

**Review of Reclamation Security  
Addressing Selenium Contamination  
Teck Coal's Elk Valley Mines**

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**Wildsight**

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## SUMMARY OF OPINIONS

Wildsight retained Burgess Environmental Ltd. (Burgess) to estimate the costs to remediate the selenium contamination in the Elk Valley watershed that is emanating from Teck Coal's mines (**Figure 1.1**), which is the subject of this report. Wildsight is specifically concerned that Teck's Reclamation Security (B.C., 2022a) is adequate to cover the cost of remediating this selenium contamination, which is expected to leach out of these mines for many decades (Teck, 2014, PDF page 4 of 290), and potentially centuries.

The cost estimate to remediate the selenium contamination emanating from Teck's mines is \$6.4 billion, which is summarized in **Table E.1** and presented in detail in **Appendix A**. It is understood that the associated Reclamation Security owing can be reduced by up to 25% because Teck's mines have been operating for more than five years, and are expected to operate for at least five more years (B.C., 2022a). This estimate excludes other reclamation requirements, such as surface reclamation and the remediation of other water-based contaminants.

**Table E.1**  
**Cost Estimate for Mitigation of Selenium Contamination**

Reclamation Requirement	Cost
Elkview	\$ 1.03 billion
Line Creek	\$ 1.86 billion
Fording River	\$ 2.88 billion
Greenhills	\$ 0.56 billion
Elk Valley Monitoring	\$ 0.07 billion
Total Reclamation Security	\$ 6.40 billion
Net Reclamation Security	\$ 4.80 billion

This cost estimate was calculated in general accordance with the B.C. (2022a) Policy guidelines regarding calculation of Reclamation Security. It is based on continued operation of Teck's existing facilities and programs for selenium remediation, the construction and operation of those planned through 2027 by Teck (2023g), and achieving the water quality targets proposed by Teck (2014). No additional measures were assumed to be required to remediate the selenium contamination. This assessment is based on the following:

- data, information, reports, and plans made available to the public by Teck Coal
- data, information, reports, and plans made available by the B.C. government
- publicly available information, including technical analyses completed by others

- the experience and judgment of the author
- a visit to the Elk Valley watershed completed in February 2024

It is further noted that the Mines Act provides the Chief Permitting Officer with discretion regarding the amount and type of Reclamation Security that is required of a major mine operator, and that the Policy guidelines (B.C., 2022a, Table 1) allows the Chief Permitting Officer to exclude the capital costs of water treatment facilities under certain circumstances. The capital costs for water treatment included in this estimate amount to approximately \$800 million.

In addition to completing this cost estimate, Wildsight asked Burgess to respond to the following questions.

**1. Does the selenium contamination in the Elk River originate from Teck's mine operations in the Elk Valley?**

**Yes.** In 2010, Teck formed a stakeholder outreach program to address water quality in the Elk Valley. A Ministerial Order to address this contamination was issued to Teck by the B.C. government in 2013. A formal Elk Valley Water Quality Plan was published by Teck (2014), and has been modified since that time (Teck, 2023g).

Review of the surface water and groundwater quality data published by Teck for its mining operations in the Elk Valley indicate a common and definitive pattern of selenium contamination emanating from these mines. Groundwater and surface water samples collected at these mines routinely measure selenium concentrations more than 2 orders of magnitude higher than B.C. (2023a) water quality guidelines and expected background concentrations. High concentrations of selenium are measured in the watersheds draining these mines, which are gradually diluted in the major water courses (e.g., Fording River and Elk River) as non-impacted creeks and streams confluence with these major water courses (see **Section 5**).

**2. Are Teck's current measures adequate for remediating the selenium contamination?**

**No.** **Table 1.1** summarizes the chronology of Teck Coal, implementation of the Elk Valley Water Quality Plan, and changes to that Plan. By the end of 2023, Teck was operating active water treatment facilities at its Line Creek and Fording River Mines, and had commissioned a saturated rock fill treatment facility at its Elkview Mine. Teck was also constructing a saturated rock fill treatment facility at its Fording River Mine, which was scheduled for commissioning in 2023 (Teck, 2023c). The total current water treatment capacity in the fall of 2023 was approximately 47,500 m<sup>3</sup>/day (Teck, 2023g). Review of water quality information collected at the Order

Stations in the Elk Valley watershed through 2022 indicates that selenium concentrations were continuing to increase at all seven Order Stations and regularly exceeded the water quality targets developed by Teck (2014) at four of the seven Order Stations (see **Section 5**). Based on extrapolation of data trends, exceedances of these water quality thresholds at some of these Order Stations are expected to occur more frequently and to a higher degree in the future if additional treatment facilities are not constructed.

Teck's total water treatment capacity of 47,500 m<sup>3</sup>/day represents only a small fraction of the water impacted by Teck's mine operations, and operating levels are often below the design capacities (B.C., 2024). The total area disturbed by Teck's mining operations exceeds 16,000 hectares, and most of this area is covered by mine spoil (see **Section 3, Table E.2**). Assuming an average annual precipitation of approximately 950 mm (Teck, 2022a, PDF page 23 of 241) and annual evapotranspiration of 250 mm (Teck, 2023, PDF page 75 of 241), Teck's total treatment capacity represents less than 20% of the total annual volume of precipitation water that infiltrates mine affected areas. Additional surface water from upstream of the mine-affected areas flows through Teck's waste rock valley fills, which convey comparatively larger quantities of water through Teck's mines and are additional sources of selenium contamination (Teck, 2014). Increasing the treatment capacity is warranted, as Teck (2023g) has committed to do as part of its water quality plan update.

### 3. Are Teck's planned measures adequate for remediating the selenium contamination?

**Possibly.** Teck plans to add additional treatment facilities between now and 2027 (see **Table 1.1**), resulting in a total treatment capacity of 150,000 m<sup>3</sup>/day (Teck, 2023g). This represents an approximate tripling of the current treatment capacity, which is equivalent to approximately one half of the precipitation water that seeps through the mine spoil piles, annually (see response to **Question 2**). It should also result in significantly higher capture of selenium contamination emanating from Teck's mines, which was estimated to be less than 20% (see **Figure 5-3, Section 5-3**) in 2022. According to Teck, water quality at Order Stations is improving in early 2024, although these data have not yet been made available.

The overall effectiveness of these systems has been predicted using a water quality model, which was first used to predict water quality in Teck's (2014) Elk Valley Water Quality Management Plan, and was updated in 2017 (Teck, 2017) and 2020/2022 (Teck, 2020). The original model underestimated the increase in selenium concentrations in the Fording and Elk Rivers by significant margins, at least in part because treatment systems were completed later than planned (see **Table 1.1**). The updated model predicts a reversal of selenium concentrations in the Elk River once these facilities are commissioned; however, this reversal is not yet evident in the measured concentrations (see **Section 6**) through mid-2023. Also, a significant proportion



of mine-impacted water will continue to flow, untreated and unabated, into the Elk Valley watershed, even after commissioning of these additional water treatment facilities.

**4. Is the current Reclamation Security for Teck's Elk Valley coal operations sufficient to fund the selenium remediation requirements?**

**No.** In 2023, Teck Coal provided \$1.49 billion of Reclamation Security financial assurances to the B.C. government for its Elk Valley mine operations, which is based on a total financial liability estimate of \$1.91 billion (B.C., 2023b, Appendix C). Although this amount is scheduled to increase, it represents less than 25% of the cost of selenium remediation calculated in this report.

The financial assurances currently provided by Teck do not appear to be reasonable or sufficient when considering Teck's past expenditures. By the end of 2022, Teck had spent \$1.45 billion (Teck, 2023h) on selenium remediation, had only constructed 30,000 m<sup>3</sup>/day of treatment capacity, and had only operated most of that treatment capacity for one or two years. Teck plans to build 150,000 m<sup>3</sup>/day of treatment capacity and will be required to operate those facilities for many decades. It will also need to continue its monitoring, community outreach, and research initiatives throughout this period (i.e., many decades).

**5. Are the selenium remediation requirements the only mine reclamation obligations covered by Teck's Reclamation Security?**

**No.** The B.C. (2022, PDF page 8 of 24) Policy states, "*reclamation security is intended to cover the cost of reclaiming a site in the event that a mining company defaults on their obligation to do so or becomes insolvent. Costs that must be considered include those necessary to: close and maintain infrastructure such as tailing dams and waste rock dumps; construct, operate and maintain water treatment plants, waste cover systems and other required mitigations; re-contour the site, prepare the surface, place a suitable growth medium, revegetate the site, and implement on-going monitoring and surveillance programs*". The following major reclamation costs have yet to be incurred by Teck, and are not included in the cost estimate for selenium remediation:

- The vast majority of the mine site surface reclamation (approximately 80%, or more than 13,000 hectares) still needs to be completed (**Section 3, Table E.2**). Monitoring and maintenance of the areas that have been revegetated is also required.
- Rehabilitation of water courses will be required in the mined areas. Although many of these water courses have been permanently filled with mine waste rock, others that have been affected (**Section 3**) will need to be rehabilitated to support aquatic life, as

these water courses did before mining. Rehabilitation of streams outside of the mines is also required as a result of the precipitation of calcium carbonate in these streams.

- Groundwater remediation is required. The selenium emanating from the Teck mine operations has contaminated aquifers that are used for domestic supplies to Fernie and Sparwood (see **Section 2.5**), as well as private landowners. These aquifers require remediation to support their continued and future use.
- The mines have also resulted in nitrate, sulphate, calcium carbonate, and other heavy metals contamination of water. Remedial actions are also required to address these contaminants in the Elk River watershed.

**Table E.2**  
**Summary of Mine Area Disturbance**

Mine	Area Disturbed (ha)	Mine Spoil (ha)	Area Revegetated (ha)	Area Remaining	Source
Elkview	4,501	3,036	1,290	3,211	Teck, 2023a
Line Creek	2,700	1,620	600	2,100	Teck 2023b
Fording River	5,250	3,730	770	4,480	Teck, 2023c
Greenhills	2,933	1,900	450	2,483	Teck, 2023d
Coal Mountain	1,050	700	290	760	Teck, 2023e
Total	16,434	10,986	3,400	13,034	

### **Can the Province of British Columbia increase the amount of Reclamation Security required from Teck?**

**Yes.** The Mines Act (B.C., 2023b) provides the following authorizations regarding the Reclamation Security required of a major mine operator (see **Appendix A**).

- Subsection (4) provides the chief permitting officer the legal authority to determine the amount and form of financial security required from Teck for (a) mine reclamation, and (b) protection of, and mitigation of damages to, watercourses.
- Subsection (5) gives the chief permitting officer the ability to require annual changes to the security so that funds are available over the life of mine to cover the costs to reclaim and close the mine, to mitigate impacts to the environment, and to fulfill the conditions of the permit and any orders relating to reclamation and the protection of watercourses.
- Subsection (7) provides the chief permitting officer with the ability to change the reclamation security requirements for a mine at any time if it is deemed necessary.

## 1 INTRODUCTION

### 1.1 Background

Teck Coal has initiated a process to sell its metallurgical coal mining and processing business (Elk Valley Resources) to Glencore PLC, with a minority stake being sold to Nippon Steel Corporation and continued minority ownership being maintained by Posco Steel Corporation. Wildsight is concerned that appropriate Reclamation Security, which is required by the Major Mines Reclamation Security Policy (B.C, 2022), is in place to cover all of the costs for reclamation of these mines, considering this transfer of ownership. By 2023, Teck Coal had set aside \$1.5 billion of Reclamation Security to cover the unplanned closure of its British Columbia (B.C.) coal mines (B.C., 2023b, Appendix C).

Wildsight is specifically concerned that the Reclamation Security is adequate to cover the cost of remediating selenium, which is leaching out of Teck Coal's active and closed mines (**Figure 1-1**), and is expected to continue to leach out of these mines for many decades (Teck, 2014, PDF page 4 of 290), and potentially centuries. By 2022, Teck had reportedly spent over \$1.4 billion trying to reduce selenium contamination (Teck, 2023g); however, the concentrations of selenium in the Elk River watershed continued to increase (USGS, 2022, PDF page 2 of 4; **Section 5**). Wildsight has retained Burgess Environmental Ltd. (Burgess) to assess this issue, and provide an independent, third-party estimate of the costs to remediate the selenium contamination emanating from Teck Coal's mines, based on available information.

### 1.2 Objective and Scope

The objective of this assessment is to estimate the financial liabilities to Teck Coal that are associated with the selenium contamination emanating from its coal mine operations in southeast B.C. The B.C. (2022, PDF page 8 of 24) Policy states, *"reclamation security is intended to cover the cost of reclaiming a site in the event that a mining company defaults on their obligation to do so or becomes insolvent. Costs that must be considered include those necessary to: close and maintain infrastructure such as tailing dams and waste rock dumps; construct, operate and maintain water treatment plants, waste cover systems and other required mitigations; re-contour the site, prepare the surface, place a suitable growth medium, revegetate the site, and implement on-going monitoring and surveillance programs"*. As such, the cost of mitigating selenium contamination emanating from Teck Coal's mine operations accounts for only a portion of Teck's reclamation liabilities; surface reclamation of the mines and the remediation of other water pollutants (Teck, 2014, PDF page 4 of 290) also need to be addressed, but are not included in this estimate.

The scope of this assessment includes a review of the relevant background information, which provides the supporting basis for the Reclamation Security estimate and includes the following:

- background information
- a description of the Elk Valley watershed
- a summary of the regulatory basis related to selenium contamination
- descriptions of Teck Coal's mine operations in the Elk Valley, including information relevant to the selenium contamination for each operation
- detailed analyses of the selenium concentrations in surface water and groundwater of the Elk Valley watershed
- assessment of Teck's existing and planned measures to remediate selenium contamination

The Reclamation Security estimate and its supporting basis are presented as **Appendix A**.

### **1.3 Reliance Materials**

This assessment is based on the following:

- data, information, reports, and plans made available to the public by Teck Coal
- data, information, reports, and plans made available by the B.C. government
- publicly available information, including technical analyses completed by others
- the experience and judgment of the authors
- a visit to the Elk Valley watershed completed in February 2024

A large body of information has been developed by Teck Coal, some of which has been submitted to B.C. regulators, which has not been made available publicly. Examples would include, but are not necessarily limited to, regulatory reporting, internal studies and research, and detailed reclamation cost information. This liabilities estimate would benefit from being provided access to this information.

### **1.4 Selenium Contamination Mechanisms and Water Quality Criteria**

The source of selenium is the rock surrounding the coal seams that are mined. This rock influences background concentrations, and where disturbed and placed as waste rock, releases elevated levels of selenium to the receiving environment. Release mechanisms from the waste rock include transformation of selenium to soluble forms (primarily as selenate) via contact with oxygen and water (SAP, 2010, PDF page 34 of 233).

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Once released, selenium follows pathways (mine drainage channels, streams, near-surface groundwater) to the receiving environment, unless it is attenuated through reduction to less soluble forms (selenite, elemental selenium, or selenide) in low flow, low oxygen environments (such as marshes and saturated sediments). Receptors in the receiving environment include aquatic organisms such as algae, bottom-dwelling and water-column invertebrates, and fish. These receptors can take selenium up into their tissues directly from water or sediment, or from food. Wildlife (including amphibians, birds, and mammals) that eat aquatic organisms are part of the aquatic-based pathways, and can also be exposed to selenium via water, sediment, or food. Other wildlife such as elk and bighorn sheep are part of terrestrial-based pathways where selenium is taken up by plants growing on waste rock. The plants are, in turn, consumed by wildlife. Humans are receptors in both aquatic and terrestrial systems; exposure may be via drinking water, consumption of fish, or consumption of plants or wildlife (SAP, 2010, PDF page 35 of 233).

Selenium exists naturally in low concentrations (typically < 1 µg/L) in unaffected waters of the Elk Valley. At higher concentrations, it can have a severe impact on ecosystems as it tends to bioaccumulate in the aquatic environment. Oxides of selenium are stable throughout the entire pH scale, making selenium available in the form of selenate ( $\text{SeO}_4^{2-}$ ) and selenite ( $\text{SeO}_3^{2-}$ ) in aquatic ecosystems. Standards have been set to limit the concentration of selenium in surface water that supports aquatic life, as well as drinking water (Ali and Shrivastava, 2021). The maximum concentration set by the World Health Organization (WHO) for selenium in water fit for consumption is 50 µg/L, and the European Union (EU) uses an even more precautionary value of 10 µg/L. The United States Environmental Protection Agency (USEPA) has placed a regulatory limit of 3.1 and 1.5 µg/L for water lotic and water lentic ecosystems respectively (USEPA, 2016). B.C. (2023a) has published a water quality guideline of 2 µg/L for the protection of freshwater aquatic life.

Teck's (2014, PDF page 4) Elk Valley Water Quality Plan states, *"to access the coal, large quantities of . . . waste rock, are mined and placed in piles within and adjacent to the mine pits. Water from both precipitation and runoff flows through these rock piles and carries selenium and other substances, including cadmium and sulphate as well as nitrate from blasting residue, into the local watershed. Geochemical study indicates waste rock piles continue to release selenium for a very long period of time. Waste rock placed decades ago continues to release selenium at a steady rate today, and is expected to continue doing so for many decades more"* (Figure 1-2).

As a result, Teck's mine operations have contaminated the Elk River, and many of its major tributaries (Fording River, Line Creek, Michel Creek), with selenium. **Section 5** summarizes the selenium impacts to surface water and groundwater in the Elk River Valley. This contamination is not constrained to the Elk River and its tributaries. The Elk River flows into the Kootenay River/ Lake Kootenay. Below the Libby Dam (and the downstream extent of Lake Kootenay),

the Kootenay River flows through Montana and Idaho, and back into Canada where it flows into Kootenay Lake and its subsequent confluence with the Columbia River at Castlegar.

The impacts to water quality in the Kootenay River system that have been caused by Teck Coal's Elk Valley operations have been measured approximately 100 km downstream of the confluence of the Elk River and Lake Koochanusa (Storb et al., 2023, PDF page 12 of 16), from samples collected from the Kootenay River downstream of the Libby Dam.

## 1.5 Mitigating Measures

Teck has implemented, or is implementing, measures at its mine operations that are designed to reduce the amount of selenium that leaches into the water systems, or remove the selenium that has leached into water (**Table 1.1**). The primary method being implemented to reduce selenium leaching include source controls and water diversions. Methods that have been implemented to remove selenium from water include active water treatment and saturated rock fills. Active water treatment plants have been constructed at Line Creek and Fording River Mines; saturated rock fill treatment has been pilot-tested and implemented at the Elkview Mine, and recently began operating at the Fording River Mine.

### Source Controls

Source control techniques are being investigated and piloted, such as the use of geomembrane covers for waste rock piles, 'naturalized covers' to increase evapotranspiration, and suboxic zones. A geomembrane is a protective layer that can be put on top of a rock pile or other source of mine waste rock. A suboxic zone is a rock disposal area that's engineered to keep oxygen away from waste rock. These techniques prevent waste rock from contacting air and water, which reduces the release of selenium and other substances (B.C., 2024). Teck was ordered to investigate geomembrane covers as a result of a Fisheries Act ruling (Canada, 2020), as an option for reducing selenium contamination of the Elk Valley watershed.

### Diversions

Diversions direct clean water, such as streams, away from and around mining areas, and especially waste rock dumps that are the primary source of selenium leaching. This helps keep water clean and reduces the amount of water needing treatment. Diverting water away from these areas prevents the water from leaching contaminants such as selenium.

### Active Water Treatment

Teck has constructed and commissioned active water treatment facilities at its Line Creek and Fording River mines. They work by pumping the water through tanks containing bacteria that remove the selenium and nitrate from the water. The removed substances are pressed into a solid and disposed in a landfill. Teck's first active water treatment facility began operating in

2018 at the Line Creek Mine. Monitoring showed that treatment removed significant amounts of selenium. It also showed that some of the selenium changed into a form that could more easily accumulate in aquatic life (Teck, 2023a). Teck tested technologies and found a chemical treatment process called advanced oxidization, which prevented the selenium from changing form and was added to the Line Creek water treatment facility (B.C., 2024).

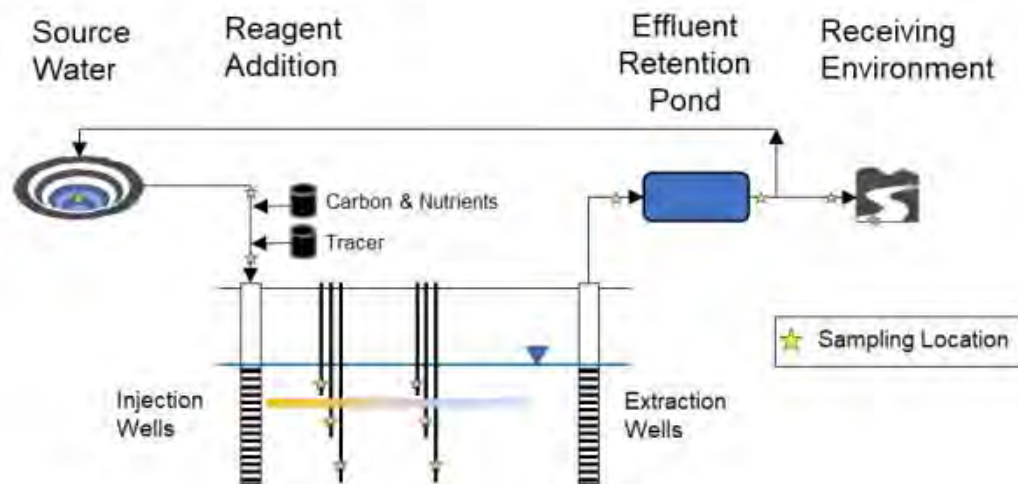
## Saturated Rock Fill

Saturate rock fill treatment involves the following steps (see **Insert 1-1**):

- selenium-contaminated water is pumped from the mine to the saturated rock fill
- reagents are added to stimulate organic reactions
- inoculated water is injected into and seeps through the saturated rock fill
- treated water is pumped out of the saturated rock fill

Treated effluent is discharged into an effluent retention pond where it re-equilibrates with atmospheric conditions. If the pond water quality meets discharge water quality criteria, it is discharged to the receiving environment; if not, it is recycled and discharged back to the flooded source pit (Mackie et al., 2022).

**Insert 1-1: Saturated Rock Fill Treatment Schematic** (Source: Mackie et al., 2022)

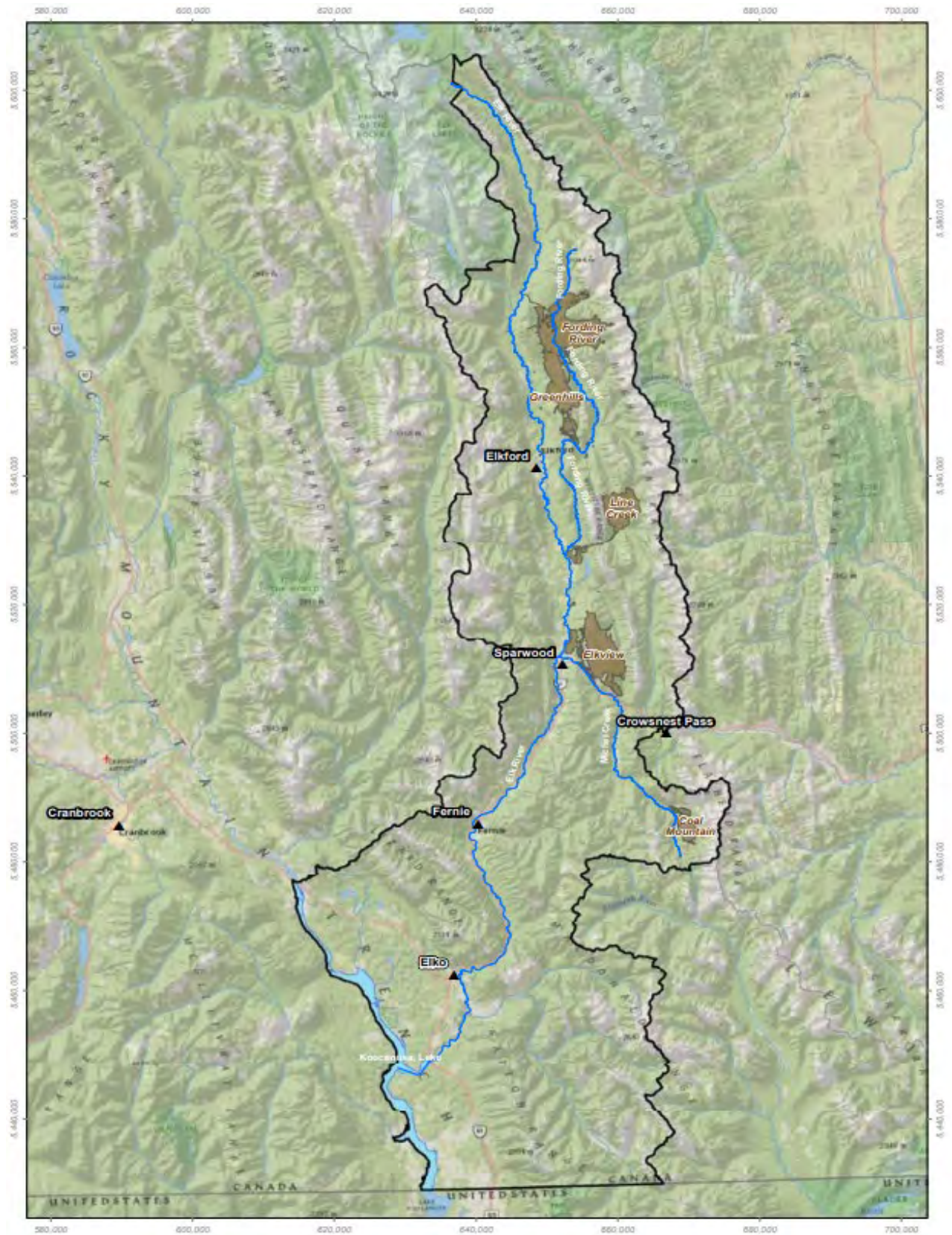


**Table 1.1**  
**Chronology of Elk Valley Coal Mining and Selenium Management**

Time Frame	Actual Action	Planned Action	Concentration of Selenium in Elk River downstream of Michel Creek
1890's	Elkview u/g mine commences	--	< 1 ug/L (assumed)
1900's	Coal Mountain u/g mine commences	--	No record
1940's	Coal Mountain open pit commences	--	No record
1960's	Elkview open pit commences	--	No record
1970's	Fording River commences	--	No record
1980's	Line Creek/Greenhills commence	--	<1 ug/L
1990's	Selenium contamination identified as an environmental concern and monitoring commences	Selenium monitoring commences	1 to 3 ug/L
2000's	Studies	Studies	3 to 5 ug/L
2010	Strategic Plan for Teck Coal	Strategic Plan for Teck Coal	5 ug/L
2011 to 2012	Planning	Planning	5 to 7 ug/L
2013	Ministerial Order 113	Planning	8 ug/L
2014	Elk Valley Water Quality Plan	WTP 1 Line Creek - 7,500 m <sup>3</sup> /day	10 ug/L
2015	--	--	10 ug/L
2016	--	--	11 ug/L
2017	--	--	10 ug/L
2018	WTP 1 Line Creek - 7,500 m <sup>3</sup> /day	WTP 2 Fording - 20,000 m <sup>3</sup> /day	12 ug/L
2019	--	--	12 ug/L
2020	SRF 1 Elkview - 10,000 m <sup>3</sup> /day	SRF 1 Elkview - 30,000 m <sup>3</sup> /day	12 ug/L
2021	SRF 1 Elkview - 10,000 m <sup>3</sup> /day	--	13 ug/L
2022	WTP 2 Fording 10,000 m <sup>3</sup> /day	--	14 ug/L
2023	WTP 2 Fording 10,000 m <sup>3</sup> /day	SRF 2 Fording - 30,000 m <sup>3</sup> /day	13 ug/L
2024	SRF 2 Fording 30,000 m <sup>3</sup> /day	--	No record
2024 to 2027	TBD	WTP 3 Line Creek - 20,000 m <sup>3</sup> /day WTP 4 Greenhills - 7,500 m <sup>3</sup> /day SRF 3 Fording - 30,000 m <sup>3</sup> /day SRF 4 Elkview - 15,000 m <sup>3</sup> /day	No record

WTP – Water Treatment Plant; SRF – Saturated Rock Fill





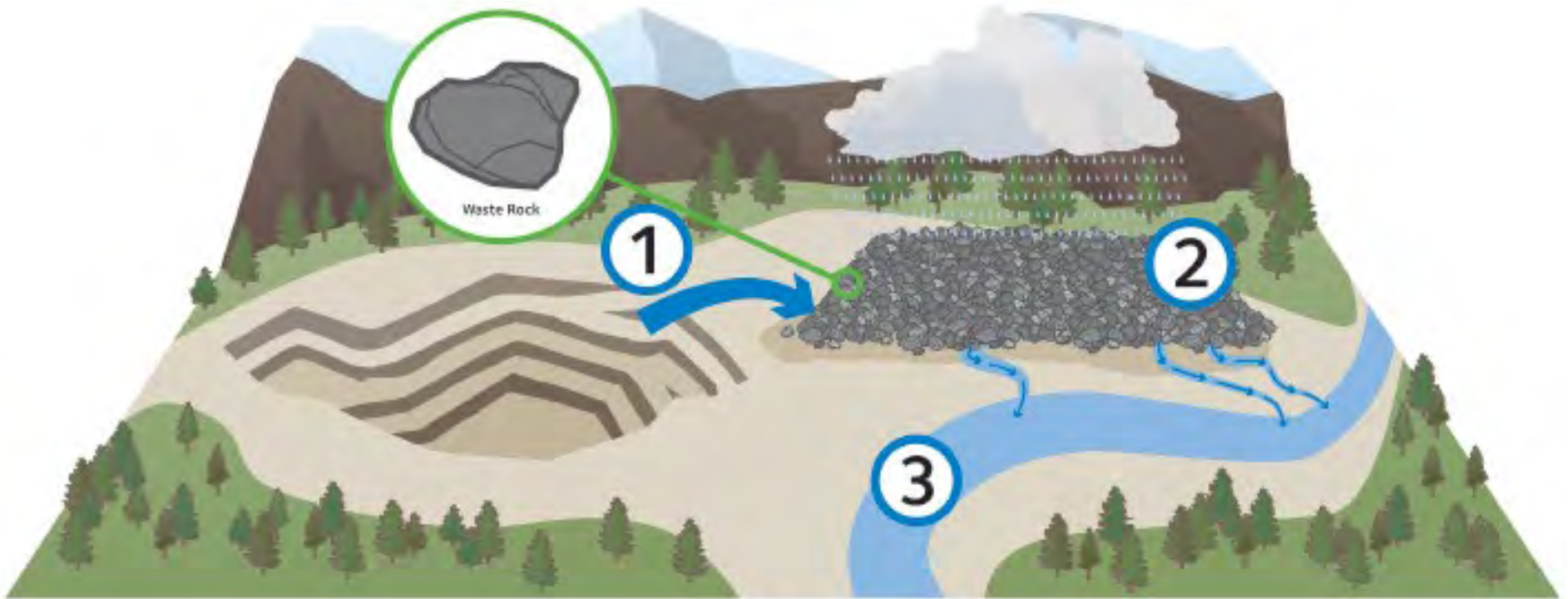
**WILDSIGHTT**  
 SELENIUM RELATED RECLAMATION LIABILITIES  
 TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Teck Coal Mines in Elk River Watershed**  
 (Source: Teck, 2014)



Date: 3/9/2024  
 Project No.: Sulp-01

Scale:  
 Figure No.: **1-1**



1. Waste Rock placed in spoil piles
2. Precipitation and runoff flow through these spoil piles
3. Impacted water flows into the local watershed

<b>WILDSIGHT</b>		
SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOIUTHEAST BRITISH COLUMBIA		
<b>Selenium Leaching from Waste Rock</b>		
Source: Teck, 2014		
<b>BURGESS</b> ENVIRONMENTAL	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>1-2</b>

## 2 SETTING

### 2.1 Physiography and Drainage

The following description of the Elk River watershed was extracted from Section 3.2.1 of the 2020 Elk Valley Regional Water Quality Model Update – Annex B (Teck, 2022a).

*“The Elk River watershed . . . is a mountainous watershed in the interior continental regions of British Columbia and has its headwaters at Elk Pass in Elk Lakes Provincial Park at the British Columbia – Alberta border (Figure 2-1). The Elk River watershed area is approximately 4,450 km<sup>2</sup> . . . . The watershed ranges in elevation from approximately 750 metres above sea level (masl) at the mouth of the Elk River to 3,450 masl at the summit of Mount Joffre. Characterized by rugged terrain of the Front and Border Ranges of the Rocky Mountain, the Elk River watershed is north-south oriented, and the Elk River flows generally south-southwest through the towns of Elkford, Sparwood and Fernie, discharging into the Kooacanusa Reservoir approximately 120 km downstream of Teck’s mining operations. Kooacanusa Reservoir is located partly in British Columbia and partly in the State of Montana; it was formed by the construction of the Libby Dam on the Kootenay River. Major tributaries of the Elk River include the Fording River, Michel Creek, and the Wigwam River.”* Minor tributaries of the Elk River that have been impacted by Teck’s operations include Line Creek, Erickson Creek, and Dry Creek.

### 2.2 Climate

The following description of the climate of Elk River watershed was extracted from Section 3.2.2 of the 2020 Elk Valley Regional Water Quality Model Update – Annex B (Teck, 2022a).

*“The climatic regime of the Elk River watershed is characterized by a continental climate with strong seasonality in precipitation and temperature (Figure 2-2). Accordingly, snow accumulates through the winter season and melts over the spring months (March, April and June) (sic), with the rate of melt influenced by local variation in elevation, hillslope, aspect and land cover. Warmer temperatures in the summer are typically accompanied by relatively low precipitation, and fall months are characterized by moderate temperatures and increased precipitation.”*

The data indicates that the average annual precipitation in the upper valley is between 800 and 900 mm per year, and that the average daily temperature varies between -10°C and +13°C. Average temperatures will be lower and average rainfall will be higher in the mountain valleys where Teck operates its mines. Most of the precipitation (or an estimated 950 mm per year, Teck, 2023a, PDF page 23 of 241) that falls on the mine areas is affected by mining (infiltration or runoff) before flowing to the Elk River.

## 2.3 Geology

### Bedrock Stratigraphy

The coal-bearing strata of Elk Valley belong to the Kootenay Group, which is of Jurassic and Cretaceous age, and includes, in ascending order, the Morrisey, Mist Mountain, and Elk Formations. The coal-bearing strata are located within the Mist Mountain Formation. The Kootenay Group is underlain by the Jurassic Period Fernie Formation, and is overlain by the Cadomin Formation of the lower Cretaceous Blairmore Group (**Figure 2-3**). Each of these formations is described below and the group form the dominant bedrock units associated with Teck's mine operations.

The Fernie Formation consists primarily of shale, with interbedded sandstone and carbonate layers, and a basal phosphorite. The uppermost unit in the Fernie Formation is known as the Passage Beds, and consists of interbedded shale and sandstone, with the sandstone beds becoming thicker and more frequent near the top of the Fernie Formation where it transitions into the Kootenay Group (Grieve, 1993, PDF page 16 of 179).

The Morrisey Formation is the basal sandstone unit of the Kootenay Group and includes the lower Weary Ridge member and the upper Moose Mountain member. The Weary Ridge is the less resistant of the two and is characterized by orange-brown weathering. It consists of argillaceous and ferruginous quartz sandstone with interbedded layers of siltstone. The more resistive Moose Mountain member is ridge forming and is a prominent marker of the base of the potential coal-bearing strata of the Mist Mountain Formation. The Moose Mountain member is composed of quartz-chert sandstone, with local occurrences of chert conglomerate. Thin carbonaceous interbeds may also be present. Regionally, the Morrisey Formation varies in thickness from 20 to 80 metres (Grieve, 1993, PDF page 17 of 179).

The Mist Mountain Formation abruptly and conformably overlies the Mouse Mountain member of the Morrisey Formation, and contains the economically minable coal deposits of the Elk Valley. It consists of interbedded coal, shale, siltstone, and sandstone, with coal comprising between 8 and 12 percent of the total thickness. Folding and faulting has caused local thinning and thickening of the coal seam, which can be up to 13 m thick (Grieve, 1993, PDF page 18 of 179).

The Elk Formation overlies the Mist Mountain Formation at the top of the Kootenay Group, and is similar to the Mist Mountain Formation with some important differences. The Elk Formation does not contain economically viable coal seams, and contains sapropelic coals in addition to humic coals. The Elk Formation also contains sandstone layers of greater thickness and lateral extent than the Mist Mountain Formation. The sandstone layers within the Elk Formation also

weather to a more orange colour than the sandstones of the Mist Mountain Formation. It varies in thickness from approximately 30 to 600 m in the area of Teck's mine operations (Grieve, 1993, PDF page 18 of 179), and is commonly ridge forming above Teck's coal mining operations.

The Cadomin Formation within the lower Cretaceous Blairmore Group is exposed at several locations in the Elk Valley, and is a prominent, massive pebble to cobble conglomerate unit, generally forming one or more continuous cliffs or ledges (Grieve, 1993, PDF page 18 of 179) near the mountain peaks in the mining areas.

## **Structural Geology**

The Elk Valley is situated in the Front Ranges of the southern Canadian Rocky Mountains, which is characterized by north to northwest trending, flexural slip folds, and southwest to west dipping thrust faults parallel to the folds. These structures were produced by compressional forces associated with the Late Cretaceous – early Tertiary orogeny. Later in the Tertiary Period, an extensional period occurred, which resulted in normal faulting along existing and new fault lines.

The coal fields are part of the Lewis thrust fault that resulted in horizontal displacement of approximately 19 km. Folding of the Lewis fault took place during movement on an underlying, younger thrust. Outcrop expressions of subsurface folds in the Lewis thrust include the Alexander Creek syncline, a major structural feature associated with the economically viable coal deposits. These coal deposits have generally been preserved and thickened in the structurally low (core) areas of the Alexander Creek syncline (Grieve, 1993, PDF page 57 of 179).

The structural and outcropping geology along the east side of the Elk River Valley is shown in **Figure 2-4**.

## **Quaternary Geology**

Quaternary geology refers to unconsolidated materials deposited during and since the glacial periods that inundated the Elk Valley. The primary Quaternary deposits in the region include the following:

- glacial till, which is deposited on the bedrock surface and is most prevalent nearer the valley bottoms
- glacial lacustrine and fluvial deposits formed as the glaciers melted and glacial lakes formed in the valley bottoms
- post-glacial alluvial deposits, which have accumulated in the Elk River Valley and its major tributaries
- colluvial deposits on the mountain slopes and at the foot of steep outcrops

Quaternary deposits are typically thin or absent in the upland areas, although significant thicknesses have accumulated on benches and in depressions in the upland areas. Organic soils, weathered bedrock (saprolite), and lacustrine sediments are also present in the region, but are typically isolated and limited in depth and extent. Uplands water courses are typically steep, have eroded into bedrock, and flow seasonally.

Glacial stratigraphy and geomorphology of the bottom areas of the Elk Valley support the existence of at least one major ice advance. Glacial Lake Elk, formed within the Elk Valley from meltwaters released by this glacier, was dammed initially by an ice plug from the Rocky Mountain Trench glacier at a point near Morrissey and subsequently less than 3 km up-valley from Elko. The lake drained in at least three stages as the Rocky Mountain Trench glacier melted, which resulted in rapid erosion of glacio-lacustrine deposits along the flanks of the Elk River Valley (George et al, 1987).

## 2.4 Hydrogeology

### Groundwater Circulation

In the uplands areas of the Elk Valley, including the areas of Teck's mine operations, rainfall and snowmelt infiltrates into the shallow groundwater systems that include colluvium, near-surface fractured bedrock, and waste rock associated with the Teck mines. Most of this groundwater discharges to the seasonal drainages that ultimately flow into tributaries of the Elk River (**Figure 2-5**). In active mining areas, large proportions of this water flow through waste rock and valley fills. Colluvial deposits in these uplands areas are often thin, have limited areal extent, and become saturated during periods of high runoff. Accordingly, the residence time of water in the ground is relatively short, with velocities on the order of hundreds of metres per year. Groundwater recharge and discharge are approximately equal and the proportion of runoff that infiltrates the ground can be highly variable. Estimates of groundwater recharge vary from less than 10% to over 40% of total precipitation (Teck, 2022a, Section 3.3.5).

Exposed waste rock and mine spoil piles typically have little or no vegetation cover, which results in reduced evapotranspiration compared to areas not affected by mining. Runoff is negligible and precipitation water not lost to evaporation or sublimation infiltrates the waste rock and mine spoil (Teck, 2022a, Section 3.4.4).

The proportion of water that recharges the competent bedrock aquifers is much lower and groundwater flow velocities can be much slower, on the order of 1 meter per year (Teck, 2022a, Section 3.3.6). Given the high degree of faulting, folding, and fracturing of rock in Elk Valley (see **Section 2.3**), zones of preference groundwater flow in deeper bedrock are also likely to occur.

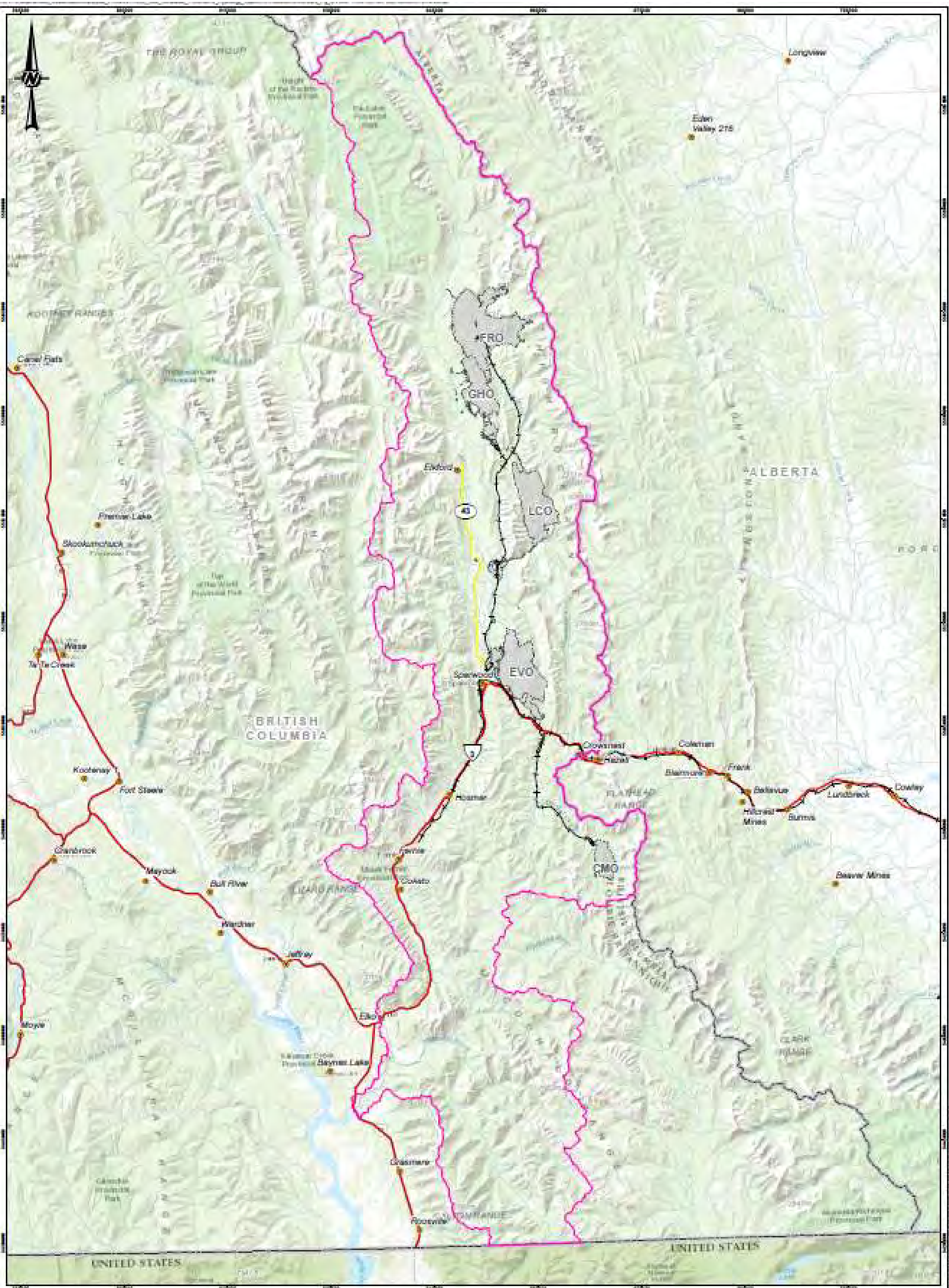
## Burgess Environmental

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At the floor of the Elk River Valley, within the historical floodplain of the Elk River, the volumes of groundwater in circulation and the residence time for that groundwater in the valley aquifers is much greater. The primary aquifers are within the alluvial sediments deposited by the Elk River, which can discharge into, or be recharged by, the river.

### **Groundwater Use**

Groundwater is used by individual residents, municipalities, and farms throughout the Elk Valley. The primary municipal users are Elkford, Sparwood, and Fernie. In 2022, Fernie obtained 13% of its 3.2 million m<sup>3</sup> annual water needs from groundwater sources, and 87% from the Fairy Creek (City of Fernie, 2022). Sparwood obtains all of its municipal water supply from groundwater sources, and used 1.7 million m<sup>3</sup> of water in 2022 (District of Sparwood, 2023). Elkford also obtains all of its water from groundwater sources, and used 1.2 million m<sup>3</sup> of water in 2022 (District of Elkford, 2022).



**LEGEND**

- CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

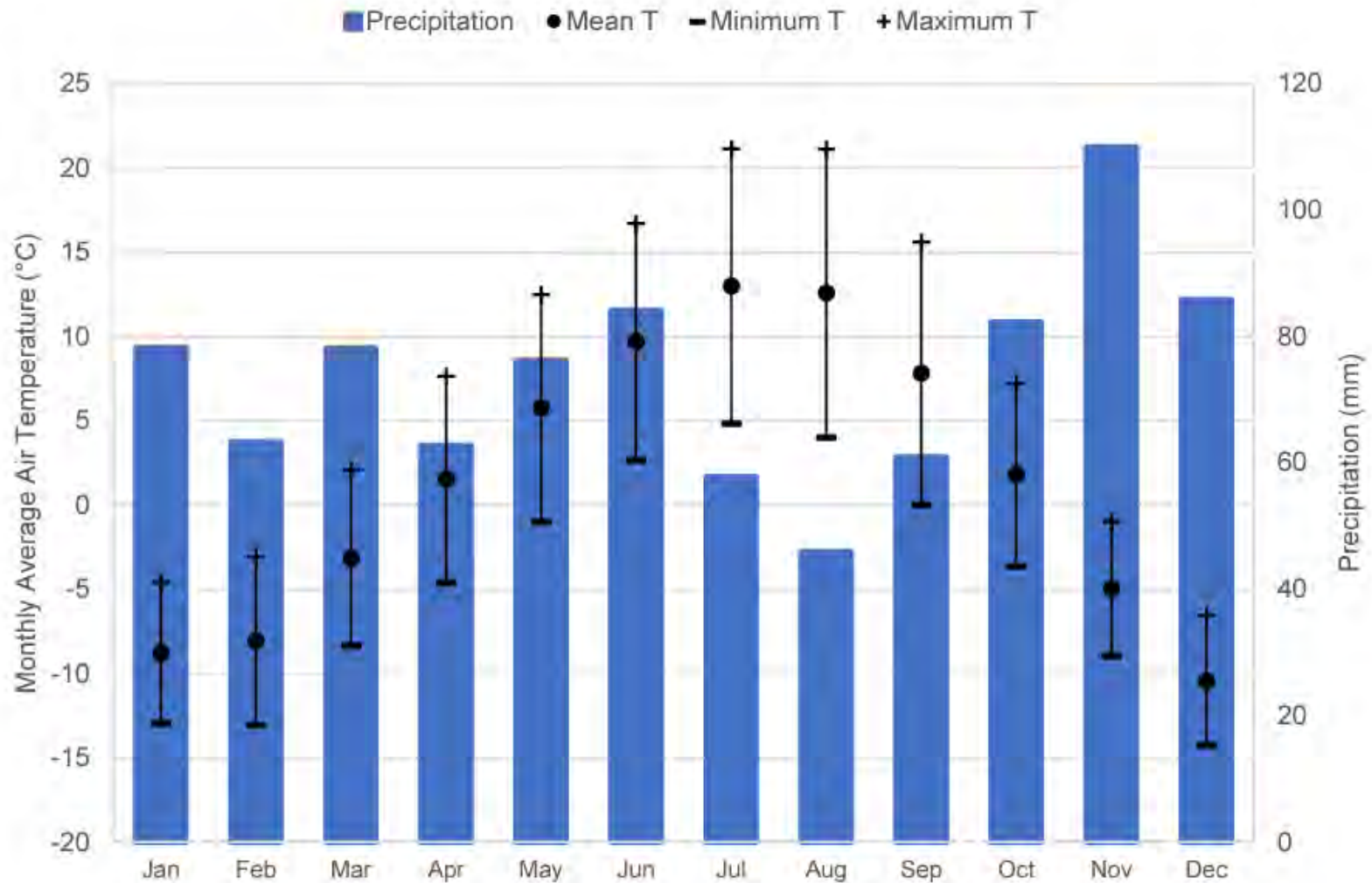
**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Elk Valley Watershed**  
Source: Teck, 2022




Date:	3/9/2024	Scale:	
Project No.:	WILD-01	Figure No.:	<b>2-1</b>

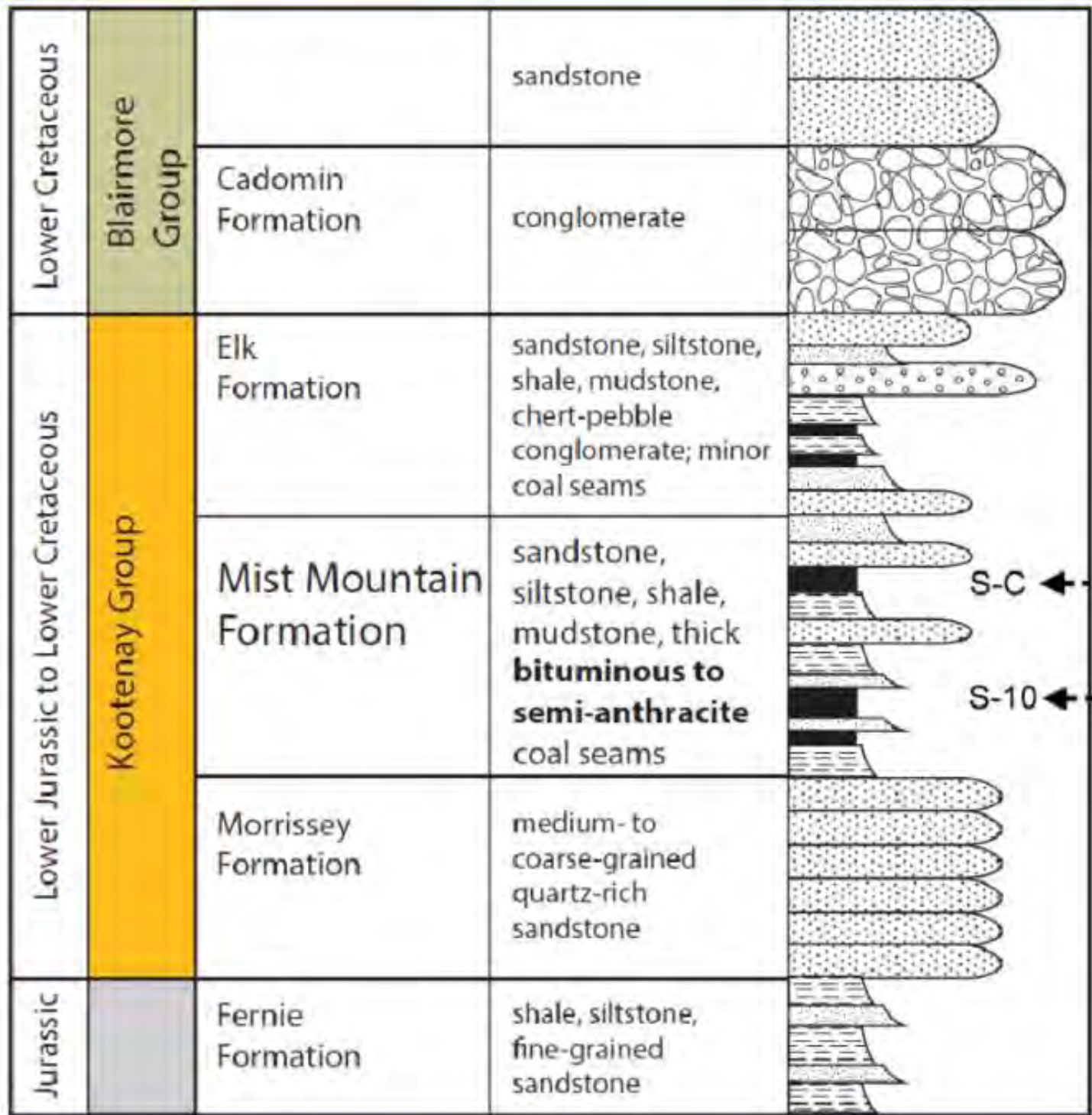




Based on data recorded at the Sparwood climate station from 1980 to 2019, in-filled, and then adjusted to account for elevation differences between Sparwood climate station (1,138 masl) and the average elevation of the Elk River watershed (1,777 masl).

°C = degrees Celsius. T = Temperature.

<b>WILDSIGHT</b>		
SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA		
<b>Climate of Elk Valley</b> (Source: Teck, 2022)		
	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>2-2</b>



<b>WILDSIGHT</b> SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA		
<b>Lithologic Section of Kootenay Group</b> (Source: Edress and Abdel-Fatah, 2021)		
	Date: 3/9/2024	Scale:
	Project No.: SULP-01	Figure No.: <b>2-3</b>



Geological Survey Branch  
**BULLETIN 82**

Figure 5, South Half  
**GEOLOGY OF THE  
ELK VALLEY COALFIELD**  
NTS 82G/10, 15; 82J/2, 6, 7, 10, 11  
Geology by D. Grieve

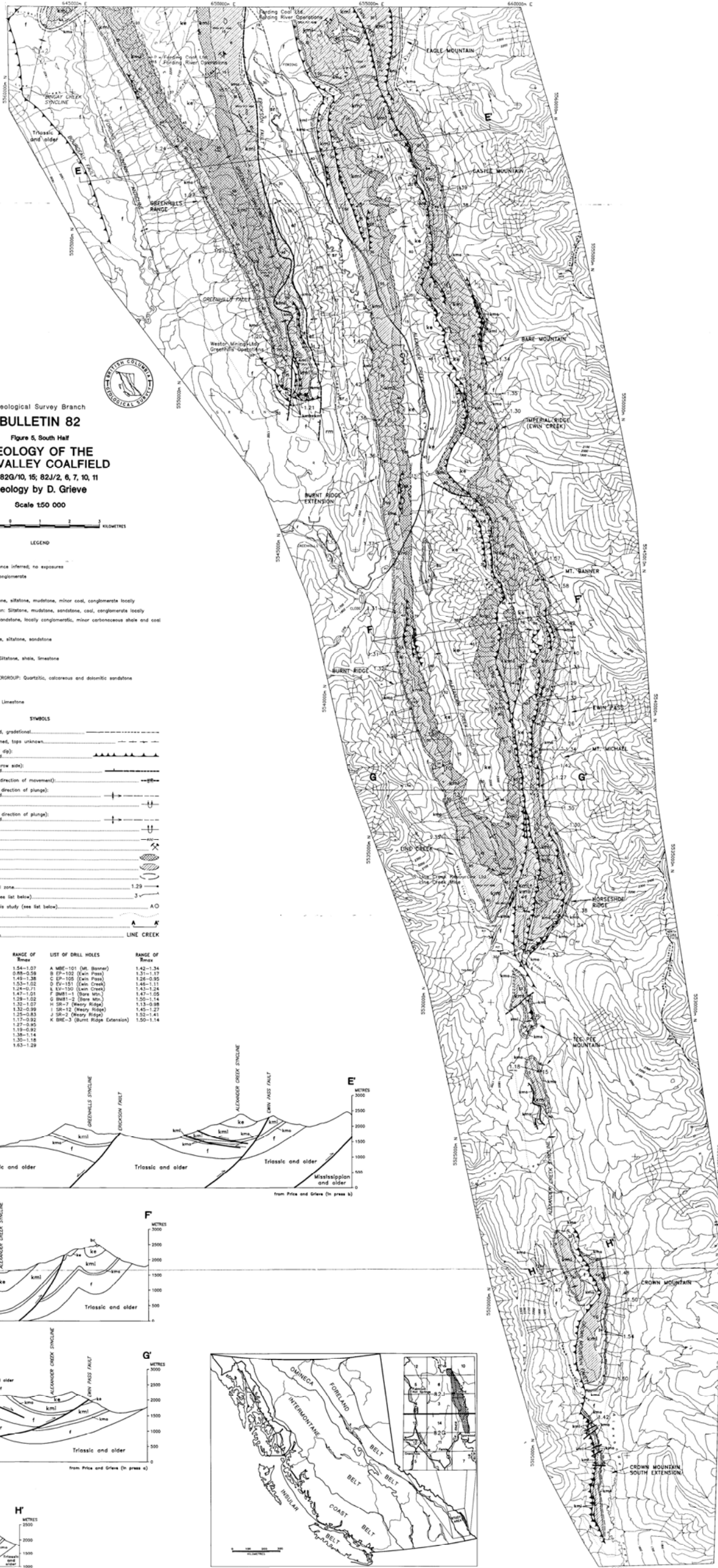
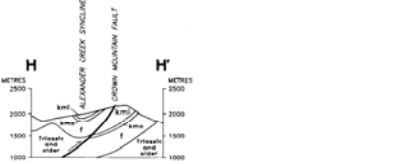
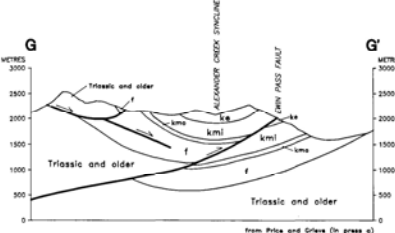
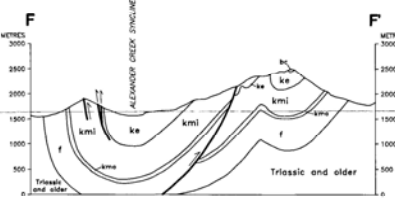
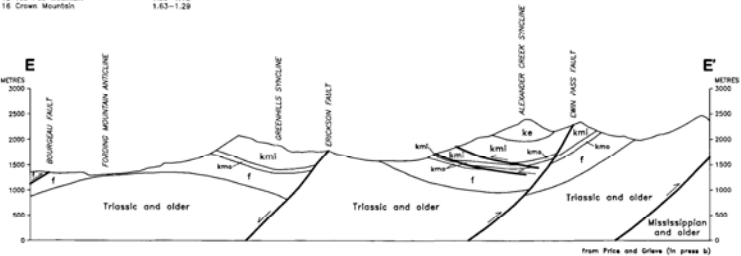
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- LEGEND**
- CRETACEOUS**  
BLADMORE GROUP  
bl Lower Bladmore: Presence inferred, no exposures  
bc Cadomin Formation: Conglomerate
- JURASSIC AND CRETACEOUS**  
KOOTENAI GROUP  
ka Elk Formation: Sandstone, siltstone, mudstone, minor coal, conglomerate locally  
kml Mt. Michael Formation: Siltstone, mudstone, sandstone, coal, conglomerate locally  
kms Marney Formation: Sandstone, locally conglomeratic, minor carbonaceous shale and coal
- JURASSIC**  
f Femia Formation: Shale, siltstone, sandstone
- TRIASSIC**  
tr SPRAY RIVER GROUP: Siltstone, shale, limestone
- PENNSYLVANIAN AND PERMIAN**  
pm ROCKY MOUNTAIN SUPERGROUP: Quartzite, calcareous and dolomitic sandstone
- MISSISSIPPIAN**  
ms MISSISSIPPIAN SCHELE GROUP  
ml Elberton Formation: Limestone

- SYMBOLS**
- Geological boundary:  
defined, approximate, assumed, gradational
- Bedding: inclined, vertical, overturned, tops unknown
- Thrust fault (teeth in direction of dip):  
defined, approximate, assumed
- Normal fault (no indicates downthrow side):  
defined, approximate, assumed
- Traverse fault (arrows indicate direction of movement)
- Syncline (upright, arrow indicates direction of plunge):  
defined, approximate, assumed
- Syncline (overturned)
- Anticline (upright, arrow indicates direction of plunge):  
defined, approximate, assumed
- Anticline (overturned)
- Contours (100 metre interval)
- Coal mines:  
High volatile bituminous  
Medium volatile bituminous  
Low volatile bituminous
- Trace on sample from best coal zone
- Location of measured sections (see list below)
- Location of drill cores used in this study (see list below)
- Limit of interpretation
- Cross sections
- Coal property and/or area names

LIST OF MEASURED SECTIONS	RANGE OF Elevations	LIST OF DRILL HOLES	RANGE OF Elevations
1 Weary Ridge	1.54-1.07	A MBE-101 (Mt. Banner)	1.42-1.34
2 Coal Creek	0.98-0.58	B CP-102 (Ewin Pass)	1.31-1.17
3 Mt. Vets	1.45-1.38	C EP-105 (Ewin Pass)	1.28-0.95
4 Mt. Tufford	1.53-1.02	D BM-101 (Ewin Creek)	1.40-1.11
5 Greenhills Range	1.24-0.71	E LV-100 (Ewin Creek)	1.43-1.24
6 Burnt Ridge Extension	1.47-1.01	F BM-1 (Ewin Mtn.)	1.47-1.05
7 Imperial Ridge	1.29-1.02	G BM-2 (Ewin Mtn.)	1.50-1.14
8 Ewin Pass	1.25-0.67	H SR-1 (Weary Ridge)	1.33-0.88
9 Burnt Ridge	1.32-0.99	I SR-12 (Weary Ridge)	1.45-1.27
10 Burnt Ridge South	1.25-0.83	J SR-2 (Weary Ridge)	1.33-0.41
11 Mt. Michael upper sheet	1.17-0.92	K BRE-3 (Burnt Ridge Extension)	1.50-1.14
12 Mt. Michael lower sheet	1.27-0.92		
13 Horseshoe Ridge	1.19-0.82		
14 Horseshoe Ridge	1.38-1.14		
15 Tee Pee Mountain	1.35-1.18		
16 Crown Mountain	1.63-1.29		



**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Geology of the East Side of Elk Valley**  
Source: Grieve, 1993



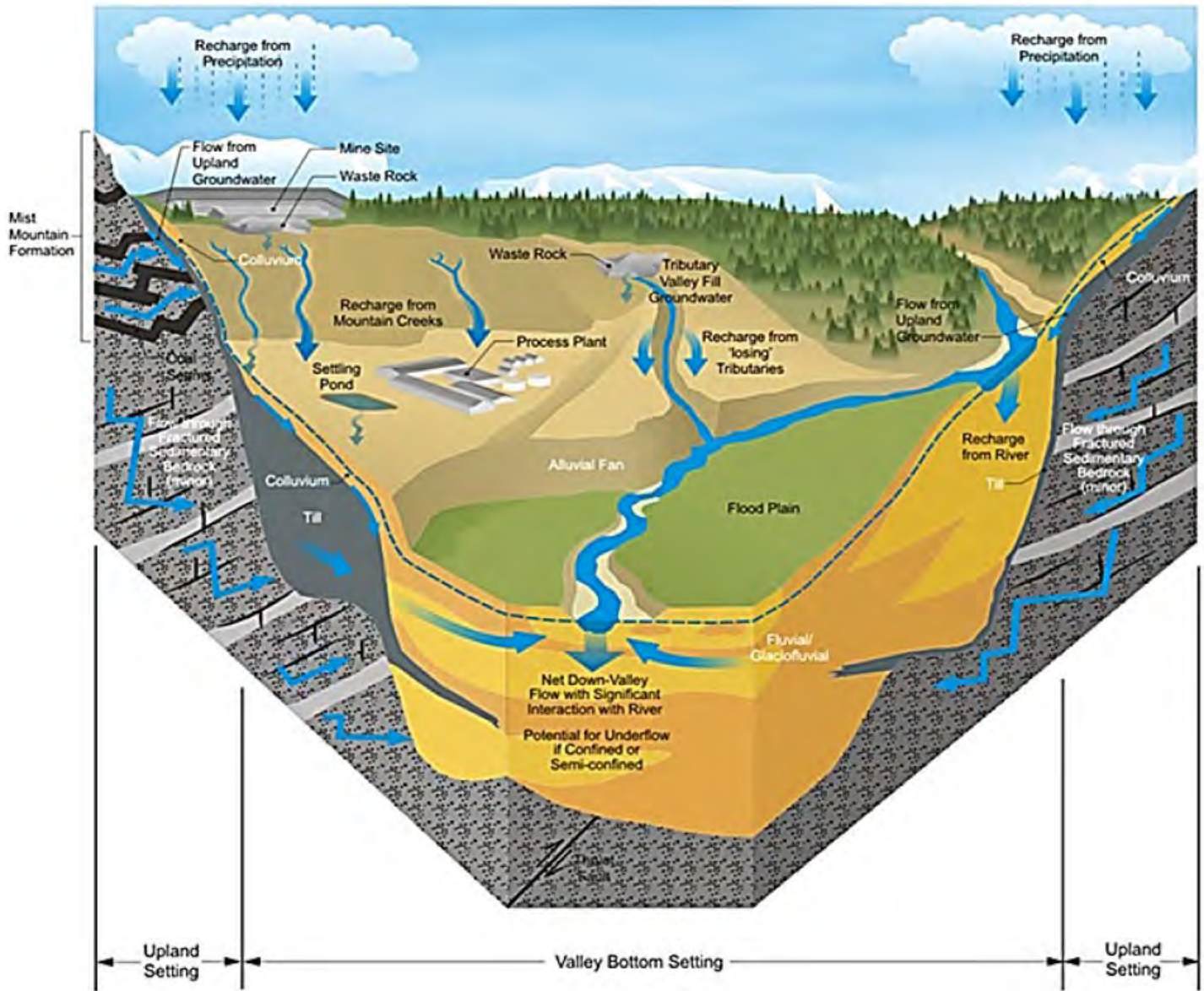
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WILD-01

Figure No.:

**2-4**



<p><b>WILDSIGHT</b>          SELENIUM RELATED RECLAMATION LIABILITIES          TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA</p>		
<p><b>Conceptual Groundwater Model</b>          (Source: Teck, 2022)</p>		
	Date: 3/9/2024	Scale:
	Project No.: SULP-01	Figure No.: <b>2-5</b>

## 3 WATER QUALITY OBJECTIVES

### 3.1 B.C. Approved Water Quality Guidelines

B.C. (2023) has published approved water quality guidelines (WQGs), which represent safe levels of substances that protect different water uses, including: drinking water, recreation, aquatic life, wildlife, and agriculture. These WQGs are updated on a periodic basis as additional information becomes available.

WQGs provide policy direction to those making decisions affecting water quality. Although WQGs do not have any direct legal standing, once approved, BC WQGs must be considered in any decision affecting water quality made by the Ministry of Environment and Climate Change Strategy. WQGs are used to assess water quality and may be used as the basis for determining the allowable limits in waste discharge authorizations. Exceeding a WQG does not imply that unacceptable risks exists, but rather that the potential for adverse effects may be increased and additional investigation may be required (B.C., 2023).

WQGs have been also been determined for long-term chronic, short-term acute exposure, and on an interim basis.

Long-term chronic (i.e., “average”) WQGs are intended to protect the most sensitive species and life stage against sub-lethal and lethal effects for indefinite exposures. An averaging period approach is used for these WQGs. This approach allows concentrations of a substance to fluctuate above and below the guideline provided that the short-term acute is never exceeded and the long-term chronic is met over the specified averaging period (e.g., 5 samples in 30 days).

Short-term acute (i.e., “maximum”) WQGs are set to protect against severe effects such as lethality (e.g. LC50) or other equivalent measures (e.g., EC50) to the most sensitive species and life stage over a defined short-term exposure period (e.g., 96 hours) (B.C., 2023).

Interim WQGs have also been developed in cases where there are insufficient data available to meet the minimum requirements of a full guideline. The interim WQGs may be upgraded to approved WQG status when the data gap is filled.

**Table 3.1** summarizes the current WQGs for selenium and **Table 3.2** summarizes the sampling guidance. Review of the background information presented in **Sections 1 to 3** of this report indicates that each of the Water Use scenarios indicated in these tables are relevant to the selenium contamination that has resulted from Teck’s mine operations in the Elk River Valley. Review of the water quality data presented in **Sections 5 and 6** indicate that these WQGs are exceeded in samples collected from most of Teck’s monitoring locations.

**Table 3.1**

**Water Quality Guidelines for Selenium (Source: B.C., 2023)**

Water Use	Long-term Chronic Se WQG	WQG Derivation Method/Approach
Aquatic Life Water column freshwater & marine Alert concentration WQG	1 µg/L 2 µg/L	<i>Water column:</i> Review of previous WQG (uncertainty factor (UF) applied to toxicity threshold); weight of evidence including food web modelling and reported relationships between impacts and Se concentrations in water.
Sediment - Alert concentration	2 µg/g (dw)	<i>Sediment:</i> Weight of evidence; lowest published toxicity thresholds, no UF applied; insufficient data for full WQGs at this time.
Dietary Invertebrate tissue (interim)	4 µg/g (dw)	<i>Dietary:</i> Weight of evidence; lowest published toxicity thresholds, no UF applied; insufficient data for full WQGs at this time. Invertebrate tissue as surrogate for aquatic dietary tissue.
Tissue (fish) Egg/ovary Whole-body (WB) Muscle/muscle plug (interim)	11 µg/g (dw) 4 µg/g (dw) 4 µg/g (dw)	<i>Egg/ovary:</i> Combination weight of evidence and mean of published effects data with an UF of 2 applied; <i>Whole-body:</i> previous WB WQG compared with published literature, mean of published effects data with UF (2) applied and weight of evidence; <i>Muscle:</i> WB translation to derive muscle WQG, no additional UF applied to muscle WQG.
Wildlife Water column Bird egg	2 µg/L 6 µg/g (dw)	The <i>water column</i> WQG for aquatic life (fish) is adopted for wildlife since dietary accumulation is most critical. <i>Bird eggs</i> were used as surrogate for all wildlife; weight of evidence; egg Se most direct/sensitive measure; mallard EC10 with UF of 2 applied.
Livestock 2001 WQG not updated	30 µg/L	Not updated at this time
Irrigation 2001 WQG not updated	10 µg/L	Not updated at this time

**Table 3.2**

**Water Quality Guidelines for Selenium (Source: B.C., 2023)**

Water Use	WQG for Total Se	Sampling Guidance
Aquatic Life Water column freshwater & marine Alert concentration WQG	1 µg/L 2 µg/L	<i>Water:</i> 30-day average determined as the mean concentration of 5 evenly spaced samples collected over 30 days and measured as total Se.
Sediment - Alert concentration	2 µg/g (dw)	<i>Sediment:</i> Mean of ≥ 5 samples collected in a representative area.
Dietary Invertebrate tissue (interim)	4 µg/g (dw)	<i>Dietary:</i> Mean concentration ≥ 8 replicate (composite) tissue samples representing an appropriate invertebrate or other prey species.
Tissue (fish) Egg/ovary Whole-body (WB) Muscle/muscle plug (interim)	11 µg/g (dw) 4 µg/g (dw) 4 µg/g (dw)	<i>Egg/ovary:</i> Mean of ≥ 8 egg or ripe ovary (from 8 individual fish) in a representative area, reported as dry weight. <i>Whole-body:</i> Mean of ≥ 8 fish in a representative area, reported as dry weight. <i>Muscle:</i> Mean of ≥ 8 muscle tissue samples (from 8 individual fish) in a representative area, reported as dry weight.
Wildlife Water Bird egg	2 µg/L 6 µg/g (dw)	<i>Water:</i> 30-day average determined as the mean concentration of 5 evenly spaced samples collected over 30 days and measured as total Se. <i>Bird egg:</i> Mean of ≥ 8 eggs (from 8 individual nests) in a representative area, reported as dry weight. A statistical analysis could also be used to determine a more specific sampling design.
Livestock 2001 WQG (not updated in 2014)	30 µg/L	<i>Water:</i> A maximum WQG not to be exceeded.
Irrigation 2001 WQG (not updated in 2014)	10 µg/L	<i>Water:</i> A maximum WQG not to be exceeded.

Companion Document to: Ambient Water Quality Guidelines for Selenium Update (B.C., 2014) provides the supporting bases for these guidelines. The selenium WQGs were developed based on the most sensitive species (birds and fish) and lentic (slow moving) waters, which are more biologically productive and reducing conditions that increase the uptake of selenium by benthic organisms. The Companion Document states, “the development of the Se WQGs recognized the need to protect the most sensitive hydrologic units (i.e., lentic areas) within an exposed watershed, since fast moving (lotic) streams are connected with, and have within them, slower moving, depositional (lentic) areas such as pools, back-eddies, back-channels, lakes, and wetlands”.

On a provincial basis, the BC WQG for selenium of 2 µg/L (mean concentration over 30 days) is considered protective of all aquatic life. An alert concentration for selenium in the water column of 1 µg/L and above background represents a threshold level of concern for bioaccumulation in the environment (e.g., sediments and biota) (B.C., 2014).

Human health is also an important component of the WQGs and the Companion Document, which states, “to protect drinking water sources and human health, Se concentrations should not exceed 10 µg /L at any time”. Health-based screening values for selenium in fish tissue were developed for high, moderate, and low fish consumption scenarios. For example, the high consumption screening scenario is applicable to subsistence fishing.

The sediment quality guideline of 2 µg/g has been established as the threshold of concern in suspended and bed sediments, which “is an important exposure route for organisms at the base of the food web”. Tissue guidelines are established because “bioaccumulation of Se in tissues is important in determining toxicity. Tissue-based guidelines provide a more direct link between Se exposure and toxic effects”. Guidelines for protection of wildlife focus on birds and sensitive species (amphibians and reptiles). They exclude fish and other freshwater aquatic organisms.

## 3.2 Teck Water-Quality Targets

### Summary of Targets

In response to Ministerial Order M113, Teck has established short-term, medium-term and long-term water-quality targets at Order Stations in the Elk River watershed that have been impacted by its mine operations. B.C. water-quality guidelines (WQGs) for aquatic life have been set as the long-term water-quality target for selenium in Lake Kocanusa. Where long-term concentrations could not meet WQGs, site-specific targets were derived for the Elk and Fording Rivers that were considered protective of aquatic life and achievable (Teck, 2014, PDF page 185 of 290). It is understood that these water-quality targets were accepted by the B.C. regulators, are still in place, and are summarized for selenium in **Table 3.3**.

**Table 3.3**

**Long-Term Water-Quality Targets and Timeframes for Selenium** (Source: Teck, 2014)

Location		Order Station	Selenium (ug/L)	Timeframe
MU-1	Upper Fording River	FR4	57	2022
MU-2	Lower Fording River	FR5	40	2023
MU-3	Elk River above Fording River	ER1	19	2014
MU-4	Elk River below Fording River	ER2	19	2023
MU-5	Elk River below Michel Creek	ER3, ER4	19	2014
MU-6	Lake Kocanusa	LK2	2	2014

The derivation of these water-quality targets is described in Section 8 of the Elk Valley Water Quality Plan (Teck, 2014), and are based on aquatic life benchmarks (**Figure 3-1**). These water-quality targets for selenium were derived to achieve the following:

- Fording River: protection of westslope cutthroat trout
- Elk River: protection of brown trout
- Lake Koochanusa: compliance with B.C. WQG

On the recommendation of the advisory committee, brown trout was used to derive the Elk and lower Fording River fish tissue benchmark because, while not present in the system, it is the most sensitive tested species similar to fish found there (Teck, 2014, PDF page 192 of 290). Short-term targets and timeframes for stabilization were also set where selenium concentrations were expected to exceed these long-term targets. Medium-term targets and timeframes were also set to demonstrate progressive improvement in water quality is occurring over time. These targets are summarized in **Tables 3.4 and 3.5**, respectively.

**Table 3.4**

**Short-Term Water-Quality Targets and Timeframes for Selenium** (Source: Teck, 2014)

Location		Order Station	Selenium (ug/L)	Timeframe
MU-1	Upper Fording River	FR4	63	2019
MU-2	Lower Fording River	FR5	51	2019
MU-4	Elk River below Fording River	ER2	19	2023

**Table 3.5**

**Medium-Term Water-Quality Targets and Timeframes for Selenium** (Source: Teck, 2014)

Location		Order Station	Selenium (ug/L)	Timeframe
MU-1	Upper Fording River	FR4	57	2022
MU-2	Lower Fording River	FR5	40	2023

### Summary of Supporting Basis

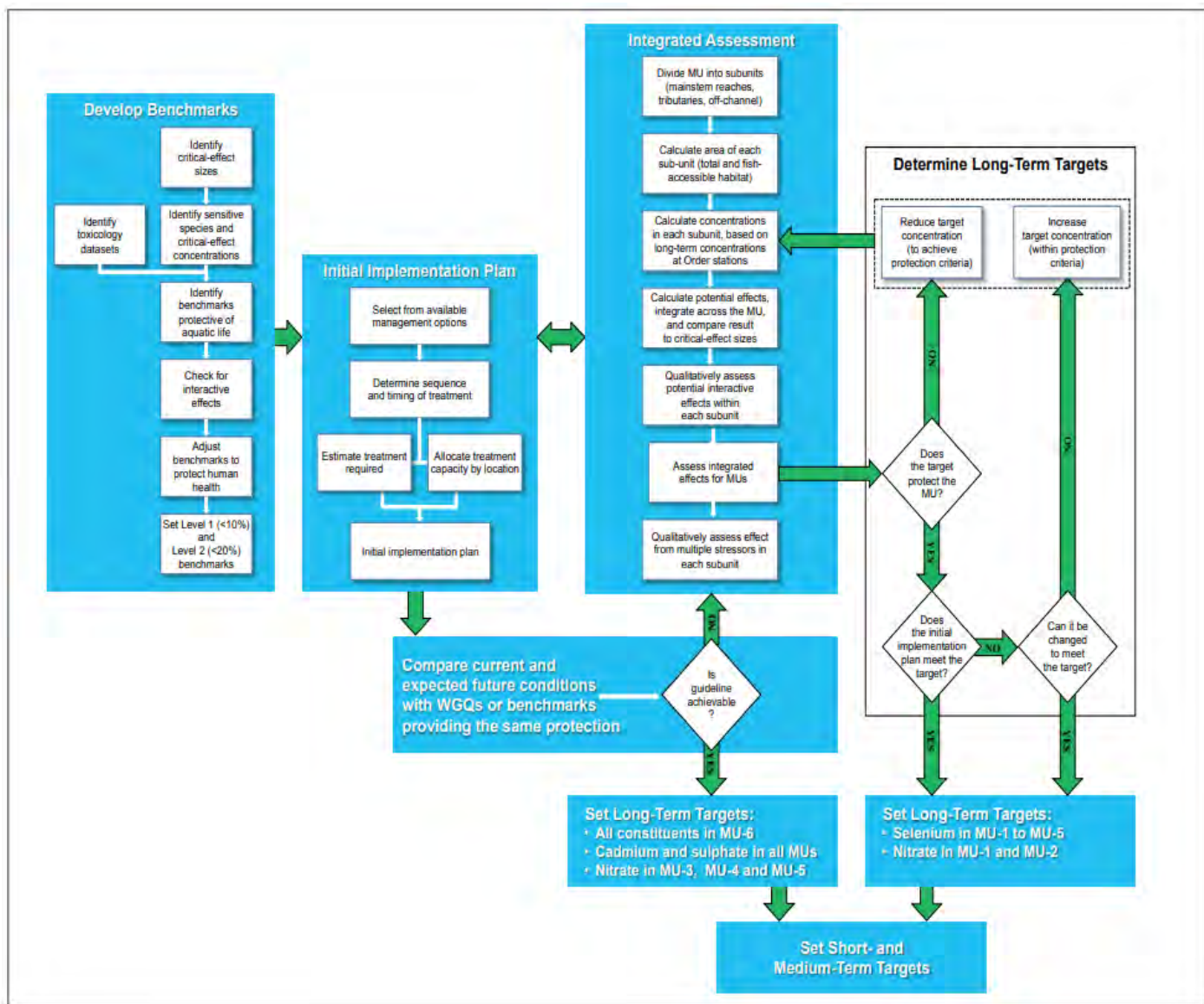
The bench-mark concentration for selenium in water is based on selenium concentrations in tissues of the most sensitive species included in the assessment (Teck, 2014, PDF page 194 of 290). Level 1 and 2 benchmarks were determined for 10% and 20% effect levels determined by laboratory testing. A total of 41 species were considered for selenium: 17 fish, 14 bird, and 10 invertebrates. The westslope cutthroat trout was identified as the most sensitive species in the Fording River and the brown trout in the Elk River (Teck, 2014, Section 8.2).



## Burgess Environmental

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A two-step bioaccumulation model was developed and used to predict the bioaccumulation of selenium in sensitive species. The Level 1 selenium water-quality benchmark applicable to the upper Fording River is 70 µg/L, which is based on reproductive effects on westslope cutthroat trout. The Level 1 selenium benchmark applicable to the Elk River is 19 µg/L. Interim assessment criteria were then applied to potentially modify these benchmarks. This resulted in a reduction of the long-term water-quality target to 57 ug/L in the upper Fording River, and 40 ug/L in the lower Fording River. The integrated assessment was implemented to account for different water quality conditions in mainstem rivers, mine-influenced tributaries, and tributaries not influenced by mining. This was determined to be a more important factor for the Fording River, which contains a higher proportion of these different water quality conditions than the Elk River.



## 4 TECK COAL MINE OPERATIONS

### 4.1 Elkview

#### General

Elkview Mine (**Figure 4-1a**) is situated north of the Michel Creek valley, approximately three kilometers east of Sparwood, B.C. It has been in operation since 1970, currently produces 9 million tonnes of clean coal per year, and is projected to be in operation through 2041.

The current surface disturbance associated with Elkview Mine is approximately 4,500 ha, of which approximately 1,300 ha is currently reclaimed (revegetated). Over 3,000 ha of the mine area is covered with mine spoil and waste rock, although it is not clear what portion of this spoil area is included in the reclamation areas. According to Teck, waste rock disposal in 2022 occurred in the Erickson Creek watershed, the Michel Creek watershed, and within mine pits (Teck, 2023a).

#### Hydrology

Mountainous terrain dominates the Elkview Mine site. According to Teck, many pre-mining drainage basins still exist within the Elkview Mine disturbance area. Generally, the mine can be divided into four main drainage areas (**Figure 4-1b**):

- Harmer Creek drainage (north-eastern quadrant),
- Elk River drainage (north-western quadrant),
- Michel Creek drainage (south-western quadrant)
- Erickson Creek drainage (south-eastern quadrant)

Ultimately all drainages associated with the Elkview Mine flow to the Elk River, or to Michel Creek upstream of its confluence into Elk River. Several of the drainages at Elkview Mine have been altered by mining, and as a result, mine runoff flows to mine pits. The following summarizes the characteristics of each drainage area within or in proximity to the Elkview Mine (Teck, 2023a).

- Dry Creek drains into Harmer Creek which drains into Elk River via Grave Creek.
- 6-Mile Creek is a small tributary that flows west from the north end of Elkview Mine and discharges directly to Elk River.
- Balmer and Fennelon Creeks are small tributaries that are not affected by mining activities and are located on the west side of the mine.
- Lower Lindsay Creek flows under coal spoil through a constructed rock drain. The rock drain discharges and infiltrates into the ground near the banks of Elk River.

# Burgess Environmental

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- The Goddard Creek watershed includes drainage from the raw coal conveyor tunnel, the plant area and the south slopes of the reject coal spoil. It flows into the Lindsay Interceptor Ditch and ultimately into Elk River.
- Otto Creek drains a portion of Baldy Ridge on the western slopes, through Cossarini Creek and discharges to Elk River.
- Erickson Creek drains the eastern side of the Elkview Mine and flows into Michel Creek. A portion of Erickson Creek flow is intercepted and transferred at rates of up to 20,000 m<sup>3</sup>/day to the saturated rock fill treatment facility. Treated water is returned to Erickson Creek.
- Gate Creek drains the western side of Natal Ridge including the reclaimed Bodie spoil. Gate Creek has historically received inputs from dewatering of the Natal West Pit either directly from the pit or via the saturated rock fill treatment facility. A large portion of the upper headwaters is diverted around the Bodie spoil in an overland culvert. The diversion reconnects with Gate Creek below the spoil before flowing into the Gate Creek sedimentation ponds.
- Bodie Creek is a highly altered drainage as the majority of the upper catchment and headwaters have been mined out. Bodie Creek receives surface runoff from the slopes and roads located within the drainage area and has also received water from dewatering of the Natal Pit, either directly from the pit or via the saturated rock fill treatment facility.

## **Existing and Planned Remedial Measures**

The Elkview Saturated Rock Fill began full-scale operation on August 14, 2021. The system is designed to treat waters from Erickson Creek and Natal Pit at a capacity of 20,000 m<sup>3</sup>/day. It discharges treated effluent to Erickson Creek and to the Bodie Rock Drain (Teck, 2023a, Section 2.2). Expansion to the SRF water treatment system is planned for 2027, which would increase the water treatment capacity of the Elkview Mine to 35,000 m<sup>3</sup>/day (Teck, 2023g).

As part of Elkview Mine Local Aquatic Effects Monitoring Program (LAEMP), routine monitoring efforts conducted in September 2021 showed increased selenium concentrations in benthic invertebrate. These increases were not expected and triggered an action response plan that included suspension of the saturate rock fill treatment facility on April 9, 2022. The facility was restarted on October 4, 2022. Summary of findings related to these increases were not found; however, active water treatment facilities at other mining areas in the Elk Valleys have indicated that treatment effluent was composed of chemically reduced forms of selenium that were more readily accumulated (i.e., bioavailable) by aquatic biota than selenate (Teck, 2023a).

## Surface Water Quality Monitoring

Teck publishes the measured concentrations of selenium in the effluent from the saturated rock fill treatment facility, as well as the average treatment rate (flow through treatment facility), and mass of selenium removed on a daily basis. This data can be used to calculate the influent concentration of selenium through the reporting period, which is summarized for 2022 in **Table 4.1**.

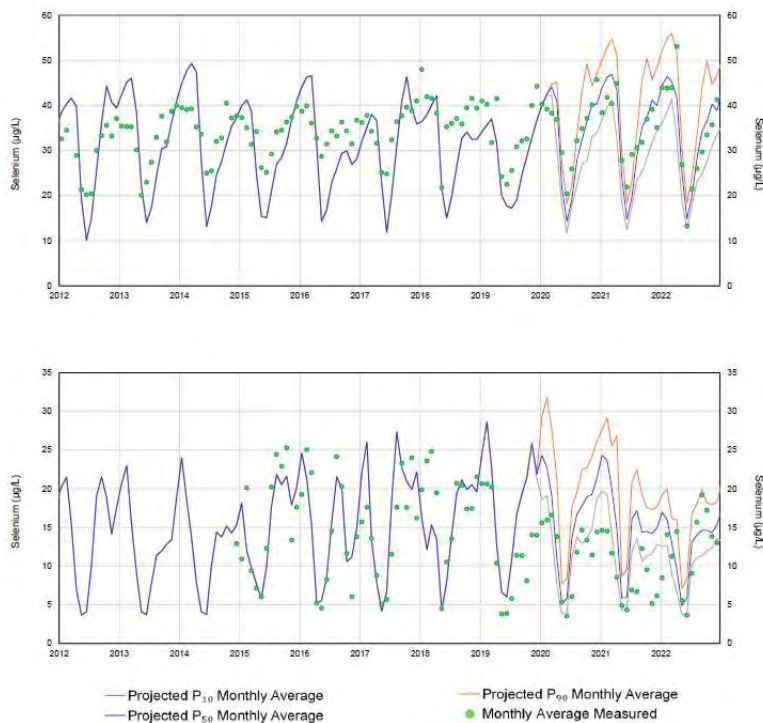
**Table 4.1**  
**Elkview Operation Saturated Rock Fill Performance** (Source: B.C., 2024)

Month	Treatment Rate (m3/day)	Effluent Concentration (ug/L)	Mass Removed (kg/day)	Influent Concentration Calculated (ug/L)
Jan-22	16,528	8.47	2.7	172
Feb-22	15,620	8.28	2.6	173
Mar-22	13,038	5.62	2.4	188
Apr-22	7,367	3.9	1.2	168
May-22	8,475	2.63	1.3	158
Jun-22	9,365	2.39	1.4	149
Jul-22	8,901	2.24	1.4	156
Aug-22	9,504	1.97	1.4	150
Sep-22	8,730	1.83	1.3	148
Oct-22	9,628	1.57	1.4	149
Nov-22	14,708	1.89	2.4	165
Dec-22	15,305	1.94	2.6	174

There are two compliance monitoring points associated with Elkview Operation water quality monitoring, one on Michel Creek and the second on Harmer Creek. Locations of these compliance stations are shown on **Figure 4-1b**. Selenium concentrations measured in 2022 at these compliance points are shown on **Insert 4-1**. It is noted that these compliance monitoring points do not capture all of the mine-impacted water draining from the Elkview Mine.

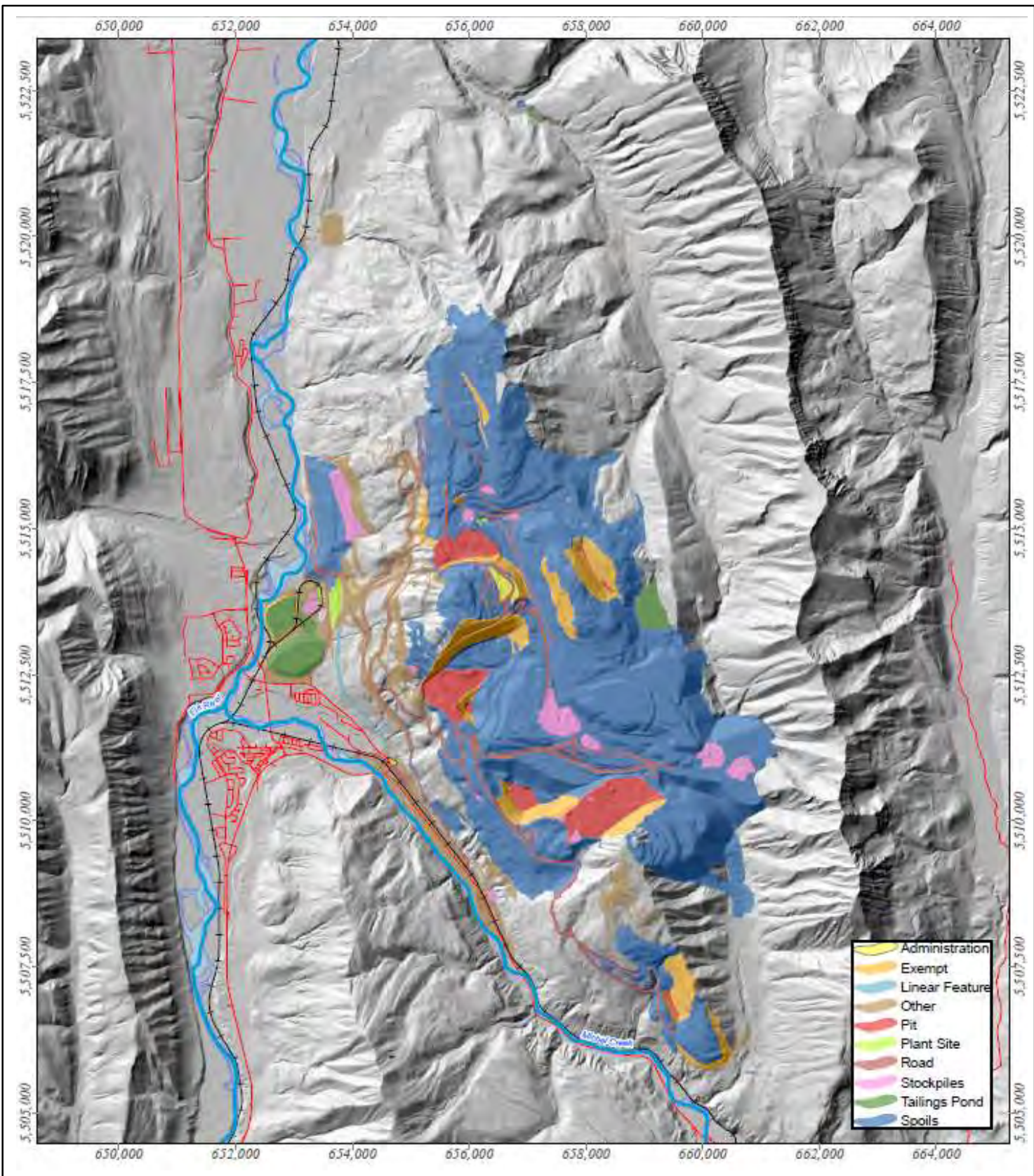
Review of the data shown on **Insert 4-1** indicates that selenium concentrations measured in samples collected from the two compliance monitoring points vary seasonally. Higher concentrations of selenium are typically measured in samples collected during low-flow conditions. Review of these data indicates a slightly increasing trend in selenium concentrations in Harmer Creek, and a slightly decreasing trend in Michel Creek, since approximately 2018.

**Insert 4-1: Selenium Concentrations at Compliance Points (upper graph is Harmer Creek, lower graph is for Michel Creek) Source: Teck, 2023a)**

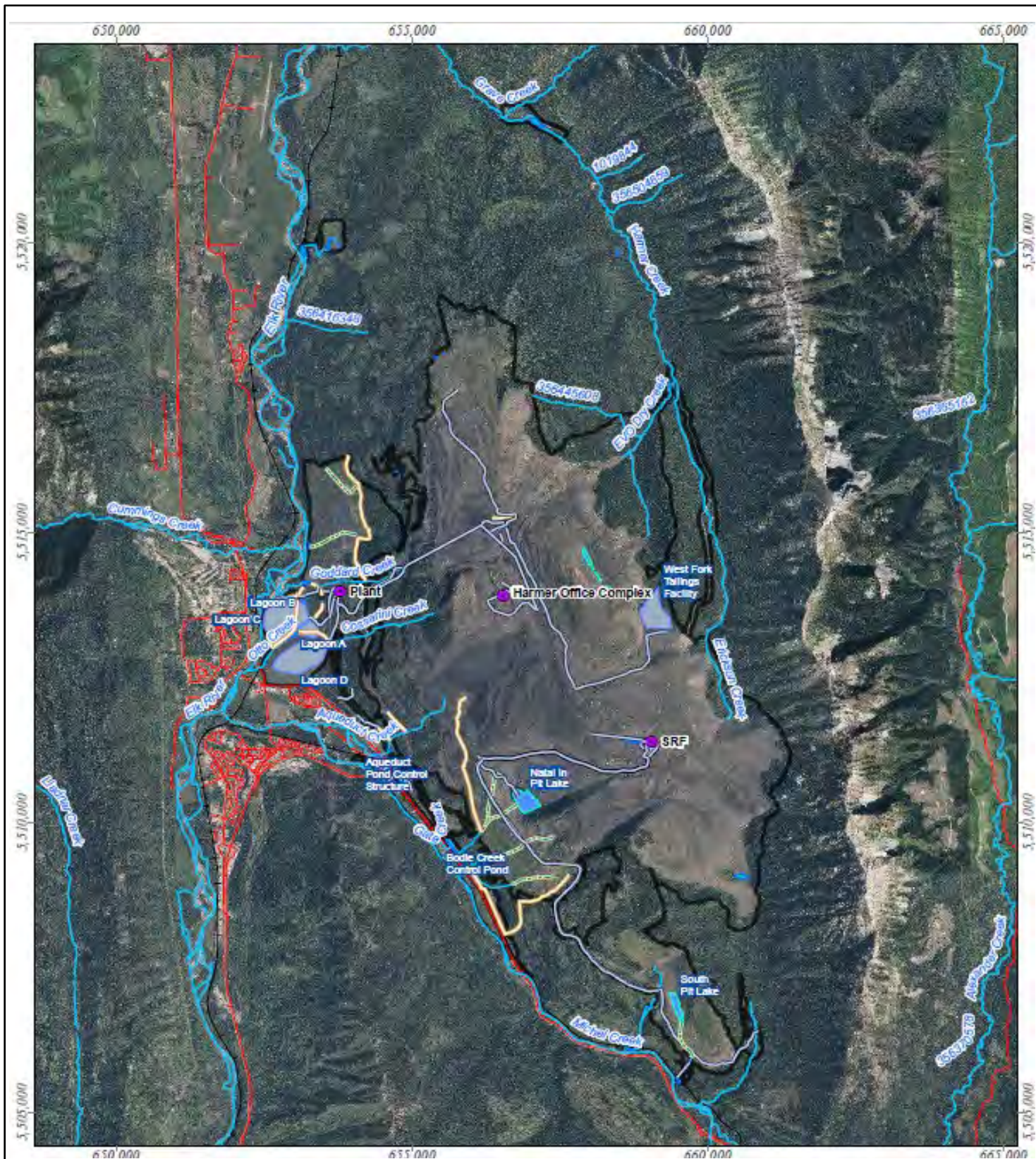


## Groundwater Monitoring

The spatial distribution of selenium concentrations in water samples collected from the Elkview Mine are shown on **Figure 4-1c** (northwest) and **Figure 4-1d** (southeast). Review of these figures indicates that groundwater impacted by mining operations contains dissolved selenium at concentrations typically between approximately 20 µg/L and 200 µg/L. Conversely, groundwater not impacted by mining operations typically contains dissolved selenium concentrations less than 1 µg/L, although there are a few outliers. Based on the distribution of impacts, it appears that selenium contamination in groundwater may be contributing to selenium contamination in Michel Creek. It also appears that selenium contamination in Elk River has resulted in selenium contamination to groundwater on the west side of Elk River, near Sparwood.



<p><b>WILDSIGHT</b>          SELENIUM RELATED RECLAMATION LIABILITIES          TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA</p>		
<p><b>Elkview Mine</b>          (Source: Teck, 2023a)</p>		
	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>4-1a</b>



- Ditch
- Rock Drain
- Water Pipeline
- End Pit Lake
- Settling Pond
- Tailings Pond
- Stream
- Railway
- Paved Road
- C-2 Permit

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

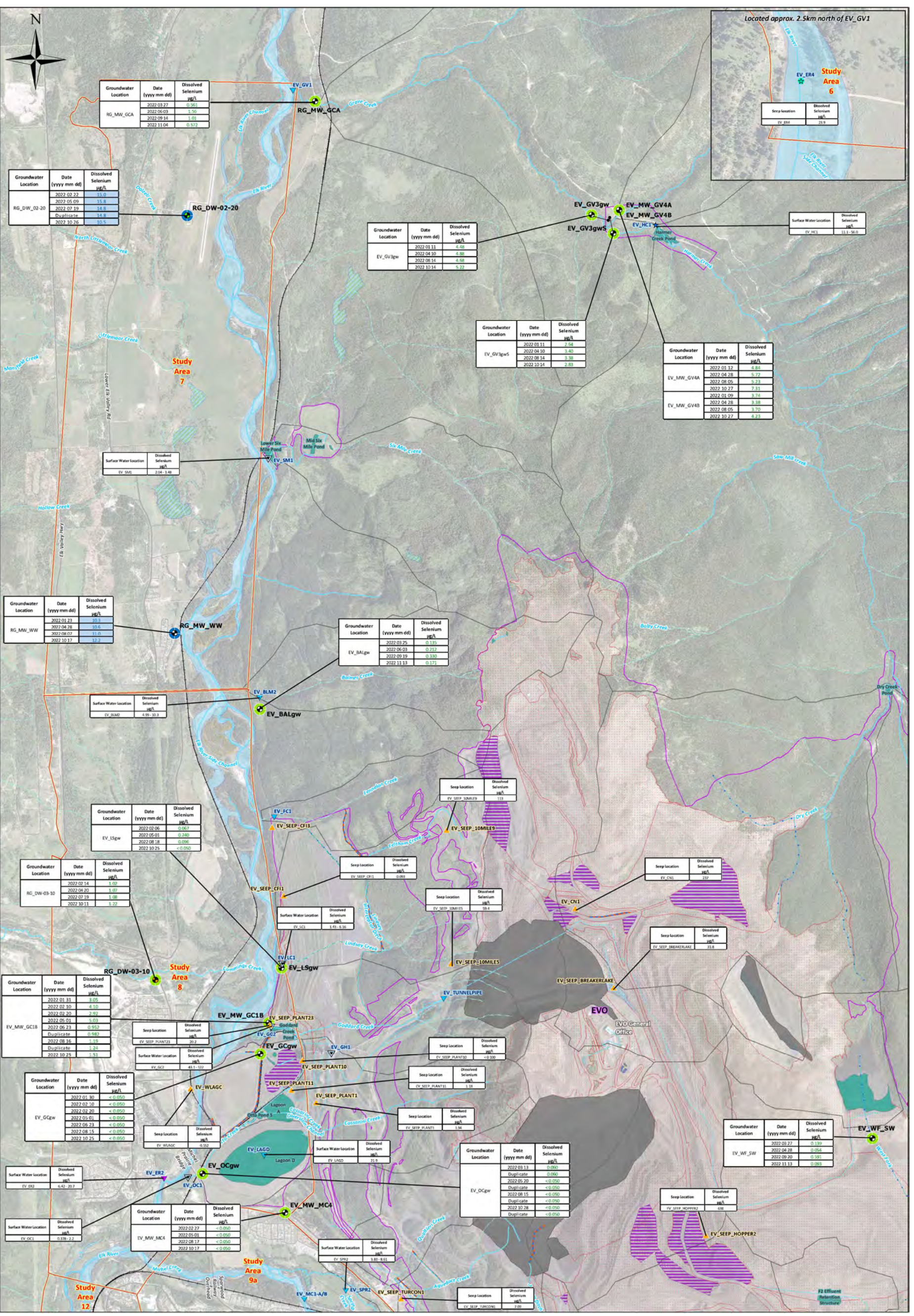
**Hydrology of Elkview Mine**  
(Source: Teck, 2023a)



Date: 3/9/2024  
Project No.: WILD-01

Scale:  
Figure No.: **4-1b**





Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
RG_MW_GCA	2022 03 27	0.961
RG_MW_GCA	2022 06 03	1.36
RG_MW_GCA	2022 09 14	0.41
RG_MW_GCA	2022 11 04	0.572

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
RG_DW_02-20	2022 02 22	13.0
RG_DW_02-20	2022 05 09	15.8
RG_DW_02-20	2022 07 19	15.8
RG_DW_02-20	Duplicate	14.8
RG_DW_02-20	2022 10 26	10.5

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_GV1	2022 03 11	4.68
EV_GV1	2022 04 10	4.88
EV_GV1	2022 08 14	3.38
EV_GV1	2022 10 14	5.27

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_GV3gw	2022 01 11	2.64
EV_GV3gw	2022 02 25	3.40
EV_GV3gw	2022 08 14	3.38
EV_GV3gw	2022 10 14	2.83

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_MW_GV4A	2022 01 12	4.84
EV_MW_GV4A	2022 04 28	5.72
EV_MW_GV4A	2022 08 05	5.23
EV_MW_GV4A	2022 10 27	7.31
EV_MW_GV4A	2022 01 09	3.74
EV_MW_GV4B	2022 04 28	3.38
EV_MW_GV4B	2022 08 05	3.70
EV_MW_GV4B	2022 10 27	4.23

Surface Water Location	Dissolved Selenium (µg/L)
EV_SMS	2.04 - 1.48

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
RG_MW_WW	2022 01 23	10.3
RG_MW_WW	2022 04 28	10.6
RG_MW_WW	2022 08 07	11.40
RG_MW_WW	2022 10 17	12.2

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_BA1gw	2022 01 25	0.135
EV_BA1gw	2022 06 07	0.122
EV_BA1gw	2022 09 19	0.330
EV_BA1gw	2022 11 13	0.171

Surface Water Location	Dissolved Selenium (µg/L)
EV_BM2	4.98 - 20.3

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_LSgw	2022 02 06	0.067
EV_LSgw	2022 05 01	0.240
EV_LSgw	2022 08 18	0.096
EV_LSgw	2022 10 25	< 0.050

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
RG_DW-03-10	2022 03 14	1.97
RG_DW-03-10	2022 06 20	1.07
RG_DW-03-10	2022 07 19	1.08
RG_DW-03-10	2022 10 11	1.22

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_MW_GC1B	2022 01 31	1.05
EV_MW_GC1B	2022 02 10	4.10
EV_MW_GC1B	2022 02 20	2.97
EV_MW_GC1B	2022 05 01	5.03
EV_MW_GC1B	2022 06 23	0.952
EV_MW_GC1B	Duplicate	0.982
EV_MW_GC1B	2022 08 16	1.18
EV_MW_GC1B	Duplicate	1.24
EV_MW_GC1B	2022 10 25	1.51

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_GCgw	2022 01 30	< 0.050
EV_GCgw	2022 02 10	< 0.050
EV_GCgw	2022 02 20	< 0.050
EV_GCgw	2022 05 01	< 0.050
EV_GCgw	2022 06 23	< 0.050
EV_GCgw	2022 08 16	< 0.050
EV_GCgw	2022 08 15	< 0.050
EV_GCgw	2022 10 25	< 0.050

Surface Water Location	Dissolved Selenium (µg/L)
EV_ER2	6.42 - 20.7

Surface Water Location	Dissolved Selenium (µg/L)
EV_OC1	0.78 - 2.3

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_MW_MC4	2022 02 27	< 0.050
EV_MW_MC4	2022 05 01	< 0.050
EV_MW_MC4	2022 08 17	< 0.050
EV_MW_MC4	2022 10 17	< 0.050

Surface Water Location	Dissolved Selenium (µg/L)
EV_SPC2	3.81 - 8.01

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_OCgw	2022 03 13	0.050
EV_OCgw	Duplicate	0.050
EV_OCgw	2022 06 20	< 0.050
EV_OCgw	Duplicate	< 0.050
EV_OCgw	2022 08 15	< 0.050
EV_OCgw	Duplicate	< 0.050
EV_OCgw	2022 10 28	< 0.050
EV_OCgw	Duplicate	< 0.050

Surface Water Location	Dissolved Selenium (µg/L)
EV_WF_SW	0.227 - 0.130

Surface Water Location	Dissolved Selenium (µg/L)
EV_SEEP_HOPPER2	0.09

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium (µg/L)
EV_DCGw	2022 03 13	0.050
EV_DCGw	Duplicate	0.050
EV_DCGw	2022 06 20	< 0.050
EV_DCGw	Duplicate	< 0.050
EV_DCGw	2022 08 15	< 0.050
EV_DCGw	Duplicate	< 0.050
EV_DCGw	2022 10 28	< 0.050
EV_DCGw	Duplicate	< 0.050


  

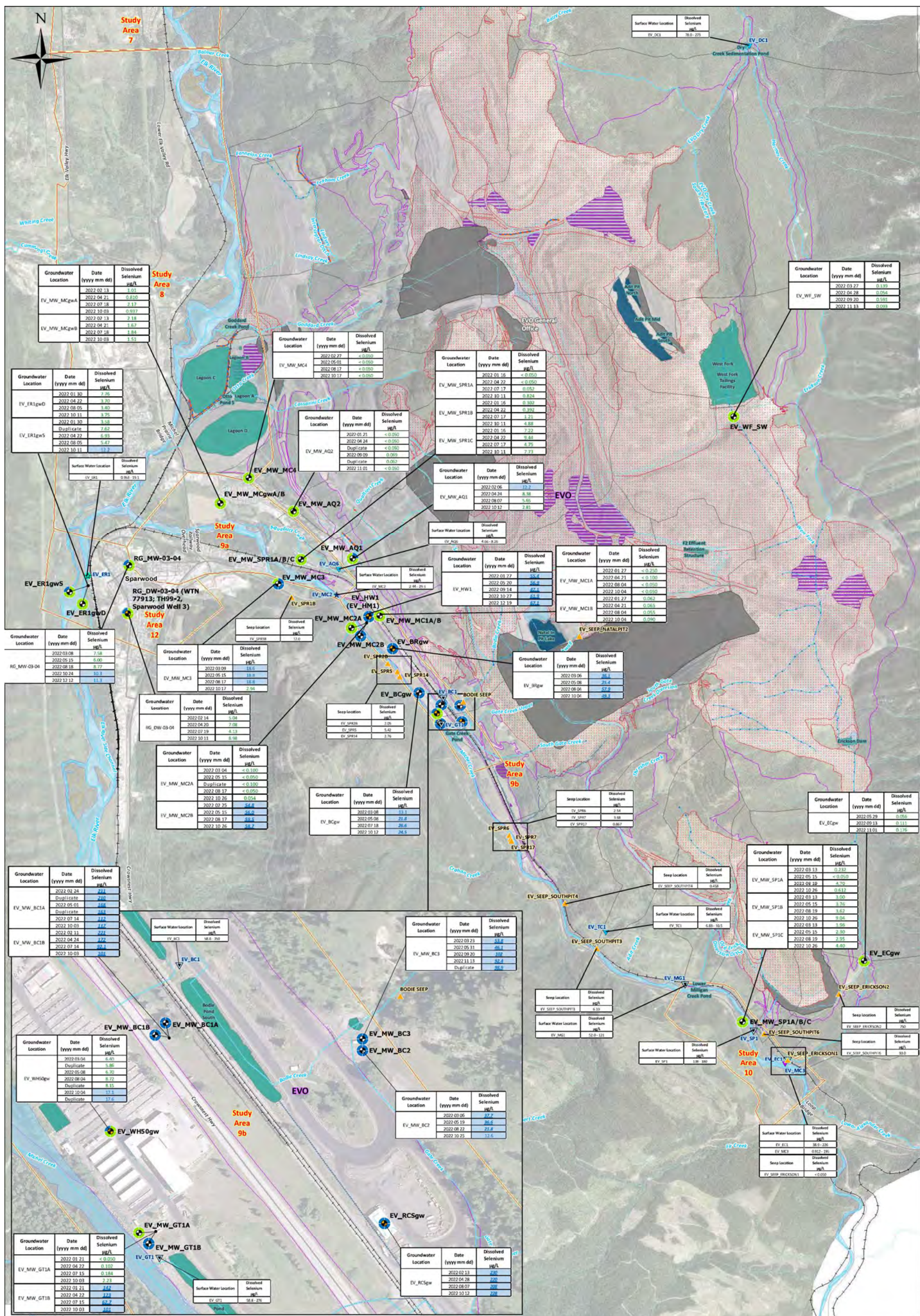
Surface Water Location	Dissolved Selenium (µg/L)
EV_SEEP_TURCON1	2.06

**Legend**  
Groundwater Stations: Monitor Well, Domestic, Supply, Compliance Point, Receiving Environment, Authorized Discharge, Monitoring, Seep.  
Site Features: Highway/Arterial, Secondary Road, Right of Way, Study Area, Filling/Settling/Sediment Pond, Waste Water Pond, PFI, Stockpiles, Waste Dumps (Sparks), Watersheds, Mine Perturbed Areas.  
Water Features: Stream + S Swath Ditch, Intermittent + Indefinite, Stream, Culvert, Ditch, Rock Drain, Water Pipeline, Island, Lake/Water Bed, Wetland Area/Wetland (Based on 1:50000 Scale), Dry or Slightly Wetland.  
**Primary Screening Criteria**  
Selenium<sup>4</sup>  
SIR Aquatic Life: 20  
SIR Invertebrate Water Bug: 20  
SIR Invertebrate Waterfowl: 20  
SIR Drinking Water: 150  
**Notes:**  
1. Organic carbon at these locations is 0.1 to 0.2.  
2. If organic carbon is above 0.15, the selenium criteria will be adjusted.  
3. The selenium criteria for aquatic life and invertebrates will be adjusted based on the organic carbon concentration.  
4. Location of monitoring wells is not accurate to scale.  
5. The selenium criteria for groundwater will be based on the selenium discharge permits.  
**Abbreviations:**  
1. Data provided by SNC Limited.

# WILDSIGHT SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHWEST BRITISH COLUMBIA

## Elkview Northwest – Spatial Distribution of Selenium (Source: SNC, 2023)

<b>BURGESS ENVIRONMENTAL</b> 	Date:	3/9/2024	Scale:
	Project No.:	WILD-01	Figure No.:



**Legend**

Groundwater Stations	Site Features	Well Features
Monitoring Well	Highway/Arterial	Stream & Stream Drain
Domestic	Secondary Road	Intermittent & Intermittent
Supply	Rail	Spring
Surface Water Stations	Study Area	Subsurface
Compliance Point	Tailings/Sediment Pond	Curvilinear
Receiving Environment	Waste Water Pond	Drain
Authorized Discharge	Water Pipeline	Rock Drain
Monitoring	Stockpile	Water Pipeline
Seep	Waste Dump (Spill)	Lake/River Bed
	Waterbed	Washed Area/Water Bed (Based on 1:5000 Scale)
	Mine Paved Area	

**Primary Screening Criteria**

Criterion	Selenium <sup>6</sup> (µg/L)
CR Aquatic Life	30
CR 1 mg/L on Water Ring	30
CR 1 mg/L on Water Ring	30
CR 1 mg/L on Water Ring	30
CR 1 mg/L on Water Ring	30

**Notes:**  
 1. Selenium is a trace element in the environment.  
 2. The maximum selenium concentration in the environment is 30 µg/L.  
 3. The maximum selenium concentration in the environment is 30 µg/L.  
 4. The maximum selenium concentration in the environment is 30 µg/L.  
 5. The maximum selenium concentration in the environment is 30 µg/L.

**WILDSIGHT**  
 SELENIUM RELATED RECLAMATION LIABILITIES  
 TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Elkview Southeast – Spatial Distribution of Selenium**  
 (Source: SNC, 2023)

Date:	3/9/2024	Scale:	
Project No.:	WILD-01	Figure No.:	4-1d

**BURGESS ENVIRONMENTAL**

## 4.2 Line Creek

### General

The Line Creek Mine is located approximately 22 km north-northeast of the Town of Sparwood, and approximately 7 km upstream of the confluence of Line Creek into Fording River (**Figure 4-2a**). By the end of 2021, the total area impacted by Line Creek Mine exceeded 2,600 hectares, with less than 20% of that area classified as reclaimed (Teck, 2022c, Section 2.1). Line Creek Mine is a truck and shovel operation, and blasting is implemented regularly to remove overburden rock and access the minable coal.

Coal is transported by conveyor along the mine access road to the processing area that is located adjacent to the confluence of Line Creek and Fording River (**Figure 4-2a**). The processed coal is loaded into railcars that convey the coal to ports on the Pacific Coast for export. Over 3 million tonnes of clean coal is produced by the Line Creek Mine, and approximately 90 million tonnes of waste rock is generated each year (Teck, 2022d, Table 2-3).

### Hydrology

Line Creek Mine is contained almost entirely within the Line Creek watershed. Line Creek flows through the mine development area and confluences with Fording River in the Elk River Valley, immediately northwest of the coal processing area of the Line Creek Mine, and approximately 1 km upstream of the confluence of Fording River into Elk River.

There are three main tributaries of Line Creek, namely Tornado Creek, West Line Creek and South Line Creek. The West Line Creek watershed has been almost entirely disturbed by Teck's mining activities. The main Line Creek drainage, West Line Creek, Dry Creek, and Tornado Creek channels have been filled with mine waste rock immediately upstream of their confluence with South Line Creek. The watershed areas of these creeks, which flow through waste rock drains, exceed the area of the Line Creek Mine that is affected by mine spoil (**Figure 4-2b**). Most of the waste rock disposal is currently occurring in the Dry Creek Valley. In 2021, a waste rock dump failure involving approximately 2 million m<sup>3</sup> of mine spoil buried a 435 m segment of Dry Creek above the rock drain (Teck, 2023b, PDF page 36 of 130).

### Existing and Planned Remedial Measures

The West Line Creek Active Water Treatment Facility was commissioned in 2018 and treats up to 7,500 m<sup>3</sup>/day water from West Line Creek and Line Creek. The average daily flow through the West Line Creek AWTF in 2022 was 6,762 m<sup>3</sup>/day, which is consistent with the average daily treated flow in 2021. Teck's permits assume that facility operates, and discharges treated water to the environment 95% of the time, with 5% downtime for maintenance and repairs. In 2022, the AWTF removed a total of 595 kg of selenium and 35,015 kg of nitrate, which is also

consistent with the performance in 2021. Teck plans to expand this facility by December 31, 2025 to treat water from North Line Creek, which will increase the treatment capacity to 17,500 m<sup>3</sup>/day. An active water treatment system with a treatment capacity of 10,000 m<sup>3</sup>/day is also planned for Dry Creek and is projected to be operational by 2027 (Teck, 2023g).

### Surface Water Quality Monitoring

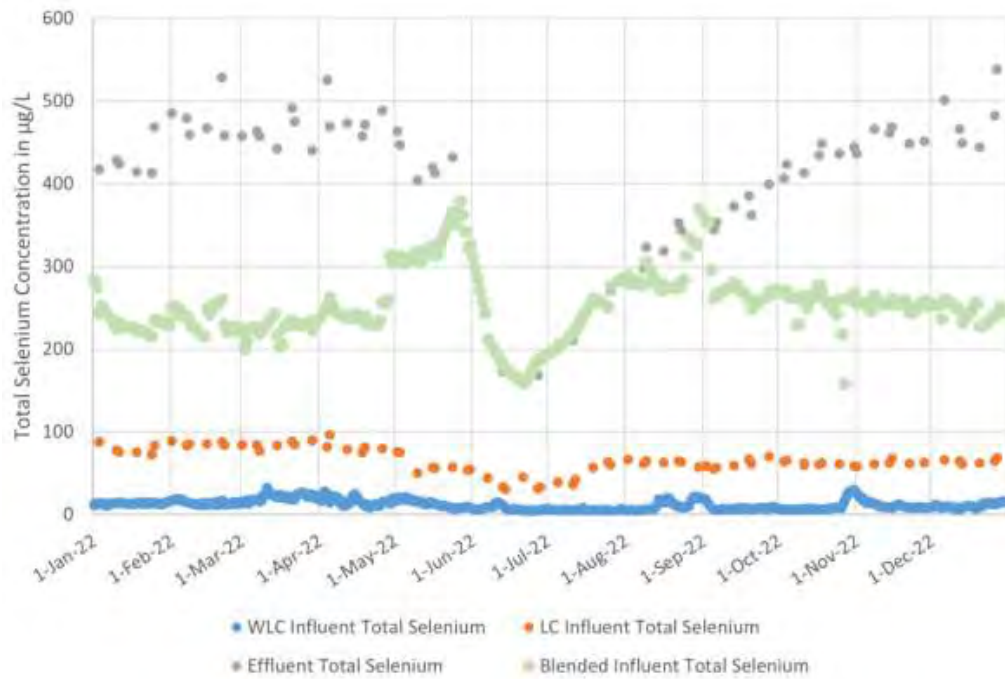
Teck publishes the measured concentrations of selenium in the effluent water treatment facility, as well as the average treatment rate (flow through treatment facility), and mass of selenium removed on a daily basis. This data can be used to calculate the influent concentration of selenium through the reporting period, which is summarized for 2022 in **Table 4.2**. Additional information made available by Teck indicates that selenium contamination is highest in the West Line Creek watershed (**Insert 4-2a**).

Line Creek Mine monitors selenium concentrations at its downstream compliance point in Line Creek, as well as in Dry Creek, downstream of the sedimentation ponds in the Elk River valley. Average monthly measurements of selenium concentrations versus those predicted by Teck’s model are shown in **Inserts 4-2b/c**, respectively. Review of these inserts shows relatively diminishing concentrations of selenium in samples collected from Line Creek since 2018, and dramatically increasing selenium concentrations in samples collected from Dry Creek.

**Table 4.2**  
**Line Creek Water Treatment Facility Performance** (Source: B.C., 2024)

Month	Treatment Rate (m <sup>3</sup> /day)	Effluent Concentration (ug/L)	Mass Removed (kg/day)	Influent Concentration (ug/L)
Jan-22	7,253	13	1.5	220
Feb-22	7,359	13	1.6	230
Mar-22	7,519	21	1.5	220
Apr-22	7,293	16	1.7	246
May-22	6,650	13	1.9	299
Jun-22	4,571	7	0.8	186
Jul-22	4,370	5	0.9	204
Aug-22	6,473	11	1.8	284
Sep-22	7,175	8	1.9	274
Oct-22	7,555	9	1.9	255
Nov-22	7,545	11	1.8	254
Dec-22	7,557	10	1.8	244

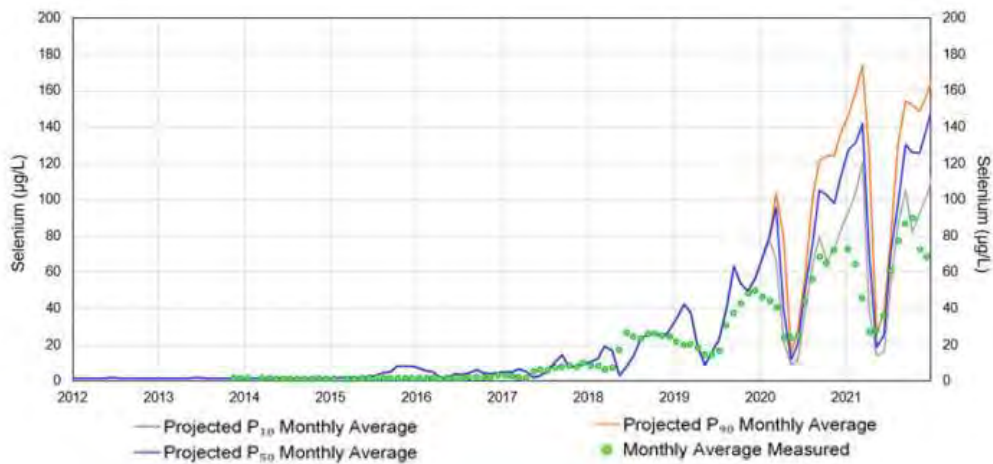
Insert 4-2a: Line Creek Mine Water Treatment (Source: Teck 2022f)



Insert 4-2b: Line Creek Water Quality Monitoring (Source: Teck, 2023b)



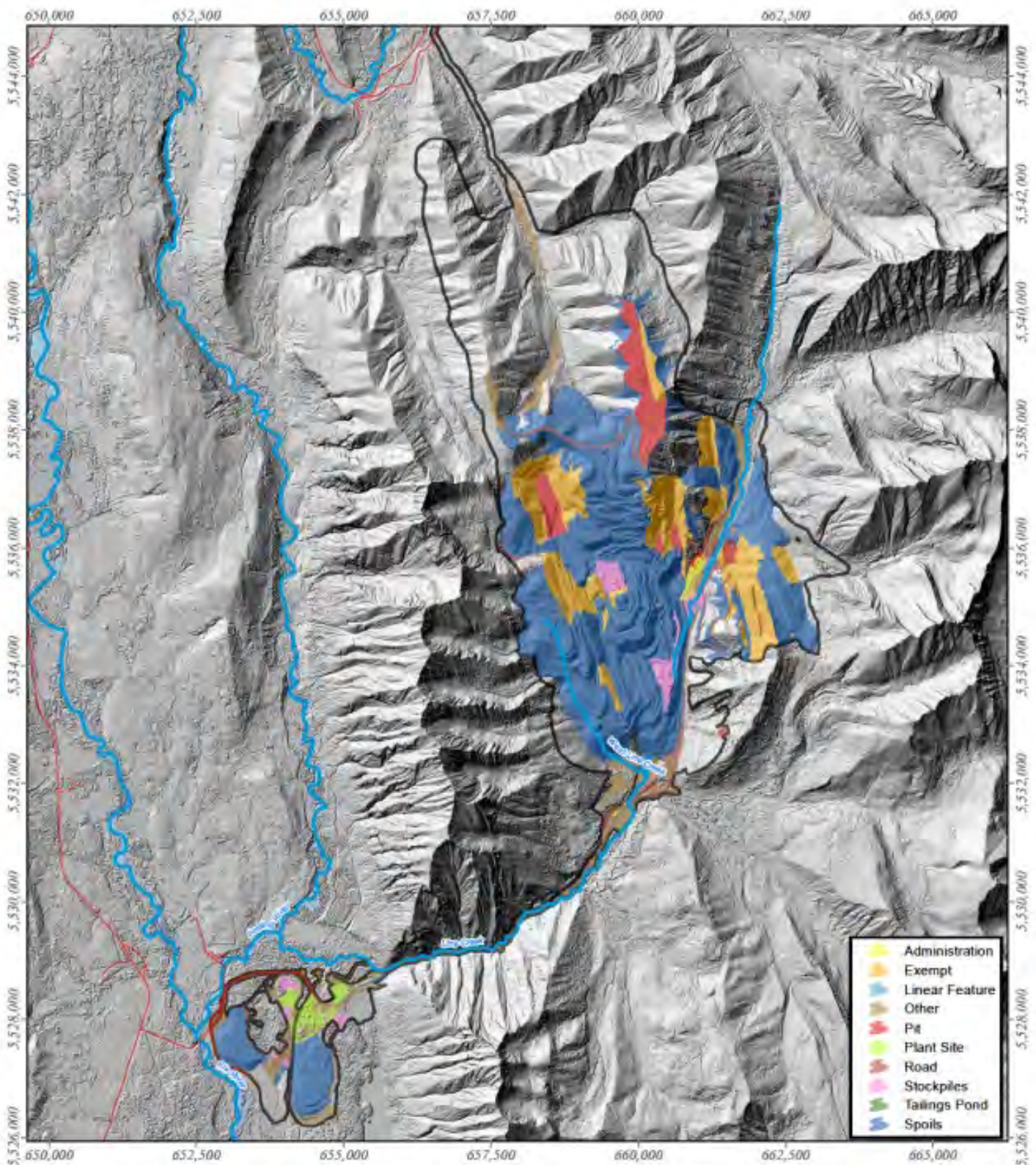
Insert 4-2c: Dry Creek Water Quality Monitoring (Source: Teck, 2023b)



## Groundwater Monitoring

The waste rock dumps, mine spoil, and coal stockpiles provide the primary surface aquifers in the mine development area. Groundwater flow through these waste dumps is very rapid and discharges to one of the main drainages within the mine described above. Inspection of **Figure 4-2a** indicates that these materials are present over about  $\frac{3}{4}$  of the mine development area.

The spatial distribution of selenium concentrations in water samples collected from the Line Creek Mine are shown on **Figure 4-2c**. Review of this figure indicates that groundwater impacted by mining operations contains dissolved selenium over a wide range of concentrations, from approximately 10 µg/L, to over 500 µg/L. Conversely, groundwater not impacted by mining operations in the region typically contains dissolved selenium concentrations less than 1 µg/L, although there are a few outliers. Based on the distribution of impacts, it is not clear to what degree selenium contamination in groundwater may be contributing to selenium contamination in surface water within the mine area, or vice versa.



- Paved Road
- Stream
- C-129

- Administration
- Exempt
- Linear Feature
- Other
- Pit
- Plant Site
- Stockpiles
- Tailings Pond
- Spoils

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Line Creek Mine**  
(Source: Teck, 2023b)

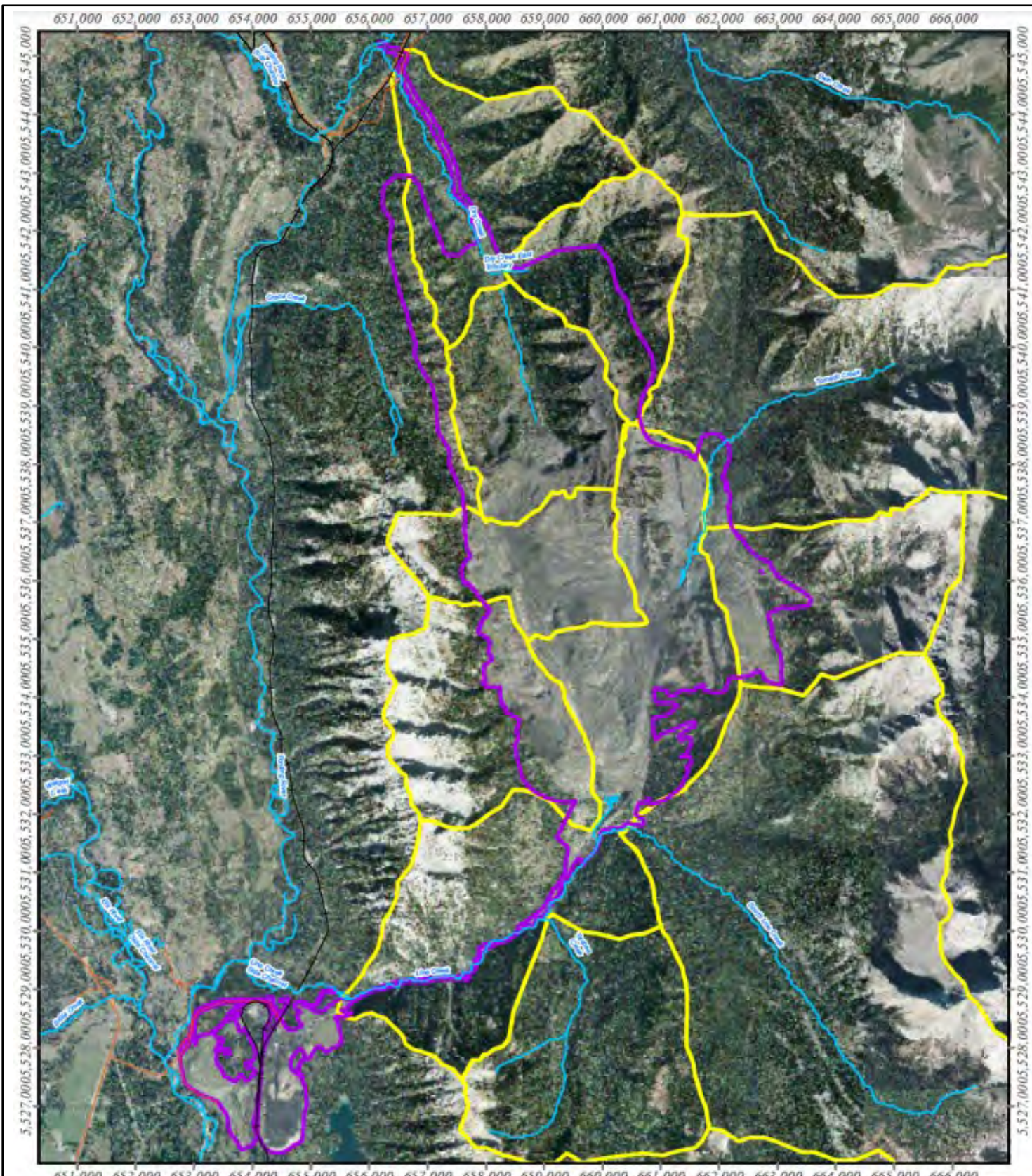







Date: 3/9/2024

Scale:

Project No.: WILD-01

Figure No.: **4-2a**



-  Current Drainage Basin
-  Creek
-  Railway
-  Paved Road
-  C-129 Permit

**WILDSIGHT**  
 SELENIUM RELATED RECLAMATION LIABILITIES  
 TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

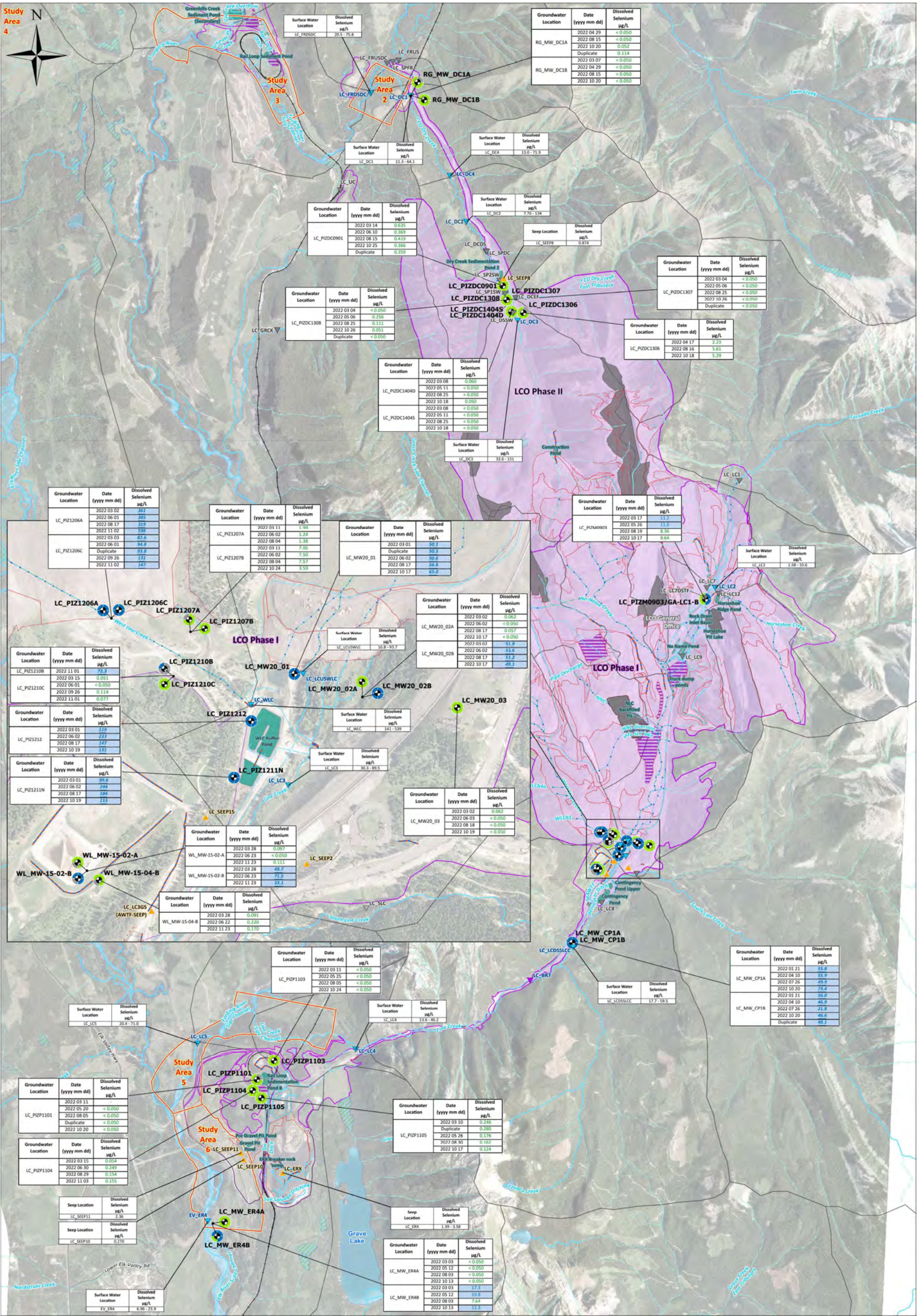
**Hydrology of Line Creek Mine**  
 (Source: Teck, 2023b)



Date: 3/9/2024  
 Project No.: WILD-01

Scale:  
 Figure No.: **4-2b**





**Legend**

**Groundwater Stations**  
 Monitoring Well  
 Surface Water Stations  
 Seep

**Site Features**  
 Highway/Arterial  
 Secondary Road  
 Rails  
 Study Areas  
 Tailings/Settling/Sediment Pond  
 End-Pit Lake  
 Pits  
 Stockpiles  
 Waste Dump (Spoils)  
 Watersheds  
 LCO Phase 1 and 2  
 Mine Permitted Areas

**Water Features**  
 Stream + Stream Ditch  
 Stream + Indefinite Intermittent  
 Stream  
 Subsurface  
 Rock Drain  
 Water Pipeline  
 Trench/Diversion Channel  
 Island  
 Lake/River Bed  
 Wetland Area/Wetland (Based on 1:30000 Scale)

**Primary Screening Criteria**

Screening Criteria	Selenium <sup>a</sup> µg/L
CSR Aquatic Life	20
CSR Irrigation Watering	20
CSR Livestock Watering	30
CSR Drinking Water	30

**Notes:**  
 1. Original or actual or upper size ANSI C 17x22 in.  
 2. Numerical scale reflects full size print. Print scaling will distort this scale however, scale bar will remain accurate.  
 3. Intended for illustrative purposes. Accuracy has not been verified for construction or reclamation.  
 4. Locations of monitoring wells have been adjusted for clarity.  
 5. The nomenclature for ponds may not accurately reflect that in the various official discharge permits.

**References:**  
 1. Data provided by Teck Coal Limited

**Scale:** 0 0.5 1 2 3 km

## WILDSIGHT SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

### Line Creek – Spatial Distribution of Selenium (Source: SNC, 2023)

	Date:	3/9/2024	Scale:
	Project No.:	WILD-01	Figure No.:

4-2c

## 4.3 Fording River

### Mine Operations

Teck's Fording River Mine is located approximately 29 kilometers northeast from the community of Elkford, British Columbia (**Figure 4-3a**), with a total of approximately 23,000 hectares under license, of which approximately 7,000 ha have been permitted for mining related activities. The truck and shovel mining operations commenced in 1972, and the current annual production capacities of the mine and preparation plant are approximately 10 million tonnes of clean coal. Mining currently occurs in the Swift and Eagle Mountain areas, which are projected to operate until approximately 2026 and 2040, respectively. The coal reserves in Eagle Mountain, Swift, Turnbull, and Castle are expected to support mining through 2064 (Teck, 2023c, Section 1.1). By the end of 2022, the Fording River Mine had disturbed an area of approximately 5,350 ha, of which 3,730 ha were covered by mine spoil and 770 hectares had been revegetated (Teck, 2023c, Table 2-1).

### Hydrology

Fording River Mine is located in the upper Fording River watershed, which covers an area of 42,600 ha that is topographically diverse and ranges in elevation from approximately 1,430 masl at the lowest portion of the valley to more than 3,000 masl. Fording River originates near Mount Maclaren on the British Columbia/Alberta border and flows south to its confluence with Henretta Creek at the northern end of the Fording River Mine. From there, it flows through the mine and confluences with several smaller tributaries that also flow through the mining area. The river confluences with Chauncey Creek, which is not affected by mining, downstream of the mining operations. Below Chauncey Creek, main tributaries to Fording River include Todhunter Creek, Ewin Creek, Dry Creek and Greenhills Creek. Based on review of aerial imagery, all of its tributaries within the mine area, appear to flow through waste rock and mine spoil (**Figure 4-3b**).

### Current and Planned Remedial Measures

In Q4 2021, Teck began commissioning the Fording River South water treatment facility. The facility entered the operational phase in Q3 of 2022, and removes nitrate and selenium from Swift Creek/Cataract Creek and from Kilmarnock Creek, and discharges treated effluent to Fording River and to Kilmarnock Creek.

Teck has constructed a saturated rock fill with a treatment capacity of up to 30,000 m<sup>3</sup>/d, to remove nitrate and selenium in water from Clode Creek, Swift Pit, and North Spoil areas. In December 2022, the saturated rock fill was mechanically completed, commissioning occurred in 2023, and the facility was operating in 2024. The treated water is to be discharged to Clode Creek.

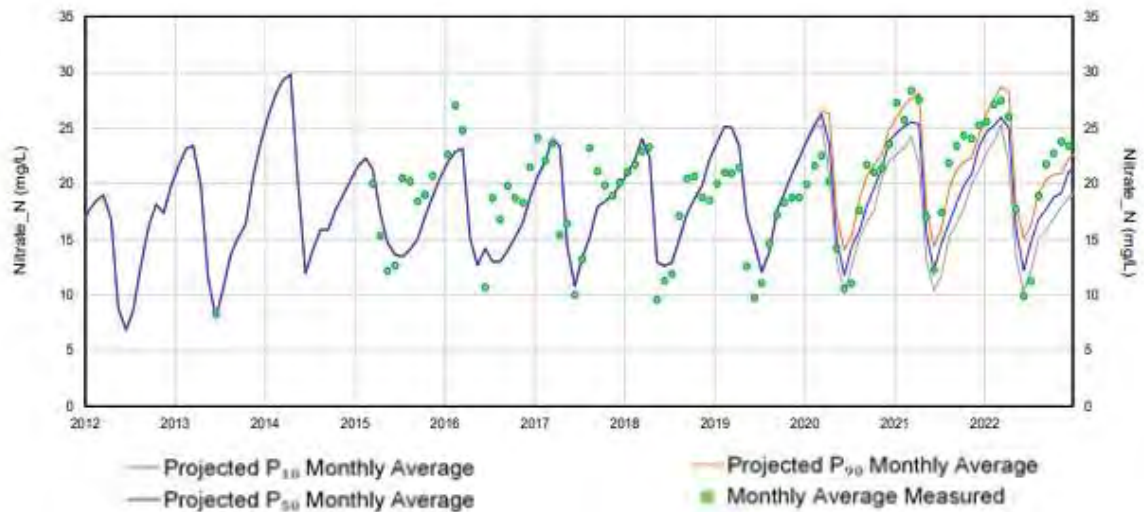
# Burgess Environmental

Teck invested approximately \$30 million, focused on improving the effectiveness of water treatment technologies and on investigating long-term solutions for managing water quality at the source. Specific to the Fording River Mine, the 2022 research program included the development of a detailed suboxic zone design for the Swift North Spoil (Teck, 2023c). Saturated rock fill treatment facilities having a treatment capacity of 30,000 m<sup>3</sup>/day are planned for the north portion of the Fording River Mine, and are scheduled to be operational by 2027 (Teck, 2023g).

## Surface Water Quality Monitoring

Teck reports the measured concentrations of selenium in the effluent water treatment facility, as well as the average treatment rate (flow through treatment facility), and mass of selenium removed on a daily basis. This data can be used to calculate the influent concentration of selenium through the reporting period, which is summarized on a monthly basis for 2022 in **Table 4.3**. **Insert 4-3a** shows the measured versus predicted selenium concentrations measured at the Fording River Compliance Point.

**Insert 4-3a: Water Quality Monitoring at Fording River Compliance Point** (Source: Teck, 2023c)



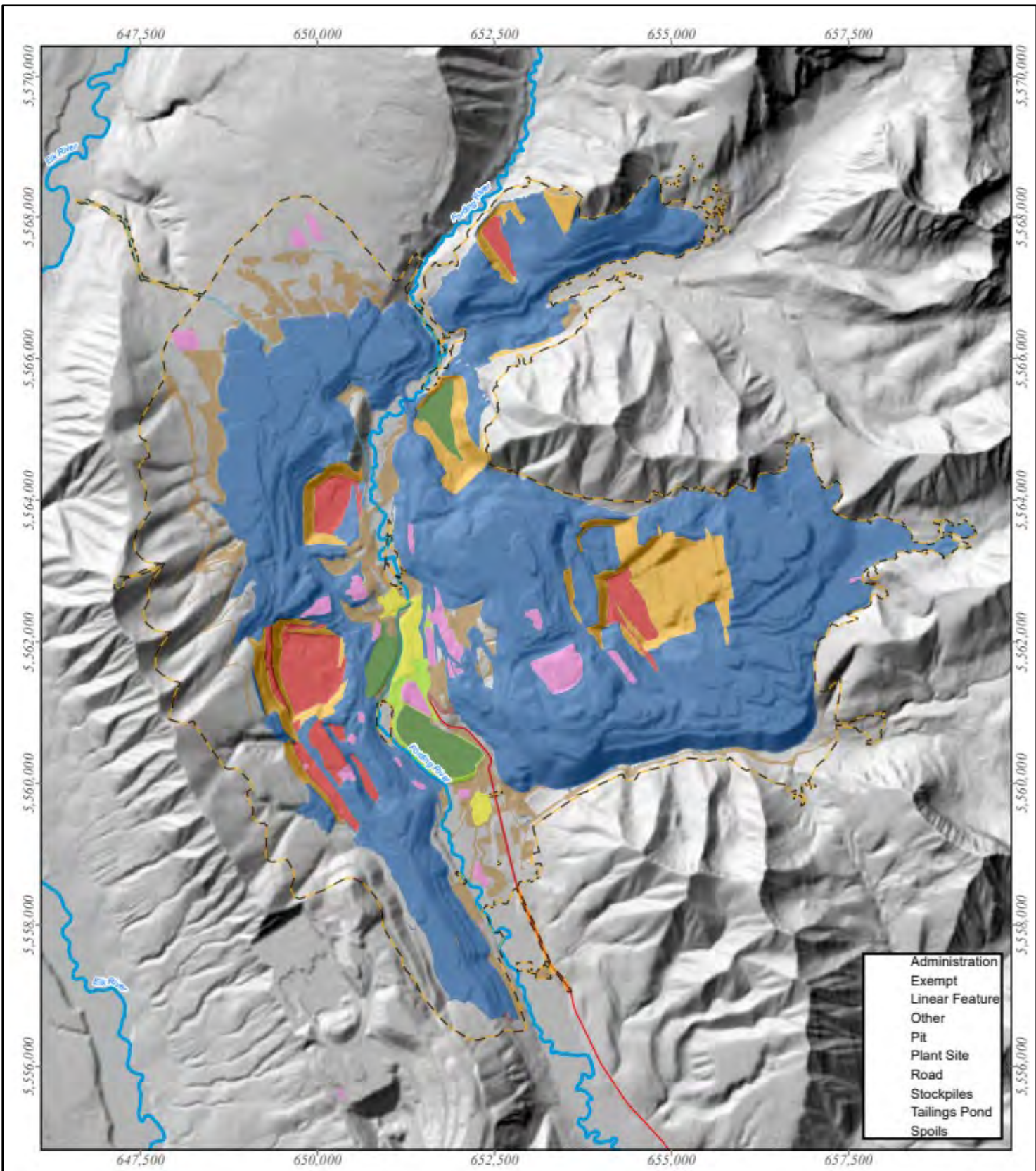
**Table 4.3**  
**Fording River Water Treatment Facility Performance** (Source: B.C., 2024)




Month	Treatment Rate (m3/day)	Effluent Concentration (ug/L)	Mass Removed (kg/day)	Influent Concentration Calculated (ug/L)
Jan-22	2,869	25.4	1.5	548
Feb-22	3,146	21.4	1.7	562
Mar-22	4,914	24.7	2.9	615
Apr-22	5,602	24.4	2.7	506
May-22	8,332	17.9	3.5	438
Jun-22	9,794	15.6	3.9	414
Jul-22	8,038	10.3	2.4	309
Aug-22	7,793	15.2	3.1	413
Sep-22	12,305	21.6	4.8	412
Oct-22	13,353	20.5	6.0	470
Nov-22	10,602	19.9	5.0	492
Dec-22	9,739	20.2	5.0	534


### Groundwater Monitoring

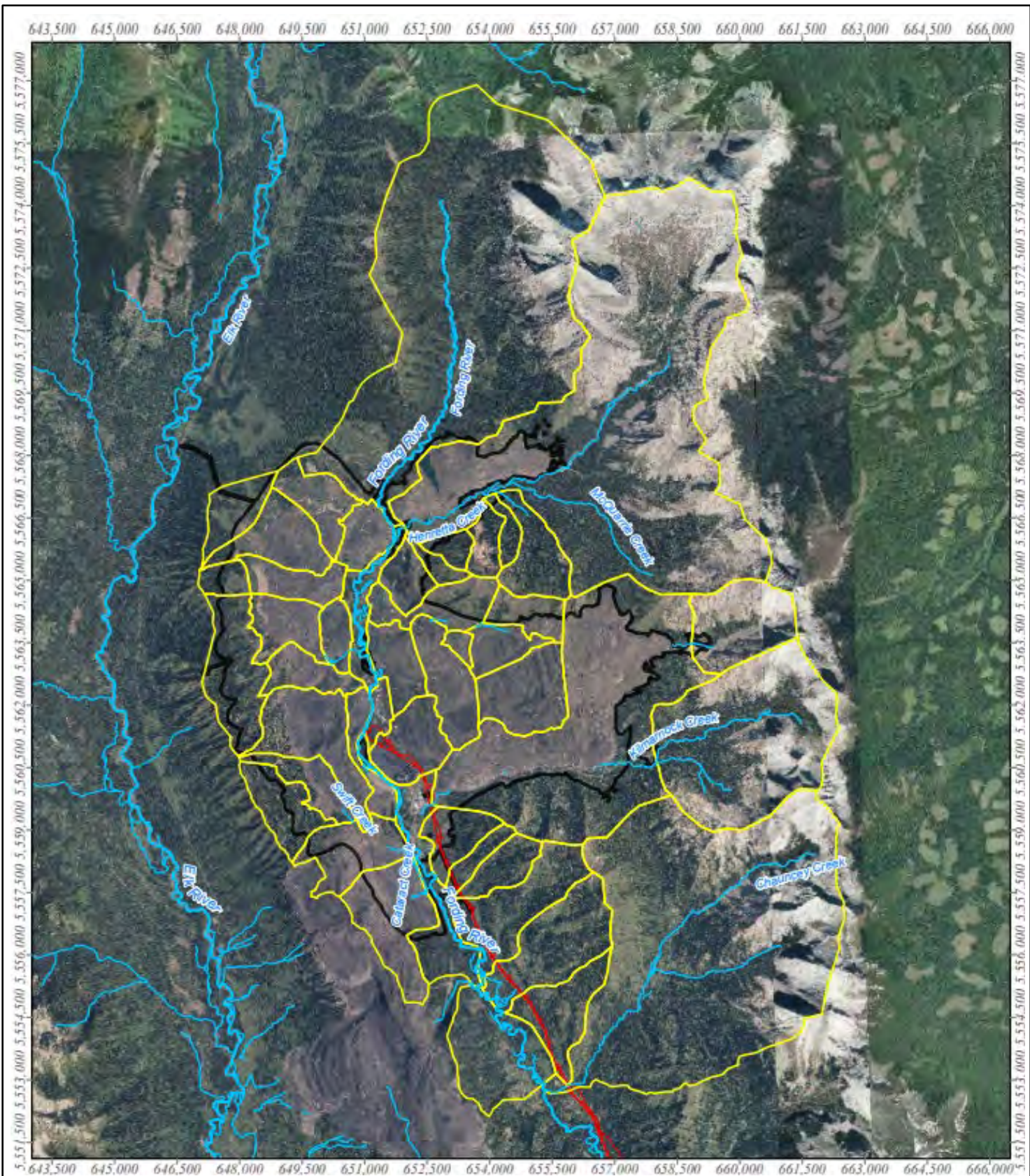
The Fording River Mine also implements groundwater and seepage water monitoring to comply with its operating permit. 29 wells (2 supply wells and 27 monitoring wells) and seepages are included in the water quality monitoring programs for the mine. Widespread contamination of groundwater by selenium, as well as other order constituents, has been measured in the mine-affected areas.

The spatial distribution of selenium concentrations in water samples collected from the Fording River Mine are shown on **Figure 4-3c** (north) and **Figure 4-3d** (south). Review of these figures indicates that groundwater impacted by mining operations typically contains dissolved selenium at concentrations higher than approximately 50 ug/L, and can exceed 450 ug/L. Conversely, groundwater in the region not impacted by mining operations typically contains dissolved selenium concentrations less than 1 ug/L, although there are a few outliers. Concentrations of dissolved selenium in seep water samples are generally consistent with those of groundwater samples. Based on the distribution of impacts, it appears that selenium contamination in groundwater is contributing to selenium contamination in surface water within the mine area, and vice versa.



-  C-3
-  Road
-  Stream

<p><b>WILDSIGHT</b>          SELENIUM RELATED RECLAMATION LIABILITIES          TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA</p>		
<p><b>Fording River Mine</b>          (Source: Teck, 2023c)</p>		
	Date:	3/9/2024
	Project No.:	WILD-01
	Scale:	
	Figure No.:	4-3a



- Current Drainage Basin
- Stream
- Road
- C-3 Permit
- Railway

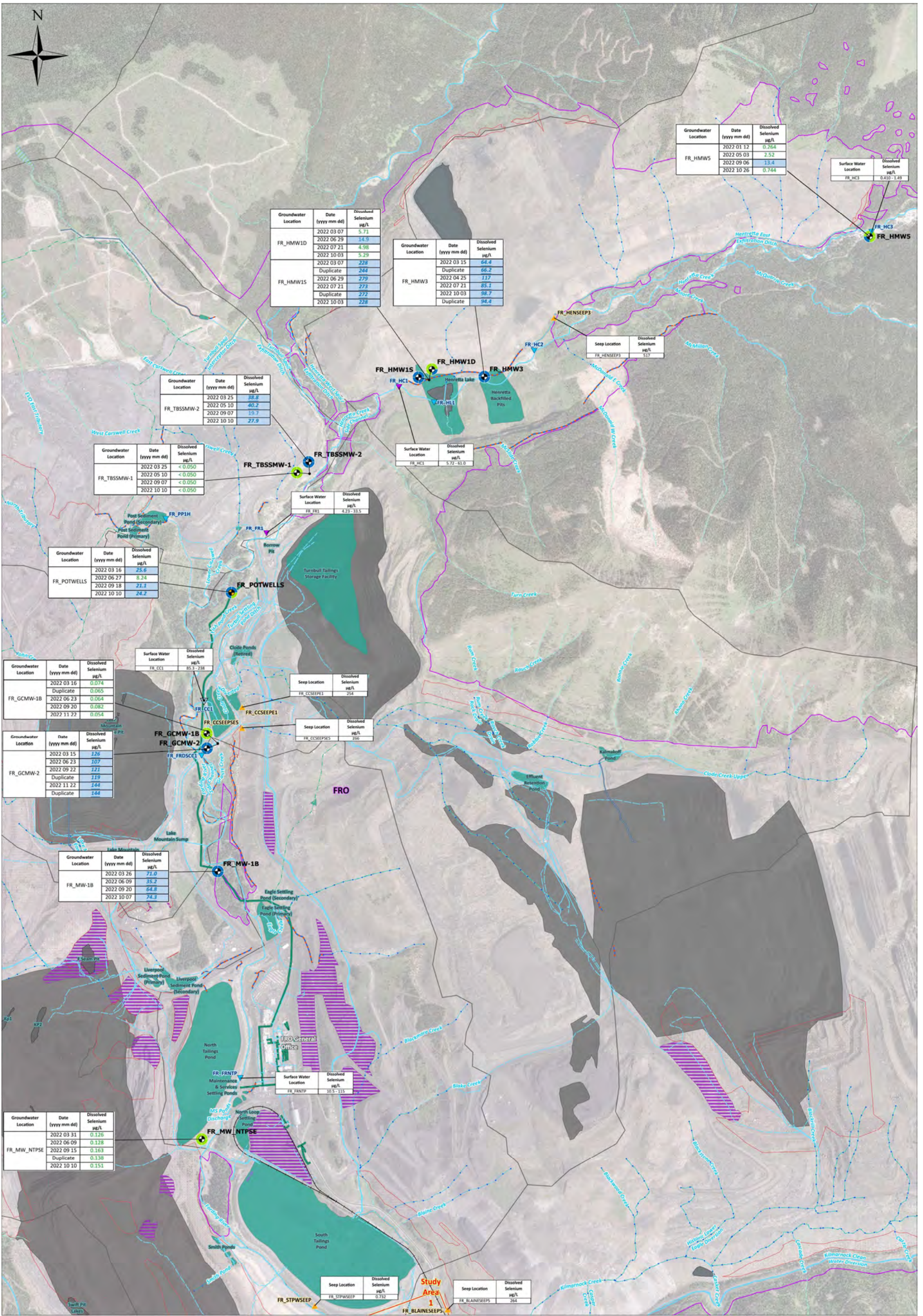
**WILDSIGHT**  
 SELENIUM RELATED RECLAMATION LIABILITIES  
 TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Hydrology of Fording River Mine**  
 (Source: Teck, 2023c)



Date: 3/9/2024  
 Project No.: WILD-01

Scale:  
 Figure No.: **4-3b**



Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1	2022 03 07	5.71
FR_HMW1	2022 06 29	14.9
FR_HMW1	2022 07 21	4.98
FR_HMW1	2022 10 03	5.29
FR_HMW1	2022 03 07	228
FR_HMW1	Duplicate	244
FR_HMW1	2022 06 29	279
FR_HMW1	2022 07 21	273
FR_HMW1	Duplicate	272
FR_HMW1	2022 10 03	228

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW3	2022 03 15	64.4
FR_HMW3	Duplicate	66.2
FR_HMW3	2022 04 25	117
FR_HMW3	2022 07 21	85.1
FR_HMW3	2022 10 03	98.7
FR_HMW3	Duplicate	94.4

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW5	2022 01 12	0.264
FR_HMW5	2022 05 03	2.52
FR_HMW5	2022 09 06	13.4
FR_HMW5	2022 10 26	0.744

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1D	2022 03 25	38.8
FR_HMW1D	2022 05 10	40.2
FR_HMW1D	2022 09 07	19.7
FR_HMW1D	2022 10 10	27.9

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1S	2022 03 25	< 0.050
FR_HMW1S	2022 05 10	< 0.050
FR_HMW1S	2022 09 07	< 0.050
FR_HMW1S	2022 10 10	< 0.050

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW3S	2022 03 15	4.23 - 13.5

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW5S	2022 03 16	25.6
FR_HMW5S	2022 06 27	8.24
FR_HMW5S	2022 09 18	21.1
FR_HMW5S	2022 10 10	24.2

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1D1	2022 03 16	0.074
FR_HMW1D1	Duplicate	0.065
FR_HMW1D1	2022 06 23	0.064
FR_HMW1D1	2022 09 20	0.082
FR_HMW1D1	2022 11 22	0.054

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1D2	2022 03 15	126
FR_HMW1D2	2022 06 23	107
FR_HMW1D2	2022 09 22	121
FR_HMW1D2	Duplicate	119
FR_HMW1D2	2022 11 22	144
FR_HMW1D2	Duplicate	144

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1D3	2022 03 26	71.0
FR_HMW1D3	2022 06 09	35.2
FR_HMW1D3	2022 09 20	64.8
FR_HMW1D3	2022 10 07	74.3

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
FR_HMW1D4	2022 03 31	0.126
FR_HMW1D4	2022 06 09	0.128
FR_HMW1D4	2022 09 15	0.163
FR_HMW1D4	Duplicate	0.138
FR_HMW1D4	2022 10 10	0.151

Surface Water Location	Dissolved Selenium µg/L
FR_HCS	5.72 - 61.0
FR_HCS1	4.23 - 13.5
FR_HCS2	254
FR_HCS3	266
FR_HCS4	10.5 - 115
FR_HCS5	0.732
FR_HCS6	264

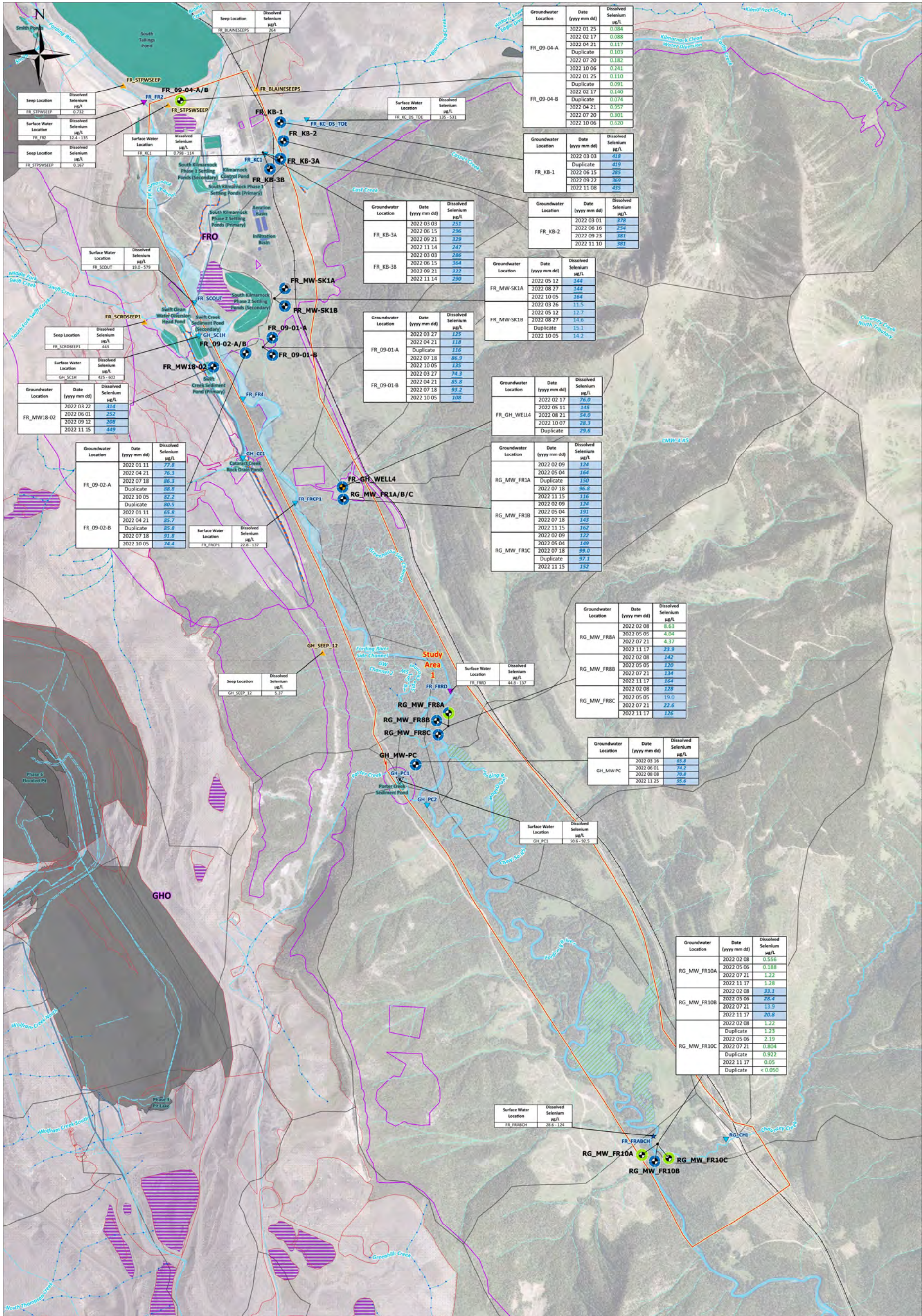
Seep Location	Dissolved Selenium µg/L
FR_HSEEP1	254
FR_HSEEP2	266
FR_HSEEP3	10.5 - 115
FR_HSEEP4	0.732
FR_HSEEP5	264

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Fording River North – Spatial Distribution of Selenium**  
(Source: SNC, 2023)

Date:	3/9/2024	Scale:	
Project No.:	WILD-01	Figure No.:	4-3c

**BURGESS**  
ENVIRONMENTAL



**Legend**

<b>Groundwater Stations</b>	<b>Site Features</b>	<b>Water Features</b>
Monitoring Well	Highway/Arterial	Streams + Stream Ditch
Drone Well	Secondary Road	Intake/Outlet/Inlet/Outfall
Stagnant	Leak	Stream
Surface Water Stations	Study Area	Subsurface
Compliance Point	Tailings/Sediment Pond	Ditch
Receiving Environment	Waste Water Pond	Rock Drain
Authorized Discharge	Pit	Water Pipeline
Monitoring	Stockpile	Island
Seep	Waste Dumps (Spills)	Lake/River Bed
	Waterbed	Washed Area/Washed (Based on 1:5000 Scale)
	Mine Permitted Area	

**Primary Screening Criteria**

Criteria	Selenium <sup>6</sup> (µg/L)
CR Aquatic Life	20
CR Long-term Watering	30
CR Long-term Watering	30
CR Drinking Water	10

**Notes:**

1. Criteria values are based on the 95th percentile of the background selenium concentration in the receiving environment.
2. The maximum value which is known and is used as the basis for the calculation of the criteria.
3. Locations of monitoring wells have been indicated for clarity.
4. The criteria values for selenium are based on the 95th percentile of the background selenium concentration in the receiving environment.

**Scale:** 0 0.25 0.5 1 1.5 km

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Fording River South – Spatial Distribution of Selenium**  
(Source: SNC, 2023)

Date:	3/9/2024	Scale:	
Project No.:	WILD-01	Figure No.:	<b>4-3d</b>

**BURGESS ENVIRONMENTAL**



## 4.4 Greenhills

### Mine Operations

Tech Coal Limited's Greenhills Mine is situated between the Elk and Fording River valleys, along the Greenhills Mountain Range, approximately 8 km northeast of Elkford (**Figure 4-4a**). Fording River Mine is located directly north and upstream (via Elk River) of the Greenhills Mine, and the two mines share an overlapping boundary. Raw coal is transported to the Fording River Mine for processing. Greenhills Mine has been producing coal since 1981, and clean coal production capabilities are between 5 and 6 million tonnes per year.

By the end of 2022, operations at the Greenhills Mine had disturbed approximately 3,000 ha of land with a total of 453.2 ha revegetated. 3.7 billion tonnes of waste rock have been removed and 104 million tonnes of coarse coal rejects have been placed in spoil piles that covered an area of 1,900 ha.

The Permitted Mine Life Plan spans 5-years from 2023 through 2027. It is unclear if this timeframe represents the planned life of mine, or if mining is planned to continue past 2027. Over that period, 385 million tonnes of waste will be moved to produce 31 million tonnes of coal. From 2023 to 2026, 66 million tonnes of waste will be spoiled in the Elk River watershed, 27 million tonnes in the Fording River watershed, and 296 million tonnes in-pit (Teck, 2023d).

### Hydrology

Greenhills Mine is located on the Greenhills Range, with runoff from the Mine partially draining west towards Elk River, and the remainder east/south towards Fording River.

Western draining tributaries that are monitored as a part of mining operations at Greenhills include Wolf, Willow, Wade, Cougar, Michelson, Leask, Wolfram, and Thompson creeks (as well as one unnamed creek). Leask, Wolfram, and Thompson creeks are impacted by the Greenhills Mine west spoil area. Many of the above creeks contain sedimentation ponds that were constructed to reduce total suspended solids prior to discharge to receiving environments.

Eastern tributaries that drain to Fording River that are monitored at Greenhills include Greenhills Creek and Porter Creek. Mine impacted tributaries of the Greenhills Creek include headwaters from the toe of the East Spoil, the Hawk Seep, and Gardine Creek. Various sediment ponds have been constructed within the eastern tributaries. The headwaters of the Porter creek drainage are impacted by mine waste rock. Branch F tributary is reported to not be affected by mining operations and is monitored as a background station.

The west spoil and west access spoil are in the Elk River watershed, the Cougar 6 backfill spoil is in-pit, and the coal spoils as well as the north and east spoils are in the Fording River watershed.

## Existing and Planned Remedial Measures

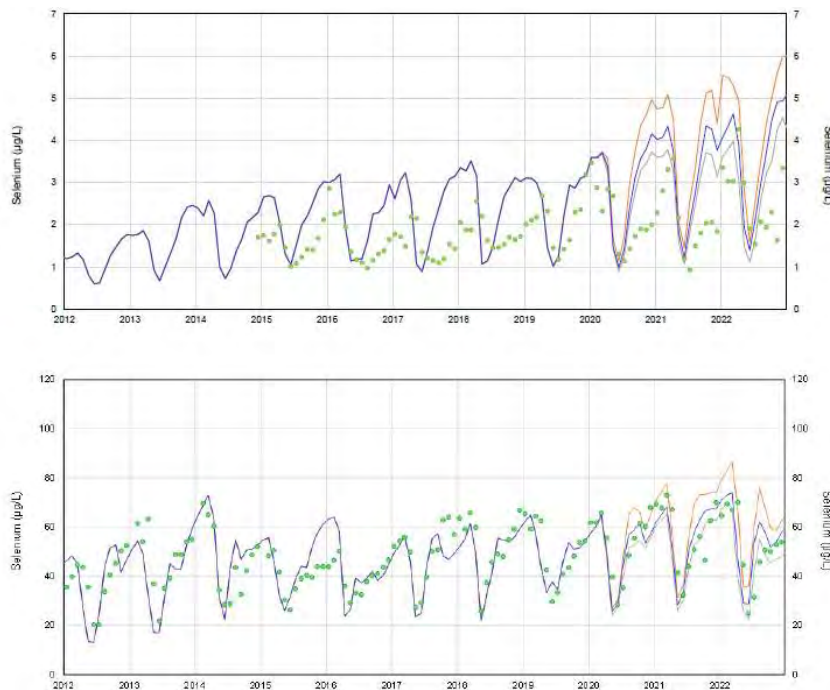
No water treatment systems have been implemented for the Greenhills Mine. An active water treatment facility for Greenhills Creek is planned for 2027, and will have a capacity of 7,500 m<sup>3</sup>/day (Teck, 2023g). This treatment system will be located downstream of mine/spoil contact water associated with the east spoil, approximately 5 km upstream of the confluence of Greenhills Creek with Fording River.

## Surface Water Quality Monitoring

There are two compliance monitoring points for the Greenhills Mine water quality monitoring, one on Fording River (205 m downstream of Greenhills Creek), and the second on Elk River (220 m downstream of Thompson Creek). Locations of these compliance stations are shown on **Figure 4-4b**. Selenium concentrations measured in 2022 at these compliance points are shown on **Insert 4-4**.

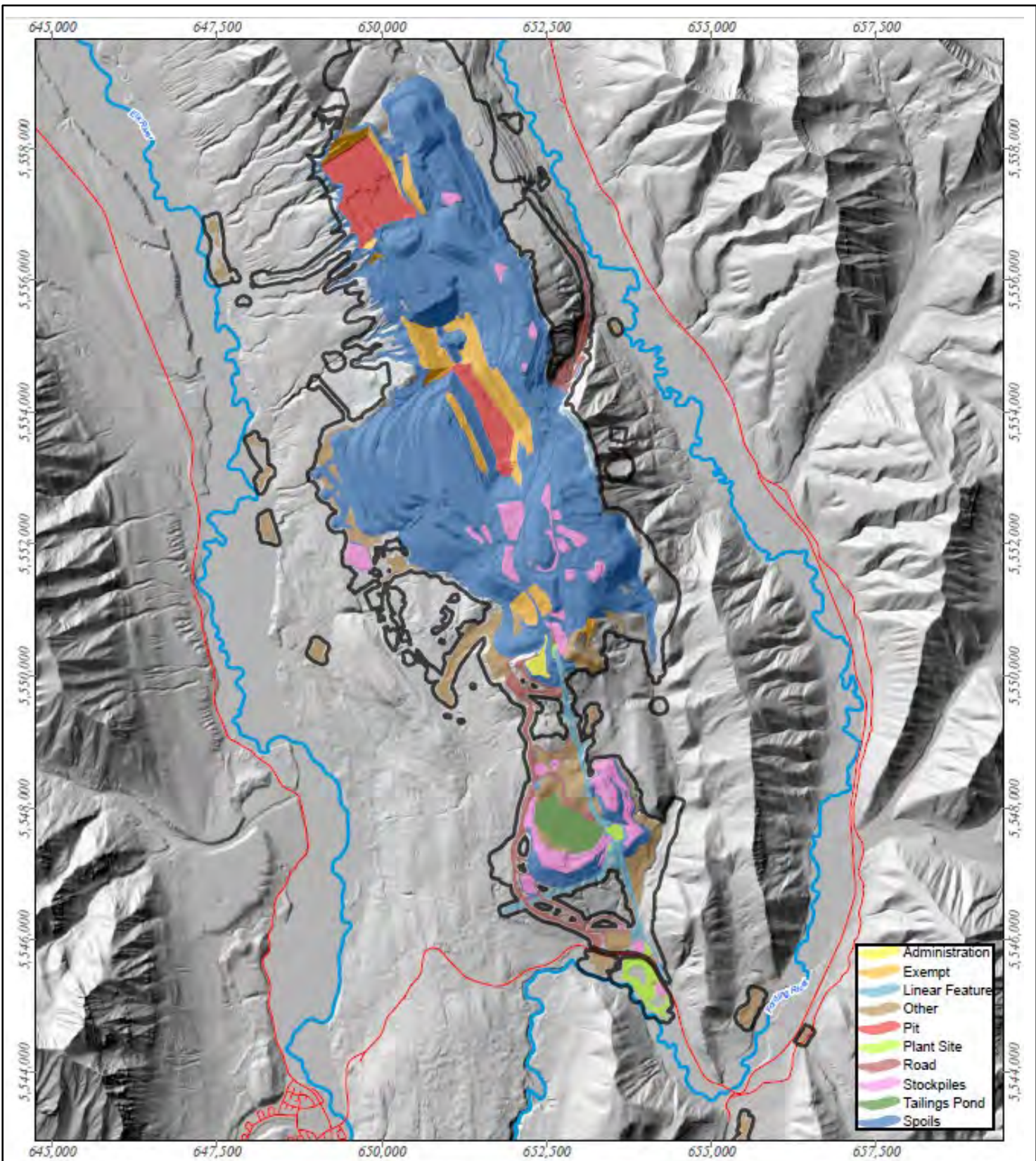
Review of the data shown on **Insert 4-4** indicates that selenium concentrations measured in samples collected from the two compliance monitoring points vary seasonally. Higher concentrations of selenium are typically measured in samples collected during low-flow conditions. Review of these data indicate an increasing trend in selenium concentrations in Elk River, and much higher concentrations and a slightly increasing trend in Fording River.

**Insert 4-4: Water Quality Monitoring in Elk River (top) and Fording River (bottom) Compliance Points (Source: Teck, 2023d)**



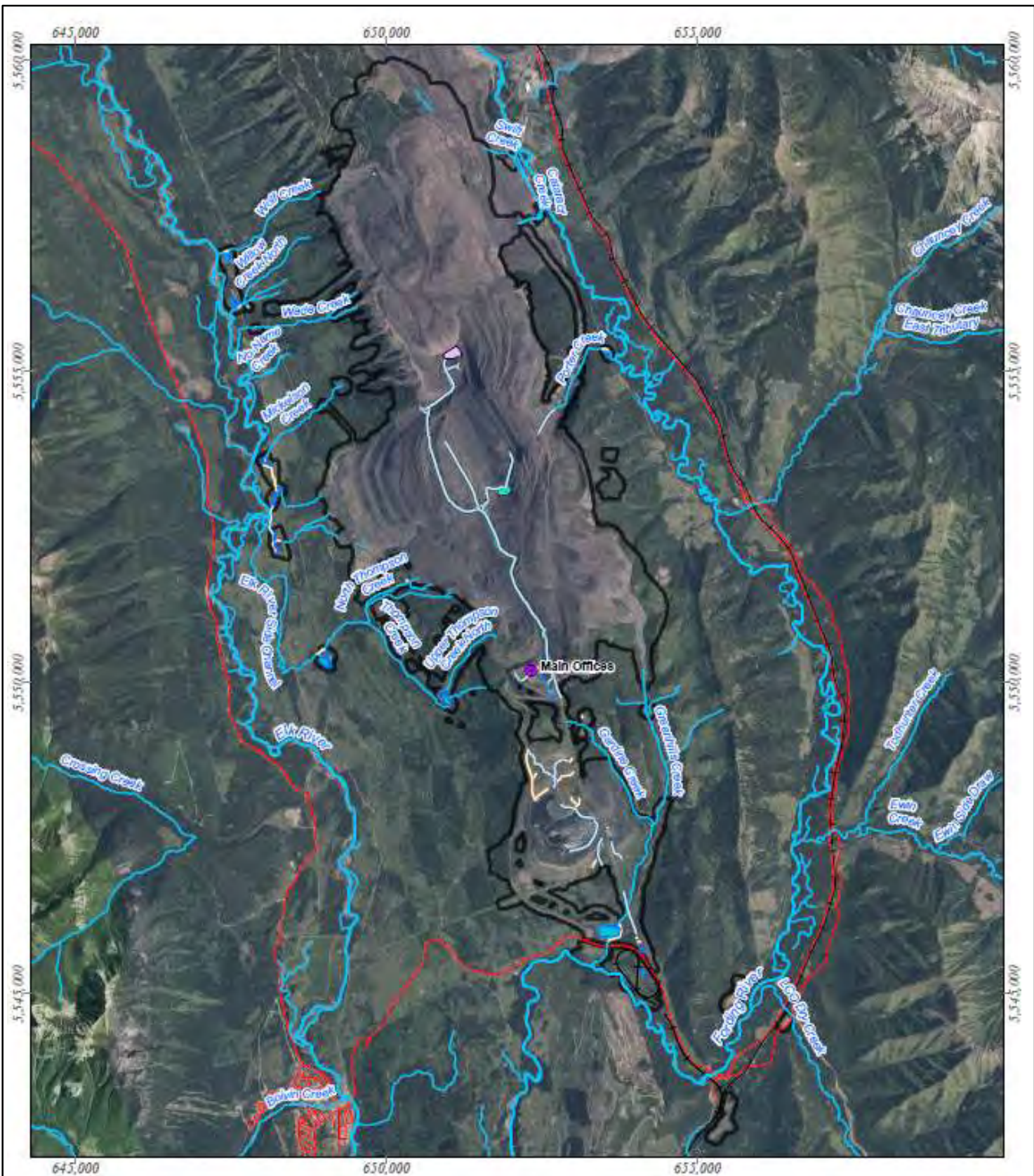
### Groundwater Monitoring

The spatial distribution of selenium concentrations in water samples collected from the Greenhills Mine is shown on **Figure 4-4c** (east) and **Figure 4-4d** (west). Review of these figures indicates that groundwater impacted by mining operations contains dissolved selenium at concentrations typically between approximately 10 ug/L and 200 ug/L. Conversely, regional groundwater not impacted by mining operations typically contains dissolved selenium concentrations less than 1 ug/L, although there are outliers and it is not always clear which wells are affected by mining and which are not. Concentrations of dissolved selenium in seep water samples are generally consistent with those of groundwater samples. Based on the generally lower dissolved selenium concentrations measured in samples collected from the Greenhills Mine, it appears that selenium contamination in groundwater beneath the Greenhills Mine is not as significant a contributor to selenium contamination in surface water as the groundwater beneath the Fording River Mine.



— Stream  
— Road

<b>WILDSIGHT</b> SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA		
<b>Greenhills Mine</b> (Source: Teck, 2023d)		
	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>4-4a</b>



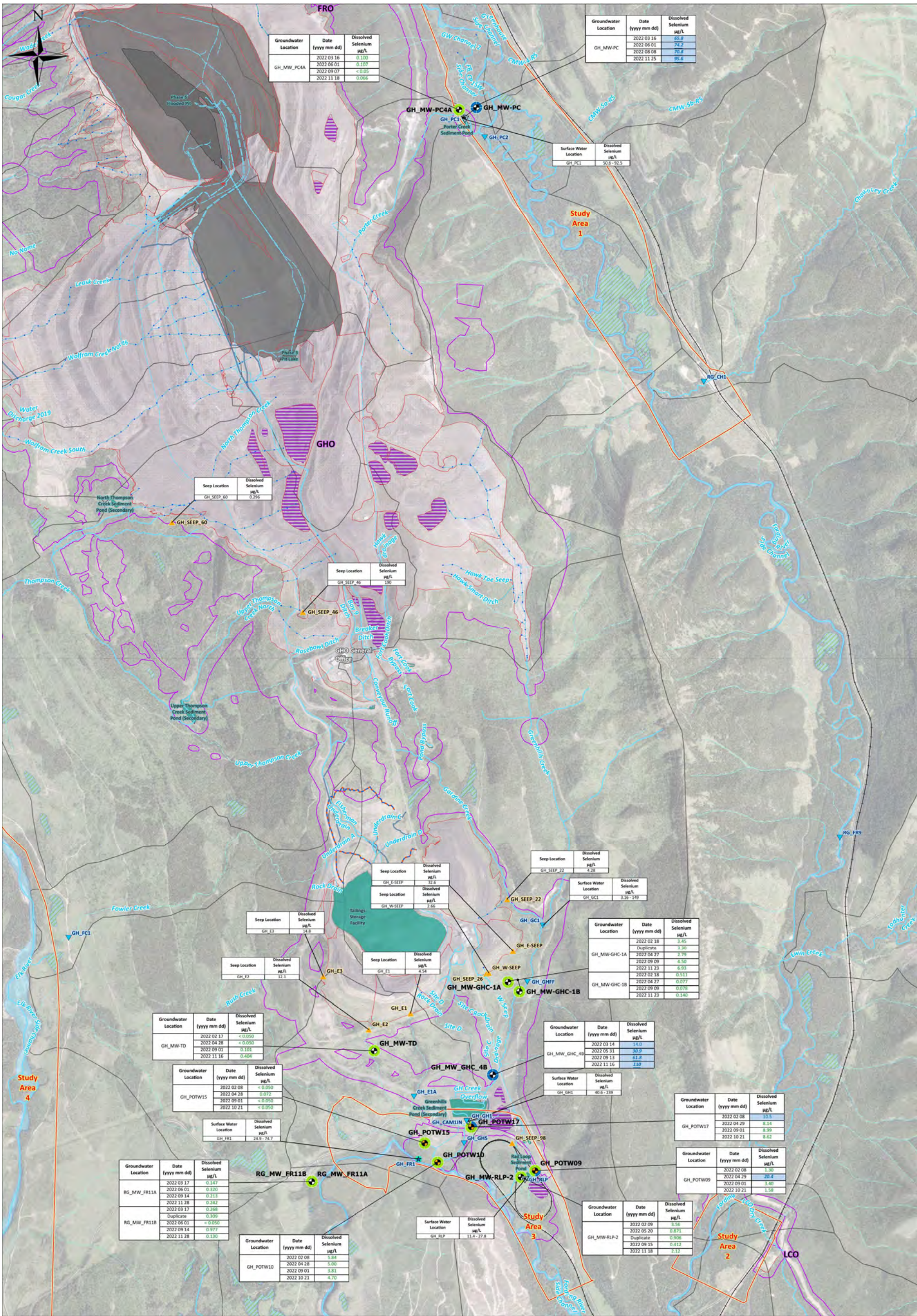
- Ditch
- Reservoir
- Railway
- Settling Pond
- Paved Road
- End Pit Lake
- Stream
- C-137 Permit

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Hydrology of Greenhills Mine**  
(Source: Teck, 2023d)



Date:	3/9/2024	Scale:
Project No.:	WILD-01	Figure No.:
		<b>4-4b</b>



Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW_PC4A	2022 03 16	0.100
	2022 06 01	0.107
	2022 09 07	< 0.05
	2022 11 18	0.066

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-PC	2022 03 16	65.8
	2022 06 01	74.2
	2022 08 08	70.8
	2022 11 25	55.4

Surface Water Location	Dissolved Selenium µg/L
GH_PC1	50.6-92.5

Seep Location	Dissolved Selenium µg/L
GH_SEEP_60	0.396

Seep Location	Dissolved Selenium µg/L
GH_SEEP_46	1.90

Seep Location	Dissolved Selenium µg/L
GH_SEEP_22	4.28

Seep Location	Dissolved Selenium µg/L
GH_E3	14.8

Seep Location	Dissolved Selenium µg/L
GH_E3	12.7

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-TD	2022 02 17	< 0.050
	2022 04 28	< 0.050
	2022 09 01	0.101
	2022 11 16	0.404

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_POTW15	2022 02 08	< 0.050
	2022 04 28	0.072
	2022 09 01	< 0.050
	2022 10 21	< 0.050

Surface Water Location	Dissolved Selenium µg/L
GH_FR1	24.9-74.7

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
RG_MW_FR11A	2022 03 17	0.117
	2022 06 01	0.120
	2022 09 14	0.213
	2022 11 28	0.242
	2022 03 17	0.208
RG_MW_FR11B	2022 06 01	< 0.050
	2022 09 14	0.977
	2022 11 28	0.130

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_POTW10	2022 02 08	1.58
	2022 04 28	5.00
	2022 09 01	3.81
	2022 10 21	4.70

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW_GHC-1A	2022 03 14	14.10
	2022 09 13	61.8
	2022 11 16	110
	Duplicate	

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-GHC-1B	2022 02 18	3.45
	Duplicate	1.30
	2022 04 27	2.79
	2022 09 09	4.50
	2022 11 23	6.93
	2022 02 18	0.511
	2022 04 27	0.077

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_POTW17	2022 02 08	1.30
	2022 04 29	5.14
	2022 09 01	8.99
	2022 10 21	8.62

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_POTW09	2022 02 08	1.30
	2022 04 29	20.8
	2022 09 01	1.40
	2022 10 21	1.58

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-RLP-2	2022 02 09	1.56
	2022 05 20	0.871
	Duplicate	0.906
	2022 09 15	0.412

Primary Screening Criteria	Selenium* 1
SR Aquatic Life	20
SR 1 mg/L in Water	20
SR 1 mg/L in Sediment	30
SR Drinking Water	10

**Legend**

- Groundwater Stations**
  - Monitoring Well
  - Domestic
  - Supply
  - Surface Water Stations
  - Compliance Point
  - Receiving Environment
  - Authorized Discharge
  - Monitoring
  - Seep
- Site Features**
  - Highway/Arterial
  - Secondary Road
  - High
  - Study Area
  - Falling/Sediment Pond
  - Waste Water Pond
  - Pit
  - Stockpile
  - Waste Dump (Spill)
  - Waste Area/Material (Based on 1:5000 Scale)
  - Mine Permitted Area
- Water Features**
  - Stream + Stream Ditch
  - Intermittent + Intermittent Stream
  - Stream
  - Subsurface
  - Culvert
  - Ditch
  - Rock Drain
  - Water Pipeline
  - Island
  - Leak/River Bed
  - Washed Area/Material (Based on 1:5000 Scale)

**Map Orientation:** Q1, Q2, Q3, Q4

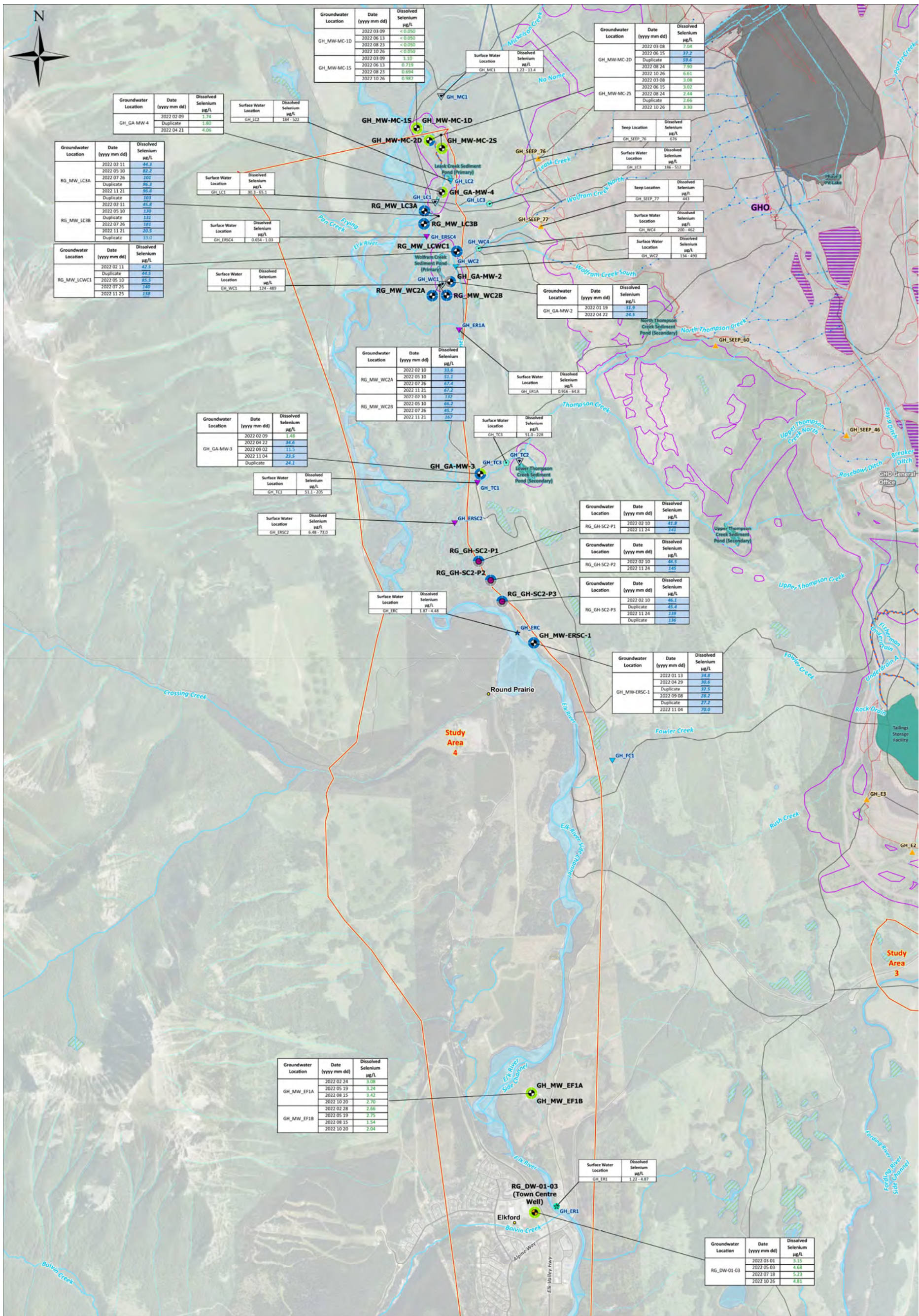
**Scale:** 0 0.25 0.5 1 1.5 km

## WILDSIGHT SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

### Greenhills East – Spatial Distribution of Selenium (Source: SNC, 2023)



Date:	3/9/2024	Scale:	
Project No.:	WILD-01	Figure No.:	4-4c



Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-MC-1D	2022 03 09	< 0.050
	2022 06 13	< 0.050
	2022 08 23	< 0.050
	2022 10 26	1.10
	2022 03 09	0.719
GH_MW-MC-1S	2022 06 13	0.694
	2022 08 23	0.987
	2022 10 26	0.987

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
RG_MW_LC3A	2022 02 11	44.8
	2022 05 10	82.2
	2022 07 26	101
	Duplicate	86.3
	2022 11 21	96.8
RG_MW_LC3B	2022 02 11	43.8
	2022 05 10	130
	2022 07 26	171
	Duplicate	171
	2022 11 21	25.5

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
RG_MW_WC2A	2022 02 10	33.6
	2022 05 10	51.1
	2022 07 26	67.4
	2022 11 21	67.2
	2022 03 10	187
RG_MW_WC2B	2022 05 10	66.2
	2022 07 26	65.7
	2022 11 21	167
	2022 02 10	33.6
	2022 05 10	51.1

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-MC-2D	2022 03 08	7.04
	2022 06 15	32.2
	Duplicate	38.6
	2022 08 24	7.96
	2022 10 26	6.61
GH_MW-MC-2S	2022 03 08	3.08
	2022 06 15	3.02
	2022 08 24	2.44
	Duplicate	2.66
	2022 10 26	3.30

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_GA-MW-3	2022 02 09	1.48
	2022 04 22	34.8
	2022 09 02	11.5
	2022 11 04	23.5
	Duplicate	24.2

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
RG_GH-SC2-P1	2022 03 10	143
	2022 11 24	143
RG_GH-SC2-P2	2022 02 10	46.5
	2022 11 24	143
RG_GH-SC2-P3	2022 02 10	46.1
	Duplicate	45.9
	2022 11 24	138
	Duplicate	138

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-ERSC-1	2022 01 13	34.8
	2022 04 29	30.6
	Duplicate	32.1
	2022 09 08	28.2
	Duplicate	27.2
2022 11 04	70.8	

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
GH_MW-EF1A	2022 02 24	3.08
	2022 05 19	3.24
	2022 10 20	2.70
GH_MW-EF1B	2022 02 28	2.66
	2022 05 19	2.75
	2022 08 15	1.54
2022 10 20	2.04	

Surface Water Location	Dissolved Selenium µg/L
GH_ER1	1.22 - 4.87

Groundwater Location	Date (yyyy mm dd)	Dissolved Selenium µg/L
RG_DW-01-03	2022 03 01	3.15
	2022 05 03	4.68
	2022 07 18	5.23
	2022 10 26	4.81
	2022 10 26	4.81

**Legend**

**Groundwater Stations**

- Monitoring Well
- Draw etc
- Supply

**Surface Water Stations**

- Compliance Point
- Monitoring Equipment
- Authorized Discharge
- Monitoring
- Seep

**Site Features**

- Highway/Arterial
- Secondary Road
- State
- Study Area
- Filling/Gravel/Sediment Pond
- Waste Water/Pond
- RR
- Stockpiles
- Waste Dump (Spills)
- Watersheds
- Mine Permitted Area

**Water Features**

- Streams & Steep Ditch
- Intermittent & Ineffluents
- Stream
- Surface
- Subsurface
- Ditch
- Stock Drain
- Water Pipeline
- Island
- Lake/River Bed
- Washed Area/Water Shed (Based on 1:5000 Scale)

**Primary Screening Criteria**

Screening Criteria	Selenium <sup>1</sup> µg/L
CSR Aquatic Life	20
CSR Ingestion Watering	30
CSR Livestock Watering	30
CSR Drinking Water	10

**Notes:**

1. Selenium is not a priority pollutant under the current water quality objectives.
2. Selenium is not a priority pollutant under the current water quality objectives.
3. The concentration for protection of sensitive wildlife is the value of the water quality objective.

**Scale:** 0 0.25 0.5 1 1.5 km

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Greenhills West – Spatial Distribution of Selenium**  
(Source: SNC, 2023)

	Date:	3/9/2024	Scale:
	Project No.:	WILD-01	Figure No.:
			<b>4-4d</b>

## 4.5 Coal Mountain

### Mine Operations

Coal Mountain mine is located within the front ranges of the southern Canadian Rocky Mountains, approximately 25 km southeast of the town of Sparwood, B.C. Mining activities ceased in April 2019 and the Coal Mountain Mine is currently being reclaimed (Teck, 2023e). The Coal Mountain mine is on 520 ha of privately owned land, 2,500 ha of leased land (**Figure 4-5a**). Formerly owned by Esso Resources Canada, and operated by its Byron Creek Collieries subsidiary, Coal Mountain was acquired by Fording Coal in 1994. In 2003, ownership of Coal Mountain was transferred to the Elk Valley Coal Partnership, which was 60% owned by Fording Canadian Coal Trust and 40% by the major Canadian mining company, Teck Cominco. In October 2008, Teck Cominco increased its stake in the Elk Valley Coal partnership to 100% and renamed the company Teck Coal.

Open-pit mining, and truck and shovels, were used at Coal Mountain, which was Teck Coal's oldest and longest operating mine. The Coal Mountain mine had a mine capacity of 2.7Mt/y while its washing plant could process up to 3.5Mt/y of run-of-mine coal (Mine Technology, 2024). The coal washing plant was located north of the main mine area, flanking Corbin Creek, and the rail loading area was located downstream of the confluence of Corbin Creek into Michel Creek. Mining encompassed Coal Mountain and the southern flank of a ridge of Mount McGladrey. The total area of surface disturbance at Coal Mountain is 1,050 hectares, 700 hectares of which consists of mine spoil and by the end of 2022, 290 hectares had been revegetated (Teck, 2023e, Table 2-1).

### Hydrology

Coal Mountain Mine is located on a steep sided, north-south trending ridge with Michel Creek directly to the west, Corbin Creek to the east, and Andy Good Creek to the north. Pengelly and Scrubby creeks are tributaries to Corbin Creek with confluences located downstream of the Corbin Creek Dam. Corbin Creek and Andy Good Creek are tributaries to Michel Creek. Michel Creek, a tributary of Elk River, has a catchment area of approximately 32 km<sup>2</sup> upstream of its confluence into Elk River. In general, the flow of water is from south to north (Teck, 2023e, Section 4.5).

Most of the Coal Mountain Mine development area drains into Corbin Creek, which flows generally northwest and confluences into Michel Creek downstream of the mine and upstream of the rail loading area associated with the mine. Mine development included dumping mine waste rock in the valley of Corbin Creek and its tributaries; hence, nearly all of the water within Corbin Creek flows through mine waste rock, mine spoil, and/or disturbed mining areas. Michel



Creek flows to the south of Coal Mountain mine before it confluences with Corbin Creek. Only a small portion of the mine development area drains directly into Michel Creek (see **Figure 4-5b**).

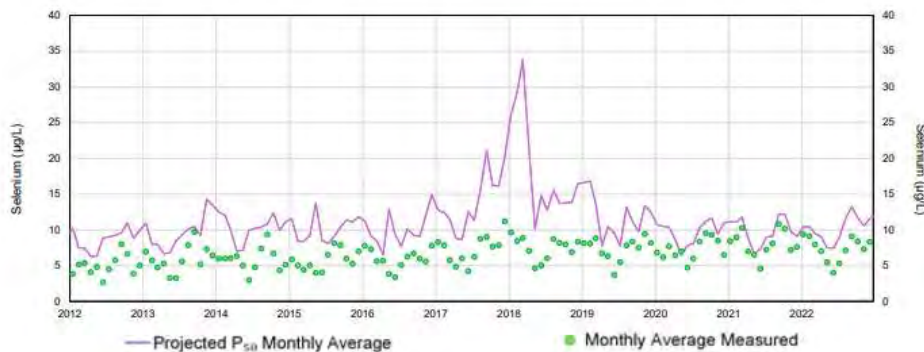
## Existing and Planned Remedial Measures

No specific remedial measures are in place to address selenium leaching from the Coal Mountain Mine. The disturbed surface areas of the former mine are currently in the process of being reclaimed (Teck, 2023e). The water management plan for the former Coal Mountain Mine appears to be focused on controlling suspended solids in the discharges to Michel Creek, and maintaining the stability of embankments in mining works associated with the former mine. The Coal Mountain Mine is not a significant contributor to selenium contamination of the Elk River.

## Surface Water Quality Monitoring

Water quality is monitored at MC-2, which is the compliance point for the Coal Mountain Mine. Monitoring station MC-2 is located downstream of the confluence of Corbin Creek into Michel Creek. **Insert 4-5** illustrates the measured and predicted selenium concentrations for samples collected at MC-2 from 2012 to 2022. Measured selenium concentrations vary from approximately 2 ug/L to 12 ug/L, with a slight increasing trend through the period. No water quality data are provided for Corbin Creek (Teck, 2023e).

### Insert 4-5: Comparison of Monitored Monthly Average Selenium Concentrations to Projected Selenium Concentrations at the Coal Mountain mine Compliance Point (Source: Teck, 2023e)



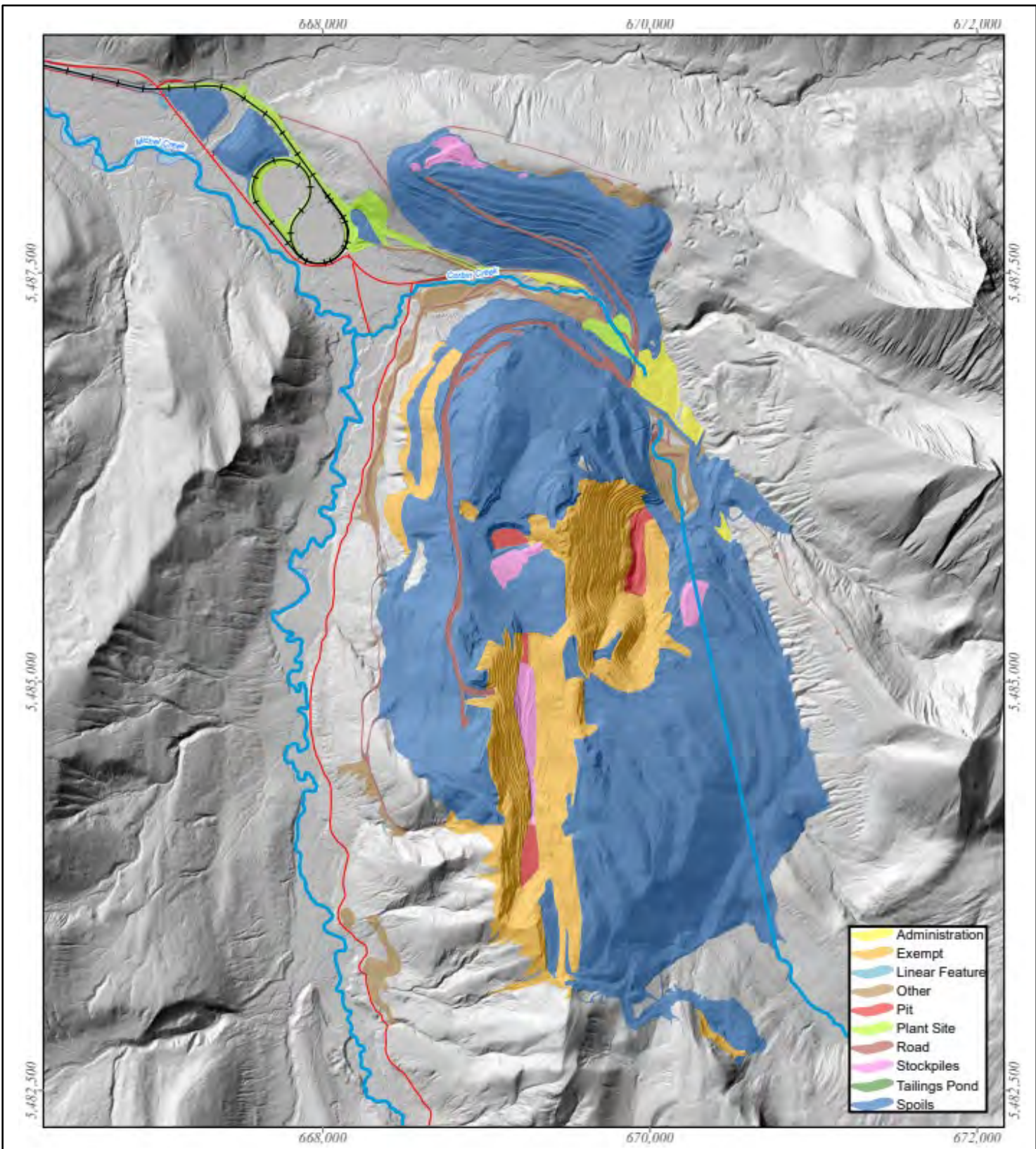
## Groundwater Monitoring

The spatial distribution of selenium concentrations in surface water, groundwater, and seepage samples collected from the Coal Mountain Mine are shown on **Figure 4-5c**. Review of this figure indicates that groundwater at the well locations has not been significantly impacted by mining operations. Groundwater typically contains dissolved selenium concentrations less than 1 ug/L, although there are a few outliers. Higher dissolved selenium concentrations are measured in seep water samples, which impact to water quality in Michel Creek and Corbin Creek.

## Burgess Environmental

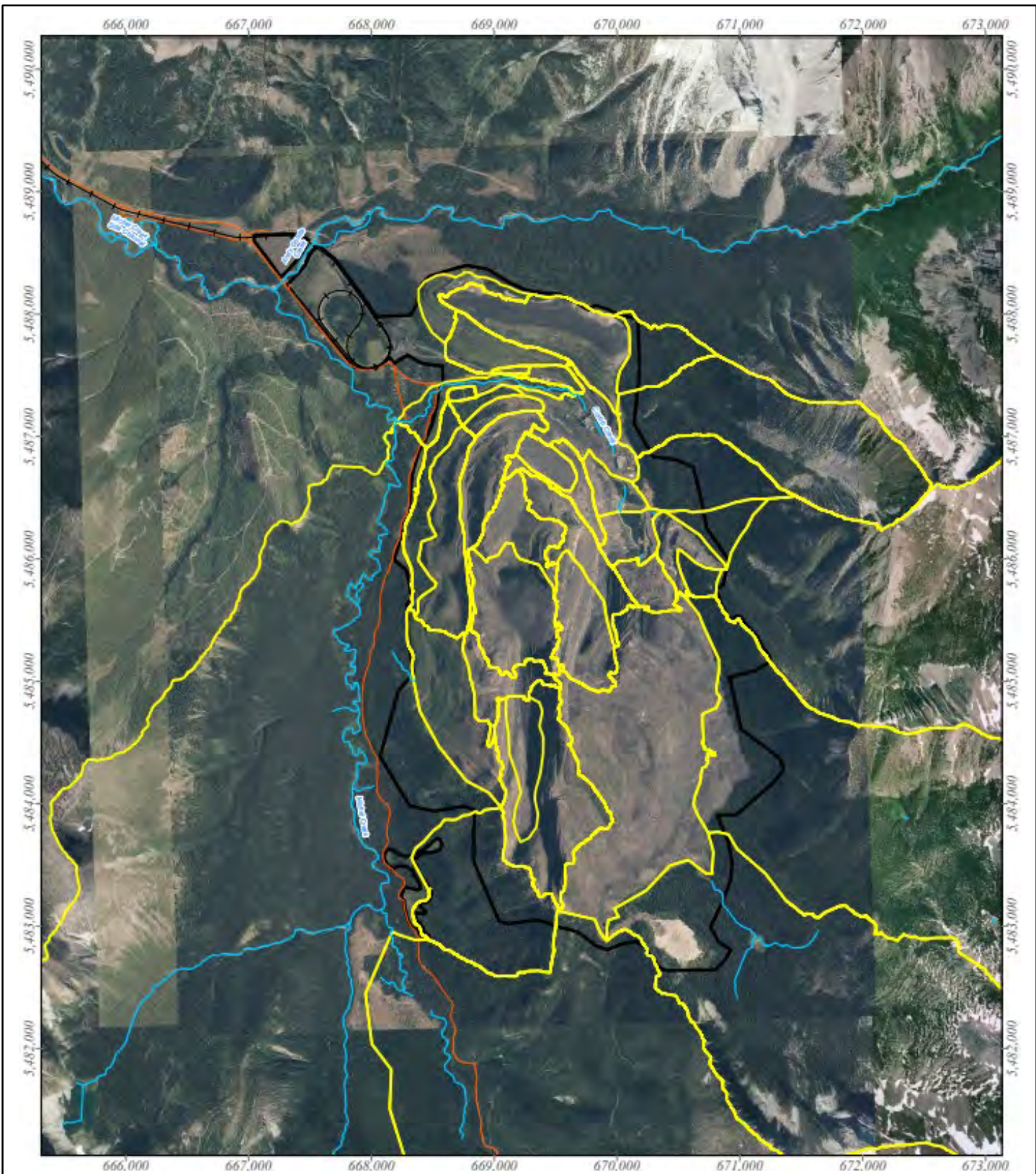
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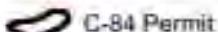


Groundwater quality is also measured on a regular basis in 19 monitoring wells. Dissolved selenium concentrations at monitoring well MW5-SH were above the screening criteria for the mine and showed an increasing trend as determined by a Mann-Kendall analysis. Increasing trends in selenium concentrations have also been measured in groundwater samples collected from three additional monitoring wells (Teck, 2023e, Section 4.3.2).



— Stream  
— Road

<b>WILDSIGHT</b> SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA		
<b>Coal Mountain Mine</b> (Source: Teck, 2023e)		
	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>4-5a</b>



-  Creek
-  Road
-  Sump
-  C-84 Permit
-  Railway
-  Current Drainage Basin

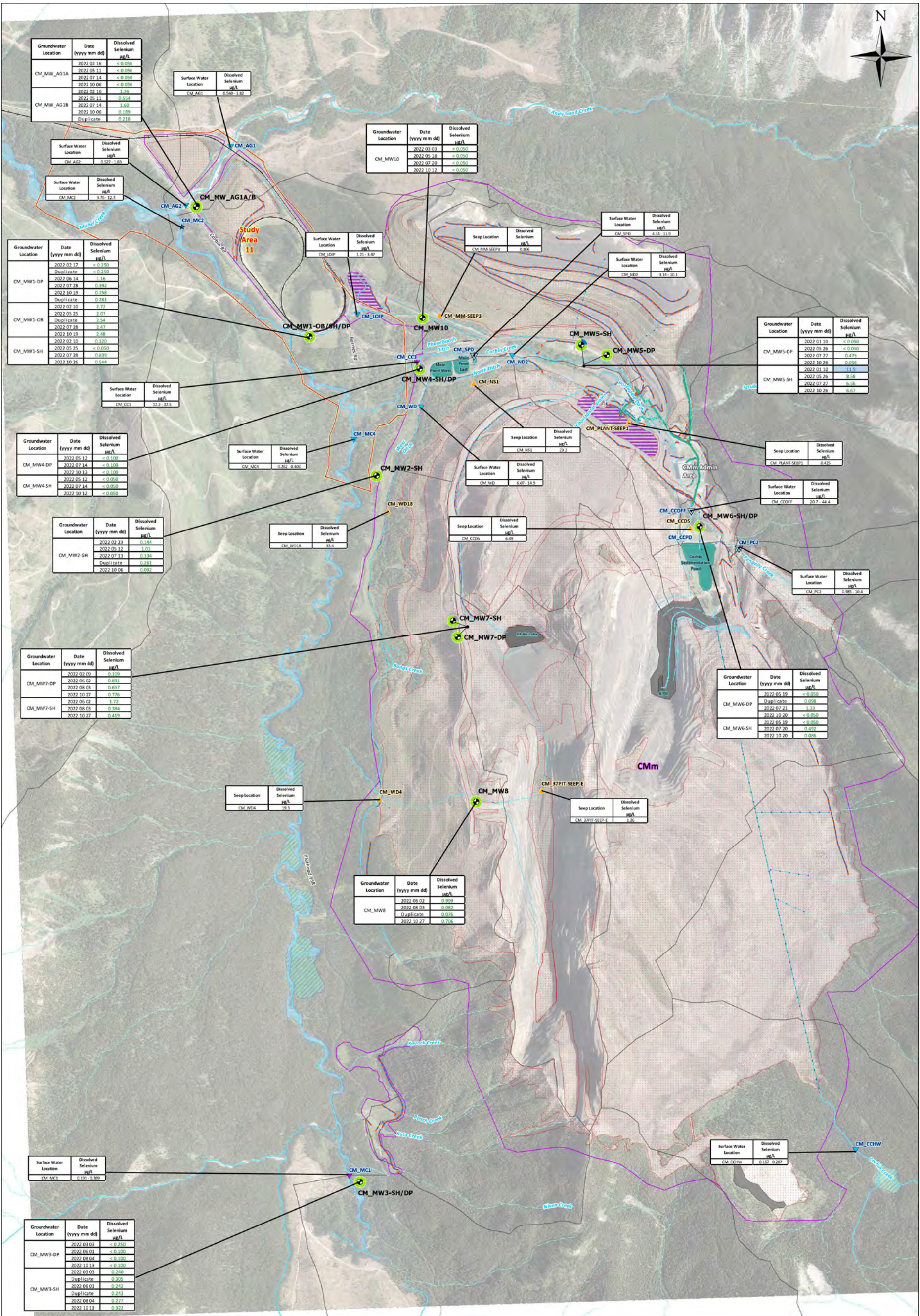
**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Hydrology of Coal Mountain Mine**  
(Source: Teck, 2023e)



Date: 3/9/2024
Project No.: WILD-01

Scale:
Figure No.: <b>4-5b</b>



**Legend**

<b>Groundwater Stations</b>	<b>Site Features</b>	<b>Water Features</b>
Monitoring Well	Secondary Road	Stream + Stream Ditch
Surface Water Stations	Rails	Intermittent + Indefinite Stream
Compliance Point	Tailings/Settling/Sediment	Stream
Receiving Environment	Pond	Subsurface
Authorized Discharge	End-Pit Lake	Ditch
Monitoring	Pit	Potable Waterline
Monitoring (Retired)	Stockpiles	Rock Drain
Seep	Waste Dump (Spills)	Water Pipeline
	Waterleeds	Bypass/Diversion Channel
	Mine Permitted Areas	Lake/River Bed
		Wetted Area/Wetland (Based on 1:10000 Scale)

**Primary Screening Criteria**

Screening Criteria	Selenium <sup>a</sup> µg/L
CSR Aquatic Life	20
CSR Irrigation Watering	20
CSR Livestock Watering	30
CSR Drinking Water	30

**Notes:**  
 1. Original in colour at paper size A4 (210x297 mm).  
 2. Unshaded wells reflect selenium levels. Free drilling will detect this well. However, wells that will remain unshaded will reflect selenium levels. Free drilling will detect this well.  
 3. Intended for illustration purposes. Accuracy has not been verified for construction or navigation.  
 4. Location of overlapping wells have been adjusted for clarity.  
 5. The contribution for ponds may not accurately reflect that in the various effluent discharge ponds.  
 References:  
 1. Data provided by Teck Coal Limited.

**Scale:** 0 125 250 500 750 1000 Meters

**WILDSIGHT**  
 SELENIUM RELATED RECLAMATION LIABILITIES  
 TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Coal Mountain – Spatial Distribution of Selenium**  
 (Source: SNC, 2023)

Date:	3/9/2024	Scale:	
Project No.:	WILD-01	Figure No.:	<b>4-5c</b>

## 5 WATER QUALITY DATA

### 5.1 Order Stations

#### General

Teck monitors surface water quality at seven order stations, as specified in Ministerial Order No. 113. Order stations are used to monitor water quality within the designated area defined by the Order and ultimately monitor the success of the Elk Valley Water Quality Plan. From downstream to upstream, these Order Stations are as follows (**Figure 5-1**):

- Lake Koocanusa downstream of Elk River (RG\_DSELK), impacted by all mines
- Elk River at Elko (RG\_ELKORES), impacted by all mines
- Elk River downstream of Michel Creek (EV\_ER1), impacted by all mines
- Elk River downstream of Fording River (EV\_ER4), impacted by Greenhills, Fording River and Line Creek Mines
- Elk River upstream of Boivin Creek (GH\_ER1), impacted by Greenhills Mine
- Fording River downstream of Line Creek (GH\_FR1), impacted by Greenhills, Fording River and Line Creek Mines
- Fording River downstream of Greenhills Creek (LC\_LC5), impacted by Greenhills and Fording River Mines

Samples analyzed for selenium concentrations are collected on a regular basis, and are averaged over a monthly period for comparison to the water quality targets (**Section 4.2**).

#### Lake Koocanusa

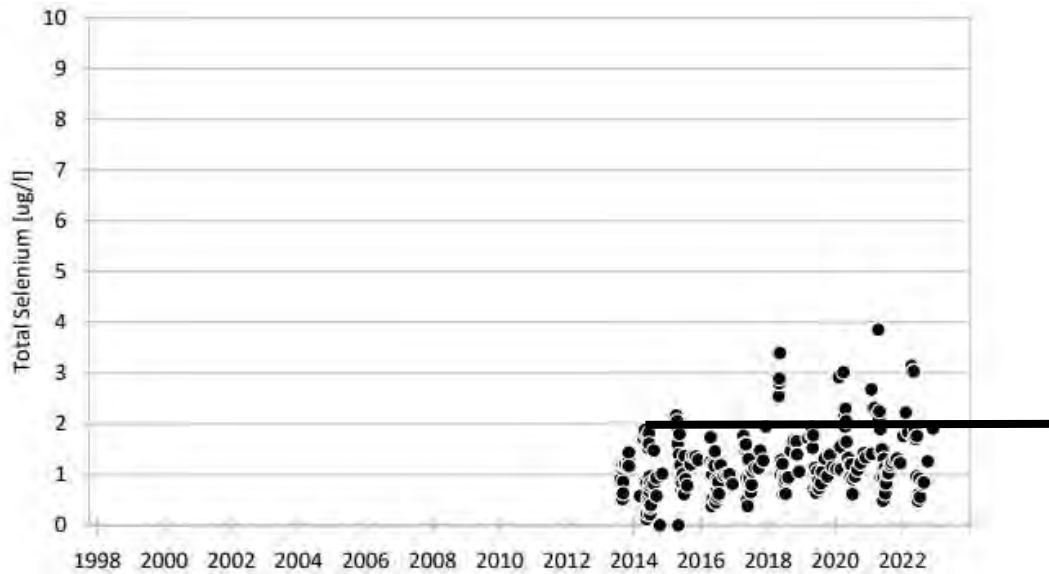
The water quality target for Lake Koocanusa is 2 ug/L, which is the B.C. (2023) surface water quality guideline, and is intended to apply to the measured monthly average concentration.

The average monthly concentrations of selenium measured at the Lake Koocanusa monitoring station from 2014 through 2022 are shown in **Insert 5-1**. Review of the data presented in **Insert 5-1** indicates an increasing trend in measured selenium concentrations as well as approximately 15 exceedances of the water quality target/objective of 2 ug/L.

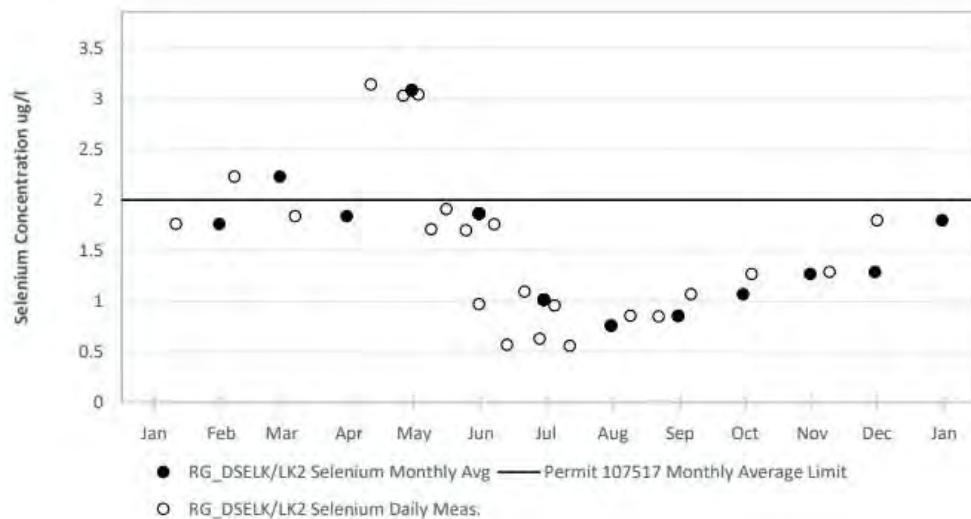
The measured average monthly and daily measured concentrations of selenium in samples collected at the Lake Koocanusa monitoring station in 2022 are shown in **Insert 5-2**. Review of the data presented in **Insert 5-2** indicates that exceedances of the water quality target of 2 ug/L occurred in the early spring, when lake levels and flow were relatively low. The lowest concentrations of selenium were measured in samples collected in the middle of the summer, when lake levels and flow were relatively high, then increased gradually between freshets.

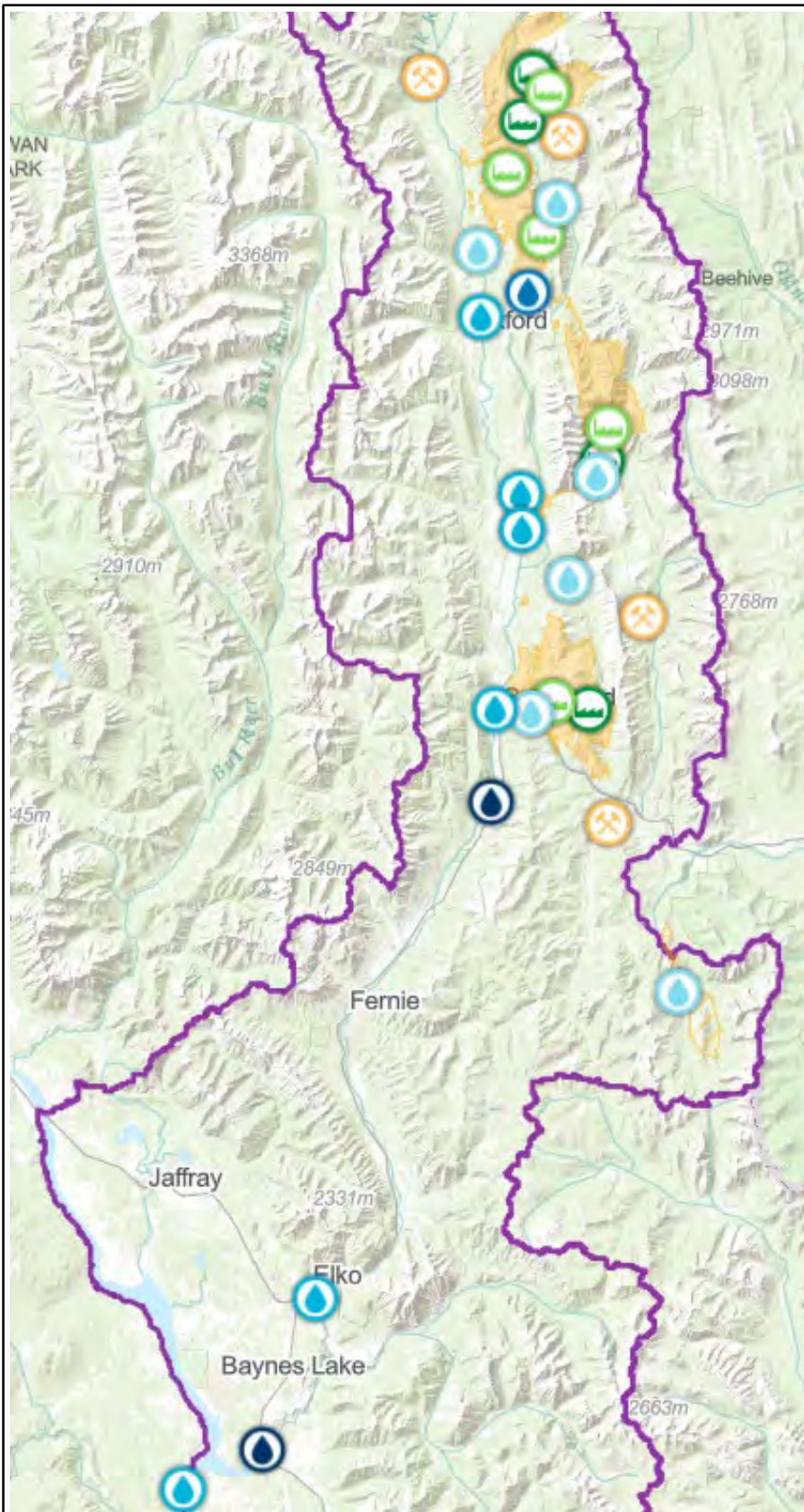
This Order Station is particularly important because it is the location where Teck committed to maintaining selenium concentrations below the B.C. (2023) water quality guideline of 2 ug/L, and it is the final Order Station in the watershed before this water flows into the United States.

**Insert 5-1: Total Selenium Concentrations in Lake Koochanusa (RG\_DSELK) - 2014 to 2022**  
(Source: Teck, 2023h, Figure 51)



**Insert 5-2: Total Selenium Concentrations in Lake Koochanusa (RG\_DSELK) – 2022** (Source: Teck, 2023h, Figure 16)





- Compliance Point
- Order Station
- Trend Site
- Order Station & Compliance Point

**Reference Data**

**Selenium & Nitrate Water Treatment Facilities**

- Operating
- Planned

**Proposed Mine Locations**



**Permitted Mine Areas**

- Currently Active Mines
- Mines Not Actively Producing

**Elk Valley Water Quality Plan Designated Area**



<p><b>WILDSIGHT</b>          SELENIUM RELATED RECLAMATION LIABILITIES          TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA</p>		
<p><b>Locations of Order Stations and Compliance Points</b>          (Source: Elk Valley Water Hub)</p>		
	Date:	3/9/2024
	Project No.:	WILD-01
	Scale:	
	Figure No.:	<b>5-1</b>

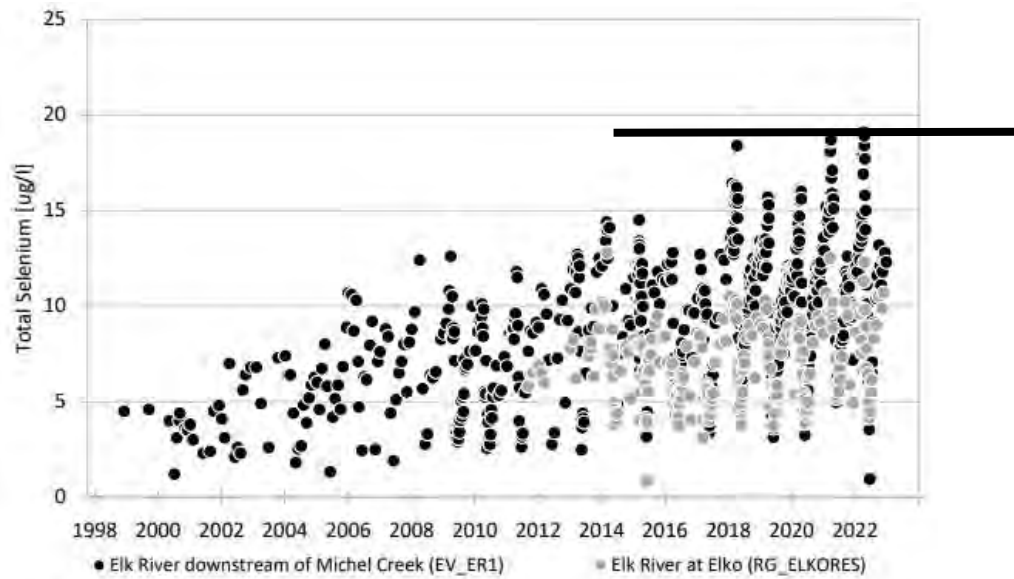


## Lower Elk River

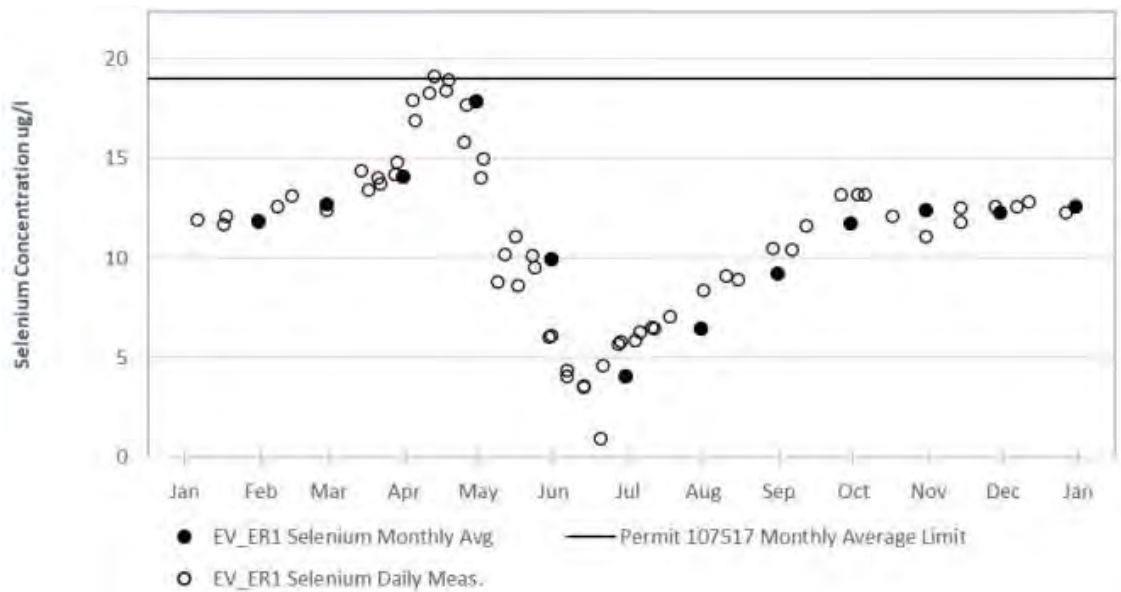
Two of the Elk River Order Stations are located downstream of the effluents of all of Teck Coal's mines in the Elk Valley; the Order Station downstream of Michel Creek (EV\_ER1) and at the Elko reservoir, downstream of Fernie (RG\_ELKORES). The water quality target for these Order Stations is 19 ug/L (see **Table 4.3**), and was committed to be met by 2014. Monitoring of the Order Station downstream of Michel Creek has occurred since 1999, and of the Elko reservoir since 2012. These data are presented in **Insert 5-3**. Review of the data presented in **Insert 5-3** indicates a steady increase in selenium concentrations measured in samples collected from both Order Stations, with these concentrations approaching and recently exceeding the water quality target downstream of Michel Creek. The upwards trend in measured selenium concentrations indicates that exceedances are likely to occur more frequently in the future unless additional treatment is brought on-line.

The measured average monthly and daily measured concentrations of selenium in samples collected at the Order Stations in Elk River downstream of Michel Creek and at Elko in 2022 are presented in **Inserts 5-4 and 5-5, respectively**. Review of the data presented in these inserts indicates that exceedances of the water quality objective of 19 ug/L occurred just prior to freshet in samples collected from the Order Station downstream of Michel Creek. The lowest concentrations of selenium were measured in samples collected during freshet, when flows are relatively high, then gradually increase until the onset of the next freshet. Measured concentrations of selenium in samples collected at the Elko Order station all complied with the water quality target of 19 ug/L.

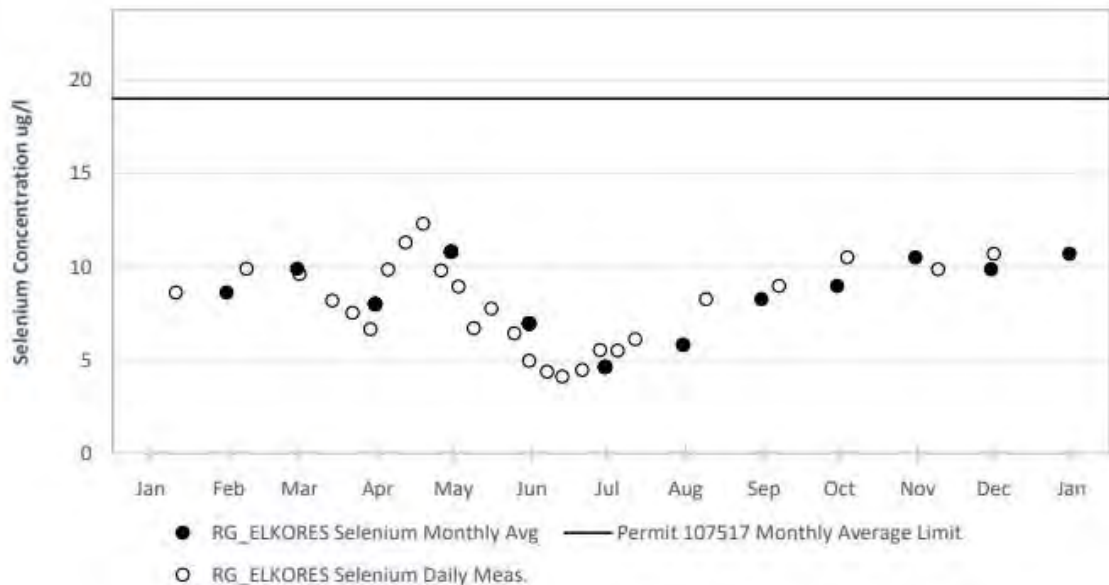
**Insert 5-3: Total Selenium Concentrations in Lower Elk River, 1999 – 2022** (Source: Teck, 2023h, Figure 50)



**Insert 5-4: Total Selenium Concentrations in Elk River Downstream of Michel Creek – 2022**  
 (Source: Teck 2023h, Figure 14)



**Insert 5-5: Total Selenium Concentrations in Elk River in Elko Reservoir – 2022** (Source: Teck, 2023h, Figure 15)



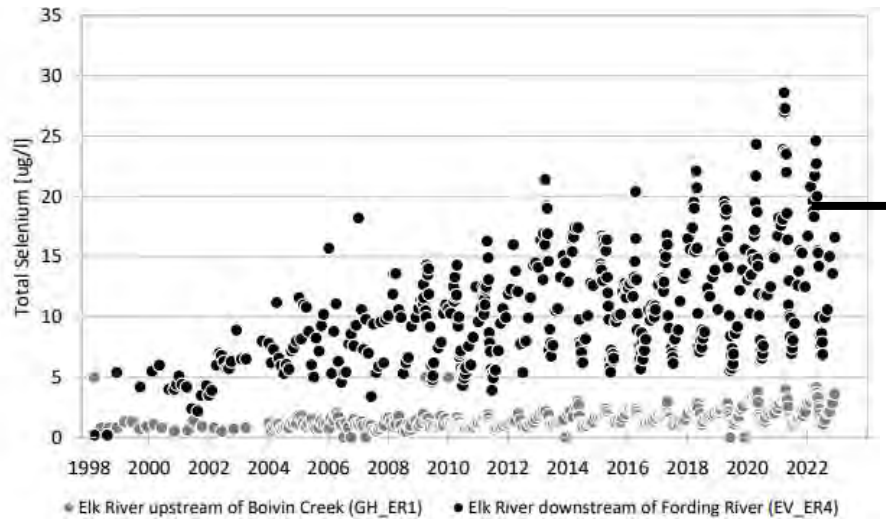
## Upper Elk River

Two of the Elk River Order Stations are located in the upper Elk River, the first upstream of Boivin Creek, above most of the mine affected discharges, and the second below the confluence of the Elk River with the Fording River. The water quality target for these Order Stations is 19 ug/L (see **Table 4.3**), and was committed to be met by 2023. Monitoring of these Order Stations has occurred since 1999 (see **Insert 5-6**). Review of the data presented in **Insert 5-6** indicates minor impact upstream of Boivin Creek. A steady increase in selenium concentrations is evident at both Order Stations, with these concentrations exceeding the water quality target of 19 ug/L consistently in samples collected in 2022 from below the confluence of the Elk River with Fording River. The upwards trend in measured selenium concentrations indicates that exceedances are likely to occur more frequently in the future at the downstream station if additional treatment capacity is not brought on-line.

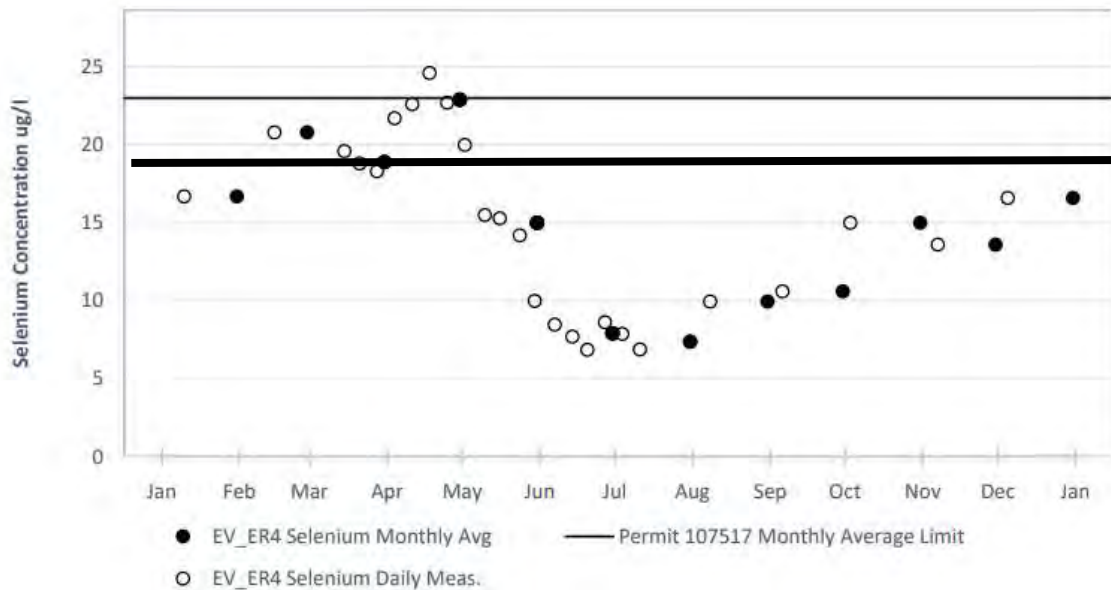
The average monthly and daily measured concentrations of selenium in samples collected at the Order Stations in the Elk River downstream of Fording River and upstream of Boivin Creek in 2022 are presented in **Inserts 5-7 and 5-8, respectively**. Review of the data presented in these charts indicates that exceedances of the water quality target of 19 ug/L occurred just prior to freshet in samples collected from the Order Station downstream of Fording River. The lowest concentrations of selenium were measured in samples collected during freshet, when flows are relatively high, then gradually increased until the onset of the next freshet. Measured concentrations of selenium in samples collected from the Elk River upstream of Boivin Creek all complied the water quality target of 19 ug/L, although the same seasonal trend is evident. It is

noted that the 19 ug/L water quality target for the Elk River Order Station downstream of Fording River was not intended to apply until 2023.

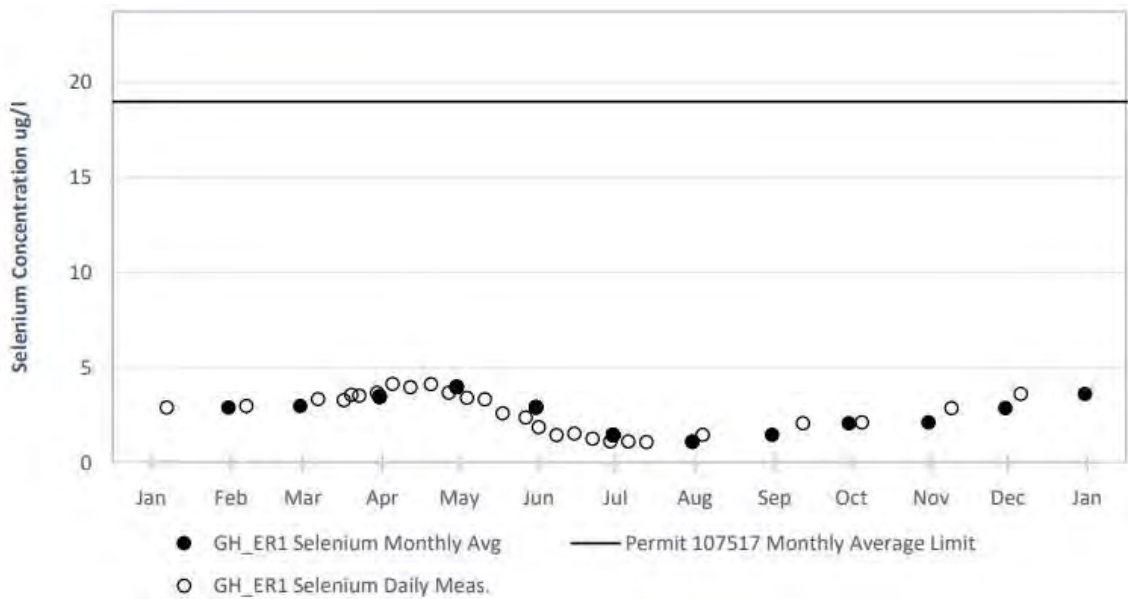
**Insert 5-6: Total Selenium Concentrations in Upper Elk River, 1999 – 2022** (Source: Teck, 2023h, Figure 49)



**Insert 5-7: Total Selenium Concentrations in Elk River Downstream of Fording River – 2022** (Source: Teck, 2023h, Figure 13)



**Insert 5-8: Total Selenium Concentrations in Elk River Upstream of Boivin Creek – 2022**  
Source: Teck, 2023h, Figure 14)



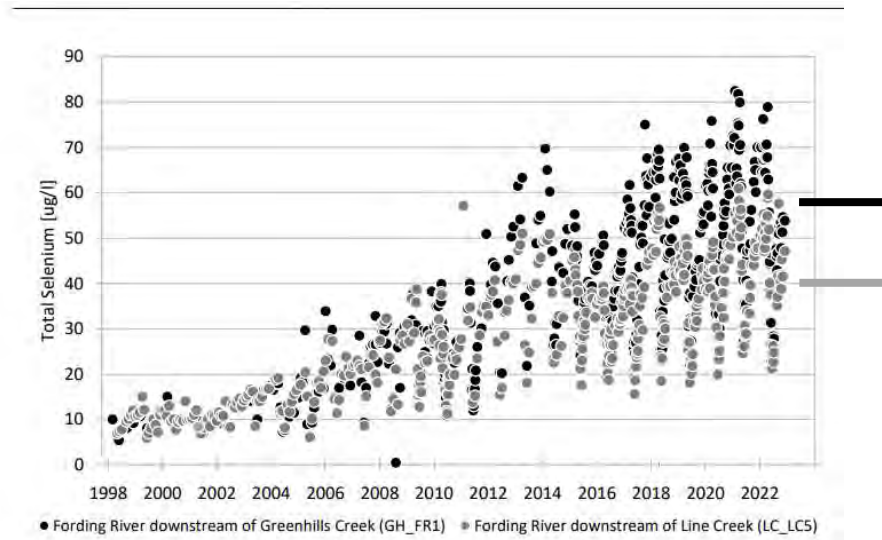
## Fording River

The two Fording River Order Stations are located downstream of Greenhills Creek (downstream of Fording River and Greenhills Mines), and downstream of Line Creek (downstream of the Line Creek Mine). The water quality targets for these Order Stations are 57 ug/L and 40 ug/L, respectively (see **Table 4.3**), and were committed to be met by 2022 and 2023, respectively. Monitoring of these Order Stations has occurred since 1998 (see **Insert 5-9**). Review of the data presented in **Insert 5-9** indicates that total selenium concentrations are steadily increasing at both monitoring points, and that measured selenium concentrations now routinely exceed the respective water quality targets. The upwards trend in measured selenium concentrations indicates that exceedances are likely to occur more frequently in the future and that the mitigations introduced between 2014 and 2022 had little measurable effect through 2022.

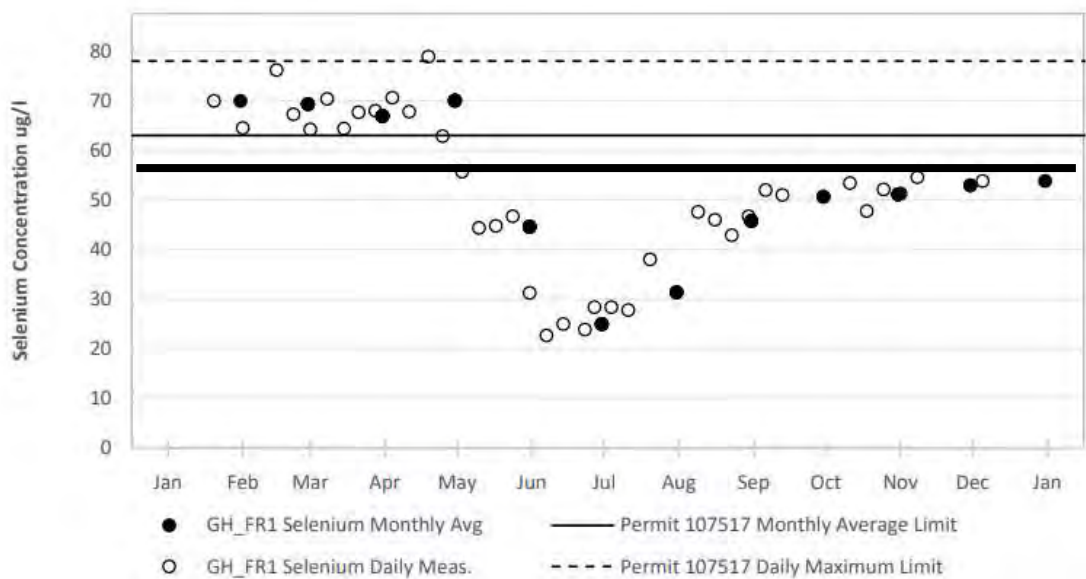
The measured average monthly and daily measured concentrations of selenium in samples collected at the Order Stations in the Fording River, downstream of Greenhills Creek and Line Creek, in 2022 are presented in **Inserts 5-10 and 5-11**, respectively. Review of the data presented in these charts indicates that exceedances of these water quality targets occur regularly at both Order Stations, up until freshet, then occasionally in the fall, following freshet. The lowest concentrations of selenium were measured in samples collected during freshet, when flows are relatively high, then increase gradually until the onset of the next freshet. It is

noted that the water quality target for the Fording River downstream of Line Creek came into effect in 2023 (Teck, 2014).

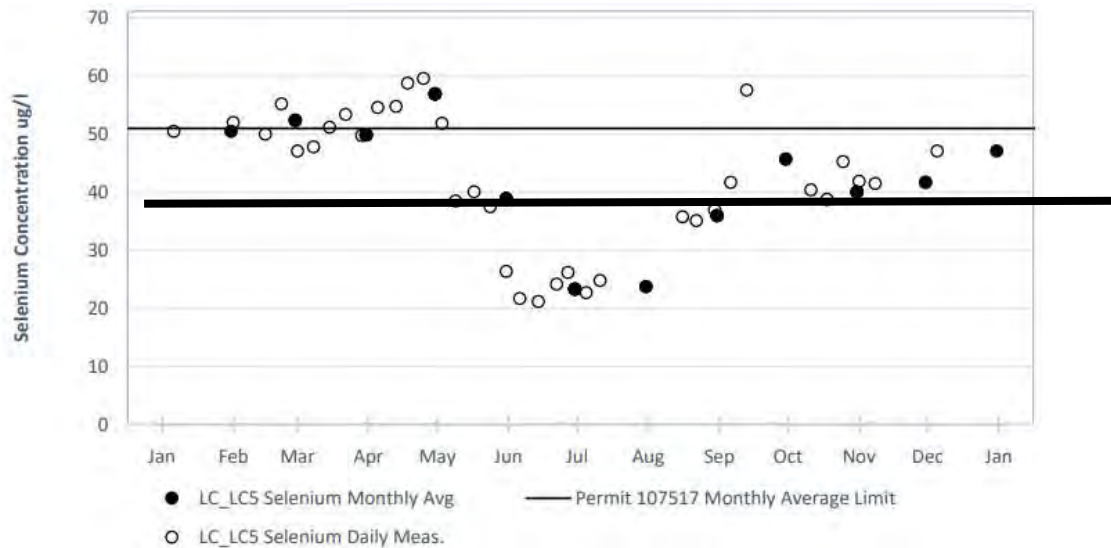
**Insert 5-9: Total Selenium Concentrations in Fording River, 1998 – 2022** (Source: Teck, 2023h, Figure 48)



**Insert 5-10: Total Selenium Concentrations in Fording River Downstream of Greenhills Creek – 2022** (Source: Teck, 2023h, Figure 10)



**Insert 5-11: Total Selenium Concentrations in Fording River Downstream of Line Creek – 2022**  
(Source: Teck, 2023h, Figure 11)



## 5.2 Compliance Points

Seven Compliance Points have been established in the Elk Valley and are described in Section 2.1 through 2.7 of Permit 107517. The compliance points are intended to capture and represent all or most point and non-point discharges from Teck mines, which each mine is intended to comply with. Each Compliance Point is meant to reflect the total discharges from the corresponding mine to the receiving environment. Compliance points are subject to the authorized discharge limits specified in Section 2.1 to 2.7 of Permit 107517 and the authorized discharge limits specified in Section 3.3 of Permit 107517 (Teck, 2023h). Generally, from upstream to downstream, these Compliance Points are as follows (**Figure 5-1**):

**Table 5.1**  
**Elk Valley Compliance Points and Description**

Name	EMS ID	Location Code	Site Description
Fording River Mine - Fording River	E223753	FR_FRABCH	Fording River, 100 m u/s of Chauncey Creek
Greenhills Mine - Elk River	E300090	GH_ERC	Elk River, 220 m d/s of Thompson Creek
Greenhills Mine - Fording River	0200378	GH_FR1	Fording River, 205 m d/s of Greenhills Creek
Line Creek Mine - Line Creek	E297110	LC_LCDSSLCC	Line Creek, 1500 m d/s of WLC AWTF
Elkview Mine - Harmer Creek	E102682	EV_HC1	Harmer Spillway
Elkview Mine - Michel Creek	E300091	EV_MC2	Michel Creek at Highway 3 bridge
Coal Mountain Mine - Michel Creek (U/S of EV_MC2)	E258937	CM_MC2	Michel Creek, 50 m u/s of Andy Good Creek

Selenium authorized discharge limits have been developed on a site-specific basis, associated with each Compliance Point. The authorized discharge limit for each Compliance Point is provided in the **Table 5.2**. They are also shown on the historical selenium data graphs (**Inserts 5-13, 5-15, 5-17, 5-19, 5-21**).

**Table 5.2**  
**Elk Valley Compliance Point Authorized Discharge Limits**

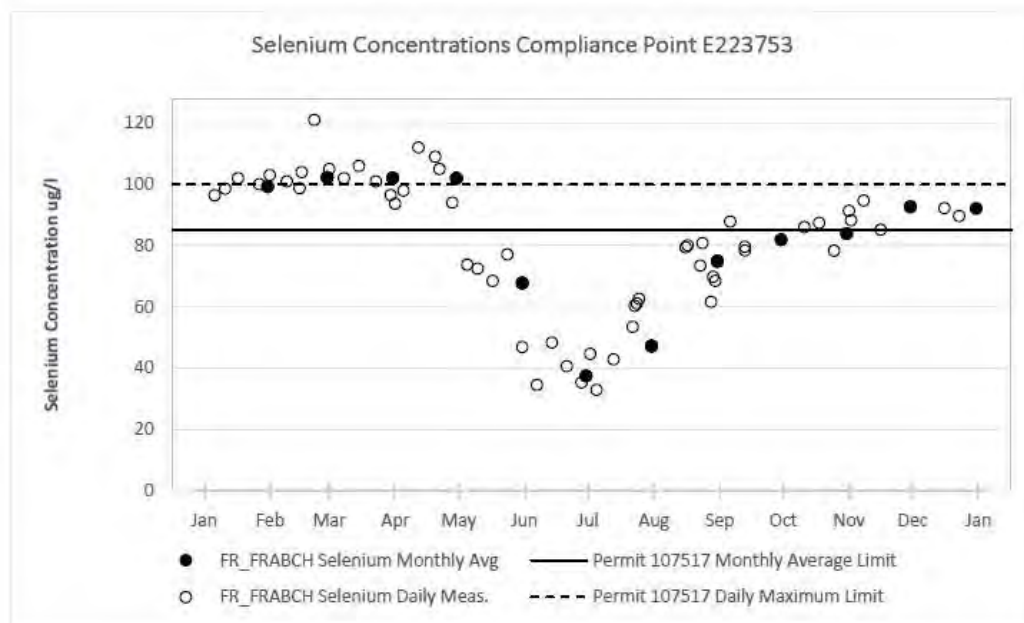
Name	Short Term	Medium Term	Long Term
Fording River Mine - Fording River	--	85 ug/L	58 ug/L
Greenhills Mine - Elk River	15 ug/L	--	8 ug/L
Greenhills Mine - Fording River	80 ug/L	63 ug/L	57 ug/L
Line Creek Mine - Line Creek	80 ug/L	50 ug/L	29 ug/L
Elkview Mine - Harmer Creek	45 ug/L	57 ug/L	57 ug/L
Elkview Mine - Michel Creek	28 ug/L	20 ug/L	19 ug/L
Coal Mountain Mine - Michel Creek (U/S of EV_MC2)	28 ug/L	20 ug/L	19 ug/L

### Fording River Mine

There is one Compliance Point associated with Fording River Mine in Fording River. The current long-term authorized discharge limit is 58 ug/L, reduced from 85 ug/L in late 2023. 2022 selenium monitoring data, as well as historical selenium monitoring data dating back to 2015 are provided in **Insert 5-12** and **Insert 5-13**, respectively. Review of the data presented in these charts indicates that there are consistent exceedances of the medium-term monthly and daily limits. Exceedances of daily and monthly average limits occurs consistently between January through April, after which high freshet flow rates likely dilute selenium concentration below the limit. After this high flow period, between May through August, selenium concentrations consistently exceed monthly average limits between October through to freshet of the following year. Similarly, historical data indicates that authorized discharge limits are not being met throughout the entire year excluding months June through September. Consistent exceedances of the medium-term water quality target (85 ug/L) are observed. The authorized discharge limit for Fording River Mine – Fording River has been reduced to 58 ug/L in 2024, indicating exceedances will be observed throughout the entire year excluding peak freshet flows in late June or early July. Historical data is only available from 2021, this is because the Compliance Point was relocated in March 2021. It is unclear why previous historical data associated with the Fording River Mine Compliance Point was not reported. Accordingly, a consistent trend in selenium concentrations is not established for this Compliance Point.



**Insert 5-12: Total Selenium Concentrations at Compliance Point Fording River Mine – Fording River – 2022 (Source: Teck, 2023h)**



**Insert 5-13: Total Selenium Concentrations at Compliance Point Fording River Mine – Fording River – 2021 through 2023 (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)**



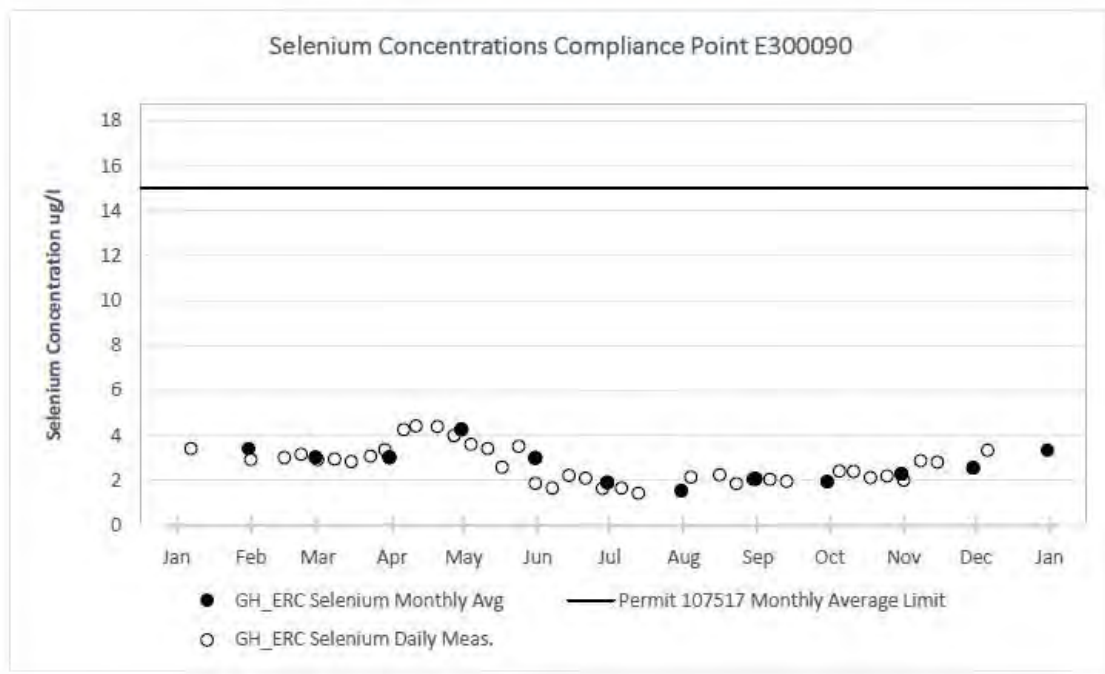
# Burgess Environmental

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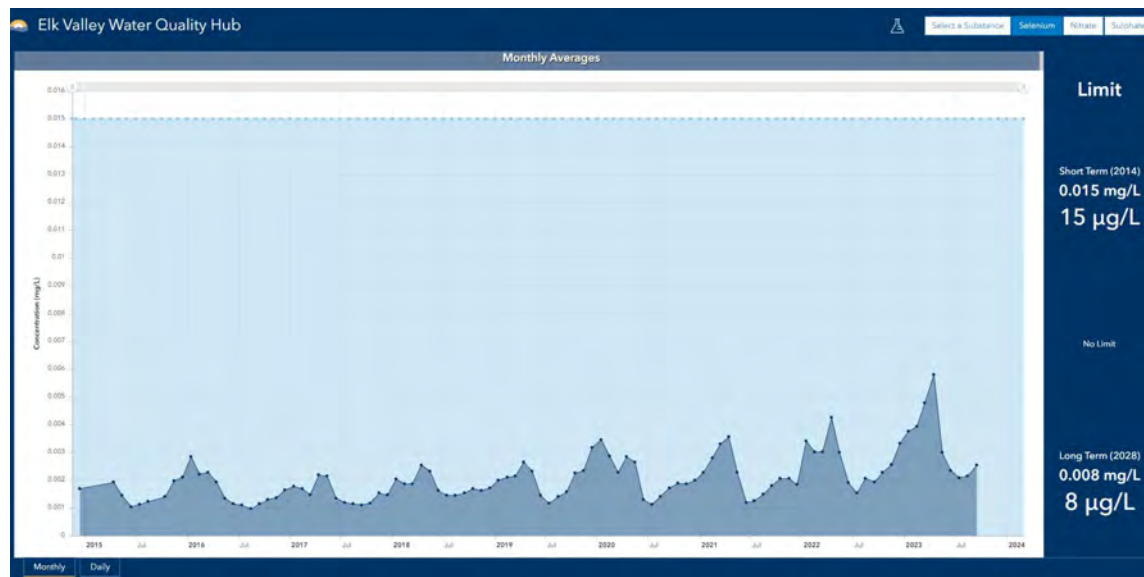
## Greenhills Mine

There are two Compliance Points associated with Greenhills Mine, one in Fording River, downstream of Greenhills Creek, and one in Elk River, downstream of Thompson Creek. The Fording River Compliance Point is also an Order Station and is discussed in the previous section. See **Insert 5-10** for Total Selenium Concentrations in Fording River – 2022 and **Insert 5-9** for Total Selenium Concentrations in Fording River, 1998 – 2022. Selenium concentrations at the Compliance Point/Order Station are steadily increasing and are routinely exceeding water quality targets. The Elk River Compliance Station associated with Greenhills Mine has a current selenium authorized discharge limit of 15 ug/L. In 2022 (**Insert 5-14**), there were no observed exceedances of the authorized discharge limit. Review of historical selenium monitoring data dating back to 2015 (**Insert 5-15**) at the Greenhills Mine – Elk River Compliance Point indicates an increasing trend. The authorized discharge limit at this Compliance Station is decreasing to 8 ug/L in 2028.

**Insert 5-14: Total Selenium Concentrations at Compliance Point Greenhills Mine – Elk River – 2022** (Source: Teck, 2023h)



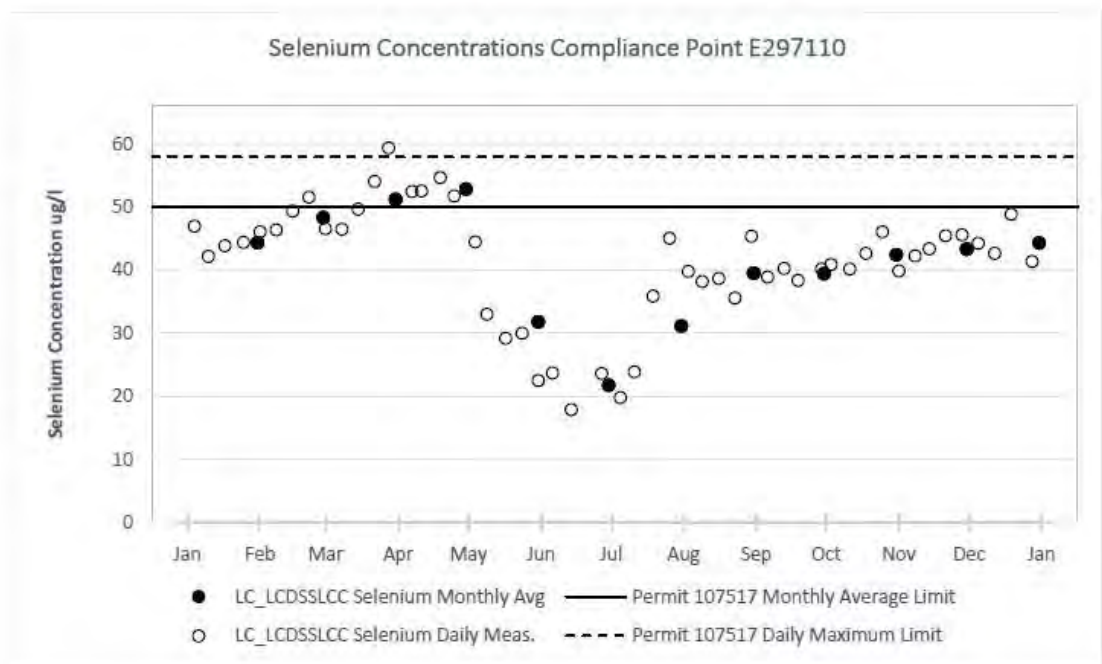
**Insert 5-15: Total Selenium Concentrations at Compliance Point Greenhills Mine – Elk River – 2015 through 2023** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)



## Line Creek Mine

There is one Compliance Station associated with Line Creek Mine and it is located in Line Creek. The current authorized discharge limit at this station is 50 ug/L, lowered from 80 ug/L in 2016. Selenium concentrations in 2022 are shown in **Insert 5-16**. Review of the data presented in this chart indicates that exceedances of the authorized discharge limits occur at the Compliance Point, up until freshet. Selenium concentrations then increase in the fall, following freshet. Historical selenium monitoring data back to 2015 is provided in **Insert 5-17**. Review of this data indicates that there were significant exceedances of authorized discharge limits in 2018 and minor exceedances in 2022. The data suggests a generally flat or stable selenium concentration trend, and a significant decrease is measured selenium concentrations is evident after commissioning of the Line Creek active water treatment facility in 2018.

**Insert 5-16: Total Selenium Concentrations at Compliance Point Line Creek Mine – Line Creek – 2022** (Source: Teck, 2023h)



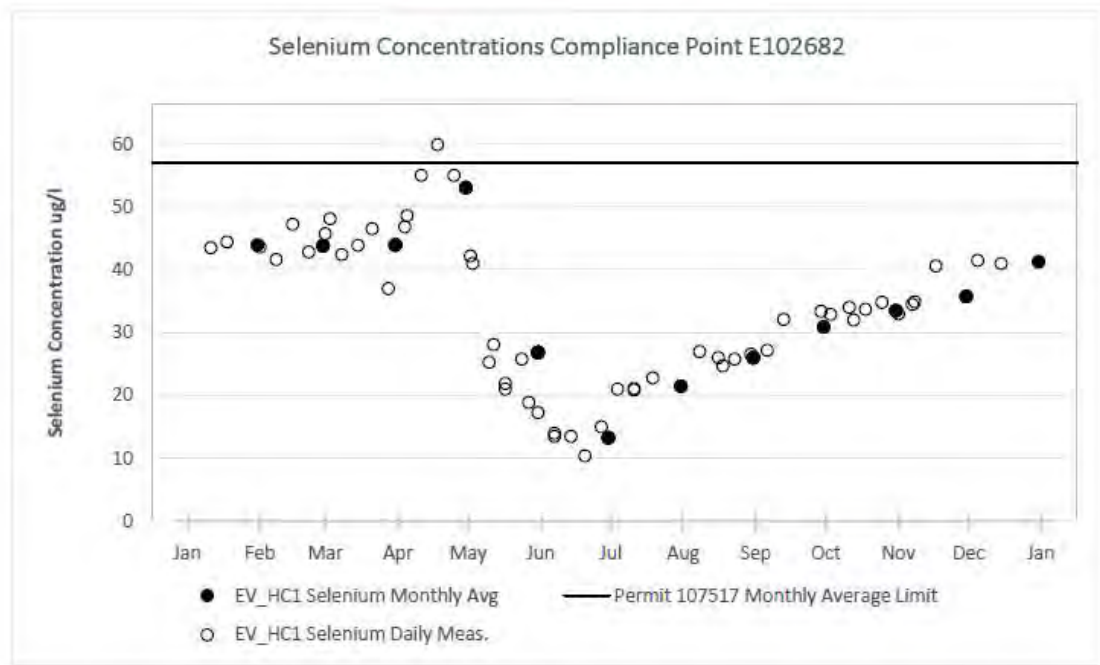
**Insert 5-17: Total Selenium Concentrations at Compliance Point Line Creek Mine – Line Creek – 2015 through 2023** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)



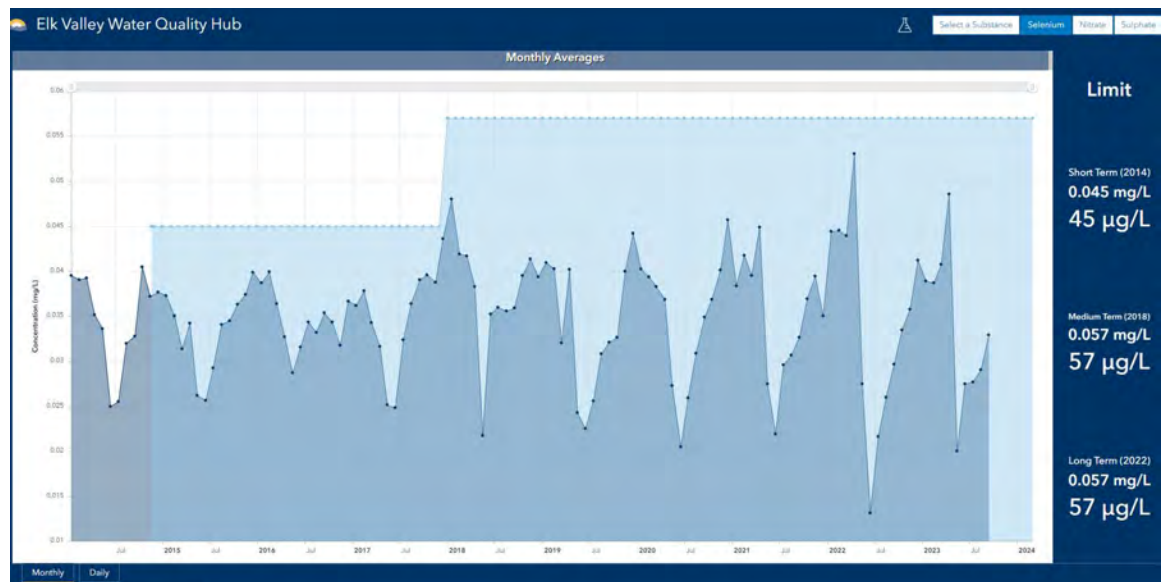
## Elkview Mine

Two Compliance Points are associated with Elkview Mine, one in Harmer Creek and one in Michel Creek. The current authorized discharge limits are 57 ug/L and 19 ug/L for Harmer Creek and Michel Creek, respectively. Harmer Creek Compliance Station selenium monitoring data for 2022, as well as historical data dating back to 2015, are provided in **Insert 5-18** and **Insert 5-19**, respectively. Review of this data indicates a single exceedance of the authorized discharge limit was observed in April 2022. Annual selenium trends are consistent with other Order Stations and Compliance Points. It is noted that in 2018, the authorized discharge limit was increased from 45 ug/L to 57 ug/L and remains the long-term target. It is unclear why this limit was increased, and appears to be the only instance of a limit increasing. Selenium concentrations would be consistently exceeding the previous target of 45 g/L, both annually and historically, if this target concentration were left in place. Historically, selenium trends are generally consistent, seemingly becoming more variable over time, with the two highest selenium concentrations occurring in 2022 and 2023. Michel Creek Compliance Station selenium monitoring data for 2022, as well as historical data dating back to 2015, are provided in **Insert 5-20** and **Insert 5-21**, respectively. Review of these data indicates that exceedances of the authorized discharge limit of 20 ug/L occurred in late April, and regularly in fall months (daily measurement only), and that measured concentrations may be decreasing.

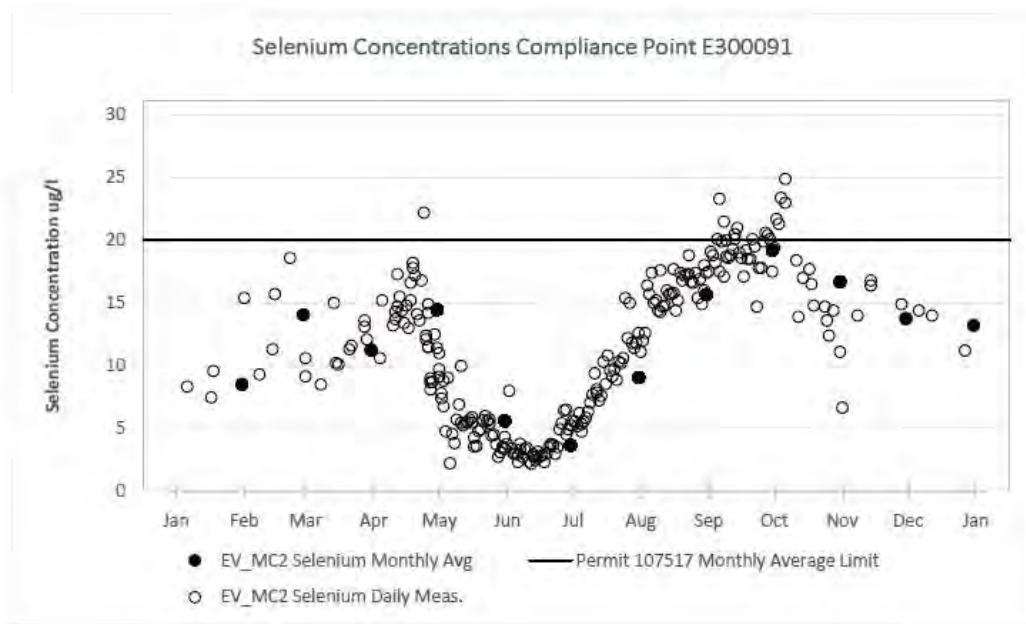
**Insert 5-18: Total Selenium Concentrations at Compliance Point Elkview Mine – Harmer Creek – 2022** (Source: Teck, 2023h)



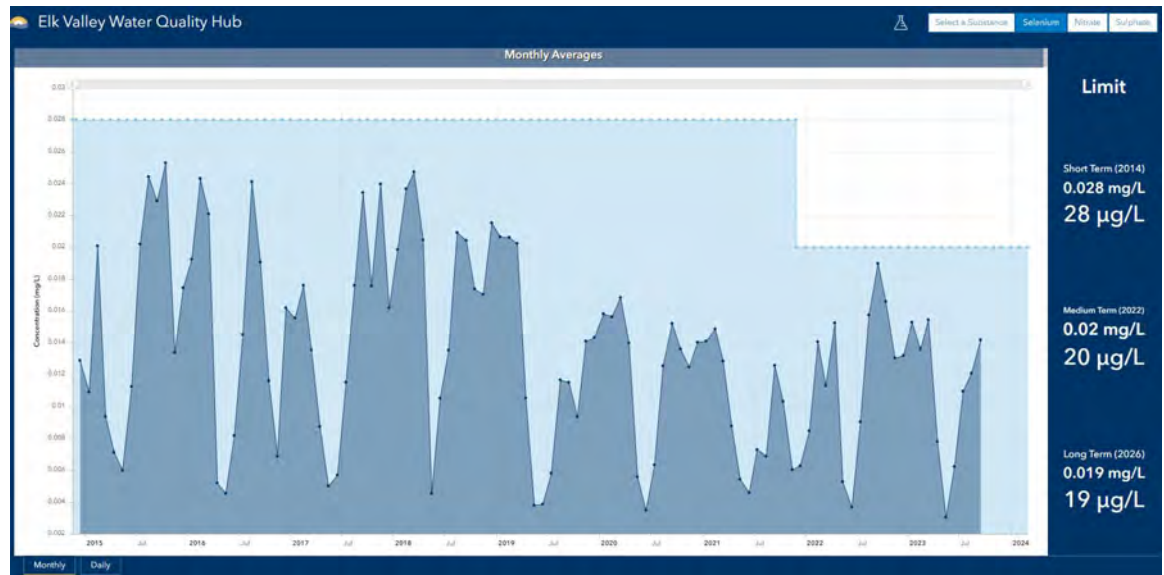
**Insert 5-19: Total Selenium Concentrations at Compliance Point Elkview Mine – Harmer Creek – 2015 through 2023** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)



**Insert 5-20: Total Selenium Concentrations at Compliance Point Elkview Mine – Michel Creek – 2022** (Source: Teck, 2023h)



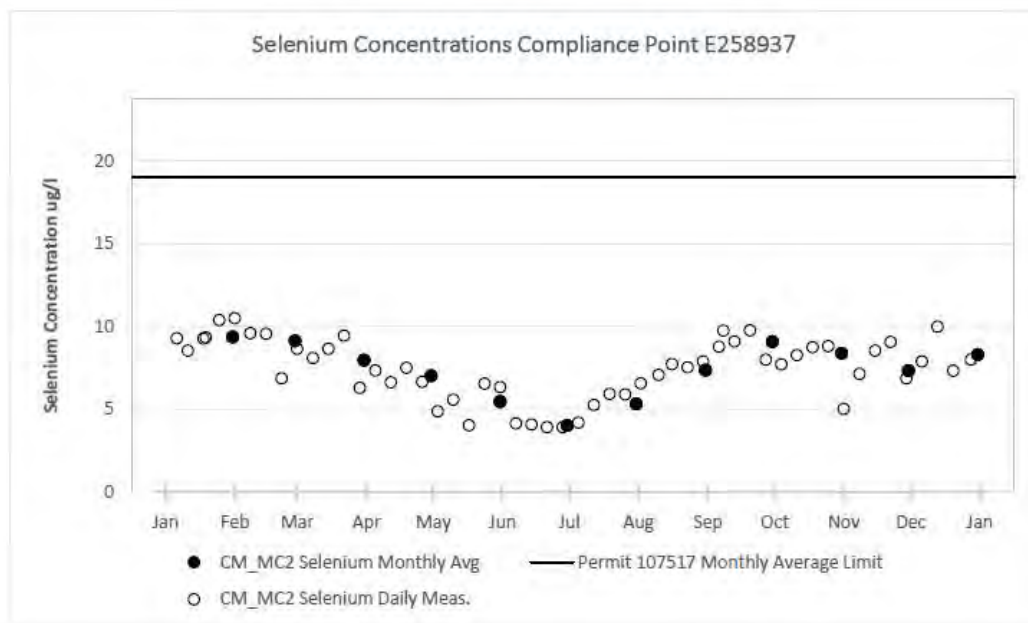
**Insert 5-21: Total Selenium Concentrations at Compliance Point Elkview Mine – Michel Creek – 2015 through 2023** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)



## Coal Mountain Mine

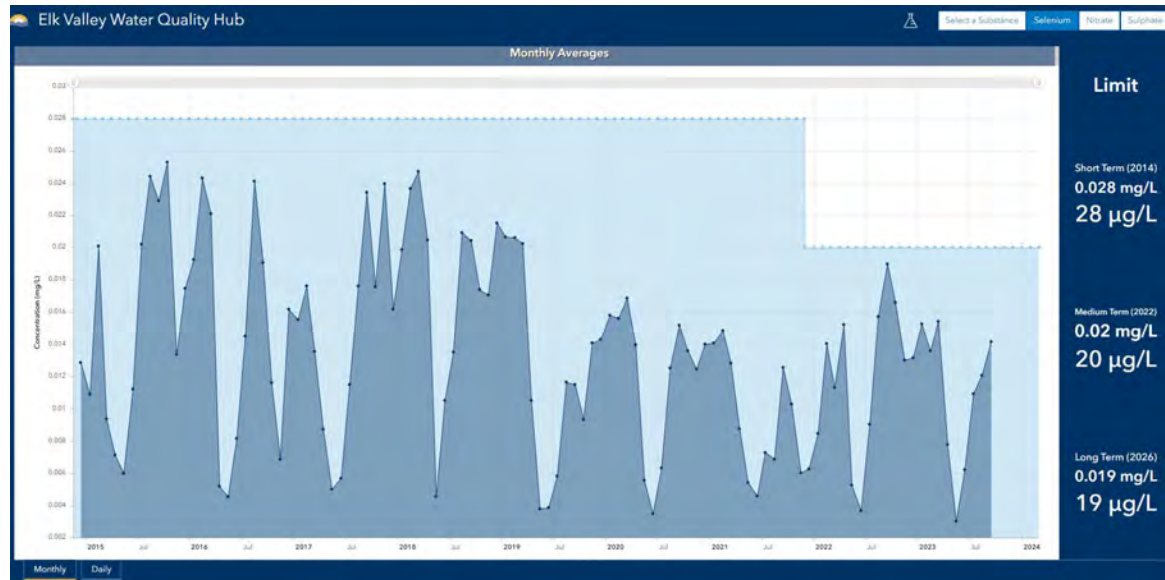
One Compliance Point is associated with the Coal Mountain Mine, located in Michel Creek, 50 m upstream of Andy Good Creek. The current authorized discharge limit at this Compliance Point is 20 ug/L, reducing to 19 ug/L in 2026 as the long-term target. 2022 Selenium monitoring data, as well as historical selenium monitoring data are provided in **Insert 5-22** and **Insert 5-23**, respectively. Review of the data presented in these charts indicates that no exceedances of the authorized discharge limit of 20 ug/L were observed in 2022. Seasonal selenium trends are generally consistent with other monitoring stations, the lowest concentrations occurring in samples collected in the middle of summer, when flows are relatively high. Historical selenium monitoring data is available dating back to 2015. Review of this data indicates that selenium concentrations recorded at the Michel Creek Compliance point for Coal Mountain Mine are generally decreasing, however, a rebound effect may be occurring since 2022.

**Insert 5-22: Total Selenium Concentrations at Compliance Point Coal Mountain Mine – Michel Creek – 2022** (Source: Teck, 2023h)





**Insert 5-23: Total Selenium Concentrations at Compliance Point Coal Mountain Mine – Michel Creek – 2015 through 2023** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)

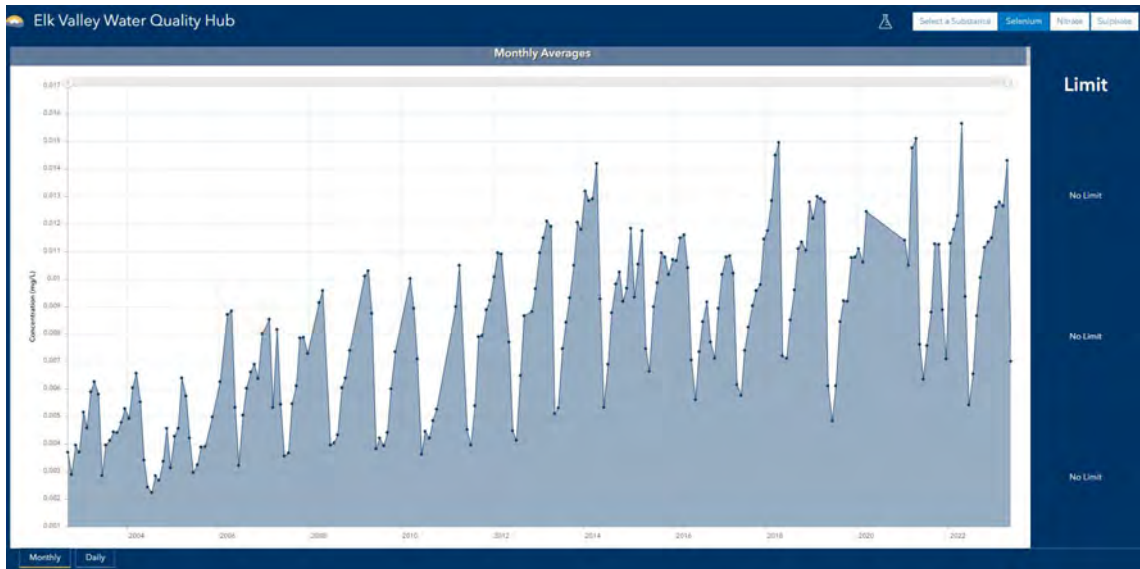


## Trend Stations

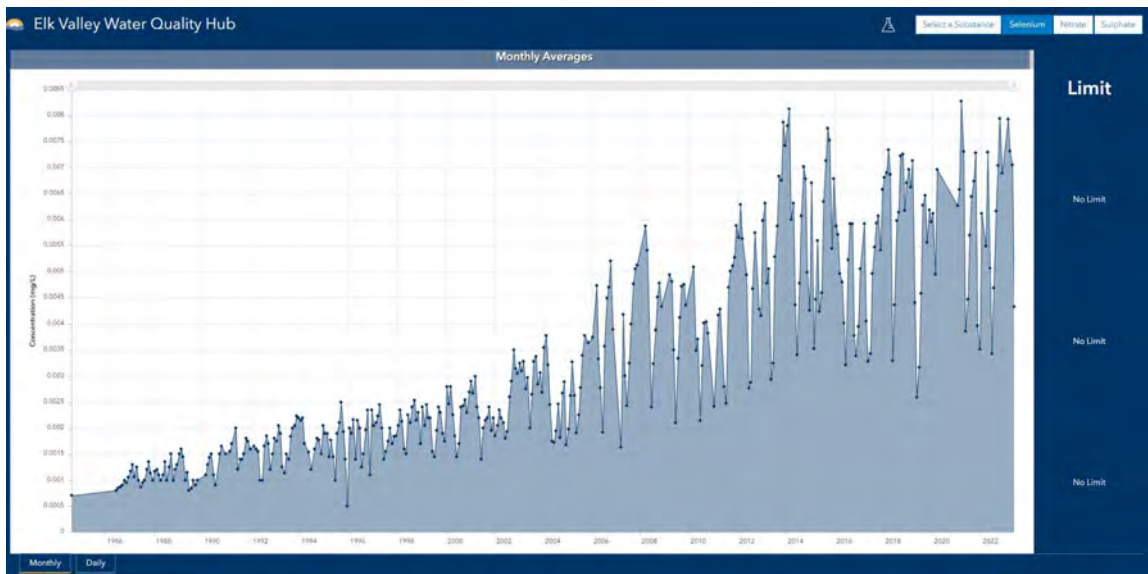
Two Trend Stations are also monitored on a regular basis, which are located on Elk River, downstream of the Town of Sparwood and downstream of Elko. These Trend Station locations are near the Order Stations located on Elk River downstream of Michel Creek, and at Elko, respectively. The data show very similar increasing trends and seasonal fluctuations. The measured concentrations of selenium are below the water quality target of 19 µg/L for Elk River, although the selenium concentrations measured at the Trend Station located downstream of Sparwood are approaching this water quality target.

Notably, the data collected at the Trend Station located downstream of Elko indicate that the measured concentrations of selenium in 1986 were consistently below 1.5 µg/L and were usually below 1.0 µg/L. The background selenium concentrations, and the selenium concentrations in Elk River at this location before mining, would typically have been below 1 µg/L. Current measured concentrations are now commonly 7 to 8 times this concentration. This Trend Station location is significant because it is located immediately upgradient of the confluence of Elk River into Lake Koochanusa.

**Insert 5-24: Total Selenium Concentrations at Trend Site: Elk River downstream of Sparwood: 2004 through 2022** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)



**Insert 5-25: Total Selenium Concentrations at Trend Site: Elk River downstream of Elko: 1986 through 2022** (Source: British Columbia Elk Valley Water Quality Hub – Water Quality Data Dashboard)

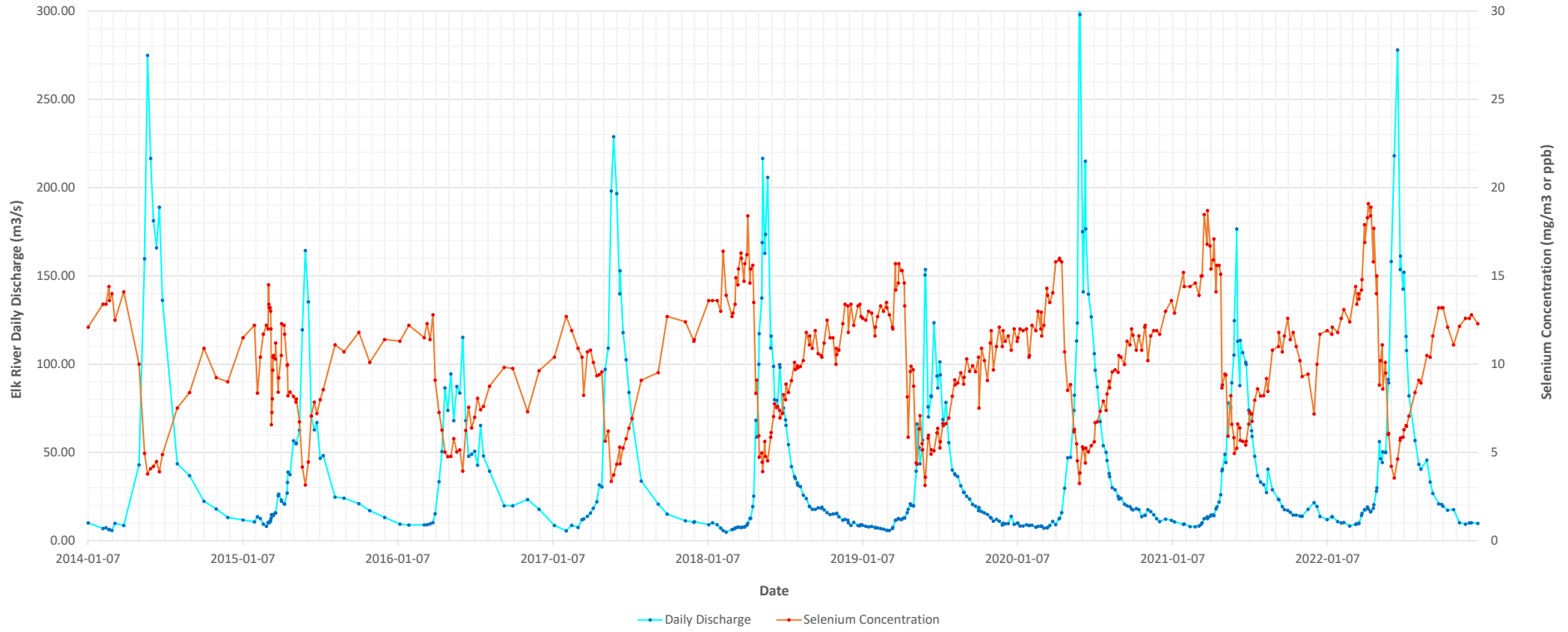


## 5.3 Assessment of Surface Water Monitoring Trends and Mass Loading


Selenium concentrations in Elk River follow a very predictable seasonal trend, which is depicted in **Figure 5-2** for the Elk River Order Station downstream of Michel Creek. This location was selected because it is the Order Station furthest upstream in Elk River that captures all of the surface water impacts from all of Teck's mines in the Elk Valley. Review of **Figure 5-2** indicates that selenium concentrations fall rapidly at the onset of freshet, then generally increase gradually throughout the year until the onset of the next freshet. This could be the result of mine spoil seepage, and to a lesser extent groundwater, accounting for an increasing proportion of the Elk River flows between freshets, as well as the diminishing dilution effects of freshet, over time, between freshets.

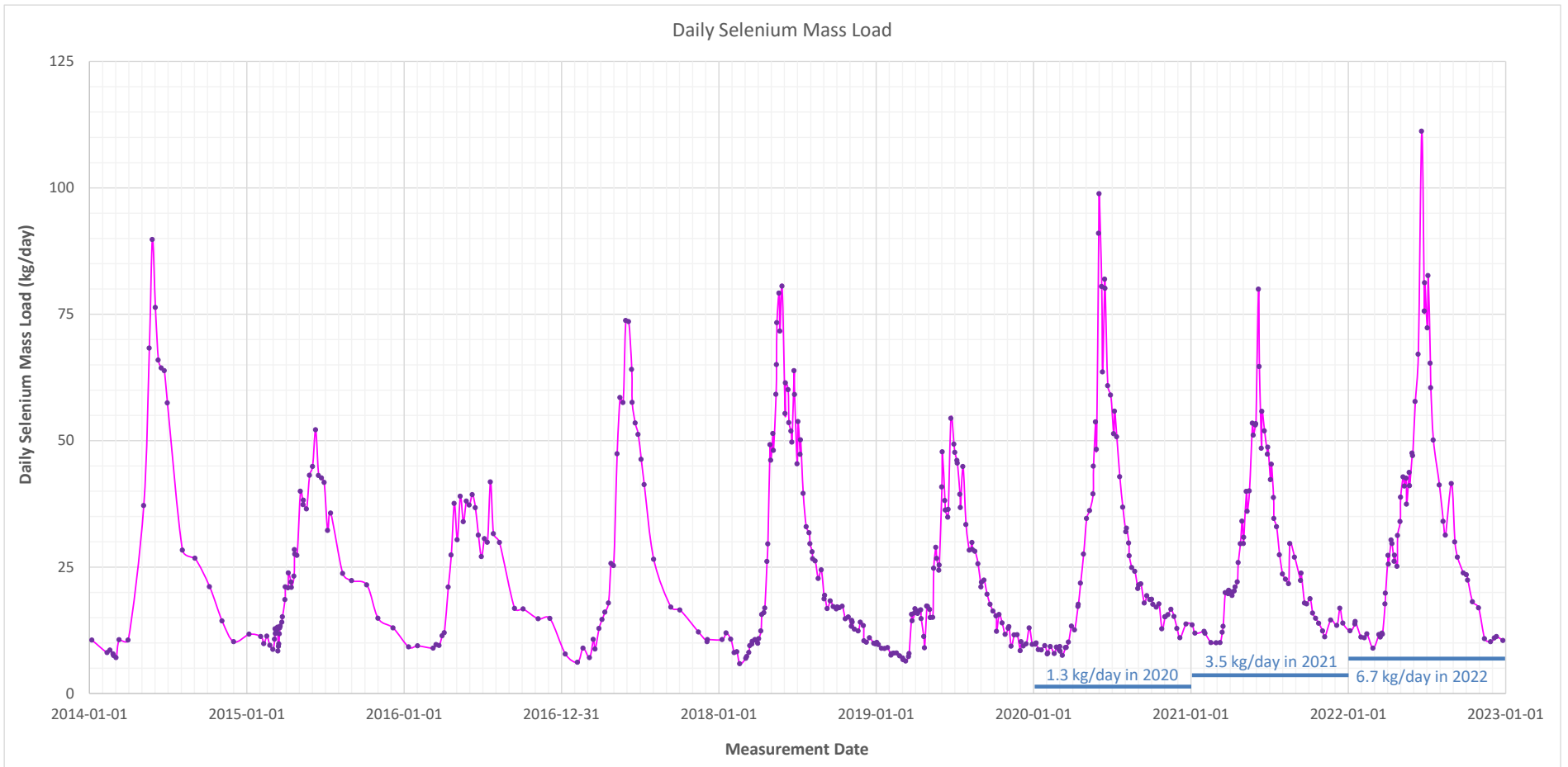
The opposite is the case when considering overall selenium mass loading in Elk River. Review of **Figure 5-3** indicates that peak selenium mass loading occurs during freshet, and then gradually diminishes until the onset of the following freshet. Review of **Figure 5-3** also indicates that the proportion of the mass of selenium removed by the water treatment is low relative to the total selenium mass loading in Elk River. The daily average mass of selenium removed by the water treatment facilities from 2020 through 2022 is superimposed on **Figure 5-3**. Review of **Figure 5-3** indicates that the water treatment facilities removed approximate 5% of the total mine-related loading to the Elk River watershed in 2020, approximately 13% in 2021, and 19% in 2022.

Daily Discharge vs. Daily Selenim Concentrations



Elk River downstream of Michel Creek


<b>WILDSIGHT</b>		
SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOIUTHEAST BRITISH COLUMBIA		
<b>Flow Rates and Measured Selenium Concentrations</b>		
	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>5-2</b>



Elk River downstream of Michel Creek

1.3 kg/day in 2020

Average Daily Selenium Removal Rate

<b>WILDSIGHT</b>		
SELENIUM RELATED RECLAMATION LIABILITIES TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA		
<b>Selenium Mass Loading</b>		
	Date: 3/9/2024	Scale:
	Project No.: WILD-01	Figure No.: <b>5-3</b>

## 5.4 Groundwater Data

### General

The groundwater monitoring program completed in 2022 by SNC (2023) includes summaries of the site-specific groundwater monitoring programs completed for the 5 mine operations, as well as the regional groundwater monitoring program. This section summarizes the results of the regional monitoring, with specific focus on groundwater used for domestic supplies. The results of groundwater monitoring at individual mines are summarized in **Section 4**.

Selenium contamination of groundwater is relevant to this assessment because most groundwater in the mine areas discharges to tributaries of Elk River. A primary objective of the groundwater monitoring program appears to have been to provide input into the surface water quality model. The regional groundwater monitoring program also provides insight into the selenium contamination of existing and potential groundwater supplies in the Elk Valley.

### Background

Background selenium concentrations in groundwater were generally determined as part of the site-specific programs. Dissolved selenium concentrations in background groundwater samples typically varied between non-detect and 1 ug/L, but could exceed 5 ug/L. Increasing concentrations of numerous order constituents (contaminants: selenium, nitrate, sulphate, etc.) were measured at some of these background monitoring well locations (SNC, 2023, Vol. I, PDF pages 7 and 8 of 110), which suggests that groundwater at some of these locations could be affected by mining.

### Groundwater Quality Criteria

The screening criteria were established for the following pathways (SNC, 2023):

- Human Health: groundwater for drinking water use was applied as a default value, using the Contaminated Sites Regulation (CSR) for drinking water. The B.C. CSR drinking water criterion for selenium is 10 ug/L. This criterion is lower than that established by Health Canada (2014), as described below.
- Freshwater Aquatic Life: groundwater discharging to aquatic environments was also applied as a default use for wells within 10 m of a high-water mark. The secondary screening values appeared to rely on the water quality targets assigned to specific reaches of the Fording and Elk Rivers.
- Irrigation and Livestock Watering: groundwater for livestock or irrigation watering use were also applied as livestock and irrigation water supplies are sourced from groundwater wells in some locations. These criteria were also used as a surrogate for wildlife watering.

A maximum acceptable concentration (MAC) of 0.05 mg/L (50 µg/L) has also been established for total selenium in drinking water by Health Canada (2014). Selenium is a naturally occurring element which is ubiquitous in the environment. It is generally present in elemental form, or in the form of selenide ( $\text{Se}^{2-}$ ), selenate ( $\text{SeO}_4^{2-}$ ), or selenite ( $\text{SeO}_3^{2-}$ ). Most literature indicates that selenium is not carcinogenic; hence, the MAC for selenium in drinking water is based on chronic, long-term exposure. Selenosis symptoms resulting from chronic exposure to high levels of selenium are characterized by hair loss, nail anomalies or loss, skin anomalies, garlic odour of the breath, tooth decay and, more severely, disturbances of the nervous system. Links have also been found between selenium exposure and other diseases such as diabetes and glaucoma, but results need to be confirmed before conclusions can be drawn (Health Canada, 2014).

### Selenium in Groundwater

Executive Summary of the groundwater report (SNC, 2023) indicates that concentrations of dissolved selenium commonly exceeded the screening criteria in mine-affected areas, and were often increasing in concentration. This was the case for samples collected from groundwater monitoring wells completed on the mine sites as well as from monitoring wells completed as part of the regional network.

Selenium contamination has been measured in private and municipal source wells for domestic consumption. Teck (2014, PDF page 118 of 290) measured selenium concentrations in excess of the MAC in 5 of the 91 private and/or public water wells that were sampled at that time. According to Wildsight, Teck has provided alternative water supplies or treatment at 9 locations. In 2020, Sparwood had to relocate a well due to rising selenium levels, Fernie posted well water selenium concerns in 2022, had exceedances in April 2023, and began exploring for new wells in the end of 2023. There is a trend of increasing selenium contamination of alluvial aquifers in the Elk Valley, over time. According to SNC (Teck, 2014, Annex L2 page 17), "*selenium exceedances in the Elk River floodplain appear to result from recharge from the Elk River*".

Teck also monitors private drinking water wells, although it does not publish these results. In 2022, the concentrations of selenium were greater than the drinking water criterion at 11 wells; 3 of these 11 wells also contained sulphate concentrations greater than the drinking water criterion. Water quality results were provided to the respective well users.

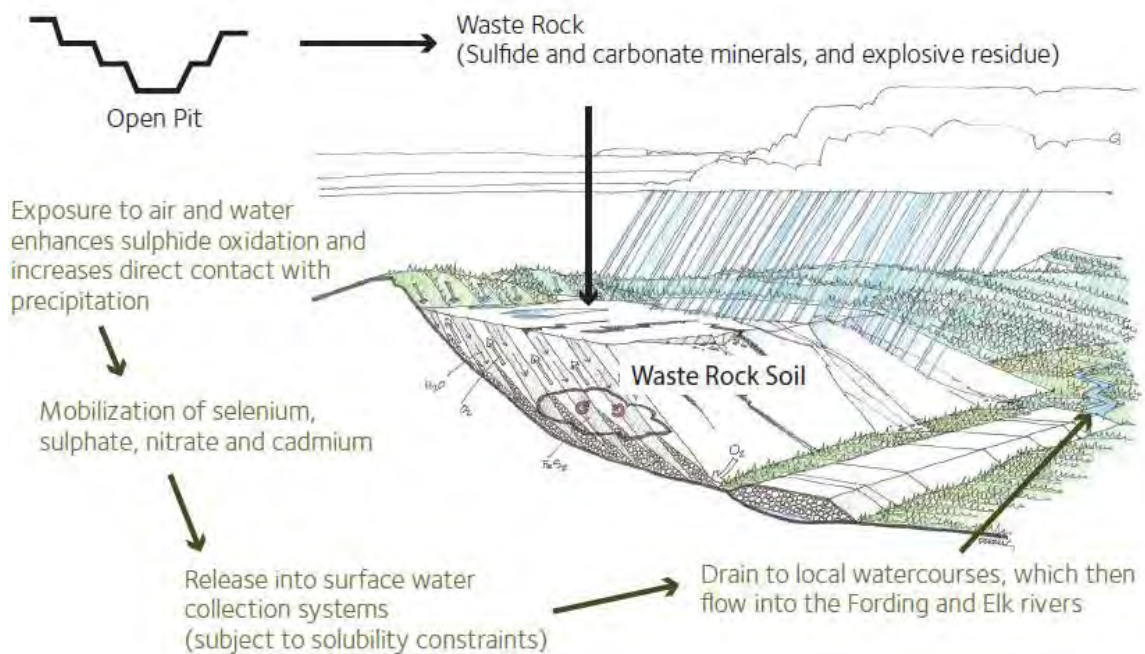
## 6 WATER QUALITY MODELING

### General

This section provides a brief overview of the regional water quality model (titled Elk Valley Water Quality Planning Model; hereinafter referred to as the RWQM) developed by Teck to simulate existing water quality conditions, and predict future contaminant concentrations in the Elk Valley. Specifically, the model was developed as a planning and assessment tool to support the development of the Elk Valley Water Quality Plan(s) required by Ministerial Order No. M113 (Golder, 2014). Permit 107517 requires Teck to update the RWQM every 3 years, based on site-specific investigations of mine-affected water, ongoing monitoring data, and Teck's research and development program regarding selenium contamination and mitigation.

The model has undergone three iterations (documented in 2014, 2017 and 2020/2022 Elk Valley Water Quality Plans and related supporting documentation) at the time of reporting. The original 2014 RWQM was built upon previous modelling tools developed to support Teck's environmental assessment for the Line Creek Mine Phase II project. This impact assessment model was expanded to build the 2014 RWQM, which includes Teck's other mine operations in the Elk Valley.

### Insert 6-1: Conceptual Model of Contaminant Release and Transport (Source: Teck, 2014)





The RWQM was developed using a commercially available, general-purpose simulation software platform called GoldSim (GoldSim Technology Group, 2010). The model includes the following four components, which are included in all three versions of the model:

1. hydrology or flow component (FC)
2. geochemical component that includes source terms that describe the release of selenium, sulphate, nitrate and other constituents from waste rock, pit walls and other mine areas (e.g. tailings and coarse coal rejects)
3. mine site data, including past, present and future conditions
4. water quality constituent transport component (WQC), that is used to estimate constituent concentrations in mine-affected watercourses in the Elk River valley

At its core, the RWQM is a water quality mass balance model. The main inputs to the model include surface water flows, geochemical source terms, and operational mine information (such as rate and placement of waste rock). Surface water flows are defined by monitoring flow data, empirical derivatives, and physically-based hydrologic models that are driven by climate-based inputs. Empirical geochemical source terms are derived from observed water quality monitoring and flow data collected downstream of representative source materials, and considered in combination with known waste rock volumes and surface water flows at the mines (SRK 2014).

The 2014 and 2017 versions of the flow component of the model were constructed using an empirical approach, which was selected as the most appropriate way of representing the current level of understanding of hydrology and geochemical processes, and conditions occurring within the waste-rock spoils and other mine features at a regional scale (Golder 2014). Due to apparent data and resource limitations, a first-principles physically-based model for the flow component was not considered feasible at those times. The 2020/2022 version of the model appears to apply physically-based principles at the local-scale (i.e. mine feature catchments) to generate flow inputs as part of the modelling process. The application of empirical-based modelling appeared to be a limitation of the 2014 and 2017 versions of the RWQM for these impacted catchments. That is, to accurately represent contaminant inputs from mining operations such as pits, rock walls and waste-rock spoils, a physically-based local-scale model was assumed to provide an improved solution compared to the empirical method used in 2014 and 2017. The 2020/2022 RWQM upgrade was likely possible due to an increase in available climate and local flow data for mine-related areas; general advancement of modelling and site understanding; and time/resources availability considering the model has been under development for almost a decade.

A high-level summary of key FC model improvement from 2017 to 2022 include:

- inclusion of a waste rock hydrology module (as discussed above) within the overall flow control module to simulate water flow through waste rock spoils versus relying on a single surrogate watershed (i.e. Cataract Creek) as in previous model versions
- inclusion of a snowmelt runoff module to simulate water flow from undisturbed areas; and to estimate infiltration rates into waste rock spoils
- increasing the level of detail to better represent sub-catchments (increasing from 96 to 154 individual mining sub-catchments)
- accounting for groundwater-surface water partitioning at monitoring locations, and locations where intakes or other water collection systems may be required for water quality management
- extending the historical period considered in the model calibration to include data from 2004 to 2019
- improving calibration in tributaries targeted for mitigation where model performance was previously classified as poor

In terms of model calibration, the objective was to match seasonal and annual patterns in the observed data for high-priority contaminants (i.e. selenium, sulphate and nitrate). The 2014 RWQM was initially calibrated to reflect conditions from 2004 to 2010 and then refined with 2011 and 2012 data. More recent versions of the model have included additional years of data for calibration (e.g. the 2020/2022 RWQM was calibrated using 2004 to 2019).

Model outputs consist of simulated concentrations of substances including nitrate, selenium, and sulphate. The output is in the form of time series (monthly for the 2014 version, weekly or monthly for the 2017 and 2020/2022 versions) at specific monitoring and reporting nodes (Order Stations) within the watershed. Depending on model setup, the output can represent either historical or future conditions.

Measures evaluated for the planning purposes using the RWQM have included:

- active water treatment to remove dissolved substances in mine-affected water and reduce concentrations downstream of the treatment
- diversion to direct clean (i.e., not mine-affected) surface water around waste-rock spoils and reduce the amount of mine-affected water

- mine-affected water management to transfer water with relatively high concentrations to the water treatment plants
- waste-rock cover systems to reduce the infiltration of water through the waste-rock spoils

Sources considered in the mass balance equation for simulations of historical conditions included waste rock, coal rejects, pit-walls and other mine-affected areas, tailings water discharges, and drainage from natural areas. Waste rock and coal rejects included the mass transported via surface flow, and that travelling into the receiving environment through interflow or groundwater (Golder 2014).

The model excludes biological, physical, and chemical decay of substances in surface water, along with adsorption, partitioning, or absorption of substances, consistent with the conceptual model. This is believed to result in conservative estimations of substance levels in the water column (Golder 2014).

### **Additional 2017 Updates**

The 2017 WQRM update report includes comparison of predicted selenium concentrations to water quality targets at the Order Stations, revised to account for delays to the water treatment facilities. The focal areas for the 2017 model update were to improve the calibration for nitrate, and improve tributary flow modelling and concentration projections. Water quality data current to the end of 2016 was used to calibrate the 2017 model update (Teck, 2017).

The conceptual model for waste rock hydrology was updated for the 2017 model. The change was primarily associated with the modeling of unsaturated waste rock. Catchment specific release rates were developed for selenium that included a catchment-specific lag and loading distribution, which was implemented to account for travel times from waste rock through to the receiving environment, as well as seasonality. These changes to model inputs were further refined through the calibration process (Teck, 2017).

### **Additional 2020 Updates**

The water quality component of the RWQM was updated in 2020 and the flow component in 2022. The RWQM did not incorporate the 2020 flow component model upgrades (physical-based modeling) described above due to time constraints. Therefore, the 2020 modelling used a similar modeling approach to 2017 (see **Figure 6-1**). Focus of the 2020 model update included (Teck, 2021, Section 7.1):

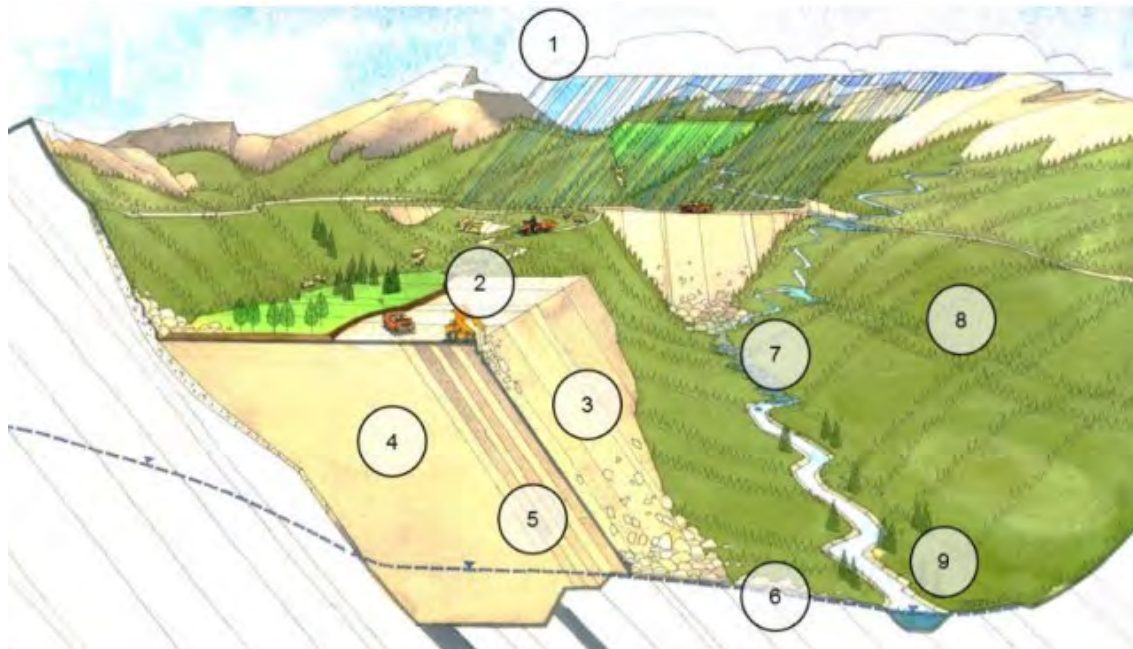
- updating the numerical representation of hydraulic lag to account for the quicker release of constituents from new mine spoils (as discussed above)

## Burgess Environmental

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- applying hydraulic lag and leaching efficiency to constituents released from rehandled materials
- changing the model framework to allow for a more dynamic release of constituent mass from waste rock spoils
- calibrating the updated model with the goal of improving model performance

The 2017 and 2020/2022 RWQM performance appears to have improved, as discussed in **Section 7**.



1	<p><b>Net Percolation</b></p> <ul style="list-style-type: none"> <li>The amount of water that enters from the surface of the waste piles is a function of precipitation and snowmelt minus evaporation, transpiration and sublimation.</li> <li>Run-off from the unsaturated waste rock is negligible</li> </ul>
2	<p><b>Rock placement and physical conditions</b></p> <ul style="list-style-type: none"> <li>Waste placement is tracked as bank cubic metres (BCM) of waste placed per year and is a primary factor in source term development.</li> <li>The method of construction can influence the flowpaths that constituents of interest (CIs) travel to exit the waste piles.</li> </ul>
3	<p><b>Leaching of explosives residuals contributes inorganic nitrogen (e.g., nitrate) to contact waters</b></p> <ul style="list-style-type: none"> <li>Leaching of explosives residuals are expected to diminish with time since a finite amount of explosives are introduced during mining and nitrogen forms are not expected to be generated significantly by rock weathering.</li> <li>The amount of <math>\text{NO}_3^-</math> present is a function of placed waste rock, powder factor, management practices, wet/dry holes, blast utilization and is present dominantly as <math>\text{NO}_3^-</math>.</li> </ul>
4	<p><b>Geochemical weathering processes under oxygenated conditions</b></p> <ul style="list-style-type: none"> <li>Oxidation of pyrite results in release of soluble components of pyrite, mainly sulphate, but also traces of elements including selenium and other metals.</li> <li>Dissolution of acid-neutralizing minerals and release of soluble components of those minerals, mainly base cations (calcium, magnesium).</li> <li>Throughout the unsaturated waste rock, it is assumed that pyrite oxidation is not oxygen limited.</li> <li>There is a strong regional correlation of selenium to sulphate.</li> <li>The interaction of reactive surfaces (e.g. iron oxides) may attenuate elements, e.g. cadmium, and precipitation of secondary minerals such as gypsum may control sulphate concentrations.</li> <li>Waste rock may break down over time, exposing new surface areas as a result of compaction, physical weathering etc.</li> </ul>
5	<p><b>Hydrological processes that may influence release of CIs from waste rock</b></p> <ul style="list-style-type: none"> <li>There are leaching inefficiencies within the waste piles that are difficult to quantify whereby not all pore spaces are leached by infiltrating waters. This can be influenced by dump height, grain size etc.</li> <li>When waste rock piles are disturbed (e.g. during rehandling), pore spaces not previously leached may leach.</li> <li>Travel time through the waste rock pile is believed to be largely a function of lift height and net percolation.</li> </ul>
6	<p><b>Transport of CIs via seepage, run-off and groundwater pathways</b></p> <ul style="list-style-type: none"> <li>Water carrying CIs from the dump exit the dump as surface water and groundwater.</li> <li>Negligible run-off occurs and groundwater pathways are expected to be minimal on a regional scale reporting ultimately to the Elk River.</li> <li>Where groundwater pathways occur, there is a potential for load bypass at specific monitoring stations and sub-oxic reduction of Se and <math>\text{NO}_3^-</math>.</li> </ul>
7	<p><b>In-stream precipitation processes</b></p> <ul style="list-style-type: none"> <li>As seepage with high partial pressure of <math>\text{CO}_2</math> exits the waste rock pile and equilibrates with the atmosphere, calcite becomes supersaturated and precipitates within the streams. Trace metals such as cobalt and cadmium (among others) have been shown to co-precipitate with calcite when this occurs.</li> <li>The precipitation of calcite is affected by seasonal changes in flow whereby during high flows and spring freshet, streams are diluted and calcite does not precipitate. During this period some trace metals concentrations (e.g. Co) tend to parallel sulphate trends in the receiving environment.</li> </ul>
8	<p><b>Undisturbed area influences</b></p> <ul style="list-style-type: none"> <li>Dilution from undisturbed areas varies by drainage and influences the monitoring station flow and water quality. A load is associated with this undisturbed area, and the relative proportion varies by constituent.</li> </ul>
9	<p><b>Monitoring location and data record</b></p> <ul style="list-style-type: none"> <li>Source term development requires data for flow and water chemistry. The extent of monitoring record varies across the region. Some stations have robust data sets while others are limited. Recent data (&lt;10 years) tends to be more complete, while older data are sometimes limited.</li> </ul>

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Water Quality Model Concept**  
(Source: Teck, 2017)



Date:	3/9/2024	Scale:
Project No.:	WILD-01	Figure No.:

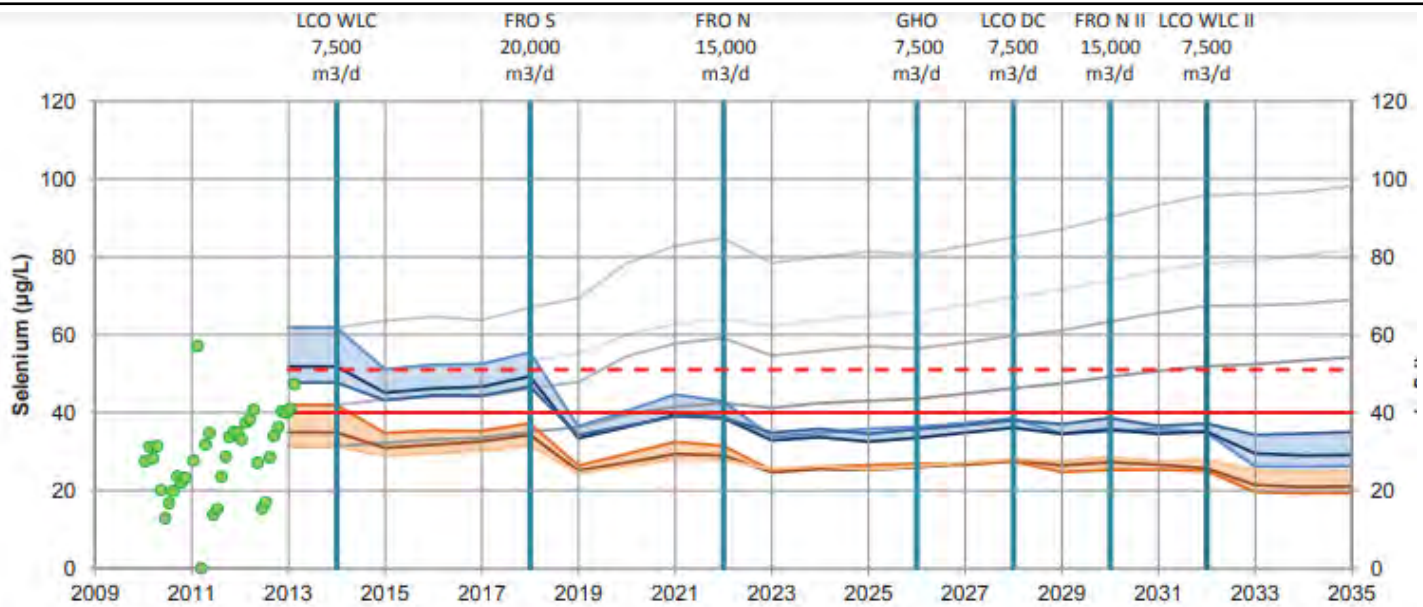
## 7 WATER QUALITY MEASUREMENTS VERSUS MODEL PREDICTIONS

### 7.1 Initial 2014 Model Predictions

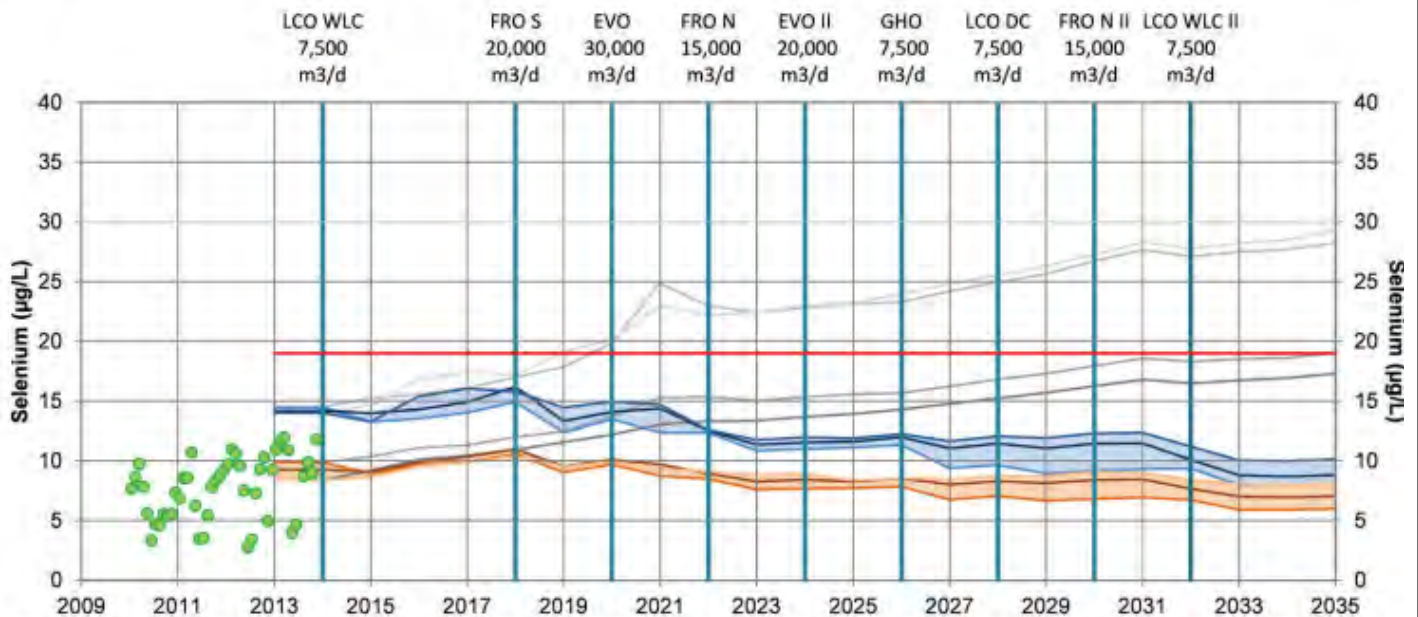
The charts shown in **Figure 7-1** were developed using the 2014 water quality model. **Figure 7-1** shows measured selenium concentrations to 2014, and projected concentrations of selenium after 2014, as mitigation measures were to be implemented. The projections represent water quality at the mouth of Fording River, downstream of Line Creek, and at Elk River downstream of its confluence with Michel Creek. Review of the monthly average mean selenium concentration in each chart indicates the following:

- The predicted maximum monthly selenium concentration under average flow conditions at the mouth of Fording River was predicted to be 50 ug/L in 2014, decreasing to approximately 45 ug/L by 2015, after construction of the Line Creek Mine active water treatment facility. It was then predicted to increase gradually to slightly less than 50 ug/L in 2018, then decrease to approximately 35 ug/L in 2019, after the first Fording River Mine active water treatment facility was constructed. The predicted maximum monthly selenium concentration under average flow conditions at the mouth of Fording River was then predicted to increase gradually to approximately 40 ug/L until 2022, when a second water treatment facility was to be constructed at the Fording River Mine.
- The predicted maximum monthly selenium concentration under average flow conditions in the Elk River downstream of its confluence with Michel Creek was predicted to be approximately 14 ug/L in 2014. It was then predicted to increase gradually to approximately 16 ug/L in 2018, then decrease to approximately 13 ug/L in 2019, after the first Fording River Mine active water treatment facility was constructed. The predicted maximum monthly selenium concentration under average flow conditions in the Elk River downstream of its confluence with Michel Creek was then predicted to increase to approximately 15 g/L until 2021, when a water treatment facility was to be constructed at the Elkview Mine, then diminish to approximately 13 ug/L by 2023.

Predictions were made for each Order Station (Teck, 2014, Sec. 8), which are discussed below.



**Figure 9: Predicted trend for selenium concentrations at FR5 during Plan implementation**



**Figure 10: Predicted trend for selenium concentrations at ER3 during Plan implementation**

- Predicted Maximum Monthly Concentration Under Low Flow Conditions without Mitigation
- Predicted Maximum Monthly Concentration Under High Flow Conditions without Mitigation
- Predicted Annual Average Concentration Under High Flow Conditions without Mitigation
- Predicted Annual Average Concentration Under Low Flow Conditions without Mitigation
- Predicted Maximum Monthly Concentration Under Low Flow Conditions and Initial Implementation Plan
- Predicted Maximum Monthly Concentration Under Average Flow Conditions and Initial Implementation Plan
- Predicted Maximum Monthly Concentration Under High Flow Conditions and Initial Implementation Plan
- Predicted Annual Average Concentration Under Low Flow Conditions and Initial Implementation Plan
- Predicted Annual Average Concentration Under Average Flow Conditions and Initial Implementation Plan
- Predicted Annual Average Concentration Under High Flow Conditions and Initial Implementation Plan
- Observed
- Long-term Target
- - - Short-term Target

● Data points prior to EVWQ Plan

- FR5: Fording River downstream of Line Creek
- ER3: Elk River downstream of Michel Creek

**WILDSIGHT**  
SELENIUM RELATED RECLAMATION LIABILITIES  
TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Selenium Concentration Predictions - 2014**  
(Source: Teck, 2014)



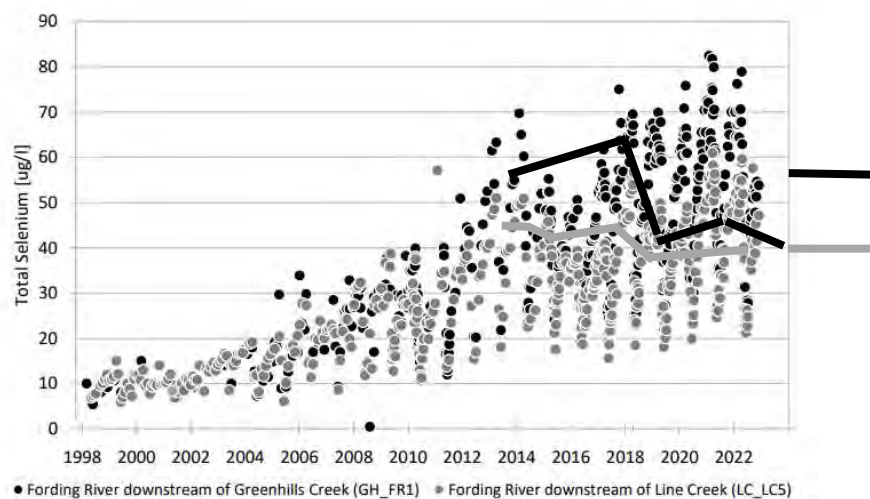
Date:	3/9/2024	Scale:
Project No.:	WILD-01	Figure No.:
		<b>7-1</b>

## Fording River

**Insert 7-1** overlays the predicted concentrations of selenium at the mouth of the Fording River (gray line) and downstream of Greenhills Creek (black line) to those measured by Teck through 2022 (see **Section 5**). Review of **Insert 7-1** and **Figure 7-1** indicates the following:

- The predicted diminishing concentrations of selenium in response to commissioning of the water treatment plants are not evident in the measured selenium concentrations. The measured selenium concentrations at the mouth of the Fording River have been increasing steadily since 2014, with only potentially minor apparent effects resulting from the commissioning of the Line Creek Mine active water treatment plant in 2018, and the Fording River Mine active water treatment plant in 2021.
- The variabilities of the measured selenium concentrations under varying flow conditions are greater than those predicted by the model, although the modelled concentrations presented by Teck (2014) were intended to reflect average concentrations under the various flow conditions, not potential variability.
- The average selenium concentrations for all flow conditions were predicted to comply with the water quality targets of 57 ug/L and 40 ug/L in the upper and lower Fording River, respectively, by 2023. Trends in measured selenium concentrations indicate that more than half of the recently-measured concentrations exceed these water quality targets, and that the frequency of exceedances is increasing.

**Insert 7-1: Predicted versus Measured Selenium Concentrations in Fording River Order Stations** (Source: Teck, 2014 and 2023h)



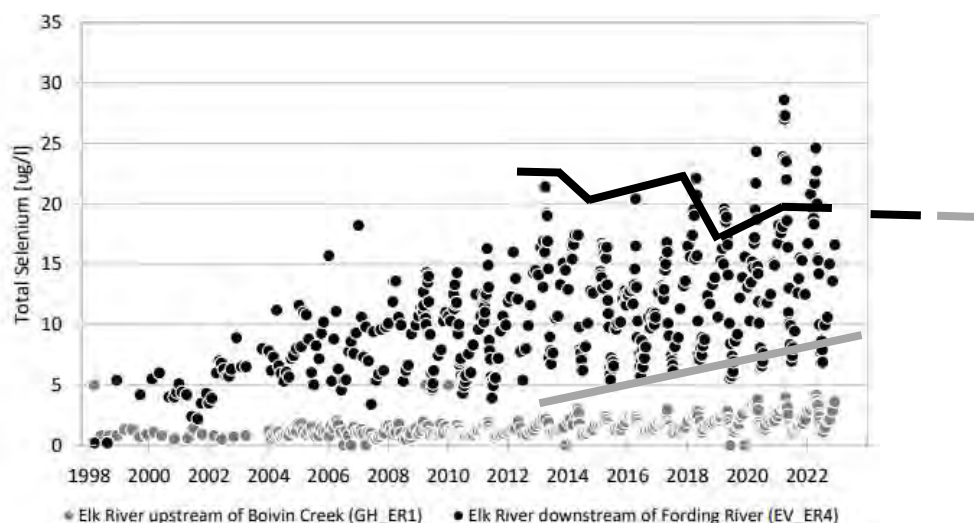


## Upper Elk River

**Insert 7-2** overlays the predicted concentrations of selenium in the Elk River upstream (gray line) and downstream (black line) of its confluence with Fording River to those reported by Teck through 2022 (see **Section 5**). Review of **Insert 7-2** indicates the following:

- The predicted diminishing concentrations of selenium in the Elk River downstream of Fording in response to commissioning of the Line Creek and Fording River Mines' water treatment plants are not as evident in the measured selenium concentrations. The measured selenium concentrations in this upper Elk River Order Station have been increasing steadily since 2014, with no significant reductions resulting from the commissioning of water treatment facilities in 2018 and 2021.
- The variability of the measured selenium concentrations under varying flow conditions is also greater than those predicted by the model, although the modelled concentrations presented by Teck (2014) were intended to reflect average concentrations under the various flow conditions, not potential variability.
- The measured selenium concentrations in the upper Elk River below its confluence with Fording River exceed the water quality target of 19 ug/L in most recent samples, and the frequency and degree of exceedances is on an increasing trend.
- The trend in measured selenium concentration in the upper Elk river above Fording River are lower than those predicted by the model, which indicates that the west side of the Greenhills Mine is contributing less to selenium contamination than was predicted, and that Line Creek and Fording River Mines are contributing more than predicted.

**Insert 7-2: Predicted versus Measured Selenium Concentrations in Upper Elk River Order Stations** (Source: Teck, 2014 and 2023h)

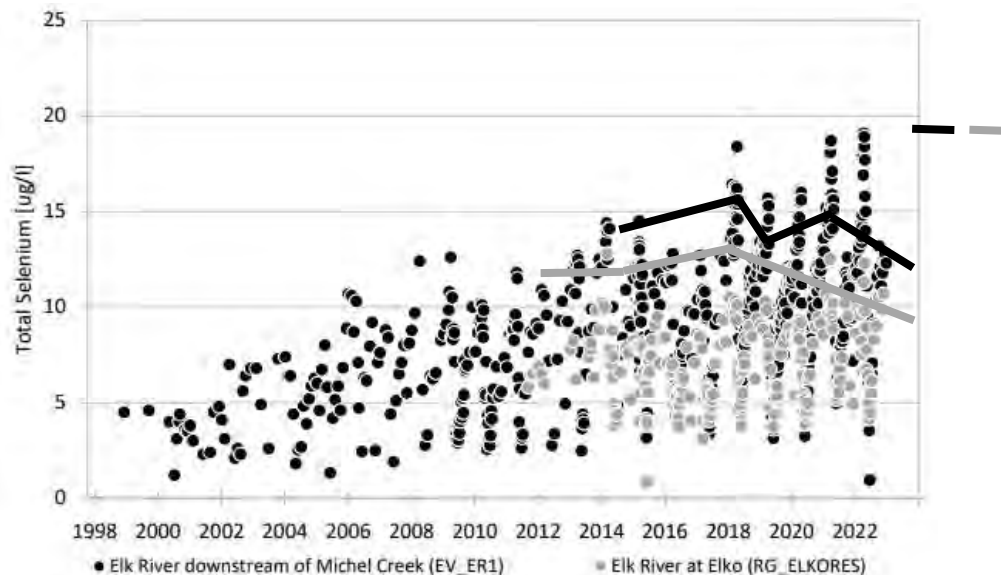


## Lower Elk River

**Insert 7-3** overlays the predicted concentrations of selenium in the Elk River downstream of its confluence with Michel Creek (black line) and at Elko (gray line) to those reported by Teck through 2022 (see **Section 5**). Review of **Insert 7-3** and **Figure 7-1** indicates the following:

- The predicted diminishing concentrations of selenium in the Elk River in response to commissioning of the water treatment plants are not evident in the measured selenium concentrations. The measured selenium concentrations at these Elk River Order Stations have been increasing steadily since 2014, with no significant reductions resulting from the commissioning of water treatment facilities in 2018, 2021, or 2022.
- The variability of the measured selenium concentrations under varying flow conditions is also greater than those predicted by the model, although the modelled concentrations presented by Teck (2014) were intended to reflect average concentrations under the various flow conditions, not potential variability.
- The average selenium concentrations for all flow conditions were predicted to remain below 15 ug/L after 2018 for the Order Station below Michel Creek. Trends in recent data indicate that measured concentrations occasionally exceed the water quality target of 19 ug/L, and that the frequency of exceedances was increasing by the end of 2022.

**Insert 7-3: Predicted versus Measured Selenium Concentrations in Lower Elk River Order Stations** (Source: Teck, 2014 and 2023h)

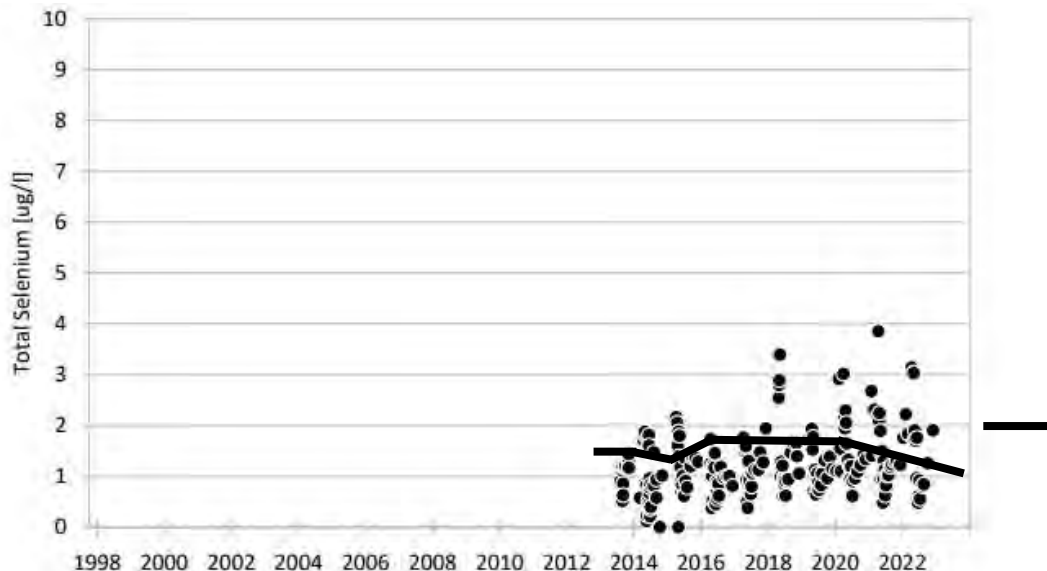


## Lake Koocanusa

**Insert 7-4** overlays the predicted concentrations of selenium in Lake Kooconusa to those reported by Teck through 2022 (see **Section 5**). Review of **Insert 7-2** and **Figure 7-1** indicates the following:

- The predicted, reasonably stable concentrations of selenium in Lake Kooconusa are not consistent with the measured selenium concentrations. The measured selenium concentrations at the Lake Kooconusa Order Station have been increasing steadily since 2014, with no significant reductions resulting from the commissioning of water treatment facilities in 2018, 2021, and 2022.
- The variability of the measured selenium concentrations under varying flow conditions is also greater than those predicted by the model. It is noted that the modelled concentrations presented by Teck (2014) were intended to reflect average concentrations under the various flow conditions, not potential variability.
- The average selenium concentrations for all flow conditions were predicted to remain below the 2 ug/L water quality target for Lake Kooconusa. Trends in recent data indicate that measured concentrations occasionally exceed this water quality target, and that the frequency of exceedances was increasing at the end of 2022.

**Insert 7-4: Predicted versus Measured Selenium Concentrations in Lake Kooconusa Order Station** (Source: Teck, 2014 and 2023h)



## Summary

The direct comparison of predicted versus measured concentrations of selenium at the Order Stations is made more complicated because the water treatment facilities planned in 2014 were commissioned later than was assumed by the model. As a result, improvements in water quality that were predicted as a result of commissioning the Line Creek, Fording River, and Elkview Mines water treatment facilities were delayed. Additionally, the model predictions were for average monthly concentrations predicted for average, high and low flow conditions, without a corresponding assessment of potential variability. Notwithstanding these complicating factors, the predicted reductions in selenium concentrations do not appear to have occurred after the treatment facilities came on-line.

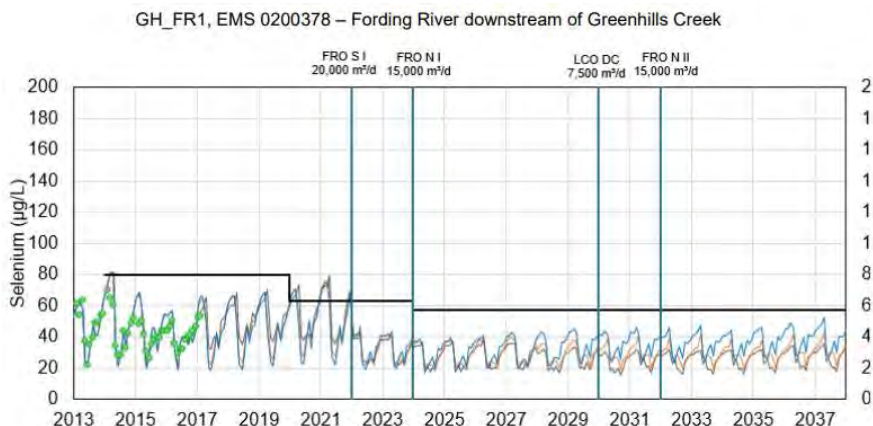
The modeling also predicted that, by 2023, concentrations of selenium would generally comply with the water quality targets at each of the Order Stations. By the end of 2022, this had not occurred. At most order stations, the recently measured concentrations of selenium have regularly exceeded the water quality targets for those stations, and the frequency and degree of exceedance appears to be worsening.

## 7.2 2017 Model Predictions

### Fording River Downstream of Greenhills Creek

**Insert 7-5** shows the concentrations of selenium in Fording River downstream of Greenhills Creek that were predicted by the 2017 model update. Review of **Insert 7-5** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 80 ug/L in 2021, then diminish in 2022 and 2023 to approximately 40 ug/L in response to the commissioning of the Fording River active water treatment facility. Review of **Insert 7-1** indicates that the selenium concentrations at this location varied seasonally, and increased gradually and consistently to a maximum of approximately 85 ug/L in 2021, then diminished to a maximum of approximately 80 ug/L in 2022. There is insufficient data available to assess the longer term effect of the Fording River water treatment facilities on selenium concentrations at this location.

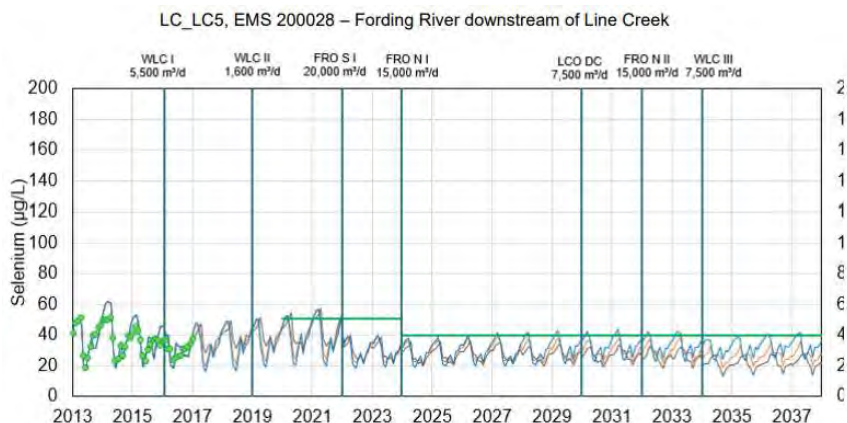
**Insert 7-5: Predicted Selenium Concentrations in Fording River downstream of Greenhills Creek (Source: Teck, 2017)**



### Fording River Downstream of Line Creek

**Insert 7-6** shows the concentrations of selenium in Fording River downstream of Line Creek that were predicted by the 2017 model update. Review of **Insert 7-6** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 58 ug/L in 2021, then diminish in 2022 and 2023 to approximately 40 ug/L in response to the commissioning of the Fording River active water treatment facility. Review of **Insert 7-1** indicates that the selenium concentrations at this location varied seasonally, and increased gradually and consistently to a maximum of approximately 62 ug/L in 2021, then diminished to a maximum of approximately 60 ug/L in 2022. There was insufficient data available to assess the effect of the Fording River water treatment facilities on selenium concentrations at this location.

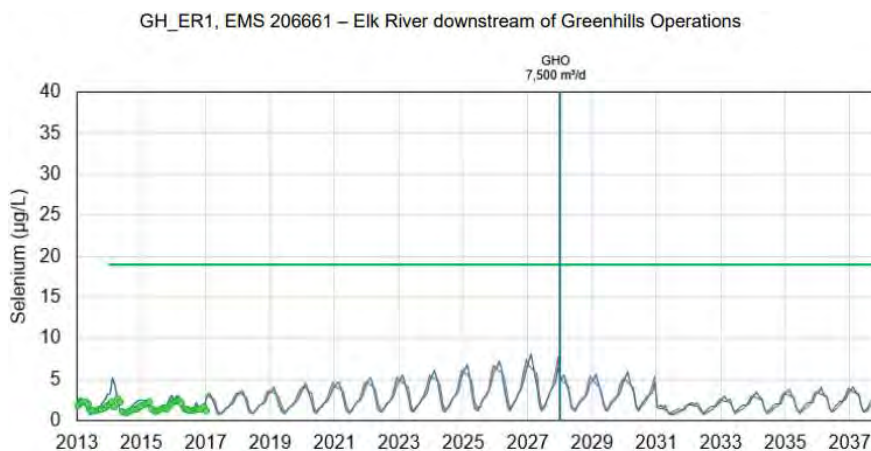
**Insert 7-6: Predicted Selenium Concentrations in Fording River downstream of Line Creek (Source: Teck, 2017)**



## Elk River Downstream of Greenhills Mine

**Insert 7-7** shows the concentrations of selenium in Elk River downstream of the Greenhills Mine that were predicted by the 2017 model update. Review of **Insert 7-7** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 5 ug/L in 2022. Review of **Insert 7-2** indicates that the selenium concentrations at this location varied seasonally, and increased consistently to a maximum of approximately 4.5 ug/L in 2022, which is consistent with the modeled predictions.

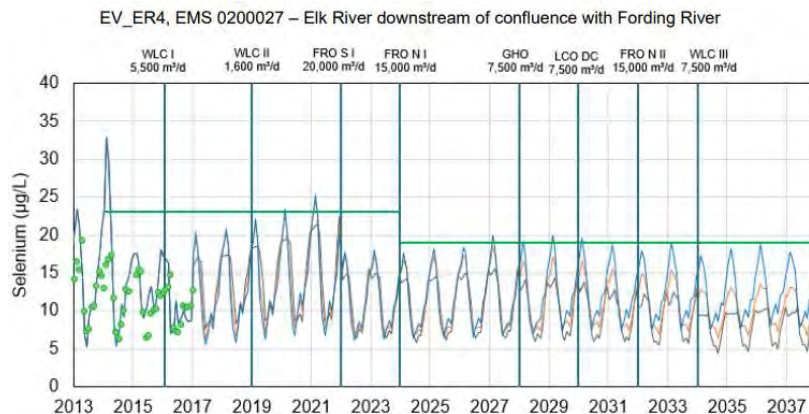
### **Insert 7-7: Predicted Selenium Concentrations in Elk River downstream of Greenhills Mine** (Source: Teck, 2017)



## Elk River Downstream of Fording River

**Insert 7-8** shows the concentrations of selenium in Elk River downstream of Fording River that were predicted by the 2017 model update. Review of **Insert 7-8** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 25 ug/L in 2021, then diminish in 2022 in response to the commissioning of the Fording River active water treatment facility. The water quality target of 19 ug/L at this location was delayed until 2024. Review of **Insert 7-2** indicates that the selenium concentrations at this location varied seasonally, and increased consistently to a maximum of approximately 29 ug/L in 2021, then diminished to a maximum of approximately 25 ug/L in 2022. There was insufficient data available to determine whether this is a short term effect, or whether the Fording River water treatment facilities will have longer term positive effects.

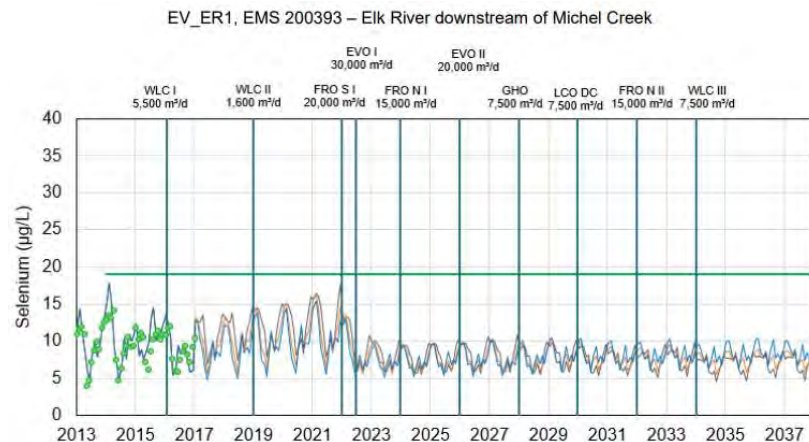
**Insert 7-8: Predicted Selenium Concentrations in Elk River downstream of Fording River**  
(Source: Teck, 2017)



### Elk River Downstream of Michel Creek

**Insert 7-9** shows the concentrations of selenium in Elk River downstream of Michel Creek that were predicted by the 2017 model update. Review of **Insert 7-9** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 16 µg/L in 2021, then diminish dramatically in 2022 and 2023 to approximately 10 µg/L in response to the commissioning of the Fording River active water treatment facility, and the Elkview saturated rock fill treatment facility. Review of **Insert 7-9** indicates that the selenium concentrations at this location varied seasonally, and increased consistently to a maximum of approximately 19 µg/L in 2022. There was no evident, significant reduction in measured selenium concentrations resulting from the commissioning of the Fording River active water treatment facility and/or the Elkview saturated rock fill treatment facility (see **Insert 7-3**).

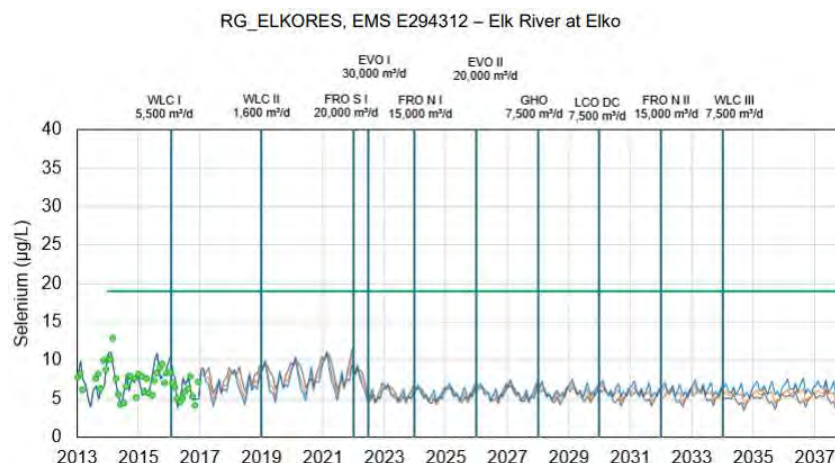
**Insert 7-9: Predicted Selenium Concentrations in Elk River downstream of Michel Creek**  
(Source: Teck, 2017)



## Elk River at Elko Reservoir

**Insert 7-10** shows the concentrations of selenium in Elk River at Elko that were predicted by the 2017 model update. Review of **Insert 7-10** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 11 ug/L in 2021, then diminish in 2022 and 2023 in response to the commissioning of the Fording River and Elkview water treatment facilities. Review of **Insert 7-10** indicates that the selenium concentrations at this location varied seasonally, and increased consistently to a maximum of between approximately 12 and 13 ug/L by 2022. There was no evident, significant reduction in measured selenium concentrations resulting from the commissioning of the Fording River and Elkview water treatment facilities (see **Insert 7-3**).

### Insert 7-10: Predicted Selenium Concentrations in Elk River at Elko (Source: Teck, 2017)

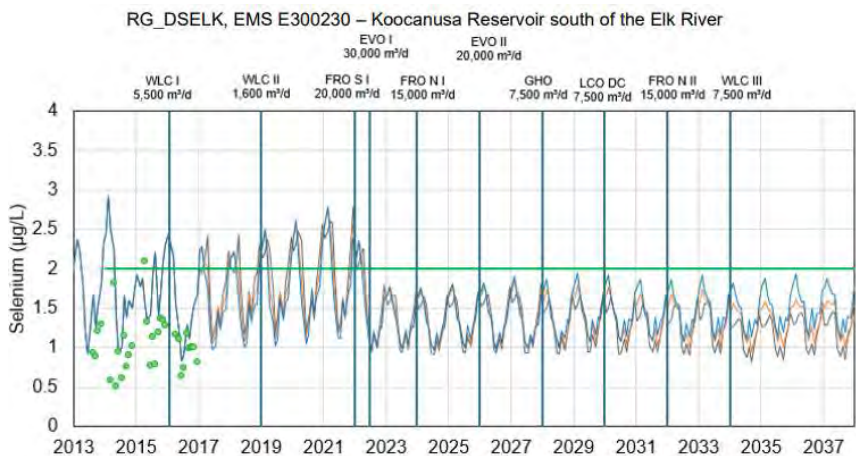


## Lake Koocanusa

**Insert 7-11** shows the concentrations of selenium in Lake Koocanusa that were predicted by the 2017 model update. Review of **Insert 7-11** indicates that the selenium concentrations were predicted to vary seasonally and gradually increase to a maximum of approximately 2.6 ug/L in 2021, then diminish in 2022 and 2023 in response to the commissioning of the Fording River and Elkview water treatment facilities. Review of **Insert 7-11** indicates that the selenium concentrations at this location varied seasonally, and the maximum concentrations varied between approximately 3 and 4 ug/L from 2018 to 2022. There was no evident reduction in measured selenium concentrations resulting from the commissioning of the Fording River and Elkview water treatment facilities.



**Insert 7-11: Predicted Selenium Concentrations in Lake Kocanusa (Source: Teck, 2017)**



## Summary

The water quality predictions in the 2017 model update account for the seasonal variance in selenium concentrations, which is generally consistent with the measured concentrations. The selenium concentrations predicted by the 2017 model update are generally closer to the measured concentrations than the 2014 model, which is expected from a more recent update. The reductions in the predicted selenium concentrations at the Order Stations located closer to the mines appear to be borne out by the measured concentrations, although additional data is required to verify these trends. Conversely, the measured selenium concentrations in lower Elk River and Lake Kocanusa are not consistent with these predicted improvements. Again, additional data is required over a longer term to verify reliable trends. In general, the model predicts lower selenium concentrations than those measured in water samples collected from the Order Stations through 2022. The 2017 model update also predicted significant improvements to water quality at all significantly impacted Order Stations between 2021 and 2023. This has not proven to be the case, although this is likely due to treatment systems being commissioned later than the timelines assumed in the model predictions.

## 7.3 2020 Model Update

In general, projected selenium concentrations made using the 2020 model were higher than those predicted using the 2017 model. The reductions in predicted selenium concentrations resulting from the water treatment facilities were also delayed until 2023; hence, this model should more accurately reflect this period. Differences in the selenium projections were attributable to the following three changes to the model (Teck, 2021, Section 8.3.2):

- surface water – groundwater partitioning at tributary monitoring stations

- incorporation of variable hydraulic lag as it applies to new waste rock spoils, along with the presence of the immediately available initial soluble load
- updated methods to simulate waste rock flow

A detailed review of individual predictions made using the 2020/2022 Model update has not been completed because there was insufficient data to evaluate trends. In general, the predicted selenium concentrations correlate more closely with the measured concentrations of selenium at the Order Stations, which is expected given the recency of the model update. Significant reductions in selenium concentrations were predicted to occur at the Order Station between 2022 and 2024. There are early indications of reductions in the measured concentrations of selenium in samples collected from the Order Stations through the first half of 2023; however, there are insufficient data available to verify these trends. Reductions in measured selenium concentrations are anticipated to occur in 2024 as a result of the increased treatment capacity that was brought on-line in 2023 and early 2024.

The flow component of the model was modified (Teck, 2022a) as part of the 2020 update. The primary change involved switching from an analogue-based model to a climate driven model for some of the flow components of the model domain. Other modifications included simulating flow through waste rock, simulating snow-melt on unaffected areas, and including groundwater.

### 7.4 Summary

It is difficult to evaluate the reliability of the model predictions because the timing of the commissioning of the water treatment facilities has not been consistent with the timing assumed in the models. In general, the predictions made by the 2020 model update more closely correlate to measured concentrations than the two prior versions of the model. Given the recency of the 2020 model update, this is to be expected. This model update, and the 2017 model update, predict significant reductions in selenium concentrations at the Order Stations, through 2024. There was insufficient data available to evaluate these predicted improvements.

The measured concentrations of selenium in samples collected from the lowest Order Stations (Elk River downstream of Michel Creek, Elk River at Elko, and Lake Koocanusa) exceed the modeled predictions in all three cases.

## 8 REFERENCES

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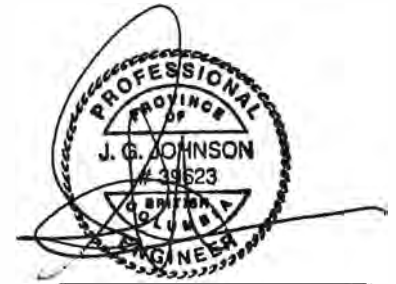
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## 9 CLOSURE

This report has been prepared for Wildsight. The text contained herein presents documentation of the assessment of the selenium contamination emanating from Teck Coal's mine operations in the Elk Valley, B.C. This represents the opinion of Burgess Environmental Ltd. that is based on this work as well as information provided by Wildsight, reports made publicly available by Teck, and publicly available information.

All data contained herein has been reviewed and interpreted by, or under the direct supervision of Gordon J. Johnson, P.Eng.



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Gordon J. Johnson, M.Sc., P. Eng.  
President  
Burgess Environmental Ltd.

## APPENDIX A RECLAMATION SECURITY ESTIMATE

**Appendix A: Estimate of  
Reclamation Security for Selenium  
Contamination Teck Coal's Elk  
Valley Mines**

Submitted to:  
**Wildsight**

Date:  
March 18, 2024

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**Burgess Environmental**



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## 1 INTRODUCTION

### 1.1 Background

Teck Coal has initiated a process to sell its metallurgical coal mining and processing business (Elk Valley Resources) to Glencore PLC, with a minority stake being sold to Nippon Steel Corporation. Wildsight is concerned that appropriate Reclamation Security, which is required by the Major Mines Reclamation Security Policy (B.C., 2022a), is in place to cover all of the costs for reclamation of these mines. By 2023, Teck Coal had set aside \$1.5 billion of Reclamation Security to cover the unplanned closure of its British Columbia (B.C.) coal mines (B.C., 2023a, Appendix C), and this amount is scheduled to increase.

Wildsight is specifically concerned that the Reclamation Security is adequate to cover the cost of remediating selenium, which is leaching out of Teck Coal's active and closed mines (**Figure A1**), and is expected to leach out of these mines for many decades (Teck, 2014, PDF page 4 of 290), and potentially centuries. Through 2022, Teck has reportedly spent over \$1.4 billion trying to reduce selenium contamination, and will spend an additional \$550 million in 2023 and 2024 (Teck, 2023). However, the concentrations of selenium in the Elk River watershed continued to worsen through 2022 (USGS, 2022, PDF page 2 of 4; **Section 5**). Wildsight has retained Burgess Environmental Ltd. (Burgess) to assess this issue, and provide an independent, third-party estimate of the costs to remediate the selenium contamination emanating from Teck Coal's mines.

### 1.2 Objective and Scope

This Appendix estimates the financial liabilities to Teck Coal that are associated with the selenium contamination emanating from its coal mine operations in southeast B.C. The B.C. (2022a, PDF page 8 of 24) Policy states, "*reclamation security is intended to cover the cost of reclaiming a site in the event that a mining company defaults on their obligation to do so or becomes insolvent. Costs that must be considered include those necessary to: close and maintain infrastructure such as tailing dams and waste rock dumps; construct, operate and maintain water treatment plants, waste cover systems and other required mitigations; re-contour the site, prepare the surface, place a suitable growth medium, revegetate the site, and implement on-going monitoring and surveillance programs*". As such, the cost of remediating selenium contamination emanating from Teck Coal's mine operations accounts for only a portion of Teck's reclamation liabilities; surface reclamation of the mines and the remediation of other water pollutants (Teck, 2014, PDF page 4 of 290) are also required but are not included in this estimate.

This Appendix estimates the Reclamation Security required to remediate selenium contamination emanating from Teck Coal's Elk Valley mines. The main report includes a review of the relevant

background information, which provides the supporting basis for this Reclamation Security estimate and includes the following:

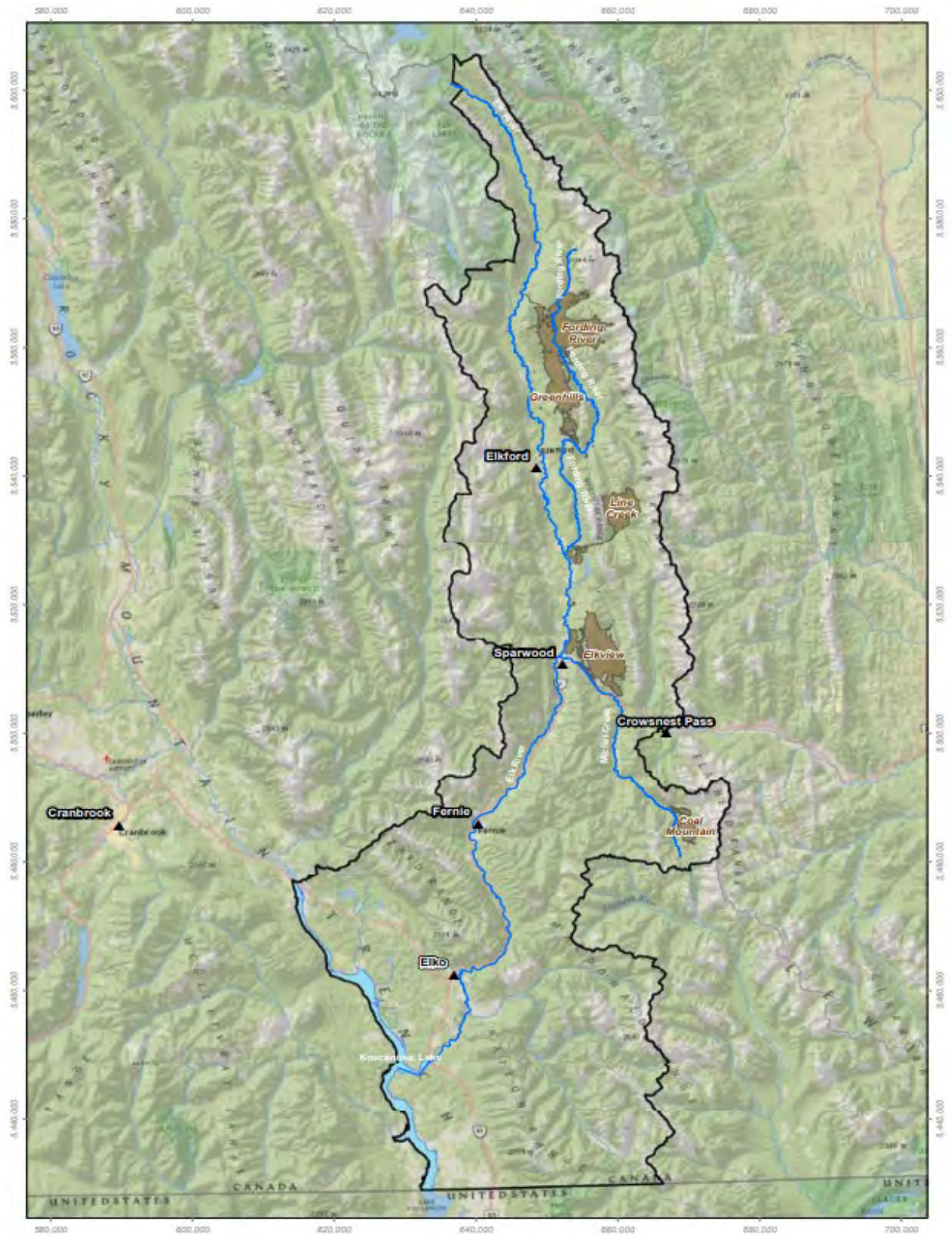
- background information
- a description of the Elk Valley watershed
- a summary of the regulatory basis related to selenium contamination
- descriptions of Teck Coal's mine operations in the Elk Valley, including information relevant to the selenium contamination for each operation
- detailed analyses of the selenium concentrations in surface water and groundwater of the Elk Valley watershed
- assessment of Teck's predictive models

### **1.3 Reliance Materials**

This assessment is based on the following:

- data, information, reports, and plans made available to the public by Teck Coal
- data, information, reports, and plans made available to the public by the B.C. government
- publicly available information, including technical analyses completed by others
- the experience and judgment of the authors

A large body of information has been developed by Teck Coal, some of which has been submitted to B.C. regulators, which has not been made available publicly. Examples would include, but are not necessarily limited to, regulatory reporting, internal studies and research, and detailed cost information submitted to support its current Reclamation Security estimates. This Reclamation Security estimate would benefit from being provided access to this information.



**WILDSIGHT**  
 SELENIUM RELATED RECLAMATION LIABILITIES  
 TECK COAL MINES IN SOUTHEAST BRITISH COLUMBIA

**Teck Coal Mines in Elk River Watershed**  
 (Source: Teck, 2014)



Date:	3/9/2024
Project No.:	SULP-01

Scale:	
Figure No.:	<b>A1</b>

## 2 RELEVANT LEGISLATION AND GUIDANCE

A summary of relevant legislation and guidance documents published by the Province of British Columbia is provided for context to this Reclamation Security estimate. This summary is not intended to represent an exhaustive review of legislation and guidance, or a legal opinion.

### 2.1 Mines Act

Review of the provisions of Section 10: Permitting of the Mines Act (B.C., 2023b) indicates that the B.C. regulator has the authority to set and change the Reclamation Security required by Teck to address liabilities associated with selenium pollution, as follows.

- Subsection (4) provides the chief permitting officer the legal authority to determine the amount and form of financial security required of Teck for (a) mine reclamation, and (b) protection of, and mitigation of damages to, watercourses.
- Subsection (5) gives the chief permitting officer the ability to require annual changes to the security so that funds are available over the life of mine to cover the costs to reclaim and close the mine, to mitigate impacts to the environment, and to fulfill the conditions of the permit and any orders relating to reclamation and the protection of watercourses.
- Subsection (7) provides the chief permitting officer with the ability to change the reclamation security requirements for a mine at any time if it is deemed necessary.

### 2.2 Environmental Management Act

The Environmental Management Act (B.C., 2023c) is relevant to the calculation of Reclamation Security for three primary reasons, as follows:

- Section 14(1)(b) allows a director that is issuing a permit authorizing the introduction of waste into the environment to require the permittee to give security in the amount and form and subject to conditions the director specifies.
- In April 2013, the B.C. Minister of Environment's Order M113, issued under Section 89 of the Environmental Management Act, directed Teck to develop an area-based water-quality management plan for the Elk Valley.
- The Environmental Management Act gives the Director the authority to prepare and publish environmental management plans for specific areas of British Columbia, including plans for the protection of water courses. It is understood that this authority was used to approve Teck's (2014) Elk Valley Water Quality Plan.

## 2.3 Major Mines Reclamation Security Policy (Interim)

This section summarizes the Major Mines Reclamation Security Policy (B.C., 2022a), and provides guidance to major mine permit holders regarding B.C.'s approach to managing Reclamation Security.

### Objectives and Scope

The B.C. (2022a, PDF page 4 of 24) Policy Statement reads, *“this policy seeks to ensure that permittees for major mines pay the full cost of environmental cleanup and reclamation for their mine. New mines and any existing mines (whether in operation, in care & maintenance or closed) having less than five years of remaining mineral reserves will be required to post full reclamation security equal to the company’s reclamation liability on the mine site. A partial exploration incentive security will be available to mines that have invested in sufficient exploration to demonstrate at least five years of remaining reserves. The policy seeks . . . to reduce the differential between reclamation liabilities and reclamation securities for existing mines”*.

It is understood that Teck is eligible for a partial (25%) reduction in Reclamation Security because its major mines have been operating for more than 5 years and will operate for more than an additional 5 years.

*“The objective of mine reclamation is to return disturbed land to a state that will achieve desired end land use goals, and to reduce risks to the public and to the environment. This requires that land and watercourses are left in a state of physical and geochemical stability and that disturbed land is revegetated to a self-sustaining state that satisfies the end land use”* (B.C., 2022, PDF page 8 of 24). *“Reclamation security is intended to cover the cost . . . to: close and maintain infrastructure such as tailing dams and waste rock dumps; construct, operate and maintain water treatment plants, waste cover systems and other required mitigations; re-contour the site, prepare the surface, place a suitable growth medium, revegetate the site, and implement on-going monitoring and surveillance programs”* (B.C., 2022a, PDF page 8 of 24). Based on these statements, the Reclamation Security for Teck is required to cover the cost of mitigating selenium contamination, as well as all other costs that would be incurred to physically secure and reclaim its mine sites and address other water contamination.

### Calculating Reclamation Security

In short, Reclamation Security is intended to cover the costs of unplanned closure/bankruptcy of the mine. Reclamation Security is calculated every five years and is based on the mine’s 5-Year Mine Plan and Reclamation and Closure Plan. Reclamation Security is based on the Net Present Value (NPV) of the estimated liability during the next 5 years (i.e. the peak liability before the next updates to the Reclamation and Closure Plan are due), and covers a 100-year post closure period.

The progress must be indicated for each task on an annual basis, and a cost estimate provided for each year of the post-closure period. For large mines, the annual discount rate for calculating the NPV of the Reclamation Security is 4%.

The Reclamation Security estimate must be completed by a qualified person and is subject to verification and acceptance by Ministry of Energy, Mines and Low-Carbon Initiatives (EMLI) (B.C., 2022a, PDF page 12 of 24).

The calculation is based on third-party contractor and consulting rates, and follows a spreadsheet format developed by EMLI. Guidance is provided for the following:

- labour and material rates
- mobilization and demobilization
- engineering
- project management
- administration
- conventional reclamation
- dismantling and demolition
- monitoring
- capital and operating costs for water treatment
- site maintenance
- contingency

For water treatment, *“capital costs should be based on a recent cost estimate provided by a supplier or on the actual cost of a similar system used elsewhere. Capital costs for water treatment facilities that are planned for construction after mine closure, or in the last 10 years of the mine life, must be included”* in the cost estimate (B.C., 2022a, PDF page 14 of 24). Table 1 of this Policy allows the Chief Permitting Officer to exclude the capital cost for water treatment under certain conditions.

### **Progressive Reclamation and Source Control**

Progressive reclamation and source control are encouraged as opportunities to reduce Reclamation Security in general, and potential liability to taxpayers in particular. The Policy states, *“progressive reclamation serves to reduce the potential reclamation liability faced by the province and reduces the corresponding reclamation security required of mining companies”*; and *“prioritizing up-front planning and source control during the early stages of mine design can significantly reduce a mining company’s environmental liability and the amount of the required reclamation security”*.

These policy positions are relevant to the calculation and management of Reclamation Security because they allow for Teck to apply for reductions in Reclamation Security as key mitigating measures, such as the construction of water treatment facilities, are implemented.

## 2.4 Code for Mines in British Columbia

Portions of the Health, Safety and Reclamation Code for Mines in British Columbia (B.C., 2022b) are also relevant to Reclamation Security, as follows:

- Part 10.1.3 (i) requires Teck to provide a detailed reclamation liability cost estimate of all outstanding reclamation and closure liabilities over the planned life of mine, including any long-term monitoring and maintenance obligations.
- Part 10.6.15 allows for the chief inspector to return all or part of a reclamation security when satisfactory work has been done.
- Part 10.6.16 allows Teck the opportunity to apply to the chief inspector for a release or partial release of reclamation security requirements based on work completed.

## 2.5 Ministerial Order 113

Ministerial Order 113 (B.C., 2013) describes additional regulatory requirements of Teck that are specific to the contamination of the Elk River by Teck's operations in the Elk Valley. Amongst other requirements, Ministerial Order 113 (Schedule C) requires the following:

1. *"immediately begin to stabilize water quality concentrations of selenium, cadmium, nitrate, and sulphate, and the rate of formation of calcite in the designated area;*
2. *in the medium-term, reduce the rate of formation of calcite and set targets to demonstrate progressive reduction in water quality concentrations of selenium, cadmium, nitrate and sulphate in the designated area; and*
3. *in the longer term, further reduce:*
  - a. *concentrations of selenium, cadmium, nitrate, and sulphate in the designated area to acceptable contaminant levels as identified in section B below, and*
  - b. *control the rate of calcite formation to acceptable levels as identified in section B below."*



## 3 SELENIUM MITIGATION REQUIREMENTS

### 3.1 General Approach

The requirements related to remediating the selenium contamination emanating from each of Teck's Elk Valley coal mines are divided into the following categories:

- operation and maintenance of existing facilities
- construction, operation, and maintenance of additional facilities identified in Teck's 2023 update
- monitoring and reporting specific to selenium contamination of surface water and groundwater

It is assumed that the current water quality targets would continue to be used as appropriate standards throughout the term of remediation. Based on the analysis of water quality testing as part of the Order (B.C., 2013), it is evident that additional water treatment is required to comply with these targets (see **Section 5, Main Report**).

Teck (2023) has identified additional water treatment facilities that it plans to build and begin operating between now and 2027, which are included in this Reclamation Security cost estimate. Teck is commissioning saturated rock fills to treat selenium contaminated water, which Burgess considers an evolving technology that still needs to demonstrate capacity and effectiveness over the longer term. It is possible that the saturated rock fills will need to be replaced by active water treatment in the future, which would significantly increase the Reclamation Security requirements associated with the selenium contamination. This possibility is not included in this Reclamation Security estimate.

In addition to Teck's mine-specific obligations, Teck is required to complete regional monitoring and reporting, as well as maintaining stakeholder engagement and outreach programs. For cost estimating purposes, it is assumed that all non-mine specific sampling (e.g. groundwater, fish tissue, benthic, etc.) is implemented as part of the Elk Valley Water Quality Plan (Teck, 2014).

### 3.2 Elkview Mine

#### Existing Treatment Facilities

Elkview is required to continue to operate and maintain its saturated rock fill treatment facility with a capacity of 20,000 m<sup>3</sup>/day.

## **New Treatment Facilities**

Based on the review of water quality and quantity data, additional water treatment is required for the Harmer Creek watershed, and Erickson Creek watershed. Teck has identified an additional 15,000 m<sup>3</sup>/day saturated rock fill water treatment requirement for its Elkview Mine.

## **Monitoring and Reporting**

Water quality monitoring is implemented for the following water courses and water bodies within the footprint area of the mine: Michel Creek, Erickson Creek, Dry Creek, Harmer Creek, Aquaduct Creek, Cosssarini Creek, Otto Creek, unnamed creeks (7), and in-pit lakes and lagoons (7). This amounts to 21 sampling locations.

### **3.3 Line Creek Mine**

#### **Existing Treatment Facilities**

Line Creek Mine is required to continue to operate its existing 7,500 m<sup>3</sup>/day active water treatment facility.

#### **New Treatment Facilities**

Based on the review of water quality and quantity data, additional active water treatment is required for the Dry Creek watershed, and North Line Creek watershed. Teck has identified an additional 20,000 m<sup>3</sup>/day active water treatment requirement for its Line Creek Mine.

#### **Monitoring and Reporting**

Review of the hydrology of the Line Creek Mine (**Main Report, Section 3.2**) indicates that there are 12 surface water catchments that warrant monitoring.

### **3.4 Fording River Mine**

#### **Existing Treatment Facilities**

Teck has constructed and commissioned a 20,000 m<sup>3</sup>/day active water treatment facility. It is commissioning a 30,000 m<sup>3</sup>/day saturated rock fill treatment facility, which for the purpose of this estimate is assumed to be 90% complete.

#### **New Treatment Facilities**

Two additional saturated rock fill treatment facilities with a combined capacity of 30,000 m<sup>3</sup>/day are planned for the north Fording River Mine area.

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## **Monitoring and Reporting**

The hydrology of Fording River is complicated by the large number of creeks and ephemeral drainages in the mine area. For cost estimating purposes, it is assumed that there are 30 surface water monitoring points in the Fording Mine area.

## **3.5 Greenhills Mine**

### **Existing Treatment Facilities**

There are no existing selenium water treatment facilities at the Greenhills Mine.

### **New Treatment Facilities**

A 7,500 m<sup>3</sup>/day active water treatment facility is planned for Greenhills Creek.

## **Monitoring and Reporting**

The hydrology of the Greenhill Mines is also complicated by the large number of creeks and ephemeral drainages in the mine area. For cost estimating purposes, it is assumed that there are 14 surface water monitoring points in the Greenhills Mine area.

## **3.6 Coal Mountain Mine**

No selenium-specific treatment is planned for the Coal Mountain Mine; therefore, the cost for environmental monitoring of selenium contamination from this mine has been rolled into the cost estimates for the Elk Valley Water Quality Plan.

## **3.7 Elk Valley Water Quality Plan**

For the purpose of establishing the Reclamation Security cost estimates, it is assumed that all compliance, groundwater, benthic organisms, and tissue monitoring is included in the regional program, within the requirements of the Elk Valley Water Quality Plan. The combined program would therefore include the following tasks:

- Order point monitoring: 5 surface water order points monitored weekly
- Compliance point monitoring: 6 surface water compliance points monitored weekly
- Groundwater monitoring: a total of 176 well sample locations (21 background, 29 Fording River, 26 Greenhills, 35 Line Creek, 46 Elkview, 19 Coal Mountain) sampled quarterly
- Benthic monitoring: estimated
- Tissue sampling: estimated

## 4 RECLAMATION LIABILITY ESTIMATES

### 4.1 Cost Basis

#### **New Water Treatment Facility**

The cost for a new water treatment facility is based on the reported cost for the 7,500 m<sup>3</sup>/day active water treatment facility. This facility is reported to have cost \$105 million in 2013 (Teck, 2014, PDF page 36 of 290). Based on 2.5% annual inflation since that time, a new active water treatment facility of similar size is estimated to cost \$140 million today, or \$18,400 per m<sup>3</sup>/day of treatment capacity.

Saturate rock fill treatment is reportedly less expensive. Mackie, et al. (2022) states, “costs of the (saturated rock fill) trial system were compared to those from the nearby West Line Creek treatment plant which treats a flow rate of 7,500 m<sup>3</sup>/d, at nitrate and selenium concentrations similar to those in the (saturated rock fill) influent. The (saturated rock fill) was constructed at a capital cost of approximately one third of that of the West Line Creek facility and operates at approximately one half the operating cost for a similar flow rate”. Based on this statement, a new saturated rock fill treatment facility is estimated to cost \$6,200 per m<sup>3</sup>/day of capacity.

#### **Treatment Facility Maintenance and Operation**

For active water treatment, the cost estimate is based on an annual maintenance cost of 6% of the capital cost for active water treatment (\$1,100 per m<sup>3</sup>/day), and an annual operation cost of 4% of the capital cost for active water treatment (\$740 per m<sup>3</sup>/day). For a saturation, the maintenance and operating costs are estimated to be \$550 per m<sup>3</sup>/day and \$370 per m<sup>3</sup>/day, which are half of the maintenance and operating costs for active water treatment.

#### **Monitoring and Reporting**

Water monitoring costs are based on weekly sampling and a crew of two collecting 4 samples per day. This is considered reasonable given the expanses of the sampling areas. The annual cost of analysis and reporting is estimated to be \$180,000, based on experience and professional judgment.

#### **Elk Valley Water Quality Plan**

Teck’s obligations for reclamation extend to maintaining the existing Elk Valley Water Quality Plan. The following assumptions were made as the bases for these cost estimates:

- Surface water monitoring costs are based on weekly sampling and a crew of two collecting 4 samples per day. The annual cost of analysis and reporting is estimated to be \$260,000.
- Groundwater monitoring costs are based on quarterly sampling and a crew of two collecting 3 samples per day. The annual cost of analysis and reporting is estimated to be \$300,000.

- Tissue sampling costs are based on annual sampling and a crew of two collecting 3 samples per day. The annual cost of analysis and reporting is estimated to be \$50,000.
- Benthic survey costs are based on annual surveys requiring a crew of completing one survey every 2 days. The annual cost of analysis and reporting is estimated to be \$50,000.
- The stakeholder engagement program is estimated to cost \$100,000 per year.

### Other Cost Items

The following cost estimating assumption were made based on the Major Mines Reclamation Security Policy (B.C., 2022a):

- Project Management: 10% of project costs
- Contingency: 15% of project costs
- NPV discount factor: 4% per annum
- Estimate Term: 60 years (maximum term as per Policy is 100 years)

## 4.2 Reclamation Security Estimate

The Reclamation Security estimate (**Table A1**) to remediate the selenium contamination emanating from Teck’s mines is \$6.4 billion, of which \$4.8 billion requires financial security as specified in the the Major Mines Reclamation Security Policy (B.C., 2022a). Note that these values have been extracted from the detailed Reclamation Security estimate that is presented in Attachment A and have been rounded. It is noted that this estimate addresses only the selenium pollution caused by Teck’s coal mines in the Elk Valley and does not include surface reclamation of the mines, remediation of water supplies in the Valley, or mitigation of other pollution.

**Table A1**  
**Reclamation Security Cost Estimate for Selenium Contamination**

Reclamation Requirement	Cost
Elkview	\$ 1.03 billion
Line Creek	\$ 1.86 billion
Fording River	\$ 2.88 billion
Greenhills	\$ 0.56 billion
Elk Valley Monitoring	\$ 0.06 billion
Total Reclamation Security	\$ 6.40 billion
Net Reclamation Security	\$ 4.80 billion

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It is further noted that the Mines Act provides the Chief Permitting Officer with discretion regarding the amount and type of Reclamation Security that is required of a major mine operator, and that the Policy guidelines (B.C., 2022a, Table 1) allows the Chief Permitting Officer to exclude the capital costs of water treatment facilities under certain circumstances. The capital costs for water treatment included in this estimate amount to approximately \$800 million. Excluding these costs would further decrease the Reclamation Security by \$600 million, to approximately \$4.2 billion.

## 5 REFERENCES

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- USGS, 2022. Selenium in the Kootenai River Basin, Montana and Idaho, United States, and British Columbia, Canada.

## ATTACHMENT A RECLAMATION SECURITY ESTIMATE



**Total Cost**

<b>Reclamation Requirement</b>	<b>Cost</b>
Elkview	\$ 1,033,413,922
Line Creek	\$ 1,858,856,440
Fording River	\$ 2,877,166,052
Greenhills	\$ 560,537,213
Elk Valley Monitoring	\$ 66,101,033
Total Reclamation Security	\$ 6,396,074,660
Net Reclamation Security	\$ 4,797,055,995

**Cost Basis for Estimate**

**Water Treatment**

Item	Value	Comment
Capital Cost Reference	\$ 105,000,000.00	Line Creek
Capacity (m3/day)	7,500	Teck 2023b
Years Ago	11	Teck 2023b
Current Cost	\$ 137,769,099	2.5% escalation
Unit Cost - Capital	\$ 18,369.21	per m3
Unit Cost - Maintenance	\$ 1,102.15	6% of capital
Unit Cost - Operation	\$ 734.77	4% of capital

**Surface Water Sampling**

Item	Number	Units	Unit Cost	Total Cost
Personnel (2)	2.5	Hours	\$ 250.00	\$ 625.00
Vehicle and Instruments	2.5	Hours	\$ 40.00	\$ 100.00
Analysis	1	Sample	\$ 300.00	\$ 300.00
<b>Per Sample Cost</b>				\$ 1,025.00

**Groundwater Sampling**

Item	Number	Units	Unit Cost	Total Cost
Personnel (2)	3.3	Hours	\$ 250.00	\$ 825.00
Vehicle and Instruments	3.3	Hours	\$ 40.00	\$ 132.00
Analysis	1	Sample	\$ 300.00	\$ 300.00
<b>Per Sample Cost</b>				\$ 1,257.00

**Benthic Surveys**

Item	Number	Units	Unit Cost	Total Cost
Personnel (2)	20	Hours	\$ 250.00	\$ 5,000.00
Vehicle and Instruments	20	Hours	\$ 40.00	\$ 800.00
Analysis	1	Sample	\$ 1,000.00	\$ 1,000.00
<b>Per Sample Cost</b>				\$ 6,800.00

**Tissue Sampling**

Item	Number	Units	Unit Cost	Total Cost
Personnel (2)	3.3	Hours	\$ 250.00	\$ 825.00
Vehicle and Instruments	3.3	Hours	\$ 40.00	\$ 132.00
Analysis	1	Sample	\$ 300.00	\$ 300.00
<b>Per Sample Cost</b>				\$ 1,257.00



Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31	Year 32	Year 33
\$ 331,068	\$ 317,825	\$ 305,112	\$ 292,908	\$ 281,191	\$ 269,944	\$ 259,146	\$ 248,780	\$ 238,829	\$ 229,276	\$ 220,105	\$ 211,301	\$ 202,849	\$ 194,735	\$ 186,945	\$ 179,467	\$ 172,289	\$ 165,397	\$ 158,781
\$ 146,815	\$ 140,942	\$ 135,305	\$ 129,893	\$ 124,697	\$ 119,709	\$ 114,921	\$ 110,324	\$ 105,911	\$ 101,674	\$ 97,607	\$ 93,703	\$ 89,955	\$ 86,357	\$ 82,903	\$ 79,586	\$ 76,403	\$ 73,347	\$ 70,413
\$ 499,695	\$ 479,707	\$ 460,519	\$ 442,098	\$ 424,414	\$ 407,438	\$ 391,140	\$ 375,495	\$ 360,475	\$ 346,056	\$ 332,214	\$ 318,925	\$ 306,168	\$ 293,921	\$ 282,165	\$ 270,878	\$ 260,043	\$ 249,641	\$ 239,655
\$ 169,402	\$ 162,626	\$ 156,121	\$ 149,876	\$ 143,881	\$ 138,126	\$ 132,601	\$ 127,297	\$ 122,205	\$ 117,317	\$ 112,624	\$ 108,119	\$ 103,794	\$ 99,642	\$ 95,657	\$ 91,831	\$ 88,157	\$ 84,631	\$ 81,246
\$ 70,979	\$ 68,140	\$ 65,415	\$ 62,798	\$ 60,286	\$ 57,875	\$ 55,560	\$ 53,337	\$ 51,204	\$ 49,156	\$ 47,189	\$ 45,302	\$ 43,490	\$ 41,750	\$ 40,080	\$ 38,477	\$ 36,938	\$ 35,460	\$ 34,042
\$ 28,234	\$ 27,104	\$ 26,020	\$ 24,979	\$ 23,980	\$ 23,021	\$ 22,100	\$ 21,216	\$ 20,367	\$ 19,553	\$ 18,771	\$ 18,020	\$ 17,299	\$ 16,607	\$ 15,943	\$ 15,305	\$ 14,693	\$ 14,105	\$ 13,541
\$ 38,398	\$ 36,862	\$ 35,387	\$ 33,972	\$ 32,613	\$ 31,309	\$ 30,056	\$ 28,854	\$ 27,700	\$ 26,592	\$ 25,528	\$ 24,507	\$ 23,527	\$ 22,586	\$ 21,682	\$ 20,815	\$ 19,982	\$ 19,183	\$ 18,416
\$ 28,234	\$ 27,104	\$ 26,020	\$ 24,979	\$ 23,980	\$ 23,021	\$ 22,100	\$ 21,216	\$ 20,367	\$ 19,553	\$ 18,771	\$ 18,020	\$ 17,299	\$ 16,607	\$ 15,943	\$ 15,305	\$ 14,693	\$ 14,105	\$ 13,541
\$ 56,467	\$ 54,209	\$ 52,040	\$ 49,959	\$ 47,960	\$ 46,042	\$ 44,200	\$ 42,432	\$ 40,735	\$ 39,106	\$ 37,541	\$ 36,040	\$ 34,598	\$ 33,214	\$ 31,886	\$ 30,610	\$ 29,386	\$ 28,210	\$ 27,082
\$ 47,788	\$ 45,877	\$ 44,042	\$ 42,280	\$ 40,589	\$ 38,965	\$ 37,407	\$ 35,910	\$ 34,474	\$ 33,095	\$ 31,771	\$ 30,500	\$ 29,280	\$ 28,109	\$ 26,985	\$ 25,905	\$ 24,869	\$ 23,874	\$ 22,919
\$ 212,562	\$ 204,060	\$ 195,897	\$ 188,061	\$ 180,539	\$ 173,317	\$ 166,385	\$ 159,729	\$ 153,340	\$ 147,206	\$ 141,318	\$ 135,665	\$ 130,239	\$ 125,029	\$ 120,028	\$ 115,227	\$ 110,618	\$ 106,193	\$ 101,945
\$ 1,629,642	\$ 1,564,457	\$ 1,501,879	\$ 1,441,803	\$ 1,384,131	\$ 1,328,766	\$ 1,275,615	\$ 1,224,591	\$ 1,175,607	\$ 1,128,583	\$ 1,083,440	\$ 1,040,102	\$ 998,498	\$ 958,558	\$ 920,216	\$ 883,407	\$ 848,071	\$ 814,148	\$ 781,582

	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50	Year 51	Year 52
\$	152,430	\$ 146,333	\$ 140,480	\$ 134,860	\$ 129,466	\$ 124,287	\$ 119,316	\$ 114,543	\$ 109,961	\$ 105,563	\$ 101,340	\$ 97,287	\$ 93,395	\$ 89,660	\$ 86,073	\$ 82,630	\$ 79,325	\$ 76,152	\$ 73,106
\$	67,596	\$ 64,893	\$ 62,297	\$ 59,805	\$ 57,413	\$ 55,116	\$ 52,912	\$ 50,795	\$ 48,763	\$ 46,813	\$ 44,940	\$ 43,143	\$ 41,417	\$ 39,760	\$ 38,170	\$ 36,643	\$ 35,177	\$ 33,770	\$ 32,419
\$	230,069	\$ 220,867	\$ 212,032	\$ 203,551	\$ 195,409	\$ 187,592	\$ 180,089	\$ 172,885	\$ 165,970	\$ 159,331	\$ 152,958	\$ 146,839	\$ 140,966	\$ 135,327	\$ 129,914	\$ 124,717	\$ 119,729	\$ 114,940	\$ 110,342
\$	77,996	\$ 74,876	\$ 71,881	\$ 69,006	\$ 66,246	\$ 63,596	\$ 61,052	\$ 58,610	\$ 56,265	\$ 54,015	\$ 51,854	\$ 49,780	\$ 47,789	\$ 45,877	\$ 44,042	\$ 42,281	\$ 40,589	\$ 38,966	\$ 37,407
\$	32,680	\$ 31,373	\$ 30,118	\$ 28,913	\$ 27,757	\$ 26,647	\$ 25,581	\$ 24,558	\$ 23,575	\$ 22,632	\$ 21,727	\$ 20,858	\$ 20,024	\$ 19,223	\$ 18,454	\$ 17,716	\$ 17,007	\$ 16,327	\$ 15,674
\$	12,999	\$ 12,479	\$ 11,980	\$ 11,501	\$ 11,041	\$ 10,599	\$ 10,175	\$ 9,768	\$ 9,378	\$ 9,002	\$ 8,642	\$ 8,297	\$ 7,965	\$ 7,646	\$ 7,340	\$ 7,047	\$ 6,765	\$ 6,494	\$ 6,235
\$	17,679	\$ 16,972	\$ 16,293	\$ 15,641	\$ 15,016	\$ 14,415	\$ 13,838	\$ 13,285	\$ 12,754	\$ 12,243	\$ 11,754	\$ 11,283	\$ 10,832	\$ 10,399	\$ 9,983	\$ 9,584	\$ 9,200	\$ 8,832	\$ 8,479
\$	12,999	\$ 12,479	\$ 11,980	\$ 11,501	\$ 11,041	\$ 10,599	\$ 10,175	\$ 9,768	\$ 9,378	\$ 9,002	\$ 8,642	\$ 8,297	\$ 7,965	\$ 7,646	\$ 7,340	\$ 7,047	\$ 6,765	\$ 6,494	\$ 6,235
\$	25,999	\$ 24,959	\$ 23,960	\$ 23,002	\$ 22,082	\$ 21,199	\$ 20,351	\$ 19,537	\$ 18,755	\$ 18,005	\$ 17,285	\$ 16,593	\$ 15,930	\$ 15,292	\$ 14,681	\$ 14,094	\$ 13,530	\$ 12,989	\$ 12,469
\$	22,003	\$ 21,123	\$ 20,278	\$ 19,467	\$ 18,688	\$ 17,940	\$ 17,223	\$ 16,534	\$ 15,872	\$ 15,238	\$ 14,628	\$ 14,043	\$ 13,481	\$ 12,942	\$ 12,424	\$ 11,927	\$ 11,450	\$ 10,992	\$ 10,553
\$	97,868	\$ 93,953	\$ 90,195	\$ 86,587	\$ 83,124	\$ 79,799	\$ 76,607	\$ 73,542	\$ 70,601	\$ 67,777	\$ 65,066	\$ 62,463	\$ 59,964	\$ 57,566	\$ 55,263	\$ 53,053	\$ 50,931	\$ 48,893	\$ 46,938
\$	750,319	\$ 720,306	\$ 691,494	\$ 663,834	\$ 637,281	\$ 611,789	\$ 587,318	\$ 563,825	\$ 541,272	\$ 519,621	\$ 498,836	\$ 478,883	\$ 459,728	\$ 441,338	\$ 423,685	\$ 406,738	\$ 390,468	\$ 374,849	\$ 359,855

Year 53	Year 54	Year 55	Year 56	Year 57	Year 58	Year 59	Year 60
\$ 70,182	\$ 67,374	\$ 64,679	\$ 62,092	\$ 59,609	\$ 57,224	\$ 54,935	\$ 52,738
\$ 31,123	\$ 29,878	\$ 28,683	\$ 27,535	\$ 26,434	\$ 25,377	\$ 24,362	\$ 23,387
\$ 105,928	\$ 101,691	\$ 97,624	\$ 93,719	\$ 89,970	\$ 86,371	\$ 82,916	\$ 79,600
\$ 35,911	\$ 34,474	\$ 33,095	\$ 31,772	\$ 30,501	\$ 29,281	\$ 28,109	\$ 26,985
\$ 15,047	\$ 14,445	\$ 13,867	\$ 13,312	\$ 12,780	\$ 12,269	\$ 11,778	\$ 11,307
\$ 5,985	\$ 5,746	\$ 5,516	\$ 5,295	\$ 5,083	\$ 4,880	\$ 4,685	\$ 4,498
\$ 8,140	\$ 7,814	\$ 7,502	\$ 7,202	\$ 6,913	\$ 6,637	\$ 6,371	\$ 6,117
\$ 5,985	\$ 5,746	\$ 5,516	\$ 5,295	\$ 5,083	\$ 4,880	\$ 4,685	\$ 4,498
\$ 11,970	\$ 11,491	\$ 11,032	\$ 10,591	\$ 10,167	\$ 9,760	\$ 9,370	\$ 8,995
\$ 10,130	\$ 9,725	\$ 9,336	\$ 8,963	\$ 8,604	\$ 8,260	\$ 7,930	\$ 7,612
\$ 45,060	\$ 43,258	\$ 41,527	\$ 39,866	\$ 38,272	\$ 36,741	\$ 35,271	\$ 33,860
\$ 345,461	\$ 331,643	\$ 318,377	\$ 305,642	\$ 293,416	\$ 281,680	\$ 270,412	\$ 259,596



Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31	Year 32	Year 33
\$ 6,223,563	\$ 5,974,620	\$ 5,735,635	\$ 5,506,210	\$ 5,285,962	\$ 5,074,523	\$ 4,871,542	\$ 4,676,680	\$ 4,489,613	\$ 4,310,029	\$ 4,137,628	\$ 3,972,122	\$ 3,813,238	\$ 3,660,708	\$ 3,514,280	\$ 3,373,709	\$ 3,238,760	\$ 3,109,210	\$ 2,984,841
\$ 4,149,042	\$ 3,983,080	\$ 3,823,757	\$ 3,670,807	\$ 3,523,974	\$ 3,383,015	\$ 3,247,695	\$ 3,117,787	\$ 2,993,076	\$ 2,873,352	\$ 2,758,418	\$ 2,648,082	\$ 2,542,158	\$ 2,440,472	\$ 2,342,853	\$ 2,249,139	\$ 2,159,173	\$ 2,072,807	\$ 1,989,894
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 4,667,672	\$ 4,480,965	\$ 4,301,727	\$ 4,129,657	\$ 3,964,471	\$ 3,805,892	\$ 3,653,657	\$ 3,507,510	\$ 3,367,210	\$ 3,232,522	\$ 3,103,221	\$ 2,979,092	\$ 2,859,928	\$ 2,745,531	\$ 2,635,710	\$ 2,530,281	\$ 2,429,070	\$ 2,331,907	\$ 2,238,631
\$ 3,111,781	\$ 2,987,310	\$ 2,867,818	\$ 2,753,105	\$ 2,642,981	\$ 2,537,262	\$ 2,435,771	\$ 2,338,340	\$ 2,244,807	\$ 2,155,014	\$ 2,068,814	\$ 1,986,061	\$ 1,906,619	\$ 1,830,354	\$ 1,757,140	\$ 1,686,854	\$ 1,619,380	\$ 1,554,605	\$ 1,492,421
\$ 12,155	\$ 11,668	\$ 11,202	\$ 10,754	\$ 10,323	\$ 9,911	\$ 9,514	\$ 9,134	\$ 8,768	\$ 8,417	\$ 8,081	\$ 7,758	\$ 7,447	\$ 7,149	\$ 6,863	\$ 6,589	\$ 6,325	\$ 6,072	\$ 5,829
\$ 101,641	\$ 97,576	\$ 93,673	\$ 89,926	\$ 86,329	\$ 82,875	\$ 79,560	\$ 76,378	\$ 73,323	\$ 70,390	\$ 67,574	\$ 64,871	\$ 62,277	\$ 59,785	\$ 57,394	\$ 55,098	\$ 52,894	\$ 50,779	\$ 48,747
\$ 1,826,585	\$ 1,753,522	\$ 1,683,381	\$ 1,616,046	\$ 1,551,404	\$ 1,489,348	\$ 1,429,774	\$ 1,372,583	\$ 1,317,680	\$ 1,264,972	\$ 1,214,374	\$ 1,165,799	\$ 1,119,167	\$ 1,074,400	\$ 1,031,424	\$ 990,167	\$ 950,560	\$ 912,538	\$ 876,036
\$ 3,013,866	\$ 2,893,311	\$ 2,777,579	\$ 2,666,476	\$ 2,559,817	\$ 2,457,424	\$ 2,359,127	\$ 2,264,762	\$ 2,174,171	\$ 2,087,205	\$ 2,003,716	\$ 1,923,568	\$ 1,846,625	\$ 1,772,760	\$ 1,701,850	\$ 1,633,776	\$ 1,568,425	\$ 1,505,688	\$ 1,445,460
\$ 23,106,305	\$ 22,182,053	\$ 21,294,771	\$ 20,442,980	\$ 19,625,261	\$ 18,840,250	\$ 18,086,640	\$ 17,363,174	\$ 16,668,648	\$ 16,001,902	\$ 15,361,826	\$ 14,747,353	\$ 14,157,458	\$ 13,591,160	\$ 13,047,514	\$ 12,525,613	\$ 12,024,589	\$ 11,543,605	\$ 11,081,861



Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50	Year 51	Year 52
\$ 2,865,448	\$ 2,750,830	\$ 2,640,797	\$ 2,535,165	\$ 2,433,758	\$ 2,336,408	\$ 2,242,952	\$ 2,153,233	\$ 2,067,104	\$ 1,984,420	\$ 1,905,043	\$ 1,828,841	\$ 1,755,688	\$ 1,685,460	\$ 1,618,042	\$ 1,553,320	\$ 1,491,187	\$ 1,431,540	\$ 1,374,278
\$ 1,910,299	\$ 1,833,887	\$ 1,760,531	\$ 1,690,110	\$ 1,622,505	\$ 1,557,605	\$ 1,495,301	\$ 1,435,489	\$ 1,378,069	\$ 1,322,947	\$ 1,270,029	\$ 1,219,228	\$ 1,170,459	\$ 1,123,640	\$ 1,078,695	\$ 1,035,547	\$ 994,125	\$ 954,360	\$ 916,186
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 2,149,086	\$ 2,063,122	\$ 1,980,597	\$ 1,901,374	\$ 1,825,319	\$ 1,752,306	\$ 1,682,214	\$ 1,614,925	\$ 1,550,328	\$ 1,488,315	\$ 1,428,782	\$ 1,371,631	\$ 1,316,766	\$ 1,264,095	\$ 1,213,531	\$ 1,164,990	\$ 1,118,391	\$ 1,073,655	\$ 1,030,709
\$ 1,432,724	\$ 1,375,415	\$ 1,320,398	\$ 1,267,582	\$ 1,216,879	\$ 1,168,204	\$ 1,121,476	\$ 1,076,617	\$ 1,033,552	\$ 992,210	\$ 952,522	\$ 914,421	\$ 877,844	\$ 842,730	\$ 809,021	\$ 776,660	\$ 745,594	\$ 715,770	\$ 687,139
\$ 5,596	\$ 5,372	\$ 5,157	\$ 4,951	\$ 4,753	\$ 4,563	\$ 4,380	\$ 4,205	\$ 4,037	\$ 3,876	\$ 3,721	\$ 3,572	\$ 3,429	\$ 3,292	\$ 3,160	\$ 3,034	\$ 2,912	\$ 2,796	\$ 2,684
\$ 46,798	\$ 44,926	\$ 43,129	\$ 41,403	\$ 39,747	\$ 38,157	\$ 36,631	\$ 35,166	\$ 33,759	\$ 32,409	\$ 31,113	\$ 29,868	\$ 28,673	\$ 27,526	\$ 26,425	\$ 25,368	\$ 24,354	\$ 23,379	\$ 22,444
\$ 840,995	\$ 807,355	\$ 775,061	\$ 744,059	\$ 714,296	\$ 685,724	\$ 658,295	\$ 631,964	\$ 606,685	\$ 582,418	\$ 559,121	\$ 536,756	\$ 515,286	\$ 494,674	\$ 474,887	\$ 455,892	\$ 437,656	\$ 420,150	\$ 403,344
\$ 1,387,642	\$ 1,332,136	\$ 1,278,851	\$ 1,227,697	\$ 1,178,589	\$ 1,131,445	\$ 1,086,187	\$ 1,042,740	\$ 1,001,030	\$ 960,989	\$ 922,549	\$ 885,648	\$ 850,222	\$ 816,213	\$ 783,564	\$ 752,222	\$ 722,133	\$ 693,247	\$ 665,518
\$ 10,638,586	\$ 10,213,043	\$ 9,804,521	\$ 9,412,340	\$ 9,035,847	\$ 8,674,413	\$ 8,327,436	\$ 7,994,339	\$ 7,674,565	\$ 7,367,583	\$ 7,072,879	\$ 6,789,964	\$ 6,518,366	\$ 6,257,631	\$ 6,007,326	\$ 5,767,033	\$ 5,536,351	\$ 5,314,897	\$ 5,102,302

Year 53	Year 54	Year 55	Year 56	Year 57	Year 58	Year 59	Year 60
\$ 1,319,307	\$ 1,266,535	\$ 1,215,873	\$ 1,167,239	\$ 1,120,549	\$ 1,075,727	\$ 1,032,698	\$ 991,390
\$ 879,538	\$ 844,357	\$ 810,582	\$ 778,159	\$ 747,033	\$ 717,151	\$ 688,465	\$ 660,927
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 989,480	\$ 949,901	\$ 911,905	\$ 875,429	\$ 840,412	\$ 806,795	\$ 774,523	\$ 743,543
\$ 659,654	\$ 633,267	\$ 607,937	\$ 583,619	\$ 560,275	\$ 537,864	\$ 516,349	\$ 495,695
\$ 2,577	\$ 2,474	\$ 2,375	\$ 2,280	\$ 2,188	\$ 2,101	\$ 2,017	\$ 1,936
\$ 21,546	\$ 20,685	\$ 19,857	\$ 19,063	\$ 18,300	\$ 17,568	\$ 16,866	\$ 16,191
\$ 387,210	\$ 371,722	\$ 356,853	\$ 342,579	\$ 328,876	\$ 315,721	\$ 303,092	\$ 290,968
\$ 638,897	\$ 613,341	\$ 588,807	\$ 565,255	\$ 542,645	\$ 520,939	\$ 500,102	\$ 480,097
\$ 4,898,209	\$ 4,702,281	\$ 4,514,190	\$ 4,333,622	\$ 4,160,277	\$ 3,993,866	\$ 3,834,112	\$ 3,680,747



Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 4,862,158	\$ 4,667,672	\$ 4,480,965	\$ 4,301,727	\$ 4,129,657	\$ 3,964,471	\$ 3,805,892	\$ 3,653,657	\$ 3,507,510	\$ 3,367,210	\$ 3,232,522	\$ 3,103,221	\$ 2,979,092	\$ 2,859,928	\$ 2,745,531	\$ 2,635,710	\$ 2,530,281	\$ 2,429,070
\$ 3,241,439	\$ 3,111,781	\$ 2,987,310	\$ 2,867,818	\$ 2,753,105	\$ 2,642,981	\$ 2,537,262	\$ 2,435,771	\$ 2,338,340	\$ 2,244,807	\$ 2,155,014	\$ 2,068,814	\$ 1,986,061	\$ 1,906,619	\$ 1,830,354	\$ 1,757,140	\$ 1,686,854	\$ 1,619,380
\$ 8,441	\$ 8,103	\$ 7,779	\$ 7,468	\$ 7,169	\$ 6,882	\$ 6,607	\$ 6,343	\$ 6,089	\$ 5,845	\$ 5,612	\$ 5,387	\$ 5,172	\$ 4,965	\$ 4,766	\$ 4,576	\$ 4,393	\$ 4,217
\$ 105,876	\$ 101,641	\$ 97,576	\$ 93,673	\$ 89,926	\$ 86,329	\$ 82,875	\$ 79,560	\$ 76,378	\$ 73,323	\$ 70,390	\$ 67,574	\$ 64,871	\$ 62,277	\$ 59,785	\$ 57,394	\$ 55,098	\$ 52,894
\$ 821,791	\$ 788,920	\$ 757,363	\$ 727,068	\$ 697,986	\$ 670,066	\$ 643,264	\$ 617,533	\$ 592,832	\$ 569,118	\$ 546,354	\$ 524,500	\$ 503,520	\$ 483,379	\$ 464,044	\$ 445,482	\$ 427,663	\$ 410,556
\$ 1,355,956	\$ 1,301,718	\$ 1,249,649	\$ 1,199,663	\$ 1,151,676	\$ 1,105,609	\$ 1,061,385	\$ 1,018,930	\$ 978,172	\$ 939,046	\$ 901,484	\$ 865,424	\$ 830,807	\$ 797,575	\$ 765,672	\$ 735,045	\$ 705,643	\$ 677,418
\$ 10,395,661	\$ 9,979,835	\$ 9,580,642	\$ 9,197,416	\$ 8,829,519	\$ 8,476,339	\$ 8,137,285	\$ 7,811,794	\$ 7,499,322	\$ 7,199,349	\$ 6,911,375	\$ 6,634,920	\$ 6,369,523	\$ 6,114,742	\$ 5,870,153	\$ 5,635,346	\$ 5,409,933	\$ 5,193,535

Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 2,331,907	\$ 2,238,631	\$ 2,149,086	\$ 2,063,122	\$ 1,980,597	\$ 1,901,374	\$ 1,825,319	\$ 1,752,306	\$ 1,682,214	\$ 1,614,925	\$ 1,550,328	\$ 1,488,315	\$ 1,428,782	\$ 1,371,631	\$ 1,316,766	\$ 1,264,095	\$ 1,213,531	\$ 1,164,990
\$ 1,554,605	\$ 1,492,421	\$ 1,432,724	\$ 1,375,415	\$ 1,320,398	\$ 1,267,582	\$ 1,216,879	\$ 1,168,204	\$ 1,121,476	\$ 1,076,617	\$ 1,033,552	\$ 992,210	\$ 952,522	\$ 914,421	\$ 877,844	\$ 842,730	\$ 809,021	\$ 776,660
\$ 4,048	\$ 3,886	\$ 3,731	\$ 3,582	\$ 3,438	\$ 3,301	\$ 3,169	\$ 3,042	\$ 2,920	\$ 2,804	\$ 2,691	\$ 2,584	\$ 2,480	\$ 2,381	\$ 2,286	\$ 2,194	\$ 2,107	\$ 2,022
\$ 50,779	\$ 48,747	\$ 46,798	\$ 44,926	\$ 43,129	\$ 41,403	\$ 39,747	\$ 38,157	\$ 36,631	\$ 35,166	\$ 33,759	\$ 32,409	\$ 31,113	\$ 29,868	\$ 28,673	\$ 27,526	\$ 26,425	\$ 25,368
\$ 394,134	\$ 378,369	\$ 363,234	\$ 348,704	\$ 334,756	\$ 321,366	\$ 308,511	\$ 296,171	\$ 284,324	\$ 272,951	\$ 262,033	\$ 251,552	\$ 241,490	\$ 231,830	\$ 222,557	\$ 213,655	\$ 205,108	\$ 196,904
\$ 650,321	\$ 624,308	\$ 599,336	\$ 575,362	\$ 552,348	\$ 530,254	\$ 509,044	\$ 488,682	\$ 469,135	\$ 450,369	\$ 432,355	\$ 415,060	\$ 398,458	\$ 382,520	\$ 367,219	\$ 352,530	\$ 338,429	\$ 324,892
\$ 4,985,794	\$ 4,786,362	\$ 4,594,908	\$ 4,411,111	\$ 4,234,667	\$ 4,065,280	\$ 3,902,669	\$ 3,746,562	\$ 3,596,700	\$ 3,452,832	\$ 3,314,718	\$ 3,182,130	\$ 3,054,845	\$ 2,932,651	\$ 2,815,345	\$ 2,702,731	\$ 2,594,622	\$ 2,490,837

Year 50	Year 51	Year 52	Year 53	Year 54	Year 55	Year 56	Year 57	Year 58	Year 59	Year 60
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 1,118,391	\$ 1,073,655	\$ 1,030,709	\$ 989,480	\$ 949,901	\$ 911,905	\$ 875,429	\$ 840,412	\$ 806,795	\$ 774,523	\$ 743,543
\$ 745,594	\$ 715,770	\$ 687,139	\$ 659,654	\$ 633,267	\$ 607,937	\$ 583,619	\$ 560,275	\$ 537,864	\$ 516,349	\$ 495,695
\$ 1,942	\$ 1,864	\$ 1,789	\$ 1,718	\$ 1,649	\$ 1,583	\$ 1,520	\$ 1,459	\$ 1,401	\$ 1,345	\$ 1,291
\$ 24,354	\$ 23,379	\$ 22,444	\$ 21,546	\$ 20,685	\$ 19,857	\$ 19,063	\$ 18,300	\$ 17,568	\$ 16,866	\$ 16,191
\$ 189,028	\$ 181,467	\$ 174,208	\$ 167,240	\$ 160,550	\$ 154,128	\$ 147,963	\$ 142,045	\$ 136,363	\$ 130,908	\$ 125,672
\$ 311,896	\$ 299,420	\$ 287,443	\$ 275,946	\$ 264,908	\$ 254,312	\$ 244,139	\$ 234,374	\$ 224,999	\$ 215,999	\$ 207,359
\$ 2,391,203	\$ 2,295,555	\$ 2,203,733	\$ 2,115,584	\$ 2,030,960	\$ 1,949,722	\$ 1,871,733	\$ 1,796,864	\$ 1,724,989	\$ 1,655,990	\$ 1,589,750



Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31	Year 32
\$ 12,965,756	\$ 12,447,125	\$ 11,949,240	\$ 11,471,271	\$ 11,012,420	\$ 10,571,923	\$ 10,149,046	\$ 9,743,084	\$ 9,353,361	\$ 8,979,227	\$ 8,620,057	\$ 8,275,255	\$ 7,944,245	\$ 7,626,475	\$ 7,321,416	\$ 7,028,560	\$ 6,747,417	\$ 6,477,520	\$ 6,218,420
\$ 8,643,837	\$ 8,298,084	\$ 7,966,160	\$ 7,647,514	\$ 7,341,613	\$ 7,047,949	\$ 6,766,031	\$ 6,495,390	\$ 6,235,574	\$ 5,986,151	\$ 5,746,705	\$ 5,516,837	\$ 5,296,163	\$ 5,084,317	\$ 4,880,944	\$ 4,685,706	\$ 4,498,278	\$ 4,318,347	\$ 4,145,613
\$ 8,751,885	\$ 8,401,810	\$ 8,065,737	\$ 7,743,108	\$ 7,433,383	\$ 7,136,048	\$ 6,850,606	\$ 6,576,582	\$ 6,313,519	\$ 6,060,978	\$ 5,818,539	\$ 5,585,797	\$ 5,362,365	\$ 5,147,871	\$ 4,941,956	\$ 4,744,278	\$ 4,554,507	\$ 4,372,326	\$ 4,197,433
\$ 5,834,590	\$ 5,601,206	\$ 5,377,158	\$ 5,162,072	\$ 4,955,589	\$ 4,757,365	\$ 4,567,071	\$ 4,384,388	\$ 4,209,012	\$ 4,040,652	\$ 3,879,026	\$ 3,723,865	\$ 3,574,910	\$ 3,431,914	\$ 3,294,637	\$ 3,162,852	\$ 3,036,338	\$ 2,914,884	\$ 2,798,289
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 10,696,748	\$ 10,268,878	\$ 9,858,123	\$ 9,463,798	\$ 9,085,246	\$ 8,721,837	\$ 8,372,963	\$ 8,038,045	\$ 7,716,523	\$ 7,407,862	\$ 7,111,547	\$ 6,827,086	\$ 6,554,002	\$ 6,291,842	\$ 6,040,168	\$ 5,798,562	\$ 5,566,619	\$ 5,343,954	\$ 5,130,196
\$ 7,131,166	\$ 6,845,919	\$ 6,572,082	\$ 6,309,199	\$ 6,056,831	\$ 5,814,558	\$ 5,581,975	\$ 5,358,696	\$ 5,144,349	\$ 4,938,575	\$ 4,741,032	\$ 4,551,390	\$ 4,369,335	\$ 4,194,561	\$ 4,026,779	\$ 3,865,708	\$ 3,711,079	\$ 3,562,636	\$ 3,420,131
\$ 18,087	\$ 17,364	\$ 16,669	\$ 16,002	\$ 15,362	\$ 14,748	\$ 14,158	\$ 13,592	\$ 13,048	\$ 12,526	\$ 12,025	\$ 11,544	\$ 11,082	\$ 10,639	\$ 10,213	\$ 9,805	\$ 9,413	\$ 9,036	\$ 8,675
\$ 105,876	\$ 101,641	\$ 97,576	\$ 93,673	\$ 89,926	\$ 86,329	\$ 82,875	\$ 79,560	\$ 76,378	\$ 73,323	\$ 70,390	\$ 67,574	\$ 64,871	\$ 62,277	\$ 59,785	\$ 57,394	\$ 55,098	\$ 52,894	\$ 50,779
\$ 5,414,795	\$ 5,198,203	\$ 4,990,275	\$ 4,790,664	\$ 4,599,037	\$ 4,415,076	\$ 4,238,473	\$ 4,068,934	\$ 3,906,176	\$ 3,749,929	\$ 3,599,932	\$ 3,455,935	\$ 3,317,697	\$ 3,184,990	\$ 3,057,590	\$ 2,935,286	\$ 2,817,875	\$ 2,705,160	\$ 2,596,954
\$ 8,934,411	\$ 8,577,034	\$ 8,233,953	\$ 7,904,595	\$ 7,588,411	\$ 7,284,875	\$ 6,993,480	\$ 6,713,741	\$ 6,445,191	\$ 6,187,383	\$ 5,939,888	\$ 5,702,292	\$ 5,474,201	\$ 5,255,233	\$ 5,045,023	\$ 4,843,222	\$ 4,649,494	\$ 4,463,514	\$ 4,284,973
\$ 68,497,150	\$ 65,757,264	\$ 63,126,974	\$ 60,601,895	\$ 58,177,819	\$ 55,850,706	\$ 53,616,678	\$ 51,472,011	\$ 49,413,131	\$ 47,436,605	\$ 45,539,141	\$ 43,717,575	\$ 41,968,872	\$ 40,290,118	\$ 38,678,513	\$ 37,131,372	\$ 35,646,117	\$ 34,220,273	\$ 32,851,462



Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50	Year 51
\$ 5,969,683	\$ 5,730,896	\$ 5,501,660	\$ 5,281,593	\$ 5,070,330	\$ 4,867,516	\$ 4,672,816	\$ 4,485,903	\$ 4,306,467	\$ 4,134,208	\$ 3,968,840	\$ 3,810,086	\$ 3,657,683	\$ 3,511,376	\$ 3,370,921	\$ 3,236,084	\$ 3,106,640	\$ 2,982,375	\$ 2,863,080
\$ 3,979,789	\$ 3,820,597	\$ 3,667,773	\$ 3,521,062	\$ 3,380,220	\$ 3,245,011	\$ 3,115,210	\$ 2,990,602	\$ 2,870,978	\$ 2,756,139	\$ 2,645,893	\$ 2,540,058	\$ 2,438,455	\$ 2,340,917	\$ 2,247,280	\$ 2,157,389	\$ 2,071,094	\$ 1,988,250	\$ 1,908,720
\$ 4,029,536	\$ 3,868,354	\$ 3,713,620	\$ 3,565,075	\$ 3,422,472	\$ 3,285,574	\$ 3,154,151	\$ 3,027,985	\$ 2,906,865	\$ 2,790,591	\$ 2,678,967	\$ 2,571,808	\$ 2,468,936	\$ 2,370,179	\$ 2,275,371	\$ 2,184,357	\$ 2,096,982	\$ 2,013,103	\$ 1,932,579
\$ 2,686,357	\$ 2,578,903	\$ 2,475,747	\$ 2,376,717	\$ 2,281,648	\$ 2,190,382	\$ 2,102,767	\$ 2,018,656	\$ 1,937,910	\$ 1,860,394	\$ 1,785,978	\$ 1,714,539	\$ 1,645,957	\$ 1,580,119	\$ 1,516,914	\$ 1,456,238	\$ 1,397,988	\$ 1,342,069	\$ 1,288,386
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 4,924,988	\$ 4,727,989	\$ 4,538,869	\$ 4,357,314	\$ 4,183,022	\$ 4,015,701	\$ 3,855,073	\$ 3,700,870	\$ 3,552,835	\$ 3,410,722	\$ 3,274,293	\$ 3,143,321	\$ 3,017,588	\$ 2,896,885	\$ 2,781,009	\$ 2,669,769	\$ 2,562,978	\$ 2,460,459	\$ 2,362,041
\$ 3,283,326	\$ 3,151,993	\$ 3,025,913	\$ 2,904,876	\$ 2,788,681	\$ 2,677,134	\$ 2,570,049	\$ 2,467,247	\$ 2,368,557	\$ 2,273,815	\$ 2,182,862	\$ 2,095,548	\$ 2,011,726	\$ 1,931,257	\$ 1,854,006	\$ 1,779,846	\$ 1,708,652	\$ 1,640,306	\$ 1,574,694
\$ 8,328	\$ 7,995	\$ 7,675	\$ 7,368	\$ 7,073	\$ 6,790	\$ 6,519	\$ 6,258	\$ 6,008	\$ 5,767	\$ 5,537	\$ 5,315	\$ 5,102	\$ 4,898	\$ 4,702	\$ 4,514	\$ 4,334	\$ 4,160	\$ 3,994
\$ 48,747	\$ 46,798	\$ 44,926	\$ 43,129	\$ 41,403	\$ 39,747	\$ 38,157	\$ 36,631	\$ 35,166	\$ 33,759	\$ 32,409	\$ 31,113	\$ 29,868	\$ 28,673	\$ 27,526	\$ 26,425	\$ 25,368	\$ 24,354	\$ 23,379
\$ 2,493,075	\$ 2,393,352	\$ 2,297,618	\$ 2,205,714	\$ 2,117,485	\$ 2,032,786	\$ 1,951,474	\$ 1,873,415	\$ 1,798,479	\$ 1,726,539	\$ 1,657,478	\$ 1,591,179	\$ 1,527,532	\$ 1,466,430	\$ 1,407,773	\$ 1,351,462	\$ 1,297,404	\$ 1,245,508	\$ 1,195,687
\$ 4,113,574	\$ 3,949,031	\$ 3,791,070	\$ 3,639,427	\$ 3,493,850	\$ 3,354,096	\$ 3,219,932	\$ 3,091,135	\$ 2,967,490	\$ 2,848,790	\$ 2,734,838	\$ 2,625,445	\$ 2,520,427	\$ 2,419,610	\$ 2,322,826	\$ 2,229,913	\$ 2,140,716	\$ 2,055,087	\$ 1,972,884
\$ 31,537,403	\$ 30,275,907	\$ 29,064,871	\$ 27,902,276	\$ 26,786,185	\$ 25,714,738	\$ 24,686,148	\$ 23,698,702	\$ 22,750,754	\$ 21,840,724	\$ 20,967,095	\$ 20,128,411	\$ 19,323,275	\$ 18,550,344	\$ 17,808,330	\$ 17,095,997	\$ 16,412,157	\$ 15,755,671	\$ 15,125,444

Year 52	Year 53	Year 54	Year 55	Year 56	Year 57	Year 58	Year 59	Year 60
\$ 2,748,557	\$ 2,638,614	\$ 2,533,070	\$ 2,431,747	\$ 2,334,477	\$ 2,241,098	\$ 2,151,454	\$ 2,065,396	\$ 1,982,780
\$ 1,832,371	\$ 1,759,076	\$ 1,688,713	\$ 1,621,165	\$ 1,556,318	\$ 1,494,065	\$ 1,434,303	\$ 1,376,931	\$ 1,321,853
\$ 1,855,276	\$ 1,781,065	\$ 1,709,822	\$ 1,641,429	\$ 1,575,772	\$ 1,512,741	\$ 1,452,232	\$ 1,394,142	\$ 1,338,377
\$ 1,236,850	\$ 1,187,376	\$ 1,139,881	\$ 1,094,286	\$ 1,050,515	\$ 1,008,494	\$ 968,154	\$ 929,428	\$ 892,251
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 2,267,559	\$ 2,176,857	\$ 2,089,783	\$ 2,006,191	\$ 1,925,944	\$ 1,848,906	\$ 1,774,950	\$ 1,703,952	\$ 1,635,794
\$ 1,511,706	\$ 1,451,238	\$ 1,393,188	\$ 1,337,461	\$ 1,283,962	\$ 1,232,604	\$ 1,183,300	\$ 1,135,968	\$ 1,090,529
\$ 3,834	\$ 3,681	\$ 3,534	\$ 3,392	\$ 3,257	\$ 3,126	\$ 3,001	\$ 2,881	\$ 2,766
\$ 22,444	\$ 21,546	\$ 20,685	\$ 19,857	\$ 19,063	\$ 18,300	\$ 17,568	\$ 16,866	\$ 16,191
\$ 1,147,860	\$ 1,101,945	\$ 1,057,868	\$ 1,015,553	\$ 974,931	\$ 935,934	\$ 898,496	\$ 862,556	\$ 828,054
\$ 1,893,969	\$ 1,818,210	\$ 1,745,481	\$ 1,675,662	\$ 1,608,636	\$ 1,544,290	\$ 1,482,519	\$ 1,423,218	\$ 1,366,289
\$ 14,520,426	\$ 13,939,609	\$ 13,382,025	\$ 12,846,744	\$ 12,332,874	\$ 11,839,559	\$ 11,365,977	\$ 10,911,338	\$ 10,474,884



Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31	Year 32	Year 33
\$ 4,667,672	\$ 4,480,965	\$ 4,301,727	\$ 4,129,657	\$ 3,964,471	\$ 3,805,892	\$ 3,653,657	\$ 3,507,510	\$ 3,367,210	\$ 3,232,522	\$ 3,103,221	\$ 2,979,092	\$ 2,859,928	\$ 2,745,531	\$ 2,635,710	\$ 2,530,281	\$ 2,429,070	\$ 2,331,907	\$ 2,238,631
\$ 3,111,781	\$ 2,987,310	\$ 2,867,818	\$ 2,753,105	\$ 2,642,981	\$ 2,537,262	\$ 2,435,771	\$ 2,338,340	\$ 2,244,807	\$ 2,155,014	\$ 2,068,814	\$ 1,986,061	\$ 1,906,619	\$ 1,830,354	\$ 1,757,140	\$ 1,686,854	\$ 1,619,380	\$ 1,554,605	\$ 1,492,421
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 12,447,125	\$ 11,949,240	\$ 11,471,271	\$ 11,012,420	\$ 10,571,923	\$ 10,149,046	\$ 9,743,084	\$ 9,353,361	\$ 8,979,227	\$ 8,620,057	\$ 8,275,255	\$ 7,944,245	\$ 7,626,475	\$ 7,321,416	\$ 7,028,560	\$ 6,747,417	\$ 6,477,520	\$ 6,218,420	\$ 5,969,683
\$ 8,298,084	\$ 7,966,160	\$ 7,647,514	\$ 7,341,613	\$ 7,047,949	\$ 6,766,031	\$ 6,495,390	\$ 6,235,574	\$ 5,986,151	\$ 5,746,705	\$ 5,516,837	\$ 5,296,163	\$ 5,084,317	\$ 4,880,944	\$ 4,685,706	\$ 4,498,278	\$ 4,318,347	\$ 4,145,613	\$ 3,979,789
\$ 6,945	\$ 6,668	\$ 6,401	\$ 6,145	\$ 5,899	\$ 5,663	\$ 5,437	\$ 5,219	\$ 5,010	\$ 4,810	\$ 4,618	\$ 4,433	\$ 4,256	\$ 4,085	\$ 3,922	\$ 3,765	\$ 3,614	\$ 3,470	\$ 3,331
\$ 101,641	\$ 97,576	\$ 93,673	\$ 89,926	\$ 86,329	\$ 82,875	\$ 79,560	\$ 76,378	\$ 73,323	\$ 70,390	\$ 67,574	\$ 64,871	\$ 62,277	\$ 59,785	\$ 57,394	\$ 55,098	\$ 52,894	\$ 50,779	\$ 48,747
\$ 2,863,325	\$ 2,748,792	\$ 2,638,840	\$ 2,533,287	\$ 2,431,955	\$ 2,334,677	\$ 2,241,290	\$ 2,151,638	\$ 2,065,573	\$ 1,982,950	\$ 1,903,632	\$ 1,827,487	\$ 1,754,387	\$ 1,684,212	\$ 1,616,843	\$ 1,552,169	\$ 1,490,083	\$ 1,430,479	\$ 1,373,260
\$ 4,724,486	\$ 4,535,507	\$ 4,354,086	\$ 4,179,923	\$ 4,012,726	\$ 3,852,217	\$ 3,698,128	\$ 3,550,203	\$ 3,408,195	\$ 3,271,867	\$ 3,140,993	\$ 3,015,353	\$ 2,894,739	\$ 2,778,949	\$ 2,667,791	\$ 2,561,080	\$ 2,458,636	\$ 2,360,291	\$ 2,265,879
\$ 36,221,060	\$ 34,772,218	\$ 33,381,329	\$ 32,046,076	\$ 30,764,233	\$ 29,533,663	\$ 28,352,317	\$ 27,218,224	\$ 26,129,495	\$ 25,084,315	\$ 24,080,943	\$ 23,117,705	\$ 22,192,997	\$ 21,305,277	\$ 20,453,066	\$ 19,634,943	\$ 18,849,546	\$ 18,095,564	\$ 17,371,741

Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40	Year 41	Year 42	Year 43	Year 44	Year 45	Year 50	Year 51	Year 52	Year 53	Year 54	Year 55	Year 56
\$ 2,149,086	\$ 2,063,122	\$ 1,980,597	\$ 1,901,374	\$ 1,825,319	\$ 1,752,306	\$ 1,682,214	\$ 1,614,925	\$ 1,550,328	\$ 1,488,315	\$ 1,428,782	\$ 1,371,631	\$ 1,316,766	\$ 1,264,095	\$ 1,213,531	\$ 1,164,990	\$ 1,118,391	\$ 1,073,655	\$ 1,030,709
\$ 1,432,724	\$ 1,375,415	\$ 1,320,398	\$ 1,267,582	\$ 1,216,879	\$ 1,168,204	\$ 1,121,476	\$ 1,076,617	\$ 1,033,552	\$ 992,210	\$ 952,522	\$ 914,421	\$ 877,844	\$ 842,730	\$ 809,021	\$ 776,660	\$ 745,594	\$ 715,770	\$ 687,139
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 5,730,896	\$ 5,501,660	\$ 5,281,593	\$ 5,070,330	\$ 4,867,516	\$ 4,672,816	\$ 4,485,903	\$ 4,306,467	\$ 4,134,208	\$ 3,968,840	\$ 3,810,086	\$ 3,657,683	\$ 3,511,376	\$ 3,370,921	\$ 3,236,084	\$ 3,106,640	\$ 2,982,375	\$ 2,863,080	\$ 2,748,557
\$ 3,820,597	\$ 3,667,773	\$ 3,521,062	\$ 3,380,220	\$ 3,245,011	\$ 3,115,210	\$ 2,990,602	\$ 2,870,978	\$ 2,756,139	\$ 2,645,893	\$ 2,540,058	\$ 2,438,455	\$ 2,340,917	\$ 2,247,280	\$ 2,157,389	\$ 2,071,094	\$ 1,988,250	\$ 1,908,720	\$ 1,832,371
\$ 3,198	\$ 3,070	\$ 2,947	\$ 2,829	\$ 2,716	\$ 2,607	\$ 2,503	\$ 2,403	\$ 2,307	\$ 2,215	\$ 2,126	\$ 2,041	\$ 1,959	\$ 1,881	\$ 1,806	\$ 1,734	\$ 1,664	\$ 1,598	\$ 1,534
\$ 46,798	\$ 44,926	\$ 43,129	\$ 41,403	\$ 39,747	\$ 38,157	\$ 36,631	\$ 35,166	\$ 33,759	\$ 32,409	\$ 31,113	\$ 29,868	\$ 28,673	\$ 27,526	\$ 26,425	\$ 25,368	\$ 24,354	\$ 23,379	\$ 22,444
\$ 1,318,330	\$ 1,265,597	\$ 1,214,973	\$ 1,166,374	\$ 1,119,719	\$ 1,074,930	\$ 1,031,933	\$ 990,656	\$ 951,029	\$ 912,988	\$ 876,469	\$ 841,410	\$ 807,754	\$ 775,443	\$ 744,426	\$ 714,649	\$ 686,063	\$ 658,620	\$ 632,275
\$ 2,175,244	\$ 2,088,234	\$ 2,004,705	\$ 1,924,517	\$ 1,847,536	\$ 1,773,635	\$ 1,702,689	\$ 1,634,582	\$ 1,569,198	\$ 1,506,430	\$ 1,446,173	\$ 1,388,326	\$ 1,332,793	\$ 1,279,482	\$ 1,228,302	\$ 1,179,170	\$ 1,132,003	\$ 1,086,723	\$ 1,043,254
\$ 16,676,872	\$ 16,009,797	\$ 15,369,405	\$ 14,754,629	\$ 14,164,443	\$ 13,597,866	\$ 13,053,951	\$ 12,531,793	\$ 12,030,521	\$ 11,549,300	\$ 11,087,328	\$ 10,643,835	\$ 10,218,082	\$ 9,809,359	\$ 9,416,984	\$ 9,040,305	\$ 8,678,693	\$ 8,331,545	\$ 7,998,283

<b>Year 57</b>	<b>Year 58</b>	<b>Year 59</b>	<b>Year 60</b>
\$ 989,480	\$ 949,901	\$ 911,905	\$ 875,429
\$ 659,654	\$ 633,267	\$ 607,937	\$ 583,619
\$ -	\$ -	\$ -	\$ -
\$ 2,638,614	\$ 2,533,070	\$ 2,431,747	\$ 2,334,477
\$ 1,759,076	\$ 1,688,713	\$ 1,621,165	\$ 1,556,318
\$ 1,472	\$ 1,413	\$ 1,357	\$ 1,303
\$ 21,546	\$ 20,685	\$ 19,857	\$ 19,063
\$ 606,984	\$ 582,705	\$ 559,397	\$ 537,021
\$ 1,001,524	\$ 961,463	\$ 923,005	\$ 886,084
\$ 7,678,352	\$ 7,371,218	\$ 7,076,369	\$ 6,793,314