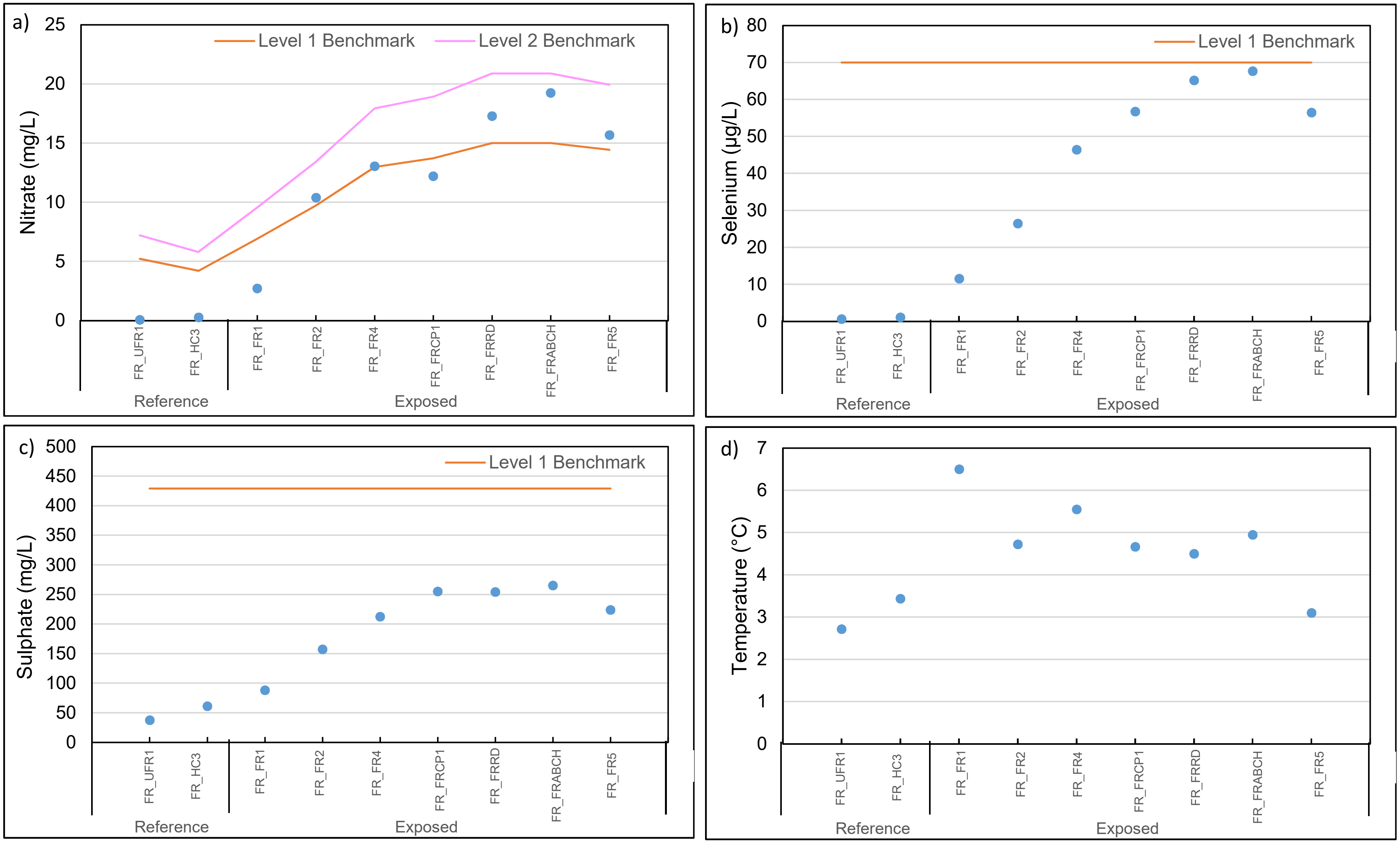

Figure 3.3: Median Water Quality Concentrations of Selected Parameters in the Fording River in 2016

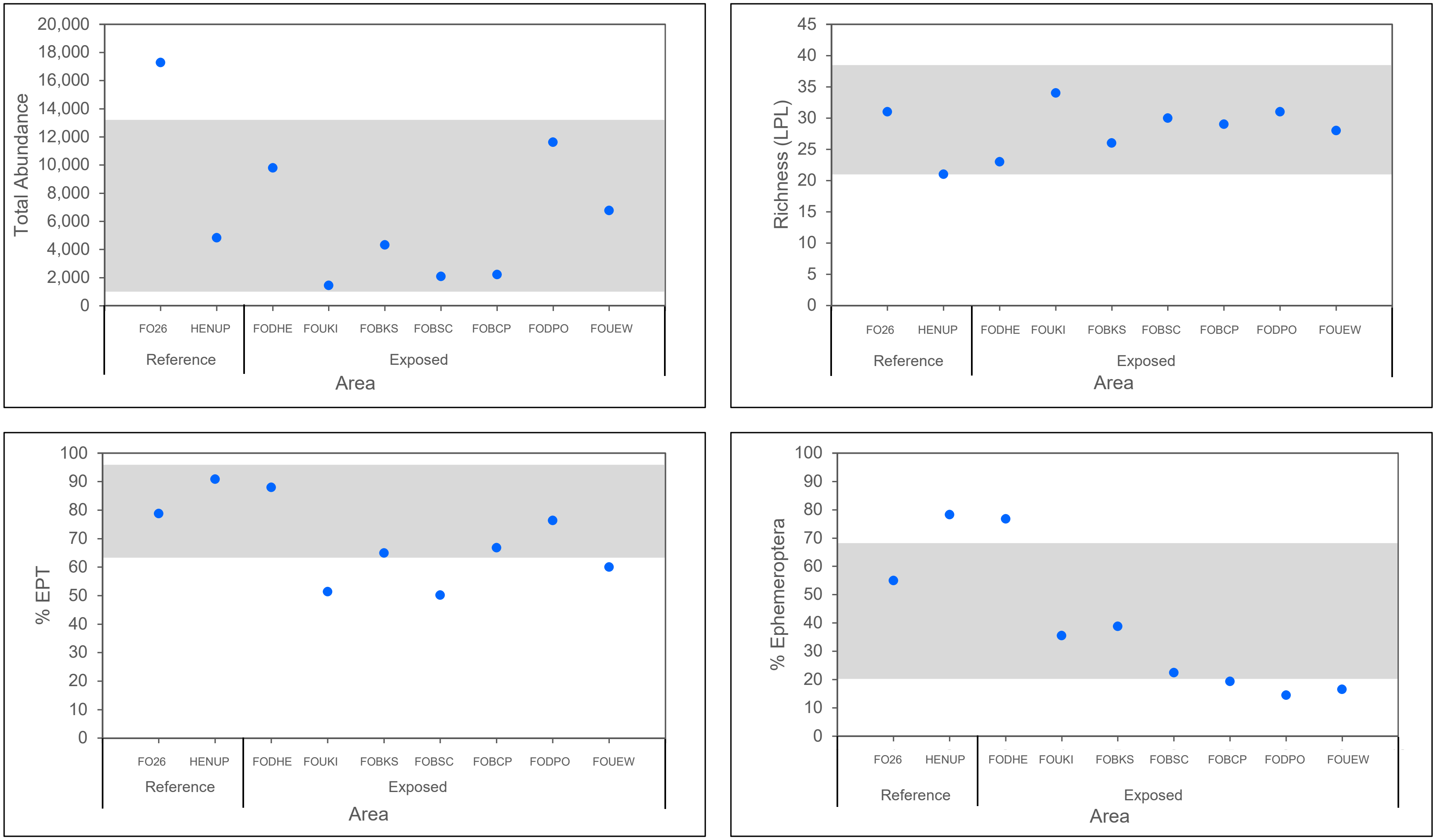

Figure 3.4: Plots of Benthic Invertebrate Community Endpoints for Areas of the Fording River Monitored in the 2016 LAEMP

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values. Water monitoring station closest to biological monitoring area: FO26:FR_UFR1, HENUP:FR_HC3, FODHE:FR_FR1, FOUKI:FR_FR2, FOBKS: no water quality station, FOBSC:FR_FR4, FOBCP:FR_FRCP1, FODPO:FR_FRABCH, FOUEW:FR_FR5.

effects to invertebrates (e.g., *C. dubia, H. azteca*) (Golder 2017b). However, water quality and quantity monitoring data have indicated that surface water flow at that station is predominantly discharge water from Cataract Creek during winter low flow months and is not representative of conditions in the Fording River (Golder 2017a,b; and as per communications with MOE). At GH_FR1 farther downstream (Figure 2.2), where nitrate concentrations have been less than projected in the EVWQP (Section 3.1), adverse effects to invertebrates were evident in tests in the second quarter of 2016 only, and no specific water quality parameter was conclusively identified as the cause (Golder 2017b).

The same benthic invertebrate community endpoints were compared over time (Figures 3.5 to 3.8), including data for areas sampled only in the 2012 and 2015 RAEMP cycles (FOUNGD, MP1, FOUSH, and FO22; Figure 2.1) to provide further spatial resolution of potential community changes over time. The data suggested a potential pattern of decreasing abundance, %EPT, and %Ephemeroptera over time at biological monitoring areas from FOUKI to FOUEW (Figures 2.2 and 3.5 to 3.8). Therefore, although a potential spatial relationship was observed involving decreasing % Ephemeroptera with increasing nitrate concentrations as stations progressing downstream from FRO, a temporal relationship was not evident (i.e., potential decline in % Ephemeroptera over time was not supported by increasing aqueous nitrate concentrations over time). Therefore, other factors that may have influenced benthic invertebrate community structure were investigated.

3.3 Other Factors Potentially Influencing Benthic Invertebrate Communities

As nitrate concentrations did not fully explain the observed spatial and temporal differences in benthic community structure among sampling areas in the upper Fording River, the evaluation related to Key Question #1 was expanded to consider other potential causes.

Selenium and sulphate are the other mine-related water quality constituents that are sometimes found at concentrations above site-specific effect benchmarks or guidelines in the Elk River watershed (Teck 2016b, 2017, and Minnow 2016a). Selenium concentrations in water were occasionally above EVWQP Level 1 benchmarks (Figure 3.9). Annual median concentrations followed a similar spatial pattern to nitrate of increasing concentrations with distance downstream in the Fording River but did not exceed the Level 1 benchmark (Figure 3.3). Also, concentrations of selenium in the tissues of benthic invertebrates did not follow the same spatial pattern (e.g., maximum tissue selenium concentrations were near the Fording River Compliance Point [FOBCP; Table 3.2], whereas % Ephemeroptera was lowest and median nitrate and selenium concentrations in water were highest farther downstream at FODPO/FR_FRRD). Also, tissue

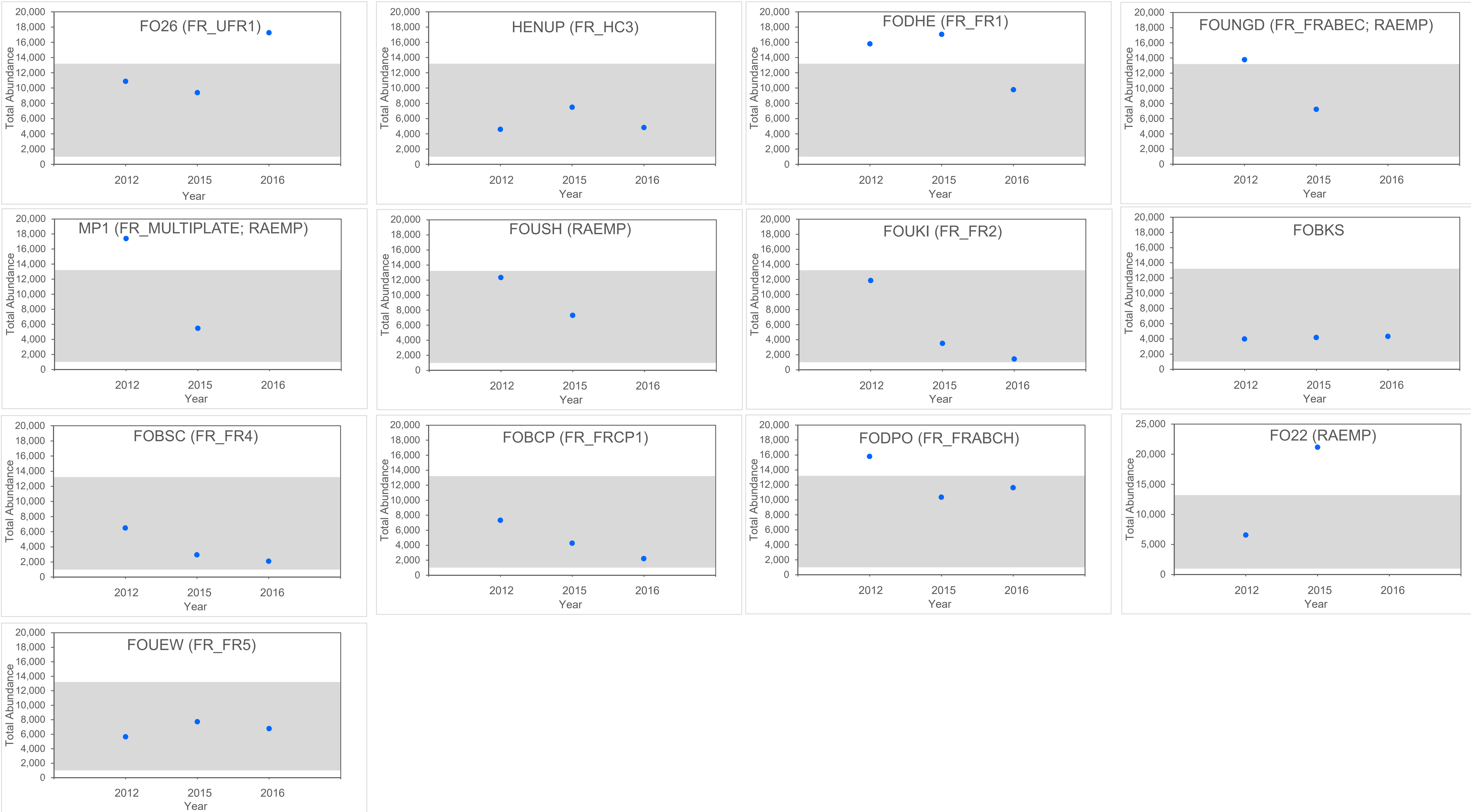

Figure 3.5: Benthic Invertebrate Community Abundance by Area from 2012 to 2016

Note: Gray shading represents the normal range bounded by the 2.5th and 97.5th percentiles of values for reference areas sampled in 2012 and 2015 for the RAEMP (n=50). Water monitoring station closest to biological monitoring area: FO26: FR_UFR1, HENUP: FR_HC3, FODHE: FR_FR1, FOUNGD: FR_FRABEC1, MP1:FR_MULTIPLATE, FOUSH: no water quality station, FOUKI: FR_FR2, FOBKS: no water quality station, FOBSC: FR_FR4, FOBCP: FR_FRCP1, FODPO: FR_FRABCH, FO22: no water quality station FOUEW: FR_FR5.

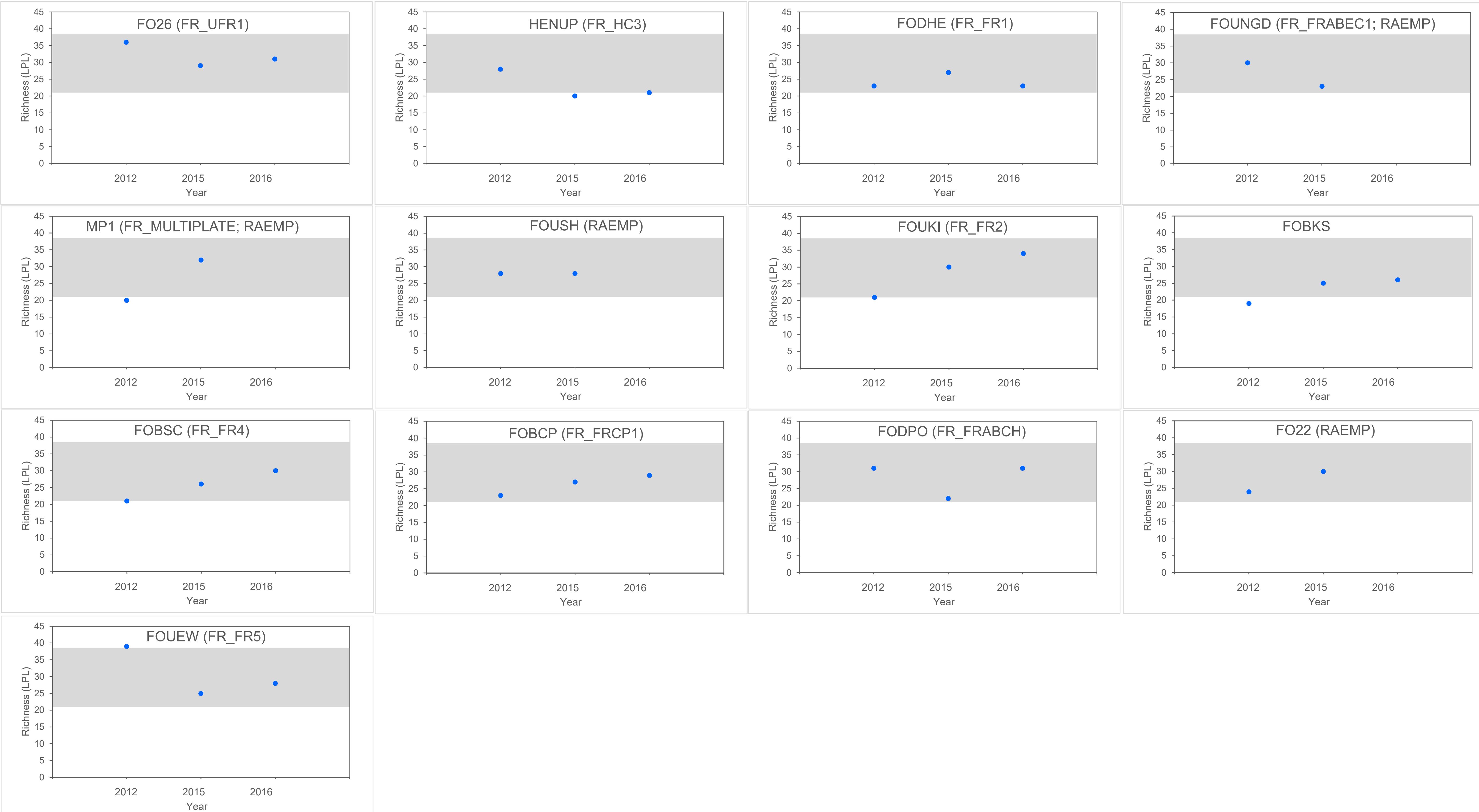

Figure 3.6: Benthic Invertebrate Community Richness (LPL Taxonomy) by Area from 2012 to 2016

Note: Gray shading represents the normal range bounded by the 2.5th and 97.5th percentiles of values for reference areas sampled in 2012 and 2015 for the RAEMP (n=75).

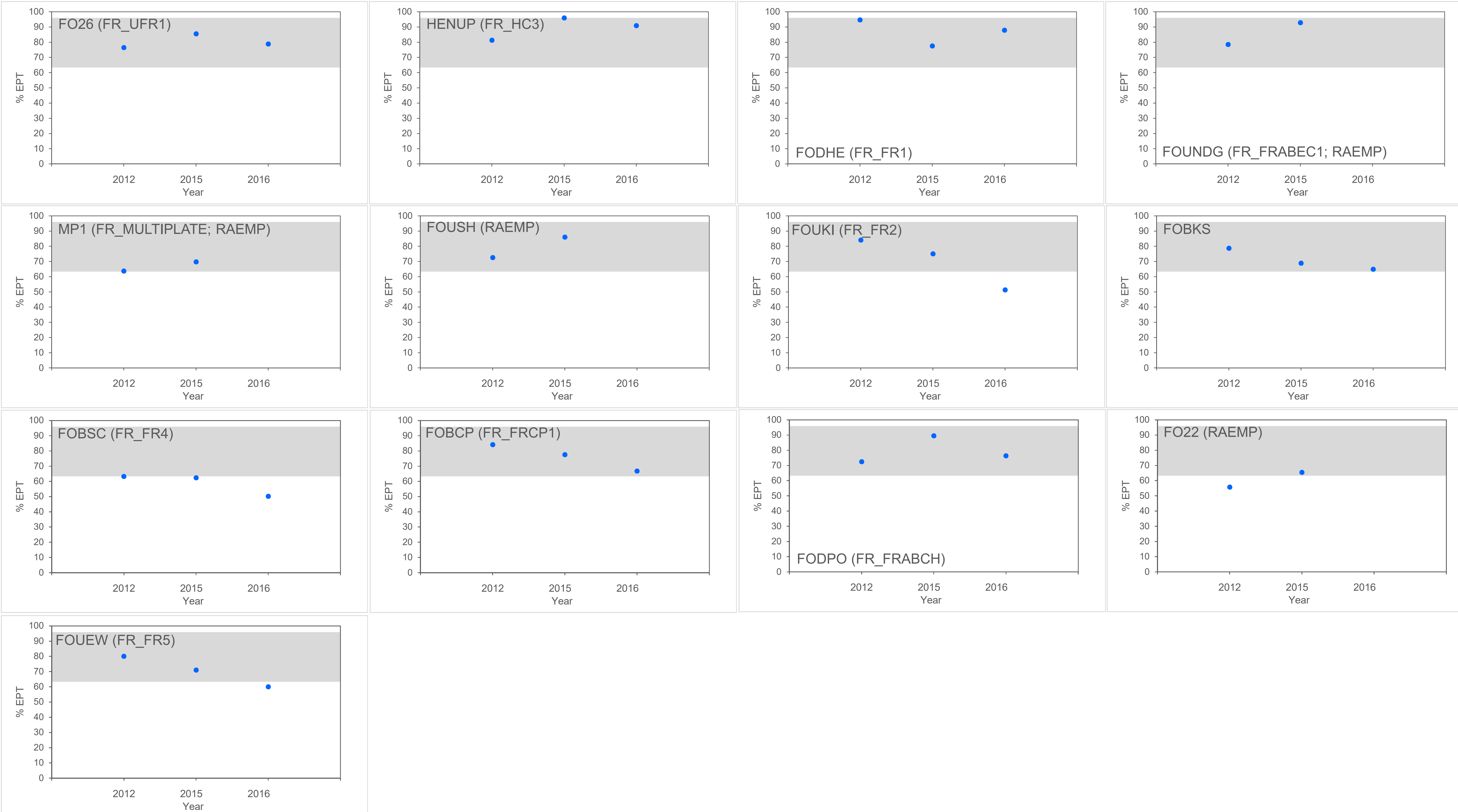

Figure 3.7: Benthic Invertebrate Community Percent EPT by Area from 2012 to 2016

Note: Gray shading represents the normal range bounded by the 2.5th and 97.5th percentiles of values for reference areas sampled in 2012 and 2015 for the RAEMP (n=72).

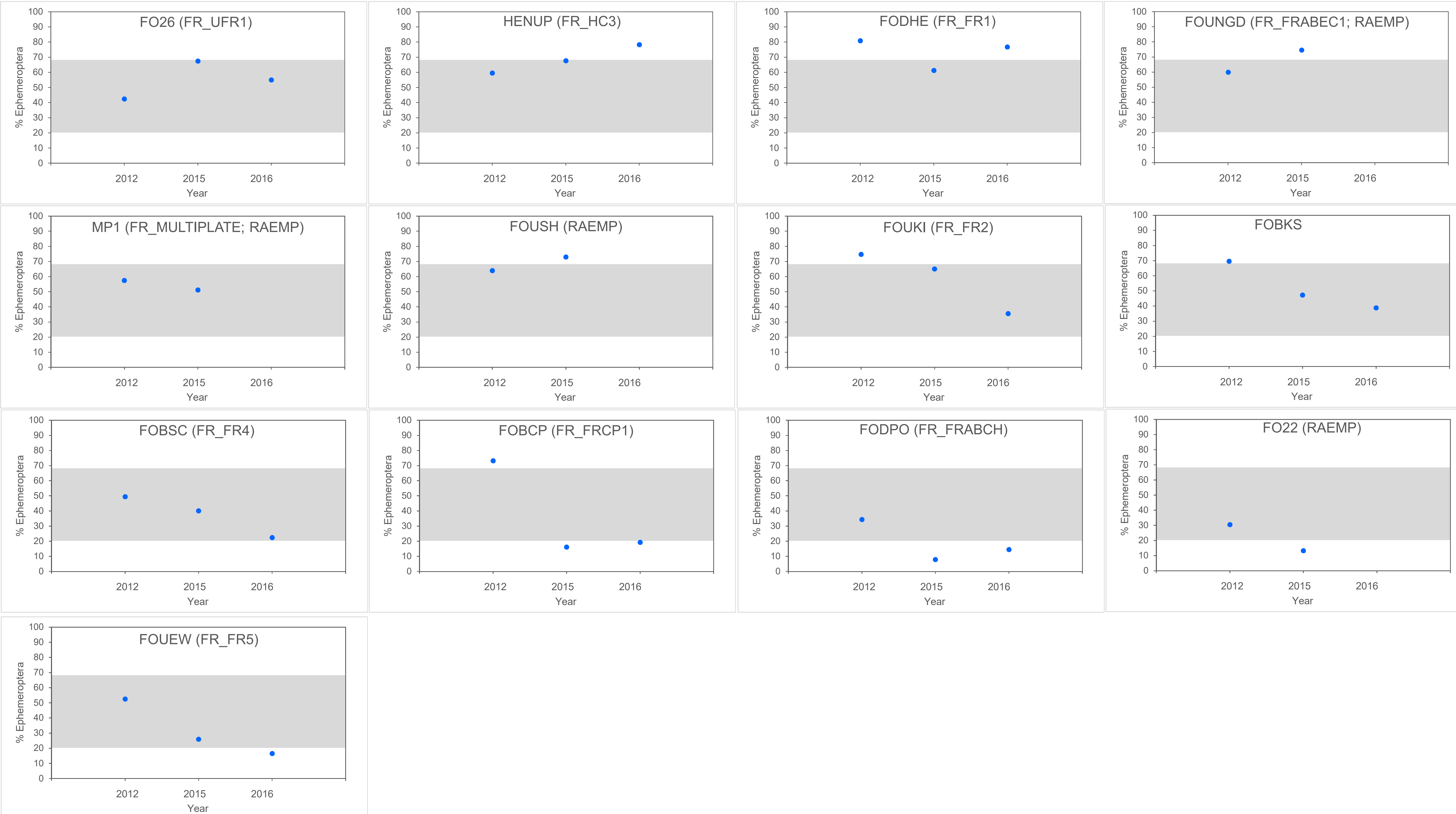

Figure 3.8: Benthic Invertebrate Community Percent Ephemeroptera by Area from 2012 to 2016

Note: Gray shading represents the normal range bounded by the 2.5th and 97.5th percentiles of values for reference areas sampled in 2012 and 2015 for the RAEMP (n=73).

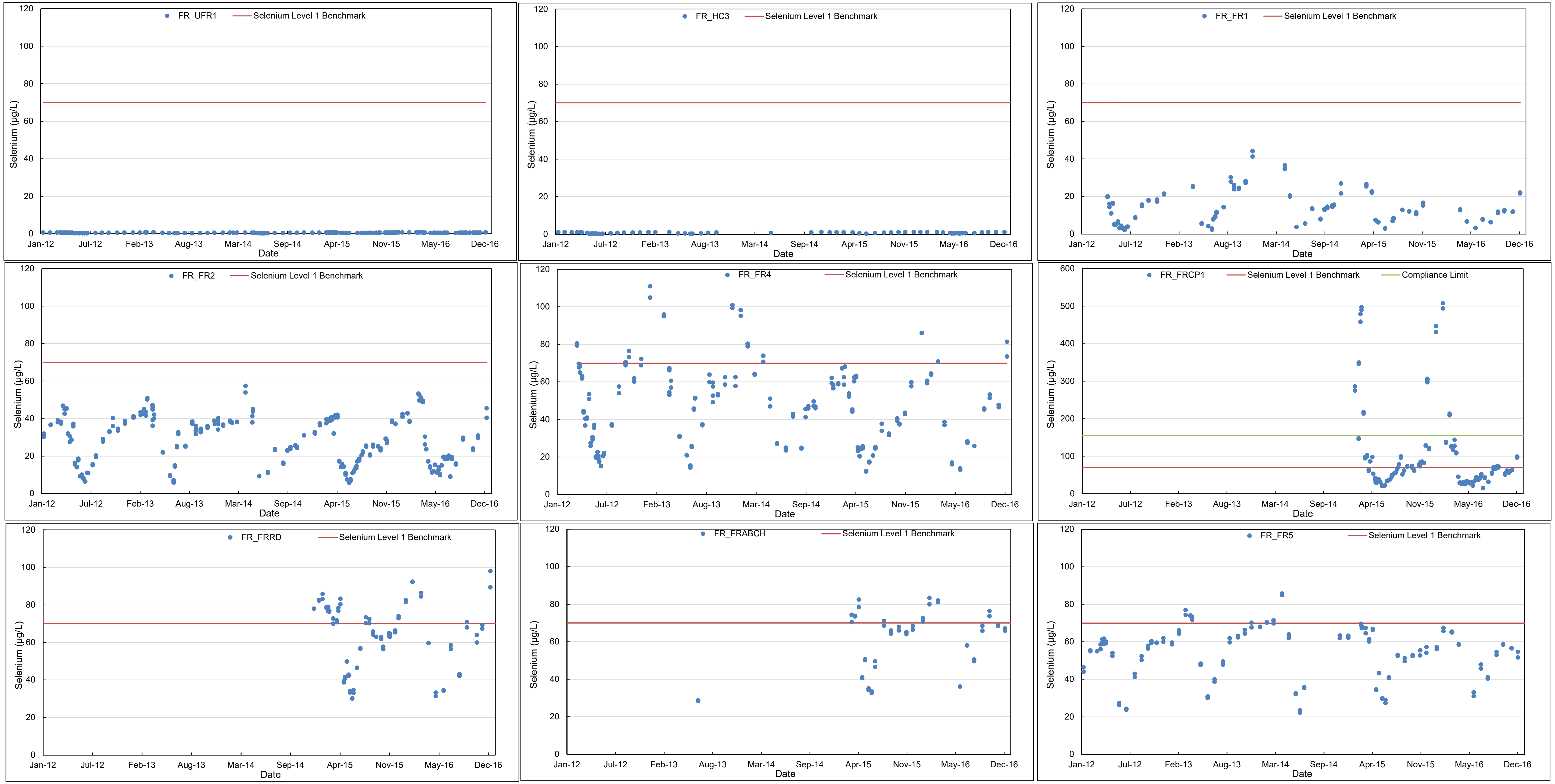

Figure 3.9: Selenium Concentrations in the Fording River Water Samples in 2012 to 2016 Compared to Level 1 Benchmarks from the EVWQP

Note: Different y-axis scale for FR_FRCP1.

Table 3.2: Benthic Invertebrate Tissue Selenium Concentrations Measured in the 2016 FRO LAEMP

Area	Tissue selenium (mg/kg dw)	
	Composite	Rhyacophilidae
FO26	3.5	5.7
HENUP	3.8	4.6
FOUKI	5.2	8.7
FOBCP	9.7	12.7
FODPO	3.8	5.5
FOUEW	5.8	6.9

selenium concentrations were generally within normal ranges[6] (Figure 3.10) and were consistently less than the corresponding EVWQP Level 1 tissue selenium benchmarks for potential effects to invertebrates or dietary effects to juvenile fish (Figures 3.10 and 3.11). Therefore, selenium concentrations do not seem to explain the spatial and temporal patterns of benthic invertebrate community characteristics in the Fording River.

Although sulphate concentrations in water followed a similar spatial pattern as nitrate concentrations, they were consistently less than the EVWQP Level 1 benchmark (Figures 3.3 and 3.12), except at the Compliance Point (FR_FRCP1; Figure 3.12) which mainly reflects water quality in Cataract Creek during winter low flow periods (Golder 2017a,b). Therefore, sulphate concentrations also do not seem to explain the observed spatial and temporal patterns of benthic invertebrate community characteristics in the Fording River.

Water temperature also did not show the pattern exhibited by invertebrates of maximum difference from reference conditions at FR_FRRD/FODPO, as the highest median temperature was observed at FR-FR2/FOUKI and then decreased with distance downstream to median reference station temperatures by FR_FR5/FOUEW (Figure 3.3). An increasing trend in temperature of about 0.4ºC per year was indicated at most mine-exposed Fording River stations having 5 years of monitoring data, but no trend was evident at the most downstream station FR_FR5 (Table 3.1). Elevated temperatures may be related to weather (precipitation and temperature) patterns that also resulted in lower than average flows in the Fording River during 2015 and 2016, at 77% and 78% of mean annual discharge (MAD) (Teck 2016b, 2017). Lower

[6] Defined as the 2.5th to 97.5th percentile of concentrations measured in the tissues of benthic invertebrates at reference areas over multiple years of study in the Elk River watershed (n=176 samples collected 1996 to 2015; Minnow, in preparation).

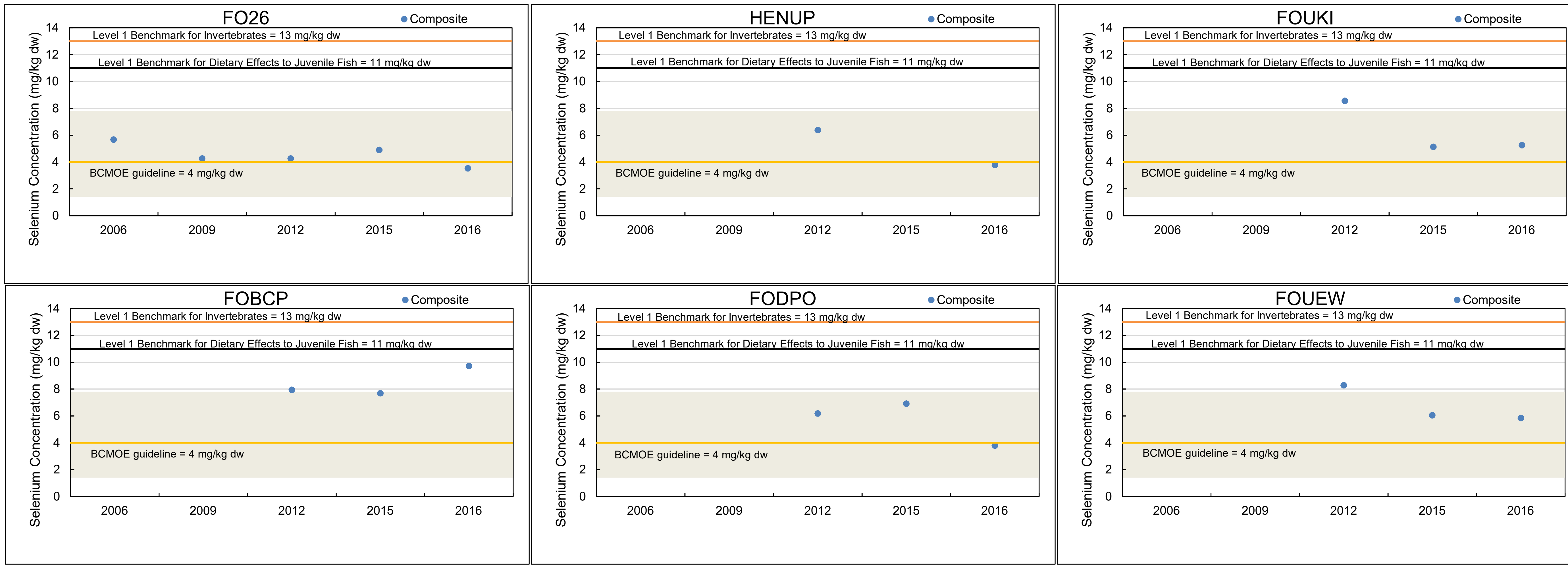

Figure 3.10: Tissue Selenium Concentrations Measured in Benthic Invertebrates Collected in the Fording River, 2006 to 2016

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values (n=176). Water monitoring station closest to biological monitoring area: FO26: FR_UFR1, HENUP: FR_HC3, FOUKI: FR_FR2, FOBCP: FR_FRCP1, FODPO: FR_FRABCH, FOUEW: FR_FR5.

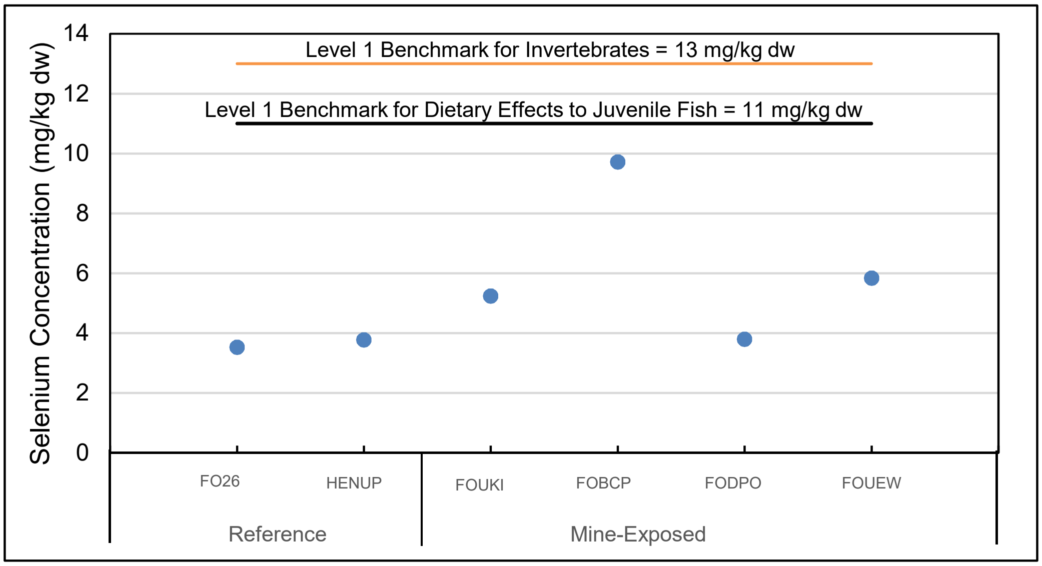

Figure 3.11: Tissue Selenium Concentrations Measured in Benthic Invertebrates Collected in the 2016 FRO LAEMP

Note: Water monitoring station closest to biological monitoring area: FO26:FR_UFR1, HENUP:FR_HC3, FOUKI:FR_FR2, FOBCP:FR_FRCP1, FODPO:FR_FRABCH, FOUEW:FR_FR5.

Figure 3.12: Sulphate Concentrations in the Fording River Water Samples in 2012 to 2016 Compared to Level 1 Benchmarks from the EVWQP

Note different water sulphate concentrations y-axis scale for FR_FRCP1.

average annual flows were mainly due to lower than average peak (freshet) flows and there was a very early freshet in 2016 compared to historical averages. Lower average flow in 2015 and 2016 were also evident in data obtained from the Water Survey of Canada for a station located near the mouth of the Fording River (Figure 3.13). Also evident in Figure 3.13 is the record flood event in 2013, which resulted in substantial substrate disturbance among streams throughout the watershed, and particularly in the upper Fording River, which may have also influenced benthic invertebrate communities. Furthermore, as reported by Golder (2017a) and Westslope Fisheries (2016), surface flow seasonally disappears in a portion of the Fording River near Cataract Creek, and extends upstream and downstream over several kilometres (as per communications with MOE). Incidences of seasonal dryness are not unique to the Fording River and are known to occur within the Wigwam and Elk Rivers (Westslope Fisheries 2016). However, the seasonally dry periods may affect benthic invertebrate community structure within and downstream from the section where this occurs. Further investigation is required to characterize the spatial extent and duration of these seasonal dewatering events to determine the potential effects on benthic invertebrate community structure in the Fording River. Overall, there is a potentially complex relationship between weather, water temperature, and surface water flow patterns that may influence benthic invertebrate communities on a seasonal and/or annual basis.

Calcite is another potential mine-related factor that may have influenced benthic invertebrate community structure in the Fording River. Calcite is created by the reaction of dissolved calcium (Ca^{2+}) and carbonate (CO_3^{2-}) ions under conditions of saturated carbonate and/or increasing water pH or calcium concentrations. Although these conditions can occur naturally, they can be enhanced when water passes through mine waste rock, which elevates aqueous concentrations of both calcium and carbonate. A study completed in 2016 showed that relative abundance of Ephemeroptera (mayflies) was the most sensitive benthic invertebrate community endpoint to increasing CI values, with a steep decrease in Ephemeroptera evident at CI >1.0 (i.e., early stages of calcite concretion; Minnow 2016a). However, increasing calcite levels were strongly correlated with increasing concentrations of mine-related water quality constituents (e.g., nitrate, sulphate, selenium), so the apparent threshold for effects at CI=1 could not be definitively associated with calcite alone. Nevertheless, CI values near or greater than 1.0 were reported for benthic invertebrate monitoring areas at and downstream from FOUKI (FR_FR2) in 2015 and 2016, indicating potential for calcite to also be contributing to changes in community structure in the Fording River. However, data associated specifically with benthic invertebrate community monitoring are not available from biological monitoring completed in 2012 (Table 3.3). The regional calcite monitoring program reported lower CI values over the same portion of the Fording River in 2015 and not all areas were re-sampled in 2016 (Table 3.3; Appendix Figure A.1). Apparent discrepancy in CI values between the regional calcite monitoring program and the local

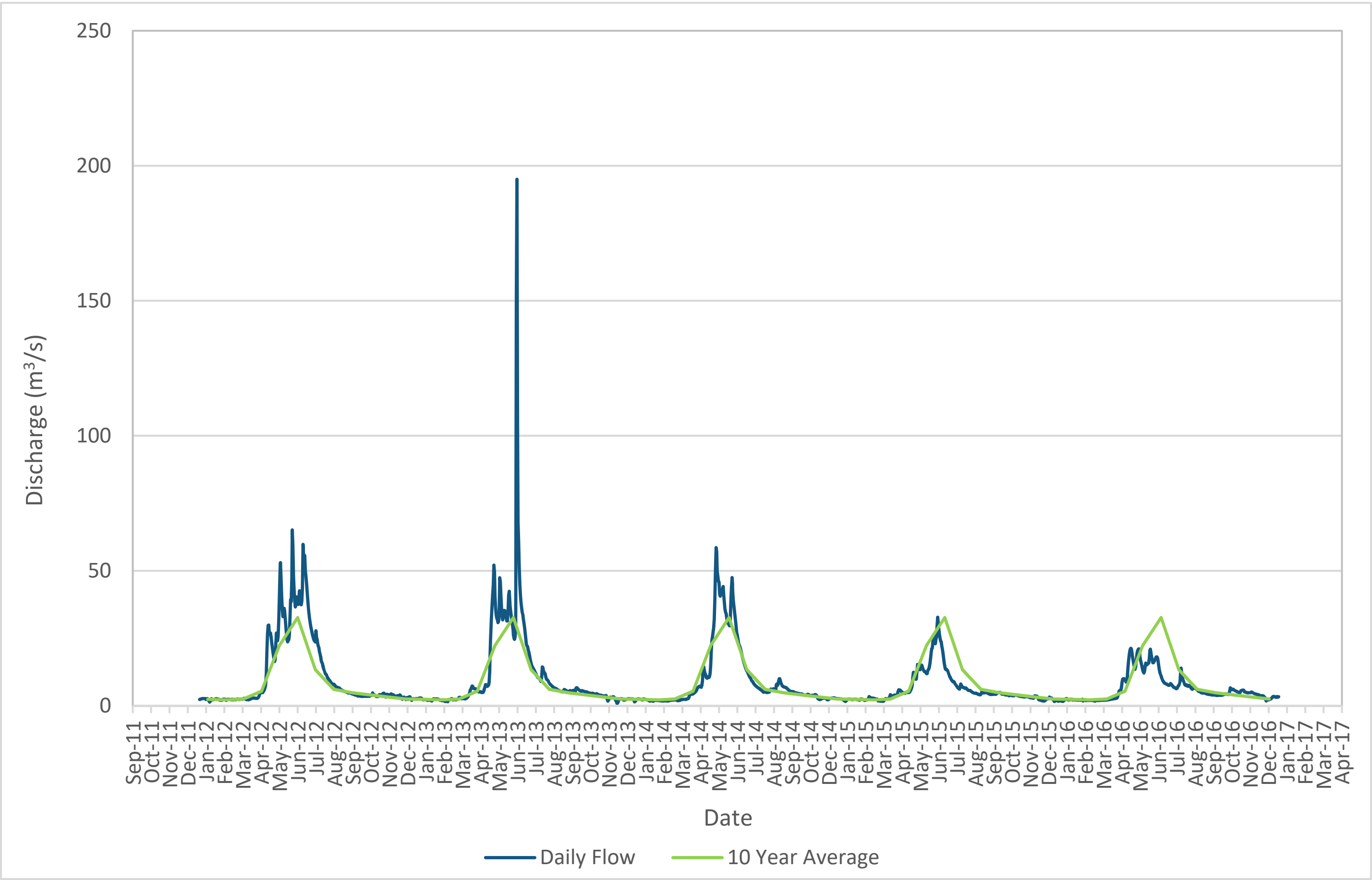

Figure 3.13: Flow Measurements at the Fording River Water Survey of Canada Station (08NK018) from 2012 to 2016

Note: 10 year average calculated from 2006-2015 average monthly flows.

Table 3.3: Calcite Index Values in Fording River from 2013 to 2016

Biological Monitoring Area	Teck Water Station	Calcite Reach*	Teck Regional Calcite Monitoring (Calcite Index)				Calcite Index at Benthic Invertebrate Monitoring Areas	
			2013	2014	2015	2016	2015	2016
FO26	FR_UFR1	FORD12	0.00	0.00	0.00	0.27	0.93	0.80
HENUP	FR_HC3	HENR3	0.00	0.00	0.00	--	0.14	0.00
FODHE	FR_FR1	FORD11	0.00	0.00	0.00	--	0.88	0.00
FOUKI	FR_FR2	FORD10	0.00	0.00	0.00	--	0.98	1.80
FOBKS	-	FORD9	0.00	0.00	0.00	--	0.92	2.00
FOBSC	FR_FR4						1.20	1.80
FOBCP	FR_FRCP1						1.30	1.60
FODPO	FR_FRABCH	FORD8	0.31	0.49	0.48	--	0.89	1.00
FOUEW	FR_FR5	FORD7/6	0.59	0.70	1.04	0.64	0.98	1.00

***** Refer to Figure A.1 for calcite reaches.

(LAEMP) and regional (RAEMP) benthic invertebrate monitoring could be due to several factors. One potential explanation is that benthic invertebrate monitoring and the associated calcite measurements focused solely on riffle habitats, whereas the regional calcite monitoring program includes calcite measurements in riffle and glide habitats (i.e., locations monitored in the calcite and biological monitoring programs were not exact matches and sampled slightly different habitats that may demonstrate different calcite deposition patterns; Appendix Figure A.1). Also, calcite measurements for the regional calcite monitoring program were done between September 29 and October 29, 2015, compared to September 13-18, 2015, for the RAEMP. Lastly, calcite monitoring in biological sampling programs did not score calcite presence/absence when fines were encountered, whereas scores were assigned in the regional calcite monitoring program. Further investigation is required to verify if these or other factors can account for the differences in calcite values measured between programs and allow for better understanding of potential spatial and temporal effects on benthic invertebrate communities.

Based on the above, nitrate concentrations may contribute to the spatial pattern of decreasing % Ephemeroptera with distance downstream, but do not explain the apparent change in benthic invertebrate community structure over time. Conversely, temperature trends (which may be related to annual variation in flows) may partially explain the temporal changes in community structure, but do not fully explain the spatial pattern of benthic invertebrate community change observed in the Fording River in 2016. Seasonal dewatering and/or calcite deposition in portions of the Fording River are additional factors potentially influencing benthic invertebrate communities. In consideration of these findings, the FRO LAEMP design will be amended to allow for further investigation of the cause(s) of benthic invertebrate community changes. This will occur in consultation with the EMC prior to implementation of field sampling in September, 2017.

4 AWTF PRE-OPERATIONAL BASELINE DATA

To address Key Questions #2 through 4 (Section 1.2), baseline data are being collected prior to the commissioning of the AWTF (Figure 2.1).

4.1 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 water concentrations prior to AWTF operation (Figure 4.1). As noted in the approved study design (Minnow 2016b), benthic invertebrate biomass samples will also be collected as part of the LAEMP, beginning in 2017 to provide two years of pre-operational baseline biological productivity data. Key Question #2 will be addressed after the AWTF is commissioned. In the meantime, the data analysis approach for addressing this question will be developed in consultation with the EMC. It is currently anticipated that statistics similar to those being applied 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).

4.2 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 2016) and individual taxa (beginning in 2016) were monitored as part of the Fording River LAEMP and other historical studies (Figures 3.10 and 3.11; Table 3.2). Tissue selenium concentrations in benthic invertebrates and fish[7] are currently within the ranges predicted in the EVWQP (Tables 4.1 and 4.2, Figure 4.2). These data, combined with data collected during 2017 LAEMP study, will characterize conditions prior to AWTF operation. In the meantime, the data analysis approach for addressing this question will be developed in consultation with the EMC.

4.3 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?: Water temperature trends in the Fording River were identified as a factor potentially contributing to

[7] Data collected in 2015 associated with the RAEMP.

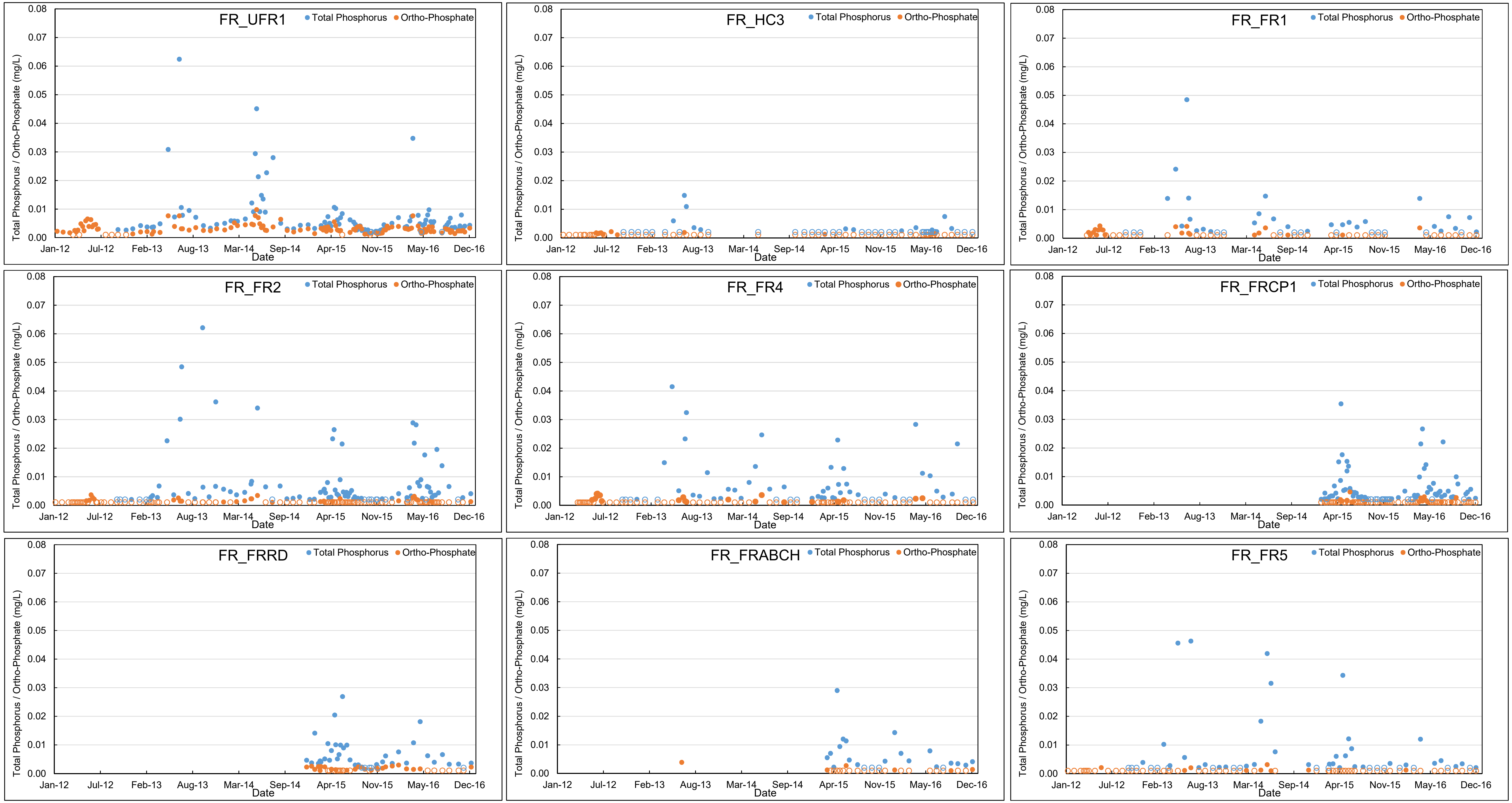

Figure 4.1: Aqueous Total Phosphorus and Ortho-Phosphate Concentrations in the Fording River, 2012 to 2016

Note: Open symbols denote values less than detection limit.

Table 4.1: Observed versus Lower (L) and Upper (U) Predicted (EVWQP) Benthic Invertebrate (Composite) Tissue Selenium Concentrations in the Fording River

Location Code (Predictions)	Biological Sampling Area Code	Description	2013 Prediction Interval (µg/g dw)[a]		2015 Se (µg/g dw)	2016 Se (µg/g dw)	2017 Prediction Interval (µg/g dw)[a]	
			L	U			L	U
FR1	FODHE	Fording River downstream of Henretta Creek	3.05	23.14	6.55		3.16	23.96
FR2	FODNGD	Fording River downstream of Clode Creek	3.38	25.61	6.21		3.56	26.99
	FOUNGD				7.19			
	MP1				5.85			
	FOUSH				6.04			
	FOUKI				5.13	5.20		
	FOBKS				6.00			
FR3	FOBSC	Fording River between Swift and Cataract Creeks	3.78	28.64	7.51		4.03	30.57
	FOBCP				7.68	9.70		
FR3b	FODPO	Fording River downstream of Porter Creek	3.96	30.02	6.92	3.80	4.03	30.57
	FO10-SP1				7.13			
	FO22				7.08			
	FOUEW				6.05	5.80		
	LC_FRUS				7.01			
	FO29				7.54			
FR4	FODGH	Fording River downstream of Greenhills Creek	3.63	27.54	8.36		3.67	27.82

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

Table 4.2: Observed verses Lower (L) and Upper (U) Predicted (EVWQP) Westslope Cutthroat Trout (Composite) Muscle Selenium Concentrations in the Fording River

Location Code (Predictions)	Biological Sampling Area Code	Description	2013 Prediction Interval (µg/g dw)[a]		Observed Maximum for 2015 Se (µg/g dw)		2017 Prediction Interval (µg/g dw)[a]	
			L	U	May	August	L	U
FR1	UFR	Fording River downstream of Henretta Creek	3.8	19.3	13.7	11.5	4.0	20.1
FR2		Fording River downstream of Clode Creek	4.3	21.8			4.6	23.0
FR3		Fording River between Swift and Cataract Creeks	4.9	24.5			5.3	26.5
FR3b		Fording River downstream of Porter Creek	5.2	26.0			5.2	26.4
FR4		Fording River downstream of Greenhills Creek	4.6	23.4			4.7	23.8

[a] Approximate 95% Prediction Interval for Westslope Cutthroat Trout Muscle Selenium Concentration (µg/g dw) (± 2 RMSD of 2-step, water to fish bioaccumulation model) Muscle values were converted from predicted ovary concentrations using the equation Muscle Se = (Egg Se/1.6862)1.0199 (Nautilus and Interior Reforestation 2011)

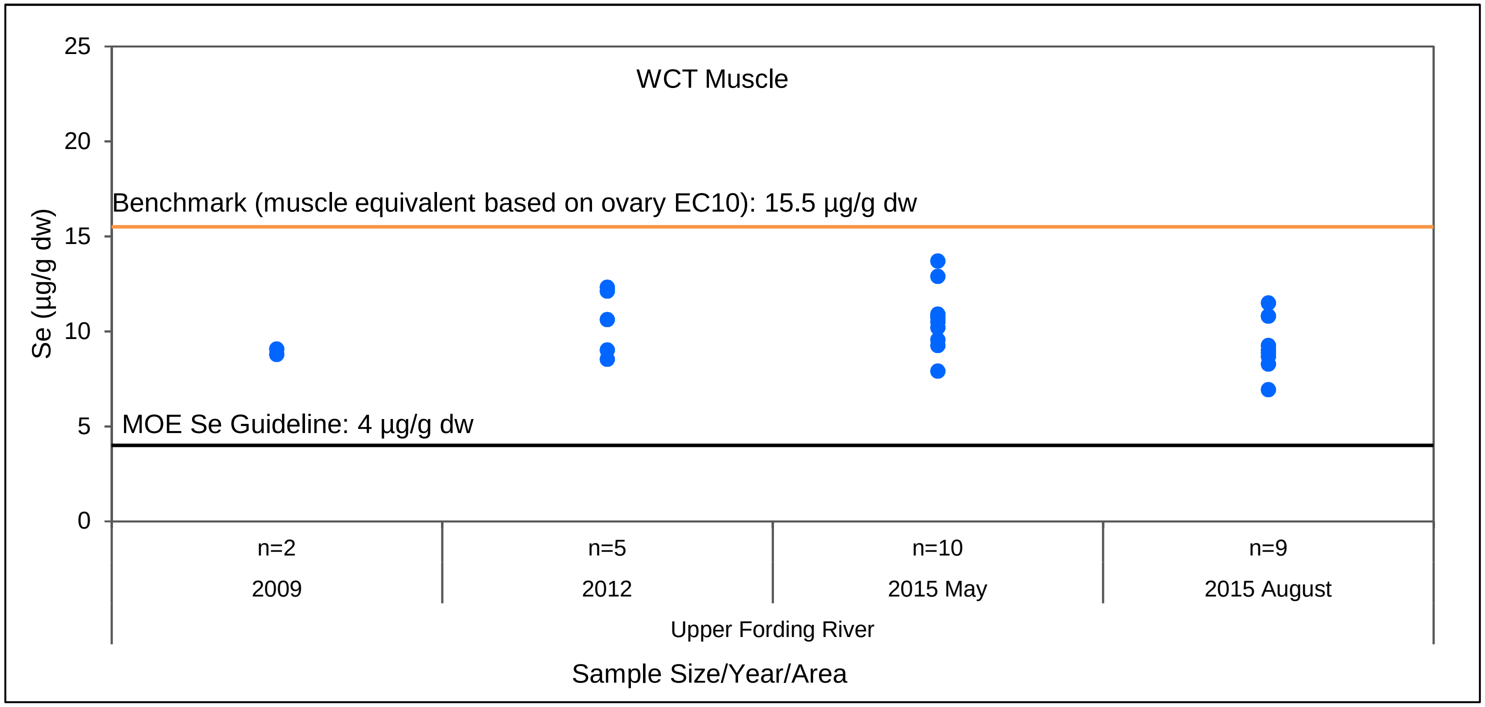

Figure 4.2: Westslope Cutthroat Trout Muscle Selenium Concentrations in the Upper Fording River

Notes: The EC10 for selenium in westslope cutthroat trout is estimated to be 24.8 µg/g dw in ovaries, which is equivalent to about 15.5 µg/g dw in muscle (Nautilus Environmental and Interior Reforestation 2011). EC10 is the concentration estimated to have an effect on 10% of the exposed population and is generally considered to approximate a threshold for effects.

changes in benthic invertebrate communities during the current baseline period preceding AWTF operation (Section 3.3). Water temperatures measured since 2012 at stations in the Fording River are presented in Figure 4.3. Water temperatures will continue to be routinely measured to further characterize baseline conditions prior to commissioning of AWTF. Once in operation, effluent toxicity testing will be required as a permit condition, which will assist in evaluating potential effects associated with treatment-related constituents.

4.4 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 during the current baseline period preceding AWTF operation (Section 3.3). Water flows recorded by Teck for stations in the upper Foring River are presented in Figure 4.3. Water flows will continue to be routinely measured to further characterize baseline conditions prior to commissioning of the AWTF. Key Question #5 will be addressed after the AWTF is commissioned. In the meantime, the data analysis approach for addressing this question will be developed in consultation with the EMC.

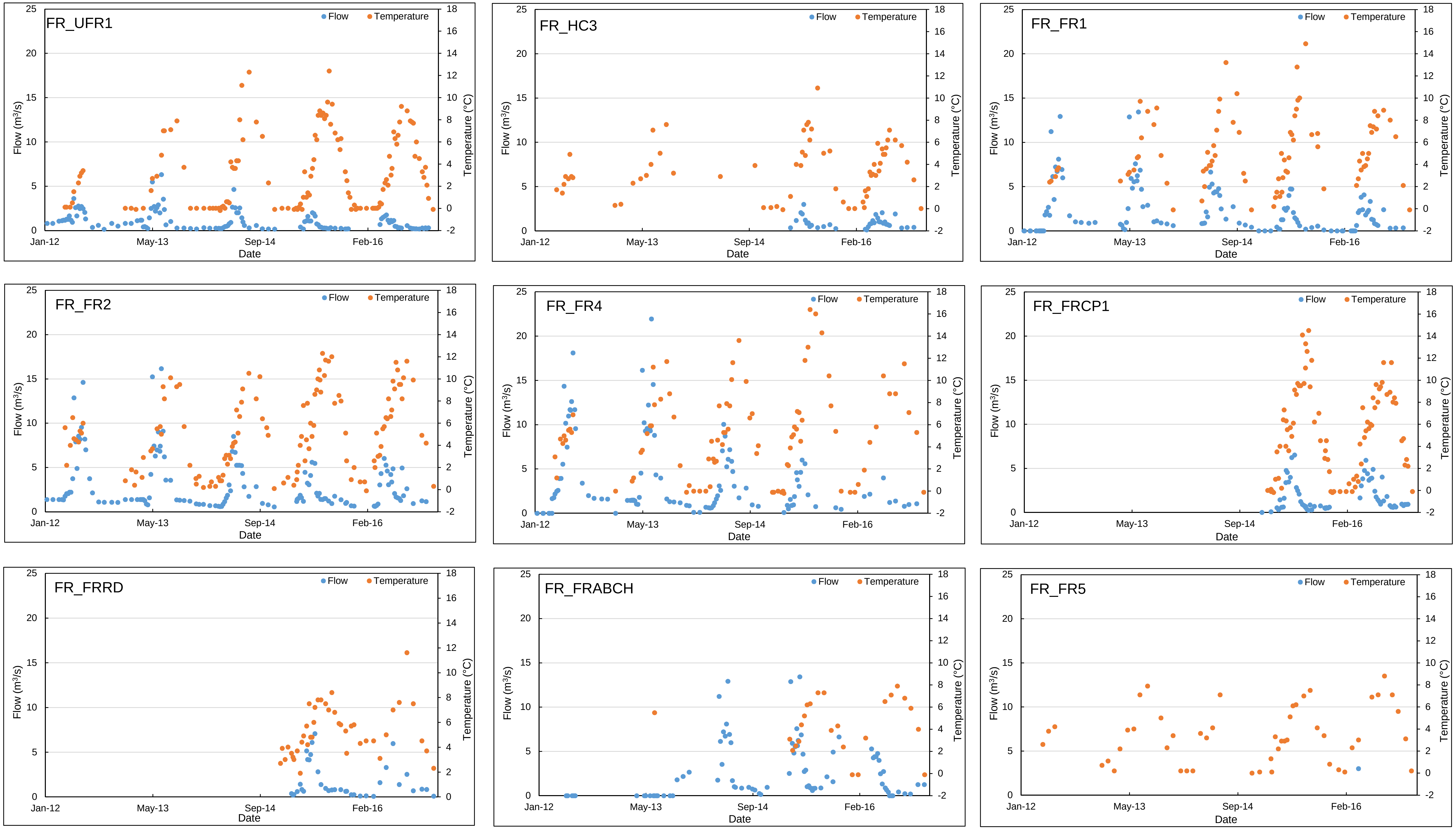

Figure 4.3: **Water Temperature and Flows for the Fording River, 2012 to 2016**

5 SUMMARY

The evaluation of data related to Key Question #1 (Are nitrate concentrations increasing, and if so, are they adversely affecting biota?), indicated that the benthic invertebrate community in the Fording River is healthy based on total abundance and richness relative to communities in local and regional reference areas. However, changes in community structure from upstream of Kilmarnock Creek to downstream from Chauncey Creek warrant further investigation. Nitrate concentrations (but not likely selenium or sulphate concentrations) may contribute to the spatial pattern of decreasing % Ephemeroptera with distance downstream, but do not explain the apparent change in benthic invertebrate community structure over time. Conversely, temperature trends (and/or associated annual variation in flows) may partially explain the observed temporal changes in benthic invertebrate community structure, but do not fully explain the spatial pattern of benthic invertebrate community change observed in the Fording River in 2016. Seasonal dewatering and/or calcite deposition in portions of the Fording River are additional factors potentially influencing benthic invertebrate communities. In consideration of these findings, the FRO LAEMP design will be amended to allow for further investigation of the cause(s) of benthic invertebrate community changes. This will occur in consultation with the EMC prior to implementation of field sampling in September, 2017. The baseline data being collected for addressing Key Questions #2-5 will also be discussed with the EMC, to determine the approach that will be used for data analysis once the AWTF is commissioned and, in that context, consider if any additional modifications to the FRO LAEMP are warranted during the pre-operational baseline period.

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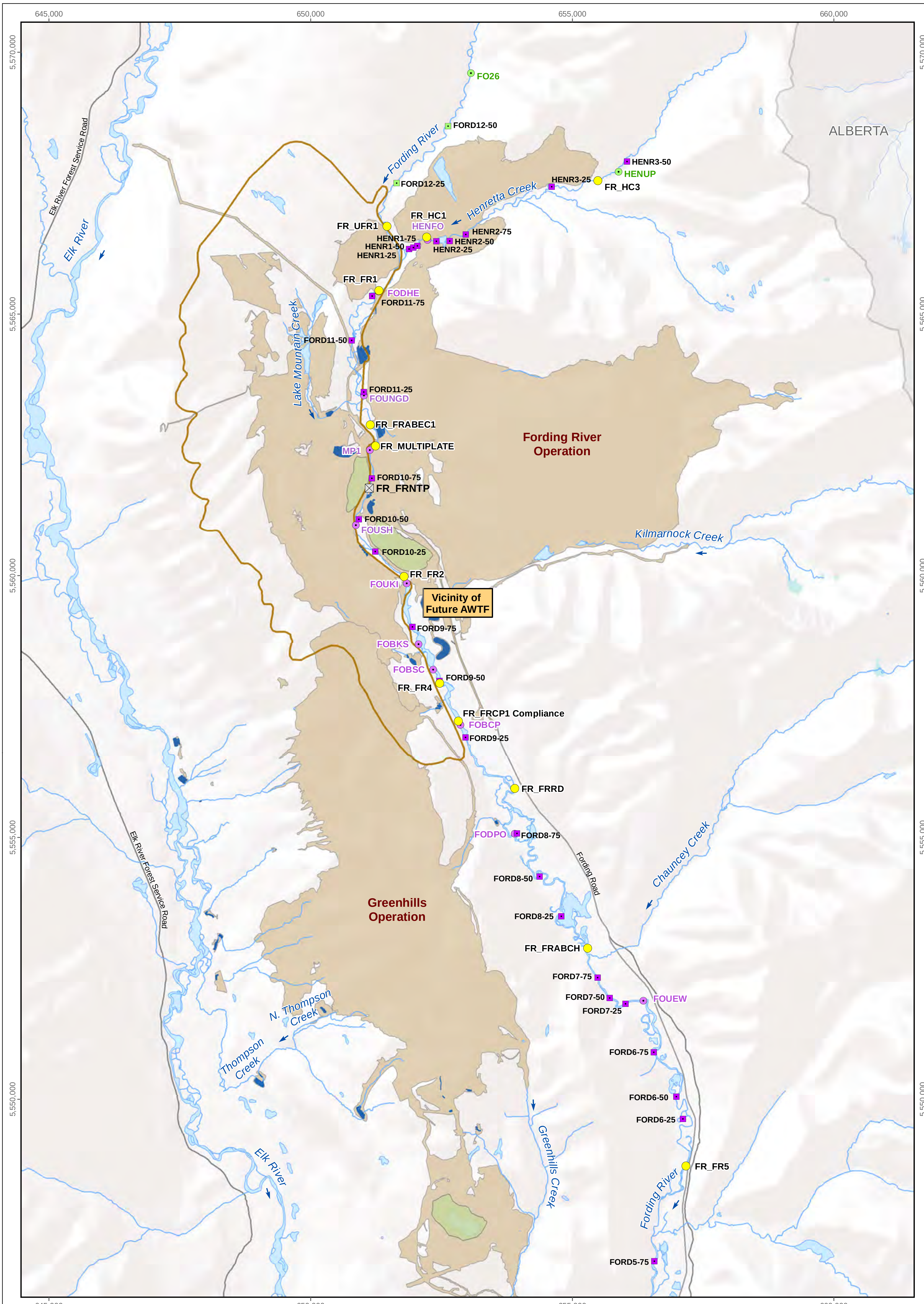
APPENDIX A
DETAILED DATA



LEGEND

- Hydrometric Station
- Water Monitoring Station

LAEMP Biological Sampling Location

- Mine-Exposed
- Reference

Teck Regional Calcite Monitoring Station

- Exposed
- Reference

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

Regional Calcite Monitoring Stations

0 1 2 4
km

N W E S

Projection: North American Datum 1983 UTM Zone 11
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Date: May 2017
Project 167202.0075

minnow environmental inc.

Figure A.1

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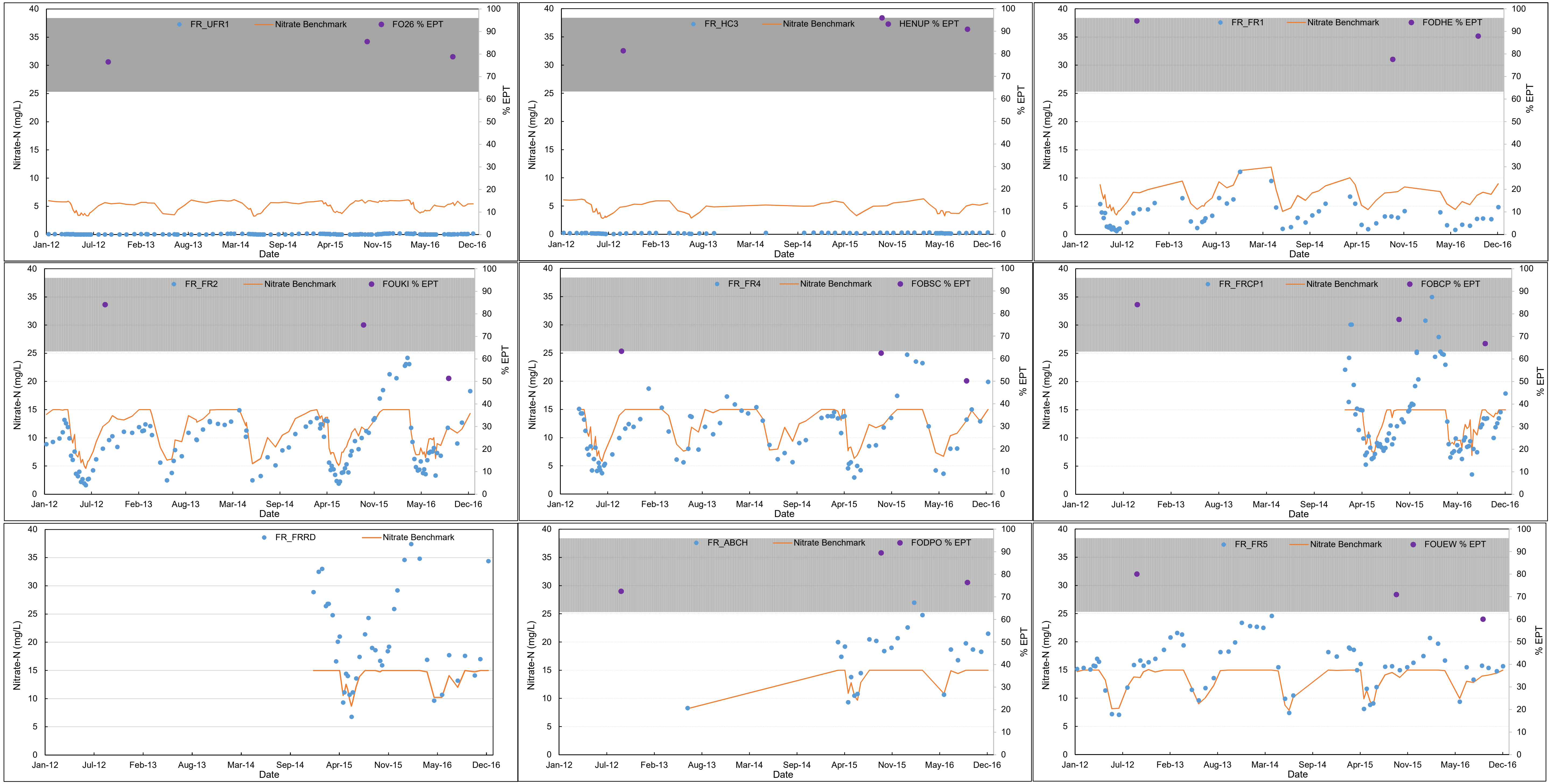

Figure A.2: Percent EPT Data Overlaid with Associated Water Nitrate Concentration Data in the Fording River, 2012 to 2016

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values.

Figure A.3: Percent Ephemeroptera Data Overlaid with Associated Water Nitrate Concentration Data in the Fording River, 2012 to 2016

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values.

Figure A.4: Percent EPT Data Overlaid with Associated Water Selenium Concentration Data in the Fording River, 2012 to 2016

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values. Note different water selenium concentrations y-axis scale for FR_FRCP1.

Figure A.5: Percent Ephemeroptera Data Overlaid with Associated Water Selenium Concentration Data in the Fording River, 2012 to 2016

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values. Note different water selenium concentrations y-axis scale for FR_FRCP1.

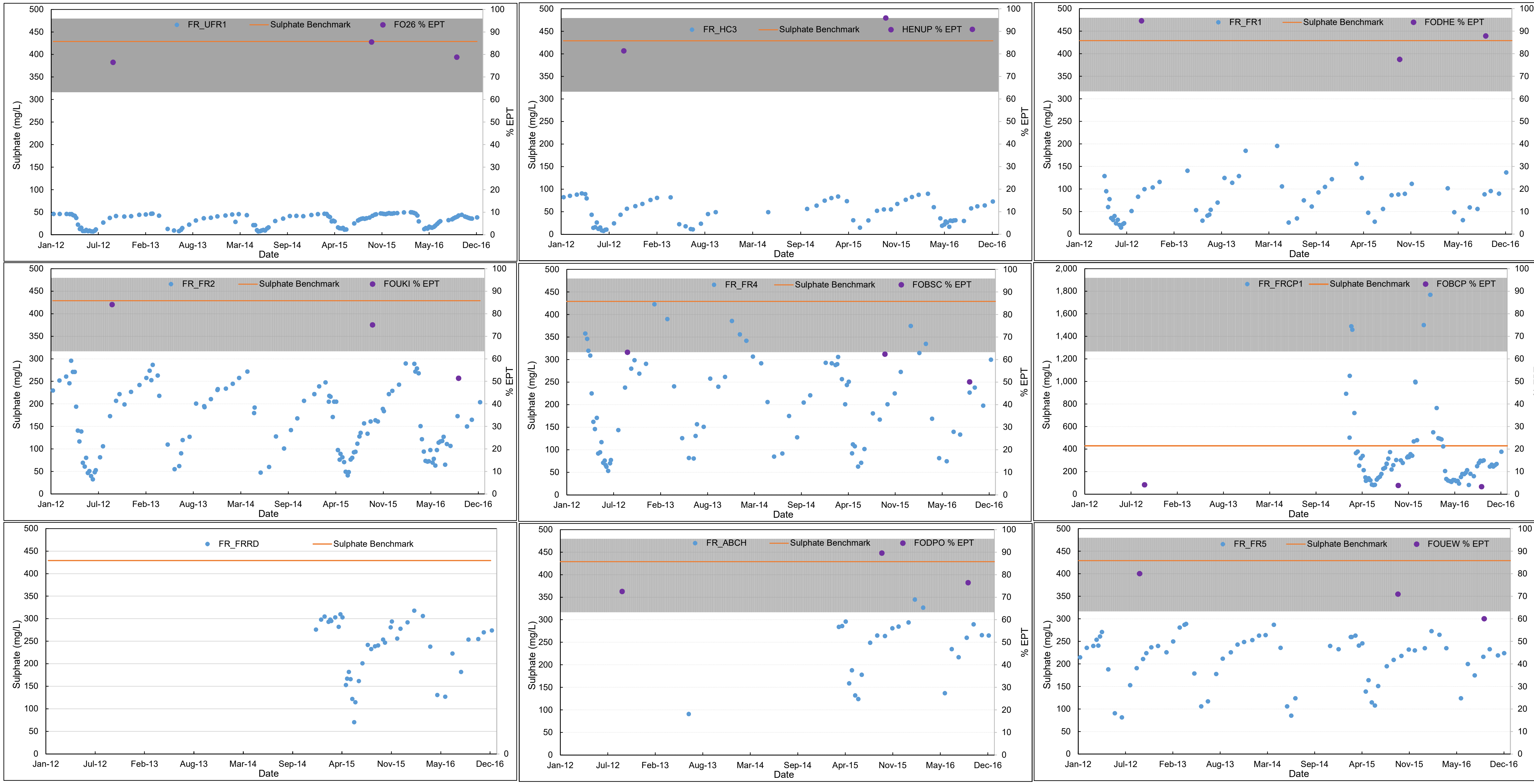

Figure A.6: **Percent EPT Data Overlaid with Associated Water Sulphate Concentration Data in the Fording River, 2012 to 201**

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values. Note different water sulphate concentrations y-axis scale for FR_FRCP1 .

Figure A.7: Percent Ephemeroptera Data Overlaid with Associated Water Sulphate Concentration Data in the Fording River, 2012 to 2016

Note: Gray shading represents the normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area values. Note different water sulphate concentrations y-axis scale for FR_FRCP1 .

Table A.1: Detailed Benthic Invertebrate Community Data, FRO 2016 LAEMP

Type	Reference		Mine-Exposed						
Sample:	**FO26**	**HENUP**	**FODHE**	**FOUKI**	**FOBKS**	**FOBSC**	**FOBCP**	**FODPO**	**FOUEW**
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0
Ameletus	0	10	120	8	0	0	0	20	0
| Family: Baetidae	0	0	0	4	0	0	0	0	0
Acentrella	0	0	0	0	0	0	0	0	0
Acentrella turbida	0	0	0	0	0	0	0	0	0
Baetis	600	0	260	40	263	106	100	460	240
Baetis tricaudatus group	40	0	0	52	63	131	33	500	180
Baetis bicaudatus	0	0	320	0	0	0	0	0	0
| Family: Ephemerellidae	2060	770	2080	72	313	94	67	140	100
Drunella	0	0	0	0	0	0	0	0	0
Drunella coloradensis	0	0	0	0	0	0	0	0	0
Drunella doddsii	1700	50	60	16	63	0	60	20	0
Drunella spinifera	0	0	0	0	0	19	7	0	20
Ephemerella	0	0	0	0	0	6	0	0	0
| Family: Heptageniidae	4640	2550	4380	320	963	106	160	540	580
Cinygmula	0	0	0	0	0	0	0	0	0
Epeorus	140	90	60	0	13	6	0	0	0
Rhithrogena	320	310	240	0	0	0	0	0	0
| Family: Leptophlebiidae	0	0	0	0	0	0	0	0	0
Neoleptophlebia	0	0	0	0	0	0	0	0	0
Paraleptophlebia	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0
| Family: Capniidae	0	0	0	0	0	13	7	100	0
| Family: Chloroperlidae	240	0	20	0	13	6	0	160	0
Suwallia	0	0	0	0	0	0	0	0	0
Sweltsa	460	40	0	4	25	6	7	80	60
| Family: Leuctridae	20	0	0	0	0	0	0	0	0
Despaxia augusta	0	0	0	0	0	0	0	0	0
| Family: Nemouridae	0	0	0	0	0	0	0	0	0
Visoka cataractae	0	10	0	0	0	0	0	0	0
Zapada	180	10	180	12	225	81	220	2000	1180
Zapada oregonensis group	120	20	0	4	13	0	0	140	200
Zapada cinctipes	0	0	0	28	63	38	107	260	300
Zapada columbiana	320	50	0	20	0	6	0	40	180
| Family: Peltoperlidae	0	0	0	0	0	0	0	0	0
Yoraperla	0	0	0	0	0	0	0	0	0
| Family: Perlidae	0	0	20	0	25	0	0	20	0
Calineuria californica	0	0	0	0	0	0	0	0	0
Hesperoperla	0	0	0	0	0	13	0	0	0
Hesperoperla pacifica	0	0	0	12	0	0	0	0	0
| Family: Perlodidae	420	0	460	32	113	69	247	800	0
Isoperla	0	0	0	0	38	44	0	300	0
Megarcys	360	20	180	28	150	44	80	200	100
Skwala	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0
Pteronarcella	0	0	0	0	0	0	0	0	0
| Family: Taeniopterygidae	920	10	220	0	50	19	0	740	0
Taenionema	0	370	0	4	0	0	20	0	20
| Order: Trichoptera	0	0	0	0	0	0	0	0	0
| Family: Apataniidae	0	0	0	0	0	0	0	0	0
Allomyia	0	0	0	0	0	0	0	0	0
Apatania	0	0	0	8	0	0	0	0	0
Pedomoecus sierra	0	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	25	6	0	0	0
Brachycentrus	0	0	0	0	0	0	7	0	0
Brachycentrus americanus	0	0	0	0	0	0	7	0	0
| Family: Glossosomatidae	0	0	0	20	0	0	0	180	360
Anagapetus	0	0	0	0	0	0	0	0	0
Glossosoma	0	20	0	28	25	19	0	1620	40
| Family: Hydropsychidae	240	20	0	0	0	0	33	0	80
Arctopsyche	0	0	0	0	0	0	0	0	0
Arctopsyche grandis	0	0	0	8	0	6	113	0	0
Arctopsyche ladogensis	0	0	0	0	0	0	7	0	0
Hydropsyche	0	0	0	0	0	0	0	0	0
Parapsyche	80	20	20	8	38	0	27	0	20
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	0	0	0	0	0
| Family: Leptoceridae	0	0	0	0	0	0	0	0	0

Table A.1: **Detailed Benthic Invertebrate Community Data, FRO 2016 LAEMP**

Type	Reference		Mine-Exposed						
Sample:	FO26	HENUP	FODHE	FOUKI	FOBKS	FOBSC	FOBCP	FODPO	FOUEW
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
| **Family: Limnephilidae**	0	0	0	4	0	0	0	20	0
Ecclisomyia	0	0	0	0	0	0	0	0	0
| **Family: Rhyacophilidae**	0	0	0	0	0	0	0	0	0
Rhyacophila	20	0	0	4	200	163	147	380	320
Rhyacophila betteni group	0	0	0	0	13	0	7	40	0
Rhyacophila brunnea/vemna group	0	0	0	4	63	25	7	100	60
Rhyacophila hyalinata group	120	20	0	0	38	19	7	0	0
Rhyacophila vofixa group	80	0	0	0	0	0	0	0	0
Rhyacophila atrata complex	0	0	0	0	13	0	0	0	0
Rhyacophila narvae	0	0	0	0	0	0	0	20	0
| **Family: Uenoidae**	0	0	0	0	0	0	0	0	0
Neothremma	0	0	0	0	0	0	0	0	0
Oligophlebodes	540	0	0	0	0	0	0	0	20
| **Order: Coleoptera**	0	0	0	0	0	0	0	0	0
| **Family: Dytiscidae**	0	0	0	0	0	0	0	0	0
Stictotarsus	0	0	0	0	0	0	0	0	0
| **Family: Elmidae**	0	0	0	4	0	0	0	200	180
Heterlimnius	0	0	0	0	0	0	0	180	40
| **Order: Diptera**	0	0	0	4	0	0	0	0	0
| **Family: Athericidae**	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0
| **Family: Ceratopogonidae**	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	0	0
Probezzia	0	20	40	28	75	19	13	40	20
| **Family: Chironomidae**	220	20	240	84	200	100	93	540	240
| **Subfamily: Chironominae**	0	0	0	0	0	0	0	0	0
| **Tribe: Chironomini**	0	0	0	0	0	0	0	0	0
Microtendipes	0	0	0	0	0	0	0	0	0
Microtendipes pedellus group	0	0	0	0	0	0	0	0	0
Pagastiella	0	0	0	0	0	0	0	0	0
Polypedilum	0	0	0	0	0	0	0	0	0
| **Tribe: Tanytarsini**	0	0	0	0	0	0	0	0	0
Constempellina sp. C	0	0	0	0	0	0	0	0	0
Micropsectra	500	50	280	148	438	138	140	260	220
Paratanytarsus	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0
Stempellinella	0	0	0	0	0	0	0	0	0
Sublettea coffmani	0	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	0	0	0	0	0	0
| **Subfamily: Diamesinae**	0	0	0	0	0	0	0	0	0
| **Tribe: Diamesini**	0	0	0	0	0	0	0	0	0
Diamesa	380	0	0	0	0	6	0	0	0
Pagastia	300	0	80	28	75	69	53	220	460
Potthastia	0	0	0	0	0	0	0	0	0
Potthastia longimana group	0	0	0	0	0	0	0	0	0
Pseudodiamesa	0	0	0	0	0	0	0	0	0
| **Subfamily: Orthocladiinae**	0	0	0	0	0	0	0	0	0
Brillia	20	0	0	4	0	0	0	0	0
Corynoneura	0	0	0	0	0	0	0	0	20
Cricotopus (Nostococladius)	40	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0
Eukiefferiella	260	60	40	16	113	25	40	180	180
Heleniella	0	0	0	0	0	0	0	0	0
Hydrobaenus	0	0	0	0	0	0	0	0	0
Limnophyes	0	0	0	0	0	0	0	0	0
Metriocnemus	0	0	0	0	0	0	0	0	0
Orthocladiinae RAI 004 (Like Heleni	0	0	0	0	0	0	0	0	0
Orthocladius complex	1300	180	140	156	13	156	60	560	620
Parakiefferiella	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0
Parorthocladius	0	0	0	0	0	0	0	0	0
Rheocricotopus	80	0	0	0	0	0	0	0	0
Synorthocladius	0	0	0	0	0	0	0	0	0
Thienemanniella	0	0	0	0	0	0	0	20	0
Tvetenia	20	30	60	28	75	56	127	160	40
| **Subfamily: Tanypodinae**	0	0	0	0	0	0	0	0	0
Zavrelimyia	0	0	0	0	0	0	0	0	0
| **Tribe: Pentaneurini**	0	0	0	0	0	0	0	0	0
Pentaneura	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	0	4	0	0	0	0	0
| **Family: Dixidae**	0	0	0	0	0	0	0	0	0
| **Family: Empididae**	0	10	0	8	0	38	0	20	40
Chelifera/ Metachela	0	0	0	4	0	0	0	40	140
Clinocera	0	0	0	0	0	0	0	0	0
Neoplasta	0	0	0	0	0	0	0	60	0
Oreogeton	20	40	0	0	0	0	0	0	0
Trichoclinocera	0	0	0	0	0	0	0	0	0
Wiedemannia	0	0	0	0	0	0	0	0	0
| **Family: Muscidae**	0	0	0	0	0	0	0	0	0
Limnophora	0	0	0	0	0	0	0	0	0
| **Family: Psychodidae**	0	0	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	40	0	140	84	463	225	120	40	80

Table A.1: Detailed Benthic Invertebrate Community Data, FRO 2016 LAEMP

Type	Reference		Mine-Exposed						
Sample:	FO26	HENUP	FODHE	FOUKI	FOBKS	FOBSC	FOBCP	FODPO	FOUEW
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
| Family: Simuliidae	0	0	0	0	0	0	0	0	0
Prosimulium	0	0	0	0	0	0	0	0	0
Prosimulium/Helodon	0	0	0	0	0	0	0	0	0
Simulium	140	0	40	0	0	0	13	80	20
| Family: Stratiomyidae	0	0	0	0	0	0	0	0	0
Euparyphus	0	0	0	0	0	0	0	0	0
| Family: Syrphidae	20	0	0	0	0	0	0	0	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0
Antocha	0	0	0	0	0	0	0	0	0
Dicranota	0	0	0	0	0	0	0	0	0
Gonomyodes	0	0	0	0	0	0	0	0	0
Hesperoconopa	0	0	0	0	0	0	0	0	0
Hexatoma	0	0	0	4	0	6	0	0	0
Tipula	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	40
| Family: Aturidae	0	0	0	0	0	0	0	0	0
Aturus	0	0	0	0	0	0	0	0	40
| Family: Feltriidae	0	0	0	0	0	0	0	0	0
Feltria	0	0	0	0	0	0	0	0	0
| Family: Hydryphantidae	0	0	0	0	0	0	0	0	0
Protzia	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	20	0	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0
Lebertia	120	10	40	40	38	88	13	140	140
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0
Sperchon	160	20	40	12	0	6	7	0	0
Sperchonopsis	0	0	0	4	0	0	7	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0
Testudacarus	20	0	0	0	0	0	0	0	0
Torrenticola	0	0	0	0	0	0	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0
| Order: Oribatida	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0
Enchytraeus	20	0	20	36	25	106	40	0	20
| Family: Naididae	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0
Nais	0	0	0	4	0	0	7	0	160
Pristina	0	0	0	0	0	0	0	0	0
Tubifex	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0
Totals:	**17280**	**4830**	**9800**	**1440**	**4323**	**2083**	**2210**	**11620**	**6760**
Taxa present but not included:									
Terrestrials	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	80	10	100	68	63	38	7	40	40
| Class: Maxillipoda	0	0	0	0	0	0	0	0	0
| Class: Copepoda	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0
| Family: Lumbricidae	0	0	0	0	0	0	0	20	0
Phylum: Nemata	0	0	0	4	13	6	7	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	10	20	4	13	6	7	20	20
Totals:	**80**	**20**	**120**	**76**	**89**	**50**	**21**	**80**	**60**

Community Endpoints

Abundance	17,280	4,830	9,800	1,440	4,323	2,083	2,210	11,620	6,760
LPL-Richness	40	28	28	44	34	38	37	41	38
%EPT	78.82%	90.89%	87.96%	51.39%	64.77%	50.15%	66.68%	76.42%	60.06%
%Ephemeroptera	54.98%	78.26%	76.73%	35.56%	38.75%	22.52%	19.31%	14.46%	16.57%

Table A.2: Habitat Information Associated with Reference and Mine-Exposed Areas Sampled During 2016 FRO LAEMP

Station ID	Reference		Mine-Exposed						
	FO26	HENUP	FODHE	FOUKI	FOBKS	FOBSC	FOBCP	FODPO	FOUEW
Waterbody	Fording River	Henretta Creek	Fording River	Fording River	Fording River	Fording River	Fording River	Fording River	Fording River
Date Sampled	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
Zone 11 UTMs - E	653049	655782	651311	651841	652084	652340	652865	653899	656360
Zone 11 UTMs - N	5569608	5567704	5565421	5559848	5558649	5558197	5557150	5555080	5551884
Elevation	1,804	1,802	1,693	1,605	1,595	1,585	1,580	1,570	1,555
Samplers' Initials	SW, DH	SW, DH	SW, DH	CR, SM, JG	CR, SM, JG	CR, SM, JG	CR, SM, JG	CR, SM, JG	CR, SM
Habitat Characteristics									
Surrounding Land Use	Forest, Logging	Forest, Mining	Forest, Mining	Mining, Logging	Mining	Mining	Mining	Mining	Mining
Anthropogenic Influences	Logging upstream	Road uphill from Henretta Lake	Upstream side of culvert past mining pit	NW of settling pond	Fording Operations	Fording River bridge construct upstream	Fording River bridge construct upstream	Fording River Coal Ops	Fording Mine - upstream
Length of Reach Assessed (m)	50		100	50	50	-	50	50	50
% Riffle	70	100	100	85	90	100	100	90	80
% Run	30	0	0	5	10	0	0	10	20
% Rapids	0	0	0	5	0	0	0	0	0
% Pool/Back Eddy	0	0	0	5	0	0	0	0	0
Streamside Vegetation (most dominant first)	Coniferous trees, shrubs, ferns/grass	Coniferous trees, ferns/ grass, shrubs	Ferns/grass	Coniferous trees, deciduous trees, ferns/grass	Coniferous trees, deciduous trees, shrubs, ferns/grass	Coniferous trees, ferns/grass	Coniferous trees, shrubs, ferns/grass	-	Coniferous trees, shrubs, ferns/grass
% Bedrock	0	0	0	0	0	0	0	0	0
% Boulder	10	10	trace	5	0	0	5	0	0
% Cobble	40	60	40	40	80	80	70	20	90
% Pebble	30	25	40	30	20	15	10	70	10
% Gravel	10	5	15	15	0	0	5	10	0
% Sand/Finer	10	trace	5	2	0	5	0	0	0
% Organic	trace	0	0	8	0	0	0	0	0
Canopy Coverage (%)	1 - 25	1 - 25	0	0	1 - 25	1 - 25	1 - 25	1 - 25	1 - 25
Macrophyte Coverage (%)	0	-	0	0	0	0	0	0	0
Periphyton Coverage	-	-	-	2	1	1	1	1	1
Bank Stability	stable, moderate	unstable, substantial erosion	stable, no erosion, moderate	moderate	moderate	moderate	moderate	moderate	unstable, substantial erosion
Water Colour & Clarity	colourless/clear	colourless/clear	colourless/clear	colourless/clear	colourless/clear	colourless/clear	colourless/clear	blue/clear	colourless/clear
Bankfull Width (m)	46	-	18	38	22	76	44	14	35
Wetted Width (m)	7	6	12	9.6	21	22.8	18	8	11
Bankfull-Wetted Depth (cm)	50	150	100	100	75	50	100	80	200
Gradient (%)	1.0 - 2.0	3.0 - 4.0	1.0 - 2.0	0.5	0.5	1.0	0.5	0.5 - 1.0	1.0 - 1.5
Comments/Notes	Collected periphyton for AFDM, CHLA and Se.	-	Benthic community sample only. Calcite observed on most rocks ~ 100m upstream. Stringy periphyton on rocks (Hydrurus?).	The rocks were more concreted form on end of the kick to the other. Cutthroat caught in net.	Substrate concreted in lower riffle with calcite.	Calcite - rocks concreted.	-	Calcite on rocks.	Calcite on rocks but not concreted.
Benthic									
Number of Samples	3	2	-	2	-	-	2	2	2
Approx. weight of sample (grams)	-	-	-	>0.5	-	-	>0.5	>0.5	>0.5
Time spent sampling (Hours)	-	-	-	1	-	-	1	1	1
Dominant Taxa	Hydropsychidae Perlidae Ephemoptera	Hydropsychidae Perlidae Ephemoptera	-	Perlidae Hydropsychidae	-	-	Perlidae Hydropsychidae	Rhyacophilidae Plecopterastoneflies Ephemoptera	Plecoptera Hydropsychidae Rhyacophilidae
Macrophyte Samples	No	No	No	No	No	No	No	No	No
CABIN									
Samplers' Initials	-	-	-	CR	CR	CR	CR	CR	CR
Equipment	triangle net	triangle net	traingle net	triangle net	triangle net	triangle net	triangle net	triangle net	triangle net
Sieve Size (um)	400	400	400	400	400	400	400	400	400
100 pebble count completed?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sampling Time (min)	-	-	-	3	3	3	3	3	3
Total Kick Distance (m)	20	15	20	25	20	19	22	32	13
Number of Jars	1	1	1	1	1	1	1	1	1
Number of transects	1	3	1	2.75	3.5	1.3	3.25	4.5	-
Distance from shore (m)	-		-	-	-	-	-	-	3.5

Table A.3: Mean Pebble Measurements for FRO 2016 LAEMP

Station ID		Intermediate Axis (cm)		Embededness (%)	
		Mean	Standard Deviation	Mean	Standard Deviation
Reference	FO26	6.9	4.6	38%	32%
	HENUP	11.1	8.9	28%	22%
Mine-Exposed	FODHE	8.5	3.9	28%	30%
	FOUKI	7.8	2.4	18%	17%
	FOBKS	8.8	2.4	28%	14%
	FOBSC	7.9	2.3	35%	27%
	FOBCP	9.6	2.5	15%	13%
	FODPO	3.7	1.6	25%	20%
	FOUEW	8.6	2.3	15%	13%

Table A.4: Calcite Measurements for FRO 2016 LAEMP

Station ID		Concreted Status	Calcite Presence	Calcite Index
Reference	FO26	0.0	0.80	0.80
	HENUP	0.00	0.00	0.00
Mine-Exposed	FODHE	0.00	0.00	0.00
	FOUKI	0.80	1.00	1.80
	FOBKS	1.00	1.00	2.00
	FOBSC	0.80	1.00	1.80
	FOBCP	0.60	1.00	1.60
	FODPO	0.00	1.00	1.00
	FOUEW	0.00	1.00	8.60

Table A.5: **Water Quality Data Associated with Reference and Mine-Exposed Sampling Areas, FRO 2016 LAEMP**

Characteristics	Reference		Mine-Exposed						
	FO26	HENUP	FODHE	FOUKI	FOBKS	FOBSC	FOBCP	FODPO	FOUEW
Date	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
Temperature (°C)	5.30	5.24	8.45	9.29	10.92	10.97	10.74	5.89	6.23
Conductivity (uS/cm)	210	199	311	525	545	594	715	621	575
Specific Conductivity (uS/cm)	337	320	455	750	745	811	983	991	897
pH	8.45	8.30	8.52	7.44	7.87	9.79	7.99	6.63	7.44
Dissolved Oxygen (mg/L)	12.21	12.06	11.68	10.45	10.02	9.80	9.82	10.70	11.15
Dissolved Oxygen (%)	96.5	95.1	99.8	91.1	91.0	89.1	88.7	86.0	90.3

APPENDIX B

BENTHIC INVERTEBRATE LABORATORY REPORT

Table B.1: Whole Sample Data

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561) Taxonomist: Sue Salter 250-494-7553
Minnow (Georgetown), Shari Weech suesalter@cordilleraconsulting.ca

Site:	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN
Sample:	FO26-BIC	HENUP-BIC	FODHE-BIC	FOUKI-BIC	FOBKS-BIC	FOBSC-BIC	FOBCP-BIC	FODPO-BIC	FOUEW-BIC
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
CC#:	CC171313	CC171282	CC171312	CC171279	CC171304	CC171306	CC171278	CC171309	CC171277
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0
Ameletus	0	10	120	8	0	0	0	20	0
| Family: Baetidae	0	0	0	4	0	0	0	0	0
Acentrella	0	0	0	0	0	0	0	0	0
Acentrella turbida	0	0	0	0	0	0	0	0	0
Baetis	600	0	260	40	263	106	100	460	240
Baetis tricaudatus group	40	0	0	52	63	131	33	500	180
Baetis bicaudatus	0	0	320	0	0	0	0	0	0
| Family: Ephemerellidae	2060	770	2080	72	313	94	67	140	100
Drunella	0	0	0	0	0	0	0	0	0
Drunella coloradensis	0	0	0	0	0	0	0	0	0
Drunella doddsii	1700	50	60	16	63	0	60	20	0
Drunella spinifera	0	0	0	0	0	19	7	0	20
Ephemerella	0	0	0	0	0	6	0	0	0
| Family: Heptageniidae	4640	2550	4380	320	963	106	160	540	580
Cinygmula	0	0	0	0	0	0	0	0	0
Epeorus	140	90	60	0	13	6	0	0	0
Rhithrogena	320	310	240	0	0	0	0	0	0
| Family: Leptophlebiidae	0	0	0	0	0	0	0	0	0
Neoleptophlebia	0	0	0	0	0	0	0	0	0
Paraleptophlebia	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0
| Family: Capniidae	0	0	0	0	0	13	7	100	0
| Family: Chloroperlidae	240	0	20	0	13	6	0	160	0
Suwallia	0	0	0	0	0	0	0	0	0
Sweltsa	460	40	0	4	25	6	7	80	60
| Family: Leuctridae	20	0	0	0	0	0	0	0	0
Despaxia augusta	0	0	0	0	0	0	0	0	0
| Family: Nemouridae	0	0	0	0	0	0	0	0	0
Visoka cataractae	0	10	0	0	0	0	0	0	0
Zapada	180	10	180	12	225	81	220	2000	1180
Zapada oregonensis group	120	20	0	4	13	0	0	140	200
Zapada cinctipes	0	0	0	28	63	38	107	260	300
Zapada columbiana	320	50	0	20	0	6	0	40	180
| Family: Peltoperlidae	0	0	0	0	0	0	0	0	0
Yoraperla	0	0	0	0	0	0	0	0	0
| Family: Perlidae	0	0	20	0	25	0	0	20	0
Calineuria californica	0	0	0	0	0	0	0	0	0
Hesperoperla	0	0	0	0	0	13	0	0	0
Hesperoperla pacifica	0	0	0	12	0	0	0	0	0
| Family: Perlodidae	420	0	460	32	113	69	247	800	0
Isoperla	0	0	0	0	38	44	0	300	0
Megarcys	360	20	180	28	150	44	80	200	100
Skwala	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0
Pteronarcella	0	0	0	0	0	0	0	0	0
| Family: Taeniopterygidae	920	10	220	0	50	19	0	740	0
Taenionema	0	370	0	4	0	0	20	0	20
| Order: Trichoptera	0	0	0	0	0	0	0	0	0
| Family: Apataniidae	0	0	0	0	0	0	0	0	0
Allomyia	0	0	0	0	0	0	0	0	0
Apatania	0	0	0	8	0	0	0	0	0
Pedomoecus sierra	0	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	25	6	0	0	0
Brachycentrus	0	0	0	0	0	0	7	0	0
Brachycentrus americanus	0	0	0	0	0	0	7	0	0
| Family: Glossosomatidae	0	0	0	20	0	0	0	180	360
Anagapetus	0	0	0	0	0	0	0	0	0

Table B.1: Whole Sample Data

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter
suesalter@cordilleraconsulting.ca
250-494-7553

Site:	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN
Sample:	FO26-BIC	HENUP-BIC	FODHE-BIC	FOUKI-BIC	FOBKS-BIC	FOBSC-BIC	FOBCP-BIC	FODPO-BIC	FOUEW-BIC
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
CC#:	CC171313	CC171282	CC171312	CC171279	CC171304	CC171306	CC171278	CC171309	CC171277
Glossosoma	0	20	0	28	25	19	0	1620	40
| Family: Hydropsychidae	240	20	0	0	0	0	33	0	80
Arctopsyche	0	0	0	0	0	0	0	0	0
Arctopsyche grandis	0	0	0	8	0	6	113	0	0
Arctopsyche ladogensis	0	0	0	0	0	0	7	0	0
Hydropsyche	0	0	0	0	0	0	0	0	0
Parapsyche	80	20	20	8	38	0	27	0	20
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	0	0	0	0	0
| Family: Leptoceridae	0	0	0	0	0	0	0	0	0
| Family: Limnephilidae	0	0	0	4	0	0	0	20	0
Ecclisomyia	0	0	0	0	0	0	0	0	0
| Family: Rhyacophilidae	0	0	0	0	0	0	0	0	0
Rhyacophila	20	0	0	4	200	163	147	380	320
Rhyacophila betteni group	0	0	0	0	13	0	7	40	0
Rhyacophila brunnea/vemna grou	0	0	0	4	63	25	7	100	60
Rhyacophila hyalinata group	120	20	0	0	38	19	7	0	0
Rhyacophila vofixa group	80	0	0	0	0	0	0	0	0
Rhyacophila atrata complex	0	0	0	0	13	0	0	0	0
Rhyacophila narvae	0	0	0	0	0	0	0	20	0
| Family: Uenoidae	0	0	0	0	0	0	0	0	0
Neothremma	0	0	0	0	0	0	0	0	0
Oligophlebodes	540	0	0	0	0	0	0	0	20
| Order: Coleoptera	0	0	0	0	0	0	0	0	0
| Family: Dytiscidae	0	0	0	0	0	0	0	0	0
Stictotarsus	0	0	0	0	0	0	0	0	0
| Family: Elmidae	0	0	0	4	0	0	0	200	180
Heterlimnius	0	0	0	0	0	0	0	180	40
| Order: Diptera	0	0	0	4	0	0	0	0	0
| Family: Athericidae	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	0	0
Probezzia	0	20	40	28	75	19	13	40	20
| Family: Chironomidae	220	20	240	84	200	100	93	540	240
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0
| Tribe: Chironomini	0	0	0	0	0	0	0	0	0
Microtendipes	0	0	0	0	0	0	0	0	0
Microtendipes pedellus group	0	0	0	0	0	0	0	0	0
Pagastiella	0	0	0	0	0	0	0	0	0
Polypedilum	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0
Constempellina sp. C	0	0	0	0	0	0	0	0	0
Micropsectra	500	50	280	148	438	138	140	260	220
Paratanytarsus	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0
Stempellinella	0	0	0	0	0	0	0	0	0
Sublettea coffmani	0	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	0	0	0	0	0	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0
Diamesa	380	0	0	0	0	6	0	0	0
Pagastia	300	0	80	28	75	69	53	220	460
Potthastia	0	0	0	0	0	0	0	0	0
Potthastia longimana group	0	0	0	0	0	0	0	0	0
Pseudodiamesa	0	0	0	0	0	0	0	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0
Brillia	20	0	0	4	0	0	0	0	0
Corynoneura	0	0	0	0	0	0	0	0	20
Cricotopus (Nostococladius)	40	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0
Eukiefferiella	260	60	40	16	113	25	40	180	180

Table B.1: Whole Sample Data

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter
suesalter@cordilleraconsulting.ca
250-494-7553

Site:	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN
Sample:	FO26-BIC	HENUP-BIC	FODHE-BIC	FOUKI-BIC	FOBKS-BIC	FOBSC-BIC	FOBCP-BIC	FODPO-BIC	FOUEW-BIC
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
CC#:	CC171313	CC171282	CC171312	CC171279	CC171304	CC171306	CC171278	CC171309	CC171277
Heleniella	0	0	0	0	0	0	0	0	0
Hydrobaenus	0	0	0	0	0	0	0	0	0
Limnophyes	0	0	0	0	0	0	0	0	0
Metriocnemus	0	0	0	0	0	0	0	0	0
Orthocladiinae RAI 004 (Like Helen	0	0	0	0	0	0	0	0	0
Orthocladius complex	1300	180	140	156	13	156	60	560	620
Parakiefferiella	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0
Parorthocladius	0	0	0	0	0	0	0	0	0
Rheocricotopus	80	0	0	0	0	0	0	0	0
Synorthocladius	0	0	0	0	0	0	0	0	0
Thienemanniella	0	0	0	0	0	0	0	20	0
Tvetenia	20	30	60	28	75	56	127	160	40
| Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0
Zavrelimyia	0	0	0	0	0	0	0	0	0
| Tribe: Pentaneurini	0	0	0	0	0	0	0	0	0
Pentaneura	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	0	4	0	0	0	0	0
| Family: Dixidae	0	0	0	0	0	0	0	0	0
| Family: Empididae	0	10	0	8	0	38	0	20	40
Chelifera/ Metachela	0	0	0	4	0	0	0	40	140
Clinocera	0	0	0	0	0	0	0	0	0
Neoplasta	0	0	0	0	0	0	0	60	0
Oreogeton	20	40	0	0	0	0	0	0	0
Trichoclinocera	0	0	0	0	0	0	0	0	0
Wiedemannia	0	0	0	0	0	0	0	0	0
| Family: Muscidae	0	0	0	0	0	0	0	0	0
Limnophora	0	0	0	0	0	0	0	0	0
| Family: Psychodidae	0	0	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	40	0	140	84	463	225	120	40	80
| Family: Simuliidae	0	0	0	0	0	0	0	0	0
Prosimulium	0	0	0	0	0	0	0	0	0
Prosimulium/Helodon	0	0	0	0	0	0	0	0	0
Simulium	140	0	40	0	0	0	13	80	20
| Family: Stratiomyidae	0	0	0	0	0	0	0	0	0
Euparyphus	0	0	0	0	0	0	0	0	0
| Family: Syrphidae	20	0	0	0	0	0	0	0	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0
Antocha	0	0	0	0	0	0	0	0	0
Dicranota	0	0	0	0	0	0	0	0	0
Gonomyodes	0	0	0	0	0	0	0	0	0
Hesperoconopa	0	0	0	0	0	0	0	0	0
Hexatoma	0	0	0	4	0	6	0	0	0
Tipula	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	40
| Family: Aturidae	0	0	0	0	0	0	0	0	0
Aturus	0	0	0	0	0	0	0	0	40
| Family: Feltriidae	0	0	0	0	0	0	0	0	0
Feltria	0	0	0	0	0	0	0	0	0
| Family: Hydryphantidae	0	0	0	0	0	0	0	0	0
Protzia	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	20	0	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0
Lebertia	120	10	40	40	38	88	13	140	140
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0
Sperchon	160	20	40	12	0	6	7	0	0
Sperchonopsis	0	0	0	4	0	0	7	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0
Testudacarus	20	0	0	0	0	0	0	0	0
Torrenticola	0	0	0	0	0	0	0	0	0

Table B.1: **Whole Sample Data**

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter
suesalter@cordilleraconsulting.ca

250-494-7553

Site:	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN	CABIN
Sample:	FO26-BIC	HENUP-BIC	FODHE-BIC	FOUKI-BIC	FOBKS-BIC	FOBSC-BIC	FOBCP-BIC	FODPO-BIC	FOUEW-BIC
Sample Collection Date:	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16	12-Sep-16
CC#:	CC171313	CC171282	CC171312	CC171279	CC171304	CC171306	CC171278	CC171309	CC171277
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0
| Order: Oribatida	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0
Enchytraeus	20	0	20	36	25	106	40	0	20
| Family: Naididae	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0
Nais	0	0	0	4	0	0	7	0	160
Pristina	0	0	0	0	0	0	0	0	0
Tubifex	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0
Totals:	**17280**	**4830**	**9800**	**1440**	**4323**	**2083**	**2210**	**11620**	**6760**

Taxa present but not included:

Terrestrials	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	80	10	100	68	63	38	7	40	40
| Class: Maxillipoda	0	0	0	0	0	0	0	0	0
| Class: Copepoda	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0
| Family: Lumbricidae	0	0	0	0	0	0	0	20	0
Phylum: Nemata	0	0	0	4	13	6	7	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	10	20	4	13	6	7	20	20
Totals:	**80**	**20**	**120**	**76**	**89**	**50**	**21**	**80**	**60**

Table B.2: Sorting Efficiency

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter 250-494-7553
suesalter@cordilleraconsulting.ca

	Total Recovered	Total from Sample	Percent Efficiency
Site - QC, Sample - QC 1, CC# - CC171277, Percent sampled = 5%, Sieve size = 400			
Plecoptera	3		
Oligochaeta	1		
Total:	**4**	**338**	**99%**
Site - QC, Sample - QC 2, CC# - CC171286, Percent sampled = 5%, Sieve size = 400			
Diptera	2		
Ephemeroptera	1		
Plecoptera	4		
Trichoptera	1		
Oligochaeta	3		
Total:	**11**	**375**	**97%**
Site - QC, Sample - QC 3, CC# - CC171298, Percent sampled = 8%, Sieve size = 400			
Ephemeroptera	2		
Trichoptera	1		
Total:	**3**	**353**	**99%**
Site - QC, Sample - QC 4, CC# - CC171310, Percent sampled = 7%, Sieve size = 400			
Plecoptera	1		
Oligochaeta	2		
Total:	**3**	**387**	**99%**

Table B.3: Taxonomic QC

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter 250-494-7553
suesalter@cordilleraconsulting.ca

Site - CABIN, Sample - HENUP-BIC, CC# - CC171282, Percent sampled = 10%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficent Taxonomic Resolution	Comments
Rhyacophila hyalinata group	2	2						
Lebertia	1	1						
Sperchon	2	2						
Parapsyche	2	2						
Hydropsychidae	2	2						
Glossosoma	2	2						
Taeniopterygidae	1	1						
Taenionema	38	37	No			X		
Megarcys	2	2						
Visoka cataractae	1	1						
Zapada	1	1						
Zapada columbiana	5	5						
Zapada oregonensis group	2	2						
Heptageniidae	255	255						
Rhithrogena	31	31						
Epeorus	9	9						
Sweltsa	4	4						
Drunella doddsii	5	5						
Ephemerellidae	77	77						
Ameletus	1	1						
Oreogeton	4	4						
Empididae	1	1						
Tvetenia	3	3						
Eukiefferiella	6	6						
Orthocladius complex	18	18						
Micropsectra	5	5						
Chironomidae	2	2						
Probezzia	2	2						
Total:	**484**	**483**						
					0	1	0	
% Total Misidentification Rate =	misidentifications / total number		x100 =		0.00	**Pass**		

Table B.3: Taxonomic QC

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter 250-494-7553
suesalter@cordilleraconsulting.ca

Site - CABIN, Sample - CORCK-BIC, CC# - CC171288, Percent sampled = 5%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficent Taxonomic Resolution	Comments
Chaetogaster	20	20						
Aturus	25	23	No			X		
Pisidiidae	1	1						
Enchytraeus	56	56						
Nais	1	1						
Rhyacophila brunnea/vemna group	5	5						
Sperchon	1	1						
Feltria	4	4						
Lebertia	3	3						
Hydroptila	68	68						
Rhyacophila	25	25						
Hydropsychidae	1	1						
Perlodidae	1	1						
Zapada	62	62						
Sweltsa	1	1						
Zapada cinctipes	62	62						
Zapada columbiana	1	1						
Chloroperlidae	1	1						
Heptageniidae	2	2						
Drunella	1	1						
Ephemerellidae	1	1						
Dicranota	9	9						
Antocha	1	1						
Simuliidae	3	3						
Limnophora	1	1						
Pericoma/Telmatoscopus	103	103						
Chelifera/ Metachela	2	2						
Empididae	22	22						
Thienemannimyia group	1	1						
Thienemanniella	1	1						
Tanypodinae	1	1						
Orthocladius complex	90	90						
Tvetenia	16	16						
Cricotopus (Nostococladius)	1	1						
Pagastia	88	88						
Eukiefferiella	11	11						
Heleniella	3	3						
Hydrobaenus	1	1						
Micropsectra	89	89						
Chironomidae	16	16						
Heterlimnius	3	3						
Elmidae	7	7						
Total:	**811**	**809**						
					0	1	0	
% Total Misidentification Rate =	misidentifications / total number		x100	=	0.00	**Pass**		

Table B.3: Taxonomic QC

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter 250-494-7553
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Site - CABIN, Sample - SLINE-BIC, CC# - CC171295, Percent sampled = 20%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficent Taxonomic Resolution	Comments
Diamesa	2	2						
Chironomidae	10	10						
Eukiefferiella	11	11						
Hydrobaenus	1	1						
Orthocladius complex	39	39						
Synorthocladius	2	2						
Tvetenia	4	4						
Dicranota	1	1						
Ameletus	14	14						
Baetis	3	3						
Oreogeton	2	2						
Baetis bicaudatus	2	2						
Ephemerellidae	26	29	No			X		
Drunella	6	6						
Drunella coloradensis	4	4						
Drunella doddsii	9	9						
Heptageniidae	107	105	No			X		
Epeorus	2	2						
Rhithrogena	2	2						
Suwallia	3	3						
Sweltsa	9	9						
Chloroperlidae	2	2						
Zapada columbiana	13	13						
Zapada	10	10						
Leuctridae	2	2						
Perlodidae	3	3						
Zapada oregonensis group	3	3						
Yoraperla	1	1						
Megarcys	6	6						
Taenionema	10	10						
Rhyacophila	4	4						
Parapsyche	1	1						
Hydropsychidae	10	10						
Glossosoma	2	2						
Lebertia	3	3						
Rhyacophila brunnea/vemna group	3	3						
Oligophlebodes	24	24						
Rhyacophila vofixa group	1	1						
Rhyacophila hyalinata group	2	2						
Baetis tricaudatus group	2	2						
Sperchonopsis	1	1						
Total:	**362**	**363**						
					0	2	0	
% Total Misidentification Rate =	misidentifications / total number		x100 =		0.00	**Pass**		

Table B.3: Taxonomic QC

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter 250-494-7553
suesalter@cordilleraconsulting.ca

Site - CABIN, Sample - FO23-BIC, CC# - CC171299, Percent sampled = 5%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficent Taxonomic Resolution	Comments
Micropsectra	42	42						
Chironomidae	5	5						
Heterlimnius	1	1						
Eukiefferiella	1	1						
Orthocladius complex	9	9						
Pagastia	2	2						
Tvetenia	2	2						
Rheocricotopus	2	2						
Chelifera/ Metachela	2	2						
Clinocera	2	2						
Pericoma/Telmatoscopus	11	11						
Wiedemannia	1	1						
Hexatoma	2	2						
Tipula	1	1						
Drunella doddsii	39	39						
Ephemerellidae	10	10						
Baetis	19	19						
Heptageniidae	24	26	No			X		
Rhithrogena	3	3						
Chloroperlidae	4	4						
Sweltsa	36	36						
Capniidae	3	3						
Perlidae	1	1						
Zapada	7	7						
Zapada cinctipes	11	11						
Megarcys	1	1						
Perlodidae	7	7						
Hesperoperla	6	6						
Taeniopterygidae	8	8						
Pedomoecus sierra	1	1						
Hydrozetidae	1	1						
Rhyacophila atrata complex	8	8						
Baetis tricaudatus group	13	12	No			X		
Enchytraeus	3	3						
Nais	6	6						
Arctopsyche grandis	1	1						
Glossosomatidae	3	3						
Glossosoma	8	8						
Rhyacophila betteni group	2	2						
Lepidostoma	1	1						
Oligophlebodes	1	1						
Trombidiformes	1	1						
Rhyacophila brunnea/vemna group	1	1						
Lebertia	16	16						
Sperchon	2	2						
Lumbriculidae	1	1						
Total:	**331**	**332**						

			0	2	0	
% Total Misidentification Rate =	misidentifications / total number	x100 =	0.00	**Pass**		

Table B.4: Sub-Sample QC

Cordillera Consulting

Project: Teck Elk Valley 2016 (2561)
Minnow (Georgetown), Shari Weech

Taxonomist: Sue Salter 250-494-7553
suesalter@cordilleraconsulting.ca

Station ID		Organisms in Subsample																				Actual Total	Precision Error		Accuracy Error	
CC#	Sample Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		Min (%)	Max (%)	Min (%)	Max (%)
171279	FOUKI-BIC	358	368	378	338																	1442	2.65	10.58	0.69	6.24
171280	MI3-BIC	382	306	307	303	333	331	320	306	360	345	311	313	338	333	315	305	310	346	345	309	6518	0.00	20.68	1.56	17.21
171282	HENUP-BIC	490	457	470	487	498	534	566	518	496	545											5061	0.40	19.26	1.60	11.84
171295	SLINE-BIC	400	411	437	426	461																2135	2.52	13.23	0.23	7.96