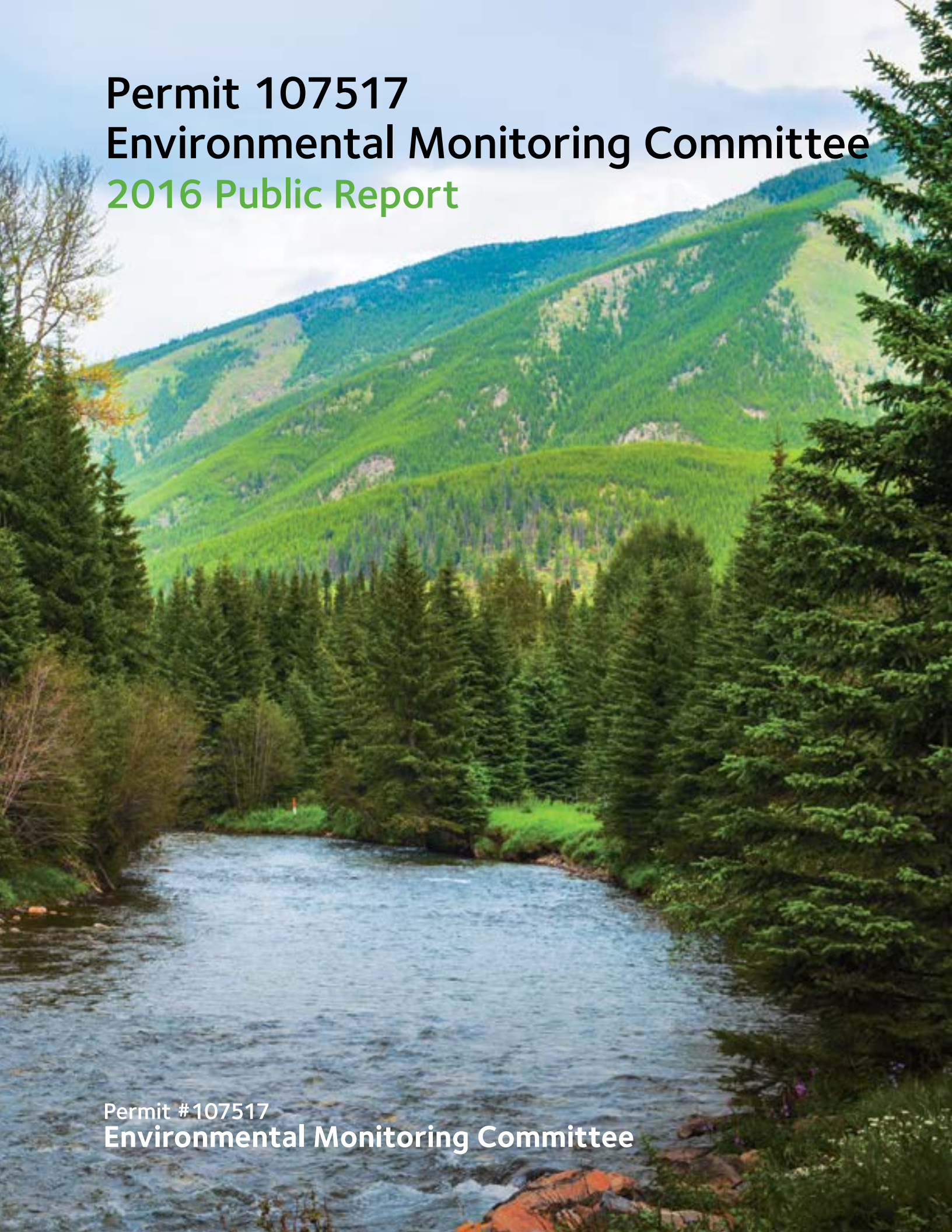
Permit 107517
Environmental Monitoring Committee
2016 Public Report



Permit #107517
Environmental Monitoring Committee

Acknowledgments and Support

This report was prepared by Teck (Teck) and the independent facilitator (Lynne Betts), with the assistance of the following members of the Environmental Monitoring Committee:

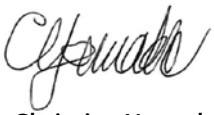
Carla Fraser (Teck), Mark Digel (Teck), Christina Yamada [Interior Health Authority(IHA), Lana Miller (B.C. Ministry of Environment (MoE)], Jillian Tamblyn (MoE), Kim Bellefontaine (B.C. Ministry of Mines), Bruce Kilgour (Independent Scientist), Don Sam [Ktunaxa Nation Council (KNC)], Heather McMahon (KNC), and Don MacDonald (KNC).

In addition, the following individuals made contributions to the preparation of this report:

- Alison Neufeld for MoE
- Sheldon Reddekopp for MoE
- Bill Green and Ali Burton for KNC
- Nicole Tremblay, April Cuffy, Avery Deboer-Smith, and Kristene Perron for the independent facilitator

The following member organizations of the Environmental Monitoring Committee have reviewed this public report and endorse its contents:

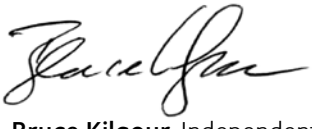
Lana Miller on behalf of B.C. Ministry of Environment



Christina Yamada on behalf of Interior Health Authority

Mark Digel on behalf of Teck

Bill Green on behalf of Ktunaxa Nation Council



Bruce Kilgour, Independent Scientist

The Ministry of Energy and Mines was not able to fully participate in the review of Environmental Monitoring Committee materials during 2016. The Ministry of Energy and Mines supports the endorsement of this report provided by the Ministry of Environment.

Feedback Form

Contact the EMC's independent facilitator if you have questions about the Environmental Monitoring Committee, the technical advice or input it provides, and responses from Teck to the EMC's technical advice. The Environmental Monitoring Committee's annual public reports are available at **www.teckelkvalley.com**

Environmental Monitoring Committee
Independent Facilitator
Lynne Betts
emcpermit107517@gmail.com
250-352-6881

☐ Notify me about the EMC's annual public meetings and reports.

I would like to request the EMC's advice or input, plus feedback from Teck on the following:

- ☐ **Third Party Audit**
- ☐ **Water Quality**
  - ☐ Water Quality Limits at Compliance Points
  - ☐ Toxicity Testing
  - ☐ Acute Toxicity Testing
  - ☐ Chronic Toxicity Testing
  - ☐ Westslope Cutthroat Trout Egg Study
  - ☐ Site Performance Objective (SPO) Mixture Study
  - ☐ Nitrate and Sulphate Toxicity Study
  - ☐ Water Quality Model
  - ☐ Elk Valley Groundwater Monitoring
- ☐ **Aquatic Ecosystem Health**
  - ☐ Aquatic Effects Monitoring
  - ☐ Koocanusa Reservoir Monitoring
  - ☐ Tributary Evaluation and Management
- ☐ **Calcite**
  - ☐ Calcite Monitoring
  - ☐ Seasonal Calcite Supporting Study
- ☐ **Human Health Risk Assessment**
- ☐ **Adaptive Management Plan**

Name: _____

Affiliation (if any): _____

Email: _____ Phone: _____

Table of Contents

1 Introduction

This section provides background information leading to the formation of the Environmental Monitoring Committee required by Permit 107517. Overview information related to mining and water quality is included here to provide context for the reader.

Background: Environmental Monitoring Committee Public Report

In April 2013, the British Columbia Ministry of Environment (MoE), under Section 89 of the Environmental Management Act (EMA) of British Columbia, issued Ministerial Order No. M113 (the Order) to Teck requiring that the company prepare an area based management plan (ABMP) for the Elk Valley to remediate water quality effects of past coal-mining activities and to guide future development.

The Order was issued in response to evidence of increasing concentrations of selenium, cadmium, nitrate, and sulphate in watercourses in the Elk Valley, as well as evidence of calcite formation in some of these watercourses. These issues are largely associated with historical and current mining activities and, in particular, leaching from waste rock dumps. The Order required Teck to assess water quality and to develop a water quality plan with the purpose of stabilizing and reducing these constituents. The Order identified that the environmental management objectives would include protection of groundwater, aquatic ecosystems and human health, and management of bioaccumulation.

In July 2014, Teck submitted its area based management plan—known as the Elk Valley Water Quality Plan—to the Ministry of Environment as required by the Order. Following approval of the Elk Valley Water Quality Plan by the Ministry of Environment, an Environmental Management Act permit (Permit 107517 or Permit) was issued in November 2014 authorizing effluent discharges from Teck's steelmaking coal operations in the Elk Valley (Figure 1-1).

One requirement of Permit 107517 was the formation of an Environmental Monitoring Committee (EMC or Committee) that will be active throughout mine operations. The Committee will review monitoring submissions required under Permit 107517 in order to provide technical and Traditional Knowledge[1] advice with the goal of strengthening technical aquatic monitoring submissions to the Ministry of Environment. The first Committee meeting was held on March 10, 2015.

The public report you are reading is an annual deliverable prepared by the Committee. Where available, results of Committee reviewed monitoring programs have been summarized. Where results are not yet available, a summary of activity to-date has been provided.

In conjunction with the release of the report, a public open house will be held each year where members of the Committee and Teck representatives will discuss information reviewed by the Committee and answer questions.

The Committee will host its second annual public meeting on Wednesday, October 19, 2016, at the Sparwood Seniors' Centre. This report is also available online at **www.teckelkvalley.com**

From Water Quality Plan to Permit 107517

In April 2013, MoE directed Teck to develop an area based management plan, known as the Elk Valley Water Quality Plan. It is available at **www.teckelkvalley.com** and the Ministry of Environment Mining and Smelting website. The goal of the Elk Valley Water Quality Plan is to stabilize and reduce concentrations of selenium, nitrate, cadmium, sulphate, and calcite formation associated with historical and current mining activity.

An EMA permit, Permit 107517 was issued authorizing continued water discharges from Teck's Elk Valley

[1]Traditional Knowledge (TK) refers to knowledge, skills, and practices that are developed, sustained, and passed on from generation to generation within a community, often forming part of its cultural or spiritual identity.

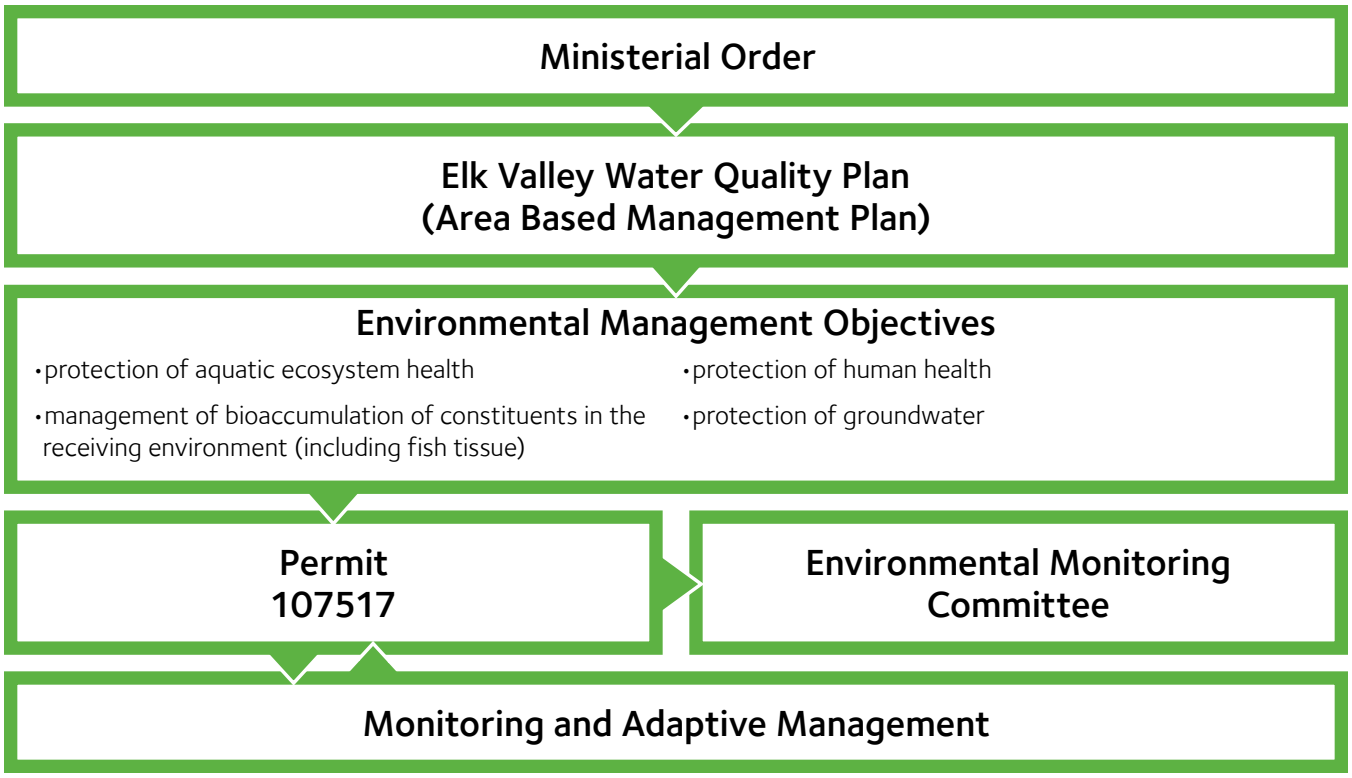


Figure 1-1. The work of the Environmental Monitoring Committee is defined by Permit 107517in support of the environmental management objectives outlined in the Elk Valley Water Quality Plan.

operations. Permit 107517 directed the formation of the EMC to review environmental monitoring submissions and reports required under Permit 107517 and provide technical advice to Teck and the Ministry of Environment decision-makers.

The Committee Terms of Reference requires the Committee to prepare an annual plain-language report, which is approved by the EMC. The annual report will communicate: the results of monitoring undertaken under Permit 107517 and reviewed by the EMC; the status of the implementation of activities and commitments under the area based management plan (i.e., the Elk Valley Water Quality Plan); and an appendix listing all non-confidential recommendations.

In the interest of transparency, the Committee's advice or input, and feedback from Teck, can be obtained by request from the EMC's independent facilitator. See the feedback form on page 2 or email **emcpermit107517@gmail.com**

Introduction to Mining and Water Quality

Steelmaking coal occurs as layers within rock. To access the coal, large quantities of this rock, referred to as waste rock, are mined and placed in piles within the pits or in nearby valleys, creating valley-fill waste rock dumps (Step 1 in Figure 1-2). Water from rain and melting snow flows through these waste rock piles (Step 2) taking selenium, cadmium, nitrate, sulphate, and other minerals, such as calcium, into nearby rivers and tributaries (Step 3). In addition to these naturally occurring elements, nitrate from blasting residue also enters rivers and tributaries, which flow downstream into the Elk River. As the Elk River flows into the Koocanusa Reservoir, mining activities conducted in the Elk Valley can influence water quality conditions in the reservoir.

These four constituents (i.e., selenium, cadmium, nitrate, and sulphate) are specifically named in the Order, along with calcite. Collectively, these five constituents of interest are referred to as Order Constituents.

Order Constituents

Selenium is a common element found naturally in rock and is an essential nutrient for living things. In water, such as tributaries and creeks, selenium can be taken up by algae and other microorganisms and transferred through the food web to aquatic invertebrates, fish, birds, and other vertebrates. When selenium occurs at higher concentrations it can interfere with reproduction, especially in animals that lay eggs such as fish, birds, amphibians, and reptiles.

Studies show that waste rock piles placed decades ago continue to release selenium and are expected to do so for many decades more.

Cadmium is a metal that can be harmful to fish and other aquatic organisms at elevated concentrations. Just like selenium, mining can speed up the release of cadmium to the environment by exposing waste rock to air and water. Unlike selenium, the primary concern for aquatic organisms

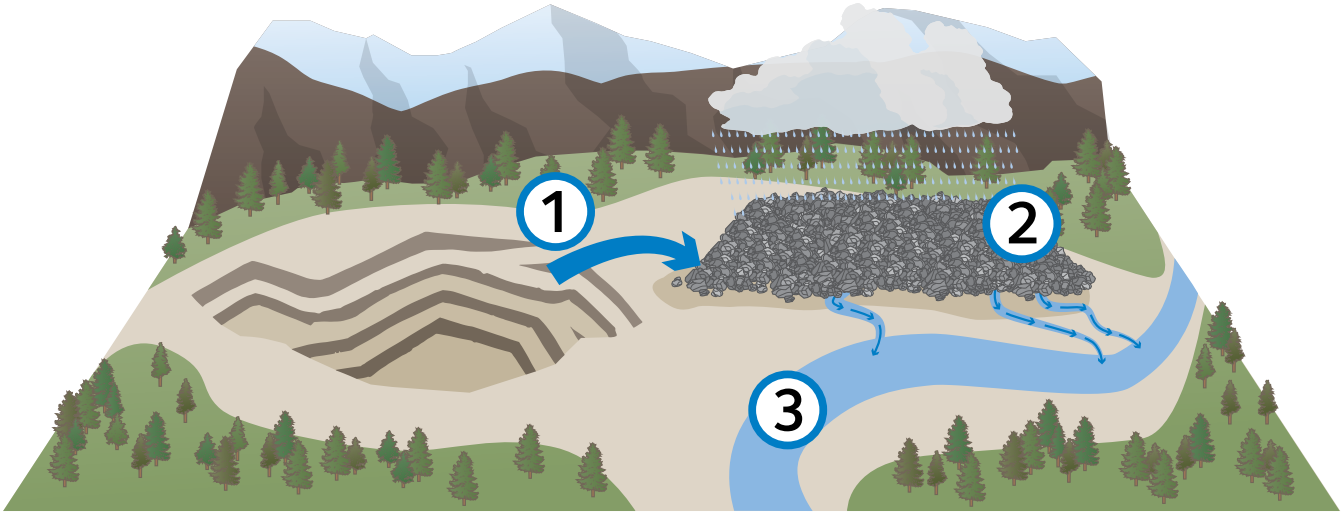


Figure 1-2. The coal mining process and its relation to water quality.

is exposure to cadmium through direct contact with water that may contain cadmium. When levels of cadmium are elevated, it can adversely affect the survival, growth, and/or reproduction of fish and other aquatic organisms.

Nitrate is an inorganic substance that is carried by water from waste rock piles containing blasting material used for mining. At elevated levels nitrate can be toxic to fish and other aquatic organisms. It disrupts their ability to use oxygen, which harms growth and development, particularly in the early life stages (e.g., larval stage) of fish. High levels of nitrate can also contribute to eutrophication, which is when excess nutrients in the water stimulate excessive plant growth.

Sulphate is a naturally occurring substance that contains sulphur and oxygen. It is released from waste rock through the oxidation of minerals containing sulphide. Exposure to sulphate in water can interfere with the ability of many aquatic invertebrates to regulate bodily fluids. At elevated levels, sulphate is toxic to fish and other aquatic organisms.

Calcite is a white or colourless mineral consisting of calcium carbonate. As water travels through the ground, or through mining waste rock, calcium carbonate is dissolved and carried downstream where it may precipitate, or separate from the water, forming a calcite crust on stream beds. This is similar to what happens when calcium builds up on the bottom of your kettle. When calcite builds up in a stream it can change the characteristic of the stream by cementing rocks together, degrading the habitat for fish and invertebrates.

2 Environmental Monitoring Committee

This section provides an overview of the Environmental Monitoring Committee, its role, and its activities in 2016.

Introduction

Permit 107517 directed the formation of the EMC that will be active throughout mine operations. The Committee will review monitoring submissions and provide technical advice or input as required by the Permit. The Committee is also charged with providing Traditional Knowledge advice on monitoring submissions.

Advice is provided to Teck with the intention of strengthening the technical aquatic monitoring submissions to MOE. The first Committee was held on March 10, 2015.

Permit 107517 requires the Committee to host an annual public meeting once per calendar year for the purpose of informing the public about environmental monitoring conducted by Teck in the Elk Valley and to present results of the third-party audit required by the permit.

The Committee's Terms of Reference requires the Committee to prepare an annual plain language interpretive report prepared by Teck or its consultant, and approved by the Committee for presentation to the general public in the Elk Valley regarding the results of the monitoring undertaken under the Environmental Management Act permit, Permit 107517; the status and implementation of activities and commitments under the area based management plan (known as the Elk Valley Water Quality Plan); and an appendix listing all non-confidential recommendations made by the Committee. The document you are reading—the 2016 Environmental Monitoring Committee Public Report—is the second report prepared by the Committee. The 2015 and 2016 EMC Annual Reports are available at **www.teckelkvalley.com**.

Membership

Permit 107517 defines membership on the Committee. The Committee consists of representatives from the following organizations, plus an independent scientist (Bruce Kilgour from Ottawa) who was selected unanimously by Teck, the Ktunaxa Nation Council, and the Ministry of Environment:

- British Columbia Ministry of Environment (MoE)
- British Columbia Ministry of Energy and Mines (MEM)
- Ktunaxa Nation Council (KNC)
- Interior Health Authority
- Teck

Environment Canada has agreed to provide its perspectives on matters related to Permit 107517 and the Committee's activities, on a case-by-case basis when requested by the Committee. To-date, the Committee has not called on Environment Canada to participate.

An independent facilitator (Lynne Betts from Nelson), facilitates Committee meetings and coordinates Committee activities, in addition to documenting all Committee advice and input on water quality monitoring activities associated with the permit.

Role of Environmental Monitoring Committee

The Committee is primarily a forum to share technical information and Traditional Knowledge related to the environmental monitoring, adaptive management, and reporting activities of Permit 107517, in order to strengthen the design of monitoring programs and ultimately support achieving the Elk Valley Water Quality Plan's four over-arching objectives.

The Committee is focused solely on its obligations specified in Permit 107517, issued to Teck by the Ministry of Environment, authorizing effluent discharges from Teck's five steelmaking coal operations in the Elk Valley.

Role of the Committee

As outlined in its Terms of Reference, the role of the Environmental Monitoring Committee is to:

- Provide science-based and/or Traditional Knowledge-based advice to Teck, the Ktunaxa Nation Council, and the Ministry of Environment
- Support communication of environmental monitoring results collected under the Elk Valley Water Quality Plan and the Environmental Management Act permit to Ktunaxa Nation members
- Provide advice to support continual improvement in monitoring activities conducted under the Elk Valley Water Quality Plan and the Environmental Management Act permit

The Committee is a non-regulatory body that will be active throughout mine operations, as required by Permit 107517. The Committee does not replace the regulatory responsibilities of government agencies, direct government-to-government agreements or discussions, or direct Teck-to-Ktunaxa Nation agreements or discussions.

The Committee is required to hold a minimum of four face-to-face meetings per year, plus at least one annual public meeting for the first two years. Thereafter, the meeting frequency will be determined by the Committee.

In accordance with Permit 107517, the Committee will review submissions and provide **technical advice** to Teck and to MOE regarding **study designs** for the following monitoring topics:

- Section 9.2[2] Groundwater Monitoring Program
- Section 9.3 Local Aquatic Effects Monitoring Program (LAEMP)
- Section 9.4 Regional Aquatic Effects Monitoring Program (RAEMP)
- Section 9.5 Calcite Monitoring
- Section 9.8 Chronic Toxicity Testing Program
- Section 9.9 Human Health Risk Assessment
- Section 11 Adaptive Management
- Section 12.3 Third-Party Audit

Teck provides written responses to the Committee about how its advice has been considered. This is in alignment with current advice and input protocol developed by the Committee.

The Committee is also required by Permit 107517 to provide **input** to Teck regarding **reports** required on the following topics:

- Section 2.7 Re-evaluation of Limits
- Section 5.0 Tributary Evaluation and Management
- Section 9.7 Lake Koocanusa Burbot Baseline Study 2015
- Section 10.2.4 Annual Reporting (Discharge and Receiving Environment Monitoring Data)
- Section 10.3 Groundwater
- Section 10.4 LAEMP
- Section 10.5 RAEMP
- Section 10.6 Calcite
- Section 10.7 Lake Koocanusa
- Section 10.8 Water Quality Modelling
- Section 11 Adaptive Management
- Section 12.3 Third-Party Audit

Currently Teck provides written responses to the Committee on how its input has been considered.

The Committee may also review other monitoring data relevant to water quality and aquatic life in the Fording and Elk rivers, as well as in Koocanusa Reservoir.

[2]Section numbers refer to Permit 107517.

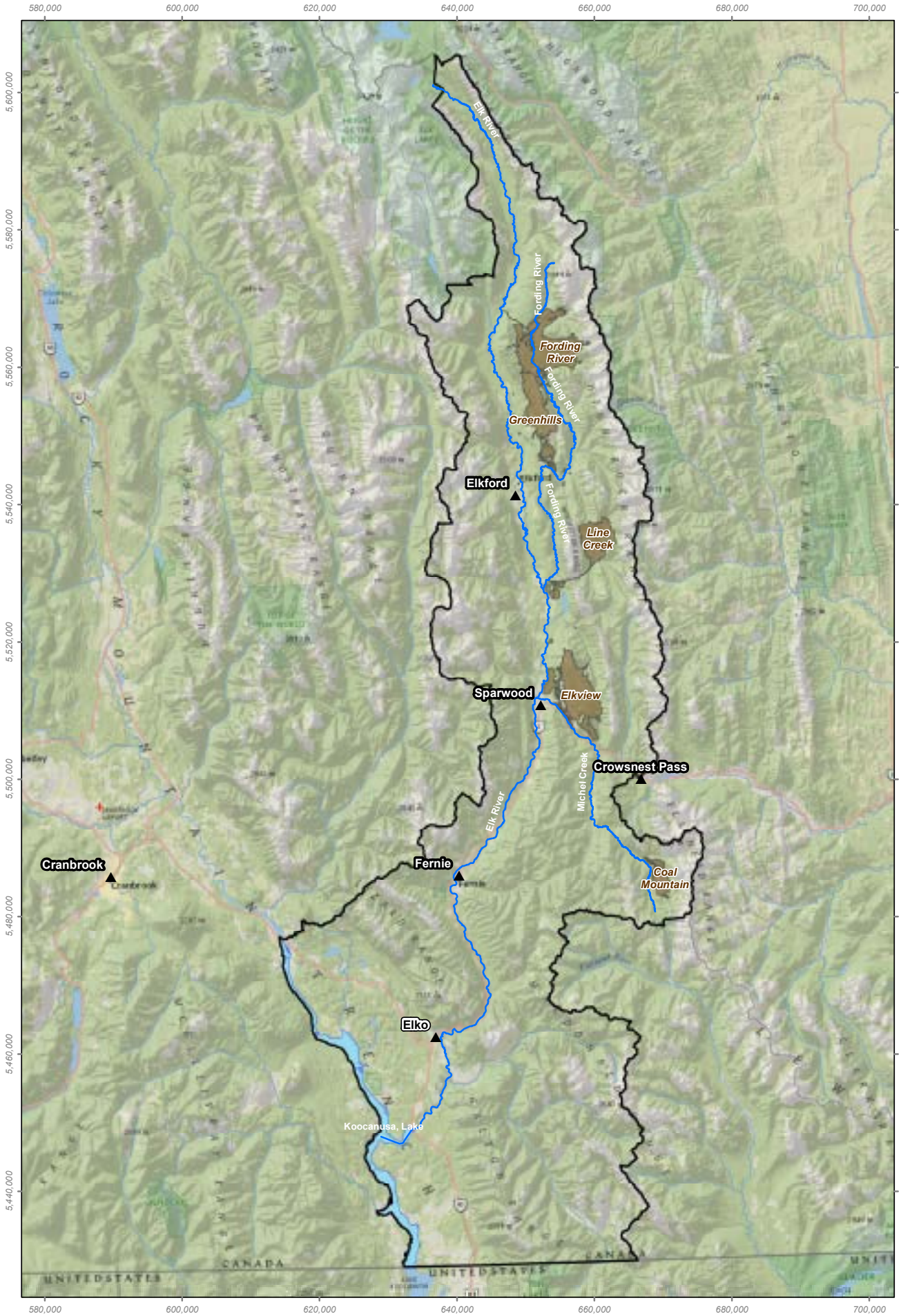


Figure 2-1. The Elk Valley Water Quality Plan boundary.

Geographic Scope

Permit 107517 defines the geographic scope of the Designated Area (i.e., the Elk Valley Water Quality Plan), which includes the Elk River valley and the Canadian portion of the Koocanusa Reservoir.

Function and Governance

Permit 107517 requires the Committee to review and provide technical advice to Teck and MOE on specific monitoring activities conducted by Teck (see *Role of Environmental Monitoring Committee* above). Input is provided by the Committee to Teck on monitoring related reports. Teck provides a written response to the Committee on how its advice on study designs for monitoring activities, and its input on annual reports, has been considered.

The Committee also reviews and provides input on reports, mostly annual reports, as outlined in Permit 107517. See Figure 2-2, which describes the process for engaging the Committee in environmental monitoring activities and annual reports.

As required by the permit, Teck provides the Committee with:

- Draft study designs for specific monitoring activities
- Reports detailing results of monitoring activities

Study designs and reports, referred to as submissions, are reviewed by the Committee. Teck presents the monitoring data to the Committee, prior to issuing final reports, to obtain initial input on the data and approaches to analyzing and interpreting the data. Presentations are made via conference call or in-person meetings with the Committee. Teck submits finalized monitoring reports to MOE. Input on final monitoring reports may be used by Teck to inform the design of subsequent monitoring activities. The study designs and reports are often complex, detailed, and require specialized knowledge and expertise to review in order to provide meaningful comments to Teck. Members of the Committee may call upon others within their member organization, or external consultants, to support their review.

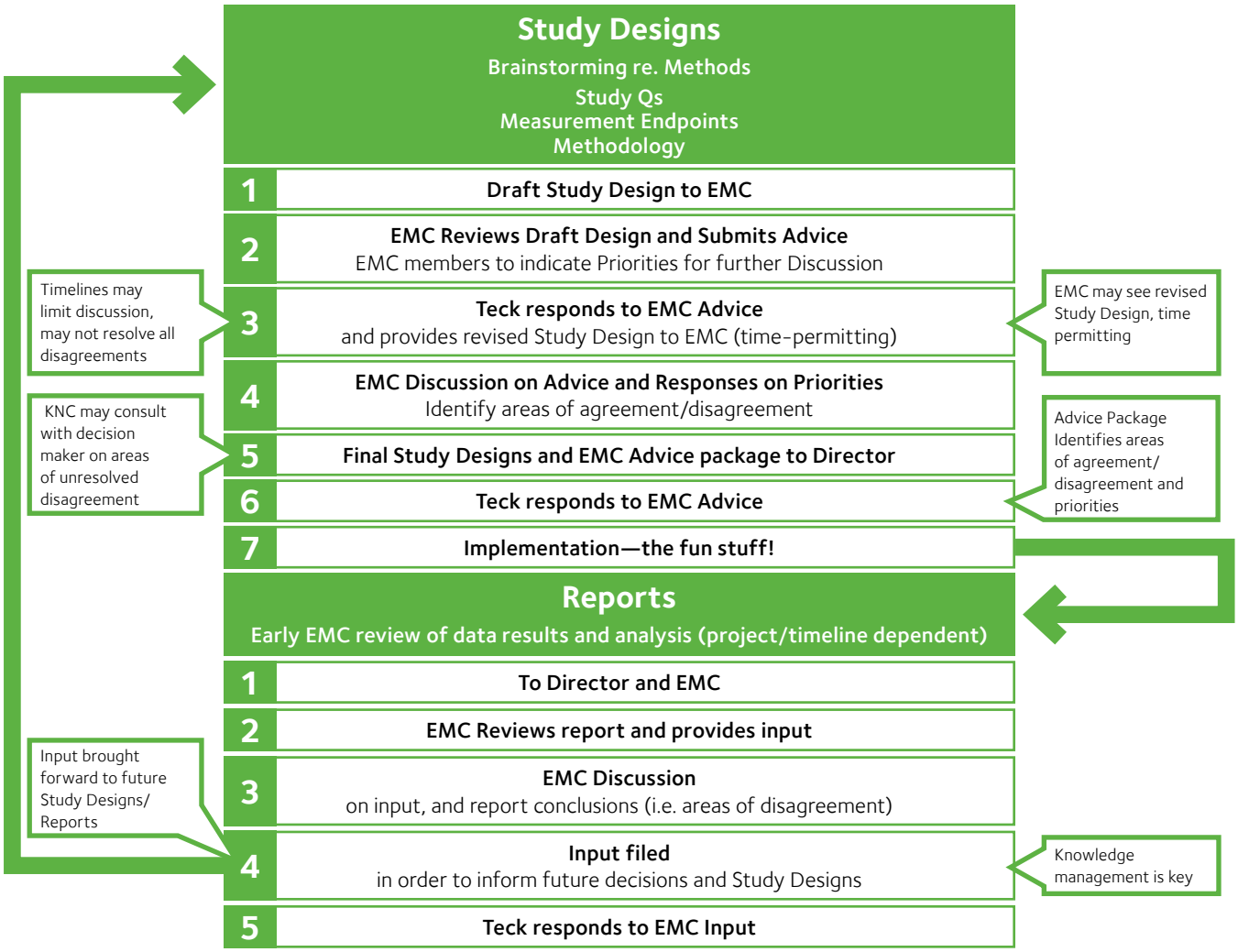


Figure 2-2. Overview of EMC engagement in the environmental monitoring activities prescribed by Permit 107517.

The Committee receives monitoring submissions and reports for review as prescribed by the permit. See Figure 2-3 for a sample template to document EMC advice. Each EMC member organization conducts an independent review and provides written comments using a template developed by the Committee for this purpose. All EMC comments are consolidated into a single document and shared with all EMC members, including Teck.

In spring 2016, the Committee took steps to identify priority advice in order to focus on the comments of the greatest importance to the EMC and identify areas where EMC member organizations are not in agreement. Technical advice and input provided by EMC members has the potential to change over time as new information is available and the study design evolves. Conference calls and in-person meetings are used to discuss and work towards resolution.

In the interest of transparency, the EMC's advice, input and feedback from Teck, can be obtained by request from to the EMC's independent facilitator. See the feedback form on page 2 or email **emcpermit107517@gmail.com.**

The Committee has been operational for less than two years and continues to evolve its internal processes based on experiences to date.

Traditional Knowledge

Including Traditional Knowledge in the Committee's work is a requirement of the Committee's Terms of Reference (See Role of Environmental Monitoring Committee) and is a unique feature of this Committee.

Recommendations on how to reflect and strengthen Traditional Knowledge in the Committee's work are expected from the Committee's Ktunaxa Nation representatives in late 2016. The next public report will provide an update on how Traditional Knowledge will be reflected in Committee activities.

Working with Other Committees

The Committee may serve a role in sharing information with other committees, as outlined in the Committee's Terms of Reference. In 2015, the Committee identified committees and other groups with objectives that align with the Committee's, particularly those groups working on aquatic issues, as those most likely for the Committee to communicate with, if and when desirable to do so.

In 2015, the Committee began working with members of the Elk Valley Fish and Fish Habitat Committee (EVFFHC) on the Tributary Evaluation Program. By inviting the EVFFHC members to participate in Committee discussions related to tributaries, the Committee benefits from theEVFFHC's extensive knowledge and experience.

The Lake Koocanusa Monitoring and Research Working Group (convened in 2014) is a transboundary initiative. Once this group has further developed its scope and priorities, there could be synergies between it and the Committee.

Permit 107517 Environmental Monitoring Committee Advice - PERMIT SECTION AND SUBMISSION NAME																	
#	Document	Page and Section	Advice	Rationale	Date Received	EMC Member	Do you agree this is Priority Advice (Yes/No)					Do you agree with this Priority Advice? (Yes/No)					Teck Response
							IHA	IS	KNC	MEM	MOE	IHA	IS	KNC	MEM	MOE	
PRIORITY ADVICE																	
ADVICE																	

Figure 2-3. The priority advice template used by EMC Members. The EMC has developed a process to identity priority advice that also allows for areas of disagreement and consensus to be identified.

Environmental Monitoring Committee Activities in 2015–2016

Submissions Reviewed

Since the last public meeting, the Committee has reviewed and provided technical advice and input on 45 submissions (i.e., draft designs for monitoring tests and studies, annual reports, etc.) or documents from Teck (Table 2-1). The Committee members provided 934 pieces of written technical advice and input—this is in addition to verbal feedback Committee members provide during meetings and conference calls. Teck considers all feedback from the Committee and provides written responses to each piece of written advice.

In addition to reviewing submissions from Teck and providing advice or input, the Committee met in-person four times and held 19 conference calls to discuss monitoring activities.

Meetings:

2016 Face-to-Face Meetings

January 26 to 29 . . . Vancouver

April 26 to 28 . . . . . Cranbrook

June 20 to 24 . . . . . Fernie

October 18 to 21 . . Fernie

2016 Conference Calls:

January 13 . . . . . EMC Meeting #7 Planning

January 14 . . . . . Adaptive Management Plan

February 23 . . . . . Human Health Risk Assessment

February 29 . . . . . Tributary Evaluation and Management Program

March 2 . . . . . Lake Koocanusa Monitoring Program

March 7 . . . . . Adaptive Management Plan

March 22 . . . . . Seasonal Calcite Supporting Study/Biological Effects of Calcite Supporting Study

April 6 . . . . . Local Aquatic Effects Monitoring Program for Line Creek Operations

April 7 . . . . . Biological Effects of Calcite Supporting Study

April 12 . . . . . EMC Meeting #8 Planning

April 19 . . . . . Integrated NO3-SO4 Toxicity Testing

May 12 . . . . . Human Health Risk Assessment

May 16 . . . . . Local Aquatic Effects Monitoring Program for Fording River Operations

May 16 . . . . . Calcite Monitoring Program

May 18 . . . . . Human Health Risk Assessment

June 6 . . . . . EMC Meeting #9 Planning

June 8 . . . . . Tributary Evaluation and Management Program

June 13 . . . . . Chronic Toxicity Testing

June 29 . . . . . Human Health Risk Assessment

July 28 . . . . . Public Report

August 18 . . . . . Public Report/Public Meeting

September 12 . . . . . Public Report/Public Meeting

September 21 . . . . . Public Report/Public Meeting

September 30 . . . . . Public Report

October 3 . . . . . Public Report

October 6 . . . . . Public Report/Public Meeting/EMC Meeting #10 Planning

October 12 . . . . . Public Meeting

What's Next?

The Committee will continue to meet in-person and via conference calls to review monitoring submissions and reports, and provide technical advice or input as required by the permit. Timing for the next public meeting will be determined by the Committee.

Teck Submissions Reviewed by the Environmental Monitoring Committee	
February 2016	**Permit Section**
Adaptive Management Plan	11
Integrated NO3-SO4 Toxicity Testing - Draft Study Design	9.8.1 and 9.4
February 2016	**Permit Section**
Adaptive Management Plan	11
February 2016	**Permit Section**
Tributary Inventory, Map, and Data Matrix	5
February 2016	**Permit Section**
Human Health Risk Assessment - Supporting Information	9.9
Human Health Risk Assessment - Additional Data Package	9.9
Human Health Risk Assessment - Draft	9.9
Seasonal Calcite Supporting Study - 2015 Data Package	9.5
Sediment Toxicity Supporting Study - 2015 Results	9.4
February 2016	**Permit Section**
Lake Koocanusa Monitoring Program - 2015 Results and 2016 Study Design	9.4
Seasonal Calcite Supporting Study - 2016 Study Design	9.5
Tributary Management Plan - Strategic Objectives	5
February 2016	**Permit Section**
Adaptive Management Plan	11
Biological Effects of Calcite Supporting Study - 2015 Data and 2016 Study Design	9.4
Chronic Toxicity Testing - Amphibian Testing Study Design	9.8
Chronic Toxicity Testing - 2015 Data Interpretation Report	10.2.4
Human Health Risk Assessment - Report	9.9
Lake Koocanusa Monitoring Program - 2015 Data Summary Report	9.4
Local Aquatic Effects Program for Line Creek Operations - 2015 Data and 2016 Study Design	9.3
Tributary Evaluation Program - Data Report	5
Tributary Management Plan - Terms of Reference	5
February 2016	**Permit Section**
Adaptive Management Plan	11
Biological Effects of Calcite - Draft Biological Endpoints Comparison	9.4
Calcite Monitoring Program - 2015 Data Package	9.5
Calcite Monitoring Program - 2016 Study Design	9.5
Human Health Risk Assessment - Report	9.9
Local Aquatic Effects Program for Line Creek Operations - 2016 Program	9.3
Local Aquatic Effects Program for Line Creek Operations - 2015 Draft Data Package	9.3
Local Aquatic Effects Program for Fording River Operations - 2016 Draft Study Design	9.3
Local Aquatic Effects Program for Fording River Operations - 2016 Study Design Summary	9.3
Regional Water Quality Annual Report	10.2.4
Regional Groundwater Annual Report	9.2
Tributary Evaluation Program - Evaluation and Prioritization Tool	5
Tributary Evaluation Program - Data Report	5
Tributary Management Plan - Terms of Reference	5
February 2016	**Permit Section**
Sediment Toxicity Supporting Study - 2015 Report	9.4
Third-Party Audit - Draft Scope #1	12.3
Tributary Evaluation Program - Criteria for Evaluation Memo	5
February 2016	**Permit Section**
Biological Effects Supporting Study - 2015 Report	9.4
Chronic Toxicity Testing Program - Daphnia Magna Testing Technique Memo	9.8
Human Health Risk Assessment - Supporting Memo	9.9
Integrated NO3-SO4 Toxicity Testing - Final Draft Study Design	9.8
Local Aquatic Effects Program for Line Creek Operations - 2015 Report	10.4
February 2016	**Permit Section**
Periphyton Community Structure Supporting Study - Final Report	9.4
Third-Party Audit - Draft Scope #2	12.3
February 2016	**Permit Section**
Third-Party Audit - Draft Scope #3	12.3

Table 2-1. Submissions reviewed by the Environmental Monitoring Committee.

3 Third-Party Audit

This section contains information on the third-party audit that is required by Permit 107517.

Context

Monitoring data required by Permit 107517 and its analysis is subject to a third-party review and audit by a qualified professional. The audit may include a review of monitoring data and analysis for all monitoring reports required by Permit 107517 for the previous two years (since Permit 107517 was issued in November 2014). The audit must consider at least one of the following topics:

- data quality and completeness
- compliance with permit requirements
- protocols and procedures from the QA/QC plan for the monitoring program
- current water quality guidance documents established by the MoE
- standard operating procedures and data-handling protocols in place for Teck

The first third-party audit report must be submitted to MOE and the Committee for review by October 31, 2017, and then every two years after that.

Status

In preparation for the first third-party audit, the Committee reviewed its obligations under Permit 107517 and provided feedback on the initial scope of work for the audit. At the EMC's June 2016 in-person meeting, members agreed to focus the first third-party audit on:

- data quality and completeness
- standard operating procedures and data-handling protocols in place for Teck Coal Limited

The EMC has reviewed the Draft Scope of the Third-Party Audit (V2, July 19, 2016) and provided feedback to Teck.

What's Next

The Committee will discuss the audit during its October 2016 in-person meeting prior to finalizing a request for proposals for this audit. The audit is scheduled to begin in January 2017 and will be submitted to the EMC and Ministry of Environment by October 31, 2017. The EMC will provide an update as part of its 2017 Annual Public Meeting and Report.

4 Water Quality

The protection of groundwater, human health, aquatic ecosystem health, and the management of bioaccumulation of constituents in the receiving environment are the environmental management objectives for the Elk Valley Water Quality Plan. This section provides an update on monitoring activities required by Permit 107517 related to these objectives including surface water quality monitoring, toxicity testing, regional groundwater monitoring, and the water quality model.

Surface Water Quality

Context

Monitoring Surface Water Quality

Permit 107517 requires an annual water quality report summarizing monitoring results and non-compliance, among other things. The 2015 Water Quality Annual Report was submitted to the Committee on March 31, 2015, and provides an overview of water quality based on 2015 data—the first full year of data collection under Permit 107517. The Committee reviewed the 2015 Water Quality Annual Report and provided input on the report content. Based on the input provided, some EMC members would prefer that the 2015 report be revised to reflect their input. At this time, Ministry of Environment does not require Teck to revise the 2015 report; however, the Ministry of Environment expects that Teck will consider all input from the Committee during the development of the 2016 report.

Managing and monitoring water quality impacted by current and/or historical mining in the Elk Valley requires an extensive surface water monitoring program. Teck monitors water quality parameters such as metals, nutrients, ions in the water, dissolved oxygen, and water temperature. The water quality monitoring program required by Permit 107517 includes monitoring at Order stations, compliance points, and other discharge and receiving water quality monitoring locations.

Surface Water Quality Limits

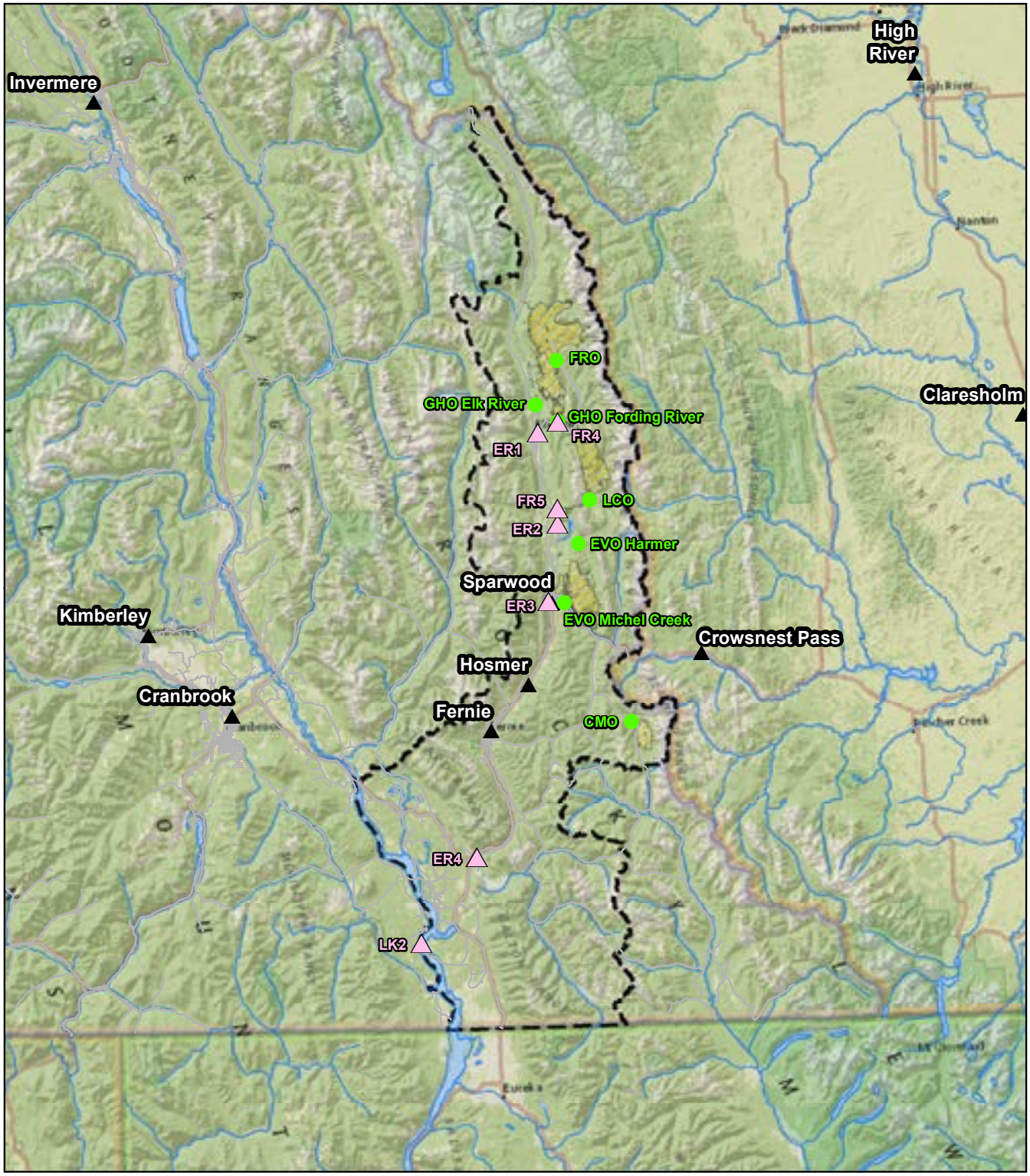
Permit 107517 defines two types of surface water quality limits that must be met: Site Performance Objectives and compliance limits. Site Performance Objectives (SPOs) are set for Order constituents (i.e., selenium, cadmium, nitrate, and sulphate) at Order stations. Compliance limits are set at compliance points, for selenium, nitrate, and sulphate. Compliance limits and SPOs are collectively referred to as water quality limits. Selenium and nitrate have both daily maximums and/or a monthly average limit. Different limits are set for different timeframes with the goal of continuously improving water quality in the Elk Valley and protecting aquatic ecosystem health as described in the Elk Valley Water Quality Plan's environmental management objectives. The 2015 Annual Water Quality Report uses the 2015 water quality limits, as specified in Permit 107517, for determining compliance.

Order Stations

Seven Order stations (Figure 4-1) have been established under Permit 107517 and Site Performance Objectives (SPOs) have been set at these locations. At each order station, the concentrations of selenium, nitrate, cadmium, and sulphate (the Order constituents) must remain below SPOs, which are designed to protect aquatic life in the long term. SPOs are set individually for each station and may differ among locations as they reflect unique nature of each site. They have also been set for different time periods to facilitate the improvement of water quality in the Elk Valley over time. Refer to Table 4-1 for SPOs. Data from the Order stations provides a broad, regional overview of water quality related to mine activities.

What is an Order Constituent?

The 2013 Ministerial Order (the Order) identifies the following specific substances related to coal-mining activities: selenium, nitrate, cadmium, and sulphate, plus calcite formation in the Elk Valley. These Order constituents are the focus of monitoring activities and permit limits.



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Elk Valley Overview Monitoring Locations

- Communities
- Railway
- Roads
- Water Network
- Mine Permit Boundaries
- Order Stations
- Compliance Points

N

0 5 10 20 Kilometers

DATE:	MINE OPERATION:
9/21/2016	Coal Mountain
SCALE:	COORDINATE SYSTEM:
1:1,000,000	NAD 1983 UTM Zone 11N

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Figure 4-1. Location of the seven Order stations and seven compliance points.

Order Station	Description	Parameter	Unit	Immediately	By Dec 31, 2019	By Dec 31, 2023	By Dec 31, 2025	By Dec 31, 2028
GH_FR1	Upper Fording River	Total Selenium	µg/L	—	63	57	57	57
		Nitrate as N	mg/L	20	14	11	11	11
		Sulphate	mg/L	429	429	429	429	429
		Dissolved Cadmium	µg/L	0.39	0.39	0.39	0.39	0.39
LC_LC5	Lower Fording River	Total Selenium	µg/L	—	51	40	40	40
		Nitrate as N	mg/L	18	10	10	10	10
		Sulphate	mg/L	429	429	429	429	429
		Dissolved Cadmium	µg/L	0.39	0.39	0.39	0.39	0.39
GH_ER1	Elk River upstream of Boivin Creek	Total Selenium	µg/L	19	19	19	19	19
		Nitrate as N	mg/L	3	3	3	3	3
		Sulphate	mg/L	309	309	309	309	309
		Dissolved Cadmium	µg/L	0.24	0.24	0.24	0.24	0.24
EV_ER4	Elk River upstream of Grave Creek	Total Selenium	µg/L	23	23	19	19	19
		Nitrate as N	mg/L	—	—	4	3.5	3
		Sulphate	mg/L	429	429	429	429	429
		Dissolved Cadmium	µg/L	0.24	0.24	0.24	0.24	0.24
EV_ER1	Elk River downstream of Michel Creek	Total Selenium	µg/L	19	19	19	19	19
		Nitrate as N	mg/L	—	3	3	3	3
		Sulphate	mg/L	429	429	429	429	429
		Dissolved Cadmium	µg/L	0.24	0.24	0.24	0.24	0.24
RG_ELKORES	Elk River at Elko Reservoir	Total Selenium	µg/L	19	19	19	19	19
		Nitrate as N	mg/L	—	3	3	3	3
		Sulphate	mg/L	429	429	429	429	429
		Dissolved Cadmium	µg/L	0.24	0.24	0.24	0.24	0.24
RG_DSELK	Koocanusa Reservoir south of the Elk River	Total Selenium	µg/L	2	2	2	2	2
		Nitrate as N	mg/L	3	3	3	3	3
		Sulphate	mg/L	308	308	308	308	308
		Dissolved Cadmium	µg/L	0.19	0.19	0.19	0.19	0.19

Table 4-1. Site Performance Objectives for the seven Order stations from Permit 107517.

Compliance Points

Seven authorized compliance points are located downstream of mining operations. Compliance points are meant to be effluent monitoring stations that capture and reflect all or most point and non-point discharges from a mine site. Selenium and nitrate are the Order constituents regulated at all seven points (with additional sulphate limits at three of the seven locations). The accumulated discharge from each mining operation is evaluated at these compliance points. Teck is required to comply with these water quality limits (site specific daily maximum limits and/or maximum monthly average limits) at these points, as defined in Permit 107517. Like the SPOs, compliance limits are set for different time periods and designed to facilitate continuous improvement of water quality in the Elk Valley. The monthly average compliance limits can be found in Table 4-2.

Authorized Discharge and Receiving Environment Water Sampling Sites

In addition to the compliance points and Order stations, water is sampled at 82 discharge and receiving environment sites at Teck's mine operations in the Elk Valley. Sampling and analysis at these sites provides additional information that helps improve the understanding of water quality conditions throughout the Elk Valley. Permit 107517 does not define any water quality limits for these monitoring sites.

Station ID	Description	Parameter	Unit	Immediately
FR_FRCP1	Fording River, downstream of Cataract Creek	Selenium	ug/L	130
FR_FRCP1	Fording River, downstream of Cataract Creek	Nitrate	mg/L	27
FR_FRCP1	Fording River, downstream of Cataract Creek	Sulphate	mg/L	580
GH_FR1	Fording River, downstream of Greenhills Creek	Selenium	ug/L	80
GH_FR1	Fording River, downstream of Greenhills Creek	Nitrate	mg/L	24
GH_ERC	Elk River, downstream of Thompson Creek	Selenium	ug/L	15
GH_ERC	Elk River, downstream of Thompson Creek	Nitrate	mg/L	3
LC_LCDSSLCC	Line Creek, below water treatment facility	Selenium	ug/L	80
LC_LCDSSLCC	Line Creek, below water treatment facility	Nitrate	mg/L	14
EV_HC1	Harmer Creek, at the spillway	Selenium	ug/L	45
EV_HC1	Harmer Creek, at the spillway	Nitrate	mg/L	4
EV_HC1	Harmer Creek, at the spillway	Sulphate	mg/L	300
EV_MC2	Michel Creek at Hwy 3 bridge	Selenium	ug/L	28
EV_MC2	Michel Creek at Hwy 3 bridge	Nitrate	mg/L	6
CM_MC2	Michel Creek, upstream of Andy Goode Creek	Selenium	ug/L	19
CM_MC2	Michel Creek, upstream of Andy Goode Creek	Nitrate	mg/L	5
CM_MC2	Michel Creek, upstream of Andy Goode Creek	Sulphate	mg/L	500

Table 4-2. Compliance limits (monthly averages) from Permit 107517. TBD = to be determined (see Harmer Creek Compliance Point)

Dec 31, 2015	Dec 31, 2017	Dec 31, 2019	Dec 31, 2021	Dec 31, 2023	Dec 31, 2025	Dec 31, 2027	Dec 31, 2033
130	130	90	90	61	61	61	61
27	27	19	19	13	13	13	13
580	580	620	620	650	650	650	650
80	80	63	63	51	51	51	51
24	24	14	14	11	11	11	11
15	15	15	15	15	15	8	8
3	3	3	3	3	3	3	3
50	50	50	50	50	50	50	29
7	7	7	7	7	7	7	3
45	57	57	TBD	TBD	TBD	TBD	TBD
4	16	16	8	8	8	8	8
300	380	380	450	450	450	450	450
28	28	28	20	20	19	19	19
6	6	6	6	6	6	6	6
19	19	19	19	19	19	19	19
5	5	5	5	5	5	5	5
500	500	500	500	500	500	500	500

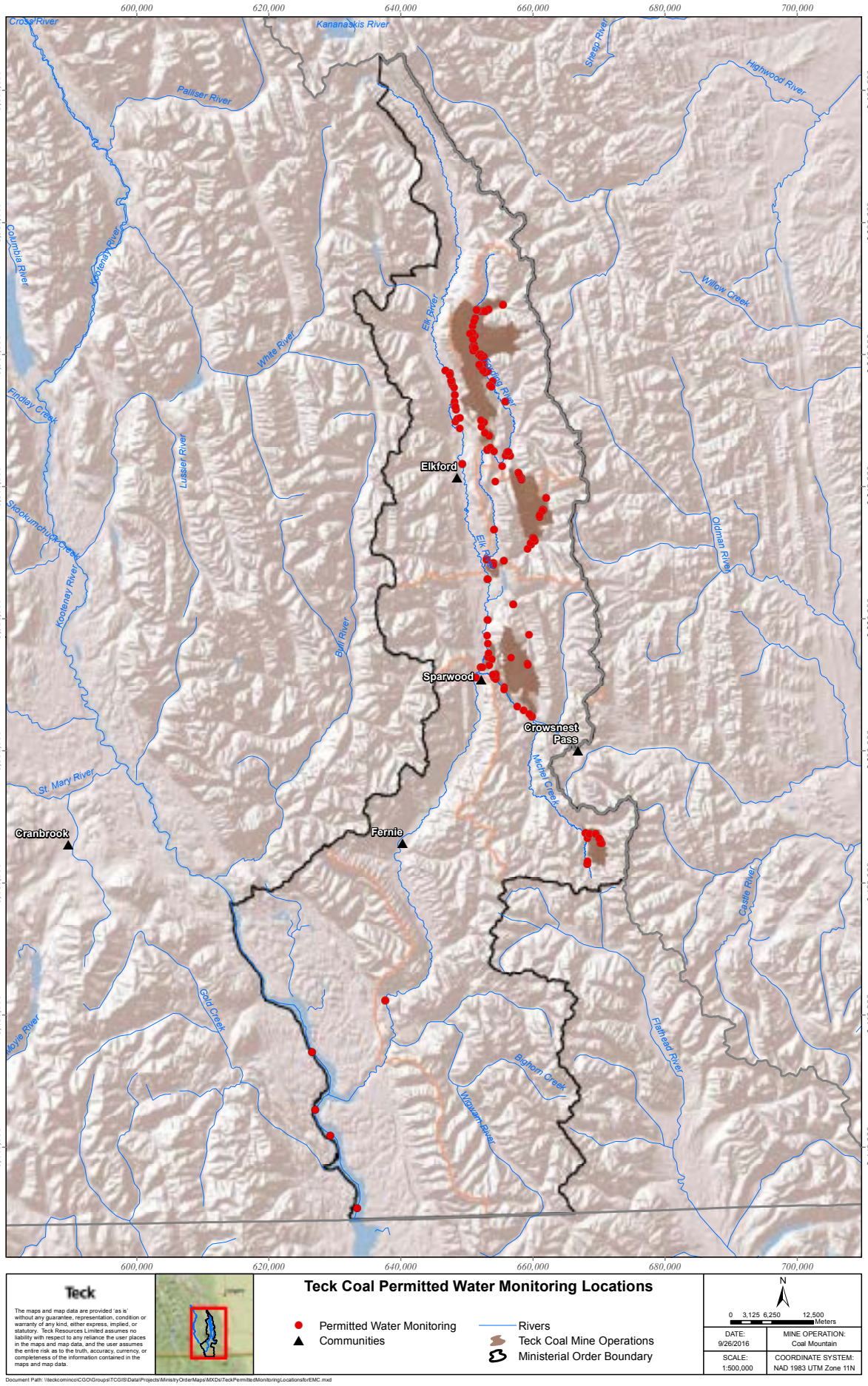


Figure 4-2. Overview of all the water sampling sites within the permit boundary.

Results

Water Quality at Order Stations

The results were compared to the BC Water Quality Guideline for each constituent. Less than 1% of the samples exceeded the BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life.

- In 2015, SPOs were met for selenium, cadmium, nitrate, and sulphate at the seven Order stations in the Elk River, Fording River, and Koocanusa Reservoir.
- In 2015, concentrations of selenium were below the BC water quality guideline (2 µg/L) at the monitoring station in the Koocanusa Reservoir.

Water Quality at Compliance Points

All compliance points have permitted maximum monthly average concentrations limits for two Order constituents (selenium and nitrate). In addition, some compliance points also have permitted daily maximum limits for selenium and nitrate and monthly average limits for sulphate.

In 2015, five compliance points met permit requirements for all limits. Two compliance points exceeded water quality limits as specified in the permit:

- At the Fording River compliance point, there were six days (total) during February, March, and November 2015 when selenium concentrations exceeded the permitted daily maximum limit. The selenium average concentrations also exceeded the permitted maximum monthly average water quality limit during these same months.
- At the Line Creek compliance point, water quality exceeded the nitrate monthly average permitted limit in February and December 2015.

Coal Mountain Operations	In compliance with water quality limits in Permit 107517 for selenium, nitrate, and sulphate (daily maximums and monthly averages).
Elk View Operations	In compliance with water quality limits for selenium, nitrate, and sulphate in Permit 107517 (daily maximums and monthly averages).
Fording River Operations	Daily compliance limits for selenium and sulphate were exceeded in February, March, and November 2015. Nitrate concentrations were in compliance with Permit 107517.
Greenhills Operations	In compliance with water quality limits for selenium and nitrate in Permit 107517 (daily maximums and monthly averages).
Line Creek Operations	Monthly average compliance limit for nitrate was exceeded in February and December 2015. Selenium concentrations were in compliance with Permit 107517 (daily maximums and monthly averages).

Table 4-3. Overview of 2015 daily and monthly compliance for all water quality limits (SPOs and compliance limits).

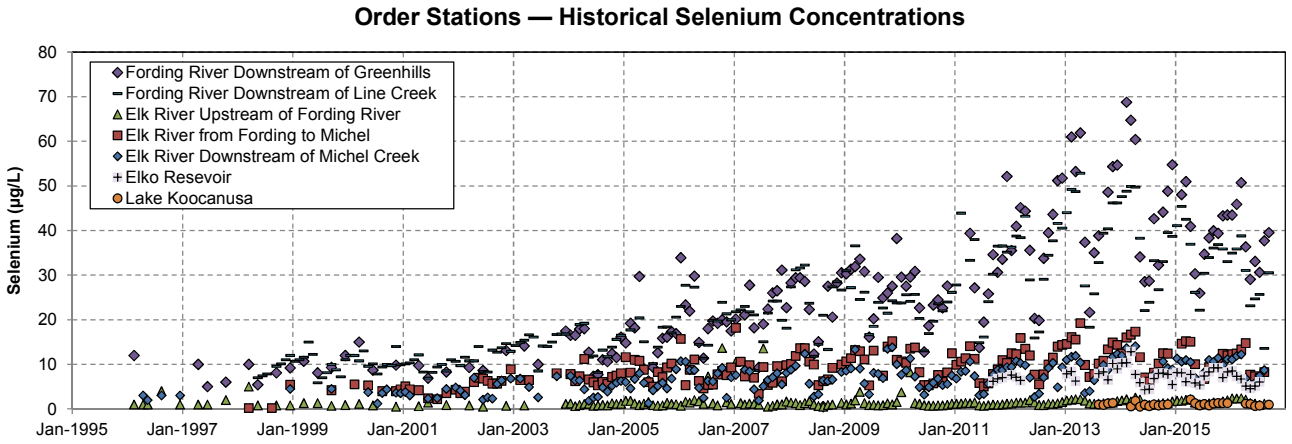


Figure 4-3. Available water selenium levels at Order stations throughout the Elk Valley from 1995 to present.

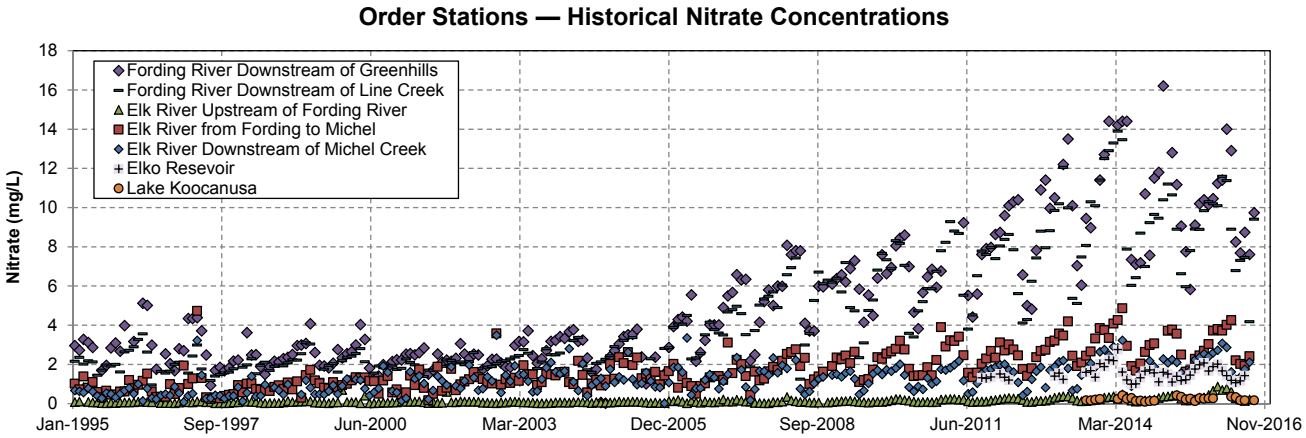


Figure 4-4. Available water nitrate levels at Order stations throughout the Elk Valley from 1995 to present.

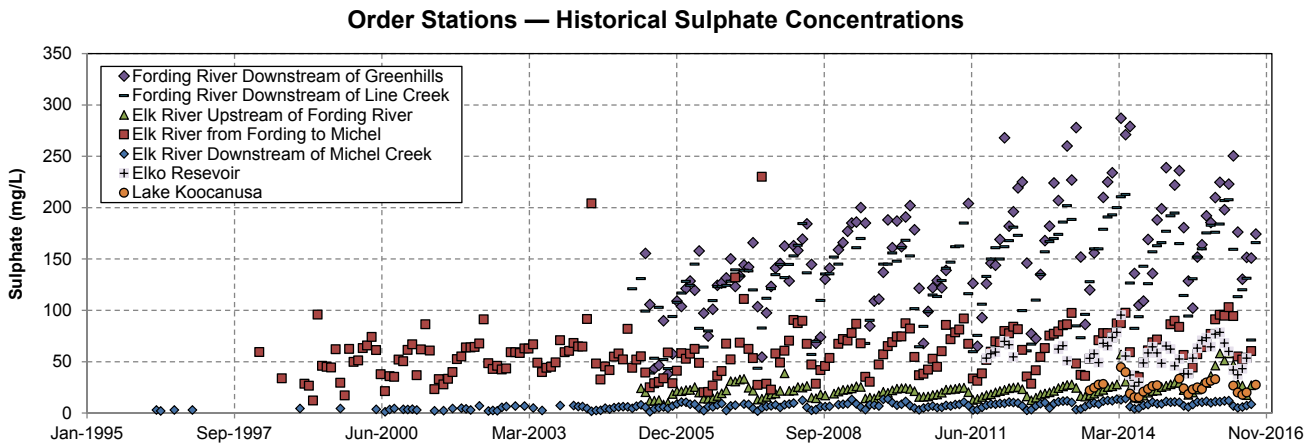


Figure 4-5. Available water sulphate levels at Order stations throughout the Elk Valley from 1995 to present.

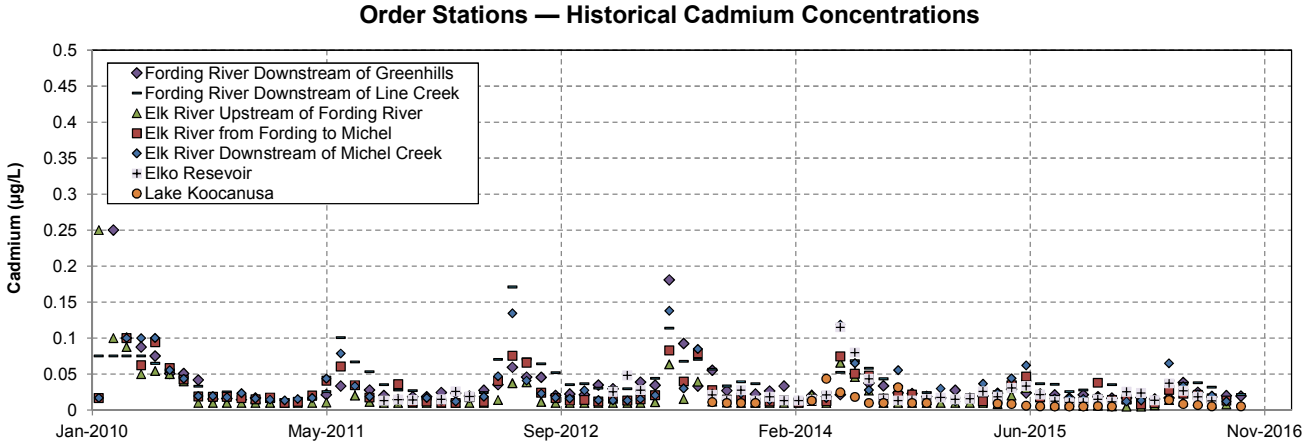


Figure 4-6. Available water cadmium levels at Order stations throughout the Elk Valley from 1995 to present.

Exceedance of selenium and sulphate at the Fording River compliance point occurred during periods of low flows (i.e., winter). Other 2015 non-compliances were the result of missed sample collection, late reporting, or failure to follow standard protocols.

Harmer Creek Compliance Point

The Harmer Compliance Point is one of seven compliance points in the Elk Valley. This compliance point is located on Harmer Creek at the edge of current mine activity (Figure 4-1). Future mining development is expected upstream of this compliance point and is expected to increase selenium levels at this location. The long-term compliance limit for selenium at this location is currently being developed and will be finalized by the Ministry of Environment in 2017, following a review by the Environmental Monitoring Committee.

Other Authorized Discharge and Water Quality Monitoring Sites

Waste rock dumps are presumed to be the major source of constituents of interest into the Elk and Fording rivers. As such, monitoring of water quality in flows from these waste rock dumps is part of the Authorized Discharge and Water Quality Monitoring Program.

Selenium levels measured in water flowing from waste rock dumps were higher (range 0.05–824 µg/L; median 7.5 µg/L; average 56.2 µg/L) than measurements at the Order stations; however, both show increasing trends with time. This confirms that the main selenium source is from waste rock dumps.

Nitrate levels measured from waste rock dumps (range 0.005–100 mg/L; median 2.83 mg/L; average 9.9 mg/L) were higher than the measurements from the Order stations and have increased with time. The primary source of nitrate is considered to be associated with current blasting practices.

Sulphate levels measured from waste rock dumps (range 0.3–1910 mg/L; median 119.5 mg/L; average 303.8 mg/L) were higher than the measurements from the Order stations and levels have been increasing with time at some locations. Also like selenium, both historical and current waste rock dumps appear to be the main source of sulphate to the receiving environment.

Unlike the other Order constituents, cadmium levels do not appear to be associated with waste rock dumps (range 0.000005–0.00664 mg/L; median 0.00002 mg/L; average 0.00012 mg/L) and are not increasing with time. Instead, there appears to be seasonal patterns in measurements of cadmium (higher levels in spring) at locations upstream and downstream of mining activity.

In 2015, 208,667 separate analyses were run on surface water samples from 82 tributary and main stem Elk and Fording River locations. Excluding the four order constituents, less than 1% of the analyses exceeded BC's Approved Guidelines for the Protection of Aquatic Life. Measurements were above the BC Approved Water Quality Guidelines for uranium (18 samples), aluminum (7 samples), iron (33 samples), cobalt (1 sample), nitrite (4 samples), and sulphide (1 sample). Teck will continue to monitor these parameters, evaluate trends, and assess impacts to aquatic life. The Committee will review this information annually.

What's Next?

Regularly scheduled sampling and analysis at the compliance points, Order stations, and other authorized monitoring sites across the Elk Valley will continue in 2016. No new additional monitoring is anticipated at this time. The 2016 Annual Water Quality Monitoring Report will be provided to the Committee for review in 2017 and will be reported on in the Committee's 2017 public report.

Toxicity Testing

Context

In general, toxicity tests are conducted to determine how organisms respond to short-term or long-term exposures to mine-influenced waters that have elevated levels of selenium, nitrate, sulphate, and cadmium. These toxicity tests measure the health (i.e., survival, growth, development, or reproduction) of various test organisms. The tests are done in a laboratory using organisms representative of those found in the Elk Valley.

To do these tests, water is collected from specific sites in the Elk Valley and shipped to laboratories where the toxicity tests are performed in alignment with accepted standards and procedures. The results of these toxicity tests indicate

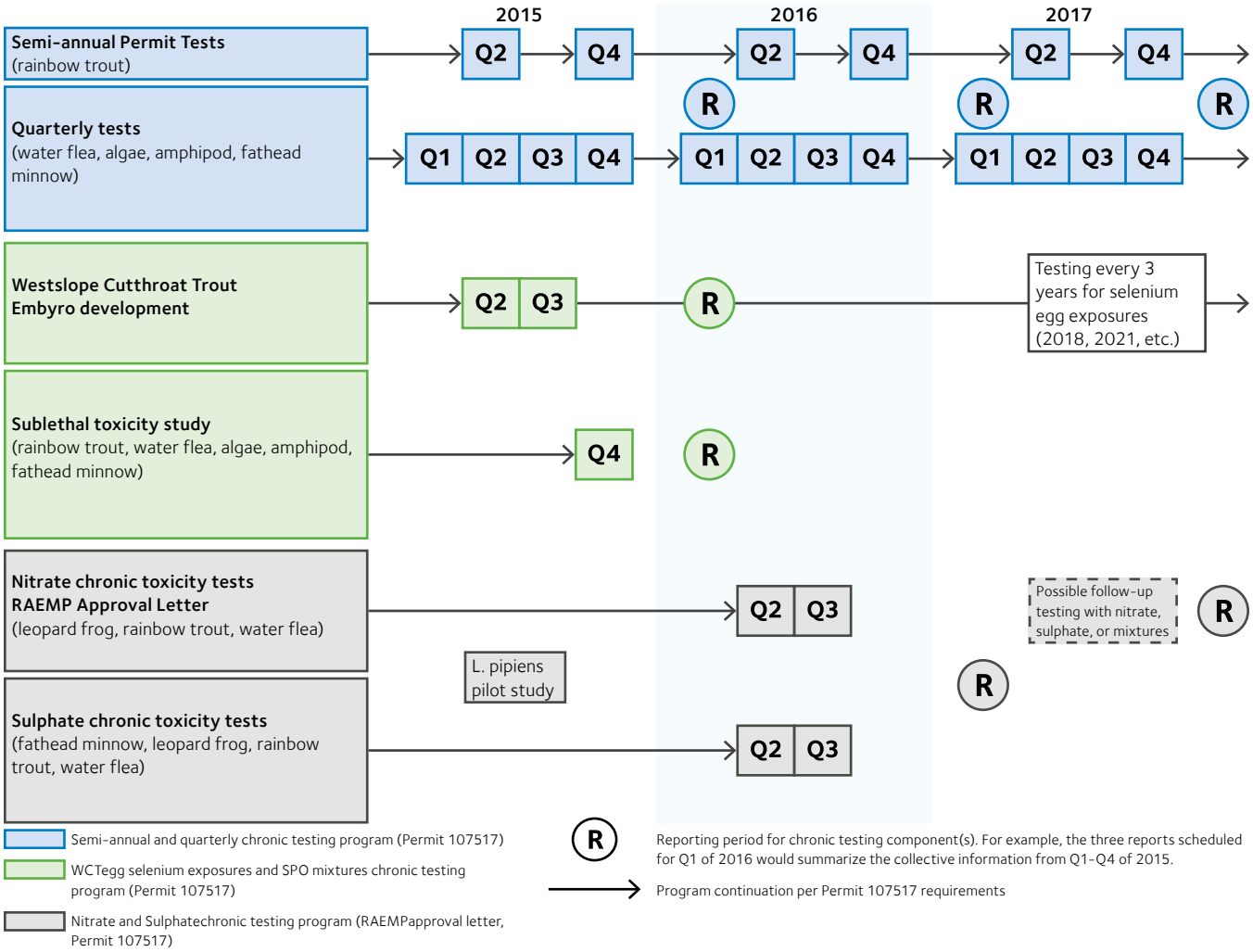


Figure 4-7. Overview of the Elk Valley chronic toxicity testing program.

if changes to mine operations, water quality management, or both, may be necessary. See Section 8 for more on Monitoring and Adaptive Management.

Permit 107517 requires Teck to carry out a series of toxicity tests to assess the short-term (i.e., acute) and long-term (i.e., chronic) effects on select organisms when they are exposed to:

- water discharged directly from mining operations (i.e., effluent at the compliance points)
- water downstream in the receiving environment (i.e., the streams and rivers that receive the effluent)

The test organisms and frequency vary by test type.

Acute Toxicity Testing

Context

Acute toxicity tests are short term (2–4 days) and are typically run with the undiluted effluent discharged from a mining operation. Acute toxicity tests are done at least four times per year using mine effluent, whereby the water is collected before leaving the mine site and is used in the laboratory test. Acute toxicity test results for each species are interpreted as either a pass (50% or more of exposed individuals in the test survive) or a fail (more than 50% of exposed individuals die).

Results

Permit 107517 requires Teck to conduct acute toxicity tests on fish (Rainbow Trout) and water fleas (Daphnia magna). In 2015, 220 acute toxicity tests were completed at 36 permitted discharge locations:

- All Rainbow Trout tests passed
- Approximately 98% of the water flea tests passed (i.e., four out of 220, or approximately 2% of water flea tests failed)

Based on initial investigations, the failed water flea tests were associated with mineral formation (precipitate) on the exposed water fleas. Further investigations and discussion with the Committee of these results are ongoing.

What's Next?

Acute toxicity testing required under Permit 107517 will continue as scheduled. Results from 2016 acute toxicity testing will be provided to the Committee for review in March 2017. The Committee will report on those results in fall 2017.

Chronic Toxicity Testing

Chronic toxicity tests determine the effects of longer-term exposures of selected organisms to mine-influenced streams and rivers (i.e., the receiving environment). In addition to measuring survival, these tests also measure the growth, development, and reproduction of toxicity test organisms exposed to surface water obtained from various locations in the Elk Valley. Chronic toxicity tests are being used to fill information or knowledge gaps, and confirm that water quality targets in Permit 107517 are protective of aquatic health.

Chronic toxicity tests are performed by toxicity testing laboratories, following standardized methods and protocols, using water collected from the Elk Valley. Chronic toxicity tests are typically conducted using a wider variety of species, take longer to complete (three to 30 days), and use more water from the Elk Valley than do the acute toxicity tests. During testing, truckloads of water from the Elk Valley are shipped weekly to labs in British Columbia and Alberta as part of the chronic toxicity testing program.

See below for more information on the following chronic toxicity tests that were conducted in 2015:

1. Ongoing scheduled chronic toxicity testing
2. Westslope Cutthroat Trout Egg Study
3. Site Performance Objective (SPO) Mixture Study
4. Nitrate and Sulphate Toxicity Study

Ongoing Scheduled Chronic Toxicity Testing

Context

The locations, frequencies, and organisms used in the ongoing scheduled chronic toxicity tests are prescribed by Permit 107517. These scheduled tests are conducted at compliance points quarterly or in some cases semi-annually, due to test organism availability. Tests are also conducted at sites not influenced by mining activities to provide a measure of background toxicity and allow for comparison of results. Species used in the chronic toxicity tests are similar to those found in the Elk Valley and include fish, amphipods, water fleas, and algae, and represent different parts of the food chain.

*Please note that these results represent a yearly summary and do not identify any seasonal differences or differences between reference sites. The Committee will continue to discuss the implications of these results.

Results

The majority of 2015 chronic toxicity tests results with water downstream of mining activities were similar to the results of the same organism in water collected upstream of mining activities. However, some tests identified lower growth, development, or reproduction in organisms exposed to mine-influenced waters. The organisms tested and their toxicity results include:

- **Algae:** Toxicity tests were done on a total of 36 water samples; 8 with reference water (collected upstream of

mining) and 28 with mine-influenced water (downstream of mining). The results of the algae toxicity tests for 2015 were that 12 of the 28 tests (43%) indicated that growth was inhibited in the mining exposed waters.

- **Amphipod:** Toxicity tests were done on a total of 16 water samples with this invertebrate; 4 with reference water and 12 with mine-influenced water. The results of these tests were 1 of 12 (8%) showed decreased survival and 2 of 12 tests (17%) showed decreased growth.
- **Water flea:** Toxicity tests were done on a total of 36 water samples with this invertebrate; 8 with reference water and 28 with mine-influenced water. The results of these tests were 5 of 28 (18%) showed inhibited reproductive capacities and all of the mine-influenced water samples showed no difference in survival of water fleas when compared to the reference water samples.
- **Fathead Minnows:** Toxicity tests were done on a total 16 water samples with this fish; 4 with reference water and 12 with mine-influenced water determining hatching success, survival, biomass, length, and normal development. Survival was lower in 3 of the 12 tests (25%), and biomass was lower in 2 of the 12 tests (17%); all of the other endpoints measured were similar to the reference response. The results for Fathead Minnow at this time are uncertain as some of the responses observed in both reference and mine-influenced water samples were likely linked to biological properties of the water (e.g., microbes causing toxicity in laboratory conditions). Discussions with the Committee are ongoing.
- **Rainbow Trout:** Toxicity tests were done on a total of 18 water samples with this fish; 4 with reference water and 14 with mine-influenced water determining survival, hatching success, length, and weight. Survival and hatching success were both lower in mine-influenced water in 5 of the 14 tests (36%), while length was lower in 3 of 14 (21%), and weight was lower in 2 of the 14 tests (14%) with mine influenced water.

The 2015 scheduled chronic toxicity testing results were provided to, and reviewed by, the Committee. The Committee also reviewed the suite of tests associated with the toxicity testing program and did not recommend any changes to the suite of toxicity tests for 2016 based on 2015 results.

What's Next

Scheduled chronic toxicity testing is part of Teck's ongoing permit monitoring. Tests will continue to be completed and results shared with the Committee. Results from 2016 chronic toxicity testing will be provided to the Committee for review in March 2017. The Committee will report on those results in fall 2017.

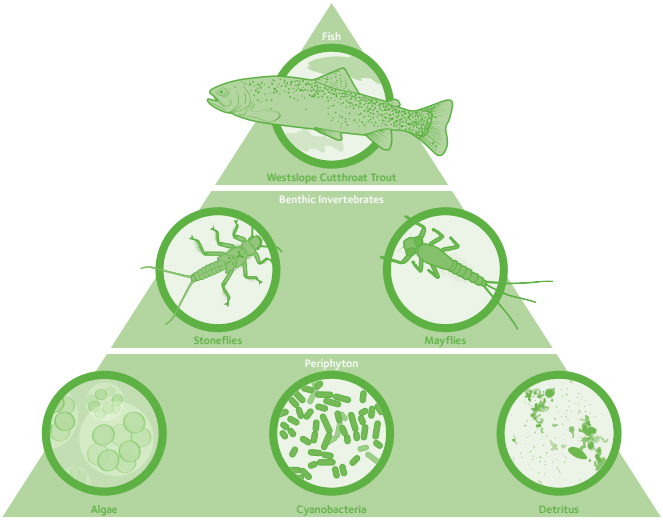


Figure 4-8. This image of the food web shows conceptually the relationships among the basic kinds of aquatic organisms in waters of the Elk Valley. Algae and bacteria are the base of the food chain. Invertebrates like clams, snails, and the larvae of various insects largely depend on algae and bacteria as a food base. Invertebrates are in the middle of the food chain and are food for fish. All levels in the food chain need to be healthy in order to ensure a fully functioning aquatic ecosystem.

Westslope Cutthroat Trout Egg Study

Context

Permit 107517 requires that every three years, starting in 2015, Teck conduct a study to evaluate the survival and development of Westslope Cutthroat Trout eggs collected from fish in the Fording River.

Status

In June 2015, eggs were collected from 33 female fish caught during the spawning period in the Fording River watershed. The eggs were tested at a laboratory for selenium concentration, and a subset of eggs were fertilized and reared to the fry stage in:

- water from the Fording River amended to match the long-term Fording River SPOs (to be met in 2024) for selenium, sulphate, nitrate, and cadmium as per Permit 107517
- water from the laboratory (i.e., control water)

Results

Results indicate:

- Of the 33 fish collected from the Elk Valley, 32 had egg selenium concentrations that were below a level where effects would be expected. No effects of egg selenium on the frequency of deformity, length, or weight were observed in fry from 32 of 33 fish.
- One of the fish sampled had non-viable eggs. These eggs had selenium concentrations above a level where effects would be expected, based on studies conducted previously in the Elk Valley.

- Survival rates differed between eggs reared in laboratory control water and water amended to match the long-term Fording River water quality limit. However, the overall pattern of survival was inconsistent and not clearly tied to these factors.

What's Next?

The Committee reviewed the results of this study. The scope/purpose of future Westslope Cutthroat Trout studies required by Permit 107517 planned for 2018 will be refined based on input from the Committee.

Site Performance Objective (SPO) Mixture Study

Context

Permit 107517 requires that Teck develop and implement a study to confirm that water meeting the long-term SPO limits is not toxic to sensitive aquatic species when all four Order constituents are present at the same time. This chronic toxicity test used the concentrations of selenium, nitrate, sulphate, and cadmium that Permit 107517 requires Teck to meet by 2024 in the Elk and Fording rivers.

Status

In early 2015, a study design was developed by Teck and reviewed by the Committee. The testing was completed in late 2015 and consisted of collecting reference and mine-influenced water from the Fording and Elk rivers. The mine-influenced water was amended to match the long-term water quality limits for 2024 as defined in Permit 107517 for selenium, sulphate, nitrate, and cadmium.

The same organisms used in the ongoing scheduled chronic toxicity testing program were used in this one-time study (i.e., one algal, two invertebrate, and two fish species). The Committee received and reviewed results of this study.

Results

The results indicated that there were no significant adverse effects for any of the five test species (one algal, two invertebrate, and two fish species) related to the mixture of selenium, nitrate, sulphate, and cadmium at long-term SPO levels.

What's Next?

This permit requirement has been completed. No further Site Performance Objectives studies have been required by the Ministry of Environment. The Committee will consider the results of studies as future toxicity studies and monitoring programs are discussed.

Nitrate and Sulphate Toxicity Study

Context

Permit 107517 requires Teck to develop a chronic toxicity testing study to increase understanding about the toxicity of nitrate and sulphate in the aquatic environment. It is expected that the results of these studies will provide a basis for determining if the SPOs for nitrate and sulphate set at the Order stations in the Elk Valley will be protective of aquatic life.

Status

In 2015, a draft study design for this program was developed and reviewed by the Committee. The final study design has been submitted and will be reviewed by the Committee in 2016. Testing associated with this program will follow in 2016 and 2017. The results of this program are scheduled to be available by the end of 2017.

In 2015, an amphibian pilot study associated with nitrate and sulphate toxicity testing was completed using Northern Leopard Frogs, which are considered to be comparable to local amphibian species in the Elk Valley (e.g., Columbia Spotted Frogs). Toxicity testing using amphibians is an emerging area of study, so work to-date has focused on developing test methods and refining draft protocols under development by Environment Canada. The results of the amphibian pilot study were reviewed by the Committee.

What's Next?

Testing of nitrate and sulphate with amphibians, fish, and aquatic invertebrates will proceed in 2016 and 2017. Results will be reviewed by the Environmental Monitoring Committee and shared in the 2017 public report.

Elk Valley Groundwater Monitoring

Context

Permit 107517 requires Teck to develop and implement a comprehensive regional groundwater monitoring program for management units 1, 2, 3, and 4 (Figure 4-9). The objective of the regional groundwater monitoring program is to assess potential effects on groundwater related to Teck's mining operations at a regional scale in these management units. Site-specific groundwater monitoring programs at each mine operation are also required by Permit 107517 and will be aligned with the regional groundwater monitoring program.

Currently, the Committee is required by Permit 107517 to provide technical advice on the groundwater monitoring programs and reports.

The regional conceptual model broadly defines two groundwater systems:

1. Upland Setting: Groundwater in the upland area typically occurs as thin saturated layers near the ground surface. Upland groundwater eventually flows into valley-bottom sediments, transporting potential mine-related constituents into the valley-bottom groundwater system.

2. Valley-Bottom Setting: Valley bottom groundwater

is the primary pathway for transporting mining-related constituents into the main river systems. Valley-bottom groundwater is assumed to have a high degree of interaction with surface water. The presence of elevated levels of Order constituents in surface water has potential to influence groundwater quality.

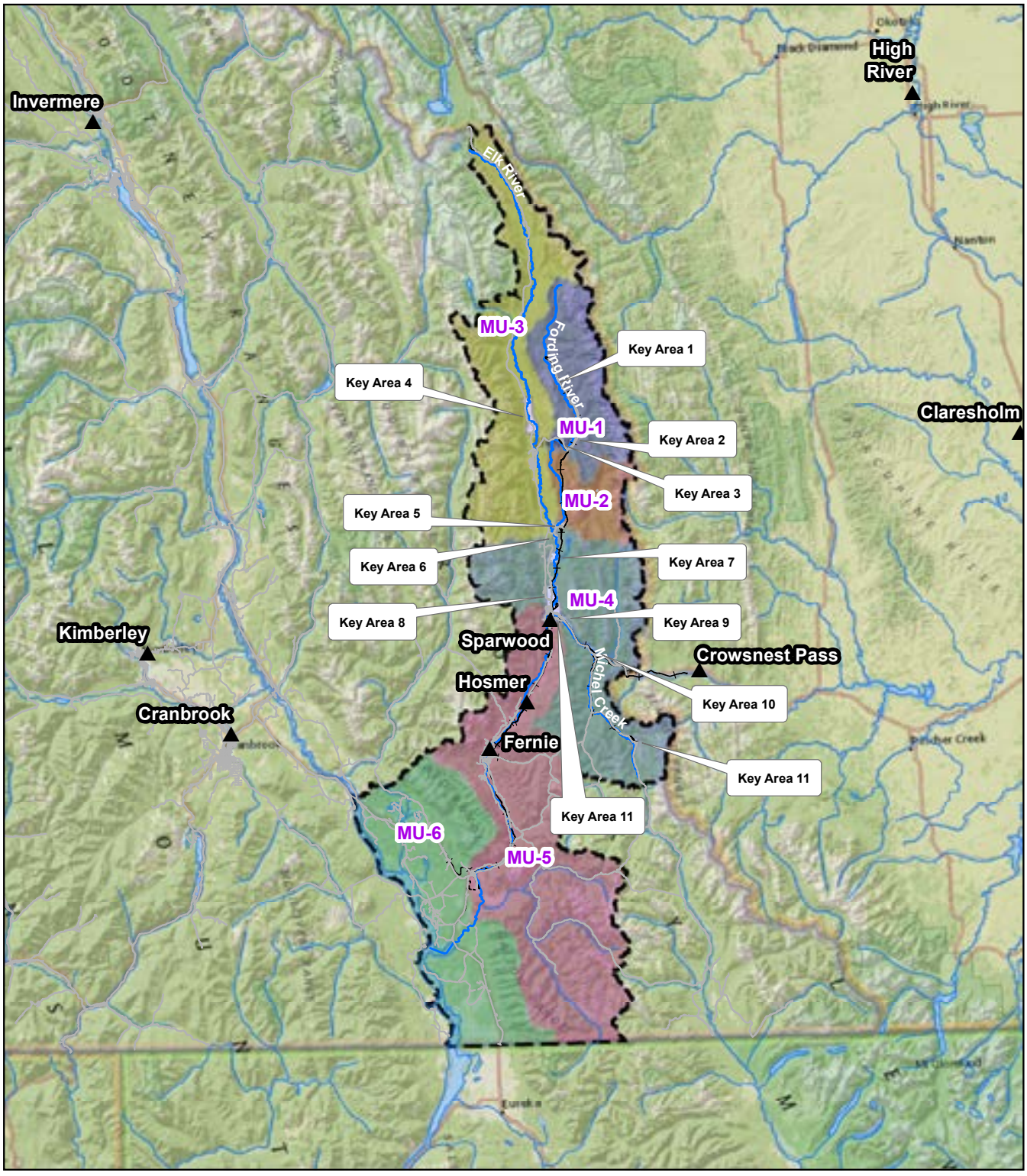
The regional groundwater monitoring program is focused on 12 key areas where transport of mining-related constituents in groundwater to the valley-bottom of the main river systems may be occurring now or in the future (Table 4-4). This approach allows for a focused assessment of groundwater while maintaining a regional scale perspective.

Status

As required by Permit 107517, Teck submitted a regional groundwater synthesis report in April 2015, which was reviewed by the Committee. Based on Committee input, the report was updated and re-submitted in November 2015. A regional hydrological conceptual model was developed (Figure 4-10) to describe groundwater flow patterns and behaviours. The Committee provided advice based on the synthesis report, which was considered in the development of the Regional Groundwater Monitoring Program that is now being implemented.

Key Area	Description	Management Unit(s)
1	Fording River Valley Bottom Downgradient of FRO, Cataract and Porter Creeks: This area is the focal point for the majority of upland and tributary flow to the Fording River valley bottom near FRO and GHO property boundaries, and the primary off-site migration pathway from FRO.	1
2	Fording River Valley Bottom Downgradient of LCO Dry Creek: This area receives drainage from the planned LCO Phase II development as well as upgradient Fording River valley-bottom groundwater from FRO and GHO.	1
3	Fording River Valley Bottom Downgradient of GHO Rail Loop and Greenhills Creek: This area receives upland groundwater from GHO.	1
4	Elk River Valley Bottom Downgradient of Leask, Wolfram and Thompson Creeks: This area receives groundwater recharge from upgradient mining activities along the western slope of GHO, and is a potential offsite migration pathway.	2
5	Fording River Valley Bottom Downgradient of Line Creek: The valley bottom in this area receives inputs from Line Creek, the Fording River and the LCO Process Plant.	2 and 4
6	Elk River Valley Bottom Downgradient of Confluence with Fording River: This area receives input from the Fording River valley-bottom, the Elk River valley-bottom, and the Line Creek Process Plant site.	4
7	Elk River Valley Bottom Downgradient of Grave Creek: This area receives input from drainages flowing from the northwest slope of EVO, as well as upgradient from the Elk River and Key Area 6.	4
8	Elk River Valley Bottom Downgradient of Balmer, Lindsay, Goddard, Otto and Marsh Creeks: Upland groundwater flows into the Elk River valley bottom from potential sources along the western slope of EVO.	4
9	Michel Creek Valley Bottom Downgradient of Bodie Creek: Upland groundwater flows into Michel Creek valley bottom from potential sources along the western slope of EVO.	4
10	Michel Creek Valley Bottom Downgradient of Erickson Creek: Mining activities on the southwest slope of EVO around Erickson Creek are a potential source of mining-related constituents to valley-bottom groundwater into the Michel Creek valley bottom.	4
11	Michel Creek Valley Bottom Downgradient of CMO: The Michel Creek valley bottom receives input from CMO immediately downgradient of the confluence of Michel and Corbin Creeks. Valley-bottom deposits in this area are the primary off-site migration pathway from CMO.	4
12	Elk River Valley Bottom at Study Area Boundary: This area is at the boundary of MU4 and the Study Area. Coarse sediments in this area have been identified as a potential migration pathway, and previous studies have inferred that surface water recharge from the Elk River occurs in this area.	4

Table 4-4. Groundwater Monitoring Program Key Areas.



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Elk Valley Overview Key Areas

- Communities
- Railway
- Roads
- Water Network
- KeyGroundWaterAreas

EVQP MU
- MU-1
- MU-2
- MU-3
- MU-4
- MU-5
- MU-6

N

0 5 10 20 Kilometers

DATE: 9/21/2016	MINE OPERATION: Coal Mountain
SCALE: 1:1,000,000	COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

Document Path: \\teckcominco\CGO\Groups\TCGIS\Data\Projects\MinistryOrderMaps\MXDs\OverviewEMC201609KeyAreas.mxd

Figure 4-9. Management units and twelve key areas of the Groundwater Monitoring Program.

Groundwater Monitoring

- 37 monitoring wells within the 12 key areas
- Monitoring includes 23 monitoring wells, 10 supply wells and 4 domestic wells
- Sampling done quarterly
- Monitoring results are compared to applicable guidelines and standards for the protection of human health, irrigation, livestock and wildlife, and aquatic life
- Secondary screening done if primary screening benchmarks are exceeded

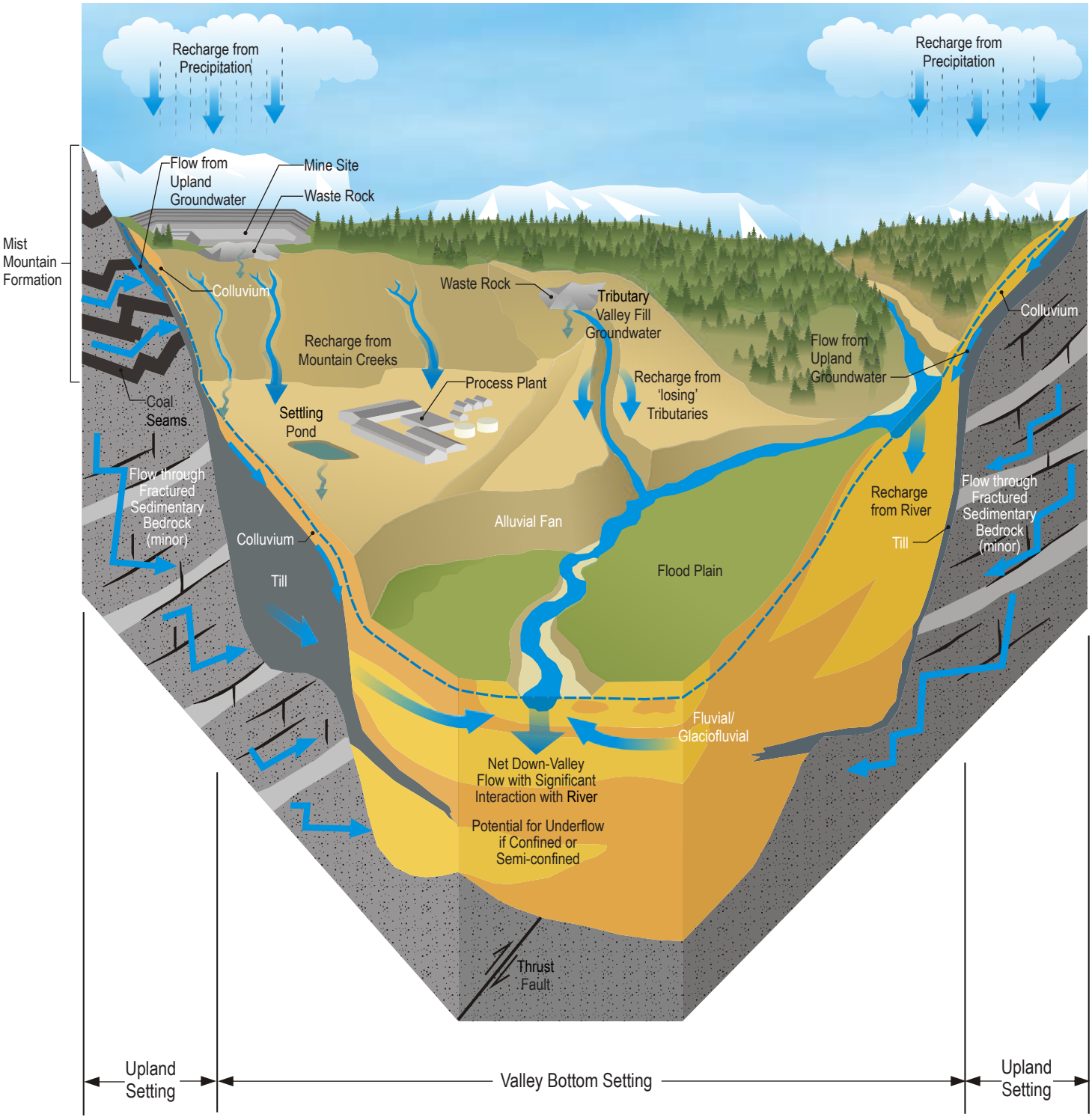


Figure 4-10. Regional groundwater conceptual model.

Key Area	Total Number of Wells Monitored in Regional Program	Number of Wells with Concentrations of Order Constituents above Screening Benchmarks*			
		Selenium	Nitrate	Sulphate	Cadmium
1	3	3	3	0	0
2	2	0	0	0	0
3	4	1	0	1	0
4	7	4	0	1	0
5	0	—	—	—	—
6	1	0	0	0	0
7	2	1	0	0	0
8	2	0	0	0	0
9	7	4	3	1	0
10	1	0	0	0	0
11	4	0	0	1	0
12	3	2	0	0	0
Total	**36**	**15**	**6**	**4**	**0**

Table 4-5. Regional Groundwater Monitoring Program Results.

*Note: Screening benchmarks include Contaminated Sites Regulation Groundwater Aquatic Life standards except for those wells located within 10 m from a receiving surface water body where the concentrations were screened against the British Columbia Water Quality Guidelines. For primary screening of groundwater data for drinking water protection for current and future use and for irrigation and livestock watering, groundwater concentrations were screened against the applicable Contaminated Sites Regulation (drinking water, irrigation, and livestock) standards.

What's Next?

Ongoing discussions are planned with the Committee to improve groundwater program monitoring designs. Quarterly groundwater monitoring will continue as per the groundwater monitoring programs. Annual groundwater monitoring program reports are required by Permit 107517. The Committee is required to provide input on the annual report. The Committee 2017 Annual Report will include an update and results from 2016 groundwater monitoring.

Water Quality Model

Context

During preparation of the Elk Valley Water Quality Plan, Teck developed the Elk Valley Water Quality Model (the water quality model). The water quality model provides a tool for predicting how historical, current, and future mining activities will affect the concentrations of selenium, nitrate, and sulphate in the Fording River, Elk River, tributaries, and Koocanusa Reservoir. The water quality model can estimate future water quality conditions throughout the Elk Valley for a 20-year planning period. The water quality model uses more than two decades of data to estimate how coal mining (i.e., waste rock) influences water quality.

The water quality model was used during the preparation of the Elk Valley Water Quality Plan to develop the initial plan for the phased implementation of water treatment to meet Site Performance Objectives and water quality limits defined in Permit 107517. During implementation of the Elk Valley Water Quality Plan (in alignment with Permit 107517), the water quality model will be used in the Adaptive Management Plan as an assessment and planning tool for adaptively managing the planned water quality mitigation measures. See Section 8 for more about the Adaptive Management Plan for the Elk Valley Water Quality Plan.

Permit 107517 requires Teck to update the water quality model and complete a water quality prediction report for each mine in the designated area by October 31, 2017 and then again every three years, or more frequently if mine plans change, concentration levels vary significantly from the water quality model's predicted concentration levels, or if directed to do so byMOE.

The Committee is required to provide input on the water quality model reports.

Status

The three-year water quality model update allows for continuous improvement of the model, which is aimed at strengthening its ability to reliably predict future water quality conditions throughout the Elk Valley. Work in 2015 has focused on improving the water quality model's ability to estimate water flows and nitrate releases into the water.

What's Next?

The water quality model update work initiated in 2016 will continue into 2017, and the results will be incorporated into the October 31, 2017 water quality model update. The Environmental Monitoring Committee's 2018 Annual Report will provide an update on the water quality model. The Environmental Monitoring Committee will be involved in discussions leading up to the 2017 update of the water quality model.

5 Aquatic Ecosystem Health

Protection of aquatic ecosystem health and management of bioaccumulation of constituents in the receiving environment (including fish tissue) are two of the environmental management objectives for the Elk Valley Water Quality Plan. This section provides an update on monitoring activities required by Permit 107517 related to these objectives. Activities include aquatic effects monitoring, monitoring of Koocanusa Reservoir, and activities under the Tributary Evaluation and Management Program.

Aquatic Effects Monitoring

Context

Teck's five coal-mining operations in the Elk Valley influence water quality in the Elk River watershed, which includes the Elk and Fording rivers, numerous smaller tributaries, and the Koocanusa Reservoir. Mining influences water quality, which can in turn affect fish and other organisms which live in, or depend on, the mine-influenced waterbodies.

Together the data collection, analysis, and supporting studies are the basis for a long-term program to monitor and asses the regional aquatic effects, known as the Regional Aquatic Effects Monitoring Program (RAEMP). Information about the aquatic environment collected in the region will influence decision-making related to mine operations and managing the chemical, physical, and biological changes in the aquatic environment through the Adaptive Management Plan. See Section 8 for more information on the Adaptive Management Plan.

Status/Results

Permit 107517 requires Teck to collect and analyze data related to water quality, its effect on the aquatic environment, and select species that live in the water. The 2015 monitoring activities and the results so far are summarized below.

What Will We Learn From Regional Monitoring?

The Regional Aquatic Effects Monitoring Program has six main study questions about the aquatic environment and mining-related impacts:

1. What are the mine-related chemical and physical changes to aquatic ecosystems, and where do they occur?
2. Are mine-related chemical and physical changes to the aquatic environment resulting in unacceptable biological effects, and where do they occur?
3. What are the specific mine-related sources of any unacceptable changes to chemical, physical, or biological conditions?
4. How are chemical, physical, and biological conditions changing over time?
5. What are the consequences of observed biological effects to the aquatic ecosystem?
6. Are the mine-related chemical and physical changes, and/or biological effects, impacting water and aquatic ecosystem uses?

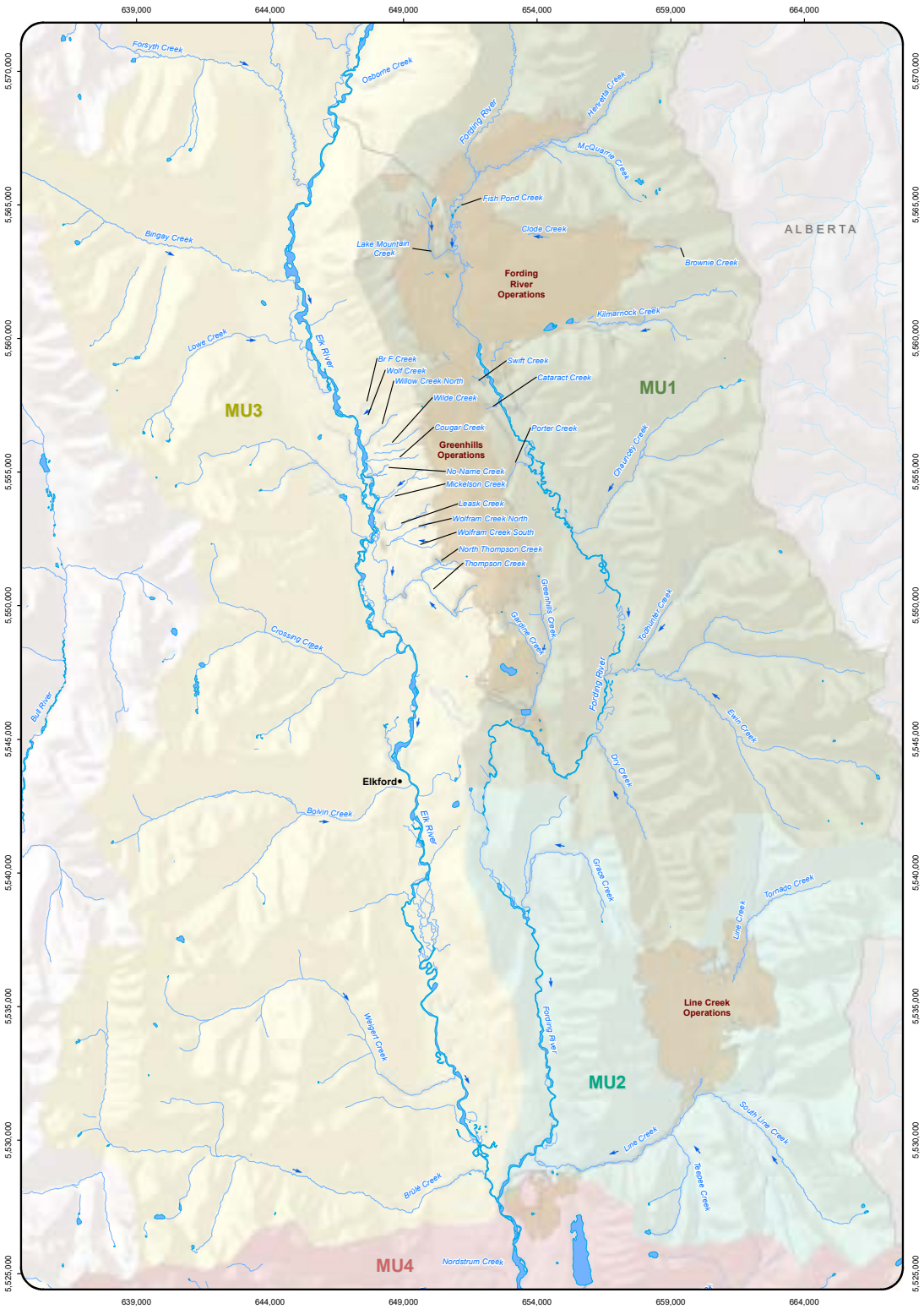


Figure 5-1. Tributaries of the Upper Fording and Upper Elk Rivers (MU1 to MU3).

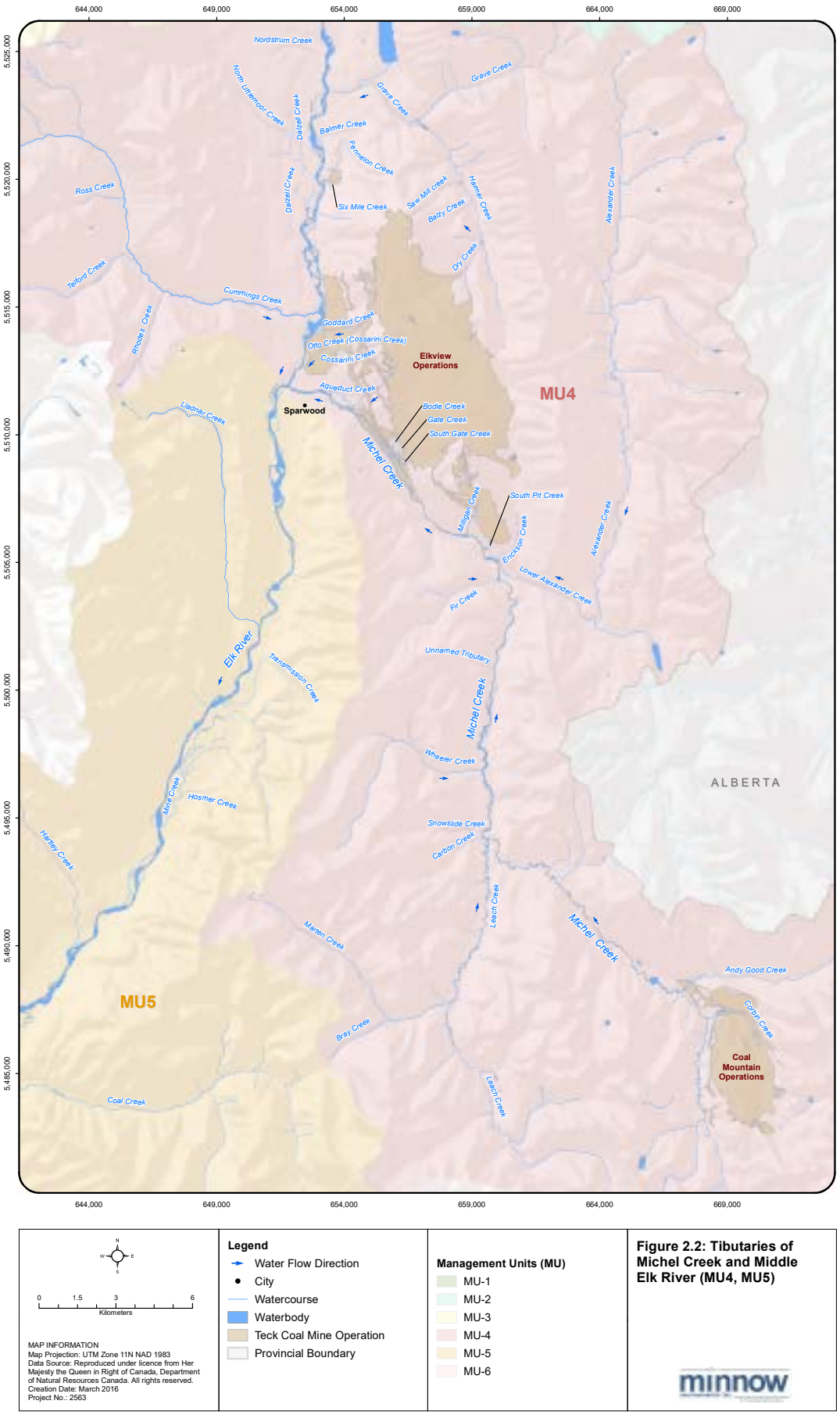


Figure 5-2. Tributaries of Michel Creek and Middle Elk River (MU4 and MU5).

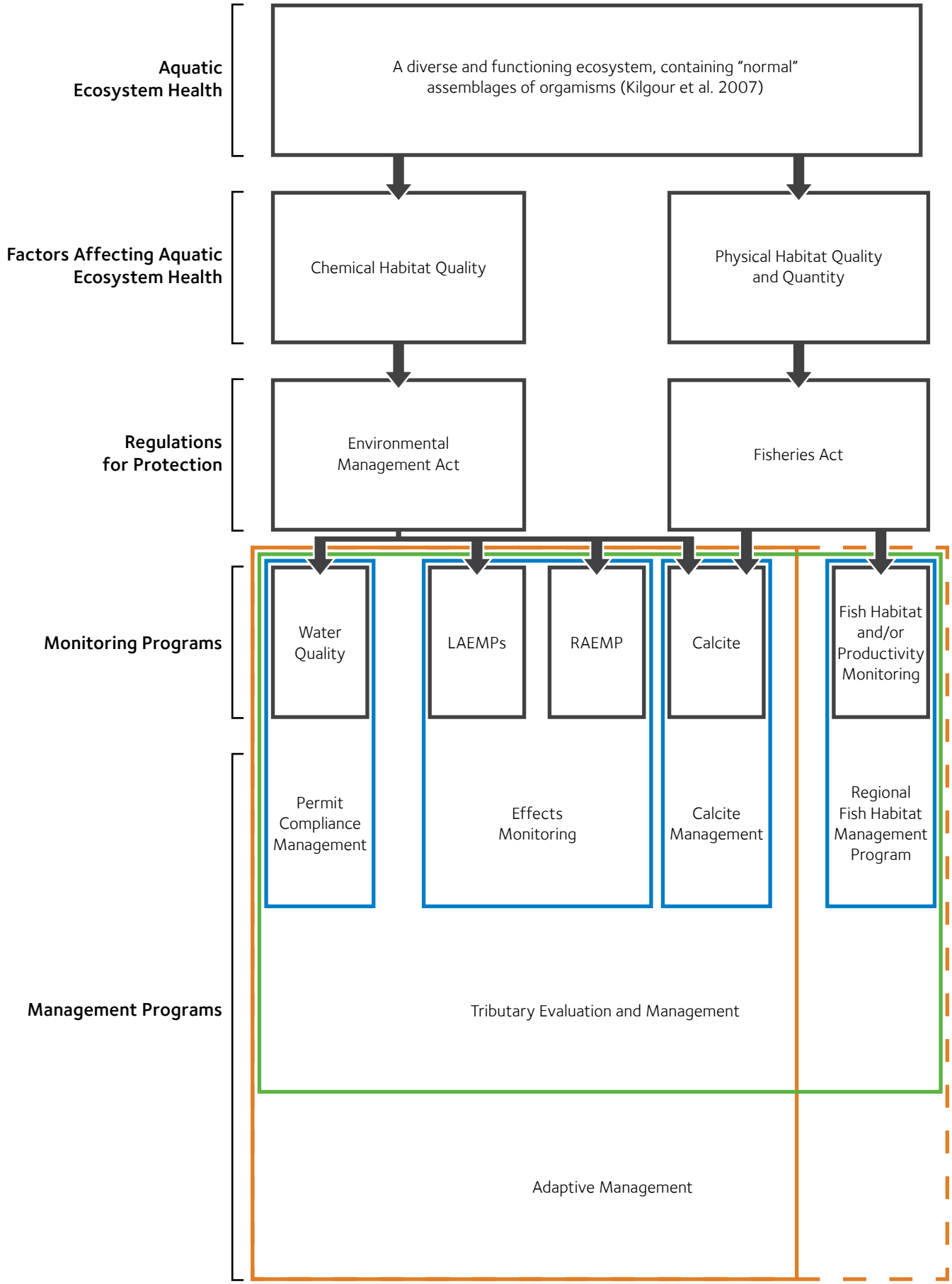


Figure 5-3. The relationship among the various environmental monitoring components and their relationships to fish habitat management, calcite management, monitoring and compliance, adaptive management, and more generally, to Permit 107517 and obligations under the Fisheries Act.

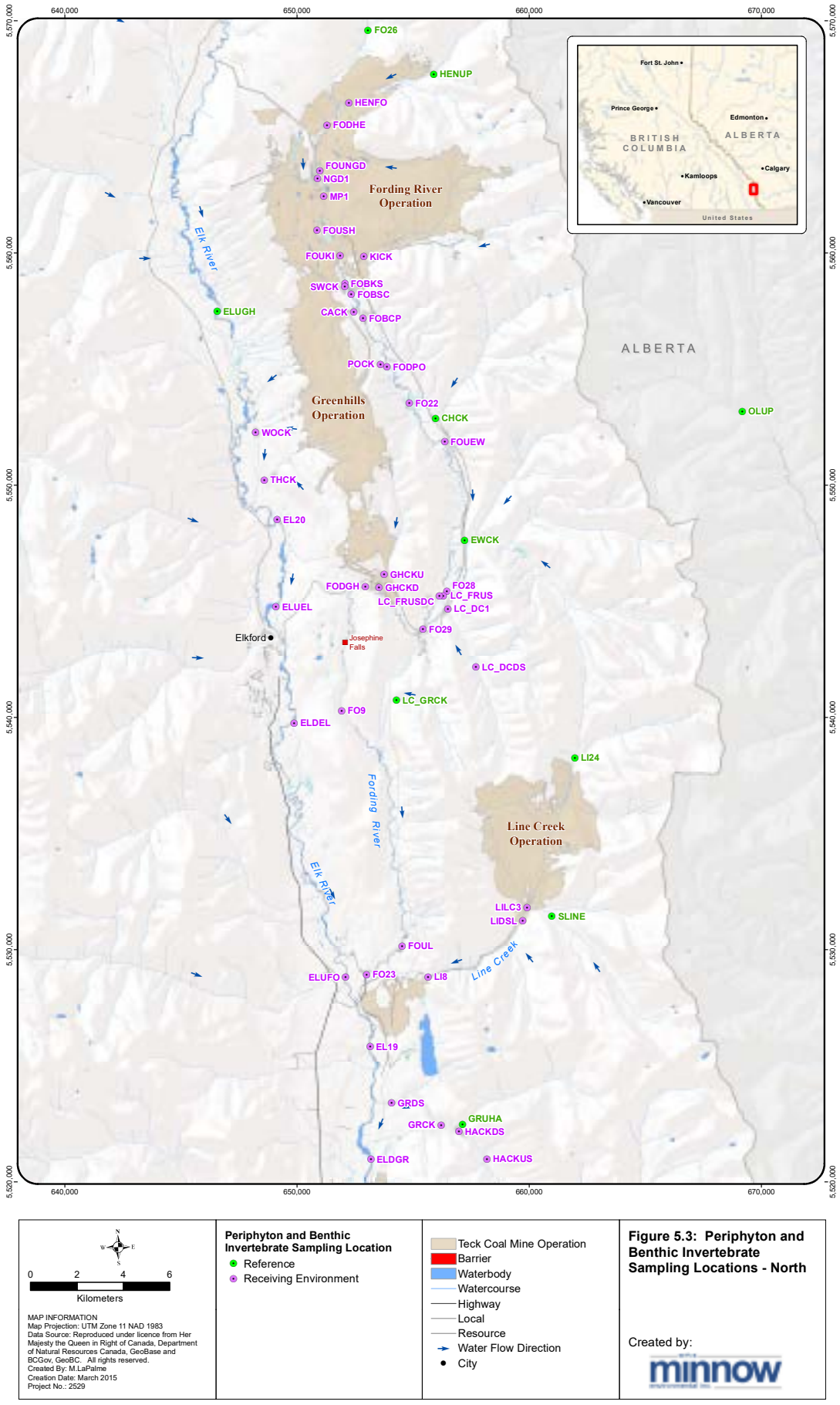
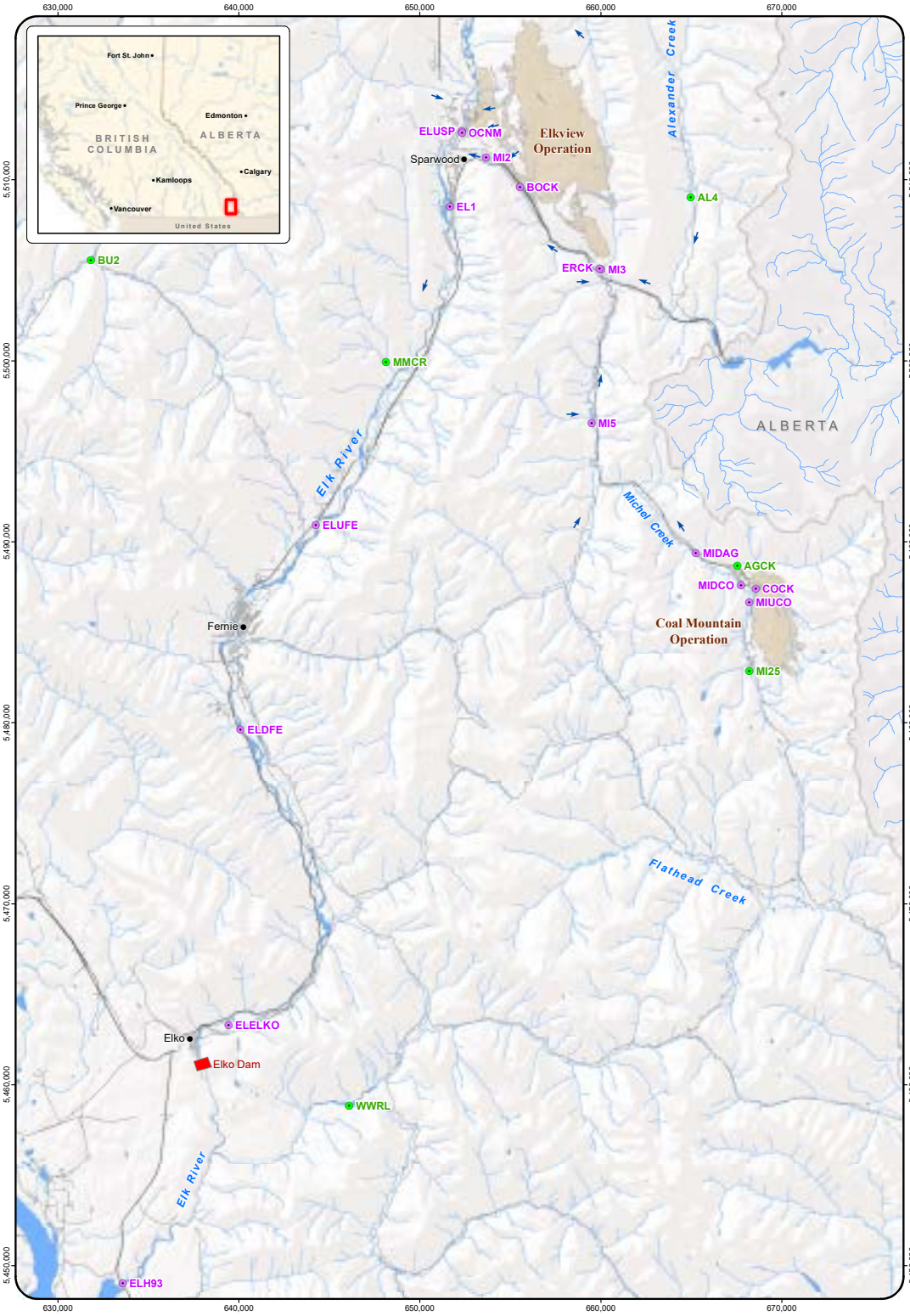


Figure 5-4. Periphyton and benthic invertebrate sampling locations (north).



0 2 4 6 8 10
Kilometers

MAP INFORMATION
Map Projection: UTM Zone 11 NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada, GeoBase and BCGov, GeoBC. All rights reserved.
Created By: M.LaPalme
Creation Date: March 2015
Project No.: 2529

Periphyton and Benthic Invertebrate Sampling Location
- Reference
- Receiving Environment

- Teck Coal Mine
- Barrier
- Waterbody
- Watercourse
- Highway
- Local
- Resource
- Water Flow
- City

Figure 5.4: Periphyton and Benthic Invertebrate Sampling Locations - South

Created by:
minnow

Figure 5-5. Periphyton and benthic invertebrate sampling locations (south).

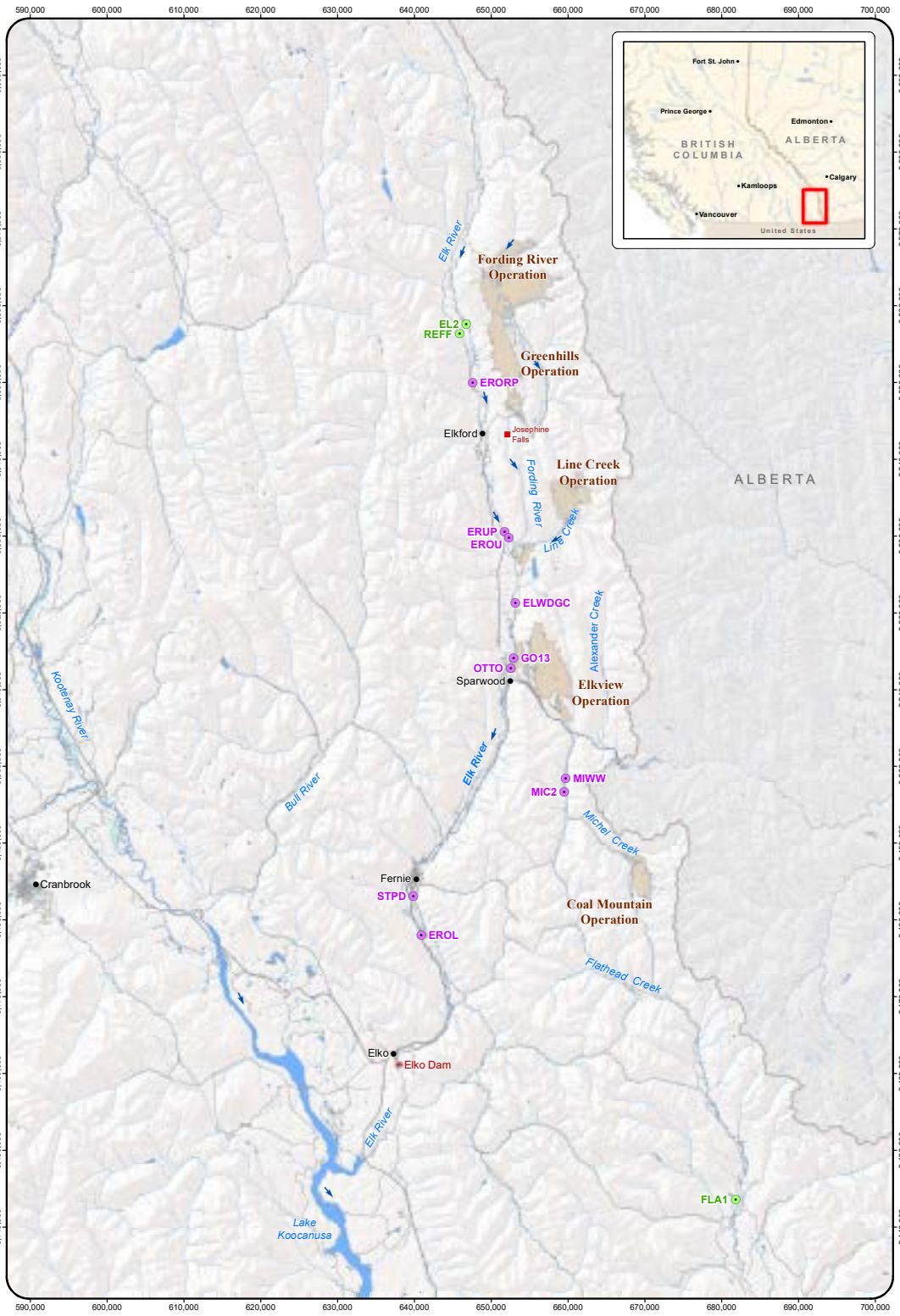
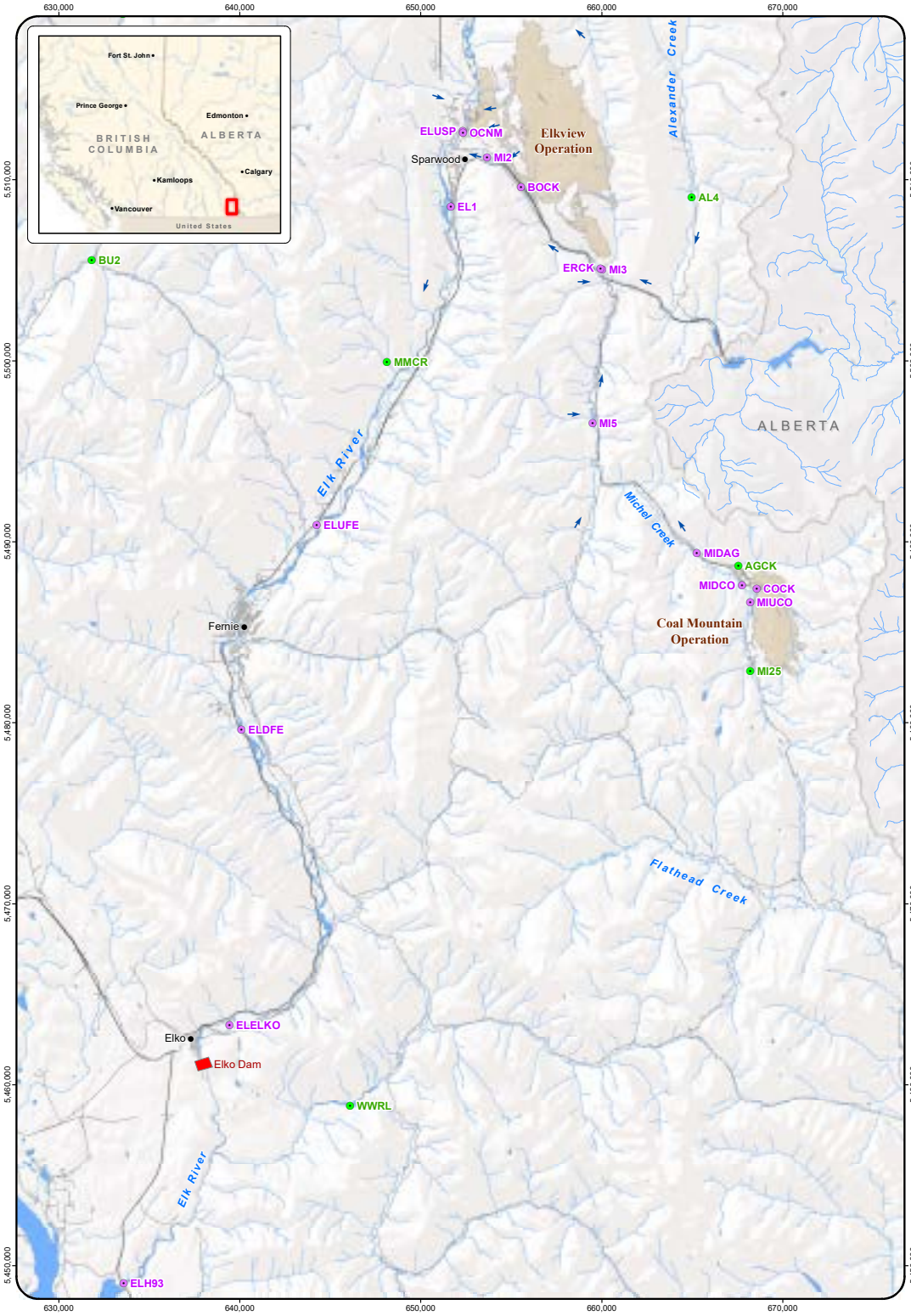


Figure 5-6. Westslope Cutthroat Trout tissue sampling locations.



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Kilometers

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Periphyton and Benthic Invertebrate Sampling Location
- Reference
- Receiving Environment

- Teck Coal Mine
- Barrier
- Waterbody
- Watercourse
- Highway
- Local
- Resource
- Water Flow
- City

Figure 5.4: Periphyton and Benthic Invertebrate Sampling Locations - South

Created by:
minnow

Figure 5-7. Mountain Whitefish tissue sampling locations.

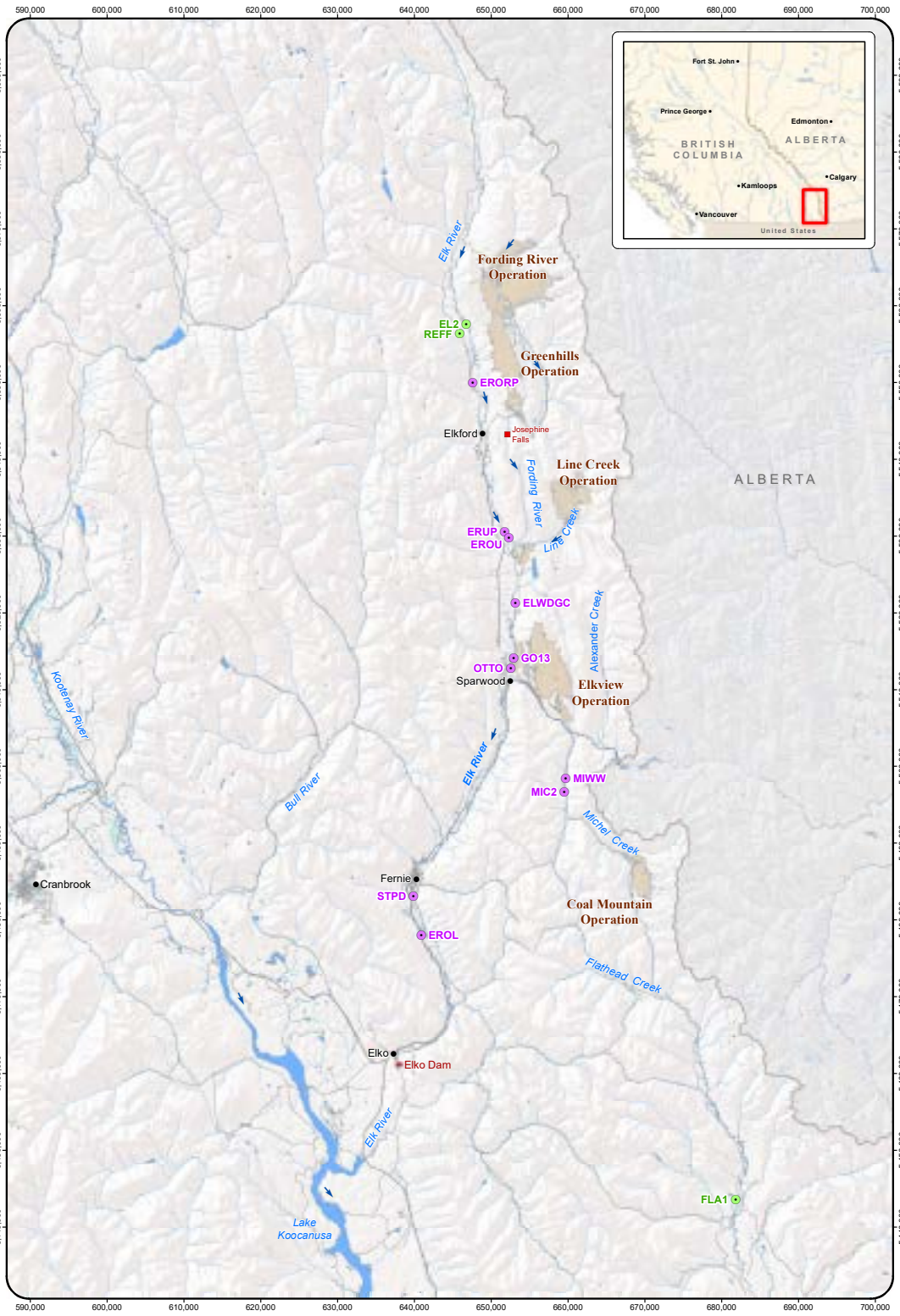

Figure 5-8. Longnose Sucker sampling locations.

Subject	2015 Update/Status	2015 Results
Sediment Chemistry	Sediments were collected from 19 exposed and 5 reference areas in August 2015. A subset of these sample locations was included in a supporting study to evaluate sediment toxicity.	These data were used to select sampling sites for fall 2015 sediment toxicity testing. Results were discussed with the Environmental Monitoring Committee and input was considered in the final report, which will inform future sediment monitoring needs in the next cycle of the Regional Aquatic Effects Monitoring Program.
Sediment Toxicity	Based on results of sediment chemistry monitoring and input from the Environmental Monitoring Committee, sediments were collected in September 2015 from five mine-exposed and three reference areas to complete toxicity testing. These tests focused on three invertebrate species living in the sediment to determine which species and which endpoints were the most sensitive to mine-related contaminants. The test species were: (1) the mayfly; (2) the amphipod; and (3) larvae of the midge, all of which are conventional test species.	The mayfly was the most consistent in producing results that corresponded with selenium levels in sediment. Growth of the three test species was lower in two areas with high concentrations of organic contaminants considered unrelated to mine influences. Survival of the three test species was generally lower in areas with higher selenium concentration (i.e., mine influence).
Algae	A supporting study was conducted in September 2015 to determine if algae responds to mine-related influences. The study involved the collection of data from 40 reference and 58 exposed locations.	Algae community composition differed from a reference condition in some mining-influenced reaches.
Benthic Invertebrates	Monitoring of the benthic invertebrate community was completed in fall 2015, and included 50 mine-exposed and 36 reference locations. This work repeated and added to the previous monitoring completed by Teck in 2012. Community structure samples and tissues were collected at both mine-exposed and reference locations.	Analysis of the 2015 monitoring data is underway and results will be reviewed with the Environmental Monitoring Committee in late 2016 and early 2017.
Fish	Monitoring of Westslope Cutthroat Trout populations upstream of Josephine Falls continued in 2015. Data collection started in 2012. This study looked at Westslope Cutthroat Trout numbers, fish condition, and the presence or absence of skeletal deformities in reference and mine-exposed areas. Longnose Sucker populations from seven mine-exposed and two reference areas were monitored in May 2015, to document abundance, survival (by age or year class), condition, and size (growth). Tissues of representative fish from each area have been analyzed for selenium and other metal concentrations. Tissues of Westslope Cutthroat Trout were collected in the spring 2015 spawning period, and in August from mine-exposed and reference areas to analyze for selenium and other metal concentrations. Tissues of Mountain Whitefish were collected from four reference and four mine-exposed areas to evaluate selenium and other metal concentrations.	The final report, including results of 2015 data, is in preparation. The Environmental Monitoring Committee has not yet reviewed the data or results. Regional Aquatic Effects Monitoring Program results will be reviewed with the Environmental Monitoring Committee in 2016 and 2017.
Amphibians and Birds	In 2016, Teck submitted to the Environmental Monitoring Committee an analysis of selenium concentrations in Spotted Sandpiper eggs as supporting information. This study was based on sampling and surveys conducted in 2013 and 2014. There was no monitoring of wild amphibian populations in 2015.	Selenium concentrations varied between about 2 and 12 ug/g in eggs of Spotted Sandpipers from reference areas, and between about 3 and 22 ug/g in eggs from mine-exposed areas. The highest selenium concentrations were associated with nests located near mine works such as settling ponds. Variability in selenium concentrations among nests at a particular study area, and within individual clutches, also tended to be highest in areas close to settling ponds. Hatching success in nests was variable in both reference and exposure areas because of predation and other factors likely unrelated to exposure to mining operations A laboratory-based amphibian toxicity test has been developed by Teck, with input from the Environmental Monitoring Committee, to assess sensitivity of amphibians to water quality in the Elk Valley.

Table 5-1. Summary of the 2015 monitoring activities and results so far.

Figure 5-9. Sampling water quality at multiple sites within the Elk Valley is an important part of ongoing monitoring activities.

What's Next

The Regional Aquatic Effects Monitoring Program requires ongoing and frequent monitoring of the aquatic environment across the watershed on a three-year cycle to fill information gaps and help manage mine-related impacts to water quality and aquatic organisms. Information collected from 2015 and2016 will be compiled and analyzed in respect to previous data in a report due to the Ministry of Environment in 2017, and then every three years after that.

Information collected from the Regional Aquatic Effects Monitoring Program will be reviewed by the Committee. The Committee may recommend changes to the regional monitoring plans (i.e., what is monitored, when, and where), or new supporting studies to help answer new questions, but monitoring generally will continue as planned until the 2017 report.

Data about the aquatic environment in Koocanusa Reservoir is being collected (2014–2016) and will be summarized in an interpretative report in 2017. See the next section for information on Koocanusa Reservoir baseline monitoring.

What About Effects to the Local Aquatic Environment?

In addition to regional monitoring, Teck is required to more closely study aquatic effects related to mining on a smaller scale to assist in answering specific questions, that can't be answered through the regional monitoring program. These monitoring programs are known as Local Aquatic Effects Monitoring Programs (LAEMP). To-date, Local Aquatic Effects Monitoring Programs have been established for the Fording River and Line Creek mining operations. The Committee reviews the study designs and reports for the Local Aquatic Effects Monitoring Programs.

Koocanusa Reservoir Monitoring

Context

Permit 107517 required Teck to conduct a baseline study in 2015 to evaluate the potential for selenium related effects in Burbot. Teck is also required to participate in, and contribute to the costs of, the Lake Koocanusa Working Group and on an annual basis, provide a report summarizing activities and monitoring results. This report is submitted to the Committee for review and input. Monitoring completed to date will inform future monitoring programs within the reservoir.

Status

2015 was the second year of a three-year baseline monitoring program to assess water quality and the biological conditions in the reservoir including: water quality, algae, invertebrates, and fish health. Data for 2015 monitoring activities were provided to the Committee in March 2016 and are summarized in the next section.

Results

2015 Water Quality Results: Water levels in the reservoir are generally lowest in late winter and highest in summer or early fall. Changing water levels influence water quality in the reservoir. Selenium concentrations are lowest during freshet and increase as water levels go down. Despite seasonal changes, selenium levels in Koocanusa Reservoir did not exceed the water quality limits in 2015. The selenium water quality limit for Koocanusa Reservoir is the BC Water Quality Guideline for the Protection of Aquatic Life (2 µg/L). Concentrations of nitrate, cadmium, and sulphate in the reservoir were all below the BC Water Quality Guidelines in 2015.

2015 Algal (Phytoplankton) Results: The reservoir contained a typical assortment of algae, with the communities being similar both upstream and downstream of the Elk River mouth in August 2015. The algal communities in 2015 were generally similar in composition to what was collected in 2014. This combined data provides a baseline against which to assess in the future.

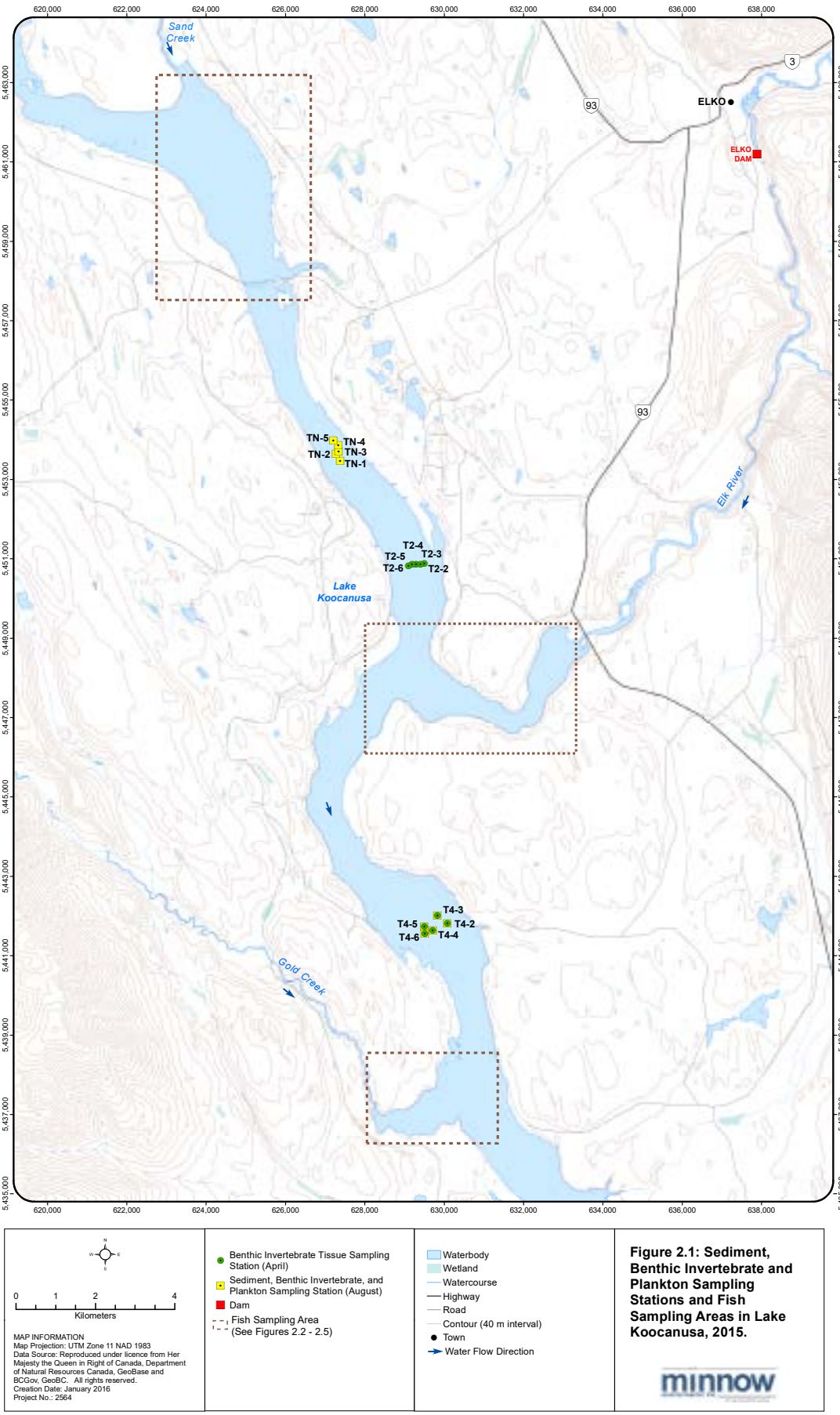

Figure 5-10. Sediment, benthic invertebrate and plankton sampling stations, and fish sampling areas in Koocanusa Reservoir.

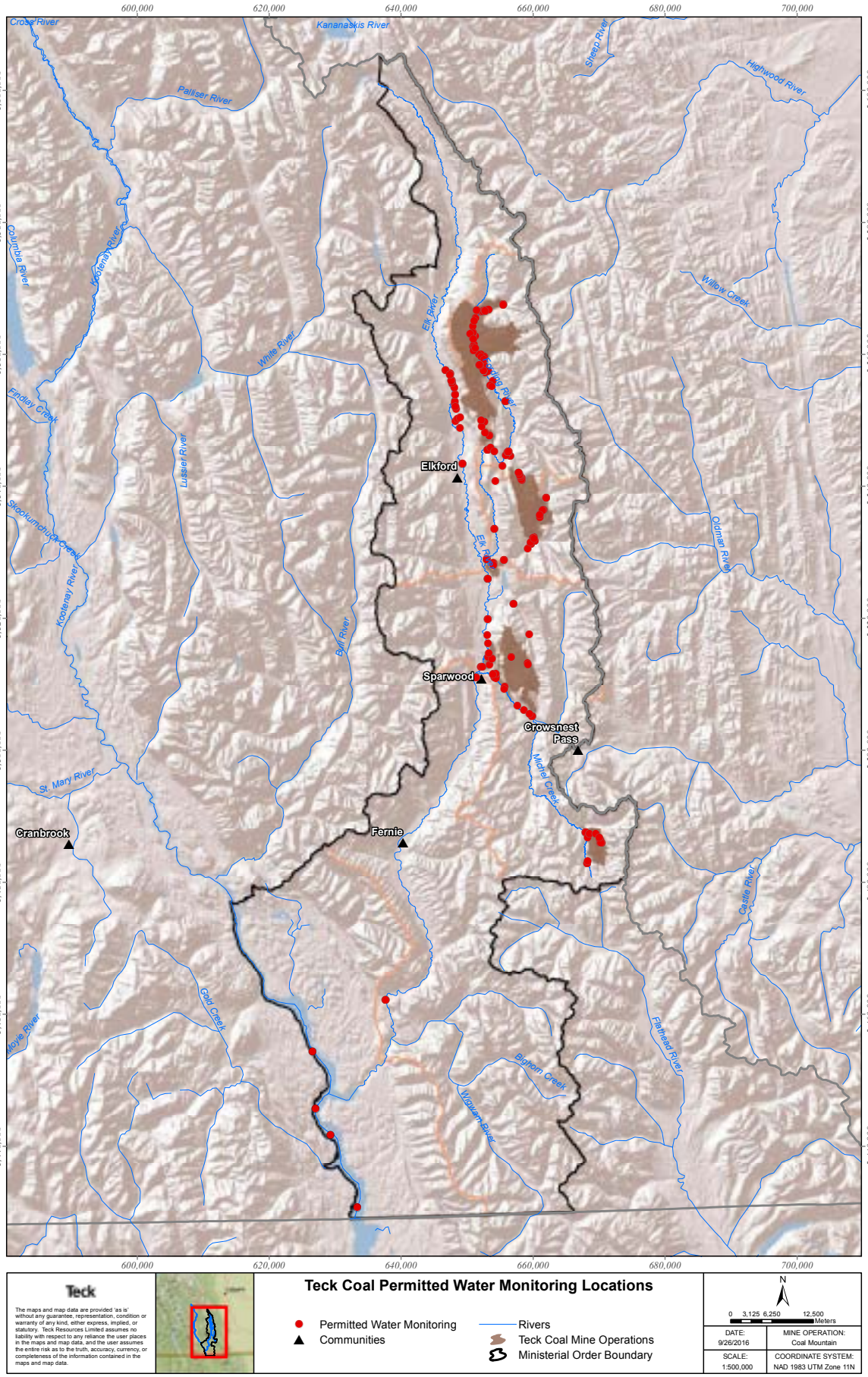

Figure 5-11. Water quality monitoring stations in Koocanusa Reservoir.

2015 Invertebrates from the Water Column (Zooplankton) Results: Invertebrate community in the Koocanusa Reservoir was comprised of a typical assortment of invertebrates (for example rotifers, cladocerans, and copepods). In August 2015, there were fewer taxa downstream from the Elk River than upstream (14 taxa downstream versus 17 upstream). There were also more rotifers and fewer cladocerans downstream of the Elk River. The community structure in 2015 was similar to 2014; however, 2014 results indicated greater diversity of invertebrate species.

2015 Benthic Invertebrate Results: Clams, insect larvae, worms, seed shrimp, and mites are among the organisms found in reservoir sediments. These types of species are typical of reservoir habitat (deep and slow moving). Differences were detected between benthic invertebrate types and abundance upstream and downstream of mining operations. This baseline information will be used to measure any future changes detected in regular water quality and biological monitoring in the reservoir.

2014–2015 Fish Health Results: Sampling of Peamouth Chub, Northern Pikeminnow, Largescale Sucker, and Yellow Perch in 2014 and 2015 provide important baseline information about fish age, condition (weight and length), liver size, gonad size, and growth. This baseline information will be used to measure any future changes related to water quality and biological monitoring in the reservoir.

Eleven fish species were collected and analyzed for selenium tissue concentrations, including Burbot, Bull Trout, Largescale Sucker, Peamouth Chub, Northern Pikeminnow, Westslope Cutthroat Trout, Kokanee, Redside Shiner, Yellow Perch, and Mountain Whitefish. Whole body, reproductive tissue (ovaries), and/ or muscle (from plugs) were analyzed from the species collected. In 2014, selenium concentrations in some fish exceeded the provincial guideline for selenium in two species (Northern Pikeminnow and Largescale Sucker). In 2015, selenium concentrations exceeded guidelines in some representatives of five species (Peamouth Chub, Northern Pikeminnow, Yellow Perch, Largescale Sucker and Burbot).

What's Next?

The three years (2014-2016) of baseline data will help reveal any future differences in water quality and the aquatic environment upstream and downstream of mine-influenced water coming from the Elk River. Data from 2014 to 2016 will be combined into an interpretive report for review by the Committee in 2017. This report will include a detailed comparison of historical data (i.e., collected prior to 2014) and will provide the foundation for defining a long-term biological monitoring program in Koocanusa Reservoir.

Involving Ktunaxa Nation Citizens in Burbot Sampling

Burbot is a fish of interest to Ktunaxa Nation citizens. This species, which spawns in deep water during winter, has proven difficult to catch in Koocanusa Reservoir using conventional, scientific collection methods. Ktunaxa Nation citizens were invited to contribute to the collection of Burbot samples in 2016 through a volunteer opportunistic sampling program which will be continued in 2017.

Tributary Evaluation and Management

Context

Permit 107517 requires Teck to develop and implement a phased study design for a Tributary Evaluation Program leading to the development and implementation of a Tributary Management Plan. The evaluation program and management plan (to be developed in 2017) must consider current and future mining operations. This work will support protection of the aquatic ecosystem.

Tributary Evaluation Program

The Tributary Evaluation Program will evaluate the ecological value of tributaries in the Elk and Fording rivers. In consultation with the Elk Valley Fish and Fish Habitat Committee, the Committee will identify those tributaries that play a significant role in supporting the ecosystem as a whole. In addition, this program will identify tributaries that should be targeted for protection from future mine-related degradation. Mine-influenced tributaries to be targeted for restoration and/or rehabilitation will also be identified.

Tributary Management Plan

The Tributary Management Plan is intended to incorporate protection and rehabilitation goals for tributaries that will support achieving the objectives of the Elk Valley Water Quality Plan.

The Tributary Management Plan will define a process for monitoring, implementing, and reviewing the management plan, as well as periodic reviews and updating of the Tributary Evaluation Program.

The Committee is required by Permit 107517 to provide input on the Tributary Evaluation Program and the Tributary Management Plan.

Status

A phased study design for the Tributary Evaluation Program was submitted to the Committee and accepted by the Ministry of Environment in December 2015. The Committee reviewed draft information tables for all tributaries, and participated in multiple discussions to refine the tributary information and identify additional criteria

for consideration, including Ktunaxa traditional uses and cultural values.

A draft data report was submitted to the Committee in March 2016. An approach to evaluating tributaries using the information collected in the data report is being developed, and the Committee and the Elk Valley Fish and Fish Habitat Committee have provided initial input into the development of objectives and criteria to be used in the tributary evaluation.

A draft Terms of Reference for the Tributary Management Plan was developed and reviewed by the Committee.

What's Next

The next development and implementation timelines are:

- **November 30, 2016:** Analysis and interpretation of the Tributary Evaluation Program data, assessment of potential for rehabilitation and/or mitigation, and prioritization of tributaries for potential future habitat rehabilitation must be compiled into a written interim report and submitted to the Ministry of Environment.
- **February 28, 2017:** An interim Tributary Management Plan report must be submitted to the Ministry of Environment.
- **April 28, 2017:** The Tributary Management Plan must be submitted for approval.
- **June 30, 2017:** The approved Tributary Management Plan must be implemented.

The Committee and the Elk Valley Fish and Fish Habitat Committee will continue to provide input into the Tributary Evaluation Program and the Tributary Management Plan in the coming year. An update on this project will be provided in the next public report.

6 Calcite

Under Permit 107517, Teck is required to manage calcite levels in streams that are fish bearing, provide fish habitat, or flow directly into fish-bearing streams (i.e., that are not scheduled to be buried under an existing Environmental Assessment Certificate). This section of the report provides an overview of monitoring that has been conducted to evaluate the distribution and effects of calcite in the Elk Valley.

Context

As water flows through waste rock piles at Teck's coal mining operations in the Elk Valley, calcium carbonate is dissolved and carried downstream. Under certain conditions (e.g., water temperature and other factors), calcite (solid calcium carbonate precipitated from the water) can form on the bottom of streams. It can occur naturally, but excessive calcite build-up can change streambeds by cementing rocks together and potentially reducing the quality of habitat available for fish spawning and foraging. This is similar to the scale that can build up in kettles.

Permit 107517 requires Teck to do annual and seasonal monitoring of calcite formation in the Elk Valley. This section reports on annual and seasonal calcite monitoring. See the section above for an update on monitoring the biological effects of calcite as part of Teck's Regional Aquatic Effects Monitoring Program. Site Performance Objectives and their respective target dates for calcite management are as follows:

- Permit 107517 requires Teck to achieve a medium-term target (i.e., Site Performance Objective) for calcite concretion by December 31, 2024, of less than 0.50 on the calcite index (i.e., CIConc ≤ 0.50).
- Permit 107517 requires Teck to achieve a long-term target (i.e., Site Performance Objective) for total calcite by December 31, 2029, of less than 0.50 on the calcite index (i.e., CItotal ≤ 0.50)

How is Calcite Measured?

Calcite Index

The calcite index is a way to quantify the calcite formation in a stream by collecting, examining, and assessing calcite formation at a monitoring site. A calcite index score is determined based on the number of pebbles (out of 100) that show calcite is present and how concreted (stuck together) the pebbles in a stream bed are as a result of calcite formation. The calcite index is the combined score for both the presence of calcite on rocks and the level of calcite concreted on the streambed.

$$\mathbf{CI_{total}: Calcite\ Index\ (total) = CI_{Conc} + CI_{Pres}}$$

$$CI_{Conc}: \text{Calcite Concretion} = \frac{\text{Sum of pebble concretion scores}}{\text{Number of pebbles counted}}$$

$$CI_{Pres}: \text{Calcite Presence} = \frac{\text{Number of pebbles with calcite}}{\text{Number of pebbles counted}}$$

A calcite index score of 0.0 indicates that no calcite was observed at a site. A score of 3.0 on the calcite index indicates the streambed surface is fully concreted. Reference streams in the Elk Valley typically have a calcite index score that is at, or near, zero, but it could be as high 0.50.

The calcite index is used in Teck's annual and seasonal monitoring of calcite formation.

Annual Calcite Monitoring

Status

Permit 107517 requires Teck to monitor calcite formation in the Elk and Fording rivers and tributaries each year for three years, and then assess next steps. 2015 was the third year. Data collected from 2013–2015 helps improve understanding about the degree and extent of calcite formation downstream of mining activities and in reference streams not influenced by mining activities. The purpose of the monitoring program was to:

1. Document the extent and degree of calcite deposition in streams downstream of Teck's coal operations and in reference streams.

2. Satisfy calcite-specific monitoring regulatory requirements, including the Elk Valley Water Quality Plan commitment to assess the rate of change in calcite formation by monitoring changes over time.

3. Provide information to support identification of priority streams in regards to calcite management decisions as presented in the Elk Valley Water Quality Plan (Teck 2014).

4. Provide data to facilitate an ongoing evaluation of the sampling methods used, and their effectiveness in detecting and describing calcite deposition.

Alexander Creek*	Fording River**	Otto Creek
Andy Good Creek*	Gardine Creek	Pengally Creek
Aqueduct Creek	Gate Creek	Porter Creek
Balmer Creek	Goddard Creek	Qualteri Creek
Bodie Creek	Grace Creek*	Sawmill Creek
CCR Seep	Grassy Creek	Six Mile Creek
Carbon Creek*	Grave Creek**	Smith Pond Outlet
Cataract Creek	Greenhills Creek	Snowslide Creek*
Chauncey Creek*	Harmer Creek	South Line Creek*
Clode Pond Outlet	Henretta Creek	South Pit Creek
Clode West Infiltration	Kilmarnock Creek	South Pond Seep
Corbin Creek	Lake Mountain Creek	South Wolfram Creek
Dry Creek (EVO)	Leask Creek	Spring Creek
Dry Creek (LCO)	Lindsay Creek	Swift Creek
Eagle Pond Outlet	Line Creek**	Thompson Creek
Elk River**	Michel Creek**	Thresher Creek
Erickson Creek	Mickelson Creek	Unnamed South of Sawmill
Feltham Creek	Milligan Creek	Wheeler Creek*
Fennelon Creek	North Thompson Creek	Wolfram Creek
Fish Pond Creek	North Wolfram Creek	

Table 6-1. Annual calcite monitoring exposed and reference streams.
*indicates reference stream
**indicates reference and exposed stream

Calcite formation was monitored annually at reaches (a section of stream that is typically a minimum of 100 metres in length) in 59 streams (51 exposed to mining influences and 13 streams either upstream of mining influences or reference streams), which are listed in Table 6-1. Up to three sites were monitored in each reach. In 2015, this resulted in 358 monitoring sites in 124 reaches.

At each reach site, the calcite index for that site was determined by selecting and assessing 100 pebbles or rocks from the stream, observing which had calcite present, and noting if the pebbles were concreted to the streambed. The calcite index was calculated (see How is Calcite Monitored?). The data from mining-influenced streams were compared to reference streams, all of which have a calcite index less than 0.5.

Results

In 2015, calcite surveys were conducted from September 23 to November 6. A total of 374 km of stream were assessed and mapped. A total of 295 km were considered exposed and downstream of mining activities. Calcite index values in streams not influenced by mining were between 0 and 0.5.

Over 80% (by length) of the stream reaches surveyed in 2015 downstream of mining influences had levels of calcite deposition that were similar to the amount of calcite formation found in the reference streams.

- 100% of the reference sites had calcite values between 0 and 0.5 in the Elk and Fording rivers
- 15% of the mine influenced sites had calcite index values over 0.5
- 100% of the reference sites had calcite values between 0 and 0.5 in the tributary streams
- 18% of the mine-influenced tributary sites had calcite index values over 0.5.

Trend Analysis 2013 to 2015

Calcite data were collected between 2013 and 2015 at 119 stream reach locations. Calcite index values at over 95% of those monitored reaches did not change over the three-year period, and the calcite index increased in value at only one of the mine-influenced stream reaches.

What's Next?

Pending approval from the Ministry of Environment, Teck is proposing to adjust the calcite monitoring program to a three-year cycle, starting in 2016. In years one (2016) and two (2017), all streams would be monitored, but the number of sites sampled per stream would be based on the levels of calcite observed in previous years. In some cases, more sites would be sampled per reach than previously, but for the most part data would be collected from fewer sites per stream.

	Reference				Exposed			
	Fording and Elk		Tributaries		Fording and Elk		Tributaries	
CI Range	km	%	km	%	km	%	km	%
0.00 – 0.50	21.8	100.00%	57.2	100.00%	130.4	85.2%	116.1	82.0%
0.51 – 1.00	0	0.0%	0	0.0%	17.9	11.7%	6.2	4.4%
1.01 – 1.50	0	0.0%	0	0.0%	0	0.0%	4	2.8%
1.51 – 2.00	0	0.0%	0	0.0%	4.7	3.1%	3.8	2.7%
2.01 – 2.50	0	0.0%	0	0.0%	0	0.0%	6.5	4.6%
2.51 – 3.00	0	0.0%	0	0.0%	0	0.0%	4.8	3.4%
Total (2015)	**21.8**	**100.0%**	**57.2**	**100.0%**	**153**	**100.0%**	**141.4**	**100.0%**
Total (2014)	**21.8**	**100.0%**	**56.3**	**100.0%**	**153.1**	**100.0%**	**136.7**	**100.0%**
Total (2013)	**21.8**	**100.0%**	**42.9**	**100.0%**	**147.7**	**100.0%**	**139.8**	**100.0%**

Table 6-2. Summary of results of the calcite index in exposed and reference streams.

Teck estimates that about 150 sites would be sampled in years one and two. By comparison, 358 sites were sampled in 2015. In year three (2018), all streams would again be monitored, but more monitoring sites would be assessed. If approved by the Ministry of Environment, this approach would reveal changes to the range and extent of calcite formation.

Calcite Treatment Starts in 2017

After considering the annual calcite monitoring data, in conjunction with data from the Tributary Evaluation Program and other data, Teck selected Greenhills Creek as the first Elk Valley stream for calcite management in 2017. See Section 5 for more information on the Tributary Evaluation Program.

Figure 6-1. Substrate with no calcite (Calcite Index score = 0).

Sample Rocks Used in Seasonal Monitoring

Sample rocks are used in Teck's seasonal monitoring of calcite formation. Sample rocks for the seasonal monitoring program are tethered in streams and left for about one month. They are removed and replaced with new sample rocks. The rocks removed from the streams are analyzed to see if calcite has been added to, or removed, from the rocks.

Figure 6-2. Substrate covered in calcite but no concretion (Calcite Index score = 1). Note uniform colour of substrate.

Figure 6-3. Substrate covered in concreted calcite (Calcite Index score = 3).

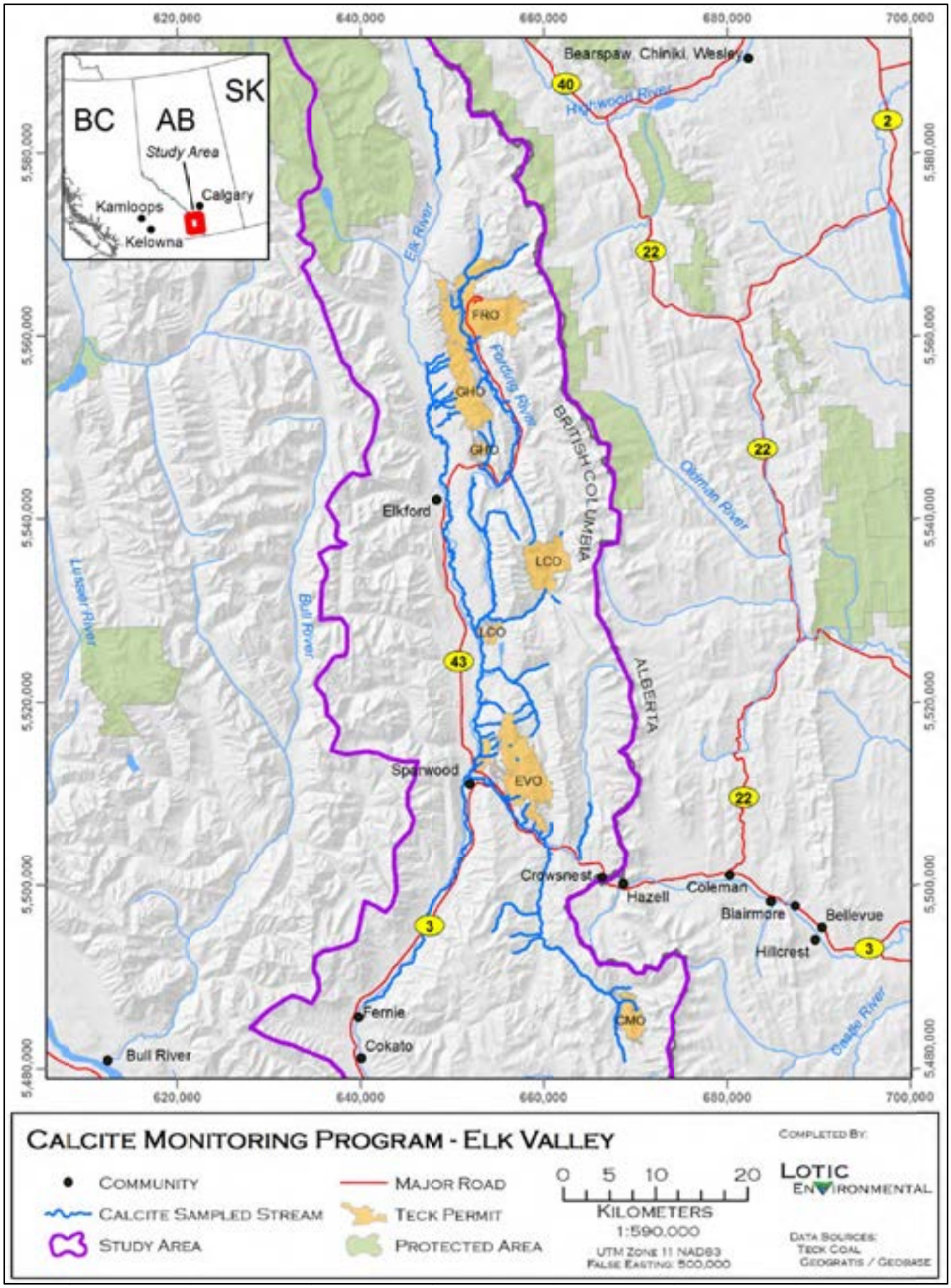

Figure 6-4. Map of the calcite monitoring program showing calcite sampled streams.

Seasonal Calcite Supporting Study

Status

Permit 107517 requires Teck to collect two years of data on seasonal variations in calcite formation. The purpose of this data collection is to determine if there is a seasonal pattern associated with calcite formation to help plan for future calcite management. Methods for the seasonal calcite monitoring were approved by MOE in May 2015, and monitoring is ongoing.

Seasonal monitoring of calcite is repeated monthly in the same streams: Bodie, Corbin, Dry (Elkview), Greenhills, Kilmarnock, Mickelson, Thompson, and Wolfram. Sites selected for seasonal calcite monitoring were chosen from sites where regular water monitoring is already occurring and reflect a range of water chemistry and calcite conditions (Figure 6-4).

Results

Monitoring for the first year of the program started in May 2015, and therefore the Committee does not yet have results representing all seasons. Year two (2016) monitoring is underway. The variability of seasonal patterns with calcite formation is inconsistent and more data is required.

What's Next

Seasonal calcite monitoring in 2016 will continue as planned and approved. Permit 107517 requires a report on the two years of data collection be provided to MOE by March 31, 2017. The 2017 EMC public report will include an interpretation of results from 2016.

Figure 6-5. Environmental Monitoring Committee members inspecting the calcite rock sampling method.

Calcite Biological Effects Evaluation

Context

Calcite, benthic invertebrates, and algae were sampled in 114 areas (74 mine-influenced, 40 reference) in 2015 to assess the relationships between calcite, benthic invertebrates, algae, and fish. Sampling areas were distributed throughout the Elk River watershed and in adjacent (reference) watersheds within the region. Similar sites were selected to try and isolate calcite effects from other water quality effects (such as elevated order constituent concentrations). Calcite indices were also mapped relative to Westslope Cutthroat Trout spawning and rearing areas in the Upper Fording River watershed to help understand calcite effects on fish.

Results

The results of the calcite biological effects evaluation were as follows:

- More algae was found in streams that had higher amounts of calcite.
- Stream areas with elevated calcite index scores greater than one tended to have fewer invertebrates groups, in particular larval mayflies. The cause of this reduction or absence of mayflies was unclear because streams with high calcite scores also had higher concentrations of selenium, nitrate, and/or sulphate. The chemical and physical changes associated with mining activities and calcite deposition could both potentially cause reductions in mayfly abundances.
- Calcite index values measured in 2015 were < 1.0 at most locations where Westslope Cutthroat Trout (WCT) redds were observed in the upper Fording River (i.e., above Josephine Falls). Additional work is planned to evaluate the relationship between calcite and fish egg incubation and spawning success.

What's Next

Teck worked with the Committee to develop a phased study to support determination of the relationship of calcite on physical and chemical conditions in the subsurface of river sediments. The study will collect data on water temperature, dissolved oxygen, and flows in streams with a range of calcite presence and concretion. The data will be examined and analyzed in 2016 with the results provided to Committee in 2017.

Future monitoring within the Regional Aquatic Effects Monitoring Program will include continued evaluation on the relationships between calcite and biological effects.

7 Human Health Risk Assessment

Protection of human health is an environmental objective of the Elk Valley Water Quality Plan. This section provides an update on the activities required by Permit 107517 related to this objective.

Context

Permit 107517 requires Teck, in consultation with the Committee, to conduct a Human Health Risk Assessment (HHRA) to examine the potential effects of mine-related constituents and other parameters of interest, including selenium, mercury, cadmium, chromium, copper, manganese, nitrate, nickel, vanadium, zinc, and others. This work must evaluate the human health risk associated with exposure to mine-related parameters from all exposure pathways (i.e., air, water, vegetation, sediment, fish, and wildlife) in accordance with conditions from the Ministry of Environment in its approval letter. (Figure 7-1).

Permit 107517 and conditions specific to MOE approval of the work plan requires that the HHRA:

- Determine and assess how people may be exposed to selenium and other mine-related constituents that may be present in potable water sources, and also in plants, fish, and game used for food or medicine.
- Follow approved methodologies and levels of acceptable risk for Human Health Risk Assessments provided in the British Columbia Contaminated Sites Regulation and consider Health Canada guidelines.
- Address First Nations consumption patterns and risk sensitivities.
- Incorporate information from a variety of sources, such as traditional use studies, consultation records, and country foods[3] consumption surveys.
- Evaluate risks for each management unit in the designated area and the entire designated area as a whole (Figure 7-2).
- Identify links with the Adaptive Management Plan and outline how data gaps or impacts identified during the HHRA will be addressed.
- Continue to provide opportunities to the Committee to provide advice on theHHRA.

The assessment of human health risks must incorporate information from many sources including, but not limited to, ongoing monitoring programs, traditional use studies, consumption surveys, monitoring of mine-related substances, and environmental assessments completed for Teck's proposed expansions at the Elkview, Fording River, and Line Creek mining operations.

What's a Human Health Risk Assessment?

Human Health Risk Assessment (HHRA) is a process to determine the potential risks to human health posed by the presence of contaminants at a site. The process considers human's exposure to, and the toxicity of, the contaminants.

[3]A country food assessment involves a chemical analysis of the typical natural food items of a First Nations community member's diet.

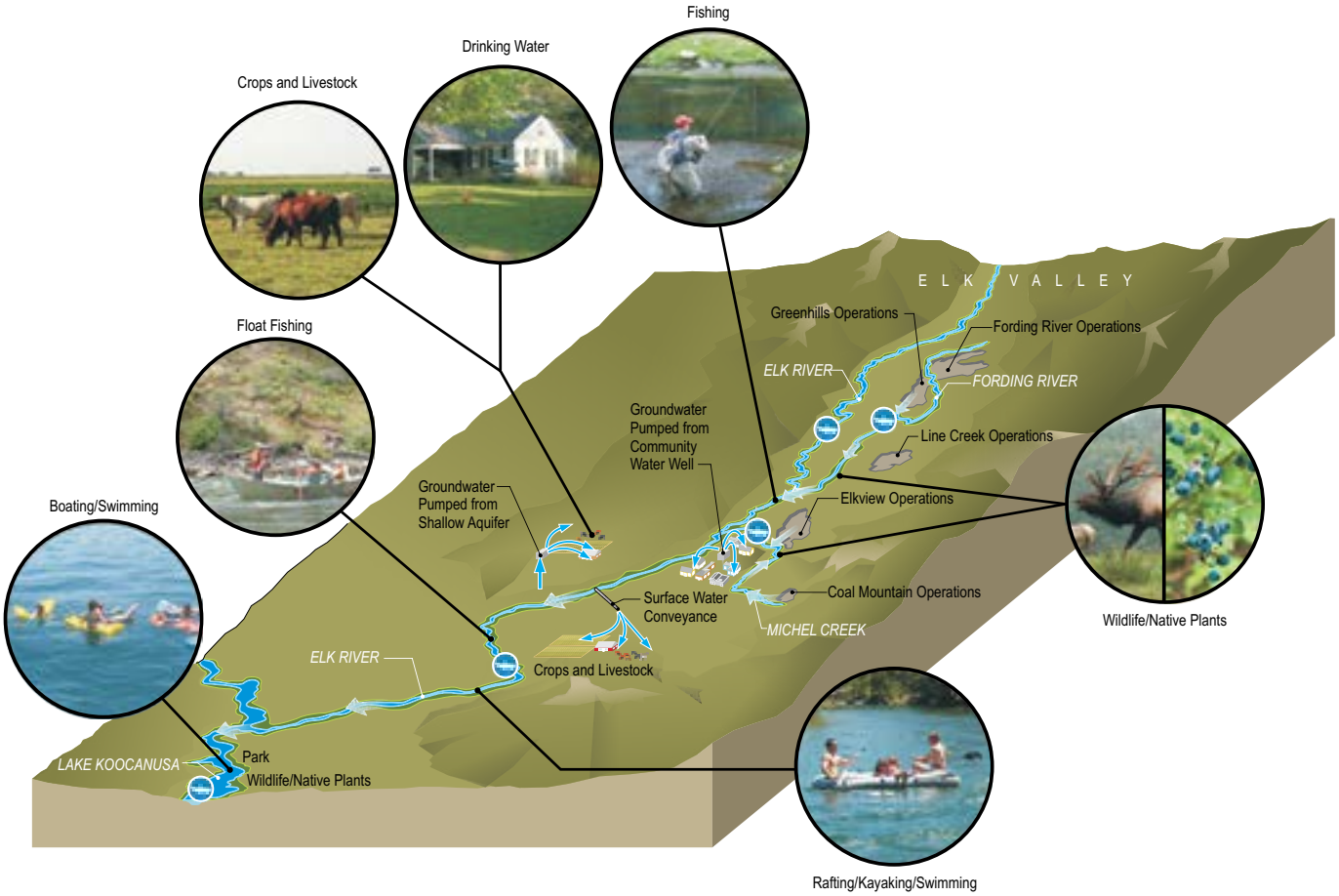

Figure 7-1. The HHRA must evaluate the human health risk associated with exposure to mine-related parameters from exposure pathways as reflected in this conceptual model of exposure pathways, including air.

Status

The Committee reviewed and provided input on the Terms of Reference for the HHRA in spring 2015, which was subsequently approved by Ministry of Environment and guided the work plan to complete the HHRA. Preliminary results were provided to the Committee for review and input throughout the HHRA process of the assessment. As required by Permit 107517, the HHRAwas submitted by March 31, 2016 to the Committee andMOE.

In spring 2016, some Committee members asked for more information to better understand the potential health risks to Ktunaxa Nation citizens from preferred consumption rates of country foods in the Elk Valley. A technical memorandum was submitted by Teck as supporting information to the HHRA to the Committee in mid-September 2016. The HHRA and supporting information is currently under review by the Committee.

Results

The following results are from the March 31, 2016 HHRA.

Groundwater

Shallow groundwater is the primary source of drinking water for communities in the Elk Valley.

- Groundwater currently used for drinking water does not present an unacceptable risk to human health.

District of Sparwood Wells

The District of Sparwood operates three wells adjacent to the Elk River. Two wells (#1 and #2) are not presently influenced by surface water under current pumping conditions. The third well (Well #3) appears to be influenced by surface water from the Elk River and/or Michel Creek, as indicated by increasing selenium concentrations that at times exceed provincial water quality guidelines. To address any concern of elevated selenium concentrations, the District of Sparwood has been operationally managing municipal water needs by taking Well #3 offline during these periods of time.

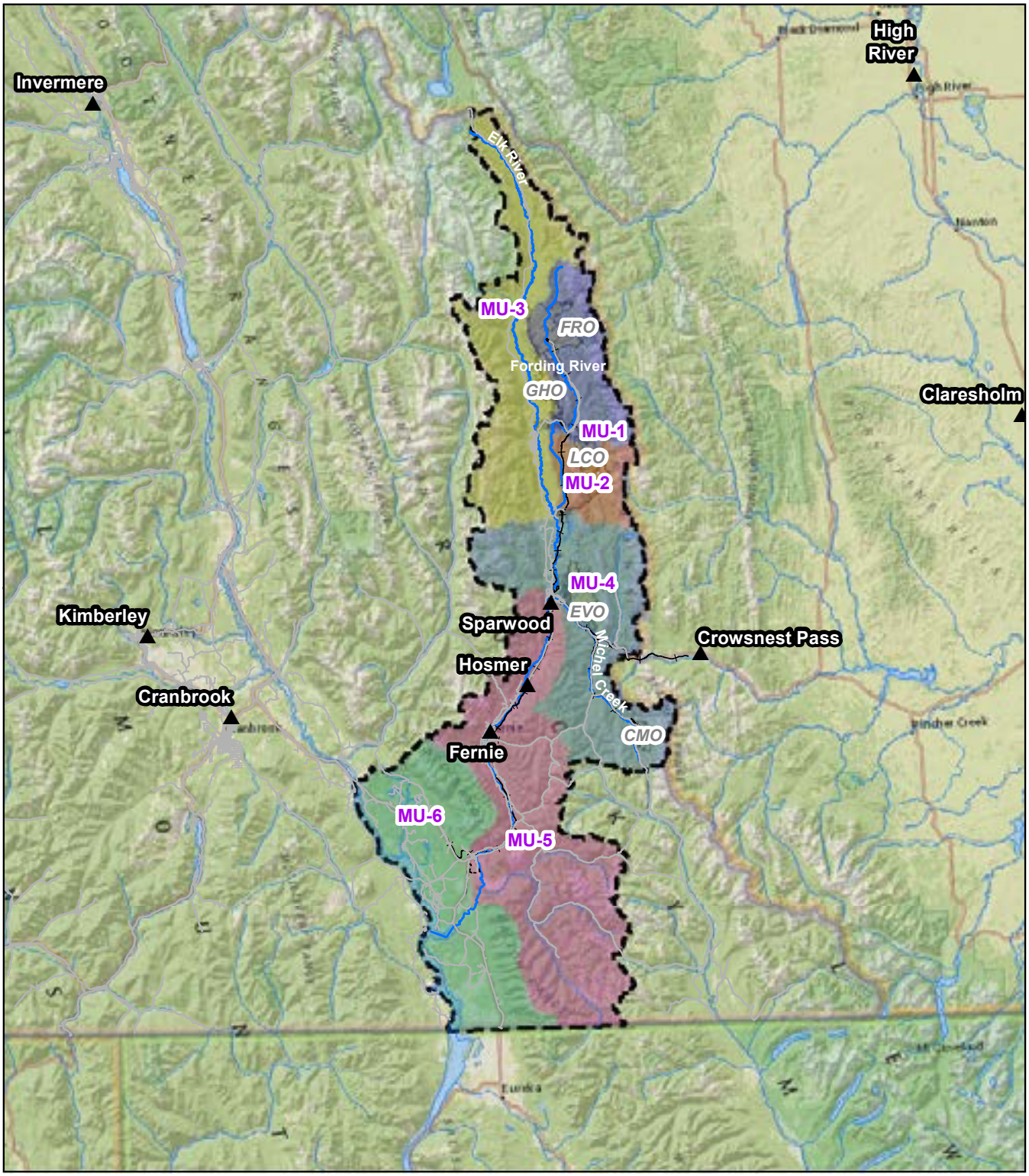

Figure 7-2. Management Units within the designated area.

Surface Water

Elk Valley surface water is used primarily for recreation (e.g., boating, fishing, and occasional swimming) with some drinking, irrigation, and industrial uses.

- Contact with surface water does not pose unacceptable risks to recreational and traditional activities.
- Use of surface water in MU-1 and MU-3 as primary sources of drinking water may pose a risk to infants due to the presence of nitrates.
- In MU-1 through MU-4, use of surface water as primary sources of drinking water may pose a risk based on concentrations of selenium (above British Columbia's Ministry of Environment's risk management threshold).

Sediment

Elk Valley residents may contact sediment in rivers (MU-1 through MU-5) or in the Koocanusa Reservoir (MU-6) while swimming or harvesting shoreline plants. All risks associated with sediment were well below the British Columbia Ministry of Environment risk management threshold. At this time, contact with sediment does not present a risk for Elk Valley residents.

Country Foods

Country foods included in this assessment: fish, berries, and game. As requested by some Committee members, evaluation of the preferred consumption rates of country foods in the Elk Valley was provided as supporting information to the HHRA in mid-September 2016. This information is currently under review by the Committee. As results of the HHRA and supporting information related to country foods are still under review by the Committee, a summary of the results is not provided at this time. It will be provided during the next update to the public on Committee activities in 2017.

Air and Soil

Based on current data, the exposure to mine-related contaminants and associated risks to human health resulting from soil contact and inhalation pathways are relatively insignificant.

What's Next

The HHRA is intended to inform the implementation of adaptive management actions required to address risks to human health from exposure to mine-related constituents. This is an ongoing process and data collected through the monitoring programs to address data gaps will be used to update risk characterization as part of the Adaptive Management Plan. See Section 8 for more on the Adaptive Management Plan for water quality.

8 Adaptive Management Plan

This section includes an introduction to adaptive management and provides an overview of the Adaptive Management Plan for the Elk Valley Water Quality Plan. The Adaptive Management Plan is intended to support the implementation of the Elk Valley Water Quality Plan by addressing key uncertainties associated with managing coal-mining operations in a manner consistent with the objectives of the Elk Valley Water Quality Plan.

What is Adaptive Management?

Adaptive management is a systematic approach to environmental management that maximizes learning about key uncertainties, while simultaneously striving to meet multiple management objectives and adapt management actions based on what is learned.

Adaptive management follows a six-stage cycle where the management problem is assessed; a solution is designed and implemented; the implementation and environment are monitored and evaluated; and adjustments are made where required. Adaptive management is an explicit focus on identifying and reducing key uncertainties that can affect management decisions. The six-stage adaptive management process is illustrated in Figure 8-1.

Context

Permit 107517 requires Teck to develop and implement an Adaptive Management Plan to support implementation of the Elk Valley Water Quality Plan to achieve water quality targets (including calcite targets) to ensure that human health and the environment are protected and, where necessary, restored, and to facilitate continuous improvement of water quality management in the Elk Valley. Permit 107517 specifies actions to be undertaken during each stage of the adaptive management cycle (Figure 8-1).

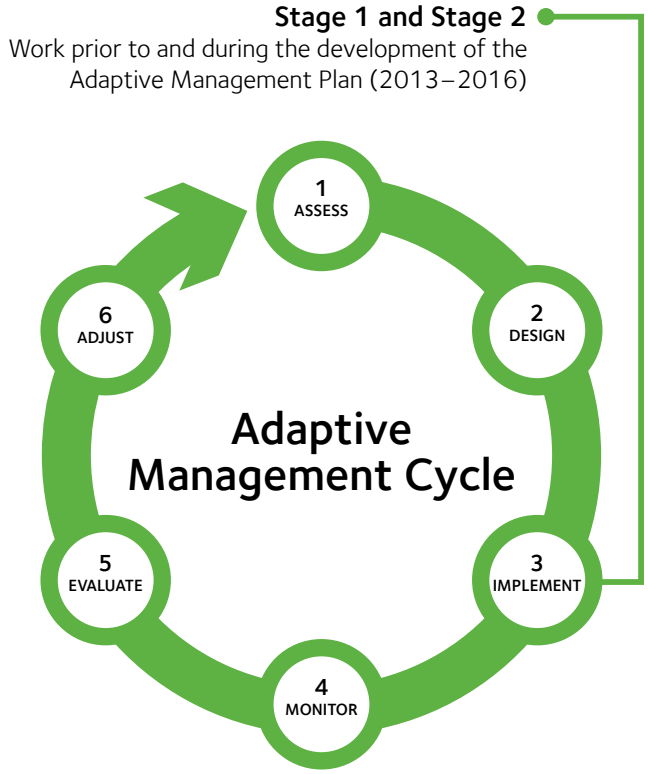

Figure 8-1. The adaptive management process provides opportunities for adjustments to management actions, monitoring programs, and evaluation processes where areas for improvement are identified.

The Adaptive Management Plan integrates all of the assessment, design, implementation, monitoring, and evaluation activities required to implement the Elk Valley Water Quality Plan into a comprehensive environmental management framework.

To facilitate the organization and communication of the proposed Adaptive Management Plan, six overarching environmental management questions were formulated, which are referred to as big questions in the Adaptive Management Plan:

1. Will water quality limits and Site Performance Objectives (SPOs) be met for selenium, nitrate, sulphate, and cadmium?

2. Will aquatic ecosystem health be protected by meeting the long-term Site Performance Objectives?

3. Are the combinations of methods for controlling selenium, nitrate, sulphate, and cadmium included in the implementation plan, the most effective for meeting limits and Site Performance Objectives?

4. Is calcite being managed effectively to meet Site Performance Objectives and protect aquatic ecosystem health?

5. Does monitoring for mine-related effects indicate that the aquatic ecosystem is healthy?

6. Is water quality being managed to be protective of human health?

Within the proposed Adaptive Management Plan there are activities that will be undertaken in order to evaluate and answer these questions. Key management uncertainties are also identified under each big question along with study designs to evaluate and reduce the uncertainties. Learnings from key uncertainty evaluations are intended to contribute to improvements to different stages of the adaptive management cycle.

A report documenting the activities undertaken in each stage of the Adaptive Management Plan must be submitted to MOE annually by July 31. The Adaptive Management Plan must be updated every three years. The first three-year update report is due July 31, 2019.

The Committee is required by Permit 107517 to provide technical advice related to the Adaptive Management Plan and to provide input on the Adaptive Management Plan annual reports.

Status

The first Adaptive Management Plan was submitted to the EMC on February 29, 2016, as required by Permit 107517. The Committee reviewed the Adaptive Management Plan and provided technical advice. A revised Adaptive Management Plan was submitted to the Committee on July 31, 2016.

EMC reviewed the revised Adaptive Management Plan and provided substantial advice as part of its review which concluded in September 2016. The Adaptive Management Plan is currently under review for a decision on acceptance by MOE . The KNC, Teck, and MOE are working to address the concerns about the Adaptive Management Plan that have been identified by the KNC.

What's Next

Permit 107517 requires Teck to submit a report annually on July 31, documenting its adaptive management activities. The Committee will be notified of any monitoring results and any changes to the Adaptive Management Plan.

When the Adaptive Management Plan is final (i.e., accepted by the Ministry of Environment), the Adaptive Management Plan will be updated, in consultation with the Committee, every three years. The first Adaptive Management Plan update is due July 31, 2019. The Adaptive Management Plan update will integrate information from Committee input as well as all relevant monitoring, risk assessments, research and management activities in the Elk Valley.

9 Water Quality Plan Updates

This section includes updates on water treatment and research and development. Permit 107517 does not require the Environmental Monitoring Committee to review or provide advice or input on these activities. Where adjustments to the Adaptive Management Plan include consideration of water treatment and research and development, the Environmental Monitoring Committee will be informed and consulted with as required by the permit.

Water Treatment at Teck's Elk Valley Coal Operations

What is Active Water Treatment?

Active water treatment has been proven to reduce constituents of interest (selenium, nitrate, cadmium, and sulphate) and is necessary to meet water quality targets in the short term. Active water treatment takes water into a treatment facility, removes unwanted constituents, and returns water back to the environment.

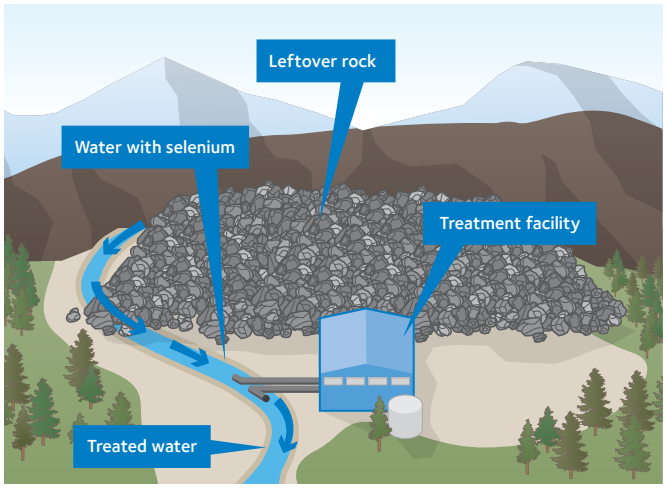

Figure 9-1. Active water treatment of mine-affected water.

Teck anticipates building five active water treatment facilities at its operations as part of its work to achieve the environmental management objectives of the Elk Valley Water Quality Plan.

The first of these facilities—the West Line Creek Active Water Treatment Facility—went into full operation in February 2016. The West Line Creek Active Water Treatment Facility treats water drawn in from Line Creek and West Line Creek at the Line Creek Operations site. Biological treatment technology is then used to precipitate selenium into a solid form that can be extracted from the water and safely disposed of in a secure onsite waste facility. The ability of the facility to meet its performance criteria is being assessed and will inform ongoing and future management of selenium.

Teck is now working to further refine operation of the facility to more consistently meet the target of treating 7,500 m3 per day on a regular basis. The second water treatment facility, which will be located at Fording River Operations, is currently in the permitting phase. This facility is being designed to stabilize selenium and nitrate concentrations in the upper Fording River. Construction is expected to begin in mid-2017, with full operation in 2019.

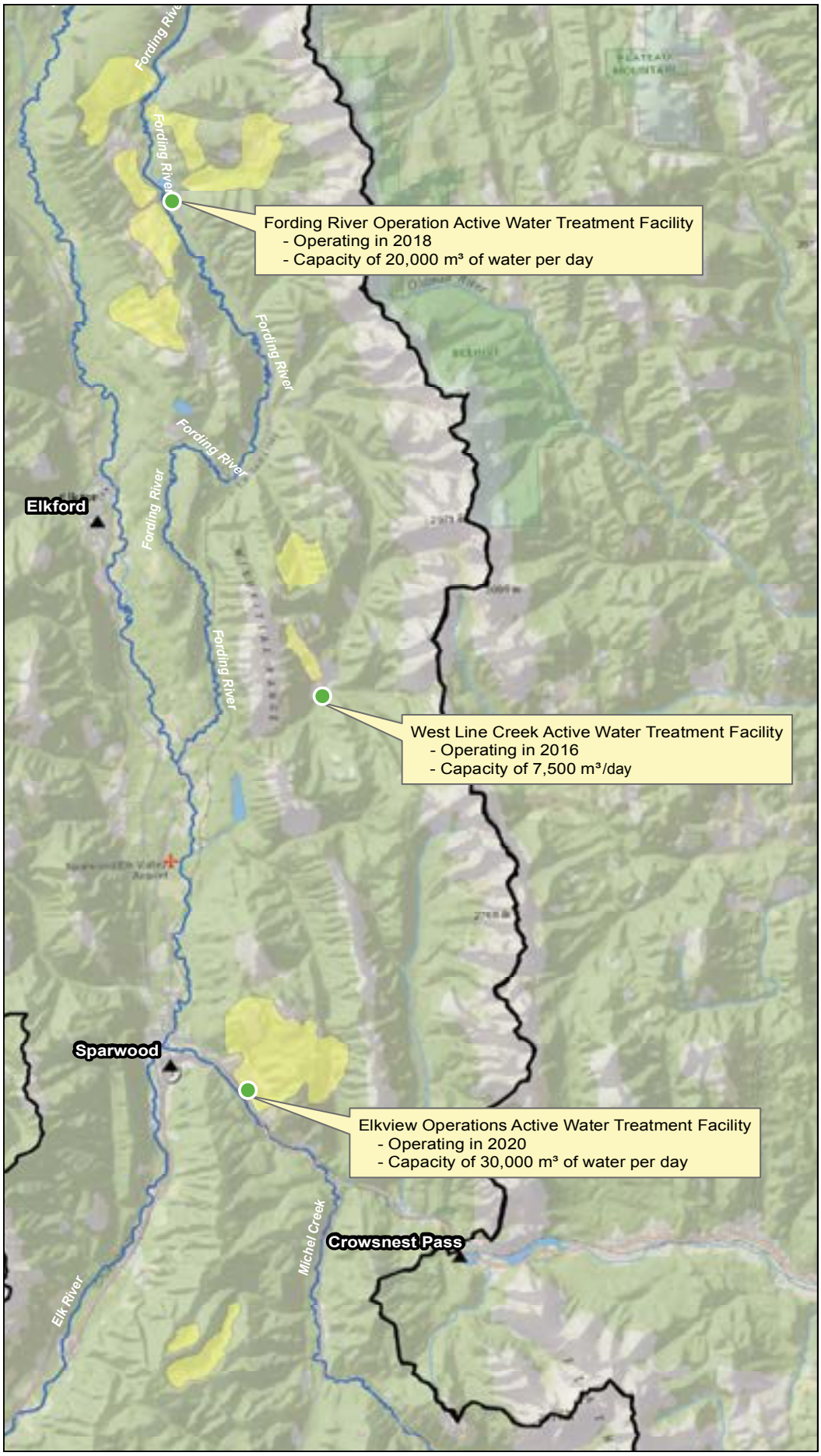

Figure 9-2. Location of the first three active water treatment facilities.

West Line Creek Active Water Treatment Facility Facts

- Treats up to 7,500 m3 of water per day—enough to fill three Olympic-sized swimming pools.
- Selenium concentrations are reduced by about 96% in treated water, to below 20 parts per billion.
- Nitrate concentrations are reduced by over 99% in treated water, to below 3 parts per million.
- Total construction cost of approximately $120 million.

Research & Development

Teck is conducting a Research and Development (R&D) Program to improve the effectiveness of water treatment technologies and water management strategies, as well as investigating potential long-term solutions for managing water quality at the source.

This R&D program has two major focus areas:

1. Source Control Applied R&D: investigating the sources of water quality constituents and examining how mine design changes could reduce the transfer of these substances into the watershed. More information about the areas of research under Teck's Source Control Applied R&D program is available at www.teck.com/elkvalley.

2. Water Treatment Technology: identifying and evaluating the effectiveness of different water treatment technologies, in addition to the water treatment technology already in use by Teck (see Water Treatment above).

Source Control Applied R&D

Teck's source control applied R&D program is conducted in cooperation with universities and consulting researchers in Canada and the United States, with a number of projects underway. In 2016, the primary focus of the R&D program has been on one of the most promising potential techniques for source control—saturated rock fills.

Saturated rock fills involve placing waste rock in mined out pits that are saturated with water. There are indications that under certain conditions, the movement of water through saturated fills can result in lower levels of selenium and nitrate, making them a potential option for treating mine-affected water. A full-scale saturated rock fill is now functioning at Teck's Cardinal River Operations in Alberta. Monitoring and testing is continuing through 2016, and data is being assessed to better understand the geochemical processes at work and to determine if results are potentially useful for future source control at Teck's Elk Valley operations.

Teck is also investigating approaches to improve blasting practices, including the use of different types of products, in order to reduce nitrate releases to the environment. This work has continued through 2016.

Water Treatment Technology

Teck continues to advance an active water treatment R&D program to identify the best water treatment technologies currently available to reliably treat mine-affected water at sites.

As part of this work, a pilot facility was established at the Fording River Operations (FRO) in order to choose the best technology to treat mine-impacted water at Fording River Operations in the planned Fording River Operations Active Water Treatment Facility. Phase 1 of the Fording River Operations pilot ran from July to December 2015, which resulted in the selection of a type of biological treatment technology—similar to that currently in use at the Line Creek facility—for Phase 2 testing through the first quarter of 2016.

Figure 9-3. The active water treatment facility at Teck's Line Creek Operations.

Glossary

Active water treatment	A method of removing constituents of concern from water that requires regular and / or frequent human intervention and management.
Acute toxicity	The adverse effects of a substance on an organism that result either from a single exposure or from multiple exposures in a short space of time.
Adaptive management	A systematic process for learning from management actions to confirm that a plan's objectives are being met and to adjust and improve management actions during implementation.
Alkalinity	A way to measure the ability of water to neutralize acid.
Aquatic organisms	Animals and plants that live in the aquatic environment.
Area based management plan	An environmental management plan for a designated area. The Elk Valley Water Quality Plan (EVWQP) is an approved area based management plan for managing water quality effects in the Elk Valley.
Average monthly maximum	The average of all samples collected in a calendar month at a sample location (from Permit 107517).
Baseline	Current or existing conditions (or a temporal period specifically defined to represent baseline [e.g., the year 2010]) and serves as a reference point to which future conditions can be compared. Unless otherwise noted, baseline refers to a surveyed or measured condition, rather than one predicted through the use of models.
BC MOE Risk Management Threshold	The level of risk to human health that is acceptable in BC. It is defined for carcinogenic and non-carcinogenic substances.
Benchmarks/screening benchmarks	A standard or point of reference against which things may be compared or assessed.
Benthic invertebrates	Organisms lacking backbones and that live in or on the bottom sediments of rivers, streams, and lakes. They include the larvae of aquatic insects, as well as clams, snails, mussels, crayfish, and various other kinds of aquatic worms.
Bioaccumulation	The accumulation of substances, including both toxic and benign substances, within the tissues of an organism.
Biological treatment	A method of treating water through the use of organisms such as bacteria and other microfauna.
Biota	The living organisms in an ecosystem.
Bryophytes	Seedless plants that include mosses and liverworts and play a vital role in regulating ecosystems.
Calcite index	A numeric expression of the extent and degree of calcite formation; typically given as a range from 0 to 3.0.
Calcite	A mineral composed of calcium, carbon, and oxygen. Calcite used in this assessment is from the carbonate class of minerals, and has the chemical formula CaCO3.
Chronic toxicity	Adverse effects on an organism as a result of long-term exposure to a toxicant or other stressor.

Compliance point	An effluent monitoring location specified in the EMA permit at which discharge limits apply.
Constituents of interest	An element or ionic compound that may pose a threat to ecological or human health when present at sufficient concentrations.
Control water	Water used in a toxicity test that has not been modified or impacted by mining.
Country foods	Foods that may be produced in an agricultural (not for commercial sale), backyard setting and/or harvested through hunting, gathering, and/or fishing activities.
Daily maximum	The maximum measurement in a 24-hour period (Permit 107517 has daily maximums, not average daily maximums).
Designated area	A portion of southeastern British Columbia that contains the Elk Valley and is geographically defined by the Order.
Discharge	The volume of water or effluent flowing past a point expressed as litres per second (L/s) or cubic metres per second (cms, or m3/s).
Effect benchmark	A concentration of a constituent in tissue that has been shown to produce effects on an organism.
Effluent	As defined by the Environmental Management Act, it is a substance that is introduced into water or onto land and that (a) injures or is capable of injuring the health or safety of a person, (b) injures or is capable of injuring property or any life form, (c) interferes with or is capable of interfering with visibility, (d) interferes with or is capable of interfering with the normal conduct of business, (e) causes or is capable of causing material physical discomfort to a person, or (f) damages or is capable of damaging the environment;
Elk River watershed	The area that includes the Elk River and all of its tributaries.
EMA/Environmental Management Act	The BC Law that regulates waste disposal to water, land, and air.
Exposed site/area/stream	Sites/areas/streams that are downstream of mining activities.
Exposure pathway	The physical mechanism whereby a constituent of interest comes into contact with an organism; typically includes ingestion and direct contact.
Food chain	A model that describes how nutrients and energy are passed from organism to organism.
Freshet	The increase in river and stream flows due to snow melt.
Gamete	Fish eggs that will be fertilized and raised.
Groundwater	That part of the subsurface water that occurs beneath the water table, in soils and geologic formations.

Hardness	Hard water has a high content of calcium and magnesium or other dissolved metals. It can form deposits similar to scale that forms on the bottom of a kettle. Calculated mainly from the calcium and magnesium concentrations in water, it originally developed as a measure of the capacity of water to precipitate soap. The hardness of water is environmentally important since it is inversely related to the toxicity of some metals (e.g., copper, nickel, lead, cadmium, chromium, silver, and zinc).
Human health risk assessment	A determination of possible impacts to human health from contaminants that considers both exposure to and toxicity of a contaminant.
LAEMP	Local area effects monitoring program
Larval life stage	Newly hatched and not fully developed stage of invertebrate animals. Normally there is a fundamental change in form that is required to get from a larval form to an adult form. Mayflies, stoneflies, and caddisflies, among many aquatic insects have larval forms that live in the water, while the adult and flying stages are more terrestrial (land based).
Management unit	A portion of the Designated Area specified for water quality management purposes.
Market foods	Food purchased from a commercial setting.
Non-point source	A source of pollution that enters the environment at multiple locations (e.g., agricultural runoff from fields).
Opportunistic sampling	Collection of a sample at irregular intervals. For fish, this means a sample will be collected if they are caught in the course of other work.
Order (the)	A directive issued by the BC Minister of Environment in April 2013 requiring Teck to develop an area based management plan (also known as the Elk Valley Water Quality Plan).
Order station	A monitoring location specified by the Order to monitor water quality in the Designated Area.
Periphyton	Algae, bacteria, and other associated microorganisms attached to a submerged surface.
Phytoplankton	Microscopic algae that live in the water column, and are food for zooplankton and fish.
Point source	A source of pollution that enters the environment at only one place (e.g., the end of a pipe).
Potable water	Water that is safe to drink.
Primary productivity	Growth of algae and other aquatic plants.
Productivity	A technical term for the amount of plant or animal matter that is grows in a year on a per unit area (i.e., a square meter) basis.
Reach	A section of stream that is typically a minimum of 100 metres in length.
Receiving environment	Bodies of water that receive runoff/effluent of wastewater discharges, such as streams, rivers, ponds, and lakes.

Reference stream	A watercourse that is not affected by point sources of contamination; used to compare the effects of mining activity on constituents of interest and calcite formation.
Regional Aquatic Effects Monitoring Program (RAEMP)	A long-term monitoring program to assess potential effects in the aquatic environment downstream of mining operations within the Elk River watershed.
Rehabilitation	Improving habitat for aquatic organisms.
Restoration	Improving habitat for aquatic organisms so it has been returned to an un-impacted state.
Site performance objective	An authorization limit or standard applicable to the receiving environment and imposed by the statutory decision maker (e.g., MoE Director) that may be an adopted guideline or site specific water quality objective, or another limit set by the statutory decision maker after weighing multiple factors.
Toxicity test	A test to determine how a certain concentration of a constituent–selenium, nitrate, sulphate and cadmium– affects the survival and reproduction of a specific species.
Trend analysis	An analysis of data that determines if variations in monitored endpoints (concentrations of chemicals for instance) are increasing or decreasing over time.
Variance analysis	An analysis of data that determines if variations in data (e.g., concentrations of chemicals for instance) are likely to be meaningful, or are otherwise related to various other factors (e.g., mine operations, land cover).
Water quality guideline	The concentration of a constituent of concern developed to protect ecological or human health; may be federal or provincial.
Water quality limits	A water quality concentration specified by EMA Permit 107517 that BC MOE requires Teck to meet. Includes both Site Performance Objectives and compliance limits.
Zooplankton	Small invertebrates that live in the water column and are a food source for many fish species.