# Elk Valley Water Quality Plan

**2022 Implementation Plan Adjustment**

**July 2022**

Teck

# List of Authors and Contributors

The preparation of the 2022 Implementation Plan Adjustment (IPA) has been a collaborative effort between Teck staff and technical consultants, with engagement from BC Ministries and Ktunaxa Nation Council (KNC):

**Teck Staff**

Adrienne Bangsund, Lead, Research and Development
Christian Baxter, Director, Environmental Strategy
Kristina Birk, Water Quality Engineer in Training
Thomas Davidson, Superintendent, Water Operations
Mark Digel, Director, Environmental Science
Lucy Eykamp, Manager, Regulatory Approvals
Carla Fraser, Director, Water
Matt Gay, Program Director, Water Strategy
Alberto Gonzalez, Principal Metallurgist, Technical Services
Cameron Griffin, Senior Lead Projects
Holly Hetherington, Coordinator, Adaptive Management
Sarah House, Manager, Aquatic Sciences
Liz Karbashewski, Manager Research & Development
Dennis Kramer, Manager, Water Sciences
Adam Langer, Director, Water Projects
Jessica Mackie, Manager, Water Modelling
Nick Manklow, Senior Lead, Aquatic Sciences
Vanessa Mann, Lead, Research and Development
Collin Miller, Program Director, Water Projects and Operations
Jared Miner, Manger, Water Projects
Shireen Ouellet, Senior Scientist, Adaptive Management
Dean Runzer, General Manager, Water Quality
James Sandland, Regional Director, Government Affairs
Robin Sidsworth, Acting Director, Indigenous and Government Affairs
Amanda Thumma, Manager, Water Integrated Planning

**Consulting Team**
J.P. Bechtold, WSP Golder
Adrian de Bruyn, ADEPT
Rachel Hodgson, ESSA
Carol Murray, ESSA
Amanda Snow, WSP Golder

# Technical Executive Summary

**Introduction**

Teck Coal Limited (Teck) operates four steelmaking coal mines in the Elk Valley in southeast British Columbia: Fording River Operations (FRO), Greenhills Operations (GHO), Line Creek Operations (LCO), and Elkview Operations (EVO), with Coal Mountain mine (CMm) currently in care and maintenance. In this region, the geological formations are such that the steelmaking coal occurs as layers or seams within other sedimentary rock. To access the steelmaking coal, waste rock that surrounds the steelmaking coal seams is mined and placed in spoils within and adjacent to the mined pits. Water from precipitation and runoff flows over and through the waste rock, mobilizing and transporting chemical constituents, including selenium, sulphate, nitrate and cadmium, into the local watersheds and downstream into the Fording River and Elk River.

In April 2013, the British Columbia (BC) Minister of Environment issued Ministerial Order No. M113 (Order), which required Teck to prepare an area-based management plan for the Elk River watershed and the Canadian portion of the Koocanusa Reservoir. In this plan, Teck was required to identify the actions Teck would take to manage water quality downstream of our steelmaking coal mines in the Elk River watershed and the Canadian portion of the Koocanusa Reservoir.

From 2013 to 2014, Teck developed the area-based management plan, called the Elk Valley Water Quality Plan (EVWQP). Teck had input from the public, Indigenous Nations, provincial and federal governments, technical experts, and other Communities of Interest (COI). Teck submitted the EVWQP to the Minister in July 2014 and it was approved in November that same year. The EVWQP included an Initial Implementation Plan (IIP) that outlines the mitigation planned to achieve limits for the concentration of selenium, sulphate, nitrate, and cadmium in surface water at specific locations throughout the Elk Valley and in the Koocanusa Reservoir. These limits, both short-term and long-term, are meant to stabilize and reverse increasing concentrations of the four constituents named in the Order.

In November 2014, the BC Ministry of Environment issued Permit 107517 to Teck under the *Environmental Management Act* (EMA). Many of the actions and commitments that Teck made in the EVWQP IIP were incorporated into the permit requirements. To be in compliance, Teck must meet the requirements in the EMA Permit 107517, including the construction and operation of treatment facilities on the timelines specified and achievement of water quality limits. At the same time, site-specific *Mines Act* C-Permits were amended to include a condition for an Implementation Plan Adjustment (IPA) to be submitted to the Chief Inspector on a three-year cycle.

**Regulatory Context**

The 2022 IPA is prepared in accordance with EMA Permit 107517 and *Mines Act* C-Permit requirements to update the IPA on a 3-year cycle. This one is due July 31, 2022 and is intended to replace the 2019 IPA. The objective of this plan is to outline the timing and sizing of treatment and other water quality mitigations that support the objectives of the EVWQP and to best meet EMA Permit 107517 commitments based on our latest understanding and progress.

**Compliance Limits and SPOs**

When approving the EVWQP in 2014, BC Ministry of Environment issued EMA Permit 107517 to Teck, which established Site Performance Objectives (SPOs) and compliance limits for the management of water quality concentrations for cadmium, selenium, nitrate and sulphate in the Elk Valley. SPOs were set at Order stations to achieve and maintain area-based protection of aquatic ecosystem health, whereas compliance limits were set at or near the downstream boundary of each operation to measure regulatory compliance at specified compliance point locations. Compliance limits were set such that, if all the compliance limits were met, the SPOs were also expected to be met. These SPOs and compliance limits are collectively referred to as water quality limits in this document. The locations of the Order stations and compliance points, as well as existing treatment facilities (active water treatment facility [AWTF] and Saturated Rock Fill [SRF]) and their respective design hydraulic capacity, are illustrated on Figure E.1.

Long-term water quality limits were developed for selenium, nitrate, sulphate and cadmium using a comprehensive process in order to protect the aquatic ecosystem in the Elk Valley. Short- and medium-term limits were set to track progress towards the long-term limits recognizing the long-term limits would take time to be achieved. The timing and magnitude of the step-downs for the compliance limits and SPOs included in EMA Permit 107517 were developed based on the 2014 RWQM and the IIP water treatment schedule.

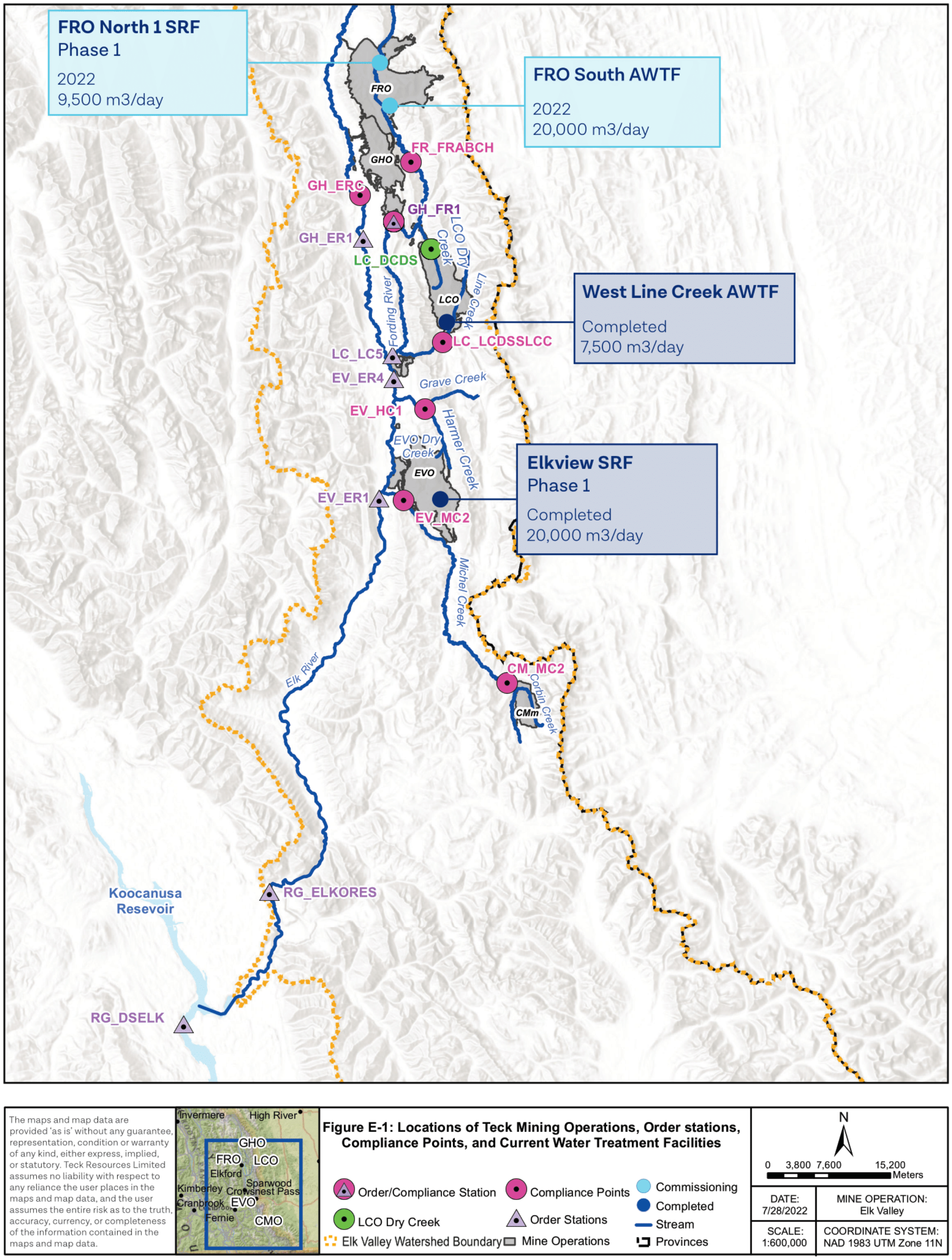



Figure E.1: Locations of Teck Mining Operations, Order stations, Compliance Points, and Current Water Treatment Facilities

**Adaptive Management**

Water quality management at Teck is structured around the six steps of the adaptive management cycle (Figure E.2) as described in the Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley (AMP). The AMP contains a set of Management Questions (MQs), the answers to which will be evaluated at regular intervals to assess Teck's progress towards achieving the objectives of the EVWQP. Water quality management is the focus of MQ 1 *Will water quality limits and site performance objectives be met for selenium, nitrate, sulphate and cadmium?* and MQ 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?* The AMP guides the process for updating the IPA: evaluating the answer to MQ 1 and identifying necessary adjustments to the IPA. Adjustments are informed by learnings from the 2020 RWQM, the evaluation of mitigation technologies under Teck's R&D program, and the reduction of key uncertainties (KUs).

Key adjustments that informed the 2022 IPA include:

- the addition of SRF as a water treatment technology option
- advancing timing of selenium and nitrate treatment into the 10-year timeframe to meet compliance as soon as possible
- the inclusion of sulphate water treatment
- updated water quality projections from the 2020 RWQM which incorporate new learnings around groundwater and constituent release mechanisms from new spoils

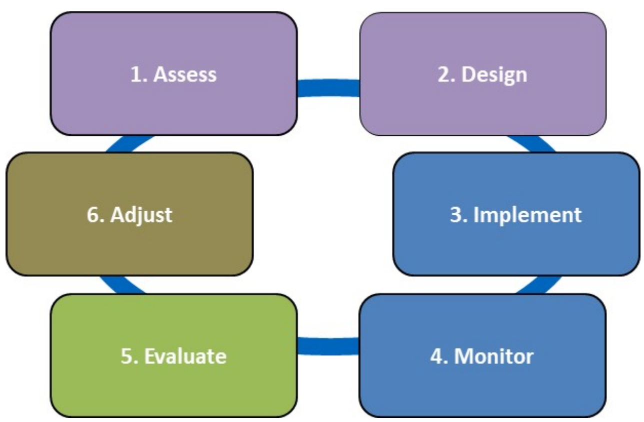



Figure E.2: The Adaptive Management Cycle

**Scope**

Water quality constituents included in the 2022 IPA are nitrate, selenium and sulphate. Cadmium treatment is not required as measured and projected concentrations are well below SPOs and compliance limits.

The spatial scope of the IPA matches the spatial scope of the EVWQP, covering the Designated Area which includes the Elk River watershed and Koocanusa Reservoir to the international boundary, and incorporating the same subdivision into Management Units (MUs) which are based on geographic features, major tributaries and hydrodynamic characteristics that were used in the EVWQP. The temporal scope of the IPA is inclusive of the full effects of the permitted mining activities at Teck's operations. The three key inputs into the IPA are the 2020 RWQM, site permitted mine plans, and site water management plans.

**Consultation and Engagement**

Teck sought early input from the B.C. Ministry of Energy, Mines and Low Carbon Innovation (EMLI), B.C. Ministry of Environment and Climate Change Strategy (ENV), and representatives of the Ktunaxa Nation Council (KNC) on the 2022 IPA through several pre-submission engagements and other communications that began in 2021. The 2022 IPA incorporates feedback received from ENV, EMLI and KNC during a series of pre-submission engagements between April 2021 to February 2022. The 2022 IPA also incorporates a plan for outreach with additional Indigenous groups, government agencies and stakeholders

**Research and Development**

Teck's Research and Technology Development (R&D) program was initiated in 2012 and is a requirement stipulated in Sections 8 and 11 of the EMA Permit 107517 first issued by ENV in 2014. One of Teck's objectives for the R&D program is to reduce key uncertainties (KUs) identified in the AMP in order to identify, develop and implement new technologies and/or enhance existing technologies with the end goal of reducing long-term reliance on active water treatment.

Teck is continually researching new technology to support remaining within water quality limits more efficiently. AWTFs (tank-based biological treatment), supported by clean water diversions (CWDs) were identified in the EVWQP as mitigation tools to achieve compliance. In April 2022, SRF technology (also biological treatment), was approved for use for planning purposes.

**Water Operations and Existing Treatment**

Since 2014, Teck has made significant progress on implementing water treatment in the Elk Valley with four water treatment facilities built and either fully operational or in commissioning. The existing treatment facilities and clean water diversions in operation and their maximum design capacity are outlined in respectively in Table E.1 and Table E.2 below.

**Table E.1: Water Treatment Facilities as of the End of 2022**

| Treatment Facility | Operational Date [1] | Hydraulic Capacity Up To ($m^3$/day) |
|---|---|---|
| LCO WLC AWTF | In place and operating | 7,500 |
| EVO SRF Phase I | In place and operating | 20,000 |
| FRO AWTF-S | Sept. 1, 2022 | 20,000 |
| FRO-N 1 SRF Phase I | Dec. 31, 2022 | 9,500 |

[1] The operational date is the date when facility commissioning activities are completed.

**Table E.2: Operating Clean Water Diversions as of the End of 2022**

| Clean Water Diversion | Associated Water Treatment Facility | Operational Date | Streams and Volume Diverted |
|---|---|---|---|
| FRO Kilmarnock Creek | FRO-S AWTF | In place and operating | Upper Kilmarnock Watershed, up to 86,000 $m^3$/d |
| EVO South Gate Creek | EVO SRF | In place and operating | South Gate Creek, up to 3,500 $m^3$/d |

### Updating the Implementation Plan

The process for updating the IPA is iterative and is informed by the evaluation under MQ 1 and MQ 3. The RWQM is the tool used to support the development of the water quality mitigation plans and the first step in this process was the update and submission of the 2020 RWQM (required 3-year update). At the time of submission of the 2020 RWQM, compliance was evaluated using the treatment plan from the 2019 IPA, and an adjustment to the implementation plan was determined to be required. Mitigation technologies to be included in the plan were evaluated (considering which technologies from the R&D program are sufficiently advanced to incorporate) and the 2020 RWQM was adjusted to accommodate changes to permitted mine plans, water management plans, mitigation planning basis and assumptions. This is an iterative process, where various mitigation scenarios are run through the RWQM to determine appropriate adjustments to mitigation timing and capacity. Selenium and nitrate mitigation was determined first, followed by sulphate mitigation. The application of mitigation measures included the assessment of sources targeted for treatment as well as the sequence, location, timing and capacity of mitigation. Through this process, learnings since the completion of the 2019 IPA and the reduction of key uncertainties (KUs) are incorporated.

### Mitigation Technologies

The evaluation of new and emerging water treatment technologies and source control measures allows the identification of effective mitigation technologies for inclusion in the IPA. An iterative evaluate-adjust loop exists between evaluating the technologies in the R&D Program, incorporating understanding from supporting studies, and adjusting the IPA through the adaptive management framework.

Updating the IPA involves reviewing the mitigation technologies in the current IPA and considering which technologies from the R&D program are sufficiently advanced to incorporate into Teck's toolbox to be considered for use in the IPA update. The following water treatment technologies have been evaluated through this process and are the basis for the 2022 IPA

Tank-based active water treatment facilities (AWTF) and non-tank-based facilities called Saturated Rock Fills (SRFs) are the current water quality treatment technologies included for selenium and nitrate in the 2022 IPA and are supported, where appropriate with clean water diversions (CWDs). AWTF use a biological treatment process that removes nitrate from mine affected water and transforms selenium into a solid using tank-based technology. The dissolved selenium in the water is extracted while the nitrate is turned into nitrogen gas and released. The treated water is then discharged. SRFs use a naturally occurring biological process to treat selenium and nitrate. Former mine pits are backfilled with rock and saturated with mine affected water. Natural bacteria then convert the dissolved selenium into a solid which is stored in the rock fill and the nitrate into inert nitrogen gas which is safely released. The treated water is then pumped from the SRF back into the environment. CWDs are implemented to redirect streamflow before it interacts with mined rock and are being studied to evaluate the effects on constituent release.

*Sulphate Treatment*

The 2022 IPA is the first to include sulphate treatment and the technology selected is a Membrane – High Density Sludge (HDS) process. In 2021, Teck piloted two commercially demonstrated technologies to understand how the treatment would work in the Elk Valley. Test results from the pilot programs provided input to technology selection and the overall process design package that will be used to support engineering design and permitting for full-scale implementation.

**Water Mitigation Project Development and Permitting Process**

The 2022 IPA is a guide to identify the operational date, sources for treatment, and preliminary capacity of the individual water mitigation projects required to support the EVWQP which are then executed in alignment with the plan and adjusted based on site specific considerations and knowledge gains through the project execution.

**2022 Implementation Plan Adjustment**

The mitigation outlined in the 2022 IPA is expected to result in the stabilization and reduction of nitrate and selenium concentrations at the compliance points and Order stations in the Elk Valley and the stabilization of sulphate concentrations. The 2022 IPA includes an accelerated mitigation implementation schedule over the next five years to support requirements of EMA Permit 107517 and additional mitigation to maintain long-term nitrate, selenium and sulphate compliance at compliance points and Order stations.

The 2022 IPA was developed based on learnings and advances in understanding since the development of the EVWQP. It is based on the application of biological water treatment through the continued operation of Teck's two AWTFs and two SRFs with the support of the Kilmarnock Creek and EVO South Gate Creek CWDs, as well as planned future water treatment to manage selenium, nitrate and sulphate concentrations in the Elk Valley. The 2022 IPA has a total of 206,500 $m^3$/day of selenium and nitrate treatment and 38,000 $m^3$/day of sulphate treatment. Treatment timing and capacity for selenium and nitrate is provided in Table E.3 and sulphate is provided in Table E.4. Clean water diversions included in the 2022 IPA that are currently operating are listed in Table E.2 and future diversions are listed in Table E.5.

Adjustments included in the 2022 IPA since the development of the 2019 IPA were identified through an iterative process and inform the answer to MQ 1, which is *Will limits and SPOs be met for selenium, sulphate, nitrate and cadmium*? The primary objectives guiding the adjustments in the 2022 IPA were to

Adjustments included in the 2022 IPA since the development of the 2019 IPA were identified through an iterative process and inform the answer to MQ 1, which is *Will limits and SPOs be met for selenium, sulphate, nitrate and cadmium*? The primary objectives guiding the adjustments in the 2022 IPA were to maintain compliance with SPOs and compliance limits, where compliance is currently being achieved, and to achieve compliance as soon as feasible in areas where SPOs and compliance limits are not currently consistently achieved. The majority of the adjustments were required to address changes in future water quality projections due to an improved understanding of flow and load in the system (particularly in groundwater pathways) and to compensate for the delays in the commissioning date of the FRO AWTF-S that resulted from the time required to understand and develop a solution for selenium bioaccumulation and speciation at WLC AWTF. Adjustments were also required to accommodate the addition of new water treatment technologies (SRFs and sulphate treatment) and the inclusion of mitigation in areas that were not included in the 2019 IPA. These combined factors resulted in changes in the planned treatment timing at FRO, with more selenium and nitrate treatment capacity sooner compared to the 2019 IPA.

The 2022 IPA also includes mitigations for LCO Dry Creek as per the LCO Dry Creek Water Management Plan, and two Best Achievable technology (BAT) assessments completed in early 2022 for LCO Dry Creek. This mitigation includes Conveyance & Supplementation (C&S) between LCO Dry Creek and the Fording River of up to 30,000 $m^3$/day and then future treatment via the LCO NLC SRF Phase I. Provincial and federal permit applications required for C&S have been submitted and are currently in the regulatory review process. However, the permitting review process has resulted in an approximate delay of 1 year from the first quarter (Q1) of 2023 operational timing included in the 2022 IPA to Q1 2024 (subject to receipt of all approvals). Due to the timing of when these delays were realized, Teck has not been able to update the water quality modelling in time to support the July 31 submission date for 2022 IPA. As such, the Q1 2023 operational date for C&S and associated modelling results has been retained in the 2022 IPA; Teck is currently updating the water quality modelling to reflect a Q1 2024 operational date (subject to receipt of approvals) for C&S and will provide that information as an update to the BAT assessments for LCO Dry Creek after the 2022 IPA submission.

**Table E.3: Selenium and Nitrate Treatment Timing and Capacity in the 2022 IPA**

| Water Treatment Facility | Operational Date [1] | Hydraulic Capacity Up To ($m^3$/d) |
|---|---|---|
| LCO WLC Phase I | December 31, 2018 | 6,000 |
| LCO WLC Phase II | January 1, 2020 | 1,500 |
| EVO SRF Phase I | September 1, 2021 | 20,000 |
| FRO South AWTF (FRO-S) | September 1, 2022 | 20,000 |
| FRO North (FRO-N) 1 SRF Phase I | December 31, 2022 | 9,500 |
| EVO SRF Phase II (Dry Creek) [2] | September 30, 2023 | 4,000 |
| FRO-N 1 SRF Phase II | December 31, 2023 | 20,500 |
| FRO-N 1 SRF Phase III | December 31, 2025 | 10,000 |
| LCO North Line Creek (NLC) SRF Phase I [3] | December 31, 2025 | 12,500 |
| FRO-N 2 SRF Phase I | December 31, 2026 | 20,000 |

**Table E.3: Selenium and Nitrate Treatment Timing and Capacity in the 2022 IPA**

| Water Treatment Facility | Operational Date [1] | Hydraulic Capacity Up To ($m^3$/d) |
|---|---|---|
| EVO SRF Phase III | December 31, 2027 | 15,000 |
| GHO Greenhills Creek [4] | December 31, 2027 | 3,000 |
| LCO NLC SRF Phase II | December 31, 2030 | 10,000 |
| LCO NLC SRF Phase III | December 31, 2033 | 17,500 |
| FRO Eagle 6 SRF Phase I | June 30, 2033 | 6,500 |
| EVO SRF Phase IV (Dry Creek) [2] | December 31, 2036 | 3,000 |
| GHO Cougar South Pit SRF | June 30, 2042 | 5,000 |
| EVO Burnt Ridge SRF Phase I | December 31, 2042 | 5,000 |
| FRO Eagle 6 SRF Phase II | +2090 | 2,500 |
| FRO-N 2 SRF Phase II | +2110 | 15,000 |
| **Total Hydraulic Capacity Up To ($m^3$/d)** | | **206,500** |

[1] The operational date is the date when facility commissioning activities are completed.

[2] Mitigation included in the 2022 IPA for EVO Dry Creek is for future permitted waste rock that was assessed and approved under the Baldy Ridge Extension (BRE) Environmental Assessment Certificate (EAC) and EVO C-2 *Mines Act* permit amendment that has not yet been placed in the EVO Dry Creek watershed. As a condition of the BRE EAC, Teck is required to prepare a Dry Creek and Harmer Creek Water Quality Management Plan 90 days prior to placement of waste rock in Dry Creek to show compliance with the Harmer Compliance Point and the treatment, capacity and timing outlined here may change as a result of that plan.

[3] Selenium and nitrate treatment of LCO Dry Creek is currently planned via LCO NLC SRF, ongoing engagement on the overall LCO Dry Creek proposed mitigation plan may result in changes to treatment, capacity, and timing from what is included in the 2022 IPA.

[4] ECCC Federal Direction (October 2020) requires a design treatment capacity of at least 7,500 $m^3$/d for selenium removal to be completed construction by December 31, 2026 and operational by the date specified in this table. The capacity included in the 2022 IPA is what is required to support compliance with the water quality limits in EMA Permit 107517 as it is acknowledged that Greenhills will not be able to treat to the full 7,500 $m^3$/day at all times of the year, so will be seasonally limited by lower flows.

**Table E.4: Sulphate Treatment Timing and Capacity in the 2022 IPA**

| Water Treatment Facility | Operational Date [2] | Hydraulic Capacity Up To ($m^3$/d) |
|---|---|---|
| LCO Phase I | December 31, 2025 | 2,500 |
| FRO-S | December 31, 2026 | 8,500 |
| LCO Dry Creek Phase I | December 31, 2029 | 2,500 |
| FRO-N | December 31, 2030 | 12,500 |
| LCO Phase II | December 31, 2030 | 2,500 |
| LCO Dry Creek Phase II | December 31, 2032 | 2,500 |
| EVO Dry Creek Phase I [1] | December 31, 2033 | 2,500 |
| LCO Dry Creek Phase III | December 31, 2037 | 2,500 |
| EVO Dry Creek Phase II [1] | December 31, 2038 | 2,000 |
| **Total Hydraulic Capacity ($m^3$/d)** | | **38,000** |

[1] Mitigation included in the 2022 IPA for EVO Dry Creek is for future permitted waste rock that was assessed and approved under the Baldy Ridge Extension (BRE) Environmental Assessment Certificate (EAC) and EVO C-2 *Mines Act* permit amendment that has not yet been placed in the EVO Dry Creek watershed. As a condition of the BRE EAC, Teck is required to prepare a Dry Creek and Harmer Creek Water Quality Management Plan 90 days prior to placement of waste rock in Dry Creek to show compliance with the Harmer Compliance Point and the treatment, capacity and timing outlined here may change as a result of that plan.

[2] Sulphate treatment is seasonal (August through April) at all locations except LCO Dry Creek where sulphate treatment is estimated to be required all year.

**Table E.5: Future Clean Water Diversion Timing and Capacity in the 2022 IPA**

| Clean Water Diversion | Associated Water Treatment Facility | Operational Date | Streams and Volume Diverted |
|---|---|---|---|
| Upper Line Creek, Horseshoe and No Name Creeks [1] | LCO NLC SRF | December 31, 2025 | Upper Line Creek and Horseshoe Creek estimated at 35,000 $m^3$/d. No Name Creek estimated at 7,000 $m^3$/d. Total estimated capacity of up to 42,000 $m^3$/d. |

[1] The efficacy of the CWDs at LCO are being evaluated with the next phase of treatment at this operation and adjustments to the diversion strategy may be made based on feasibility and environmental effects.

### Compliance Evaluation

The mitigation outlined in the 2022 IPA results in the stabilization and reduction of selenium and nitrate concentrations in the Elk Valley. Compliance for nitrate and selenium is currently achieved and is projected to be maintained at the Elk River upstream of Boivin (GH_ER1; E206661) and the Elk River at Elko Reservoir (RG_ELKORES; E294312) Order stations and at the following compliance points: GHO Elk River Compliance Point (GH_ERC; 300090), EVO Harmer Creek Compliance Point (EV_HC1; E102682), CMm Compliance Point (CM_MC2; E258937), and the EVO Michel Creek Compliance Point (EV_MC2; E300091). Selenium and nitrate concentrations will be at or below SPOs and compliance limits at all seven Order stations and all seven compliance points following the commissioning of the FRO-N 1 SRF Phases II and III, FRO-N 2 SRF Phase I, the LCO NLC SRF Phase I and the EVO SRF Phase III and earlier in LCO Dry Creek following commissioning of conveyance and supplementation (C&S). As these treatment facilities are commissioned selenium and nitrate concentrations decrease and compliance is projected to be achieved in varying years, as summarized below in Table E-6.

**Table E.6: Summary of Projected Timing for Nitrate and Selenium Compliance with EMA Permit 107517**

| Type | Location | Compliance Projected to be Achieved by | | Response Summary Name under the AMP |
|---|---|---|---|---|
| | | Nitrate | Selenium | |
| Order Station | Fording River downstream of Greenhills Creek (GH_FR1; 0200378) [1] | Mid-2023 onward | Mid-2025 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | Fording River downstream of Line Creek (LC_LC5; 0200028) | In compliance | Mid-2026 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | Elk River upstream of Grave Creek (EV_ER4; 0200027) | Mid-2027 onward | 2026 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | Elk River downstream of Michel Creek (EV_ER1; 0200393) | Mid-2025 onward | In compliance | Elk and Fording rivers water quality exceedances (Order stations) |

**Table E.6: Summary of Projected Timing for Nitrate and Selenium Compliance with EMA Permit 107517**

| Type | Location | Compliance Projected to be Achieved by | | Response Summary Name under the AMP |
|---|---|---|---|---|
| | | Nitrate | Selenium | |
| | Koocanusa Reservoir downstream of the Elk River (RG_DSELK; E300230) | In compliance | Mid-2027 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| Compliance Point | FRO Compliance Point (FR_FRABCH; E223753) | Mid-2028 onward | Mid-2027 onward | FRO Fording River water quality exceedances |
| | GHO Fording River Compliance Point (GH_FR1; 0200378) [1] | Mid-2027 onward | Mid-2025 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | LCO Compliance Point (LC_LCDSSLCC; E297110) | 2026 onward | 2026 onward | LCO Line Creek water quality exceedances |
| LCO Dry Creek [2] | LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210) | Mid-2024 onward | Mid-2023 onward | LCO Dry Creek water quality exceedances |

[1] GHO Fording River Compliance Point (GH_FR1; 0200378) is also an Order Station

[2] The compliance evaluation for selenium at LC_DCDS is based on the proposed targeted receiving environment objective of 70 µg/L that was presented in the LCO Dry Creek Water Management Plan. It is acknowledged that at the time of the submission of the 2022 IPA there has not been a decision on SPOs in LCO Dry Creek and this work is proceeding via the Best Achievable Technology (BAT) assessments that are under review.

Sulphate compliance with EMA Permit 107517 water quality limits is currently achieved at all Order stations and compliance points. Sulphate treatment is planned at FRO, LCO and EVO to support stabilization below the long-term water quality limits; however, peak projected concentrations are above the water quality limits seasonally at LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210) in February and March of 2022 and 2023, at the LCO Line Creek Compliance Point (LC_LCDSSLCC; E297110) in February and March of 2023 through 2025, and at GHO Fording River Compliance Point/Order station (GH_FR1; 0200378) in March of 2026. Compliance with EMA Permit 107517 water quality limits is projected to be maintained at all Order stations and compliance points from early 2026 onward, following the commissioning of the sulphate treatment facilities at LCO and FRO.

There is a significant amount of mitigation being advanced now through 2027 to support compliance. Additional potential short-term adjustments to support incremental reductions in nitrate and selenium concentrations, such as additional mitigations and management actions, will be identified using the response framework (Step 6 **Adjust** in the adaptive management cycle) and reported in the annual AMP reports. The summary of adjustments in response to projected water quality exceedances will be tracked in existing water quality exceedance response summaries that are noted in Table E-6.

Sensitivity analyses were completed for the 2022 IPA in order to understand the potential risks of uncertainty in model inputs and assumptions on future compliance.

**Integrated Effects Assessment**

The objective of integrated effects assessment (IEA) was to evaluate potential area-based effects to aquatic health for each management unit during periods when water quality is projected to be potentially greater than compliance limits and SPOs. Constituent-specific assessments were conducted for nitrate, sulphate, and selenium using the same approach used in the 2019 IPA with a few improvements. Assessment criteria[1] are based on area-based protection goals from the EVWQP (Chapter 8). Where assessment criteria are met, area-based protection goals are considered to have been attained. Key findings of the integrated assessment are summarized by constituent:

- Nitrate – Assessment criteria for benthic invertebrates, fish, and amphibians were met for all assessment years (2021-2053) in all assessed MUs (1-5).
- Sulphate – Assessment criteria for benthic invertebrates, fish, and amphibians were met for all assessment years (2021-2053) in all assessed MUs (1-5).
- Selenium - Assessment criteria for benthic invertebrates, fish, and amphibians were met for all assessment years (2021-2053) in all assessed MUs (1-6).

Based on the above results, projected water quality conditions as presented in the 2022 IPA are expected to be protective of aquatic health in the MUs.

**Next Steps**

The 2022 IPA was developed to support compliance, through the re-evaluation and optimization of the sources targeted for treatment and the sequence, timing, and capacity of treatment to achieve the water quality limits included in the EVWQP and EMA Permit 107517 for selenium, nitrate, and sulphate. Cadmium treatment is not required to meet the SPOs and compliance limits as the concentrations are well below specified limits in EMA Permit 107517. Mitigation in the 2022 IPA is expected to stabilize and reduce concentrations of selenium, nitrate and sulphate for Teck's permitted mine plans. The 2022 IPA includes the mitigation that is operational (WLC AWTF and EVO SRF), in the commissioning phase (FRO AWTF-S, FRO-N 1 SRF Phase I) and undergoing permitting (FRO-N 1 SRF Phase II). The 2022 IPA includes an accelerated mitigation implementation schedule over the next five years to support requirements of EMA Permit 107517 and additional mitigation to maintain long-term nitrate, selenium and sulphate compliance at compliance points and Order stations aligned with the objectives of the EVWQP to support healthy ecosystems which is support by the IEA completed for the 2022 IPA.

Each future facility is an individual water quality project and the final configuration (treatment timing, hydraulic capacity, source prioritization and associated CWDs) may vary from the 2022 IPA. Permitting and detailed design are based on the most up-to-date understanding of the components of each water treatment facility or mitigation project, as each project will be optimized based on knowledge gained through the work to complete engineering and permitting and based on the experience of operating other facilities at Teck's operations. Future IPAs, through the AMP process, will build on the knowledge attained through our extensive operating experience of existing water treatment technologies and those mitigation measures, such as SOZs, that are developed and proven through the R&D program, as well as the cumulative improvements in the RWQM that result from our consistent focus on uncertainty reduction.

---

[1]For fish and amphibians, the assessment criteria are a <10 percent integrated effect in each MU to the most sensitive endpoint and a <10% effect in each mainstem river segment. For benthic invertebrates, the assessment criteria are a <20 percent integrated effect in each MU to the community endpoint and a <20% effect in each mainstem river segment.

Teck is actively advancing the projects that need to be executed over the next five years and each are in various stages of characterization to support engineering design and permitting. There is at least one project at each of Teck's active mining operations and each has an important role in attaining and maintaining compliance with EMA Permit 107517 requirements Teck works to stabilize and reduce the concentrations of the Order constituents.

In parallel to executing treatment, Teck is advancing source control options (including SOZs), which could replace or supplement treatment in future adjustments to the IPA. Teck will place a continued focus on, and application of, nitrate source control through improved blasting practices. The R&D program will continue to work to identify alternate technologies with potential to reduce water quality impacts from Teck's steelmaking coal operations and to potentially reduce reliance on active water treatment. The reduction of KUs will continue and will be reported in the annual AMP reports.

The RWQM will next be updated in 2023 and will be based on the cumulative advances in our knowledge and understanding from the reduction of KUs outlined in the AMP and reported annually.

Teck will continue to reduce KUs that support MQ 2 to evaluate the effects on the aquatic ecosystem, including studying the ecological relevance of near-term and seasonal nitrate, selenium and sulphate concentrations above SPOs under the MQ 2 study plan. This will inform future adjustments to projects, the implementation plan and permitting as required.

# Table of Contents

## List of Tables

## List of Figures

## List of Annexes

# Acronyms and Abbreviations

| Acronym or Abbreviation | Description |
|---|---|
| AMP | Adaptive Management Plan |
| ANFO | Ammonium nitrate fuel oil |
| AOP | Advanced oxidation process |
| AWTF | Active water treatment facility |
| BAT | Best achievable technology |
| BC | British Columbia |
| BRE | Baldy Ridge Extension |
| BRN | Burnt Ridge North |
| CMm | Coal Mountain mine |
| COI | Communities of Interest |
| CPX | Cougar Pit Extension |
| CWD | Clean water diversion |
| C&S | Conveyance and Supplementation |
| ECCC | Environment and Climate Change Canada |
| EMA | Environmental Management Act |
| EMC | Environmental Monitoring Committee |
| EMLI | Ministry of Energy Mines and Low Carbon Innovation |
| ENV | Ministry of Environment and Climate Change Strategy |
| EVO | Elkview Operations |
| EVWQP | Elk Valley Water Quality Plan |
| FBR | Fluidized bed reactor |
| FRO | Fording River Operations |
| FRO-N | Fording River Operations - North |
| FRO-S | Fording River Operations - South |
| GHO | Greenhills Operations |
| HDS | High Density Sludge |
| HHRA | Human Health Risk Assessment |
| IIP | Initial Implementation Plan |
| IPA | Implementation Plan Adjustment |
| KNC | Ktunaxa Nation Council |

| Acronym or Abbreviation | Description |
|---|---|
| KU | Key uncertainty |
| LAEMP | Local Aquatic Effects Monitoring Program |
| LCO | Line Creek Operations |
| MCW | Mine Contact Water |
| MQ | Management question |
| MSAW | Mine Services Area West |
| MU | Management Unit |
| NLC | North Line Creek |
| NLP | North Loop Settling Pond |
| NLX | North Line Extension |
| PAG | Potentially Acid Generating |
| R&D | Research and Technology Development |
| RAEMP | Regional Aquatic Effects Monitoring Program |
| RO | Reverse osmosis |
| RWQM | Regional Water Quality Model |
| SOZ | Suboxic zone |
| SPO | Site Performance Objective |
| SRF | Saturated Rock Fill |
| STP | South Tailings Pond |
| TCCC | Transfer of Care, Custody and Control |
| Teck | Teck Coal Limited |
| TMP | Tributary Management Plan |
| ToR | Terms of Reference |
| TRL7 | Technology Readiness Level 7 |
| TSF | Tailings Storage Facility |
| UU | Underlying uncertainty |
| WFTF | West Fork Tailings Facility |
| WLC | West Line Creek |

# Units of Measure

| Unit of Measure | Description |
|---|---|
| % | percent |
| > | greater than |
| < | less than |
| BCM | bank cubic metre |
| $m^3$ | cubic metres |
| $m^3/d$ | cubic metres per day |
| mg/L | milligrams per litre |
| µg/L | micrograms per litre |

# 1 Introduction

## 1.1 Purpose and Content of Report

The objective of the 2022 Implementation Plan Adjustment is to outline the timing, location and capacity of water treatment for nitrate, selenium and sulphate and other water quality mitigations in the Elk Valley, based on Teck's current understanding of water quality aligned with Teck's internal sustainability objectives, values, and policies in order to:

- mitigate impacts to the receiving environment by meeting regulatory and permit compliance as soon as feasible,
- guide for planning future water mitigation projects (site investigations, baseline data collection to support engineering design and permitting information needs, engineering design, Environmental assessments, permitting, construction, commissioning),
- support the objectives of the EVWQP,
- support safe and sustainable mining, and
- meet permit requirements to submit an updated IPA by July 31, 2022.

The submission of this report is intended to meet the requirements in *Environmental Management Act* (EMA) Permit 107517 and British Columbia (BC) *Mines Act* C-Permits specific to the submission of an updated implementation plan developed by a Qualified Professional and informed by all components of the adaptive management cycle, to the Ministry of Environment and Climate Change Strategy (ENV) Director and Ministry of Energy Mines and Low Carbon Innovation (EMLI) Chief Inspector on or before July 31, 2022. The purpose of the Implementation Plan Adjustment (IPA) aligns with the Permit and reflects the requirement of Ministerial Order M113 to consider environmental, economic, and social factors to achieve a sustainable balance for managing water quality. The 2022 IPA achieves the primary objective of the EVWQP which is to stabilize and reduce selenium and nitrate concentrations.

The plan is aggressive but achievable and is designed to meet full compliance as quickly as possible utilizing the best achievable technologies, incorporating learnings from the Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley (AMP) and using a regulatory approvals approach that requires the submission of phased permit applications to meet the implementation schedule. The updated plan includes current and future mitigation with estimated sequence, timing, location, and capacity of future treatment as well as identifying the sources prioritized and included in the treatment plan. Teck Coal Limited (Teck) acknowledges the original EVWQP schedule has been delayed in response to new and critical learnings such as development of the advanced oxidation process (AOP) process to reduce selenium speciation and bioaccumulation, the effects of lag times on constituent release from waste rock and understanding the influence of groundwater in the system.

Teck has performed over a decade of research and development in the Elk Valley. This has included completing and continuing to update extensive technology scans and reviews, bench scale testing, pilot testing, and development of full-scale treatment facilities. Based on that work, biological treatment has been identified as the most suitable option for treatment in the Elk Valley because it can remove significant amounts of selenium and nitrate with minimal treatment by-products or residuals that need to be subsequently managed. Based on piloting work in the Elk Valley, a membrane treatment integrated with high density sludge precipitation has been determined to be the most suitable technology option for sulphate removal.

This report includes:

- An overview of the IPA history and regulatory commitments (Section 1.2)
- An overview of the how the AMP supports the update of the IPA (Section 1.3)
- A summary of the pre-submission engagement with EMLI, ENV and Ktunaxa Nation Council (KNC) and planned Communities of Interest (COIs) engagement (Section 1.5)
- An overview of linkages between the IPA and related initiatives (Section 1.6)
- The 2022 IPA update process and alignment with the AMP, including update of the Regional Water Quality Model (RWQM) and the evaluation of mitigation technologies, planning basis and assumptions, and adjustments to the 2022 IPA (Section 3)
- A summary of the planned mitigation in the 2022 IPA and of the water quality projections for selenium, nitrate, and sulphate (Section 3)
- A summary of the next steps anticipated to be completed prior to the next IPA (Section 4)

Some information provided in this report is a summary of more detailed annex documents appended to this report. The annex documents are:

- Annex–A - Modifications to the 2020 Regional Water Quality Model
- Annex–B - Methods Used to Develop the 2022 Implementation Plan Adjustment
- Annex–C - Projected Concentrations of Nitrate, Selenium, and Sulphate
- Annex–D - Integrated Effects Assessment

## 1.2 Background and Regulatory Context

### 1.2.1 Background

Teck operates four open-pit steelmaking coal mines and one in care and maintenance in the Elk River watershed in southeastern BC. The individual operations are listed below and shown in Figure 1.1.

- Fording River Operations (FRO)
- Greenhills Operations (GHO)
- Line Creek Operations (LCO)
- Elkview Operations (EVO)
- Coal Mountain mine (CMm)

The mining process generates large quantities of waste rock that contains naturally occurring constituents such as selenium, an element that is essential for human and animal health in small amounts. Water from precipitation and runoff flows through waste rock and carries selenium, nitrate, sulphate, cadmium and other constituents to the local watershed. If present in high enough concentrations, these constituents can adversely affect aquatic health.

The BC Ministry of Environment issued Ministerial Order No. M113 (the Order), under Section 89 of the EMA, to Teck in April 2013, requiring Teck to develop an Area Based Management Plan called the Elk Valley Water Quality Plan (EVWQP). The EVWQP included an Initial Implementation Plan (IIP) and a description of the adaptive management process. The IIP identified the water mitigation required to meet the water quality requirements outlined in the EVWQP. In November 2014, the BC Ministry of Environment issued EMA Permit 107517 to Teck, which established Site Performance Objectives (SPOs) and water quality limits at compliance points for managing water quality for selenium, nitrate, sulphate, and cadmium in the Elk River. The Ministry of Energy, Mines and Low Carbon Initiative (EMLI) also amended Teck's C-Permits under the *Mines Act* (dated November 27, 2014) to approve the water quality mitigation strategy in the EVWQP and to set out requirements related to implementation of the EVWQP.

Both EMA Permit 107517 and the *Mines Act* C-Permit amendments set out requirements for ongoing monitoring, research and technology development, adaptive management, and other conditions considered essential for the full and effective implementation of the EVWQP. The Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley provides the guiding framework for designing, implementing, monitoring, evaluating, and making adjustments to the RWQM and water quality mitigations and supporting activities under the IPA, as well as for identifying and reducing key uncertainties (KUs) and incorporating the learnings into the RWQM and IPA. Both permits require Teck to complete updates to the RWQM every three years. The RWQM updates reflect changes to the permitted mine plan, incorporate new data and learnings and if required adjust the initial implementation plan submitted as part of the EVWQP to meet changes to predicted water quality values from the RWQM update. Teck developed the 2019 IPA in response to the updated 2017 RWQM and the 2022 IPA is the second adjustment of the initial implementation plan in response to the updated 2020 RWQM.

The Designated Area managed by the EVWQP defined in 2013 by the BC Minister of Environment, includes the Elk River watershed and Koocanusa Reservoir to the international boundary. The Designated Area is further divided into six Management Units (MUs) based on geographic features, major tributaries and hydrodynamic characteristics (Figure 1.1). These MUs are central to the area-based nature of the EVWQP. It is recognized that the Koocanusa Reservoir extends into the United States and as such, Teck participates in the Lake Koocanusa Monitoring and Research Working Group. Through this working group, monitoring data collected on both sides of the border are shared and discussed. These data and resulting findings are considered by Teck in the implementation of the EVWQP.

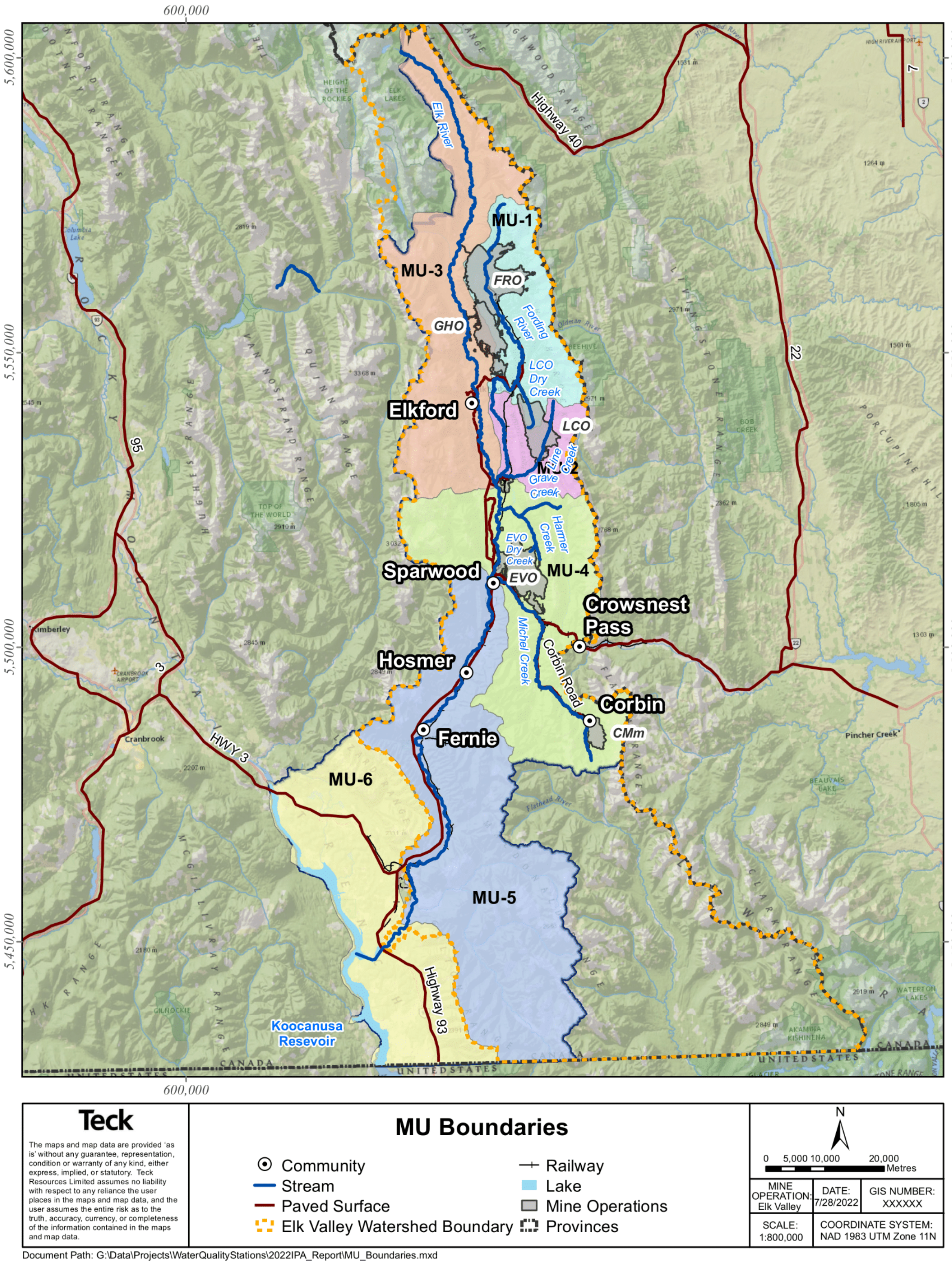



Figure 1.1: Location of Teck's Mining Operations, Designated Area, and Management Unit Boundaries

The water quality assessment, during development of the EVWQP, identified that selenium and nitrate concentrations in the Fording and Elk rivers were routinely elevated above water quality guidelines and were generally increasing in many areas. There was evidence of selenium bioaccumulation in fish and other biota, and while no regional effects were detected, localized effects were observed close to mine sources.

A human health risk assessment (HHRA) was completed in 2016 to evaluate risk to human health throughout the Elk Valley and identify any needed adaptive management actions to address unacceptable human health risks. The 2016 HHRA concluded that there were no unacceptable human health risks associated with concentrations of constituents in water, sediment or fish, based on the understanding of consumption at that time. Teck submitted an updated HHRA report on July 1, 2022.

The RWQM was developed by Teck to examine how activities at its steelmaking coal mines in the Elk Valley watershed could affect water quality in the Elk River and Fording River, as well as in tributaries located in and around each operation. The 2014 RWQM informed development of the IIP to meet regional water quality requirements (SPOs and compliance limits) defined in EMA Permit 107517 and the Mines Act C-permit requirements for each operation. The locations of the compliance points and Order stations are shown in Figure 1.2.

The RWQM has been updated twice since the EVWQP was developed, in 2017 (Teck 2017) and in 2020 (Teck 2021a). Projected water quality concentrations for three of the Order constituents (nitrate, selenium, and sulphate) were above SPOs and compliance limits at some locations and timeframes in the 2020 RWQM (based on the 2019 IPA treatment schedule); cadmium (the fourth Order constituent) is projected to remain below the compliance limits and SPOs. In accordance with Teck Coal's permits, the new projected concentrations triggered a review of the implementation plan. The permit requirements related to the 2022 IPA are provided in Table 1.3.

At the time of developing EVWQP, results from Teck's Research and Technology Development (R&D) Program determined that tank-based active water treatment supported by clean water diversions (CWDs) were the most effective options for stabilizing selenium and nitrate in the near term. Although saturated rock fill (SRF) technology was advancing and operating in a full-scale trial at EVO, the 2019 IPA utilized active water treatment supported by CWDs and included the Alternate Mitigation Plan using SRF technology. SRF technology has now been designated provincially at a Technology Readiness Level 7 (TRL7) where it can be proposed for use in planning activities such as the IPA[2]; therefore, the 2022 IPA includes active water treatment facility (AWTF) and SRF technology supported by CWDs. The 2022 IPA is the first implementation plan adjustment to include sulphate treatment which utilizes a commercially available proven technology of membrane treatment integrated with high density sludge precipitation.

[2] Per the *Technology Readiness Levels Interim Guidance,V02.00* (ENV and EMLI, March 2022)

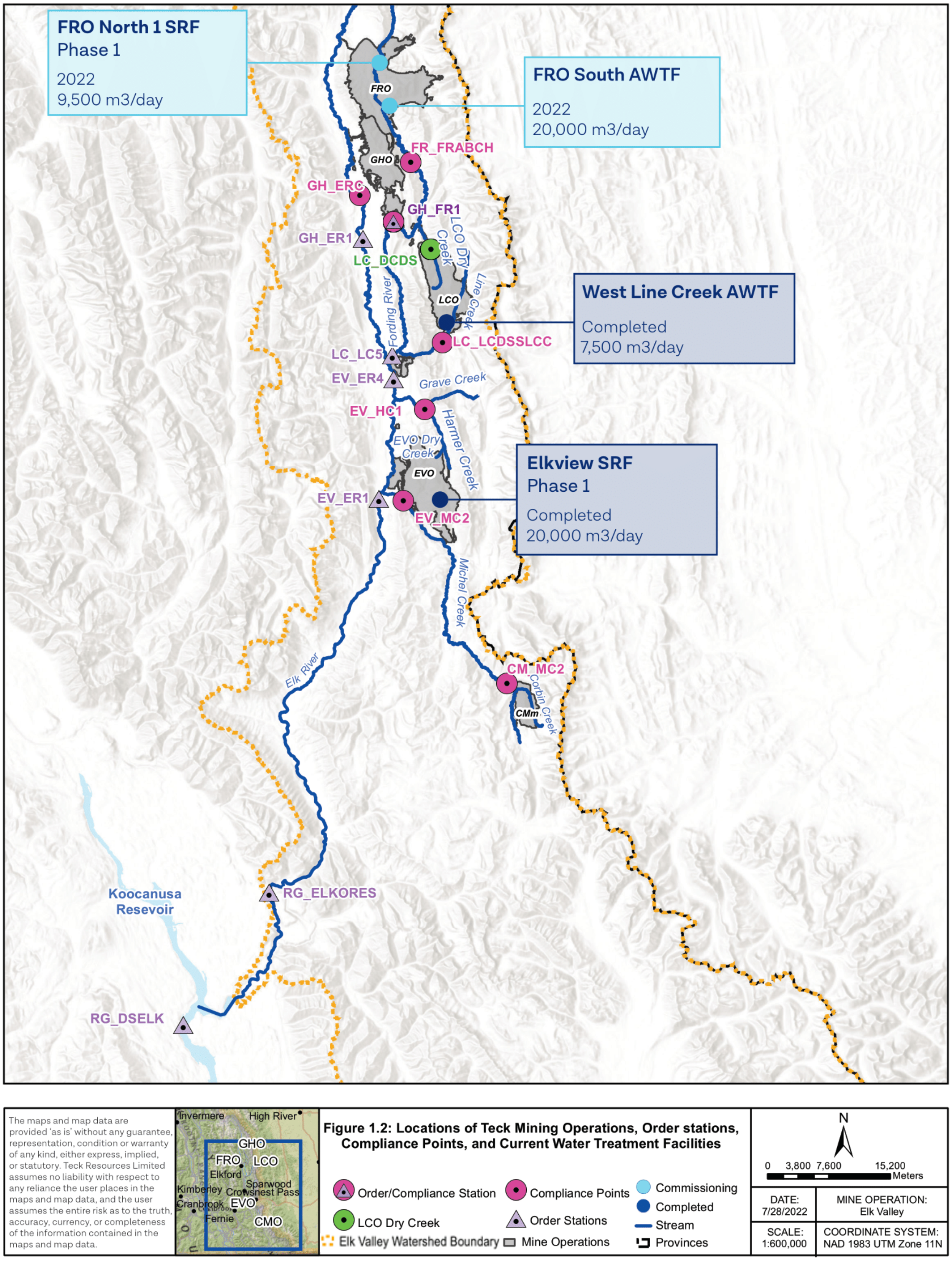



Figure 1.2: Locations of Teck Mining Operations, Order stations, Compliance Points, and Current Water Treatment Facilities

Since 2014, Teck has made significant progress on implementing water treatment in the Elk Valley with four water treatment facilities built and fully operational or in commissioning. The existing treatment facilities and clean water diversions in operation and their maximum design capacity are outlined in Table 1.1 and Table 1.2 respectively.

**Table 1.1: Treatment Facilities as of the End of 2022**

| Treatment Facility | Operational Date [1] | Hydraulic Capacity Up To ($m^3$/day) |
|---|---|---|
| LCO WLC AWTF | In place and operating | 7,500 |
| EVO SRF Phase I | In place and operating | 20,000 |
| FRO-S AWTF | Sept. 1, 2022 | 20,000 |
| FRO-N 1 SRF Phase I | Dec. 31, 2022 | 9,500 |

[1] The operational date is the date when facility commissioning activities are completed.

**Table 1.2: Operating Clean Water Diversion Facilities as of the End of 2022**

| Clean Water Diversion | Associated Water Treatment Facility | Operational Date | Streams and Volume Diverted |
|---|---|---|---|
| FRO Kilmarnock Creek | FRO-S AWTF | In place and operating | Upper Kilmarnock Watershed, up to 86,000 $m^3$/d |
| EVO South Gate Creek | EVO SRF | In place and operating | South Gate Creek, up to 3,500 $m^3$/d |

### 1.2.2 Regulatory Context

The 2022 IPA is prepared in accordance with permit requirements under EMA Permit 107517 and site-specific *Mines Act* C-Permits that requires that the IPA be updated every three years in consultation with ENV, EMLI, and KNC and is intended to supersede the 2019 IPA. Table 1.3 provides the permit conditions in relation to this management plan and how they have been addressed. Feedback received during the review of the 2020 RWQM that is relevant to the 2022 IPA is captured in the ENV Letter Amendment to waive and replace section 7.1.3 for 2022 Implementation Plan and summarized in this table.

**Table 1.3: Permit Requirements Related to the Implementation Plan**

| Permit | Date | Permit Section | Condition | How the requirement is addressed |
|---|---|---|---|---|
| **EMA 107517 Amendment to *Environmental Management Act* Permit 107517 to require submission of an Implementation Plan** | May 11, 2022 | Letter Amendment to add a new section 7.1 to EMA 107517 | IMPLEMENTATION PLAN<br>7.1.1 The permittee must cause a Qualified Professional to develop an Implementation Plan and submit it to the director, with a copy provided to the Ministry of Energy, Mines and Low Carbon Innovation Chief Permitting Officer, by July 31, 2022, and every third year thereafter.<br>The Implementation Plan must: | This report |
| | | | 7.1.1.1 Demonstrate how the Compliance Point limits and Site Performance Objectives for Compliance Points and Order Stations for the Order Constituents will be met, using the most recent Regional Water Quality Model described in Section 9.9, the most recent permitted development for the permittee's five Elk Valley coal mine sites, and by implementing Best Achievable Technology, including effluent treatment technologies that have been accepted for use in mitigation planning; | Section 3.2 |
| | | | 7.1.1.2 Clearly identify the proposed location, treatment sources, capacity, and Operational Date b for each proposed effluent treatment facility; | Section 3.1 |
| | | | 7.1.1.3 Provide water quality projections for Order Constituents at Compliance Points and Order stations for the Permitted Development Planning Period; | Section 3.2.2 and Annex C |
| | | | 7.1.1.4 Be modified or amended by a Qualified Professional as required by the director, and the permittee must, within the timeframe specified by the director, resubmit to the director the Implementation Plan with any required modifications or amendments; and | Not applicable |
| | | | 7.1.1.5 Be developed in accordance with the approved Terms of Reference described in Section 7.1.3. | Not applicable for the 2022 IPA. See EMA 107517 Amendment to *Environmental Management Act* Permit 107517 to require submission of an Implementation Plan |
| | | | 7.1.2 The permittee must submit RWQM output data in digital spreadsheet format (i.e., Microsoft Excel) for the Implementation Plan scenario including projected monthly average concentrations under the range of projections used for mitigation planning. | Excel file provided |
| | | | 7.1.3 The permittee must develop a Terms of Reference for the Implementation Plan update. The Terms of Reference shall describe the treatment-related model assumptions used, the sensitivity scenarios, and other expectations for the update. The permittee must submit the initial terms of reference to the director, with a copy provided to the Ministry of Energy, Mines and Low Carbon Innovation Chief Permitting Officer, for approval, by July 31, 2024, and updates must be provided every third year thereafter. | Not applicable for the 2022 IPA |
| | | | 7.1.4 The director may consider the Implementation Plan and/or request additional information to update other requirements such as those in Section 7.2 of this permit. | Acknowledged |
| **EMA 107517 Amendment to *Environmental Management Act* Permit 107517 to require submission of an Implementation Plan** | Dec 1, 2022 | Letter Amendment to waive and replace section 7.1.3 for 2022 Implementation Plan | (…)Noting that the Implementation Plan is to be updated in 2022, there is insufficient time to prepare, review and approve a Terms of Reference (ToR) for the 2022 update.<br>(…) As such, in lieu of a ToR for 2022, this letter outlines a list of items that must be included in the 2022 Implementation Plan. The sensitivity analyses that are listed herein are intended to investigate uncertainties related to mitigation planning. They provide an opportunity to understand the potential risks that each category of uncertainty has on future compliance and highlight potential areas of focus for monitoring and adaptive management. Results should be used to inform the need for, and priority of, additional studies to support development of future mitigation planning. Sensitivity scenario results must not be used to reduce required treatment proposed in the final mitigation strategy.<br>Instead the 2022 Implementation Plan must be prepared in accordance with the following requirements: | Section 2.6 |

**Table 1.3: Permit Requirements Related to the Implementation Plan**

| Permit | Date | Permit Section | Condition | How the requirement is addressed |
|---|---|---|---|---|
| | | | 1. Information Requirements, Inputs, and Planning Assumptions | |
| | | | 1.1. Base case – The base case must assume no decay rate of selenium or sulphate generation and must not consider improved model performance for nitrate attributed to the use of liners in blast holes. | Section 2.2, Table 2.3 |
| | | | 1.2. Load removal - Assumed treatment performance must be rationalized using results from appropriate pilot studies and performance monitoring. | Section 2.2, Table 2.5 and Table 2.6 |
| | | | 1.3. Entrainment – Include information on how in situ pit water entrained in the SRF effluent is accounted for in the SRF effluent projections. | Table 2.4 of this report and Annex A: Section 2.1 |
| | | | 1.4. Expected capacity – Provide graphs to illustrate the range in treated flow, up to the design or planned capacity for each facility. | Annex C: Section 3 |
| | | | 1.5. Effects assessment – Include an updated integrated effects assessment in the Designated Area for the proposed mitigation strategy. | Section 2.5 of this report and Annex D |
| | | | 1.6. Full suite of planned mitigations - Identify which treatment facilities are also required to satisfy Environment and Climate Change Canada (ECCC) requirements, which may be different from or in addition to the requirements in EMA Permit 107517 | Section 3.1, Table 3-1, Table 3-2 and Table 3-3 |
| | | | 1.7. Treatment development timelines (pit investigations, engineering, design, construction, commissioning) – Provide detailed development schedules for each treatment type (AWTF, SRF, other) proposed in the Implementation Plan. | Section 2.5 |
| | | | 2. Sensitivity Analyses The Implementation Plan must include projections for each sensitivity scenario presented in a graphical format with accompanying written discussion interpreting the results and what they indicate about the sensitivity of the proposed mitigation strategy. At a minimum, the following sensitivity scenarios must be included: | Section 3.3 of this report and Annex C: Section 4 |
| | | | 2.1. Nitrate from ion exchange - Examine how the presence of exchangeable ammonium in waste rock spoils could affect nitrate release and longer-term nitrate projections. | Section 3.3.2 |
| | | | 2.2. Nitrate from explosives residue – Separate from the previous sensitivity, examine how future projections change if nitrate loadings are reduced by up to 20% due to the improved blasting practices. | Section 3.3.2 |
| | | | 2.3. Groundwater bypass of treatment – Using the water availability model parameter, examine how uncertainty in the volume of groundwater bypassing treatment collection in, at a minimum, Kilmarnock Creek, Clode Creek, West Line Creek and Erickson Creek, affects the performance of the proposed mitigation strategy. | Section 3.3.1 |
| | | | 2.4. Instream sinks – Examine how a 50% reduction in instream sinks affects performance of the proposed mitigation strategy. | Section 3.3.6 |
| | | | 2.5. Treatment performance - Examine how the proposed mitigation strategy performs in the absence of assumed improvements in treatment effluent quality. | Section 3.3.5 |
| | | | 2.6. Decay in selenium and sulphate release rates – Examine how future projections would change if the rates of selenium and sulphate release from waste rock decay over time. This sensitivity should utilize the Decay Rate 2 included in the 2020 RWQM. | Section 3.3.3 |
| | | | 2.7. Climate change – Examine how climate change could influence performance of the proposed mitigation strategy. This sensitivity should utilize Representative Concentration Pathways 4.5 and 8.5. | Section 3.3.4 |

**Table 1.3: Permit Requirements Related to the Implementation Plan**

| Permit | Date | Permit Section | Condition | How the requirement is addressed |
|---|---|---|---|---|
| **EMA 107517** | Dec 1, 2022 | Section 7 | ABMP COMMITMENTS<br>The following section identifies specific commitments made by the permittee in the Elk Valley Area Based Management Plan. The permittee must aggressively pursue all viable approaches for reducing contaminant loadings to the environment and implement in a timely manner. Treatment approaches include passive and active water treatment. | This report |
| **EMA 107517** | Dec 1, 2022 | Section 10 | ADAPTIVE MANAGEMENT<br>Stage 6 – Adjust and Revise the Hypothesis and Management Strategies<br>a. Adjust the ABMP implementation plans and actions as required, including knowledge gained from Section 7.2 – Research and Development.<br>b. Communicate changes to ABMP implementation plans and activities to the EMC.<br>c. Reassesses expected outcomes, potential impacts, and responses to these outcomes for an adjusted plan. Where plan components are related to Human Health, the permittee shall make reasonable efforts to consult with Interior Health (hbe@interiorhealth.ca).<br>Adjust the AMP as required in consultation with the EMC. | Section 1.5<br>Section 2<br><br>Reported in AMP annual reports |
| **EMA 107517** | Dec 1, 2022 | Section 11 | DATA ANALYSIS ACCOUNTABILITY AND TRANSPARENCY - FIRST NATIONS REPORTING REQUIREMENT<br>d. Unless otherwise agreed to by the Ktunaxa Nation Council (KNC) and the Permittee, the Permittee shall provide the KNC with information related to any material changes to the IIP, AMP, the Calcite Management Plan and the Research and Technology Development Plan. In addition, the Permittee shall provide the KNC with all data, information and/or reports generated during the implementation of these plans in accordance with this permit. | Section 1.4<br>Pre-engagement in this report |
| **C-Permits** [1] | November 27, 2014 | B.1. (c) | UPDATES TO THE INITIAL IMPLEMENTATION PLAN<br>i. The IIP shall be periodically reviewed and revised, based on an adaptive management approach, to meet the objectives and timeframes for water quality, consistent with the EVWQP.<br>ii. The updated Implementation Plan shall include refinements and changes to management limits, mitigation strategies, timelines for implementing mitigation, monitoring plans and research and technology development programs as necessary to meet the objectives and timelines for water quality constituents in the EVWQP.<br>iii. Future iterations of the update Implementation Plan shall specifically evaluate the effectiveness of:<br>- mitigation measures to minimize release of order constituents and reduce reliance on long term active water treatment; and<br>- progressive reclamation and closure activities.<br>iv. The Permittee shall provide an annual report to the Chief Inspector beginning July 31, 2016 that documents adaptive management activities and any proposed changes to the IIP.<br>An update IIP, informed by all components of the adaptive management cycle, shall be provided to the Chief Inspector every three years. The first update report is due on or before July 31, 2019. | This report<br><br>Reported in AMP annual reports |

[1] Common requirement to the following C-Permits: Fording River Operations C-3 Approving Water Quality and Calcite Mitigation Strategy (27Nov14); Greenhills Operations C-137 Approving Water Quality and Calcite Mitigation Strategy (27Nov14); Line Creek Mine C-129 Approving Water Quality and Calcite Mitigation Strategy (27Nov14); Elkview Operations C-2 Approving Water Quality and Calcite Mitigation Strategy (27Nov14); Coal Mountain Operations C-84 Approving Water Quality and Calcite Mitigation Strategy (27Nov14).

**Environment and Climate Change Canada 2020 Direction**

On October 29, 2020, Environment and Climate Change Canada issued a Direction under the *Fisheries Act* (the "Direction") to Teck Coal Limited ("Teck"), requiring measures to be taken to reduce selenium in the Elk Valley in waters affected by Teck's Fording River and Greenhills Operations. The Direction includes 11 measures (teck.com) of which 5 have been completed to date. The mitigation measures relevant to the 2022 IPA are listed in Table 1.4.

**Table 1.4: ECCC Mitigation Measures Relevant to the 2022 Implementation Plan Adjustment**

| Direction Number | Site | Description | Status |
|---|---|---|---|
| 1 | FRO | By December 31, 2021, at Fording River Operations, re-construct, commission, and thereafter maintain and operate the Kilmarnock Creek clean water diversion, with a capacity to divert up to 86,000 m³/day of non-contact water from upstream Kilmarnock Creek (upstream waste rock spoils) around waste rock in the Kilmarnock valley. | The Kilmarnock Creek CWD is completed and started operating on October 16, 2021 with a capacity of 86,000 m³/day. |
| 2 | FRO | By September 30, 2021 (as amended), at Fording River Operations, complete construction of an Active Water Treatment Facility for selenium removal, and thereafter commission and operate the facility, with influent made up of mine impacted water from Fording River and Greenhills Operations including Kilmarnock Creek, Cataract Creek, and Swift Creek, with a design treatment capacity of at least 20,000 m³ of influent per day. | The construction of FRO-S AWTF was completed by September 30, 2021 with a design treatment capacity of at least 20,000 m³ of influent per day, which will treat water from Kilmarnock Creek, Cataract Creek, and Swift Creek. |
| 3 | FRO | By December 31, 2022, at Fording River Operations, complete construction of selenium treatment processes for selenium removal, and thereafter commission and operate those processes, made up of mine impacted water from sources at Fording River Operations including the Clode Creek drainage, Swift Pit, and the North Spoil area with a design treatment capacity of at least 30,000 m³ of influent per day. | The construction of FRO-N SRF Phase I and Phase II is on plan to be completed by December 31, 2022 with a total design treatment capacity of at least 30,000 m³ of influent per day which will treat water from Clode Creek drainage, Swift Pit, and the North Spoil area. |
| 4 | GHO | By December 31, 2026, at Greenhills Operations, complete construction of selenium treatment processes for selenium removal, and thereafter commission and operate those processes, made up of mine impacted water from the Greenhills Creek drainage, with a design treatment capacity of at least 7,500 m³ of influent per day. | This GHO Greenhills selenium treatment process is in the scoping design stage currently assessing two options as of the submission of the 2022 IPA. |

**Table 1.4: ECCC Mitigation Measures Relevant to the 2022 Implementation Plan Adjustment**

| Direction Number | Site | Description | Status |
|---|---|---|---|
| 5 | FRO | By December 31, 2026, at Fording River Operations, develop the Swift North Spoil in such a way as to promote the development of suboxic zones to attenuate selenium. | The FRO Swift North Spoil SOZ is proceeding to the detailed design stage and construction is anticipated to commence in early 2023 as of the submission of the 2022 IPA. Reduction of water quality constituents from SOZ are not included in the 2022 IPA as SOZ is an emerging source control method and data is currently being collected; therefore, it is not sufficient for modelling purposes. |
| 6 | FRO<br>GHO | By December 31, 2021, develop a plan to reduce selenium releases from Porter Creek and Eagle Creek into the upper Fording River and submit the plan to Environment and Climate Change Canada. | Porter Creek and Eagle Creek selenium reduction plans were submitted to ECCC on Dec 2, 2021.[1] |
| 8 | GHO | By December 31, 2030, at the Greenhills Operations mine, conduct a trial by installing a geosynthetic cover over the East Spoil in the Greenhills Creek drainage, covering approximately 200 hectares. By December 31, 2025, an Interim Report on progress made with the installation of the geosynthetic cover at this location shall be submitted to Environment and Climate Change Canada. | The cover trial is moving forward. Reduction of water quality constituents from the cover are not included in the 2022 IPA as the cover trial is in the early stages of development and data will be collected in the future; therefore, it is not sufficient for modelling purposes |

[1] ECCC responded on Feb 7, 2022 outlining due diligence concerns and Teck responded on June 16, 2022.

**2019 IPA submission acknowledgement letter from ENV**

On October 3, 2019, Teck received a letter from ENV which acknowledged Teck's submission of the 2019 IPA. The letter also includes ENV's expectations for future IPA updates, which are detailed below.

*"It is expected that Teck will begin development of the next Implementation Plan update in response to adjusted mitigation strategies and outcomes from the implementation of the Adaptive Management Plan. ENV understands that the next complete update is due no later than July 31, 2022 as required under the Mines Act permits, but that specific parts of the IPA could be updated sooner.*

*Further, ENV expects Teck to consider the following recommendations in the development of future Implementation Plan updates:*

- Show how order station Site Performance Objectives will be attained and update the IPA to reflect continued advancement of alternative water treatment and source control strategies.
- Work with ENV, EMPR, and KNC to determine criteria for inclusion of mitigation currently in the research and development phase. It is expected that Teck will make the best attempts to model any mitigations that meet the criteria and will present the results in future updates.

- Assess ecological relevance of any short term, seasonal exceedances of selenium and nitrate using methodology developed as per the Adaptive Management Plan Key Uncertainty 2.3. It is expected that Teck will work with the EMC to refine this methodology.
- Incorporate advancements in understanding of uncertainties related to water availability, active water treatment effluent quality, and sulphate treatment into refined assumptions related to IPA mitigation strategies, and within the temporal scope noted below.
- Define a temporal scope in consultation with ENV, EMPR, and KNC. Given the continuous collection of data, research and development and project development, a clearly established temporal scope will put boundaries on the inclusion of available data and avoid delays and review comments related to recent data and learning.
- Incorporate into the regional water quality model the SPOs and compliance limits for constituents of interest established by Permit 107517."

Teck considered the recommendations above in the 2022 IPA.

**SRF Technology TRL 7 Designation Letter from ENV and EMLI**

On April 25, 2022, ENV and EMLI jointly issued a joint letter to Teck stating their agreement with Teck's assessment that the SRF technology had achieved a TRL7 for selenium and nitrate treatment**.** The letter also includes ENV's expectations for planning activities where SRF technology is proposed, which are detailed below.

"*While the fundamental science of SRF technology for selenium and nitrate treatment may be similar at each potential SRF location in the Elk Valley, EMLI and ENV recognize that site-specific characteristics can influence the design, operation, and effective performance of an SRF facility. With* respect to *planning activities where SRF technology is proposed, Teck is expected to:*

- Ensure the IPA includes appropriate timeframes for technology implementation. Timeframes must be supported by rationale that considers mine plans, site characterization, engineering design, and construction;
- Use conservative SRF effluent quality assumptions in the RWQM to account for potential complicating factors such as capture of treated water and entrainment of in situ water and recharge water that may reduce overall selenium and nitrate treatment efficiencies; and,
- Continue to validate the lifespan of SRFs used in mitigation planning through ongoing research and development programs to reduce uncertainty of operational longevity."

The 2022 IPA and AMP annual reports address the expectations above.

**Site Performance Objectives and Compliance Limits**

Long-term water quality limits were developed for selenium, nitrate, sulphate and cadmium to protect the aquatic ecosystem and human health in the Designated Area under the EVWQP. Long-term limits were developed using a comprehensive process. Long-term limits were set to be protective of aquatic health and short- and medium-term limits were meant to track progress towards the long-term limits recognizing the long-term limits would take time to be achieved. Three building blocks were considered to develop long-term water quality limits:

1. Science-based water quality benchmarks were developed to be protective of aquatic life present in the Elk Valley.
2. A RWQM was developed to evaluate trends in current and projected future constituent concentrations. The model incorporated the projected influence of AWTFs, SRFs and NWDs, and the ability to adjust the sequence, timing, location, and capacity of treatment and diversions.
3. An integrated effects assessment methodology was developed to assess area-based effects in each MU and evaluate long-term concentrations at specific locations (Order stations). The methodology accounts for spatial differences in water quality and aquatic effects within the MUs.

Long-term water quality limits that protect aquatic ecosystem health at a MU scale were derived by an iterative assessment of future water quality conditions under a range of treatment and diversion scenarios. If projected future constituent concentrations could be managed to remain below BC water quality guidelines (BC WQG) or site-relevant water quality benchmarks, then these values were set as the long-term limits. Where future constituent concentrations were projected to be higher than guideline or benchmark values, an integrated effects assessment was used to derive site-specific long-term limits and timeframes at Order stations that were achievable and would provide a defined level of protection to aquatic ecosystem health in each MU. This process resulted in the design of the IIP for the phased construction of AWTFs and associated water management measures to meet the long-term limits. Short-term limits and timeframes were then set to define stabilization of concentrations where they are expected to exceed long-term limits without mitigation; medium-term limits were set between short-term and long-term limits to track that the Implementation Plan would stay on track to meet the long-term limits.

When approving the EVWQP, BC Ministry of Environment issued EMA Permit 107517 to Teck, which established Site Performance Objectives (SPOs) and compliance limits for the management of water quality concentrations for cadmium, selenium, nitrate and sulphate in the Elk Valley. SPOs, which are equivalent to water quality limits in the EVWQP, were set at Order stations to achieve and maintain area-based protection of aquatic ecosystem health, whereas compliance limits were set to measure regulatory compliance at specified compliance point locations at or near the downstream boundary of each operation. The compliance limits and SPOs in EMA Permit 107517 were developed based on the values from the 2014 RWQM and IIP within the submission of the EVWQP in 2014.

The water quality limits in the Elk Valley Plan, and the corresponding SPOs, were initially set primarily for the protection of aquatic ecosystem health. A human health risk assessment (HHRA) completed in 2016 concluded that there were no unacceptable human health risks in the Elk Valley associated with concentrations of constituents in water, sediment or fish, based on the understanding of consumption at that time. Teck submitted an updated HHRA report on July 1, 2022.

Teck's AMP (Section 1.3) provides a process for reviewing the protectiveness of human health and the aquatic ecosystem in the Elk Valley in order to meet the objectives of the EVWQP, through the evaluation of two management questions (MQs): MQ 2 (*Will the aquatic ecosystem be protected by meeting the long-term SPOs?*) and MQ 6 (*Is water quality being managed to be protective of human health?*). See Section 4 for next steps under these evaluations.

## 1.3 Adaptive Management and the Implementation Plan Adjustment Process

As required in EMA Permit 107517 Section 10, Teck's AMP (Teck 2021b) supports the implementation of the EVWQP to achieve water quality limits to ensure that human health and the aquatic environment are protected, and where necessary, restored, and to facilitate continuous improvement of water quality in the Elk Valley. The AMP guides the process for updating the IPA. The adaptive management cycle comprises six steps: assess, design, implement, monitor, evaluate and adjust (Figure 1.3). The AMP identifies six Management Questions (MQs) that are evaluated at regular intervals as work under the EVWQP progresses. Regular re-evaluation of these MQs collectively determines whether Teck is on track to meet the environmental objectives of the EVWQP, and if not, what adjustments are needed.

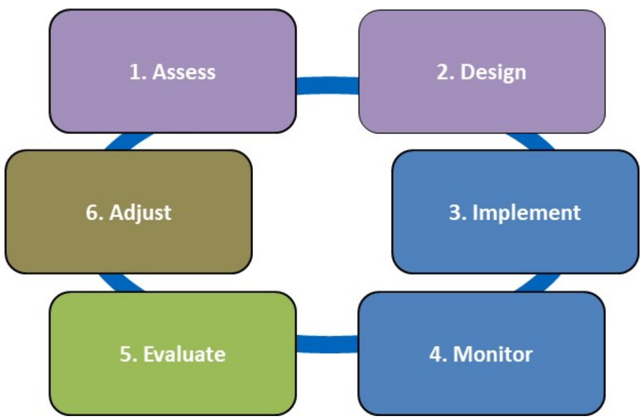



Figure 1.3: The Six Steps of the Adaptive Management Cycle

The IPA is a water quality mitigation plan that Teck implements (step 3 **Implement**) to meet specific water quality limits. Each successive IPA is an adjustment (step 5 **Adjust**) of Teck's water quality mitigation plan. The 2022 IPA update has been undertaken through evaluating (step 5 **Evaluate**) the answer to MQ 1 (*Will water quality limits and Site Performance Objectives be met for selenium, nitrate, sulphate and cadmium?*) and adjusting (step 6 **Adjust**) the water quality mitigation plan. This process was informed by updates to the 2020 RWQM and evaluation of the mitigation technologies in Teck's R&D Program. The 2022 IPA is used to evaluate the answer to MQ 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 SPOs?*). The evaluations of MQ 1 and MQ 3 are reported in the MQ 1 and 3 Evaluation Report (Teck 2022a). The AMP is updated every three years and further details on the MQ evaluations can be found in the 2021 AMP Update (Teck 2021b).

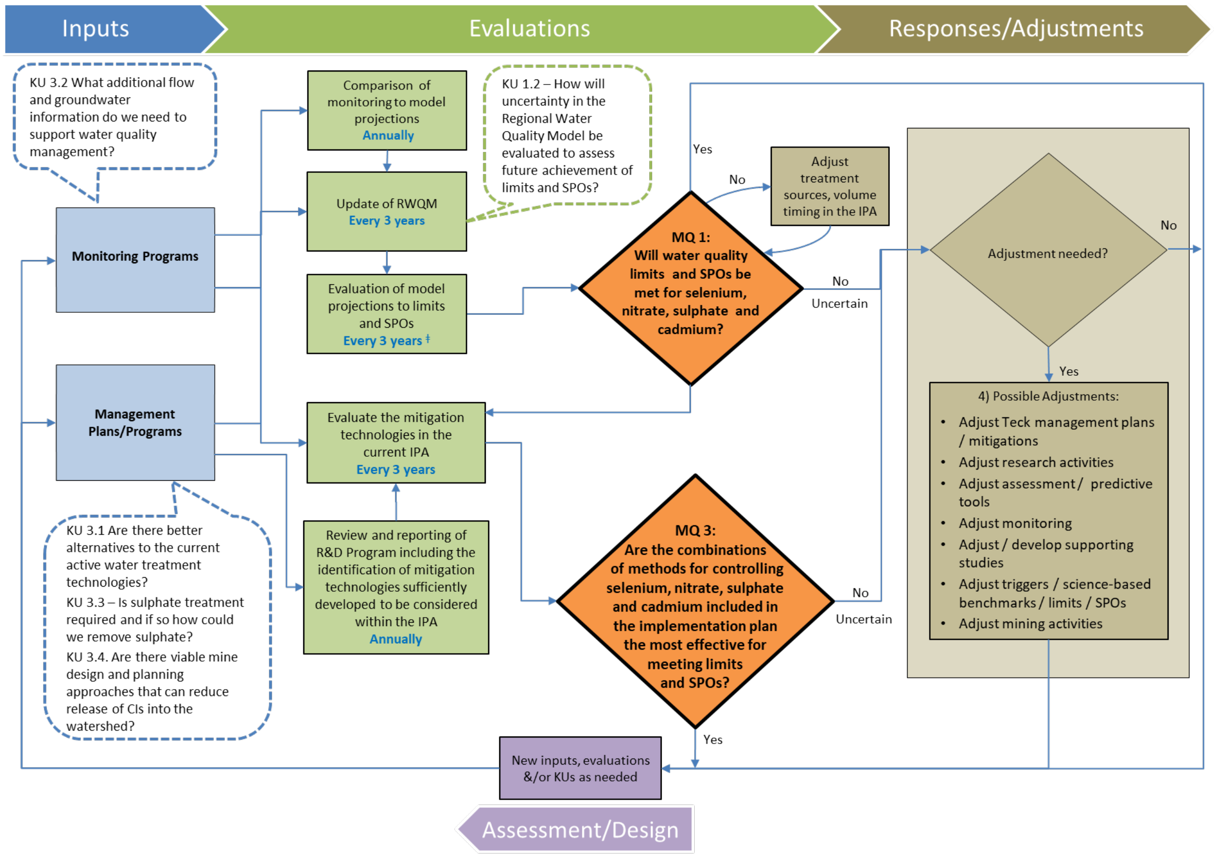
The AMP response framework is used to determine when additional mitigation or other adjustments may be needed. Adjustments to water quality mitigation planning (i.e., the IPA) represent a response (step 6 **Adjust**) identified from the evaluation of the answer to MQ 1 (as reported in the MQ 1 and 3 Evaluation Report). Relevant additional responses to water quality projections compared to limits/SPOs are referenced in Section 3.2. These responses are organized by location and tracked in annual AMP reports.

Reducing uncertainty is an important aspect of the AMP. The AMP identifies key uncertainties (KUs) that, as reduced, fill gaps in the current understanding in order to answer the MQs and support achievement of the EVWQP objectives. Some KUs also have underlying uncertainties (UUs) that provide greater technical detail about KUs. Five KUs identified in the AMP informed the 2022 IPA:

- KU 1.2. How will uncertainty in the Regional Water Quality Model be evaluated to assess future achievement of limits and SPOs?
- KU 3.1. Are there better alternatives to the current active water treatment technologies?
- KU 3.2. What additional flow and groundwater information do we need to support water quality management?
- KU 3.3. Is sulphate treatment required and if so how could we remove sulphate?
- KU 3.4. Are there viable mine design and planning approaches that can reduce release of constituents of interest into the watershed?

The objectives and design for reducing KUs are described in the 2021 AMP Update (Teck 2021b), and details of activities and learnings that support reducing KUs are included in annual AMP reports.

The process for evaluating each MQ and reducing related KUs follows the six stages of the adaptive management cycle (Figure 1.3). A simplified process flow diagram that combines MQ 1 and MQ 3 is presented in Figure 1.4 and shows where information from the six stages informs the evaluation of MQ 1 and MQ 3.




Note: this is a simplified version of the MQ 1 and 3 combined process flow diagram that focuses on MQ evaluations

Figure 1.4: Simplified process flow diagram for the evaluation of MQ 1 and MQ 3.

Table 1.5 provides a reference to sections in this report that discuss KUs and responses.

**Table 1.5: Report section discussing KUs (and UUs) and responses.**

| AM Framework Component | Referenced in section |
|---|---|
| KU 1.2. *How will uncertainty in the Regional Water Quality Model be evaluated to assess future achievement of limits and SPOs*? | Section 2.2<br>Section 3.3.1 |
| UU 1.2.2. *Can the RWQM be improved in specific catchments where mitigation decision are required and uncertainty is high*? | Section 2.2<br>Section 3.3.1 |
| UU 1.2.3. *How may selenium and sulphate release rates change over time*? | Section 2.2<br>Section 3.3.5 |
| UU 1.2.4. *What mechanisms are causing the reduction in mass observed between tributaries and at monitoring stations in the mainstems*? | Section 2.2<br>Section 3.3.8 |
| UU 1.2.5. *How do the nitrate source terms need to be adjusted to account for the loading from exchangeable ammonium (naturally present in the waste rock) in addition to the blasting residuals*? | Section 2.2 and 2.2.1<br>Section 3.3.2 |
| KU 3.1. *Are there better alternatives to the current active water treatment technologies*? | Section 2.3 and 2.3.2 |

**Table 1.5: Report section discussing KUs (and UUs) and responses.**

| AM Framework Component | Referenced in section |
|---|---|
| KU 3.2. *What additional flow and groundwater information do we need to support water quality management?* | Section 3.1.1 |
| KU 3.3. *Is sulphate treatment required and if so how could we remove sulphate*? | Section 1.6.1<br>Section 2.3.3 |
| KU 3.4. *Are there viable mine design and planning approaches that can reduce release of constituents of interest into the watershed*? | Section 2.3 |
| UU 3.1.1. *Are saturated rock fills a viable alternative to active water treatment*? | Section 2.3.2 |
| UU 3.1.2. *Can the performance of current and planned active water treatment facilities be materially improved*? | Section 2.3.1 |
| UU 3.4.2. *What is the most feasible and effective method (or combination of methods) for source control of nitrate release*? | Section 1.6.1<br>Section 2.4.3<br>Section 3.3.2 |
| UU 3.4.3. *Is clean water diversion a feasible and effective water management strategy to support water quality management*? | Section 2.4.2 |
| UU 3.4.5. *Are there ways to construct waste rock dumps that materially reduce the rate of oxidation of constituents of interest*? | Section 1.6.1<br>Section 2.3 |
| Responses to:<br>• LCO Line Creek water quality exceedances<br>• FRO Fording River water quality exceedances<br>• LCO Dry Creek water quality exceedances<br>• Elk and Fording rivers Order station water quality exceedances | Section 3.2.1 |

## 1.4 Scope and Scale

The water quality constituents considered under the 2022 IPA are the Order constituents of nitrate, selenium and sulphate, noting that cadmium mitigation is not required to meet SPOs or compliance limits and is therefore not included in the 2022 IPA. The temporal scale of the IPA is the period of time in which the permittee's

development activities in the Elk Valley are proposed to be carried out, plus the time required for the full effects (constituent loadings) of that development to report to the environment which is referred to as the permitted development planning period. The spatial scale of the 2022 IPA is defined in by the Designated Area and 6 MUs as described Section 1.2.1. The purpose is to demonstrate how the 2022 IPA will manage the full effects of the permitted mine plan and to form the base case for future mining permit applications.

There are three key initial inputs utilized in the IPA: the 2020 RWQM; the permitted mine plans; and the site water management plans.

- The 2022 IPA utilizes the 2020 RWQM to compare projected concentrations to limits and SPOs. The 2020 RWQM supports the evaluation of mitigation technologies and is used to develop the mitigation plan which is described in Section 2.2 and Annex A.

- The permitted mine plans are the site-specific mine plans comprised of approved permits that identify pit designs and waste placement. The permitted mine plans do not include any future planned development that has not been approved. Further details are found in Section 2.2.2 and Annex B.
- The site-specific Water Management Plans outline the plans to manage the movement and discharge of mine-influenced and non-contact water. Further details are found in Section 2.4.1 and Annex A and Annex B.

Mitigation measures included in the 2022 IPA are described in Section 2.3. For selenium and nitrate treatment, the 2022 IPA is based on the application of biological treatment through the continued operation of Teck's existing tank-based AWTFs, non-tank-based SRF's and CWDs, with the addition of future non-tank-based SRFs, sulphate treatment plus CWDs (where practical to support efficient treatment) to manage selenium, nitrate and sulphate concentrations in the Elk Valley. Removal of sulphate was successfully piloted in 2021 using membrane treatment integrated with high density sludge precipitation. This integrated sulphate removal process can now be used to remove sulphate from Elk Valley waters, either as a stand-alone process or as a bolt-on to water fed to an AWTF or an SRF. The integrated sulphate removal process can be used seasonally, and as required to meet sulphate SPOs and compliance limits in the receiving environment.

The application of these mitigation measures included the assessment of sources targeted for treatment, as well as the sequence, location, timing and capacity of mitigation (see Section 3.1).

## 1.5 Consultation and Engagement

Teck hosted six pre-submission 2022 IPA engagement meetings with EMLI, ENV, and representatives of the KNC between April 2021 and February 2022 (Table 1.6). Where necessary, information and communications were also exchanged between meetings.

**Table 1.6: Pre-submission Engagements with EMLI, ENV and KNC**

| Subject | Topics | Type | Date | Participants |
|---|---|---|---|---|
| 2022 IPA introduction and overview | IPA objectives, regulatory requirements, process, scope, inputs, planning assumptions | Meeting | Apr 21, 2021 | ENV, EMLI. KNC, Teck |
| 2022 IPA initial planning assumptions | Planning assumptions table – tank-based treatment, SRF treatment, sulphate treatment, CWD, intake water collection, outfall locations, nitrate management | Spreadsheet | Sep 24, 2021 | ENV, EMLI, KNC, Teck and consultants, Golder |
| 2022 IPA overview and method | IPA objectives, regulatory requirements, process, scope, inputs, planning assumptions, linkages with other projects & regulatory processes, external engagement, technologies, technology readiness | Meeting | Oct 7, 2021 | ENV, EMLI, KNC and consultants, Golder |

**Table 1.6: Pre-submission Engagements with EMLI, ENV and KNC**

| Subject | Topics | Type | Date | Participants |
|---|---|---|---|---|
| | assessments, planning assumptions, 2020 RWQM, IEA overview | | | |
| 2022 IPA mitigation plan update | IPA status and external engagement, LCO Line Creek compliance, water quality technology and projects strategy, development of sulphate technology | Meeting | Oct 21, 2021 | ENV, EMLI. KNC, Waterline Resources, LGL Limited, M. Tinholt, Teck |
| 2022 IPA mitigation plan update | IPA status and external engagement, sources of nitrate in waste rock, sensitivity analysis overview | Meeting | Nov 25, 2021 | ENV, EMLI. KNC, Waterline Resources, LGL Limited, M. Tinholt, Teck, Golder, SRK |
| 2022 IPA final draft Selenium and Nitrate mitigation plan | IPA status and external engagement, execution feasibility process, selenium and nitrate table of treatment and projection graphs | Meeting | Jan 20, 2022 | ENV, EMLI. KNC, Waterline Resources, LGL Limited, M. Tinholt, Teck, Golder |
| 2022 IPA final draft Sulphate mitigation plan | IPA status and external engagement, sulphate table of treatment and projection graphs, follow up on selenium and nitrate table of treatment and projection graphs | Meeting | Feb 14, 2022 | ENV, EMLI. KNC, Waterline Resources, LGL Limited, M. Tinholt, Teck, Golder |

This 2022 IPA update was informed by learning within the water quality programs as documented within four Annual AMP reports in 2018, 2019, 2020, and 2021(Teck 2019, 2020, 2021c, 2022c), and related consultation and engagement with the Environmental Monitoring Committee (EMC). In addition, the 2021 AMP Update was submitted to ENV, EMLI, KNC, and the EMC on December 15, 2021, which describes Teck's adaptive management approach to managing water quality in the Elk Valley and is updated every three years. The MQ 1 and 3 Evaluation Report is submitted to ENV, EMLI, KNC, and EMC along with the 2022 IPA which provides a comprehensive review of Teck's water quality programs and related management adjustments (Teck 2022a).

Outreach to the following COIs on water quality in the Elk Valley also occurred in 2021 and 2022:

- United States Environmental Protection Agency
- ECCC
- State of Montana Department of Environmental Quality
- State of Montana Lincoln County Commissioners
- Kootenai Tribe of Idaho

- Confederated Salish and Kootenai Tribes

The outreach with the above-listed COIs involved meetings and tours of the Elk Valley and Teck Operations.

An EVWQP 2022 IPA Overview document was developed for COI outreach and communications. This summary will be posted Teck's website in 2022 for general public access. It will be distributed to relevant BC and Canadian government agencies; State of Montana and US government agencies; Canadian and US Indigenous Nations; local governments; non-government organizations; Teck employees; local residents; and mining companies and associations with an offer for further engagement.

Teck is committed to building strong relationship with KNC, government, local communities and other COIs that creates lasting benefits for all stakeholders. Teck will continue to seek input and advice from these groups as Teck moves forward with implementing the 2022 IPA and continuing to work towards achieving the goals of the EVWQP.

## 1.6 Linkages Between Water-Related Initiatives and the Implementation Plan Adjustment

An overview of the work Teck is undertaking on other water-related initiatives; water operations projects and permitting; and programs and management plans at the regional and operations levels is provided in this section.

### 1.6.1 Research and Technology Development Program

Teck's R&D program and focus on constituents of concern in the Elk Valley started in 2005 as the priority to remove selenium was highlighted at this time. Teck has progressed understanding of selenium chemistry, speciation, and bioaccumulation. Technology investigations began with Membrane methods like Electro-Dialysis Reversal (EDR), Reverse Osmosis (RO), Nanofiltration (NF), and Forward Osmosis (FO). All simply concentrate the soluble ions into a brine that must be subsequently treated. Due to the brine and the complexities around further treatment, Teck moved towards biological treatment. Teck from 2005 onward has reviewed over one hundred proposed technologies and have tested over thirty, resulting in an AWTF initiation in 2010 (active in 2013) and more recently the acceptance of SRFs as a viable technology in the treatment of selenium and nitrate.

The current Applied R&D Program at Teck was initiated approximately in 2011 and since then Teck has performed over a decade of research and development in the Elk Valley with the program focusing on improving the effectiveness of water treatment technologies and investigating approaches to managing constituents at source. Research and technology development under the R&D program with respect to the IPA falls into one of four programs:

- Source Control
- Non-Tank-Based Treatment
- Tank-Based Treatment
- Fundamental Studies

Teck generally follows five R&D stages when developing new or evaluating existing technologies. Those 5 stages are concept identification; preliminary lab studies, field studies or modelling; detailed lab / field studies or modelling; pilot studies; and implement as permitted technology.

In addition to Teck's R&D Program, Teck also pilots commercially demonstrated technology (i.e. technology at TRL9: *Actual technology proven through successful deployment in an operational setting*) such as the sulphate technologies piloted in 2021 as described in Section 2.3.2. Piloting objectives for commercially available technologies and larger scale R&D trials include determining the design required to achieve treatment objectives; confirmation that treatment objectives can be achieved; effluent toxicity testing; residuals characterization and to collect data to support information requirements for permitting of full scale facilities per section 5.6.4 Water Treatment of the "Joint Application Information Requirements for *Mines Act* and *Environmental Management* Act Permits" (EMPR and ENV, 2019) .

Teck continues to research and implement methods to control selenium and nitrate release at the source under UU 3.4.2 (*What is the most feasible and effective method [or combination of methods] for source control of nitrate release*?); UU 3.4.4 (*Can treatment zones be built into waste rock dumps so that constituents of interest can be removed before entering the receiving environment?*) and UU 3.4.5 (*Are there ways to construct waste rock dumps that materially reduce the rate of oxidation of constituents of interest*?)

Teck has completed its pilot of sulphate removal technologies under KU 3.3 (*Is sulphate treatment required and if so how could we remove sulphate*?) as discussed in Section 2.3.3.

Teck's goal for the R&D program is reduce KUs and identify, develop and implement new technologies and/or enhance existing technologies with the end goal of reducing long-term reliance on active water treatment and focusing on source control. Teck constructed a diversion for non-contact Kilmarnock Creek water around the Eagle Mine waste rock at FRO to reduce the quantity of impacted water transiting the rock drain underlying the mine waste rock. Three pre-diversion tracer studies were completed in 2020 and 2021 (fall 2020, spring 2021 and, summer 2021) and the first of three post-diversion tracer studies was completed in the fall of 2021. Tracer studies provide additional insights into the local groundwater/surface water interactions surrounding the existing Kilmarnock Creek channel, located downstream of the mine rock spoil.

Recent research of mine-impacted watersheds in the Elk Valley suggests that diversions of this type will reduce the volume of mine-rock-influenced water in the rock drain, but it is unclear whether diversions will reduce the total chemical load reporting downstream. Teck identified the diversion project as an opportunity to test this hypothesis by systematically evaluating the influence of a non-contact water diversion on chemical load reporting through a mine rock spoil and rock drain. For more information, please refer to Section 2.4.

Further information on technologies utilized in the 2022 IPA are provided in Section 2.3 as well as in the 2021 Annual AMP Report (Teck 2022c).

### 1.6.2 Current Water Mitigation Projects Under Development

The table below provides a summary of water treatment facilities that are in Teck's project stage gate process and the associated permit status as applicable.

**Table 1.7: Water Treatment Facilities in Teck's Project Stage Gate Process at the Time of the 2022 Implementation Plan Adjustment**

| Treatment Type | Water Treatment Facility | Planned Operational Date [1] | Hydraulic Capacity Up To ($m^3$/day) | Project Status |
|---|---|---|---|---|
| Selenium and Nitrate | FRO-N 1 SRF Phase II | December 31, 2023 | 20,500 | Project in execution stage and facility under construction and planned to start commissioning Nov 2022, pending approval of operational permits. Operations permit applications submitted May and June 2022 and currently under review. |
| | EVO SRF Phase II (Dry Creek) [5] | September 30, 2023 | 4,000 | Project in execution stage and ready to commence construction, pending approvals. Construction applications submitted and under review. |
| | FRO-N 1 SRF Phase III | December 31, 2025 | 10,000 | Prefeasibility engineering studies underway. Baseline studies and site investigative field programs underway to support future permit applications. |
| | LCO Dry Creek Conveyance & Supplementation (C&S)[2] | Q1 2023 [3] | 30,000 | Project in execution stage. Construction & Operations applications submitted in March 2022 and under review.[2] |
| | LCO North Line Creek (NLC) SRF Phase I[4] | December 31, 2025 | 12,500 | Prefeasibility engineering studies are underway, including options analysis. Baseline studies and investigative field programs underway to support future permit applications. |
| Sulphate | LCO Phase I | December 31, 2025 | 2,500 | Included with as part of the LCO North Line Creek (NLC) SRF Phase I project |

[1] The operational date is the date when facility commissioning activities are completed.
[2] It is acknowledged that C&S is not treatment, but a management option to improve water quality in LCO Dry Creek. The LCO C&S facility was identified in the LCO Dry Creek Water Management Plan and in the Best Achievable Technology (BAT) Assessments for the period 2022-2025 as the interim management option to improve water quality in LCO Dry Creek in the fastest time possible while future water treatment for LCO Dry Creek can be designed, permitted and constructed (treatment of LCO Dry Creek planned as a source in LCO NLC SRF Phase I).
[3] Provincial and federal applications required for the LCO C&S facility have been submitted and are currently in the regulatory review process. Information requests and uncertainty in timelines associated with federal review of the *Fisheries* Act authorization application has meant that both provincial and federal reviews and permit decisions will now carry into 2023, meaning the March 31, 2023 planned operational date for C&S is no longer achievable. As such the expected commissioning for C&S is now delayed approximately 1 year to Q1 2024, subject to receipt of all provincial and federal approvals or any other orders or outcomes related to a potential HADD during early works construction to achieve this revised date. Teck has, therefore, not been able to update the water quality modelling to reflect the 1 year delay in time to support the July 31 submission date for 2022 IPA. As such the March 31, 2023 operational date for C&S and associated modelling results has been retained in the 2022 IPA; however Teck is currently updating the water quality modelling to reflect a Q1 2024 operational date for C&S and will provide that information to the Province and KNC as an update to the BAT assessments for LCO Dry Creek.
[4] Selenium and nitrate treatment of LCO Dry Creek is currently planned via LCO NLC SRF, ongoing engagement on the overall LCO Dry Creek proposed mitigation plan may result in changes to treatment, capacity, and timing from what is included in the 2022 IPA.
[5] Mitigation included in the 2022 IPA for EVO Dry Creek is for future permitted waste rock that was assessed and approved under the Baldy Ridge Extension (BRE) Environmental Assessment Certificate (EAC) and EVO C-2 *Mines Act* permit amendment that has not yet been placed in the EVO Dry Creek watershed. As a condition of the BRE EAC, Teck is required to prepare a Dry Creek and Harmer Creek Water Quality Management Plan 90 days prior to placement of waste rock in Dry Creek to show compliance with the Harmer Compliance Point and the treatment, capacity and timing outlined here may change as a result of that plan.

### 1.6.3 Additional Water-Related Initiatives

Additional initiatives that are related to the 2022 IPA are described in Table 1.8.

**Table 1.8: Additional Water-related Initiatives Related to the 2022 Implementation Plan Adjustment**

| Initiative | Description | Key Linkage to the IPA |
|---|---|---|
| Site 5 Year Reclamation and Mine Plans | Includes details of the mining and reclamation activities for the permitted mine plans at each site. Background information on the operation is provided, including descriptions of the regulatory and environmental context, communities of interest and Ktunaxa Nation title, rights and interests. It outlines mine designs and reclamation planning for both the first five years of the permitted mine plans and a conceptual plan spanning to the end of closure. The plan is a 'living document' that will be updated every five years and as required for permitting of changes in the mine plan. | Within the site 5 Year Reclamation and Mine Plans there is a volume dedicated to Water Management. It describes Teck's plan for water management at each site, including water management structures, water quality, water quantity and conceptual closure plans. It includes information on water treatment and water infrastructure. Tools such as the site Mine RWQM that are used for current mining and planning will also be utilized at time of closure.<br>The site 5 Year Reclamation and Mine Plans were submitted Sep 30, 2021 for FRO, Dec 31, 2021 for LCO, Mar 31, 2022 for GHO and Jun 30, 2022 for EVO and are updated every 5 years. |
| Calcite Management Plan | A regional plan developed to identify management solutions to the issues of calcite precipitation in receiving environment waters as set through the EVWQP. Treatment plans for calcite management are prevention via anti-scalent addition systems and calcite remediation via physical excavation and stream bed restoration. | Together, the IPA and the CMP are developed to manage constituents in relation to EMA Permit 107517 and in alignment with limits/targets set out within the 2014 EVWQP. Calcite prevention projects are often bolt-on antiscalant based solutions to existing and planned AWTF and SRF projects outlines within the IPA.<br>Both the 2022 CMP and 2022 IPA will be submitted by July 31, 2022 as required by permit and are updated every 3 years. |
| Tributary Management Plan (TMP) | A plan developed to support the maintenance of healthy aquatic ecosystems while considering the sustainable balancing of the environmental, economic, and societal costs and benefits. Within the TMP, the Tributary Evaluation Program provides a compilation, analysis and interpretation of the data for tributaries to the Elk and Fording Rivers, assessment of potential for rehabilitation and/or mitigation, and prioritization of tributaries for potential future habitat rehabilitation. | For each prioritized tributary, the TMP summarizes a holistic watershed view of projects for water quality improvement along with rational for new adjusted rank, habitat rehabilitation projects for DFO offsetting (completed or proposed), projects for calcite management, and habitat rehabilitation projects.<br>The 2020 TMP was submitted July 30, 2021 and is updated every 3 years. |
| Nitrogen Source Control Plan | Site Nitrogen Source Control Plans are comprehensive plans that encompasses all water management and blasting practices at each site related to nitrogen management and controlling the release of nitrogen from the source. These plans set out management practices and responsibilities that relate to the | The 2022 IPA section 2.4.2 provides an overview nitrate management. The 2022 IPA does not include any benefit for nitrate management at this time due to recent findings of naturally present source of nitrogen in the waste rock called exchangeable ammonium. However, the 2022 |

**Table 1.8: Additional Water-related Initiatives Related to the 2022 Implementation Plan Adjustment**

| Initiative | Description | Key Linkage to the IPA |
|---|---|---|
| | management of water effluent discharge as required by each site's existing regulatory needs. | IPA does include a sensitivity analysis on nitrate management in section 3.3.2.<br>Site Nitrogen Source Control Plans are submitted annually on May 31.<br>Supports the evaluation of MQ 1 (*Will water quality limits and Site Performance Objectives be met for selenium, nitrate, sulphate and cadmium?*) and can inform adjustments to the IPA. |
| Site Metal Leaching (ML) and Acid Rock Drainage (ARD)Plans | The objective of the site ML and ARD Plans are to determine when Potentially Acid Generating (PAG) waste rock may be encountered during operations within currently authorized pit designs and to describe the management of this material such that potential for ML/ARD in waste rock is minimized to the extent practicable both during active operations and at closure; operational flexibility is maintained by incorporating PAG waste rock monitoring and management activities into normal mining operations; requirements for active management of the site following the end of operations are minimized; and ARD potential, the potential for pH depression and accelerated leaching of heavy elements (such as cadmium) is controlled. The site ML and ARD plans are intended to cover active and future mining with monitoring being conducted on a routine basis. | PAG waste rock is included in the RWQM source terms which supports updates of the evaluation of mitigation technologies in the IPA.<br>The site ML/ARD Plans were submitted Aug 1, 2019 for FRO, Jan 1, 2021 for LCO, Feb 6, 2019 for GHO and Mar 28, 2018 for EVO. |
| Monitoring Programs | **Regional Aquatic Effects Monitoring Program (RAEMP)**<br>The RAEMP provides spatially comprehensive monitoring and assessment of potential mine related effects to on aquatic environment downstream of Teck's Elk Valley mines. Data from this assessment will determine if additional management responses needed.<br>**Local Aquatic Effects Monitoring Program (LAEMP)**<br>The LAEMP program includes monitoring and reporting on the aquatic conditions in areas local to Teck's different Elk Valley mine sites. The data collected through the LAEMPs supports the evaluation of the potential | **RAEMP and LAEMP**<br>The RAEMP and LAEMP support the development, implementation, adaptive management, and updates to the RWQM and the evaluation of mitigation technologies in the IPA.<br>The last RAEMP report was submitted November 30$^{th}$ 2020 and covers monitoring from 2017-2019.The RAEMP is updated every three years.<br>LAEMP programs include Fording River, Greenhills, Line Creek, Coal Mountain, LCO – Dry Creek, and Elkview.<br>Submittal Dates:<br>• LCO LAEMP - April 30, 2022<br>• FRO LAEMP - May 31, 2022 |

**Table 1.8: Additional Water-related Initiatives Related to the 2022 Implementation Plan Adjustment**

| Initiative | Description | Key Linkage to the IPA |
| --- | --- | --- |
| | The RAEMP and LAEMP were designed with input and advice from the EMC; is currently being implemented across the watershed; and is reviewed regularly with the EMC.<br><br>**Regional and Local Water Quality and Flow Monitoring Programs**<br>Regional Surface Water Quality Monitoring Program (annual report submitted March 31, 2022)<br>• Includes collection of monitoring data for discharges and receiving environment water sampling sites set out in EMA Permit 107517.<br>Regional Surface Flow Monitoring Program (submitted as an appendix to the Regional Surface Water Quality Monitoring Program annual report submitted March 31, 2022)<br>• Includes collection flow data required at the appropriate frequency, grade (quality) and spatial distribution to support the range of data uses<br>Regional and Site-Specific Groundwater Monitoring Programs (annual report submitted March 31, 2022)<br>• Includes collection and comparison of groundwater quality and quantity to relevant screening values as well as historical data. These comparisons are done on both a site specific and regional level and are reported out on an annual basis. Groundwater chemistry is also compared to surface water chemistry to facilitate an understanding of the interactions and groundwater pathways.<br>The Regional Surface Water Quality and Regional Surface Water Flow Monitoring Programs were designed with input and advice from the EMC; are currently being implemented across the watershed; and are reviewed regularly with the EMC. | • EVO LAEMP - June 30, 2022<br>• CMm LAEMP - June 30, 2022<br>• LCO DRY LAEMP - April 30, 2022<br>• RAEMP - June 30, 2023<br>Supports the evaluation of MQ 5 (*Does Monitoring indicate that mine-related changes in aquatic ecosystem conditions are consistent with expectations?)* and can inform adjustments to the IPA.<br><br>**Regional and Local Water Quality and Flow Monitoring Programs**<br>Supports updates to the RWQM, comparison to limits and SPOs, and the evaluation of mitigation technologies in the IPA, and the evaluation of Management Question 1 under the Adaptive Management Plan. |
| UFR and Harmer Grave West Cutthroat | In response to a decline in the abundance of subadult and adult Westslope Cutthroat Trout (WCT; Oncorhynchus clarkii lewisi) in | Water quality in the Elk Valley is managed through the EVWQP, the IPA, and CMP processes. Although this process is directed outside of |

**Table 1.8: Additional Water-related Initiatives Related to the 2022 Implementation Plan Adjustment**

| Initiative | Description | Key Linkage to the IPA |
|---|---|---|
| Trout Recovery Projects | the upper Fording River (UFR) Teck initiated an Evaluation of Cause (EoC) process to investigate and report on the cause of the decline between 2017 and 2019. An EoC was also initiated for within the Harmer-Grave Watershed (HGW) upstream of the Harmer Sediment Pond to investigate and report on the cause of the decline between 2016 and 2019.<br><br>**UFR EoC**<br>Based on EoC findings, Teck assembled a team of qualified scientists to develop a recovery action plan for UFR WCT (the "Action Plan"). The Action Plan focuses on three pillars of WCT habitat: physical habitat, water quantity, and water quality, and identifies specific recovery projects prioritized within a five-year holistic watershed plan to restore WCT habitat and create conditions that:<br>• Support the recovery of the WCT population following the decline observed in 2019;<br>• Promote the long-term sustainability of the WCT population by mitigating environmental impacts that jeopardize the health of the WCT population; and,<br>• Build resilience in the UFR WCT population by enhancing the population's natural capacity of the population to withstand disturbance and its ability to recover following disturbance.<br><br>**Harmer-Grave EoC**<br>Preliminary findings of the EoC indicate that the population decline was primarily associated with a loss of juveniles due to failed, or poor, recruitment during this period. The HGW WCT Recovery Project has been developed to address the population decline by supporting the WCT population recovery while building long-term population resilience. Teck has assembled a team of qualified scientists to develop a recovery action plan for HGW | the UFR Recovery Project, water quality is a key consideration of recovery and therefore a summary of the EVWQP process, existing and planned treatment, and expected outcomes was considered relative to the WCT population and identified recovery projects which were prioritized within the Action Plan. |

**Table 1.8: Additional Water-related Initiatives Related to the 2022 Implementation Plan Adjustment**

| Initiative | Description | Key Linkage to the IPA |
|---|---|---|
| | WCT (the "Action Plan"). The Action Plan focuses on three pillars of WCT habitat: water quality, water temperature, and physical habitat, and will identify specific recovery projects prioritized within a five-year holistic watershed plan to restore WCT habitat and create conditions that:<br>• Support the progressive recovery of the WCT population to pre-decline conditions with regards to adult, sub-adult, and juvenile densities and population structure.<br>• Promote the long-term sustainability of the WCT population by mitigating environmental impacts that jeopardize the health of the WCT population in the HGW.<br>• Build resilience into the HGW WCT population by enhancing the population's natural capacity to adapt to change from natural and anthropogenic stressors and environmental disturbances. | |
| Site Environmental Management System | Description of the processes and procedures established, implemented and maintained to meet the requirements of effective environmental management. These requirements are outlined in the ISO 14001. | Water treatment operations facilities are operated within the scope of the Water Quality Management Environmental Management System. This management system puts in place process to identify and mitigate environmental risk and maintain compliance with regulatory requirements. Programs supporting this management system include an environmental risk register, regulatory compliance and incident management system, environmental training program, and ongoing continual improvement objectives. |

# 2 Implementation Plan Adjustment Update Process

## 2.1 Overview

The process for updating the implementation plan for water quality mitigation for nitrate, selenium and sulphate was iterative and informed by AMP evaluations under MQ 3, with input from MQ 1. The first step in this process was the update of the RWQM and the submission of the 2020 RWQM. Compliance was evaluated upon completion of the 2020 RWQM update and an adjustment to the implementation plan for water quality mitigation for nitrate, selenium and sulphate was determined to be required. Mitigation technologies included in the plan were evaluated (considering which technologies from the R&D program are sufficiently advanced to incorporate) and the 2020 RWQM was adjusted to include the inputs and assumptions for these relevant treatment technologies. The mitigation planning process is iterative and various mitigation scenarios were run through the RWQM to determine appropriate adjustments to mitigation timing and capacity. Selenium and nitrate mitigation was determined first, followed by sulphate mitigation. The 2022 IPA is informed by new and updated findings since the previous IPA was completed, including those from the 2020 RWQM and the reduction of KUs.

The process to develop the 2022 IPA included refinements to both the water quality management decisions (i.e., the sources to target for treatment and how quickly treatment could be constructed) and data based inputs (i.e., the effluent quality from treatment, release rates, and water availability for treatment) used to develop the 2019 IPA. The updated understanding was reflected in the water quality modelling completed to support the development of the 2022 IPA and is expected to be adjusted over time.

Adjustments to the permitted mine plans were not considered in the development of the 2022 IPA for the following two reasons: (1) it is a requirement that the IPA include a mitigation plan for the permitted development for each operation, and (2) adjustments to the locations and schedule of future permitted waste rock have no influence on the near-term compliance challenges as projected concentrations of Order constituent over the next five to ten years are influenced primarily by waste rock that has already been placed.

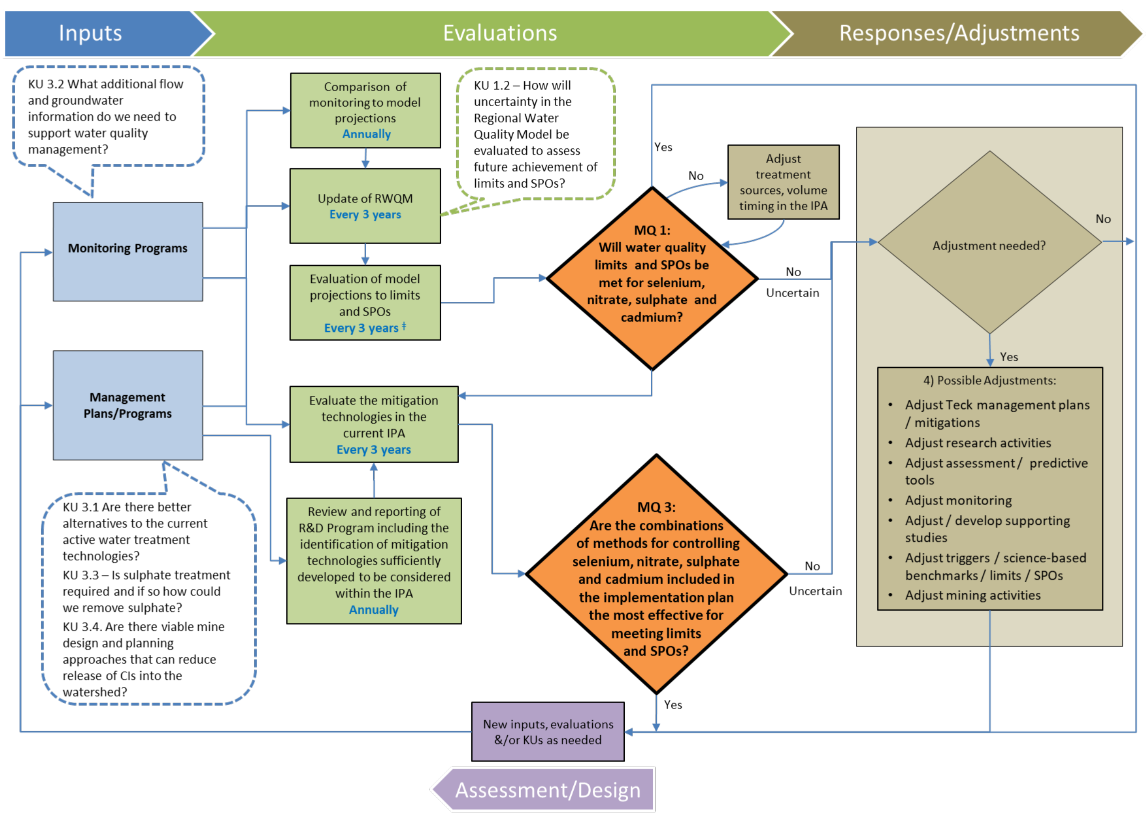
Preparation of the 2022 IPA involved the following steps, first to determine the mitigation plan for selenium and nitrate, and then to determine the mitigation plan for sulphate:

- Adjust the 2020 RWQM to accommodate changes to the permitted mine plans and water management (Section 2.2.1 and Section 2.2.2)
- Evaluate the mitigation technologies to be included in the plan (Section 2.3)
- Confirm planning basis and assumptions for treatment effectiveness (Section 2.2.3)
- Formulate the mitigation plan for the 2022 IPA (the methods are detailed in Annex B and the results are presented in Section 3):
    - Review, and where appropriate, update source prioritization of the sources targeted for treatment.
    - Identify treatment capacity to meet the long-term compliance limits.

- Identify additional treatment capacity to meet the long-term SPOs through 2053.
- Phasing of mitigation over time to meet the short- and medium-term compliance limits and SPOs through 2053, to the extent possible.
- Optimization of water management to support meeting short-, medium-, and long-term compliance limits and SPOs and reduce reliance on water treatment.

- Identify additional potential treatment requirements through the far-future (post 2053).
- Complete sensitivity analyses on specific model assumptions and inputs in order to understand the potential risks that each category of uncertainty poses to mitigation planning (Section 3.3 and Annex B).
- Evaluate potential effects to aquatic health through completion of the integrated effects assessment (Annex E).

Updates to the 2020 RWQM and the evaluation of the mitigation technologies in the 2022 IPA support the evaluations of the answers of MQ 1 and MQ 3, respectively, reported in the MQ 1 and 3 Evaluation Report (Teck 2022a). For additional information on the evaluation approach for MQ 1 and MQ 3, including the list of possible adjustments, please see the 2021 AMP Update (Teck 2021b).




Note: this is a simplified version of the MQ 1 and 3 combined process flow diagram that focuses on the evaluations of the answer to the MQs

Figure 2.1: Overview of the Process for Updating the RWQM and IPA

## 2.2 Water Quality Modelling, Planning Basis and Assumptions

The RWQM was developed by Teck to examine how activities at its steelmaking coal mines in the Elk River watershed could affect water quality in the Elk River and Fording River, as well as tributaries located in and around each operation. The 2014 RWQM was used to support the development of the EVWQP. Teck is required to update the RWQM every three years in accordance with EMA Permit 107517, Section 9.9 and the *Mines Act* C-Permits for each operation. There have been two updates to the RWQM since the first model was developed for the EVWQP in 2014, with the most recent update being the 2020 RWQM.

The 2020 RWQM update was informed by improved modelling methods and an improved understanding of the system resulting from the advancement of work to reduce KU 1.2 (*How will uncertainty in the RWQM be evaluated to assess future achievement of limits and SPOs*?) This was accomplished through the refinement of historical mining and water management information, conceptual models for constituent release, and the continuation of studies in key tributaries and mainstem locations. Work to reduce four UUs supported the reduction of KU 1.2:

- UU 1.2.2. Can the RWQM be improved in specific catchments where mitigation decision are required and uncertainty is high?
- UU 1.2.3. How may selenium and sulphate release rates change over time?
- UU 1.2.4. What mechanisms are causing the reduction in mass observed between tributaries and at monitoring stations in the mainstems?
- UU 1.2.5. How do the nitrate source terms need to be adjusted to account for the loading from exchangeable ammonium (naturally present in the waste rock) in addition to the blasting residuals?

Updates to the 2020 RWQM included:

- transition to a climate driven approach for hydrology modelling
- refinements to the waste rock hydrological and geochemical conceptual models, incorporating updated understandings of the mechanisms driving constituent release and transport in new and mature waste rock spoils
- implementation of a waste rock hydrology module
- explicit incorporation of groundwater flow pathways, including groundwater bypass, using the findings from completed and ongoing investigations
- updated source terms from historical operational data (waste rock placement, waste by drainage, and groundwater bypass of discharge monitoring stations)

Modifications made to the 2020 RWQM since the submission of the 2020 Elk Valley Regional Water Quality Model Update (Teck 2021a) are described in detail in Annex A. These changes were made prior to undertaking the process of updating the mitigations for the 2022 IPA and were to address feedback received during the review of the 2020 RWQM, model modifications to support mitigation functionality, and updates related to permit approvals received since the 2020 RWQM was updated. They are grouped into two categories: changes made to the 2020 RWQM and modifications made to model inputs related to mine site conditions. Along with the RWQM, the 2022 IPA includes key learnings and challenges outlines in the MQ 1 and 3 Evaluation Report submitted by July 31, 2022.

The 2020 RWQM, like its predecessors, uses a simplistic representation of Koocanusa Reservoir, whereby the reservoir is treated like a river. Inflows from the Elk River mix with inflows from the Kootenay River and the Bull River to produce estimates of fully mixed concentrations of the reservoir. Storage volumes and dam operations vary seasonally and from year to year, and both affect reservoir water quality. The RWQM tends to overestimate measured concentrations of selenium within the reservoir, and projections are bias-corrected to support mitigation planning. An alternative modelling approach to Koocanusa Reservoir was initiated with the intention of explicitly representing water storage and dam operations to gain a better understanding of the processes that influence reservoir water quality. This model is referred to as the Koocanusa Reservoir Module (Teck 2021d) and projections for selenium are included for comparison with the 2020 RWQM projections in the 2022 IPA.

### 2.2.1 Modifications Made to the 2020 Regional Water Quality Model

Updates were made to the 2020 RWQM following the submission of the 2020 RWQM to support the 2022 IPA including:

- waste rock volumes and explosives information updated to the end of 2020
- updated permitted mine plans to reflect recent approvals (i.e., FRO 2/3 Pit, FRO Swift Phase I Pit Re-design, LCO East Coal Rejects Dump Extension, EVO Cedar North In-pit Backfill Extension)
- updates to the treatment model logic for SRFs based on results from EVO SRF and advancement of characterization of the FRO-N 1 SRF
- updates to reflect the refinements included in the GHO Site F MCR (Mixed Coal Rejects) Storage Facility Application

Detailed information around updates made to the 2020 RWQM between the submission in March 2021 and the development of the 2022 IPA are documented in Annex A. Teck has undertaken significant field and laboratory evaluations to support the quantification of the benefits of the changes to explosive management practices for mitigation planning (through adjustments to the RWQM source terms). However, there have been new findings on the sources of nitrogen in Teck's mine waste since the 2020 RWQM update and as a result Teck assumed no benefits to nitrate concentrations from improved blasting practices. The presence of natural leachable nitrogen, in the form of ammonium ions, was detected during the analytical testing of rock samples. Work to understand this is captured under UU 1.2.5 (*How do the nitrate source terms need to be adjusted to account for the loading from exchangeable ammonium [naturally present in the waste rock] in addition to the blasting residuals*?). It is important to highlight that leachable ammonium is not a new source of nitrogen, and that it has been predominantly accounted for in the current empirically derived nitrate source terms in the RWQM, but was incorrectly attributed to blasting residuals alone. Further details on nitrate management can be found in section 2.4.3.

### 2.2.2 Modifications Made to Model Inputs Related to Mine Site Conditions

The 2019 Permitted Mine Plans are used in the 2020 RWQM to assess the 2022 IPA. The Permitted Mine Plans include existing waste rock and water management through to the end of 2020 and all permitted development for Teck's Elk Valley operations. The Permitted Mine Plan does not include any future planned development that has not been approved. The 2020 RWQM was modified to extend further into the future to accommodate projections for the full effects of the permitted development (full effects of loading from the permitted waste rock and from pit decanting).

The permitted mine plans are the site-specific mine plans comprised of approved permits that identify pit designs and waste placement. The permitted mine plans do not include any future planned development that has not been approved.

The site mine engineering teams routinely review and update mine plans. The mine plans may be adjusted based on a variety factors including new data collected through surveying, drill hole data, geotechnical analysis, and geological model interpretations. All changes to the permitted mine plans are assessed for their potential impact or benefit to the environmental and other Teck programs.

If these changes are deemed to be significant, they would be the subject of a submission to the EMLI and/or the ENV. Depending on their scale and scope, submissions may take the form of a Notice of Departure, a *Mines Act* permit amendment application or a Joint *Mines Act* and *Environmental Management Act* amendment applications which may include water quality modelling if applicable.

Teck provides monthly updates on these projects to the Province through the update and review of the Application Summary Tables.

All approved changes to the placement of mined rock and tailings are captured in the updates to the RWQM or the subsequent IPA which are submitted every three years in accordance with permit conditions associated with the Elk Valley Water Quality Plan.

Updates that were completed to advance the 2022 IPA are:

- permitted mine development projects included in the RWQM
- waste rock placement schedule by drainage
- changes in topography, drainage boundaries and mining features due to advancing mine development (e.g., the creation of pits, waste rock spoils and the deposition of coal rejects), and
- water management activities (both operational and closure).

A summary of existing and anticipated cumulative waste rock volumes through to the end of permitted mining activities is provided in Table 2.1.

**Table 2.1: Cumulative Waste Rock Volumes in the 2022 Implementation Plan Adjustment**

| Operation | Waste Rock [million BCM] [1] | |
|---|---|---|
| | Existing [2] | Cumulative Permitted End of Mining |
| Fording River [3] | 3,036 | 4,787 |
| Greenhills[3] | 808 | 1,186 |
| Line Creek | 797 | 1,445 |
| Elkview | 1,787 | 3,304 |
| Coal Mountain | 311 | 311 |
| **Total** | 6,739 | 11,033 |

[1] Annual waste rock placement schedules are included in Appendix A.
[2] Actual waste rock volumes to the end of 2020.
[3] Waste rock placed in the Swift and Cataract watersheds by both Fording River and Greenhills are listed in this table as part of Fording River.
BCM = bank cubic metre.

Changes to site conditions considered in the 2022 IPA are outlined in Table 2.2, identifying how they compare to the information considered in the 2019 IPA and the 2020 RWQM.

**Table 2.2: Changes to Site Conditions Between the 2019 IPA, the 2020 RWQM Update and the 2022 IPA**

| Theme | 2019 IPA | 2020 RWQM Update – Permitted Mine Plan | 2022 IPA |
|---|---|---|---|
| Planning Window | 2017 to far future (>2100) | 2020 to far future (>2100) | 2021 to far future (>2100) |
| Mining and Mine Related Areas included in the RWQM | FRO:<br>• Turnbull South, Eagle 4, Eagle 6, Lake Mountain, Swift, Henretta<br>GHO:<br>• Cougar South (historical Cougar North, Phases 3, 4, 6), Phase 7 (Cougar Pit Extension [CPX])<br>LCO:<br>• Phase I: Horseshoe Ridge (historical mining), Burnt Ridge South, Mine Services Area West (MSAW), South<br>• Phase II: Mount Michael (MTM) 1, 2 and 3 pits, Burnt Ridge 1, 2 and 3<br>EVO:<br>• Baldy Ridge, Natal, F2, Adit Ridge, Cedar<br>CMm:<br>• 6, 14, 34 and 37 Pits | FRO:<br>• FRO Swift South Spoil permit amendment<br>GHO:<br>• Phase 7-1 permit amendment<br>LCO:<br>• No new or amended permitted mining areas<br>EVO:<br>• Cedar North permit amendment, Permit 425 amendment for an increase to West Fork Tailings Facility [WFTF] flows)<br>CMm:<br>• No new or amended permitted mining areas as CMm is in care and maintenance | FRO:<br>• FRO 2 Pit and 3 Pit Tailings Relocation (to Swift South Spoil); FRO-N SRF Phase 2 Design Basis<br>GHO:<br>• GHO Tailings Management Project<br>LCO:<br>• East Coal Rejects Dump Extension<br>EVO:<br>• Cedar North In-pit Backfill Extension<br>CMm:<br>• No new or amended permitted mining areas as CMm is in care and maintenance |
| Waste Rock Volumes | Includes existing and permitted waste rock through the permitted mine plan | Includes existing and permitted waste rock through the permitted mine plans for an increased number of sub-catchments due to increased spatial resolution and subdivision of catchments.<br>Incorporates reconciled historical waste rock volumes by drainage, based on internal audits completed by Teck. | Includes existing waste placed through to the end of 2020 and permitted waste rock through the permitted mine plans |
| Watersheds | The 2019 IPA was based on the 2017 RWQM, without the addition of any sub-watersheds. | Increased local-scale delineation at each operation relative to the 2017 RWQM, with the addition of supplementary sub-watersheds to support local-scale modelling. | Additional sub-watersheds included in GHO and FRO to support local-scale modelling of additional permitting projects. |
| Water Management Activities | FRO:<br>• Some pits were modelled as reservoirs (Swift, Turnbull South), tailings water management was considered at the Fording South Tailings Pond (STP) and Turnbull Tailings Storage Facility (TSF), and consumptive water uses were implicitly considered.<br>GHO:<br>• The Cougar South and Phase 7 pits were modelled as reservoirs, pumping records for the Cougar Phase 3 Pit in 2015 were considered, and consumptive water loss at the process plant were incorporated.<br>LCO:<br>• Minimal active water management was modelled. Pits at LCO Phase I were not modelled as reservoirs, and no tailings water management was considered as there is not a TSF at LCO.<br>EVO:<br>• Generally consistent with the EVO Baldy Ridge Extension (BRE) water management plan, with some refinements:<br>• Revision of flows from the WFTF to Erickson Creek from 2005 to 2016;<br>• Revision of water management at Cedar Pit/Baldy Ridge Pit 6 from 2012 to 2016; and<br>  • Change to future pumping rates from Cedar North [tunnel water] to the WFTF | The representation of water management activities in the 2020 RWQM constituted a notable update from the 2019 IPA to the 2020 RWQM Update, with additional details incorporated at each operation:<br>FRO:<br>• Additional pits were modelled as reservoirs (e.g., Eagle 4, Eagle 6 West Pit, Eagle 6 Pit to Clode);<br>• Detailed storage capacity curves were developed for large pits (e.g., Swift Pit, Eagle 4, Eagle 6 Pit to Clode);<br>• Dust suppression withdrawal and other consumptive use information was incorporated where available (e.g., from the Clode Creek catchment and Swift Pit catchment);<br>• Pit dewatering information was updated, using available data and best understanding of historical information from Teck (e.g., Eagle 4 Pit, Shandley Pit);<br>• Information on make-up water sources to the process plant were updated (e.g., at FRO Wash Plant / North Loop Settling Pond (NLP) and Fording STP, Shandley, Turnbull TSF; and<br>• Tailings water management information was updated (e.g., rates of dredging from the STP to the Turnbull TSF).<br>GHO:<br>• Additional pits were modelled as reservoirs (e.g., water stored in Phase 3 and Phase 6 pits historically);<br>• Detailed storage capacity curves were developed for large pits (e.g., Combined Phase 3, 4/5, 6 Pits at GHO, Phase 7 Pit, historical Phase 6 Pit);<br>• Dust suppression withdrawal and other consumptive use information was incorporated where available (e.g., from all GHO pits);<br>• Pit dewatering information was updated, using available data and best understanding of historical information from Teck (e.g., Phase 6 dewatering to Cataract, Mickelson and Leask, Phase 3 dewatering to Leask and Wolfram);<br>• Information on make-up water sources to the process plant were updated (e.g., use of Phase 3 and Phase 6 pit water at the process plant); and<br>• Tailings water management information was updated (e.g., historical use of groundwater wells at the process plant, groundwater seepage at the tailings facility and closed-circuit flows at the TSF)<br>LCO: | Water management activities at each operation were updated to reflect new permits, recent permit submissions, and additional records collected since the 2020 RWQM was implemented (where available):<br>FRO:<br>• Make-up supply to the wash plant was updated to reflect the FRO-N SRF Phase 2 Design Basis (i.e., future Eagle 4 make-up supply replaced with increased supply from TSF).<br>GHO:<br>• Updates were made to water management activities involving the wash plant/TSF loop to reflect the Tailings Management Project, including seepage and wash plant demand calculations.<br>EVO:<br>• Water management around the tunnel and tailings flows were updated to reflect Cedar North in-pit backfill extension project. |

**Table 2.2: Changes to Site Conditions Between the 2019 IPA, the 2020 RWQM Update and the 2022 IPA**

| Theme | 2019 IPA | 2020 RWQM Update – Permitted Mine Plan | 2022 IPA |
|---|---|---|---|
| | | • Additional pits were modelled as reservoirs (e.g., Horseshoe Ridge, North Line Extension (NLX) and NLC pits at LCO Phase 1);<br>• Detailed storage capacity curves were developed for large pits (e.g., Burnt Ridge North (BRN) 3 pit at LCO Phase 2);<br>• Dust suppression withdrawal and other consumptive use information was incorporated where available (e.g., use at LCO Phase 1);<br>• Pit dewatering information was updated, using available data and best understanding of historical information from Teck (e.g., direction and dates of future dewatering from BRN and MTM pits);<br>• Information on water diverted to the LCO AWTF were updated using observed flows (e.g., from the WLC and Line Creek intakes); and<br>EVO:<br>• Additional pits were modelled as reservoirs (e.g., South Pit, F2 pits, Cedar North);<br>• Detailed storage capacity curves were developed for large pits (e.g., Natal West Pit, F2 Pit, Combined Natal Pit at end of mining);<br>• Dust suppression withdrawal and other consumptive use information was incorporated where available (e.g., from EVO pits, Breaker Lake, F2 Pit);<br>• Pit dewatering information was updated, using available data and best understanding of historical information from Teck (e.g., at Natal West Pit, Breaker Lake, Cedar Pit);<br>• Information on make-up water sources to the process plant were updated (e.g., Elk River use, tunnel water diversion); and<br>• Tailings water management information was updated (historical use of Lagoon D, historical and future tailings rates to the WFTF).<br>CMm:<br>• The latest information from the local-scale water quality model was used. | |

### 2.2.3 Planning Basis and Assumptions

The 2022 IPA was developed based on refinements and additions to both the management decisions (i.e., the sources to target for treatment and how quickly treatment could be constructed) and inputs (i.e., the effluent quality from treatment, release rates, and water availability for treatment) used to set the 2019 IPA. These collectively constitute the planning basis on which the 2022 IPA was formed. The planning basis for the 2022 IPA is summarized in Table 2.3 and input assumptions for water treatment planning used to inform the 2022 IPA are summarized in Table 2.4 and in Annex A. Monthly average influent and effluent selenium and nitrate concentrations for the WLC AWTF and the EVO SRF are summarized in Table 2.5 and Table 2.6, respectively, to support the assumptions related to treatment performance included in the 2022 IPA.

**Table 2.3: 2022 Implementation Plan Adjustment Planning Basis**

| Parameter | Planning Basis | Rationale |
|---|---|---|
| **Water Quality SPOs** | SPOs at Order Stations as described in EMA Permit 107517 | SPOs at Order stations were based on the long-term objectives from the EVWQP. They were set based on the effects benchmarks and integrated assessment completed for the EVWQP. |
| **Water Quality Compliance Limits** | Compliance limits at compliance points as described in EMA Permit 107517 | Compliance limits at compliance points were set based on the 2014 RWQM, and the IIP, which had limited data at some of the compliance points. Resulting modelled concentrations at compliance points will be compared to compliance limits. |
| **Water Constituents** | Selenium, nitrate, sulphate, and cadmium as described in EMA Permit 107517 | Removal of cadmium is not currently required to meet SPOs. |
| **Mine Plan** | 2019 Permitted Mine Plans as updated for the 2022 IPA as defined in EMA Permit 107517 | 2019 permitted mine plan was updated between the submission of the 2020 RWQM and 2022 IPA to account for recent approvals (GHO Site F application, FRO 2/3 Pit, FRO Swift Phase I Pit re-design, LCO East Coal Rejects Dump Extension, EVO Cedar North In-pit Backfill Extension). Waste rock volumes and explosives information were updated to the end of 2020. Detailed information about model updates can be found in Annex A. |
| **Water Management Plan** | 2020 Mine Water Management plan as updated for the 2022 IPA | The 2020 Mine Water Management plan was updated between the submission of the 2020 RWQM and the 2022 IPA to reflect changes to water management to support permit applications. Detailed information about model updates can be found in Annex A |
| **Water Quality Model Projections** | 2020 RWQM as updated for the 2022 IPA | See section 3.2 Project Water Quality for results |
| **Flow Conditions** | 20 climate realizations based on historical climate data | Future flow projections were developed based on the previous 20 years (1999 to 2019) of historical climate data run repeatedly through the flow component of the RWQM using a multi-realization approach. The results from the 20 realizations were imported into the water quality component of the RWQM. They were then used to produce three time-series of weekly average flows, one based on each of the following statistics: $10^{th}$ percentile (P10), median (P50) and $90^{th}$ percentile (P90). These three time-series account for variability in hydrologic patterns in projecting a corresponding range of water quality conditions. |
| **Geochemical Release Rates** | Catchment-specific average release rates as incorporated in the 2020 RWQM<br>No decay of selenium or sulphate generation | These reflect current understanding of constituent transport and release<br>Understanding of selenium and sulphate decay is preliminary and is not sufficient to support mitigation planning |
| **Mitigation Measures** | AWTF, SRFs, C&S and CWD where practical to support efficient treatment | Water treatment technologies include AWTFs and SRFs; AWTFs are consistent with the IIP and 2019 IPA and SRFs are now included as this technology has been approved at Technology Readiness Level (TRL) 7. Clean water diversions are included, where required and where practical to support efficient treatment and C&S is included at LCO Dry Creek. |
| **Sources targeted for management and sequence** | Organized by area:<br>• FRO North: Clode Creek, Liverpool Ponds / Swift Pit, Post Ponds, and Eagle Pond<br>• FRO South: Swift Creek, Cataract Creek, and Kilmarnock Creek<br>• GHO: Cougar South Pit, Leask Creek, Wolfram Creek, Thompson Creek, Greenhills Creek, and Porter Creek<br>• LCO: WLC, Mine Service Area West, North Line Creek, and Line Creek upstream of West Line Creek<br>• LCO Dry Creek: LCO Dry Creek upstream of East Tributary<br>• EVO: Erickson Creek, Natal Pit, and Baldy Ridge Pit<br>• EVO Dry Creek: EVO Dry Creek Sedimentation Pond Decant<br>These drainages will contain approximately 97% of the waste rock in the valley in 2053. | Consideration was given to both the constituent load and constituent concentrations in each potential source, with the intention to optimize water treatment (maximizing the load removal and minimizing the volume of water treated), as outlined in Annex B. |

**Table 2.4: 2022 Implementation Plan Adjustment – Summary Table of Input Assumptions for Water Treatment Planning**

| Parameter | Input | Rationale |
|---|---|---|
| **Tank-Based Treatment - Existing Facilities** | | |
| **Treatment Type** | Biological Treatment with AOP | Based on the addition of the AOP process to WLC AWTF, inclusion of AOP in the FRO AWTF-S |
| **Ramp-Up Period/Operational at 100% Capacity** | 1 year | Conservatively, no benefit of treatment is incorporated into the model until one year after the biological seeding date for an AWTF.<br>Based on one year between biological seeding date and AWTF being fully effective at design capacity.<br>The operational date for the FRO AWTF-S in the 2022 IPA is September 1, 2022 based on the 1 year ramp-up assumption, which differs from the commissioning period end date in permit condition (June 30, 2022). |
| **Hydraulic Capacity - WLC AWTF** | Up to 7,500 $m^3$/day | As per current design. Operational capacity achieved a maximum throughput of 7,580 $m^3$/day in 2021. |
| **Effluent Quality - WLC AWTF through end of 2024 - Selenium (total)** | 20 µg/L or 95% removal if influent greater than 400 ug/L | Based on actual data / performance to date (Table 2.5) plus the addition of the AOP. Consistent with AOP Operational Permit application and end of pipe permit limits for the WLC AWTF. |
| **Effluent Quality - WLC AWTF 2025 onward - Selenium (total)** | 20 ug/L | Represents estimated improvements over time based on to date WLC AWTF operational data |
| **Effluent Quality - WLC AWTF - Nitrate** | 1 mg/L N-$NO_3$ | Based on actual data/ performance to date (Table 2.5) plus the addition of the AOP. Consistent with AOP Operational Permit application and end of pipe permit limits for the WLC AWTF. All measured effluent data at WLC in 2020 were below 1 mg/L (Teck 2020). |
| **Nitrate Load Limit - WLC AWTF** | 250 kg-N-$NO_3$/day | Reflects current operations |
| **Hydraulic Capacity - FRO AWTF-S** | Up to 20,000 $m^3$/day | As per current design |
| **Effluent Quality - FRO AWTF-S through end of 2026 - Selenium (total)** | 30 µg/L or 95% removal if influent greater than 600 µg/L | Based on actual performance of WLC AWTF, same (biological treatment plus AOP) treatment flowsheet, and FRO AWTF-S model projected influent concentrations. |
| **Effluent Quality - FRO AWTF-S 2027 onwards - Selenium (total)** | 20 µg/L | Represents estimated improvements over time based on to-date WLC AWTF operational data, to-date pilot test work, and focused R&D effort to improve AWTF selenium effluent concentrations. |
| **Effluent Quality - FRO AWTF-S - Nitrate** | 2 mg/L N-$NO_3$ | Based on actual performance of WLC AWTF, same (biological treatment plus AOP) treatment flowsheet, and FRO S AWTF-S model projected influent concentrations. |
| **Nitrate Load Limit - FRO AWTF-S** | 1,400 kg-N-$NO_3$/day | Reflects current design specifications |
| **Tank-Based Treatment - Future facilities** | | |
| **Treatment Type** | Biological Treatment with AOP | Based on the addition of the AOP process to WLC AWTF and FRO AWTF-S. |
| **Ramp-Up Period/Operational at 100% Capacity** | 1 year | Conservatively, no benefit of treatment is incorporated into the model until one year after the biological seeding date an AWTF.<br>Based on one year between biological seeding date and AWTF being fully effective at design capacity. |
| **Effluent Quality (all new AWTFs) - Selenium (total)** | 20 µg/L | Represents estimated improvements over time based on to-date WLC AWTF operational data, to-date pilot test work, and focused R&D effort to improve AWTF selenium effluent concentrations. |

**Table 2.4: 2022 Implementation Plan Adjustment – Summary Table of Input Assumptions for Water Treatment Planning**

<table>
<tr><th>Parameter</th><th>Input</th><th>Rationale</th></tr>
<tr><td>Effluent Quality (all new AWTFs) - Nitrate</td><td>2 mg/L</td><td>Represents estimated improvements over time based on to-date WLC AWTF operational data, to-date pilot test work, and focused R&D effort to improve AWTF selenium effluent concentrations.</td></tr>
<tr><td colspan="3">Existing Saturated Rock Fill Treatment</td></tr>
<tr><td>SRF porosity - EVO SRF</td><td>0.19</td><td>Values based on analysis of EVO SRF full scale trial (SRK 2020).</td></tr>
<tr><td>SRF porosity - FRO-N 1 SRF</td><td>0.21</td><td>Based on most recent pumping information and consistent with current design basis.</td></tr>
<tr><td>Hydraulic Capacity - EVO SRF Phase 1</td><td>Up to 20,000 m$^3$/day</td><td>Aligned with EVO SRF Phase 2 trial application and current operating capacity.</td></tr>
<tr><td>Hydraulic Capacity - FRO-N 1 SRF Phase 1</td><td>Up to 9,500 m$^3$/day</td><td>Aligned with FRO-N SRF Phase 1 application.</td></tr>
<tr><td>SRF Load Removal</td><td>95% removal of influent selenium and nitrate load</td><td>95% removal for EVO SRF Phase I and II, FRO-N 1 Phase I SRF</td></tr>
<tr><td>Entrainment Water in SRF Effluent</td><td>5% for EVO SRF<br>3.6% for FRO-N 1 SRF</td><td>Entrainment of recharge water was estimated for future SRFs based on the efficiency of far field wells ($F_E$=0.75), the rate of recharge into the SRF($Q_R$), and the well field flow rate ($Q_W$). The rate of recharge into the SRF ($Q_R$) is the local watershed flow, calculated using the P50 monthly average flows from the 20 climate realizations from the treatment start date until December 31, 2053. Detailed information can be found in Annex A.</td></tr>
<tr><td>Reactor Utilization</td><td>30%</td><td>Starting assumption to reflect pit geometry and stratification. Based on EVO SRF full scale trial. Used to estimate maximum SRF treatment capacity. Actual range 10 % to 100%. Engineering adaptations are available to increase reactor utilization if required (SRK 2020).</td></tr>
<tr><td colspan="3">Future Saturated Rock Fill Treatment</td></tr>
<tr><td>SRF porosity-All New SRFs</td><td>0.30</td><td>Consistent with mine planning swell factor for blasted rock.</td></tr>
<tr><td>SRF Load Removal</td><td>90% for future SRFs<br>95% for FRO-N 1 Phase II and III, FRO-N 2 Phase I and II, NLC SRF as of 1/1/2034</td><td>FRO-N SRF removal rate is based on characterization to date; NLC SRF removal rate is based on continuous improvement assumptions given sufficient time since planned initial operation.</td></tr>
<tr><td>Entrainment Water in SRF Effluent</td><td>See Table for future SRFs</td><td>Entrainment of recharge water was estimated for future SRFs based on the efficiency of far field wells ($F_E$=0.75), the rate of recharge into the SRF($Q_R$), and the well field flow rate ($Q_W$). The rate of recharge into the SRF($Q_R$) is the local watershed flow, calculated using the P50 monthly average flows from the 20 climate realizations from the treatment start date until December 31, 2053. Detailed information can be found in Annex A
<table>
<tr><th>Future SRF</th><th>Efficiency of Far Field Wells (%)</th><th>Rate of Recharge into SRF (m$^3$/day)</th><th>Well Field Flow Rate (m$^3$/day)</th><th>Entrainment of Recharge Water (%)</th></tr>
<tr><td>North Line Creek SRF</td><td>75</td><td>6,000</td><td>12,500</td><td>12</td></tr>
<tr><td>Baldy Ridge Pit SRF</td><td>75</td><td>11,482</td><td>5,000</td><td>57</td></tr>
<tr><td>Cougar South Pit SRF</td><td>75</td><td>7,147</td><td>5,000</td><td>36</td></tr>
<tr><td>Eagle 6 SRF</td><td>75</td><td>1,263</td><td>6,500</td><td>5</td></tr>
</table>
</td></tr>
</table>

**Table 2.4: 2022 Implementation Plan Adjustment – Summary Table of Input Assumptions for Water Treatment Planning**

| Parameter | Input | Rationale |
|---|---|---|
| **Reactor Utilization** | 30% | Starting assumption to reflect pit geometry and stratification. Based on EVO SRF full scale trial. Used to estimate maximum SRF treatment capacity. Actual range 10% to 100%. Engineering adaptations are available to increase reactor utilization if required (SRK 2020). |
| **Potential SRF Opportunities for Evaluation** | EVO – Baldy Ridge 3<br>LCO - NLC, NLX, MSAW<br>FRO - Eagle 4, Eagle 6 South<br>GHO - Cougar South (Phase 4, 5, 6, 6x) | The availability of SRFs is dependent on the permitted mine plans. This information is provided by Teck mine planning teams based on the 2019 permitted mine plans and considers the date the pits are expected to be fully backfilled. Once the pits are fully backfilled, the RWQM simulates pit filling to determine the time until saturated conditions are achieved.<br>The SRFs included in this table are starting assumptions only. Those that best meet objectives will be selected for inclusion in mitigation planning. |
| | | **Sulphate Treatment** |
| **Sulphate Load Removal** | 90% Removal | Removal rate based on pilot work carried out in 2021 as described in section 2.3.3. Removal of other constituents through the sulphate treatment process is not accounted for in the modelling to support the 2022 IPA. |
| **Sulphate Treatment Duration** | Seasonally (August through April) except LCO Dry Creek (year-round) | Sulphate treatment is modelled seasonally at all facilities except the LCO Dry Creek facility, where treatment is modelled year-round. |
| | | **Clean Water Diversions** |
| **Kilmarnock Creek Diversion** | up to 86,000 $m^3$/day | Aligns with current design capacity. |
| **Upper Line Creek/Horseshoe Creek/No Name Creek Diversions** | up to 42,000 $m^3$/day | Aligns with Phase 2 of Line Creek mitigation and *Mines Act* C-permit requirements. |
| **South Gate Creek Diversion** | Up to 3,500 $m^3$/day | Aligns with current design capacity |
| | | **Intake Water Collection** |
| **Water Availability** | Tributary specific | Surface water and groundwater partitioning in tributaries is defined as per the 2020 RWQM update. Groundwater collection is required in some tributaries as described in Table 3-7 in Annex B. |
| **Intake Collection Efficiency** | 95% | The percentage of available flow that is captured by the intake. Intended as a secondary collection factor of safety to reflect infrastructure capabilities to collect and convey water. Refer to Annex B for more detail. |
| | | **Outfall Locations** |
| **Outfall Locations** | Facility specific | Water collected for treatment will be returned down-gradients of, and/or near to, the collection point, where required. The water is returned at the equivalent flow rate at which it was collected. |
| | | **Nitrate Management** |
| **Liner integrity assumption** | 0% | No improvement in future nitrate release assumed for the 2022 IPA, despite actual measures to improved nitrate management, due to unresolved uncertainty as a result of new findings on natural sources of nitrate (from exchangeable ammonium) in waste rock. |

Notes: These are initial input assumptions; adjustments may be made during the development of the IPA.

**Table 2.5: West Line Creek Active Water Treatment Facility Mean Monthly Influent and Effluent Concentrations**

| Month-Year | Influent Mean Total Selenium Concentration (ug/L) | Effluent Mean Total Selenium Concentration (ug/L) | Influent Mean Nitrate Concentration (mg/L) | Effluent Mean Nitrate Concentration (mg/L) |
|---|---|---|---|---|
| Mar-19 | 266 | 15 | 18 | 0.2 |
| Apr-19 | 235 | 18 | 17 | 0.2 |
| May-19 | 449 | 18 | 14 | 0.2 |
| Jun-19 | 229 | 13 | 10 | 0.2 |
| Jul-19 | 243 | 13 | 10 | 0.2 |
| Aug-19 | 249 | 10 | 12 | 0.2 |
| Sep-19 | 243 | 12 | 13 | 0.2 |
| Oct-19 | 242 | 14 | 15 | 0.2 |
| Nov-19 | 300 | 13 | 15 | 0.2 |
| Dec-19 | 253 | 14 | 18 | 0.2 |
| Jan-20 | 213 | 17 | 19 | 0.2 |
| Feb-20 | 243 | 16 | 19 | 0.2 |
| Mar-20 | 229 | 19 | 18 | 0.2 |
| Apr-20 | 233 | 19 | 18 | 0.2 |
| May-20 | 319 | 16 | 13 | 0.2 |
| Jun-20 | 208 | 5 | 8 | 0.2 |
| Jul-20 | 262 | 8 | 11 | 0.2 |
| Aug-20 | 252 | 9 | 13 | 0.2 |
| Sep-20 | 265 | 11 | 15 | 0.2 |
| Oct-20 | 236 | 16 | 16 | 0.2 |
| Nov-20 | 230 | 20 | 17 | 0.2 |
| Dec-20 | 225 | 18 | 18 | 0.2 |
| Jan-21 | 226 | 20 | 18 | 0.2 |
| Feb-21 | 240 | 19 | 19 | 0.2 |
| Mar-21 | 210 | 18 | 18 | 0.2 |
| Apr-21 | 206 | 17 | 17 | 0.2 |
| May-21 | 295 | 20 | 13 | 0.2 |
| Jun-21 | 211 | 9 | 8 | 0.3 |
| Jul-21 | 283 | 11 | 10 | 0.3 |

**Table 2.5: West Line Creek Active Water Treatment Facility Mean Monthly Influent and Effluent Concentrations**

| Month-Year | Influent Mean Total Selenium Concentration (ug/L) | Effluent Mean Total Selenium Concentration (ug/L) | Influent Mean Nitrate Concentration (mg/L) | Effluent Mean Nitrate Concentration (mg/L) |
|---|---|---|---|---|
| Aug-21 | 225 | 10 | 12 | 0.2 |
| Sep-21 | 236 | 9 | 13 | 0.2 |
| Oct-21 | 215 | 12 | 14 | 0.2 |
| Nov-21 | 210 | 10 | 15 | 0.2 |
| Dec-21 | 254 | 12 | 16 | 0.2 |
| Jan-22 | 236 | 13 | 17 | 0.2 |
| Feb-22 | 232 | 13 | 18 | 0.2 |
| Mar-22 | 226 | 21 | 19 | 0.2 |
| Apr-22 | 248 | 16 | 18 | 0.6 |
| May-22 | 335 | 13 | 14 | 0.2 |

**Table 2.6: EVO SRF Mean Monthly Influent and Effluent Concentrations**

| Month-Year | Influent Mean Total Selenium Concentration (ug/L) | Effluent Mean Total Selenium Concentration (ug/L) | Influent Mean Nitrate Concentration (mg/L) | Effluent Mean Nitrate Concentration (mg/L) |
|---|---|---|---|---|
| Feb-21 | 158 | 4 | 17 | 0.1 |
| Mar-21 | 160 | 4 | 16 | 0.3 |
| Apr-21 | 157 | 1 | 16 | 0.1 |
| May-21 | 157 | 4 | 16 | 0.2 |
| Jun-21 | 156 | 6 | 16 | 0.7 |
| Jul-21 | 147 | 10 | 17 | 0.9 |
| Aug-21 | 160 | 14 | 15 | 1.1 |
| Sep-21 | 153 | 13 | 15 | 1.1 |
| Oct-21 | 158 | 14 | 19 | 1.3 |
| Nov-21 | 163 | 10 | 20 | 1.1 |
| Dec-21 | 162 | 8 | 18 | 0.9 |
| Jan-22 | 166 | 8 | 18 | 0.9 |
| Feb-22 | 170 | 8 | 19 | 0.8 |
| Mar-22 | 174 | 6 | 19 | 0.7 |
| Apr-22 | 167 | 4 | 25 | 0.3 |
| May-22 | 156 | 3 | 26 | 0.2 |

## 2.3 Mitigation Technologies

The evaluation of new and emerging treatment technologies allows identification of effective mitigation technologies for inclusion in the IPA. An iterative evaluate-adjust loop exists between evaluating the technologies in the IPA, incorporating understanding from the RWQM, and adjusting the IPA.

Updating the IPA involves reviewing the mitigation technologies in the current IPA and considering which technologies from the R&D program are sufficiently advanced to incorporate into Teck's toolbox to be considered for use in the IPA update. This process supports the evaluation of the answer to MQ 3 (*Are the combinations of methods included in the implementation plan the most effective for meeting limits and SPOs?).*

The goal is to have technologies available that can be deployed to meet Teck's permit, regulatory and legal requirements and support the protection of aquatic and human health. To date, these technologies include AWTFs, SRFs, and membrane high-density-sludge flowsheet for sulphate treatment supported by CWDs. Work to identify additional effective treatment processes is advanced by studies under KU 3.1 (*Are there better alternatives to the current active water treatment technologies*?).

When evaluating treatment processes for the IPA, several criteria are evaluated to identify which technology is ultimately used. The list of criteria include:

- Suitable location sized to facility footprint
  - Example: SRF - mined out, backfilled pit, available volume to support treatment, ability to install wells and support infrastructure
- Allowance for appropriate baseline data collection and engineering (typically 3-5+ years before treatment is required)
- Source water availability based on the RWQM
- Sources to target for treatment and how quickly treatment could be constructed

Currently, based on the work done by the R&D program, biological treatment - which includes both tank-based and non-tank-based treatment – has been determined to be the most suitable option for selenium and nitrate treatment in the Elk Valley since it was found to remove significant amounts of selenium and nitrate with minimal treatment by-products that would need to be managed after treatment. These technologies are described in Section 2.3.1 and 2.3.2, respectively.

**Identification of Future Technologies**

Teck has a dedicated team completing technology scans and evaluations. This team develops roadmaps linking anticipated water treatment needs and timelines to technology and integrated process development. Teck is continually performing technology scans and evaluations to:

- Identify current and emerging technologies that would improve process reliability, better address constituents of interest, or decrease risk
- Identify game changers that unlock new technologies or technology combinations, decrease risk, or address current and emerging constituents of interest
- Develop integrated flowsheets and techno-economic models to aid in assessing/sorting/selection process, and on the assessment of integrated processes

As part of the technology scan process, Teck undertakes the following key activities:

- Perform ongoing literature (including new regulations) and patent reviews
- Interview vendors (all ideas received are assessed)
- Work with subject matter experts from external consultants and universities (globally)
- Launch global events (e.g., Nine Sigma in 2014, Brine Management in June 2022 in collaboration with Electric Power Research Institute)
- Participate in multiple programs (e.g., Electrical Power Research Institute, North American Metals Council-Selenium Working Group, National Alliance for Water Innovation, Se Summits (2018 to 2021), university programs)
- Screen, gate-assess, demo and pilot promising technologies (screening initially based on possible technology effectiveness, fit, and readiness: use holistic approach)
- Link with other dedicated Technology Scan and Evaluation (TSE) programs, e.g., source control, microbiology, selenium analytical chemistry, selenium speciation, nickel/cobalt removal

Source control is a major focus of Teck's research and development program and research is conducted under KU 3.4 (*Are there viable mine design and planning approaches that can reduce release of constituents of interest into the watershed?*). Work is progressing to reduce uncertainty related to the use of SOZs under UU 3.4.5 (*Are there ways to construct waste rock dumps that materially reduce the rate of oxidation of constituents of interest*?). A SOZ is defined as an area within the unsaturated zone of a mine rock spoil where oxygen concentrations are lower than 1% by volume. A waste rock spoil that contains engineered structures designed to promote suboxia has been constructed at EVO Cedar North in a full-scale trial. Additionally, a second trial is being designed at FRO Swift North, with construction expected to commence in early 2023.

Five other source control technologies have been evaluated at the preliminary stage, comprised of weep berms; in-pit treatment; tailings and waste rock co-disposal; alternate spoil construction methods and amendments. All but the in-pit treatment are being progressed to detailed R&D.

Weep berms are developed from earth material that is formed perpendicular to the direction of runoff. This traps sediments while encompassing perimeter areas with affected runoff hydrology and can lead to the saturation of the base layer of a mine rock pile, producing the formation of SOZs and result the attenuation of constituents of interest.

In-pit treatment is a passive treatment method for mine-impacted water where amendments are added directly to a pit lake which allows treatment to take place within the structure before it is discharged into the receiving environment.

Tailings that result from coal processing have been recognized to decrease the concentration of certain constituents of interest in certain conditions. Work was conducted to understand if, during mine rock pile construction, tailings could be used as an amendment and/or fine construction materials to create a SOZ or as a layer or blended with mine rock.

To minimize the sulphide oxidation that results from advective gas transport occurring in end-dumping, alternative methods of spoil construction have been suggested. These methods include: building in shorter lifts, using engineered layers between lifts, encapsulation and paddock dumping. These alternative methods were also identified to manage contact water flow paths, or create SOZs within piles.

Both organic and inorganic amendments have been identified to have a high potential to alter conditions within a mine rock pile through either the minimization of CIs or by acting as a reactive medium to sequester CI. Amendments can also be used in isolation as a final layer or as a layer during the mine rock pile's construction to assist in developing the SOZ.

The following sections provide a brief overview of the technologies identified in the 2022 IPA. The information presented in this section supports the evaluation of the answer to MQ 3 as reported in the MQ 1 and 3 Evaluation Report.

### 2.3.1 Biological Tank-Based Water Treatment Targeting Selenium and Nitrate

Enhancements to treatment facilities are assessed under UU 3.1.2 (*Can the performance of current and planned active water treatment facilities be materially improved*?) and are reported in annual AMP reports. Biological tank-based treatment relies on microorganisms to convert dissolved nitrate and selenium into forms which can be removed from the water. Nitrate is largely converted into nitrogen gas which is off gassed to atmosphere, and dissolved selenium is converted to solid forms and removed from the water via solid-liquid separation steps.

Effluent assumptions for AWTFs are summarized in Table 2.3. Effluent water quality data for 2019-2022 from WLC AWTF is summarized in Table 2.5.

### 2.3.2 Saturated Rock Fills Targeting Selenium and Nitrate Removal

Work to understand the viability of SRFs as a water treatment technology has progressed under UU 3.1.1 (*Are saturated rock fills a viable alternative to active water treatment*?) of KU 3.1 (*Are there better alternatives to the current active water treatment technologies*?) and SRFs have been included as a water quality mitigation in the 2022 IPA.

An SRF, which is a biologically based non-tank--based process, is a mined-out pit backfilled with waste rock, with a portion of that rock submerged in water. The water-saturated rock is an environment capable of supporting a microbial community that can reduce nitrate (denitrification) to intermediate soluble nitrogen compounds such as dissolved nitrite ($NO_2$), a fraction of $N\text{-}NO_3$ incorporated into the biomass and ultimately nitrogen gas (N2). Reduction of soluble selenate occurs in this same environment, transitioning to less mobile forms (selenite and ultimately elemental selenium) (Bianchin et al. 2013; Kirk 2014). Denitrification and selenate reduction are forms of anaerobic respiration in which bacteria use nitrate or selenate instead of oxygen to gain energy from consumption of carbon. This is a natural process that occurs in nearly all environments where conditions are oxygen-free. Iron and sulphate reduction occur by the same process and by many of the same bacteria.

An actively managed non-tank-based water treatment such as SRF technology relies on the same biogeochemical processes as occurs naturally, however, a carbon source (methanol) and nutrients (phosphoric acid) are supplied to enhance reducing conditions and growth of a robust microbiological community. Mine contact water (MCW) is injected into one location of the pit with the reagents and flows towards extraction wells at another location. An extensive network of monitoring wells covers the wellfield to enable thorough water quality monitoring.

In early 2021, the Technology Readiness Assessment and Emerging Technology Readiness Review Guidance Document V01.01 (Technology Readiness Assessment [TRA] Guidance Document) was issued for Teck Coal use only (ETWG n.d.). The TRA Guidance Document provides a framework for conducting TRAs for emerging water treatment technologies. It also describes the regulatory process for conducting Emerging Technology Readiness Reviews. Along with the TRA Guidance Document, ENV and EMLI jointly issued a Technology Readiness Assessment Submission letter allowing Teck Coal to use the TRA process (Downie and Constable 2021). On January 26, 2021, Teck submitted a TRA request for SRF technology at a (TRL7) which would allow SRFs to be proposed for use in planning activities (such as the 2022 IPA) and for mitigation projects in permitting applications for authorization under EMA and *Mines Act*. On April 25, 2022, Teck received a joint letter from ENV and EMLI agreeing that SRF technology for selenium and nitrate treatment has been developed sufficiently by Teck to be designated at TRL 7 for use in the Elk Valley Designated Area under the EMA Permit 107517.

Effluent assumptions for SRFs are summarized in Table 2.4.

### 2.3.3 Sulphate Treatment

Sulphate treatment has advanced via piloting of various technologies to remove sulphate from Elk Valley waters and has been included as a water quality mitigation in the 2022 IPA, reducing KU 3.3 (*Is sulphate treatment required and if so how could we remove sulphate*?). Two options have been determined to be technically feasible for implementation as bolt-on processes to existing fluidized bed reactor tank-based treatment facilities: membrane high-density-sludge, and barium precipitation. Based on the results of pilot-scale tests Teck has chosen the membrane high-density-sludge flowsheet for further consideration in sulphate removal projects.

#### Technologies assessed and selected

The comprehensive search for a technically viable, environmentally practicable, and economically feasible technology to remove sulphate from Teck Coal's MCW started in late 2018, with eleven options (Table 2.7) considered by Teck with support from internal and external SMEs. The primary objective of the sulphate pilot program was to evaluate technology options in an integrated process flowsheet to enable a full-scale design of at least one viable option for sulphate removal.

**Table 2.7: Options Evaluated for Sulphate Treatment**

| Membranes | Chemical Precipitation | Ion Exchange | Others |
|---|---|---|---|
| Electrodialysis Reversal (EDR) | Barium Hydroxide | BQE Sulf-IX Config 1 | Paques SulfateQ |
| Vibratory Shear Enhanced Processing (VSEP) | Barium Hydroxide with Hydrated Lime | BQE Sulf-IX Config 2 | Ettringite |
| Max$H_2O$ | Barium Carbonate | - | - |
| Nanofiltration (NF) | - | - | - |

Two technologies were selected for piloting in 2021 based on a range of criteria including technological feasibility; control effectiveness; reliability and cost effectiveness.

**Barium Pilot Results**

Precipitation of sulphate as barium sulphate ($BaSO_4$) using barium hydroxide monohydrate ($Ba(OH)_2{\cdot}H_2O$) was tested. The barium pilot program operated for seven weeks from January to March 2021, treating close to 24 $m^3$ of LCO WLC MCW.

A single demonstration phase was completed in the barium program which showed high utilization of barium hydroxide reagent and high sulphate removal, approximately 93% and 91% respectively.

In addition to effective sulphate removal, the barium process partially removed alkalinity, nickel, cobalt, and up to one third of the selenium present in the influent MCW. Treated water consistently passed acute toxicity (*D. magna* and Rainbow Trout) and chronic toxicity (*C. dubia)* testing. However, when blending process effluent with the influent water the blends did not consistently pass *C. dubia* testing, with no root cause determined at this time.

Due to treatment volumes and sulphate removal quantities expected to be required in the FRO watershed, barium precipitation is not an economical option for sulphate treatment with FRO MCW and was tested with LCO WLC MCW only.

Treatment with Barium hydroxide could still be considered economically viable for seasonal treatment (e.g., < 90 days) of low flow streams (e.g., < 4,000 $m^3$/d), with low sulphate concentrations ([$SO_4$] < 1,200 mg/L), but unresolved chronic toxicity issues remain to be addressed before this process can be deployed to full scale.

**Membrane-HDS Process**

The membrane-HDS pilot operated for 23 weeks from April to October 2021, treating close to 1,450 $m^3$ of mine contact water from LCO WLC and FRO Eagle Pond North Seep (EPNS) water was used as a proxy for FRO-S MCW.

During piloting, the membrane-HDS process demonstrated versatility in treating various types of MCW, comprising a wide range of [$SO_4$]. The process operated over an extended period under various operational conditions without acute or chronic toxicity issues in the produced blended effluents from the process. The integrated pilot operation demonstrated high mechanical availability (>95%) across all demonstration phases with no major, unresolved operational issues.

The pilot plant campaign demonstrated improved overall water recovery and sulphate removal demonstrating over 90% water recovery and over 90% sulphate removal for the final three demonstration campaigns operating with FRO EPNS and LCO WLC MCW.

Residues were classified as non-hazardous as they passed the toxicity characteristic leaching procedure test This test uses a chemical analysis process that simulates what could happen to a residue during leaching, and whether residues are considered hazardous or non-hazardous.

As a result of a successful 2021 pilot plant campaign treating various types of MCW from the Elk Valley, and the capacity of the process to treat high volumes of water, the advanced integrated membrane-HDS process was selected as BAT for sulphate removal and its use is considered in the 2022 IPA.

Effluent assumptions for sulphate treatment are summarized in Table 2.3.

## 2.4 Water Quality Management

Water management best practices are fundamental aspects of water quality management planning and the 2022 IPA. During the development of the 2022 IPA, prevention was prioritized over treatment where possible.

### 2.4.1 Mine Water Management

Water management is key to the sustained future of Teck's operations. Managing the movement and discharge of mine-influenced and non-contact water to the receiving environment requires the implementation of effective strategies, activities and practices to meet site objectives and to support regional objectives, such as those outlined in the EVWQP and as updated in the 2022 IPA.

The objective of water management is to manage the movement and discharge of mine-influenced and non-contact water in order to:

- support safe and sustainable mining
- support geotechnical, water quality and quantity aspects
- mitigate impacts to the receiving environment and meet regulatory and permit compliance
- support the objectives of the EVWQP and IPAs
- maximize the availability of water resources at the operations and downstream water use

The purpose of each site's Mine Water Management Plan (MWMP) is to describe how water is managed at site in order to remain consistent with the objective described above. The site MWMPs are expected to guide site personnel in making informed operational water management decisions. Specifically, the MWMP intends to:

- provide an overview of the site in an environmental context
- provide required detail on how water is managed at each operation, including historical knowledge to guide maintenance and inspections
- describe the tools, studies and monitoring programs that support water management decisions
- guide water usage with respect to consumptive and non-consumptive water licenses
- describe contingency water management measures, including associated authorization requirements
- describe the implementation requirements of the MWMP

The MWMPs are reviewed annually as per the Health, Safety and Reclamation Code for Mines in British Columbia and updated as required. The annual review also satisfies the EMA Permit 424 requirements for each operation, which required a review of the MWMP every five years. Interim updates may be required to support mining operations and operational management decision making. Updates or changes to the MWMP will be assessed on a case-by-case basis and will follow corresponding regulatory requirements. Water management in the 2020 RWQM is based on the 2020 MWMPs for each site with updates to mine water management tracked in Annex A and Annex B.

The MWMP applies to all aspects of water management including water use, reuse, diversion, collection, treatment and discharge occurring within the *Mines Act* C-3 Permit boundaries for each operation or to those permitted activities that are directly associated with each operation that exist outside of the permitted mine boundary and have influence on water. The MWMPs inform management decisions and execution of mining activities, with focus on short- and medium-term (i.e., one to three years) operational conditions of the permitted mine plan. The MWMPs also provide high-level descriptions of future projects under internal and external review and of the water management aspects for the long-term closure conditions. The 2022 IPA development process included optimization of mine water management, where feasible, to support meeting short-, medium-, and long-term compliance limits and SPOs.

### 2.4.2 Clean Water Diversions

Clean water diversions (CWDs) involve the construction of earthen dikes, physical barriers and/or pipes or other conduits to route clean water from non-mine-impacted areas around mining activities. An R&D study is being undertaken under UU 3.4.3 (*Is clean water diversion a feasible and effective water management strategy to support water quality management*?) to assess how CWDs affect water quality. More information on the study design, uncertainty reduction and next steps under UU 3.4.3 are reported in the annual AMP reports.

The objective under the R&D program, is to characterize the effects of CWDs on mass loading; that is, to quantify if diversions reduce the total mass loads of constituents of interest to the downstream environment and associated receptors. The FRO Kilmarnock Creek CWD is the study site that has been selected to assess this hypothesis.

Through the conceptual model and detailed assessment of CWDs since the IIP. CWDs like FRO Kilmarnock Creek have been shown to reduce the volume of water that is directed to treatment. The relationship between this reduction in flow and total mass loads is being monitored, but no definitive trends can be identified given the short duration of the post-diversion monitoring period to date (i.e., less than 1 year of operation).

The IIP included CWDs in three watersheds: FRO Kilmarnock Creek (including the upper Brownie catchment), LCO Line Creek (upper Line Creek, No Name Creek and Horseshoe Creek), and EVO Erickson Creek and Gate Creek. An evaluation of potential CWDs was completed to inform which to include in the 2019 IPA. The evaluation considered technical feasibility, operability and projected benefit to downstream water quality of different CWD configurations, which resulted in the inclusion of the FRO Kilmarnock Creek, LCO Upper Line Creek, LCO No Name Creek and LCO Horseshoe Creek. These diversions are also included in the 2022 IPA, with details below.

Detailed diversion specific assessments will be completed for each future potential diversion as part of treatment projects that they are linked to. For example, the three CWDs included in the 2022 IPA for LCO are currently under evaluation for the LCO NLC SRF project. These assessments will be used to refine the efficacy of proposed CWDs, timing and capacity, as well as the construction and operating approach, for each CWD, providing a clear linkage with the design basis and permit application of the associated treatment. Consequently, this detailed assessment may change the configuration of individual CWDs and will be used to inform future adjustments to the implementation plan.

**FRO Kilmarnock Creek Clean Water Diversion**

The FRO Kilmarnock Creek CWD was constructed in 2020 and began operating in October 2021. To evaluate the effect of this CWD on constituent of interest loadings, a monitoring program has been implemented to collect high-quality surface water and groundwater data pre- and post-diversion.

The FRO Kilmarnock Creek CWD comprises an intake structure connected to a gravity-fed pipeline with capacity to divert up to 86,000 $m^3$/d of clean runoff to the lower reaches of the Kilmarnock Creek watershed, below the toe of the Eagle waste rock spoils. The intake structure is located above the spatial extent of waste rock spoiling in the basin within upper Kilmarnock Creek. The CWD is designed to divert water from the upper catchment of the Kilmarnock Creek, through a diversion channel, and back into the creek at a location further downstream away from the waste rock spoils.

**LCO Upper Line Creek, Horseshoe, and No Name Creek Clean Water Diversions**

The LCO Upper Line Creek and Horseshoe Creek CWDs are not yet constructed. The LCO No Name Creek diversion is partially constructed. Detailed assessments of operability and constructability for all three CWDs are currently underway as a part of the LCO NLC SRF treatment project. Data collection is essential to better constrain available flows for collection. Technical feasibility and possible environmental impacts of the Upper Line Creek and Horseshoe Creek diversions are currently being investigated. With future mitigation plans shifting from a second phase of the LCO WLC AWTF to the LCO NLC SRF, targeting in pit sources rather than Line Creek proper as a source, water quality benefits of the Upper Line Creek and Horseshoe Creek diversions are less material. The conceptual configuration of the LCO CWDs remains unchanged in the 2022 IPA; however, this may change as a result of these assessments and information to support the necessary refinements will be included in the project design and permitting documentation. The LCO No Name Creek CWD is required to reduce inflows to the LCO NLC SRF and support operation of the SRF.

**EVO South Gate Creek Clean Water Diversion**

The EVO South Gate CWD is in place as part of EVO site water management and included in the 2022 IPA.

The EVO South Gate Creek CWD has been constructed as a collection ditch system and has not been sized designed to a specific volume per day. The EVO South Gate Creek CWD was designed to capture and divert surface water runoff from an area of non-mining impacted land around down gradient waste rock spoils.

### 2.4.3 Nitrate Management

As part of Teck’s commitment to improving water quality in the Elk Valley, Teck has been investigating means of managing nitrate releases from its steelmaking coal mining operations to reduce UU 3.4.2 (*What is the most feasible and effective method (or combination of methods) for source control of nitrate release*?).

Nitrate source control measures have been implemented at all Teck operations to reduce the impacts of blasting on nitrate concentrations downstream of mine discharge locations. Scoping level estimates of losses were made for each type of blasting product and practice used at Teck operations through a combination of literature review, laboratory testing, and field testing. This information was used to identify and prioritize best management practices. The following best management practices have been implemented and are incorporated into each sites Nitrogen Management Plans:

1. Eliminating the use of all augured emulsion (or regular viscosity emulsion) products and replaced with high viscosity emulsion: This method of loading blast holes causes blasting product to stick to the sides of the upper section of the blast hole, where it remains undetonated. In 2016, use of augured emulsion was eliminated.
2. Preferential loading of ammonium nitrate fuel oil (ANFO), dewatering of ANFO blast holes, and use of liners in blast holes to minimize leaching to the receiving environment.
3. In 2019, Teck pioneered and implemented the process of lining emulsion in wet blast holes to minimize leaching to the receiving environment.
4. Standardization of procedures to reduce blasting misfires and explosive losses in blast holes including limiting sleep time (i.e., the time explosives are in the blast hole before detonation). Reducing sleep time reduces the potential for explosives leaching when in contact with water. Teck sites limit sleep times of 6 days or less, compared to manufactures recommendations for sleep times of 15 days.

Teck continues to modify the blast hole lining processes to improve safety, efficiency, and is in the process of developing methods to test effectiveness of the lining process and develop more water resistant emulsion products.

There have been new learnings on the sources of nitrogen in Teck’s mine waste since the 2020 RWQM update. As a result, it was determined no benefits to nitrate concentrations from improved blasting practices were considered in the development of the 2022 IPA as Teck works to understand this better (section 2.2). A sensitivity analysis was completed on nitrate release (section 3.3.2).

Further information on nitrate management thru blasting processes can be found in Teck’s annual AMP reports.

## 2.5 Water Mitigation Project Development and Permitting Process

The 2022 IPA outlines the timing, location and capacity of water treatment and other water quality mitigations of all current and proposed future water mitigations using a technology at TRL7 or greater in order to meet overall compliance in EMA Permit 107517 and aligned with the objectives in the EVWQP. The 2022 IPA is a guide to identify the operational date, sources for treatment, and preliminary capacity of the individual water mitigation projects required to support the EVWQP which are then executed in alignment with the plan and adjusted based on site specific considerations and knowledge gains through the project execution. Water mitigation projects and timelines vary depending on the type of mitigation, technologies, capacity, and site-specific considerations. Despite this variation, all water mitigation projects follow the same key steps:

- Site investigations, baseline data collection to support engineering design and permitting information needs
- Engineering design
- Environmental assessments
- Permitting
- Construction

- Commissioning

Environmental and engineering site investigations and baseline data are required to refine the objective of the mitigation and to understand any potential environmental impacts. In accordance with the BC Ministry of Environment (2016) guidance, permitting of a water mitigation project requires 2 years of baseline data. One full year of data covering a full range of seasons is required to inform engineering design, the second year required to support permitting and construction. Engineering site investigations include activities such as pit characterization work for SRF's and geotechnical studies. Environmental site investigations include baseline data collected for both water quality and quantity (surface and ground), climate, terrestrial, aquatic and fish and fish habitat. These data inform water quality and quantity modelling as well as aquatic and terrestrial health assessments.

The site investigations support the Engineering design in which a technology option assessment is completed. Based on the site conditions and treatment objectives treatment technologies are considered based on their level of maturity; safety; environmental risk; the ability to achieve the required effluent quality; the ability to permit; constructability; operability and reliability; costs; alignment with closure and reclamation objectives.

The environmental site investigations provide the basis for the environmental assessments and the water quality and quantity modelling. The water model is an input to the Engineering design to define the source water location (including seasonal water availability and flow rates) and refined mitigation capacity.

Project permitting requirements are guided by provincial and federal authorization information needs and vary depending on the scope, scale and nature of the water mitigation project. Provincial permits are supported by the Feasibility study deliverables with approval timelines between 6 – 12 months. Federal authorization under the *Fisheries Act* requires Detailed Design deliverables and have approval timelines of approximately 9 months. Teck follows the BC published guidance outlining information requirements to support obtaining required authorizations and depending on the complexity of the project.

Construction activities are scheduled to avoid seasonal constraints including confining instream work to the least risk work window for fish; and vegetation clearing outside of the bird nesting window. The regulatory Acts which determine these windows are important considerations in the mitigation construction schedule as are the water management strategies required to manage any environmental impacts during construction. Further, construction activities are integrated with other operational needs of mining operations and other seasonal constraints.

Pre-commissioning and commissioning activities to bring the mitigation online are required to protect human health, to manage any environmental risks and to identify any issues which will prevent the mitigation from operating at full capacity.

Project overview schedules for the identified mitigations including SRF, AWTF, and Sulphate are shown on Figures 2.2 to 2.5. In alignment with current guidance from regulators and external stakeholders the planning basis for project regulatory approvals is a single permit application for construction and operations. An overview of a SRF project schedule with the single permit application is shown on Figure 2.2. In order to support an expedited mitigation schedule, a phased application process may be required with individual applications for early works, full construction, and operations. The overview of an SRF project with the expedited phased permit approach is shown on Figure 2.3 with Transfer of Custody, Care and Control (TCCC) advanced by a full year.

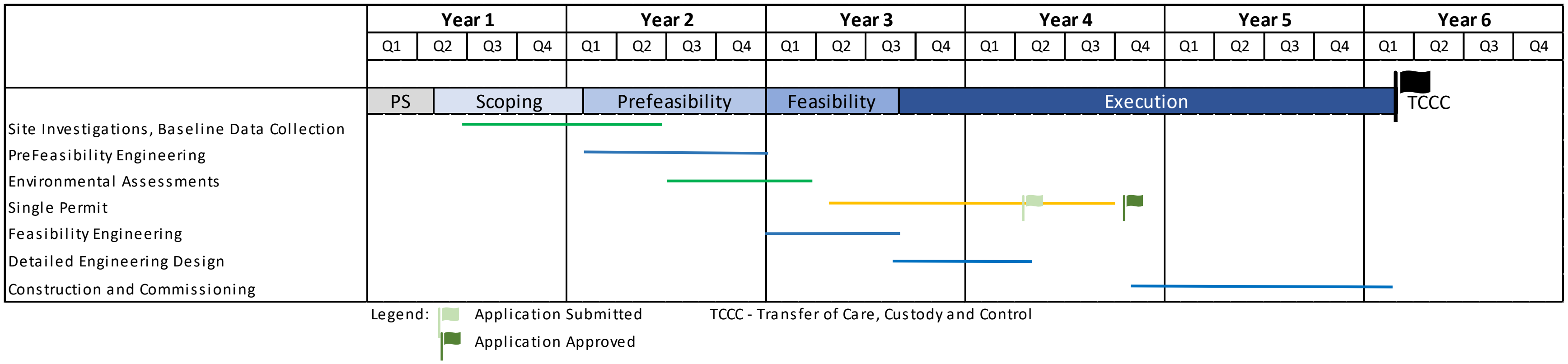



Figure 2.2: Overview Schedule of SRF when Employing a Separate Permit Strategy -– New Facility

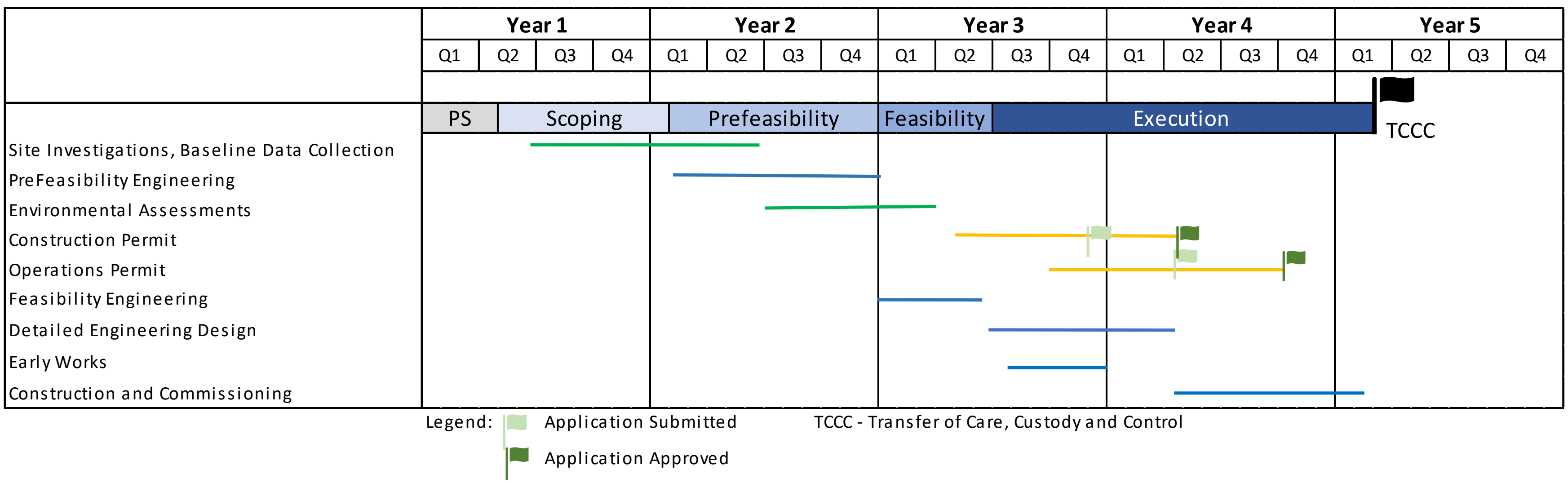



Figure 2.3: Overview Schedule of SRF When Employing a Single Permit Strategy - New Facility

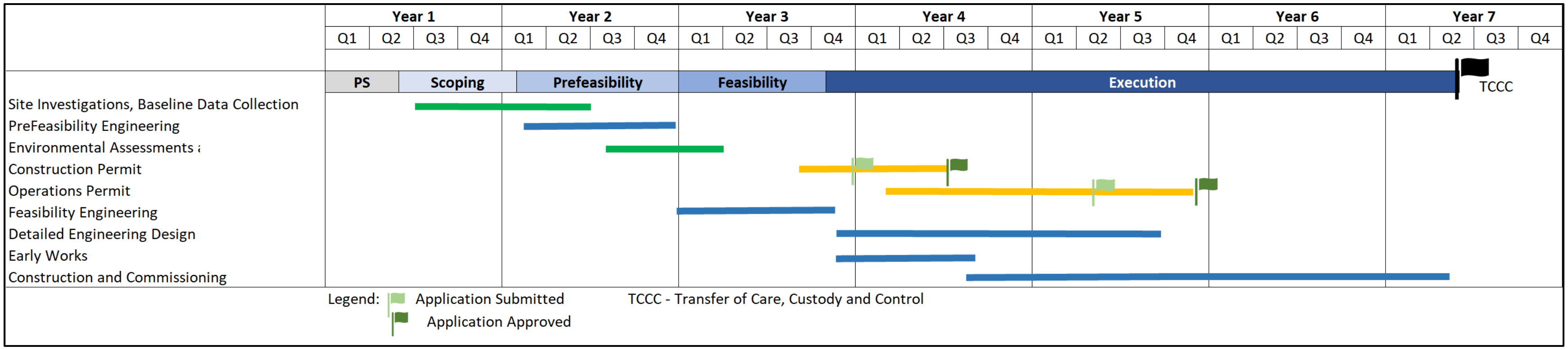



Figure 2.4: Overview Schedule of AWTF When Employing a Separate Permit Strategy – New Facility

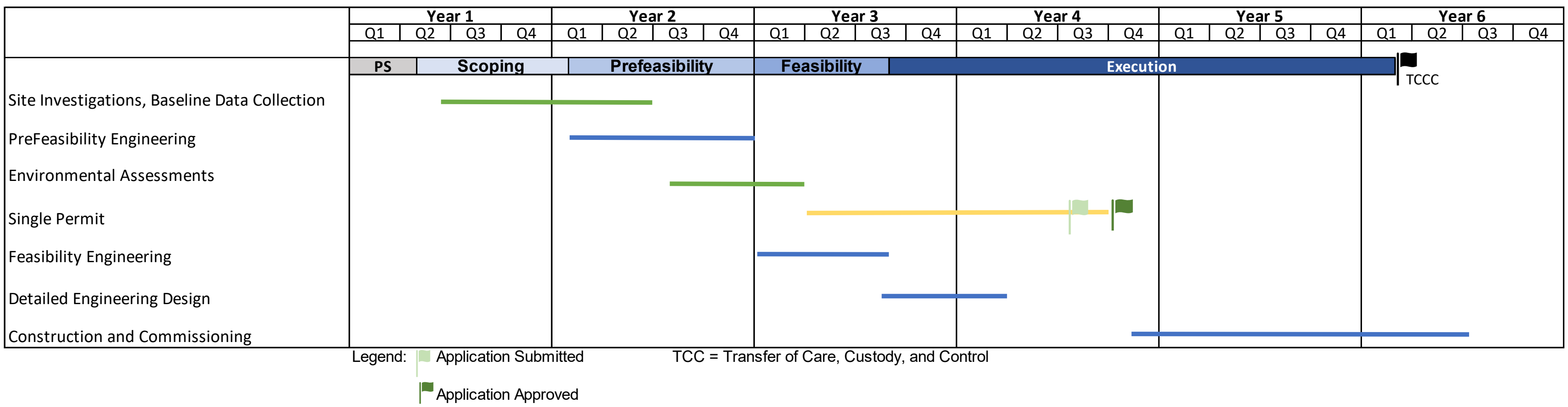



Figure 2.5: Overview Schedule of a Sulphate Facility When Employing a Combined Permit Strategy

# 3 2022 Implementation Plan

## 3.1 Mitigation Plan and Summary of Adjustments to the Implementation Plan

The mitigation outlined in the 2022 IPA is expected to result in the stabilization and reduction of nitrate and selenium concentrations at the compliance points and Order stations in the Elk Valley and the stabilization of sulphate concentrations. The 2022 IPA includes an accelerated mitigation implementation schedule over the next five years to support requirements of EMA Permit 107517 and additional mitigation to maintain long-term nitrate, selenium and sulphate compliance at compliance points and Order stations.

The challenges to meeting requirements of EMA Permit 107517, despite Teck's reasonable efforts, have included delays in the execution of the original EVWQP water treatment schedule as a result of the need to assess and implement an additional treatment step (i.e., AOP) at WLC AWTF to reduce selenium speciation in the effluent and reduce bioaccumulation and to changes in Teck's understanding of water quality that resulted from the effects of lag times on constituent release from waste rock and the influence of groundwater. The timing of step-downs from short to medium, and medium to long-term compliance limits and SPOs included in EMA Permit 107517 were developed based on the 2014 RWQM, which was based on current information at the time and did not account for any potential delays in the water treatment implementation or include the refinements in the understanding of the effects of lag times and the influence of groundwater. As previously noted, the 2022 IPA schedule over the next five years is expected to be feasible, is based on the current improved understanding of water quality and is specifically designed to make up for delays and achieve compliance as soon as possible. Modelling uncertainty is an inherent risk and is addressed in the 2022 IPA through the evaluation of targeted sensitivity analyses. Further, the proposed schedule is based on the assumption of receiving all applicable authorizations in a timely manner.

This section includes a summary of the changes since the 2019 IPA; the current and planned treatment for nitrate, selenium and sulphate; projected water quality for each Order station and compliance point (including a compliance evaluation); an overview of the results of the sensitivity analyses; and an overview of the outcome of the assessment of potential ecological effects. Cadmium treatment is not included in the 2022 IPA as compliance is expected to be maintained without it.

Adjustments included in the 2022 IPA since the development of the 2019 IPA were identified through an iterative process and inform the answer to MQ 1, which is *Will limits and SPOs be met for selenium, sulphate, nitrate and cadmium*? The primary objectives guiding the adjustments in the 2022 IPA were to maintain compliance with SPOs and compliance limits, where compliance is currently being achieved, and to achieve compliance as soon as feasible in areas where SPOs and compliance limits are not currently consistently achieved. The majority of the adjustments were required to address changes in future water quality projections due to an improved understanding of flow and load in the system (particularly in groundwater pathways) and to compensate for the delays in the commissioning date of the FRO AWTF-S that resulted from the time required to understand and develop a solution for selenium bioaccumulation and speciation at WLC AWTF. Adjustments were also required to accommodate the addition of new water treatment technologies (SRFs and sulphate treatment) and the inclusion of mitigation in areas that were not included in the 2019 IPA. These combined factors resulted in changes in the planned treatment timing at FRO, with more selenium and nitrate treatment capacity sooner compared to the 2019 IPA.

Nitrate and selenium water treatment facilities that are operational (WLC AWTF and EVO SRF Phase I), undergoing commissioning (FRO AWTF-S and FRO-N 1 SRF Phase I, and in final stages of detailed design and permitting (FRO-N 1 Phase II) have been included in the 2022 IPA as per their design basis. Additional treatment capacity required to support compliance was considered in future phases of treatment, as the hydraulic capacities of existing built facilities has already been set. The next phases of nitrate and selenium mitigation at FRO are advanced at a faster pace over the next five years in the 2022 IPA compared to the 2019 IPA, to support compliance as soon as possible; however, the total estimated treatment capacity remains similar to that estimated in the 2019 IPA.

Modifications to treatment source prioritization were made in the 2022 IPA to accommodate the inclusion of SRFs, to optimize water availability through targeting upstream sub-catchments over downstream locations and groundwater sources, and to align with project specific designs for mitigations permitted and undergoing permitting since the 2019 IPA. In the 2019 IPA, all source intakes for water treatment were assumed to be located at surface in water management infrastructure downstream of waste rock spoils. The reprioritization of treatment sources for SRFs was required, as the priority for treatment is the SRF catchment itself. Groundwater sources were also not included in the 2019 IPA but have been included in the 2022 IPA at FRO (Kilmarnock Creek) and LCO (West Line Creek).

Potential locations and timing of sulphate treatment were identified in the 2019 IPA but estimates for hydraulic capacity were not included, as pilot studies needed to be advanced to support treatment technology selection. The 2022 IPA includes an estimate of the sulphate mitigation requirements (location, timing and capacity) to support stabilization of sulphate concentrations below the long-term compliance limits and SPOs, based on the selection of a Membrane – HDS treatment process (described in Section 2.3.3).

The 2022 IPA also includes nitrate, selenium and sulphate mitigation for both EVO Dry Creek and LCO Dry Creek. Mitigation for these sources was not included in the 2019 IPA as LCO Dry Creek and EVO Harmer Creek Structured Decisions Making processes were underway at that time and compliance limits and SPOs had not been set for either watershed. The treatment included in the 2022 IPA for EVO Dry Creek is for future permitted waste rock that was assessed and approved under the Baldy Ridge Extension (BRE) Environmental Assessment Certificate (EAC) and EVO C-2 *Mines Act* permit amendment and that has not yet been placed in the EVO Dry Creek watershed. As a condition of the BRE EAC, Teck is required to prepare a Dry Creek and Harmer Creek Water Quality Management Plan 90 days prior to placement of waste rock in Dry Creek and the treatment, capacity and timing outlined here may change as a result of that plan.

The mitigations included in the 2022 IPA for LCO Dry Creek are per the LCO Dry Creek Water Management Plan, and two Best Achievable technology (BAT) assessments completed in early 2022 for LCO Dry Creek. This mitigation includes Conveyance & Supplementation (C&S) and then future treatment via the LCO NLC SRF Phase I. Provincial and federal permit applications required for C&S have been submitted and are currently in the regulatory review process. However, the permitting review process has resulted in an approximate delay of 1 year from the first quarter (Q1) of 2023 operational timing included in the 2022 IPA to Q1 2024 (subject to receipt of all approvals). Information requests and uncertainty in timelines associated with federal review of the *Fisheries* Act authorization application for LCO Dry Creek C&S has meant that both provincial and federal reviews and permit decisions will now carry into 2023, meaning the Q1 2023 planned operational date for C&S is no longer achievable. As such the expected commissioning for C&S is now delayed approximately 1 year to Q1 2024, subject to receipt of all provincial and federal approvals to achieve this revised date. Due to the timing of when these delays were realized, Teck has not been able to update the water quality modelling in time to support the July 31 submission date for 2022 IPA. As such, the Q1 2023 operational date for C&S and associated modelling results has been retained in the 2022 IPA; Teck is currently updating the water quality modelling to reflect a Q1 2024 operational date (subject to receipt of approvals) for C&S and will provide that information as an update to the BAT assessments for LCO Dry Creek after the 2022 IPA submission. Additionally, ongoing engagement on the overall LCO Dry Creek proposed mitigation plan may result in further changes to treatment, capacity and timing from what is included in the 2022 IPA.

The 2022 IPA includes active management of the water volume in Natal Pit at EVO (i.e., 5,000 $m^3$/day until December 31, 2027 and 20,000 $m^3$/d of water 2028 onwards from Natal Pit is pumped year-round to the EVO SRF, thereby controlling the timing of pit filling and decant), and passive management of other pits (i.e., all other pits are allowed to passively fill and decant over time, without active management of pit water volumes). Model projections accounting for the decant of these pits, and the influence of the waste rock contained therein, are included in Annex C.

A summary of the 2022 IPA nitrate and selenium treatment plan is provided in Table 3.1, the sulphate treatment plan is provided in Table 3.2, and the CWDs are provided in Table 3.3.

**Table 3.1: 2022 Implementation Plan Adjustment – Nitrate and Selenium Treatment Summary**

| Site | Treatment Vessel | Abbreviation on Graphs | Hydraulic Capacity Up To ($m^3/d$) | Operational Date [1] | Sources Treated /Added |
|---|---|---|---|---|---|
| FRO | FRO AWTF-S | FRO S | 20,000 | Sep 1, 2022 | Swift/Cataract, Kilmarnock |
| | FRO-N 1 SRF Phase I | FRO N 1 SRF I | 9,500 | Dec 31, 2022 | Eagle 4 Pit |
| | FRO-N 1 SRF Phase II | FRO N 1 SRF II | 20,500 | Dec 31, 2023 | Clode, Liverpool, Swift Pit, Post Ponds |
| | FRO-N 1 SRF Phase III | FRO N 1 SRF III | 10,000 | Dec 31, 2025 | Clode, Liverpool, Swift Pit, Post Ponds, Eagle Pond |
| | FRO-N 2 SRF Phase I | FRO N 2 SRF I | 20,000 | Dec 31, 2026 | FRO-N 1 SRF sources, Kilmarnock |
| | Eagle 6 South SRF Phase I | E6S SRF I | 6,500 | Jun 30, 2033 | Eagle 6 Pit North and South |
| | Eagle 6 South SRF Phase II | E6S SRF II | 2,500 | Dec 31, 2092 | Eagle 6 Pit North |
| | FRO-N 2 SRF Phase II | FRO-N 2 SRF II | 15,000 | Dec 31, 2118 | Swift Pit |
| LCO | WLC AWTF | WLC | 7,500 | Jan 1, 2020 | WLC, Line Creek |
| | WLC AWTF | WLC | - | June 30, 2023 [7] | MSAW |
| | NLC SRF Phase I | NLC SRF I | 12,500 | Dec 31, 2025 | NLC, NLX, LCO Dry Creek (2,500 $m^3/d$) [4] |
| | NLC SRF Phase II | NLC SRF II | 10,000 | Dec 31, 2030 | NLC, NLX, WLC groundwater, Line Creek |
| | NLC SRF Phase III | NLC SRF III | 17,500 | Dec 31, 2033 | NLC, NLX, WLC groundwater, Line Creek, LCO Dry Creek (7,500 $m^3/d$) [4] |
| | *Conveyance and Supplementation* [2,3] | | *Up to 30,000* | Mar 29, 2023 | - |
| GHO | Cougar South Pit SRF | CSP SRF | 5,000 | Jun 30, 2042 | Cougar South Pit, Leask, Wolfram, Thompson, Porter |
| | Greenhills Creek Treatment [5] | GHC | 3,000* | Dec 31, 2027 | Greenhills Creek |

**Table 3.1: 2022 Implementation Plan Adjustment – Nitrate and Selenium Treatment Summary**

| Site | Treatment Vessel | Abbreviation on Graphs | Hydraulic Capacity Up To ($m^3$/d) | Operational Date [1] | Sources Treated /Added |
|---|---|---|---|---|---|
| EVO | EVO SRF Phase I | | 20,000 | Sep 1, 2021 | Erickson, Natal |
| | EVO SRF Phase II [6] | | 4,000 | Sep 30, 2023 | EVO Dry [6] |
| | EVO SRF Phase III | | 15,000 | Dec 31, 2027 | Erickson, Natal |
| | EVO SRF Phase IV [6] | | 3,000 | Dec 31, 2036 | EVO Dry [6] |
| | BRP SRF | | 5,000 | Dec 31, 2042 | Baldy Ridge Pit, Erickson, Natal |
| **Total Estimated Hydraulic Capacity up to ($m^3$/d)** | | | **206,500** | | |

[1] The operational date is the date when facility commissioning activities are completed.

[2] It is acknowledged that C&S is not treatment, but a management option to improve water quality in LCO Dry Creek. The LCO C&S facility was identified in the LCO Dry Creek Water Management Plan and in the Best Achievable Technology (BAT) Assessments for the period 2022-2025 as the interim management option to improve water quality in LCO Dry Creek in the fastest time possible while future water treatment for LCO Dry Creek can be designed, permitted and constructed (treatment of LCO Dry Creek planned as a source in LCO NLC SRF Phase I).

[3] Provincial and federal applications required for the LCO C&S facility have been submitted and are currently in the regulatory review process. Information requests and uncertainty in timelines associated with federal review of the *Fisheries* Act authorization application has meant that both provincial and federal reviews and permit decisions will now carry into 2023, meaning the March 31, 2023 planned operational date for C&S is no longer achievable. As such the expected commissioning for C&S is now delayed approximately 1 year to Q1 2024, subject to receipt of all provincial and federal approvals or any other orders or outcomes related to a potential HADD during early works construction to achieve this revised date. Teck has, therefore, not been able to update the water quality modelling to reflect the 1 year delay in time to support the July 31 submission date for 2022 IPA. As such the March 31, 2023 operational date for C&S and associated modelling results has been retained in the 2022 IPA; however Teck is currently updating the water quality modelling to reflect a Q1 2024 operational date for C&S and will provide that information to the Province and KNC as an update to the BAT assessments for LCO Dry Creek.

[4] Selenium and nitrate treatment of LCO Dry Creek is currently planned via LCO NLC SRF, ongoing engagement on the overall LCO Dry Creek proposed mitigation plan may result in changes to treatment, capacity, and timing from what is included in the 2022 IPA.

[5] ECCC Federal Direction (October 2020) requires a design treatment capacity of at least 7,500 $m^3$/d for selenium removal to be completed construction by December 31, 2026 and operational by the date specified in this table. The capacity included in the 2022 IPA is what is required to support compliance with the water quality limits in EMA Permit 107517 as it is acknowledged that Greenhills will not be able to treat to the full 7,500 $m^3$/day at all times of the year, so will be seasonally limited by lower flows.

[6] Mitigation included in the 2022 IPA for EVO Dry Creek is for future permitted waste rock that was assessed and approved under the Baldy Ridge Extension (BRE) Environmental Assessment Certificate (EAC) and EVO C-2 *Mines Act* permit amendment that has not yet been placed in the EVO Dry Creek watershed. As a condition of the BRE EAC, Teck is required to prepare a Dry Creek and Harmer Creek Water Quality Management Plan 90 days prior to placement of waste rock in Dry Creek to show compliance with the Harmer Compliance Point and the treatment, capacity and timing outlined here may change as a result of that plan.

[7]Operational date may shift as investigations are underway to understand impacts to flow, fish and fish habitat and potential for habitat offsetting requirements as a result of conveying MSAW directly to WLC AWTF.

**Table 3.2: 2022 Implementation Plan Adjustment – Sulphate Treatment Summary**

| Site | Treatment Area | Abbreviation on Graphs | Hydraulic Capacity up to ($m^3/d$) [2] | Operational Date [2] | Sources Treated |
|---|---|---|---|---|---|
| FRO | FRO South | FRO S | 8,500 | Dec 31, 2026 | Swift/Cataract, Kilmarnock |
| | FRO North | FRO N | 12,500 | Dec 31, 2030 | Clode, Liverpool, Swift Pit, Post Ponds, Eagle Pond |
| LCO | Line Creek Phase I | LCO I | 2,500 | Dec 31, 2025 | WLC, MSAW, Line Creek |
| | Line Creek Phase II | LCO II | 2,500 | Dec 31, 2030 | WLC, MSAW, Line Creek |
| | Dry Creek Phase I | LCO DC I | 2,500 | Dec 31, 2029 | LCO Dry Creek |
| | Dry Creek Phase II | LCO DC II | 2,500 | Dec 31, 2032 | LCO Dry Creek |
| | Dry Creek Phase III | LCO DC III | 2,500 | Dec 31, 2037 | LCO Dry Creek |
| EVO[1] | Dry Creek Phase I | EVO DC I | 2,500 | Dec 31, 2033 | EVO Dry Creek |
| | Dry Creek Phase II | EVO DC II | 5,000 | Dec 31, 2038 | EVO Dry Creek |
| **Total Estimated Hydraulic Capacity up to ($m^3/d$)** | | | **38,000** | | |

[1] Mitigation included in the 2022 IPA for EVO Dry Creek is for future permitted waste rock that was assessed and approved under the Baldy Ridge Extension (BRE) Environmental Assessment Certificate (EAC) and EVO C-2 *Mines Act* permit amendment that has not yet been placed in the EVO Dry Creek watershed. As a condition of the BRE EAC, Teck is required to prepare a Dry Creek and Harmer Creek Water Quality Management Plan 90 days prior to placement of waste rock in Dry Creek to show compliance with the Harmer Compliance Point and the treatment, capacity and timing outlined here may change as a result of that plan.

[2] Sulphate treatment is seasonal (August through April) at all locations except LCO Dry Creek where sulphate treatment is estimated to be required all year.

**Table 3.3: 2022 Implementation Plan Adjustment – Clean Water Diversions Summary**

| Clean Water Diversion | Associated Water Treatment Facility | Operational Date | Streams and Volume Diverted |
|---|---|---|---|
| Kilmarnock Creek | FRO AWTF-S | In place and operating | Upper Kilmarnock Watershed, up to 86,000 $m^3/d$ |
| South Gate Creek | EVO SRF | In place and operating | South Gate Creek, up to 3,500 $m^3/d$ |
| Upper Line Creek, Horseshoe and No Name Creeks [1] | LCO NLC SRF | December 31, 2025 | Upper Line Creek and Horseshoe Creek estimated at 35,000 $m^3/d$. No Name Creek estimated at 7,000 $m^3/d$. Total estimated capacity of up to 42,000 $m^3/d$. |

[1] The efficacy of the CWDs at LCO are being evaluated with the next phase of treatment at this operation and adjustments to the diversion strategy may be made based on feasibility and environmental effects.

## 3.2 Projected Water Quality

This section includes the outcomes of the compliance evaluation for the 2022 IPA projections and the water quality projection plots for nitrate, selenium and sulphate for each of the Order stations and compliance points and LCO Dry Creek. These water quality projections support the evaluation of the answer to MQ 1 (*Will water quality limits and SPOs be met for selenium, nitrate, sulphate and cadmium?*) as reported in the MQ 1 and 3 Evaluation Report (Teck 2022a).

### 3.2.1 Compliance Evaluation Overview

Compliance for nitrate and selenium is currently achieved and is projected to be maintained at the Elk River upstream of Boivin (GH_ER1; E206661) and the Elk River at Elko Reservoir (RG_ELKORES; E294312) Order stations and at the following compliance points: GHO Elk River Compliance Point (GH_ERC; 300090), EVO Harmer Creek Compliance Point (EV_HC1; E102682), CMm Compliance Point (CM_MC2; E258937), and EVO Michel Creek Compliance Point (EV_MC2; E300091). Selenium and nitrate concentrations will be at or below SPOs and compliance limits at all seven Order stations and all seven compliance points following the commissioning of the FRO-N 1 SRF Phases II and III, FRO-N 2 SRF Phase I, the LCO NLC SRF Phase I and the EVO SRF Phase III and earlier in LCO Dry Creek following commissioning of C&S. As these treatment facilities are commissioned, selenium and nitrate concentrations decrease and compliance is projected to be achieved at all locations by mid-2028 onward, but in varying years by location, as summarized in Table 3.4.

Additional potential short-term adjustments to support incremental reductions in nitrate and selenium concentrations, such as additional mitigations and management actions, will be identified using the response framework (Step 6 **Adjust** in the adaptive management cycle) and reported in annual AMP reports. The summary of adjustments in response to projected water quality exceedances will be tracked in existing water quality exceedance response summaries as noted in Table 3.4: FRO Fording River (FR_FRABCH), LCO Line Creek (LC_LCDSSLCC) and Elk and Fording rivers (Order stations; GH_FR1, LC_LC5, EV_ER4, EV_ER1, and RG_DSELK), and LCO Dry Creek (LC_DCDS) water quality exceedances.

**Table 3.4: Summary of Projected Timing for Nitrate and Selenium Compliance with EMA Permit 107517**

| Type | Location | Compliance Projected to be Achieved by | | Response Summary Name under the AMP |
|---|---|---|---|---|
| | | Nitrate | Selenium | |
| Order Station | Fording River downstream of Greenhills Creek (GH_FR1; 0200378) [1] | Mid-2023 onward | Mid-2025 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | Fording River downstream of Line Creek (LC_LC5; 0200028) | In compliance | Mid-2026 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | Elk River upstream of Grave Creek (EV_ER4; 0200027) | Mid-2027 onward | 2026 onward | Elk and Fording rivers water quality exceedances (Order stations) |

**Table 3.4: Summary of Projected Timing for Nitrate and Selenium Compliance with EMA Permit 107517**

| Type | Location | Compliance Projected to be Achieved by | | Response Summary Name under the AMP |
|---|---|---|---|---|
| | | Nitrate | Selenium | |
| | Elk River downstream of Michel Creek (EV_ER1; 0200393) | Mid-2025 onward | In compliance | Elk and Fording rivers water quality exceedances (Order stations) |
| | Koocanusa Reservoir downstream of the Elk River (RG_DSELK; E300230) | In compliance | Mid-2027 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| Compliance Point | FRO Compliance Point (FR_FRABCH; E223753) | Mid-2028 onward | Mid-2027 onward | FRO Fording River water quality exceedances |
| | GHO Fording River Compliance Point (GH_FR1; 0200378) [1] | Mid-2027 onward | Mid-2025 onward | Elk and Fording rivers water quality exceedances (Order stations) |
| | LCO Compliance Point (LC_LCDSSLCC; E297110) | 2026 onward | 2026 onward | LCO Line Creek water quality exceedances |
| LCO Dry Creek [2] | LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210) | Mid-2024 onward | Mid-2023 onward | LCO Dry Creek water quality exceedances |

[1] GHO Fording River Compliance Point (GH_FR1; 0200378) is also an Order Station

[2] The compliance evaluation for selenium at LC_DCDS is based on the proposed targeted receiving environment objective of 70 µg/L that was presented in the LCO Dry Creek Water Management Plan. It is acknowledged that at the time of the submission of the 2022 IPA there has not been a decision on SPOs in LCO Dry Creek and this work is proceeding via the Best Achievable Technology (BAT) assessments that are under review.

Compliance for sulphate is currently achieved at all Order stations and compliance points and projected to be maintained at these locations, with the exception of the following:

1. Order station/Compliance Point: Fording River downstream of Greenhills Creek (GH_FR1; 0200378), which is projected to exceed the SPO in March 2026, prior to sulphate treatment coming into effect at FRO
2. LCO Compliance Point (LC_LCDSSLCC; E297110), which is projected to exceed the compliance limit in February and March from 2023 to 2025, prior to sulphate treatment coming into effect at LCO
3. LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210), which is projected to exceed the targeted receiving environment objective in February and March of 2022 and 2023, prior to C&S coming into effect

**Projected Concentrations**

The nitrate, selenium and sulphate projections are presented in this section along with a more detailed summary of compliance. Projected monthly average concentrations of nitrate, selenium, and sulphate at Order stations, compliance points, and in LCO Dry Creek are shown in Figure 3.1 to Figure 3.8, respectively. The projections on the plots included in this section extend to 2053. The Swift Pit at FRO, Cougar Phase 7 Pit at GHO, Burnt Ridge North 3 Pit at LCO and Natal Pit at EVO are projected to be at some stage of filling in 2053 and far future projections when these pits are expected to decant are provided in Annex C.

The format of the figures is as follows:

- The x-axis runs from the start of 2004 (for selenium and sulphate) or 2006 (for nitrate) to the end of 2053. The start date corresponds to the start of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate, selenium, and sulphate load).
- Projected 10$^{th}$ percentile ($P_{10}$), 50$^{th}$ percentile ($P_{50}$), and 90$^{th}$ percentile ($P_{90}$) monthly average concentrations produced using the 2020 RWQM are shown as solid orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021a).
- Compliance limits are shown as a solid black line, SPOs and targeted receiving environment objectives are shown as a dashed green line.
- The operational dates for the SRFs and AWTFs are shown as a vertical blue line.

#### 3.2.1.1 Nitrate Projections

*Order Stations*

Monthly average nitrate concentrations are projected to meet short-, medium- and long-term SPOs at the following Order Stations (Figure 3.1):

- Fording River downstream of Line Creek (LC_LC5; 0200028)
- Elk River upstream of Boivin Creek (GH_ER1; 020661)
- Elk River at Elko Reservoir (RG_ELKORES; E294312)
- Koocanusa Reservoir (RG_DSELK; E300230)

Monthly average nitrate concentrations are also projected to meet long-term SPOs at the remaining Order stations, as follows (Figure 3.1):

- Fording River downstream of Greenhills Creek (GH_FR1; 0200378) – mid-2023 onward after commissioning of the FRO AWTF-S and the first two phases of the FRO-N 1 SRF

- Elk River upstream of Grave Creek (EV_ER4; 0200027) – mid-2027 onward after commissioning of the FRO AWTF-S, FRO-N 1 SRF, the first phases of the NLC SRF and FRO-N 2 SRF, as well as treatment in Greenhills Creek
- Elk River downstream of Michel Creek (EV_ER1; 0200393) – mid-2025 onward after commissioning of the FRO AWTF-S, FRO-N 1 SRF, the first phase of the NLC SRF and the second phase of the EVO SRF

Prior to the commissioning of these facilities, monthly average nitrate concentrations at the three aforementioned Order stations are projected to be higher than SPOs seasonally. This information is summarized in Table 3.5.

*Compliance Points*

Monthly average nitrate concentrations are projected to meet short-, medium- and long-term compliance limits at the following compliance points (Figure 3.2):

- GHO Elk River Compliance Point (GH_ERC; E300090)
- CMO Compliance Point (CM_MC2; E258937)
- EVO Harmer Compliance Point (EV_HC1; E102682)
- EVO Michel Creek Compliance Point (EV_MC2; E300091)

Monthly average nitrate concentrations are also projected to meet Compliance Limits at the remaining compliance points, as follows (Figure 3.2):

- FRO Compliance Point (FR_FRABCH; E223753) – mid-2028 onward
- GHO Fording River Compliance Point (GH_FR1; 0200378) – mid-2027 onward
- LCO Compliance Point (LC_LCDSSLCC; E297110) – 2026 onward

Between 2020 and 2029, monthly average nitrate concentrations at the four aforementioned locations are projected to be higher than Compliance Limits. At all four locations, monthly projected nitrate concentrations are following a downward trend.

*LCO Dry Creek*

Monthly average nitrate concentrations are projected to meet the targeted receiving environment objective in LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS) one year after the commissioning of the conveyance and supplementation (C&S) system in LCO Dry Creek (i.e., from 2025 onward; Figure 3.3). Prior to the commissioning of the C&S system, monthly average nitrate concentrations in LCO Dry Creek are projected to be higher than the targeted receiving environment objective seasonally. This information is summarized in Table 3.5.

**Table 3.5: Summary of Projected Monthly Average Nitrate Concentrations above EMA Permit 107517 SPOs or Compliance Limits between 2022 and 2053**

| Type | Location | Year [1] | Month | Maximum Projected Concentration (mg/L) | Corresponding SPO / Limit (mg/L) | Maximum Magnitude of Exceedance (mg/L) |
|---|---|---|---|---|---|---|
| Order Stations | Fording River downstream of Greenhills Creek (GH_FR1; 0200378) | 2022 to 2023 | August to April | 20.9 | 14.0 [2] | 6.9 |
| | Elk River upstream of Grave Creek (EV_ER4; 0200027) | 2022 to 2025 | August to April | 6.7 | 4.0 | 2.7 |
| | | 2026 to 2027 | November to March | 4.0 | 3.5 | 0.5 |
| | Elk River downstream of Michel Creek (EV_ER1; 0200393) | 2022 to 2025 | July to August and October to April | 4.1 | 3.0 | 1.1 |
| Compliance Points | FRO Compliance Point (FR_FRABCH; E223753) | 2022 to 2023 | August to May | 29.5 | 18.0 | 11.5 |
| | | 2024 to 2028 | August to May | 19.8 | 12.0 | 7.8 |
| | GHO Fording River Compliance Point (GH_FR1; 0200378) | 2022 to 2023 | August to April | 20.9 | 14.0 | 6.9 |
| | | 2024 to 2027 | August to April | 15.2 | 11.0 | 4.2 |
| | LCO Compliance Point (LC_LCDSSLCC; E297110) | 2022 to 2025 | January to December | 13.2 | 7.0 | 6.2 |
| LCO Dry Creek | LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210) | 2022 to 2024 | June to April | 96.6 | 15.0 | 81.6 |

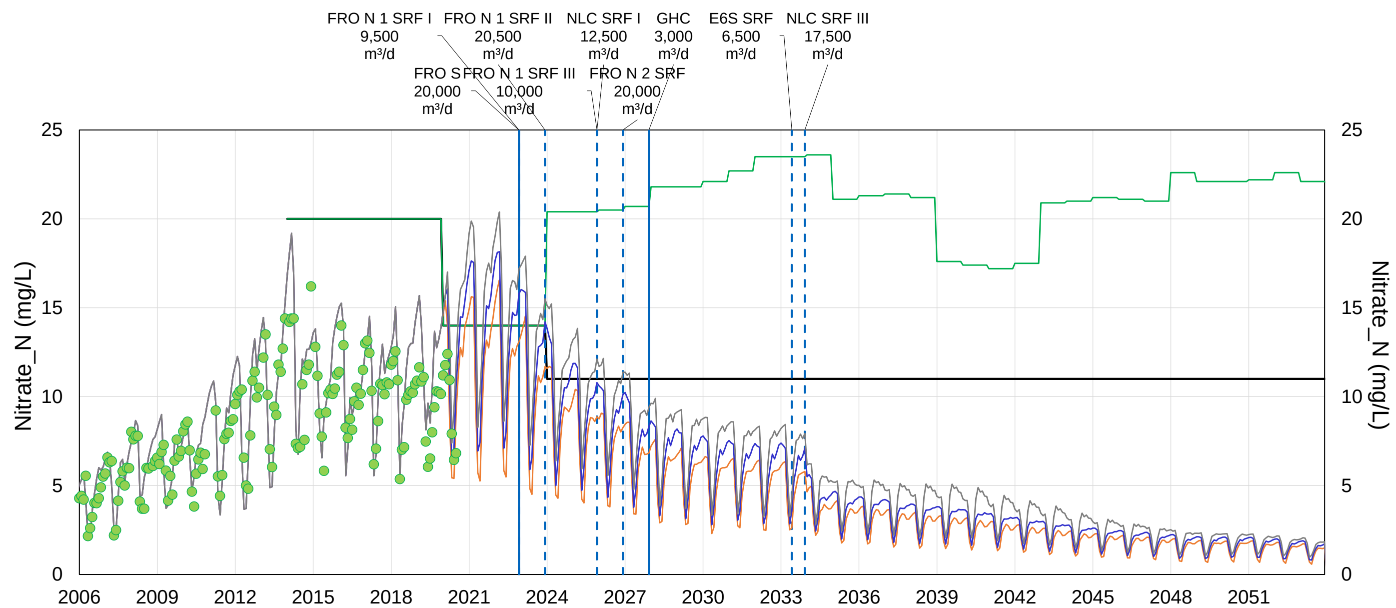
Note: mg/L = milligrams per liter.

[1] Compliance summary is for 2022 and onward; historical compliance is based on monthly average concentrations for samples collected at the Order stations and compliance points.

[2] SPOs for nitrate at GH_FR1 as of 2023 are hardness dependent based on the following formula: Level 1 benchmark for the Fording River N as mg/L = 101.0003log10(hardness)-1.52 where hardness is in mg/L of CaCO3. Values in the table above were calculated based on a hardness of 360 mg/L.

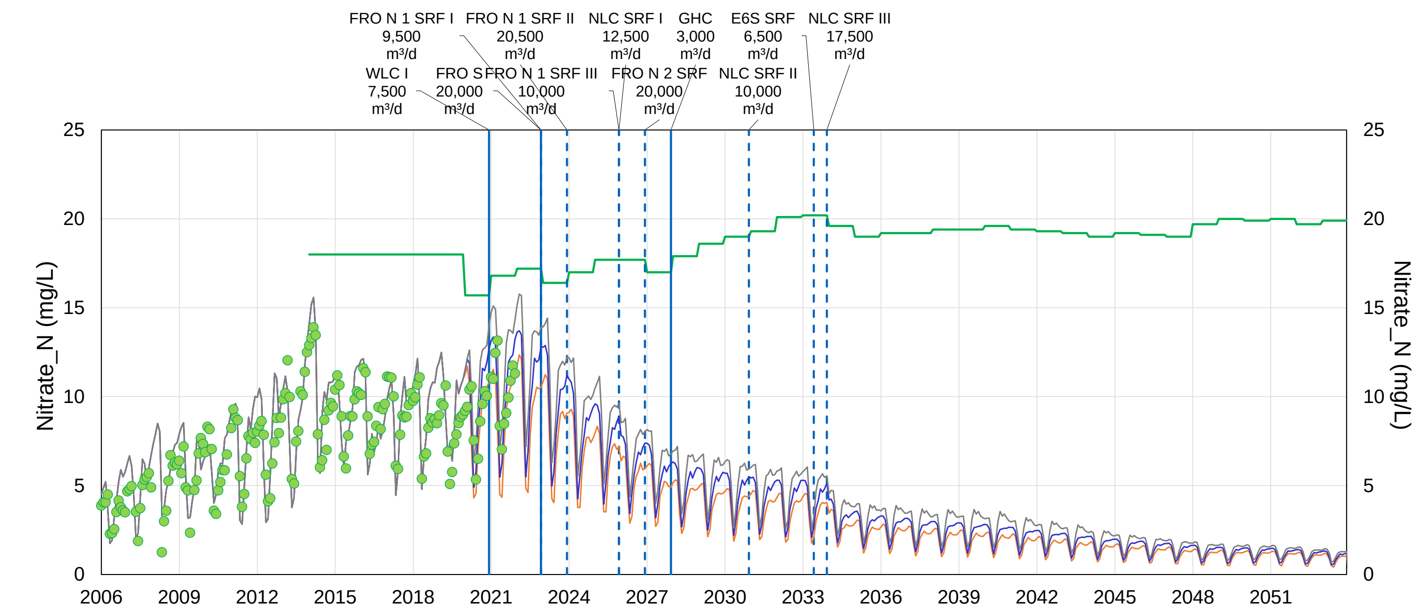
## Figure 3.1: Projected Monthly Average Nitrate Concentrations at Order Stations from 2006 to 2053

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



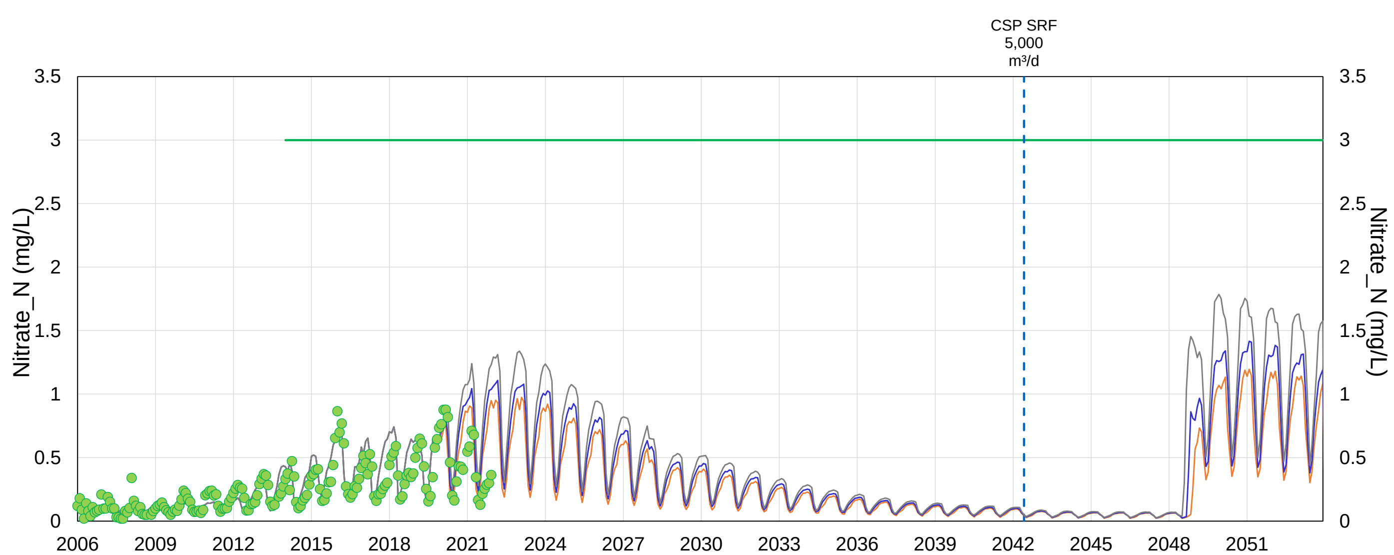

Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



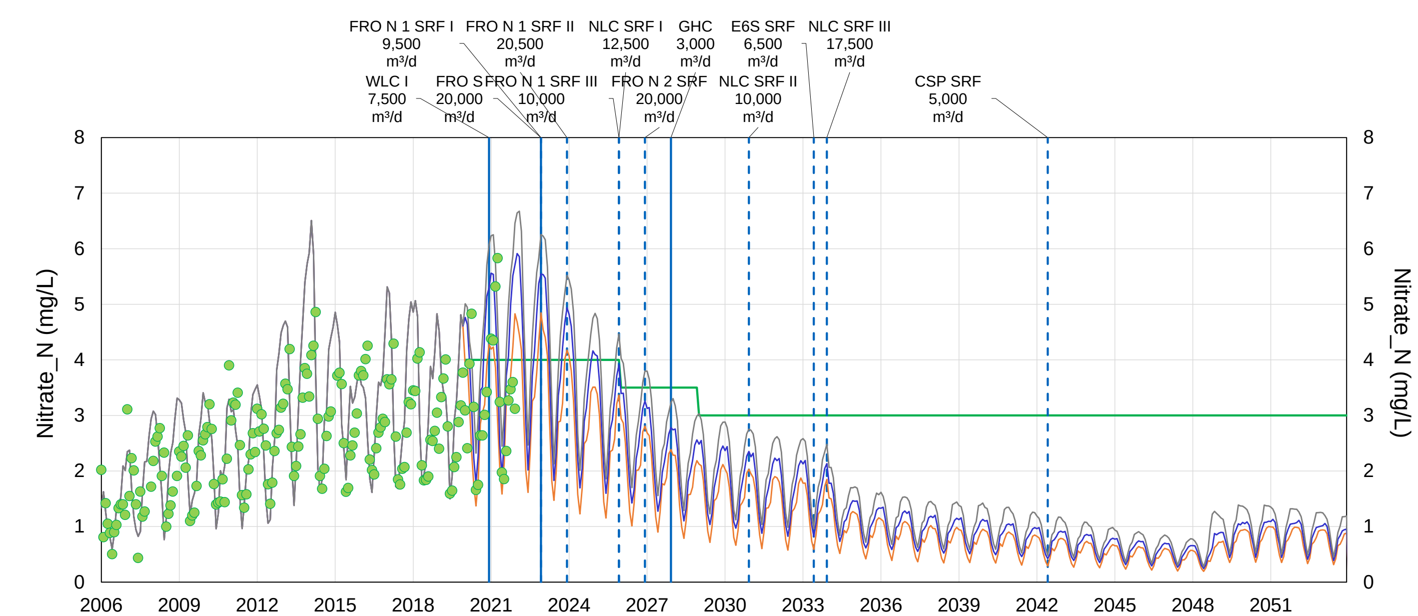

Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



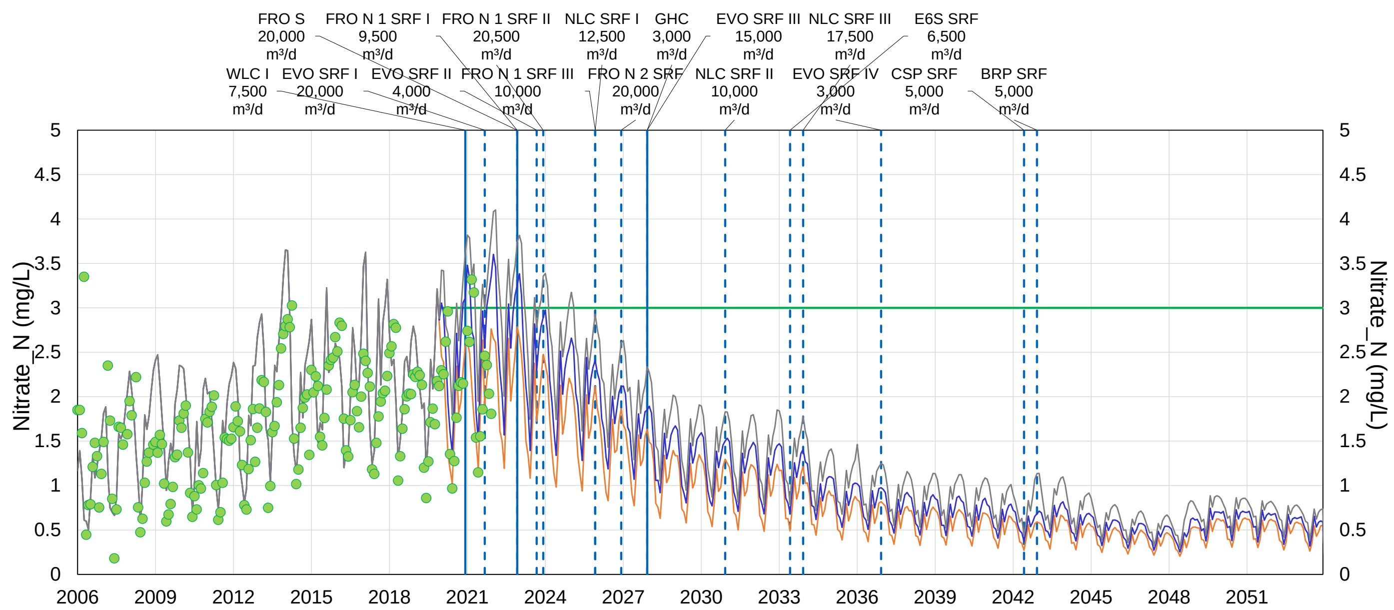

Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

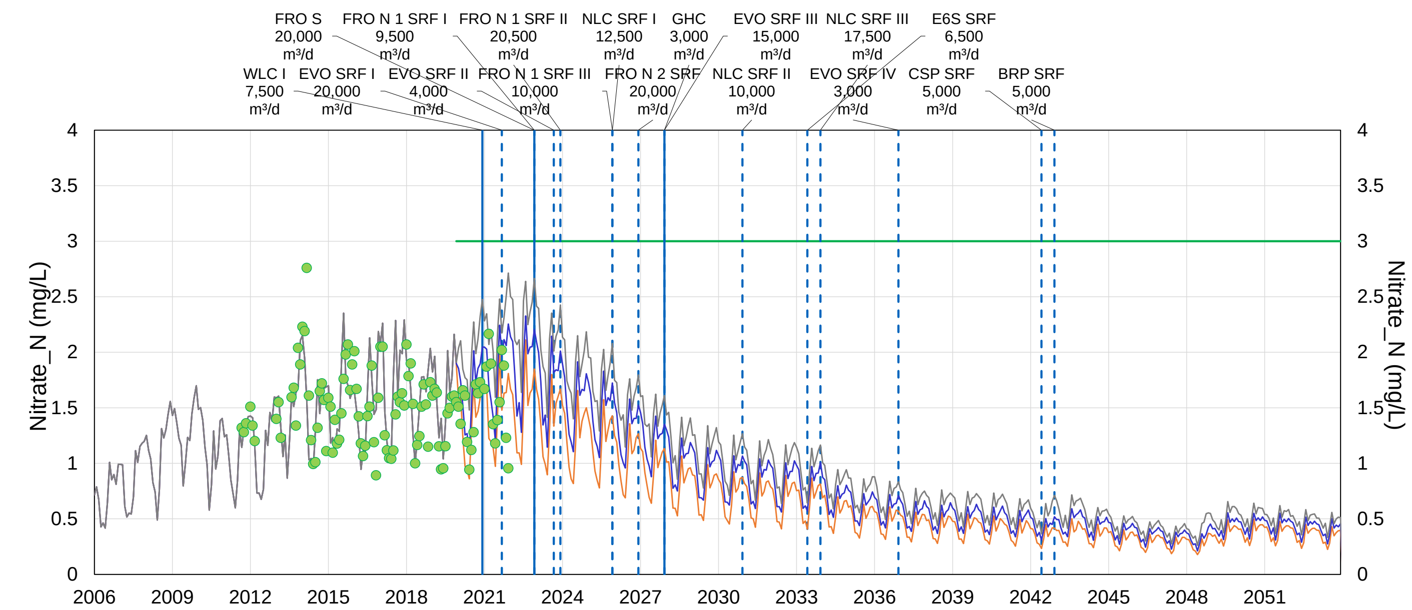



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

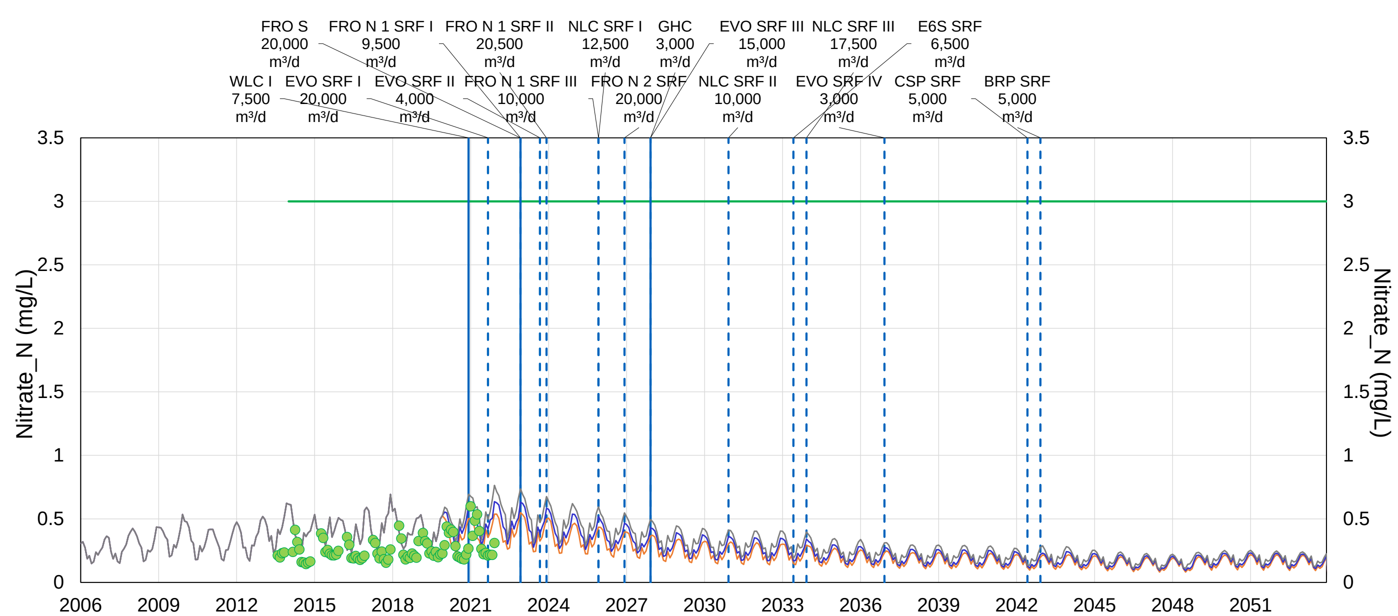
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)




(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)




(g) Koocanusa Reservoir (RG_DSELK; E300230)



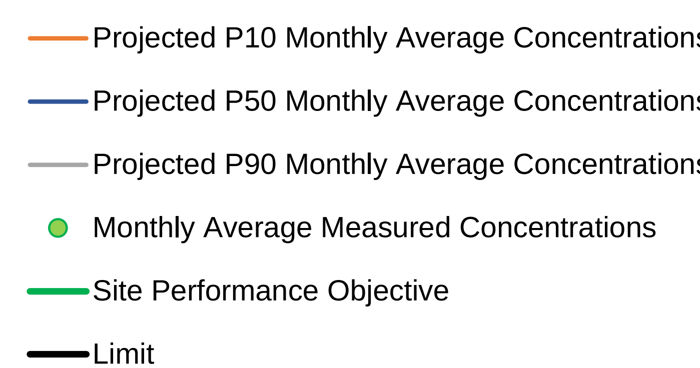
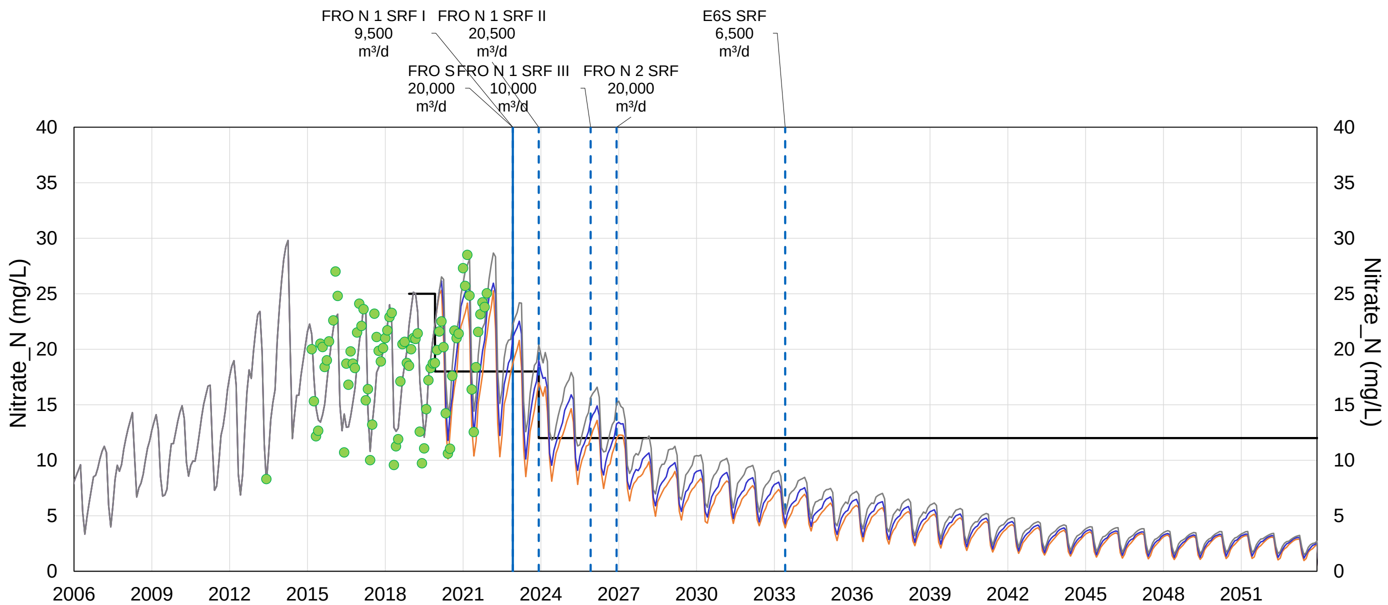
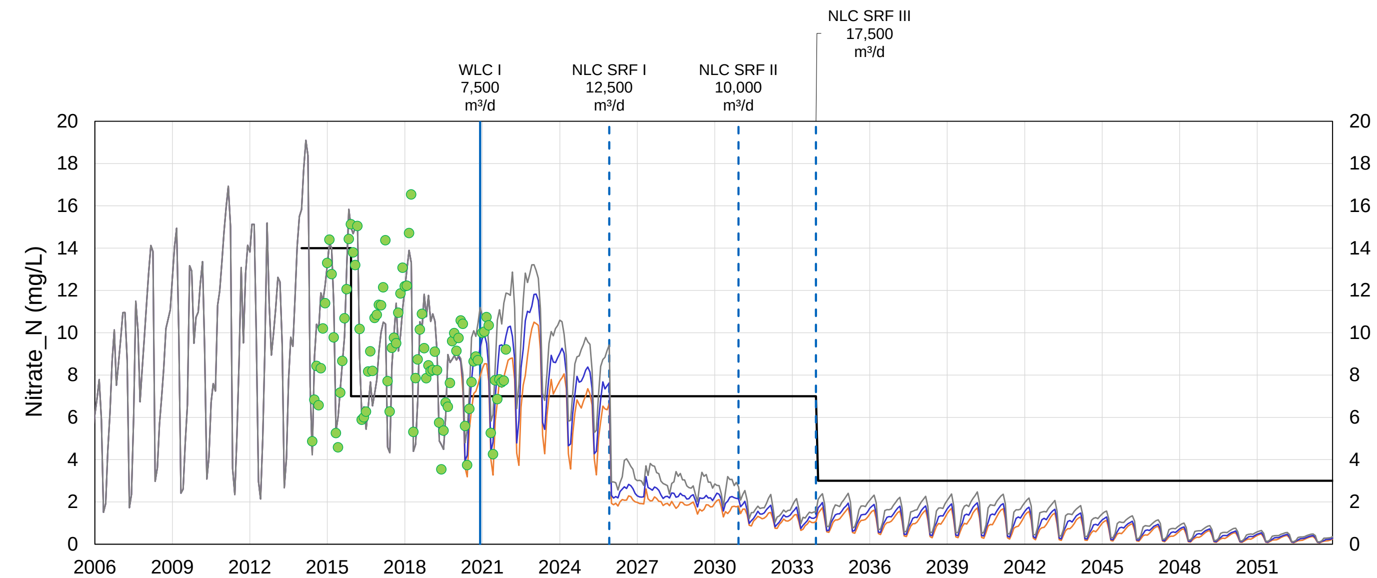



Figure 3.2: Projected Monthly Average Nitrate Concentrations at Compliance Points from 2006 to 2053

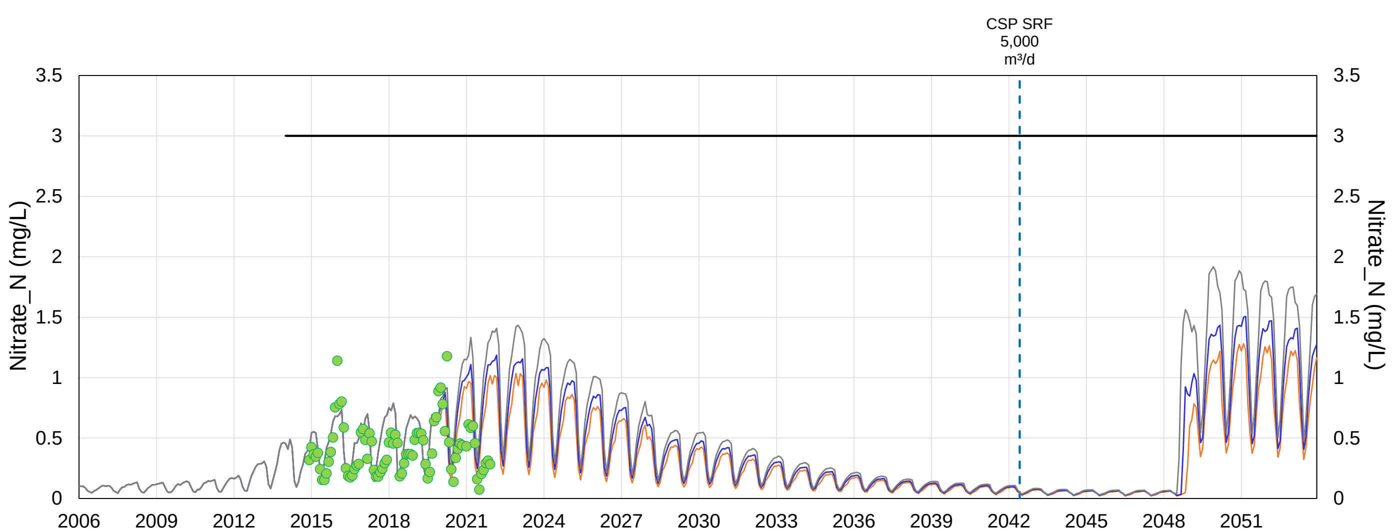
(a) FRO Compliance Point (FR_FRABCH; E223753)



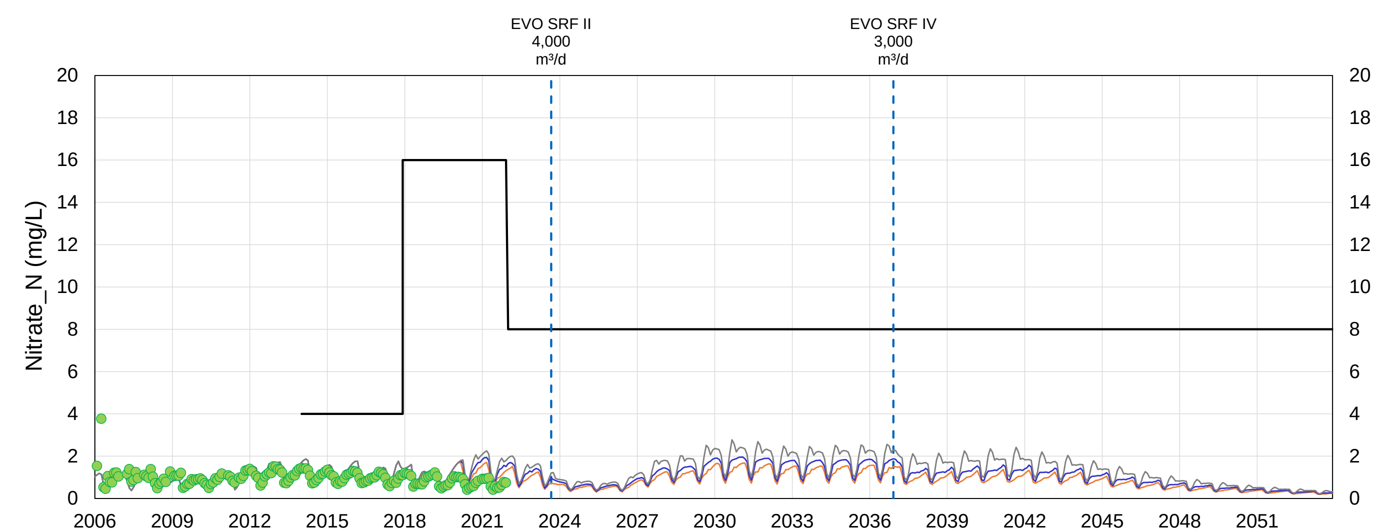

(b) LCO Compliance Point (LC_LCDSSLCC; E297110)




(c) GHO Elk River Compliance Point (GH_ERC; E300090)

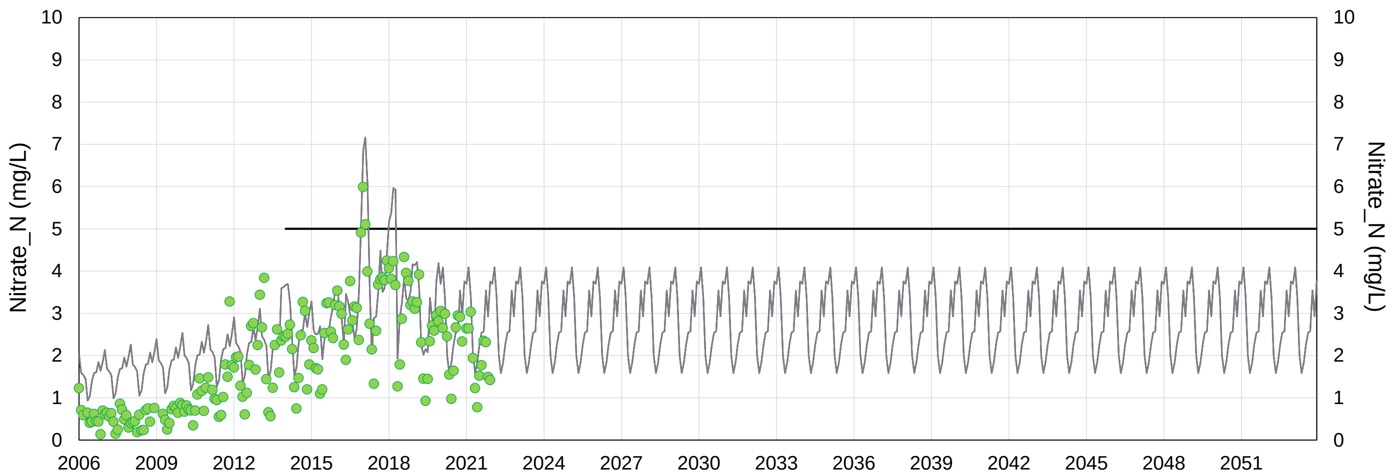



(d) EVO Harmer Compliance Point (EV_HC1; E102682)

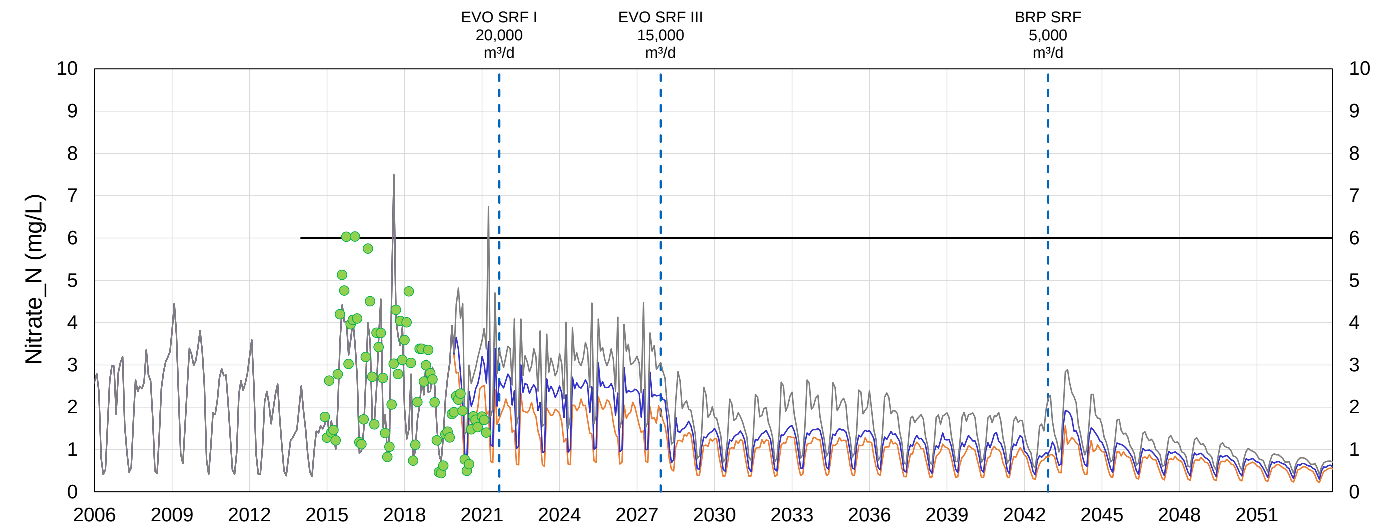



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

(e) CMO Compliance Point (CM_MC2; E258937)




(f) EVO Michel Creek Compliance Point (EV_MC2; E300091)

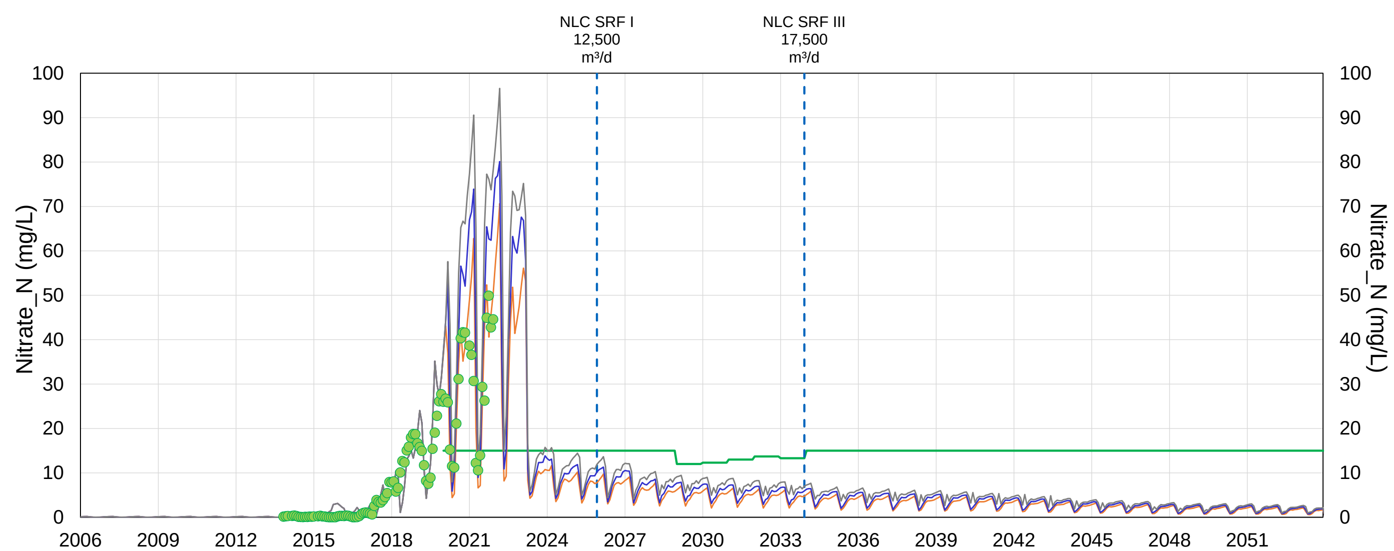



Note: Projected concentrations are from the CMO Water and Load Balance Model.

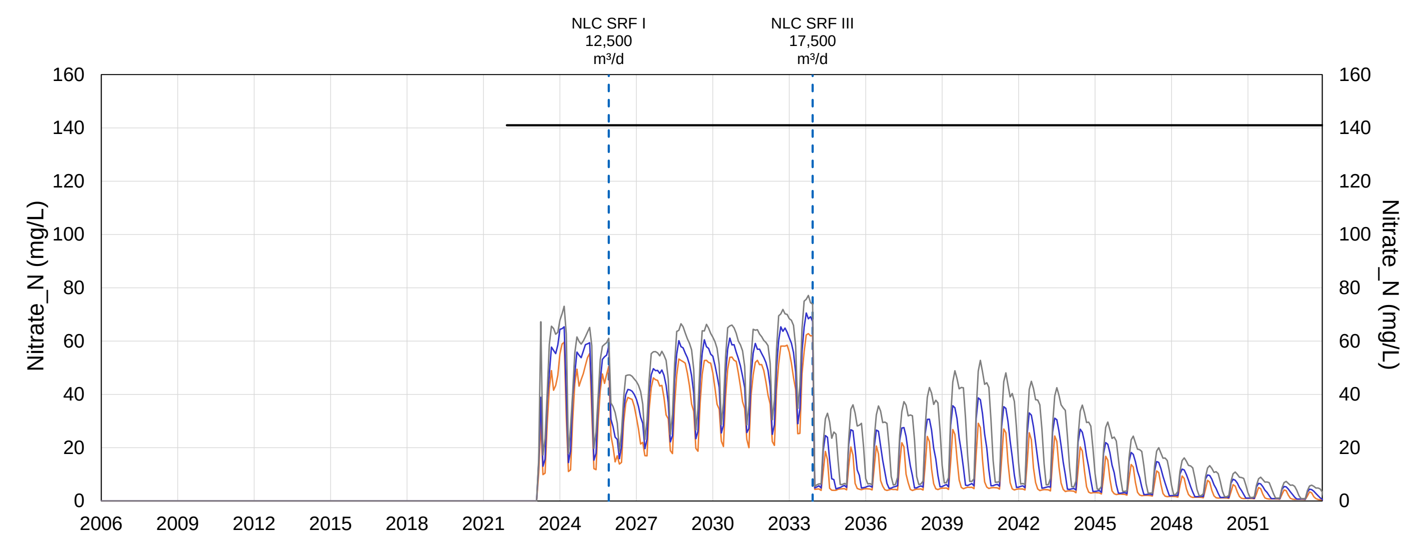
- Projected P10 Monthly Average Concentrations
- Projected P50 Monthly Average Concentrations
- Projected P90 Monthly Average Concentrations
- Monthly Average Measured Concentrations
- Site Performance Objective
- Limit

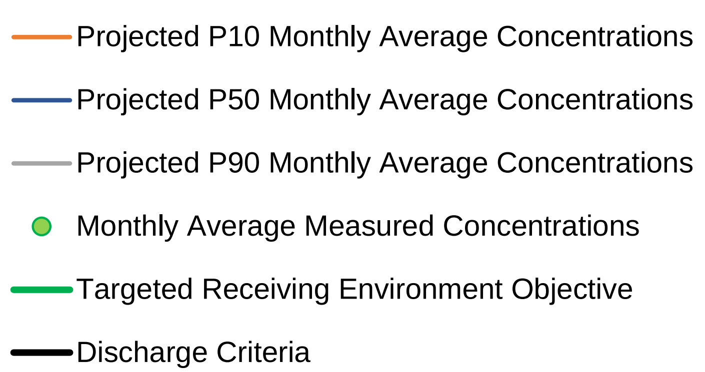
Figure 3.3: Projected Monthly Average Concentrations of Nitrate in LCO Dry Creek from 2006 to 2053

(a) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)




(b) LCO Dry Creek - Conveyance Water



#### 3.2.1.2 Selenium Projections

*Order Stations*

Monthly average selenium concentrations are projected to meet short-, medium- and long-term SPOs at the following Order Stations (Figure 3.4):

- Elk River upstream of Boivin Creek (GH_ER1; E206661)
- Elk River downstream of Michel Creek (EV_ER1; 0200393)
- Elk River at Elko Reservoir (RG_ELKORES; E294312)

Monthly average selenium concentrations are also projected to meet long-term SPOs at the remaining Order Stations, as follows (Figure 3.4):

- Fording River downstream of Greenhills Creek (GH_FR1; 0.00378) – mid-2025 onward after commissioning of the FRO AWTF-S, FRO-N 1 SRF, and the first phase of the NLC SRF
- Fording River downstream of Line Creek (LC_LC5; 0200028) – mid-2026 onward after commissioning of the FRO-S AWTF, FRO-N 1 SRF, and the first phases of the NLC SRF and FRO-N 2 SRF
- Elk River upstream of Grave Creek (EV_ER4; 0200027) – mid-2025 onward after commissioning of the FRO AWTF-S, FRO-N 1 SRF, and the first phase of the NLC SRF
- Koocanusa Reservoir (RG_DSELK; E300230) – mid-2027 onward after the commissioning of the FRO AWTF-S, FRO-N 1 SRF, the first phases of the NLC SRF and FRO-N 2 SRF, treatment in Greenhills Creek and the second and third phases of the EVO SRF

Prior to commissioning these SRFs and AWTFs, monthly average selenium concentrations are projected to be higher than SPOs at the four aforementioned Order Stations. This information is summarized in Table 3.6.

*Compliance Limits*

Monthly average selenium concentrations are projected to meet short-, medium- and long-term Compliance Limits at the following compliance points (Figure 3.5):

- GHO Elk River Compliance Point (GH_ERC; E300090)
- CMO Compliance Point (CM_MC2; E258937)
- EVO Harmer Compliance Point (EV_HC1; E102682)
- EVO Michel Creek Compliance Point (EV_MC2; E300091)

Monthly average selenium concentrations are also projected to meet Compliance Limits at the remaining compliance points, as follows (Figure 3.5):

- FRO Compliance Point (FR_FRABCH; E223753) – mid-2027 onward
- LCO Compliance Point (LC_LCDSSLCC; E297110) – 2026 onward

Between 2020 and 2028, monthly average selenium concentrations at the two aforementioned locations are projected to be higher than Compliance Limits. This information is summarized in Table 3.6.

*LCO Dry Creek*

Monthly average selenium concentrations are projected to meet the targeted receiving environment objective in LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS) after the commissioning of the C&S system in LCO Dry Creek (i.e., from 2024 onward; Figure 3.6). Prior to the commissioning of the C&S system, monthly average selenium concentrations in LCO Dry Creek are projected to be higher than the targeted receiving environment objective seasonally. This information is summarized in Table 3.6.

**Table 3.6: Summary of Projected Monthly Average Selenium Concentrations above EMA Permit 107517 SPOs or Limits between 2022 and 2053**

| Type | Location | Year [1] | Month | Maximum Projected Concentration (µg/L) | Corresponding SPO / Limit (µg/L) | Maximum Magnitude of Exceedance (µg/L) |
|---|---|---|---|---|---|---|
| Order Stations | Fording River downstream of Greenhills Creek (GH_FR1; 0200378) | 2022 to 2023 | December to April and August to September | 85 | 63 | 22 |
| | | 2024 to 2025 | January to March | 60 | 57 | 3 |
| | Fording River downstream of Line Creek (LC_LC5; 0200028) | 2022 to 2023 | August and September and December to March | 64 | 51 | 13 |
| | | 2024 to 2026 | August to March | 50 | 40 | 10 |
| | Elk River upstream of Grave Creek (EV_ER4; 0200027) | 2022 to 2023 | December to March | 27 | 23 | 4 |
| | | 2024 to 2025 | December to March | 22 | 19 | 2 |
| | Koocanusa Reservoir (RG_DSELK; E300230 | 2022 to 2027 | February to May | 2.8 | 2.0 | 0.8 |
| Compliance Points | FRO Compliance Point (FR_FRABCH; E223753) | 2022 to 2023 | August and January to April | 122 | 85 | 37 |
| | | 2024 to 2027 | November to April | 73 | 58 | 15 |
| | Fording River downstream of | 2022 to 2023 | December to April and | 85 | 63 | 22 |

**Table 3.6: Summary of Projected Monthly Average Selenium Concentrations above EMA Permit 107517 SPOs or Limits between 2022 and 2053**

| Type | Location | Year [1] | Month | Maximum Projected Concentration (µg/L) | Corresponding SPO / Limit (µg/L) | Maximum Magnitude of Exceedance (µg/L) |
|---|---|---|---|---|---|---|
| | Greenhills Creek (GH_FR1; 0200378) | | August to September | | | |
| | | 2024 to 2025 | January to March | 60 | 57 | 3 |
| | LCO Compliance Point (LC_LCDSSLCC; E297110) | 2022 to 2025 | September to April | 69 | 50 | 19 |
| LCO Dry Creek [2] | LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210) | 2022 to 2023 | July to April | 198 | 70 | 128 |

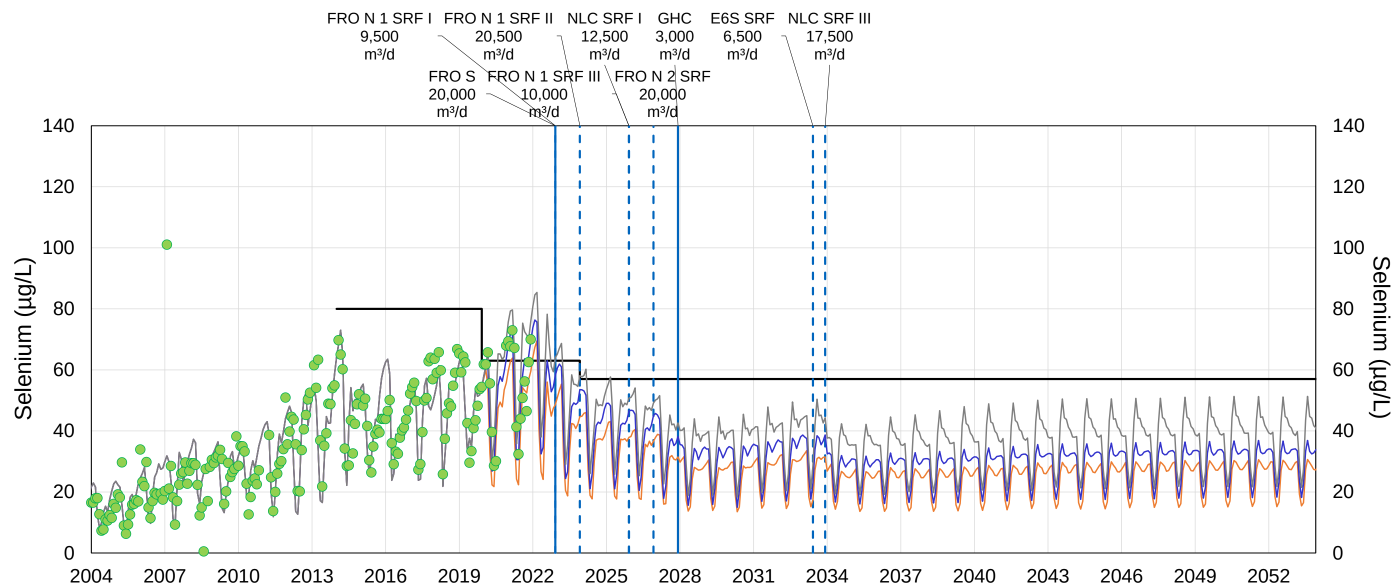
Note: µg/L = micrograms per liter.

[1] Compliance summary is for 2022 and onward; historical compliance is based on monthly average concentrations for samples collected at the Order stations and compliance points.

[2] The compliance evaluation for selenium at LC_DCDS is based on the proposed targeted receiving environment objective of 70 µg/L that was presented in the LCO Dry Creek Water Management Plan. It is acknowledged that at the time of the submission of the 2022 IPA there has not been a decision on SPOs in LCO Dry Creek and this work is proceeding via the Best Achievable Technology (BAT) assessments that are under review.

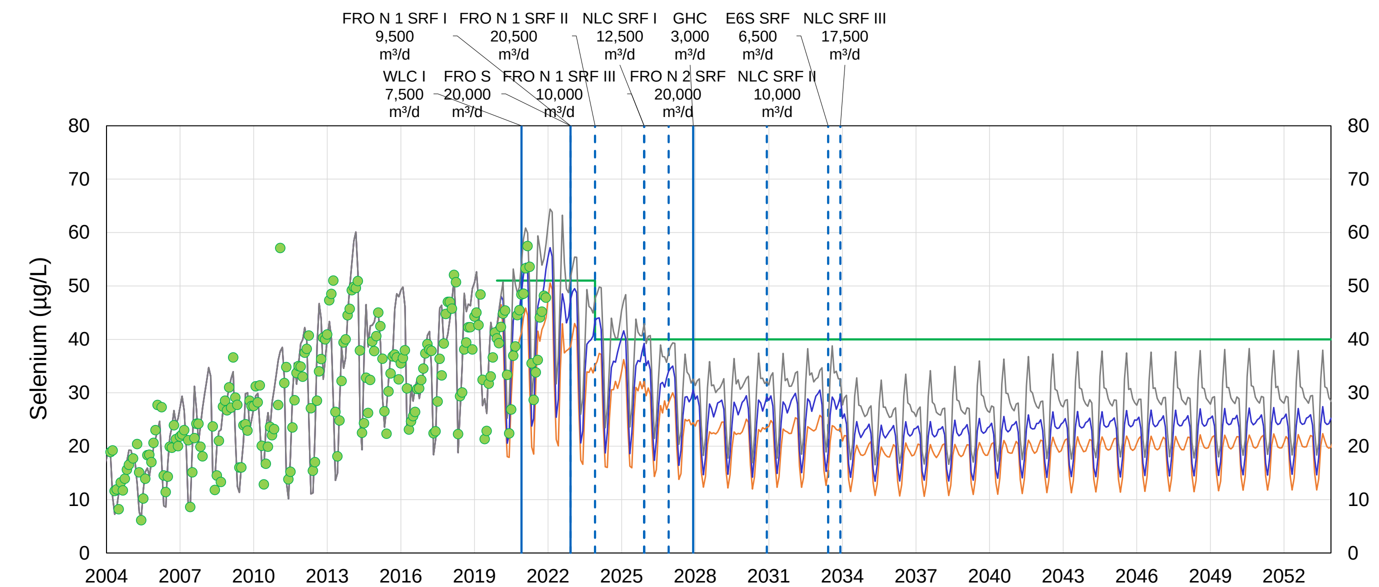
Figure 3.4: Projected Monthly Average Selenium Concentration at Order Stations from 2004 to 2053

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

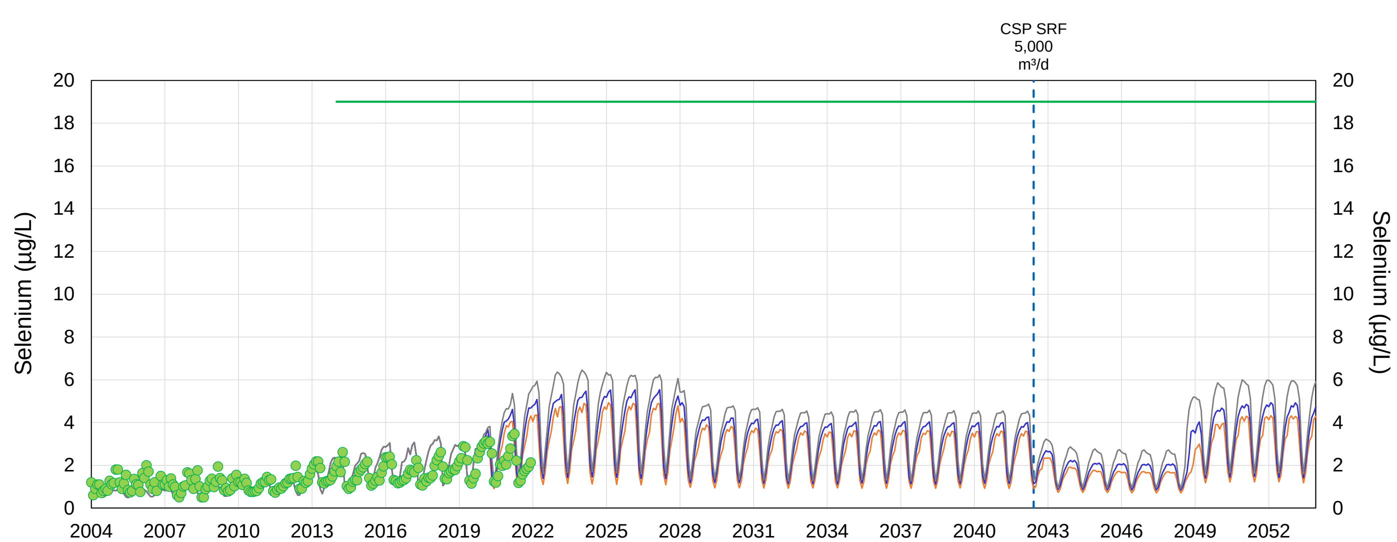



Note: This location is also the GHO Fording River Compliance Point.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

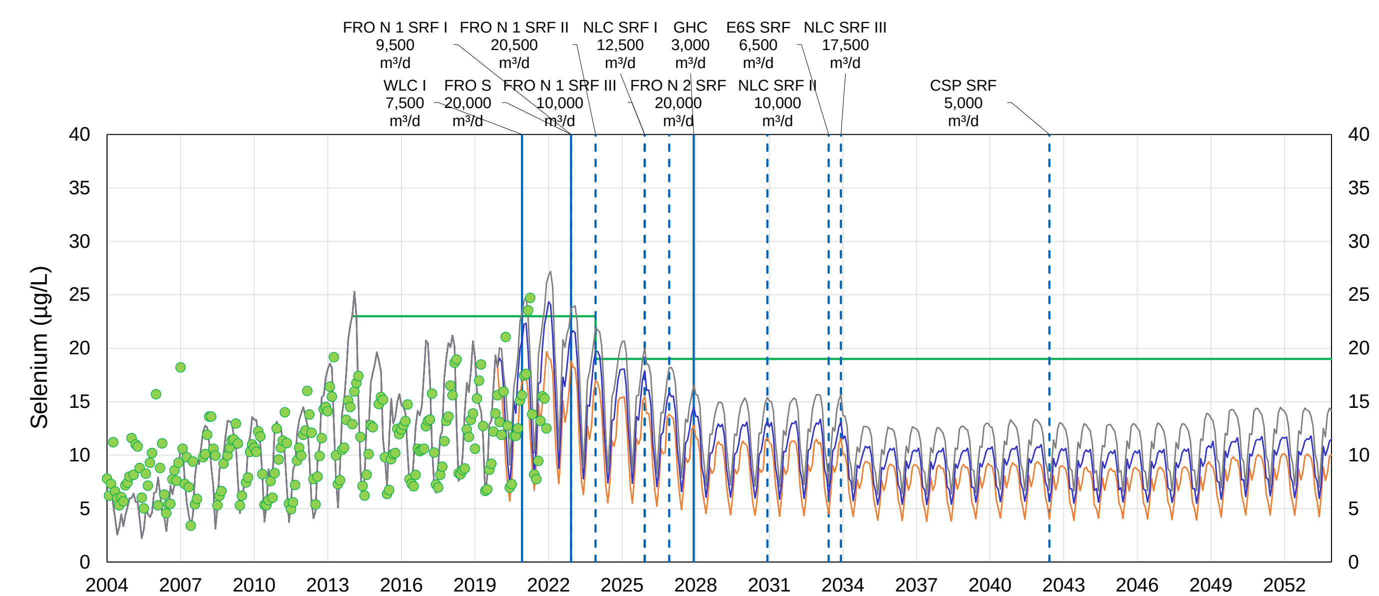



(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



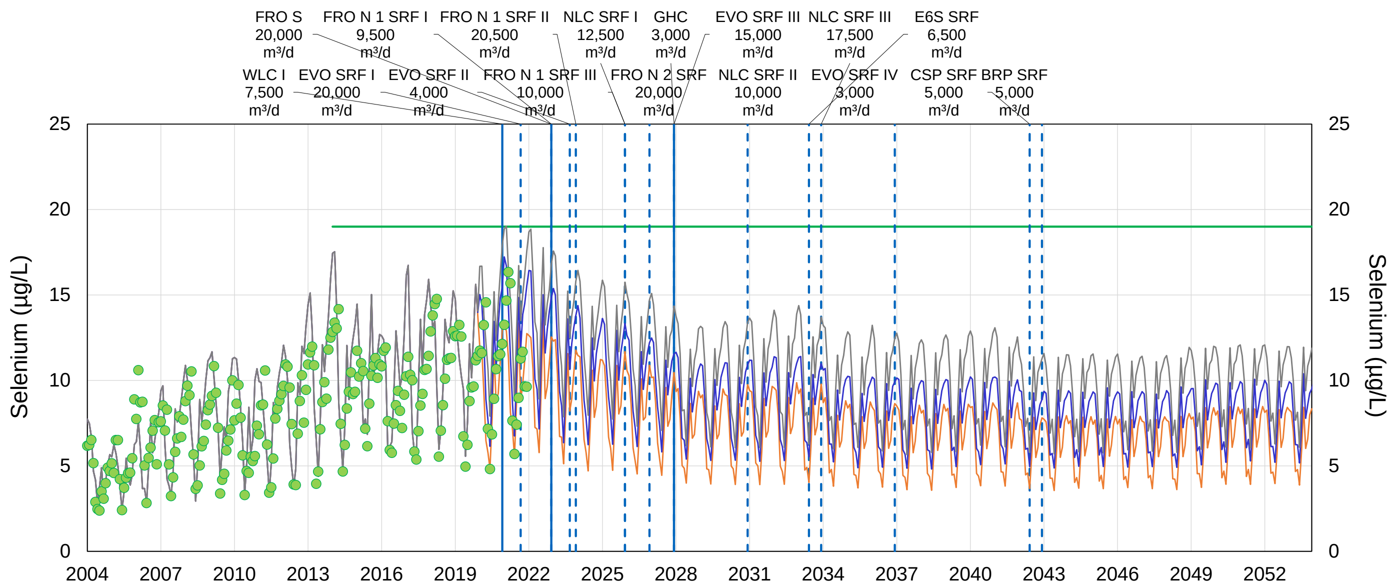

Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

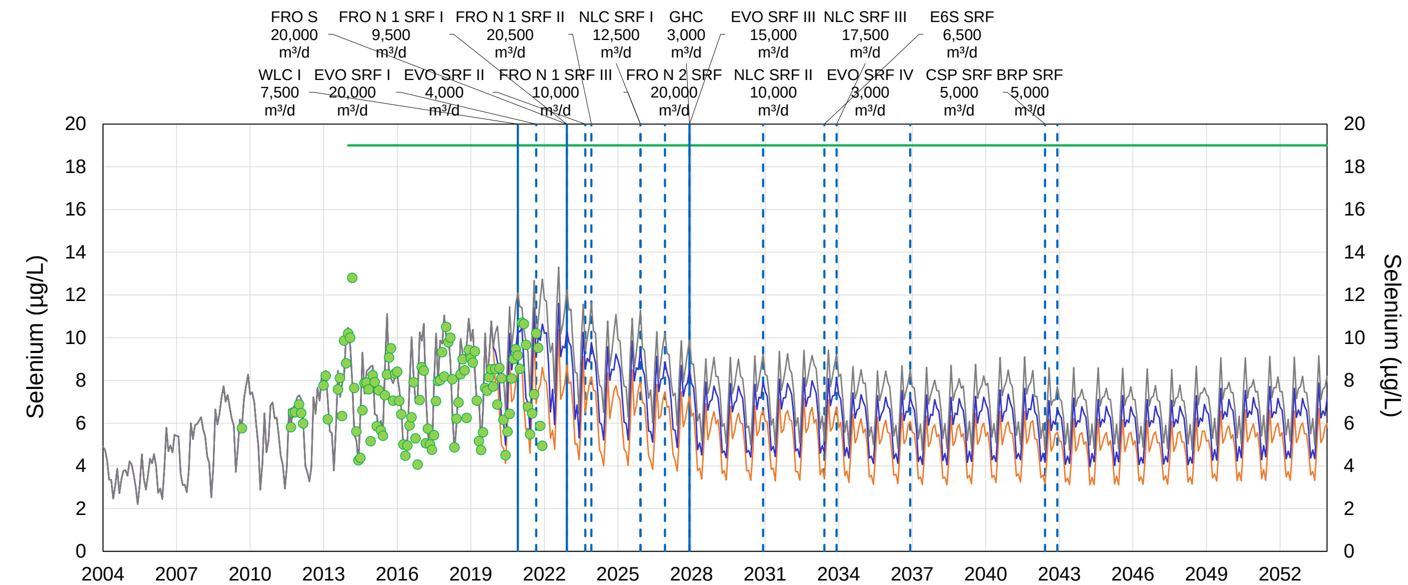



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

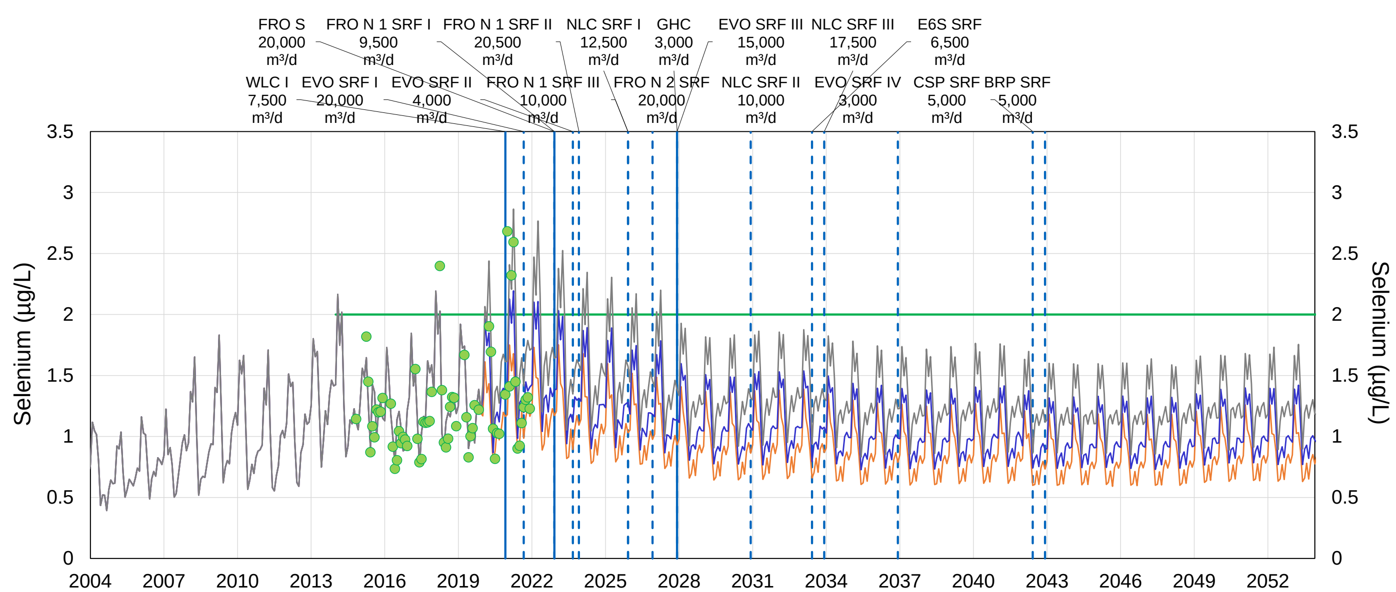
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



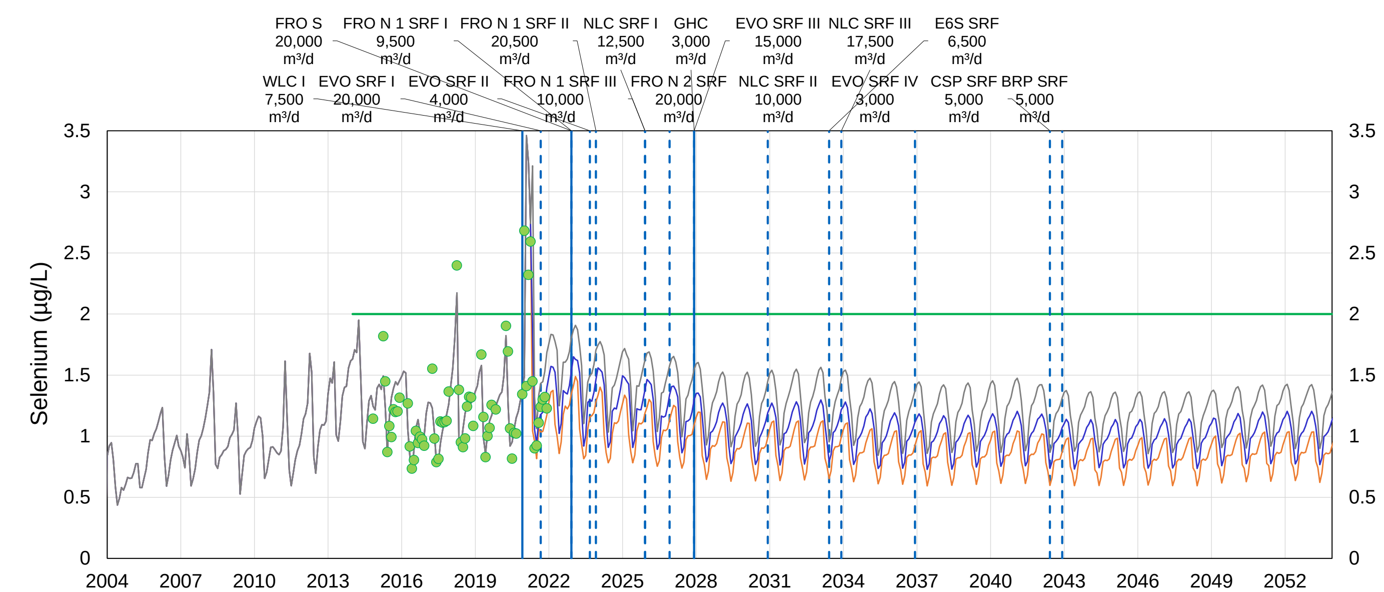

(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)




(g) Koocanusa Reservoir (RG_DSELK; E300230)



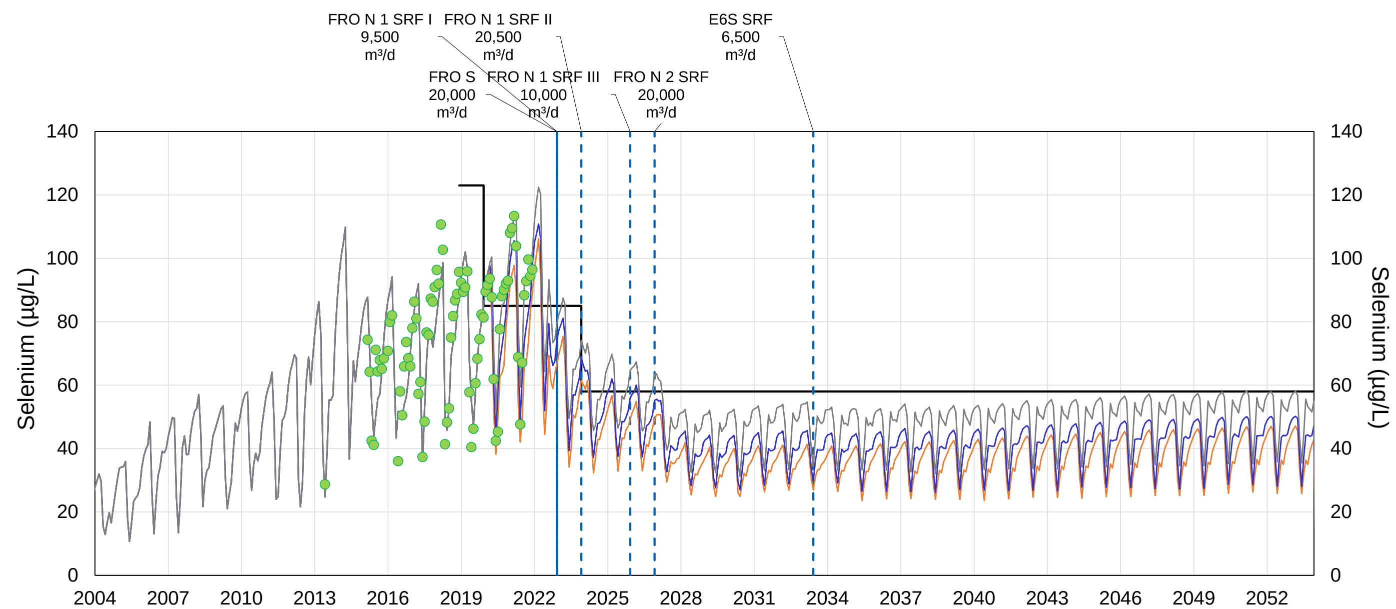

(h) Koocanusa Reservoir – Koocanusa Reservoir Module



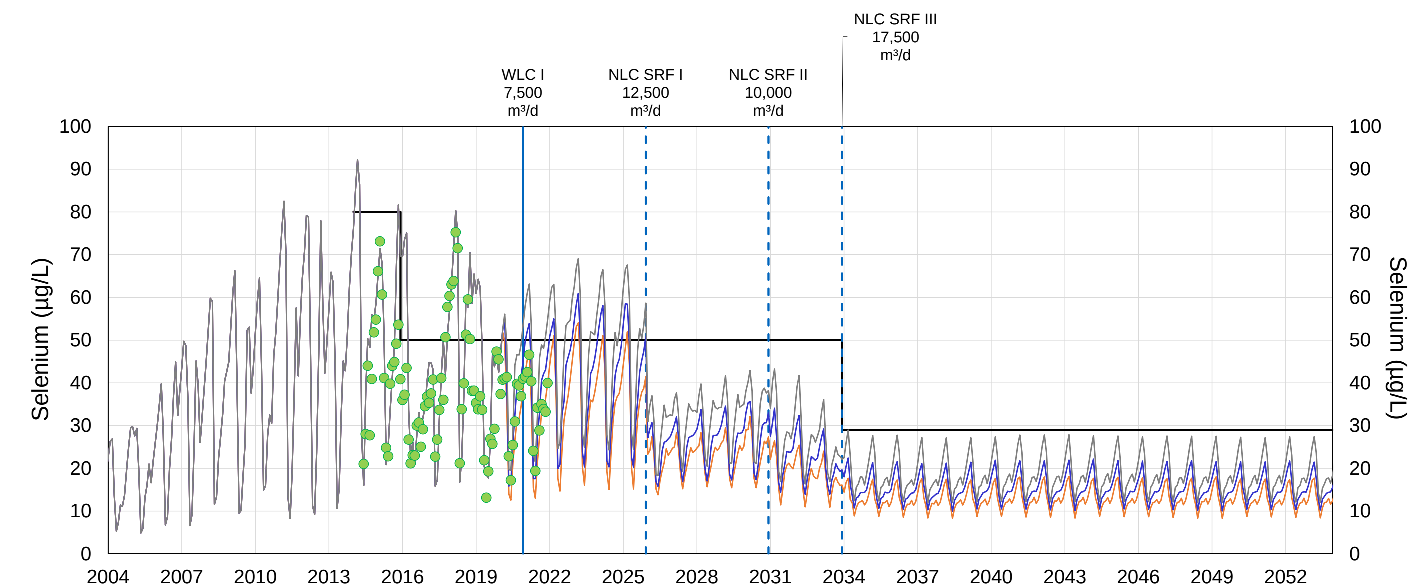

- Projected P10 Monthly Average Concentrations
- Projected P50 Monthly Average Concentrations
- Projected P90 Monthly Average Concentrations
- Monthly Average Measured Concentrations
- Site Performance Objective
- Limit

Figure 3.5: Projected Monthly Average Selenium Concentrations at Compliance Points from 2004 to 2053

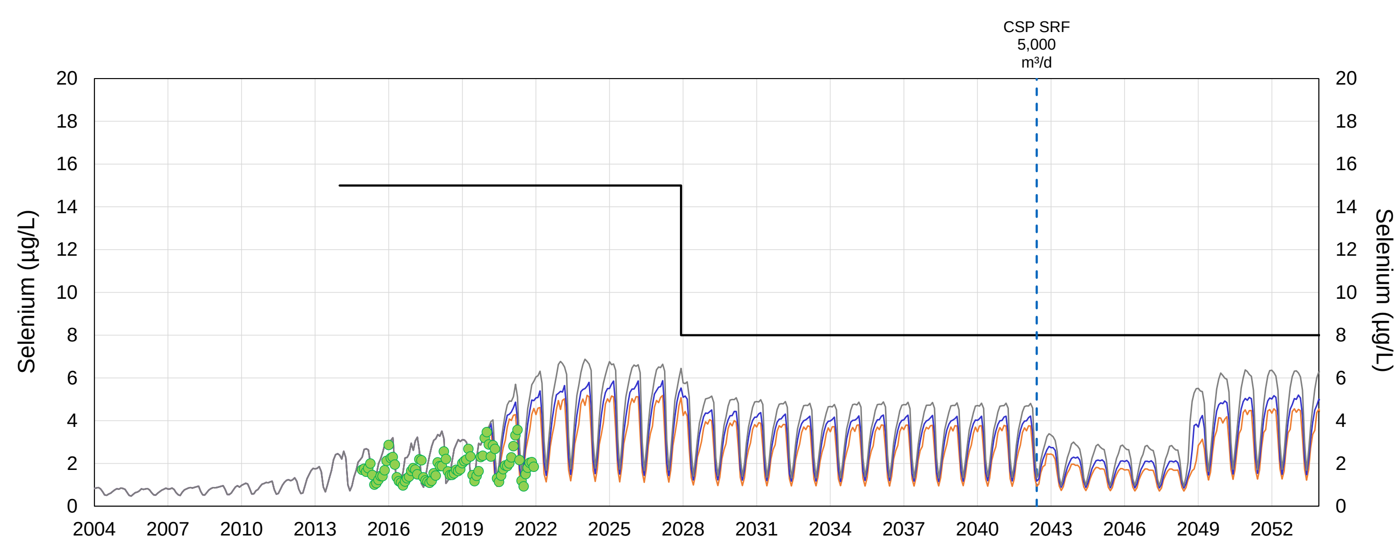
(a) FRO Compliance Point (FR_FRABCH; E223753)




(b) LCO Compliance Point (LC_LCDSSLCC; E297110)

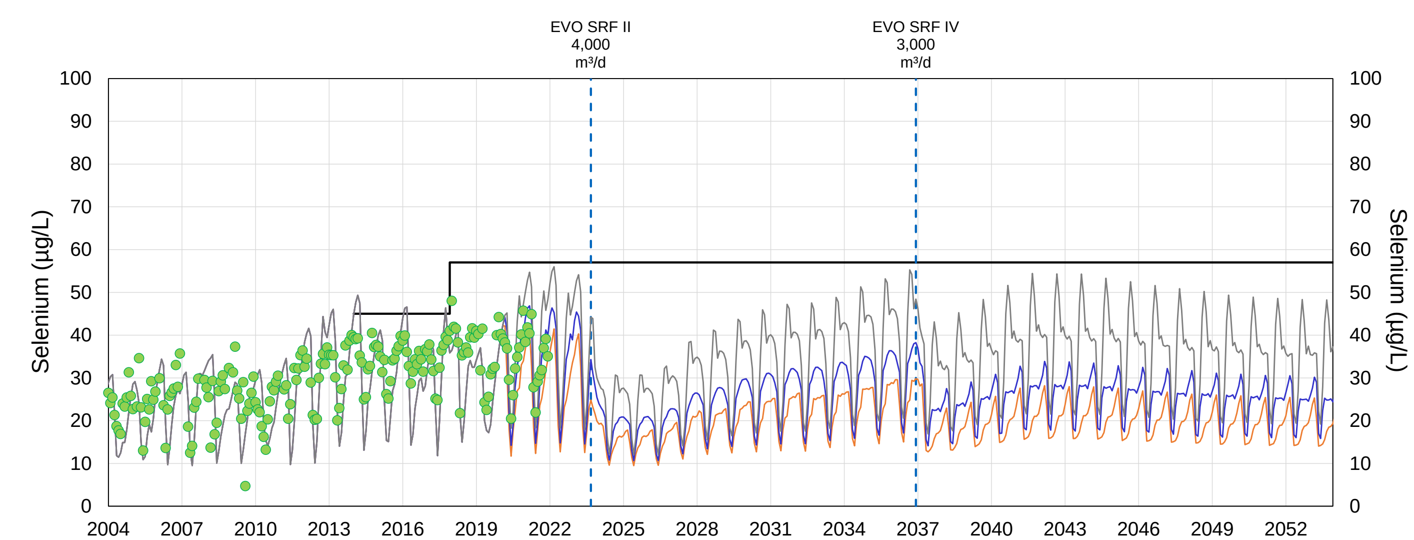



(c) GHO Elk River Compliance Point (GH_ERC; E300090)

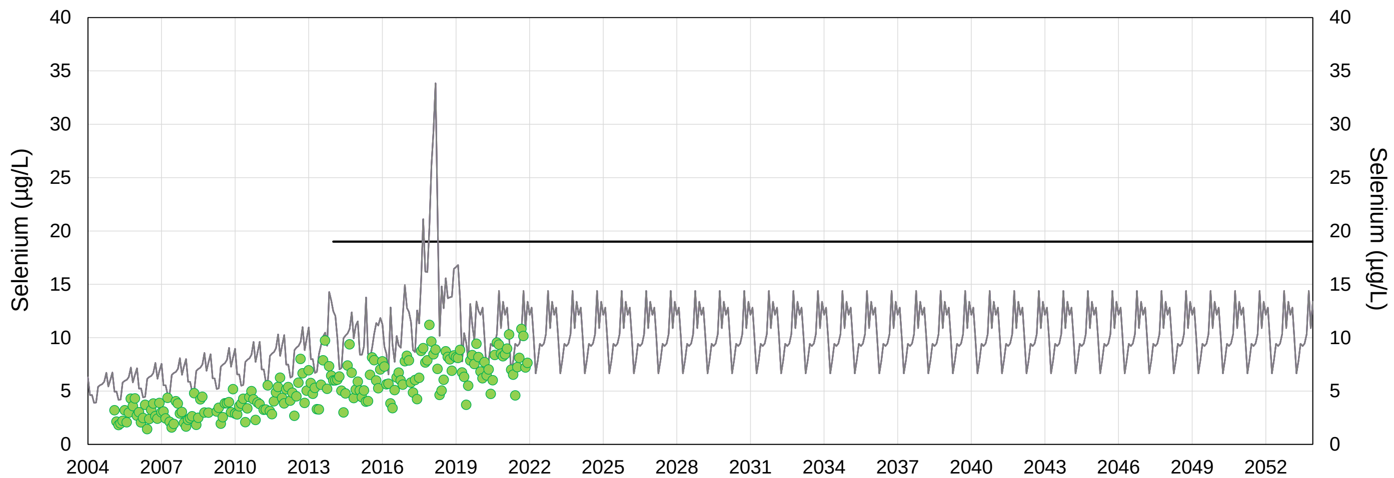



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

(d) EVO Harmer Compliance Point (EV_HC1; E102682)

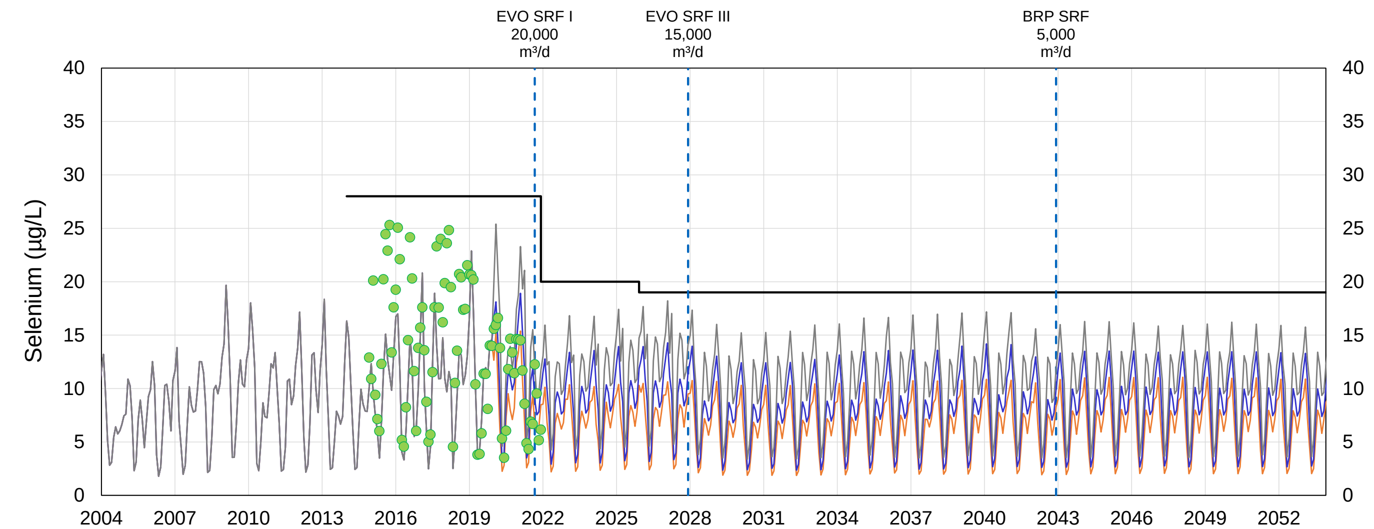


(e) CMO Compliance Point (CM_MC2; E258937)




Note: Projected concentrations are from the CMO Water and Load Balance Model.

(f) EVO Michel Creek Compliance Point (EV_MC2; E300091)




Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

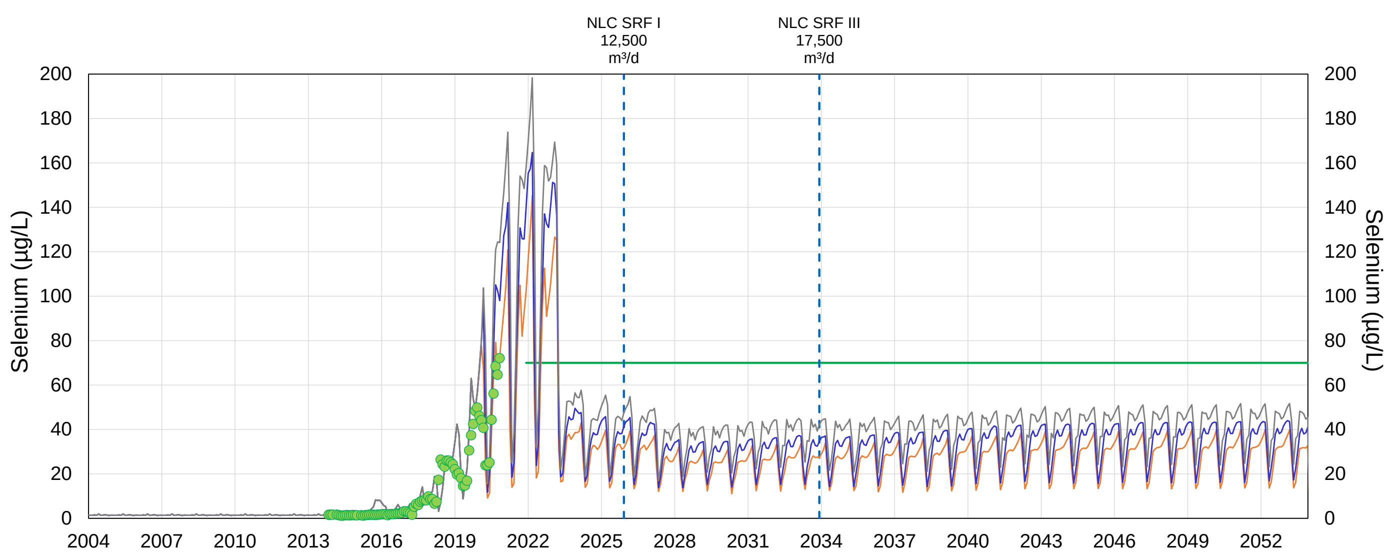
Monthly Average Measured Concentrations

Site Performance Objective

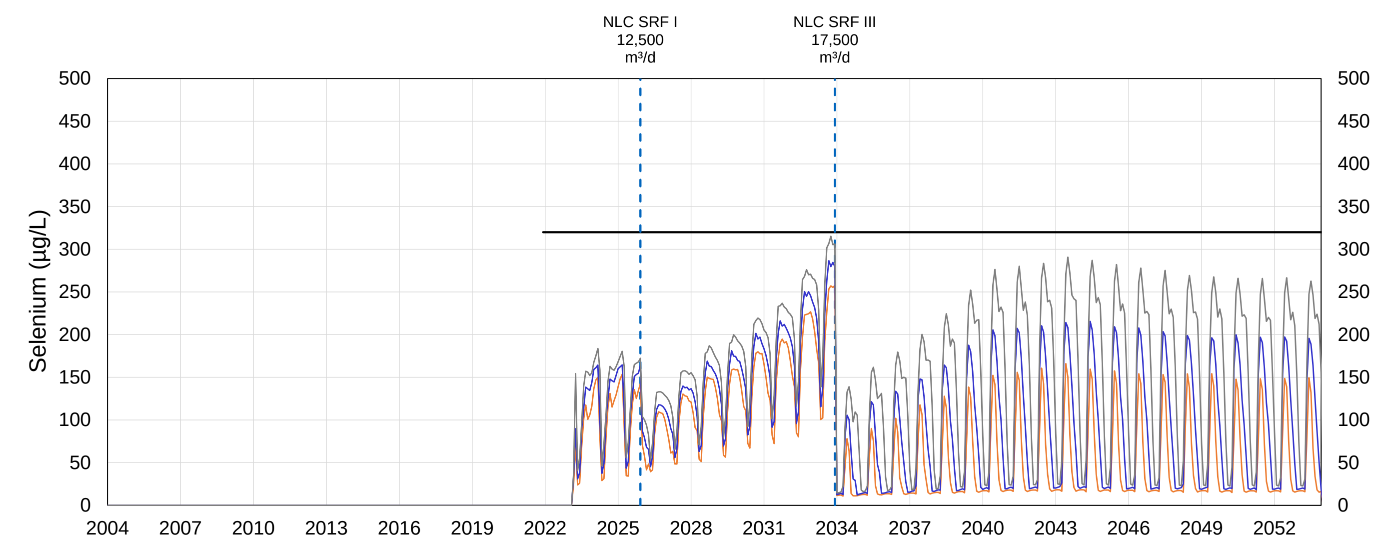
Limit

Figure 3.6: Projected Monthly Average Concentrations of Selenium in LCO Dry Creek from 2004 to 2053

(a) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)




(b) LCO Dry Creek - Conveyance Water




Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

Monthly Average Measured Concentrations

Targeted Receiving Environment Objective

Discharge Criteria

#### 3.2.1.3 Sulphate Projections

*Order Stations*

Monthly average sulphate concentrations are projected to meet short-, medium- and long-term SPOs at the following Order Stations (Figure 3.7):

- Fording River downstream of Line Creek (LC_LC5; 0200028)
- Elk River upstream of Boivin Creek (GH_ER1; 020661)
- Elk River upstream of Grave Creek (EV_ER4; 0200027)
- Elk River downstream of Michel Creek (EV_ER1; 0200393)
- Elk River at Elko Reservoir (RG_ELKORES; E294312)
- Koocanusa Reservoir (RG_DSELK; E300230)

Monthly average sulphate concentrations are also projected to meet the SPO in the Fording River downstream of Greenhills Creek (GH_FR1; 0200378) after the commissioning of sulphate treatment at the FRO-S AWTF (i.e., from 2027 onward; Figure 3.7). Prior to the commissioning of this facility, monthly average sulphate concentrations in the Fording River downstream of Greenhills Creek are projected to be higher than the SPO in March 2026. This information is summarized in Table 3.7.

*Compliance Points*

Monthly average sulphate concentrations are projected to meet short-, medium- and long-term Compliance Limits at the following compliance points (Figure 3.8):

- FRO Compliance Point (FR_FRABCH; E223753)
- GHO Elk River Compliance Point (GH_ERC; E300090)
- CMO Compliance Point (CM_MC2; E258937)
- EVO Harmer Compliance Point (EV_HC1; E102682)
- EVO Michel Creek Compliance Point (EV_MC2; E300091)

Monthly average sulphate concentrations are also projected to meet the Compliance Limit at the LCO Compliance Point (LC_LCDSSLCC; E297110) after the commissioning of the first phase of sulphate treatment at the LCO WLC AWTF (i.e., from 2026 onward; Figure 3.8). Prior to the commissioning of this facility, monthly average sulphate concentrations at the LCO Compliance Point are projected to be higher than the Compliance Limit seasonally. This information is summarized in Table 3.7.

*LCO Dry Creek*

Similar to selenium and nitrate, monthly average sulphate concentrations are projected to meet the targeted receiving environment objective in LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS) after the commissioning of the C&S system in LCO Dry Creek (i.e., from 2024 onward; Figure 3.9). Prior to the commissioning of the C&S system, monthly average sulphate concentrations in LCO Dry Creek are projected to be higher than the targeted receiving environment objective seasonally. This information is summarized in Table 3.7.

**Table 3.7: Summary of Projected Monthly Average Sulphate Concentrations above EMA Permit 107517 SPOs or Limits between 2022 and 2053**

| Type | Location | Year [1] | Month | Maximum Projected Concentration (mg/L) | Corresponding SPO / Limit (mg/L) | Maximum Magnitude of Exceedance (mg/L) |
|---|---|---|---|---|---|---|
| Order Stations/ Compliance Point | Fording River downstream of Greenhills Creek (GH_FR1; 0200378) | 2026 | March | 433 | 429 | 4 |
| Compliance Points | LCO Compliance Point (LC_LCDSSLCC; E297110) | 2023 to 2025 | February and March | 470 | 429 | 41 |
| LCO Dry Creek | LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210) | 2022 [2] to 2023 | February and March | 548 | 499 | 49 |

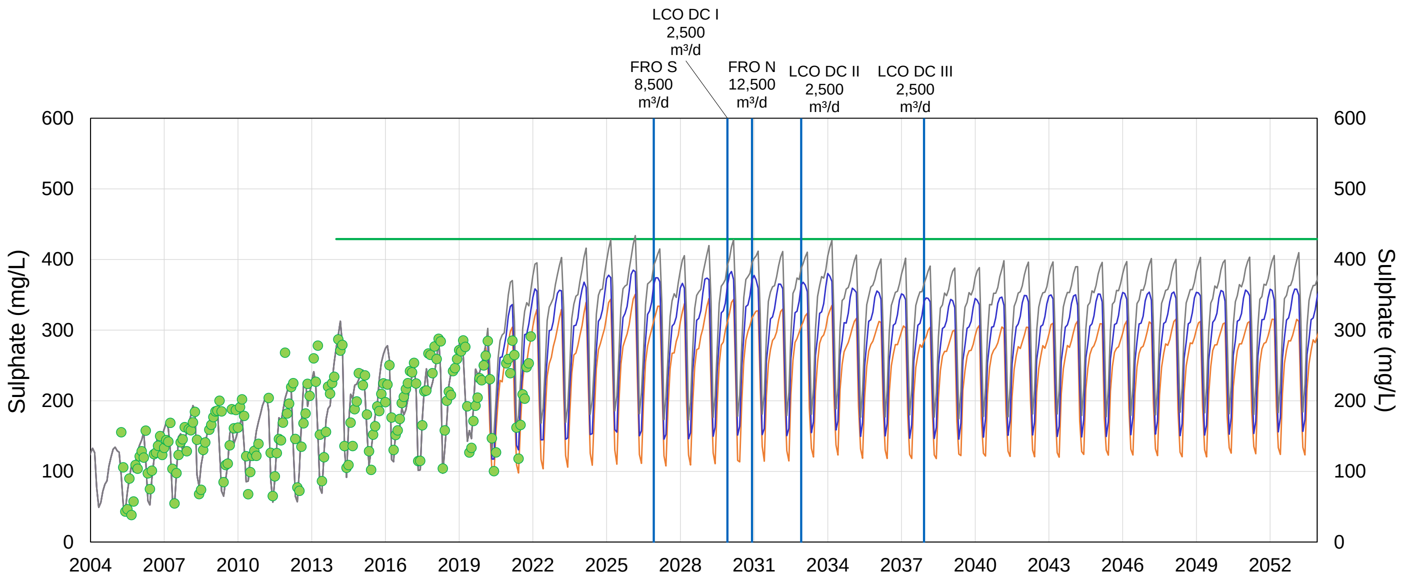
Note: mg/L = milligrams per liter

[1] Compliance summary is for 2022 and onward; historical compliance is based on monthly average concentrations for samples collected at the Order stations and compliance points.

[2] The 2022 measured monthly average concentrations of sulphate at LC_DCDS were 236 mg/L and 200 mg/L in February and March respectively and did not exceed the limit as projected for the P90 projected sulphate concentrations that are summarized in this table.

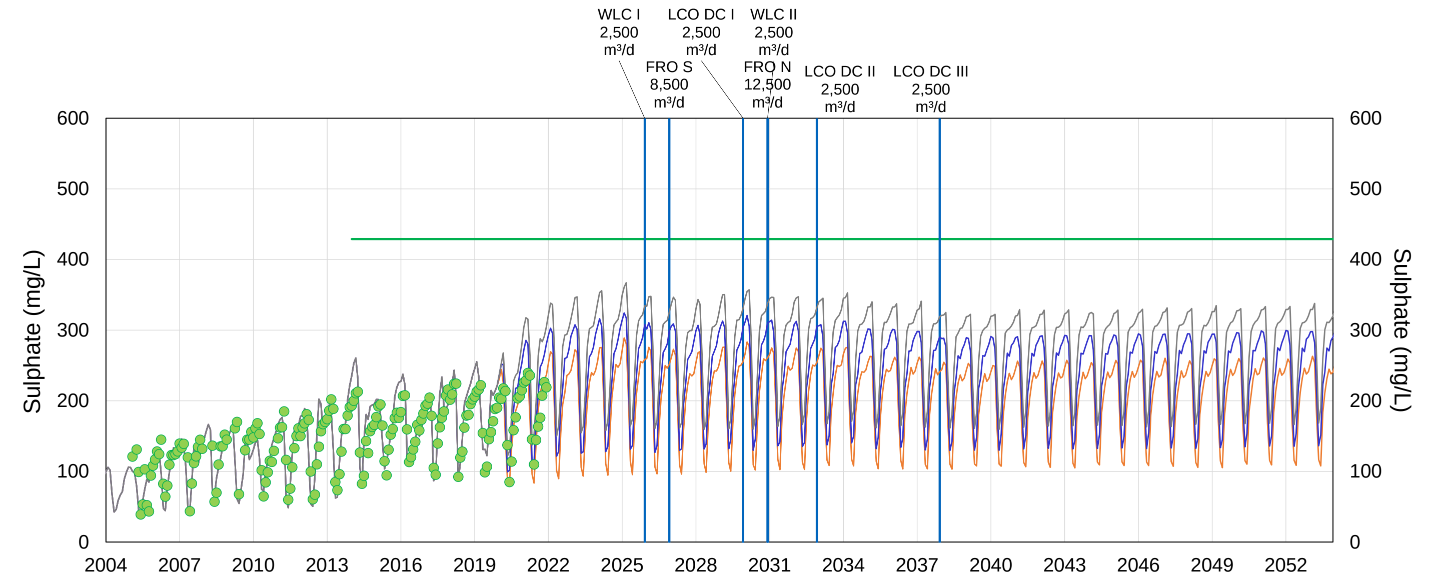
Figure 3.7: Projected Monthly Average Sulphate Concentrations at Order Stations from 2004 to 2053

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

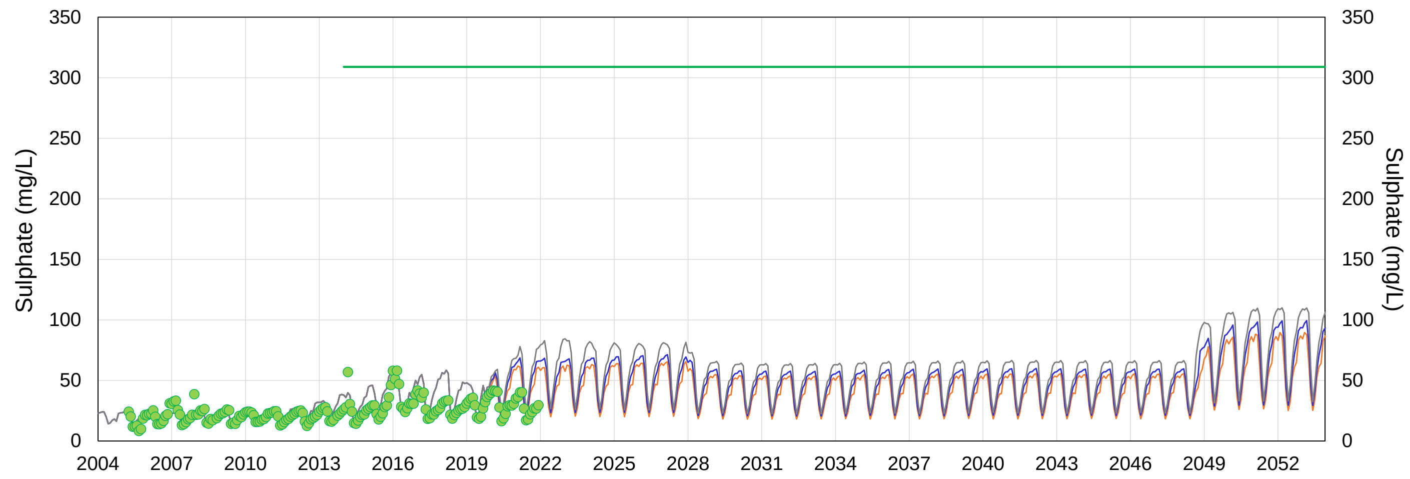



Note: This location is also the GHO Fording River Compliance Point.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

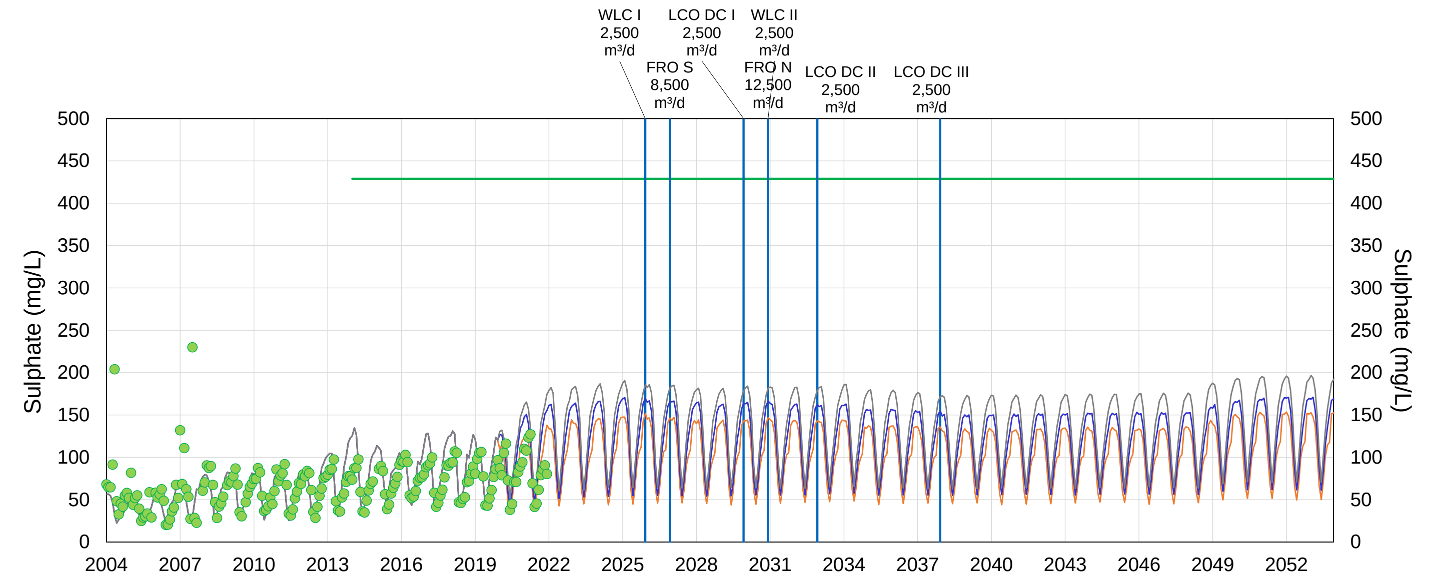



(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

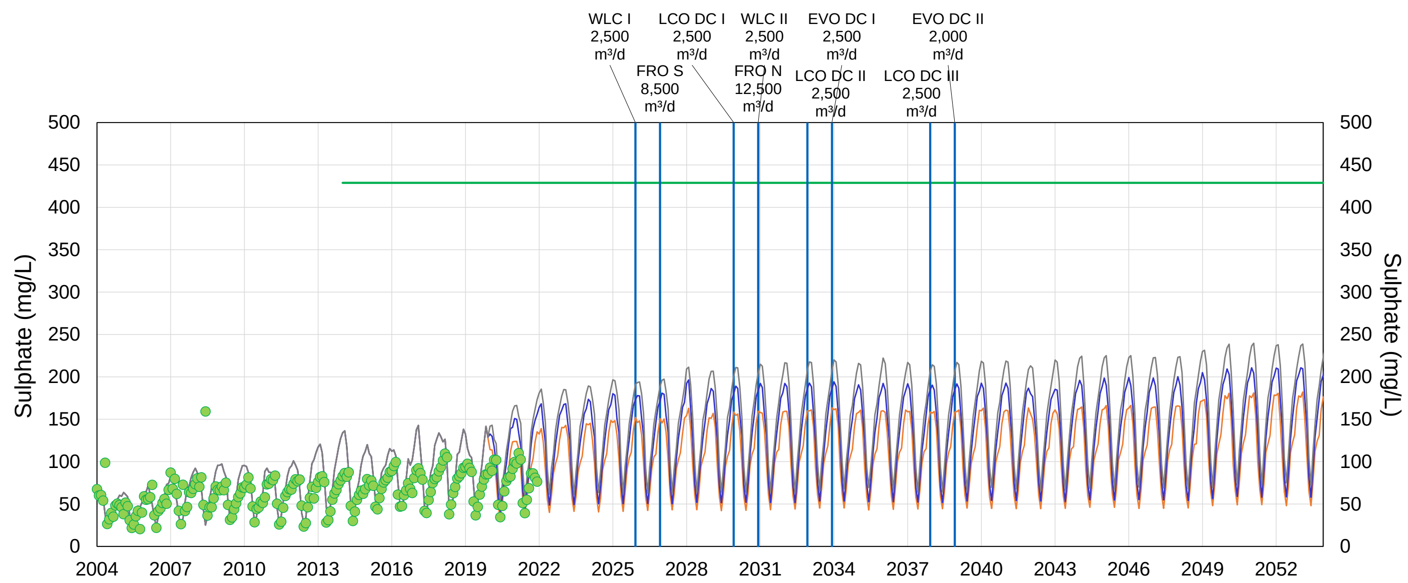



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

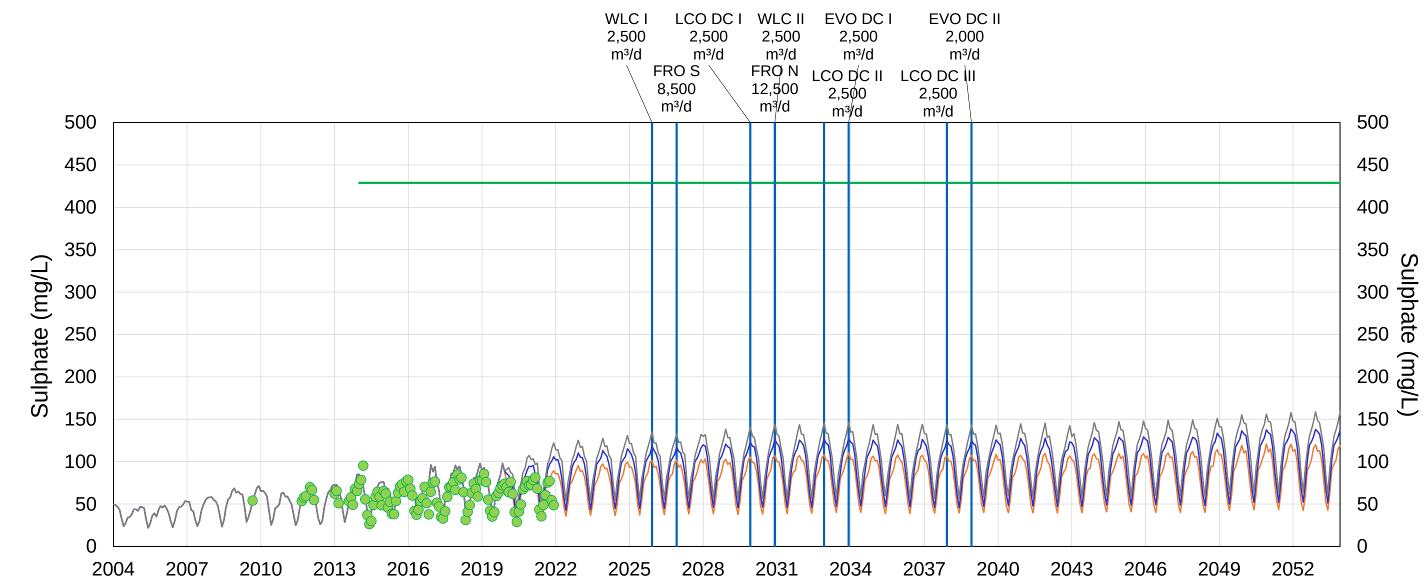
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



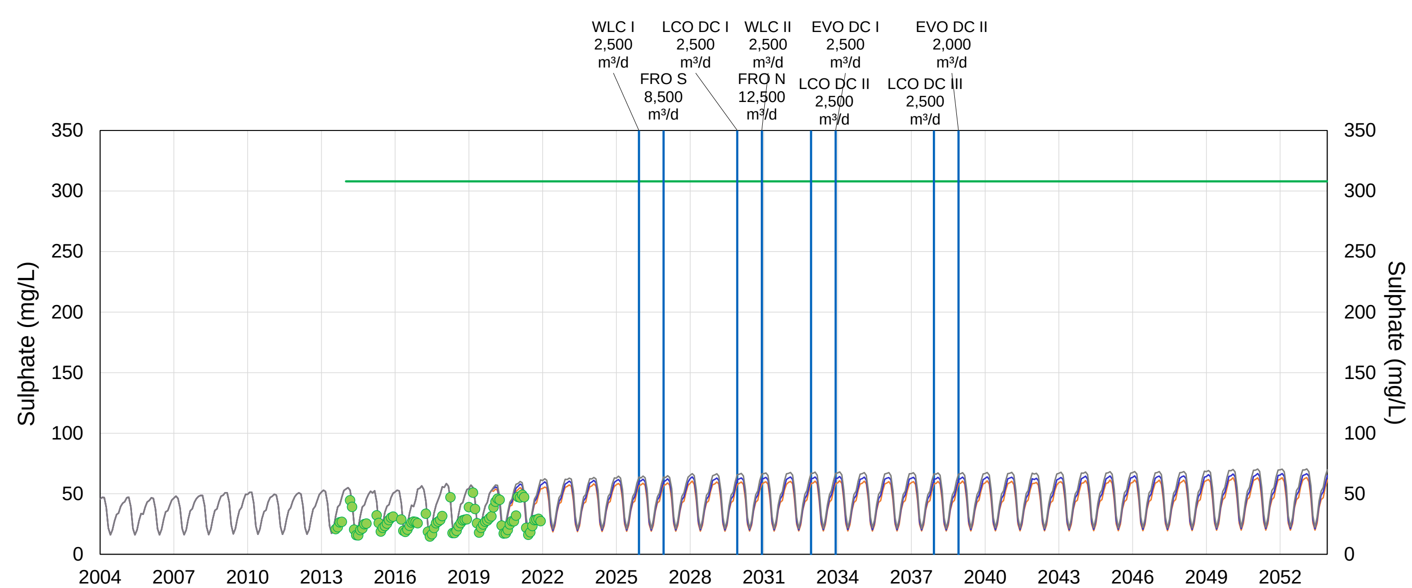
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)




(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)




(g) Koocanusa Reservoir (RG_DSELK; E300230)



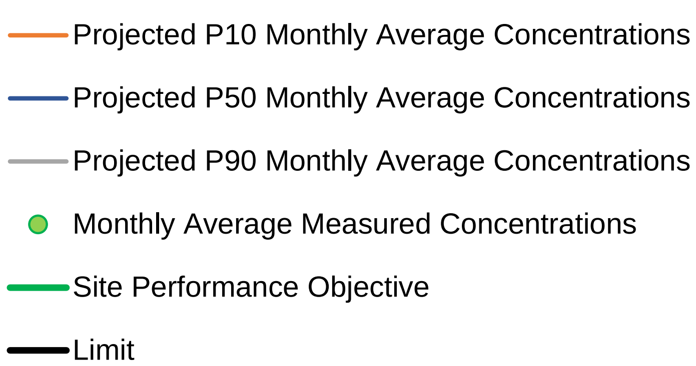
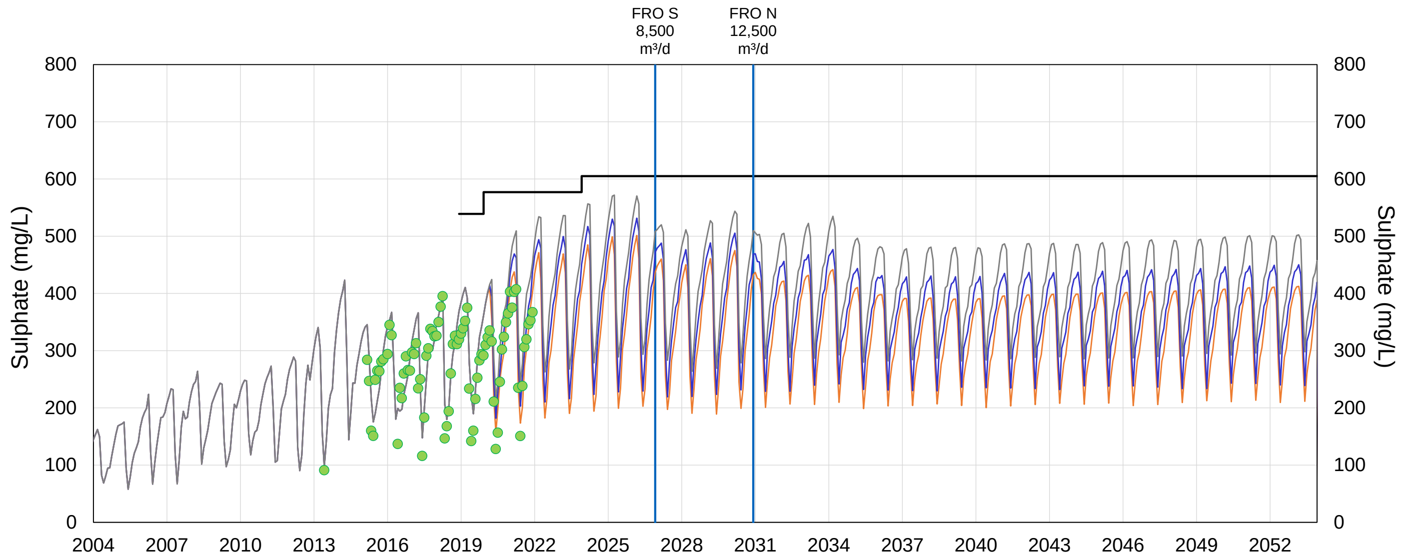
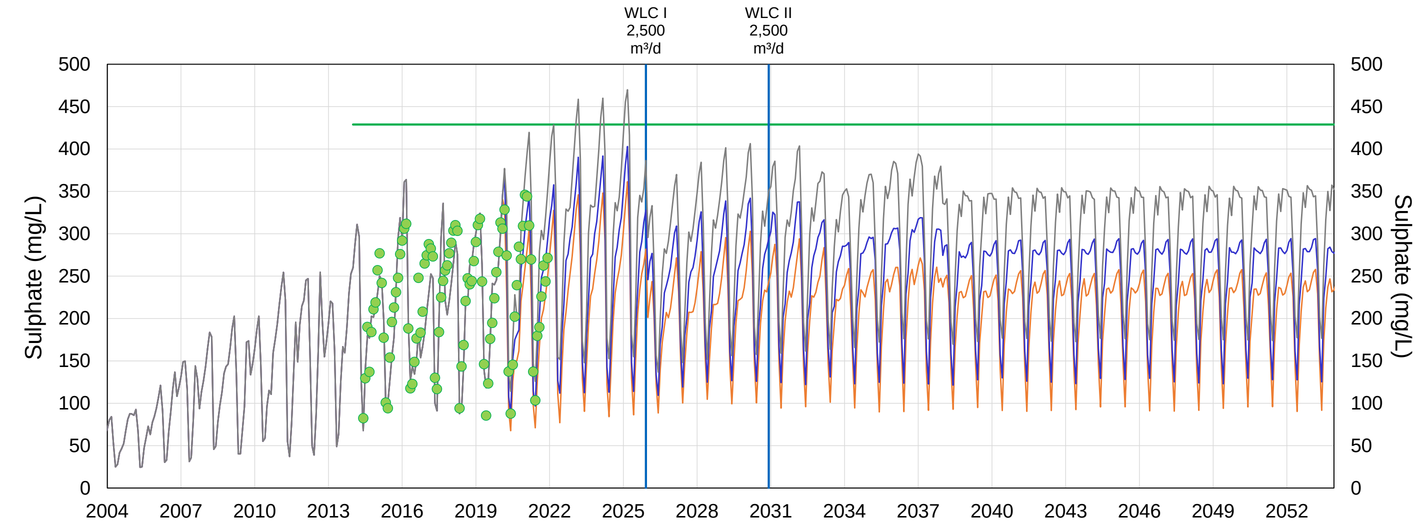



Figure 3.8: Projected Monthly Average Sulphate Concentrations at Compliance Points from 2004 to 2053

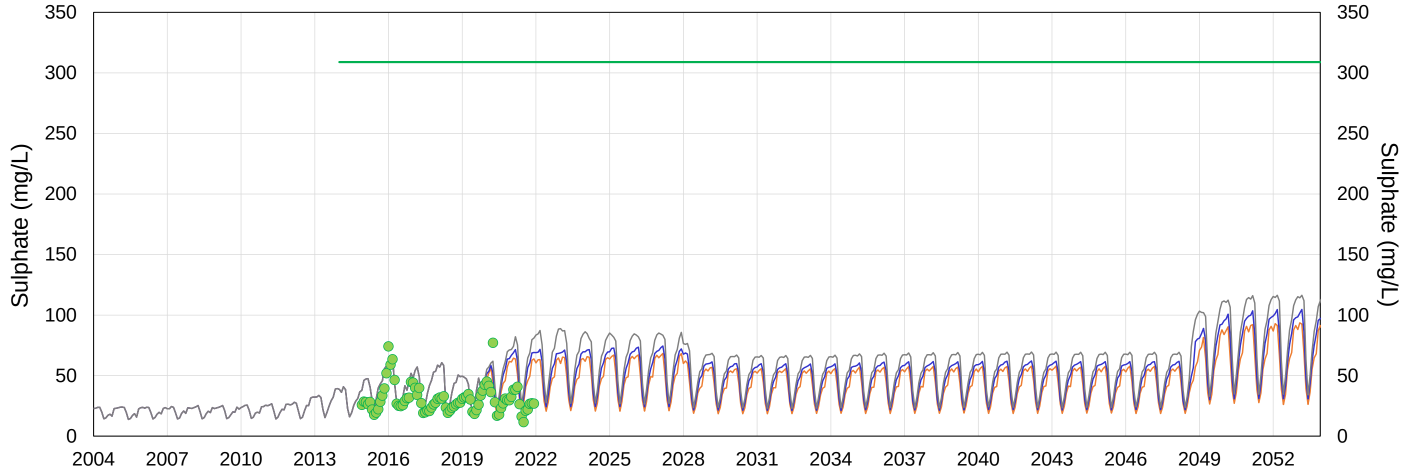
(a) FRO Compliance Point (FR_FRABCH; E223753)




(b) LCO Compliance Point (LC_LCDSSLCC; E297110)

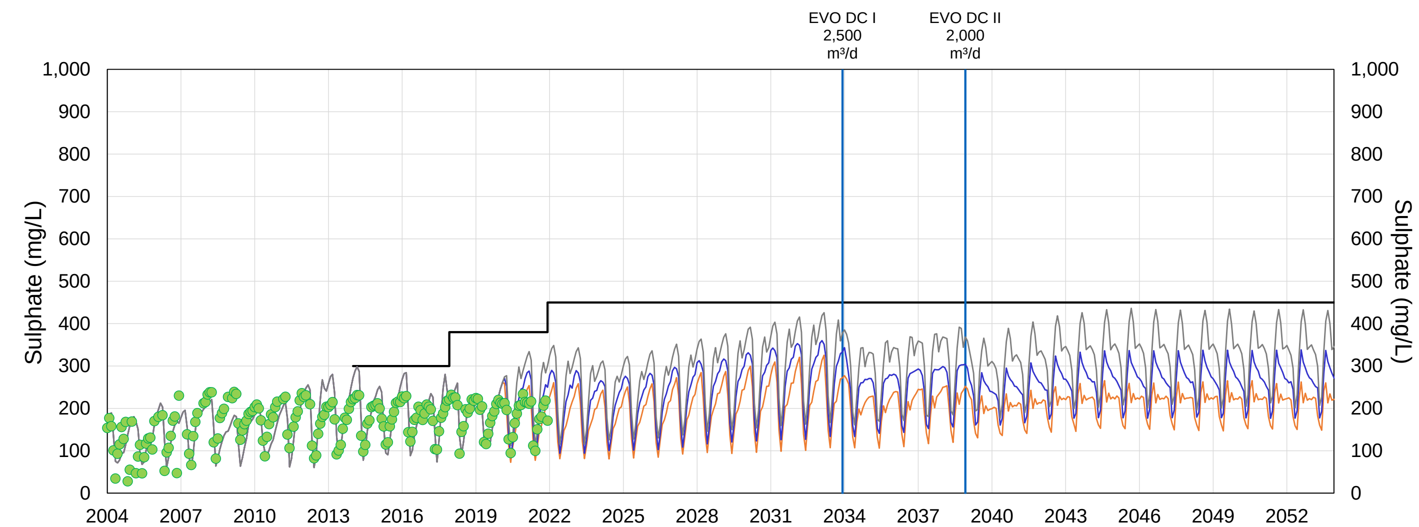



(c) GHO Elk River Compliance Point (GH_ERC; E300090)

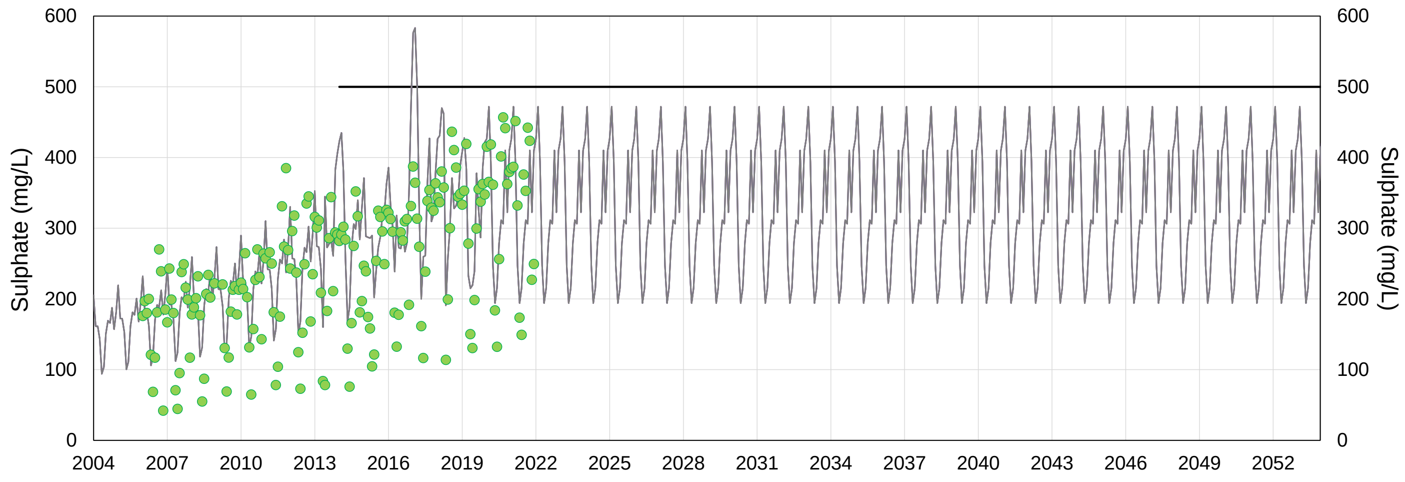



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at GHO is modelled to spill.

(d) EVO Harmer Compliance Point (EV_HC1; E102682)

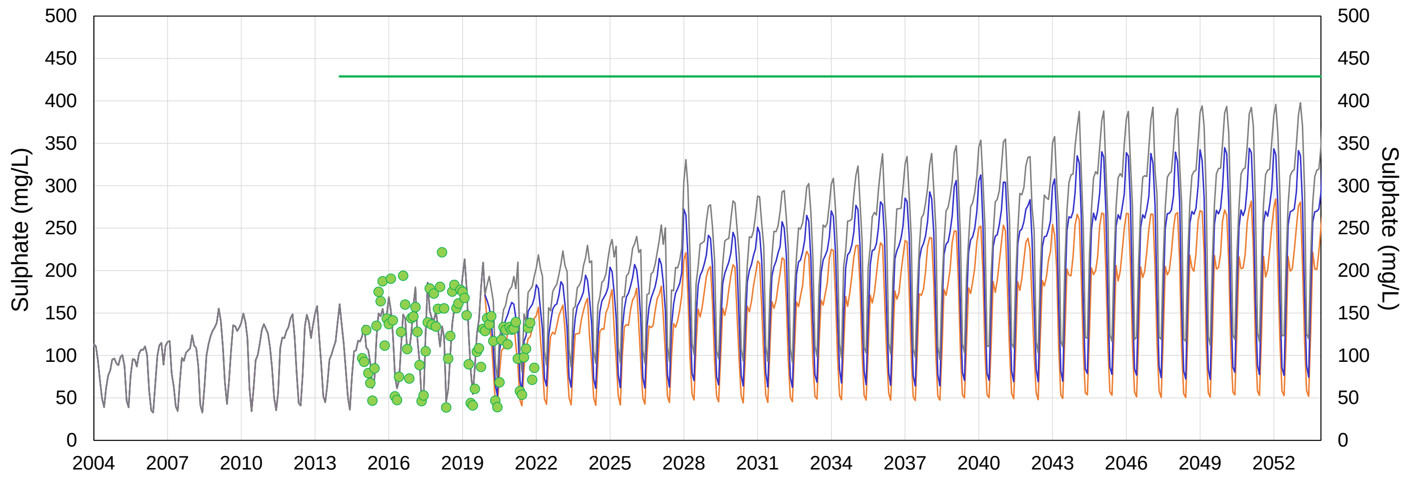


(e) CMO Compliance Point (CM_MC2; E258937)




Note: Projected concentrations are from the CMO Water and Load Balance Model.

(f) EVO Michel Creek Compliance Point (EV_MC2; E300091)




Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

Monthly Average Measured Concentrations

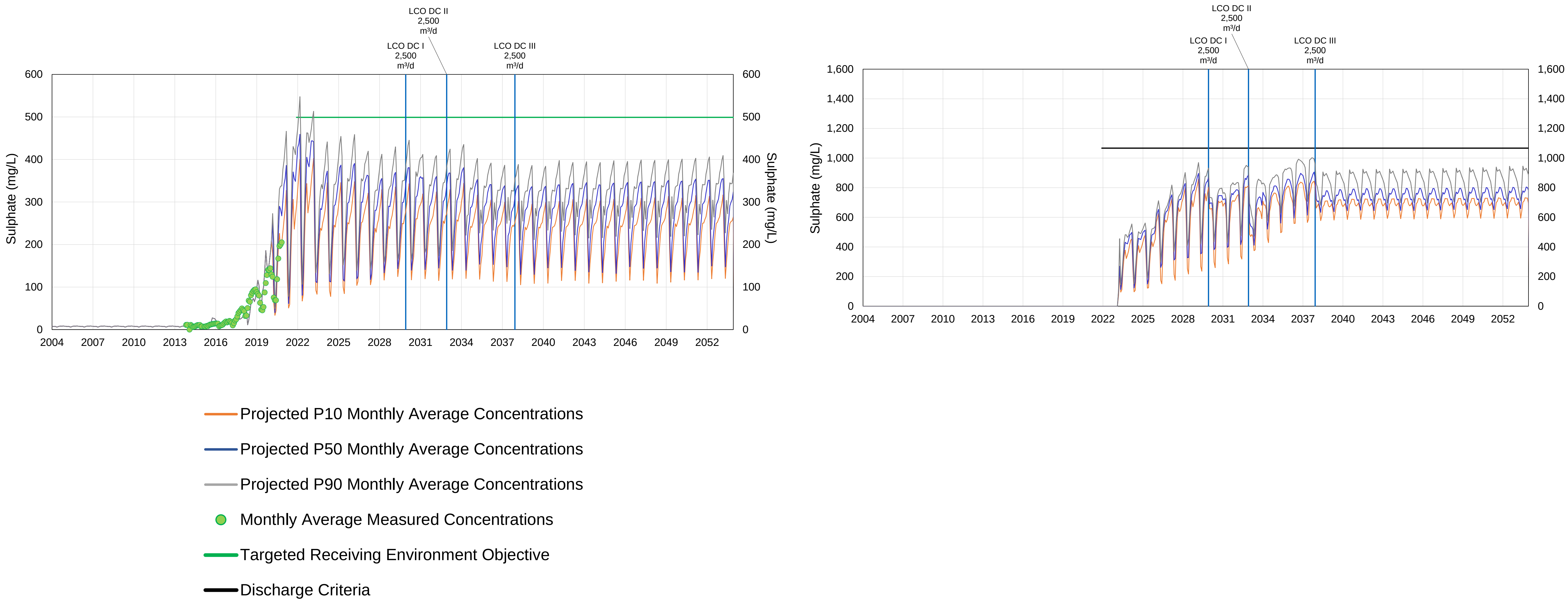
Site Performance Objective

Limit

Figure 3.9: Projected Monthly Average Concentrations of Sulphate in LCO Dry Creek from 2004 to 2053

(a) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)

(b) LCO Dry Creek - Conveyance Water



## 3.3 Sensitivity Analysis

Sensitivity analyses were completed for the 2022 IPA in order to understand the potential risks of uncertainty in model inputs and assumptions on future compliance. The majority of the uncertainties being evaluated in for the 2022 IPA are included in the AMP evaluations and the specific MQs, KUs and UUs are provided in the discussed for the relevant analyses and detailed in the AMP reports. The purpose of these sensitivity analyses is not to inform future non-compliances, but to provide an opportunity to understand potential changes to projected water quality associated with each uncertainty. The outcomes will be used to inform potential modifications to ongoing investigations and early monitoring programs to ensure that there is sufficient time to adapt future mitigation plans and support compliance.

Seven sensitivity analyses were conducted to identify how projected water quality under the 2022 IPA may change with changes to model input assumptions. The seven analyses involved:

- changes to model inputs related to water availability of sources targeted for treatment
- changes to model inputs related to nitrate content of waste rock spoils
- changes to model inputs related to improvements in blasting practices (nitrate only)
- changes to model inputs related to selenium and sulphate release rates
- changes to model inputs related to climate (i.e., evaluation of how projections may vary as a result of climate change)
- changes to model inputs related to selenium effluent quality
- changes to model inputs related to instream sinks (selenium and nitrate only)

The methods used to complete the sensitivity analyses along with the results are presented in Annex C. A summary of the results is provided below.

### 3.3.1 Changes to Model Inputs Related to Water Availability

Water availability refers to the RWQM input values that inform the proportion of total watershed yield that is expected to be captured at each intake location for conveyance to a treatment facility. Significant progress has been made in the characterization flow (surface water and groundwater) at sources targeted for water treatment and has been considered in the intake design for constructed projects and is being considered in current and future design work and findings of the investigations have been used to inform the assumptions in the 2020 RWQM. The evaluations and progress to reduce uncertainties related to water availability at treatment sources is reported under MQ 1 and MQ 3 in the AMP and the following are the relevant KUs and associated UUs:

- KU 1.2 *How will uncertainty in the RWQM be evaluated to assess future achievement of limits and SPOs*?
  - UU 1.2.2. *Can the RWQM be improved in specific catchments where mitigation decisions are required and uncertainty is high*?
  - KU 3.2. *What additional flow and groundwater information do we need to support water quality management*?

- UU 3.2.1 *Is it necessary for water management structures (that collect surface water from mine-influenced sources) to collect groundwater and/or be lined in order to achieve limits and SPOs*?

The values assigned to water availability at most sources in the 2020 RWQM were set based on the proportion of total watershed yield that is assumed to be readily available as surface flow. At two sources (i.e., West Line Creek and Kilmarnock Creek), capture of some of the subsurface flow that would otherwise bypass the intake is also represented in the 2020 RWQM. Water availability assumptions at the following four sources were varied individually, while water availability assumptions for other sources were unchanged:

- Clode Creek
- Kilmarnock Creek groundwater
- West Line Creek groundwater
- Erickson Creek

Clode Creek and Erickson Creek were selected for the sensitivity analysis because these drainage areas contain most of the waste rock in the FRO-N and EVO treatment areas, respectively. West Line Creek and Kilmarnock Creek were selected for the sensitivity analysis because explicit representation of the division of flow between surface and groundwater pathways (i.e., surface water - groundwater partitioning) in these tributaries is included in the 2020 RWQM (Teck 2021a). Each of these sources are high priority sources for water treatment due to selenium and nitrate loading, there is uncertainty in the groundwater assumptions and these areas continue to be the focus of ongoing groundwater and water balance uncertainty evaluations. Thus, sensitivity analysis model projections downstream of these locations can be used to identify how future projections could change with changes to groundwater capture.

Increasing the water availability of sources targeted for treatment resulted in a decrease in projected concentrations at the nearest downstream compliance point, while decreasing the water availability of sources targeted for treatment resulted in the opposite effect (i.e., an increase in projected concentrations). This general pattern is not surprising, as reduced water availability equates to less water being available for and ultimately receiving treatment. However, the level of projected response at the nearest downstream compliance point to a similar level of change to water availability differed among the locations tested (i.e., same percentage change to water availability did not lead to a consistent comparable percentage change in constituent concentrations at the nearest downstream compliance point).

The sensitivity of projected concentrations at the FRO Compliance Point (FR_FRABCH; E300071) to changes to the water availabilities of Kilmarnock Creek groundwater and Clode Creek was low relative to the other sources considered in the analysis. The sensitivity of projected concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) to changes to the water availability of West Line Creek groundwater was moderate relative to the other sources considered in the analysis, while the sensitivity of projected concentrations at the EVO Michel Creek Compliance Point (EV_MC2; E300091) to changes to the water availability in Erickson Creek was high relative to the other sources considered in the analysis.

The sensitivity of projected concentrations at the FRO Compliance Point to changes to the water availabilities of Kilmarnock Creek groundwater and Clode Creek was low relative to the other sources considered in the analysis because there are multiple sources with high selenium loads and instream concentrations targeted for treatment at FRO (see Table 2.3 in Annex B). The sensitivity of projected concentrations at the EVO Michel Creek Compliance Point to changes to the water availability in Erickson Creek was high relative to the other sources considered in the analysis because Erickson Creek has high selenium loads and instream concentrations relative to other sources (i.e., Natal Pit) targeted for treatment at EVO (see Table 2.6 in Annex B). In other words, the larger the contribution of an individual tributary to instream concentrations at the downstream compliance point, the more sensitive projected concentrations at that location will be to changes to/uncertainty in the water availability at the intake location of that tributary.

### 3.3.2 Sensitivity Analyses Related to Nitrate Release

Teck has undertaken significant field and laboratory evaluations to support the quantification of the benefits of the changes to explosive management practices for mitigation planning (through adjustments to the RWQM source terms). The presence of natural leachable nitrogen, in the form of ammonium ions, was detected during the analytical testing of the rock samples; this is in addition to the blasting residuals, which was previously assumed to be the only source of nitrogen in mine waste materials and water. The ammonium is understood to originate from the degradation of the organic nitrogen compounds in the geologically deposited plant and animal matter. Explosive residues are water-soluble and present on the surface of the waste rock particles. Ammonium is present within the rock matrix as an exchangeable ion and release is accommodated through a diffusion process. Upon exposure to oxic conditions, the exchanged ammonium is rapidly oxidised to nitrite and then nitrate under laboratory conditions. The rate of diffusion of exchangeable ammonium is under evaluation but is currently understood to result in rapid exchange near the particle surfaces leading to overall release being a function of particle size.

It is important to note that this is not a new source of nitrogen, and it is currently understood that it has been predominantly accounted for in the current empirically derived nitrate source terms in the 2020 RWQM, but incorrectly assumed to be attributed to blasting residuals alone. A new UU was added to the AMP in 2021: UU 1.2.5. (*How do the nitrate source terms need to be adjusted to account for the loading from exchangeable ammonium [naturally present in waste rock] in addition to the blasting residuals*?). The objective of the work associated with this UU is to obtain sufficient information to support the numerical representation of the two sources of nitrogen and the relative release over time and support the quantification of the benefits of the improved blasting practices.

The current understanding is that both processes (i.e., explosives residue and exchangeable ammonium) can be approximated as a flush, with explosives residue yielding the initial nitrate loading and exchangeable ammonium yielding a tail which is higher than the pre-mining baseline. The 2020 RWQM has not been updated to include a second source of nitrogen (i.e., exchangeable ammonium) because it was a recent finding; however, the conceptual and numerical models for nitrate release from waste rock will be updated to include exchangeable ammonium for the next model update in 2023.

No credit for blasting practice improvements has been included in the modelling to support the 2022 IPA, but two sensitivity analyses have been included to support an understanding of the sensitivity of future projections to changes in nitrate content and to understand the potential benefits to future projections if some level of effectiveness can be reasonably quantified. A summary of the outcomes of theses analyses are provided in the following subsections and detailed in Annex C.

#### *3.3.2.1* Changes to Model Inputs Related to Nitrate Content

This sensitivity analysis was undertaken to address the uncertainty in long-term projected downstream nitrate concentrations with a simplistic consideration of the influence of exchangeable ammonium that result in a higher and longer tail in the nitrate concentrations. The analysis involved decreasing the leaching efficiency applied to waste rock spoils in the model by 50% beginning January 1, 2020. The lower the leaching efficiency, the slower the nitrate washes out of the spoil resulting in a tail with higher nitrate concentrations. It is acknowledged that the approach is simplistic. It is intended to support an understanding of the change to the tail of the projected nitrate concentrations and is expected to poorly represent projected nitrate concentrations in the near term.

Reducing the leaching efficiency applied to waste rock spoils in the model by 50% beginning on January 1, 2020 resulted in lower projected concentrations of nitrate at Order Stations and compliance points in the Fording River watershed and in LCO Dry Creek from 2020 to the late 2030s or early 2040s, depending on the location, and higher projected concentrations from the late 2030s or early 2040s onward. This pattern is not surprising because reducing the leaching efficiency means that nitrate is washed out of the spoil more slowly resulting initially in lower projected concentrations and eventually in prolonged and higher projected concentrations.

Although reducing the leaching efficiency resulted in higher projected concentrations at Order Stations and compliance points in the Fording River watershed and in LCO Dry Creek from the late 2030s or early 2040s onward, the absolute differences in projected concentrations were small (i.e., less than 1 mg N/L). The small absolute differences in projected concentrations are not surprising because SRFs and AWTFs were sized so that projected selenium concentrations would be below long term SPOs and Compliance Limits. By 2033, there will be enough hydraulic capacity at the SRFs and AWTFs in the Fording River watershed to treat the prolonged and elevated nitrate concentrations that would result from a 50% reduction in leaching efficiency.

Although the numerical model has not been updated to include a second source of nitrogen (i.e., exchangeable ammonium), the results of this sensitivity analysis indicate that exchangeable ammonium may have limited influence on projected peak concentrations in the Fording River watershed because treatment systems, sized for selenium compliance, will be large enough to treat prolonged and elevated nitrate concentrations. That being said, it is acknowledged that this sensitivity analysis is a simplified approach meant to consider the concept of exchangeable ammonium. The concept of exchangeable ammonium will be incorporated into the numerical model as part of the next model update in 2023.

#### 3.3.2.2 Changes to Model Inputs Related to Blasting Practices

Lining of blast holes began in 2017 at Teck's operations in the Elk Valley, the purpose of which is to limit the loss of explosives prior to blasting. Limiting the loss of explosives reduces the amount of explosive residual associated with freshly blasted waste rock, which, in turn, reduces the release of nitrate from waste rock spoils. This sensitivity analysis was undertaken to understand the potential improvements in future concentrations if some level of liner integrity was assumed, thus decreasing the amount of nitrate introduced into the waste rock. The sensitivity analysis involved increasing liner effectiveness values assigned to lined blast holes at FRO, GHO, LCO and EVO from 0% to 20%.

Limiting the loss of explosives reduces the amount of explosives residual associated with freshly blasted waste rock, which, in turn, reduces the release of nitrate from waste rock spoils. Therefore, increasing the liner effectiveness value resulted in lower projected concentrations of nitrate at Order Stations, compliance points and in LCO Dry Creek from approximately 2020 to 2053. For example, increasing the liner effectiveness value resulted in a decrease in projected peak concentrations by 0.4 mg N/L (or 6%), on average, at the FRO Compliance Point (FR_FRABCH; E223753) and 0.2 mg N/L (or 8%), on average, at the LCO Compliance Point (LC_LCDSSLCC; E297110). This pattern is not surprising because the purpose of lining blast holes is to limit the loss of explosives prior to blasting.

### 3.3.3 Changes to Model Inputs Related to Selenium and Sulphate Release Rates

Teck has advanced evaluations to understand how selenium and sulphate rates may change over time and in order to reduce uncertainty in future selenium and sulphate projections that could result from the depletion of sulphate minerals over time. Although the 2020 RWQM has been calibrated and future projections generated assuming no decline in selenium and sulphate release rates over time, the body of evidence to either support or refute a first order decay to selenium and sulphate release rates from waste rock continues to be developed by reducing UU 1.2.3 UU 1.2.3. (*How may selenium and sulphate release rates change over time*?). Activities to reduce UU 1.2.3 are reported in annual AMP reports.

Results from longer-term humidity cell tests indicate that selenium and sulphate release rates from waste rock decline over time as sulphide minerals are depleted (Teck 2021a). The decline tends to follow first order decay kinetics. The 2020 RWQM includes functionality to maintain selenium and sulphate release rates unchanged over the entire simulation period or to allow the release rates to decline over time, on a sub-catchment by sub-catchment basis, once spoiling in a given area has effectively stopped. The 2020 RWQM has been calibrated and future projections used to develop the 2022 IPA are based on the assumption that there is no decline in selenium and sulphate release rates over time.

A sensitivity analysis was undertaken to identify how future projections could change with application of first order decay to selenium and sulphate release rates. One decay rate (i.e., Decay Rate 2) was evaluated.

Application of first order decay to selenium and sulphate release rates resulted in lower projected concentrations of both constituents at all Order Stations and compliance points, once spoiling in upstream areas had effectively stopped. The relative difference in projected concentrations of both constituents with and without application of first order decay to selenium and sulphate release rates increased with time at all Order Stations and compliance points. For example, application of first order decay resulted in a decrease in projected peak concentration of selenium at the FRO Compliance Point (FR_FRABCH; E223753) by 3% in 2040 and 20% in 2053.

### 3.3.4 Changes to Model Inputs Related to Climate

This sensitivity analysis was undertaken to understand the potential influence of climate change on projected flows and projected concentrations of nitrate, selenium, and sulphate in the Elk Valley. Projected changes to climate variables (e.g., precipitation and air temperature) for two time periods (i.e., 2050s and 2080s) under two representative concentration pathway (RCP) scenarios (i.e., RCP 4.5 and RCP 8.5) were considered as outlined in Annex C. The two scenarios were selected to represent little (RCP 8.5) to moderate (RCP 4.5) global success at controlling greenhouse gas emissions.

Three climate driven inputs were adjusted within the 2020 RWQM: precipitation, air temperature, and evapotranspiration. The adjustments are outlined below.

- Projected changes to mean monthly precipitation ranged from -5.6 to +9.0% in the 2050s and from -5.8% to +9.8% in the 2080s across all months for the RCP 4.5 scenario. For the RCP 8.5 scenario, they ranged from -3.2% to +12.2% in the 2050s, and from -11.8% to +21.3% in the 2080s across all months and across the Elk River valley. The largest projected decreases occurred from July to September, while the largest projected increases occurred from March to April and September to November.
- Projected changes to mean monthly air temperature ranged from +1.0°C to +1.8°C in the 2050s and +1.5°C to +2.4°C in the 2080s across all months for the RCP 4.5 scenario. For the RCP 8.5 scenario, they ranged from +1.6°C to +2.7°C in the 2050s and +3.2°C to +4.9°C in the 2080s across all months and across the Elk River valley. Projected changes to mean monthly air temperature were applied in the 2020 RWQM without alteration related to local topography or local climatology as outlined in Annex C.
- Projected changes to average annual potential evapotranspiration ranged from +5.4% in the 2050s to +8.5% in the 2080s for the RCP 4.5 scenario. For the RCP 8.5 scenario, they ranged from +8.3% in the 2050s to +17.6% in the 2080s across the Elk River valley. The increase in potential evapotranspiration across scenarios and time periods aligns with / reflects the projected changes to air temperature (i.e., higher air temperatures allow for higher levels of evapotranspiration with all else being equal).

Water flows in the Fording River, Elk River and in associated tributaries throughout the Elk Valley are likely to change under the influence of climate change. As illustrated in Figures 3.10 and 3.11, late spring / summer runoff flows are, in general, projected to decrease, while winter flows are, in general, projected to increase. Climate change may also result in summer dry conditions extending later into September and increases to early spring precipitation in March and April may result in earlier freshets. The projected effects of climate change on water flows are more pronounced under RCP 8.5 than under RCP 4.5, in line with the fact that projected changes to precipitation and air temperature are higher under RCP 8.5 than RCP 4.5.

Potential changes to conditions in Koocanusa Reservoir were not estimated as part of this sensitivity analysis. Most of the influent flow to Koocanusa Reservoir arrives via the Kootenay River and the Bull River, and there was not a readily available mechanism by which to estimate how influent flows through these two rivers may change in response to climate change. Similarly, it is not possible, within the scope of the 2022 IPA, to estimate how dam operations may vary in response to climate change and, therefore the sensitivity analysis related to climate change stopped at Elko Reservoir.

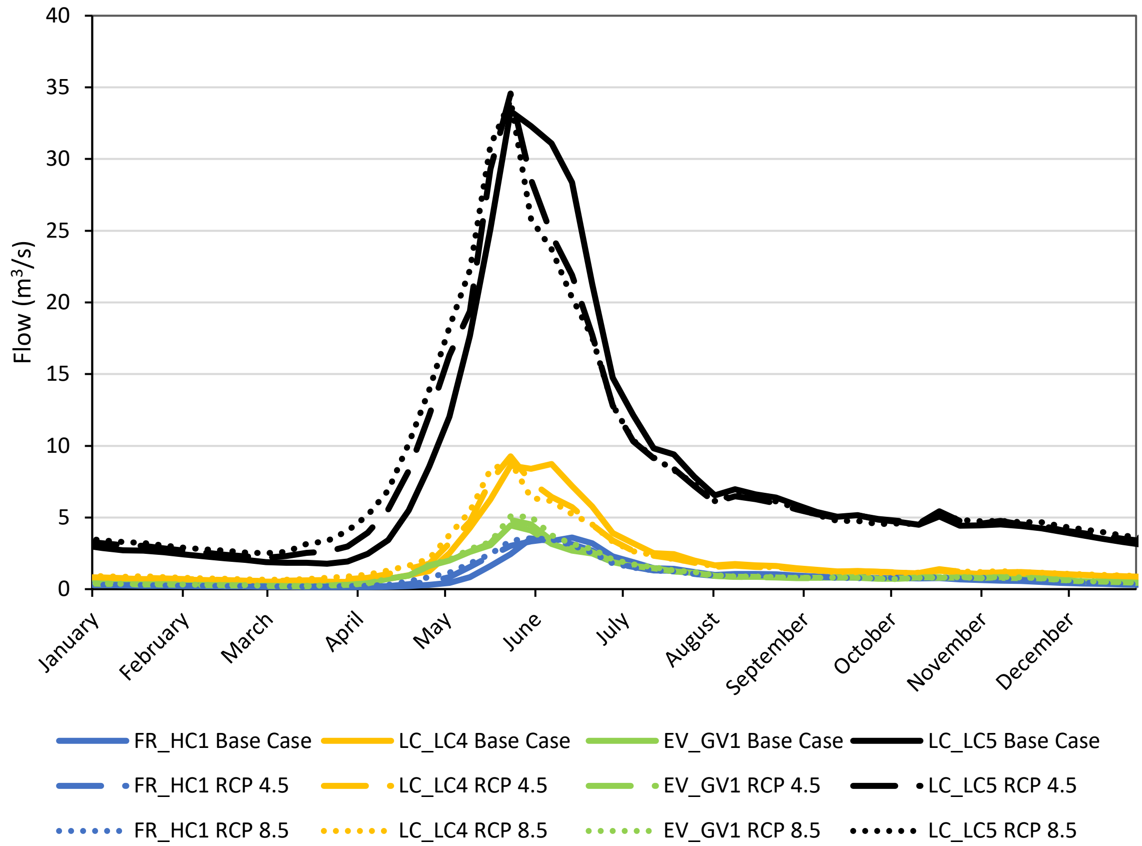



Figure 3.10: Modelled Median Flows for 2080 under Base Case, RCP 4.5 and RCP 8.5 at or near the Mouths of Selected Tributaries (Harmer Creek [FR_HC1], Grave Creek [EV_GC1], Line Creek [LC_LC4] and the Fording River [LC_LC5])

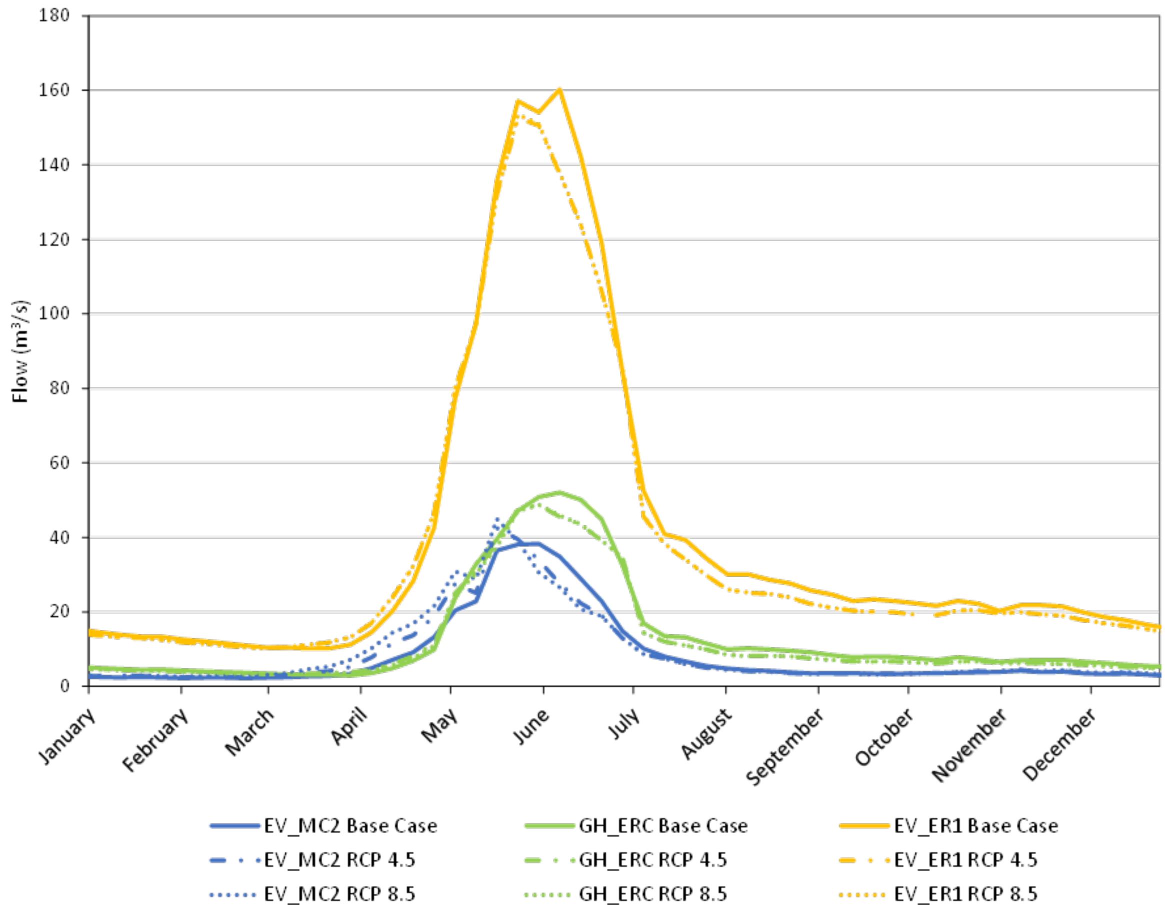



Figure 3.11: Modelled Median Flows for 2080 under Base Case, RCP 4.5 and RCP 8.5 at Selected Mainstem Nodes (Michel Creek downstream of Highway 3 [EV_MC2], GHO Elk River Compliance Point [GH_ERC] and the Elk River downstream of Michel Creek [EV_ER1])

Overall, consideration of potential changes to climate results in an increase to projected maximum $P_{90}$ monthly average concentrations (i.e., projected peak concentrations) at Order Stations, compliance points, and in LCO Dry Creek. The projected effects of climate change are more pronounced under RCP 8.5 than RCP 4.5, and projected changes to the concentrations of selenium and sulphate are of greater relevance than those of nitrate. Although nitrate concentrations are projected to change with consideration of climate change, the changes are minor (in the order of less than 0.5 mg/L) in comparison to the dominate declining trend that is expected as nitrate is leached from waste rock spoils. It is acknowledged that long-term nitrate projections are uncertain and subject to update based on the potential influence of exchangeable ammonium.

Projected changes to concentrations of selenium and sulphate are similar, in general, across Order Stations, compliance points and in LCO Dry Creek. Projected concentrations of both constituents are typically higher in June to September / October and lower in April and May under either RCP 8.5 or RCP 4.5 compared to the base case. These patterns are illustrated in Figure 3.12 with reference to projected selenium concentrations at the FRO Compliance Point under the base case and under RCP 8.5.

Projected concentrations are typically higher than the base case between June and September / October because projected flows, particularly those originating from non-mining areas, are lower (Figure 3.13) and there is proportionally more mine-influenced flow relative to natural flow in the receiving environment. In other words, although flows from both mine-influenced and non-mine areas are lower with consideration of climate change, the relative change to non-mine flows is larger than that for mine-influenced flows (due to the slower release of water from waste rock spoils), which results in less assimilative capacity in the receiving environment (Figure 3.14).

In April and May, projected concentrations are typically lower than the base case because of the earlier onset of freshet, which results in increased flow with proportionally more water in the receiving environment originating from non-mine areas during this time. Thus, between April and May, there is typically more assimilative capacity in the receiving environment than the base case.

Between November and March, changes to projected concentrations are variable, although projected $P_{90}$ concentrations are higher with consideration of climate change than the base case (Figure 3.12). Flows between November and March are projected to be higher with consideration of climate change, as noted above. However, the degree to which mine-influenced versus non-mine influenced flows increase is variable among individual climate years, which results in different proportions of the total flow in the receiving environment having originated from mine-influenced areas compared to the base case (Figure 3.14). In some individual climate years, the proportion of mine-influenced water in the environment is higher than the base case. A higher proportion of mine-influenced water yields higher concentrations, which results in higher $P_{90}$ concentrations calculated across the 20 realizations.

Treatment vessels are more likely to have available operating capacity during winter lower flow periods. Thus, there is available treatment capacity for some of the additional mine-influenced flow. However, some of the additional mine-influenced flow will bypass treatment (once capacity within the 2022 IPA is fully allocated) and enter the receiving environment, carrying with it a larger load than the base case (i.e., waste rock spoils are assumed in the 2020 RWQM to be effectively chemostatic, with concentrations being relatively constant over time; thus, more waste rock flow equals more constituents load, some of which bypasses treatment). Hence, even though treatment volumes may be higher, a higher proportion of mine-influenced flow in the receiving environment yields higher concentrations and a higher $P_{90}$ estimate.

There are two exceptions to the general patterns outlined above. Projected peak selenium concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) are lower with consideration of climate change than under the base case. Similarly, projected peak sulphate concentrations in the Elk River downstream of Michel Creek (EV_ER1; 0200393) are lower with consideration of climate change than under the base case. The underlying drivers for these contradictory model results have not yet been identified; this remains an area of ongoing investigation.

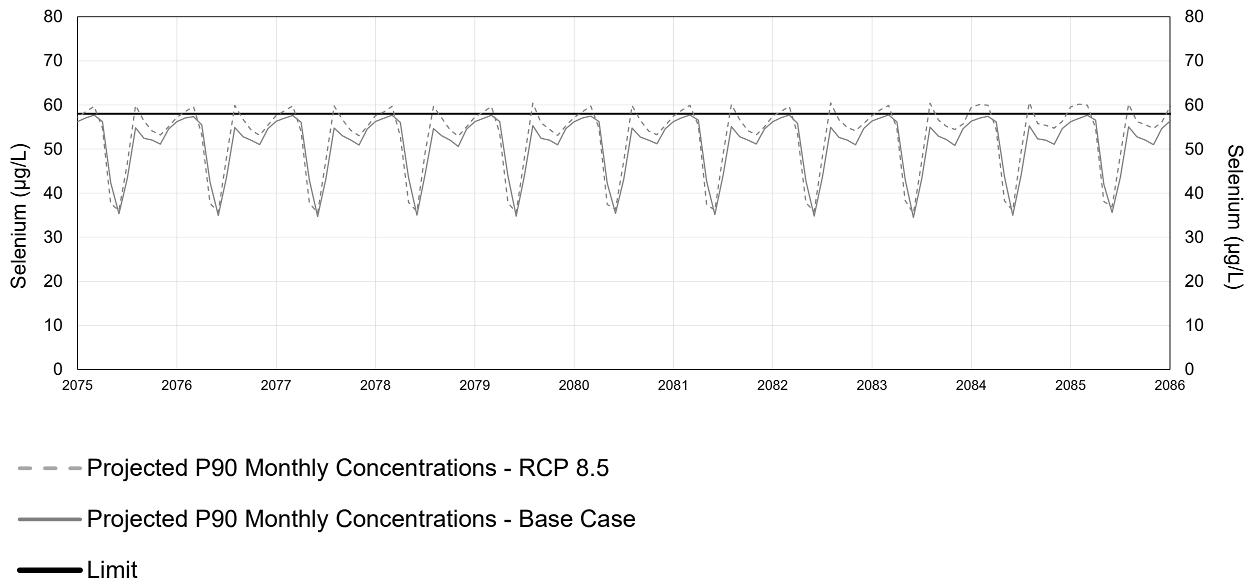



Figure 3.12: Projected P90 Monthly Average Selenium Concentrations at the FRO Compliance Point (FR_FRABCH; E223753) With and Without Consideration of Climate Change

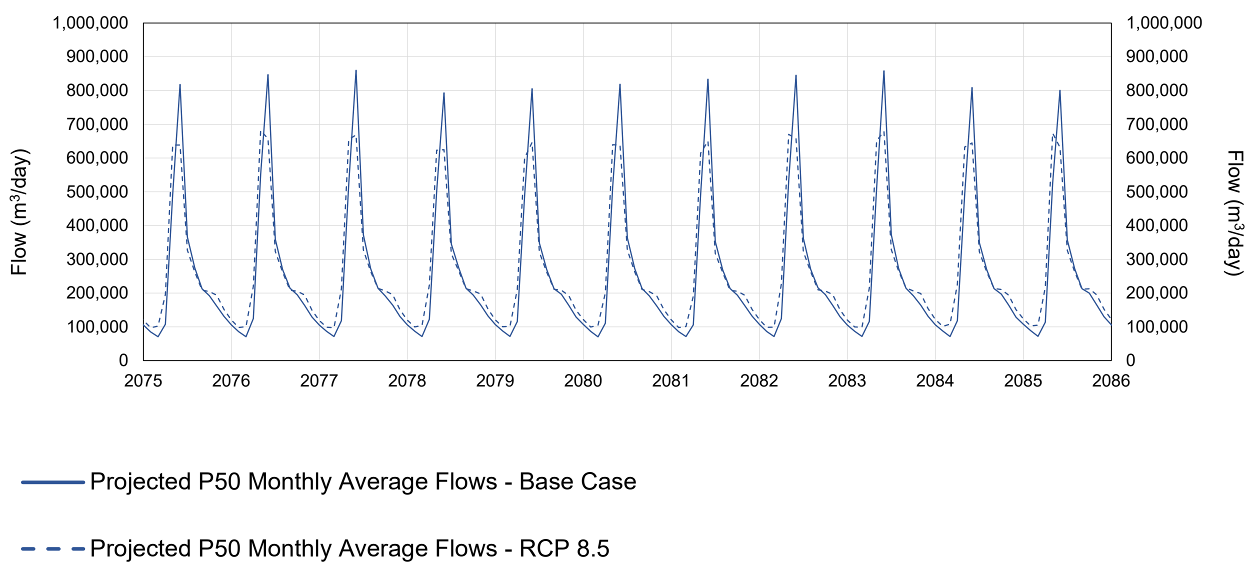



Figure 3.13: Projected P50 Monthly Average Flows at the FRO Compliance Point (FR_FRABCH; E223753) With and Without Consideration of Climate Change

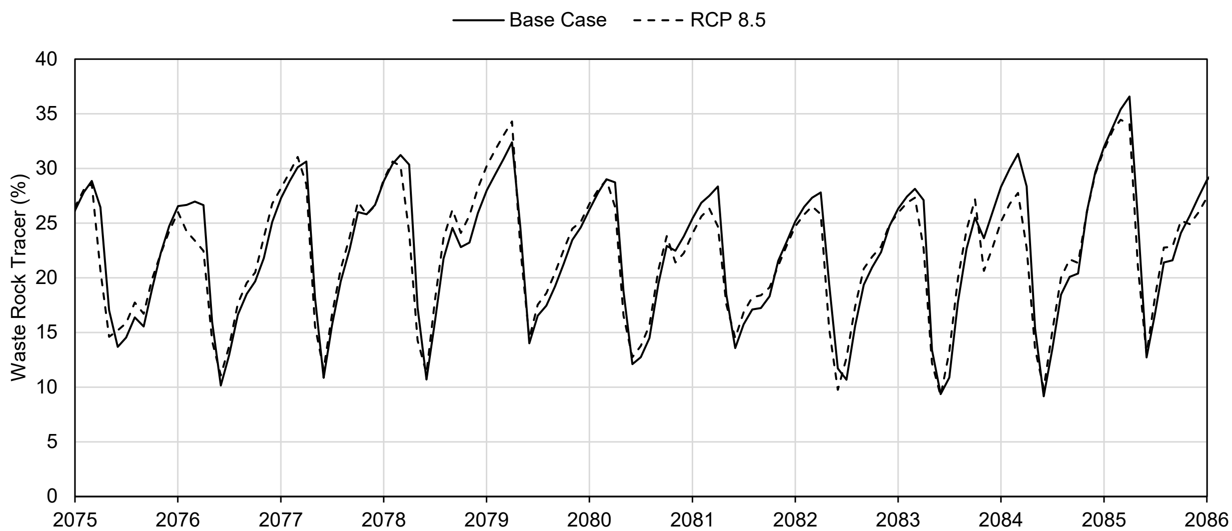



Figure 3.14: Proportion of Mine-Influenced Flow to Natural Flow at the FRO Compliance Point (FR_FRABCH; E223753) With and Without Consideration of Climate Change using Realization 1

### 3.3.5 Changes to Model Inputs Related to Selenium Effluent Quality

Selenium effluent concentrations are expected to decrease over time as Teck gains experience operating biologically-based treatment systems in the Elk Valley. This expectation is reflected in the assumptions used to develop the 2022 IPA and is the focus of UU 3.1.2. (*Can the performance of current and planned active water treatment facilities be materially improved?)*. A sensitivity analysis was undertaken to understand how changes to selenium effluent quality affect projected selenium concentrations at Order Stations, compliance points and in LCO Dry Creek. The changes to selenium effluent quality are outlined in Annex C.

Projected selenium concentrations at Order Stations, compliance points and in LCO Dry Creek increased without the assumed improvements to selenium effluent quality. For example, projected peak concentrations increased by 3 µg/L (or 6%), on average, at the FRO Compliance Point (FR_FRABCH; E300071) and 3 µg/L (or 18%), on average, at the LCO Compliance Point (LC_LCDSSLCC; E297110), without the assumed improvements to selenium effluent quality. The increase in projected peak concentrations at downstream Order Stations ranged from <0.1 µg/L to 2 µg/L (or from 3% to 5%), on average, without the assumed improvements to selenium effluent quality.

### 3.3.6 Changes to Model Inputs Related to Instream Sinks

The 2020 RWQM includes instream sinks (i.e., load reduction factors) in the Fording River, Elk River and in water travelling from Kilmarnock Creek to the Fording River mainstem. The Mass Balance Investigation was kicked off in 2018 to support the evaluation of the potential mechanisms resulting in the apparent or real loss of nitrate and selenium load between source and downstream mainstem Fording River and Elk River locations and between mainstem locations. The ongoing evaluations include focus on the role of surface water - groundwater interactions and the impacts that groundwater travel time and groundwater bypass could have on the load sinks and the role of suboxic groundwater and hyporheic conditions in reduction/removal of these constituents. The ongoing evaluations are reported on in the AMP under

UU 1.2.4. (*What mechanism(s) are causing the reduction in mass observed between the tributaries and at monitoring stations in the mainstems*?).

A sensitivity analysis was undertaken to understand how changes to instream sinks affect projected concentrations of nitrate and selenium at Order Stations and compliance points. The sensitivity analysis involved reducing instream sinks for nitrate and selenium by 50%.

Reducing instream sinks by 50% resulted in an increase to projected peak concentrations of nitrate and selenium in the Fording River and the Elk River which typically occur in winter. Reducing instream sinks resulted in no change to projected concentrations during much of the open-water period because instream sinks are applied from September to April at most locations.

The change to projected peak concentrations was greater in the Elk River compared to the Fording River, in part, because instream sinks are cumulative. For example, changes to projected peak concentrations ranged from 19% to 28% in the Elk River, including a 23% increase in Koocanusa Reservoir. Changes to projected peak concentrations ranged from 6% to 12% in the Fording River. Changes to projected peak concentrations declined overtime with the onset of treatment reflecting a reduction in the sensitivity of projected peak concentrations to changes to the values assigned to instream sinks with time.

Reducing instream sinks by 50% resulted in an increase to projected peak concentrations of selenium in the Fording River and Elk River, which would imply a higher potential risk of non-compliance. However, model error with reduced sinks is also higher (due to changes through the calibration period), so confidence in projected concentrations with reduced instream sinks is low. Nevertheless, Teck acknowledges that instream sinks are a key assumption included in the 2020 RWQM, which is why the mass balance investigation was initiated and will continue to resolve residual uncertainties associated with instream sinks.

Projected peak concentrations of nitrate with and without a 50% reduction to instream sinks show the same patterns as selenium (i.e., greater change in the Elk River compared to the Fording River and increase to projected concentrations declines over time with the onset of treatment). However, nitrate projections are less sensitive to reduced sinks than selenium, because of the underlying declining trend in nitrate in the numerical model. It is acknowledged that long-term nitrate projections are uncertain and subject to update based on the potential influence of exchangeable ammonium.

## 3.4 Integrated Effects Assessment

The objective of the integrated effects assessment (IEA) was to evaluate potential area-based effects to aquatic health for each management unit during periods when water quality is projected to be potentially greater than compliance limits and SPOs. Constituent-specific assessments were conducted for nitrate, sulphate, and selenium using the same approach used in the 2019 IPA. The IEA is presented in Annex D and an overview of refinements to the methods and a summary of the findings is presented below.

A number of refinements have been made to the spatial delineation in the IEA to better align with biological monitoring locations and to incorporate learnings from adaptive management key uncertainty evaluations that have reduced a number of uncertainties. The refined spatial delineation allows for improved comparison of IEA results to biological and water quality monitoring data summarized in the Aquatic Data Integration Tool (ADIT; Golder 2020a).

Reductions in uncertainties related to the IEA have occurred in three main areas: 1) incorporation of updated nitrate and sulphate aquatic effects concentrations for sensitive invertebrates, fish, and amphibians; 2) incorporation of improvements in selenium speciation monitoring and bioaccumulation modelling that has reduced model uncertainty by modelling separately areas with elevated organo-selenium concentrations and areas with low organo-selenium concentrations; and 3) reduced uncertainty in selenium bioaccumulation model results has allowed for a simplified approach to estimating percent effects in model segments. Collectively, these reductions in key uncertainties result in lower predicted effects and improved confidence in effects predictions.

Assessment criteria[3] are based on area-based protection goals from the EVWQP (Teck, 2014) (Chapter 8). Where assessment criteria are met, area-based protection goals are considered to have been attained. Key findings of the integrated assessment are summarized by constituent:

- Nitrate – Assessment criteria for benthic invertebrates, fish, and amphibians were met for all assessment years (2021-2053) in all assessed MUs (1-5).
- Sulphate – Assessment criteria for benthic invertebrates, fish, and amphibians were met for all assessment years (2021-2053) in all assessed MUs (1-5).
- Selenium - Assessment criteria for benthic invertebrates, fish, and amphibians were met for all assessment years (2021-2053) in all assessed MUs (1-6).

Based on the above results, projected water quality conditions as presented in the 2022 IPA are expected to be protective of aquatic health in the MUs.

# 4 Next Steps and Future Implementation Plan Adjustments

The mitigation outlined in the 2022 IPA is expected to result in the stabilization and reduction of nitrate and selenium concentrations at the compliance points and Order stations in the Elk Valley and the stabilization of sulphate concentrations. The 2022 IPA includes the mitigation that is operational (WLC AWTF and EVO SRF), in the commissioning phase (FRO AWTF-S, FRO-N 1 SRF Phase I) undergoing permitting (FRO-N 1 SRF Phase II) and outlines future mitigation in various stages of the project development cycle. The 2022 IPA includes an accelerated mitigation implementation schedule over the next five years to support requirements of EMA Permit 107517 and additional mitigation to maintain long-term nitrate, selenium and sulphate compliance at compliance points and Order stations.

The challenges to meeting requirements of EMA Permit 107517, despite Teck's reasonable efforts, have included delays in the execution of the original EVWQP water treatment schedule as a result of the need to assess and implement an additional treatment step (i.e., AOP) at WLC AWTF to reduce selenium speciation in the effluent and reduce bioaccumulation and to changes in Teck's understanding of water quality that resulted from the effects of lag times on constituent release from waste rock and the influence of groundwater. The timing of step-downs from short to medium, and medium to long-term compliance limits and SPOs included in EMA Permit 107517 were developed based on the 2014 RWQM, which was based on current information at the time and did not account for any potential delays in the water treatment implementation or include the refinements in the understanding of the effects of lag times and the influence of groundwater.

[3]For fish and amphibians, the assessment criteria are a <10 percent integrated effect in each MU to the most sensitive endpoint and a <10% effect in each mainstem river segment. For benthic invertebrates, the assessment criteria are a <20 percent integrated effect in each MU to the community endpoint and a <20% effect in each mainstem river segment.

As previously noted, the 2022 IPA schedule over the next five years is expected to be feasible, is based on the current improved understanding of water quality and is specifically designed to make up for delays and achieve compliance as soon as possible and is dependent upon the assumption of receiving all applicable authorizations in a timely manner. The 2022 IPA is aligned with the objectives of the EVWQP to support healthy ecosystems which is support by the IEA completed for the 2022 IPA.

## 4.1 Executing the 2022 Implementation Plan Adjustment

The 2022 IPA is a guide for permitting and projects to identify the operational date, sources for treatment, and preliminary capacity of the individual water mitigation projects required to support the EVWQP, which are then executed in alignment with the plan. Information gained through the various stages leading up to final engineering and permitting will be used to optimize the projects, meaning that the final configurations may vary from what is included in the 2022 IPA. The schedule is also based on the assumption of receiving all applicable authorizations in a timely manner. The most important items to be advanced to execute the 2022 IPA over the next five years to support compliance with EMA Permit 107517 water quality compliance limits and SPOs, are presented below by operation.

At FRO, Teck is in the final stages of ramping and completing commissioning at FRO AWTF-S, is operating the Kilmarnock Clean Water Diversion and is commissioning FRO-N 1 SRF. Teck has been focused on the characterization of the FRO-N 1 and 2 SRFs for the last several years through the execution of environmental and engineering site investigations and advanced R&D evaluations. The permit to construct the supporting infrastructure (i.e., intakes, outfalls and conveyance) and to operate the second phase of FRO-N 1 SRF is under review. Teck is also advancing the necessary field investigations, engineering options evaluations, and environmental evaluations to support permitting for the collection and treatment of Kilmarnock groundwater. Water treatment for sulphate is also being planned for FRO. The following is the list of future facilities and phases of treatment at FRO for the next five years and the 2022 IPA operational dates:

- Permitted - FRO-N 1 SRF Phase I: operational date by December 31, 2022
- Operations Application under review: FRO-N 1 SRF Phase II: operational date by December 31, 2023
- FRO-N 1 SRF Phase III: operational date by December 31, 2025
- Kilmarnock groundwater collection for treatment by December 31, 2026
- FRO-N 2 SRF: operational date by December 31, 2026
- FRO South treatment area: operational date by December 31, 2026

At GHO, the ECCC required Greenhills Creek selenium treatment process is currently in the scoping design stage and two options are being assessed as of the 2022 IPA. It is also important to note that GHO sources are being treated through the FRO AWTF-S, with the combined Swift and Cataract treatment through the Swift intake. The following is the list of future facilities at GHO for the next five years and the 2022 IPA operational dates:

- Greenhills Creek selenium treatment: operational date by December 31, 2027

At LCO, Teck continues to operate the WLC AWTF and is targeting treatment of higher concentration sources from within the mine footprint, intercepting the MSAW drainage before it discharges to the Line Creek rock drain. Teck is advancing the engineering and environmental characterization activities and engineering design options to support permitting and development of the NLC SRF Phase 1, which currently includes planning for treatment for LCO Dry Creek. This project also includes water treatment for sulphate. Permitting to support C&S for LCO Dry Creek is also underway, but as previously discussed, delays to the schedule are expected (from what is included in the 2022 IPA) and ongoing engagement on the overall LCO Dry Creek proposed mitigation plan may result in further changes to treatment, capacity and timing from what is included in the 2022 IPA. The following is the list of future facilities and phases of treatment at LCO for the next five years and the 2022 IPA operational dates:

- LCO Dry Creek C&S: operational date by March 2023, with acknowledged delays as described above
- MSAW treatment at the WLC AWTF: operational date by June 30,2023 pending fish and fish habitat investigations that could lead to habitat offsetting requirements
- NLC SRF Phase I: operational date by December 31, 2025
- Line Creek Phase I sulphate treatment: operational date by December 31, 2025

At EVO, the EVO SRF and supporting infrastructure are operational and valuable operational experience will be used to plan for future expansions of this facility. Teck is preparing the Dry Creek and Harmer Creek Water Quality Management Plan that is required 90 days prior to placement of future permitted waste rock in Dry Creek approved under the BRE EAC and EVO C-2 *Mines Act* permit amendment. The water quality management plan is required as a condition of the BRE EAC and feedback through the engagement process may results in changes to the treatment capacity and timing for EVO Dry Creek currently included in the 2022 IPA. The following is the list of future facilities and phases of treatment at EVO for the next five years and the 2022 IPA operational dates:

- EVO SRF Phase II (EVO Dry Creek): operational date by September 30, 2023
- EVO SRF Phase III: operational date by December 31, 2027

In parallel to executing treatment, Teck will continue to advance source control technologies (including SOZs) that could replace or supplement treatment in future adjustments to the implementation plan. The ECCC Direction issued to Teck in October 2020 includes 11 measures (teck.com) of which 5 have been completed to date. The mitigation measures relevant to the IPA are listed in Table 1 4.

## 4.2 Future Adjustments of the Implementation Plan through the Adaptive Management Process

Teck will have the opportunity to add new, improved and approved technologies and source control measures for planning purposes and to revise inputs into the RWQM and mitigations in the IPA through future evaluations of the answer to MQ 1 and 3.

The review of the implementation plan occurs every three years in conjunction with scheduled RWQM updates. The next RWQM update will be submitted by October 31, 2023, in accordance with EMA Permit 107517 (Section 10.9) and the BC *Mines Act* C-Permit requirements for each operation. The focus of this and each RWQM update is to answer KU 1.2 ("*How will uncertainty in the RWQM be evaluated to assess future achievement of limits and SPOs*?"). As a part of each update of the RWQM, some uncertainties are reduced through study, and new uncertainties identified. Uncertainties are reduced through a combination of compilation and synthesis of information in new ways, design and implementation of supporting studies and evaluation of the data collected, and changes in monitoring programs to optimize for newly identified required information. Model inputs and assumptions will be adjusted based on the findings from these programs and updated water quality projections will be generated. The next required IPA will be updated for submission by July 31, 2025.

Uncertainties that impact the IPA will continue to be resolved through KU reduction and be reported on annually in annual AMP reports. Findings will be used to support future iterations of the RWQM and the IPA and guide Teck's R&D Program. The rapid advancement of alternative technologies, including source control, periodic review of monitoring data, changes to mine plans and updating of planning tools may result in adjustments to the implementation plan. The ongoing application of the six-step adaptive management cycle will inform necessary adjustments to the implementation plan to reflect updated understanding and new information from monitoring programs, management plans, and the RWQM.

Future iterations of the IPA will also incorporate findings from the evaluations of the answers to MQ 2 and MQ 6. Evaluations under MQ 6 (*Is water quality being managed to be protective of human health?*), will confirm whether current and future water quality as it relates to the consumption of drinking water, vegetation, fish and wildlife is also protective of human health, and will identify any potential management implications As a condition of EMA Permit 107517, water quality risks are evaluated for exposures to surface water, groundwater, and sediment, and the consumption of fish. An updated 2022 HHRA was completed to understand if the risks to human health have changed based on recent monitoring data and a revised understanding of current and preferred consumption rates of foods harvested within the Elk Valley. The final HHRA report was submitted to regulators and the HHRA work group on July 1, 2022. Teck, through evaluations under MQ 6, will continue to assess whether current water quality as it relates to the consumption of drinking water, vegetation, fish and wildlife is protective of human health. The results of these evaluations will be reported in the MQ 6 Evaluation Report, expected for December 15, 2024.

The protectiveness of SPOs will be evaluated by answering MQ 2: *Will the aquatic ecosystem be protected by meeting the long-term SPOs?* The long-term SPOs in EMA Permit 107517 for selenium, nitrate, sulphate and cadmium were developed at Order stations to protect the aquatic ecosystem and human health in the Elk River watershed and Koocanusa Reservoir while allowing for continued sustainable mining in the Elk Valley (EVWQP; Teck 2014). The evaluation of the answer to MQ 2 will be included in the MQ 2 Evaluation Report in Q1 2023. Details on how MQ 2 and 6 will be evaluated can be found in the 2021 AMP Update (Teck 2021b).

Teck is focused on continuing to improve mine design for the purpose of minimizing constituent release. This includes targeting water treatment sources from within the mine footprint (improving water availability); utilizing existing pits and waste rock spoils for future waste placement and SRF development; and minimizing impact to new drainages. These considerations are being built into future planned mining areas to minimize additional treatment requirements. In addition, adjustments of the implementation plan are anticipated as alternative technologies are advanced, proven and incorporated in the RWQM in an effort to reduce reliance on treatment.

# 5 References


BC Ministry of Environment and Climate Change Strategy (ENV). 2014. Permit No. 107517. Issued under the *Environmental Management Act* to Teck Coal Ltd. on November 19, 2014 (December 1, 2021 Amendment).

Teck Coal Limited (Teck). 2014. Elk Valley Water Quality Plan. July 22, 2014

Bianchin, M., Martin, A.J., & Adams, J. (2013, September 16−19). In situ immobilization of selenium within the saturated zones of backfilled pits at coal-mine operations. 37th Annual British Columbia Mine Reclamation Symposium. Vancouver, BC, Canada, 1–16.

BC Ministry of Energy, Mines and Petroleum Resources and BC Ministry of Environment and Climate Change Strategy (ENV and EMPR), Sept 2019. Joint Application Information Requirements for *Mines* Act and *Environmental Management Act* Permits

BC Ministry of Environment. 2016. Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators, Version 2. June 2016.

BC Southeast Coal Emerging Technologies Working Group (ETWG). n.d. Technology Readiness Assessment & Emerging Technology Readiness Review Guidance Document (V01.01).

Downie, A. J., and L. Constable. 2021. RE: Technology Readiness Assessment Submissions (Letter to Teck Coal Ltd. February 17).

Golder. 2020a. User's Manual: Aquatic Data Integration Tool (ADIT) for the Elk Valley. Submitted to Teck Coal Limited. September 2020.

Kirk, L.B., (2014). In Situ Microbial Reduction of Selenate in Backfilled Phosphate Mine Waste, S.E. Idaho. Montana State University Doctoral Dissertation.

SRK Consulting (Canada) Inc. (SRK). 2020. Revised - Recommended assumptions for modelling of future SRF capacity. Memo prepared by SRK Consulting (Canada) Inc. for Teck Coal Limited. January 13, 2020.

SRK Consulting (Canada) Inc. (SRK). 2019. Recommended SRF inputs for Water Quality Modelling Evaluations. Memo prepared by SRK Consulting (Canada) Inc. for Teck Coal Limited. October 2019.

Teck. 2017. *2017 Elk Valley Regional Water Quality Model Update.* Prepared by Teck Coal Limited and submitted to the BC Ministry of Environment and Ministry of Energy, Mines and Petroleum Resources. October 31, 2017.

Teck Coal Limited (Teck). 2019. Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley - 2018 Annual Report. July 31, 2019.

Teck Coal Limited (Teck). 2020. Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley - 2019 Annual Report. July 31, 2020.

Teck Coal Limited (Teck). 2021a. 2020 Elk Valley Regional Water Quality Model Update Report. Submitted to British Columbia (BC) Ministry of Environment and Climate Change Strategy and the BC Ministry of Energy, Mines and Low Carbon Innovation (EMLI). Submitted by Teck Coal Limited, Sparwood, BC. March 2021.

Teck Coal Limited (Teck). 2021b. Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley – 2021 Update. December 15, 2021.

Teck Coal Limited (Teck). 2021c. Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley - 2020 Annual Report. July 31, 2021.

Teck Coal Limited (Teck). 2021d. Koocanusa Reservoir Module: Modelling Methods and Calibration. August 2021.

Teck Coal Limited (Teck). 2022a. Adaptive Management Plan: Management Question 1 and 3 Evaluation Report. July 31, 2022.

Teck Coal Limited (Teck). 2022b. Teck response to Environment and Climate Change Canada's Proposed Coal Mining Effluent Regulations Discussion Document, January 2022. March 1, 2022.

Teck Coal Limited (Teck). 2022c. Water Quality Adaptive Management Plan for Teck Coal Operations in the Elk Valley - 2021 Annual Report. July 31, 2022.