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Memorandum

To: Scott Davidson;Jim Harrington

From: Eric Lancaster

CC:

Date: February 22, 2013

Re: Complete Water Treatment Description

WATER TREATMENT OPTIONS FOR COMPLEX SITE

This section describes the estimated closure costs for the individual simple and complex sites. Cost is one of the criteria that will be used to evaluate closure options. The cost estimate information presented in this report was generated with input from Alexco Environmental Group, EBA Engineering Consultants, InTerraLogic, and SRK.

These costs are considered as being accurate to "Level 5" criteria (+100% to -50%). The costs presented are for implementation of the closure and reclamation of all site mine components associated with the historic UKHM liability, and include 30 years of operations, in 2012 dollars, including maintenance, monitoring, and reporting, as required.

1.1 MANAGED NATURAL ATTENUATION

Managed Natural Attenuation (MNA) is not an active treatment system, but generally describes a range of physical and biological processes that reduce the concentration, toxicity, or mobility of contaminates. In the past, Alexco conducted studies of the effectiveness of MNA and its ability to reduce contaminate loading in effluent waters by upwelling adit water through tubes filled with peat moss. These studies confirmed that MNA can be an effective treatment process and should be considered as a possible treatment method in the Keno Closure Options. In order to compare MNA to other treatment methods, the costs associated with this treatment option have been included within this report.

Manager Natural Attenuation requires proper setup to ensure performance. The basic set-up required for MNA to be effective includes:

- Initial aeration where water, once collected from the adit, is tumbled and aerated as it passes over a rigid structure;
- Optional - The addition of an iron source, typically ferric chloride;

- A settling basin where heavier particulates are allowed to settle; and,
- Passive injection trenches where water is collected in a pipe and then discharged through perforated sections that are installed perpendicular to the slope. This disperses the discharged water and provides non-destructive attenuation as existing biomass filters the water.

The long-term monitoring of the site is necessary and requires the largest amount of costs associated with this treatment system when conducting MNA. Monitoring is required to demonstrate that contaminant concentrations continue to decrease at a rate sufficient to ensure regulatory criteria, as well as provide direction in the event that additional reagents are necessary for treatment. Alexco proposes initial monthly monitoring studies conducted at each MNA adit as well as the receiving environment. Once the MNA system is proven to be effective, monitoring will be reduced to quarterly studies for five years, and then transitioning to annually for 5 years, and finally transitioning to every five years until closure.

1.2 MINE POOL TREATMENT

Earlier closure studies performed by SRK (March 31, 2008 Memo titled "Outcomes from 2007/08 Keno Hill Adit Closure Studies") included an assessment of closure options for 70 known adits in the United Keno Hill Mines district on behalf of Elsa Reclamation and Development Company Ltd. (ERDC). Closure options were considered for each adit, with objectives for each adit closure including preventing public access, water control, and water treatment. For eight adits, adit plugs were recommended for primary consideration. An adit plug would provide the ability to control mine drainage rate and timing, potentially allowing for treatment in seasonal campaigns or for temporary control of drainage during maintenance of treatment projects outside of the adit. An adit plug may also be part of an underground water treatment project where the underground mine pool behind the adit plug could be the vessel for water treatment.

The eight adits where adit plugs were recommended were Silver King 100, No Cash 500, Galkeno 300, Galkeno 900, Belkeno 625, Onek 400, Keno 700, and Sadie Ladue 600. At each of these locations there is an existing discharge that is being treated or may be treated in the future. Due to the active development of the Belkeno deposit, this mine is not included in this analysis.

The preliminary analysis in this document is intended to define costs associated with the initial installation of a mine pool injection and monitoring system, as well as the estimate for 30 years of reagent costs and long-term monitoring costs associated with treatment. Special attention is placed on the Hector-Calumet mine (Galkeno 300) workings because it is the dominant system generating zinc loading in the district, and because of its potential to drive long term water treatment costs during closure.

Metals generation from underground mine workings is a function of oxidation and dissolution of metals from metal sulfides. This requires both air and water contact the sulfides. At the Keno Hill mining district, the drainage from the underground mines is typically neutral, but metals that are still soluble in neutral pH conditions, especially zinc and cadmium, are often elevated as a result of this process. Treatment of drainage from the underground mines discussed herein will necessarily focus on zinc and cadmium. However, other metals, including manganese and iron will affect reagent demand during treatment, and may also add to the toxicity profile of the mine drainage. Thus inhibiting the formation of metals by preventing the dissolution of metal sulfides within the mine workings is an objective that should be considered during closure. Installation of hydraulic plugs and flooding underground mine workings can be part of a closure approach that prevents metals dissolution, rather than simply relying on long term treatment.

At other mine sites with similar metals issues, flooding of historic ore bodies where successful reduced metals loading from mine workings by 65% (Brittania mine, BC) to 85% (Eagle mine, CO). While these mines had substantially different chemistry than that typically encountered in the mining district, especially far higher acidity, fundamentally the exclusion of oxygen by exchanging the voids with 20% oxygen with voids with 8 ppm oxygen saturated in water still will have a great benefit to preventing metals leaching.

There are several current discharges (Silver King, Sadie Ladue, Keno 700) whose concentrations is less than 3 mg/L on average. It is possible that by flooding these workings that in time the concentrations will decrease and will not require long term treatment simply as a consequence of flooding the mine workings. In addition to flooding the mine pool, Alexco proposes the injection of a carbon source into the mine pool for an in-situ treatment via sulfate reduction.

Sulfate reduction is a chemical transformation performed by microbes that transfers electrons from organic carbon to sulfate, causing sulfate to be reduced to sulfide. Sulfide reacts with many dissolved metals, forming very insoluble metal precipitates. The reactor also has the potential for other reactions to occur as a result of alkalinity being generated from the oxidation of organic carbon.

Alexco owns six patents and has additional patents allowed and pending for the in-situ use of organic substrates and nutrients in earthen materials to stabilize metals. Alexco's technologies and patents provide in-situ encapsulation technologies whereby soluble toxic metals including arsenic, cadmium, nickel, selenium, and zinc are geochemically encapsulated by more benign minerals within the groundwater aquifer or within and downgradient of sources of contamination such as within a pit lake, tailings impoundment, heap leach pad, or waste storage area.

1.3 BIOREACTOR TREATMENT

The formation of metal precipitates in a bioreactor that has carbon sources added to or present in the solid phase of the bioreactor has been extensively studied for 30+ years. There are several different styles of bioreactors both in terms of carbon sources and in terms of flow dynamics. To reduce the “black box”, many studies have attempted to identify directly by examination of mineral formation or by inference from water chemistry signatures what primary mechanisms are responsible for metals removal. When complex carbon sources are added as a solid phase in the bioreactor construction, a “kitchen sink” list of mechanisms have been documented, which include:

- Sorption of metals on organic matter;
- Precipitation of iron hydrous oxides including ferric and mixed valence minerals, which then provide mineral surfaces for sorptive removal of metals, or metals can also be co-precipitated within the iron mineral matrix;
- Precipitation of manganese oxides including manganese (IV) oxides and mixed valence (III/IV) oxides and manganese carbonates, which then provide mineral surfaces sorptive removal of metals, or metals can also be co-precipitated within the manganese mineral matrix;

- Precipitation of metal sulfides, including primary metal sulfides such as ZnS or CdS, as well as precipitation of iron sulfides such as amorphous FeS and co-precipitation of metals within the FeS matrix. Depending on the pH of the bioreactor and the availability of structural iron, a very large amount of FeS minerals can be formed by aqueous sulfide formed by microbes reductively dissolving iron from the rock matrix, creating a "bank" of amorphous sulfide which has reactivity toward dissolved metals;
- Precipitation of some metals in their reduced forms, for example selenium reduction from a Se(VI or IV) anion to elemental selenium precipitates Se^0; and,
- Precipitation of metals as carbonate minerals. Some of the relevant metals have somewhat soluble carbonate minerals (e.g., zinc carbonate minerals including smithsonite, and hydrozincite) which are relatively more soluble than sulfides. When sulfide is not present, these minerals may provide a precipitation-removal mechanism.

To better understand the performance of a bioreactor in the Keno Hill District, Alexco Environmental Group has operated and maintained a small bioreactor near the Galkeno 900 adit since October 2008. The key objectives of the study were to determine sulphate reducing rates across year-round operation, and it was demonstrated that the sulphate bioreactor technology could achieve discharge water quality standards set under the existing water licence QZ06-074. For more information regarding this bioreactor study, see *Galkeno 900 Sulfate-Reducing Bioreactor Summary Report (*Alexco Resource US Corp., 2011.)*.*

The results from the study demonstrate the viability of sulfate reduction technology for the removal of metals, especially zinc and other metals that react with aqueous sulfide, in the Keno Hills Silver District (KHSD). The bioreactor solid phase substrate utilized to construct the bioreactor was coarse rock from a nearby placer mining operation. The organic substrate supplied to the bioreactor included dissolved organic carbon forms, with sugars, alcohols and complex carbohydrates and proteins from milk used during the growth phase of the bioreactor operation, and sugars and alcohols used during the maintenance phase. The purpose of the organic substrate was initially to support microbial growth until sulfate reduction became the predominant microbial activity in the reactor, and during the treatment phase to support microbial sulfate reduction.

This test was of sufficient scale and operated long enough to provide design information that allows for the design of either a large scale bioreactor or an in situ reduction field at several other adit drainage locations in the KHSD. The test was operated in a lined bioreactor allowing for the performance of the technology to be assessed while still in containment, but the results of the tests (reaction rates and stoichiometry) can be extended in the design of either a lined or an unlined system. The operation of the reactor continued through the winter season to demonstrate durability of metals removal mechanisms. During the course of the bioreactor demonstration, the conventional lime treatment system was maintained to ensure water license discharge compliance criteria were met.

In the Galkeno 900 bioreactor, because only coarse rock was used as a solid substrate, sorption of metals on organic matter is not a relevant metals removal mechanism. The metal removal mechanisms appear to initially relate to removal of iron and manganese during the recirculation phase, and then over time transition to a metal sulfide removal mechanism. The precipitation and removal of metals in their reduced forms is not a significant potential mechanism for most of the metals present in Galkeno 900 adit water, with the potential exception of uranium which was only present in very low concentrations in the influent water.

Consequently, the formation of sulfide from sulfate, which is a chemical reaction that is catalyzed by microbes and relies on the availability of organic carbon, is the primary performance variable that is relevant in the Galkeno 900 bioreactor performance evaluation. In typical evaluation of bioreactors where sulfate reduction/sulfide precipitation is a dominant mechanism, the Sulfate Reduction Rate (SRR) is determined as a primary design variable.

After the bioreactor entered stable operation, metals removal mechanisms appear to have shifted from the mixed reaction primarily a sulfide-based precipitation process. The effectiveness of this process is sensitive to important variables including the hydraulic residence time in the bioreactor, the sulfate reduction rate, and the filtration capacity of the media.

Because the products of the sulfate reduction reaction include both sulfide and bicarbonate alkalinity, it is possible that carbonate precipitation is also an important mode of precipitation for some of the metals removed in the reactor. However, for most of the metals being removed in the bioreactor, including antimony, arsenic, cadmium, cobalt, iron, nickel, and zinc, a sulfide precipitation mechanism appears more likely because sulfide precipitates are less soluble than the carbonate precipitates of these elements. Thus the sulfate reduction reaction is the primary reaction that we will focus on optimizing in the bioreactor operations.

1.4 ACTIVE WATER TREATMENT FACILITY

The installation, operation, and maintenance of an actively managed Water Treatment Facility (WTF) is another option of ensuring effluent waters meet emission standards. However, the design, build, and operation/maintenance of an active treatment facility can be expensive, typically ranging from $3M to $12M for a thirty year operation cycle at flow rates between 2.0 to 14.0 litres per second.

The Water Treatment Facilities quoted in this report include similar proposed designs, with the process of active treatment as follows:

- Adit discharge water is collected in a pipe and is either pumped or gravity flows to the treatment facility;
- Water first enters the Reactor Chamber of a Clarifier where it is actively mixed and amended with a lime slurry, an iron source, and/or a flocculant;
- Water then up-wells along the settling plates of the Clarifier. This process separates cleaner water which is decanted from the top of the Clarifier, while heavier particles accumulate as a sludge at the base of the Clarifier;
- If no additional treatment is required, the decanted water is then discharged to either a lined settling pond or to the receiving environment through either a pipe discharged to a stream or a pipe buried along an injection trench;
- At smaller treatment facilities, the collected sludge may be pumped into geotextile bags which then slowly densifies and dewaters the sludge;
- Another option is to discharge the collected sludge to a filter press where the sludge is manually dewatered and disposed of;

- For larger treatment facilities, the collected sludge may be sent to a Thickener where the sludge is compacted further before it is discharged to a Filter Press; and,
- The Filter Press provides a final compaction step where 2/3 of the water is removed and sent back to the Reactor for re-treatment. The remaining water and solids from the Filter Press form a "cake" of solid material that can be hauled and disposed of in a landfill.

A visual layout of the system described above can be found in Figure 1 below.

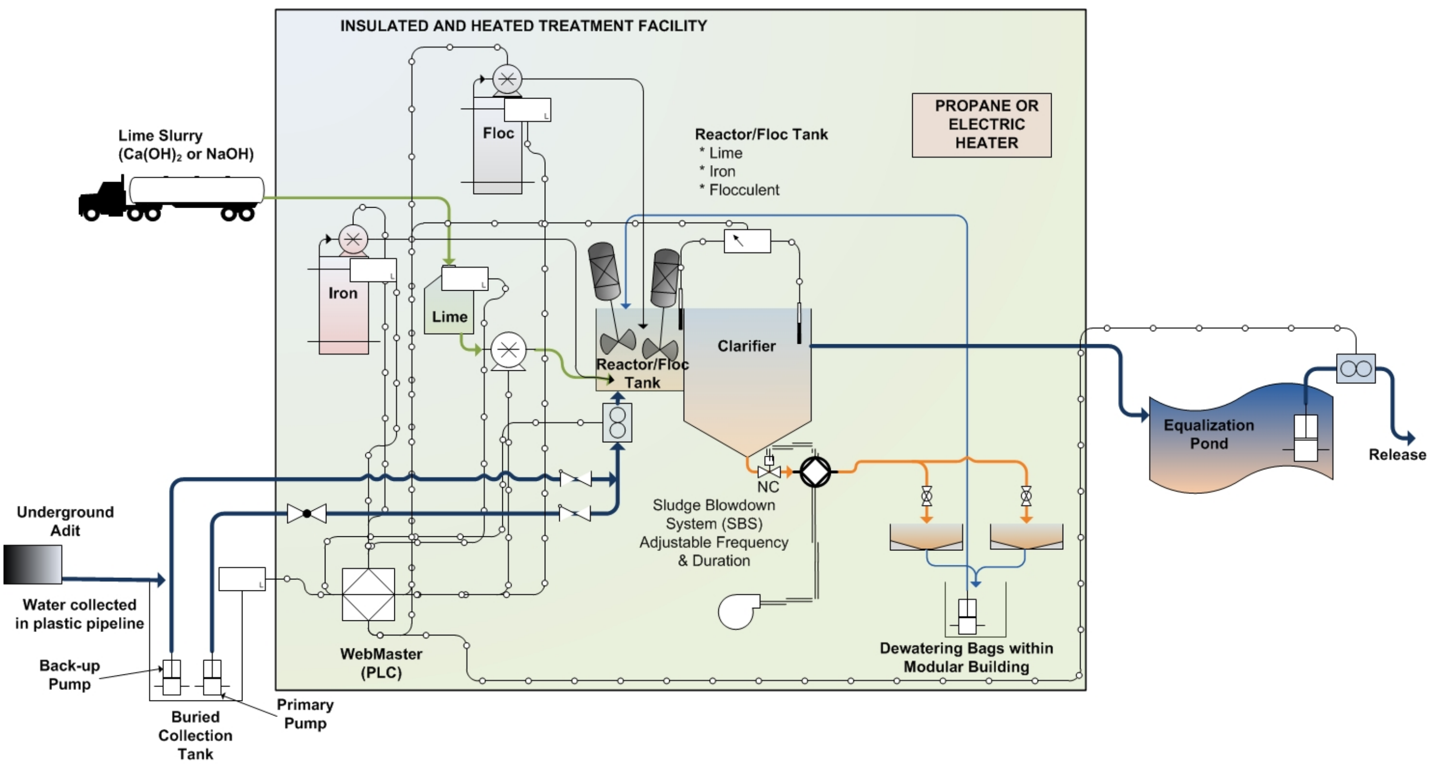

Figure 1 - Layout of Water Treatment Facility

With most water treatment facilities, the majority of costs come from the required reagents (lime, iron, and flocculants) and the labor required for operation and maintenance. In addition, because water treatment facilities only treat the discharged water and not the source of underground contamination, water treatment facilities must be operated indefinitely to ensure effluent waters meet standards.

Similar to other treatment methods, long-term monitoring of the water treatment facility's influent/effluent is necessary. Monitoring is required to demonstrate that contaminant concentrations in the receiving environment remain unchanged or decrease at a rate sufficient to meet regulatory requirements.

1.5 PRICING OF CLOSURE OPTIONS

Below are the estimated costs for each closure options.

Site Name:	*Silver King 100 Adit*			
Water Discharge Rate (lps):	*5.6*			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Managed Natural Attenuation			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 130,000.00	$ 130,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 220,000.00	$ 220,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 89,000.00	$ 89,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 211,000.00	$ 211,000.00
			Sub-total:	**$ 650,000.00**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 319,000.00	$ 319,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 185,000.00	$ 185,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 994,000.00	$ 994,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 744,000.00	$ 744,000.00
			Sub-total:	**$ 2,296,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 327,000.00	$ 327,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 289,000.00	$ 289,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 250,000.00	$ 250,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 441,000.00	$ 441,000.00
			Sub-total:	**$ 1,361,000.00**
	Active Water Treatment Facility			
CapEx	Initial Installation of Water Treatment Facility	1	$ 418,000.00	$ 418,000.00
OpEx	Initial Installation of Treatment & Monitoring System	1	$ 212,000.00	$ 212,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,339,000.00	$ 1,339,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 2,647,000.00	$ 2,647,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 2,212,000.00	$ 2,212,000.00
			Sub-total:	**$ 6,828,000.00**

Site Name:	*Husky SW Adit*			
Water Discharge Rate (lps):	*0.4*			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Managed Natural Attenuation			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 70,000.00	$ 70,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 192,000.00	$ 192,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ -	$ -
OpEx	Additional Oversight/Taxes/etc.	1	$ 126,000.00	$ 126,000.00
			Sub-total:	**$ 388,000.00**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 119,000.00	$ 119,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 150,000.00	$ 150,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 94,000.00	$ 94,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 200,000.00	$ 200,000.00
			Sub-total:	**$ 617,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 147,000.00	$ 147,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 219,000.00	$ 219,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 18,000.00	$ 18,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 210,000.00	$ 210,000.00
			Sub-total:	**$ 648,000.00**
	Active Water Treatment Facility			
CapEx	Initial Installation of Water Treatment Facility	1	$ 284,000.00	$ 284,000.00
OpEx	Initial Installation of Treatment & Monitoring System	1	$ 77,000.00	$ 77,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 531,000.00	$ 531,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 190,000.00	$ 190,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 519,000.00	$ 519,000.00
			Sub-total:	**$ 1,601,000.00**
	Reclamation Only			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 61,000.00	$ 61,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 84,000.00	$ 84,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ -	$ -
OpEx	Additional Oversight/Taxes/etc.	1	$ 70,000.00	$ 70,000.00
			Sub-total:	**$ 215,000.00**

Site Name:	*No Cash 500*			
Water Discharge Rate (lps):	*5.5*			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Managed Natural Attenuation			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 122,000.00	$ 122,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 220,000.00	$ 220,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ -	$ -
OpEx	Additional Oversight/Taxes/etc.	1	$ 164,000.00	$ 164,000.00
			Sub-total:	**$ 506,000.00**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 199,000.00	$ 199,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 184,000.00	$ 184,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 569,000.00	$ 569,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 482,000.00	$ 482,000.00
			Sub-total:	**$ 1,488,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 327,000.00	$ 327,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 287,000.00	$ 287,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 245,000.00	$ 245,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 438,000.00	$ 438,000.00
			Sub-total:	**$ 1,351,000.00**
	Active Water Treatment Facility			
CapEx	Initial Installation of Water Treatment Facility	1	$ 386,000.00	$ 386,000.00
OpEx	Initial Installation of Treatment & Monitoring System	1	$ 212,000.00	$ 212,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,336,000.00	$ 1,336,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 2,600,000.00	$ 2,600,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 2,172,000.00	$ 2,172,000.00
			Sub-total:	**$ 6,706,000.00**
	New WTF at Elsa			
CapEx	Initial Installation of Support Facility	1	$ 386,000.00	$ 386,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ -	$ -
OpEx	Operation & Maintenance for 30 years	1	$ 335,000.00	$ 335,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 2,600,000.00	$ 2,600,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 1,591,000.00	$ 1,591,000.00
			Sub-total:	**$ 4,912,000.00**

Site Name:	*Bermingham 200 Adit*			
Water Discharge Rate (lps):	*2.0*			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Managed Natural Attenuation			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 105,000.00	$ 105,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 192,000.00	$ 192,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ -	$ -
OpEx	Additional Oversight/Taxes/etc.	1	$ 143,000.00	$ 143,000.00
			Sub-total:	**$ 440,000.00**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 96,000.00	$ 96,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 150,000.00	$ 150,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 508,000.00	$ 508,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 388,000.00	$ 388,000.00
			Sub-total:	**$ 1,196,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 198,000.00	$ 198,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 219,000.00	$ 219,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 90,000.00	$ 90,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 269,000.00	$ 269,000.00
			Sub-total:	**$ 830,000.00**
	Active Water Treatment Facility			
CapEx	Initial Installation of Water Treatment Facility	1	$ 364,000.00	$ 364,000.00
OpEx	Initial Installation of Treatment & Monitoring System	1	$ 139,000.00	$ 139,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,086,000.00	$ 1,086,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 946,000.00	$ 946,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 1,215,000.00	$ 1,215,000.00
			Sub-total:	**$ 3,750,000.00**

Site Name:	***Ruby 400 Adit***			
Water Discharge Rate (lps):	***1.0***			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Managed Natural Attenuation			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 84,000.00	$ 84,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 186,000.00	$ 186,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ -	$ -
OpEx	Additional Oversight/Taxes/etc.	1	$ 130,000.00	$ 130,000.00
			Sub-total:	**$ 400,000.00**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 176,000.00	$ 176,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 140,000.00	$ 140,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 274,000.00	$ 274,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 309,000.00	$ 309,000.00
			Sub-total:	**$ 953,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 198,000.00	$ 198,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 199,000.00	$ 199,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 45,000.00	$ 45,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 238,000.00	$ 238,000.00
			Sub-total:	**$ 734,000.00**
	Active Water Treatment Facility			
CapEx	Initial Installation of Water Treatment Facility	1	$ 279,000.00	$ 279,000.00
OpEx	Initial Installation of Treatment & Monitoring System	1	$ 139,000.00	$ 139,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 586,000.00	$ 586,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 473,000.00	$ 473,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 708,000.00	$ 708,000.00
			Sub-total:	**$ 2,185,000.00**

Site Name:	*Galkeno 300 Adit*			
Water Discharge Rate (lps):	*14*			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 792,000.00	$ 792,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 247,000.00	$ 247,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 2,515,000.00	$ 2,515,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 1,729,000.00	$ 1,729,000.00
			Sub-total:	**$ 5,337,000.00**
	Upgrade at Galkeno 300			
CapEx	Initial Installation of Support Facility	1	$ 301,000.00	$ 301,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 92,000.00	$ 92,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,747,000.00	$ 1,747,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 5,672,000.00	$ 5,672,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 3,742,000.00	$ 3,742,000.00
			Sub-total:	**$ 11,554,000.00**
	New WTF at Elsa			
CapEx	Initial Installation of Injection Facility	1	$ 1,652,000.00	$ 1,652,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 214,000.00	$ 214,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 2,639,000.00	$ 2,639,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 6,617,000.00	$ 6,617,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 5,328,000.00	$ 5,328,000.00
			Sub-total:	**$ 16,450,000.00**
	New WTF at ST Hwy near Galkeno 900			
CapEx	Initial Installation of Support Facility	1	$ 1,001,000.00	$ 1,001,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 214,000.00	$ 214,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 2,639,000.00	$ 2,639,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 6,617,000.00	$ 6,617,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 5,016,000.00	$ 5,016,000.00
			Sub-total:	**$ 15,487,000.00**

Site Name:	***Galkeno 900 Adit***			
Water Discharge Rate (lps):	***3.1***			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Bioreactor treatment			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 327,000.00	$ 327,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 240,000.00	$ 240,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 138,000.00	$ 138,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 364,000.00	$ 364,000.00
			Sub-total:	**$ 1,123,000.00**
	Stand-alone small WTF			
CapEx	Initial Installation of Injection Facility	1	$ 386,000.00	$ 386,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 212,000.00	$ 212,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,182,000.00	$ 1,182,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 1,466,000.00	$ 1,466,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 1,555,000.00	$ 1,555,000.00
			Sub-total:	**$ 4,801,000.00**
	New WTF at ST Hwy near Galkeno 900			
CapEx	Initial Installation of Support Facility	1	$ 353,000.00	$ 353,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 62,000.00	$ 62,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 192,000.00	$ 192,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 1,466,000.00	$ 1,466,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 993,000.00	$ 993,000.00
			Sub-total:	**$ 3,066,000.00**

Site Name:	***Sadie Ladue 600 Adit***			
Water Discharge Rate (lps):	***7.6***			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Reclamation-only, No Water Treatment			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ -	$ -
OpEx	Operation & Maintenance for 30 years	1	$ 79,000.00	$ 79,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ -	$ -
OpEx	Additional Oversight/Taxes/etc.	1	$ 38,000.00	$ 38,000.00
			Sub-total:	**$ 117,000.00**
	Managed natural attenuation			
CapEx	Initial Installation of Injection Facility	1	$ -	$ -
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 162,000.00	$ 162,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 183,000.00	$ 183,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 234,000.00	$ 234,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 278,000.00	$ 278,000.00
			Sub-total:	**$ 857,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 32,000.00	$ 32,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 307,000.00	$ 307,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 180,000.00	$ 180,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 339,000.00	$ 339,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 411,000.00	$ 411,000.00
			Sub-total:	**$ 1,269,000.00**

Site Name:	***Onek 400 Adit***			
Water Discharge Rate (lps):	***2.3***			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Bioreactor treatment with natural attenuation			
CapEx	Initial Installation of Support Facility	1	$ 107,000.00	$ 107,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 149,000.00	$ 149,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 191,000.00	$ 191,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 139,000.00	$ 139,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 281,000.00	$ 281,000.00
			Sub-total:	**$ 867,000.00**
	Stand-alone small WTF			
CapEx	Initial Installation of Injection Facility	1	$ 386,000.00	$ 386,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 212,000.00	$ 212,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,150,000.00	$ 1,150,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 1,088,000.00	$ 1,088,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 1,359,000.00	$ 1,359,000.00
			Sub-total:	**$ 4,195,000.00**
	New WTF at ST Hwy near Galkeno 900			
CapEx	Initial Installation of Support Facility	1	$ 343,000.00	$ 343,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ -	$ -
OpEx	Operation & Maintenance for 30 years	1	$ 161,000.00	$ 161,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 1,088,000.00	$ 1,088,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 763,000.00	$ 763,000.00
			Sub-total:	**$ 2,355,000.00**

Site Name:	*Keno 700 Adit*			
Water Discharge Rate (lps):	*3.4*			
Work Item	**Description**	**Qnty**	**Unit Cost**	**Total Cost**
	Managed Natural Attenuation			
CapEx	Initial Installation of Support Facility	1	$ -	$ -
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 148,000.00	$ 148,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 199,000.00	$ 199,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 105,000.00	$ 105,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 217,000.00	$ 217,000.00
			Sub-total:	**$ 669,000.00**
	Mine Pool Treatment			
CapEx	Initial Installation of Injection Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Injection Control & Monitoring System	1	$ 919,000.00	$ 919,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 163,000.00	$ 163,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 557,000.00	$ 557,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 811,000.00	$ 811,000.00
			Sub-total:	**$ 2,504,000.00**
	Bioreactor			
CapEx	Initial Installation of Support Facility	1	$ 54,000.00	$ 54,000.00
CapEx	Initial Installation of Treatment & Monitoring System	1	$ 327,000.00	$ 327,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 197,000.00	$ 197,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 152,000.00	$ 152,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 350,000.00	$ 350,000.00
			Sub-total:	**$ 1,080,000.00**
	Active Water Treatment Facility			
CapEx	Initial Installation of Water Treatment Facility	1	$ 418,000.00	$ 418,000.00
OpEx	Initial Installation of Treatment & Monitoring System	1	$ 212,000.00	$ 212,000.00
OpEx	Operation & Maintenance for 30 years	1	$ 1,138,000.00	$ 1,138,000.00
OpEx	Reagent Costs for 30 years of Operation	1	$ 1,607,000.00	$ 1,607,000.00
OpEx	Additional Oversight/Taxes/etc.	1	$ 1,617,000.00	$ 1,617,000.00
			Sub-total:	**$ 4,992,000.00**

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Draft Technical Memorandum

TO: Elsa Reclamation and Development Company, Ltd. (ERDC)

FROM: Interralogic, Inc.

DATE: March 28, 2011 (revision)

SUBJECT: Remedial Alternatives Description, Valley Tailings Facility Keno Hills Mining District, Elsa, YT

1.0 CLOSURE ISSUES

Elsa Reclamation and Development Company (ERDC) is developing a closure plan for the Valley Tailings Facility (VTF). The VTF is located in the Keno Hills Mining District near Elsa, YT. Closure-related issues have been previously described in (SRK 2008a, 2008b, 2009a, 2009b). The main issues that require assessment in the selection of remedial alternatives for closure at the current time are:

- Wind erosion and dispersion of tailings to nearby areas
- Surface water management and erosion of tailings and transport of tailings to downstream areas of Flat Creek
- Mobilization of metals and sulfate from tailings
- Long-term maintenance of man-made structures

The purpose of this memorandum is to describe remedial alternatives for reclaiming the VTF and provide Level 5 cost estimates for the alternatives. Level 5 cost estimates are considered to be accurate to +100% / -50%.

2.0 DOCUMENT REVIEW

Closure options for the VTF were previously evaluated by SRK (2009b). At the time of the SRK evaluation, two main objectives were considered:

- Prevention of wind dispersion of tailings and erosion of tailings by surface runoff
- Management of surface water through and/or around the VTF.

Based on these two objects, SRK (2009b) developed two broad closure options:

- Alternative 1 – tailings would be left in place and covered with soil; dispersed tailings from the Elsa hillside would be relocated
  - Variant 1 for surface water management - Maintain current water management
  - Variant 2 for surface water management - Abandon Porcupine Creek diversion and develop stable channel over tailings cover and construct Lower North Fork Flat Creek channel through borrow area
- Alternative 2 – the older thin tailings located behind Dams #2 and #3 and tailings in the southeast quadrant of the VTF would be removed and relocated behind Dam #1; dispersed tailings from the Elsa hillside would be relocated
  - Surface water management - Abandon Porcupine Creek diversion and develop stable channel over tailings cover and construct Lower North Fork Flat Creek channel through borrow area

The SRK (2009b) evaluation was considered in the development of the current set of closure issues listed above in Section 1.0. Other reports reviewed in the preparation of this technical memorandum are listed in Section 7.0 (References).

3.0 BACKGROUND

Mills operated in Elsa from 1932 to 1942 and from 1949 to 1988 (UKHM, 1996). A total of 5.3 million Imperial tons of ore was milled at Elsa from 1936 to 1989, which yielded 4.6 million tonnes of tailings (Hawthorne 1996). The ore mineralogy included primarily lead, zinc, and silver sulfides with variable amounts of lead, zinc, and calcium sulfate minerals (SRK, 2009b; 2009c).

Tailings produced from milling operations were placed over the original Flat Creek stream channel in the valley below the Elsa mill site (Figure 1). Three dams were constructed to contain tailings and tailings drainage water (UKHM, 1996). Dam No. 1 was constructed in 1968 and was fortified in 1968 after a failure. Dam No. 2 was constructed in 1972, and Dam No. 3 was constructed in 1979. The soils under all three dams have thawed since construction, resulting in an unknown amount of subsidence of the dams.

Dam No. 2 and Dam No. 3 were constructed to create ponds (Figure 1) and thereby increase the residence time of tailings pond water prior to discharge and improve water quality especially during freshet and periods of high precipitation. Lime has been added to the pond behind Dam No. 3 during freshet to reduce zinc concentration below permitted discharge levels. In 2008, 5.95 tonnes of lime was used for treatment, which resulted in the removal of approximately 2000 kg of zinc from the pond water.

A series of diversions were also constructed to convey surface water away from the tailings deposits and dams. These diversions include (Figure 1):

- A north diversion channel (flowing east to west) for diversion of Flat Creek flows around the facility.
- A south diversion channel (also with east to west flows) for interception of north-flowing runoff from Porcupine Creek and re-direction of flow to the west of Dam No. 3.

The valley bottom where the bulk of the tailings are deposited was originally a relatively flat boggy area underlain by peat up to a few meters in thickness and/or peaty soils with permafrost (SRK, 2009b; 2009c). Tailings in the valley bottom are saturated at depths of 1 to a few meters below the surface. Analyses of porewater within the tailings show elevated metal (cadmium, lead, iron, manganese, zinc) and sulfate concentrations (ERDC, 2007; SRK 2009c). However, groundwater below the peat layer beneath the tailings and water in the ponds behind the ponds, have significantly lower metal concentrations than in tailings porewater, indicative attenuation processes occurring in the peat (SRK, 2009c; 2009d).

The tailings behind Dam No. 1, where wet, have re-vegetated and vegetation has also been re-established in other wet areas. The dry, sandy, upper part of the tailings deposit is barren. The dry tailings are subject to wind erosion from time to time. The tailings generally have an excess of acid generation potential compared to acid neutralization potential (SRK, 2009c). However, most paste pH values for the tailings are in the neutral to slightly acidic range (SRK, 2009c). The pH in the top 2-3 cm is about 6.7 to 6.8, which has been judged to be close enough to neutral as to not be a significant impediment to plant growth (Withers, 2008). Withers (2008) reports that the major to the inhibition of long-term plant growth on the tailings is the development of surface salts with high zinc sulfate content that create an impermeable surface unsuitable for plant growth.

4.0 ESTIMATED VOLUMES AND AREAS

4.1 Tailings

The distribution of tailings is shown on Figure 1. Volumes and areas are provided in Table 1. The tailings are categorized as follows, referring to the colored areas in Figure 1:

- Elsa hillside (blue) – discontinuous small areas of tailings accumulations from the historic use of Porcupine Creek drainage as route for tailings disposal. Tailings are of variable thickness and areal extent and re-vegetated in some areas.
- Valley bottom tailings (pink) – thicker deposits of mostly dry tailings in the former Flat Creek valley located behind Dam No. 1 and southeast of Dam No. 3 and extending southward to the Elsa hillside.
- Pond tailings – submerged and seasonally wet tailings behind Dams No. 1, No. 2, and No. 3

Table 1. Summary of tailings and borrow material areas and volumes

Area	Area (m^2)	Volume (m^3)
Elsa Hillside Tailings	70,192	35,096
Valley Bottom Tailings	608,371	1,215,933
Pond 1	67,440	243,850
Pond 2	44,224	42,987
Pond 3	94,420	15,392
Total	884,647	1,583,258

4.2 Borrow Sources

A borrow source for cover material has been identified by Alexco (2007). The borrow source is located north of Dam No. 3 (Figure 1) and is comprised of glacial silty to sandy till, sands, and gravels with a thin layer of organic material at the surface. The volume of borrow material in the area outlined in Figure 1 has been estimated at 1,523,000 m^3 (SRK, 2009b). After excavation of the borrow material to create cover for reclamation of the tailings areas, the borrow area would need to be covered and reclaimed as well. Organic material (peat) would be obtained from a nearby area and tilled into the borrow area, fertilized, and seeded after cover excavation is completed.

Rehabilitation of existing diversions and stabilization of the Porcupine Creek channel would require placement of riprap. A quarry in bedrock located about 0.75 to 1 km east of the borrow area and north of the existing tailings has been identified as a suitable nearby source for riprap.

4.3 Lime Addition

Excavation, placement, and grading activities have the potential to mobilize metals from porewater and salts in the tailings for a short period after reclamation before establishment of a vegetated cover. SRK (2009c) has determined through a series of experimental tests that the addition of lime during tailings reclamation should significantly reduce metal release. The dosage rate recommended by SRK (2009c) is 6 kg $Ca(OH)_2$ per dry tonne of tailings based on their test results. The method of lime application would be determined during detailed design. Methods under consideration are broadcasting over existing tailings in their current position or consolidated tailings in their final position with tilling to mix or addition to tailings slated for removal prior to excavation with the assumption that the lime would be mixed into tailings by subsequent placement and grading.

5.0 RECLAMATION ALTERNATIVE DESCRIPTIONS

Four remedial alternatives have been developed. They are grouped into the following categories:

- **Alternative 1** - Cover in Place (limited relocation)
- Alternative 2 - Relocation-Consolidation of Shallow Tailings and Cover
    - **Alternative 2A** - Dams No.1, No. 2, and No. 3 remain
    - **Alternative 2B** - Dams No.1, No. 2, and No. 3 are removed
- **Alternative 3** - Relocation-Consolidation of All Tailings to Synthetic Lined Facilities

Descriptions of the alternatives are provided in the following sections. The alternatives are compared side by side in Table 2.

5.1 Alternative 1 - Cover in Place

The goal of Alternative 1 is to minimize the relocation of tailings and borrow material. The ponds and dams would remain in their current configuration. Figure 2 shows a map view with text description of Alternative 1.

5.1.1 Tailings Relocation

Alternative 1 would involve relocation of tailings only where necessary to rehabilitate existing drainage ways or place new diversions. Tailings would be removed from areas subject to erosion into the eastern end of the south diversion channel and southeastern end of the north diversion channel (green area in Figure 2). The tailings removed from these areas would be placed on top of existing tailings in two areas north of the south diversion (brown areas in Figure 2). The tailings areas on the Elsa hillside would not be relocated but would be left in their current configuration.

5.1.2 Cover

Cover material would be obtained from the borrow area located northwest of Dam No. 3. The areas of unsubmerged tailings in the valley bottom located east and south of the ponds would be covered with 1 m of material. The area of relocated tailings from which tailings are removed would be covered with 0.3 m of material.

Relocated tailings would be amended with lime at a rate of 6 kg/tonne prior to placement to minimize metals mobilization. Also, the existing areas of unsubmerged tailings would be broadcast with lime at a rate of 6 kg/tonne for the top 1 meter and tilled to mix the lime into the surface layer to minimize metals mobilization prior to placement of the 1 m cover. The peat layer underlying tailings in the valley is assumed to continue to attenuate metals released from tailings leaching processes. The cover material would be amended with organic material and fertilizer and seeded to promote vegetation growth.

The dams and submerged tailings in Ponds 1, 2, and 3 would remain. Dams No. 1, No. 2 and No. 3 would be re-sloped with rock material to provide a structural buttress at the toes of these dams.

5.1.3 Water Management

Diversions would be established along both the north and south sides of the tailings area to intercept surface water runoff and convey to minimize the exposure of surface water to tailings. The existing Porcupine diversion would be rehabilitated. The south diversion would discharge into the rehabilitated Porcupine diversion, which would flow to a sediment pond in the valley bottom below Dam No. 3. The north diversion would wrap around the east side of the tailings and then around the north side of the facility and also discharge into the sediment pond. The No Cash Ditch diversion would be rehabilitated to achieve design criteria for size and slope for its catchment area. Riprap would be added to the stream channel of Porcupine Creek in the steeper areas of Elsa hill to minimize erosion and sediment transport. A sediment pond would be placed downstream of Dam No. 3 to reduce suspended sediment loads prior to discharge to Flat Creek. An additional sediment pond would be placed on Flat Creek near the Silver King highway to reduce suspended loads downstream in Flat Creek and the Porcupine diversion.

Ponds 1, 2, and 3 would be retained to collect water from surface drainage from the area between the north and south diversion and shallow groundwater moving downgradient from the tailings areas. Water collected in Pond 3 would be directed to a water treatment plant prior to discharge to Flat Creek.

5.1.4 Post Construction Requirements

Water treatment would be required for Alternative 1 for an extended period of time. Pond 3 would be used as a storage reservoir to feed the water treatment plant. The rate of water treatment is estimated to average about 5 to 7 L/s. The water treatment plant would be operated for approximately 5 to 6 months per year during the warmer months when surface flows occur.

Routine dam inspections would be required because the dams would remain in their existing configuration. Monitoring of the surface and groundwater would be required. Monitoring of vegetation would be required to determine the rate and effectiveness of reclamation work. General maintenance would be required on the diversion channels.

5.1.5 Risks

The following risks would occur for Alternative 1:

- All dams are subject to potential failure in the event of an intense precipitation event or freshet
- Water treatment may be needed for a long period of time because the area of tailings contributing mobilized metals to the shallow groundwater system would not have been reduced from its current configuration. Closure costs may be underestimated because of an extended period of water treatment plant operation.
- Water treatment plant failure would potentially result in the discharge of water to Flat Creek that does not meet water quality criteria.
- Alternative 1 would involve the addition of lime to only the top layer of tailings prior to cover placement; hence has less capacity for reducing in situ metal mobilization than other alternatives where lime would be mixed into relocated material as well as the top surface of tailings receiving relocated tailings.
- The peat layer underlying tailings may fail over time with respect to attenuation capacity and ability to reduce vertical infiltration, resulting in metal transport to the shallow groundwater system below the pear.
- Poor cover performance could lead to continued movement of elevated metal contents into the ponds, requiring water treatment and creating a potential exposure route for wildlife. The area of cover is greatest for Alternative 1; hence the potential for cover failure is greater compared to the other alternatives.
- The site would remain largely in its current appearance, which may have an unacceptable aesthetic appeal.

5.2 Alternative 2A – Relocation-Consolidation of Shallow Tailings and Cover; Dams Remain

The goal of Alternative 2A is to consolidate tailings in a smaller footprint to minimize cover requirements and reduce the area of potential metals mobilization. The pond and dams would remain in their current configuration. Figure 3 shows a map view with text descriptions of Alternative 2A.

5.2.1 Tailings Relocation

Alternative 2A would involve relocating shallow tailings from the following areas:

- Elsa hillside (blue area on Figure 3)
- Area of between the Elsa hillside and valley bottom extending to Pond 3 (green area on Figure 3)
- Unsubmerged tailings on the southeast side of Ponds 2 and 3 (purple areas on Figure 3)

The tailings excavated from these areas would be consolidated on top of existing valley bottom area shown on Figure 3 as the brown-colored Consolidation Area.

The Elsa hillside tailings would be excavated from identified pockets and discontinuous deposits as identified by field investigation. The areas of relocated tailings in the valley bottom would be over-excavated by approximately 0.5 m into the underlying peat layer to remove material potentially containing elevated metal contents resulting from vertical migration of water through the tailings into the pear. The unsubmerged tailings in Ponds 2 and 3 would be excavated to the extent possible and placed on top of existing tailings behind Pond 1.

5.2.2 Cover

The Consolidated Area and the Cover in Place Area of tailings would be covered with 1 m of material from the borrow area. The areas from which tailings are removed would be covered with 0.3 m of borrow material. The cover material for all areas would be amended with organic material and fertilizer and seed to promote vegetation growth.

Relocated tailings would be amended with lime at a rate of 6 kg/tonne prior to placement to minimize metals mobilization. Also, the existing areas of unsubmerged tailings area of consolidation would be broadcast with lime at a rate of 6 kg/tonne for the top 1 meter and tilled to mix the lime into the surface layer to minimize metals mobilization prior to placement of the 1 m cover. The peat layer underlying tailings in the valley is assumed to continue to attenuate metals released from tailings leaching processes.

Dams No. 1, No. 2, and No. 3 and Ponds 1, 2, and 3 would remain in their existing configuration and the submerged tailings in the ponds would remain covered by water. Dams No. 1, No. 2, and No. 3 would be re-sloped with rock material to provide a structural buttress at the toes of these dams.

5.2.3 Water Management

Diversions would be established along both the north and south sides of the tailings area to intercept surface water runoff and convey to minimize the exposure of surface water to tailings. The existing Porcupine diversion would be rehabilitated. The south diversion would discharge into the rehabilitated Porcupine diversion and flow to a sediment pond in the valley bottom below Dam No. 3. The north diversion would wrap around the east side of the tailings and then around the north side of the facility and also discharge into the sediment pond. The No Cash Ditch diversion would be rehabilitated to achieve design criteria for size and slope for its catchment area. Riprap would be added to the stream channel of Porcupine Creek in the steeper areas of Elsa hill to minimize erosion and sediment transport. A sediment pond would be placed downstream of Dam No. 3 to reduce suspended sediment loads prior to discharge to Flat Creek. An additional sediment pond would be placed on Flat Creek near the Silver King highway to reduce suspended loads downstream in Flat Creek and the Porcupine diversion.

Ponds 1, 2, and 3 would be retained to collect water from surface drainage from the area between the north and south diversion and shallow groundwater moving downgradient from the tailings areas. Water collected in Pond 3 would be directed to a water treatment plant prior to discharge to Flat Creek.

5.2.4 Post Construction Requirements

Treatment of water collected in the ponds would be required for Alternative 2A. Pond 3 would be used as a storage reservoir to feed the water treatment plant. The rate of water treatment is estimated to average about 5 to 7 L/s. The duration of water treatment is anticipated to be less than Alternative 1 because of consolidation of tailings into a smaller footprint and addition of lime to a comparatively larger volume of relocated tailings. The water treatment plant would be operated for approximately 5 to 6 months per year during the warmer months when surface flows occur.

Routine dam inspections would be required because the dams would remain in their existing configuration. Monitoring of the surface and groundwater would be required. Monitoring of vegetation would be required to determine the rate and effectiveness of reclamation work. General maintenance would be required on the diversion channels.

5.2.5 Risks

The following risks would occur for Alternative 2A:

- All dams are subject to potential failure in the event of an intense precipitation event or freshet
- Water treatment would be needed for at least five years. Water treatment plant failure would potentially result in the discharge of water to Flat Creek that does not meet water quality criteria.
- Poor cover performance could lead to continued movement of elevated metal contents into the ponds, requiring water treatment and creating a potential exposure route for wildlife.
- Poor mixing or poor performance of lime amendment in combination with exposure of relocated tailings to air may result in at least a short-term elevation in metals release to

the shallow groundwater system beneath the tailings in the valley bottom. This process may increase water treatment costs in the short term when metal levels are highest.

- The peat layer underlying tailings may fail over time with respect to attenuation capacity and ability to reduce vertical infiltration, resulting in metal transport to the shallow groundwater system below the pear.
- The retention of the dams and ponds may have an unacceptable aesthetic appeal.

5.3 Alternative 2B – Relocation-Consolidation of Shallow Tailings and Cover; Dams Removed

The goal of Alternative 2B is to consolidate tailings in a smaller footprint to minimize cover requirements and metals mobilization similar to Alternative 2A. In addition, the ponds and dams would be removed to eliminate these manmade structures and their associated potential risks. Figure 4 shows a map view with text descriptions of Alternative 2B.

5.3.1 Tailings Relocation

The relocation plan for shallow tailings is similar to Alternative 2A in that Alternative 2B would involve relocating shallow tailings from the following areas:

- Elsa hillside (blue area on Figure 4)
- Area between the Elsa hillside and valley bottom extending to Pond 3 (green area on Figure 4)

The Elsa hillside tailings would be excavated from identified pockets and discontinuous deposits as identified by field investigation. The areas of relocated tailings in the valley bottom would be over-excavated by approximately 0.5 m into the underlying peat layer to remove material potentially containing elevated metal contents resulting from vertical migration of water through the tailings into the peat.

The tailings excavated from these areas would be consolidated on top of existing tailings in the valley bottom area shown on Figure 3 as the brown-colored Consolidation Area.

A difference is that in Alternative 2B the submerged and unsubmerged tailings in Ponds 1, 2, and 3 would be left in place and subsequently drained and covered (see below).

5.3.2 Cover

The Consolidated Area and the Cover in Place Area of tailings would be covered with 1 m of material from the borrow area. The areas from which tailings are removed would be covered with 0.3 m of borrow material. The cover material for all areas would be amended with organic material and fertilizer and seed to promote vegetation growth.

Ponds 1, 2, and 3 would be drained and water collected in a new pond constructed downstream of the current location of Dam No. 3. The collected water would be treated and discharged to Flat Creek. The centers of Dams No. 1, No. 2, and No. 3 would be excavated and re-filled with gravel to allow groundwater to pass through after cover placement. Borrow material would be brought in to bring the depression areas of the ponds up to grade. The re-filled pond areas would be covered with 1 m of borrow material and graded so that the surface has a gradual slope from east to west.

Relocated tailings placed in the Consolidation Area would be amended with lime at a rate of 6 kg/tonne prior to placement to minimize metals mobilization. Also, the existing areas of unsubmerged tailings area of consolidation would be broadcast with lime at a rate of 6 kg/tonne for the top 1 meter and tilled to mix the lime into the surface layer to minimize metals mobilization prior to placement of the 1 m cover. The drained pond areas would also receive lime amendment prior to cover placement to minimize metal mobilization. The peat layer underlying tailings in the valley is assumed to continue to attenuate metals released from tailings leaching processes.

5.3.2 Water Management

Diversions would be established along both the north and south sides of the tailings area to intercept surface water runoff and convey to minimize the exposure of surface water to tailings. The existing Porcupine diversion would be rehabilitated. The south diversion would discharge into the rehabilitated Porcupine diversion and flow to a sediment pond in the valley bottom below Dam No. 3. The north diversion would wrap around the east side of the tailings and then around the north side of the facility and also discharge into the sediment pond. The No Cash Ditch diversion would be rehabilitated to achieve design criteria for size and slope for its catchment area. Riprap would be added to the stream channel of Porcupine Creek in the steeper areas of Elsa hill to minimize erosion and sediment transport. A sediment pond would be placed downstream of Dam No. 3 to reduce suspended sediment loads prior to discharge to Flat Creek. An additional sediment pond would be placed on Flat Creek near the Silver King highway to reduce suspended loads downstream in Flat Creek and the Porcupine diversion.

An additional pond would be constructed below the base of the former location of Dam No. 3. This pond would be designed to collect seepage water flowing through the refilled ponds and breached dams prior to pumping to the water treatment plant.

5.3.3 Post Construction Requirements

Water treatment would be required for the water collected below former Dam No. 3. The rate of water treatment is estimated to average about 5 to 7 L/s. The duration of water treatment is anticipated to be less than Alternatives 1 and 2A because of consolidation of tailings into a smaller footprint and addition of lime to a comparatively larger volume of relocated tailings and the addition of lime to tailings in the areas of the former ponds. The water treatment plant would be operated for approximately 5 to 6 months per year during the warmer months when surface flows occur.

Routine dam inspections would no longer be required because the dams would be removed. Monitoring of the surface and groundwater would be required. Monitoring of vegetation would be required to determine the rate and effectiveness of reclamation work. General maintenance would be required on the diversion channels.

5.3.4 Risks

The following risks would occur for Alternative 2B:

- The potential exists for seasonal pooling of water in the areas of the former ponds if slopes and covers over the former pond areas have poor performance.
- Water treatment would be needed for at least five years. Water treatment plant failure would potentially result in the discharge of water to Flat Creek that does not meet water quality criteria.
- Poor cover performance could lead to continued movement of elevated metal contents into the ponds, requiring water treatment and creating a potential exposure route for wildlife.
- The peat layer underlying tailings may fail over time with respect to attenuation capacity and ability to reduce vertical infiltration, resulting in metal transport to the shallow groundwater system below the pear.
- Poor mixing or poor performance of lime amendment in combination with exposure of relocated tailings to air may result in at least a short-term elevation in metals release to the shallow groundwater system beneath the tailings in the valley bottom. This process may increase water treatment costs in the short term when metal levels are highest.

5.4 Alternative 3 – Relocation-Consolidation of All Tailings to Synthetic Lined Facilities

The goal of Alternative 3 is to consolidate tailings in facilities with synthetic liners to eliminate potential releases of metals and sulfate and return the valley tailings area to a more natural configuration. In addition, the ponds and dams would be removed to eliminate these manmade structures and potential risks. Figure 5 shows a map view with text descriptions of Alternative 3.

5.4.1 Tailings Relocation

Alternative 3 would involve construction of two lined facilities located northwest of the existing valley tailings. The smaller facility would be used to contain drier tailings excavated from the Elsa hillside (blue area on Figure 5), valley edge (pink area on Figure 5), and top meter of the thicker tailings east of Pond 1 (green area on Figure 5). The tailings in drier areas would be over-excavated by about 0.5 m to remove peat and soils potentially containing mixed in tailings and elevated metals. Standard excavation and hauling in trucks would be used to move the drier tailings to the smaller lined facility. The drier tailings would be placed at slopes of approximately 5:1, resulting in a final height of approximately 20 m in the smaller lined facility at the end of relocation.

The larger lined facility would be used to contain the wet tailings located below the phreatic surface in the thick area of tailings east of Pond 1 (green area on Figure 5) and wet and submerged tailings relocated from Ponds 1, 2, and 3. The wet tailings would be transported to the larger lined facility by a combination of hauling and slurry pumping.

5.4.2 Cover

The lined facilities would be covered with 1 m of material from the borrow area. The dams would be flattened and any excess material from the dams may also be used as cover material. The areas of relocated tailings would be covered with 0.3 m of cover. The covers would be amended with organic material, fertilizer, and seeded to promote vegetation growth after placement and grading.

5.4.3 Water Management

The water in Ponds 1, 2, and 3 would be pumped and treated at a water treatment plant prior to discharge to Flat Creek. A south diversion would be constructed to convey surface water from the Elsa hillside and Porcupine Creek to the Porcupine diversion. The existing Porcupine diversion would be rehabilitated and routed to a sediment pond in Flat Creek downstream of the former location of Dam No. 3. A north diversion channel would connect to the natural drainage path of Flat Creek on the east side of the current tailings location and directed to the sediment pond.

The No Cash Ditch diversion would be rehabilitated to achieve design criteria for size and slope for its catchment area. Riprap would be added to the stream channel of Porcupine Creek in the steeper areas of Elsa hill to minimize erosion and sediment transport. A sediment pond would be placed downstream of Dam No. 3 to reduce suspended sediment loads prior to discharge to Flat Creek. An additional sediment pond would be placed on Flat Creek near the Silver King highway to reduce suspended loads downstream in Flat Creek and the Porcupine diversion.

5.4.4 Post construction Requirements

Water treatment would be required for water pumped from the ponds and during construction. Monitoring of the surface and groundwater downgradient of the lined facilities would be required. Temporary monitoring of surface water quality at the sediment pond would be needed until it is evident that the reclaimed areas have stabilized at which point water quality criteria may be met. Monitoring of vegetation would be required to determine the rate and effectiveness of reclamation work. General maintenance would be required on the diversion channels.

5.4.5 Risks

The following risks would occur for Alternative 3:

- Water treatment would be needed at least during the construction period. Water treatment plant failure would potentially result in the discharge of water to Flat Creek that does not meet water quality criteria.
- An additional area of disturbance is created by the construction of the lined facilities resulting in decrease in aesthetic appeal.
- Excavation of wet tailings with heavy equipment and slurry pumps may be difficult, depending on water levels in the lower portions of the valley bottom and climatic conditions thereby resulting in substantial cost increases.
- Poor cover performance at the lined facilities could lead to releases of metals and sulfate to downgradient soils and possibly Flat Creek.
- Poor mixing or poor performance of lime amendment in combination with exposure of relocated tailings to air may result in at least a short-term elevation in metals release to

the shallow groundwater system beneath the tailings in the valley bottom. This process may increase water treatment costs in the short term when metal levels are highest.

6.0 SUMMARY

The main components, costs, and risks of each alternative are summarized side by side in Table 2. The major features of each alternative are:

- **Alternative 1:** This alternative requires the least amount of material movement and surface disruption resulting in decreased construction time, comparatively more simple engineering design requirements, and lowest cost.
- **Alternative 2A:** This alternative would result in consolidation of the tailings into a small footprint with the installation of a robust cover over the tailings. The cover and large addition of lime should reduce metal mobilization in both the short-term and long-term. The dams and ponds are retained resulting in lower construction costs than Alternatives 2B and 3.
- **Alternative 2B:** The main features of this alternative are similar to Alternative 2A except that the dams and ponds would be removed. Removal of the dams and ponds eliminates these structures as points of potential failure and long-term maintenance and also significantly reduces the number of unnatural, manmade structures in the valley.
- **Alternative 3:** This alternative completely removes the tailings from the vicinity of Flat Creek and consolidates them in an engineered facility designed to prevent transport paths to the environment. This approach minimizes the potential for tailings and metal transport to the groundwater and surface water reducing overall risk to the environment as well as removing all of the manmade structures in the valley such that the upper reach of Flat Creek is returned to its more natural course.

7.0 REFERENCES

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Table 3. Summary of remedial alternatives for methods, cost, and risks

	Alternative 1 **Cover in Place (limited relocation)**	**Alternative 2A** **Relocation-Consolidation of Shallow Tailings and Cover Dams No.1, No. 2, and No. 3 remain**	**Alternative 2B** **Relocation-Consolidation of Shallow Tailings and Cover Dams No.1, No. 2, and No. 3 removed**	**Alternative 3** **Relocation-Consolidation of All Tailings to Synthetic Lined Facilities**
Components and Remedial Methods				
Tailings Relocation	Tailings relocation is minimal and limited to areas needed for stabilization of diversions	Tailings from the Elsa hillside; area between the hillside and valley bottom, and unsubmerged portions of Ponds 2 and 3 are relocated and consolidated behind Pond 1	Tailings from the Elsa hillside; area between the hillside and valley bottom, and unsubmerged portions of Ponds 2, and 3 are relocated and consolidated behind Pond 1; tailings in the submerged and unsubmerged portions of Ponds 1, 2, and 3 are drained and left in place.	All tailings are removed by excavation and hauling for dry tailings and slurry pumping/dredging for wet tailings; removed tailings are placed in two new storage facilities with synthetic liners located outside of the Flat Creek valley bottom
Cover	1-m cover is placed over the valley floor tailings with amendments for vegetation; Elsa hillside tailings are not covered and are re-vegetated directly	Area of consolidated tailings is covered with 1 m with amendments for vegetation; Areas of removed tailings are covered with 0.3 m with amendments for vegetation	Area of consolidated tailings is covered with 1 m with amendments for vegetation; Areas of removed tailings are covered with 0.3 m with amendments for vegetation; tailings in Ponds 1, 2, and 3 are covered in place with 1 m and graded to slope toward to the east	Areas of removed tailings are covered with 0.3 m with amendments for vegetation; areas of removed tailings are graded to drain to diversions; lined storage facilities covered with 1 m and re-vegetated
Lime Amendment	Lime added to the tailings surfaces in the valley bottom prior to cover placement; limited surface disruption reduced potential for metal release by oxidation processes compared to other alternatives	Lime is added to the volume relocated tailings and to the surfaces of existing and consolidated tailings areas; large amount of added lime may reduce short-term metal mobilization prior to establishment of vegetated cover		Lime is added to all of the removed tailings placed in the synthetic lined facility; metal mobilization and transport to Flat Creek eliminated
Surface Water Management	North and south diversions are constructed to keep surface water from covered tailings; both			A north is constructed to

	diversions end in a sediment pond; the south diversion is directed to the existing Porcupine Diversion; the Porcupine diversion is rehabilitated; additional sediment pond constructed on Flat Creek near the Silver King highway to reduce suspended loads downstream in Flat Creek and the Porcupine diversion			follow the historic path of Flat Creek; south diversions is constructed to drain Elsa hillside to a rehabilitated Porcupine Diversion; both diversions end in a sediment pond;
Dams and Ponds	The dams and ponds are retained in their current configuration; Dams No. 1, No. 2, and No. 3 are fortified		All dams are breached with center portions filled with gravel for drainage; ponds drained, covered, and graded for drainage	All dams are removed, ponds drained, and areas graded for drainage
Water Treatment	Water treatment required during construction and in future; Pond 3 used as a storage reservoir for water treatment plant; water treatment for metal removal and clarification prior to discharge to Flat Creek		Water treatment required during construction and for short-term future; a collection pond constructed below the current location of Dam No. 3 for storage for the treatment plant; water treatment for metal removal and clarification prior to discharge to Flat Creek	Water treatment required during construction and until all onsite surface exposed to tailings treated and discharged; water treatment expected to end after all tailing are removed
Post-construction requirements	Dam inspection; groundwater and surface water monitoring; vegetation monitoring; general maintenance of diversions		Groundwater and surface water monitoring; vegetation monitoring; general maintenance of diversions	Groundwater and surface water monitoring; vegetation monitoring; general maintenance of diversions; maintenance of lined facilities
Estimated Costs				
Total Cost (present-day actual cost, CAD)	$21,200,000	$23,000,000	$26,500,000	$54,100,000
Risks				
Performance of covers and reclamation	Largest area of cover increases potential for failure; direct revegetation of tailings in the Elsa hillside may be difficult	Poor cover performance may result in erosion of tailings and transport to Flat Creek and failure of re-vegetation		Liner may leak or water buildup may overflow and be released to downgradient areas above Flat Creek; removal of wet tailings may be difficult
Dams	Dam failure due to intense	Dam failure due to intense	Not applicable (dams removed)	

	freshet or precipitation event; inspections required	freshet or precipitation event		
Ponds	Ponds are retained and are potential transport pathways for metal uptake by wildlife	Ponds are retained and are potential transport pathways for metal uptake by wildlife	Not applicable (ponds removed)	
Water treatment performance	Improvements in water quality unlikely, resulting in long-term operation of a water treatment plant; Plant failure would discharge poor water quality to Flat Creek	Plant failure would discharge poor water quality to Flat Creek		
Metal mobilization	Limited amount of lime addition may not appreciable improve metal release from current rates; failure of containment by peat may result in metal release to groundwater	Large amount of surface disruption may result in short-term release of metals; failure of containment by peat may result in metal release to groundwater		Metals may be released from the lined facility due to liner failure or buildup of water in the lined facility, overflowing to downgradient area
Aesthetics	All manmade structures left in place in the valley bottom results in unnatural landscape		Consolidated tailings may have unnatural appearance until vegetation is established; loss of historical mining facility	Consolidated tailings may have unnatural appearance until vegetation is established; loss of historical mining facility; previously unaffected area is disrupted to construct lined facility
Cost Increases	Unknown longevity of water treatment; erosion of tailings from Elsa hillside and poor cover performance may require repair and maintenance; inflationary cost increases for labor, equipment, repair, and inspection and maintenance of structures	Poor cover performance may require repair and maintenance; inflationary cost increases for labor, equipment, repair, and inspection and maintenance of structures		Difficulties in removing wet tailings may take longer and be more difficult than expected; poor cover performance may require repair and maintenance; inflationary cost increases for labor, equipment, repair, and inspection and maintenance of structures

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Memorandum

To: Scott Davidson, Senior Project Manager – Keno Closure

From: Jim Theriault

CC:

Date: February 13, 2012

Re: Updated Tailings Closure Costing (Wernecke, Mackeno and Valley Tailings) to Include Dispersed Tailings

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This tailings reclamation costing update builds on the previous closure costing spreadsheets developed by ITL in 2011 and has been modified to reflect additional studies into the distribution of dispersed tailings located downgradient from the main tailings areas. The costing has also been adjusted to reflect updated costs for lime (based on Keno site costs).

The most complete characterization of the dispersed tailings downgradient of both the Valley Tailings and Wernecke is contained in the DRAFT report "Dispersed Tailings Drainage Studies" (ITL, March 2012). The above mentioned report does not cover the Mackeno and Tailings (site visit was impeded by heavy snow). Available information on the Mackeno dispersed tailings has been pieced together based on a review of the 2009 report "Site Investigation and Improvements, Special Projects: Mackeno and Wernecke Tailings Assessment" (Access, 2009) and recent (2012) visual site reconnaissance, shallow sampling programs and geochemical characterization work.

Valley Tailings

The original costing developed by ERDC and ITL was presented in an Excel spreadsheet "Alternatives 1-3 Cost and Quantities 3-26-2011.xls" and is described in some detail in a Draft Technical Memorandum (ITL, 2011a). A sensitivity analysis of the Valley Tailings costing was previously performed in GoldSim in order to better define the costing assumptions which have the greatest impact on the reclamation costs. Based on a review of the costing, it has been determined that, with the exception of updating a few notable unit costs (e.g., lime) the costing was found to be consistent with the current costing requirements. A total of four (4) potential tailings reclamation scenarios have been costed for the main tailings area of the Valley Tailings. The four Valley Tailings reclamation scenarios are as follows: 1) Alternative 1 (Cover in Place); 2) Alternative 2A (Tailings Relocation/Consolidation – Dams Remain); 3) Alternative 2B (Tailings Relocation/Consolidation – Dams Removed); 4) Alternative 3 (Tailings Relocation to New Constructed Facility).

The primary modification to the previous costing is the inclusion of remediating/stabilizing the dispersed tailings which are known to exist down-gradient of the proposed future settling pong (i.e., about 300m down-gradient of Dam 3).

A variety of reclamation strategies will be adopted for remediating/stabilizing the dispersed tailings downgradient of the main Valley Tailings area. They are broadly categorized as follows:

1) **In-stream actively eroding islands of tailings**: This refers to pockets of tailings which are largely barren and showing signs of active eroding around the perimeter. These tailings will be removed from the stream course and relocated to main Valley Tailings impoundment where they will be managed with the rest of the tailings. The rationale for removing these tailings is that they pose a significant risk of tailings remobilization and would be difficult to effectively stabilize.

   Based on preliminary reconnaissance associated with the Dispersed Tailings and Drainages Studies report (ITL, 2012) and a review of available air photos, it is estimated that there are approximately 4 areas in the Flat Creek stream channel that fit this description. Allowing for an average of 5 m^3 of tailings per site, it is assumed that a total of 20 m^3 of tailings will be removed in this manner.

2) **In-stream naturally revegetated islands of tailings:** This refers to pockets of tailings which are showing good signs of revegetation and have a stable perimeter which is showing little/no signs of active erosion. These islands of tailings will be left in place and further stabilized by the addition of growth media/amendments to enhance vegetation and the addition of self-armouring granular (e.g., sand and gravel) erosion protection (if required) in areas adjacent to the stream channel.

   For costing purposes, it has been assumed that approximately 10 locations of concentrated dispersed tailings, with an average area of 50 m^2 each, will be remediated in-situ using enhanced revegetation along the Flat Creek drainage. It is anticipated that growth media, soil amendments and granular erosion protection will be delivered to the locations to be remediated using helicopters.

3) **Actively eroding stream channel cut through tailings:** This refers to area of the stream channel where tailings area actively being eroded along the stream banks. These areas will be physically stabilized using a combination of resloping (manually flattening actively eroding shoreline) combined with the placement of geotextiles and erosion protection(e.g. self armouring sand and gravel or river rock). The intension is to create a stable shoreline profile that will protect the tailings from further erosion and encourage natural revegetation. We propose to also initiate revegetation through to inclusion of manual plantings, such as willow whips, to further enhance shoreline stability and naturalization.

   For costing purposes, it is assumed that up to 200m of shoreline along the Flat Creek drainage channel will require stabilization. In areas of constrained flow, the stream course will be widen (using manual labour) by a minimum of 0.5m to ensure that the addition of the erosion protection does not restrict flow and/or contribute to additional erosive energy. An allowance of 0.1m^3 of erosion protection per linear meter of shoreline stabilization has been assumed. It is anticipated that the erosion protection and geotextile will be delivered to the site via helicopter. Similarly, tailings excavated in connection with channel resloping/widening will be stored in free-draining geotextile bags and relocated to the main tailings area using helicopters.

The updated costing for remediating the Valley Tailings (4 scenarios) is detailed in an updated Excel spreadsheet. The associated detailed costing summary worksheets are appended to this memo. The costing calculation associated with addressing the dispersed tailings are summarized in the table below. Given the limited detailed information available for the distribution of the dispersed tailings only one (robust) scenario has been costed for addressing the dispersed tailings. The cost incorporates all three forms of dispersed tailings remediation outlined above.

The itemized costs associated with addressing the dispersed tailings (not considered in earlier Valley Tailings reclamation costing exercises) include the following:

	Unit	Quantity	Unit Cost	Element Cost
Initial Helicopter Mob/Demob (MD900 Explorer out of Whitehorse)	hr	3	3000	9000
Rental of Argos to transport staff and light equipment through marshy area	rental	3	10000	30000
Stabilize Shoreline (200m total assumed to require improvements)				
- Helicopter drop off of granular fill and pumps (multiple locations)	hr	3	3000	9000
- portable 3" trash pump for slurrying tailings	lump	2	6000	12000
- 20 woven geotextile sling bags for transporting washed granular fill	each	20	50	1000
- washed granular to be dropped off in areas to be stabilized	tonne	20	200	4000
- misc. geotextile, geogrid, sediment control and field gear	lump	1	2000	2000
- junior / intermediate field staff to relocate tailngs and stabilize slopes	hr	200	100	20000
- senior field supervisor	hr	40	160	6400
- helicopter removal of tailings from Creek to Valley Tailings impoundment	hr	4	3000	12000
Revegetate Tailings Islands				
- helicopter time for dropping off of soil, lime and seed	hr	2	3000	6000
- lime ammendment for in-situ stabilization (20 kg bags)	allowance	50	30	1500
- soil/mulch to dress barren patches on tailings islands (allow 100m^2 total)	cu.m bag	10	200	2000
- seed mixture for revegetation	kg	10	100	1000
- junior / intermediate staff to complete revegetation	hr	160	100	16000
- senior field supervision	hr	30	160	4800
Remove Tailings Islands				
- helicopter drop off of pumps, granular and equipment	hr	2	3000	6000
- 20 woven geotextile sling bags for transporting washed granular fill	each	20	50	1000
- misc. sedimentation control	lump	1	2000	2000
- washed granular to be dropped off via helicopter	tonne	10	200	2000
- junior / intermediate field staff to relocate tailings	hr	100	100	10000
- senior field supervision	hr	20	160	3200
- helicopter removal of tailings	hr	4	3000	12000
Final Helicopter Mob/Demob (MD900 Explorer out of Whitehorse)	hr	3	3000	9000
Direct Costs	Remediation of Dispersed Tailings			**$181,900**
Indirect Costs	Allow 45% of direct costs			**$81,855**
Total Direct and Indirect Costs				**$263,755**

The estimate of indirect costs associated with the dispersed tailings is consistent with the main Valley Tailings reclamation alternatives (1, 2A, 2B and 3). The cost for remediating dispersed tailings is to be added to each of the 4 main tailings reclamation alternatives which were previously costed.

Wernecke Tailings

The original costing developed by ERDC and ITL was presented in an Excel spreadsheet "Wernecke Tailings Cost and Quantities 3-31-2011.xls". The accuracy of the costing is discussed in a Draft Technical

Memorandum (ITL, 2011b) and has been characterized as a Level 5 cost estimate considered accurate to -50% / +100% of actual cost.

The Closure-related issues have been previously described in Site Investigation and Improvements, Special Projects Mackeno and Wernecke Tailings Assessment, March 31, 2009 and prepared by Access Consulting Group (ACG. 2009).

This initial costing was largely based on visual inspection, historical records and preliminary site reconnaissance work that ITL completed in connection with the "Natural Attenuation Study Report" (ITL, March 2012). The original costing focused primarily on the upper areas of clearly defined tailings in an adjacent to the original (failed) tailings impoundment.

It is agreed that only areas of barren tailings (largely devoid of vegetation) and of sufficient depth (i.e., greater than 0.5m depth) will be physically excavated and either removed from the site or consolidated below a revegetated cover. Areas identified in ACG (2009) were addressed in the original cost estimate from March 2011 (prepared by ITL with input from AEG). The three reclamation scenarios considered for the main tailings include: 1) Cover in Place; 2) Consolidate and Cover; 3) Relocate and Stabilize. Detailed costing summary tables for each of these three alternatives are appended.

This updated estimate addresses in-situ stabilization of additional very shallow areas ("lobe") of dispersed tailings, typically on the order of 5 to 10cm thick to a maximum of 0.3m thick. These areas are typically sparsely vegetated and would result in significant disturbance / damage and increased risk of sediment transport if the vegetation was to be cleared. For the purpose of costing, it is assumed that approximately 1000 m^2 of vegetated dispersed tailings will be treated with lime addition (at a rate of 6 kg / tonne). Lime mixing will be limited to the upper 10 cm – which translates to 100 m^3 of tailings or 160 tonnes of tailings. At a lime application rate of 6 kg of lime per tonne of tailings, this translates to 960 kg of lime. It is assumed that lime will be delivered to the site in roughly 20 kg bags and manually mixed with the tailings using a combination of manual labour with shovels and small rototill equipment.

Modification to the original cost estimate includes t-he increase in lime unit rate to $650/tonne (bulk delivered) from $500/tonne plus the addition of the following cost items related to dispersed tailings which are thinly deposited (and largely vegetated) downgradient of the main tailings deposit:

Costs Associated with Reclaiming Mackeno Dispersed/Subaqueous Tailings

Direct Costs	**Comment**	**Incremental Cost**
Lime amendment (20 kg bags):	Allowance	$1,000
Seed/fertilizer	Allowance	$1,000
Labour (application of lime/seed)	60hrs @ $100/hr	$6,000
Sediment Control Measures	Allowance	$2,000
Rototiller Rental	Allowance	$1,000
Indirect Costs		
Costed at 45% of direct costs		$4,950
	Total Dispersed Tailings Cost:	**$15,950**

The above costing exercise indicates that an additional $11K of direct costs is anticipated in addition to the previously costed reclamation efforts for the Wernecke tailings.. It is anticipated that the original cost estimate adequately accounts for the requirement to stabilize and rip-rap erosional gullies and drainage channels. This rip-rap material would be sourced from the existing waste rock at the Wernecke or Sadie Ladue sites.

Total additional direct and indirect costs to include remediation of dispersed tailings downgradient of the main tailings lobe at Wernecke is approximately $16,000. The methodology and associated costs for remediating the dispersed tailings is common to all Wernecke tailings reclamation scenarios.

The updated detailed cost estimates for remediating the Wernecke Tailings (including the areas of dispersed tailings described above) are appended to this technical memorandum.

Mackeno Tailings

The original costing of the Mackeno Tailings was developed by ERDC and ITL was presented in an Excel spreadsheet "Mackeno Tailings Cost and Quantities 3-31-2011.xls". The accuracy of the costing is discussed in a Draft Technical Memorandum (ITL, 2011b) and has been characterized as a Level 5 cost estimate considered accurate to -50% / +100% of actual cost. Two reclamation scenarios have been considered for addressing the main tailings mass: 1) Consolidate, Stabilize and Cover and 2) Relocate Tailings and Stabilize. Detailed costing summary tables for these two reclamation alternatives are appended.

It is anticipated that the original costing adequately accounts for the costs associated with consolidating and or relocating the tailings which are readily accessible to heavy equipment operating on dry land; however, additional equipment and time has been added to address tailings which are currently located either subaqueously or remotely in heavily vegetated areas.

Areas of subaqueously deposited tailings will be isolated using a combination of aquadams, floating silt fences and standard silt fencing. The subaqueous tailings will be relocated using a 6" trash pump and dewatered using large geotubes. Lime will be added to the tailings to add alkalinity and polymer will be added to facilitate dewatering. Dispersed tailings along the shore of Christal Creek will be manually shoveled (or pumped as slurry) into woven geotextile bags and removed via helicopter to either the main tailings consolidation area or to the Valley Tailings. The use of a helicopter will eliminate the need to create an access road across the marshy areas and vegetated surrounding the tailings and the associated disturbance.

Additional Elements Added to the Mackeno Tailings Reclamation to Address the Remediation of Subaqueous/Dispersed Tailings:

Direct Costs		Comment	Incremental Cost
	Tailings characterization for dewatering (3 tests by Layfield)		$1,500
	2 aquadams (1.3 m diameter, 30 m long), installed	allowance	$15,000
	2 geotubes (60 feet by 100 feet)		$15,000
	Pump rental (6" trash pump for slurried tailings)		$10,000
	CAT 320 excavator for subaqueous tailings support	Allow 20 hrs @ $300/hr	$6,000
	Polymer (for dewatering tailings in geotubes)		$3,000
	Floating silt fencing (8 x50' @ $350 each, plus delivery)		$4,000
	Miscellaneous pump rental		$1,000
	Woven geotextile bags (40 x 1 m^3 bags @ $40 each)		$2,000
	Helicopter heavy lift support (3 hrs)	$3000/hr, includes fuel	$9,000
	Clean granular fill for diffusion barrier along shoreline (40 m3)	estimate	$2,000
	Junior/Intermediate staff (80 hrs @ $100/hr)		$8,000
		Total Direct Costs	**$76,500**
Indirect Costs			
	Costed at 45% of Direct Costs	Total Indirect Costs	**$34,425**
		Total Dispersed Tailings Cost	**$110,925**

It is assumed that the original costing already allowed for costs associated with recontouring and revegetating disturbed areas where tailings are to be removed. Total estimated additional direct costs is approximately $76,500. If we allow 45% for indirect costs, the total additional costs associated with the Mackeno tailings reclamation amounts to approximately $111,000.

Key References:

Access Consulting Group (2009). Site Investigation and Improvements, Special Projects, Mackeno and Wernecke Tailings Assessment, prepared for ERDC, dated March 31, 2009

ITL (2011a). Draft Technical Memorandum - Remedial Alternatives Description, Valley Tailings Facility, prepared for ERDC, dated March 28, 2011.

ITL (2011b). Draft Technical Memorandum – Reclamation Description and Costing, Mackeno and Wernecke Tailings Area, Keno Hills Mining District, Elsa, YT, prepared for ERDC, dated April 1, 2011.

ITL (2011c). Draft Technical Memorandum – Keno Closure Cost Accuracy Evaluation and Model Description, Memo to Scott Davidson and Jim Harrington, dated December 21, 2011.

ITL (2012). DRAFT Dispersed Tailings and Drainage Studies, United Keno Hill Mines, Yukon Territory, Canada, Project No. 102003, prepared for Access Consulting Group, dated March 2012

SRK (2009a). 2007/08 Geochemical Studies, Keno Hill Silver District, YT. Report prepared for Elsa Reclamation and Development Company. Project No. 1CE012.001. February 2009.

SRK (2009b) 2009 Valley Tailings Facility Closure Options, Keno Hill Silver District, YT. Prepared by SRK Consulting, prepared for Elsa Reclamation and Development Company, June 2009.

Valley Tailings Reclamation - Does NOT Include Dispersed Tailings Downgradient of Tailings Impoundment
03/03/2011 (Updated Dec 2012 - just lime pricing)
CLW

Alternative 1 - Cover In Place (Limited Taillings Relocation)

Assumptions

Insitu Unit Weight Tails	1.97	tonnes/m3	Lime Added	6	kg/tonnes
Unit Weight of Borrow Material	1.5	tonnes/m3	Lime	650	$/tonnes
Unit Weight of Diversion Material	1.5	tonnes/m3	Northern Channel Riprap Depth	0.5	m
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1		Southern Channel Riprap Depth	0.5	m
Est. Coefficient for 3D Surface Consolidated Area	1		Porcupine Creek	0.5	m
Cover Thickness Over Tails	1	m	Blasting	0.4	$/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3	m	Water Treatment Plant	300,000	$
Depth of Tailings Relocated (Elsa Hillside) 1/10th of Total Area	0.5	m	Water Treatment	0.5	$/m3
Stripping Depth	0.3	m	Rip Rap Weight	2.1	tonnes/m3
Unit Weight of Stripping Material	1	tonnes/m3	Filter Fabric	5	$/m2 for $1.5 to buy, $3.5 to place
Project Management & Field Supervision	7.0%		Seed, Fertilizer, Spreading (m^2)	0.55	$/m2 for $0.55 Seed/Fertilizer
Profit & Overhead	10.0%		Lime Application (m^3)	1	$/m3
Insurance & Bonding	1.4%		Crush & Screen (m^3)	4.45	$/tonnes
Field Engineering, QA & Surveying	7.0%		Compost Depth	0.05	m
Mob & Demob	5.0%		Compost	0.3	tonnes/m3
Living Allowances	8.0%		Compost Cost	81	$/m3
Taxes	7.0%		Over Excavation	0.5	m
Contingency	0.0%		Tailings Dry Weight For Lime	1.55	tonnes/m3
			Unit Weight Over Excavated Material	1.2	tonnes/m3
			Percent by Volume of Tails in OverEx Material	75%	

Alt-1 Clear and Grub Borrow Area to Stockpile					Cost	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	325 Excavator 76 m^3/hr
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$138,570.71
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$138,570.71**

$290,044.76

Alt-1 Reclaim Borrow Area By Replacing Stockpile					Cost	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	Seed, Fertilizer, Spreading (m^2)
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$102,852.75
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$102,852.75**

$254,326.80

Alt-1 Tailings To Be Relocated					**Cost**			
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 276 m^3/hr	740 Truck 133 m^3/hr
Elsa Hillside Area	21,058	21,058	10,529	16,320	$28,427.63	$5,790.81	$7,264.84	$18,320.03
Relocated Tailings Area	59,435	59,435	98,586	152,808	$266,182.20	$54,222.30	$68,024.34	$171,539.64
Over Excavation	59,435	59,435	29,718	46,062	$80,237.25	$16,344.63	$20,505.08	$51,708.45
Totals	**139,928**	**139,928**	**138,832**	**215,190**	**$374,847.08**	**$76,357.74**	**$95,794.25**	**$241,568.12**

$788,567.18

Alt-1 Revegetation Cover, Reseed, Fertilize					**Cost**			
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	740 Truck 70 m^3/hr	D6 Dozer 320 m^3/hr	Seed, Fertilizer, Spreading (m^2)
Elsa Hillside Area	21,058	21,058	6,317	9,476	$4,358.90	$21,036.44	$3,474.49	$11,581.63
Relocated Tailings Area	59,435	59,435	17,831	26,746	$12,303.05	$59,375.57	$9,806.78	$32,689.25
Consolidation Tailings Area	62,982	62,982	62,982	94,473	$43,457.58	$209,730.06	$34,640.10	$34,640.10
Tailings Not Disturbed Area	575,250	575,250	575,250	862,875	$396,922.50	$1,915,582.50	$316,387.50	$316,387.50
Totals	**718,725**	**718,725**	**662,380**	**993,570**	**$457,042.03**	**$2,205,724.57**	**$364,308.86**	**$395,298.48**

$3,422,373.93

Alt-1 Diversion Channels				**Cost**					
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)
Northern Diversion Channel	3,086	176,366	9,987	$121,692.54	$8,388.66	$24,666.67	$33,255.06	$37,948.72	$93,323.90
Southern Diversion Channel	1,843	42,630	8,025	$29,414.70	$6,740.67	$19,820.79	$26,721.95	$30,493.52	$74,989.98
Sediment Pond	100	100	100		$84.00	$247.00	$333.00	$380.00	$934.50
Totals	**5,029**	**219,096**	**18,111**	**$151,107.24**	**$15,213.34**	**$44,734.46**	**$60,310.02**	**$68,822.24**	**$169,248.38**

$509,435.66

Alt-1 Channel Rehab					**Cost**						
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen (m^3)
Porcupine Creek	1,018	12,888	9,738	12,681	$8,892.72	$8,179.92	$24,052.86	$32,427.54	$37,004.40	$63,405.00	$91,001.61
No Cash Diversion	1,902	14,964	9,938	18,878	$10,325.16	$8,347.92	$24,546.86	$33,093.54	$37,764.40	$94,390.00	$92,870.61
Totals	**2,920**	**27,852**	**19,676**	**31,559**	**$19,217.88**	**$16,527.84**	**$48,599.72**	**$65,521.08**	**$74,768.80**	**$157,795.00**	**$183,872.22**

$566,302.54

Alt-1 Lime Added							**Cost**	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application
Elsa Hillside Area	21,058	21,058	10,529	16,320	97,917	98	$63,646.29	$10,528.75
Relocated Tailings Area	59,435	59,435	98,586	152,808	916,850	917	$595,952.37	$98,586.00
Tailings Not Disturbed Area	575,250	575,250	575,250	891,638	5,349,825	5,350	$3,477,386.25	$575,250.00
Over Excavation	59,435	59,435	29,718	34,547	207,280	207	$134,731.72	$29,717.50
Totals	**715,178**	**715,178**	**714,082**	**1,095,312**	**6,571,872**	**6,572**	**$4,271,716.63**	**$714,082.25**

$4,985,798.88

Alt-1 Water Treatment		**Cost**
Description	Quantity	Unit Cost
Treat Water Plant	1	$300,000.00
Treat Water (m3/day)	267	$243,637.50
Totals		**$543,637.50**

$543,637.50

Alt-1 Dam Rehab					**Cost**					
Areas	Length (m)	Area (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)
Dam 1	400	3.25	1300	2730	$897.00	$2,293.20	$6,743.10	$9,090.90	$10,374.00	$25,511.85
Dam 2	400	8	3200	6720	$2,208.00	$5,644.80	$16,598.40	$22,377.60	$25,536.00	$62,798.40
Dam 2	450	18	8100	17010	$5,589.00	$14,288.40	$42,014.70	$56,643.30	$64,638.00	$158,958.45
Totals	**1,250**	**29**	**12,600**	**26,460**	**$8,694.00**	**$22,226.40**	**$65,356.20**	**$88,111.80**	**$100,548.00**	**$247,268.70**

$532,205.10

Alt-1 Compost		**Cost**
Description	Compost (m3)	Compost Cost
Compost	35,936	$2,910,834.23
Totals	**35936**	**$2,910,834.23**

$2,910,834.23

Alt-1 Manpower		**Cost**
Description	Quantity	Unit
Labor		$352,000.00
Monitoring for 5 years		$250,000.00
Totals		**$602,000.00**

$602,000.00

Alt-1 Contingency			**Cost**
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$15,405,526.58	$0.00
Totals	**0.0%**	**$15,405,526.58**	**$0.00**

Alt-1 Closure Indirect Costs			**Cost**
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$15,405,526.58	$1,078,386.86
Profit & Overhead	10.0%	$15,405,526.58	$1,540,552.66
Insurance & Bonding	1.4%	$15,405,526.58	$215,677.37
Field Engineering, QA & Surveying	7.0%	$15,405,526.58	$1,078,386.86
Mob & Demob	5.0%	$15,405,526.58	$770,276.33
Living Allowances	8.0%	$15,405,526.58	$1,232,442.13
Taxes	7.0%	$15,405,526.58	$1,078,386.86
Totals			**$6,994,109.07**

Direct Cost	**$15,405,526.58**
Indirect Cost	**$6,994,109.07**
Total Direct & Indirect	**$22,399,635.64**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$22,399,635.64**

Valley Tailings Reclamation - Does NOT Include Dispersed Tailings Downgradient of Tailings Impoundment
######### (Lime pricing updated Dec 2012)
CLW

Alternate 2A - Tailings Relocation/Consolidation of Shallow Tailings (Dams Remain)

Assumptions

Insitu Unit Weight Tails	1.97 tonnes/m3	Lime Added	6 kg/tonnes
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	650 $/tonnes
Unit Weight of Diversion Material	1.5 tonnes/m3	Northern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Relocated & Undisturbed Are	1	Southern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Consolidated Area	1	Porcupine Creek	0.5 m
Cover Thickness Over Tails	1 m	Blasting	0.4 $/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment Plant	300,000 $
Depth of Tailings Relocated (Elsa Hillside) 1/3rd of Total Area	0.5 m	Water Treatment	0.5 $/m3
Stripping Depth	0.3 m	Rip Rap Weight	2.1 tonnes/m3
Unit Weight of Stripping Material	1 tonnes/m3	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place
Pond 2 Unsubmerged Tailings	0.5 m	Seed, Fertilizer, Spreading (m^2)	0.55 $/m2 for $0.55 Seed/Fertilizer
Pond 3 Unsubmerged Tailings	0.3 m	Lime Application (m^3)	1 $/m3
Depth To Overexcavate Under Tailings	0.5 m	Tailings Dry Weight For Lime	1.55 tonnes/m3
Depth of Water in Ponds (Fill for Option 2b)	2 m	Unit Weight of Relocated pumped Tails	1.76 tonnes/m3
Depth of Undisturbed Tailings	1 m	Freeboard Volume Percentage	15.00%
Project Management & Field Supervision	7.0%	Crush & Screen (m^3)	4.45 tonnes/m3
Profit & Overhead	10.0%	Compost Depth	0.05 m
Insurance & Bonding	1.4%	Compost	0.3 tonnes/m3
Field Engineering, QA & Surveying	7.0%	Compost Cost	81 $/m3
Mob & Demob	5.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3
Living Allowances	8.0%	Unit Weight Over Excavated Material	1.2 tonnes/m3
Taxes	7.0%	Percent by Volume of Tails in OverEx Material	75%
Contingency	0.0%		

Alt-2A Clear and Grub Borrow Area to Stockpile					Cost	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	325 Excavator 76 m^3/hr
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$138,570.71
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$138,570.71**

$290,044.76

Alt-2A Reclaim Borrow Area By Replacing Stockpile					Cost	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	Seed, Fertilizer, Spreading (m^2)
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$102,852.75
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$102,852.75**

$254,326.80

Alt-2A Tailings & Over Excavation To Be Relocated					**Cost**				
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 276 m^3/hr	740 Truck 133 m^3/hr	980 Loader 240 m^3/hr
Elsa Hillside Area	70,192	70,192	35,096	69,139	$94,758.75	$19,302.71	$24,216.13	$61,066.75	
Relocated Tailings Area	296,295	296,295	337,273	664,427	$910,636.02	$185,499.93		$586,854.32	$347,390.78
Pond 2	10,850	10,850	5,425	10,687	$14,647.50	$2,983.75	$1,871.63	$9,439.50	$5,587.75
Pond 3	38,820	38,820	11,646	22,943	$31,444.20	$6,405.30	$4,017.87	$20,264.04	$11,995.38
Over Excavation	296,295	296,295	148,148	229,629	$399,998.25	$81,481.13		$257,776.65	$152,591.93
Totals	**712,452**	**712,452**	**537,587**	**996,824**	**$1,451,484.72**	**$295,672.81**	**$30,105.62**	**$935,401.26**	**$517,565.83**

$3,230,230.24

Alt-2A Revegetation Cover, Reseed, Fertilize					**Cost**			
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	740 Truck 70 m^3/hr	D6 Dozer 320 m^3/hr	Seed, Fertilizer, Spreading (m^2)
Elsa Hillside Area	70,192	70,192	21,058	31,586	$14,529.68	$70,121.48	$11,581.63	$38,605.42
Relocated Tailings Area	296,295	296,295	88,889	133,333	$61,333.07	$295,998.71	$48,888.68	$162,962.25
Consolidation Tailings Area	158,922	158,922	158,922	238,383	$109,656.18	$529,210.26	$87,407.10	$87,407.10
Tailings Not Disturbed Area	175,124	175,124	175,124	262,686	$120,835.56	$583,162.92	$96,318.20	$96,318.20
Totals	**700,533**	**700,533**	**443,992**	**665,988**	**$306,354.48**	**$1,478,493.36**	**$244,195.60**	**$385,292.97**

$2,414,336.41

Alt-2A Diversion Channels				**Cost**					
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)
Northern Diversion Channel	3,086	176,366	9,987	$121,692.54	$8,388.66	$24,666.67	$33,255.06	$37,948.72	$93,323.90
Southern Diversion Channel	1,843	42,630	8,025	$29,414.70	$6,740.67	$19,820.79	$26,721.95	$30,493.52	$74,989.98
Sediment Pond	100	100	100		$84.00	$247.00	$333.00	$380.00	$934.50
Totals	**5,029**	**219,096**	**18,111**	**$151,107.24**	**$15,213.34**	**$44,734.46**	**$60,310.02**	**$68,822.24**	**$169,248.38**

$509,435.66

Alt-2A Channel Rehab					**Cost**						
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen (m^3)
Porcupine Creek	1,018	12,888	9,738	12,681	$8,892.72	$8,179.92	$24,052.86	$32,427.54	$37,004.40	$63,405.00	$91,001.61
No Cash Diversion	1,902	14,964	9,938	18,878	$10,325.16	$8,347.92	$24,546.86	$33,093.54	$37,764.40	$94,390.00	$92,870.61
Totals	**2,920**	**27,852**	**19,676**	**31,559**	**$19,217.88**	**$16,527.84**	**$48,599.72**	**$65,521.08**	**$74,768.80**	**$157,795.00**	**$183,872.22**

$566,302.54

Alt-2A Lime Added							**Cost**	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application
Elsa Hillside Area	70,192	70,192	35,096	54,399	326,391	326	$212,154.31	$35,095.83
Relocated Tailings Area	296,295	296,295	337,273	522,773	3,136,635	3,137	$2,038,812.86	$337,272.60
Tailings Not Disturbed Area	175,124	175,124	175,124	271,442	1,628,653	1,629	$1,058,624.58	$175,124.00
Pond 2 Relocated Unsubmerged	10,850	10,850	5,425	8,409	50,453	50	$32,794.13	$5,425.00
Pond 3 Relocated Unsubmerged	38,820	38,820	11,646	18,051	108,308	108	$70,400.07	$11,646.00
Over Excavated Area	296,295	296,295	148,148	172,221	1,033,329	1,033	$671,663.73	$148,147.50
Totals	**887,576**	**887,576**	**712,711**	**1,047,295**	**6,283,769**	**6,284**	**$4,084,449.67**	**$712,710.93**

$4,797,160.61

Alt-2A Water Treatment		**Cost**
Description	Quantity	Unit
Treat Water Plant	1	$300,000.00
Treat Water (m3/day)	267	$243,637.50
Totals		**$543,637.50**

$543,637.50

Alt-2A Dam Rehab					**Cost**					
Areas	Length (m)	Area (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)
Dam 1	400	3.25	1300	2730	$897.00	$2,293.20	$6,743.10	$9,090.90	$10,374.00	$25,511.85
Dam 2	400	8	3200	6720	$2,208.00	$5,644.80	$16,598.40	$22,377.60	$25,536.00	$62,798.40
Dam 2	450	18	8100	17010	$5,589.00	$14,288.40	$42,014.70	$56,643.30	$64,638.00	$158,958.45
Totals	**1,250**	**29**	**12,600**	**26,460**	**$8,694.00**	**$22,226.40**	**$65,356.20**	**$88,111.80**	**$100,548.00**	**$247,268.70**

$532,205.10

Alt-2A Compost		**Cost**
Description	Compost (m3)	Compost Cost
Compost	35,027	$2,837,157.30
Totals		**$2,837,157.30**

$2,837,157.30

Alt-2A Manpower		**Cost**
Description	Quantity	Unit
Labor		$352,000.00
Monitoring for 5 years		$250,000.00
Totals		**$602,000.00**

$602,000.00

Alt-2A Contingency			**Cost**
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$16,576,836.91	$0.00

Alt-2A Closure Indirect Costs			**Cost**
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$16,576,836.91	$1,160,378.58
Profit & Overhead	10.0%	$16,576,836.91	$1,657,683.69
Insurance & Bonding	1.4%	$16,576,836.91	$232,075.72
Field Engineering, QA & Surveying	7.0%	$16,576,836.91	$1,160,378.58
Mob & Demob	5.0%	$16,576,836.91	$828,841.85
Living Allowances	8.0%	$16,576,836.91	$1,326,146.95
Taxes	7.0%	$16,576,836.91	$1,160,378.58
Totals			**$7,525,883.96**

Direct Cost	**$16,576,836.91**
Indirect Cost	**$7,525,883.96**
Total Direct & Indirect	**$24,102,720.87**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$24,102,720.87**

Valley Tailings Reclamation Costing - Does NOT include Dispersed Tailings Downgradient of Tailings Impoundment
03/03/2011 (Lime pricing updated Dec 2012)
CLW

Alternate 2B - Tailings Relocation/Consolidation of Shallow Tailings (Dams Removed)

Assumptions

Insitu Unit Weight Tails	1.97 tonnes/m3	Lime Added	6 kg/tonnes
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	650 $/tonnes
Unit Weight of Diversion Material	1.5 tonnes/m3	Northern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Relocated & Undisturbed Are	1	Southern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Consolidated Area	1	Porcupine Creek	0.5 m
Cover Thickness Over Tails	1 m	Blasting	0.4 $/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment Plant	300,000 $
Depth of Tailings to be Relocated (Elsa Hillside)	0.5 m	Water Treatment	0.5 $/m3
Stripping Depth	0.3 m	Rip Rap Weight	2.1 tonnes/m3
Unit Weight of Stripping Material	1 tonnes/m3	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place
Pond 2 Unsubmerged Tailings	0.5 m	Seed, Fertilizer, Spreading (m^2)	0.55 $/m2 for $0.55 Seed/Fertilizer
Pond 3 Unsubmerged Tailings	0.3 m	Lime Application (m^3)	1 $/m3
Depth To Overexcavate Under Tailings	0.5 m	Unit Weight Over Excavated Material	1.2 tonnes/m3
Depth of Water in Ponds (Fill for Option 2b)	2 m	Unit Weight of Relocated pumped Tails	1.76 tonnes/m3
Depth of Undisturbed Tailings	1 m	Freeboard Volume Percentage	15.00%
Project Management & Field Supervision	7.0%	Crush & Screen (m^3)	4.45 $/tonnes
Profit & Overhead	10.0%	Compost Depth	0.05 m
Insurance & Bonding	1.4%	Compost	0.3 tonnes/m3
Field Engineering, QA & Surveying	7.0%	Compost Cost	81 $/m3
Mob & Demob	5.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3
Living Allowances	8.0%	Unit Weight Over Excavated Material	1.2 tonnes/m3
Taxes	7.0%	Percent by Volume of Tails in OverEx Material	75%
Contingency	0.0%		

Alt-2B Clear and Grub Borrow Area to Stockpile					Cost	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	325 Excavator 76 m^3/hr
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$138,570.71
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$138,570.71**

$290,044.76

Alt-2B Reclaim Borrow Area By Replacing Stockpile					Cost	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	Seed, Fertilizer, Spreading (m^2)
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$102,852.75
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$102,852.75**

$254,326.80

Alt-2B Tailings & Over Excavation To Be Relocated					**Cost**				
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 276 m^3/hr	740 Truck 133 m^3/hr	980 Loader 240 m^3/hr
Elsa Hillside Area	70,192	70,192	35,096	69,139	$94,758.75	$19,302.71	$24,216.13	$61,066.75	
Relocated Tailings Area	296,295	296,295	337,273	664,427	$910,636.02	$185,499.93		$586,854.32	$347,390.78
Pond 2	10,850	10,850	5,425	10,687	$14,647.50	$2,983.75	$1,871.63	$9,439.50	$5,587.75
Pond 3	38,820	38,820	11,646	22,943	$31,444.20	$6,405.30	$4,017.87	$20,264.04	$11,995.38
Over Excavation	296,295	296,295	148,148	177,777	$399,998.25	$81,481.13		$257,776.65	$152,591.93
Totals	**712,452**	**712,452**	**537,587**	**944,973**	**$1,451,484.72**	**$295,672.81**	**$30,105.62**	**$935,401.26**	**$517,565.83**

$3,230,230.24

Alt-2B Revegetation Cover, Reseed, Fertilize					**Cost**			
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	740 Truck 70 m^3/hr	D6 Dozer 320 m^3/hr	Seed, Fertilizer, Spreading (m^2)
Elsa Hillside Area	70,192	70,192	21,058	31,586	$14,529.68	$70,121.48	$11,581.63	$38,605.42
Relocated Tailings Area	296,295	296,295	88,889	133,333	$61,333.07	$295,998.71	$48,888.68	$162,962.25
Consolidation Tailings Area	158,922	158,922	158,922	238,383	$109,656.18	$529,210.26	$87,407.10	$87,407.10
Tailings Not Disturbed Area	175,124	175,124	175,124	262,686	$120,835.56	$583,162.92	$96,318.20	$96,318.20
Fill Ponds	152,065	152,065	304,130	456,195	$209,849.70	$1,012,752.90	$167,271.50	$83,635.75
Totals	**852,598**	**852,598**	**748,122**	**1,122,183**	**$516,204.18**	**$2,491,246.26**	**$411,467.10**	**$468,928.72**

$3,887,846.26

Alt-2B Diversion Channels				**Cost**					
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)
Northern Diversion Channel	3,086	176,366	9,987	$121,692.54	$8,388.66	$24,666.67	$33,255.06	$37,948.72	$93,323.90
Southern Diversion Channel	1,843	42,630	8,025	$29,414.70	$6,740.67	$19,820.79	$26,721.95	$30,493.52	$74,989.98
Sediment Pond	350	350	350		$294.00	$864.50	$1,165.50	$1,330.00	$3,270.75
Totals	**5,279**	**219,346**	**18,361**	**$151,107.24**	**$15,423.34**	**$45,351.96**	**$61,142.52**	**$69,772.24**	**$171,584.63**

$514,381.91

Alt-2B Channel Rehab					**Cost**						
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen (m^3)
Porcupine Creek	1,018	12,888	9,738	12,681	$8,892.72	$8,179.92	$24,052.86	$32,427.54	$37,004.40	$63,405.00	$91,001.61
No Cash Diversion	1,902	14,964	9,938	18,878	$10,325.16	$8,347.92	$24,546.86	$33,093.54	$37,764.40	$94,390.00	$92,870.61
Totals	**2,920**	**27,852**	**19,676**	**31,559**	**$19,217.88**	**$16,527.84**	**$48,599.72**	**$65,521.08**	**$74,768.80**	**$157,795.00**	**$183,872.22**

$566,302.54

Alt-2B Lime Added							**Cost**	
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application
Elsa Hillside Area	70,192	70,192	35,096	54,399	326,391	326	$212,154.31	$35,095.83
Relocated Tailings Area	296,295	296,295	337,273	522,773	3,136,635	3,137	$2,038,812.86	$337,272.60
Tailings Not Disturbed Area	327,189	327,189	327,189	507,143	3,042,858	3,043	$1,977,857.51	$327,189.00
Pond 2 Relocated Unsubmerged	10,850	10,850	5,425	8,409	50,453	50	$32,794.13	$5,425.00
Pond 3 Relocated Unsubmerged	38,820	38,820	11,646	18,051	108,308	108	$70,400.07	$11,646.00
Over Excavated Area	296,295	296,295	148,148	172,221	1,033,329	1,033	$671,663.73	$148,147.50
Totals	**1,039,641**	**1,039,641**	**864,776**	**1,282,996**	**7,697,973**	**7,698**	**$5,003,682.60**	**$864,775.93**

$5,868,458.53

Alt-2B Water Treatment		**Cost**
Description	Quantity	Unit
Treat Water Plant	1	$300,000.00
Treat Water (m3/day)	267	$243,637.50
Totals		**$543,637.50**

$543,637.50

Alt-2B Dam Demo					**Cost**					
Areas	Length (m)	Area (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)
Dam 1	5	45	225	472.5	$155.25	$396.90	$1,167.08	$1,573.43	$1,795.50	$4,415.51
Dam 2	5	45	225	472.5	$155.25	$396.90	$1,167.08	$1,573.43	$1,795.50	$4,415.51
Dam 2	5	45	225	472.5	$155.25	$396.90	$1,167.08	$1,573.43	$1,795.50	$4,415.51
Totals	**15**	**135**	**675**	**1,418**	**$465.75**	**$1,190.70**	**$3,501.23**	**$4,720.28**	**$5,386.50**	**$13,246.54**

$28,510.99

Alt-2B Compost		**Cost**
Description	Compost (m3)	Compost Cost
Compost	42,630	$3,453,020.55
Totals	**42,630**	**$3,453,020.55**

$3,453,020.55

Alt-2B Manpower		**Cost**
Description	Quantity	Unit
Labor		$352,000.00
Monitoring for 5 years		$250,000.00
Totals		**$602,000.00**

$602,000.00

Alt-2B Contingency			**Cost**
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$19,238,760.08	$0.00
Totals	**0.0%**	**19,238,760**	**$0.00**

Alt-2B Closure Indirect Costs			**Cost**
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$19,238,760.08	$1,346,713.21
Profit & Overhead	10.0%	$19,238,760.08	$1,923,876.01
Insurance & Bonding	1.4%	$19,238,760.08	$269,342.64
Field Engineering, QA & Surveying	7.0%	$19,238,760.08	$1,346,713.21
Mob & Demob	5.0%	$19,238,760.08	$961,938.00
Living Allowances	8.0%	$19,238,760.08	$1,539,100.81
Taxes	7.0%	$19,238,760.08	$1,346,713.21
Totals			**$8,734,397.07**

Direct Cost	**$19,238,760.08**
Indirect Cost	**$8,734,397.07**
Total Direct & Indirect	**$27,973,157.15**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$27,973,157.15**

Valley Tailings Reclamation - Does NOT include Dispersed Tailings Downgradient of Tailings Impoundment
03/03/2011 (Lime pricing updated Dec 2012)
CLW

Alternative 3 - Tailings Relocation to a Newly Constructed Facility

Assumptions

Insitu Unit Weight Tails	1.97	tonnes/m3	Lime Added	6	kg/tonnes
Unit Weight of Borrow Material	1.5	tonnes/m3	Lime	650	$/tonnes
Unit Weight of Diversion Material	1.5	tonnes/m3	Northern Channel Riprap Depth	0.5	m
Est. Coefficient for 3D Surface Relocated & Undisturbed Are	1		Southern Channel Riprap Depth	0.5	m
Est. Coefficient for 3D Surface Consolidated Area	1		Porcupine Creek	0.5	m
Cover Thickness Over Tails	1	m	Blasting	0.4	$/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3	m	Water Treatment Plant	300,000	$
Depth of Tailings to be Relocated (Elsa Hillside)	0.5	m	Water Treatment	0.5	$/m3
Stripping Depth	0.3	m	Rip Rap Weight	2.1	tonnes/m3
Unit Weight of Stripping Material	1	tonnes/m3	Filter Fabric	5	$/m2 for $1.5 to buy, $3.5 to place
Pond 2 Unsubmerged Tailings	0.5	m	Seed, Fertilizer, Spreading (m^2)	0.55	$/m2 for $0.55 Seed/Fertilizer
Pond 3 Unsubmerged Tailings	0.3	m	Lime Application (m^3)	1	$/m3
Depth To Overexcavate Under Tailings	0.5	m	Unit Weight Over Excavated Material	1.2	tonnes/m3
Depth of Water in Ponds (Fill for Option 2b)	2	m	Unit Weight of Relocated pumped Tails	1.76	tonnes/m3
Depth of Undisturbed Tailings	1	m	Freeboard Volume Percentage	15.00%	
Project Management & Field Supervision	7.0%		Crush & Screen (m^3)	4.45	$/tonnes
Profit & Overhead	10.0%		Compost Depth	0.05	m
Insurance & Bonding	1.4%		Compost	0.3	tonnes/m3
Field Engineering, QA & Surveying	7.0%		Compost Cost	81	$/m3
Mob & Demob	5.0%		Tailings Dry Weight For Lime	1.55	tonnes/m3
Living Allowances	8.0%		Unit Weight Over Excavated Material	1.2	tonnes/m3
Taxes	7.0%		Percent by Volume of Tails in OverEx Material	75%	
Contingency	0.0%				

Alt-3 Clear and Grub Borrow Area to Stockpile					Cost		
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	325 Excavator 76 m^3/hr	
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$138,570.71	
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$138,570.71**	**$290,044.76**

Alt-3 Reclaim Borrow Area By Replacing Stockpile					Cost		
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	Seed, Fertilizer, Spreading (m^2)	
Borrow Area	187,005	187,005	56,102	56,102	$151,474.05	$102,852.75	
Totals	**187,005**	**187,005**	**56,102**	**56,102**	**$151,474.05**	**$102,852.75**	**$254,326.80**

Alt-3 Tailings & Over Excavation To Be Relocated					Cost					
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 276 m^3/hr	740 Truck 133 m^3/hr	980 Loader 240 m^3/hr	
Elsa Hillside Area	70,192	70,192	35,096	69,139	$94,758.75	$19,302.71	$24,216.13	$61,066.75		
Relocated Shallow Tailings Area	284,362	284,362	308,938	608,608	$834,132.60	$169,915.90	$106,583.61	$537,552.12	$318,206.14	
Relocated Deep Tailings Area (1 m thick haul)	324,010	324,010	324,010	638,300	$874,827.00	$178,205.50	$111,783.45	$563,777.40	$333,730.30	
Pond 2	10,850	10,850	5,425	10,687	$14,647.50	$2,983.75	$1,871.63	$9,439.50		
Pond 3	38,820	38,820	11,646	22,943	$31,444.20	$6,405.30	$4,017.87	$20,264.04	$11,995.38	
Over Excavation	814,456	814,456	407,228	488,674	$1,099,515.60	$223,975.40		$708,576.72	$419,444.84	
Totals	**1,542,690**	**1,542,690**	**1,092,343**	**1,838,350**	**$2,949,325.65**	**$600,788.56**	**$248,472.68**	**$1,900,676.53**	**$1,083,376.66**	**$6,782,640.08**

Alt-3 Revegetation Cover, Reseed, Fertilize					Cost				
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	325 Excavator 276 m^3/hr	740 Truck 70 m^3/hr	D6 Dozer 320 m^3/hr	Seed, Fertilizer, Spreading (m^2)	
Elsa Hillside Area	70,192	70,192	21,058	31,586	$14,529.68	$70,121.48	$11,581.63	$38,605.42	
Relocated Shallow Tailings Area	284,362	284,362	85,309	127,963	$58,862.93	$284,077.64	$46,919.73	$156,399.10	
Relocated Deep Tailings Area (1 m thick haul)	324,010	324,010	97,203	145,805	$67,070.07	$323,685.99	$53,461.65	$178,205.50	
Fill Ponds	152,065	152,065	45,620	68,429	$31,477.46	$151,912.94	$25,090.73	$83,635.75	
Dry Tails On Liner Area	76,000	76,000	76,000	114,000	$52,440.00	$253,080.00	$41,800.00	$41,800.00	
Wet Tails Pumped To Pond Area	190,000	190,000	190,000	285,000	$131,100.00	$632,700.00	$104,500.00	$104,500.00	
Pond Berm			170,922	256,383	$117,936.18	$569,170.26	$94,007.10		
Totals	**1,096,629**	**1,096,629**	**686,111**	**1,029,166**	**$473,416.31**	**$2,284,748.30**	**$377,360.83**	**$603,145.77**	**$3,738,671.21**

Alt-3 Diversion Channels				Cost						
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Crush & Screen (m^3)	
Northern Diversion Channe	1,607	176,366	5,200	$121,692.54	$4,368.30	$12,844.89	$17,317.20	$19,761.37	$48,597.38	
Southern Diversion Channe	1,690	42,630	7,358	$29,414.70	$6,181.08	$18,175.33	$24,503.58	$27,962.04	$68,764.55	
Sediment Pond	100	100	100		$84.00	$247.00	$333.00	$380.00	$934.50	
Totals	**3,397**	**219,096**	**12,659**	**$151,107.24**	**$10,633.39**	**$31,267.22**	**$42,153.78**	**$48,103.42**	**$118,296.43**	**$401,561.47**

Alt-3 Channel Rehab					Cost							
Channel	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 276 m^3/hr	Blasting	325 Excavator 76 m^3/hr	740 Truck 70 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen (m^3)	
Porcupine Creek	1,018	12,888	9,738	12,681	$8,892.72	$8,179.92	$24,052.86	$32,427.54	$37,004.40	$63,405.00	$91,001.61	
No Cash Diversion	1,902	14,964	9,938	18,878	$10,325.16	$8,347.92	$24,546.86	$33,093.54	$37,764.40	$94,390.00	$92,870.61	
Totals	**2,920**	**27,852**	**19,676**	**31,559**	**$19,217.88**	**$16,527.84**	**$48,599.72**	**$65,521.08**	**$74,768.80**	**$157,795.00**	**$183,872.22**	**$566,302.54**

Alt-3 Lime Added							Cost		
Areas	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	
Elsa Hillside Area	70,192	70,192	35,096	54,399	326,391	326	$212,154.31	$35,095.83	
Relocated Shallow Tailings Area	284,362	284,362	323,689	501,718	3,010,310	3,010	$1,956,701.60	$323,689.26	
Relocated Deep Tailings Area (1 m thick haul)	324,010	324,010	324,010	502,216	3,013,293	3,013	$1,958,640.45	$324,010.00	
Pond 2 Relocated Unsubmerged	10,850	10,850	5,425	8,409	50,453	50	$32,794.13	$5,425.00	
Pond 3 Relocated Unsubmerged	38,820	38,820	11,646	18,051	108,308	108	$70,400.07	$11,646.00	
Over Excavated Area	814,456	814,456	407,228	631,203	3,787,220	3,787	$2,461,693.26	$407,228.00	
Deep Tails Pumped	582,985	582,985	582,985	903,627	5,421,761	5,422	$3,524,144.33	$582,985.00	
Pond 1 Pumped Tails	67,440	67,440	243,850	377,968	2,267,805	2,268	$1,474,073.25	$243,850.00	
Pond 2 Pumped Tails	33,374	33,374	37,562	58,221	349,327	349	$227,062.29	$37,562.00	
Pond 3 Pumped Tails	55,600	55,600	3,746	4,355	26,128	26	$16,983.43	$3,746.00	
Totals	**2,282,089**	**2,282,089**	**1,975,237**	**3,060,166**	**18,360,996**	**18,361**	**$11,934,647.11**	**$1,975,237.10**	**$13,909,884.21**

Alt-3 Water Treatment		Cost	
Description	Quantity	Unit	
Treat Water Plant	1	$300,000.00	
Treat Water (m3/day)	267	$243,637.50	
Totals		**$543,637.50**	**$543,637.50**

Alt-3 Dam Demo					Cost	
Areas	Length (m)	Area (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 520 m^3/hr	
Dam 1	400	25	10,000	21,000	$6,200.00	
Dam 2	400	38	15,200	31,920	$9,424.00	
Dam 2	450	47	21,150	44,415	$13,113.00	
Totals	**1,250**	**110**	**46,350**	**97,335**	**$28,737.00**	**$28,737.00**

Alt-3 Compost		Cost	
Description	Compost (m3)	Compost Cost	
Compost	54,831	$4,441,346.10	
Totals	**54,831**	**$4,441,346.10**	**$4,441,346.10**

Alt-3 Submerged Tailings Pumping	Cost			
Description	Power	Manpower	Sum	
Flump & Dredge	$25,940.00	$2,275,920.00		
Pump from Tank to Thickener	$78,615.00	$439,920.00		
Pump from Thickener to Pond	$57,381.00	$439,920.00		
Pump from Pond to Water Treatment	$25,135.00	$439,920.00		
Pump from Thickener to Water Treatment	$259,759.00	$439,920.00		
Water to be treated			$384,132.68	
Flump			$80,000.00	
Thickener			$50,000.00	
Pipeline to thickener			$100,000.00	
Pipeline from thickener to pond			$100,000.00	
Water Treatment Plant			$300,000.00	
Liner (pond & stockpile)			$2,112,784.00	
Pipe cost			$561,360.00	
Dredge			$100,000.00	
Labor		$352,000.00		
Monitoring for 5 years		$250,000.00		
Totals	**$446,830.00**	**$4,637,600.00**	**$3,788,276.68**	**$8,872,706.68**

Alt-3 Contingency			Cost
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$39,829,858.35	$0.00
Totals	**0%**	**$39,829,858.35**	**$0.00**

Alt-3 Closure Indirect Costs			Cost
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$39,829,858.35	$2,788,090.08
Profit & Overhead	10.0%	$39,829,858.35	$3,982,985.83
Insurance & Bonding	1.4%	$39,829,858.35	$557,618.02
Field Engineering, QA & Surveying	7.0%	$39,829,858.35	$2,788,090.08
Mob & Demob	5.0%	$39,829,858.35	$1,991,492.92
Living Allowances	8.0%	$39,829,858.35	$3,186,388.67
Taxes	7.0%	$39,829,858.35	$2,788,090.08
Totals			**$18,082,755.69**

Direct Cost	**$39,829,858.35**
Indirect Cost	**$18,082,755.69**
Total Direct & Indirect	**$57,912,614.04**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$57,912,614.04**

Wernecke Tailings Reclamation
3/3/2011 (Lime costing updated and dispersed tailings added Dec. 2012)
CLW / JAT

Mackeno Tailings - Consolidate, Stabilize, Cover, Creek Rehab, Lime

Assumptions

Insitu Unit Weight Tails	1.8 tonnes/m3	Lime Added	6 kg/tonnes
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	650 $/tonnes
Unit Weight of Diversion Material	1.5 tonnes/m3	Northern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1	Southern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Consolidated Area	1	Porcupine Creek	0.5 m
Tailings Depth	1 m	Blasting	0.4 $/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment Plant	300,000 $
Depth of Tailings Relocated (Elsa Hillside) 1/10th of Total Area	0.5 m	Water Treatment	0.5 $/m3
Stripping Depth	0.3 m	Rip Rap Weight	2.1 tonnes/m3
Unit Weight of Stripping Material	1 tonnes/m3	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place
Project Management & Field Supervision	7.0%	Seed, Fertilizer, Spreading	0.55 $/m2 for $0.55 Seed/Fertilizer
Profit & Overhead	10.0%	Lime Application	1 $/m3
Insurance & Bonding	1.4%	Crush & Screen	4.45 $/tonnes
Field Engineering, QA & Surveying	7.0%	Organics Depth	0.05 m
Mob & Demob	5.0%	Organics Weight	0.3 tonnes/m3
Living Allowances	8.0%	Organics Cost	81 $/m3
Taxes	7.0%	Over Excavation	0.5 m
Contingency	0.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3
Creek Rehab Area	1 m2	Unit Weight Over Excavated Material	1.2 tonnes/m3
		Percent by Volume of Tails in OverEx Material	75%

Wernecke Tailings - Borrow For Cover In Place					Cost						
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 27 m^3/hr	980 Loader 240 m^3/hr	Seed, Fertilizer, Spreading	
Wernecke Tailings	946	946	1,159	2,086	$3,129.30	$637.45	$1,431.37	$10,013.76	$596.89	$520.30	
Totals	**946**	**946**	**1,159**	**2,086**	**$3,129.30**	**$637.45**	**$1,431.37**	**$10,013.76**	**$596.89**	**$520.30**	$16,329.06

Wernecke Tailings - Creek Rehab					Cost						
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen	
Christal Creek	500	1,500	225	1,500	$5,700.00	$189.00	$1,944.00	$855.00	$7,500.00	$2,102.63	
Totals	**500**	**1,500**	**225**	**1,500**	**$5,700.00**	**$189.00**	**$1,944.00**	**$855.00**	**$7,500.00**	**$2,102.63**	$18,290.63

Wernecke Tailings - Lime Added							Cost		
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	
Wernecke Tailings	946	946	1,159	2,086	12,517	13	$8,136.18	$946.00	
Totals	**946**	**946**	**1,159**	**2,086**	**12,517**	**13**	**$8,136.18**	**$946.00**	$9,082.18

Wernecke Tailings - Organics		Cost	
Description	Organics (m3)	Organics Cost	
Compost	47	$3,831.30	
Totals	**47**	**$3,831.30**	$3,831.30

Wernecke Tailings - Site Access		Cost	
Description	Qty	Lump Sum	
Access Road Rehab	1	$7,000.00	
Totals	**1**	**$7,000.00**	$7,000.00

Alt-1 Contingency			Cost
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$54,533.17	$0.00
Totals		**$54,533.17**	**$0.00**

Alt-1 Closure Indirect Costs			Cost
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$54,533.17	$3,817.32
Profit & Overhead	10.0%	$54,533.17	$5,453.32
Insurance & Bonding	1.4%	$54,533.17	$763.46
Field Engineering, QA & Surveying	7.0%	$54,533.17	$3,817.32
Mob & Demob	5.0%	$54,533.17	$2,726.66
Living Allowances	8.0%	$54,533.17	$4,362.65
Taxes	7.0%	$54,533.17	$3,817.32
Totals			**$24,758.06**

Main Tailings Mass

Direct Cost	**$54,533.17**
Indirect Cost	**$24,758.06**
Total Direct & Indirect	**$79,291.22**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$79,291.22**
Dispersed Tailings (Direct, Indirect)	**$15,950**

Wernecke Tailings Reclamation
3/3/2011 (Lime costing updated and dispersed tailings added Dec. 2012)
CLW / JAT

Mackeno Tailings - Consolidate, Stabilize, Cover, Creek Rehab, Lime

Assumptions

Insitu Unit Weight Tails	1.8 tonnes/m3	Lime Added	6 kg/tonnes
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	650 $/tonnes
Unit Weight of Diversion Material	1.5 tonnes/m3	Northern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1	Southern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Consolidated Area	1	Porcupine Creek	0.5 m
Tailings Depth	1 m	Blasting	0.4 $/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment Plant	300,000 $
Depth of Tailings Relocated (Elsa Hillside) 1/10th of Total Area	0.5 m	Water Treatment	0.5 $/m3
Stripping Depth	0.3 m	Rip Rap Weight	2.1 tonnes/m3
Unit Weight of Stripping Material	1 tonnes/m3	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place
Project Management & Field Supervision	7.0%	Seed, Fertilizer, Spreading	0.55 $/m2 for $0.55 Seed/Fertilizer
Profit & Overhead	10.0%	Lime Application	1 $/m3
Insurance & Bonding	1.4%	Crush & Screen	4.45 $/tonnes
Field Engineering, QA & Surveying	7.0%	Organics Depth	0.05 m
Mob & Demob	5.0%	Organics Weight	0.3 tonnes/m3
Living Allowances	8.0%	Organics Cost	81 $/m3
Taxes	7.0%	Over Excavation	0.5 m
Contingency	0.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3
Creek Rehab Area	1 m2	Unit Weight Over Excavated Material	1.2 tonnes/m3
		Percent by Volume of Tails in OverEx Material	75%

Wernecke Tailings - Borrow For Cover In Place					Cost					
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 27 m^3/hr	980 Loader 240 m^3/hr	Seed, Fertilizer, Spreading
Wernecke Tailings	946	946	1,159	2,086	$3,129.30	$637.45	$1,431.37	$10,013.76	$596.89	$520.30
Totals	**946**	**946**	**1,159**	**2,086**	**$3,129.30**	**$637.45**	**$1,431.37**	**$10,013.76**	**$596.89**	**$520.30**

$16,329.06

Wernecke Tailings - Creek Rehab					Cost					
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen
Christal Creek	500	1,500	225	1,500	$5,700.00	$189.00	$1,944.00	$855.00	$7,500.00	$2,102.63
Totals	**500**	**1,500**	**225**	**1,500**	**$5,700.00**	**$189.00**	**$1,944.00**	**$855.00**	**$7,500.00**	**$2,102.63**

$18,290.63

Wernecke Tailings - Lime Added							Cost	
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application
Wernecke Tailings	946	946	1,159	2,086	12,517	13	$8,136.18	$946.00
Drainage Creek	1,500	1,500	1,500	2,700	16,200	16	$10,530.00	$1,500.00
Totals	**2,446**	**2,446**	**2,659**	**4,786**	**28,717**	**29**	**$18,666.18**	**$2,446.00**

$21,112.18

Wernecke Tailings - Organics		Cost
Description	Organics (m3)	Organics Cost
Compost	47	$3,831.30
Totals	**47**	**$3,831.30**

$3,831.30

Wernecke Tailings - Relocate Tails At Drainage Creek		Cost	
Description	Tailings (m3)	325 Excavator 22 m^3/hr	740 Truck 46 m^3/hr
Drainage Creek	1,500	$12,525.00	$7,500.00
Totals	**1500**	**$12,525.00**	**$7,500.00**

$20,025.00

Wernecke Tailings - Site Access		Cost
Description	Qty	Lump Sum
Access Road Rehab	1	$7,000.00
Totals	**1**	**$7,000.00**

$7,000.00

Alt-1 Contingency			Cost
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$86,588.17	$0.00
Totals		**$86,588.17**	**$0.00**

Alt-1 Closure Indirect Costs			Cost
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$86,588.17	$6,061.17
Profit & Overhead	10.0%	$86,588.17	$8,658.82
Insurance & Bonding	1.4%	$86,588.17	$1,212.23
Field Engineering, QA & Surveying	7.0%	$86,588.17	$6,061.17
Mob & Demob	5.0%	$86,588.17	$4,329.41
Living Allowances	8.0%	$86,588.17	$6,927.05
Taxes	7.0%	$86,588.17	$6,061.17
Totals			**$39,311.03**

Main Tailings Mass

Direct Cost	**$86,588.17**
Indirect Cost	**$39,311.03**
Total Direct & Indirect	**$125,899.19**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$125,899.19**

Dispersed Tailings (Direct, Indirect)	**$15,950**

Wernecke Tailings Reclamation
3/3/2011 (Lime costing updated and dispersed tailings added Dec. 2012)
CLW / JAT

Mackeno Tailings

Assumptions

Insitu Unit Weight Tails	1.8 tonnes/m3	Lime Added	6 kg/tonnes	
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	650 $/tonnes	Adjust up from $500/tonne based on S.D. calcs for Onek delivered lime ($620/tonne)
Unit Weight of Diversion Material	1.5 tonnes/m3	Northern Channel Riprap Depth	0.5 m	
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1	Southern Channel Riprap Depth	0.5 m	
Est. Coefficient for 3D Surface Consolidated Area	1	Porcupine Creek	0.5 m	
Tailings Depth	1 m	Blasting	0.4 $/tonnes	
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment Plant	300,000 $	
Depth of Tailings Relocated (Elsa Hillside) 1/10th of Total Area	0.5 m	Water Treatment	0.5 $/m3	
Stripping Depth	0.3 m	Rip Rap Weight	2.1 tonnes/m3	
Unit Weight of Stripping Material	1 tonnes/m3	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place	
Project Management & Field Supervision	7.0%	Seed, Fertilizer, Spreading	0.55 $/m2 for $0.55 Seed/Fertilizer	
Profit & Overhead	10.0%	Lime Application	1 $/m3	
Insurance & Bonding	1.4%	Crush & Screen	4.45 $/tonnes	
Field Engineering, QA & Surveying	7.0%	Organics Depth	0.05 m	
Mob & Demob	5.0%	Organics Weight	0.3 tonnes/m3	
Living Allowances	8.0%	Organics Cost	81 $/m3	
Taxes	7.0%	Over Excavation	0.5 m	
Contingency	0.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3	
Creek Rehab Area	1 m2	Unit Weight Over Excavated Material	1.2 tonnes/m3	
		Percent by Volume of Tails in OverEx Material	75%	

Makeno Tailings - Relocate Tailings					Cost					
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 9 m^3/hr	980 Loader 240 m^3/hr	
Mackeno Tailings	946	946	1,159	2,086	$3,129.30	$637.45	$1,431.37	$30,388.98	$596.89	
Totals	**946**	**946**	**1,159**	**2,086**	**$3,129.30**	**$637.45**	**$1,431.37**	**$30,388.98**	**$596.89**	$36,183.98

Mackeno Tailings - Creek Rehab					Cost						
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen	
Christal Creek	500	1,500	225	1,500	$5,700.00	$189.00	$1,944.00	$855.00	$7,500.00	$2,102.63	
Totals	**500**	**1,500**	**225**	**1,500**	**$5,700.00**	**$189.00**	**$1,944.00**	**$855.00**	**$7,500.00**	**$2,102.63**	$18,290.63

Wernecke Tailings - Lime Added							Cost		
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	
Wernecke Tailings	946	946	1,159	2,086	12,517	13	$8,136.18	$946.00	
Drainage Creek	1,500	1,500	1,500	2,700	16,200	16	$10,530.00	$1,500.00	
Totals	**2,446**	**2,446**	**2,659**	**4,786**	**28,717**	**29**	**$18,666.18**	**$2,446.00**	$21,112.18

Wernecke Tailings - Relocate Tails At Drainage Creek		Cost		
Description	Tailings (m3)	325 Excavator 22 m^3/hr	740 Truck 27 m^3/hr	
Drainage Creek	1,500	$12,525.00	$12,960.00	
Totals	**1500**	**$12,525.00**	**$12,960.00**	$25,485.00

Wernecke Tailings - Site Access		Cost	
Description	Qty	Lump Sum	
Access Road Rehab	1	$7,000.00	
Totals	**1**	**$7,000.00**	$7,000.00

Alt-1 Contingency	Cost

Mackeno Tailings Reclamation
3/3/2011 (Lime pricing updated and dispersed tailings added Dec. 2012)
CLW / JAT

Mackeno Tailings - Consolidate, Stabilize, Cover, Creek Rehab, Lime

Assumptions

Insitu Unit Weight Tails	1.8	tonnes/m3	Lime Added	6	kg/tonnes
Unit Weight of Borrow Material	1.5	tonnes/m3	Lime	650	$/tonnes
Unit Weight of Diversion Material	1.5	tonnes/m3	Northern Channel Riprap Depth	0.5	m
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1		Southern Channel Riprap Depth	0.5	m
Est. Coefficient for 3D Surface Consolidated Area	1		Porcupine Creek	0.5	m
Tailings Depth	1	m	Blasting	0.4	$/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3	m	Water Treatment Plant	300,000	$
Depth of Tailings Relocated (Elsa Hillside) 1/10th of Total Area	0.5	m	Water Treatment	0.5	$/m3
Stripping Depth	0.3	m	Rip Rap Weight	2.1	tonnes/m3
Unit Weight of Stripping Material	1	tonnes/m3	Filter Fabric	5	$/m2 for $1.5 to buy, $3.5 to place
Project Management & Field Supervision	7.0%		Seed, Fertilizer, Spreading	0.6	$/m2 for $0.55 Seed/Fertilizer
Profit & Overhead	10.0%		Lime Application	1	$/m3
Insurance & Bonding	1.4%		Crush & Screen	4.45	$/tonnes
Field Engineering, QA & Surveying	7.0%		Organics Depth	0.05	m
Mob & Demob	5.0%		Organics Weight	0.3	tonnes/m3
Living Allowances	8.0%		Organics Cost	81	$/m3
Taxes	7.0%		Over Excavation	0.5	m
Contingency	0.0%		Tailings Dry Weight For Lime	1.55	tonnes/m3
Creek Rehab Area	1	m2	Unit Weight Over Excavated Material	1.2	tonnes/m3
			Percent by Volume of Tails in OverEx Material	75%	

Makeno Tailings - Borrow For Cover In Place					Cost						
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 27 m^3/hr	980 Loader 240 m^3/hr	Seed, Fertilizer, Spreading	
Mackeno Tailings	5,463	5,463	5,463	8,440	$14,750.10	$3,004.65	$6,746.81	$47,200.32	$2,813.45	$3,277.80	
Christal Creek	100	100	100	180		$55.00	$123.50				
Totals	**5,563**	**5,563**	**5,563**	**8,620**	**$14,750.10**	**$3,059.65**	**$6,870.31**	**$47,200.32**	**$2,813.45**	**$3,277.80**	$77,971.62

Mackeno Tailings - Creek Rehab					Cost						
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen	
Christal Creek	192	192	59	384	$729.60	$49.56	$509.76	$224.20	$1,920.00	$551.36	
Totals	**192**	**192**	**59**	**384**	**$729.60**	**$49.56**	**$509.76**	**$224.20**	**$1,920.00**	**$551.36**	$3,984.48

Mackeno Tailings - Lime Added							Cost		
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	
Mackeno Tailings	5,463	5,463	4,689	8,440	50,640	51	$32,916.00	$5,463.00	
Totals	**5,463**	**5,463**	**4,689**	**8,440**	**50,640**	**51**	**$32,916.00**	**$5,463.00**	$38,379.00

Mackeno Tailings - Organics		**Cost**	
Description	Organics (m3)	Organics Cost	
Compost	273	$22,125.15	
Totals	**273**	**$22,125.15**	$22,125.15

Mackeno Tailings - Relocate Tails At Head Of Christal Creek		**Cost**	
Description	Qty	Lump Sum	
Head Of Christal Creek	1	$15,300.00	
Totals	**1**	**$15,300.00**	$15,300.00

Mackeno Tailings - Site Access		**Cost**	
Description	Qty	Lump Sum	
Access Road Rehab	1	$7,000.00	
Totals	**1**	**$7,000.00**	$7,000.00

Alt-1 Contingency			**Cost**
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$164,760.25	$0.00
Totals		**$164,760.25**	**$0.00**

Alt-1 Closure Indirect Costs			**Cost**
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$164,760.25	$11,533.22
Profit & Overhead	10.0%	$164,760.25	$16,476.02
Insurance & Bonding	1.4%	$164,760.25	$2,306.64
Field Engineering, QA & Surveying	7.0%	$164,760.25	$11,533.22
Mob & Demob	5.0%	$164,760.25	$8,238.01
Living Allowances	8.0%	$164,760.25	$13,180.82
Taxes	7.0%	$164,760.25	$11,533.22
Totals			**$74,801.15**

Main Tailings Mass	
Direct Cost	**$164,760.25**
Indirect Cost	**$74,801.15**
Total Direct & Indirect	**$239,561.40**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$239,561.40**
Dispersed/Subaqueous Tailings	**$110,925**

ADDITIONAL COSTS (Associated with Dispersed Tailings)

Mackeno Tailings Reclamation
3/3/2011 (Lime pricing updated and dispersed tailings added Dec. 2012)
CLW / JAT

Mackeno Tailings Reclamation - Relocate Tailings, Stabilize

Assumptions

Insitu Unit Weight Tails	1.8 tonnes/m3	Lime Added	6 kg/tonnes
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	500 $/tonnes
Unit Weight of Diversion Material	1.5 tonnes/m3	Northern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1	Southern Channel Riprap Depth	0.5 m
Est. Coefficient for 3D Surface Consolidated Area	1	Porcupine Creek	0.5 m
Tailings Depth	1 m	Blasting	0.4 $/tonnes
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment Plant	300,000 $
Depth of Tailings Relocated (Elsa Hillside) 1/10th of Total Area	0.5 m	Water Treatment	0.5 $/m3
Stripping Depth	0.3 m	Rip Rap Weight	2.1 tonnes/m3
Unit Weight of Stripping Material	1 tonnes/m3	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place
Project Management & Field Supervision	7.0%	Seed, Fertilizer, Spreading	0.55 $/m2 for $0.55 Seed/Fertilizer
Profit & Overhead	10.0%	Lime Application	1 $/m3
Insurance & Bonding	1.4%	Crush & Screen	4.45 $/tonnes
Field Engineering, QA & Surveying	7.0%	Organics Depth	0.05 m
Mob & Demob	5.0%	Organics Weight	0.3 tonnes/m3
Living Allowances	8.0%	Organics Cost	81 $/m3
Taxes	7.0%	Over Excavation	0.5 m
Contingency	0.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3
Creek Rehab Area	1 m2	Unit Weight Over Excavated Material	1.2 tonnes/m3
		Percent by Volume of Tails in OverEx Material	75%

Makeno Tailings - Relocate Tailings					Cost					
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 14 m^3/hr	980 Loader 240 m^3/hr	
Mackeno Tailings	5,463	5,463	4,689	8,440	$12,660.30	$2,578.95	$11,581.83	$78,868.98	$4,829.67	
Totals	**5,463**	**5,463**	**4,689**	**8,440**	**$12,660.30**	**$2,578.95**	**$11,581.83**	**$78,868.98**	**$4,829.67**	$110,519.73

Mackeno Tailings - Creek Rehab					Cost						
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen	
Christal Creek	192	192	59	384	$729.60	$49.56	$509.76	$224.20	$1,920.00	$551.36	
Totals	**192**	**192**	**59**	**384**	**$729.60**	**$49.56**	**$509.76**	**$224.20**	**$1,920.00**	**$551.36**	$3,984.48

Mackeno Tailings - Lime Added							Cost		
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	
Mackeno Tailings	5,463	5,463	4,689	8,440	50,640	51	$25,320.00	$5,463.00	
Totals	**5,463**	**5,463**	**4,689**	**8,440**	**50,640**	**51**	**$25,320.00**	**$5,463.00**	$30,783.00

Mackeno Tailings - Relocate Tails At Head Of Christal Creek		**Cost**	
Description	Qty	Lump Sum	
Head Of Christal Creek	1	$15,300.00	
Totals	**1**	**$15,300.00**	$15,300.00

Mackeno Tailings - Site Access		**Cost**	
Description	Qty	Lump Sum	
Access Road Rehab	1	$7,000.00	
Totals	**1**	**$7,000.00**	$7,000.00

Alt-2 Contingency			**Cost**
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$167,587.21	$0.00
Totals		**$167,587.21**	**$0.00**

Alt-2 Closure Indirect Costs			**Cost**
Description	Percent	Direct Costs	

The metal(loid) removal efficiency for the water treatment plants operating at the adits of Silver King 100 (Jun 2006 – Sep 2013), Galkeno 300 (Jan 2010 – Sep 2013), and Galkeno 900 (Jul 2005 – Sep 2013) are shown in the table below. Due to improvements implemented at Galkeno 300, only the post Jan 2010 data have been used in calculating the metal removal and average treated metal(loid) concentrations, although the dataset is displayed in the following figures from Mar 2004 for Galkeno 300. Arsenic, cadmium, copper, lead, nickel, silver, and zinc are regulated under the water use licence QZ12-057, and the concentrations of these elements in the raw discharge and treated decant waters for each adit are shown in the following figures. The source data are available on the SharePoint portal and on request.

		Al	**As**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Ni**
Treatment efficiencies	Silver King	90.7%	89.0%	93.9%	35.0%[2]	94.4%	93.4%	83.3%	74.3%	69.4%
	Galkeno 300[1]	91.9%	99.4%	97.1%	0.0%[2]	80.0%	99.8%	99.4%	78.2%	98.8%
	Galkeno 900	61.5%[2]	82.0%	96.5%	40.0%	0.0%[2]	97.6%	65.4%[2]	76.8%	64.1%
Average treated conc	Silver King	0.014	0.0078	0.00063	0.00065	0.001	1.2	0.0002	0.71	0.022
Total, (mg/L)	Galkeno 300[1]	0.005	0.0007	0.00606	0.001	0.0005	0.04	0.0001	28.2	0.004
	Galkeno 900	0.005	0.015	0.00005	0.0006	0.0005	0.05	0.0002	4.16	0.070
Effluent quality standard (mg/L)		-	0.5	0.05	-	0.3	-	0.2	-	0.5

[1] Post treatment plant improvements (2010 data onwards)

[2] Adit metal concentrations low and/or close to detection limit

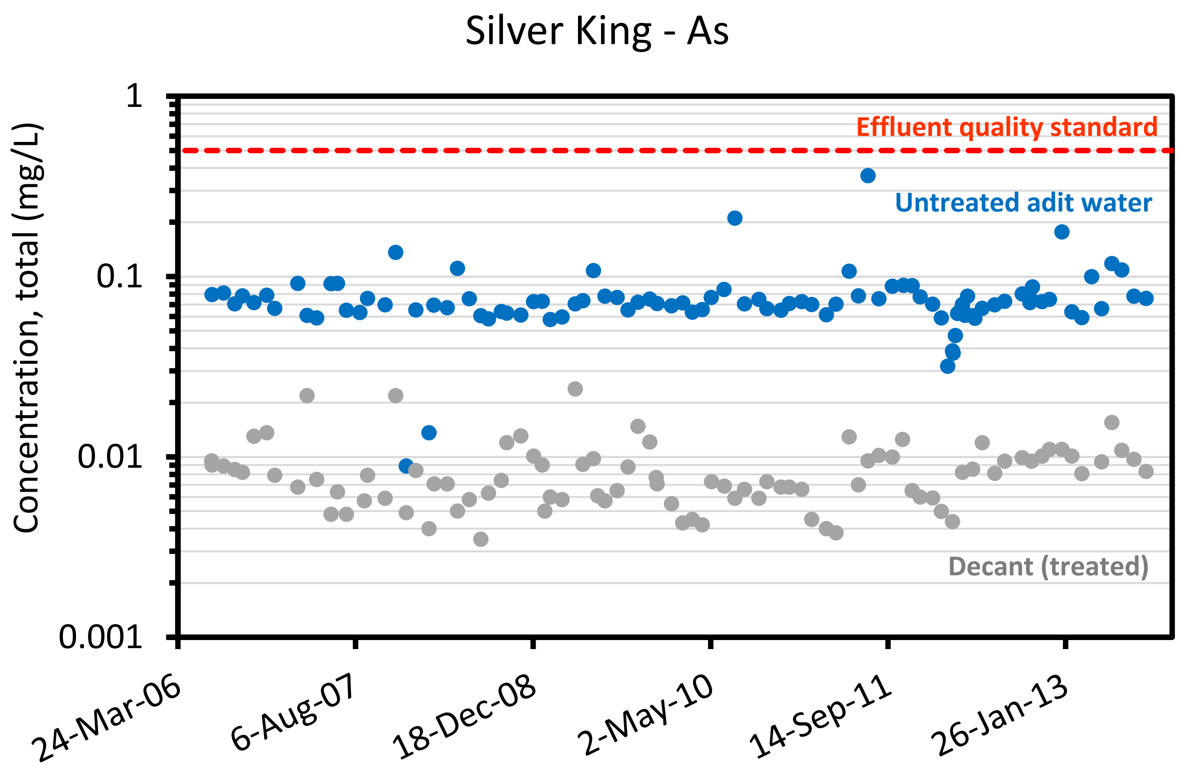
		Hg	P	Se	Ag	U	Zn
Treatment efficiencies	Silver King	0.0%[2]	86.4%	0.0%[2]	0.0%[2]	31.3%	91.1%
	Galkeno 300[1]	0.0%[2]	56.3%[3]	0.0%[2]	50.0%[2]	87.5%	99.8%
	Galkeno 900	0.0%[2]	75.0%[3]	0.0%[2]	0.0%[2]	41.0%	98.5%
Average treated conc	Silver King	0.0001	0.0105	0.0004	0.00005	0.0022	0.077
Total, (mg/L)	Galkeno 300[1]	0.0001	0.0175	0.0004	0.00005	0.00005	0.179
	Galkeno 900	0.0001	0.005	0.0004	0.00005	0.0059	0.081
Effluent quality standard (mg/L)		-	-	-	0.1	-	0.5

[1] Post treatment plant improvements (2010 data onwards)

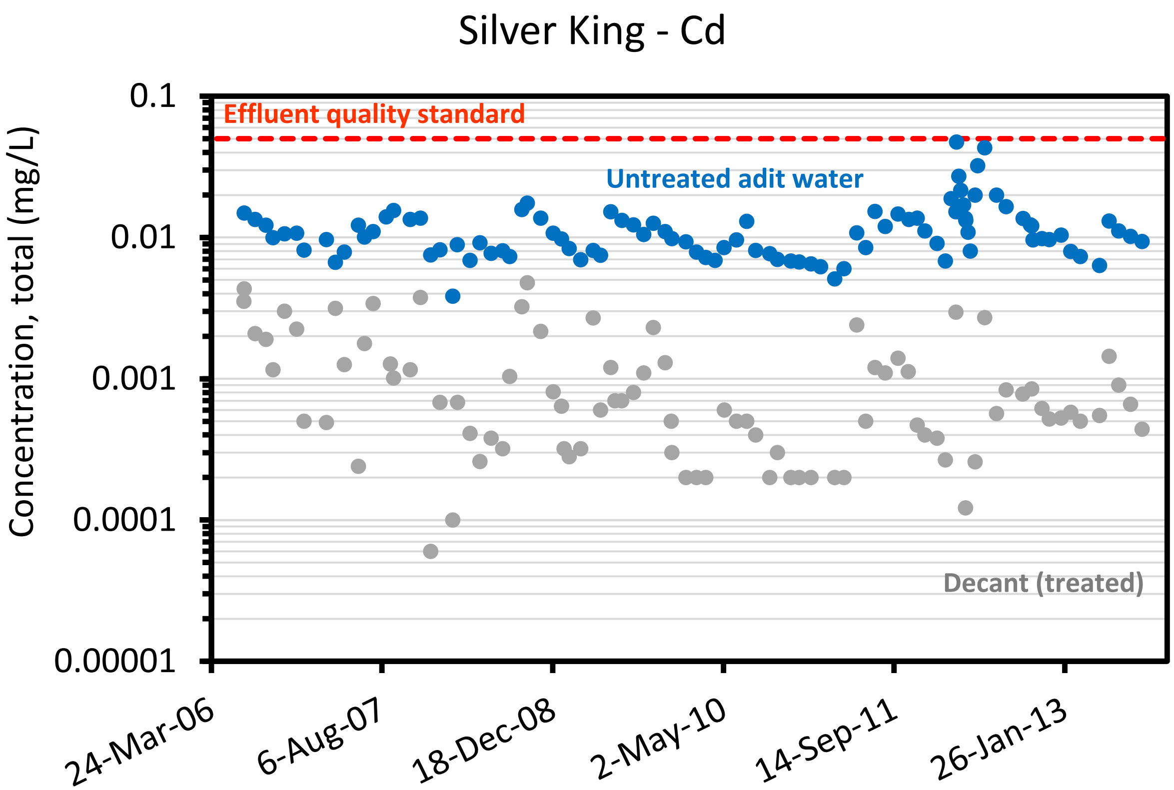
[2] Adit metal concentrations low and/or close to detection limit

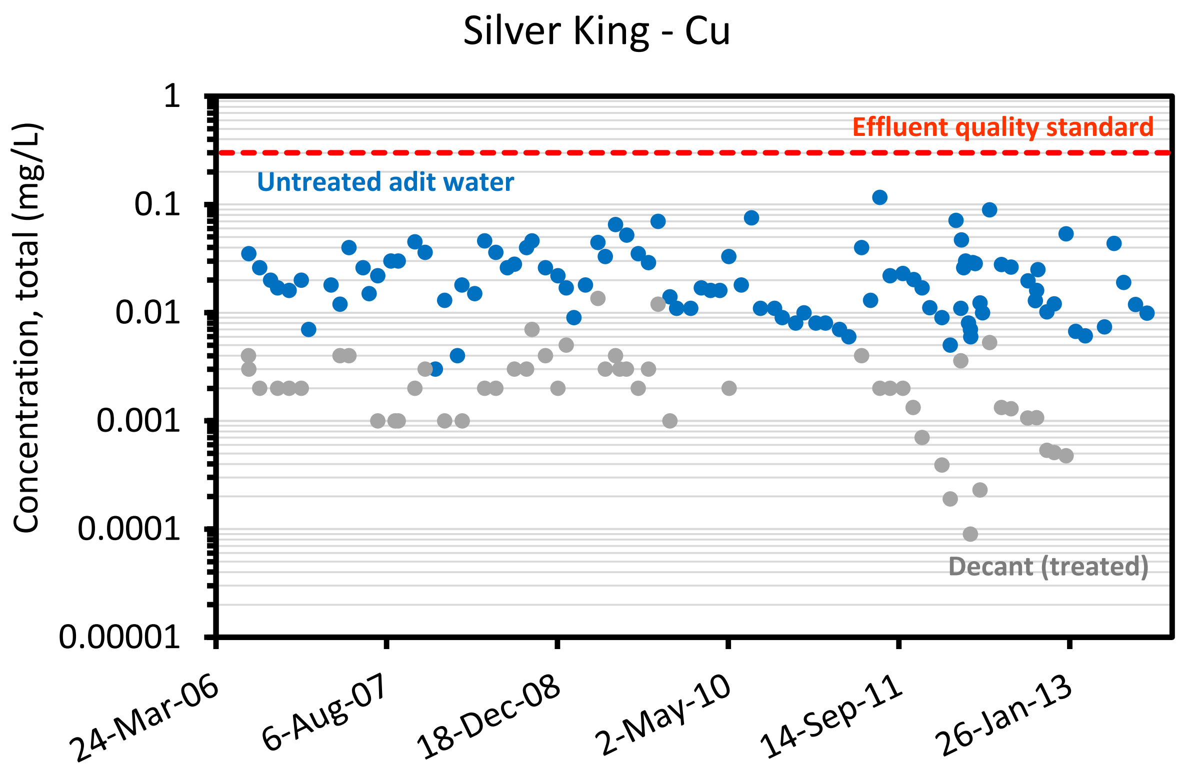
[3] Too few paired data for adequate assessment to be made

Silver King 100

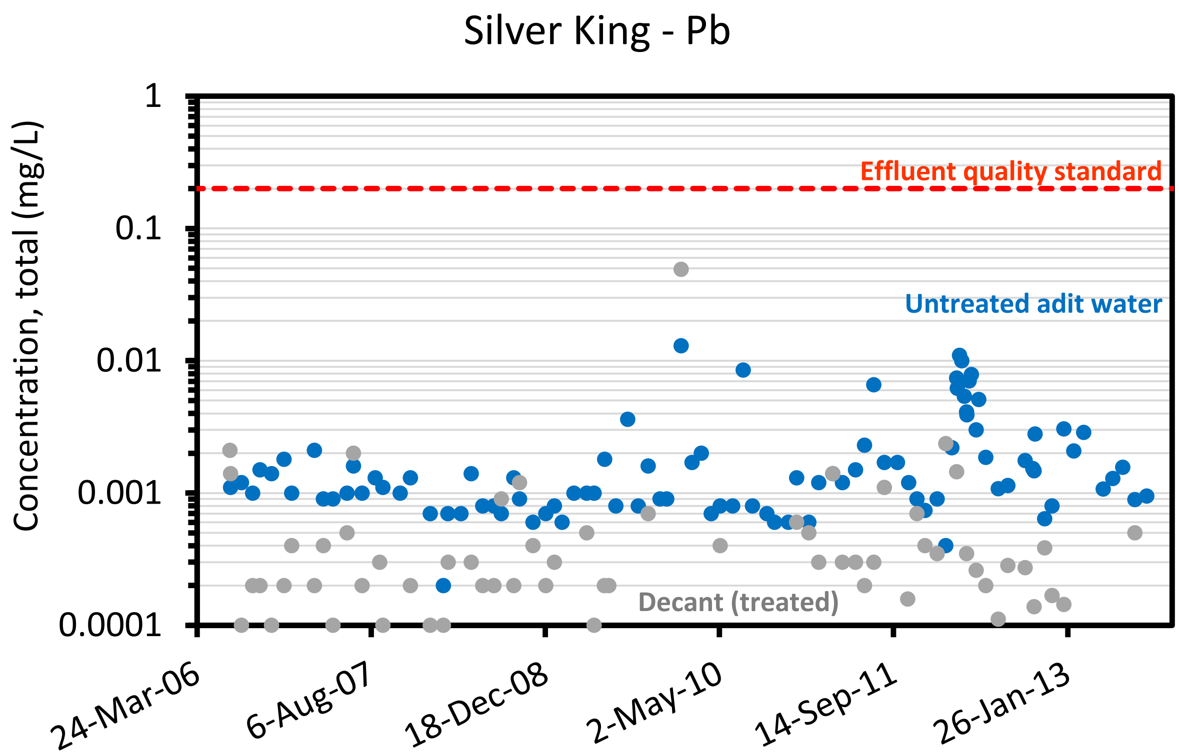


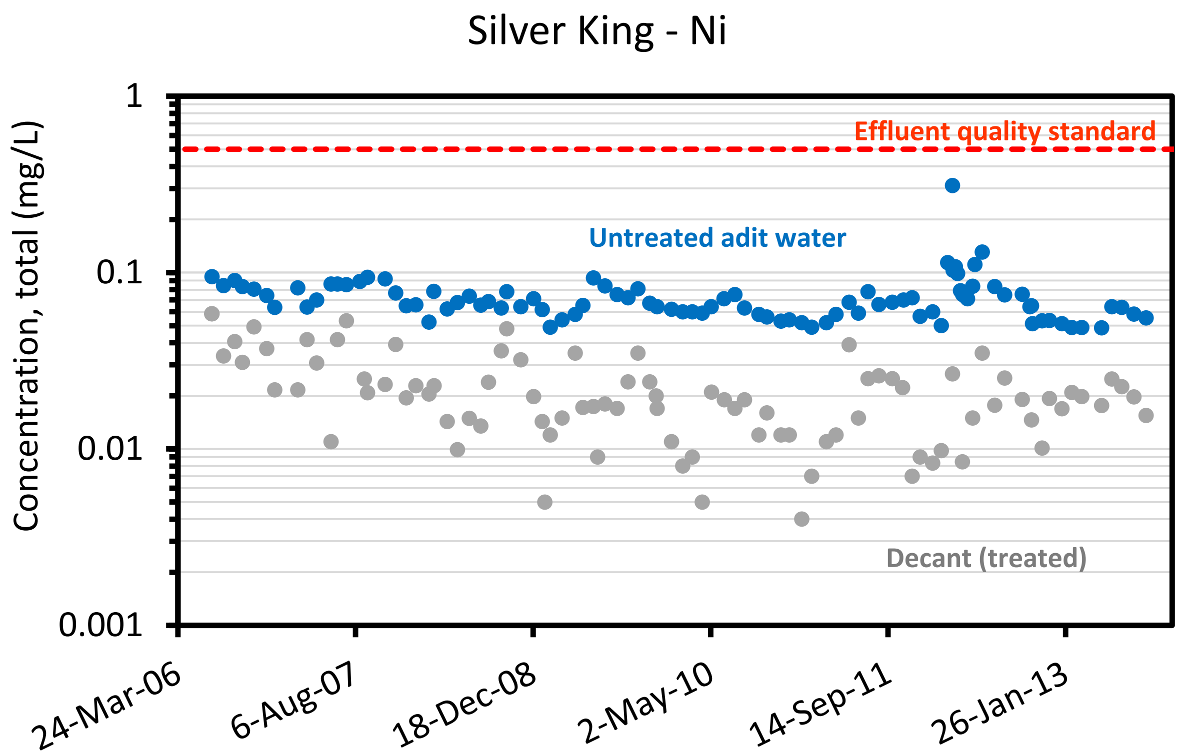
Silver King - As
Concentration, total (mg/L)
1
0.1
0.01
0.001
Effluent quality standard
Untreated adit water
Decant (treated)
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13

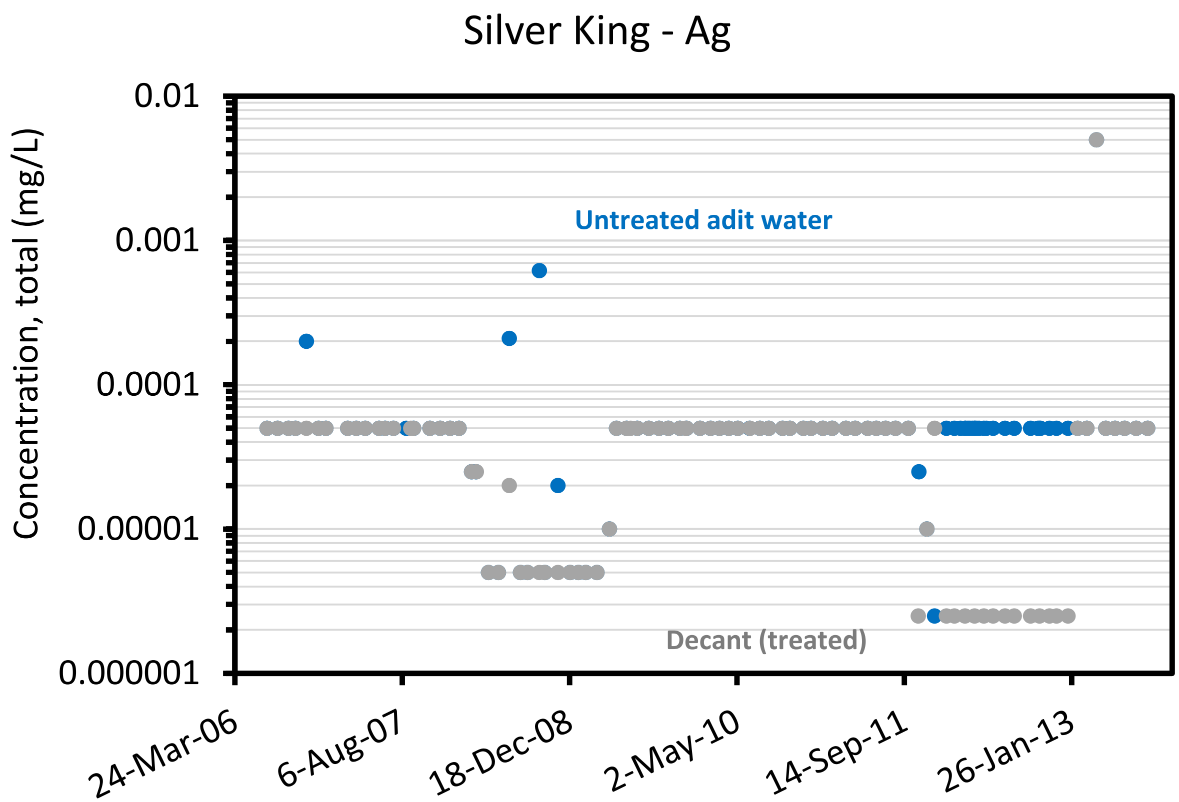

Silver King - Cd
Effluent quality standard
Untreated adit water
Decant (treated)
Concentration, total (mg/L)
0.1
0.01
0.001
0.0001
0.00001
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13



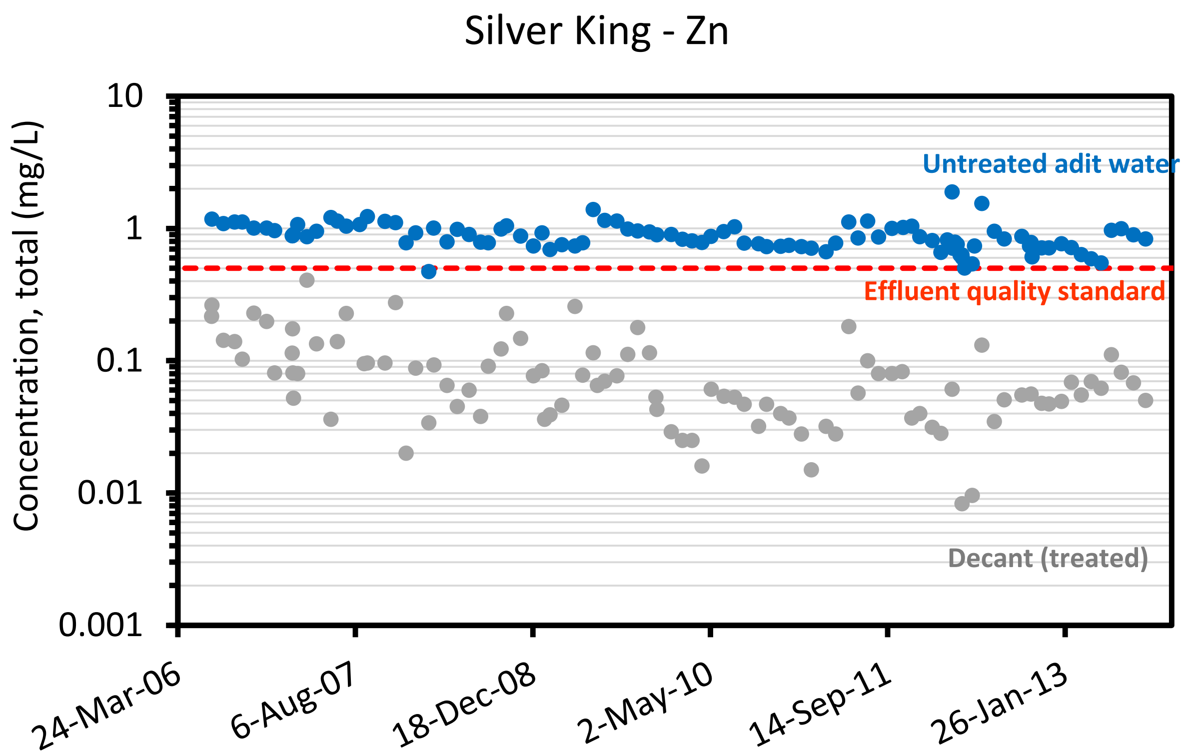
Silver King - Cu
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
Effluent quality standard
Untreated adit water
Decant (treated)
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13


Silver King - Pb
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
Effluent quality standard
Untreated adit water
Decant (treated)
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13


Silver King - Ni
Concentration, total (mg/L)
1
0.1
0.01
0.001
Effluent quality standard
Untreated adit water
Decant (treated)
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13

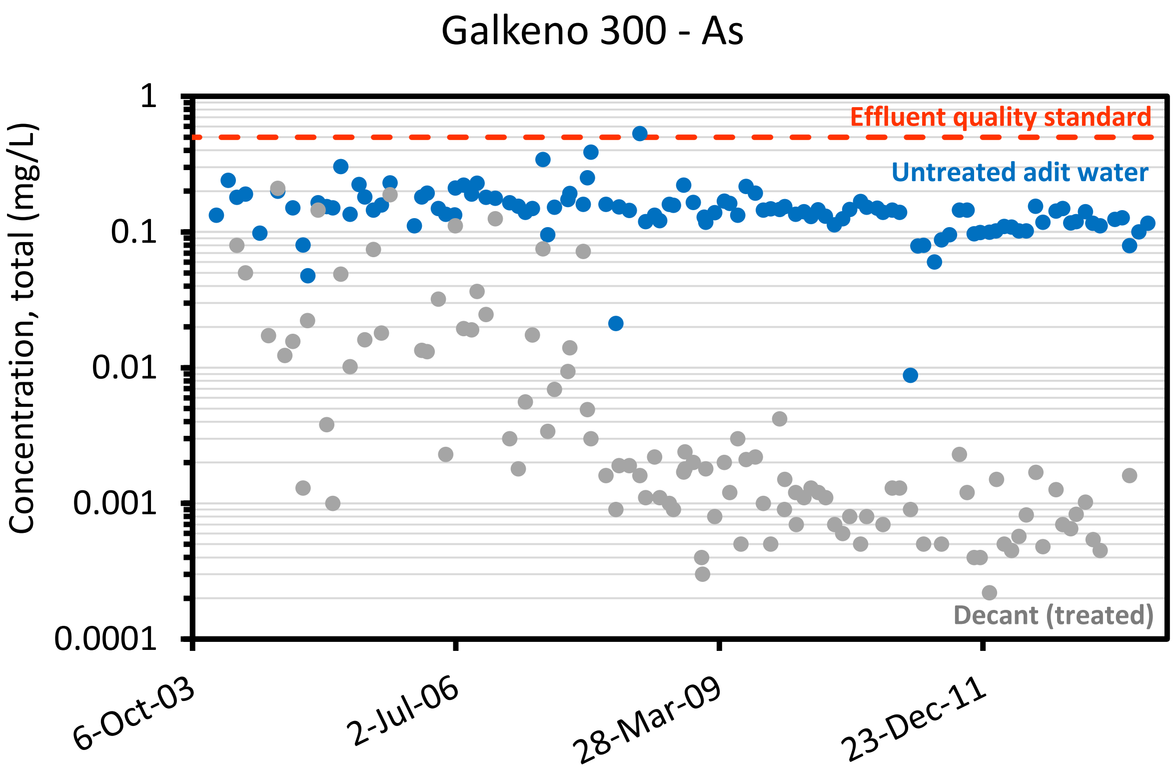


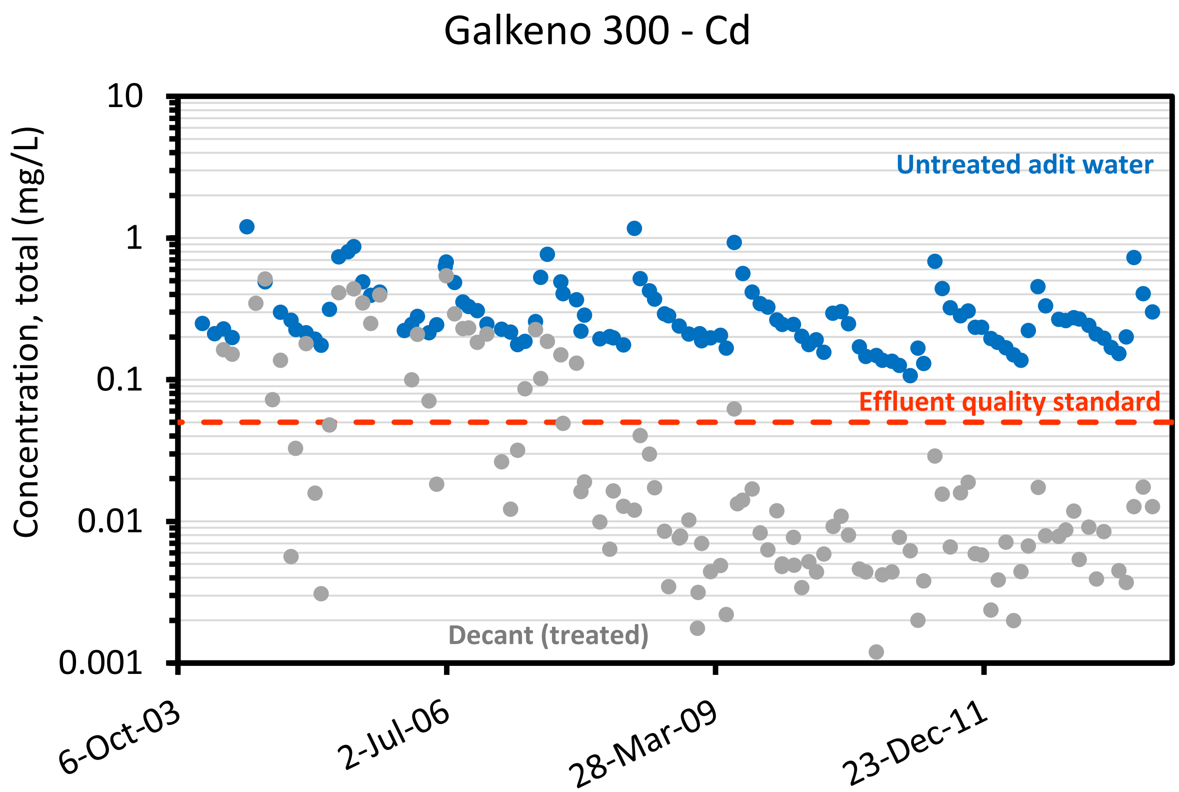
Silver King - Ag
Concentration, total (mg/L)
0.01
0.001
0.0001
0.00001
0.000001
Untreated adit water
Decant (treated)
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13



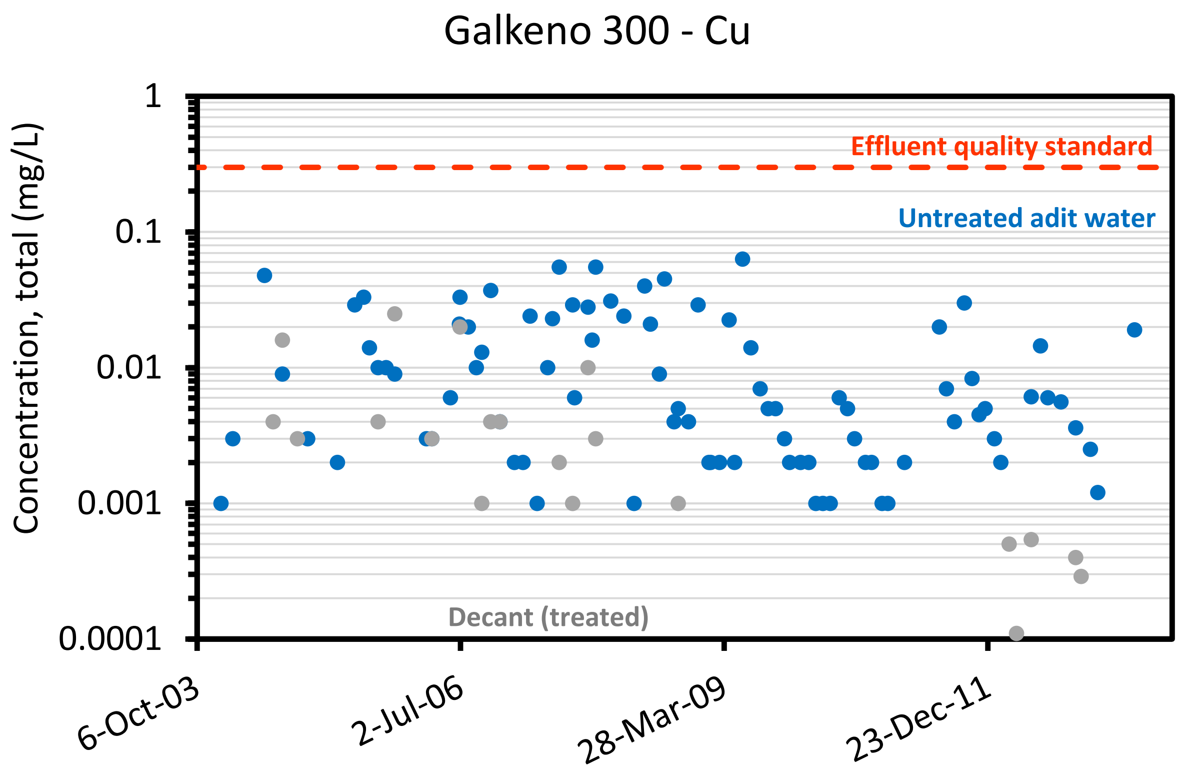
Silver King - Zn
Concentration, total (mg/L)
10
1
0.1
0.01
0.001
Untreated adit water
Effluent quality standard
Decant (treated)
24-Mar-06
6-Aug-07
18-Dec-08
2-May-10
14-Sep-11
26-Jan-13

Galkeno 300

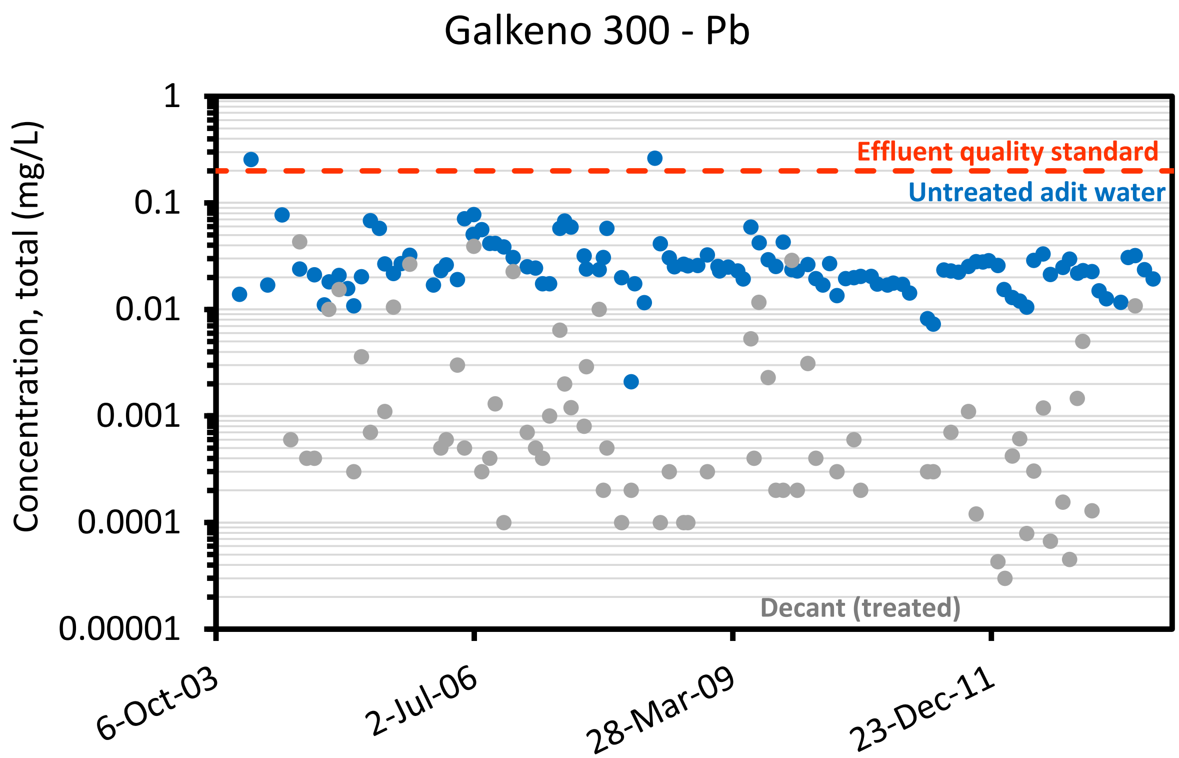

Galkeno 300 - As
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11
Effluent quality standard
Untreated adit water
Decant (treated)



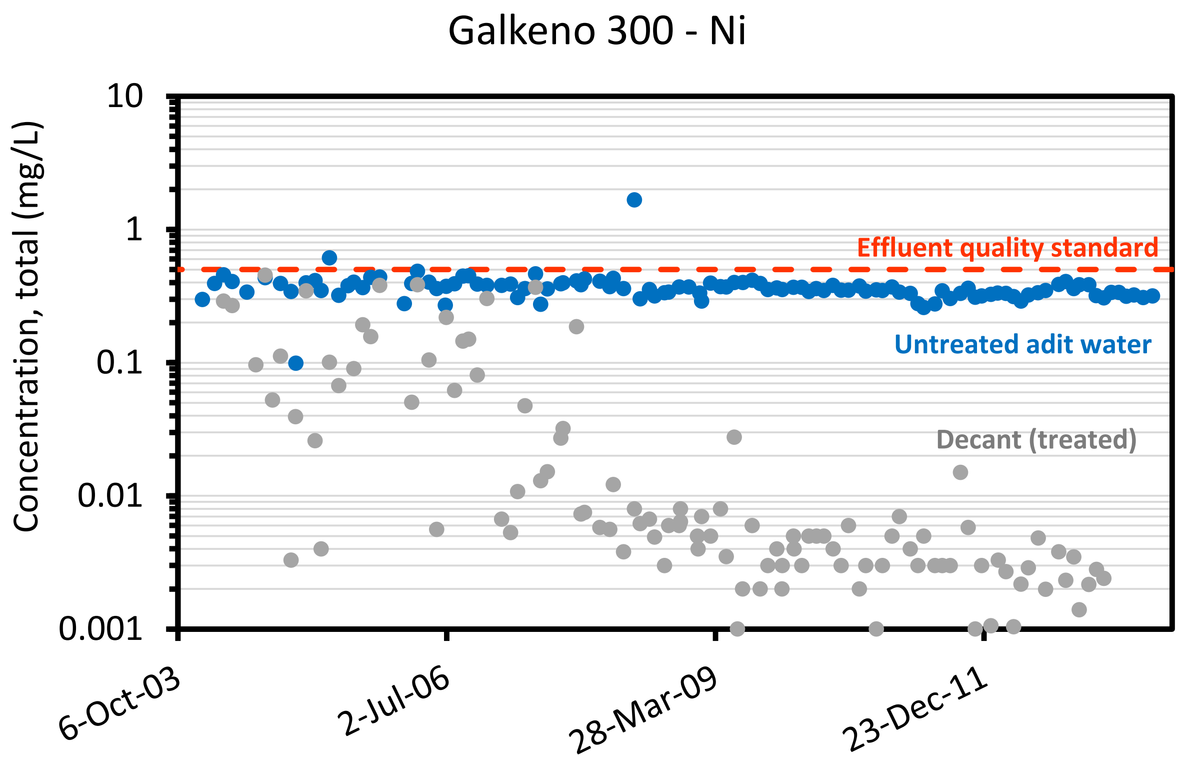
Galkeno 300 - Cd
Concentration, total (mg/L)
10
1
0.1
0.01
0.001
Untreated adit water
Effluent quality standard
Decant (treated)
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11



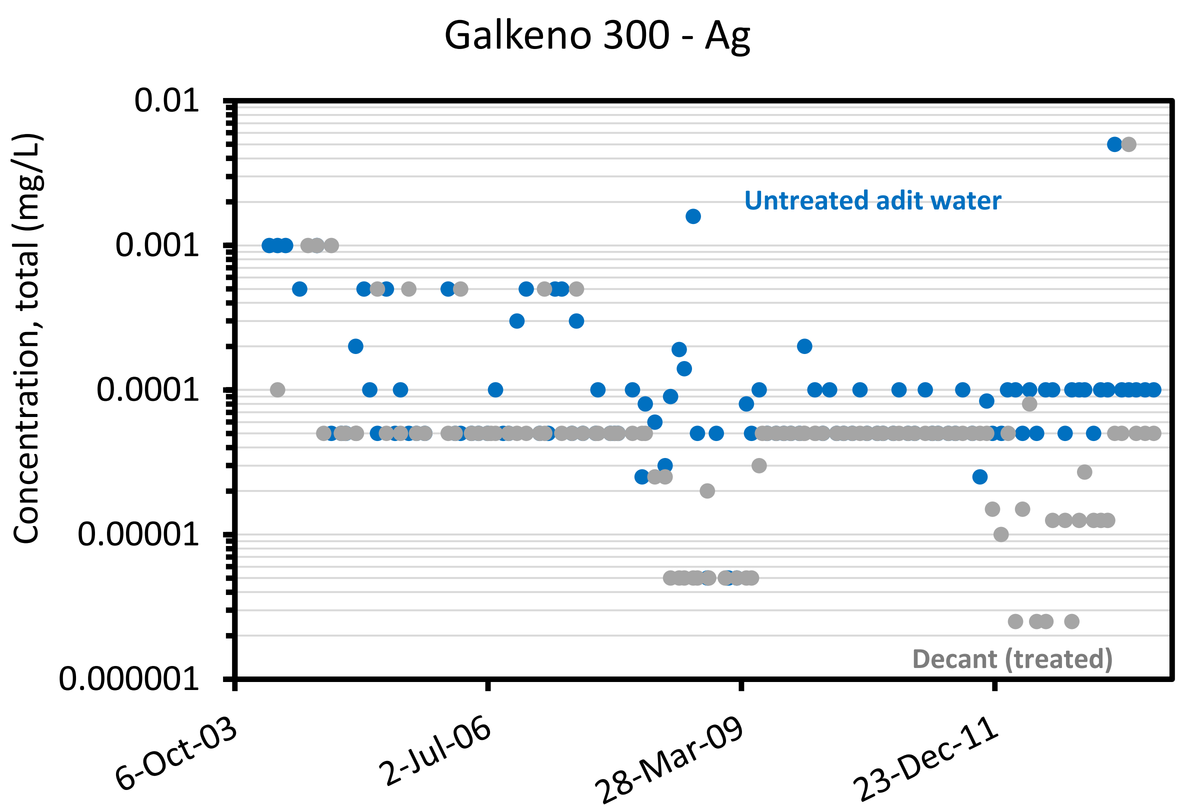
Galkeno 300 - Cu
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
Effluent quality standard
Untreated adit water
Decant (treated)
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11



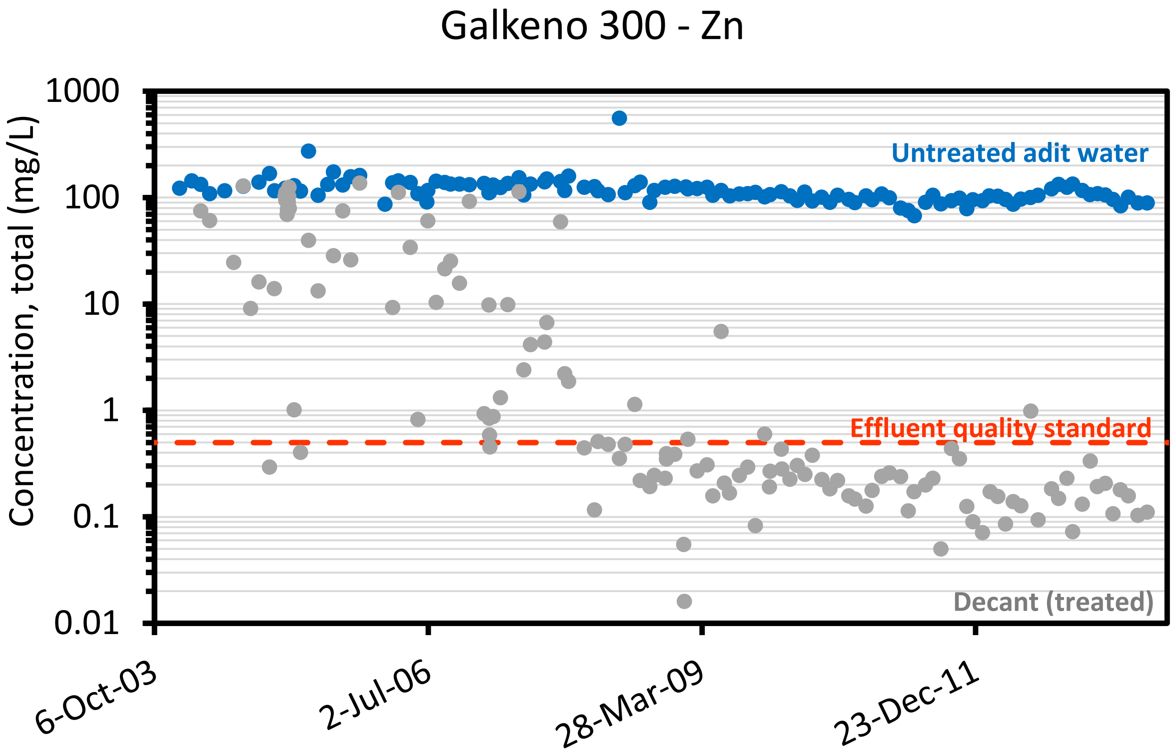
Galkeno 300 - Pb
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
Effluent quality standard
Untreated adit water
Decant (treated)
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11



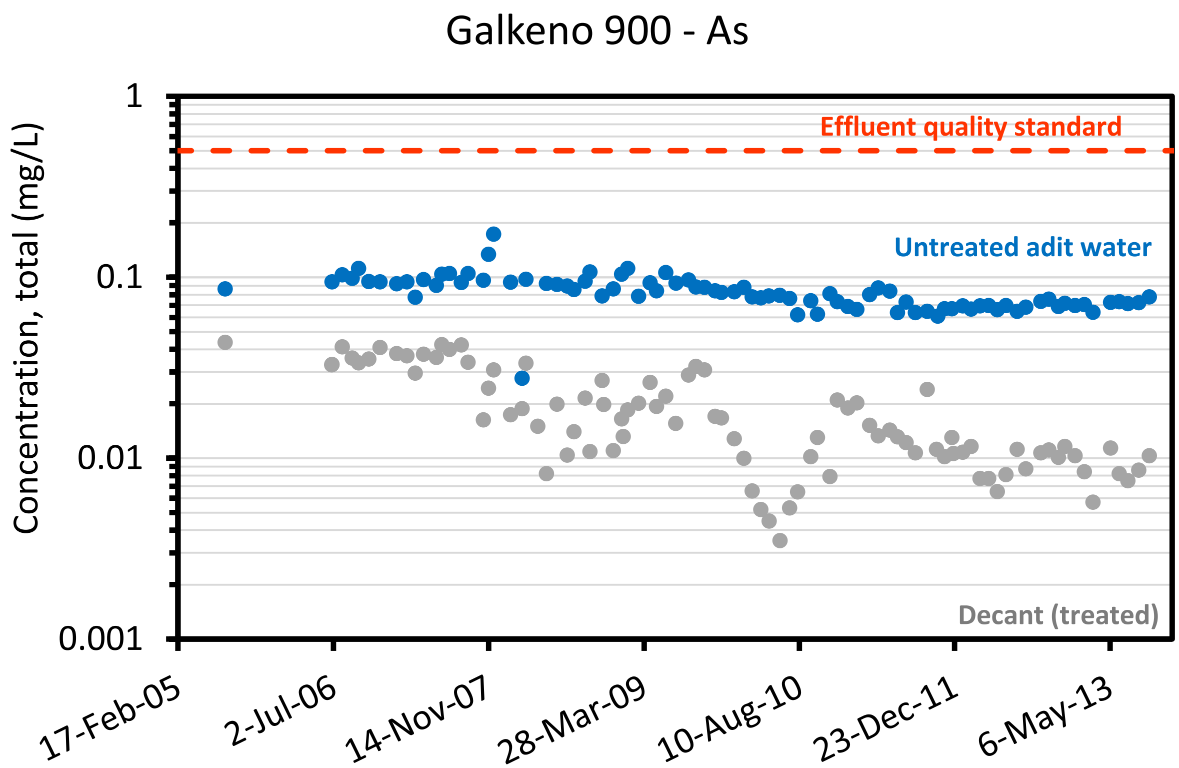
Galkeno 300 - Ni
Concentration, total (mg/L)
10
1
0.1
0.01
0.001
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11
Effluent quality standard
Untreated adit water
Decant (treated)



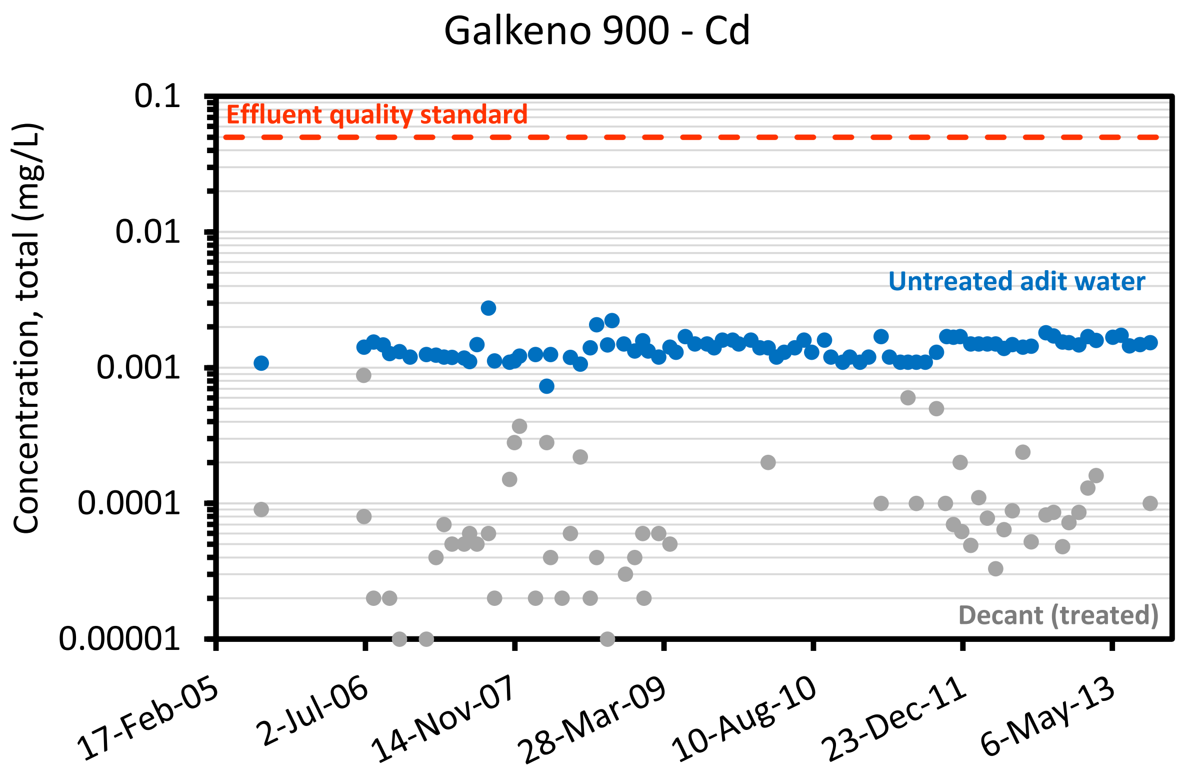
Galkeno 300 - Ag
Concentration, total (mg/L)
0.01
0.001
0.0001
0.00001
0.000001
Untreated adit water
Decant (treated)
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11

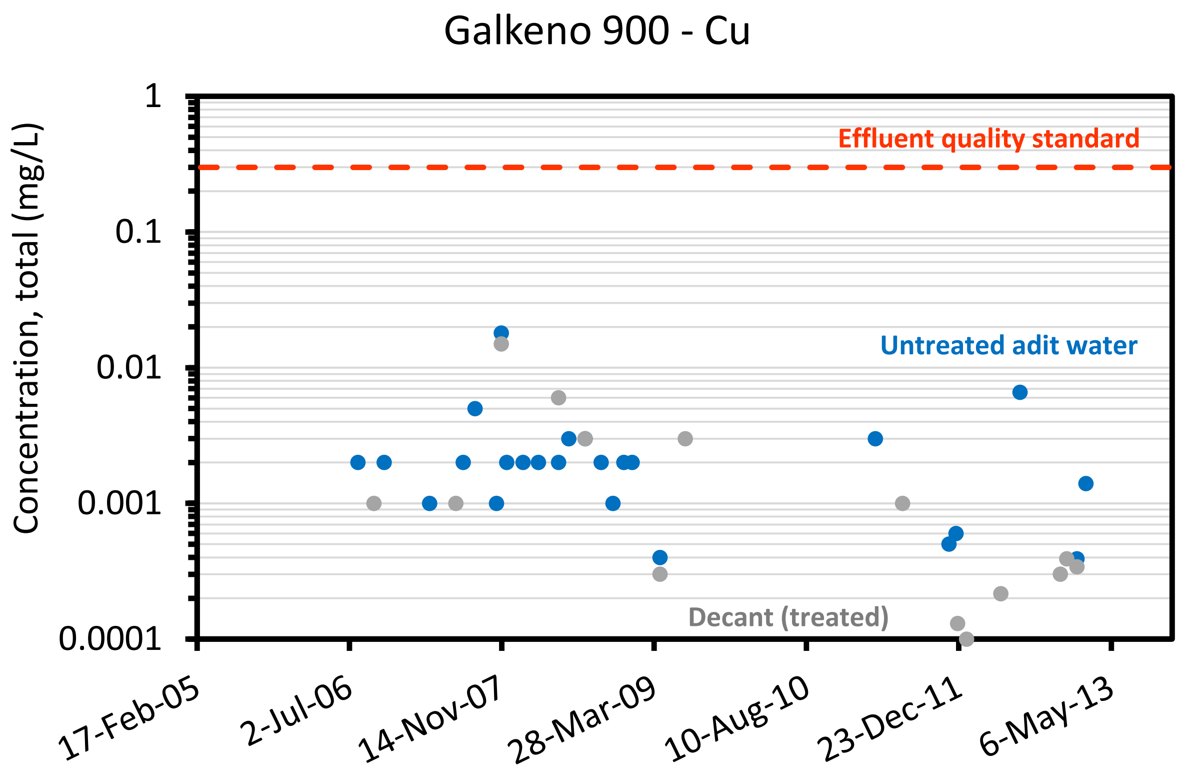

Galkeno 300 - Zn
Concentration, total (mg/L)
1000
100
10
1
0.1
0.01
Untreated adit water
Effluent quality standard
Decant (treated)
6-Oct-03
2-Jul-06
28-Mar-09
23-Dec-11

Galkeno 900

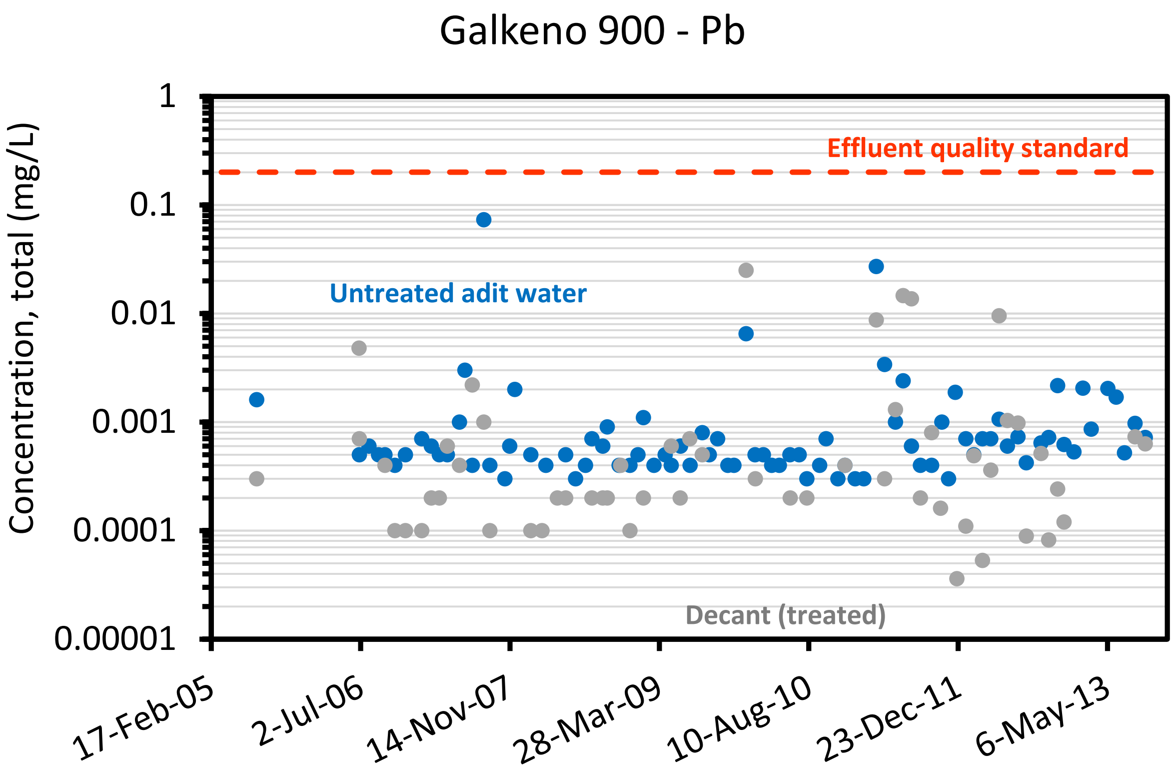


Galkeno 900 - As
Concentration, total (mg/L)
1
0.1
0.01
0.001
Effluent quality standard
Untreated adit water
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13

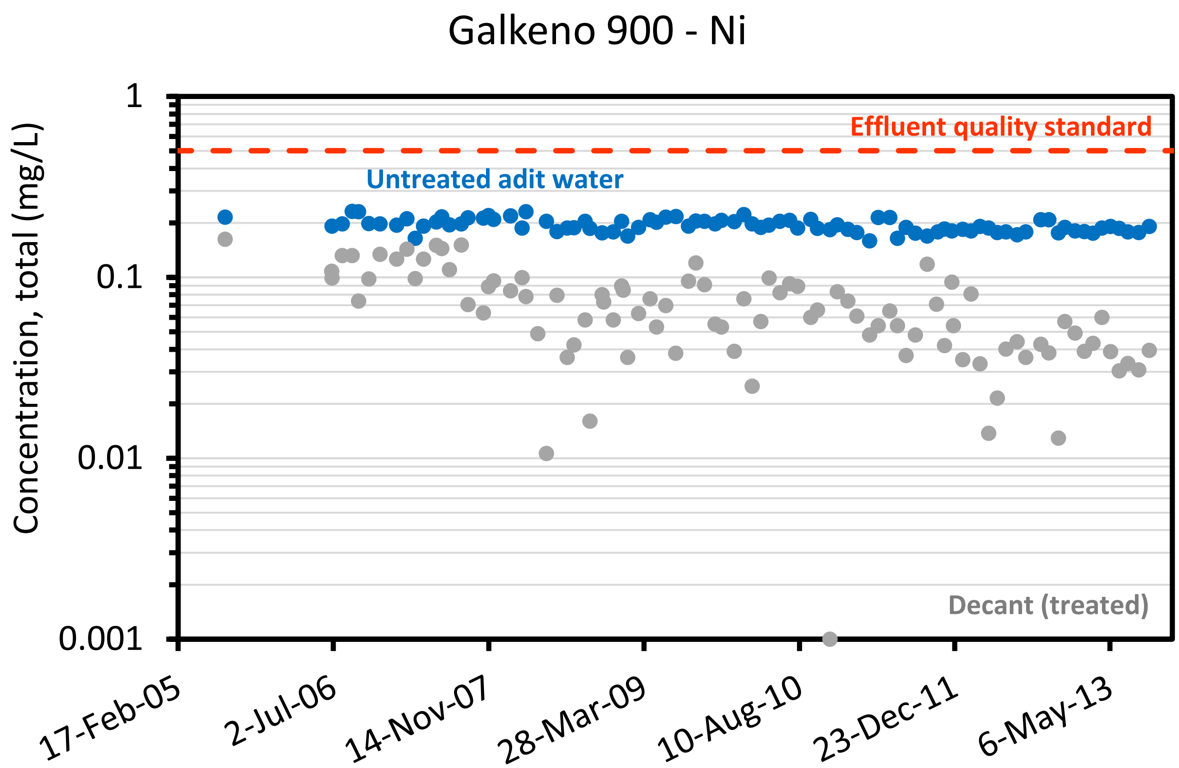

Galkeno 900 - Cd
Concentration, total (mg/L)
0.1
0.01
0.001
0.0001
0.00001
Effluent quality standard
Untreated adit water
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13



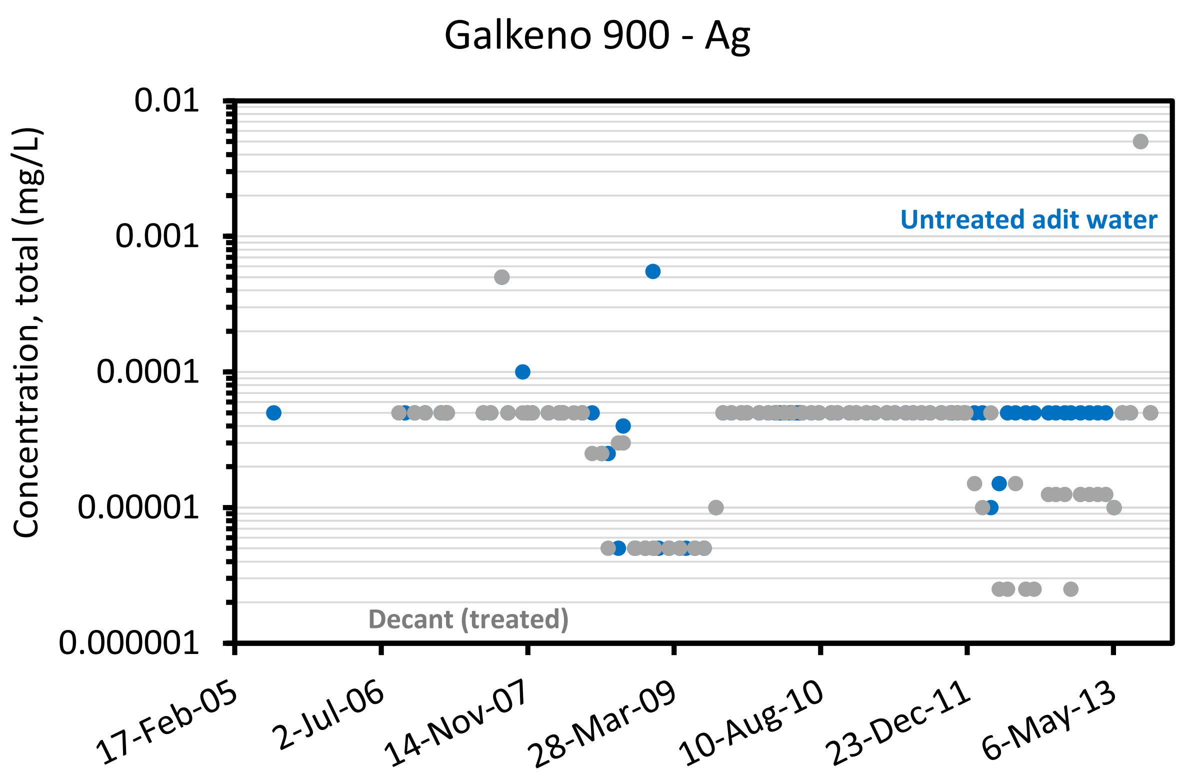
Galkeno 900 - Cu
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
Effluent quality standard
Untreated adit water
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13

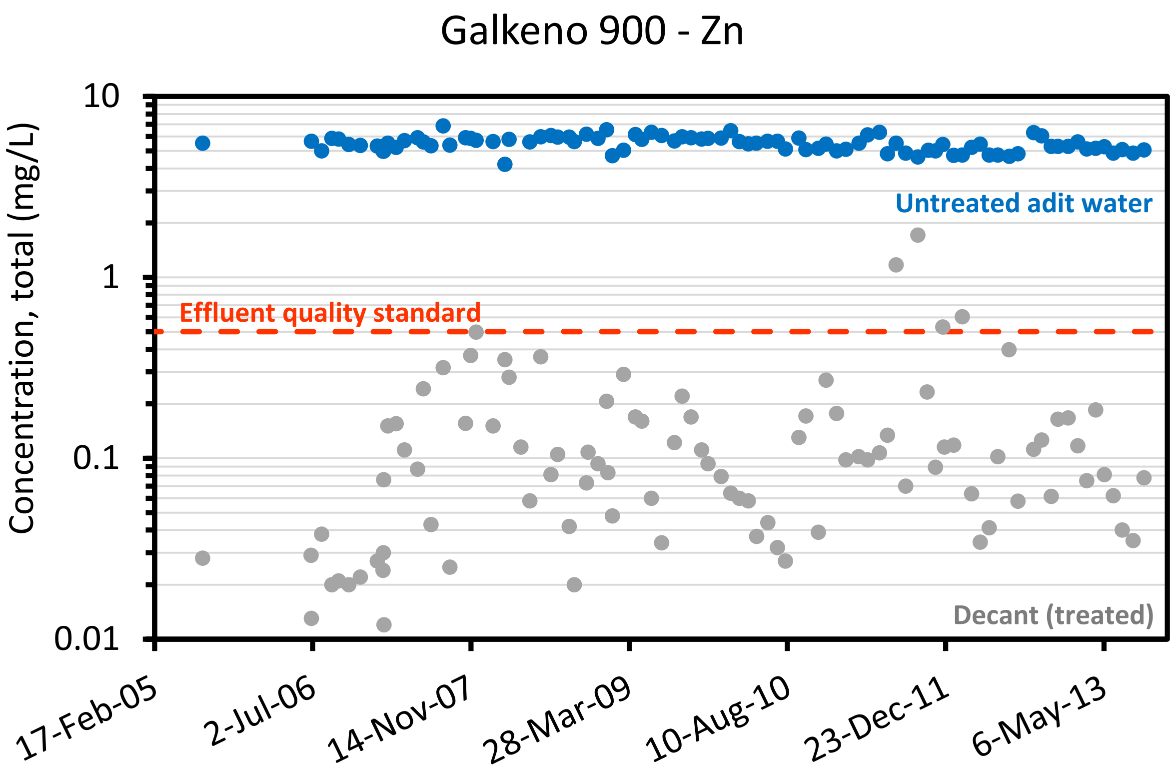


Galkeno 900 - Pb
Concentration, total (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
Effluent quality standard
Untreated adit water
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13



Galkeno 900 - Ni
Concentration, total (mg/L)
1
0.1
0.01
0.001
Effluent quality standard
Untreated adit water
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13

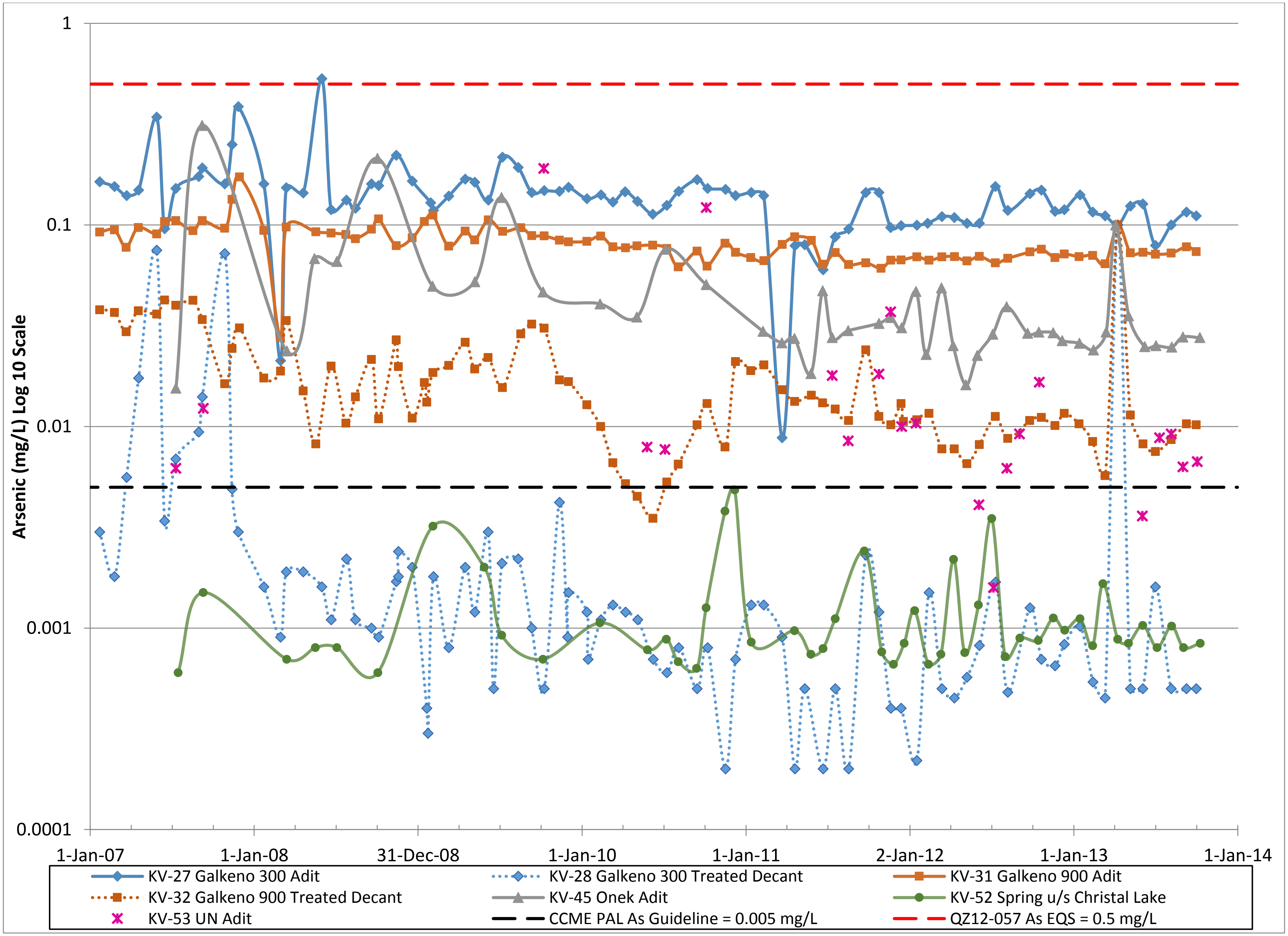

Galkeno 900 - Ag
Concentration, total (mg/L)
0.01
0.001
0.0001
0.00001
0.000001
Untreated adit water
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13



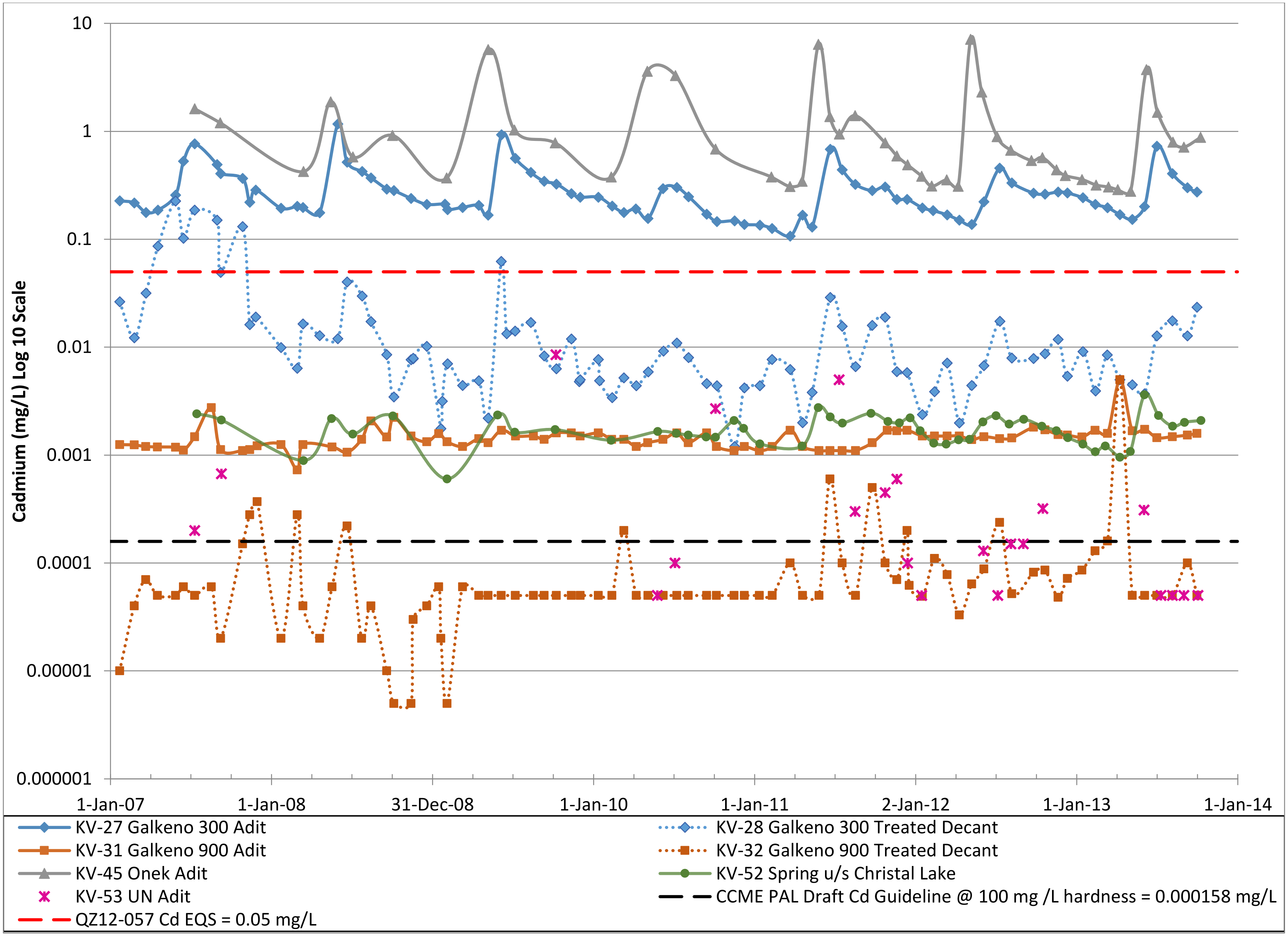
Galkeno 900 - Zn
Concentration, total (mg/L)
10
1
0.1
0.01
Untreated adit water
Effluent quality standard
Decant (treated)
17-Feb-05
2-Jul-06
14-Nov-07
28-Mar-09
10-Aug-10
23-Dec-11
6-May-13

Total arsenic, cadmium, lead, silver, and zinc concentrations measured between 2007 and 2013 from point sources within the KHSD are presented by watershed. For each element, the CCME guideline is indicated as is the effluent quality standard for those watersheds that contain one or more discharges that are regulated by the current Water Licence QZ12-057. The source data are available on the SharePoint portal and on request.

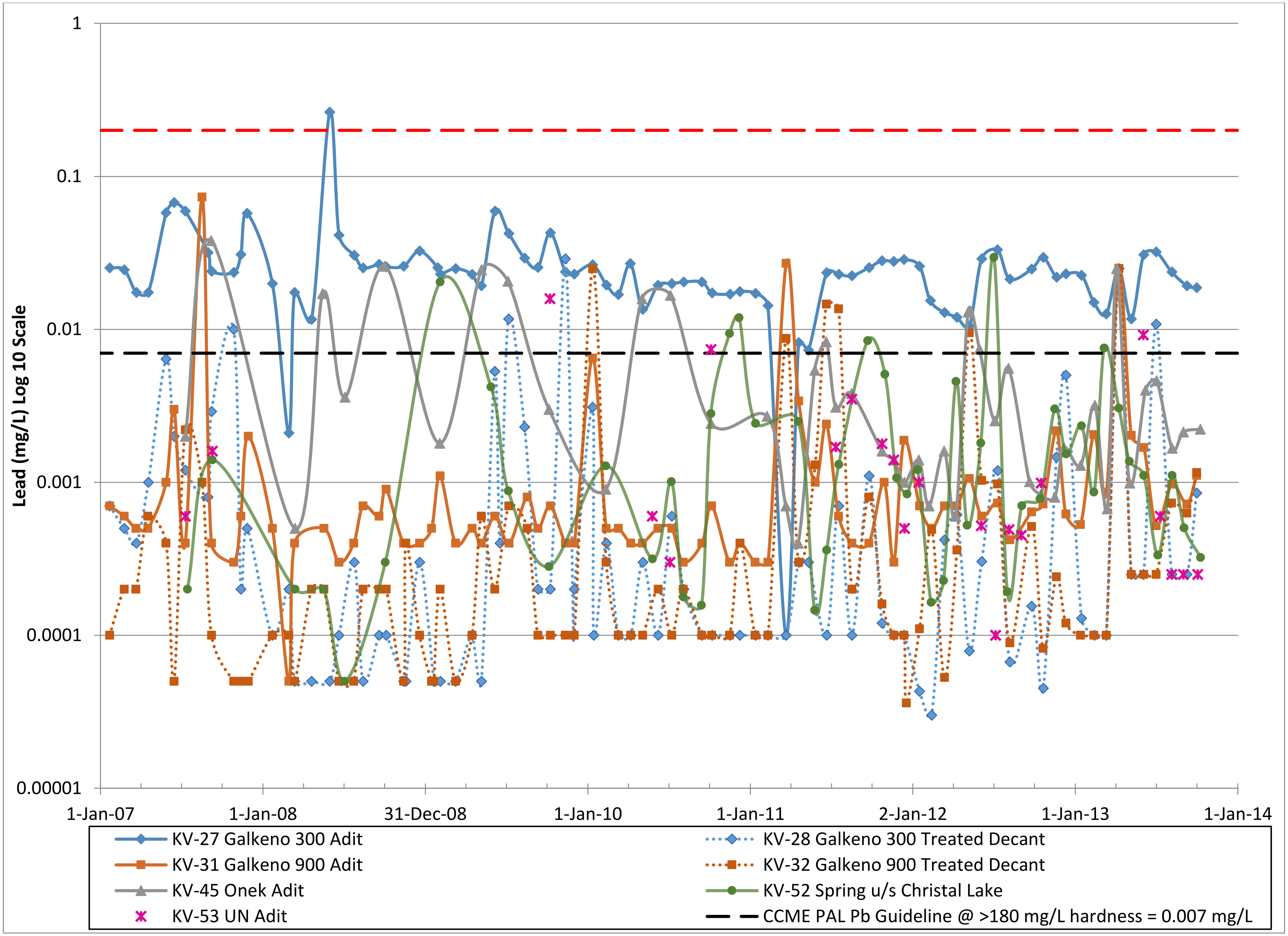
Christal Creek



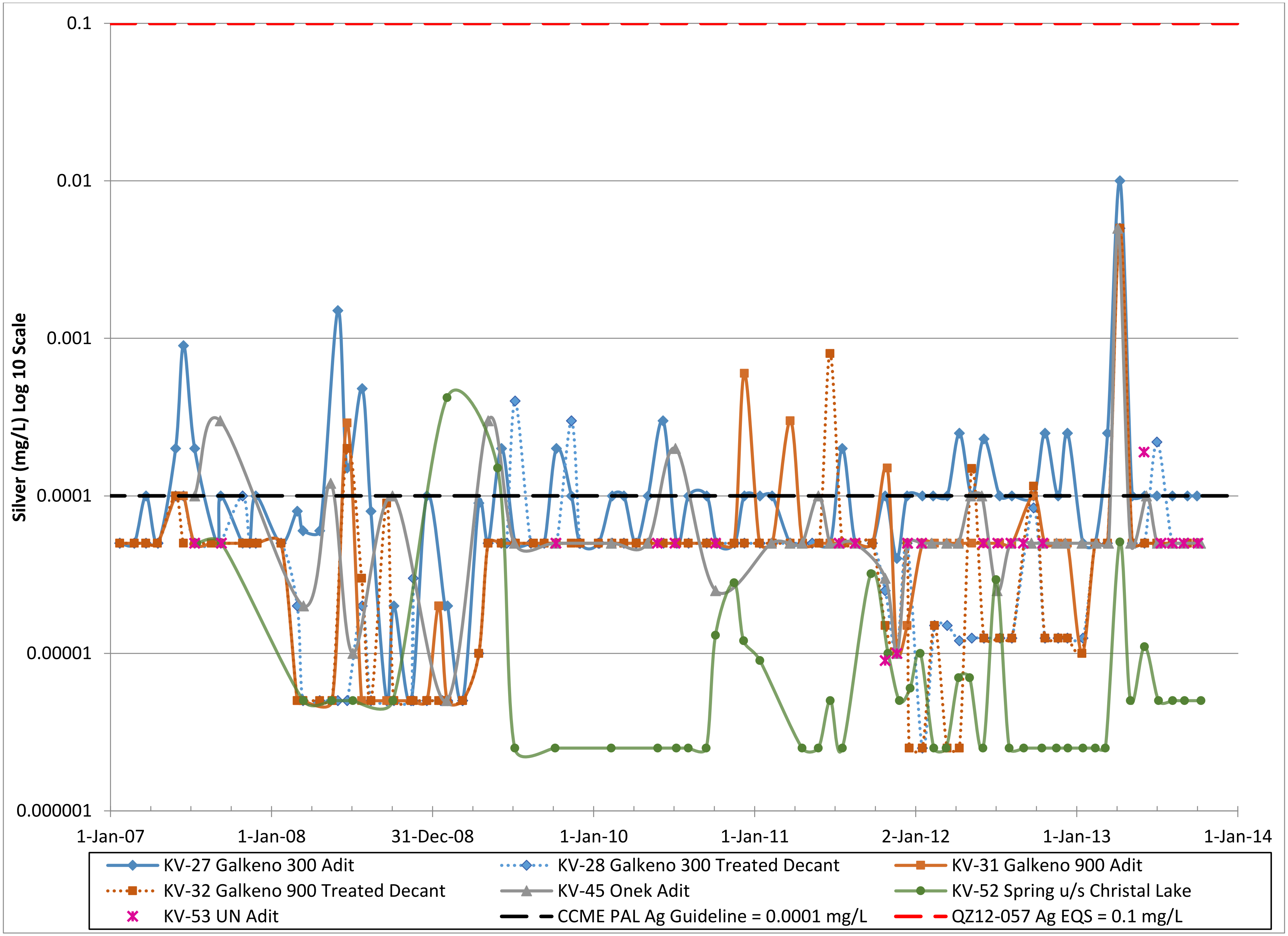
1
0.1
0.01
0.001
0.0001
Arsenic (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-27 Galkeno 300 Adit
KV-28 Galkeno 300 Treated Decant
KV-31 Galkeno 900 Adit
KV-32 Galkeno 900 Treated Decant
KV-45 Onek Adit
KV-52 Spring u/s Christal Lake
KV-53 UN Adit
CCME PAL As Guideline = 0.005 mg/L
QZ12-057 As EQS = 0.5 mg/L



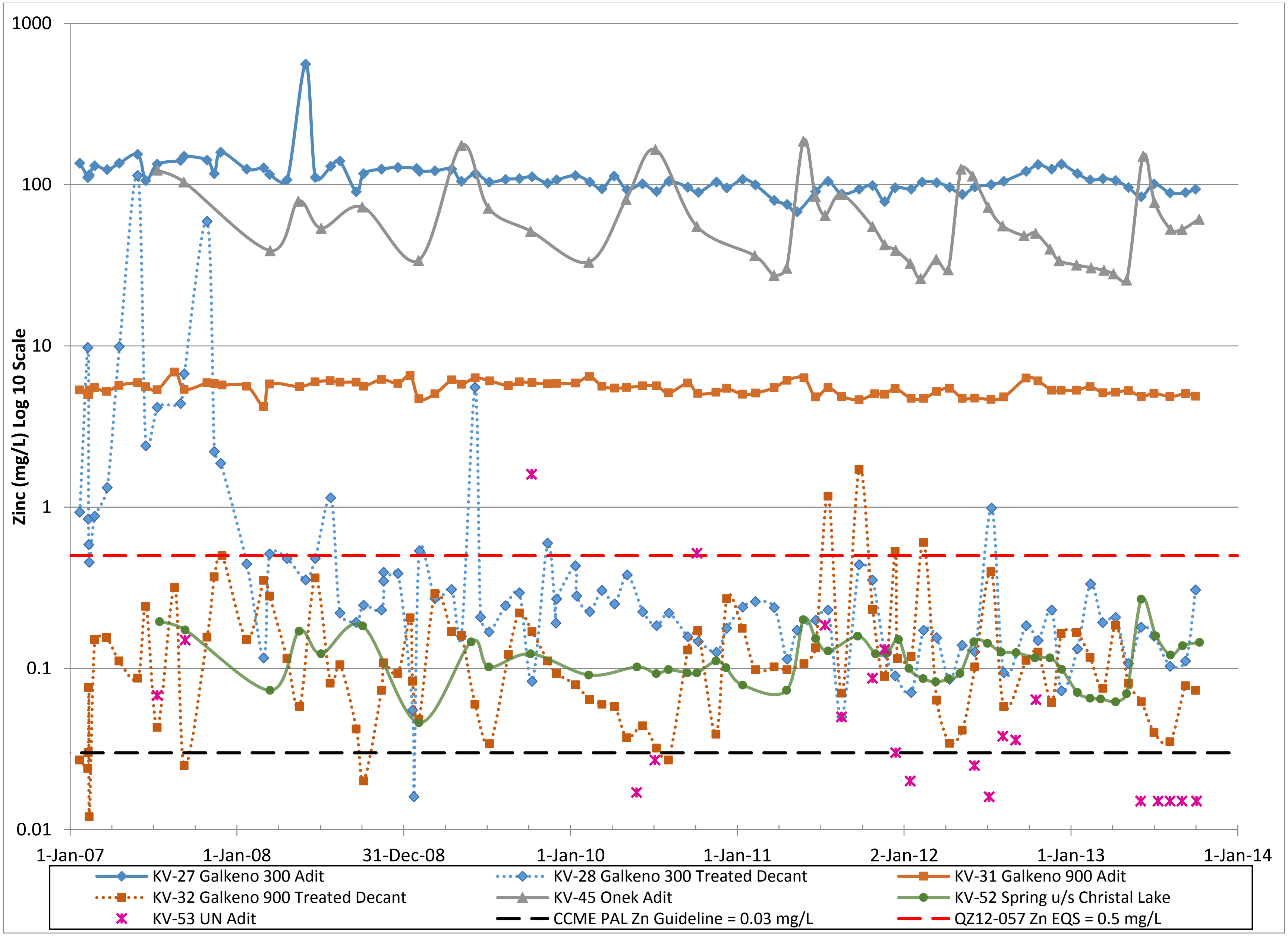
10
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
Cadmium (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-27 Galkeno 300 Adit
KV-28 Galkeno 300 Treated Decant
KV-31 Galkeno 900 Adit
KV-32 Galkeno 900 Treated Decant
KV-45 Onek Adit
KV-52 Spring u/s Christal Lake
KV-53 UN Adit
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L
QZ12-057 Cd EQS = 0.05 mg/L



Lead (mg/L) Log 10 Scale
1
0.1
0.01
0.001
0.0001
0.00001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-27 Galkeno 300 Adit
KV-28 Galkeno 300 Treated Decant
KV-31 Galkeno 900 Adit
KV-32 Galkeno 900 Treated Decant
KV-45 Onek Adit
KV-52 Spring u/s Christal Lake
KV-53 UN Adit
CCME PAL Pb Guideline @ >180 mg/L hardness = 0.007 mg/L

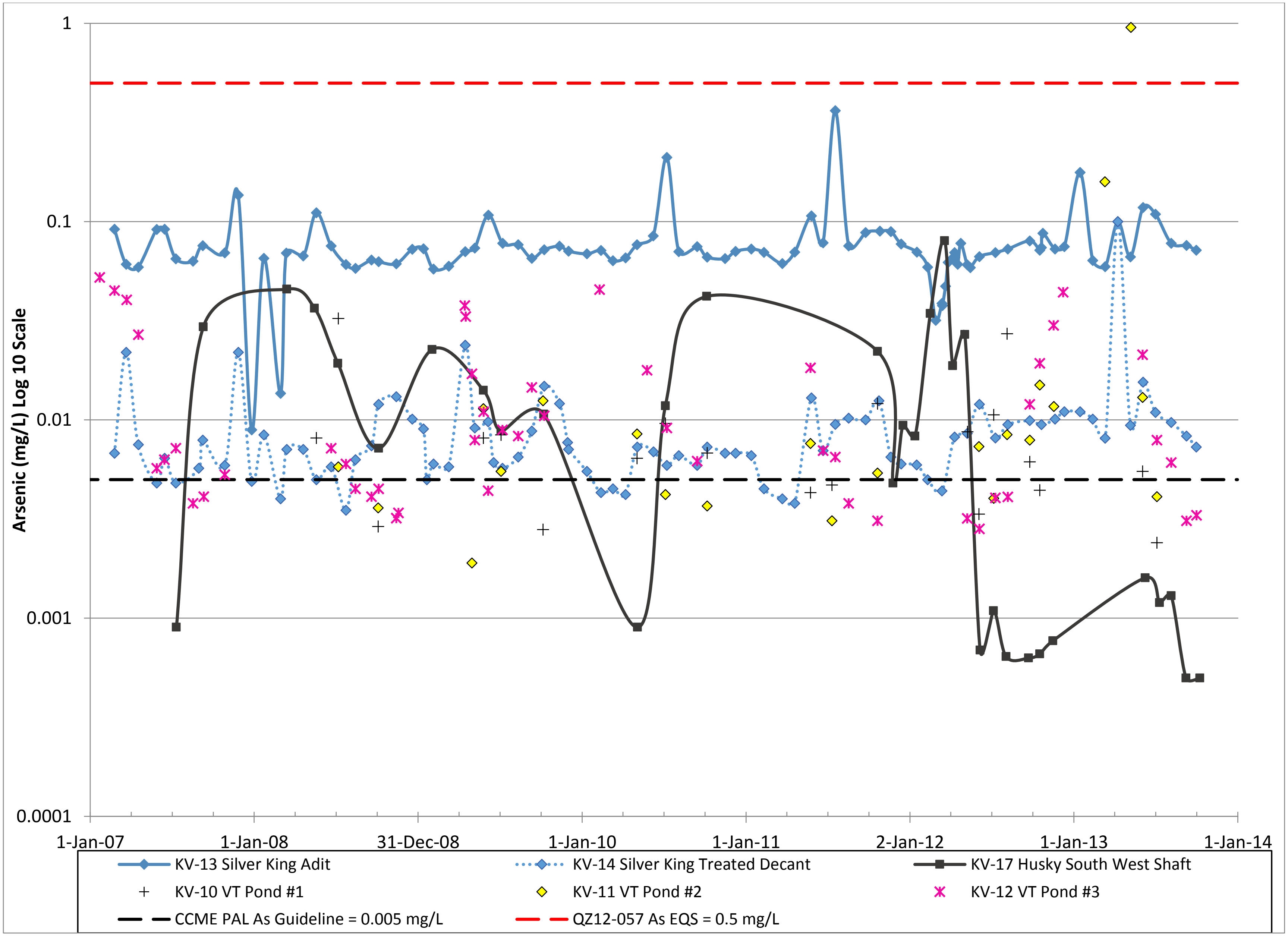


Silver (mg/L) Log 10 Scale
0.1
0.01
0.001
0.0001
0.00001
0.000001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-27 Galkeno 300 Adit
KV-28 Galkeno 300 Treated Decant
KV-31 Galkeno 900 Adit
KV-32 Galkeno 900 Treated Decant
KV-45 Onek Adit
KV-52 Spring u/s Christal Lake
KV-53 UN Adit
CCME PAL Ag Guideline = 0.0001 mg/L
QZ12-057 Ag EQS = 0.1 mg/L

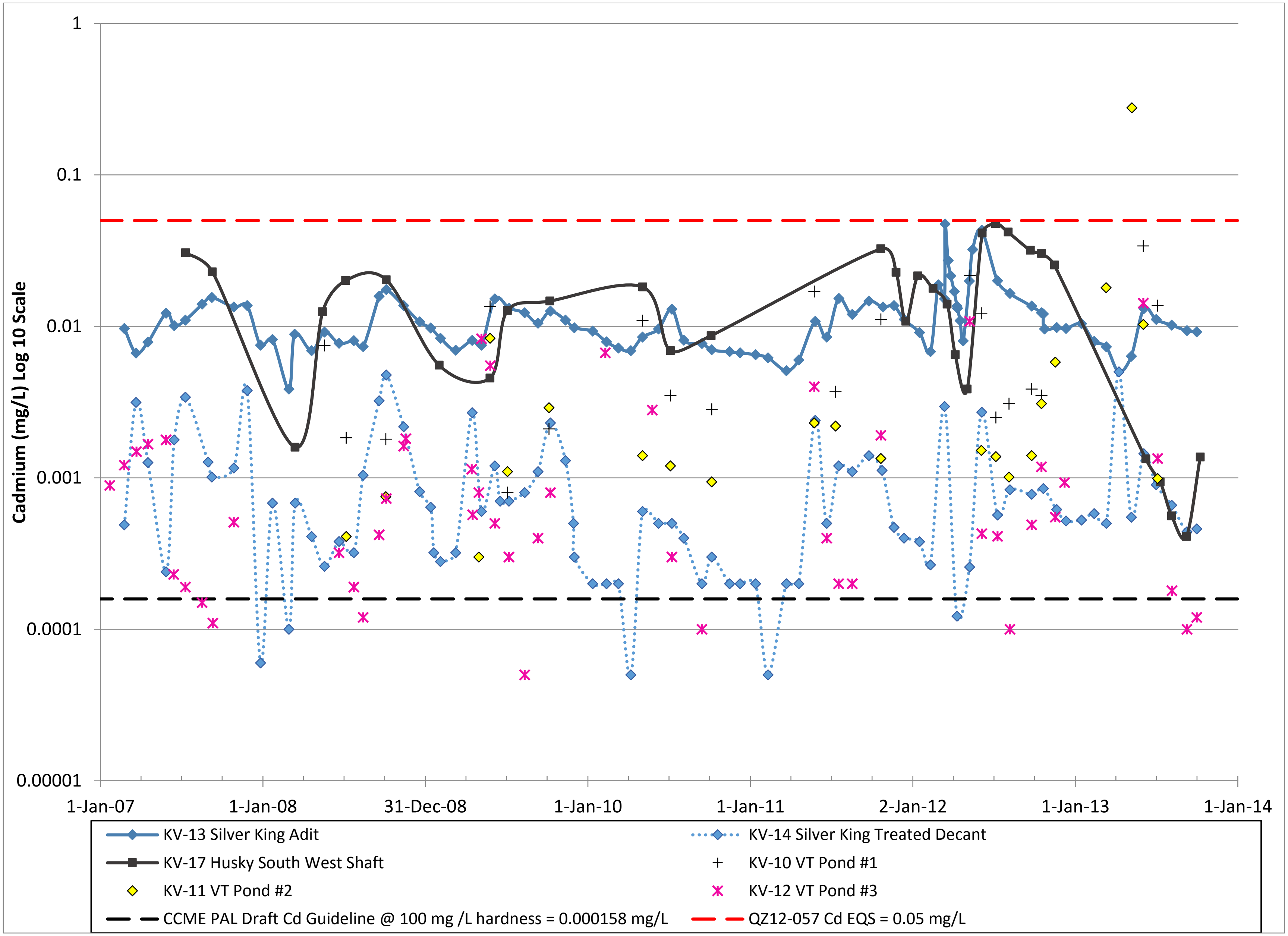


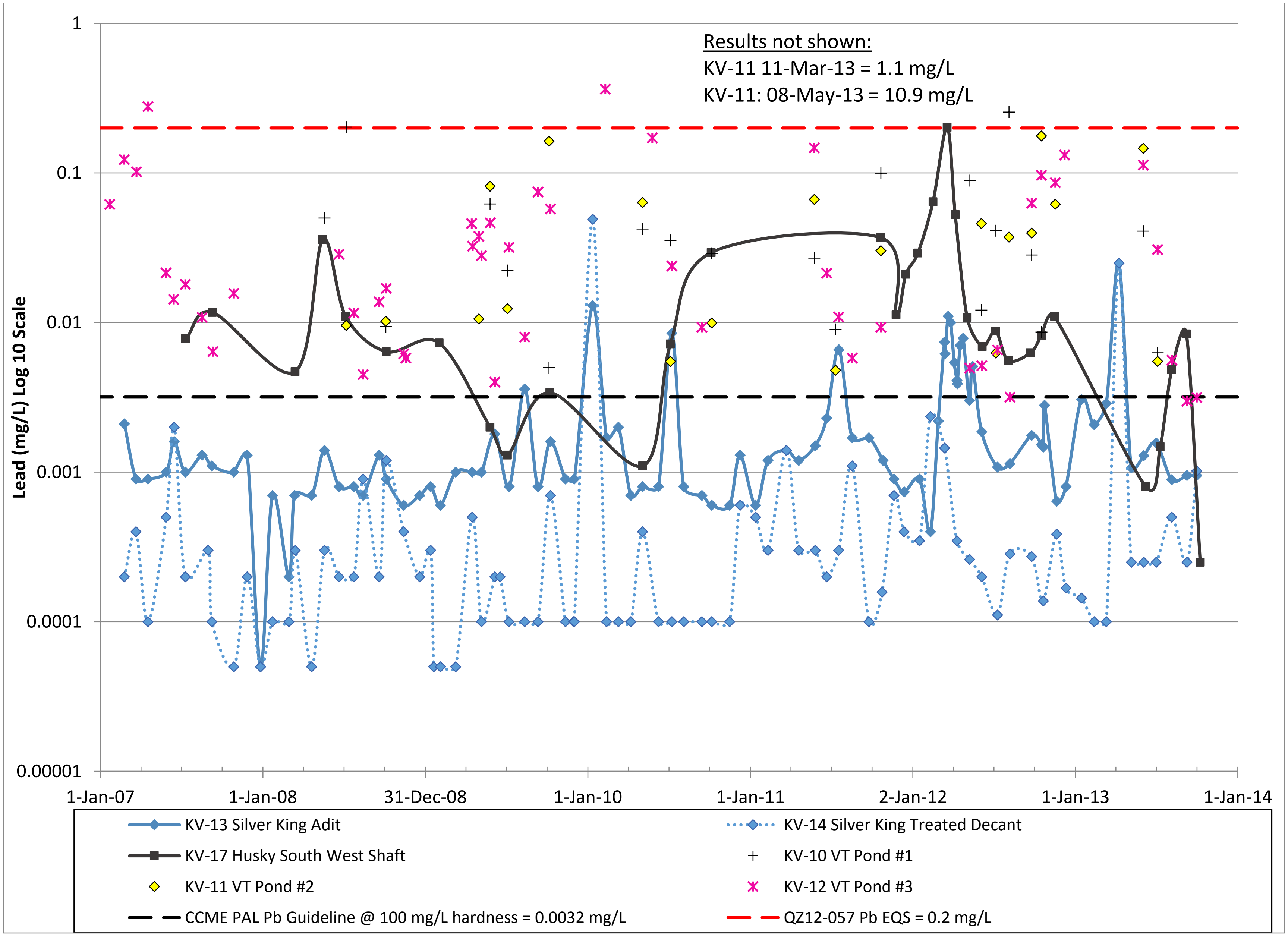
1000
100
10
1
0.1
0.01
Zinc (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-27 Galkeno 300 Adit
KV-28 Galkeno 300 Treated Decant
KV-31 Galkeno 900 Adit
KV-32 Galkeno 900 Treated Decant
KV-45 Onek Adit
KV-52 Spring u/s Christal Lake
KV-53 UN Adit
CCME PAL Zn Guideline = 0.03 mg/L
QZ12-057 Zn EQS = 0.5 mg/L

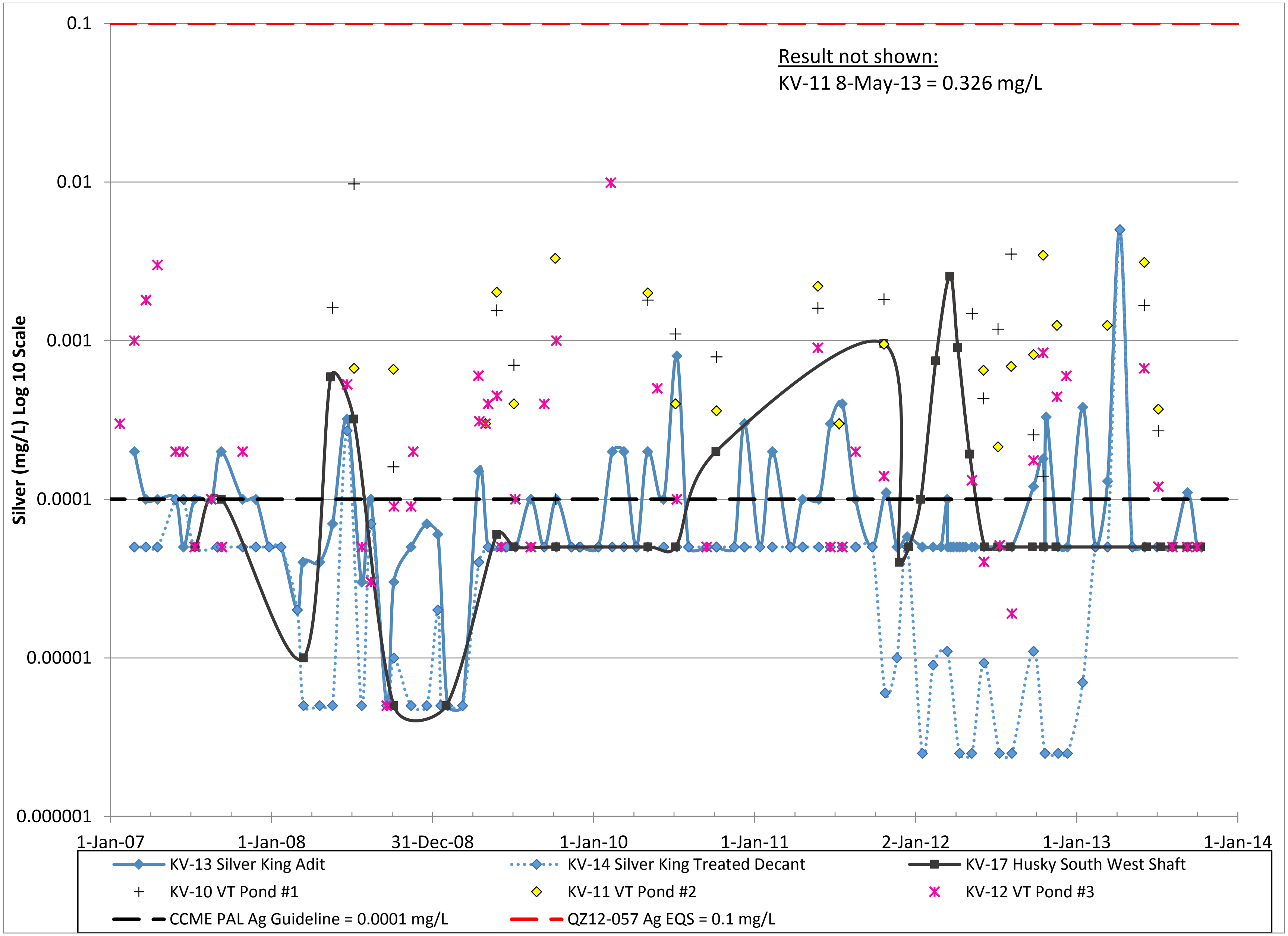
Flat Creek



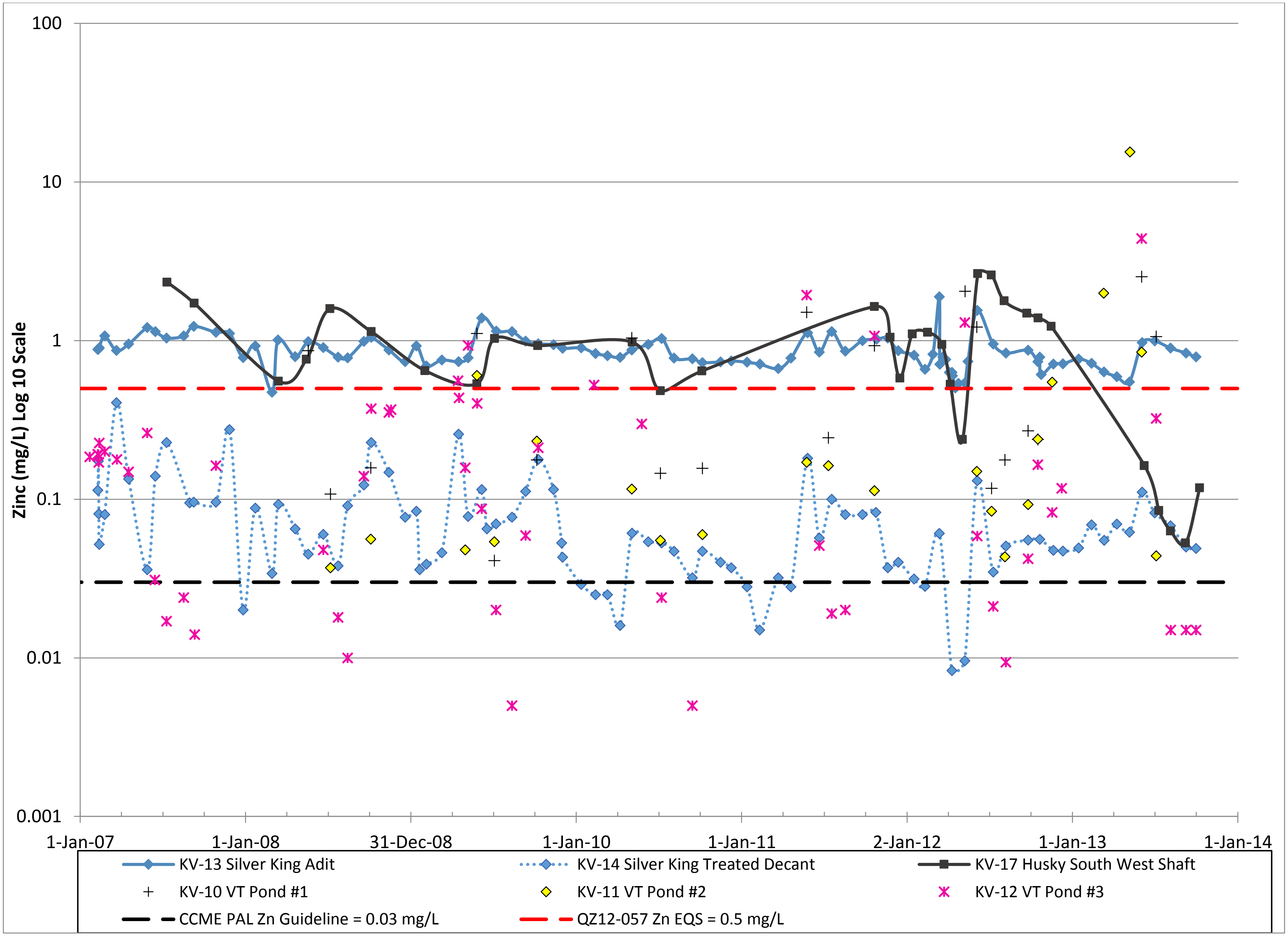
1
0.1
0.01
0.001
0.0001
Arsenic (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-13 Silver King Adit
KV-14 Silver King Treated Decant
KV-17 Husky South West Shaft
KV-10 VT Pond #1
KV-11 VT Pond #2
KV-12 VT Pond #3
CCME PAL As Guideline = 0.005 mg/L
QZ12-057 As EQS = 0.5 mg/L


1
0.1
0.01
0.001
0.0001
0.00001
Cadmium (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-13 Silver King Adit
KV-14 Silver King Treated Decant
KV-17 Husky South West Shaft
KV-10 VT Pond #1
KV-11 VT Pond #2
KV-12 VT Pond #3
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L
QZ12-057 Cd EQS = 0.05 mg/L


Results not shown:
KV-11 11-Mar-13 = 1.1 mg/L
KV-11: 08-May-13 = 10.9 mg/L
Lead (mg/L) Log 10 Scale
1
0.1
0.01
0.001
0.0001
0.00001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-13 Silver King Adit
KV-14 Silver King Treated Decant
KV-17 Husky South West Shaft
KV-10 VT Pond #1
KV-11 VT Pond #2
KV-12 VT Pond #3
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L
QZ12-057 Pb EQS = 0.2 mg/L

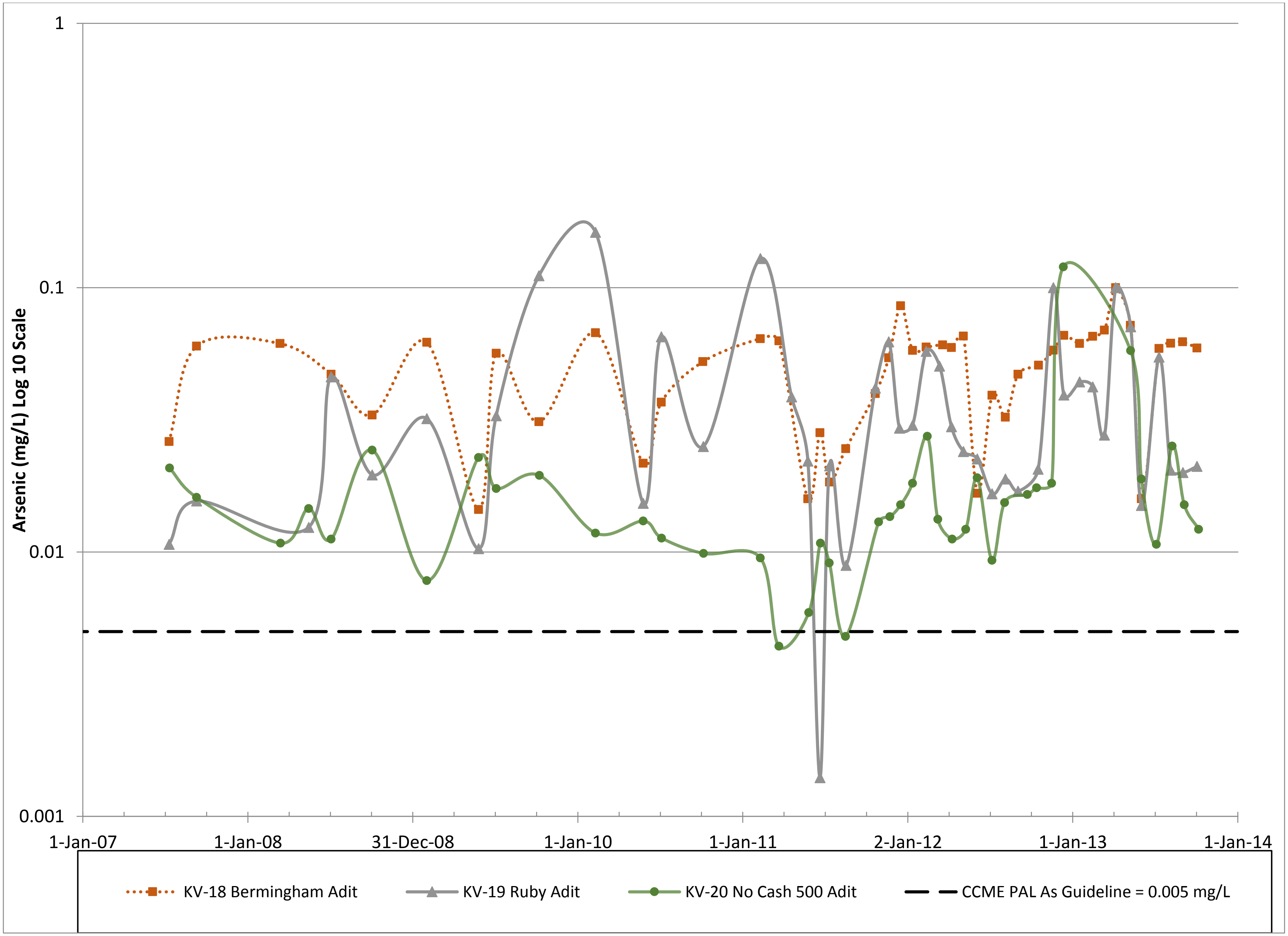


Result not shown:
KV-11 8-May-13 = 0.326 mg/L
Silver (mg/L) Log 10 Scale
0.1
0.01
0.001
0.0001
0.00001
0.000001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-13 Silver King Adit
KV-14 Silver King Treated Decant
KV-17 Husky South West Shaft
KV-10 VT Pond #1
KV-11 VT Pond #2
KV-12 VT Pond #3
CCME PAL Ag Guideline = 0.0001 mg/L
QZ12-057 Ag EQS = 0.1 mg/L

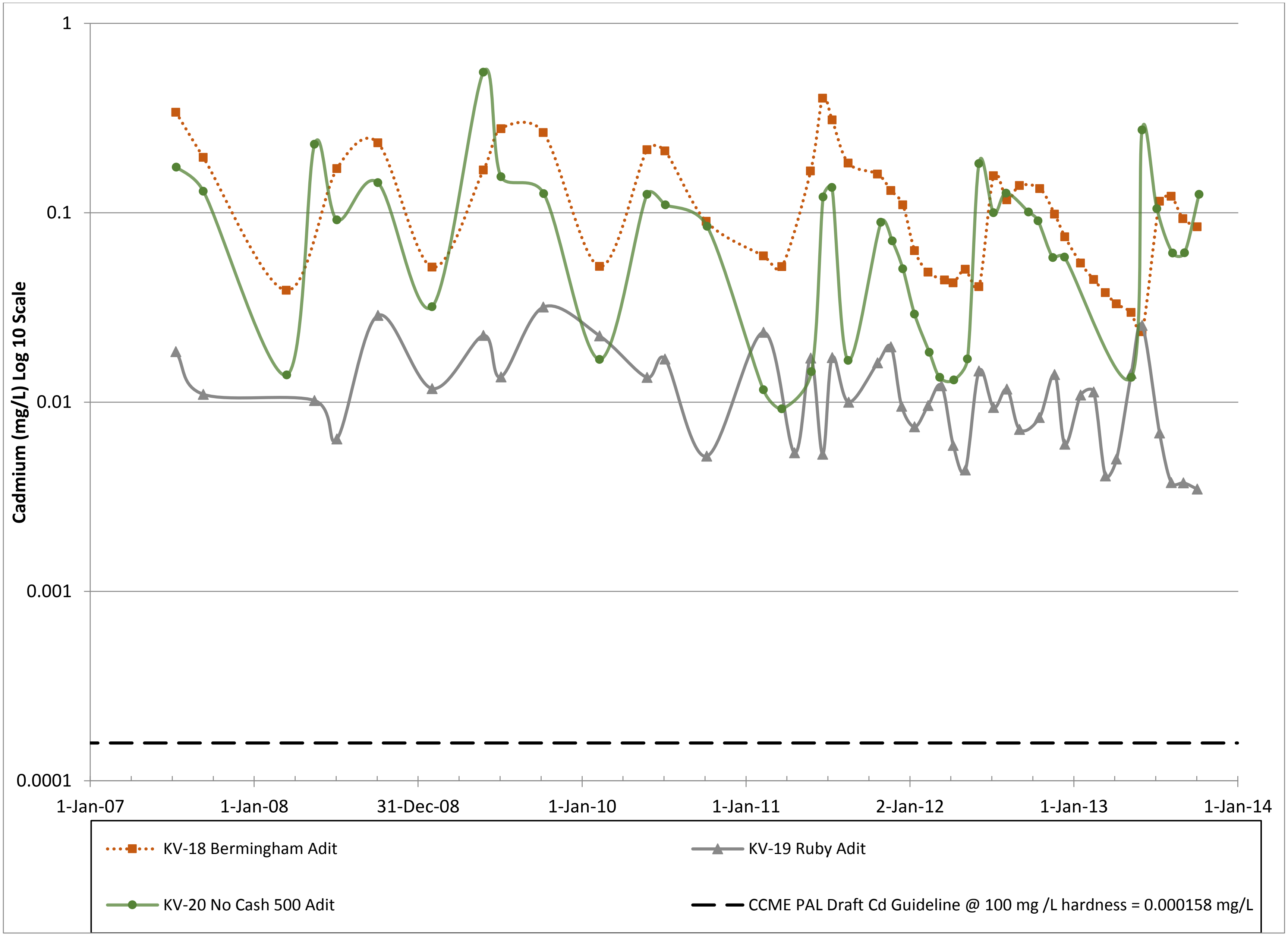


Zinc (mg/L) Log 10 Scale
100
10
1
0.1
0.01
0.001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-13 Silver King Adit
KV-14 Silver King Treated Decant
KV-17 Husky South West Shaft
KV-10 VT Pond #1
KV-11 VT Pond #2
KV-12 VT Pond #3
CCME PAL Zn Guideline = 0.03 mg/L
QZ12-057 Zn EQS = 0.5 mg/L

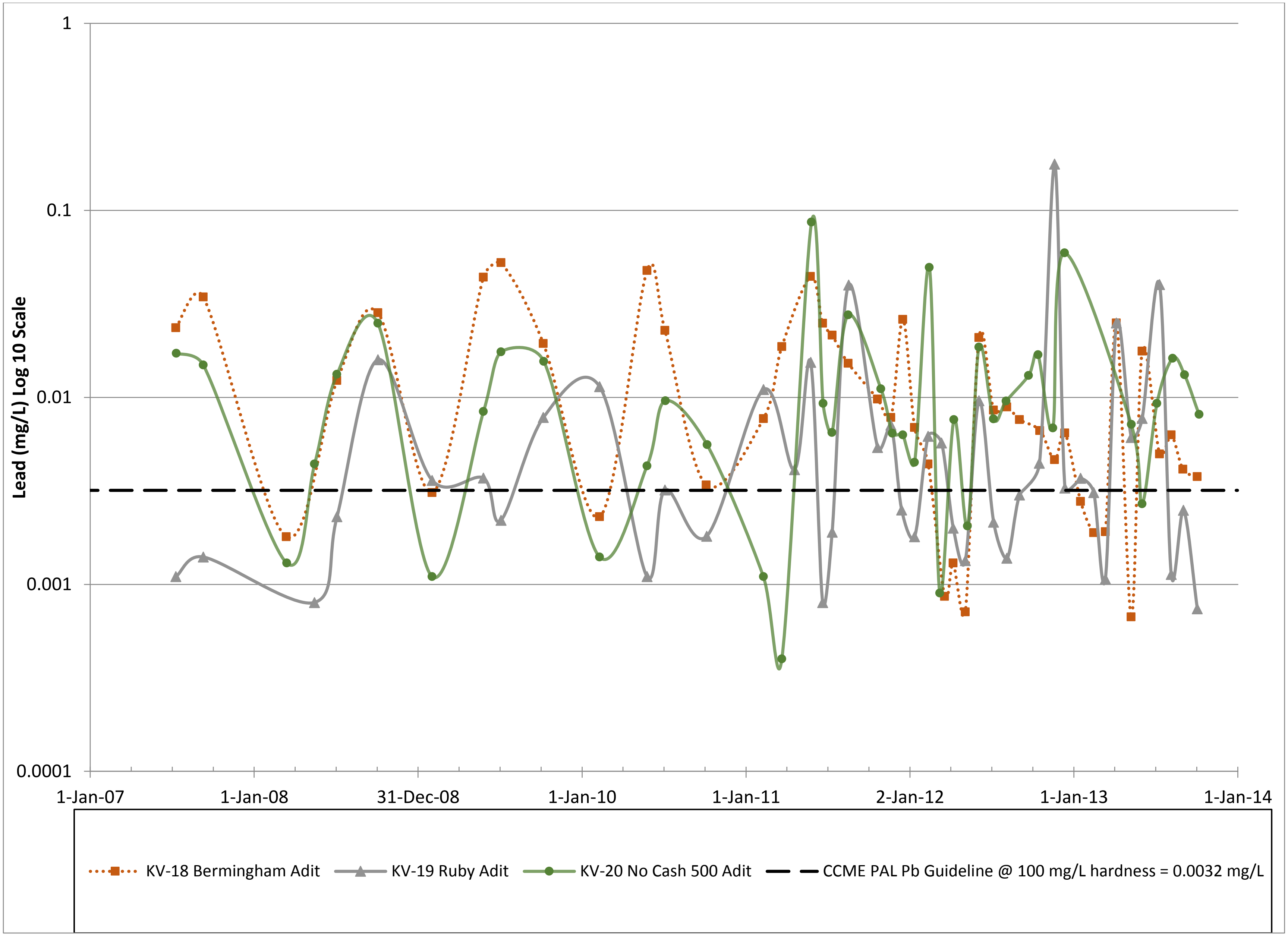
No Cash Bog



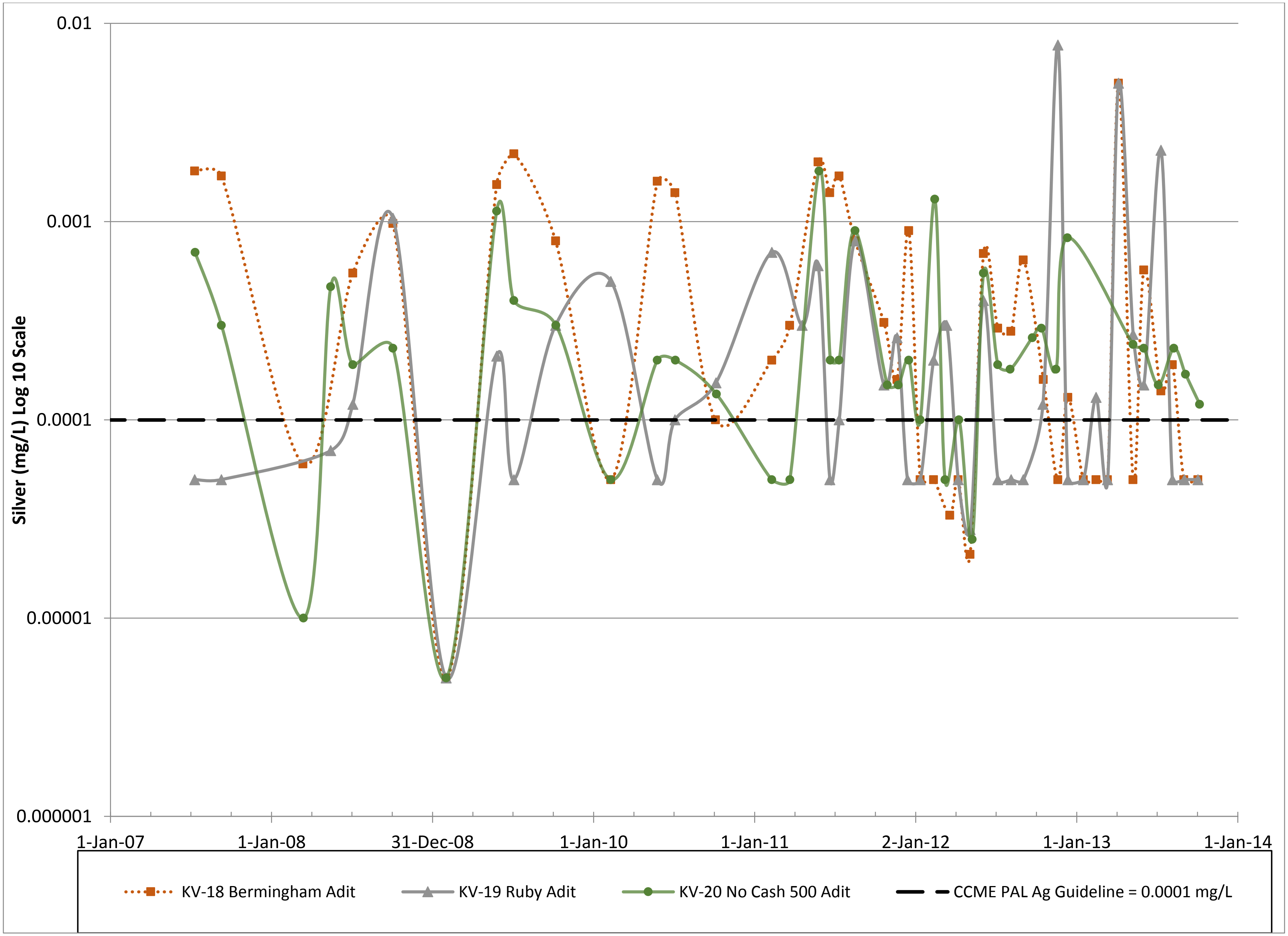
1
0.1
0.01
0.001
Arsenic (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-18 Bermingham Adit
KV-19 Ruby Adit
KV-20 No Cash 500 Adit
CCME PAL As Guideline = 0.005 mg/L



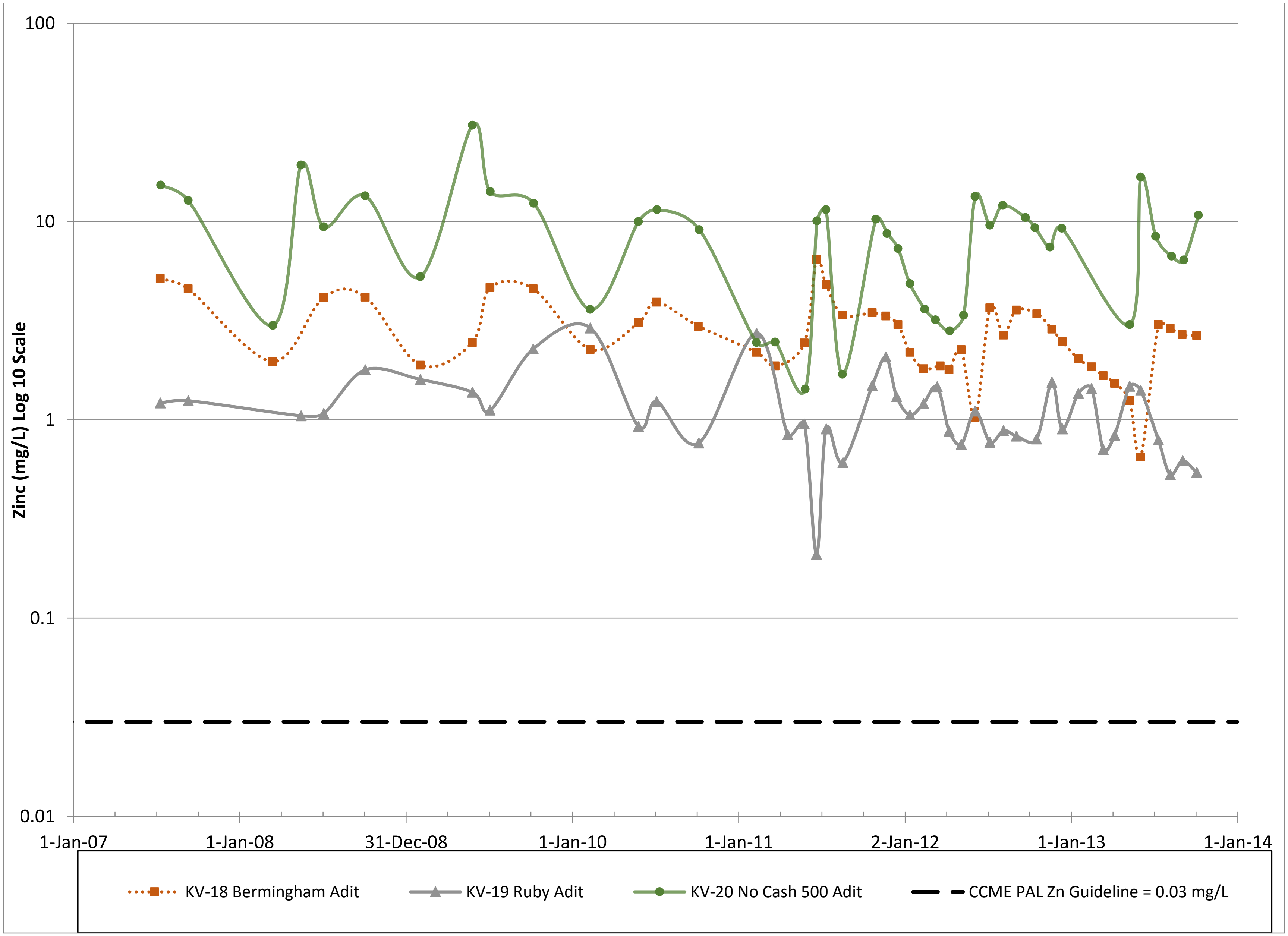
Cadmium (mg/L) Log 10 Scale
1
0.1
0.01
0.001
0.0001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-18 Bermingham Adit
KV-19 Ruby Adit
KV-20 No Cash 500 Adit
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L



Lead (mg/L) Log 10 Scale
1
0.1
0.01
0.001
0.0001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-18 Bermingham Adit
KV-19 Ruby Adit
KV-20 No Cash 500 Adit
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L

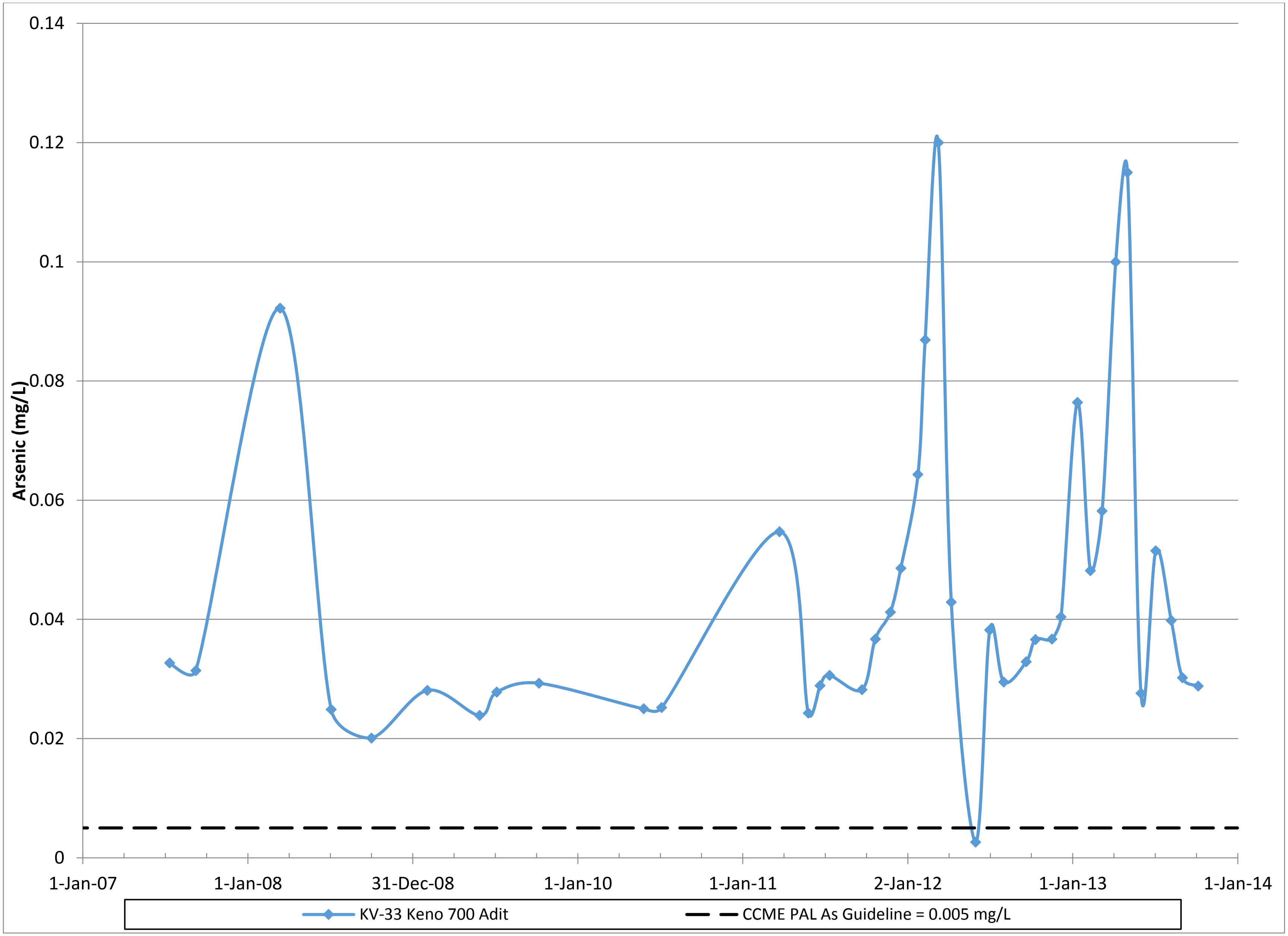


Silver (mg/L) Log 10 Scale
0.01
0.001
0.0001
0.00001
0.000001
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-18 Bermingham Adit
KV-19 Ruby Adit
KV-20 No Cash 500 Adit
CCME PAL Ag Guideline = 0.0001 mg/L

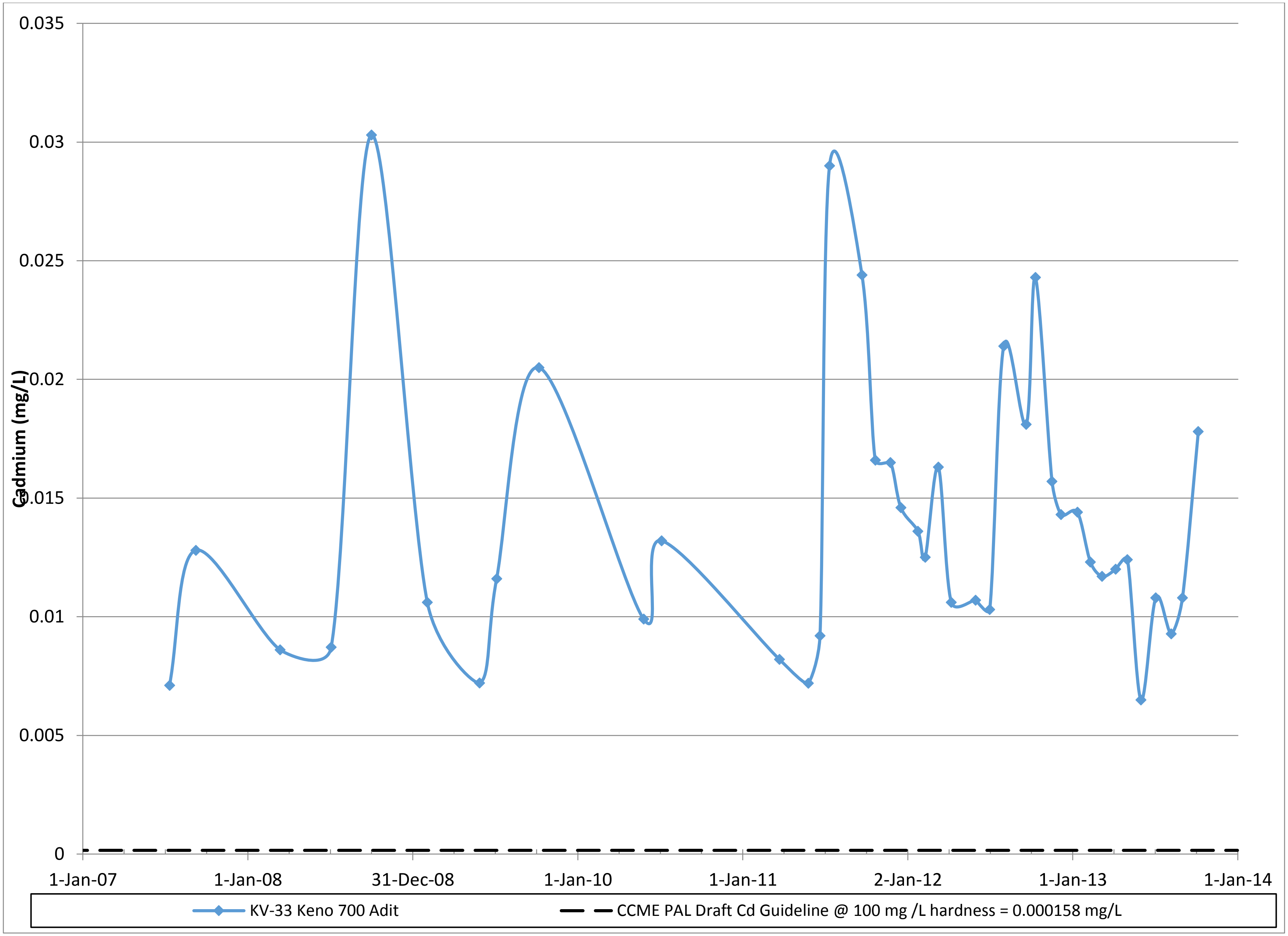


100
10
1
0.1
0.01
Zinc (mg/L) Log 10 Scale
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-18 Bermingham Adit
KV-19 Ruby Adit
KV-20 No Cash 500 Adit
CCME PAL Zn Guideline = 0.03 mg/L

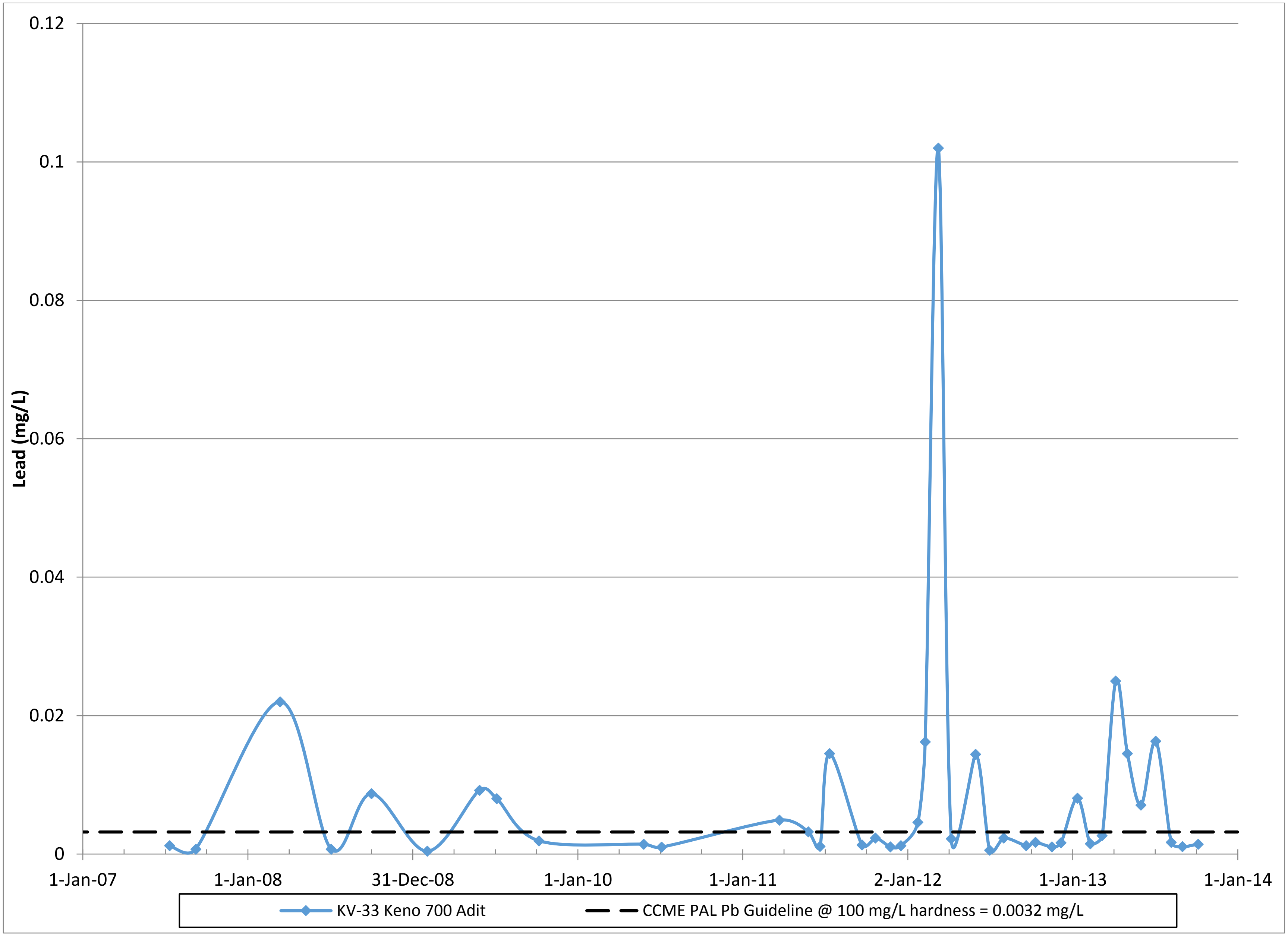
Lightning Creek



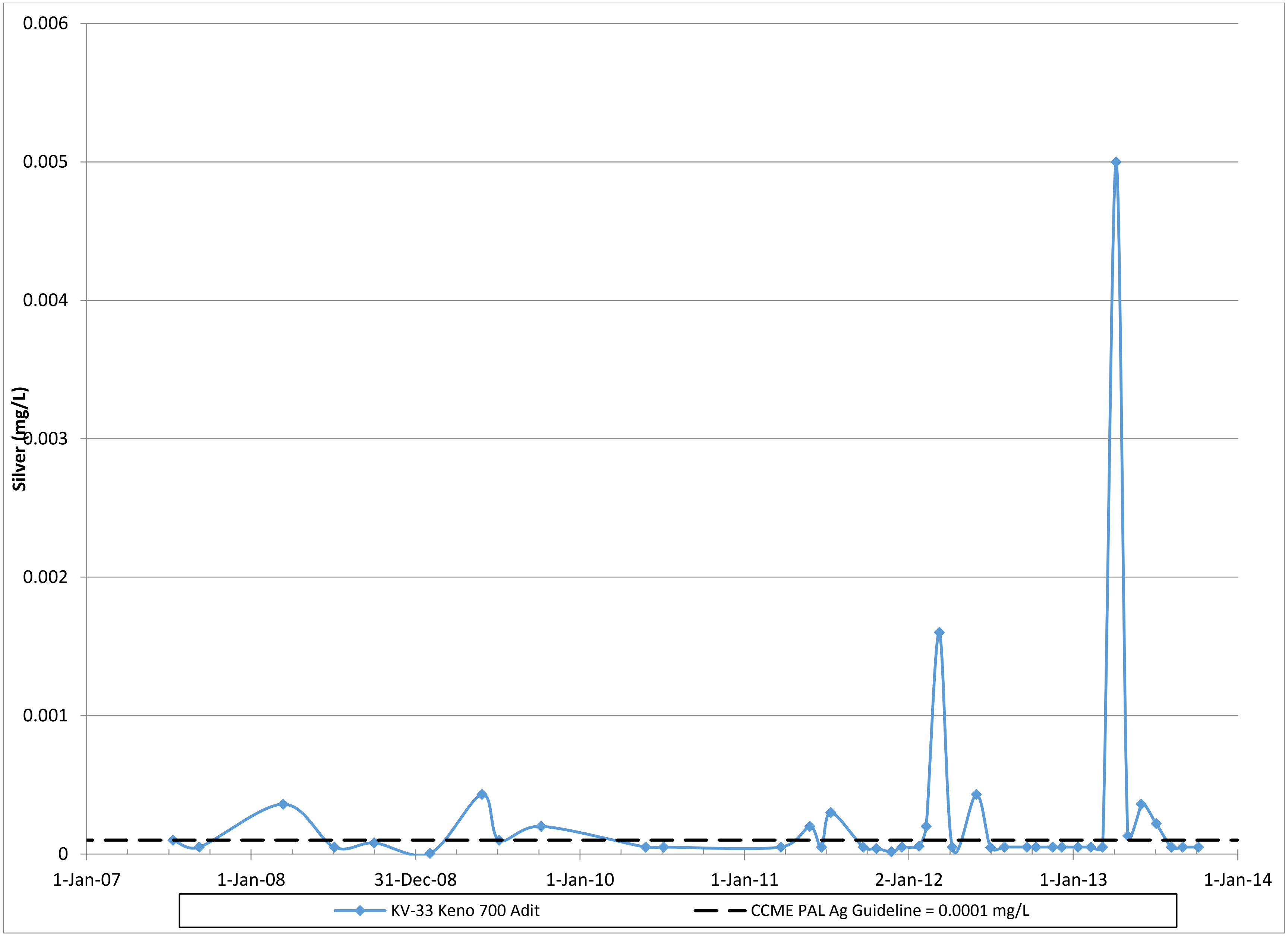
Arsenic (mg/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-33 Keno 700 Adit
CCME PAL As Guideline = 0.005 mg/L



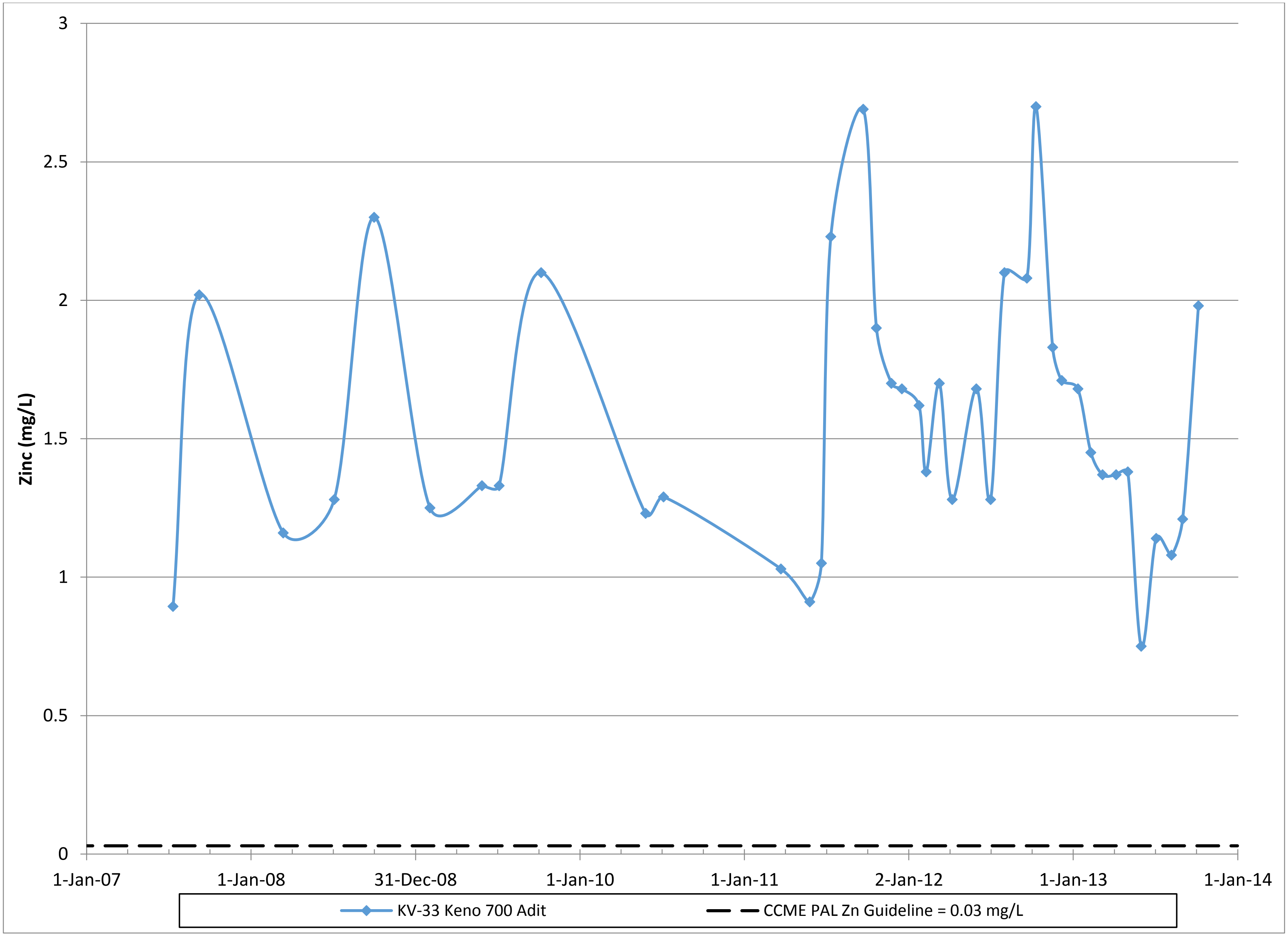
Cadmium (mg/L)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-33 Keno 700 Adit
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L



0.12
0.1
0.08
0.06
0.04
0.02
0
Lead (mg/L)
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-33 Keno 700 Adit
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L

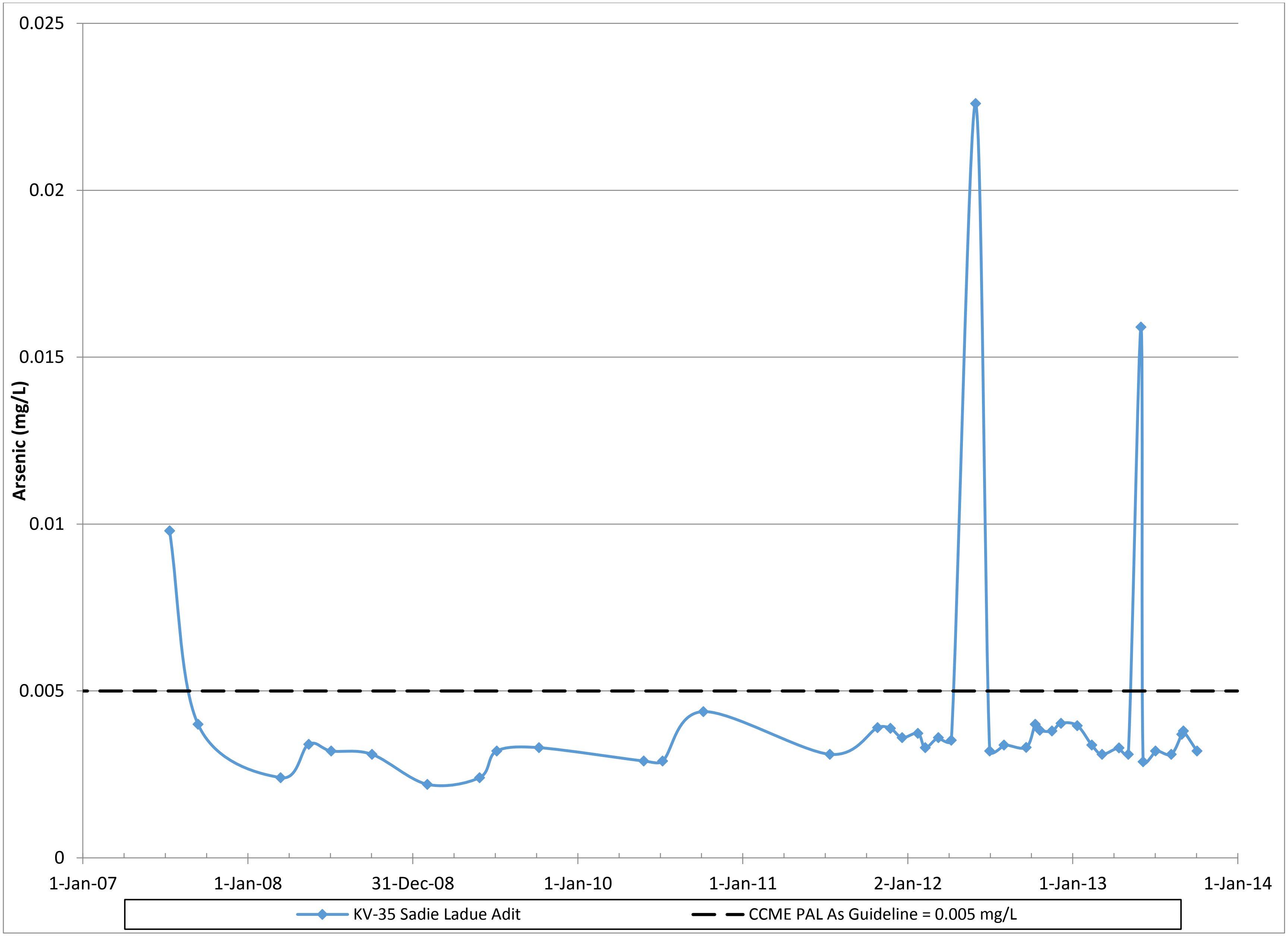


0.006
0.005
0.004
0.003
0.002
0.001
0
Silver (mg/L)
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-33 Keno 700 Adit
CCME PAL Ag Guideline = 0.0001 mg/L

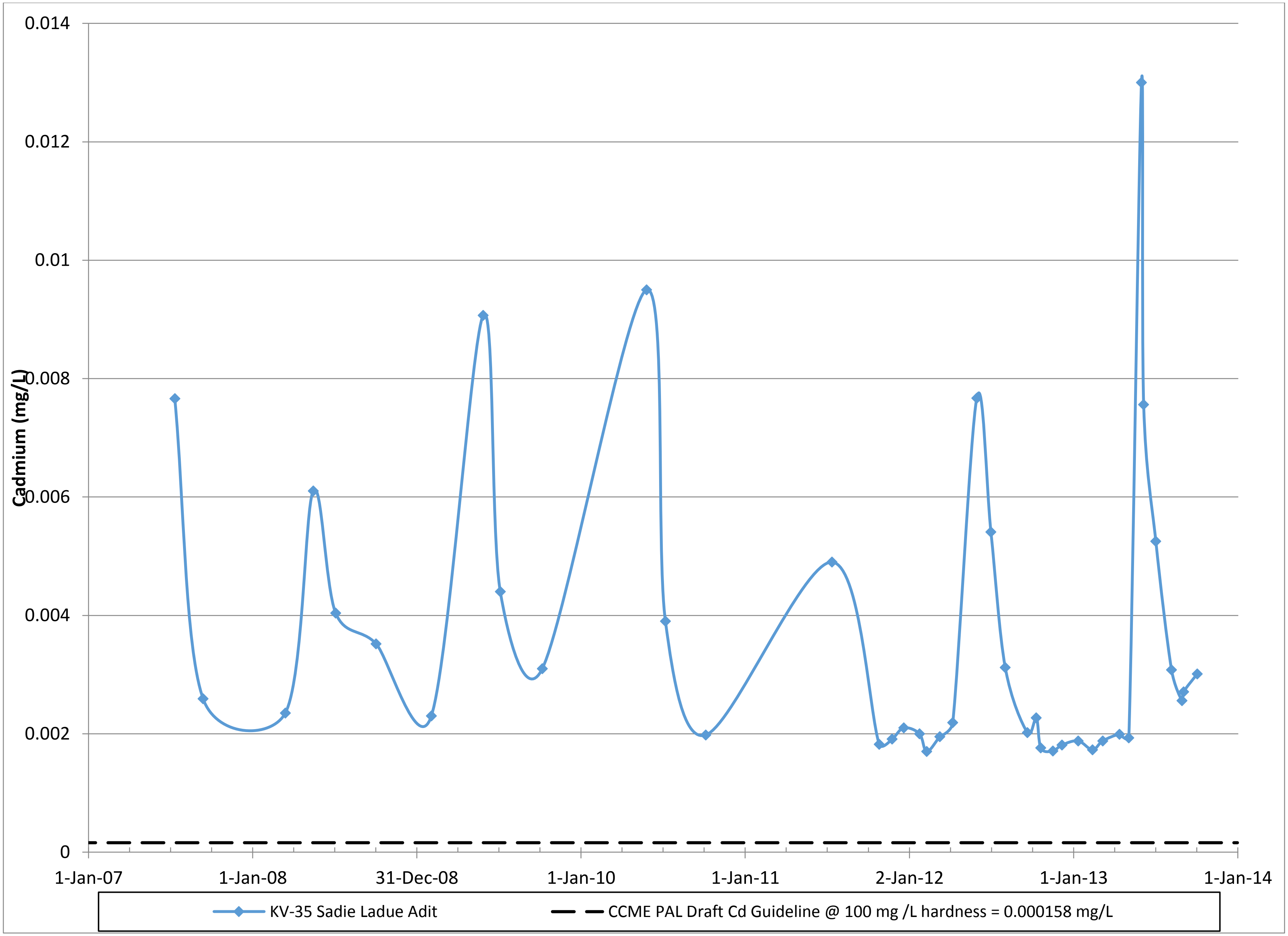


3
2.5
2
1.5
1
0.5
0
Zinc (mg/L)
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-33 Keno 700 Adit
CCME PAL Zn Guideline = 0.03 mg/L

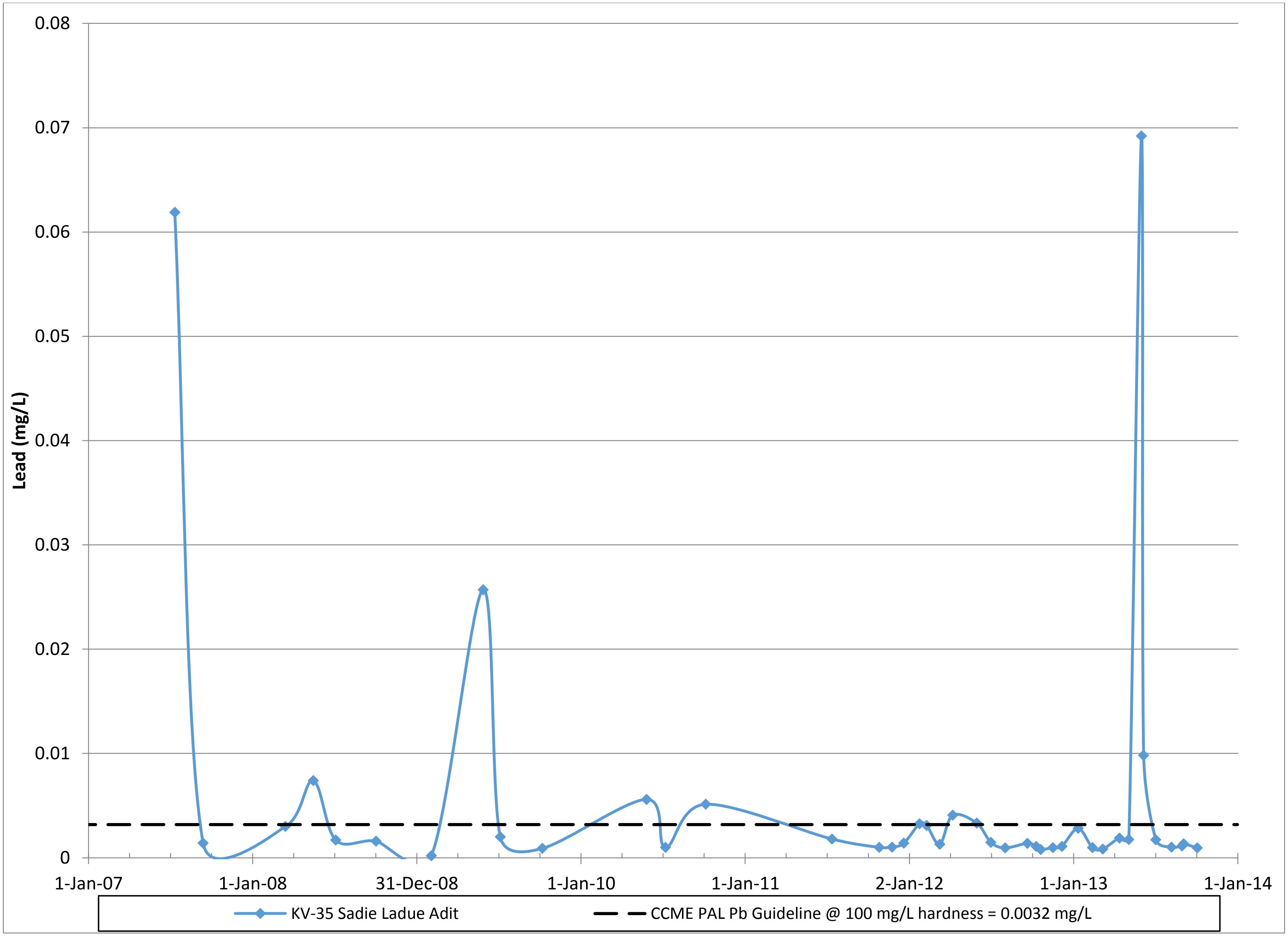
Sadie-Ladue



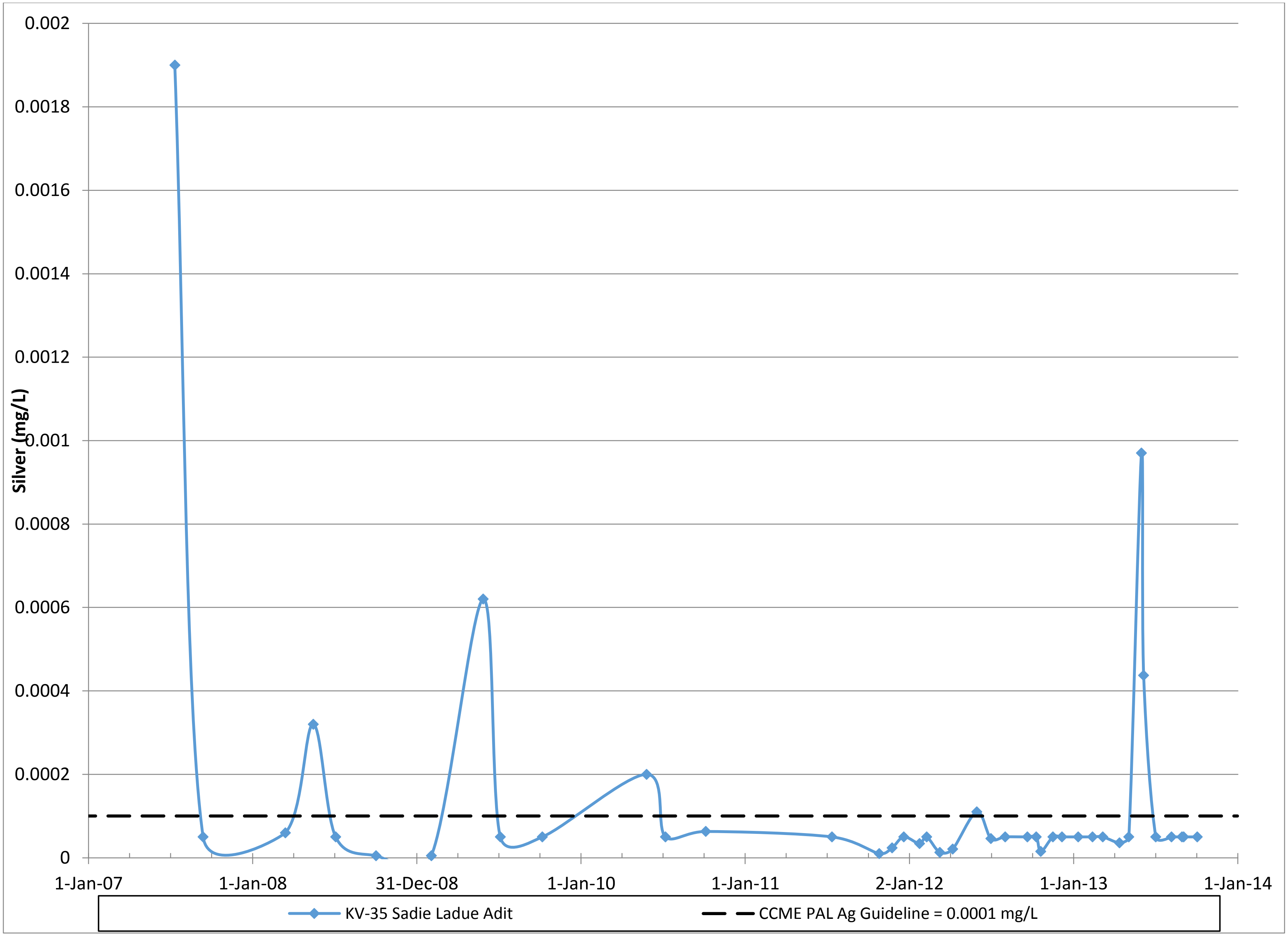
Arsenic (mg/L)
0.025
0.02
0.015
0.01
0.005
0
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-35 Sadie Ladue Adit
CCME PAL As Guideline = 0.005 mg/L

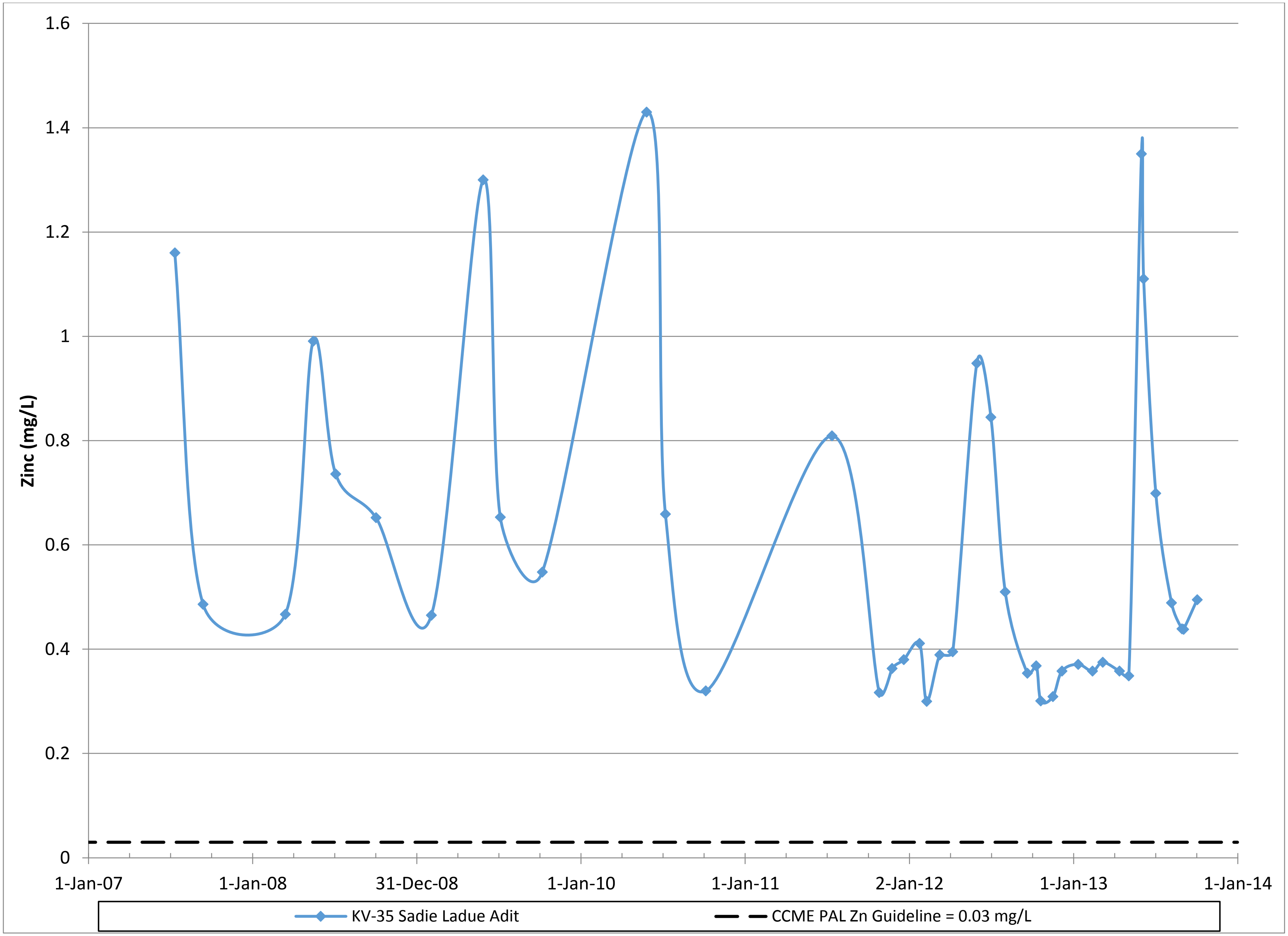


Cadmium (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-35 Sadie Ladue Adit
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L



Lead (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-35 Sadie Ladue Adit
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L


0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Silver (mg/L)
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-35 Sadie Ladue Adit
CCME PAL Ag Guideline = 0.0001 mg/L



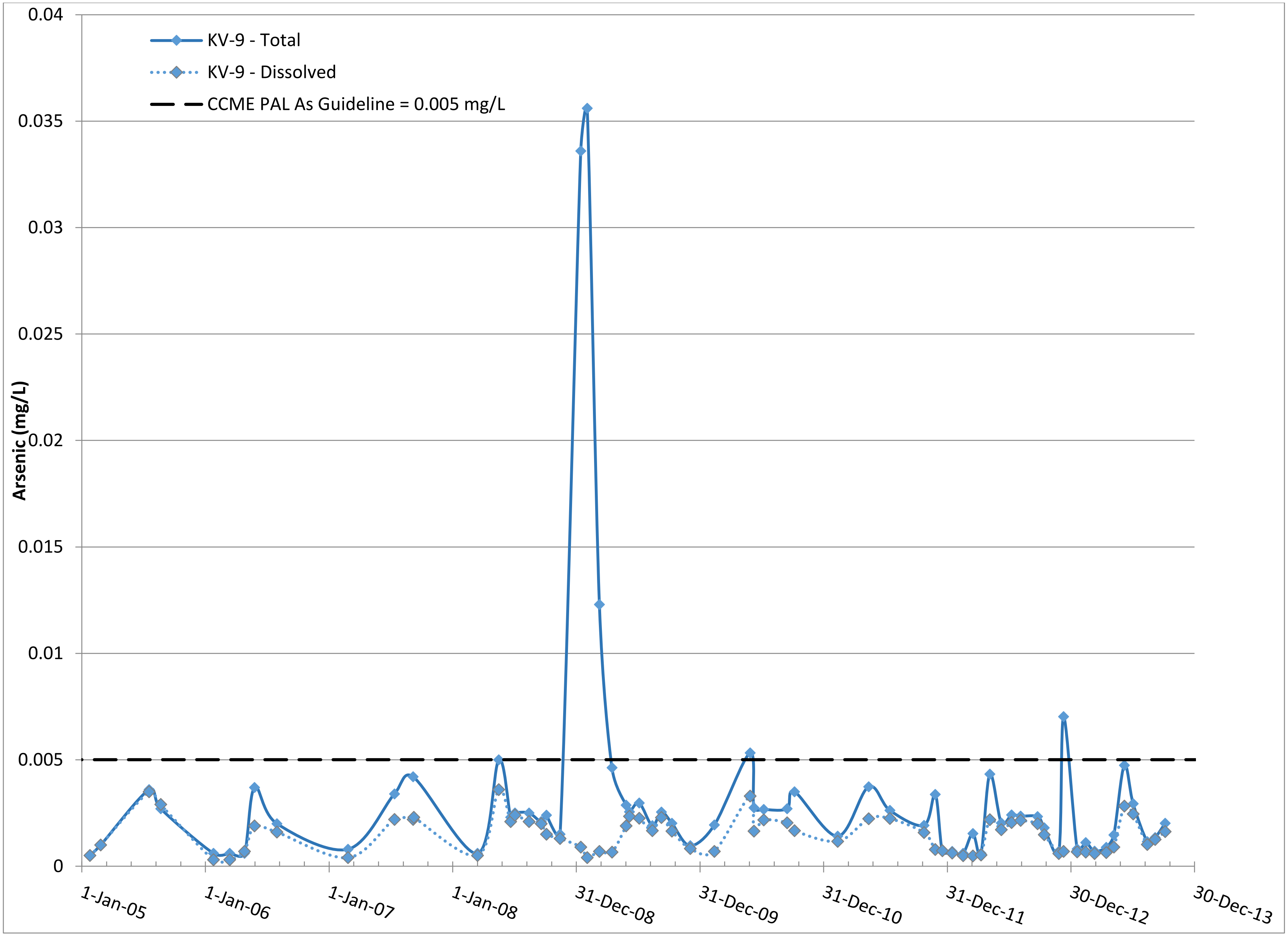
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Zinc (mg/L)
1-Jan-07
1-Jan-08
31-Dec-08
1-Jan-10
1-Jan-11
2-Jan-12
1-Jan-13
1-Jan-14
KV-35 Sadie Ladue Adit
CCME PAL Zn Guideline = 0.03 mg/L

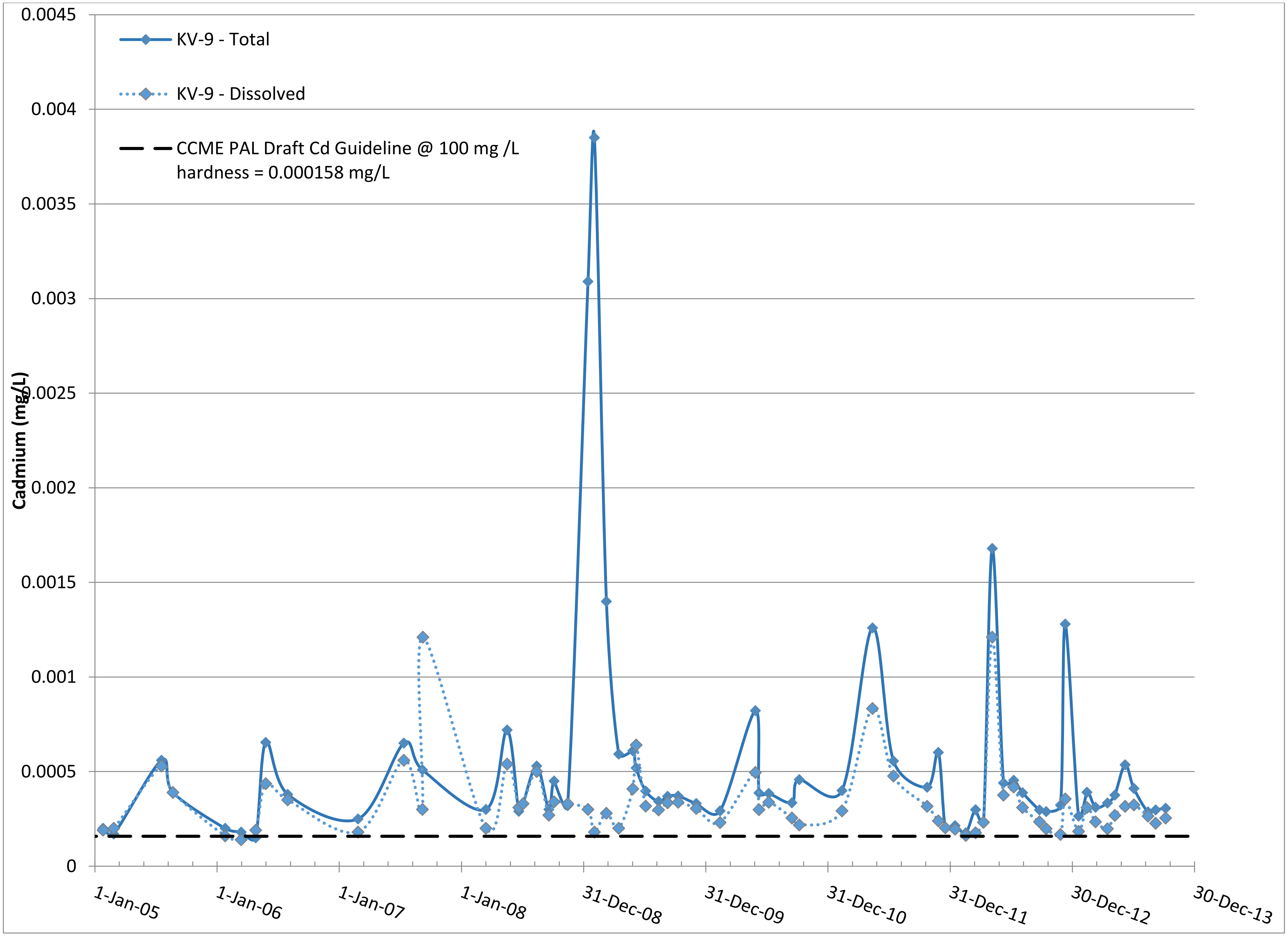
APPENDIX XX

CHRISTAL, FLAT AND LIGHTNING CREEK RECEIVING ENVIRONMENT AS, CD, PB, AG, ZN WATER QUALITY DATA

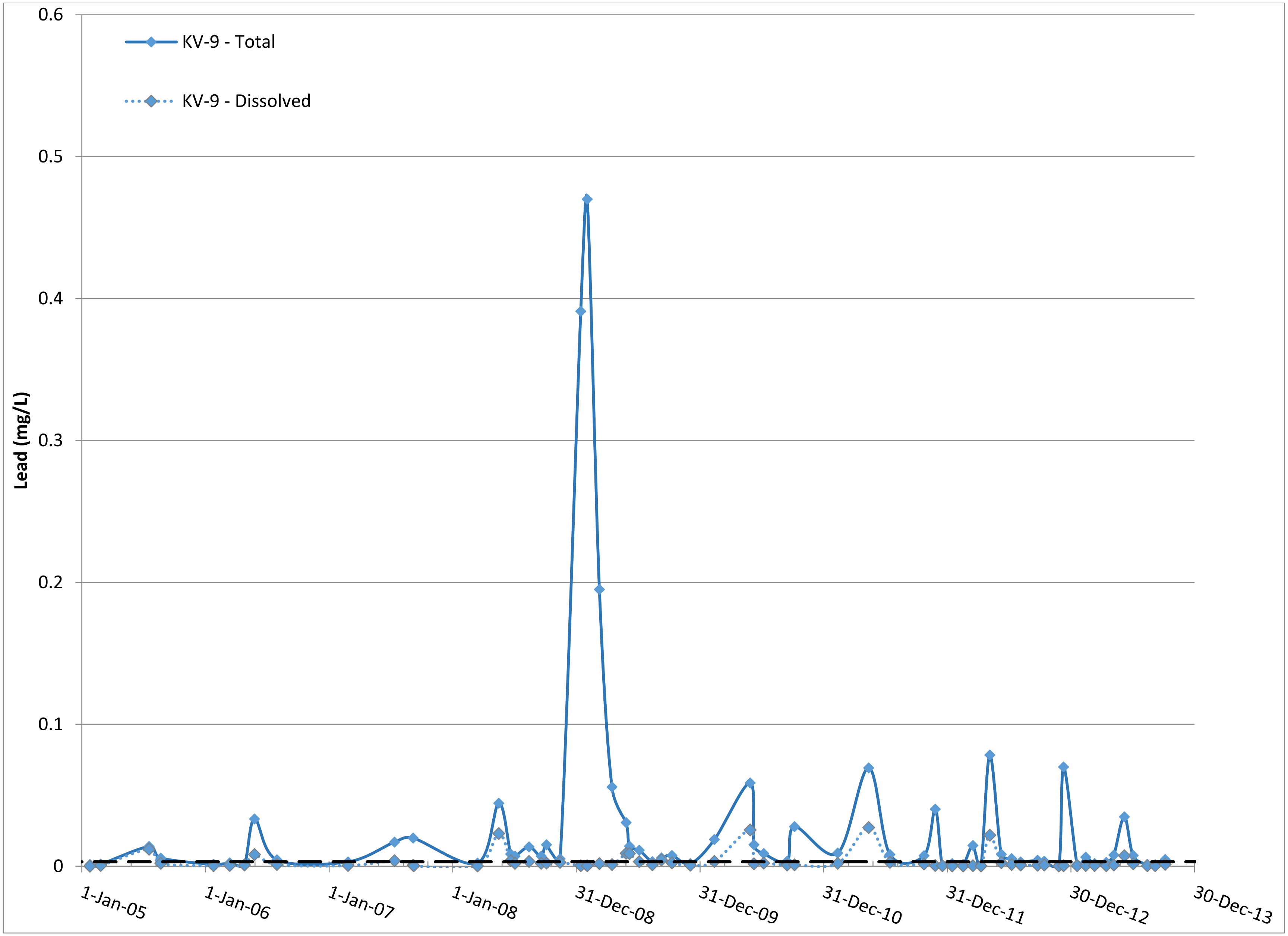
Christal Creek

Flat Creek

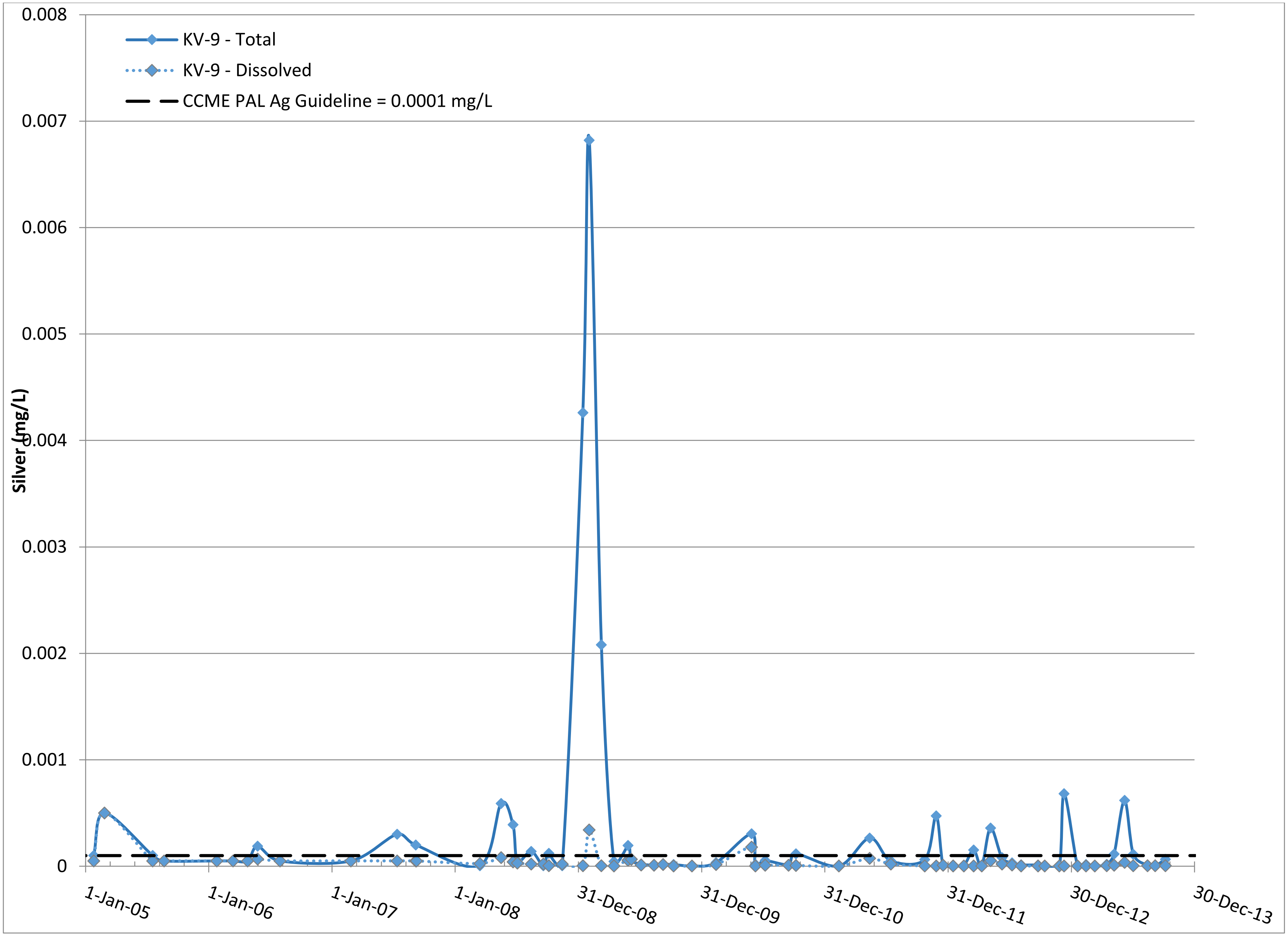

KV-9 - Total
KV-9 - Dissolved
CCME PAL As Guideline = 0.005 mg/L
Arsenic (mg/L)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13



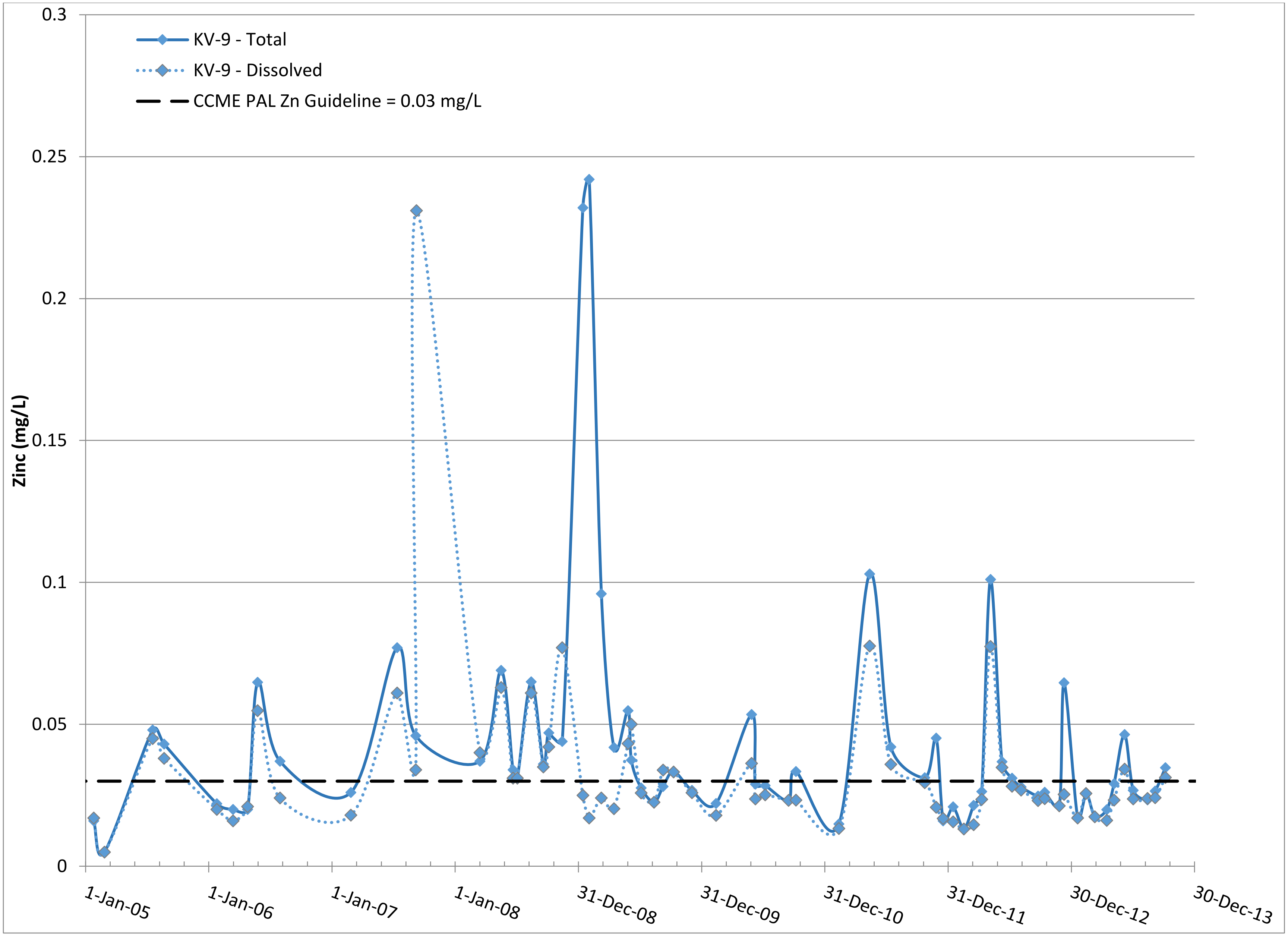
Cadmium (mg/L)
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
KV-9 - Total
KV-9 - Dissolved
CCME PAL Draft Cd Guideline @ 100 mg /L
hardness = 0.000158 mg/L
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13



KV-9 - Total
KV-9 - Dissolved
Lead (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13



0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Silver (mg/L)
KV-9 - Total
KV-9 - Dissolved
CCME PAL Ag Guideline = 0.0001 mg/L
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13

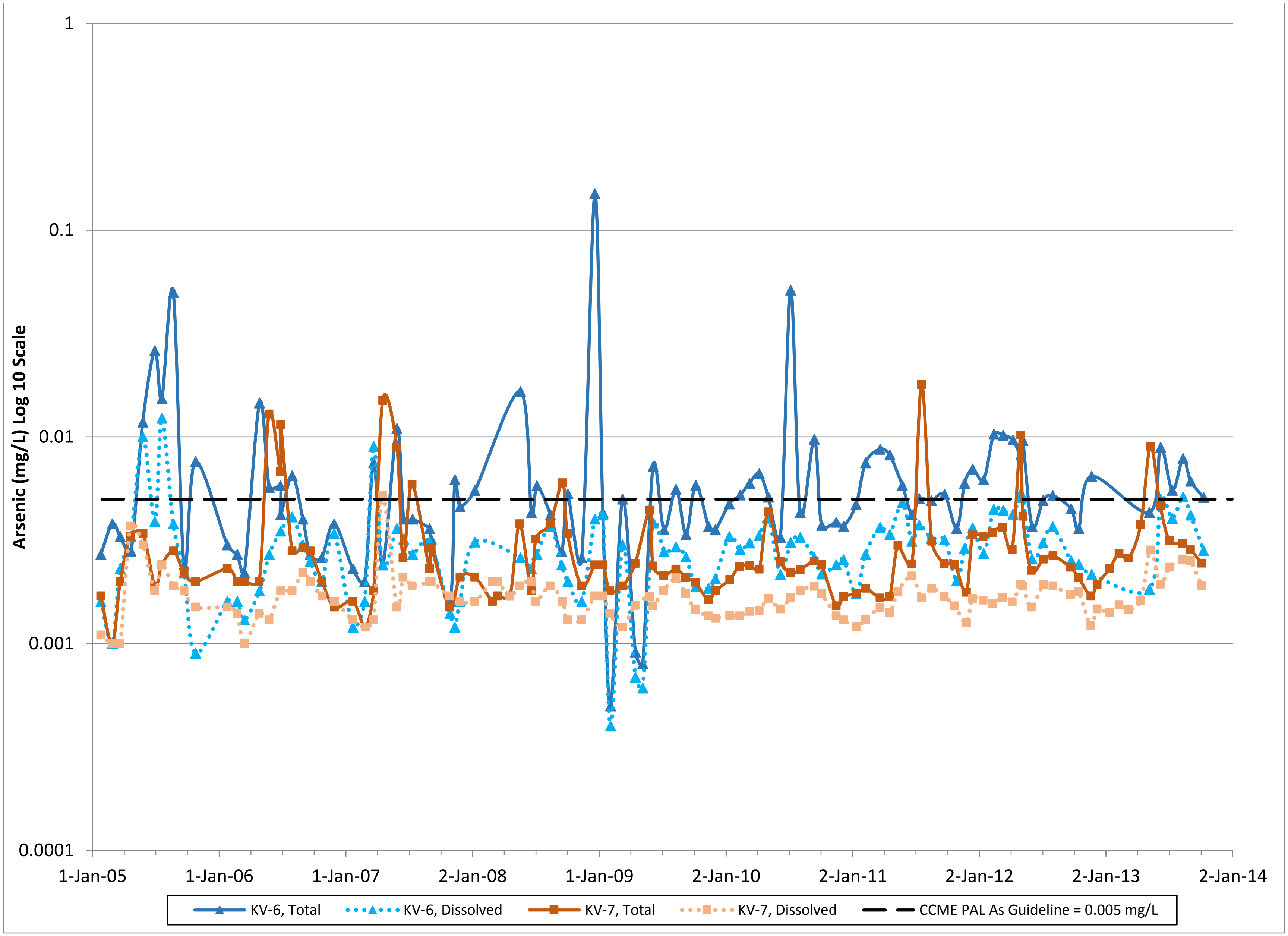


KV-9 - Total
KV-9 - Dissolved
CCME PAL Zn Guideline = 0.03 mg/L
Zinc (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13

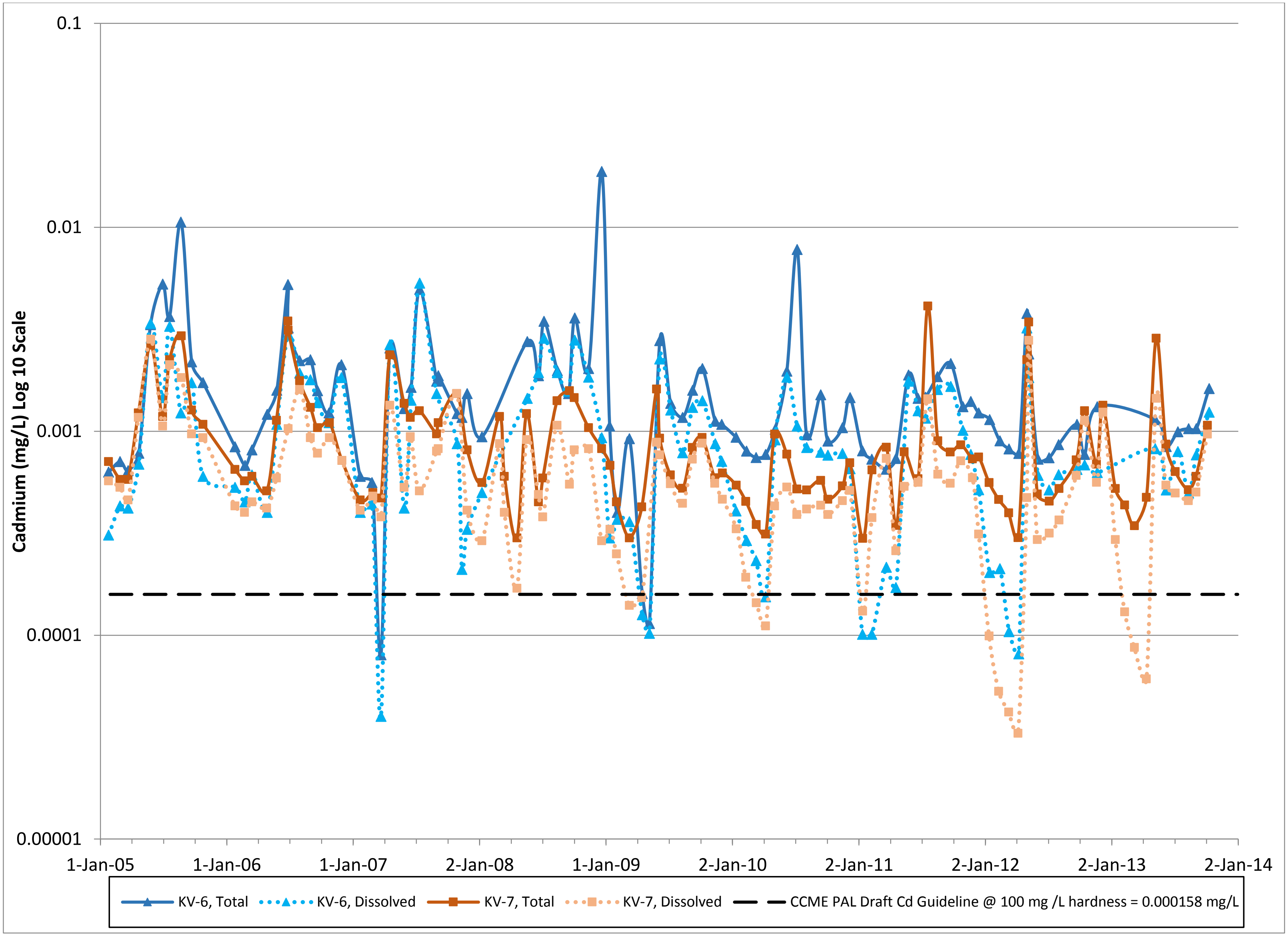
Lightning Creek

Total and drissolved concentrations of arsenic, cadmium, lead, silver, and zinc measured between 2007 and 2013 at water quality stations positioned in the receiving environment of the Christal (KV-6, KV-7), Flat (KV-9), and Lightning Creek (KV-41) watersheds are presented. For each element, the CCME guideline is indicated as is the effluent quality standard for those watersheds that contain one or more discharges that are regulated by the current Water Licence QZ12-057. The source data are available on the SharePoint portal and on request. The source data are available on the SharePoint portal and on request.

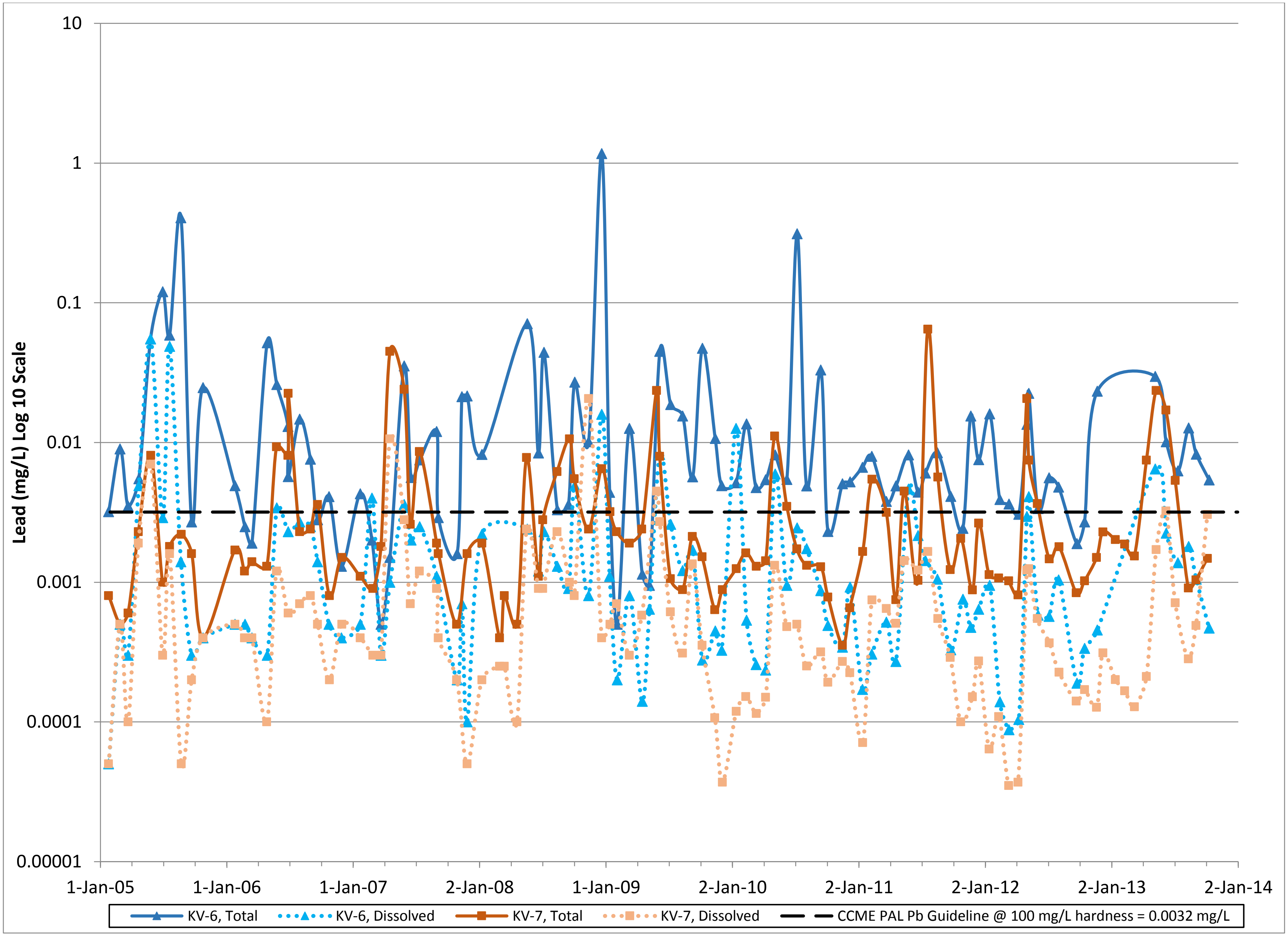
Christal Creek



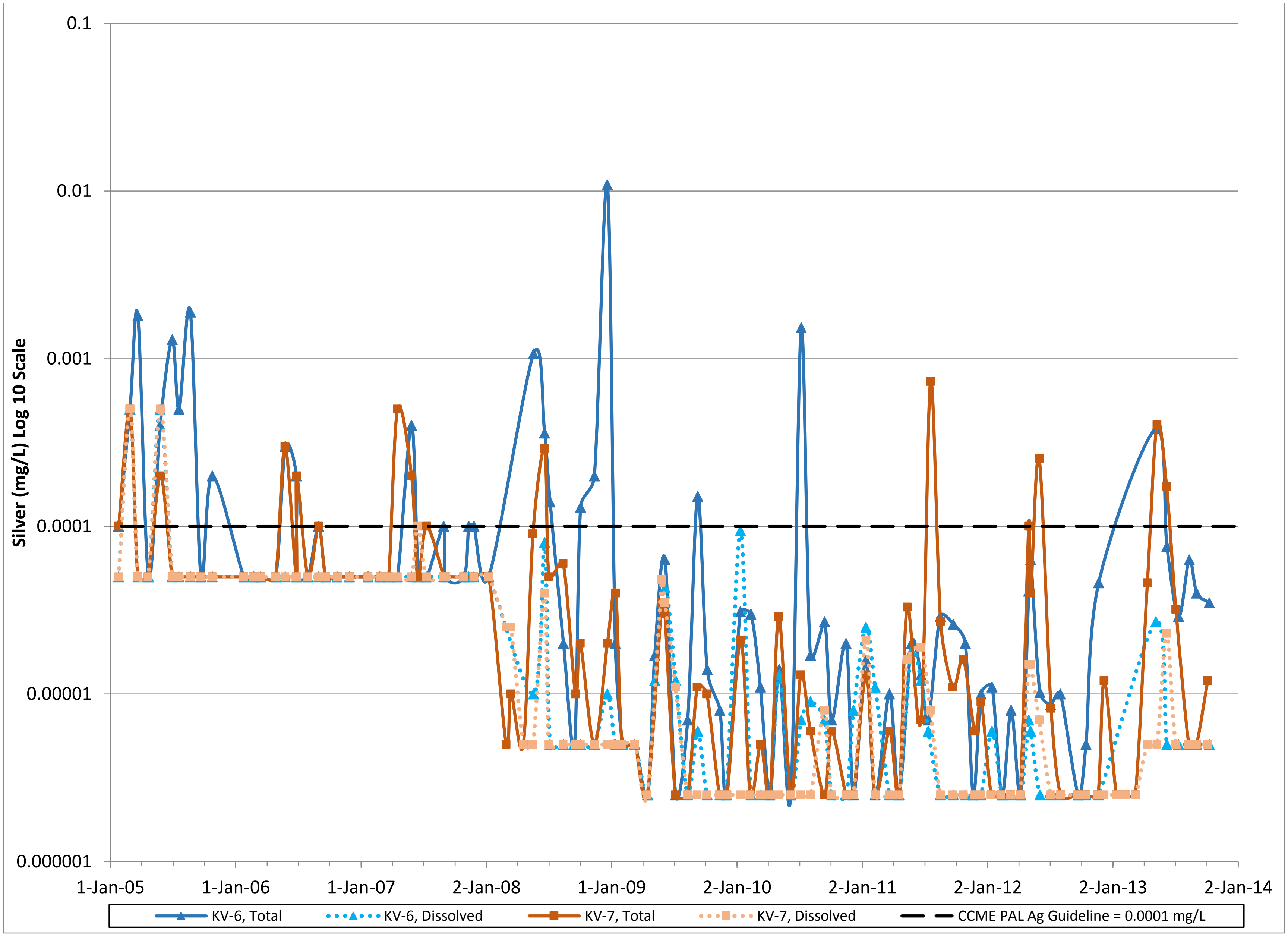
1
0.1
0.01
0.001
0.0001
Arsenic (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-6, Total
KV-6, Dissolved
KV-7, Total
KV-7, Dissolved
CCME PAL As Guideline = 0.005 mg/L

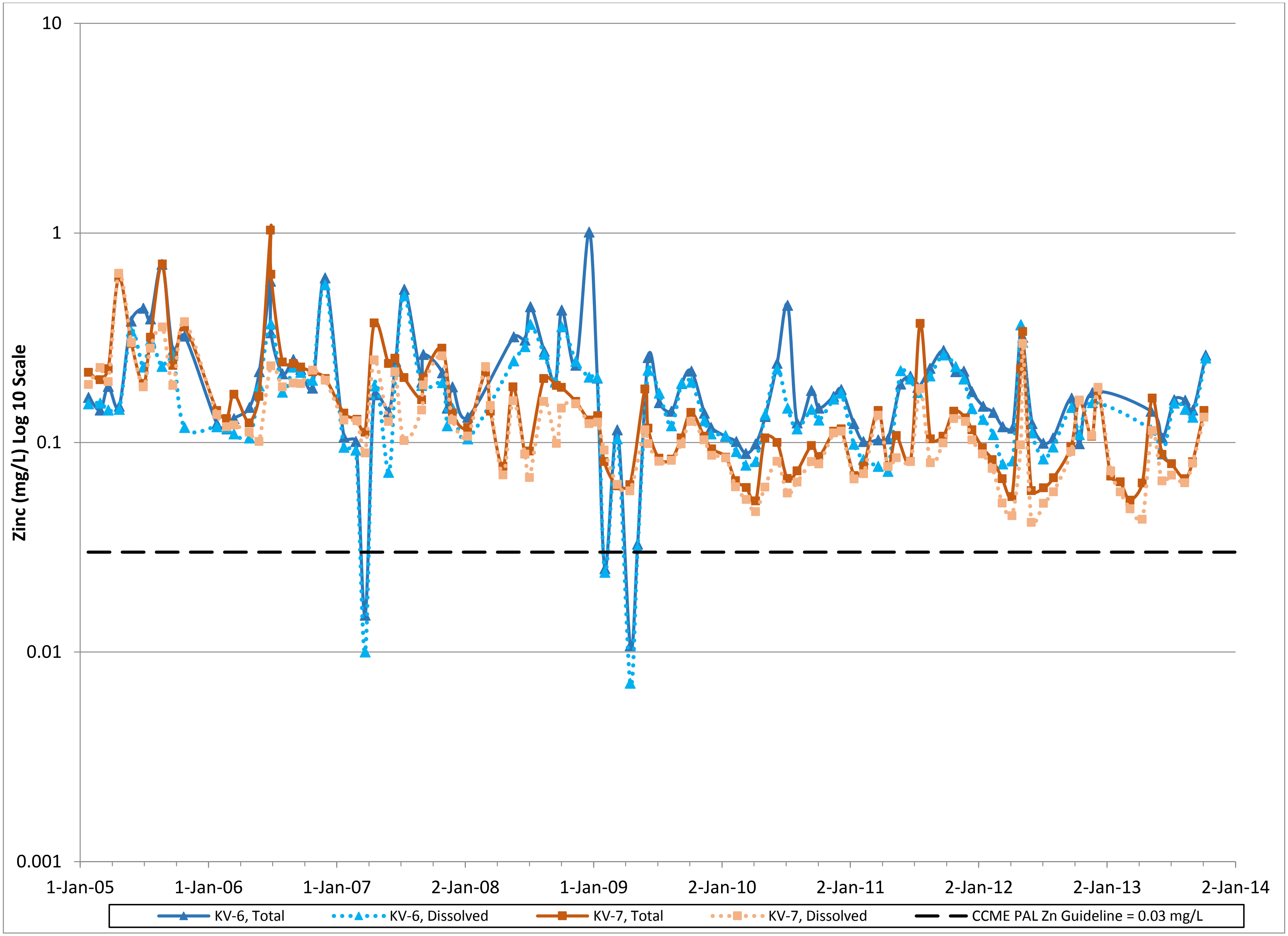


0.1
0.01
0.001
0.0001
0.00001
Cadmium (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-6, Total
KV-6, Dissolved
KV-7, Total
KV-7, Dissolved
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L



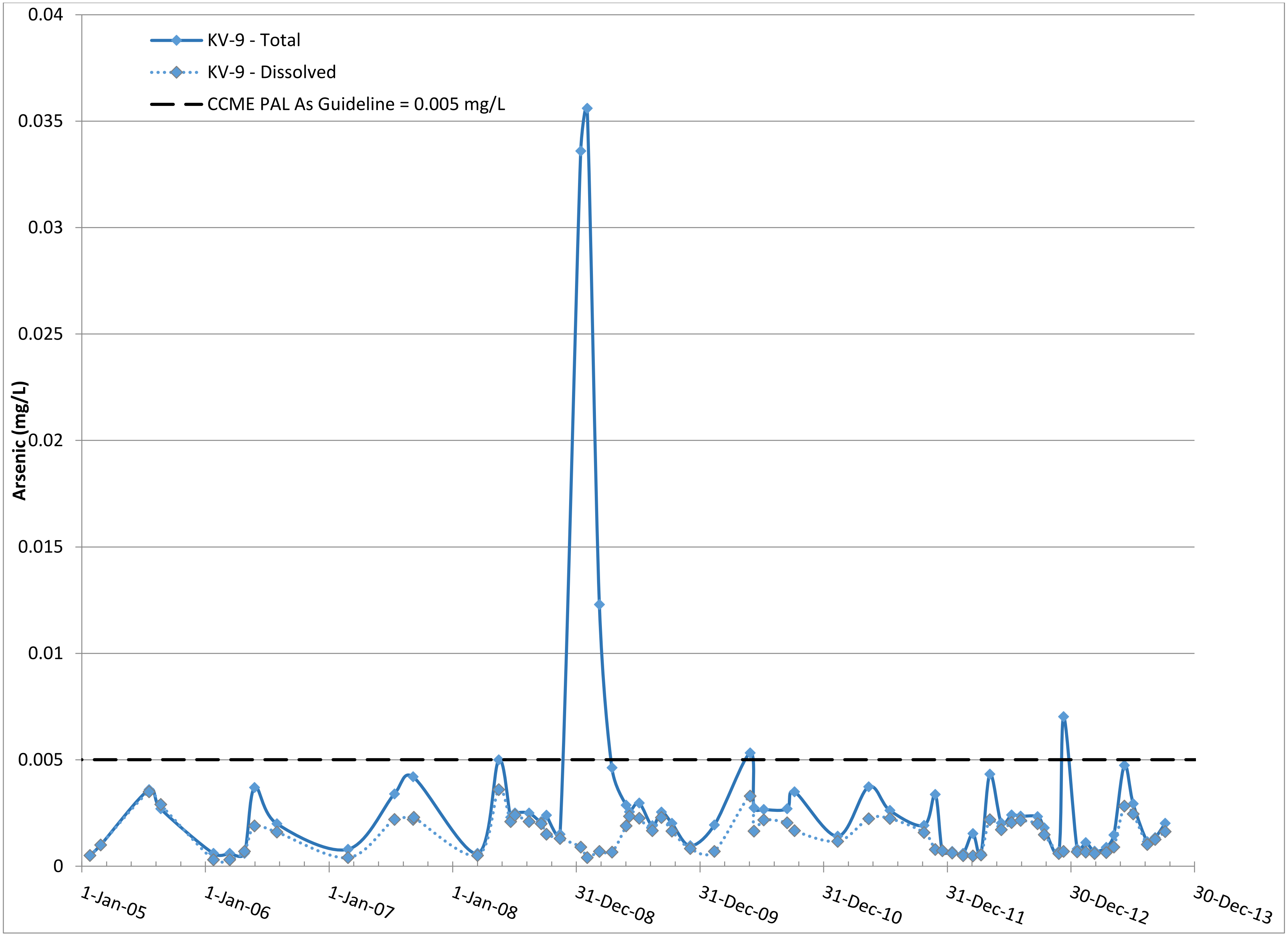
Lead (mg/L) Log 10 Scale
10
1
0.1
0.01
0.001
0.0001
0.00001
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-6, Total
KV-6, Dissolved
KV-7, Total
KV-7, Dissolved
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L


0.1
0.01
0.001
0.0001
0.00001
0.000001
Silver (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-6, Total
KV-6, Dissolved
KV-7, Total
KV-7, Dissolved
CCME PAL Ag Guideline = 0.0001 mg/L

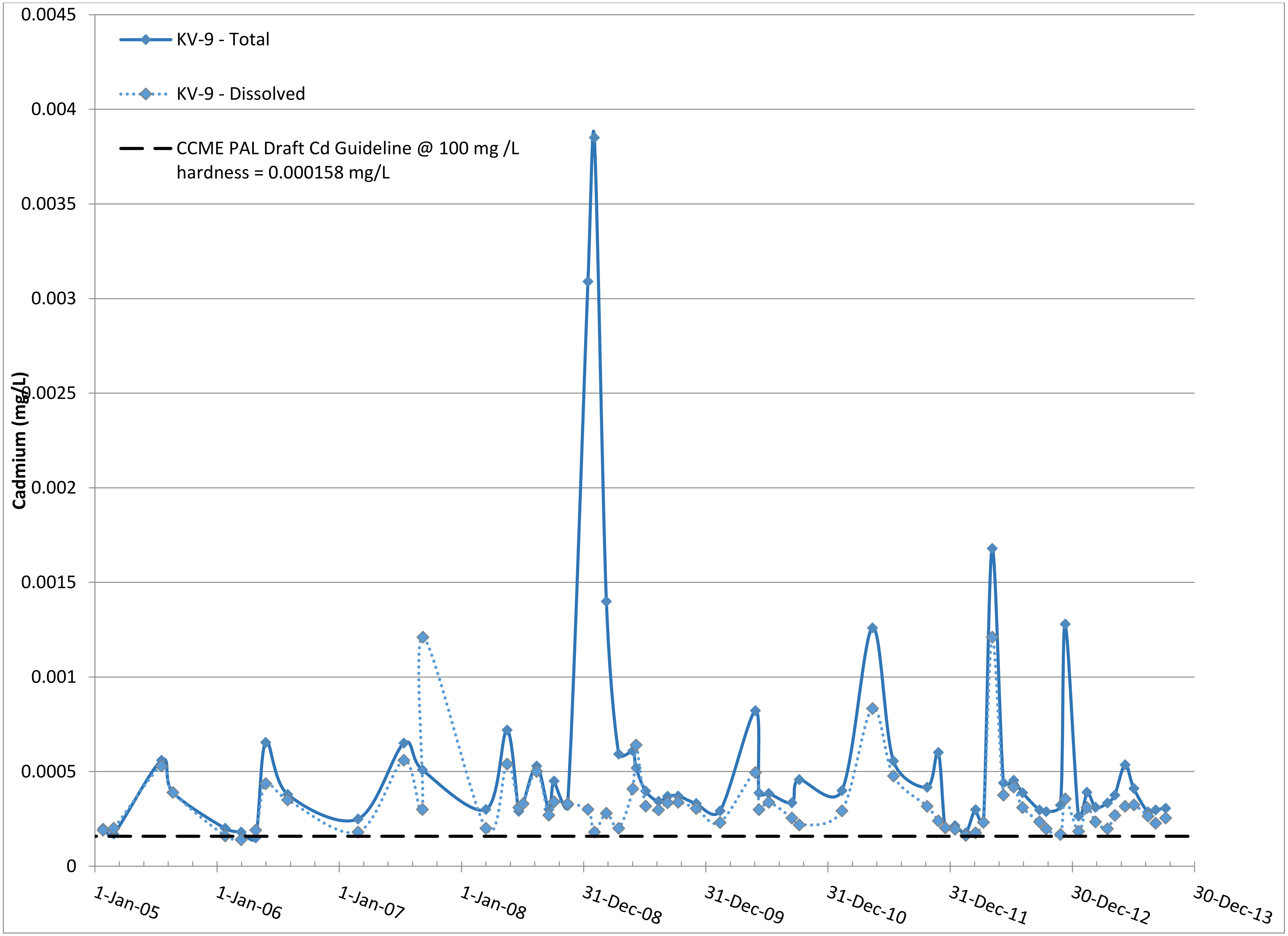


10
1
0.1
0.01
0.001
Zinc (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-6, Total
KV-6, Dissolved
KV-7, Total
KV-7, Dissolved
CCME PAL Zn Guideline = 0.03 mg/L

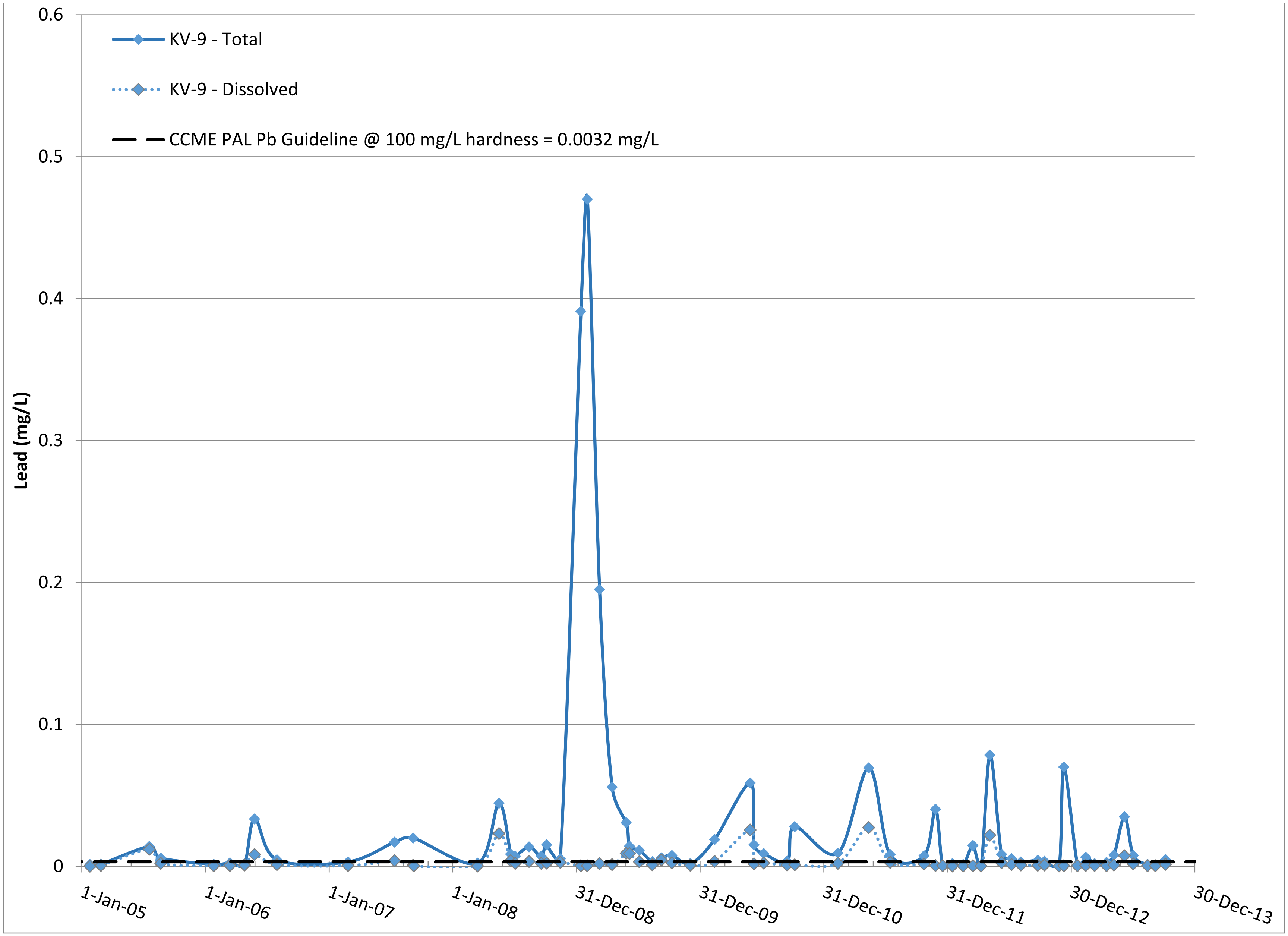
Flat Creek



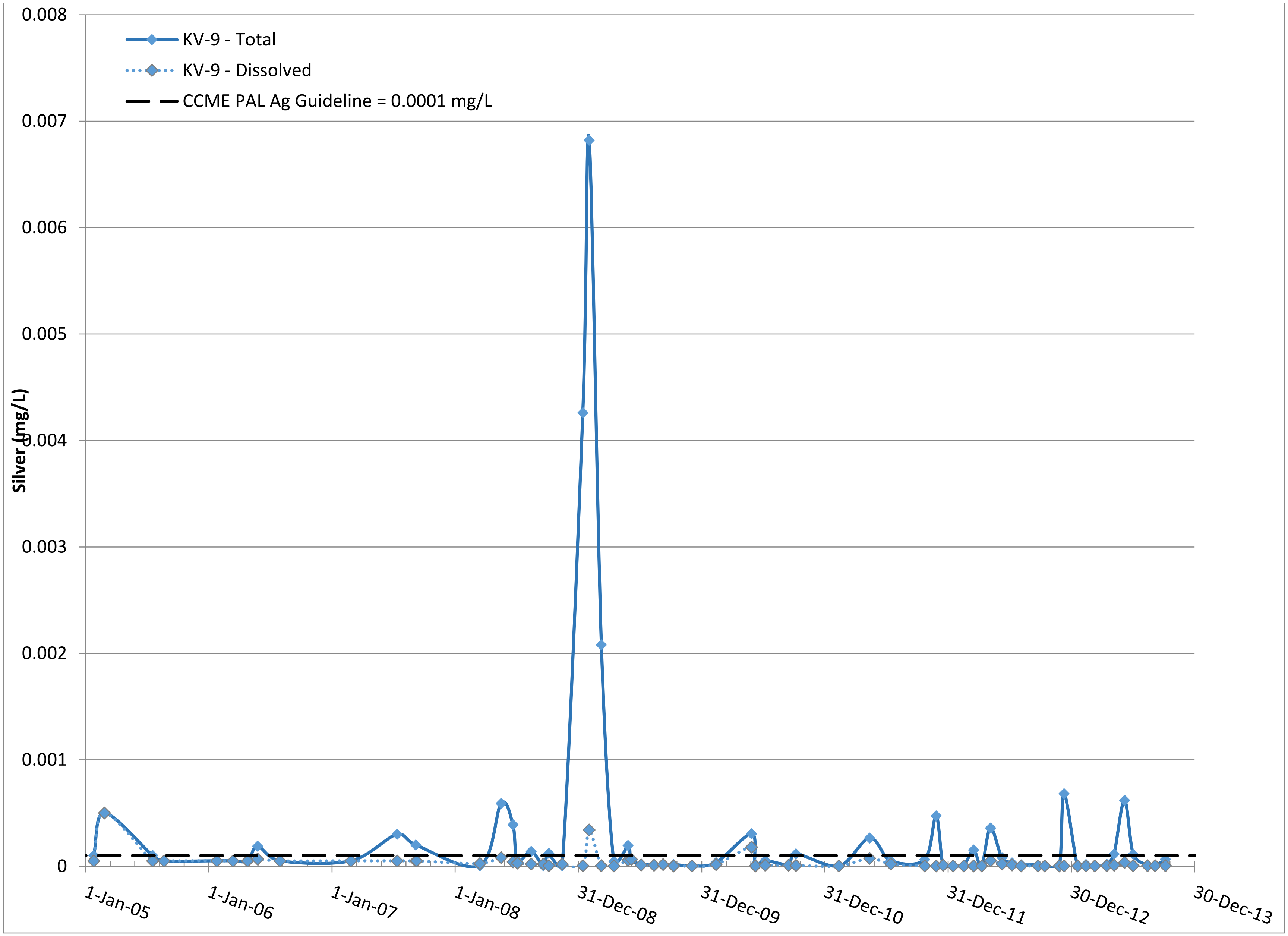
KV-9 - Total
KV-9 - Dissolved
CCME PAL As Guideline = 0.005 mg/L
Arsenic (mg/L)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13



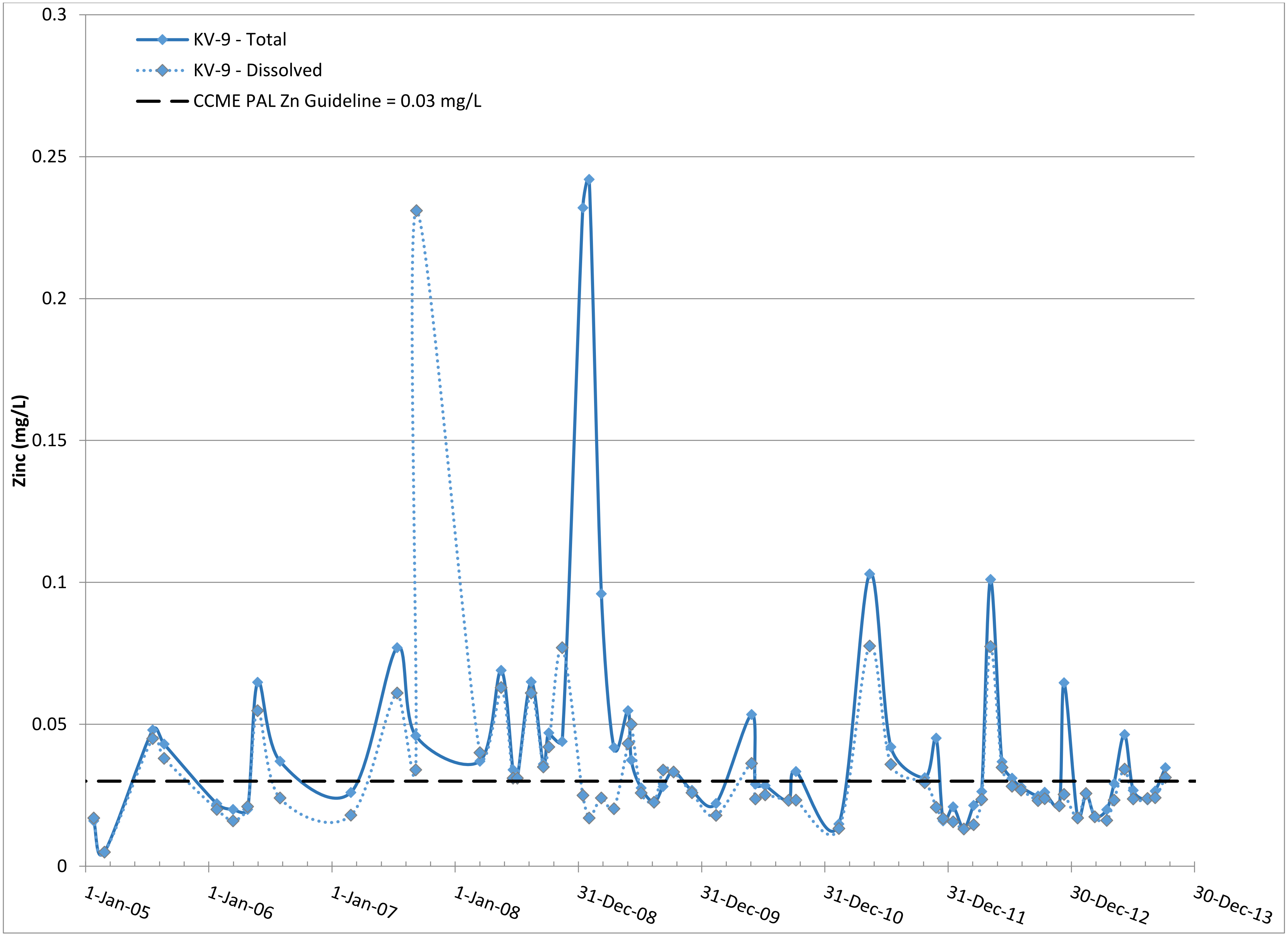
KV-9 - Total
KV-9 - Dissolved
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L
Cadmium (mg/L)
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13



KV-9 - Total
KV-9 - Dissolved
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L
Lead (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13

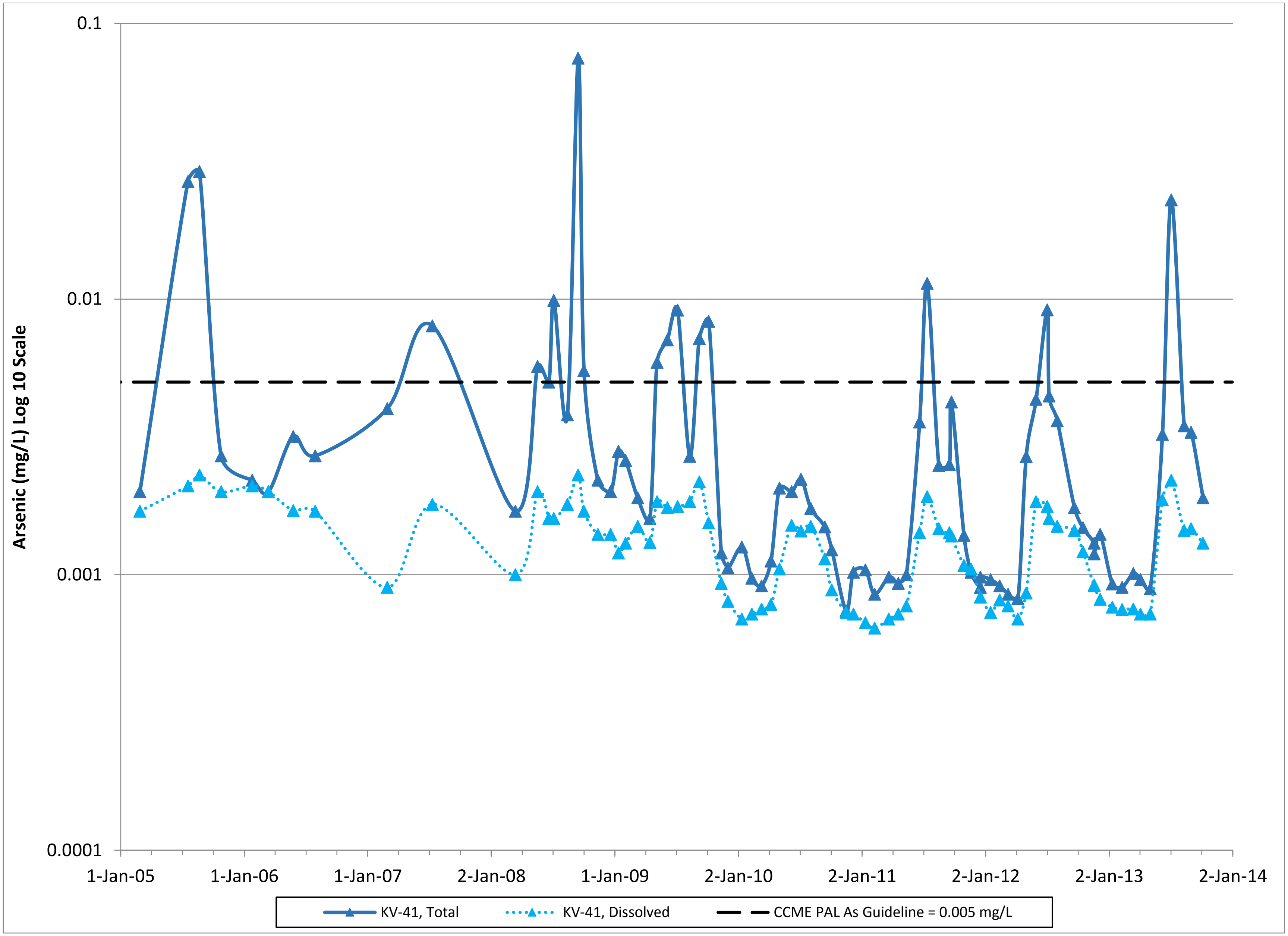


0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Silver (mg/L)
KV-9 - Total
KV-9 - Dissolved
CCME PAL Ag Guideline = 0.0001 mg/L
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13

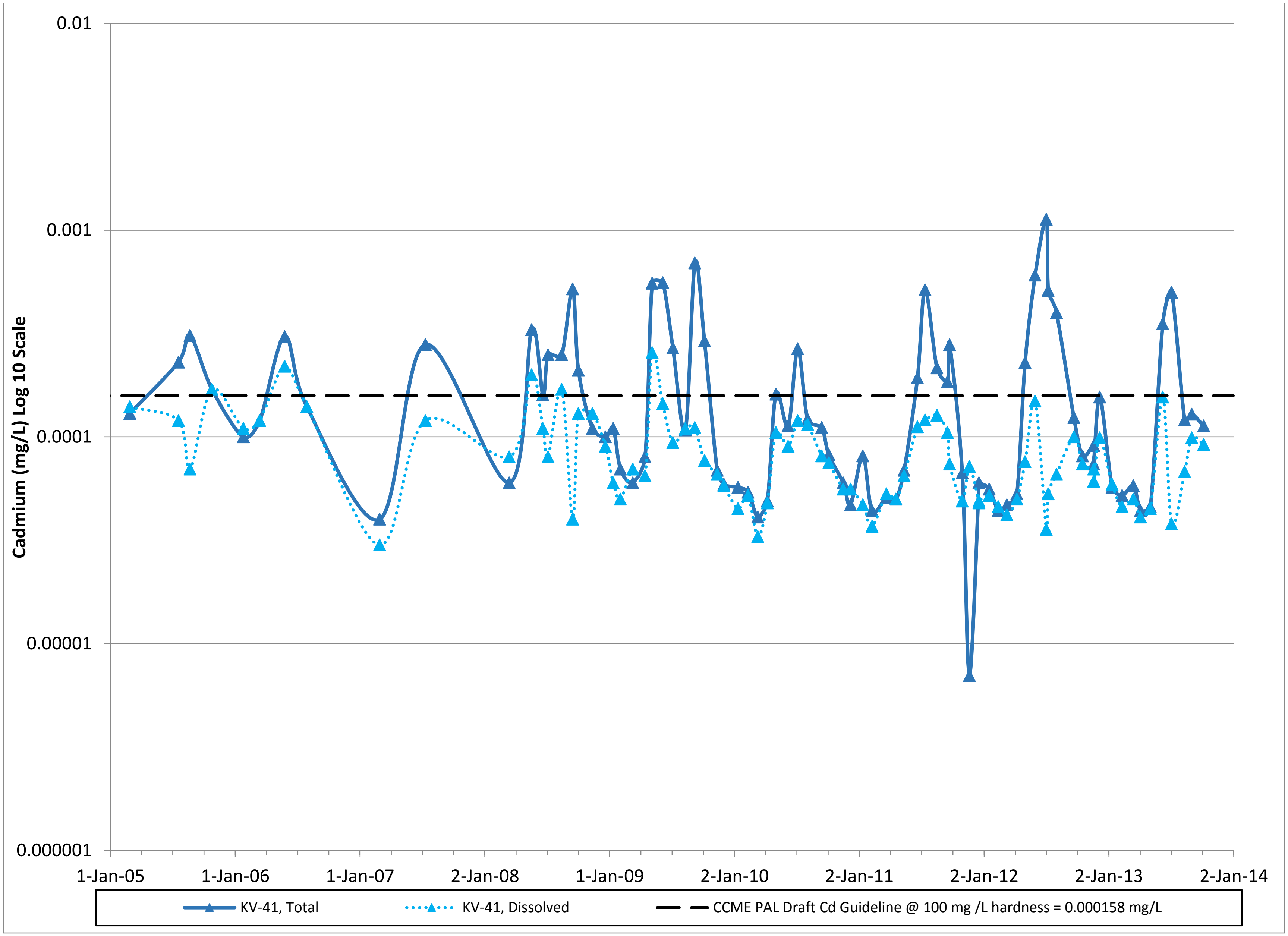


KV-9 - Total
KV-9 - Dissolved
CCME PAL Zn Guideline = 0.03 mg/L
Zinc (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13

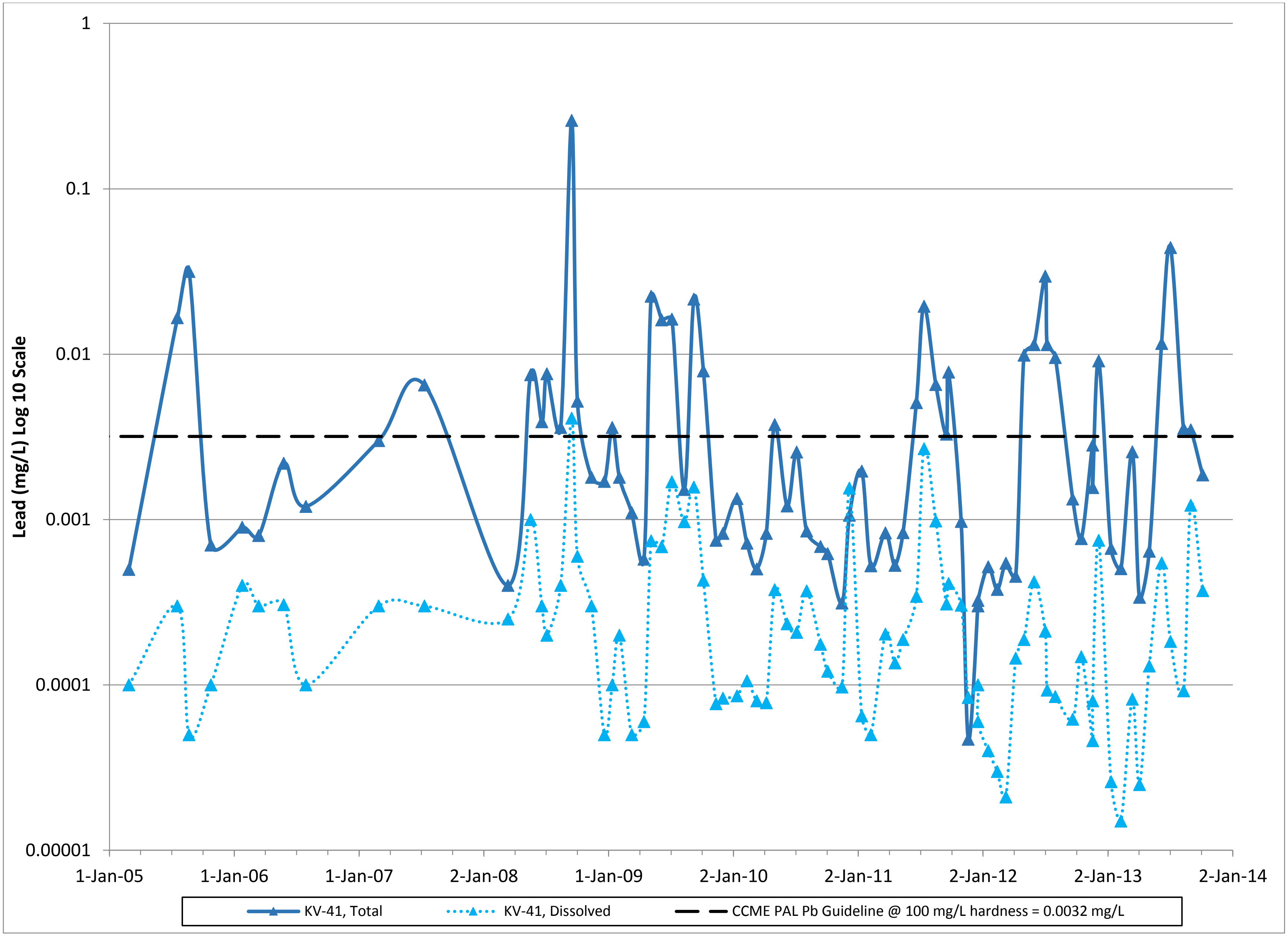
Lightning Creek



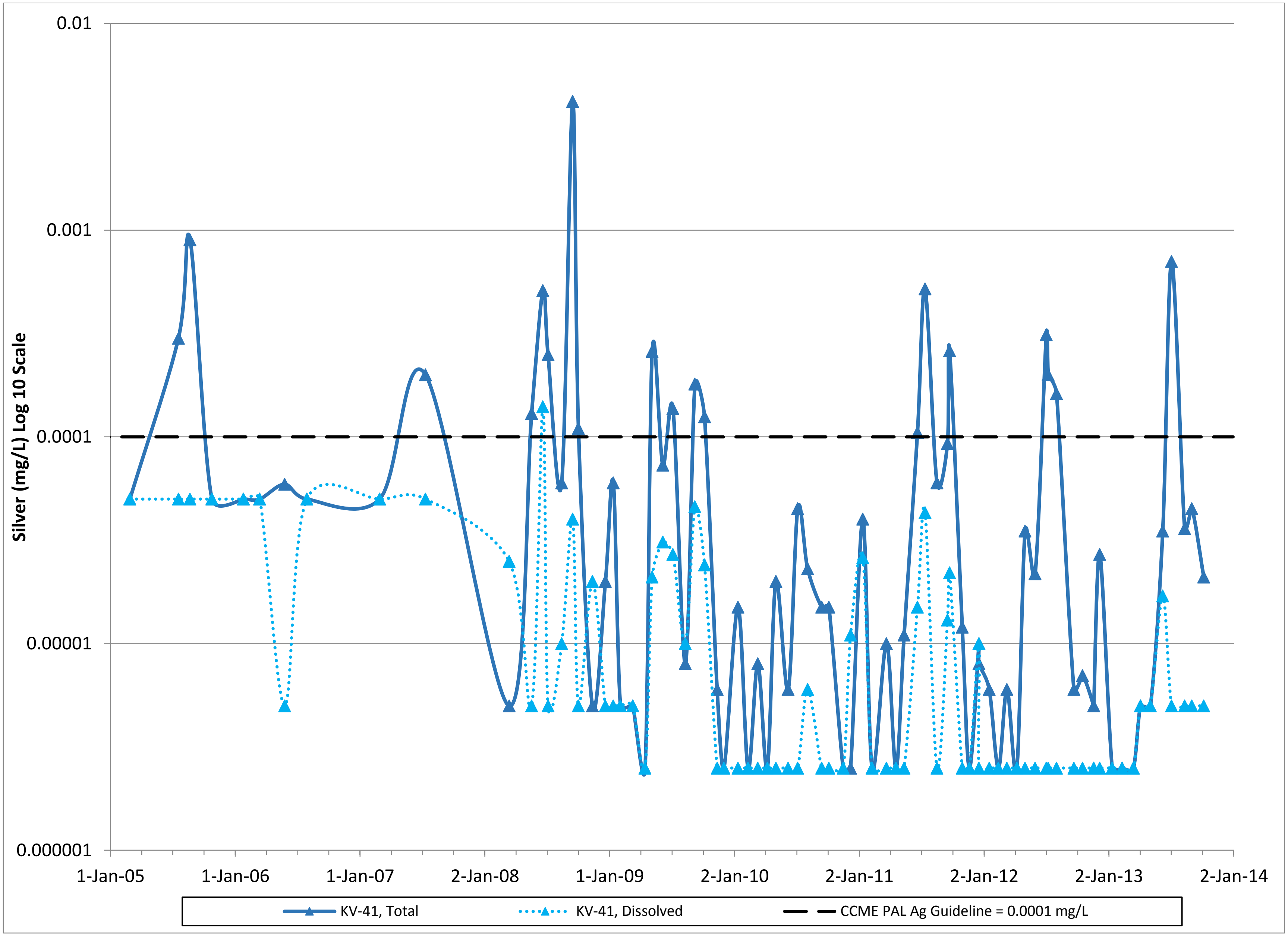
Arsenic (mg/L) Log 10 Scale
0.1
0.01
0.001
0.0001
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-41, Total
KV-41, Dissolved
CCME PAL As Guideline = 0.005 mg/L



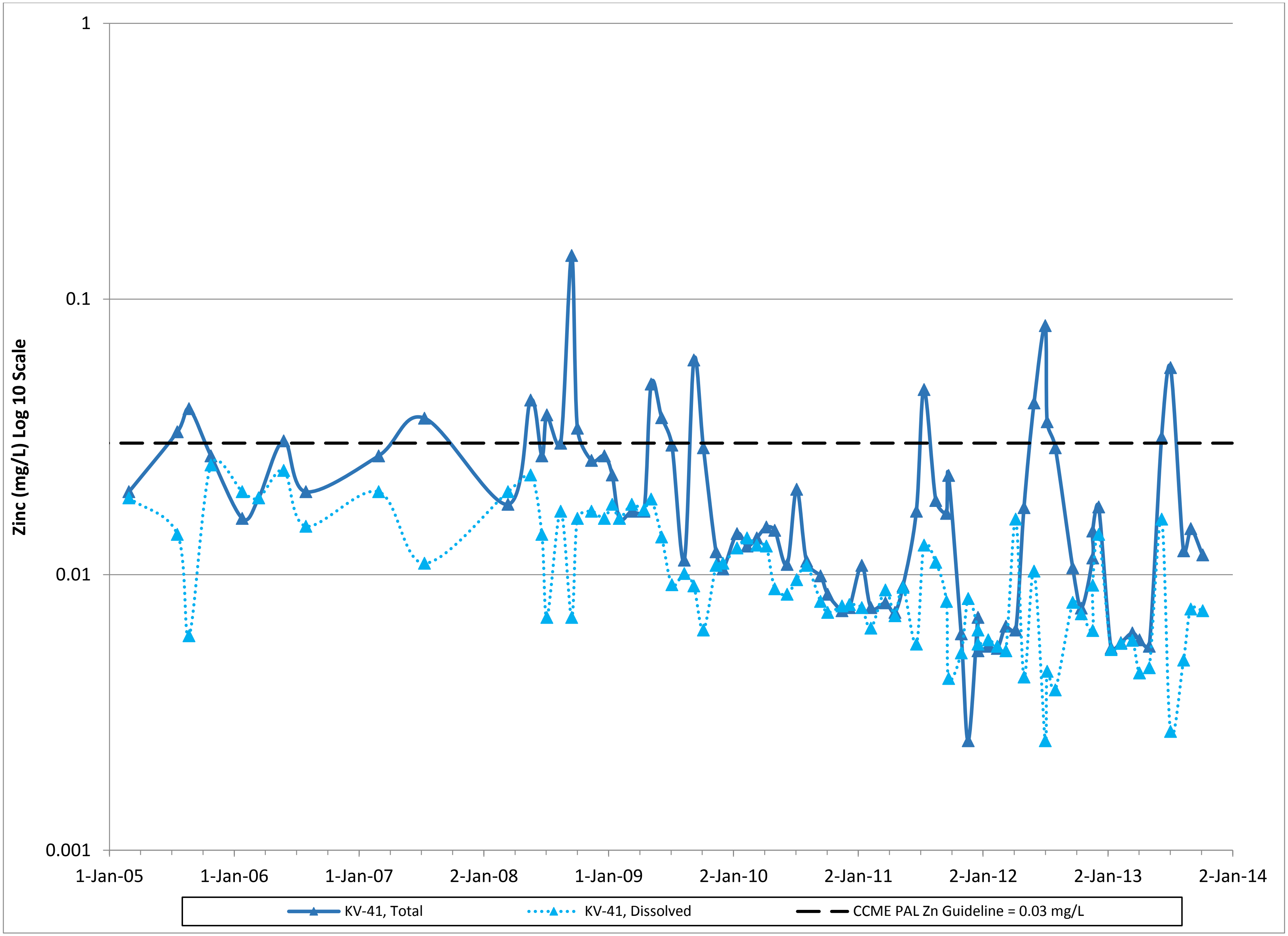
0.01
0.001
0.0001
0.00001
0.000001
Cadmium (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-41, Total
KV-41, Dissolved
CCME PAL Draft Cd Guideline @ 100 mg /L hardness = 0.000158 mg/L



Lead (mg/L) Log 10 Scale
1
0.1
0.01
0.001
0.0001
0.00001
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-41, Total
KV-41, Dissolved
CCME PAL Pb Guideline @ 100 mg/L hardness = 0.0032 mg/L



0.01
0.001
0.0001
0.00001
0.000001
Silver (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-41, Total
KV-41, Dissolved
CCME PAL Ag Guideline = 0.0001 mg/L



1
0.1
0.01
0.001
Zinc (mg/L) Log 10 Scale
1-Jan-05
1-Jan-06
1-Jan-07
2-Jan-08
1-Jan-09
2-Jan-10
2-Jan-11
2-Jan-12
2-Jan-13
2-Jan-14
KV-41, Total
KV-41, Dissolved
CCME PAL Zn Guideline = 0.03 mg/L

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Memorandum

To: Jim Harrington, President Alexco Environmental Group

Kai Woloshyn, Project Manager, Access Consulting Group

From: Cynthia Russel, Minnow Environmental Inc.

Date: November 13, 2013

Re: Evaluation of Contaminants of Concern for the United Keno Hill Mines Long Term Monitoring Program (revised).

Minnow Environmental Inc. has been involved in the assessment of water quality and the aquatic environment at United Keno Hill Mines (UKHM) since 2006. In 2011, Minnow prepared a study design for an Interim Long-Term Aquatic Monitoring Program (LTAMP). As part of this report, cadmium and zinc were identified as contaminants of concern (COCs) and a number of substances were identified as possible COCs (aluminum, arsenic, cyanide, chromium, copper, iron, lead, manganese, mercury, nitrate, nitrite, nickel, phosphorus, selenium, silver, sulphate, total Kjeldahl nitrogen (TKN) and uranium). These substances were identified as possible COCs because the existing data was generally insufficient to assess them (i.e., too few data points, poor method detection limits and limited reference data). In order to develop a final list of COCs for the UKHM area that could be used in the assessment and monitoring of closure conditions, recommendations were provided that allowed for the deficiencies in the data base to be addressed. Specifically:

- monitoring frequencies were increased to monthly,
- additional reference areas were added to the program,
- the list of substances to be analyzed was increased to include those for which limited or no information was available,
- method detection limits were established at levels less than relevant guidelines, and
- several laboratory measures were included to aid in the interpretation of the water quality data (hardness, dissolved organic carbon (DOC), total suspended solids (TSS)).

The revised program was implemented in January 2011 such that there is now two years of data for most of the monitoring stations. However, ammonia measurements were only routinely collected at the stations included in the water license (i.e., KV-6, KV-7 and KV-41). While ammonia concentrations were assessed at these stations, there continues to be insufficient data to assess all stations and as such ammonia will need to remain as a potential COC until additional data is collected[1]. In addition, cyanide has not been included in the monitoring program to date and as such it cannot be assessed at this time and will need to remain a potential COC until sufficient data has been compiled[1].

A list of substances that were proposed for monitoring are provided on Table 1 and the proposed monitoring stations are described on Table 2 (Minnow 2011). Access Consulting Group (Access) provided the monitoring data (2011 to 2012) Minnow in excel format. The assessment of COCs was limited to the immediate receiving stations in Christal Creek (KV-6 and KV-7), Flat Creek (KV-9 and KV-9A) and Lightning Creek (KV-38 and KV-41) and the tributary reference stations[2]. Stations within the South McQuesten River (KV-2, KV-3, KV-4 and KV-5) were not included in the assessment as these are downstream of the immediate receiving waters where the highest concentrations of mine-related substances would be expected to be observed[3]. This memo presents the findings of our assessment of the water quality data for the UKHM site and our recommendations for COCs for the LTAMP.

In order to identify the COCs, the following steps were undertaken:

1. Established an upper limit of background (95th percentile) for each analyte.
2. Compared the upper limit of background to the Canadian Water Quality Guidelines (CWQG; CCME, 2007 plus updates) to identify naturally elevated substances.
3. Compared the concentrations of each analyte at each mine-exposed station to background and CWQG and flagged those that exceeded these benchmarks.
4. Analytes that exceeded background but not CWQG were plotted over time (2005 to 2012) together with analytes with maximum concentrations above guidelines to determine if the concentrations of these analytes are increasing over time and as such represent potential future COCs.
5. Total and filtered concentrations for analytes which exceeded CWQG were plotted to determine if both fractions exceeded the guideline.

[1] Ammonia and Cyanide should be measured at all reference and mine-exposed stations as described in the Interim Long-Term Aquatic Monitoring Program design report.

[2] Reference stations on the South McQuesten River (KV-1 and KV-72) were not used in the determination of background as the habitat of these stations and catchment areas are not comparable to the tributary stations. In addition, KV-1 has shown impaired water quality associated with upstream Cache Creek.

[3] There are no additional sources to the South McQuesten River.

6. Analytes were considered for inclusion as COCs if the median concentration was higher than background and CWQG or if the maximum concentration was two times the CWQG for both total and dissolved measures.
7. Analytes for which no guideline exists were considered for inclusion as COC's if the median concentration was ten times background.[4]

Concentrations among tributary reference stations (KV-37, KV-60, KV-61, KV-64, KV-65, WILC and FIELC) were found to be similar with the exception of KV-60 (Galena Creek upstream of Silver King adit) and therefore the data from all reference stations, except KV-60[5], were combined and a 95th percentile was calculated for each substance which served as the upper limit of background (Table 3). The upper limit of background was compared to the most recent CWQG[6,7] to identify substances that are naturally elevated in the region (i.e., ammonia, aluminum, copper, iron and selenium, although selenium and copper were only slightly higher in background than the CWQG). The water quality data collected from January 2011 to December 2012 (i.e., 24 months) was compared to the upper limit of background and the CWQG (Table 4 and Appendix Tables A.1 to A.18). Based on this assessment, median values of arsenic, cadmium, sulphate and zinc were found to exceed both background and CWQG (Table 4 and 5). However, arsenic and sulphate were only elevated at KV-6 and arsenic was slightly above CWQG (i.e., 0.005 vs. 0.0059; Figure A.2)[8]. The median sulphate concentration at KV-6 (335 mg/L) was greater than the guideline calculated at 100 mg/L hardness (309 mg/L) but less than the guidelines value at 200 mg/L hardness (429 mg/L sulphate BCMOE 2013; Figure A.1). Review of hardness concentrations at KV-6 indicates that hardness values at this station are consistently above 200 mg/L (Appendix Figure A.8) and as such the higher guideline is applicable at this station.

[4] Analytes with no established water quality guidelines are generally considered non-toxic and would only be of potential concern at very high concentrations.

[5] The concentrations at KV-60 suggested possible mine-exposure influence due to elevated zinc and cadmium concentrations. The 95th percentile of background was calculated with KV-60 included and excluded to determine the potential influence of including KV-60 in the determination of background (Table A.19). The comparison indicated that the inclusion of KV-60 would increase the 95th percentile of the reference stations and may not be representative of true reference condition. For this reason KV-60 was excluded from the assessment of reference conditions.

[6] The guidelines used were the most recent CWQG with the following exceptions: the draft cadmium CWQG (Environment Canada 2012) and proposed zinc values (Roe, 2010) were used as they represent the most current information on cadmium and zinc toxicity; the Federal Water Quality Guideline for cobalt (Environment Canada 2013) was used as there is no CWQG; the BCMOE manganese and sulphate guidelines were used as a federal guideline does not exist for these substances (BCMOE 2006 and 2013) and the BCMOE guideline for iron was used as it represent the most recent and comprehensive iron review in Canada (BCMOE 2008).

[7] Where guidelines were hardness dependant, a value of 100 mg/L hardness was used to calculate the guideline. In Chrsital Creek and Flat Creek (highest metal concentrations), the minimum hardness observed is greater than 100 mg/L hardness and is typically greater than 200 mg/L hardness. Thus, the use of 100 mg/L hardness to calculate guidelines is conservative.

[8] All dissolved concentrations were less than the CWQG (Figure A.2).

Some analytes had median concentrations that were greater than background but less than the guideline values (ammonia, cobalt, iron, nickel, molybdenum, and uranium; Tables 4 and 5). Review of concentrations over time for these substances does not indicate any increasing trend and as such they are not expected to become COC's in the future (Figure A.7).

A number of analytes were higher than background but have no applicable water quality guidelines for the protection of aquatic life (i.e., hardness, specific conductance, calcium, lithium, magnesium, manganese, potassium, silicon, sodium, strontium and sulphur). Generally, there are no guidelines for these analytes as they are not known to cause toxicity to aquatic life. In all instances median concentrations at all mine-exposed stations were less than 10 times background (Tables 4 and 5). While these analytes should continue to be monitored as they represent indicators of mine-exposure they are not considered COCs.

Review of maximum values found that total suspended solids (TSS), aluminum, arsenic, cadmium, copper, iron, lead, silver and zinc were elevated well above CWQG (Tables 4 and 5). However, review of the raw data found that the maximum values tended to occur when TSS was also elevated, suggesting that the high maximum concentrations may have been associated with particulate matter in the water samples. To assess this, filtered metal concentrations were compared to total concentrations for these substances at stations KV-7, KV-9A and KV-41 (i.e., immediate receivers; Figures 1 to 3). With the exception of cadmium and zinc, the filtered concentrations of all other substances were below the CWQG, confirming that the elevated metal concentrations were likely associated with elevated TSS. Generally, it is the dissolved portion (largely represented by filtered metals) of the metal concentration that is the bioavailable fraction (Prothro 1993). Thus dissolved concentrations below guidelines are likely protective of aquatic species.

In addition, analytes with maximum concentrations that were greater than the guideline were plotted over time (2005 to 2011; Appendix Figure A.7 a-o). These plots show that concentrations of these substances were either decreasing or stable over time and therefore, do not represent future COC's.

Based on the assessment above, the following recommendations are provided:

- Station KV-60 should not be used as a reference station.
- Cadmium and zinc should remain COCs for the LTAMP and no additional COCs are warranted.
- The LTAMP should include monitoring of the following analytes; hardness, alkalinity, specific conductance, pH, DOC, TSS, aluminum, ammonia, arsenic, cadmium, calcium, copper, cobalt, cyanide, chromium, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, silicon, sodium, strontium, sulphate, silver, uranium and

zinc. These represent mine related analytes but only cadmium and zinc are currently observed at levels which could be harmful to aquatic life.

- Given the fluctuations in the concentrations of total metals, dissolved metals should be analyzed as well.
- The assessment provided herein is based on existing monitoring data. It is possible that in the future, additional COC could be identified if new sources were to connect to the downstream receiving environments. The adaptive management plan for the district should be structured to allow for identification of new COC's in the future in response to changes in source areas.

References

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OMOE (Ontario Ministry of Environment). 1994. Water Management: Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of the Environment. July, 1994.

Prothro, M. 1993. Technical Memorandum Regarding Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria. U.S. Environmental Protection Agency. October 1, 1993. 40CFRS131.36(b)(1). Available at: http://www.epa.gov/waterscience/library/wqcriteria/metalsinterpret.pdf

Roe, S. 2010. Canadian Water Quality Guidelines for the Protection of Aquatic Life for Cadmium, Uranium and Zinc developed under the Canadian Council for Ministers of the Environment. Aquatic Toxicity Workshop 2010.

Table 1: Water quality variables recommended for the Interim LTAMP (Minnow 2011).

Variables	Unit	Guideline	Target MDL[n]	Sampling Freqency
Laboratory Measures				Monthly during the ice-free period and once during the ice-on period. If possible, one additional sample per year should be collected after a runoff event (e.g., storm)[o]
Non-Metals and Nutrients				
Cyanide (free)	mg/L	0.005[a,b]	< 0.0025	
Hardness	mg/L	n/a	n/a	
Sulphate	mg/L	50[c]	< 25	
Total Suspended Solids	mg/L	6.6[a,d]	< 3.35	
Nitrate (as N)	mg/L	1.3[a]	< 6.5	
Nitrite (as N)	mg/L	0.06[a]	< 0.03	
Total Kjeldahl Nitrogen	mg/L	n/a	n/a	
Dissolved Organic Carbon	mg/L	n/a	n/a	
Phosphorus	mg/L	0.03[i,j]	< 0.015	
Total Metals				
Aluminum	mg/L	0.1[a,e]	< 0.05	
Arsenic	mg/L	0.005[a]	< 0.0025	
Cadmium[m]	mg/L	0.000033[a,f]	< 0.000025	
Chromium	mg/L	0.001[a,g]	< 0.0005	
Copper	mg/L	0.002[a,f]	< 0.0015	
Iron	mg/L	1.00[a]	< 0.15	
Lead	mg/L	0.0032[a,f]	< 0.002	
Magnesium	mg/L	-	< 41	
Manganese	mg/L	1.3[c,f]	< 6.5	
Mercury	mg/L	0.000026[a,h]	< 0.000013	
Nickel	mg/L	0.065[a,f]	< 0.055	
Selenium	mg/L	0.001[a]	< 0.0005	
Silver	mg/L	0.0001[a]	< 0.00005	
Uranium	mg/L	0.005[j,k]	< 0.0025	
Zinc[m]	mg/L	0.03[a]	< 0.015	
Field Measures				
Temperature	˚C	n/a	n/a	
Dissolved Oxygen	mg/L	6.5 - 9.5[a,k,l]	3.3	
Dissolved Oxygen	%	n/a	n/a	
Conductivity	uS/cm	n/a	n/a	
pH	pH units	6.5 - 9.0[a]	3.3	
Flow	m/s	n/a	n/a	

n/a - not available

[a] Canadian Water Quality Guidelines (CCME 1999)

[b] Based on free cyanide

[c] British Columbia Water Quality Guidelines (BCMOE 2006)

[d] No more than 5,000 ug/L above background; mean of background TSS values was used in calculating guideline shown.

[e] 5 ug/L at pH<6.5 or 100 ug/L at pH≥ 6.5; since pH measured at water quality stations in the vicinity of UKHM is typically ≥ 6.5, 100 ug/L was chosen as guideline.

[f] Hardness dependent; hardness of 100 mg/L representing the lower range of hardness values in the near-field receiving environment. Guideline will be re-calculated using hardness of monitoring station at the time of each survey.

[g] Hexavalent form

[h] Inorganic mercury

[i] Ontario Water Quality Objectives (OMOE 1994)

[j] Interim objective or guideline

[k] For cold water streams

[l] Upper end of range is applicable for protecting early life-stages

[m] Should draft CWQG for Cd and Zn become finalized, then the target MDLs should be adjusted to ensure they are less than the guideline.

[n] Target method detection limit (MDL) calculated as one half the guideline however these are maximum limits and efforts should be made to achieve MDLs of ≤ 1/10 guideline. For parameters lacking a guideline, the target MDL should be the lowest MDL that can be reasonably achieved by a reputable analytical laboratory (e.g., Maxxam Analytics)

[o] Sample should be collected within 24 hours of runoff event.

Table 2: Water quality stations monitored under the Water Licences and included in the interim LTAMP.

Station ID	Station Description	Reference/ Exposed	Water Licences[a]	Rationale for Inclusion
KV-1	South McQuesten River upstream of Christal Creek	Exposed	✓	Historical reference station recently determined to be impacted by an unknown upstream source. Include to characterize water quality on the South McQuesten River upstream of UKHM.
KV-2	South McQuesten River at Pumphouse downstream of Christal Creek	Exposed	✓	Characterizes water quality in the South McQuesten River downstream of Christal Creek and upstream of Flat Creek.
KV-3	South McQuesten River upstream of Flat Creek	Exposed	✓	Characterizes water quality in the South McQuesten River immediately upstream of Flat Creek and captures possible subsurface contributions between KV-2 and KV-3.
KV-4	South McQuesten River downstream of Flat Creek	Exposed	✓	Characterizes water quality in the South McQuesten River immediately downstream of Flat Creek.
KV-5	South McQuesten River 9 km downstream of Flat Creek	Exposed	✓	Delineates possible spatial extent of mine influence on water quality in the South McQuesten River.
KV-6	Christal Creek at Keno Highway	Exposed	✓	Characterizes water quality on Christal Creek in a reach where concentrations of substances in water and sediment have been elevated in past surveys.
KV-7	Christal Creek at Hanson Road	Exposed	✓	Characterizes water quality on Christal Creek downstream of all tributaries discharging into Christal Creek.
KV-9A	Flat Creek between Valley Tailings and station KV-9, upstream of Galena Creek	Exposed		Characterizes water quality in Flat Creek closer to the source (Valley Tailings) than KV-9.
KV-9	Flat Creek upstream of South McQuesten River	Exposed	✓	Downstream of the Valley tailings and Silver King sources.
KV-37	Lightning Creek upstream of Hope Gulch	Reference	✓	Located upstream of mine influence on Lightning Creek and would therefore serve as a reference station.
KV-38	Lightning Creek upstream of Thunder Gulch	Exposed	✓	Characterizes water quality in Lightning Creek upstream of Bellekeno Mine discharge into Thunder Gulch.
KV-41	Lightning Creek upstream of bridge at Keno City	Exposed	✓	Located within an area influenced by placer mining. Data collected from this station could be used to separate UKHM from placer mining influence on water quality.
KV-60	Galena Creek upstream of Silver King adit	Reference	✓	This station is upstream of Silver King adit and thus serves as an upstream reference area.
KV-61	Porcupine Gulch at Calumet Road Crossing	Reference	✓	This station is upstream of mine workings on Porcupine Creek and thus serves as an upstream reference area
KV-64	Flat Creek at Silver Trail Highway	Reference	✓	This reach of Flat Creek is upstream of mine influence on Flat Creek and therefore serves as a reference area.
KV-65	Thunder Gulch upstream of Bellekeno	Reference	✓	This station is upstream of Bellekeno influence and thus serves as an upstream reference area.
KV-72[b]	South McQuesten River upstream of Cache Creek	Reference	✓	Located upstream of mine influence on the South McQuesten River and would therefore serve as a pristine reference area.
WILC	Williams Creek downstream of Duncan Creek Road	Reference		Williams Creek is outside of mine infuence and habitat at this station is an adequate match to habitat at exposure stations.
FIEC	Field Creek upstream of Duncan Creek Road	Reference		Field Creek is outside of mine infuence and habitat at this station is an adequate match to habitat at exposure stations.

[a] Station included in one or both Water Licences.

[b] Once more suitable tributary reference areas are established, KV-72 should be excluded from the program.

Table 3: Water quality 95th (and/or 5th if noted[a]) percentile of reference stations (without KV-60) and the Canadian Water Quality Guidelines (CWQG). Shading denotes reference concentrations greater than CWQG.

Variables	Units	Reference 95th (and/or 5th)	Canadian Water Quality Guideline (for protection of aquatic life) 2007 (plus updates)
Laboratory Measures			
Non-Metals and Nutrients			
Hardness (from total)	mg/L	383.5	
Hardness (from dissolved)	mg/L	388.5	
Dissolved Sulphate[d]	mg/L	220.85	309
Total Suspended Solids	mg/L	20.7	25.7
Nitrite (N)	mg/L	0.056	0.06
Nitrate (N)	mg/L	0.3133	3.0
Total Kjeldahl Nitrogen	mg/L	0.435	
Dissolved Organic Carbon	mg/L	9.255	
Total Phosphate	mg/L	0.0271	
Total Alkalinity	mg/L	93.0	
Alkalinity bicarbonate HCO3	mg/L	113.3	
Ammonia (N)	mg/L	0.0308	
Specific Conductance (lab)	µS/cm	714	
Chloride	mg/L	1.32	120
pH (lab)	pH units	7.44 - 8.30[a]	
Totals Metals			
Total Aluminum (Al)	mg/L	0.153	0.1
Total Antimony (Sb)	mg/L	0.00096	
Total Arsenic (As)	mg/L	0.00342	0.005
Total Barium (Ba)	mg/L	0.082	
Total Beryllium (Be)	mg/L	0.000015	
Total Bismuth (Bi)	mg/L	0.000007	
Total Boron (B)	mg/L	0.05	1.5
Total Cadmium (Cd)	mg/L	0.00016	0.00016[b]
Total Calcium (Ca)	mg/L	125.5	
Total Chromium (Cr)	mg/L	0.000875	0.0089
Total Cobalt (Co)[e]	mg/L	0.00029	0.0025
Total Copper (Cu)	mg/L	0.00280	0.00236
Total Iron (Fe)[c]	mg/L	0.4085	1.0
Total Lead (Pb)	mg/L	0.00579	0.0032
Total Lithium (Li)	mg/L	0.00537	
Total Magnesium (Mg)	mg/L	18.40	
Total Manganese (Mn)	mg/L	0.243	1.0[f]
Total Mercury (Hg)	mg/L	0.00001	0.00026
Total Molybdenum (Mo)	mg/L	0.00035	0.073
Total Nickel (Ni)	mg/L	0.0015	0.0960
Total Phosphorus (P)	mg/L	0.0202	
Total Potassium (K)	mg/L	0.660	
Total Selenium (Se)	mg/L	0.00109	0.001
Total Silicon (Si)	mg/L	4.10	
Total Silver (Ag)	mg/L	0.000047	0.0001
Total Sodium (Na)	mg/L	1.95	
Total Strontium (Sr)	mg/L	0.354	
Total Sulphur (S)	mg/L	89.1	
Total Thallium (Tl)	mg/L	0.000034	0.0008
Total Tin (Sn)	mg/L	0.00033	
Total Titanium (Ti)	mg/L	0.0048	
Total Uranium (U)	mg/L	0.00326	0.015
Total Vanadium (V)	mg/L	0.00052	
Total Zinc (Zn)	mg/L	0.0138	0.017[b]
Total Zirconium (Zr)	mg/L	0.00027	
Field Measures			
Temperature (field)	C	5.2	
Dissolved Oxygen (field) mg/L	mg/L	10.3[a]	6.5 - 9.5
Dissolved Oxygen (field) %	%	72[a]	
Conductivity (field)	µS/cm	275	
Specific Conductance (field)	µS/cm	699	
pH (field)	pH units	7.17 - 8.49[a]	6.5-9.0
ORP (field)	mV	349.4	

[a] 5th percentile also presented

[b] Value presented based on draft equation for that analyte.

[c] Guideline based on BCMOE 2008.

[d] Guideline based on BCMOE 2013.

[e] Guideline based on Federal Environmental Quality Guideline (Environment Canada 2013).

[f] Guideline based on BCMOE 2006 at 100 mg/L water hardness.

Table 4: Mean and maximum concentrations in water for exposed Keno stations relative to background and guidelines.

Analytes	Units	guideline[f]	background	KV-6		KV-7		KV-9A		KV-9		KV-38		KV-41	
				median	maximum	median	maximum	median	maximum	median	maximum	median	maximum	median	maximum
Laboratory Measures															
Non-Metals and Nutrients															
Hardness (from total)	mg/L		384	**495**	**573**	383	**495**	**528**	**721**	315	341	84	89	108	127
Hardness (from dissolved)	mg/L		389	**480**	**566**	368	**487**	**532**	**751**	315	373	84	87	100	126
Dissolved Sulphate[a]	mg/L	309	221	**335**	**390**	200	**280**	**239**	**386**	129	160	42	53	56	70
Total Suspended Solids	mg/L	25.7	20.7	2	4	2	**72**	9	**182**	1	10	1	13	5	**540**
Nitrite (N)	mg/L	0.060	0.056	< 0.005	< 0.050	0.005	**<0.5**	0.050	**0.060**	< 0.050	< 0.050	< 0.050	< 0.050	0.022	**<0.5**
Nitrate (N)	mg/L	3.00	0.31	0.22	**1.06**	0.19	**2.00**	0.20	0.20	0.20	0.21	0.20	0.27	0.25	**2.63**
Total Kjeldahl Nitrogen	mg/L		0.44	0.23	**1.20**	0.26	**0.89**	**0.60**	**1.28**	0.22	0.33	0.20	**0.51**	0.20	**0.66**
Dissolved Organic Carbon	mg/L		9.26	1.80	**10.40**	1.70	**19.40**	6.63	**13.50**	4.35	**15.10**	0.93	4.60	0.96	3.63
Total Phosphate	mg/L		0.027	0.0070	0.0211	0.0040	**0.0605**	0.008	**0.064**	0.0032	0.0250	0.0070	0.0104	0.0090	**0.6520**
Total Alkalinity	mg/L		93	**124**	**140**	**140**	**160**	-	-	-	-	40	46	51	60
Alkalinity bicarbonate HCO3	mg/L		113	**151**	**171**	**170**	**200**	-	-	-	-	48	56	62	74
Ammonia (N)[b]	mg/L	0.343 - 23.1	0.031	**0.05**	**0.18**	**0.033**	**0.24**	-	-	-	-	-	0.00	0.016	**0.071**
Specific Conductance (lab)	µS/cm		714	**890**	**955**	690	**820**	**950**	**1270**	589	673	-	-	222	256
Chloride	mg/L	120	1.3	1.20	**1.80**	1	**1.7**	-	-	-	-	1	1	0.76	**2.40**
pH (lab)	pH units	6.5 - 9.0	7.44 - 8.30	7.82	8.16	8.08	8.26	8.09	8.36	8.19	8.35	7.72	7.93	7.75	7.98
Total Metals															
Total Aluminum (Al)	mg/L	0.10	0.15	0.009	0.041	0.009	**0.946**	0.022	**0.309**	0.007	0.059	0.007	0.077	0.048	**3.520**
Total Antimony (Sb)	mg/L		0.00096	0.00028	0.00052	0.00024	**0.00105**	0.0006	**0.0011**	0.0008	**0.0018**	0.0003	0.0004	0.00030	0.00074
Total Arsenic (As)	mg/L	0.0050	0.0034	**0.0059**	**0.0103**	0.0024	**0.0179**	**0.0046**	**0.0459**	0.0020	**0.0070**	0.0027	**0.0062**	0.0013	**0.0114**
Total Barium (Ba)	mg/L		0.082	0.054	0.069	0.053	0.080	0.082	**0.154**	0.073	**0.107**	0.057	0.069	0.053	**0.202**
Total Beryllium (Be)	mg/L		0.000015	0.000010	0.000010	0.000010	**0.000050**	0.000010	**0.000030**	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	**0.00018**
Total Bismuth (Bi)	mg/L		0.000007	0.000005	**0.000008**	0.000005	**0.000040**	0.000005	**0.000014**	< 0.000005	< 0.000005	< 0.000005	< 0.000009	0.000005	**0.001000**
Total Boron (B)	mg/L	1.50	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Total Cadmium (Cd)	mg/L	0.000158	0.000156	**0.00111**	**0.00378**	**0.000724**	**0.004110**	**0.000394**	**0.002120**	**0.000394**	**0.001680**	0.000112	**0.000784**	0.000081	**0.001130**
Total Calcium (Ca)	mg/L		126	**154.0**	**183.0**	115.0	**155.0**	**152.0**	**199.0**	87.9	95.7	25.6	27.9	33.7	39.7
Total Chromium (Cr)	mg/L	0.00890	0.00088	0.00020	**0.00090**	0.00020	**0.00160**	0.00010	**0.00090**	0.00010	0.00050	0.00011	0.00040	0.00041	**0.00700**
Total Cobalt (Co)[c]	mg/L	0.0025	0.00029	**0.001345**	**0.002430**	0.00019	**0.00214**	**0.000635**	**0.002860**	0.000057	0.000161	0.000021	0.000214	0.000110	**0.005230**
Total Copper (Cu)	mg/L	0.0024	0.0028	0.00041	0.00248	0.00062	**0.00940**	0.00123	**0.03740**	0.00138	**0.00439**	0.00035	0.00155	0.00091	**0.02530**
Total Iron (Fe)[d]	mg/L	1.00	0.41	0.382	**0.991**	0.145	**2.940**	**1.000**	**20.200**	0.081	**0.767**	0.030	0.384	0.082	**7.540**
Total Lead (Pb)	mg/L	0.0032	0.0058	0.00524	**0.02330**	0.00166	**0.06480**	0.0048	**0.0520**	**0.00639**	**0.07840**	0.00030	**0.01030**	0.00145	**0.02960**
Total Lithium (Li)	mg/L		0.0054	**0.016**	**0.018**	**0.0076**	**0.0107**	**0.0082**	**0.0118**	0.0027	0.0045	0.0011	0.0013	0.0017	**0.0055**
Total Magnesium (Mg)	mg/L		18	**25.5**	**28.5**	**22.2**	**29.0**	**35.9**	**54.3**	**23.1**	**25.2**	4.7	5.1	6.0	6.9
Total Manganese (Mn)[e]	mg/L	1.0	0.243	**0.8845**	**1.8400**	0.1650	**0.6700**	**0.9450**	**5.9600**	0.0586	**0.4290**	0.0057	0.0439	0.0097	**0.4140**
Total Mercury (Hg)	mg/L	0.00026	0.00001	< 0.00001	< 0.00001	0.00001	0.00001	< 0.00001	**< 0.00002**	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	**0.00005**
Total Molybdenum (Mo)	mg/L	0.0730	0.00035	0.00021	**0.00037**	**0.00036**	**0.00049**	0.00032	**0.00041**	0.00022	0.00030	0.00017	0.00025	0.00023	**0.00100**
Total Nickel (Ni)	mg/L	0.0960	0.0015	**0.00434**	**0.00677**	**0.00178**	**0.00680**	**0.00164**	**0.01060**	0.00061	**0.02500**	0.00027	0.00092	0.00053	**0.01370**
Total Phosphorus (P)	mg/L		0.020	0.008	**0.024**	0.005	**0.181**	0.011	**0.056**	0.003	0.020	0.007	**0.029**	0.010	**0.681**
Total Potassium (K)	mg/L		0.66	0.43	0.61	0.43	**0.92**	**0.82**	**2.27**	0.54	**0.80**	0.17	0.32	0.20	0.54
Total Selenium (Se)	mg/L	0.00100	0.00109	0.00085	**0.00111**	0.00082	0.00106	0.00028	0.00082	0.00012	0.00026	0.00071	0.00092	0.00090	**0.00117**
Total Silicon (Si)	mg/L		4.10	3.78	**4.82**	3.30	**4.49**	**4.70**	**7.20**	2.64	3.20	3.40	3.70	3.35	**6.86**
Total Silver (Ag)	mg/L	0.000100	0.000047	0.000010	**0.000063**	0.000007	**0.000732**	0.000021	**0.000393**	0.000022	**0.000681**	0.000005	**0.000081**	0.000012	**0.000520**
Total Sodium (Na)	mg/L		1.95	1.61	**2.43**	1.44	**2.05**	**3.05**	**6.52**	1.75	**3.05**	0.91	1.13	1.02	1.82
Total Strontium (Sr)	mg/L		0.35	0.252	0.274	0.238	0.278	**0.366**	**0.522**	0.198	0.226	0.085	0.088	0.0890	0.1020
Total Sulphur (S)	mg/L		89	**131**	**152**	82	**112**	**102**	**153**	45	53	15	20	20	50
Total Thallium (Tl)	mg/L	0.000800	0.000034	0.000003	0.000010	0.000002	**0.000036**	0.000009	**0.000038**	0.000011	0.000031	0.000002	0.000003	0.000002	**0.000050**
Total Tin (Sn)	mg/L		0.00033	0.00020	**0.00055**	0.00020	0.00029	0.00020	0.00028	0.00020	**0.00040**	0.00020	0.00020	0.00020	**0.00500**
Total Titanium (Ti)	mg/L		0.0048	0.0005	0.0033	0.0005	**0.0240**	0.0006	**0.0114**	0.0005	0.0017	0.0005	0.0024	0.0015	**0.1000**
Total Uranium (U)	mg/L	0.0150	0.0033	**0.0040**	**0.0049**	0.0025	0.0031	0.00145	0.00187	0.00104	0.00113	0.00019	0.00028	0.00044	0.00090
Total Vanadium (V)	mg/L		0.0005	0.0002	0.0002	0.0002	**0.0026**	0.0002	**0.0022**	0.0002	0.0002	0.0002	0.0002	0.0002	**0.0096**
Total Zinc (Zn)	mg/L	0.017	0.014	**0.1560**	**0.3640**	**0.1040**	**0.3700**	**0.0578**	**0.1570**	**0.0271**	**0.1030**	0.0108	**0.0666**	0.0107	**0.0801**
Total Zirconium (Zr)	mg/L		0.0003	0.0001	**0.0004**	0.0001	**0.0007**	0.0001	**0.0007**	0.0001	0.0002	0.0001	0.0001	0.0001	**0.0011**
Field Measures															
Discharge (Flow)	L/s		8 - 711	89	147	259	600	109	222	244	1574	205	2367	795	1958
Temperature (field)	C		5.2	0.7	**13.1**	0.2	**8.1**	0.1	**13.3**	1.9	**13.4**	0.8	**5.7**	0.8	**7.8**
Dissolved Oxygen (field)	mg/L	9.5	10.3	12.00	14.70	13.17	16.10	**9.71**	13.76	**9.40**	10.85	12.87	15.71	12.86	14.50
Dissolved Oxygen (field)	%		72	89	134	97	110	76	96	**68**	86	94	108	94	107
Conductivity (field)	µS/cm		275	**465**	**1127**	**410**	**632**	-	-	148	163	180	188	138	**331**
Specific Conductance (field)	µS/cm		699	**894**	**1056**	671	**846**	**968**	**1495**	589	**708**	183	217	220	267
pH (field)	pH units	6.5 - 9.0	7.17 - 8.49	7.75	8.23	8.05	8.47	7.61	7.99	7.78	8.23	7.74	8.20	7.83	8.52
ORP (field)	mV		349	185.0	**361.3**	115.4	**428.1**	156.7	345.4	149.7	300.4	105.3	**369.4**	156.1	**351.2**

Bold - value greater than background or less than background for dissolved oxygen and pH
light grey - value greater than guideline or less than guideline for dissolved oxygen and pH
dark grey - value greater than 2x guideline or less than 2x guideline for dissolved oxygen and pH

[a] - BCMOE guideline for sulphate at 100 mg/L hardness, BCMOE, April 2013.

[b] - Ammonia guideline range calculated from CCME guideline table, based on pH and temperature, see Appendix Table A.20

[c] - Federal Environmental Quality Guideline, Environment Canada, February 2013

[d] - BCMOE Iron guideline, February 2008.

[e] - BCMOE Manganese guideline, August 2006.

[f] - hardness based guidelines calculated based on 100 mg/L hardness.

Table 5: Summary of substances that exceed background and guidelines.

Station	Median				Maximum
	> guideline and > background	> guideline < background	>background < guideline	> background no guideline	2 times > guideline
KV-6	SO4, As, Cd, Zn		NH3, Co, Mn, Ni, U	hardness, alkalinity, specific conductance, Ca, Li, Mg, S	As, Cd, Pb, Zn
K-7	Cd, Zn		NH3, Ni, Mo	alkalinity, specific conductance, Li, Mg	TSS, Al, As, Cd, Cu, Fe, Pb, Ag, Zn
KV-9	Cd, Zn			Mg	Cd, Pb, Ag, Zn
KV-9A	Cd, Zn		Co, Fe, Mn, Ni	specific conductance, Ca, Li, Mg, K, Si, Na, Sr, S	TSS, Al, As, Cd, Cu, Fe, Pb, Ag, Mn, Zn
KV-38					Cd, Pb, Zn
KV-41	Cd,		NH3		TSS, Al, As, Cd, Cu, Fe, Pb, Ag, Zn

values > 10 times background are underlined

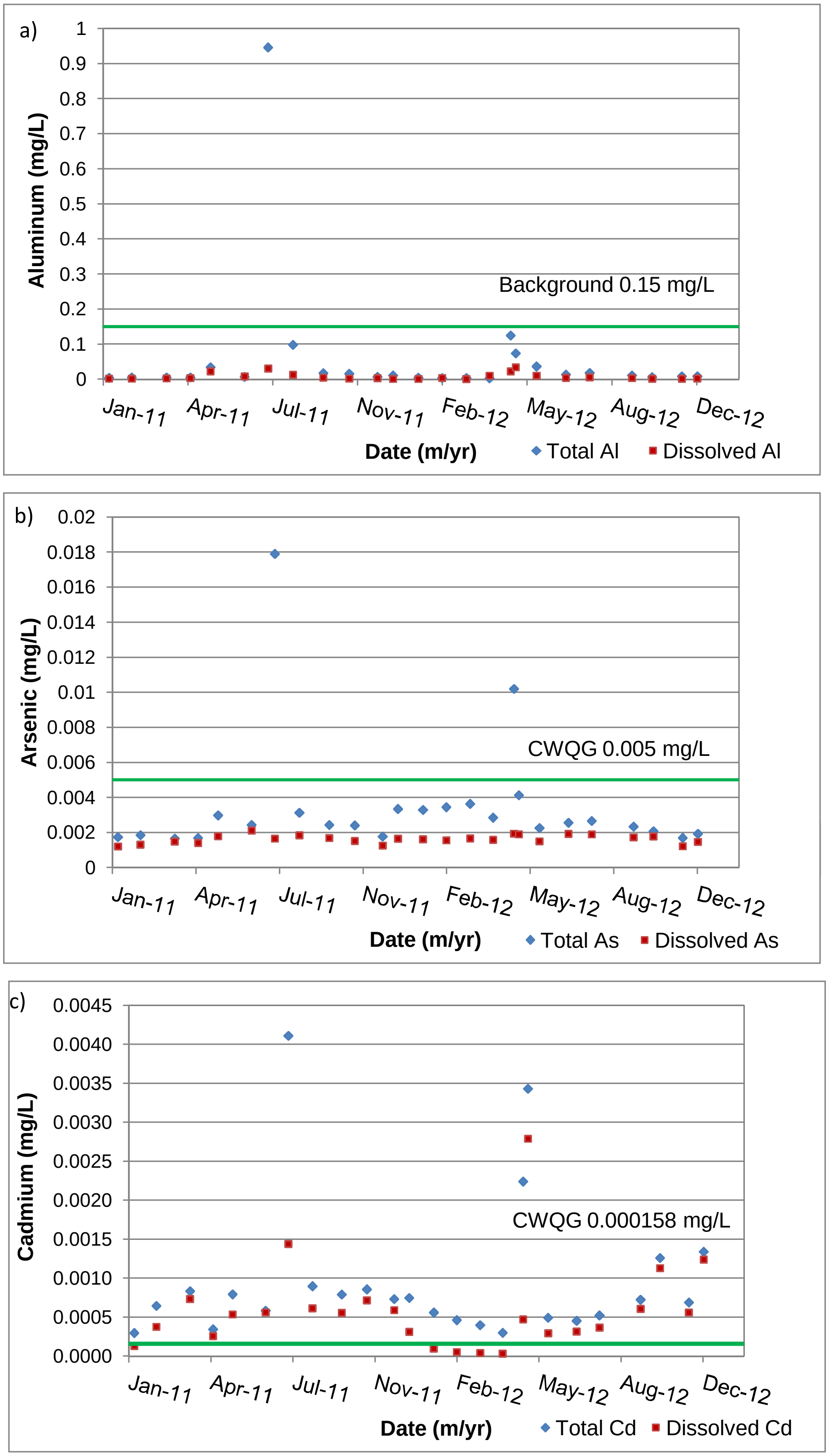


Figure 1: Selected total and dissolved analytes (2011-2012) at station KV-7 relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.

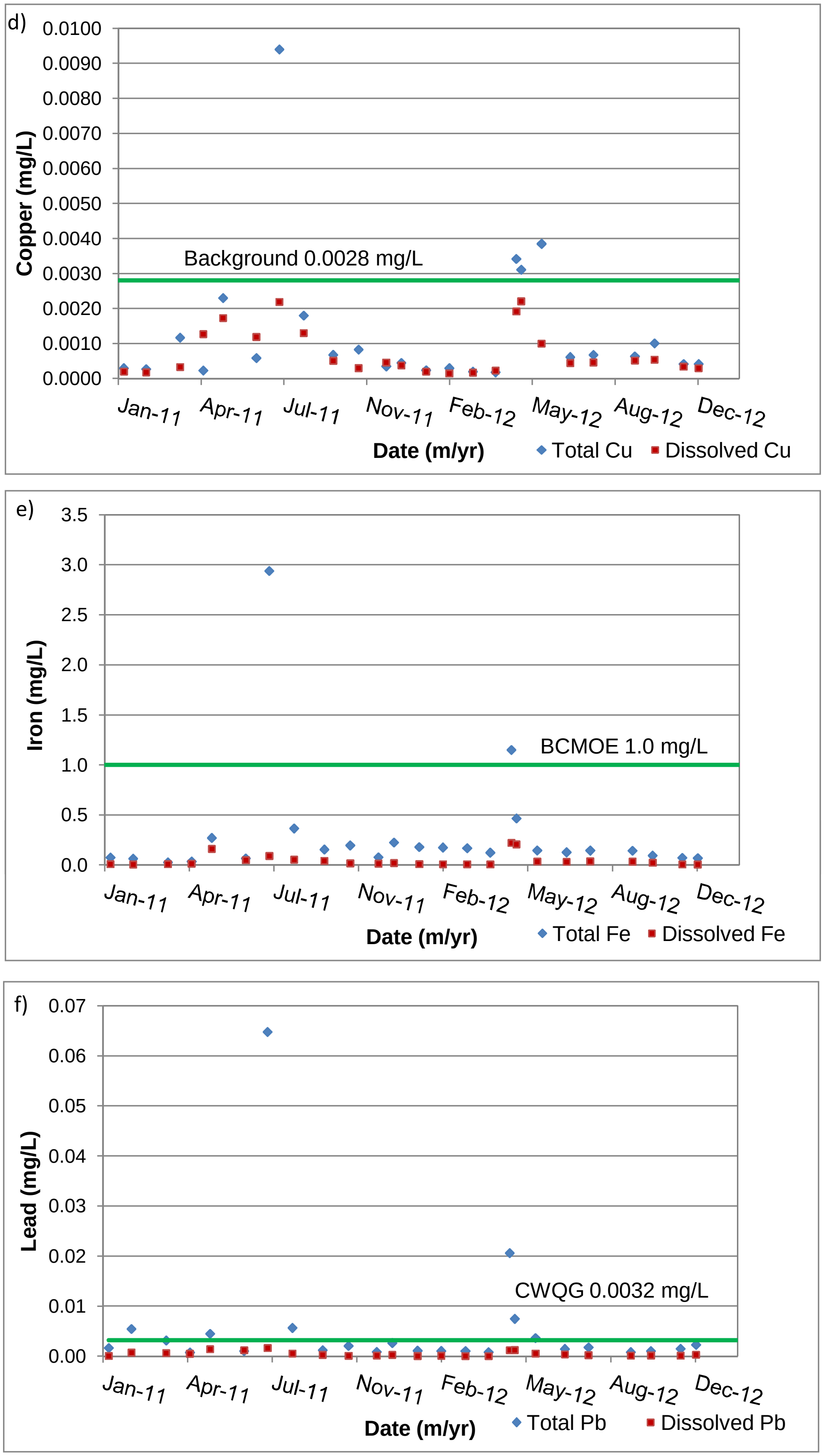
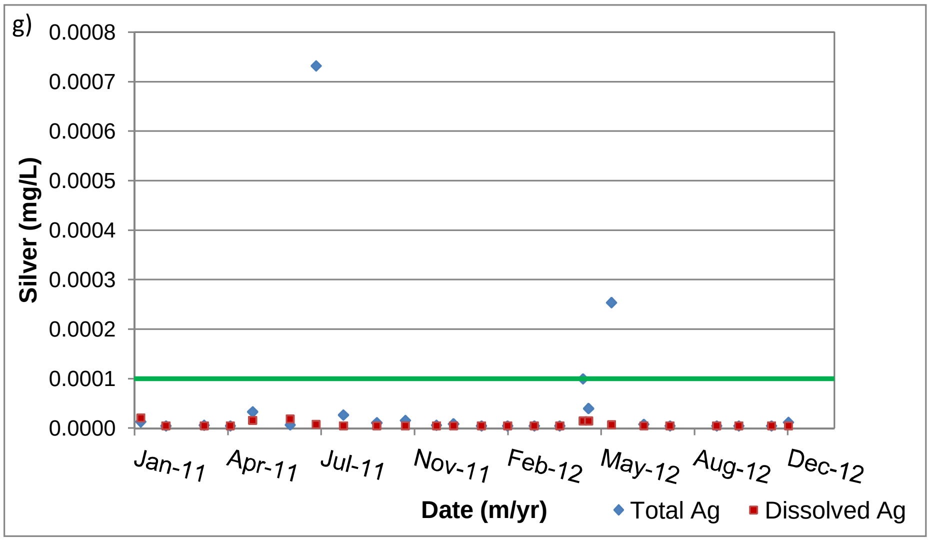


Figure 1: Selected total and dissolved analytes (2011-2012) at station KV-7 relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.



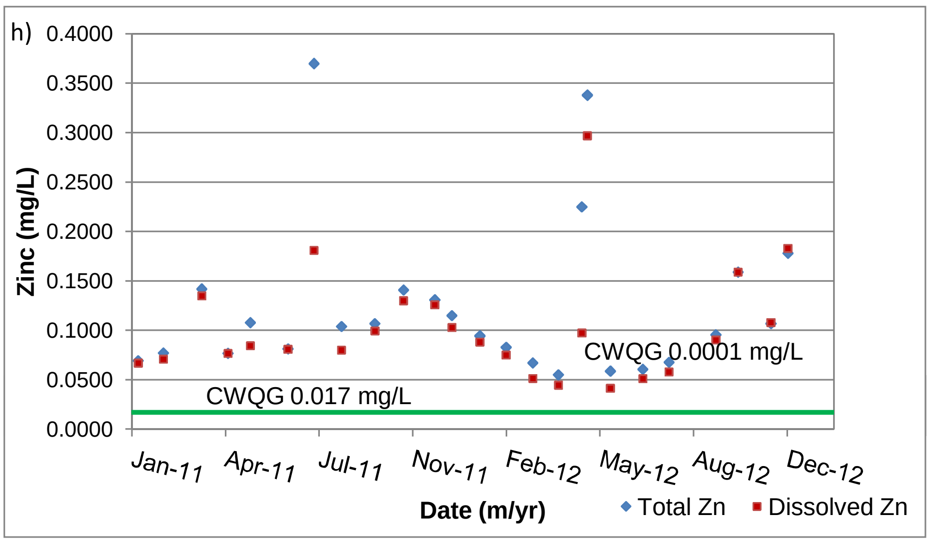


Figure 1: Selected total and dissolved analytes (2011-2012) at station KV-7 relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.

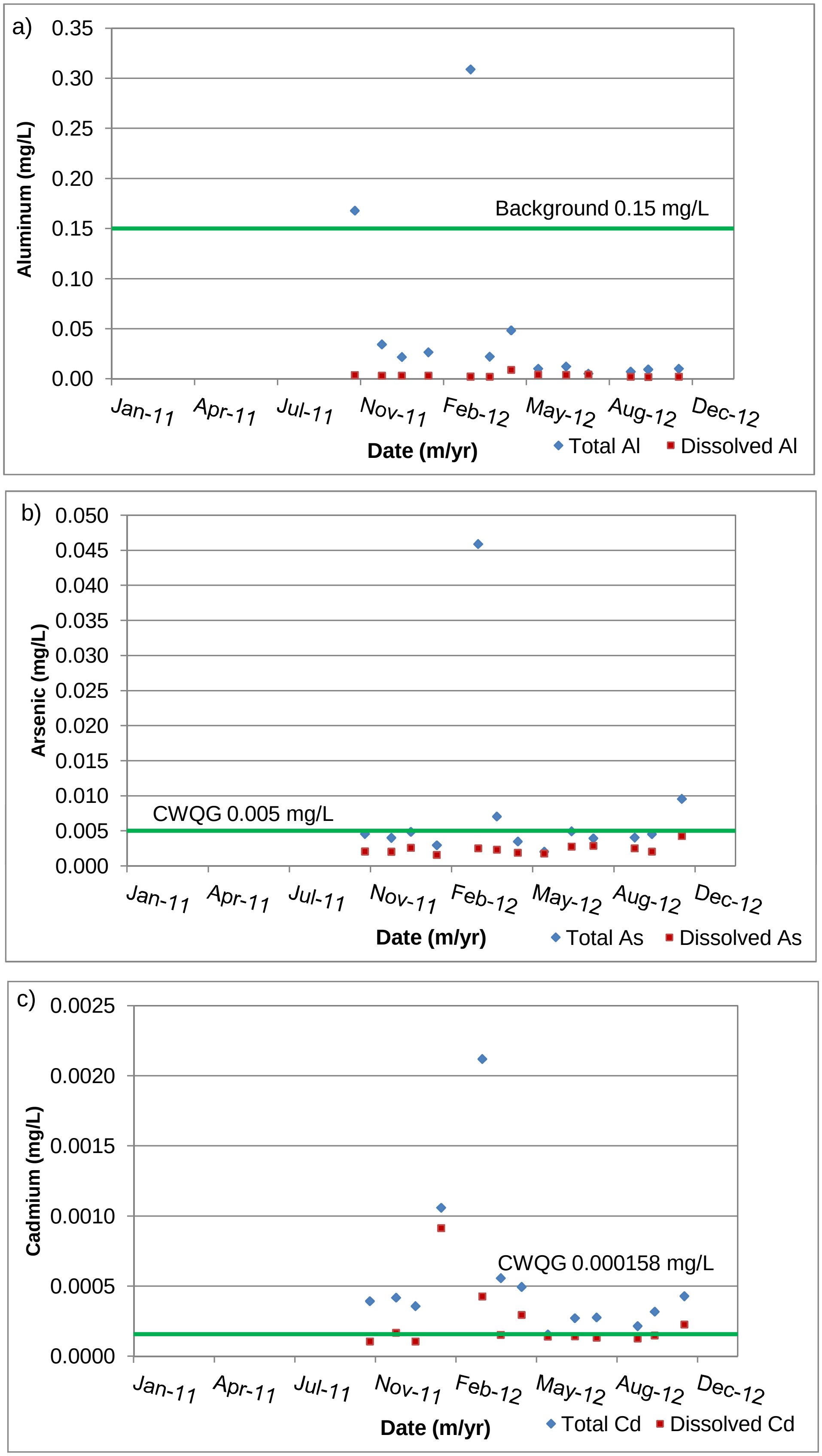


Figure 2: Selected total and dissolved analytes (2011-2012) at station KV-9A relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.

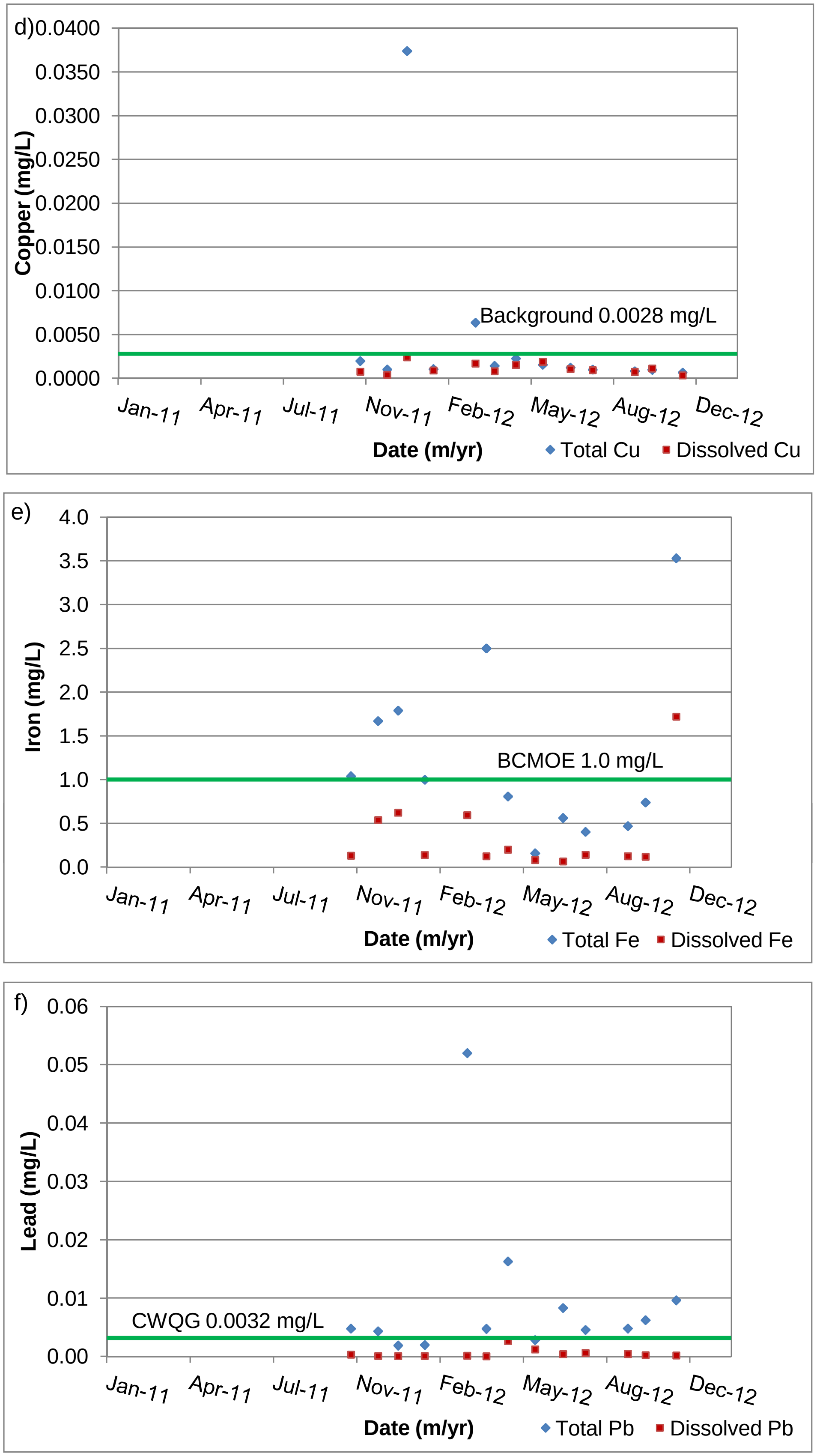
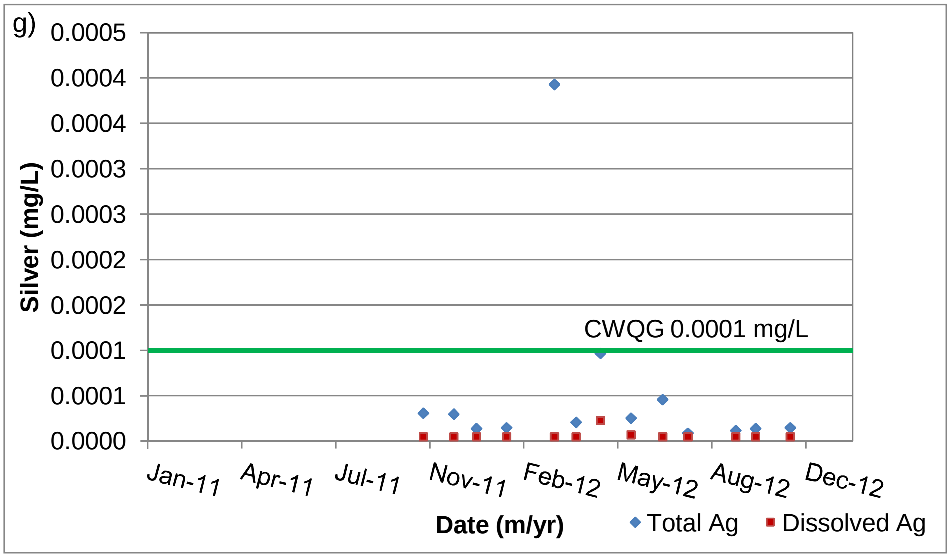


Figure 2: Selected total and dissolved analytes (2011-2012) at station KV-9A relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.



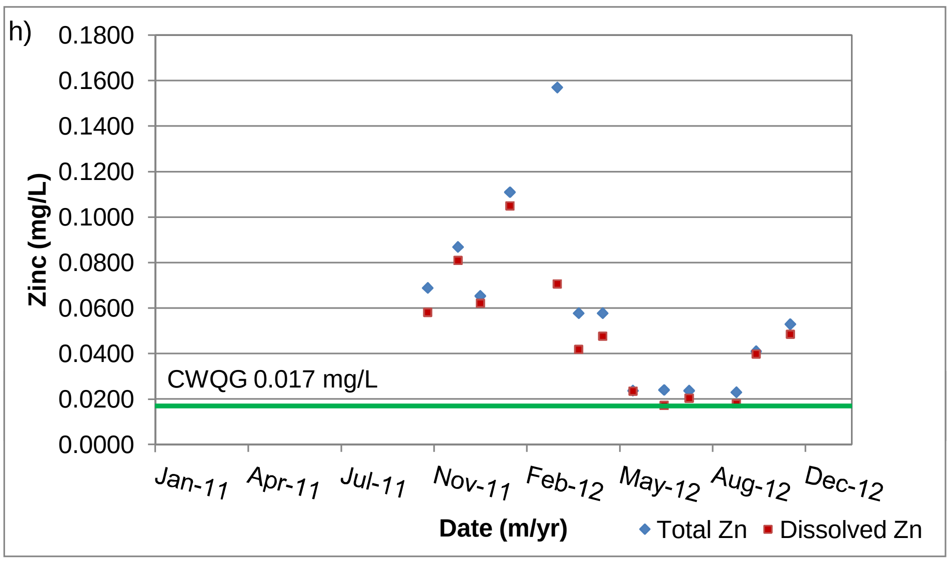


Figure 2: Selected total and dissolved analytes (2011-2012) at station KV-9A relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.

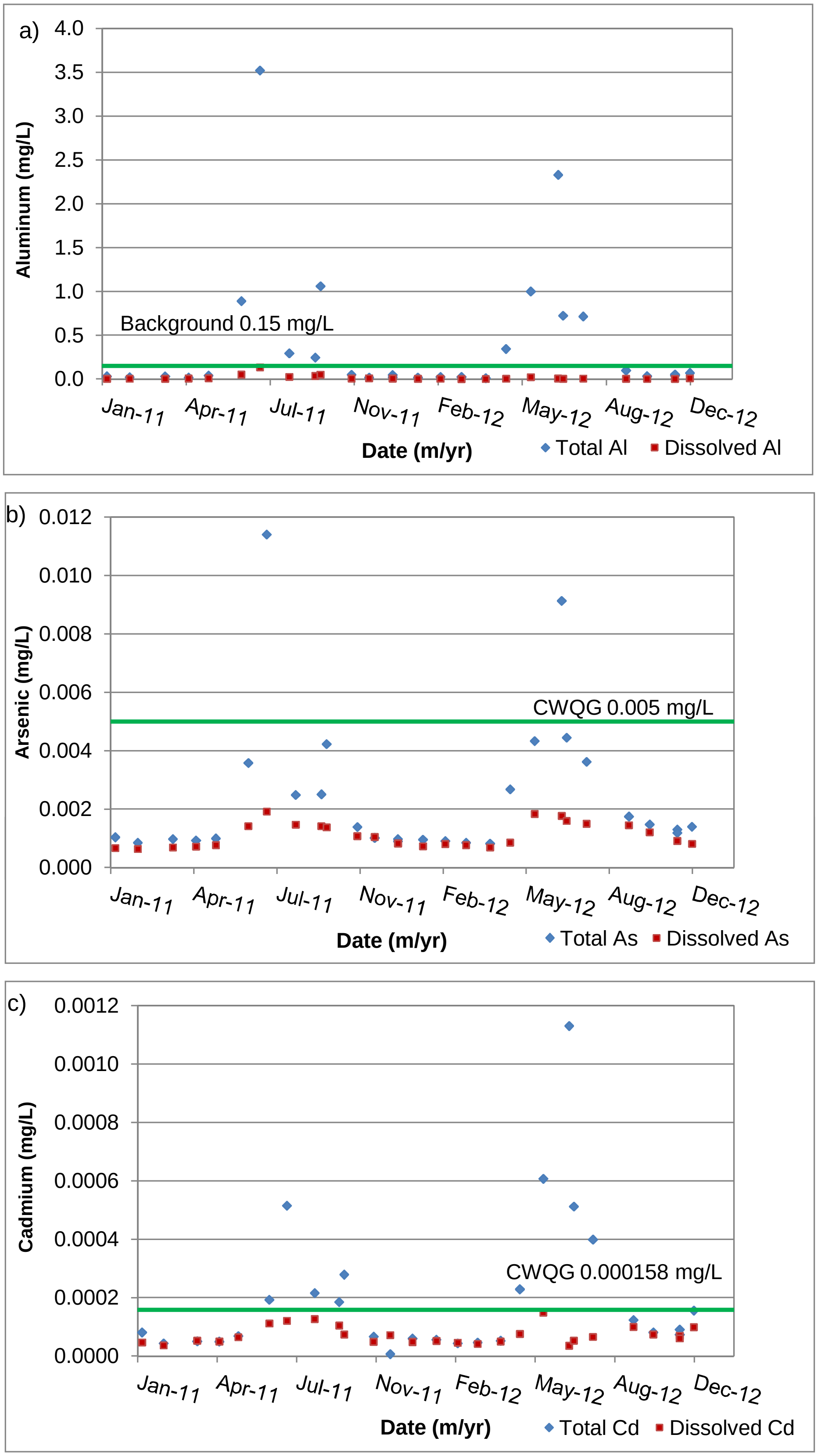


Figure 3: Selected total and dissolved analytes (2011-2012) at station KV-41 relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.

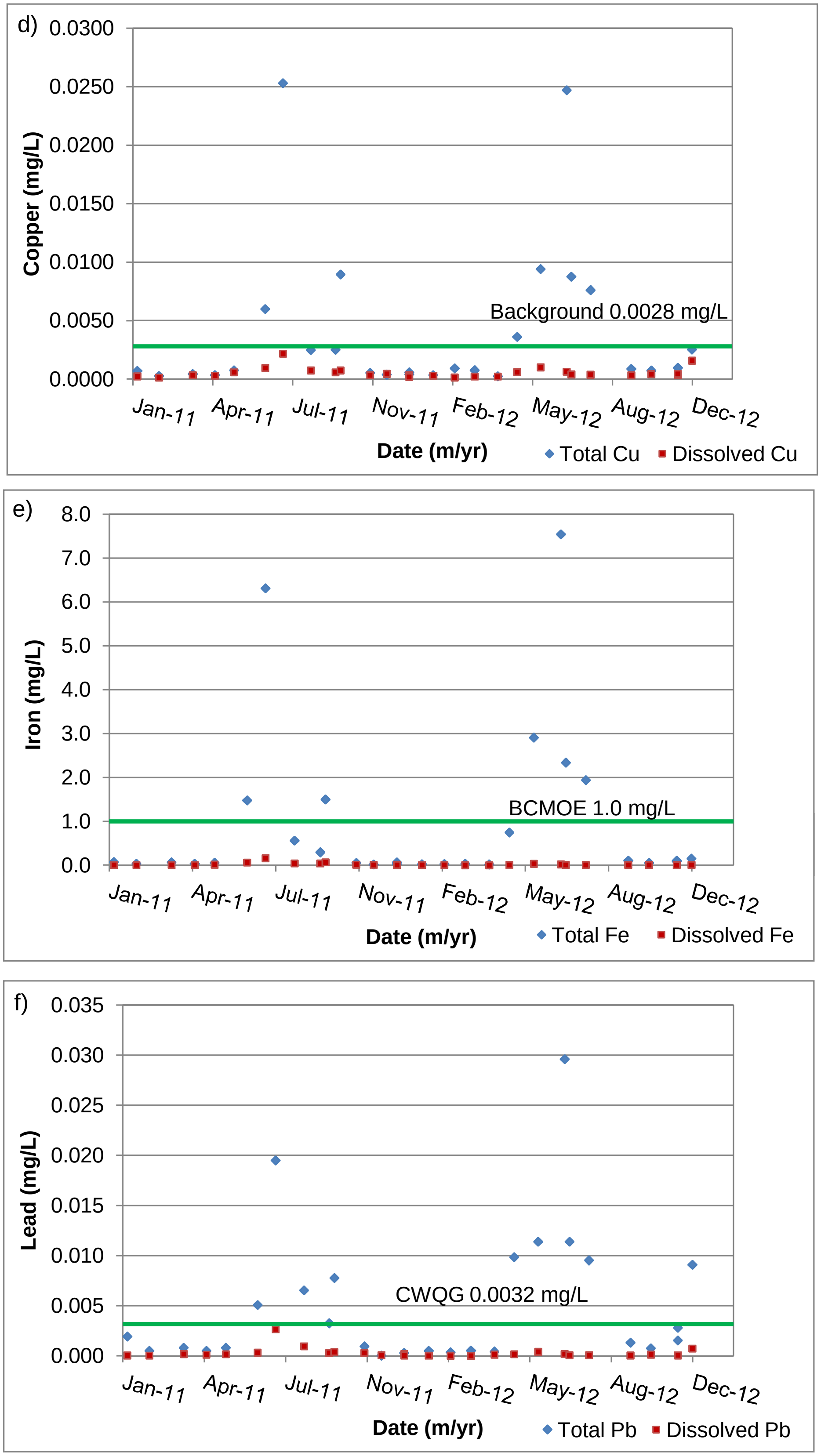
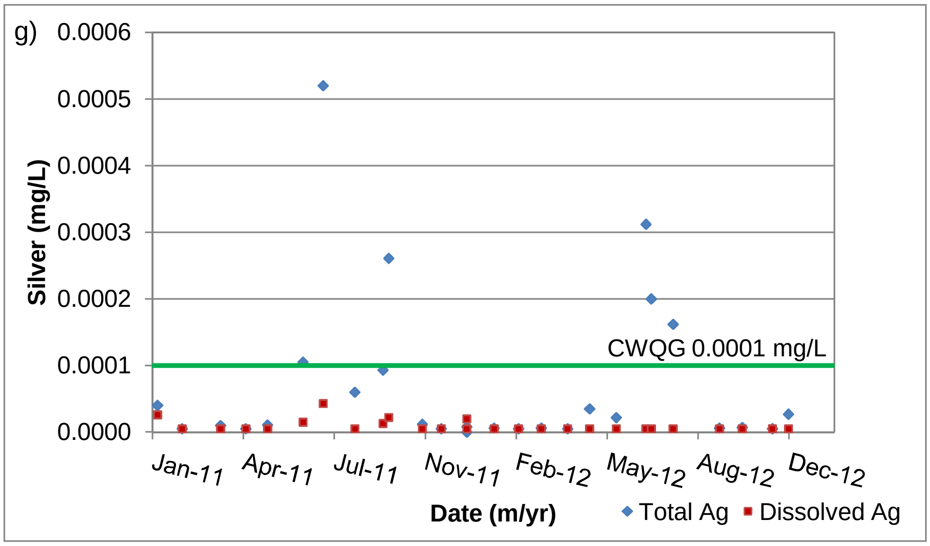


Figure 3: Selected total and dissolved analytes (2011-2012) at station KV-41 relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.



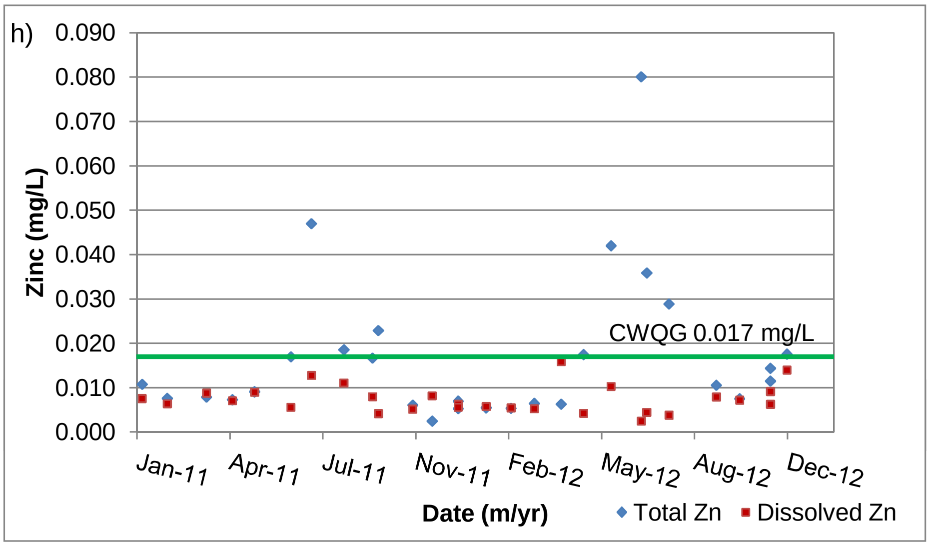


Figure 3: Selected total and dissolved analytes (2011-2012) at station KV-41 relative to the upper limit of background or the Canadian Water Quality Guideline (CWQG), whichever is higher.

APPENDIX A

Water Quality Tables and Figures

Table A.1: Water quality concentrations for KV-37, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011		7.98	7.52	124		132	0.0				2.0	58	55	38	46		29		
5/25/2011		7.75	**7.30**	36		61	3.1				11.0	28	28	11	14		18		
7/14/2011	1,021	7.71	7.55		112	118	**6.5**				1.0	54	53	26	31		30		
9/17/2011	348	7.88	7.76		171	148	2.0				<1	64	62	34	41		32	0.010	<0.005
10/30/2011	206	7.72	7.47		142	134	1.4	10.3	72	293	<1	63	57	33	41		28		<0.050
11/22/2011	162	8.06	7.73			132	0.0	12.6	86		<1	60	57				28		<0.005
12/18/2011			7.60			130					1.0	64	60	36	44		24	0.008	<0.005
12/18/2011	92	7.40	7.75			131	0.0	12.4	85		<1	58	58				30		
1/18/2012	120	7.51	7.73		115	135	0.0	11.1	76	**366**	<1	58	57				26		<0.005
2/9/2012	135	7.64	7.68		132	127	0.1	13.5	93	168	4.9	61	61	37	46		24		<0.005
3/9/2012		7.37	7.96			143	0.0	12.4	85	0	<1	64	60				27		**0.190**
4/7/2012	69	7.87	7.77		154	134	0.2	15.6	107	185	<1	59	62				26		<0.005
5/6/2012	62	8.21	7.74		116	127	0.5	14.3	99	88	<1	59	59	38	46	<0.5	22		<0.005
6/1/2012	781	7.65	7.66		71	90	2.0				2.5	36	38				20		<0.050
6/13/2012			**7.43**			104					1.7	48	47	21	25	<0.5	29	0.015	<0.050
7/1/2012	691	7.77	**7.43**		147	135	**6.5**	12.1	99	92	1.0	64	61			<0.5	34		<0.050
7/8/2012		7.64	7.71		154	143	4.9	12.5	98	93	<1	60	61	29	35		38	<0.0050	<0.050
8/1/2012	62	**7.00**	7.51		160	144	5.0	13.3	103	104	1.0	69	66				35		<0.050
9/20/2012	387	8.03	7.79			159	4.1	12.1	93	64	<1	75	73				43		<0.050
10/10/2012	262	7.60	7.71		175	147	0.0	12.3	85	176	<1	66	67	36	43	<0.5	37		<0.050
11/16/2012		7.83	**7.38**		149	141	0.1	13.0	89	344	<1	67	64				30		**0.077**
11/18/2012		**6.75**	7.70		128	141	0.1	**8.2**	**68**		<1	66	67	38	46	<0.5	30	0.008	<0.050
12/6/2012		**7.06**	7.86		150	135	0.1			137	<1	60	64				26		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	14	21	23	2	15	23	21	15	15	13	23	23	23	12	12	5	23	5	19
median	184	7.71	7.70	80	147	134	0.2	12.43	89	137	1	60	60	34.8	42	< 0.5	28.7	0.0082	0.050
mean	314	7.64	7.64	80	138	130	1.7	12.37	89	162	2	59	58	31.3	38	< 0.5	28.9	0.0092	0.040
standard deviation	305	0.36	0.17	62	27	21	2.3	1.69	11	111	2	10	10	8.4	10	< 0.0	5.9	0.0037	0.044
minimum	62	6.75	7.30	36	71	61	0.0	8.20	68	0	< 1	28	28	11.0	14	< 0.5	18.0	< 0.005	< 0.005
maximum	1021	8.21	7.96	124	175	159	6.5	15.59	107	366	11	75	73	38.0	46	< 0.5	43.0	0.0150	0.190
# < detection limit	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	5	0	1	17
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	61%	0%	0%	0%	0%	100%	0%	20%	89%
# > guideline		0	0					1			0					0		0	2
% > guideline		0%	0%					7%			0%					0%		0%	11%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.1: Water quality concentrations for KV-37, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011			0.006	1.00	0.01	0.00007	0.0027	0.059	<0.00001	<0.000005	<0.05	0.00001	18	0.00030	0.00002	0.0004	0.05	0.0003	0.0008	3	0.006
5/25/2011			0.009	4.60	0.07	0.00010	0.0034	0.031	<0.00001	<0.000005	<0.05	0.00007	8	0.00040	0.00012	0.0013	0.17	0.0023	<0.0005	2	0.019
7/14/2011			0.005	2.70	0.03	0.00012	0.0022	0.040	<0.00001	<0.000005	<0.05	0.00001	16	0.00030	0.00004	0.0009	0.06	0.0001	<0.0005	3	0.007
9/17/2011	0.07		0.005	<0.5	0.01	0.00009	0.0025	0.052	<0.00001	<0.000005	<0.05	0.00003	20	0.00010	0.00003	0.0004	0.06	0.0008	0.0006	4	0.009
10/30/2011	<0.20	0.30	0.005	1.10	0.01	0.00009	0.0024	0.056	<0.00001	<0.000005	<0.05	0.00001	19	0.00010	0.00002	0.0003	0.04	0.0000	0.0008	4	0.007
11/22/2011	0.14	0.19	0.004	0.62	0.01	0.00008	0.0025	0.056	<0.00001	<0.000005	<0.05	0.00001	18	<0.00010	0.00002	0.0001	0.04	0.0001	0.0008	4	0.007
12/18/2011	0.16		0.007	0.67	0.01	<0.00050	0.0027	0.062	<0.00010	<0.001000	<0.05	0.00002	19	**0.00100**	<0.0005	0.0003	0.07	<0.00020	<0.0050	4	0.008
12/18/2011					0.01	0.00007	0.0029	0.060	<0.00001	<0.000005	<0.05	0.00001	18	0.00020	0.00002	0.0003	0.05	0.0001	0.0008	4	0.007
1/18/2012	0.17	0.05	0.008	0.83	0.01	0.00007	0.0028	0.063	<0.00001	<0.000005	<0.05	0.00001	18	0.00030	0.00002	0.0004	0.05	0.0004	0.0008	3	0.007
2/9/2012	0.23	0.04	0.013	<0.5	0.02	0.00008	**0.0035**	0.063	<0.00001	<0.000005	<0.05	0.00001	19	0.00020	0.00004	0.0003	0.10	0.0005	0.0008	3	0.009
3/9/2012	**1.93**	<0.20	0.010	0.74	0.01	0.00011	0.0031	0.064	<0.00001	<0.000005	<0.05	0.00001	20	0.00060	0.00004	0.0006	0.04	0.0006	0.0009	3	0.005
4/7/2012	0.14	0.05	0.006	<0.5	0.01	0.00008	0.0029	0.064	<0.00001	<0.000005	<0.05	0.00001	18	0.00020	0.00002	0.0002	0.03	0.0001	0.0008	3	0.004
5/6/2012	0.10	0.17	0.010	1.56	0.01	0.00008	0.0031	0.062	<0.00001	<0.0000050	<0.05	0.00001	17	<0.00010	0.00003	0.0006	0.08	0.0002	0.0008	4	0.007
6/1/2012	<0.20	<0.20	0.010	<0.5	0.04	0.00008	0.0024	0.040	<0.00001	<0.0000050	<0.05	0.00010	10	0.00015	0.00005	0.0010	0.08	0.0004	<0.0005	2	0.008
6/13/2012	<0.20			1.36	0.02	0.00012	0.0019	0.039	<0.00001	<0.0000050	<0.05	0.00003	15	<0.00010	0.00004	0.0006	0.06	0.0002	<0.0005	3	0.005
7/1/2012	<0.20	<0.20	0.005	1.22	0.01	0.00012	0.0024	0.048	<0.00001	<0.0000050	<0.05	0.00002	20	0.00014	0.00003	0.0005	0.04	0.0001	<0.0005	3	0.006
7/8/2012	<0.20		0.004	0.72	0.01	0.00013	0.0022	0.047	<0.00001	<0.0000050	<0.05	0.00001	18	<0.00010	0.00003	0.0004	0.04	0.0001	0.0005	3	0.007
8/1/2012	<0.20	<0.20	0.004	1.12	0.01	0.00011	0.0025	0.054	<0.00001	<0.0000050	<0.05	0.00010	21	<0.00010	0.00005	0.0004	0.06	0.0001	0.0006	4	0.011
9/20/2012	<0.20	<0.20	0.005	0.69	0.01	0.00009	0.0025	0.058	<0.00001	<0.0000050	<0.05	0.00001	23	<0.00010	0.00003	0.0003	0.05	0.0001	0.0005	4	0.009
10/10/2012	<0.20	0.21		1.85	0.01	0.00009	0.0024	0.055	<0.00001	<0.0000050	<0.05	0.00001	20	0.00011	0.00003	0.0003	0.04	0.0001	0.0006	4	0.009
11/16/2012	<0.20	0.22	0.007	<0.5	0.01	0.00012	0.0026	0.059	<0.00001	<0.0000050	<0.05	0.00001	20	<0.00010	0.00003	0.0004	0.08	0.0000	0.0008	4	0.010
11/18/2012	<0.20		0.006	<0.5	0.01	0.00009	0.0025	0.062	<0.00001	<0.0000050	<0.05	0.00001	20	0.00040	0.00003	0.0004	0.05	0.0001	0.0008	4	0.009
12/6/2012	0.18	0.09	0.007	0.70	0.01	0.00009	0.0029	0.066	<0.00001	<0.0000050	<0.05	0.00001	18	<0.00010	0.00003	0.0002	0.06	0.0005	0.0007	4	0.010
guideline	3.00				0.10		0.0050				1.50	0.000158		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.000156	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	19	14	20	22	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
median	0.20	0.20	0.0062	0.7	0.009	0.00009	0.0025	0.058	< 0.00001	< 0.000005	< 0.05	0.000013	18.4	0.00014	0.00003	0.00036	0.053	0.00011	0.0008	3.50	0.0073
mean	0.27	0.17	0.0068	1.1	0.014	0.00011	0.0026	0.055	< 0.00001	< 0.00005	< 0.05	0.000023	18.0	0.00023	0.00005	0.00046	0.060	0.00031	0.0009	3.43	0.0080
standard deviation	0.40	0.08	0.0025	0.9	0.015	0.00009	0.0004	0.010	0.000019	0.000207	0.00	0.000027	3.2	0.00021	0.00010	0.00027	0.027	0.00048	0.0009	0.55	0.0030
minimum	0.07	0.04	0.0035	< 0.5	0.005	0.00007	0.0019	0.031	< 0.00001	< 0.000005	< 0.05	0.000007	8.3	< 0.0001	0.00002	0.00014	0.030	0.00004	< 0.0005	1.72	0.0040
maximum	1.93	0.30	0.0130	4.6	0.071	< 0.0005	0.0035	0.066	< 0.00010	< 0.001000	< 0.05	0.000102	22.8	0.00100	0.00050	0.00127	0.165	0.00228	0.0050	4.29	0.0193
# < detection limit	10	5	0	6	0	1	0	0	23	23	23	0	0	8	1	0	0	1	6	0	0
% < detection limit	53%	36%	0%	27%	0%	4%	0%	0%	100%	100%	100%	0%	0%	35%	4%	0%	0%	4%	26%	0%	0%
# > guideline	0				0		0				0	0		0		0	0	0			0
% > guideline	0%				0%		0%				0%	0%		0%		0%	0%	0%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.1: Water quality concentrations for KV-37, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011	<0.000010	0.0002	0.0007	0.007	0.18	0.00051	3.84	<0.000005	0.86	0.06	<10	0.000003	<0.00001	<0.00050	0.0001	<0.0002	0.001	<0.00010
5/25/2011	<0.000010	0.0001	0.0007	0.019	0.33	0.00026	1.34	0.000023	0.25	0.03	<10	<0.000002	<0.00001	0.0015	0.0000	<0.0002	0.005	<0.00010
7/14/2011	<0.000010	0.0001	0.0005	0.005	<0.050	0.00038	2.04	<0.000005	0.43	0.05	10	<0.000002	<0.00001	<0.00050	0.0000	<0.0002	0.001	<0.00010
9/17/2011	<0.000010	0.0001	0.0002	0.007	0.12	0.00053	2.80	0.000010	0.62	0.06	13	<0.000002	0.00004	<0.00050	0.0001	<0.0002	0.002	<0.00010
10/30/2011	<0.000010	0.0001	0.0002	0.004	0.16	0.00056	3.50	<0.000005	0.89	0.07	12	<0.000002	0.00006	<0.00050	0.0001	<0.0002	0.001	<0.00010
11/22/2011	<0.000010	0.0001	0.0001	0.005	0.17	0.00063	3.60	<0.000005	0.95	0.07	<10	<0.000002	0.00001	<0.00050	0.0001	<0.0002	0.001	<0.00010
12/18/2011	<0.000050	<0.00100	<0.00100	<0.0100	0.17	0.00060	3.91	<0.00002	1.02	0.07	8	<0.00005	<0.00500	<0.00500	<0.0001	<0.0050	<0.0050	<0.00050
12/18/2011	<0.000010	0.0002	0.0002	0.006	0.17	0.00062	3.50	<0.000005	0.96	0.07	<10	<0.000002	0.00003	<0.00050	0.0001	<0.0002	0.001	<0.00010
1/18/2012	<0.000010	0.0001	0.0002	0.010	0.20	0.00062	4.00	<0.000005	1.93	0.07	<10	<0.000002	<0.00020	<0.00050	0.0001	<0.0002	0.003	<0.00010
2/9/2012	<0.000010	0.0001	0.0002	0.012	0.19	0.00057	4.00	<0.000005	1.03	0.07	<10	<0.000002	<0.00020	<0.00050	0.0001	<0.0002	0.002	<0.00010
3/9/2012	<0.000010	0.0002	0.0002	0.010	0.24	0.00060	4.10	<0.000005	**2.96**	0.07	<10	<0.000002	<0.00020	<0.00050	0.0001	<0.0002	0.005	<0.00010
4/7/2012	<0.000010	0.0002	0.0002	0.006	0.17	0.00060	3.60	<0.000005	1.00	0.07	<10	<0.000002	<0.00020	<0.00050	0.0001	<0.0002	0.004	<0.00010
5/6/2012	<0.000010	0.0001	0.0003	0.008	0.32	0.00056	3.35	<0.0000050	0.97	0.07	<10	<0.0000020	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
6/1/2012	<0.000010	0.0001	0.0006	0.010	0.21	0.00031	1.44	0.000006	0.40	0.04	<10	<0.0000020	<0.00020	<0.00050	0.0000	<0.0002	0.010	<0.00010
6/13/2012	<0.000010	0.0001	0.0004	0.005	0.09	0.00042	1.59	0.000005	0.34	0.04	<10	<0.0000020	<0.00020	0.0005	0.0000	0.0002	0.003	<0.00010
7/1/2012	<0.000010	0.0001	0.0003	<0.0020	0.06	0.00047	2.15	<0.000005	0.46	0.06	13	<0.0000020	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
7/8/2012	<0.000010	0.0001	0.0003	0.004	0.07	0.00046	1.88	<0.000005	0.43	0.06	13	<0.0000020	<0.00020	<0.00050	0.0000	<0.0002	0.001	<0.00010
8/1/2012	<0.000010	0.0001	0.0003	<0.0020	0.07	0.00048	2.78	<0.000005	0.65	0.07	13	<0.0000020	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
9/20/2012	<0.000010	0.0001	0.0002	0.004	0.13	0.00058	2.69	<0.000005	0.65	0.07	17	<0.0000020	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
10/10/2012	<0.000010	0.0001	0.0002	0.005	0.15	0.00057	3.41	<0.000005	0.74	0.07	14	<0.0000020	0.00032	<0.00050	0.0001	<0.0002	0.002	<0.00010
11/16/2012	<0.000010	0.0002	0.0003	0.007	0.19	0.00064	3.48	<0.000005	0.98	0.07	12	0.000005	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
11/18/2012	<0.000010	0.0002	0.0002	0.008	0.17	0.00061	3.85	<0.000005	0.93	0.07	11	<0.0000020	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
12/6/2012	<0.000010	0.0001	0.0004	0.008	0.23	0.00060	3.46	0.000006	1.00	0.07	10	<0.0000020	<0.00020	<0.00050	0.0001	<0.0002	0.001	<0.00010
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
median	< 0.00001	0.00013	0.00025	0.0067	0.170	0.00057	3.5	0.000005	0.89	0.0660	10	0.000002	0.00020	0.00050	0.00008	0.0002	0.0014	< 0.00010
mean	< 0.00001	0.00016	0.00034	0.0071	0.166	0.00053	3.1	0.000007	0.89	0.0613	11	0.000004	0.00036	0.00074	0.00007	0.0004	0.0023	< 0.0001
standard deviation	0.000008	0.00018	0.00022	0.0037	0.073	0.00010	0.9	0.000005	0.57	0.0112	2	0.000010	0.00102	0.00095	0.00003	0.0010	0.0023	0.00008
minimum	< 0.00001	0.00007	0.00014	< 0.0020	< 0.050	0.00026	1.3	< 0.000005	0.25	0.0273	8	< 0.000002	< 0.00001	< 0.00050	0.00002	< 0.0002	0.0006	< 0.00010
maximum	< 0.00005	0.00100	0.00100	0.0190	0.330	0.00064	4.1	0.000023	2.96	0.0710	17	0.000050	0.00500	0.00500	0.00011	0.0050	0.0102	< 0.00050
# < detection limit	23	1	1	3	1	0	0	18	0	0	11	21	18	21	1	22	1	23
% < detection limit	100%	4%	4%	13%	4%	0%	0%	78%	0%	0%	48%	91%	78%	91%	4%	96%	4%	100%
# > guideline	0	0	0			0		0				0			0		0	
% > guideline	0%	0%	0%			0%		0%				0%			0%		0%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.2: Water quality concentrations for KV-60, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	L/s	pH units	pH units	µS/cm	µS/cm	µS/cm	C	mg/L	%	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2/10/2011		7.52	8.01	120		534	0.0				<1	292	281						
5/27/2011		8.30	7.73	81		122	3.9				6.0	67	68						
7/14/2011		7.93	8.16		215	228	**9.4**				6.0	122	126						
10/27/2011	28	8.40	8.26		454	427	0.0	11.6	80	238	<1	247	221				45		<0.005
11/20/2011	22	7.92	8.22			489	0.1	12.4	82	73	1.2	299	255				53		<0.005
12/16/2011	15	7.76	8.09		491	491	-0.1	13.3	92		1.0	272	269				62		<0.005
1/24/2012	7	8.20	8.23		635	512	0.0	12.5	86	346	1.8	276	280				73		<0.005
2/16/2012		7.85	**8.33**		514	514	-0.1	14.3	98	-18	<1	275	304				68		<0.005
3/12/2012	4	7.95	**8.34**		530	519	-0.1	14.5	99	30	<1	284	268				72		<0.050
4/6/2012		8.21	**8.36**		578	496	0.0	13.5	93	25	<1	264	262				60		<0.005
5/1/2012		8.34	7.91		208	204	0.0	14.6	100	199	10.1	110	106	88	107	0.6	19	0.025	<0.050
5/7/2012		8.06	7.78		92	105	0.0	15.4	105	157	**98.7**	61	58				1		<0.050
5/9/2012	387																		
6/6/2012	76	8.08	8.10		241	216	**5.8**	13.6	109	300	**47.5**	117	118				21		<0.050
7/9/2012	41	8.23	**8.36**		356	323	**5.8**	12.8	102	143	1.1	172	181				31		<0.050
8/3/2012	56	8.44	8.28		341	340	**7.7**	12.4	104	300	8.5	188	193			0.7	29		<0.050
9/2/2012	101	7.76	**8.35**		346	295	4.8	13.2	103	125	8.5	149	156				20		<0.050
10/15/2012	25	8.09	**8.37**		507	451	0.0	13.0	89	117	3.3	240	244				51		<0.050
11/21/2012		**8.56**	8.20		417	493	0.0	14.2	97	**351**	**21.3**	266	268			1.1	70		<0.050
12/12/2012		7.36	8.21		509	508	0.0	**9.3**	**63**		1.9	275	272			0.7	70		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	11	19	19	2	16	19	19	16	16	14	19	19	19	1	1	4	16	1	16
median	28	8.08	8.22	100	435	451	0.0	13.25	97	150	2	247	244	87.5	107	0.7	51.9	0.025	< 0.050
mean	69	8.05	8.17	100	402	382	2.0	13.16	94	170	12	209	207	87.5	107	0.8	46.5	0.025	0.030
standard deviation	110	0.31	0.19	28	153	147	3.2	1.43	12	122	24	82	79	-	-	0.2	23.4	-	0.023
minimum	4	7.36	7.73	81	92	105	-0.1	9.26	63	-18	< 1	61	58	87.5	107	0.6	0.5	0.025	< 0.005
maximum	387	8.56	8.37	120	635	534	9.4	15.41	109	351	99	299	304	87.5	107	1.1	72.8	0.025	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	16
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	26%	0%	0%	0%	0%	0%	0%	0%	100%
# > guideline		0	0					1			2					0		1	0
% > guideline		0%	0%					6%			11%					0%		100%	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.2: Water quality concentrations for KV-60, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011					0.00	0.00039	0.0018	**0.099**	<0.00001	<0.000005	<0.05	**0.00036**	80	0.00030	0.00029	0.0003	0.02	0.0002	0.0029	**23**	0.025
5/27/2011					0.06	0.00042	0.0013	0.034	<0.00001	<0.000005	<0.05	0.00008	20	0.00040	0.00013	0.0018	0.23	0.0011	0.0006	4	0.013
7/14/2011					0.07	0.00048	0.0020	0.055	<0.00001	<0.000005	<0.05	0.00009	35	0.00040	0.00013	0.0023	0.24	0.0007	0.0013	8	0.015
10/27/2011	0.18	0.16	0.011	2.70	0.01	0.00031	0.0025	**0.091**	<0.00001	<0.000005	<0.05	**0.00021**	67	0.00010	**0.00030**	0.0005	0.09	0.0003	0.0024	**20**	0.024
11/20/2011	0.22	0.19	0.004	1.31	0.01	0.00035	0.0031	**0.101**	<0.00001	<0.000005	<0.05	**0.00031**	81	0.00020	**0.00048**	0.0004	0.10	0.0004	0.0028	**23**	0.035
12/16/2011	0.21	0.06	0.003	1.56	0.01	0.00037	0.0025	**0.095**	<0.00001	<0.000005	<0.05	**0.00040**	74	<0.00010	**0.00059**	0.0005	0.10	0.0003	0.0027	**21**	0.044
1/24/2012	0.19	0.14	0.005	1.13	0.01	0.00042	0.0033	**0.101**	<0.00001	<0.000005	<0.05	**0.00048**	73	0.00020	**0.00070**	0.0011	0.13	**0.0092**	0.0029	**23**	0.061
2/16/2012	0.17	0.12	0.003	0.82	0.01	0.00030	0.0029	**0.095**	<0.00001	<0.000005	<0.05	**0.00035**	74	0.00020	**0.00050**	0.0005	0.10	0.0006	0.0027	**22**	0.047
3/12/2012	<0.20	0.32	0.005	1.97	0.01	0.00027	**0.0036**	**0.104**	<0.00001	<0.000005	<0.05	**0.00026**	75	<0.00010	**0.00040**	0.0003	0.09	0.0003	0.0028	**23**	0.048
4/6/2012	0.15	0.11	0.004	0.62	0.01	0.00023	**0.0040**	**0.099**	<0.00001	<0.000005	<0.05	0.00013	71	<0.00010	0.00021	0.0003	0.08	0.0004	0.0028	**21**	0.017
5/1/2012	**0.57**	<0.20	**0.030**	**10.50**	**0.19**	0.00058	**0.0044**	0.058	0.000011	<0.0000050	<0.050	**0.00088**	30	0.00042	**0.00029**	**0.0050**	**0.50**	**0.0132**	0.0011	8	0.039
5/7/2012	<0.20	**0.79**		**18.10**	**0.52**	**0.00124**	**0.0089**	0.061	**0.000044**	**0.000010**	<0.050	**0.00082**	17	**0.00101**	**0.00086**	**0.0077**	**1.55**	**0.0605**	0.0008	4	0.148
5/9/2012																					
6/6/2012	<0.20	0.35	**0.070**	7.85	**0.26**	0.00060	0.0032	0.067	**0.000025**	0.000006	<0.050	**0.00022**	34	0.00043	**0.00050**	**0.0029**	**0.80**	**0.0070**	0.0014	8	0.082
7/9/2012	<0.20	0.33	0.005	7.15	0.02	0.00049	0.0021	0.073	<0.00001	<0.0000050	<0.050	0.00013	49	0.00011	0.00011	0.0013	0.11	0.0005	0.0019	12	0.009
8/3/2012	<0.20	**0.44**	0.014	7.07	0.08	0.00041	0.0025	**0.086**	<0.00001	<0.0000050	<0.050	0.00010	54	0.00019	0.00019	0.0012	0.37	0.0005	0.0017	13	0.028
9/2/2012	<0.20	**0.45**	0.015	8.77	0.07	0.00030	0.0021	0.073	<0.00001	0.000006	<0.050	0.00008	42	0.00028	0.00019	0.0011	0.34	0.0003	0.0015	11	0.048
10/15/2012	<0.20	0.30	0.007	2.10	0.03	0.00033	0.0026	**0.095**	<0.00001	<0.0000050	<0.050	0.00014	65	0.00013	0.00017	0.0008	0.10	0.0003	0.0024	**19**	0.020
11/21/2012	<0.20	0.38	0.010	2.30	0.06	0.00046	0.0030	**0.099**	<0.00001	<0.0000050	<0.050	**0.00044**	72	0.00015	**0.00033**	0.0010	0.21	0.0032	0.0026	**21**	0.030
12/12/2012	0.16	0.23	0.005	1.73	0.01	0.00036	0.0030	**0.105**	<0.00001	<0.0000050	<0.050	**0.00039**	73	0.00013	**0.00066**	0.0006	0.12	0.0017	0.0027	**22**	0.055
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	16	16	15	16	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
median	0.20	0.26	0.005	2.20	0.021	0.00039	0.0029	0.0946	0.00001	0.000005	< 0.05	0.00026	66.5	0.00020	0.00030	0.0010	0.122	0.00049	0.0024	19.7	0.035
mean	0.22	0.29	0.013	4.73	0.075	0.00044	0.0031	0.0837	0.00001	0.000005	< 0.05	0.00031	57.0	0.00026	0.00037	0.0016	0.277	0.00529	0.0021	16.2	0.041
standard deviation	0.10	0.18	0.017	4.83	0.128	0.00022	0.0016	0.0206	0.00001	0.000001	0.00	0.00023	21.1	0.00022	0.00022	0.0019	0.361	0.01385	0.0008	7.1	0.032
minimum	0.15	0.06	0.003	0.62	0.003	0.00023	0.0013	0.0337	< 0.00001	< 0.000005	< 0.05	0.00008	17.2	< 0.00010	0.00011	0.0003	0.017	0.00016	0.0006	4.1	0.009
maximum	0.57	0.79	0.070	18.10	0.523	0.00124	0.0089	0.1050	0.00004	0.000010	< 0.05	0.00088	81.1	0.00101	0.00086	0.0077	1.550	0.06050	0.0029	23.3	0.148
# < detection limit	8	1	0	0	0	0	0	0	16	16	19	0	0	3	0	0	0	0	0	0	0
% < detection limit	50%	6%	0%	0%	0%	0%	0%	0%	84%	84%	100%	0%	0%	16%	0%	0%	0%	0%	0%	0%	0%
# > guideline	0				3		1				0	12		0		3	1	4			0
% > guideline	0%				16%		5%				0%	63%		0%		16%	5%	21%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.2: Water quality concentrations for KV-60, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2/10/2011	<0.000010	**0.0018**	**0.0022**	<0.002	0.55	0.00068	3.14	<0.000005	1.12	0.21	23	**0.000043**	0.00003	<0.0005	0.0018	<0.00020	**0.018**	<0.00010
5/27/2011	<0.000010	0.0003	0.0014	0.014	0.22	0.00020	1.73	0.000011	0.40	0.07	<10	0.000007	<0.00001	0.0019	0.0002	0.0003	0.005	0.0002
7/14/2011	<0.000010	**0.0005**	**0.0018**	0.009	0.14	0.00027	2.55	0.000006	0.61	0.13	<10	0.000007	<0.00001	0.0015	0.0006	0.0003	0.007	0.0002
10/27/2011	<0.000010	**0.0010**	**0.0022**	0.005	0.35	**0.00156**	3.60	<0.000005	1.09	0.19	17	0.000016	0.00008	<0.0005	0.0013	<0.00020	**0.015**	<0.00010
11/20/2011	<0.000020	**0.0014**	**0.0029**	0.005	0.47	**0.00146**	4.10	<0.000005	1.27	0.20	21	0.000026	0.00001	<0.0005	0.0016	<0.00020	**0.020**	<0.00010
12/16/2011	<0.000010	**0.0016**	**0.0029**	0.002	0.42	**0.00117**	3.40	<0.000005	1.09	0.20	20	0.000029	0.00001	<0.0005	0.0016	<0.00020	**0.020**	<0.00010
1/24/2012	<0.000010	**0.0016**	**0.0036**	0.007	0.56	0.00083	3.50	0.000043	1.20	0.18	23	**0.000035**	<0.00020	<0.0005	0.0018	<0.00020	**0.023**	<0.00010
2/16/2012	<0.000010	**0.0016**	**0.0028**	0.004	0.52	0.00085	3.40	<0.000005	1.16	0.19	24	**0.000037**	<0.00020	<0.0005	0.0018	<0.00020	**0.019**	<0.00010
3/12/2012	<0.000010	**0.0018**	**0.0025**	0.006	0.57	0.00085	3.50	<0.000005	1.15	0.20	24	**0.000036**	<0.00020	<0.0005	0.0014	<0.00020	0.013	<0.00010
4/6/2012	<0.000010	**0.0018**	0.0015	<0.002	0.48	0.00072	3.30	<0.000005	1.17	0.19	20	0.000022	<0.00020	<0.0005	0.0016	<0.00020	0.008	<0.00010
5/1/2012	<0.000010	**0.0005**	**0.0018**	0.018	**1.03**	0.00029	2.74	**0.000406**	0.83	0.09	<10	0.000026	<0.00020	**0.0102**	0.0004	**0.0006**	**0.063**	0.0002
5/7/2012	0.00001	0.0002	**0.0033**	**0.094**	**0.73**	0.00024	2.30	**0.001800**	0.47	0.06	<10	**0.000072**	<0.00020	**0.0277**	0.0002	**0.0018**	**0.051**	**0.0006**
5/9/2012																		
6/6/2012	<0.000010	**0.0004**	**0.0024**	**0.052**	0.26	0.00030	2.29	**0.000083**	0.66	0.12	<10	0.000014	<0.00020	**0.0065**	0.0007	**0.0008**	0.014	0.0002
7/9/2012	<0.000010	**0.0008**	**0.0016**	0.006	0.21	0.00080	2.90	0.000007	0.78	0.17	<10	0.000017	<0.00020	0.0007	0.0009	<0.00020	0.007	0.0001
8/3/2012	<0.000010	**0.0007**	0.0014	0.007	0.22	0.00083	2.97	0.000006	0.83	0.19	<10	0.000008	<0.00020	0.0021	0.0010	0.0004	0.005	**0.0007**
9/2/2012	<0.000010	**0.0006**	0.0013	0.012	0.26	0.00067	2.62	0.000005	0.82	0.15	<10	0.000003	<0.00020	0.0022	0.0007	0.0005	0.005	0.0002
10/15/2012	<0.000010	**0.0012**	**0.0015**	0.006	0.36	**0.00124**	3.32	<0.000005	0.97	0.19	17	0.000017	<0.00020	0.0011	0.0014	<0.00020	0.009	<0.00010
11/21/2012	<0.000010	**0.0013**	**0.0023**	0.015	0.42	**0.00110**	3.29	0.000010	1.10	0.19	19	0.000033	<0.00020	0.0016	0.0016	0.0003	**0.020**	<0.00010
12/12/2012	<0.000010	**0.0015**	**0.0029**	0.004	0.46	0.00097	3.55	<0.000005	1.13	0.20	23	**0.000036**	<0.00020	<0.0005	0.0015	<0.00020	**0.019**	<0.00010
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
median	0.000010	0.0012	0.0022	0.006	0.42	0.00083	3.29	0.000005	1.09	0.188	17	0.000026	0.00020	0.0007	0.00137	0.00020	0.0150	0.00010
mean	0.000011	0.0011	0.0022	0.014	0.43	0.00079	3.06	0.000127	0.94	0.164	16	0.000025	0.00014	0.0032	0.00116	0.00038	0.0178	0.00018
standard deviation	0.000002	0.0006	0.0007	0.022	0.21	0.00041	0.57	0.000415	0.26	0.047	6	0.000016	0.00008	0.0064	0.00054	0.00038	0.0152	0.00016
minimum	< 0.000010	0.0002	0.0013	< 0.002	0.14	0.00020	1.73	< 0.000005	0.40	0.060	< 10	0.000003	0.00001	< 0.0005	0.00021	< 0.00020	0.0048	0.00010
maximum	0.000020	0.0018	0.0036	0.094	1.03	0.00156	4.10	0.001800	1.27	0.206	24	0.000072	0.00020	0.0277	0.00183	0.00179	0.0627	0.00065
# < detection limit	18	0	0	2	0	0	0	9	0	0	8	0	15	9	0	11	0	11
% < detection limit	95%	0%	0%	11%	0%	0%	0%	47%	0%	0%	42%	0%	79%	47%	0%	58%	0%	58%
# > guideline	0	0	0			5		2				0			0		9	
% > guideline	0%	0%	0%			26%		11%				0%			0%		47%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.3: Water quality concentrations for KV-61, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011		7.29	8.02	96		**790**	0.1				2.0	**424**	**419**						
5/25/2011		7.75	**7.24**	21		70	1.6				**47.0**	33	35						
7/12/2011	20	8.14	8.11		289	298	3.4				<1	158	151						
10/27/2011		8.24	8.15		598	569	0.0	**10.3**	**71**	158	<1	304	285				176		<0.005
11/20/2011		7.85	8.10		614	632	0.6	13.9	97	127	<1	372	349				193		<0.005
12/14/2011		7.50	7.94		**702**	688	0.0	15.1	104		**21.1**	348	372				220		<0.005
1/15/2012		7.61	7.79		658	693	0.0	12.2	84	342	14.0	367	336				203		<0.005
2/11/2012		7.51	8.21		**728**	**715**	-0.1	14.1	96	100	<1	**384**	**406**				**232**		<0.005
3/12/2012		7.60	8.23		677	**740**	-0.1	10.5	72	79	<1	**408**	385				**245**		<0.050
4/5/2012		7.59	8.16		**897**	**772**	0.0			66	<1	**400**	**424**				**268**		<0.005
5/4/2012		8.00	8.26		**726**	**724**	0.0	15.6	107	168	<1	**397**	**392**				**238**		<0.005
5/7/2012		8.06	8.12		614	657	0.0	13.4	95	227	<1	350	361				216		<0.050
6/4/2012	325	7.66	7.89		200	180	1.6	15.2	108	314	**30.9**	84	78				41		<0.050
7/6/2012		8.13	8.15		471	429	2.5	13.5	99	112	6.3	238	201				130		<0.050
8/5/2012	10	8.05	8.08		495	449	2.1	13.5	98	287	<1	239	243				141		<0.050
9/2/2012	8	**7.10**	8.23		521	530	2.1	13.6	99	127	<1	256	265				160		<0.050
10/15/2012		7.72	8.18		639	568	0.2	12.7	88	121	<1	280	292				178		<0.050
11/20/2012		7.43	8.03			713	0.1	**9.8**	100	327	**28.4**	383	**392**				**221**		**0.075**
12/12/2012		7.64	8.21		**828**	**875**	0.0	14.6	101		<1	**477**	**479**				**277**		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	4	19	19	2	16	19	19	15	15	14	19	19	19	0	0	0	16	0	16
median	15	7.66	8.12	59	626	657	0.1	13.50	98	143	1	350	349	-	-	-	210	-	0.028
mean	91	7.73	8.06	59	604	584	0.7	13.19	95	183	9	311	309	-	-	-	196	-	0.029
standard deviation	156	0.31	0.23	53	180	214	1.1	1.79	11	97	14	118	121	-	-	-	59	-	0.026
minimum	8	7.10	7.24	21	200	70	-0.1	9.80	71	66	< 1	33	35	-	-	-	41	-	< 0.005
maximum	325	8.24	8.26	96	897	875	3.4	15.57	108	342	47	477	479	-	-	-	277	-	0.075
# < detection limit	0	0	0	0	0	0	0	0	0	0	12	0	0	-	-	-	0	-	15
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	63%	0%	0%	-	-	-	0%	-	94%
# > guideline		0	0					0			3								1
% > guideline		0%	0%					0%			16%								6%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.3: Water quality concentrations for KV-61, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011					0.01	0.00036	0.0005	0.079	<0.00001	<0.000005	<0.05	0.00012	**139**	0.00040	0.00003	0.0004	0.023	0.0018	0.0053	**19**	0.005
5/25/2011					0.12	0.00029	0.0015	0.014	<0.00001	<0.000020	<0.05	0.00004	11	<0.00050	0.00017	0.0016	0.118	0.0005	0.0010	2	0.036
7/12/2011					0.02	0.00043	0.0019	0.034	<0.00001	<0.000005	<0.05	0.00002	52	0.00030	0.00004	0.0008	0.029	0.0002	0.0030	7	0.005
10/27/2011	0.07	0.10	0.008	1.90	0.01	0.00035	0.0004	0.060	<0.00001	<0.000005	<0.05	0.00002	99	<0.00010	0.00001	0.0004	0.006	0.0000	0.0051	14	0.002
11/20/2011	<0.02	0.28	<0.002	1.04	0.00	0.00035	0.0005	0.063	<0.00001	<0.000005	<0.05	0.00010	122	0.00010	0.00001	0.0004	0.005	0.0002	**0.0056**	16	0.002
12/14/2011	0.12	0.07	**0.039**	1.44	**0.18**	0.00045	0.0021	0.071	<0.00001	<0.000005	<0.05	**0.00038**	114	0.00030	**0.00029**	0.0017	0.388	**0.0085**	0.0050	15	0.062
1/15/2012	0.13	0.07	0.004	1.13	0.01	0.00036	0.0004	0.068	<0.00001	<0.000005	<0.05	0.00004	120	<0.00010	0.00002	0.0005	0.015	0.0003	0.0046	16	0.002
2/11/2012	0.13	0.06	0.002	1.84	0.00	0.00032	0.0003	0.078	<0.00001	<0.000005	<0.05	0.00004	**126**	0.00010	0.00001	0.0005	0.006	0.0001	0.0047	17	0.001
3/12/2012	0.28	<0.20	0.003	1.77	0.00	0.00030	0.0004	0.082	<0.00001	<0.000005	<0.05	0.00005	**133**	<0.00010	0.00001	0.0004	0.009	0.0001	0.0047	18	0.002
4/5/2012	0.11	0.07	<0.002	0.61	0.00	0.00031	0.0006	0.076	<0.00001	<0.000005	<0.05	0.00005	**131**	<0.00010	0.00001	0.0004	0.004	0.0000	0.0050	18	0.001
5/4/2012	0.06	**0.49**	0.004	2.49	0.01	0.00042	0.0007	0.068	<0.00001	<0.000005	<0.05	0.00011	**131**	<0.00010	0.00004	0.0008	0.030	0.0021	**0.0060**	17	0.013
5/7/2012	<0.20	<0.20		3.93	0.01	0.00028	0.0008	0.061	<0.00001	<0.000005	<0.05	0.00003	115	<0.00010	0.00004	0.0005	0.025	0.0001	**0.0054**	15	0.014
6/4/2012	<0.20	0.42	**0.038**	5.93	**0.19**	0.00051	**0.0083**	0.030	<0.00001	**0.000009**	<0.05	**0.00025**	26	0.00029	**0.00034**	0.0020	0.324	**0.0078**	0.0021	5	0.042
7/6/2012	<0.20	<0.20	0.006	3.26	0.02	0.00038	0.0007	0.045	<0.00001	<0.000005	<0.05	0.00003	76	<0.00010	0.00004	0.0006	0.026	0.0003	0.0042	12	0.004
8/5/2012	<0.20	0.24	0.003	2.41	0.01	0.00039	0.0017	0.048	<0.00001	<0.000005	<0.05	0.00002	77	<0.00010	0.00002	0.0005	0.016	0.0001	0.0044	12	0.003
9/2/2012	<0.20	<0.20	0.005	2.47	0.01	0.00036	0.0007	0.051	<0.00001	<0.000005	<0.05	0.00004	81	0.00015	0.00002	0.0005	0.020	0.0010	0.0046	13	0.006
10/15/2012	<0.20	<0.20	0.003	1.64	0.01	0.00034	0.0008	0.053	<0.00001	<0.000005	<0.05	0.00003	89	<0.00010	0.00002	0.0005	0.019	0.0001	0.0049	14	0.004
11/20/2012	<0.20	0.37	0.006	1.06	0.03	0.00033	0.0007	0.067	<0.00001	<0.000005	<0.05	0.00007	125	<0.00010	0.00004	0.0006	0.056	0.0038	**0.0057**	18	0.010
12/12/2012	0.05	0.25	0.014	1.63	0.00	0.00038	0.0009	**0.103**	<0.00001	<0.000005	<0.05	**0.00018**	**152**	<0.00010	0.00002	0.0007	0.006	0.0004	**0.0056**	**24**	0.004
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	16	16	15	16	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
median	0.17	0.20	0.004	1.81	0.009	0.00036	0.0007	0.063	< 0.00001	0.000005	< 0.05	0.000042	115.0	0.00010	0.000024	0.00052	0.020	0.00026	0.0049	15.3	0.0043
mean	0.15	0.21	0.009	2.16	0.033	0.00036	0.0013	0.061	< 0.00001	0.000006	< 0.05	0.000087	101.0	0.00017	0.000062	0.00073	0.059	0.00143	0.0046	14.2	0.0114
standard deviation	0.07	0.13	0.012	1.32	0.058	0.00006	0.0018	0.021	0.00000	0.000004	0.00	0.000094	38.9	0.00012	0.000095	0.00049	0.108	0.00256	0.0013	5.2	0.0166
minimum	< 0.02	0.06	< 0.002	0.61	0.003	0.00028	0.0003	0.014	< 0.00001	< 0.000005	< 0.05	0.000023	10.7	< 0.00010	0.000008	0.00038	0.004	0.00002	0.0010	1.6	0.0010
maximum	0.28	0.49	0.039	5.93	0.187	0.00051	0.0083	0.103	< 0.00001	0.000020	< 0.05	0.000380	152.0	0.00050	0.000335	0.00201	0.388	0.00852	0.0060	23.6	0.0618
# < detection limit	8	5	2	0	0	0	0	0	19	18	19	0	0	12	0	0	0	0	0	0	0
% < detection limit	50%	31%	13%	0%	0%	0%	0%	0%	100%	95%	100%	0%	0%	63%	0%	0%	0%	0%	0%	0%	0%
# > guideline	0				3		1				0	3		0		0	0	3			0
% > guideline	0%				16%		5%				0%	16%		0%		0%	0%	16%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.3: Water quality concentrations for KV-61, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011	<0.000010	0.0002	0.0004	0.003	0.27	0.00049	3.73	<0.000005	1.04	0.23	88	<0.000002	<0.00001	<0.0005	0.0028	<0.00020	0.009	<0.00010
5/25/2011	<0.000010	0.0002	0.0009	0.014	<0.30	0.00016	1.28	0.000019	<0.30	0.03	<50	0.000004	<0.00020	<0.0050	0.0001	<0.00050	0.002	0.0002
7/12/2011	<0.000010	0.0002	0.0004	0.003	0.13	0.00071	3.99	<0.000005	0.75	0.09	27	<0.000002	<0.00001	<0.0005	0.0005	<0.00020	0.001	<0.00010
10/27/2011	<0.000010	0.0002	0.0002	0.004	0.20	0.00061	**4.20**	<0.000005	0.99	0.18	63	<0.000002	0.00004	<0.0005	0.0017	<0.00020	0.000	<0.00010
11/20/2011	<0.000020	0.0002	0.0003	<0.002	0.26	0.00052	**4.50**	<0.000005	1.15	0.19	82	<0.000002	<0.00001	<0.0005	0.0021	<0.00020	0.004	<0.00010
12/14/2011	<0.000010	0.0001	0.0010	**0.023**	0.22	0.00043	3.60	**0.000109**	0.90	0.20	72	0.000023	0.00003	0.0046	0.0023	0.0005	**0.021**	<0.00010
1/15/2012	<0.000010	0.0002	**0.0060**	0.005	0.23	0.00048	4.00	<0.000005	0.96	0.20	**102**	<0.000002	<0.00020	<0.0005	0.0024	<0.00020	0.001	<0.00010
2/11/2012	<0.000010	0.0002	0.0003	0.005	0.22	0.00044	3.70	<0.000005	1.00	0.21	82	<0.000002	<0.00020	<0.0005	0.0027	<0.00020	0.001	<0.00010
3/12/2012	<0.000010	0.0001	0.0003	0.008	0.27	0.00043	3.90	<0.000005	1.08	0.22	**97**	<0.000002	<0.00020	<0.0005	0.0021	<0.00020	0.002	<0.00010
4/5/2012	<0.000010	0.0002	0.0003	0.002	0.24	0.00042	3.70	<0.000005	1.10	0.23	**94**	<0.000002	<0.00020	<0.0005	0.0028	<0.00020	0.002	<0.00010
5/4/2012	<0.000010	0.0001	0.0005	0.008	0.37	0.00035	3.97	<0.000005	1.08	0.22	**94**	0.000004	<0.00020	<0.0005	0.0031	<0.00020	0.007	<0.00010
5/7/2012	<0.000010	0.0001	0.0004	0.005	0.37	0.00037	3.49	<0.000005	0.92	0.19	77	<0.000002	<0.00020	<0.0005	0.0026	<0.00020	0.002	<0.00010
6/4/2012	<0.000010	0.0001	0.0009	0.019	0.19	0.00059	2.62	**0.000128**	0.49	0.06	15	0.000009	<0.00020	0.0047	0.0002	0.0004	**0.019**	0.0001
7/6/2012	<0.000010	0.0002	0.0004	0.005	0.16	0.00050	**4.26**	<0.000005	0.90	0.12	48	<0.000002	<0.00020	<0.0005	0.0009	<0.00020	0.001	<0.00010
8/5/2012	<0.000010	0.0002	0.0003	<0.002	0.16	0.00064	3.75	<0.000005	0.87	0.14	48	<0.000002	<0.00020	<0.0005	0.0009	<0.00020	0.001	<0.00010
9/2/2012	<0.000010	0.0002	0.0003	0.005	0.22	0.00057	3.34	0.000007	0.97	0.15	63	<0.000002	<0.00020	<0.0005	0.0012	<0.00020	0.002	<0.00010
10/15/2012	<0.000010	0.0002	0.0003	0.002	0.19	0.00052	3.72	<0.000005	0.94	0.17	65	<0.000002	<0.00020	<0.0005	0.0015	<0.00020	0.002	<0.00010
11/20/2012	<0.000010	0.0002	0.0005	0.007	0.29	0.00038	3.57	<0.000005	1.02	0.22	**90**	0.000003	<0.00020	0.0012	0.0025	<0.00020	0.004	<0.00010
12/12/2012	<0.000010	0.0002	0.0004	0.003	0.45	0.00054	**4.69**	<0.000005	1.33	0.28	**109**	0.000002	<0.00020	<0.0005	0.0026	<0.00020	**0.017**	<0.00010
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
median	< 0.000010	0.00016	0.00041	0.005	0.23	0.00049	3.73	0.000005	0.97	0.193	77	0.000002	0.00020	0.0005	0.00213	0.00020	0.0020	0.00010
mean	< 0.000011	0.00016	0.00075	0.007	0.25	0.00048	3.68	0.000018	0.94	0.175	72	0.000004	0.00015	0.0012	0.00184	0.00024	0.0052	0.00011
standard deviation	0.000002	0.00001	0.00130	0.006	0.08	0.00012	0.73	0.000036	0.23	0.063	26	0.000005	0.00008	0.0016	0.00096	0.00010	0.0066	0.00002
minimum	< 0.000010	0.00012	0.00020	< 0.002	0.13	0.00016	1.28	< 0.000005	0.30	0.026	15	< 0.000002	< 0.00001	< 0.0005	0.00012	< 0.00020	0.0004	< 0.00010
maximum	< 0.000020	0.00017	0.00603	0.023	0.45	0.00071	4.69	0.000128	1.33	0.281	109	0.000023	0.00020	0.0050	0.00314	0.00050	0.0213	0.00020
# < detection limit	19	0	0	2	1	0	0	15	1	0	1	13	17	16	0	17	0	17
% < detection limit	100%	0%	0%	11%	5%	0%	0%	79%	5%	0%	5%	68%	89%	84%	0%	89%	0%	89%
# > guideline	0	0	0			0		2				0			0		2	
% > guideline	0%	0%	0%			0%		11%				0%			0%		11%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.4: Water quality concentrations for KV-64, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011		7.80	8.05	152		521	0.6				<1	259	263						
5/25/2011		8.40	7.72	62		114	0.9				6.0	63	61						
7/12/2011		8.35	8.26		332	342	3.7				2.0	194	186						
10/29/2011		**8.50**	8.12		445	421	2.0	10.3	75	268	<1	225	227				51		<0.050
11/21/2011	8	8.23	8.28			464	0.0	12.6	86		1.5	252	242				54		<0.005
12/19/2011		7.87	8.17		469	465	-0.1	11.7	80		18.3	246	248				59		<0.005
1/13/2012		7.63	8.00		454	465	0.0	11.0	76		1.1	236	251				56		<0.005
2/16/2012	5	7.99	8.30		484	484	-0.1	13.8	94	20	1.1	258	269				60		<0.005
3/14/2012		8.03	**8.39**		504	496	-0.1	13.2	90	48	<1	260	261				66		<0.050
4/9/2012		**8.52**	8.29			496	-0.1			122	<1	259	270				68		<0.005
5/3/2012	7	8.36	8.21		330	373	0.0	14.4	98	234	<1	229	204				46		<0.050
5/7/2012		8.43	8.12		259	276	0.0	15.6	106	179	4.4	148	154				33		<0.050
6/6/2012	148	8.35	8.13		282	250	2.9	14.7	109	304	5.6	138	139				22		<0.050
7/6/2012		8.30	**8.32**		379	342	2.7	14.2	106	97	1.2	192	170				33		<0.050
8/5/2012	40	8.31	8.24		409	382	3.5	13.6	104	290	1.5	205	206				38		<0.050
9/2/2012	30	7.79	**8.40**		446	379	2.9	13.6	101	131	<1	192	196				34		<0.050
10/15/2012	23	8.00	**8.35**		457	412	0.2	12.9	89	115	1.2	212	215				42		<0.050
11/21/2012		8.23	8.27			452	0.0	15.4	105	**362**	1.7	240	246				51		<0.050
12/14/2012		7.37	8.24		516	499	0.1	12.8	88		1.2	265	263				64		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	7	19	19	2	14	19	19	15	15	12	19	19	19	0	0	0	16	0	16
median	23	8.23	8.24	107	445	421	0.1	13.60	94	154.9	1	229	227	-	-	-	50.9	-	< 0.050
mean	37	8.13	8.20	107	412	402	1.0	13.32	94	180.9	3	214	214	-	-	-	48.5	-	< 0.033
standard deviation	51	0.32	0.16	63	82	104	1.4	1.51	11	109.4	4	52	55	-	-	-	13.6	-	0.023
minimum	5	7.37	7.72	62	259	114	-0.1	10.31	75	20.0	1	63	61	-	-	-	22.3	-	< 0.005
maximum	148	8.52	8.40	152	516	521	3.7	15.61	109	362.4	18	265	270	-	-	-	68.4	-	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	6	0	0	-	-	-	0	-	16
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	32%	0%	0%	-	-	-	0%	-	100%
# > guideline		0	0					0			0								0
% > guideline		0%	0%					0%			0%								0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.4: Water quality concentrations for KV-64, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011					0.00	0.00042	0.0005	0.076	<0.00001	<0.000005	<0.05	0.00002	78	0.00040	0.00001	0.0003	0.006	0.0002	0.0023	15	0.001
5/25/2011					0.06	0.00018	0.0006	0.026	<0.00001	<0.000005	<0.05	0.00003	21	0.00040	0.00010	0.0015	0.101	0.0004	0.0006	3	0.006
7/12/2011					0.01	0.00035	0.0005	0.059	<0.00001	<0.000005	<0.05	0.00002	61	0.00030	0.00003	0.0014	0.021	0.0004	0.0015	10	0.001
10/29/2011	0.20	0.30	<0.0020	2.00	0.01	0.00043	0.0006	0.072	<0.00001	<0.000005	<0.05	0.00003	68	0.00040	0.00002	0.0005	0.014	0.0005	0.0020	13	0.001
11/21/2011	0.24	0.35	<0.0020	1.88	0.01	0.00045	0.0006	0.072	<0.00001	<0.000005	<0.05	0.00003	77	0.00010	0.00002	0.0004	0.014	0.0030	0.0021	15	0.002
12/19/2011	0.28	0.11	0.019	2.88	0.10	0.00048	0.0012	**0.085**	<0.00001	0.000005	<0.05	0.00010	75	0.00030	0.00019	0.0017	0.300	0.0048	0.0022	14	0.028
1/13/2012	0.29	0.09	0.011	1.86	0.00	0.00040	0.0006	0.076	<0.00001	<0.000005	<0.05	0.00004	73	<0.00010	0.00001	0.0003	0.005	0.0001	0.0019	13	0.001
2/16/2012	0.31	0.14	0.002	0.82	0.00	0.00036	0.0005	0.079	<0.00001	<0.000005	<0.05	0.00002	79	0.00010	0.00001	0.0003	0.008	0.0001	0.0019	15	0.002
3/14/2012	**0.32**	<0.20	0.003	1.04	0.01	0.00041	0.0005	0.078	<0.00001	<0.000005	<0.05	0.00002	80	0.00050	0.00003	0.0004	0.021	0.0003	0.0022	14	0.004
4/9/2012	**0.33**	0.07	<0.0020	1.03	0.01	0.00041	0.0006	**0.091**	<0.00001	<0.000005	<0.05	0.00006	80	0.00050	0.00002	0.0014	0.014	0.0020	0.0022	14	0.004
5/3/2012	0.23	0.35	0.008	6.50	0.02	0.00036	0.0008	0.074	<0.00001	<0.000005	<0.05	0.00008	73	<0.00010	0.00004	0.0014	0.048	0.0004	0.0015	11	0.005
5/7/2012	<0.20	**0.56**		**11.10**	0.02	0.00030	0.0007	0.056	<0.00001	<0.000005	<0.05	0.00006	45	<0.00010	0.00006	0.0017	0.055	0.0043	0.0010	8	0.008
6/6/2012	0.22	<0.20	0.009	4.22	0.04	0.00035	0.0006	0.048	<0.00001	<0.000005	<0.05	0.00003	44	<0.00010	0.00008	0.0010	0.082	0.0008	0.0013	7	0.006
7/6/2012	<0.20	0.32	0.003	3.38	0.01	0.00037	0.0005	0.060	<0.00001	<0.000005	<0.05	0.00002	61	<0.00010	0.00002	0.0006	0.012	0.0001	0.0015	10	0.001
8/5/2012	0.25	<0.20	0.004	1.92	0.01	0.00036	0.0005	0.069	<0.00001	<0.000005	<0.05	0.00002	65	<0.00010	0.00002	0.0005	0.017	0.0002	0.0018	11	0.002
9/2/2012	<0.20	0.24	0.004	2.86	0.01	0.00035	0.0005	0.067	<0.00001	<0.000005	<0.05	0.00002	59	0.00013	0.00002	0.0005	0.015	0.0005	0.0017	11	0.002
10/15/2012	<0.20	0.28	0.004	0.82	0.01	0.00038	0.0005	0.072	<0.00001	<0.000005	<0.05	0.00002	66	0.00012	0.00002	0.0011	0.012	0.0002	0.0018	11	0.001
11/21/2012	<0.20	0.42	0.004	2.41	0.01	0.00039	0.0005	0.077	<0.00001	<0.000005	<0.05	0.00003	74	0.00011	0.00002	0.0011	0.023	0.0009	0.0017	14	0.003
12/14/2012	0.23	0.22	0.006	1.96	0.01	0.00052	0.0006	0.080	<0.00001	<0.000005	<0.05	0.00004	80	0.00012	0.00002	0.0012	0.014	0.0010	0.0021	16	0.003
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	16	16	15	16	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
median	0.23	0.23	0.0041	1.98	0.008	0.00038	0.0006	0.072	< 0.00001	< 0.000005	< 0.05	0.000028	72.7	0.00012	0.000022	0.00104	0.015	0.00045	0.0018	12.9	0.0021
mean	0.24	0.25	0.0055	2.92	0.017	0.00038	0.0006	0.069	< 0.00001	< 0.000005	< 0.05	0.000035	66.4	0.00021	0.000038	0.00091	0.041	0.00106	0.0018	11.8	0.0042
standard deviation	0.05	0.13	0.0047	2.62	0.024	0.00007	0.0002	0.015	0.00000	0.000000	0.00	0.000023	15.5	0.00015	0.000044	0.00051	0.068	0.00143	0.0004	3.3	0.0061
minimum	< 0.20	0.07	< 0.0020	0.82	0.002	0.00018	0.0005	0.026	< 0.00001	< 0.000005	< 0.05	0.000017	20.5	< 0.00010	0.000006	0.00026	0.005	0.00006	0.0006	2.9	0.0006
maximum	0.33	0.56	0.0190	11.10	0.098	0.00052	0.0012	0.091	< 0.00001	< 0.000005	< 0.05	0.000104	80.3	0.00050	0.000192	0.00171	0.300	0.00483	0.0023	15.9	0.0279
# < detection limit	5	3	3	0	0	0	0	0	19	18	19	0	0	6	0	0	0	0	0	0	0
% < detection limit	31%	19%	20%	0%	0%	0%	0%	0%	100%	95%	100%	0%	0%	32%	0%	0%	0%	0%	0%	0%	0%
# > guideline	0				0		0				0	0		0		0	0	2			0
% > guideline	0%				0%		0%				0%	0%		0%		0%	0%	11%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.4: Water quality concentrations for KV-64, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011	<0.00001	0.0004	0.0003	<0.002	0.56	**0.00128**	2.51	<0.000005	1.13	0.33	19	**0.000050**	<0.00001	<0.0005	0.0023	<0.0002	0.002	<0.0001
5/25/2011	<0.00001	0.0001	0.0007	0.016	0.44	0.00029	1.26	0.000006	0.25	0.09	<10	0.000002	<0.00001	0.0009	0.0003	<0.0002	0.002	0.0001
7/12/2011	<0.00001	0.0002	0.0004	0.004	0.30	0.00108	2.73	<0.000005	0.69	0.25	11	0.000004	<0.00001	<0.0005	0.0013	<0.0002	0.001	<0.0001
10/29/2011	<0.00001	0.0003	0.0002	0.002	0.47	0.00106	2.70	0.000006	1.03	0.31	19	0.000017	0.00008	<0.0005	0.0019	<0.0002	0.002	<0.0001
11/21/2011	<0.00001	0.0003	0.0002	0.002	0.45	**0.00119**	2.90	<0.000005	1.13	0.33	19	0.000022	0.00015	<0.0005	0.0023	<0.0002	0.003	<0.0001
12/19/2011	<0.00001	0.0003	0.0007	0.017	0.49	**0.00115**	2.70	**0.000059**	1.55	0.34	17	**0.000039**	<0.00001	0.0023	0.0020	0.0002	0.011	<0.0001
1/13/2012	<0.00001	0.0002	0.0002	<0.002	0.42	**0.00153**	3.20	<0.000005	1.01	0.32	25	0.000029	<0.00020	<0.0005	0.0018	<0.0002	0.001	<0.0001
2/16/2012	<0.00001	0.0002	0.0002	0.003	0.46	0.00107	2.90	<0.000005	1.19	0.34	22	0.000030	<0.00020	<0.0005	0.0022	<0.0002	0.001	<0.0001
3/14/2012	<0.00001	0.0003	0.0002	0.003	0.48	**0.00109**	2.90	<0.000005	1.20	**0.37**	20	0.000024	<0.00020	<0.0005	0.0022	<0.0002	0.004	<0.0001
4/9/2012	<0.00001	0.0003	0.0002	0.002	0.60	0.00108	3.00	<0.000005	1.27	**0.36**	21	0.000022	<0.00020	<0.0005	0.0021	<0.0002	0.004	<0.0001
5/3/2012	<0.00001	0.0002	0.0005	0.007	**0.77**	0.00075	3.12	0.000013	0.90	0.27	17	0.000009	<0.00020	<0.00050	0.0015	<0.00020	0.005	<0.0001
5/7/2012	<0.00001	0.0002	0.0005	0.008	**0.82**	0.00055	2.16	0.000020	0.60	0.20	10	0.000006	<0.00020	0.0007	0.0011	<0.00020	0.005	<0.0001
6/6/2012	<0.00001	0.0001	0.0005	0.008	0.32	0.00069	2.14	0.000014	0.56	0.19	<10	0.000004	<0.00020	0.0010	0.0009	<0.00020	0.003	<0.0001
7/6/2012	<0.00001	0.0001	0.0003	<0.002	0.29	0.00079	2.91	<0.0000050	0.76	0.25	<10	0.000005	**0.00034**	<0.0005	0.0014	<0.00020	0.001	<0.0001
8/5/2012	<0.00001	0.0002	0.0003	<0.002	0.33	0.00101	2.62	<0.0000050	0.81	0.29	12	0.000005	<0.00020	<0.0005	0.0015	<0.00020	0.002	<0.0001
9/2/2012	<0.00001	0.0002	0.0002	0.002	0.38	0.00083	2.49	0.000009	0.86	0.30	14	0.000006	<0.00020	<0.0005	0.0015	<0.00020	0.001	<0.0001
10/15/2012	0.00001	0.0002	0.0004	0.003	0.37	0.00091	2.78	<0.0000050	0.87	0.31	15	0.000009	0.00024	<0.0005	0.0017	<0.00020	0.002	<0.0001
11/21/2012	<0.00001	0.0003	0.0003	0.002	0.46	0.00107	2.71	0.000005	1.08	0.31	17	0.000014	<0.00020	<0.0005	0.0020	<0.00020	0.007	<0.0001
12/14/2012	<0.00001	0.0003	0.0003	0.004	0.61	**0.00135**	2.94	<0.0000050	1.22	0.34	21	0.000034	<0.00020	<0.0005	0.0021	<0.00020	0.003	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
median	0.00001	0.00023	0.00032	0.003	0.46	0.00107	2.73	0.000005	1.01	0.313	17	0.000014	0.00020	0.0005	0.0018	0.0002	0.0022	0.0001
mean	0.00001	0.00023	0.00035	0.005	0.47	0.00099	2.67	0.000010	0.95	0.289	16	0.000017	0.00016	0.0007	0.0017	0.0002	0.0030	0.0001
standard deviation	0.00000	0.00007	0.00016	0.005	0.15	0.00029	0.44	0.000013	0.30	0.069	5	0.000014	0.00009	0.0004	0.0005	0.0000	0.0025	0.0000
minimum	< 0.00001	0.00007	0.00016	< 0.002	0.29	0.00029	1.26	< 0.000005	0.25	0.086	< 10	0.000002	< 0.00001	< 0.0005	0.0003	< 0.0002	0.0008	< 0.0001
maximum	0.00001	0.00035	0.00073	0.017	0.82	0.00153	3.20	0.000059	1.55	0.366	25	0.000050	0.00034	0.0023	0.0023	0.0002	0.0107	0.0001
# < detection limit	18	0	0	4	0	0	0	11	0	0	3	0	15	15	0	18	0	18
% < detection limit	95%	0%	0%	21%	0%	0%	0%	58%	0%	0%	16%	0%	79%	79%	0%	95%	0%	95%
# > guideline	0	0	0			12		0				0			0		0	
% > guideline	0%	0%	0%			63%		0%				0%			0%		0%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.5: Water quality concentrations for KV-65, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/12/2011		**8.66**	7.73	132		276	0.0				3.0	140	141	83	100		57		
2/10/2011		7.81	7.96	97		289	0.2				2.0	134	146	86	100		60		
3/23/2011		8.04	7.44	189		303	0.1				3.0	168	159	**98**	**120**		71		
4/20/2011			7.78	**380**		305	0.4				4.0	160	164	89	110		63	0.013	<0.005
5/28/2011		7.72	7.51	35		58	2.3				12.0	27	27	18	22		12	0.012	<0.005
6/21/2011	246	**8.57**	7.78	79		128	**5.3**				2.0	66	62	42	51		21	0.008	
7/19/2011		8.12	**7.36**		91	92	4.2				**33.0**	42	47	31	38		13	**0.033**	0.035
8/18/2011	272	**8.78**	7.69		123	127	4.2				3.0	62	56	43	52		19	0.028	<0.500
9/25/2011	228	8.38	7.85		178	178	2.6				2.0	86	81	59	72		24		
10/25/2011	115	8.45	8.02		252	219	0.8	11.3	79	263	1.0	109	106	70	86		41		<0.005
11/20/2011		8.05	7.90		234	244	0.0	14.1	97	122	1.7	127	132	76	93		46		<0.005
12/18/2011	53	7.89	7.77		260	257	0.0	13.6	94		1.5	127	126	75	92		52		<0.005
1/17/2012	46	7.87	7.87		260	273	0.0	11.9	81	**355**	2.5	137	123	81	98		52		<0.005
2/13/2012	27	7.90	8.09		288	286	0.0	14.0	96	87	<1	135	147	87	106		56		<0.005
3/12/2012	34	7.81	8.10			298	-0.1	15.0		88	1.6	150	144	88	107		63		<0.050
4/8/2012		8.35	8.07		331	306	0.1			107	2.0	141	151	91	111		67		<0.005
5/8/2012	83	8.34	7.98		202	233	0.6	14.0	98	71	14.2	120	109	67	81	**1.5**	46		0.007
6/4/2012	735	7.65	7.49		72	66	2.1	14.8	108	291	20.2	32	29			0.6	8		<0.050
7/4/2012	283	8.13	7.77		133	124	**5.5**	12.5	99	54	2.5	67	55	40	49	0.7	19		<0.050
8/1/2012	283	7.95	7.68		179	164	**5.5**	13.7	109	111	1.2	89	82	53	65	1.2	25		<0.050
9/2/2012	224	7.37	8.07		210	182	4.3	13.0	100	129	1.6	85	86	59	72	0.6	29		<0.050
10/16/2012	164	7.76	7.91		207	183	0.7	12.9	90	181	2.6	89	90	59	72	<0.5	31		<0.050
11/20/2012		8.00	7.51		227	235	0.0	13.0	102	**355**	3.8	117	121	75	91	<0.5	45		**0.075**
12/11/2012		7.68	8.04		295	274	0.1	15.7	108		1.6	136	129	85	103	1.2	57		0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	14	23	24	6	17	24	24	14	13	13	24	24	24	23	23	8	24	5	19
median	194	8.00	7.82	115	210	234	0.5	13.67	98	121.9	2	119	115	74.9	91	0.6	45	0.013	0.007
mean	199	8.06	7.81	152	208	213	1.6	13.53	97	170.2	5	106	105	67.6	82	0.8	41	0.019	0.051
standard deviation	183	0.36	0.22	123	73	80	2.1	1.21	9	108.2	8	41	42	21.5	26	0.4	20	0.011	0.111
minimum	27	7.37	7.36	35	72	58	-0.1	11.27	79	53.9	< 1	27	27	18.0	22	0.5	8	0.008	< 0.005
maximum	735	8.78	8.10	380	331	306	5.5	15.73	109	355.2	33	168	164	98.0	120	1.5	71.0	0.033	0.500
# < detection limit	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	15
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	25%	0%	0%	79%
# > guideline		0	0					0			1					0		2	2
% > guideline		0%	0%					0%			4%					0%		40%	11%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.5: Water quality concentrations for KV-65, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/12/2011				0.50	0.02	0.00010	0.0004	0.043	<0.00001	<0.000005	<0.05	0.00002	45	0.00060	0.00002	0.0003	0.02	0.0004	0.0028	7	0.001
2/10/2011			0.007	0.80	0.01	0.00009	0.0004	0.042	<0.00001	<0.000005	<0.05	0.00002	43	0.00030	0.00002	0.0003	0.02	0.0004	0.0027	7	0.001
3/23/2011			0.008	0.60	0.05	0.00015	0.0006	0.051	<0.00001	<0.000005	<0.05	0.00006	55	0.00080	0.00010	0.0006	0.10	0.0016	0.0030	8	0.006
4/20/2011	0.15		0.008	1.00	0.02	0.00014	0.0005	0.045	<0.00001	<0.000005	<0.05	0.00005	53	**0.00090**	0.00004	0.0005	0.047	0.0033	0.0027	7	0.005
5/28/2011	0.06		0.021	5.10	**0.16**	0.00009	0.0005	0.024	<0.00001	<0.000005	<0.05	0.00004	9	0.00060	0.00014	0.0015	0.157	0.0024	0.0009	1	0.007
6/21/2011			0.005	2.10	0.04	0.00013	0.0004	0.032	<0.00001	<0.000005	<0.05	0.00002	21	0.00030	0.00004	0.0007	0.048	0.0018	0.0017	3	0.002
7/19/2011	0.11		0.004	4.60	**0.82**	**0.00098**	0.0031	0.042	**0.000020**	**0.000030**	<0.05	**0.00051**	13	**0.00190**	**0.00075**	**0.0045**	**1.300**	**0.1010**	0.0020	3	0.046
8/18/2011	<2.00		0.003	2.20	0.05	<0.0005	0.0005	0.032	<0.00020	<0.001000	<0.10	**0.00020**	19	<0.00200	<0.000500	0.0010	0.080	**0.0105**	<0.010	3	0.006
9/25/2011			0.004	1.20	0.02	0.00013	0.0005	0.038	<0.00001	<0.000005	<0.05	0.00004	27	0.00020	0.00003	0.0005	0.031	0.0027	0.0022	4	0.002
10/25/2011	0.15	0.35	0.006	0.90	0.01	0.00011	0.0004	0.041	<0.00001	<0.000005	<0.05	0.00003	35	<0.0001	0.00002	0.0003	0.016	0.0008	0.0024	6	0.001
11/20/2011	0.18	0.20	0.007	1.04	0.02	0.00012	0.0004	0.045	<0.00001	<0.000005	<0.05	0.00005	40	0.00010	0.00002	0.0007	0.019	0.0013	0.0026	6	0.002
12/18/2011	0.17	0.04	0.006	0.74	0.01	0.00012	0.0004	0.045	<0.00001	<0.000005	<0.05	0.00004	41	<0.00010	0.00002	0.0004	0.014	0.0007	0.0026	6	0.001
1/17/2012	0.19	0.07	0.008	1.21	0.01	0.00013	0.0005	0.049	<0.00001	<0.000005	<0.05	0.00004	45	**0.00110**	0.00010	0.0003	0.017	0.0011	0.0028	6	0.002
2/13/2012	0.17	0.08	0.007	1.26	0.01	0.00012	0.0004	0.049	<0.00001	<0.000005	<0.05	0.00004	44	<0.00010	0.00001	0.0002	0.008	0.0004	0.0029	6	0.000
3/12/2012	0.29	<0.20	0.008	0.95	0.01	0.00014	0.0005	0.047	<0.00001	<0.000005	<0.05	0.00004	48	0.00010	0.00002	0.0004	0.017	0.0010	0.0029	7	0.002
4/8/2012	0.17	0.04	0.012	<0.50	0.01	0.00012	0.0005	0.048	<0.00001	<0.000005	<0.05	0.00005	46	<0.00010	0.00001	0.0003	0.008	0.0008	0.0028	7	0.001
5/8/2012	0.25		**0.029**	4.22	**0.22**	**0.00142**	**0.0042**	0.052	**0.000016**	**0.000029**	<0.050	**0.00070**	39	0.00077	0.00027	**0.0033**	**0.443**	**0.1900**	0.0024	6	0.058
6/4/2012	<0.20	0.28	**0.027**	4.02	0.12	0.00011	0.0006	0.022	<0.00001	<0.000005	<0.050	0.00005	10	0.00024	0.00012	0.0014	0.158	**0.0068**	0.0011	2	0.008
7/4/2012	<0.20	0.21	0.006	1.70	0.03	0.00016	0.0005	0.030	<0.00001	<0.000005	<0.050	0.00005	22	0.00011	0.00004	0.0006	0.038	0.0036	0.0016	3	0.003
8/1/2012	<0.20	<0.20	0.006	1.67	0.02	0.00014	0.0004	0.040	<0.00001	<0.000005	<0.050	0.00006	29	<0.00010	0.00003	0.0004	0.038	0.0034	0.0021	4	0.002
9/2/2012	<0.20	<0.20	0.009	1.27	0.02	0.00014	0.0004	0.037	<0.00001	<0.000005	<0.050	0.00007	27	<0.00010	0.00003	0.0004	0.027	0.0036	0.0021	4	0.002
10/16/2012	<0.20	0.22	0.007	<0.50	0.02	0.00011	0.0004	0.036	<0.00001	<0.000005	<0.050	0.00005	28	0.00010	0.00003	0.0004	0.023	0.0021	0.0020	5	0.002
11/20/2012	0.24	<0.20	0.009	0.50	0.02	0.00013	0.0004	0.044	<0.00001	<0.000005	<0.050	0.00007	38	<0.00010	0.00003	0.0004	0.035	0.0021	0.0025	6	0.002
12/11/2012	0.24	0.04	0.009	0.91	0.02	0.00014	0.0004	0.050	<0.00001	<0.000005	<0.050	0.00007	43	<0.00010	0.00003	0.0003	0.028	0.0045	0.0028	7	0.002
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	19	14	23	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
median	0.20	0.20	0.0070	1.12	0.020	0.00013	0.0004	0.042	0.00001	0.000005	< 0.05	0.000046	38.2	0.00016	0.00003	0.00044	0.029	0.00206	0.0025	5.7	0.0021
mean	0.28	0.17	0.0094	1.65	0.073	0.00023	0.0007	0.041	0.00002	0.000049	< 0.05	0.000098	34.1	0.00046	0.00010	0.00082	0.112	0.01442	0.0026	5.1	0.0068
standard deviation	0.42	0.10	0.0069	1.39	0.168	0.00032	0.0009	0.008	0.00004	0.000203	0.01	0.000162	13.4	0.00055	0.00018	0.00102	0.269	0.04251	0.0017	1.8	0.0141
minimum	0.06	0.04	0.0030	0.50	0.008	0.00009	0.0004	0.022	< 0.00001	< 0.000005	< 0.05	0.000021	8.6	< 0.00010	0.00001	0.00023	0.008	0.00037	0.0009	1.4	0.0005
maximum	2.00	0.35	0.0290	5.10	0.823	0.00142	0.0042	0.052	0.00020	0.001000	< 0.10	0.000695	54.8	0.00200	0.00075	0.00450	1.300	0.19000	0.0100	7.6	0.0576
# < detection limit	6	4	0	2	0	1	0	0	22	22	24	0	0	9	1	0	0	0	1	0	0
% < detection limit	32%	29%	0%	8%	0%	4%	0%	0%	92%	92%	100%	0%	0%	38%	4%	0%	0%	0%	4%	0%	0%
# > guideline	0				4		0				0	3		0		2	1	9			0
% > guideline	0%				17%		0%				0%	13%		0%		8%	4%	38%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.5: Water quality concentrations for KV-65, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/12/2011	<0.00001	0.0003	0.0002	0.010	0.14	0.00085	3.02	0.000012	0.80	0.11	19	<0.000002	<0.00001	<0.0005	0.0012	<0.0002	0.002	0.0002
2/10/2011	<0.00001	0.0003	0.0002	0.006	0.14	0.00082	2.39	<0.000005	0.74	0.11	19	<0.000002	<0.00001	<0.0005	0.0012	<0.0002	0.001	<0.0001
3/23/2011	<0.00001	0.0003	0.0005	0.020	0.19	0.00087	3.55	0.000014	0.91	0.13	23	0.000002	<0.00001	0.0010	0.0015	0.0003	0.004	<0.0001
4/20/2011	<0.00001	0.0004	0.0003	0.009	0.16	0.00088	3.31	0.000010	0.80	0.12	19	<0.000002	0.00001	<0.0005	0.0014	<0.0002	0.005	<0.0001
5/28/2011	<0.00001	0.0001	0.0009	0.018	0.19	0.00029	1.69	0.000026	0.27	0.03	<10	0.000002	0.00006	**0.0048**	0.0001	0.0004	0.003	0.0001
6/21/2011	<0.00001	0.0002	0.0003	0.007	0.15	0.00056	2.62	0.000013	0.54	0.06	<10	0.000004	<0.00001	0.0006	0.0003	<0.0002	0.002	<0.0001
7/19/2011	<0.00001	0.0002	**0.0025**	**0.040**	<0.30	0.00033	3.20	**0.000878**	0.50	0.05	<50	0.000034	<0.00020	**0.0260**	0.0002	**0.0020**	**0.041**	**0.0005**
8/18/2011	<0.00020	<0.00100	0.0010	<0.040	<1.00	<0.00080	3.00	<0.000100	<1.00	0.06	<60	<0.00005	<0.00500	<0.0100	0.0003	<0.0050	<0.0100	<0.0020
9/25/2011	<0.00001	0.0002	0.0003	0.006	0.11	0.00073	2.90	0.000020	0.64	0.08	10	<0.000002	0.00014	0.0006	0.0005	<0.0002	0.003	<0.0001
10/25/2011	<0.00001	0.0003	0.0002	0.008	0.12	0.00091	3.10	<0.000005	0.76	0.09	14	<0.000002	0.00004	0.0005	0.0007	<0.0002	0.002	<0.0001
11/20/2011	<0.00002	0.0002	0.0003	0.004	0.14	0.00099	3.30	<0.000005	0.81	0.10	16	<0.000002	0.00010	<0.0005	0.0008	<0.0002	0.003	<0.0001
12/18/2011	<0.00001	0.0003	0.0002	0.007	0.13	0.00094	3.00	<0.000005	0.76	0.10	17	<0.000002	0.00005	<0.0005	0.0009	<0.0002	0.003	<0.0001
1/17/2012	<0.00001	0.0003	0.0002	0.009	0.15	0.00093	3.30	<0.000005	0.78	0.11	22	<0.000002	<0.00020	<0.0005	0.0010	<0.0002	0.004	<0.0001
2/13/2012	<0.00001	0.0003	0.0002	0.007	0.14	0.00095	2.90	<0.000005	0.73	0.11	18	<0.000002	<0.00020	<0.0005	0.0012	<0.0002	0.002	<0.0001
3/12/2012	<0.00001	0.0003	0.0002	0.013	0.20	0.00100	3.20	<0.000005	0.85	0.11	23	<0.000002	<0.00020	<0.0005	0.0010	<0.0002	0.003	<0.0001
4/8/2012	<0.00001	0.0003	0.0002	0.006	0.16	0.00100	3.00	<0.000005	0.87	0.12	20	<0.000002	<0.00020	<0.0005	0.0013	<0.0002	0.003	<0.0001
5/8/2012	<0.00001	0.0003	0.0012	**0.020**	0.28	0.00065	3.30	**0.000217**	0.93	0.09	16	**0.000168**	<0.00020	**0.0052**	0.0008	**0.0006**	**0.055**	**0.0003**
6/4/2012	<0.00001	0.0001	0.0008	0.019	0.14	0.00031	1.90	0.000035	0.36	0.03	<10	0.000003	<0.00020	0.0028	0.0001	0.0004	0.004	<0.0001
7/4/2012	<0.00001	**0.0012**	0.0003	0.008	0.12	0.00062	3.30	0.000011	0.61	0.05	<10	0.000002	<0.00020	0.0006	0.0002	<0.0002	0.004	<0.0001
8/1/2012	<0.00001	0.0002	0.0003	0.003	0.11	0.00086	3.27	<0.000005	0.65	0.08	<10	<0.0000020	<0.00020	<0.0005	0.0004	<0.0002	0.003	<0.0001
9/2/2012	<0.00001	0.0002	0.0002	0.007	0.10	0.00078	2.63	0.000013	0.68	0.08	<10	<0.0000020	<0.00020	0.0006	0.0004	0.0002	0.004	<0.0001
10/16/2012	<0.00001	0.0002	0.0002	0.009	0.11	0.00078	3.07	0.000006	0.67	0.08	11	0.000002	<0.00020	0.0005	0.0005	<0.0002	0.004	<0.0001
11/20/2012	<0.00001	0.0002	0.0002	0.016	0.13	0.00100	3.00	0.000005	0.75	0.10	18	0.000002	<0.00020	<0.0005	0.0008	<0.0002	0.004	<0.0001
12/11/2012	<0.00001	0.0002	0.0003	0.008	0.17	0.00107	3.13	0.000010	0.83	0.11	20	<0.0000020	<0.00020	0.0006	0.0011	<0.0002	0.005	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
median	< 0.00001	0.00026	0.00025	0.009	0.14	0.00085	3.05	0.00001	0.75	0.095	17	0.000002	0.00020	0.0005	0.0008	0.0002	0.003	0.0001
mean	< 0.00002	0.00031	0.00046	0.013	0.19	0.00079	2.96	0.00006	0.72	0.087	19	0.000012	0.00034	0.0025	0.0007	0.0005	0.007	0.0002
standard deviation	0.00004	0.00025	0.00052	0.010	0.18	0.00022	0.44	0.00018	0.17	0.029	12	0.000035	0.00100	0.0055	0.0004	0.0010	0.013	0.0004
minimum	< 0.00001	0.00009	0.00016	0.003	0.10	0.00029	1.69	0.00001	0.27	0.027	< 10	< 0.000002	< 0.00001	< 0.0005	0.0001	< 0.0002	0.001	< 0.0001
maximum	< 0.00020	0.00119	0.00250	0.040	1.00	0.00107	3.55	0.00088	1.00	0.127	60	0.000168	0.00500	0.0260	0.0015	0.0050	0.055	0.0020
# < detection limit	24	1	0	1	2	1	0	10	1	0	8	15	18	12	0	18	1	20
% < detection limit	100%	4%	0%	4%	8%	4%	0%	42%	4%	0%	33%	63%	75%	50%	0%	75%	4%	83%
# > guideline	0	0	0			1		2				0			0		2	
% > guideline	0%	0%	0%			4%		8%				0%			0%		8%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.6: Water quality concentrations for WILC, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
11/22/2011	21	8.15	8.22			455	-0.1	**6.1**	**42**		<1	245	239				55		<0.005
12/21/2011	20	7.59	8.17		478	476	-0.1	12.5	85		1.3	250	242				61		<0.005
1/25/2012		8.46	**8.33**		660	534	0.0	11.8	81	330	<1	285	297				78		<0.005
2/17/2012		7.66	8.24		523	526	-0.1	13.3	91	57	<1	281	296				78		<0.005
3/14/2012		7.70	8.27		555	540	0.1	13.4	94	33	1.5	287	286				78		<0.050
4/9/2012		7.92	8.08			534	-0.1			169	<1	274	296				77		<0.005
5/4/2012		7.82	7.58		119	119	0.0	15.9	109	216	<1	68	68				<0.50		<0.050
6/3/2012	264	8.12	8.12		201	184	4.2	16.0	123	346	15.6	86	86				15		<0.050
7/3/2012	221	8.14	8.05		279	255	4.6	12.9	100	101	10.7	139	133				20		<0.050
8/5/2012	98	8.28	8.22		352	332	4.9	13.5	106	293	<1	178	183				25		<0.050
9/3/2012	117	7.79	8.18		348	296	2.7	13.9	102	122	<1	147	153	**133**	**162**		28		<0.050
10/18/2012		8.04	8.23		437	393	-0.1	14.4	99	192	<1	211	211				45		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	6	12	12	0	10	12	12	11	11	10	12	12	12	1	1	0	12	0	12
median	108	7.98	8.20	-	394	424	0.0	13.41	99	180.4	1	228	225	133.0	162	-	50	-	< 0.028
mean	123	7.97	8.14	-	395	387	1.3	13.06	94	185.7	3	204	207	133.0	162	-	47	-	< 0.028
standard deviation	101	0.27	0.19	-	167	148	2.1	2.65	21	110.6	5	79	83	-	-	-	28	-	0.024
minimum	20	7.59	7.58	-	119	119	-0.1	6.11	42	33.4	< 1	68	68	133.0	162	-	< 0.5	-	< 0.005
maximum	264	8.46	8.33	-	660	540	4.9	16.00	123	345.6	16	287	297	133.0	162	-	78	-	< 0.050
# < detection limit	0	0	0	-	0	0	0	0	0	0	8	0	0	0	0	-	1	-	12
% < detection limit	0%	0%	0%	-	0%	0%	0%	0%	0%	0%	67%	0%	0%	0%	0%	-	8%	-	100%
# > guideline		0	0					1			0					-		-	0
% > guideline		0%	0%					9%			0%					-		-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.6: Water quality concentrations for WILC, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
11/22/2011	0.06	0.26	<0.0020	4.29	0.01	0.00093	0.0020	0.057	<0.000010	<0.000005	<0.05	0.00001	69	<0.00010	0.00003	0.0006	0.05	0.0001	0.0017	18	0.024
12/21/2011	0.03	0.27	0.002	4.99	0.01	0.00094	0.0019	0.059	<0.000010	<0.000005	<0.05	0.00002	73	<0.00010	0.00004	0.0007	0.05	0.0005	0.0017	17	0.022
1/25/2012	0.06	0.15	0.005	4.21	0.00	**0.00101**	0.0019	0.066	<0.000010	<0.000005	<0.05	0.00002	80	0.00010	0.00002	0.0007	0.03	0.0002	0.0021	**21**	0.012
2/17/2012	0.03	0.20	0.003	3.89	0.01	**0.00110**	0.0018	0.063	<0.000010	<0.000005	<0.05	0.00002	80	<0.00010	0.00002	0.0005	0.02	0.0002	0.0019	**20**	0.009
3/14/2012	<0.20	0.23	0.006	2.61	0.01	**0.00128**	0.0017	0.059	<0.000010	<0.000005	<0.05	0.00003	82	0.00020	0.00006	0.0008	0.04	0.0004	0.0021	**20**	0.012
4/9/2012	0.06	0.14	0.002	2.89	0.00	**0.00119**	0.0021	0.067	<0.000010	<0.000005	<0.05	0.00001	79	<0.00010	0.00004	0.0005	0.03	0.0001	0.0020	**19**	0.071
5/4/2012	<0.20	**0.82**	0.023	**24.50**	0.07	0.00037	0.0024	0.025	<0.000010	<0.000005	<0.05	0.00004	20	0.00020	0.00011	0.0020	0.30	0.0001	0.0006	5	0.043
6/3/2012	<0.20	0.31	**0.497**	7.67	0.09	0.00064	0.0032	0.034	0.000013	<0.000005	<0.05	0.00003	24	0.00019	0.00016	0.0017	0.31	0.0008	0.0009	7	0.037
7/3/2012	<0.20	0.34	0.019	9.17	0.10	0.00077	**0.0047**	0.042	<0.000010	<0.000005	<0.05	0.00002	41	0.00023	0.00017	0.0015	**0.44**	0.0003	0.0011	9	0.044
8/5/2012	<0.20	0.32	0.006	7.36	0.02	0.00081	**0.0047**	0.046	<0.000010	<0.000005	<0.05	0.00001	52	<0.00010	0.00007	0.0008	0.26	0.0001	0.0013	12	0.028
9/3/2012	<0.20	0.31	0.008	**9.27**	0.02	0.00072	**0.0039**	0.041	<0.000010	<0.000005	<0.05	0.00001	42	0.00019	0.00009	0.0010	0.25	0.0003	0.0011	10	0.042
10/18/2012	0.03	0.20	0.004	5.04	0.01	0.00085	0.0032	0.049	<0.000010	<0.000005	<0.05	0.00001	61	<0.00010	0.00005	0.0008	0.14	0.0002	0.0016	14	0.036
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
median	0.13	0.27	0.0053	5.02	0.011	0.00089	0.0023	0.053	0.000010	< 0.000005	< 0.05	0.000017	65.0	0.00010	0.000054	0.00078	0.095	0.00024	0.0016	15.4	0.0324
mean	0.12	0.30	0.0480	7.16	0.029	0.00088	0.0028	0.051	0.000010	< 0.000005	< 0.05	0.000017	58.4	0.00014	0.000071	0.00097	0.159	0.00029	0.0015	14.2	0.0317
standard deviation	0.08	0.18	0.1416	5.92	0.036	0.00025	0.0011	0.013	0.000001	0.000000	0.00	0.000010	22.6	0.00005	0.000051	0.00051	0.145	0.00021	0.0005	5.6	0.0177
minimum	0.03	0.14	0.0020	2.61	0.004	0.00037	0.0017	0.025	< 0.000010	< 0.000005	< 0.05	0.000007	19.5	< 0.00010	0.000020	0.00049	0.016	0.00008	0.0006	4.7	0.0092
maximum	0.20	0.82	0.4970	24.50	0.095	0.00128	0.0047	0.067	0.000013	< 0.000005	< 0.05	0.000036	81.9	0.00023	0.000168	0.00203	0.439	0.00083	0.0021	20.9	0.0711
# < detection limit	6	0	1	0	0	0	0	0	11	12	12	0	0	6	0	0	0	0	0	0	0
% < detection limit	50%	0%	8%	0%	0%	0%	0%	0%	92%	100%	100%	0%	0%	50%	0%	0%	0%	0%	0%	0%	0%
# > guideline	0				0		0				0	0		0		0	0	0			0
% > guideline	0%				0%		0%				0%	0%		0%		0%	0%	0%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.6: Water quality concentrations for WILC, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
11/22/2011	<0.00001	0.0003	0.0005	<0.002	0.43	0.00014	3.80	<0.000005	1.86	0.34	20	<0.000002	0.00003	<0.0005	**0.0034**	<0.0002	0.000	0.0001
12/21/2011	<0.00001	0.0003	0.0005	0.003	0.49	0.00011	3.90	<0.000005	1.76	0.35	22	<0.000002	<0.00001	<0.0005	**0.0034**	<0.0002	0.002	<0.0001
1/25/2012	<0.00001	0.0003	0.0006	0.005	**0.71**	0.00008	**4.30**	<0.000005	**2.29**	**0.36**	25	<0.000002	<0.00020	<0.0005	**0.0042**	<0.0002	0.002	<0.0001
2/17/2012	<0.00001	0.0002	0.0005	0.004	0.60	0.00007	3.90	<0.000005	**2.04**	**0.37**	28	<0.000002	<0.00020	<0.0005	**0.0039**	<0.0002	0.001	<0.0001
3/14/2012	<0.00001	0.0003	0.0006	0.006	0.57	0.00009	4.10	<0.000005	**2.12**	**0.39**	25	0.000003	0.00030	0.0005	**0.0038**	<0.0002	0.003	<0.0001
4/9/2012	<0.00001	0.0003	0.0005	<0.002	0.55	0.00009	3.90	<0.000005	1.91	**0.38**	26	<0.000002	<0.00020	<0.0005	**0.0039**	<0.0002	0.001	<0.0001
5/4/2012	<0.00001	0.0001	0.0012	0.019	**0.77**	0.00017	1.73	0.000005	0.56	0.09	<10	<0.0000020	<0.00020	0.0008	0.0005	<0.0002	0.003	0.0003
6/3/2012	<0.00001	0.0002	0.0012	0.012	0.36	0.00016	1.90	<0.0000050	0.71	0.13	<10	<0.0000020	<0.00020	0.0028	0.0009	0.0003	0.003	0.0002
7/3/2012	<0.00001	0.0002	0.0012	0.011	0.20	0.00014	3.32	<0.0000050	1.02	0.19	<10	<0.0000020	<0.00020	0.0031	0.0012	0.0004	0.001	0.0003
8/5/2012	<0.00001	0.0002	0.0007	0.003	0.27	0.00013	3.41	<0.0000050	1.26	0.25	<10	<0.0000020	<0.00020	<0.00050	0.0017	<0.0002	0.000	0.0002
9/3/2012	<0.00001	0.0002	0.0008	0.005	0.28	0.00008	2.98	<0.0000050	1.25	0.22	<10	<0.0000020	<0.00020	0.0006	0.0014	0.0003	0.001	0.0002
10/18/2012	<0.00001	0.0003	0.0006	<0.002	0.33	0.00010	3.65	<0.0000050	1.49	0.29	14	<0.0000020	0.00024	<0.00050	0.0025	<0.0002	0.001	0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
median	0.00001	0.00025	0.00062	0.004	0.46	0.00011	3.73	0.000005	1.63	0.316	17	0.000002	0.00020	0.0005	0.0029	0.0002	0.0013	0.0001
mean	0.00001	0.00023	0.00075	0.006	0.46	0.00011	3.41	0.000005	1.52	0.280	18	0.000002	0.00018	0.0009	0.0026	0.0002	0.0015	0.0002
standard deviation	0.00000	0.00006	0.00028	0.005	0.18	0.00003	0.83	0.000000	0.57	0.103	7	0.000000	0.00008	0.0009	0.0014	0.0001	0.0010	0.0001
minimum	0.00001	0.00009	0.00050	0.002	0.20	0.00007	1.73	< 0.000005	0.56	0.091	< 10	< 0.000002	< 0.00001	< 0.0005	0.0005	< 0.0002	0.0004	< 0.0001
maximum	0.00001	0.00030	0.00119	0.019	0.77	0.00017	4.30	0.000005	2.29	0.389	28	0.000003	0.00030	0.0031	0.0042	0.0004	0.0032	0.0003
# < detection limit	12	0	0	3	0	0	0	11	0	0	5	11	9	7	0	9	0	5
% < detection limit	100%	0%	0%	25%	0%	0%	0%	92%	0%	0%	42%	92%	75%	58%	0%	75%	0%	42%
# > guideline	0	0	0			0		0				0			0		0	
% > guideline	0%	0%	0%			0%		0%				0%			0%		0%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.7: Water quality concentrations for FIELC, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
11/22/2011	34	8.06	8.19			353	-0.1	13.3	91		<1	193	187				24		<0.005
12/21/2011	26	7.73	8.21		370	370	0.0	12.9	88		1.1	192	189				24		<0.005
1/25/2012		7.92	8.25		466	397	0.0	12.2	84	339	1.1	210	202				25		<0.005
2/17/2012		7.52	8.24			396	-0.1	14.6	99	80	1.1	205	219				23		<0.005
3/14/2012	12	7.59	8.26		339	406	-0.1	12.7	87	89	<1	205	211				23		<0.050
4/9/2012		7.88	8.13			407	0.0			259	1.1	205	219				24		<0.005
5/4/2012		7.48	7.76		108	105	0.0	16.0	109	205	1.5	65	63						<0.050
6/3/2012	346	**8.55**	8.04		187	172	5.0	15.8	124	271	4.7	98	82				9		<0.050
7/3/2012	399	8.05	8.01		214	196	4.8	13.1	103	114	**24.9**	109	104				13		<0.050
8/5/2012	14	8.37	8.21		304	285	**5.8**	13.7	109	288	1.2	153	159				14		<0.050
9/3/2012	170	7.77	8.29		296	255	3.9	13.4	102	129	7.5	127	133				13		<0.050
10/18/2012		**7.00**	8.21		355	321	-0.1	15.1	103	170	1.0	176	171				19		<0.005
11/24/2012		7.42	8.22		412	377	0.0			46	1.4	203	205				23		<0.050
12/13/2012		**6.77**	8.22		426	417	0.0	12.6	86		1.0	219	222				23		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	7	14	14	0	11	14	14	12	12	11	14	14	14	0	0	0	13	0	14
median	34	7.75	8.21	-	339	362	0.0	13.4	101	169.6	1	193	188	-	-	-	23	-	< 0.028
mean	143	7.72	8.16	-	316	318	1.4	13.8	99	181.0	4	169	169	-	-	-	20	-	< 0.028
standard deviation	167	0.48	0.14	-	109	101	2.3	1.3	12	97.7	6	50	53	-	-	-	6	-	0.023
minimum	12	6.77	7.76	-	108	105	-0.1	12.2	84	45.8	< 1	65	63	-	-	-	9	-	< 0.005
maximum	399	8.55	8.29	-	466	417	5.8	16.0	124	339.3	25	219	222	-	-	-	25	-	< 0.050
# < detection limit	0	0	0	-	0	0	0	0	0	0	2	0	0	-	-	-	0	-	14
% < detection limit	0%	0%	0%	-	0%	0%	0%	0%	0%	0%	14%	0%	0%	-	-	-	0%	-	100%
# > guideline		0	0					0			0					-		-	0
% > guideline		0%	0%					0%			0%					-		-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.7: Water quality concentrations for FIELC, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
11/22/2011	0.11	0.27	<0.0020	4.33	0.01	0.00011	0.0015	0.065	<0.000010	<0.000005	<0.05	0.00001	51	<0.00010	0.00013	0.0006	0.25	0.0000	0.0017	16	0.236
12/21/2011	0.05	0.31	0.004	3.89	0.01	0.00013	0.0015	0.069	<0.000010	<0.000005	<0.05	0.00002	52	<0.00010	0.00014	**0.0149**	0.28	0.0013	0.0018	15	**0.249**
1/25/2012	0.13	0.15	0.004	3.34	0.01	0.00009	0.0015	0.080	<0.000010	<0.000005	<0.05	0.00002	54	<0.00010	0.00019	0.0006	0.24	0.0000	0.0017	18	**0.342**
2/17/2012	0.12	0.20	0.003	3.26	0.01	0.00009	0.0012	0.076	<0.000010	<0.000005	<0.05	0.00001	54	<0.00010	0.00014	0.0006	0.16	0.0003	0.0016	17	**0.298**
3/14/2012	0.23	<0.20	0.003	3.31	0.00	0.00009	0.0011	0.073	<0.000010	<0.000005	<0.05	0.00001	54	0.00050	0.00015	0.0004	0.18	0.0002	0.0017	17	**0.316**
4/9/2012	0.13	0.18	<0.0020	2.64	0.00	0.00009	0.0011	**0.090**	<0.000010	<0.000005	<0.05	0.00003	56	<0.00010	0.00014	0.0004	0.18	0.0002	0.0016	16	**0.328**
5/4/2012	**0.39**	**0.49**	0.020	**30.60**	0.14	0.00008	0.0009	0.037	**0.000017**	<0.000005	<0.05	0.00004	18	0.00035	0.00023	0.0021	0.40	0.0001	0.0006	5	0.090
6/3/2012	<0.20	0.38	0.013	8.11	0.11	0.00046	0.0020	0.038	<0.000010	<0.000005	<0.05	0.00013	27	**0.00937**	0.00029	**0.0095**	0.37	0.0046	0.0016	7	0.062
7/3/2012	<0.20	**0.44**	0.027	**11.20**	**0.21**	0.00022	0.0029	0.052	**0.000024**	<0.000005	<0.05	0.00004	31	0.00041	**0.00042**	0.0023	**0.85**	0.0006	0.0011	8	0.095
8/5/2012	<0.20	0.35	0.006	7.34	0.02	0.00015	0.0022	0.055	<0.000010	<0.000005	<0.05	0.00001	42	<0.00010	0.00012	0.0009	**0.42**	0.0002	0.0014	12	0.075
9/3/2012	<0.20	0.37	0.017	**9.63**	0.07	0.00018	0.0025	0.054	<0.000010	<0.000005	<0.05	0.00003	35	0.00043	0.00025	0.0016	**0.64**	0.0009	0.0011	10	0.116
10/18/2012	0.06	0.23	0.003	5.60	0.01	0.00011	0.0017	0.058	<0.000010	<0.000005	<0.05	0.00001	48	0.00011	0.00011	0.0008	0.30	0.0003	0.0016	14	0.158
11/24/2012	<0.20	0.39	0.004	4.32	0.01	0.00010	0.0013	**0.083**	<0.000010	<0.000005	<0.05	0.00001	53	0.00085	0.00015	**0.0050**	0.28	0.0003	0.0014	17	**0.257**
12/13/2012	0.11	0.37	0.003	4.90	0.01	0.00019	0.0009	**0.083**	<0.000010	<0.000005	<0.05	0.00004	58	0.00022	0.00010	**0.0039**	0.14	0.0021	0.0015	18	0.156
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
median	0.17	0.33	0.0038	4.62	0.010	0.00011	0.0015	0.067	0.000010	< 0.000005	< 0.05	0.000021	51.5	0.00017	0.00015	0.00125	0.279	0.00027	0.0016	15.4	0.1970
mean	0.17	0.31	0.0080	7.32	0.044	0.00015	0.0016	0.065	0.000012	< 0.000005	< 0.05	0.000029	45.2	0.00092	0.00018	0.00312	0.335	0.00080	0.0015	13.5	0.1984
standard deviation	0.09	0.11	0.0081	7.19	0.065	0.00010	0.0006	0.017	0.000004	0.000000	0.00	0.000031	12.7	0.00244	0.00009	0.00422	0.199	0.00124	0.0003	4.4	0.1019
minimum	0.05	0.15	< 0.0020	2.64	0.004	0.00008	0.0009	0.037	< 0.000010	< 0.000005	< 0.05	0.000007	17.8	0.00010	0.00010	0.00042	0.140	0.00003	0.0006	5.0	0.0623
maximum	0.39	0.49	0.0271	30.60	0.212	0.00046	0.0029	0.090	0.000024	< 0.000005	< 0.05	0.000128	57.7	0.00937	0.00042	0.01490	0.853	0.00462	0.0018	18.1	0.3420
# < detection limit	5	1	2	0	0	0	0	0	12	14	14	0	0	6	0	0	0	0	0	0	0
% < detection limit	36%	7%	14%	0%	0%	0%	0%	0%	86%	100%	100%	0%	0%	43%	0%	0%	0%	0%	0%	0%	0%
# > guideline	0				3		0				0	0		1		4	0	1			0
% > guideline	0%				21%		0%				0%	0%		7%		29%	0%	7%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.7: Water quality concentrations for FIELC, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
11/22/2011	<0.00001	**0.0004**	0.0009	0.003	0.47	0.00037	3.50	<0.000005	1.69	0.28	<10	<0.000002	0.00003	<0.0005	0.0025	<0.0002	0.000	0.0001
12/21/2011	<0.00001	0.0002	**0.0030**	0.005	0.54	0.00037	3.50	<0.000005	1.59	0.29	<10	<0.000002	<0.00001	0.0006	0.0027	<0.0002	0.003	0.0001
1/25/2012	<0.00001	0.0002	0.0011	0.004	0.50	0.00026	3.50	<0.000005	1.80	0.30	<10	<0.000002	<0.0002	<0.0005	0.0031	<0.0002	0.001	0.0001
2/17/2012	<0.00001	0.0002	0.0010	<0.002	0.55	0.00029	3.40	<0.000005	1.75	0.30	<10	<0.000002	<0.0002	<0.0005	0.0030	<0.0002	0.001	<0.0001
3/14/2012	<0.00001	0.0002	0.0009	0.003	0.50	0.00032	3.30	<0.000005	1.72	0.31	<10	<0.000002	<0.0002	<0.0005	0.0032	<0.0002	0.001	<0.0001
4/9/2012	<0.00001	0.0002	0.0009	0.002	0.51	0.00036	3.50	<0.000005	1.57	0.31	<10	<0.000002	<0.0002	<0.0005	0.0030	<0.0002	0.003	<0.0001
5/4/2012	<0.00001	0.0001	**0.0017**	**0.020**	0.57	0.00025	1.82	0.000006	0.58	0.10	<10	<0.000002	<0.00020	0.0015	0.0005	<0.0002	0.005	**0.0003**
6/3/2012	<0.00001	**0.0036**	**0.0030**	**0.067**	**2.05**	0.00022	2.40	0.000034	**2.75**	0.15	<10	0.000004	**0.00059**	0.0039	0.0006	0.0004	**0.030**	0.0002
7/3/2012	<0.00001	0.0001	**0.0017**	0.020	0.20	0.00019	3.22	0.000007	1.00	0.17	<10	0.000002	<0.00020	0.0047	0.0009	**0.0007**	0.002	**0.0005**
8/5/2012	<0.00001	0.0002	0.0010	0.004	0.33	0.00027	3.17	<0.000005	1.26	0.25	<10	<0.000002	<0.00020	<0.0005	0.0015	<0.0002	0.002	0.0002
9/3/2012	<0.00001	0.0002	0.0013	0.009	0.34	0.00027	2.88	0.000011	1.22	0.21	<10	<0.000002	<0.00020	0.0025	0.0012	**0.0005**	0.002	0.0003
10/18/2012	<0.00001	0.0002	0.0009	<0.002	0.38	0.00023	3.53	<0.000005	1.40	0.26	<10	<0.000002	<0.00020	<0.0005	0.0019	<0.0002	0.001	0.0001
11/24/2012	<0.00001	0.0003	0.0010	0.005	0.47	0.00034	3.34	<0.000005	1.71	0.31	8	<0.000002	**0.00037**	0.0006	0.0027	0.0003	0.001	0.0001
12/13/2012	<0.00001	0.0002	0.0011	0.002	0.52	0.00021	3.67	<0.000005	**1.97**	0.34	8	0.000003	**0.00056**	<0.0005	0.0028	<0.0002	0.009	0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
median	< 0.00001	0.00021	0.00107	0.004	0.50	0.00027	3.37	0.000005	1.64	0.286	10	0.000002	0.00020	0.00050	0.0026	0.0002	0.0019	0.0001
mean	< 0.00001	0.00046	0.00139	0.011	0.57	0.00028	3.20	0.000008	1.57	0.254	10	0.000002	0.00024	0.00127	0.0021	0.0003	0.0044	0.0002
standard deviation	0.00000	0.00092	0.00074	0.017	0.44	0.00006	0.51	0.000008	0.50	0.072	1	0.000001	0.00016	0.00142	0.0010	0.0002	0.0078	0.0001
minimum	< 0.00001	0.00007	0.00085	< 0.002	0.20	0.00019	1.82	< 0.000005	0.58	0.098	8	< 0.000002	< 0.00001	0.00050	0.0005	0.0002	0.0004	0.0001
maximum	< 0.00001	0.00364	0.00303	0.067	2.05	0.00037	3.67	0.000034	2.75	0.337	10	0.000004	0.00059	0.00473	0.0032	0.0007	0.0303	0.0005
# < detection limit	14	0	0	2	0	0	0	10	0	0	12	11	10	8	0	10	0	3
% < detection limit	100%	0%	0%	14%	0%	0%	0%	71%	0%	0%	86%	79%	71%	57%	0%	71%	0%	21%
# > guideline	0	0	0			0		0				0			0		1	
% > guideline	0%	0%	0%			0%		0%				0%			0%		7%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.8: Water quality concentrations for KV-1, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011		7.72	7.89	**519**		492	0.0				**90.0**	238	223	**140**	**170**		120		
3/22/2011		7.69	8.00	**460**		**796**	0.4				2.0	**450**	**453**				170		
5/25/2011		8.24	7.77	113		169	**6.3**				**160.0**	80	85	53	64		35		
6/22/2011		8.23	8.04	260		328	**15.0**				6.0	172	167				74		
7/20/2011		8.06	7.81		301	310	**13.1**				**31.0**	153	158	81	98		72		
8/19/2011		8.31	8.18			294	**10.7**				<1	159	151				32		
9/24/2011		7.39	8.10		351	356	**7.0**				7.0	174	165				84		
10/24/2011	3,505	**7.01**	8.05			391	0.3	10.9	76	273	3.0	186	200	**110**	**140**		83		<0.005
11/24/2011		8.00	8.05			425	-0.1	**10.2**	**70**		**65.7**	226	237				102		<0.005
12/15/2011		7.58	7.82		446	436	-0.1	**10.2**	**70**		1.8	224	224	**126**	**154**		98	**0.055**	<0.005
1/13/2012		7.65	8.12		411	473	0.0	**9.3**	**63**		1.7	236	245				102		<0.005
2/10/2012		7.47	8.21		484	513	-0.1	**10.1**	**69**	86	1.4	273	275	**154**	**188**		121		0.012
3/10/2012		7.61	8.09		486	479	-0.1	12.1	82	69	3.6	250	239				113		<0.05
4/6/2012		7.56	8.19		550	482	-0.1	**9.9**	**68**	56	11.0	237	253				109		<0.005
5/5/2012	6,155	7.85	7.65		287	273	2.2	13.2	96	44	**34.4**	141	138	77	94	0.9	53		<0.050
6/1/2012	8,779	7.91	8.06		245	288	**11.7**				**42.2**	139	128				57		<0.050
7/5/2012		7.97	8.08		359	327	**14.6**	**9.5**	94	114	**57.9**	179	149	88	107	0.7	79		<0.050
8/2/2012	6,315	7.98	8.17		358	335	**15.5**	**9.4**	94	120	3.3	174	173				77		<0.050
9/21/2012	2,681	8.00	8.10		424	380	**7.0**	11.5	95	116	2.7	174	191				96		<0.050
10/11/2012	2,267	**7.08**	8.15		464	403	0.0			161	4.0	184	196	**109**	**133**	1.1	103		<0.050
11/19/2012		7.99	8.21		390	462	0.0	**5.1**	77	**413**	1.9	246	254				115		**0.061**
12/7/2012		**7.09**	8.14		600	531	0.0				1.7	270	261				130		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	6	22	22	4	15	22	22	12	12	10	22	22	22	9	9	3	22	1	15
median	4830	7.79	8.09	360	411	397	0.4	10.17	77	114.7	4	185	198	109.0	133	0.9	97	0.055	0.05
mean	4950	7.75	8.04	338	410	407	4.7	10.12	80	145.1	24	207	208	104.2	128	0.9	92	0.055	0.03
standard deviation	2546	0.37	0.16	187	98	127	6.0	1.97	12	114.5	39	73	74	32.6	40	0.2	32	0	0.02
minimum	2267	7.01	7.65	113	245	169	-0.1	5.10	63	44.0	< 1	80	85	53.0	64	0.7	32	0.0550	0.01
maximum	8779	8.31	8.21	519	600	796	15.5	13.21	96	412.6	160	450	453	154.0	188	1.1	170	0.0550	0.06
# < detection limit	0	0.00	0.00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	13
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	87%
95th Percentile	8163	8	8	510	565	530	15	13	95	350	89	273	274	148	181	1	130	0	0

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light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.8: Water quality concentrations for KV-1, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011			0.009	3.30	**2.91**	0.00014	**0.0075**	**0.092**	**0.000120**	<0.000005	<0.05	**0.00196**	61	**0.00160**	**0.01080**	**0.0115**	**2.37**	**0.0117**	**0.0077**	**21**	**0.706**
3/22/2011				3.30	0.02	0.00008	0.0031	**0.114**	<0.000010	<0.000005	<0.05	**0.00031**	117	0.00040	**0.00121**	0.0010	0.35	0.0011	**0.0076**	**38**	**0.313**
5/25/2011			**0.031**	**11.50**	**0.27**	0.00015	0.0008	0.034	**0.000020**	<0.000020	<0.05	**0.00027**	22	<0.00050	**0.00273**	**0.0042**	0.31	0.0005	0.0026	6	0.185
6/22/2011					**0.77**	0.00010	0.0009	0.051	**0.000040**	<0.000005	<0.05	**0.00094**	45	0.00020	**0.00457**	**0.0059**	0.29	0.0003	**0.0063**	15	0.220
7/20/2011			0.002	5.70	**1.91**	0.00031	0.0022	0.060	**0.000080**	<0.00002	<0.05	**0.00131**	40	**0.00180**	**0.00698**	**0.0120**	**1.90**	0.0018	**0.0069**	13	**0.278**
8/19/2011					0.00	0.00029	**0.0076**	0.061	<0.000010	<0.000005	<0.05	<0.000005	40	0.00020	0.00004	0.0003	0.04	0.0002	0.0029	14	0.021
9/24/2011					**0.60**	0.00010	0.0010	0.046	**0.000040**	<0.000005	<0.05	**0.00082**	45	0.00030	**0.00392**	**0.0049**	0.35	0.0005	**0.0060**	15	0.178
10/24/2011	0.03	0.07	0.005	3.90	**0.35**	0.00007	0.0010	0.052	**0.000020**	<0.000005	<0.05	**0.00063**	49	0.00010	**0.00284**	**0.0030**	0.27	0.0002	**0.0060**	15	0.166
11/24/2011	0.04	0.34	0.011	3.81	**0.35**	0.00035	0.0016	0.059	**0.000020**	**0.000007**	<0.05	**0.00082**	58	0.00050	**0.00366**	**0.0043**	**0.46**	**0.0063**	**0.0069**	**20**	0.241
12/15/2011	0.05	0.17	0.005	3.52	**0.23**	0.00008	0.0013	0.063	0.000010	<0.000005	<0.05	**0.00066**	58	<0.00010	**0.00244**	0.0027	0.25	0.0002	**0.0063**	**19**	0.180
1/13/2012	0.06	0.19	0.006	3.49	**0.16**	0.00007	0.0016	0.069	**0.000020**	<0.000005	<0.05	**0.00074**	63	<0.00010	**0.00199**	0.0022	0.26	0.0003	**0.0063**	**20**	0.183
2/10/2012	0.21	0.14	0.005	4.23	0.11	0.00012	0.0015	0.078	<0.000010	<0.000005	<0.05	**0.00081**	72	<0.00010	**0.00240**	0.0023	0.24	0.0004	**0.0071**	**23**	0.226
3/10/2012	<0.20	**0.53**	0.007	3.90	0.14	0.00011	0.0016	0.069	0.000010	<0.000005	<0.05	**0.00060**	65	0.00030	**0.00154**	0.0025	0.24	0.0009	**0.0066**	**21**	0.162
4/6/2012	0.10	0.22	0.007	2.98	**0.25**	0.00011	0.0018	0.069	0.000010	<0.000005	<0.05	**0.00076**	62	0.00020	**0.00234**	0.0026	0.32	0.0019	**0.0065**	**20**	0.202
5/5/2012	**0.33**	<0.20	**0.046**	**11.80**	**0.64**	0.00011	0.0019	0.057	**0.000038**	**0.000008**	<0.05	**0.00041**	37	0.00047	**0.00191**	**0.0042**	**0.96**	0.0015	0.0033	12	0.201
6/1/2012	<0.20	0.28	**0.051**	4.84	**0.77**	0.00013	0.0017	0.056	**0.000051**	<0.000005	<0.05	**0.00079**	35	0.00051	**0.00402**	**0.0064**	**0.81**	0.0014	0.0048	13	0.222
7/5/2012	<0.20	0.24	0.013	4.49	**0.87**	0.00012	0.0009	0.048	**0.000048**	<0.000005	<0.05	**0.00097**	48	0.00022	**0.00463**	**0.0064**	0.39	0.0004	**0.0063**	14	0.181
8/2/2012	<0.20	0.22	0.005	5.15	**0.49**	0.00009	0.0008	0.048	**0.000025**	<0.000005	<0.05	**0.00073**	45	0.00015	**0.00306**	**0.0044**	0.23	0.0002	**0.0064**	15	0.144
9/21/2012	<0.20	0.23	0.005	4.04	**0.49**	0.00012	0.0021	0.048	**0.000028**	**0.000039**	<0.05	**0.00115**	44	<0.00010	**0.00517**	**0.0039**	0.22	0.0010	**0.0075**	16	0.222
10/11/2012	<0.20	0.26	0.006	5.33	**0.32**	0.00008	0.0011	0.048	0.000014	<0.000005	<0.05	**0.00070**	48	<0.00010	**0.00395**	**0.0031**	0.22	0.0001	**0.0061**	15	0.202
11/19/2012	<0.20	**1.01**	0.007	3.46	**0.25**	0.00008	0.0014	0.066	0.000010	<0.000005	<0.05	**0.00085**	64	0.00010	**0.00355**	**0.0030**	0.30	0.0005	**0.0071**	**21**	**0.252**
12/7/2012	0.06	0.29	0.006	3.11	0.11	0.00006	0.0021	0.080	<0.000010	<0.000005	<0.05	**0.00068**	69	0.00028	**0.00206**	0.0019	0.36	0.0006	**0.0068**	**24**	**0.244**
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	15	15	18	19	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
median	0.20	0.23	0.0067	3.90	0.335	0.00011	0.0016	0.059	0.000020	0.000005	< 0.05	0.000748	48.8	0.00021	0.002950	0.00347	0.305	0.00052	0.0064	15.6	0.2020
mean	0.15	0.29	0.0126	4.83	0.546	0.00013	0.0021	0.062	0.000029	0.000008	< 0.05	0.000769	53.9	0.00038	0.003446	0.00421	0.505	0.00145	0.0061	17.7	0.2240
standard deviation	0.09	0.22	0.0145	2.52	0.669	0.00008	0.0019	0.018	0.000027	0.000008	0.00	0.000390	18.8	0.00045	0.002226	0.00291	0.567	0.00263	0.0014	6.2	0.1215
minimum	0.03	0.07	0.0020	2.98	0.003	0.00006	0.0008	0.034	< 0.000010	< 0.000005	< 0.05	< 0.000005	22.1	< 0.00010	0.000038	0.00025	0.036	0.00011	0.0026	5.9	0.0206
maximum	0.33	1.01	0.0509	11.80	2.910	0.00035	0.0076	0.114	0.000120	0.000039	< 0.05	0.001960	117.0	0.00180	0.010800	0.01200	2.370	0.01170	0.0077	38.2	0.7060
# < detection limit	7	1	0	0	0	0	0	0	4	19	22	1	0	6	0	0	0	0	0	0	0
% < detection limit	47%	7%	0%	0%	0%	0%	0%	0%	18%	86%	100%	5%	0%	27%	0%	0%	0%	0%	0%	0%	0%
95th Percentile	0	1	0	12	2	0	0	0	0	0	0	0	72	0	0	0	2	0	0	23	0

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.8: Water quality concentrations for KV-1, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011	<0.00001	**0.0008**	**0.0513**	**0.052**	**0.79**	0.00058	3.13	<0.000005	**2.93**	0.28	35	0.000007	0.00002	**0.0090**	0.0019	**0.0008**	**0.377**	0.0002
3/22/2011	<0.00002	**0.0024**	**0.0166**	0.010	**2.20**	0.00022	**6.26**	0.000006	**9.09**	**0.41**	63	0.000003	0.00001	<0.0005	0.0015	<0.0002	**0.065**	<0.0001
5/25/2011	<0.00001	**0.0005**	**0.0156**	0.011	0.50	0.00028	1.36	0.000007	0.60	0.08	<50	0.000004	<0.0002	<0.0050	0.0004	0.0005	**0.039**	**0.0003**
6/22/2011	<0.00001	**0.0004**	**0.0317**	0.007	0.44	0.00048	1.91	<0.000005	1.25	0.20	30	0.000004	0.00002	0.0009	0.0007	0.0002	**0.147**	<0.0001
7/20/2011	<0.00001	**0.0005**	**0.0417**	**0.062**	0.50	0.00057	2.99	0.000041	1.20	0.16	<50	0.000014	<0.00020	**0.0220**	0.0009	**0.0021**	**0.213**	**0.0007**
8/19/2011	<0.00001	**0.0009**	0.0009	0.012	**0.66**	0.00006	1.30	<0.000005	**3.69**	0.21	13	<0.000002	0.00002	<0.0005	0.0001	<0.0002	0.001	<0.0001
9/24/2011	<0.00001	**0.0004**	**0.0265**	0.011	0.43	0.00048	1.90	0.000009	1.33	0.19	29	0.000003	0.00013	0.0016	0.0009	0.0003	**0.137**	<0.0001
10/24/2011	<0.00001	**0.0004**	**0.0220**	0.008	0.49	0.00051	2.00	<0.000005	1.58	0.22	32	<0.000002	0.00015	0.0015	0.0010	<0.0002	**0.106**	<0.0001
11/24/2011	<0.00002	**0.0005**	**0.0292**	0.016	**0.73**	0.00056	2.60	0.000023	**2.46**	0.23	35	0.000004	**0.00093**	0.0024	0.0009	0.0004	**0.148**	<0.0001
12/15/2011	<0.00001	**0.0006**	**0.0261**	0.002	0.60	0.00056	2.50	<0.000005	**2.39**	0.25	35	<0.000002	0.00003	<0.0005	0.0008	<0.0002	**0.122**	<0.0001
1/13/2012	<0.00001	**0.0007**	**0.0237**	0.004	**0.75**	0.00058	3.10	<0.000005	**2.64**	0.25	42	<0.000002	<0.00020	<0.0005	0.0008	<0.0002	**0.113**	<0.0001
2/10/2012	<0.00001	**0.0007**	**0.0313**	0.005	**0.92**	0.00061	3.30	<0.000005	**3.17**	0.28	41	<0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.149**	<0.0001
3/10/2012	<0.00001	**0.0007**	**0.0231**	0.009	**0.93**	0.00056	3.00	<0.000005	**2.99**	0.25	40	<0.000002	<0.00020	0.0007	0.0007	<0.0002	**0.112**	<0.0001
4/6/2012	<0.00001	**0.0006**	**0.0286**	0.007	**0.77**	0.00058	2.90	0.000009	**2.87**	0.26	38	<0.000002	<0.00020	0.0009	0.0008	<0.0002	**0.138**	<0.0001
5/5/2012	<0.00001	**0.0004**	**0.0120**	**0.033**	**0.80**	0.00028	2.57	0.000017	1.25	0.14	19	0.000007	0.00025	**0.0146**	0.0008	**0.0010**	**0.069**	**0.0004**
6/1/2012	<0.00001	0.0003	**0.0233**	**0.040**	0.55	0.00050	1.90	0.000006	1.15	0.16	22	0.000007	<0.00020	**0.0056**	0.0008	**0.0008**	**0.130**	**0.0004**
7/5/2012	<0.00001	**0.0004**	**0.0307**	0.008	0.36	0.00057	2.38	0.000006	1.32	0.17	26	0.000003	<0.00020	0.0028	0.0008	0.0003	**0.169**	<0.0001
8/2/2012	<0.00001	**0.0005**	**0.0231**	0.003	0.37	0.00055	1.73	<0.000005	1.33	0.20	29	0.000002	<0.00020	<0.0005	0.0007	<0.0002	**0.113**	<0.0001
9/21/2012	<0.00001	**0.0005**	**0.0313**	0.002	0.42	0.00060	1.55	**0.000070**	1.49	0.21	32	0.000002	<0.00020	0.0005	0.0010	<0.0002	**0.147**	**0.0004**
10/11/2012	<0.00001	**0.0004**	**0.0252**	0.007	0.48	0.00057	2.10	<0.000005	1.55	0.20	41	<0.0000020	<0.00020	<0.0005	0.0008	<0.0002	**0.117**	0.0002
11/19/2012	<0.00001	**0.0005**	**0.0313**	0.005	**0.69**	0.00066	2.70	<0.000005	**2.52**	0.26	43	0.000002	<0.00020	0.0007	0.0008	<0.0002	**0.161**	<0.0001
12/7/2012	<0.00001	**0.0008**	**0.0268**	0.004	**0.88**	0.00059	3.21	<0.000005	**3.62**	0.29	44	0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.133**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
median	< 0.00001	0.00053	0.02630	0.008	0.63	0.00056	2.54	0.000005	1.99	0.215	35	0.000002	0.00020	0.0008	0.0008	0.0002	0.1315	0.0001
mean	< 0.00001	0.00063	0.02600	0.014	0.69	0.00050	2.56	0.000012	2.38	0.222	36	0.000004	0.00019	0.0033	0.0009	0.0004	0.1321	0.0002
standard deviation	0.00000	0.00042	0.01003	0.017	0.38	0.00015	1.03	0.000016	1.75	0.065	11	0.000003	0.00018	0.0054	0.0003	0.0004	0.0711	0.0002
minimum	< 0.00001	0.00033	0.00086	0.002	0.36	0.00006	1.30	< 0.000005	0.60	0.084	13	< 0.000002	0.00001	< 0.0005	0.0001	< 0.0002	0.0013	< 0.0001
maximum	< 0.00002	0.00240	0.05130	0.062	2.20	0.00066	6.26	0.000070	9.09	0.407	63	0.000014	0.00093	0.0220	0.0019	0.0021	0.3770	0.0007
# < detection limit	22	0	0	0	0	0	0	12	0	0	2	8	13	9	0	13	0	15
% < detection limit	100%	0%	0%	0%	0%	0%	0%	55%	0%	0%	9%	36%	59%	41%	0%	59%	0%	68%
95th Percentile	0	0	0	0	1	0	3	0	4	0	50	0	0	0	0	0	0	0

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.9: Water quality concentrations for KV-2, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011		8.05	8.02	138		**775**	0.5				16.0	377	382	**230**	**290**		170		
5/27/2011		8.00	8.09	210		259	**8.4**				2.0	131	131	**98**	**120**		39		
7/12/2011		**8.61**	8.20		300	279	**16.2**				<1	144	142	**110**	**130**		32		
10/29/2011		8.27	7.87		442	419	0.1	10.7	74	284	2.0	220	221	**120**	**150**		90		<0.050
11/23/2011		7.95	8.15			473	-0.1	**9.9**	**68**		1.9	245	246				109		<0.005
12/15/2011		7.59	7.82		468	453	-0.1	**9.5**	**65**		1.7	237	235	**133**	**163**		101	**0.045**	<0.005
1/14/2012		7.57	8.11		464	496	0.0	**9.1**	**63**	315	12.1	241	254				112		<0.005
2/10/2012		7.52	8.24		505	501	-0.1	**10.2**	**70**	57	14.4	259	270	**154**	**188**		117		<0.005
3/19/2012		7.52	8.24		506	506	-0.1	**9.9**	**67**	-3	4.7	252	253				98		<0.050
4/5/2012		7.43	8.12		595	509	0.0			105	1.1	249	262				112		<0.005
5/3/2012		8.00	7.87		247	245	0.6	13.4	93	231	**42.1**	130	122	72	87	0.6	50		<0.050
6/4/2012		7.82	8.09		336	308	**11.9**	10.6	99	315	**22.7**	153	143				65		<0.050
7/6/2012		8.06	8.06		376	343	**15.2**	**9.4**	94	120	7.3	177	152	92	113	1.0	85		<0.050
8/5/2012	6,486	8.21	8.20		386	357	**13.2**	10.5	100	265	2.5	189	186				85		<0.050
9/23/2012	3,554	8.02	8.20			405	**7.3**	11.1	92		2.1	207	201				102		<0.050
10/13/2012	3,061	7.37	8.07		469	427	-0.1	13.7	94	-41	3.2	224	223	**125**	**153**	0.8	104		<0.050
11/17/2012			8.04		516	480	0.0				1.3	247	257				115		**0.059**
12/8/2012		**7.09**	7.98		597	520	0.0	10.7	73		1.5	270	259				124		<0.005
guideline		6.5 - 9.0						9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	3	17	18	2	14	18	18	13	13	10	18	18	18	9	9	3	18	1	15
median	3554	7.95	8.09	174	466	440	0.1	10.50	74	175.9	2	231	229	120.0	150.0	0.8	102	0.045	0.050
mean	4367	7.83	8.08	174	443	431	4.1	10.66	81	164.9	8	220	219	126.0	154.9	0.8	95	0.045	0.033
standard deviation	1852	0.39	0.13	51	104	126	6.1	1.40	14	134.1	11	60	65	45.8	58.7	0.2	33	0	0.023
minimum	3061	7.09	7.82	138	247	245	-0.1	9.10	63	-41.2	< 1	130	122	71.6	87.3	0.6	32	0.045	< 0.005
maximum	6486	8.61	8.24	210	597	775	16.2	13.70	100	315.1	42	377	382	230.0	290.0	1.0	170	0.045	0.059
# < detection limit	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	14
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	93%
# > background		2	0	0	0	1	6	6	5	0	2	0	0	7	7	0	0	1	1
% > background		12%	0%	0%	0%	6%	33%	46%	38%	0%	11%	0%	0%	78%	78%	0%	0%	100%	7%
# > guideline		0	0					2			1					0		1	0
% > guideline		0%	0%					15%			6%					0%		100%	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.9: Water quality concentrations for KV-2, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011			0.007	4.30	0.11	0.00018	**0.0050**	**0.122**	0.000010	<0.000005	<0.05	**0.00112**	100	0.00060	**0.00238**	0.0026	**0.47**	0.0016	**0.0089**	**31**	**0.308**
5/27/2011			0.015	9.00	0.02	0.00028	**0.0080**	0.054	<0.000010	<0.000005	<0.05	0.00005	34	0.00030	0.00011	0.0005	0.17	0.0007	0.0022	11	0.053
7/12/2011			0.010	**9.40**	0.01	0.00033	**0.0075**	0.056	<0.000010	<0.000005	<0.05	0.00001	34	0.00020	0.00007	0.0003	0.07	0.0004	0.0029	14	0.026
10/29/2011	<0.20	0.30	0.004	3.80	**0.26**	0.00014	0.0014	0.061	<0.000010	<0.000005	<0.05	**0.00061**	57	0.00020	**0.00249**	**0.0033**	0.24	0.0029	**0.0061**	**19**	0.173
11/23/2011	0.08	0.38	0.003	4.15	0.13	0.00014	0.0017	0.072	<0.000010	<0.000005	<0.05	**0.00054**	64	0.00020	**0.00175**	0.0023	0.22	0.0021	**0.0065**	**21**	0.175
12/15/2011	0.09	0.17	0.004	3.32	0.15	0.00010	0.0015	0.073	<0.000010	<0.000005	<0.05	**0.00056**	63	<0.00010	**0.00160**	0.0023	0.20	0.0004	**0.0058**	**20**	0.159
1/14/2012	0.10	**0.44**	0.011	2.91	0.13	0.00013	0.0022	0.074	0.000010	<0.000005	<0.05	**0.00070**	66	<0.00010	**0.00143**	0.0019	0.27	0.0019	**0.0056**	**19**	0.166
2/10/2012	0.14	0.22	0.019	3.00	**0.31**	0.00016	**0.0039**	**0.085**	**0.000020**	<0.000005	<0.05	**0.00094**	70	0.00020	**0.00259**	**0.0030**	**0.54**	**0.0084**	**0.0060**	**21**	**0.287**
3/19/2012	<0.20	**0.56**	0.005	3.05	0.11	0.00014	0.0018	0.072	0.000010	<0.000005	<0.05	**0.00052**	67	0.00030	**0.00092**	0.0017	0.25	0.0014	**0.0060**	**21**	0.133
4/5/2012	0.14	**0.88**	0.006	4.31	0.06	0.00020	0.0016	0.076	<0.000010	<0.000005	<0.05	**0.00058**	67	0.00010	**0.00086**	0.0023	0.17	0.0014	**0.0060**	**20**	0.127
5/3/2012	**0.32**	0.27	**0.060**	**12.20**	**0.85**	0.00017	**0.0047**	0.050	**0.000038**	0.000006	<0.05	**0.00099**	35	0.00037	**0.00339**	**0.0057**	**1.21**	**0.0103**	0.0030	10	**0.306**
6/4/2012	<0.20	0.41	**0.032**	4.61	**0.72**	0.00016	0.0020	0.050	**0.000042**	0.000006	<0.05	**0.00089**	41	0.00036	**0.00340**	**0.0053**	**0.71**	**0.0093**	0.0048	13	0.212
7/6/2012	<0.20	0.24	0.010	4.73	**0.81**	0.00012	0.0011	0.051	**0.000049**	<0.0000050	<0.05	**0.00089**	47	0.00019	**0.00415**	**0.0060**	0.33	0.0006	**0.0064**	15	0.171
8/5/2012	<0.20	0.39	0.005	4.11	**0.41**	0.00009	0.0011	0.051	**0.000021**	<0.0000050	<0.05	**0.00064**	49	0.00010	**0.00265**	**0.0036**	0.21	0.0003	**0.0059**	16	0.138
9/23/2012	<0.20	0.22	0.005	3.58	**0.37**	0.00010	0.0014	0.057	**0.000020**	<0.0000050	<0.05	**0.00083**	54	<0.00010	**0.00368**	**0.0031**	0.21	0.0004	**0.0068**	17	0.201
10/13/2012	<0.20	0.26	0.006	4.24	0.14	0.00010	0.0014	0.062	<0.000010	<0.0000050	<0.05	**0.00044**	61	<0.00010	**0.00152**	0.0018	0.23	0.0007	**0.0054**	17	0.125
11/17/2012	<0.20	0.43	0.006	3.36	**0.17**	0.00013	0.0017	0.076	<0.000010	<0.0000050	<0.05	**0.00083**	67	<0.00010	**0.00230**	0.0025	0.25	0.0014	**0.0061**	**20**	0.204
12/8/2012	0.11	0.24	0.004	2.70	0.05	0.00014	0.0021	**0.091**	<0.000010	<0.0000050	<0.05	**0.00057**	71	<0.00010	**0.00112**	0.0012	0.25	0.0008	**0.0056**	**22**	0.202
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	15	15	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	0.20	0.30	0.006	4.13	0.146	0.00014	0.0018	0.067	0.000010	0.000005	< 0.05	0.000623	61.9	0.00020	0.002025	0.00238	0.243	0.00140	0.0060	18.7	0.1720
mean	0.17	0.36	0.012	4.82	0.268	0.00016	0.0028	0.068	0.000017	0.000005	< 0.05	0.000650	58.1	0.00021	0.002022	0.00275	0.333	0.00249	0.0056	18.1	0.1759
standard deviation	0.06	0.18	0.014	2.62	0.265	0.00006	0.0021	0.018	0.000013	0.000000	0.00	0.000293	16.5	0.00014	0.001186	0.00161	0.265	0.00323	0.0016	4.7	0.0754
minimum	0.08	0.17	0.003	2.70	0.015	0.00009	0.0011	0.050	< 0.000010	< 0.000005	< 0.05	0.000014	33.8	< 0.00010	0.000066	0.00032	0.068	0.00029	0.0022	10.1	0.0255
maximum	0.32	0.88	0.060	12.20	0.845	0.00033	0.0080	0.122	0.000049	0.000006	< 0.05	0.001120	100.0	0.00060	0.004150	0.00602	1.210	0.01030	0.0089	30.6	0.3080
# < detection limit	8	0	0	0	0	0	0	0	9	16	18	0	0	6	0	0	0	0	0	0	0
% < detection limit	53%	0%	0%	0%	0%	0%	0%	0%	50%	89%	100%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%
# > background	1	3	2	2	8	0	5	3	6	0	0	16	0	0	16	7	4	3	14	10	3
% > background	7%	20%	11%	11%	44%	0%	28%	17%	33%	0%	0%	89%	0%	0%	89%	39%	22%	17%	78%	56%	17%
# > guideline	0				14		2				0	16		0		9	1	3			0
% > guideline	0%				78%		11%				0%	89%		0%		50%	6%	17%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.9: Water quality concentrations for KV-2, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/9/2011	<0.00001	**0.0013**	**0.0326**	0.007	**1.19**	0.00090	**4.33**	<0.000005	**4.03**	0.35	57	<0.000002	0.00002	<0.0005	0.0012	<0.0002	**0.175**	<0.0001
5/27/2011	<0.00001	**0.0015**	**0.0018**	0.014	**0.95**	0.00007	0.96	0.000006	**2.72**	0.17	13	<0.000002	<0.00001	<0.0005	0.0002	<0.0002	0.004	<0.0001
7/12/2011	<0.00001	**0.0013**	0.0010	0.015	**0.72**	0.00006	0.59	<0.000005	**3.83**	0.20	13	<0.000002	<0.00001	<0.0005	0.0001	<0.0002	0.001	<0.0001
10/29/2011	<0.00001	**0.0006**	**0.0201**	0.006	0.57	0.00056	2.30	0.000017	1.90	0.22	37	<0.000002	**0.00045**	<0.0005	0.0009	<0.0002	**0.100**	<0.0001
11/23/2011	<0.00001	**0.0007**	**0.0197**	0.006	**0.70**	0.00058	2.90	0.000009	**2.29**	0.23	38	0.000003	0.00004	<0.0005	0.0010	<0.0002	**0.098**	<0.0001
12/15/2011	<0.00001	**0.0006**	**0.0200**	0.003	0.61	0.00061	2.70	<0.000005	**2.22**	0.23	34	<0.000002	0.00004	<0.0005	0.0009	<0.0002	**0.100**	<0.0001
1/14/2012	<0.00001	**0.0007**	**0.0168**	0.010	**0.69**	0.00068	3.30	<0.000005	**2.32**	0.22	43	<0.000002	<0.0002	<0.0005	0.0009	<0.0002	**0.094**	<0.0001
2/10/2012	<0.00001	**0.0006**	**0.0233**	0.017	**0.77**	0.00060	3.10	0.000007	**2.63**	0.24	39	<0.000002	<0.0002	0.0014	0.0010	<0.0002	**0.151**	<0.0001
3/19/2012	<0.00001	**0.0008**	**0.0169**	0.006	**0.86**	0.00060	2.90	0.000008	**2.70**	0.24	35	<0.000002	<0.0002	<0.0005	0.0009	<0.0002	**0.096**	<0.0001
4/5/2012	<0.00001	**0.0008**	**0.0179**	0.005	**1.19**	0.00058	3.00	<0.000005	**2.83**	0.23	40	<0.000002	<0.0002	<0.0005	0.0009	<0.0002	**0.093**	<0.0001
5/3/2012	<0.00001	**0.0004**	**0.0156**	**0.053**	**0.77**	0.00035	2.24	**0.000057**	1.09	0.12	17	0.000006	<0.00020	**0.0086**	0.0007	**0.0008**	**0.149**	**0.0003**
6/4/2012	<0.00001	**0.0004**	**0.0212**	**0.024**	0.49	0.00047	2.08	0.000040	1.15	0.16	23	0.000007	<0.00020	0.0044	0.0007	0.0005	**0.127**	0.0001
7/6/2012	<0.00001	**0.0004**	**0.0287**	0.007	0.37	0.00060	2.26	0.000006	1.32	0.18	28	0.000004	<0.00020	0.0026	0.0008	0.0003	**0.152**	<0.0001
8/5/2012	<0.00001	**0.0005**	**0.0203**	0.002	0.38	0.00057	1.89	<0.000005	1.38	0.19	30	<0.0000020	<0.00020	<0.0005	0.0007	<0.0002	**0.096**	<0.0001
9/23/2012	<0.00001	**0.0005**	**0.0242**	0.003	0.52	0.00051	2.04	<0.000005	1.65	0.21	37	<0.0000020	<0.00020	<0.0005	0.0009	<0.0002	**0.119**	<0.0001
10/13/2012	<0.00001	**0.0005**	**0.0135**	0.004	0.61	0.00060	2.30	<0.000005	1.70	0.23	35	<0.0000020	<0.00020	<0.0005	0.0010	<0.0002	**0.070**	<0.0001
11/17/2012	<0.00001	**0.0006**	**0.0229**	0.006	**0.71**	0.00065	2.78	<0.000005	**2.27**	0.24	39	0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.130**	<0.0001
12/8/2012	<0.00001	**0.0008**	**0.0173**	0.003	**0.79**	0.00066	3.26	<0.000005	**2.99**	0.25	41	0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.103**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	< 0.00001	0.00062	0.01985	0.006	0.71	0.00059	2.50	0.000005	2.28	0.224	36	0.000002	0.00020	0.0005	0.0009	0.0002	0.0997	0.0001
mean	< 0.00001	0.00071	0.01854	0.011	0.72	0.00054	2.50	0.000011	2.28	0.216	33	0.000003	0.00017	0.0013	0.0008	0.0003	0.1032	0.0001
standard deviation	0	0.00033	0.00775	0.012	0.23	0.00020	0.86	0.000014	0.84	0.048	11	0.000002	0.00011	0.0021	0.0003	0.0001	0.0454	0.0001
minimum	< 0.00001	0.00036	0.00103	0.002	0.37	0.00006	0.59	< 0.000005	1.09	0.115	13	< 0.000002	< 0.00001	< 0.0005	0.0001	< 0.0002	0.0014	< 0.0001
maximum	< 0.00001	0.00153	0.03260	0.053	1.19	0.00090	4.33	0.000057	4.03	0.347	57	0.000007	0.00045	0.0086	0.0012	0.0008	0.1750	0.0003
# < detection limit	18	0	0	0	0	0	0	10	0	0	0	12	14	14	0	15	0	16
% < detection limit	100%	0%	0%	0%	0%	0%	0%	56%	0%	0%	0%	67%	78%	78%	0%	83%	0%	89%
# > background	0	18	17	2	11	0	1	1	11	0	0	0	1	1	0	1	16	1
% > background	0%	100%	94%	11%	61%	0%	6%	6%	61%	0%	0%	0%	6%	6%	0%	6%	89%	6%
# > guideline	0	0	0			0		0				0			0		16	
% > guideline	0%	0%	0%			0%		0%				0%			0%		89%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.10: Water quality concentrations for KV-3, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
5/12/2011		7.72	7.80	145		283	1				17	148	151				60		
7/14/2011		8.09	7.98		331	335	**16**				5	171	175				78		
10/23/2011	4,291	8.14	8.04		423	410	1	11.27	81	268	4	199	210				85		<0.005
11/25/2011		8.23	8.17			476	0	**9.09**	**62**		<1	250	260				104		<0.005
12/16/2011		7.47	7.96		466	463	0	**9.39**	**64**		3	237	256				99		<0.005
1/14/2012		7.30	7.91		461	482	0	**9.00**	**62**	299	<1	253	250				102		<0.005
2/15/2012		7.50	8.16		506	506	0	**9.77**	**67**	41	<1	256	294				110		<0.005
3/15/2012		7.51	8.24		509	499	0	**9.75**	**67**	41	<1	246	255				109		<0.050
4/8/2012		7.88	8.15		544	504	0	**10.01**	**69**	102	<1	250	261				119		<0.005
5/4/2012		7.80	8.15		511	258	0				**40**	133	126				52		<0.050
6/7/2012	9,281	7.92	8.08		336	299	**11**	10.40	90	299	**24**	156	159				74		<0.050
7/7/2012		8.10	8.16		377	344	**15**	**8.18**	81	113	8	180	163				81		<0.050
8/3/2012	7,539	8.18	8.16		354	351	**14**	**9.70**	96	281	2	190	186				80		<0.050
9/22/2012	3,584	7.90	8.12			405	**5**	11.70	93	93	4	209	205				100		<0.050
10/12/2012	2,576	7.28	8.28		485	431	0	12.28	84	137	4	209	215				103		<0.050
11/24/2012		7.53	8.22		540	482	0	11.60	78	56	2	261	259				119		<0.050
12/8/2012		**6.97**	8.21		595	527	0	10.36	**71**		2	271	262				119		<0.005
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	5	17	17	1	14	17	17	14	14	11	17	17	17	0	0	0	17	0	15
median	4291	7.80	8.15	145	476	431	0.0	9.89	75	113.2	3	209	215	-	-	-	100	-	< 0.050
mean	5454	7.74	8.11	145	460	415	3.8	10.18	76	157.2	7	213	217	-	-	-	94	-	< 0.029
standard deviation	2834	0.37	0.13	-	84	87	6.1	1.17	12	107.2	11	44	50	-	-	-	20	-	0.023
minimum	2576	6.97	7.80	145	331	258	-0.1	8.18	62	40.5	< 1	133	126	-	-	-	52	-	< 0.005
maximum	9281	8.23	8.28	145	595	527	16.0	12.28	96	299.3	40	271	294	-	-	-	119	-	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	5	0	0	-	-	-	0	-	15
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	29%	0%	0%	-	-	-	0%	-	100%
# > background		1	0	0	0	0	5	8	7	0	2	0	0	-	-	-	0	-	0
% > background		6%	0%	0%	0%	0%	29%	57%	50%	0%	12%	0%	0%	-	-	-	0%	-	0%
# > guideline		0	0					4			1					-		-	0
% > guideline		0%	0%					29%			6%					-		-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.10: Water quality concentrations for KV-3, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
5/12/2011					**0.52**	0.00017	0.0028	0.046	**0.000020**	0.000005	<0.05	**0.00066**	40	0.00050	**0.00190**	**0.0038**	**0.68**	**0.0081**	0.0033	12	0.215
7/14/2011					**0.65**	0.00014	0.0015	0.050	**0.000030**	<0.000005	<0.05	**0.00070**	44	0.00030	**0.00274**	**0.0048**	0.24	0.0018	**0.0059**	15	0.151
10/23/2011	0.05	0.15	0.007	4.20	**0.24**	0.00013	0.0017	0.064	<0.000010	<0.000005	<0.05	**0.00054**	54	0.00010	**0.00221**	0.0025	0.29	0.0023	0.0044	16	0.182
11/25/2011	0.077	0.29	<0.0020	4.29	0.09	0.00011	0.0014	0.074	<0.000010	<0.000005	<0.05	**0.00051**	66	0.00020	**0.00144**	0.0019	0.19	0.0007	**0.0063**	**21**	0.170
12/16/2011	0.08	0.16	0.004	3.34	0.15	0.00011	0.0017	0.075	<0.000010	<0.000005	<0.05	**0.00055**	63	<0.00010	**0.00137**	0.0022	0.26	0.0009	**0.0056**	**20**	0.158
1/14/2012	0.10	0.30	0.004	3.19	0.08	0.00010	0.0018	0.081	0.000010	<0.000005	<0.05	**0.00064**	69	<0.00010	**0.00107**	0.0015	0.22	0.0007	**0.0059**	**20**	0.164
2/15/2012	0.12	0.27	**0.028**	3.86	0.06	0.00011	0.0016	0.079	<0.000010	<0.000005	<0.05	**0.00047**	68	0.00020	**0.00094**	0.0019	0.20	0.0011	**0.0055**	**21**	0.152
3/15/2012	<0.20	0.37	0.004	3.60	0.05	0.00011	0.0016	0.072	<0.000010	<0.000005	<0.05	**0.00045**	65	<0.00010	**0.00067**	0.0010	0.19	0.0005	**0.0058**	**20**	0.124
4/8/2012	0.13	0.14	0.002	2.21	0.04	0.00009	0.0017	0.082	<0.000010	<0.000005	<0.05	**0.00053**	66	<0.00010	**0.00064**	0.0013	0.18	0.0005	**0.0057**	**20**	0.117
5/4/2012	<0.20	**0.56**	**0.055**	**11.90**	**0.71**	0.00021	**0.0043**	0.057	**0.000027**	**0.000007**	<0.05	**0.00082**	36	0.00046	**0.00264**	**0.0049**	**1.22**	**0.0107**	0.0029	10	**0.264**
6/7/2012	<0.20	0.40	**0.035**	5.70	**1.05**	0.00019	0.0025	0.053	**0.000060**	0.0000051	<0.05	**0.00102**	41	0.00036	**0.00448**	**0.0076**	**0.80**	**0.0065**	**0.0062**	13	**0.253**
7/7/2012	<0.20	0.26	0.008	4.41	**0.63**	0.00029	0.0013	0.054	**0.000034**	<0.000005	<0.05	**0.00076**	49	0.00017	**0.00293**	**0.0049**	0.28	0.0019	**0.0062**	14	0.150
8/3/2012	<0.20	0.36	0.004	4.29	**0.36**	0.00011	0.0014	0.053	**0.000021**	<0.000005	<0.05	**0.00056**	51	<0.00010	**0.00189**	**0.0034**	0.22	0.0005	**0.0058**	15	0.123
9/22/2012	<0.20	0.20	0.008	3.85	**0.33**	0.00012	0.0019	0.061	**0.000017**	<0.000005	<0.05	**0.00083**	55	<0.00010	**0.00347**	**0.0030**	0.27	0.0019	**0.0065**	17	0.208
10/12/2012	<0.20	0.26	0.006	2.45	**0.25**	0.00013	0.0018	0.068	**0.000016**	<0.000005	<0.05	**0.00066**	55	0.00016	**0.00317**	**0.0030**	0.28	0.0017	**0.0059**	17	0.208
11/24/2012	<0.20	0.31	0.006	3.07	0.11	0.00017	0.0016	0.082	<0.000010	<0.000005	<0.05	**0.00068**	69	0.00022	**0.00195**	0.0024	0.28	**0.0065**	**0.0062**	**21**	0.205
12/8/2012	0.11	0.22	0.005	3.08	0.05	0.00015	0.0021	**0.094**	<0.000010	<0.000005	<0.05	**0.00059**	71	<0.00010	**0.00106**	0.0015	0.28	0.0023	**0.0055**	**23**	0.224
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	15	15	15	15	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
median	0.20	0.27	0.0059	3.85	0.239	0.00013	0.0017	0.068	0.000010	0.000005	< 0.05	0.000639	55.1	0.00016	0.001900	0.00248	0.268	0.00176	0.0058	17.4	0.170
mean	0.15	0.28	0.0118	4.23	0.315	0.00014	0.0019	0.067	0.000019	0.000005	< 0.05	0.000646	56.6	0.00020	0.002034	0.00302	0.356	0.00286	0.0055	17.4	0.180
standard deviation	0.06	0.11	0.0153	2.29	0.298	0.00005	0.0007	0.014	0.000013	0.000000	0.00	0.000148	11.6	0.00013	0.001083	0.00173	0.280	0.00310	0.0010	3.7	0.044
minimum	0.05	0.14	< 0.0020	2.21	0.044	0.00009	0.0013	0.046	< 0.000010	< 0.000005	< 0.05	0.000451	36.1	0.00010	0.000638	0.00099	0.179	0.00048	0.0029	10.3	0.117
maximum	0.20	0.56	0.0553	11.90	1.050	0.00029	0.0043	0.094	0.000060	0.000007	< 0.05	0.001020	71.4	0.00050	0.004480	0.00761	1.220	0.01070	0.0065	22.6	0.264
# < detection limit	8	0	1	0	0	0	0	0	8	14	17	0	0	7	0	0	0	0	0	0	0
% < detection limit	53%	0%	7%	0%	0%	0%	0%	0%	47%	82%	100%	0%	0%	41%	0%	0%	0%	0%	0%	0%	0%
# > background	0	1	3	1	9	0	1	1	8	1	0	17	0	0	17	8	3	4	14	8	2
% > background	0%	7%	20%	7%	53%	0%	6%	6%	47%	6%	0%	100%	0%	0%	100%	47%	18%	24%	82%	47%	12%
# > guideline	0				11		0				0	17		0		9	1	4			0
% > guideline	0%				65%		0%				0%	100%		0%		53%	6%	24%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.10: Water quality concentrations for KV-3, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
5/12/2011	<0.00001	**0.0004**	**0.0135**	**0.026**	**0.73**	0.00031	2.24	0.000029	1.14	0.14	20	0.000005	0.00002	0.0022	0.0007	0.0004	**0.095**	<0.0001
7/14/2011	<0.00001	**0.0004**	**0.0222**	0.006	0.38	0.00042	1.85	<0.000005	1.26	0.18	28	0.000003	<0.00001	0.0039	0.0007	0.0002	**0.098**	<0.0001
10/23/2011	<0.00001	**0.0005**	**0.0167**	0.007	0.52	0.00051	2.20	0.000021	1.57	0.22	31	<0.000002	<0.00001	0.0009	0.0009	<0.0002	**0.084**	<0.0001
11/25/2011	<0.00001	**0.0007**	**0.0190**	0.006	**0.67**	0.00053	2.90	0.000008	**2.32**	0.23	36	<0.000002	0.00013	<0.0005	0.0009	<0.0002	**0.090**	<0.0001
12/16/2011	<0.00001	**0.0007**	**0.0188**	<0.002	0.61	0.00054	2.70	0.000005	**2.27**	0.23	34	0.000002	0.00003	<0.0005	0.0009	<0.0002	**0.094**	<0.0001
1/14/2012	<0.00001	**0.0008**	**0.0165**	0.005	**0.73**	0.00061	3.30	<0.000005	**2.51**	0.24	44	<0.000002	<0.0002	<0.0005	0.0009	<0.0002	**0.084**	<0.0001
2/15/2012	<0.00001	**0.0008**	**0.0175**	0.004	**0.80**	0.00053	3.10	<0.000005	**2.72**	0.23	39	<0.000002	<0.0002	0.0005	0.0009	<0.0002	**0.089**	<0.0001
3/15/2012	<0.00001	**0.0008**	**0.0152**	0.003	**0.69**	0.00056	2.80	<0.000005	**2.59**	0.23	35	<0.000002	<0.0002	<0.0005	0.0009	<0.0002	**0.076**	<0.0001
4/8/2012	<0.00001	**0.0008**	**0.0166**	0.003	**0.75**	0.00053	3.00	<0.000005	**2.68**	0.23	39	<0.000002	<0.0002	<0.0005	0.0009	<0.0002	**0.077**	<0.0001
5/4/2012	<0.00001	**0.0004**	**0.0133**	**0.043**	**0.78**	0.00030	2.35	**0.000076**	1.10	0.12	16	0.000005	<0.00020	**0.0085**	0.0008	**0.0007**	**0.120**	0.0002
6/7/2012	<0.00001	**0.0004**	**0.0281**	**0.024**	0.47	0.00056	2.28	**0.000056**	1.14	0.16	26	0.0000053	<0.00020	0.0040	0.0007	**0.0007**	**0.161**	0.0001
7/7/2012	<0.00001	**0.0004**	**0.0235**	0.002	0.37	0.00062	2.22	0.000013	1.27	0.18	26	0.000004	<0.00020	0.0009	0.0007	0.0002	**0.113**	<0.0001
8/3/2012	<0.00001	**0.0005**	**0.0174**	<0.002	0.38	0.00054	1.89	<0.000005	1.36	0.19	29	<0.000002	<0.00020	<0.0005	0.0008	<0.0002	**0.077**	<0.0001
9/22/2012	<0.00001	**0.0005**	**0.0238**	0.004	0.52	0.00048	2.05	<0.000005	1.65	0.21	37	<0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.117**	<0.0001
10/12/2012	<0.00001	**0.0006**	**0.0227**	0.006	0.59	0.00044	2.13	<0.000005	1.70	0.22	38	0.0000020	**0.00045**	0.0007	0.0009	<0.0002	**0.104**	<0.0001
11/24/2012	<0.00001	**0.0007**	**0.0240**	0.004	**0.70**	0.00055	2.91	0.000007	**2.50**	0.25	40	0.0000030	<0.00020	<0.0005	0.0010	<0.0002	**0.123**	<0.0001
12/8/2012	<0.00001	**0.0008**	**0.0168**	0.003	**0.79**	0.00054	3.25	0.000006	**3.00**	0.25	41	0.000003	<0.00020	<0.0005	0.0009	<0.0002	**0.100**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
median	< 0.00001	0.00056	0.01750	0.004	0.67	0.00053	2.35	0.000005	1.70	0.223	35	0.000002	0.00020	0.0005	0.0009	0.0002	0.0947	0.0001
mean	< 0.00001	0.00059	0.01915	0.009	0.62	0.00050	2.54	0.000015	1.93	0.206	33	0.000003	0.00017	0.0015	0.0008	0.0003	0.1001	0.0001
standard deviation	0.00000	0.00016	0.00417	0.011	0.15	0.00009	0.48	0.000020	0.67	0.038	8	0.000001	0.00011	0.0021	0.0001	0.0002	0.0217	0.0000
minimum	< 0.00001	0.00039	0.01330	0.002	0.37	0.00030	1.85	< 0.000005	1.10	0.121	16	< 0.000002	< 0.00001	< 0.0005	0.0007	< 0.0002	0.0761	< 0.0001
maximum	< 0.00001	0.00084	0.02810	0.043	0.80	0.00062	3.30	0.000076	3.00	0.249	44	0.000005	0.00045	0.0085	0.0010	0.0007	0.1610	0.0002
# < detection limit	17	0	0	2	0	0	0	8	0	0	0	8	13	9	0	12	0	15
% < detection limit	100%	0%	0%	12%	0%	0%	0%	47%	0%	0%	0%	47%	76%	53%	0%	71%	0%	88%
# > background	0	17	17	3	9	0	0	2	8	0	0	0	1	1	0	2	17	0
% > background	0%	100%	100%	18%	53%	0%	0%	12%	47%	0%	0%	0%	6%	6%	0%	12%	100%	0%
# > guideline	0	0	0			0		0				0			0		17	
% > guideline	0%	0%	0%			0%		0%				0%			0%		100%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.11: Water quality concentrations for KV-4, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011		8.32	7.92	**310**		533	0				<1	263	278				120		
5/12/2011		7.89	7.84	135		243	1				5	120	115				60		
7/14/2011		8.03	8.15		352	362	**16**				4	184	187				83		
10/23/2011	5,507	8.04	8.06		603	583	0	10.70	83	283	1	316	301				127		<0.005
11/25/2011		7.96	8.18			505	0	**9.08**	**63**		<1	263	277				111		<0.005
12/16/2011		7.45	7.89		475	470	0	**9.45**	**65**		1	239	240				100		<0.005
1/14/2012		7.29	8.13		431	490	0	**9.20**	**63**	312	2	242	235				112		<0.005
2/15/2012		7.54	8.21		517	517	0	**9.78**	**67**	30	3	264	304				113		<0.005
3/15/2012		7.59	8.25		511	505	0	**9.79**	**67**	54	<1	248	254				112		<0.050
4/8/2012		7.85	8.15		547	507	0			101	1	251	257				119		<0.005
5/4/2012		7.63	8.06		597	248	0				**24**	131	123				51		<0.005
6/7/2012		7.97	8.08		350	313	**11**	11.00	100	301	18	162	163				75		<0.050
7/7/2012		8.05	8.23		402	366	**15**	**9.62**	95	113	5	194	197				88		<0.050
8/3/2012	7,852	8.14	8.08		379	372	**14**	**10.00**	97	289	3	204	193				84		<0.050
9/22/2012	4,504	7.85	8.17			447	**5**	11.28	89	94	2	235	233				109		<0.050
10/12/2012	2,908	7.30	8.22		511	458	0	12.53	86	133	2	231	232				104		<0.050
11/24/2012		7.68	8.15		517	491	0	11.40	79	64	1	258	260				114		<0.050
12/8/2012		**7.02**	8.13		601	531	0	**9.91**	**68**		2	272	265				125		<0.005
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	4	18	18	2	14	18	18	13	13	11	18	18	18	0	0	0	18	0	15
median	5006	7.85	8.14	223	511	480	0.1	9.91	79	113.0	2	241	238	-	-	-	110	-	< 0.005
mean	5193	7.76	8.11	223	485	441	3.5	10.29	79	161.3	4	227	229	-	-	-	100	-	< 0.026
standard deviation	2071	0.34	0.12	124	90	100	5.9	1.02	14	110.9	6	51	55	-	-	-	22	-	0.023
minimum	2908	7.02	7.84	135	350	243	-0.1	9.08	63	30.1	1	120	115	-	-	-	51	-	< 0.005
maximum	7852	8.32	8.25	310	603	583	15.7	12.53	100	312.1	24	316	304	-	-	-	127	-	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	3	0	0	-	-	-	0	-	15
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	-	-	-	0%	-	100%
# > background		1	0	1	0	0	5	8	6	0	1	0	0	-	-	-	0	-	0
% > background		6%	0%	50%	0%	0%	28%	62%	46%	0%	6%	0%	0%	-	-	-	0%	-	0%
# > guideline		0	0					3			0					-		-	0
% > guideline		0%	0%					23%			0%					-		-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.11: Water quality concentrations for KV-4, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011					0.042	0.00015	0.0015	**0.094**	<0.000010	<0.000005	<0.05	**0.00061**	71	0.00030	**0.00115**	0.0012	0.19	0.0008	**0.0061**	**21**	0.192
5/12/2011					0.036	**0.00178**	**0.0038**	0.020	<0.000010	<0.000005	<0.05	**0.00122**	34	0.00050	0.00017	**0.0047**	0.34	**0.0716**	0.0017	9	0.199
7/14/2011					**0.491**	0.00042	0.0017	0.047	**0.000020**	<0.000005	<0.05	**0.00064**	49	0.00030	**0.00217**	**0.0042**	0.20	0.0028	0.0052	15	0.124
10/23/2011	0.08	0.09	<0.0050	4.60	0.022	0.00075	0.0019	0.063	<0.000010	<0.000005	<0.05	**0.00042**	91	<0.00010	0.00019	0.0011	0.14	**0.0068**	0.0045	**22**	0.084
11/25/2011	0.10	0.30	<0.0020	3.64	0.084	0.00025	0.0013	0.076	<0.000010	<0.000005	<0.05	**0.00044**	70	0.00020	**0.00110**	0.0017	0.16	0.0016	0.0053	**22**	0.142
12/16/2011	0.09	0.15	0.003	3.53	0.097	0.00012	0.0015	0.076	<0.000010	<0.000005	<0.05	**0.00053**	64	<0.00010	**0.00122**	0.0018	0.19	0.0006	**0.0054**	**20**	0.148
1/14/2012	0.10	0.21	0.004	3.01	0.075	0.00013	0.0018	0.076	<0.000010	<0.000005	<0.05	**0.00061**	66	<0.00010	**0.00093**	0.0016	0.21	0.0011	0.0053	**19**	0.153
2/15/2012	0.12	0.16	0.005	2.44	0.051	0.00014	0.0016	0.080	<0.000010	<0.000005	<0.05	**0.00047**	71	<0.00010	**0.00079**	0.0016	0.20	0.0016	0.0049	**21**	0.149
3/15/2012	<0.20	0.29	0.003	3.05	0.044	0.00012	0.0016	0.072	<0.000010	<0.000005	<0.05	**0.00045**	65	<0.00010	**0.00065**	0.0010	0.18	0.0006	**0.0057**	**21**	0.125
4/8/2012	0.12	0.17	0.003	2.52	0.044	0.00011	0.0016	**0.084**	<0.000010	<0.000005	<0.05	**0.00057**	66	<0.00010	**0.00066**	0.0014	0.18	0.0006	**0.0056**	**21**	0.120
5/4/2012	0.03	**0.61**	**0.041**	**14.80**	**0.393**	0.00078	**0.0047**	0.042	**0.000024**	0.000005	<0.05	**0.00125**	36	0.00030	**0.00149**	**0.0052**	**0.87**	**0.0457**	0.0022	10	**0.283**
6/7/2012	<0.20	0.27	0.023	4.97	**0.891**	0.00029	0.0021	0.050	**0.000046**	<0.000005	<0.05	**0.00088**	43	0.00024	**0.00383**	**0.0055**	**0.61**	0.0046	**0.0058**	13	0.205
7/7/2012	<0.20	0.24	0.008	4.34	**0.558**	0.00028	0.0016	0.053	**0.000034**	<0.000005	<0.05	**0.00075**	52	0.00015	**0.00261**	**0.0053**	0.27	0.0018	**0.0065**	16	0.146
8/3/2012	<0.20	0.35	0.005	4.85	**0.319**	0.00021	0.0015	0.054	**0.000016**	<0.000005	<0.05	**0.00056**	55	0.00011	**0.00173**	**0.0033**	0.20	0.0016	**0.0055**	16	0.115
9/22/2012	<0.20	<0.20	0.005	4.52	**0.231**	0.00030	0.0019	0.059	0.000012	<0.000005	<0.05	**0.00067**	63	<0.00010	**0.00250**	0.0023	0.21	0.0022	**0.0059**	**19**	0.160
10/12/2012	<0.20	0.26	0.006	3.23	**0.210**	0.00018	0.0016	0.064	0.000011	<0.000005	<0.05	**0.00060**	61	<0.00010	**0.00278**	0.0026	0.23	0.0014	**0.0057**	**19**	0.183
11/24/2012	<0.20	0.30	0.006	3.21	0.094	0.00014	0.0015	**0.084**	<0.000010	<0.000005	<0.05	**0.00062**	69	<0.00010	**0.00182**	0.0019	0.24	0.0013	**0.0058**	**21**	0.191
12/8/2012	0.10	0.17	0.004	2.57	0.045	0.00019	0.0020	**0.094**	<0.000010	<0.000005	<0.05	**0.00058**	72	<0.00010	**0.00102**	0.0014	0.26	0.0032	0.0052	**23**	0.213
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	15	15	15	15	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	0.12	0.24	0.005	3.53	0.089	0.00020	0.0016	0.068	0.000010	0.000005	< 0.05	0.000604	64.3	0.00010	0.001185	0.00188	0.205	0.00158	0.0055	19.5	0.1510
mean	0.14	0.25	0.008	4.35	0.207	0.00035	0.0019	0.066	0.000015	0.000005	< 0.05	0.000659	60.9	0.00017	0.001490	0.00266	0.270	0.00832	0.0051	18.1	0.1629
standard deviation	0.06	0.12	0.010	3.02	0.239	0.00041	0.0009	0.019	0.000010	0.000000	0.00	0.000238	14.1	0.00011	0.000977	0.00159	0.182	0.01891	0.0012	4.1	0.0464
minimum	0.03	0.09	0.002	2.44	0.022	0.00011	0.0013	0.020	< 0.000010	< 0.000005	< 0.05	0.000415	33.8	< 0.00010	0.000168	0.00098	0.142	0.00056	0.0017	8.7	0.0844
maximum	0.20	0.61	0.041	14.80	0.891	0.00178	0.0047	0.094	0.000046	0.000005	< 0.05	0.001250	90.9	0.00050	0.003830	0.00554	0.867	0.07160	0.0065	22.6	0.2830
# < detection limit	7	1	2	0	0	0	0	0	11	17	18	0	0	10	0	0	0	0	0	0	0
% < detection limit	47%	7%	13%	0%	0%	0%	0%	0%	61%	94%	100%	0%	0%	56%	0%	0%	0%	0%	0%	0%	0%
# > background	0	1	1	1	7	1	2	4	5	0	0	18	0	0	16	6	2	3	10	12	1
% > background	0%	7%	7%	7%	39%	6%	11%	22%	28%	0%	0%	100%	0%	0%	89%	33%	11%	17%	56%	67%	6%
# > guideline	0				7		0				0	18		0		7	0	5			0
% > guideline	0%				39%		0%				0%	100%		0%		39%	0%	28%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.11: Water quality concentrations for KV-4, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011	<0.00001	**0.0009**	**0.0182**	<0.002	**0.74**	0.00044	2.70	0.000007	**2.56**	0.26	38	<0.000002	<0.00001	<0.0005	0.0009	<0.0002	**0.089**	<0.0001
5/12/2011	<0.00001	0.0002	**0.0412**	0.019	**0.79**	0.00007	1.79	**0.000420**	0.71	0.08	18	0.000026	0.00005	0.0006	0.0002	<0.0002	**0.105**	<0.0001
7/14/2011	<0.00001	**0.0004**	**0.0177**	0.006	0.36	0.00036	1.98	0.000016	1.30	0.17	29	0.000005	<0.00001	0.0016	0.0006	<0.0002	**0.085**	<0.0001
10/23/2011	<0.00001	0.0003	**0.0017**	0.004	0.55	0.00025	3.00	**0.000061**	1.73	0.22	52	0.000009	<0.00001	<0.0005	0.0011	<0.0002	**0.033**	<0.0001
11/25/2011	<0.00001	**0.0006**	**0.0140**	0.005	0.64	0.00045	2.80	0.000008	**3.13**	0.22	40	0.000003	0.0001	<0.0005	0.0010	<0.0002	**0.073**	<0.0001
12/16/2011	<0.00001	**0.0006**	**0.0172**	<0.002	0.60	0.00054	2.70	<0.000005	**2.69**	0.23	34	<0.000002	0.00004	<0.0005	0.0008	<0.0002	**0.085**	<0.0001
1/14/2012	<0.00001	**0.0008**	**0.0150**	0.005	**0.69**	0.00060	3.20	<0.000005	**2.62**	0.21	44	<0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.078**	<0.0001
2/15/2012	<0.00001	**0.0007**	**0.0153**	0.002	**0.73**	0.00046	2.90	0.000014	**2.57**	0.22	40	<0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.079**	<0.0001
3/15/2012	<0.00001	**0.0008**	**0.0145**	0.003	**0.69**	0.00057	2.90	0.000005	**2.62**	0.23	35	<0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.076**	<0.0001
4/8/2012	<0.00001	**0.0008**	**0.0161**	<0.002	**0.75**	0.00051	2.90	<0.000005	**2.65**	0.24	39	<0.000002	<0.00020	0.0014	0.0009	<0.0002	**0.084**	<0.0001
5/4/2012	<0.00001	0.0002	**0.0081**	**0.034**	**0.76**	0.00030	2.12	**0.000238**	0.98	0.11	18	0.000018	<0.00020	0.0030	0.0005	0.0004	**0.117**	0.0001
6/7/2012	<0.00001	**0.0004**	**0.0245**	0.017	0.48	0.00045	2.20	0.000040	1.16	0.16	27	0.0000064	<0.00020	**0.0053**	0.0007	0.0004	**0.137**	0.0001
7/7/2012	<0.00001	**0.0004**	**0.0215**	0.008	0.37	0.00050	2.23	0.000017	1.39	0.19	32	0.0000041	0.00031	0.0020	0.0007	<0.0002	**0.110**	<0.0001
8/3/2012	<0.00001	**0.0005**	**0.0156**	0.003	0.36	0.00044	2.22	<0.000005	1.44	0.20	29	0.0000040	<0.00020	<0.0005	0.0008	<0.0002	**0.075**	<0.0001
9/22/2012	<0.00001	**0.0004**	**0.0169**	0.003	0.53	0.00035	2.29	0.000009	1.70	0.21	40	0.0000030	<0.00020	<0.0005	0.0009	<0.0002	**0.089**	<0.0001
10/12/2012	<0.00001	**0.0005**	**0.0199**	0.004	0.57	0.00046	2.32	0.000005	1.92	0.22	39	0.0000030	<0.00020	0.0005	0.0010	<0.0002	**0.094**	<0.0001
11/24/2012	<0.00001	**0.0007**	**0.0211**	0.004	0.66	0.00049	2.77	0.000005	**2.44**	0.24	38	0.000003	<0.00020	<0.0005	0.0009	0.00023	**0.111**	<0.0001
12/8/2012	<0.00001	**0.0009**	**0.0157**	0.003	**0.76**	0.00054	3.21	0.000005	**2.93**	0.24	40	0.000004	<0.00020	<0.0005	0.0009	<0.0002	**0.092**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	< 0.00001	0.00055	0.01650	0.004	0.65	0.00046	2.70	0.000008	2.18	0.219	38	0.000003	0.00020	0.0005	0.000891	0.0002	0.0869	0.0001
mean	< 0.00001	0.00056	0.01746	0.007	0.61	0.00043	2.57	0.000048	2.03	0.203	35	0.000006	0.00015	0.0011	0.000814	0.0002	0.0895	0.0001
standard deviation	0.00000	0.00022	0.00776	0.008	0.15	0.00013	0.43	0.000108	0.74	0.048	9	0.000006	0.00009	0.0012	0.000207	0.0001	0.0221	0.0000
minimum	< 0.00001	0.00017	0.00173	< 0.002	0.36	0.00007	1.79	< 0.000005	0.71	0.078	18	< 0.000002	< 0.00001	< 0.0005	0.000182	< 0.0002	0.0331	< 0.0001
maximum	< 0.00001	0.00093	0.04120	0.034	0.79	0.00060	3.21	0.000420	3.13	0.262	52	0.000026	0.00031	0.0053	0.001080	0.0004	0.1370	0.0001
# < detection limit	18	0	0	3	0	0	0	4	0	0	0	6	14	11	0	15	0	16
% < detection limit	100%	0%	0%	17%	0%	0%	0%	22%	0%	0%	0%	33%	78%	61%	0%	83%	0%	89%
# > background	0	15	18	1	8	0	0	3	9	0	0	0	0	1	0	0	18	0
% > background	0%	83%	100%	6%	44%	0%	0%	17%	50%	0%	0%	0%	0%	6%	0%	0%	100%	0%
# > guideline	0	0	0			0		2				0			0		18	
% > guideline	0%	0%	0%			0%		11%				0%			0%		100%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.12: Water quality concentrations for KV-5, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011		8.31	7.89	**495**		510	0.5				<1	236	254				110		
5/25/2011		7.79	7.72	138		180	**6.3**				**24**	89	90				33		
7/14/2011		8.09	7.92		324	325	**15.1**				15	173	168				71		
10/23/2011		**8.60**	8.09		422	410	1.0	11.40	87	124	4	200	212				76		<0.005
11/25/2011		8.00	8.13			468	-0.1	**9.14**	**63**		2	247	260				101		<0.005
12/16/2011		7.40	7.78		472	463	-0.1	**10.00**	**69**		2	241	245	**145**	**177**		93	**0.060**	<0.005
1/14/2012		7.47	8.14		459	488	0.0	**8.80**	**60**	271	2	243	266				95		<0.005
2/15/2012		7.48	8.19		500	501	-0.1	**10.03**	**69**	6	1	251	291				108		<0.005
3/15/2012		7.69	8.27		508	501	-0.1	**10.23**	**70**	17	1	250	253				103		<0.050
4/8/2012		7.75	8.10		536	504	0.0	10.89	74	62	1	249	263				103		<0.005
5/6/2012		7.92	7.89		214	214	1.9	13.36	97	89	**42**	123	111			0.8	44		<0.050
6/7/2012		7.93	8.06		338	299	**11.4**	10.80	99	296	**25**	152	162				65		<0.050
7/7/2012		8.09	8.22		384	348	**14.0**	**9.60**	93	124	9	191	162				76		<0.050
8/3/2012	8,170	8.01	8.20		364	361	**13.5**	10.40	100	246	7	193	191				77		<0.050
9/22/2012	4,656	7.93	8.18			414	**5.8**	11.82	95	99	4	217	204				88		<0.050
10/12/2012	4,088	7.34	8.28		501	444	-0.1	12.91	88	133	18	227	220				98		<0.050
11/24/2012		7.86	8.20		551	483	0.0	15.00	107	85	1	264	252				110		<0.050
12/8/2012		**6.89**	8.21		586	518	0.0	**9.99**	**69**		1	267	264				115		<0.005
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	3	18	18	2	14	18	18	15	15	12	18	18	18	1	1	1	18	1	15
median	4656	7.89	8.14	317	465	454	0.3	10.40	87	111.8	3	232	233	145	177	0.81	94	0.06	< 0.050
mean	5638	7.81	8.08	317	440	413	3.8	10.96	83	129.4	9	212	215	145	177	1	87	0	< 0.029
standard deviation	2211	0.39	0.17	252	104	104	5.7	1.70	16	94.8	12	50	57	-	-	-	23	-	< 0.023
minimum	4088	6.89	7.72	138	214	180	-0.1	8.80	60	5.5	< 1	89	90	145	177	1	33	0	< 0.005
maximum	8170	8.60	8.28	495	586	518	15.1	15.00	107	296.2	42	267	291	145	177	0.81	115	0.06	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	15
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	100%
# > background		2	0	1	0	0	6	7	6	0	3	0	0	1	1	0	0	1	0
% > background		11%	0%	50%	0%	0%	33%	47%	40%	0%	17%	0%	0%	100%	100%	0%	0%	100%	0%
# > guideline		0	0					2			1					0		1	0
% > guideline		0%	0%					13%			6%					0%		100%	0%

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light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.12: Water quality concentrations for KV-5, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011					0.03	0.00011	0.0023	**0.088**	<0.000010	<0.000005	<0.05	**0.00053**	61	0.00030	**0.00083**	0.0011	0.23	0.0008	0.0052	**20**	0.170
5/25/2011					**0.75**	0.00064	**0.0041**	0.054	**0.000030**	<0.000020	<0.05	**0.00029**	25	**0.00120**	**0.00100**	**0.0047**	**1.38**	**0.0075**	0.0025	6	0.088
7/14/2011					**0.54**	0.00030	**0.0036**	0.055	**0.000030**	<0.000005	<0.05	**0.00054**	47	0.00040	**0.00198**	**0.0044**	**0.44**	0.0019	0.0050	14	0.130
10/23/2011	0.05	0.09	0.008	4.50	**0.21**	0.00020	**0.0038**	0.067	0.000010	<0.000005	<0.05	**0.00042**	54	0.00010	**0.00164**	0.0021	0.32	0.0025	0.0047	16	0.164
11/25/2011	0.09	0.30	0.002	4.00	0.08	0.00016	**0.0036**	0.079	<0.000010	<0.000005	<0.05	**0.00041**	66	0.00020	**0.00100**	0.0017	0.28	0.0012	**0.0056**	**20**	0.151
12/16/2011	0.11	0.16	0.007	3.56	0.08	0.00013	**0.0039**	0.081	<0.000010	<0.000005	<0.05	**0.00042**	65	<0.00010	**0.00098**	0.0017	0.27	0.0007	0.0050	**20**	0.145
1/14/2012	0.13	0.19	0.007	3.27	0.06	0.00013	**0.0041**	**0.086**	<0.000010	<0.000005	<0.05	**0.00050**	67	<0.00010	**0.00069**	0.0012	0.27	0.0006	0.0048	**19**	0.143
2/15/2012	0.15	0.18	0.006	2.67	0.04	0.00013	**0.0038**	**0.084**	<0.000010	<0.000005	<0.05	**0.00045**	68	<0.00010	**0.00061**	0.0011	0.28	0.0013	0.0049	**20**	0.137
3/15/2012	<0.20	0.35	0.005	3.40	0.03	0.00013	**0.0037**	0.078	0.000010	<0.000005	<0.05	**0.00040**	66	0.00010	**0.00046**	0.0009	0.26	0.0009	0.0053	**21**	0.115
4/8/2012	0.16	0.17	0.004	1.92	0.03	0.00011	**0.0035**	**0.090**	<0.000010	<0.000005	<0.05	**0.00047**	68	0.00020	**0.00042**	0.0011	0.26	0.0006	0.0050	**20**	0.108
5/6/2012	**0.48**	<0.20	**0.064**	**14.00**	**0.42**	0.00034	**0.0084**	0.054	**0.000029**	**0.000007**	<0.05	**0.00060**	34	0.00053	**0.00179**	**0.0039**	**1.08**	**0.0139**	0.0025	9	0.239
6/7/2012	<0.20	0.34	**0.033**	5.12	**0.86**	0.00027	**0.0035**	0.055	**0.000050**	0.0000058	<0.05	**0.00073**	40	0.00034	**0.00304**	**0.0057**	**0.69**	0.0041	0.0053	13	0.182
7/7/2012	<0.20	0.28	0.012	4.72	**0.54**	0.00024	0.0034	0.057	**0.000026**	<0.000005	<0.05	**0.00060**	52	0.00016	**0.00248**	**0.0042**	0.37	0.0014	**0.0055**	15	0.138
8/3/2012	<0.20	0.36	0.011	5.00	**0.32**	0.00019	**0.0036**	0.059	**0.000021**	<0.000005	<0.05	**0.00047**	51	<0.00010	**0.00154**	**0.0033**	0.33	0.0014	0.0053	16	0.116
9/22/2012	<0.20	0.24	0.008	4.36	**0.25**	0.00021	**0.0040**	0.065	**0.000016**	<0.000005	<0.05	**0.00056**	58	<0.00010	**0.00224**	0.0023	0.29	0.0012	**0.0056**	17	0.161
10/12/2012	<0.20	0.31	0.019	2.38	**0.26**	0.00021	**0.0049**	0.070	**0.000020**	<0.000005	<0.05	**0.00064**	60	0.00011	**0.00295**	**0.0030**	**0.49**	0.0056	0.0054	**19**	0.231
11/24/2012	<0.20	0.29	0.006	4.40	0.08	0.00014	**0.0037**	**0.090**	<0.000050	<0.000025	<0.25	**0.00052**	71	<0.00050	**0.00146**	0.0017	0.33	0.0014	**0.0056**	**21**	0.188
12/8/2012	0.12	0.25	0.005	3.45	0.03	0.00016	0.0030	**0.101**	<0.000010	<0.000005	<0.05	**0.00051**	71	0.00012	**0.00082**	0.0011	0.31	0.0014	0.0050	**22**	0.201
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	15	15	15	15	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	0.20	0.25	0.0070	4.00	0.147	0.00018	0.0037	0.074	0.000013	0.000005	< 0.05	0.000500	60.5	0.00014	0.001230	0.00193	0.317	0.00139	0.0051	18.6	0.1480
mean	0.18	0.25	0.0131	4.45	0.257	0.00021	0.0039	0.073	0.000020	0.000007	< 0.06	0.000503	56.8	0.00026	0.001440	0.00251	0.437	0.00268	0.0049	17.0	0.1560
standard deviation	0.10	0.08	0.0160	2.81	0.264	0.00013	0.0012	0.015	0.000013	0.000006	< 0.05	0.000102	13.2	0.00027	0.000827	0.00151	0.313	0.00336	0.0009	4.3	0.0408
minimum	0.05	0.09	0.0020	1.92	0.029	0.00011	0.0023	0.054	< 0.000010	< 0.000005	< 0.05	0.000286	25.2	< 0.00010	0.000420	0.00094	0.226	0.00056	0.0025	6.2	0.0883
maximum	0.48	0.36	0.0643	14.00	0.863	0.00064	0.0084	0.101	0.000050	0.000025	< 0.25	0.000725	70.7	0.00120	0.003040	0.00574	1.380	0.01390	0.0056	21.9	0.2390
# < detection limit	7	1	0	0	0	0	0	0	8	16	18	0	0	6	0	0	0	0	0	0	0
% < detection limit	47%	7%	0%	0%	0%	0%	0%	0%	44%	89%	100%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%
# > background	1	0	2	1	9	0	15	6	9	3	1	18	0	1	18	7	5	2	4	10	0
% > background	7%	0%	13%	7%	50%	0%	83%	33%	50%	17%	6%	100%	0%	6%	100%	39%	28%	11%	22%	56%	0%
# > guideline	0				9		1				0	18		0		7	2	4			0
% > guideline	0%				50%		6%				0%	100%		0%		39%	11%	22%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.12: Water quality concentrations for KV-5, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011	<0.00001	**0.0010**	**0.0160**	<0.002	**0.76**	0.00041	2.54	<0.000005	**2.81**	0.24	34	<0.000002	<0.00001	<0.0005	0.0008	<0.0002	**0.077**	<0.0001
5/25/2011	0.00001	**0.0006**	**0.0084**	**0.033**	0.60	0.00027	2.28	**0.000093**	0.60	0.09	<50	0.000012	<0.00020	**0.0110**	0.0004	**0.0016**	**0.041**	**0.0004**
7/14/2011	<0.00001	**0.0004**	**0.0167**	0.017	0.49	0.00037	2.20	0.000009	1.33	0.18	25	0.000005	<0.00001	0.0024	0.0007	0.0004	**0.075**	0.0001
10/23/2011	<0.00001	**0.0006**	**0.0130**	0.009	0.53	0.00047	2.40	0.000017	1.62	0.22	30	0.000002	<0.00001	0.0008	0.0011	<0.0002	**0.063**	<0.0001
11/25/2011	<0.00002	**0.0007**	**0.0142**	0.006	**0.67**	0.00051	3.20	0.000007	**2.31**	0.24	34	<0.000002	0.00012	0.0006	0.0011	0.0002	**0.069**	<0.0001
12/16/2011	<0.00001	**0.0007**	**0.0147**	0.004	0.63	0.00052	3.00	<0.000005	**2.37**	0.24	32	<0.000002	0.00003	<0.0005	0.0010	<0.0002	**0.073**	<0.0001
1/14/2012	<0.00001	**0.0008**	**0.0120**	0.005	**0.71**	0.00058	3.70	<0.000005	**2.35**	0.24	39	<0.000002	<0.00020	<0.0005	0.0010	<0.0002	**0.060**	<0.0001
2/15/2012	<0.00001	**0.0008**	**0.0134**	0.004	**0.76**	0.00051	3.40	0.000014	**2.77**	0.24	35	<0.000002	<0.00020	<0.0005	0.0010	<0.0002	**0.066**	<0.0001
3/15/2012	<0.00001	**0.0009**	**0.0115**	0.005	**0.72**	0.00050	3.20	<0.000005	**2.84**	0.25	31	<0.000002	<0.00020	<0.0005	0.0009	<0.0002	**0.059**	<0.0001
4/8/2012	<0.00001	**0.0010**	**0.0124**	0.003	**0.72**	0.00050	3.30	<0.000005	**2.75**	0.25	35	<0.000002	<0.00020	<0.0005	0.0010	<0.0002	**0.058**	<0.0001
5/6/2012	<0.00001	0.0004	**0.0084**	**0.052**	**0.79**	0.00033	2.36	**0.000091**	0.98	0.12	16	0.000011	<0.00020	**0.0121**	0.0006	**0.0009**	**0.076**	**0.0003**
6/7/2012	<0.00001	**0.0005**	**0.0207**	**0.020**	0.51	0.00052	2.33	0.000041	1.21	0.16	24	0.0000057	<0.00020	0.0045	0.0007	0.0005	**0.118**	0.0002
7/7/2012	<0.00001	**0.0005**	**0.0192**	0.009	0.39	0.00053	2.45	0.000011	1.41	0.19	28	0.0000042	<0.00020	0.0028	0.0009	0.0003	**0.096**	<0.0001
8/3/2012	<0.00001	**0.0005**	**0.0146**	0.005	0.38	0.00045	2.28	<0.000005	1.49	0.20	27	0.0000030	<0.00020	0.0012	0.0009	<0.0002	**0.066**	<0.0001
9/22/2012	<0.00001	**0.0006**	**0.0168**	0.004	0.54	0.00049	2.34	<0.000005	1.76	0.22	34	<0.000002	<0.00020	0.0007	0.0010	<0.0002	**0.077**	<0.0001
10/12/2012	<0.00001	**0.0006**	**0.0198**	0.017	0.55	0.00056	2.61	0.000006	1.93	0.22	34	0.0000030	<0.00020	0.0021	0.0010	<0.0002	**0.095**	<0.0001
11/24/2012	<0.00005	**0.0008**	**0.0194**	<0.010	**0.73**	0.00075	3.24	<0.000025	**2.72**	0.25	35	<0.000010	<0.00100	<0.0025	0.0010	<0.0010	**0.099**	<0.0005
12/8/2012	<0.00001	**0.0010**	**0.0134**	0.004	**0.76**	0.00053	3.42	0.000006	**3.11**	0.26	36	0.000002	<0.00020	<0.0005	0.0010	<0.0002	**0.077**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	0.00001	0.00065	0.01440	0.006	0.65	0.00051	2.58	0.000007	2.12	0.230	34	0.000002	0.0002	0.0008	0.0010	0.0002	0.0737	0.0001
mean	0.00001	0.00068	0.01470	0.012	0.62	0.00049	2.79	0.000020	2.02	0.211	32	0.000004	0.00020	0.0025	0.0009	0.0004	0.0746	0.0002
standard deviation	0.00001	0.00022	0.00362	0.013	0.13	0.00010	0.50	0.000028	0.75	0.047	7	0.000003	0.00021	0.0035	0.0002	0.0004	0.0181	0.0001
minimum	< 0.00001	0.00035	0.00840	0.002	0.38	0.00027	2.20	< 0.000005	0.60	0.093	16	< 0.000002	< 0.00001	< 0.0005	0.0004	< 0.0002	0.0410	< 0.0001
maximum	0.00005	0.00102	0.02070	0.052	0.79	0.00075	3.70	0.000093	3.11	0.257	50	0.000012	0.001	0.0121	0.0011	0.0016	0.1180	0.0005
# < detection limit	17	0	0	2	0	0	0	8	0	0	1	9	16	8	0	12	0	14
% < detection limit	94%	0%	0%	11%	0%	0%	0%	44%	0%	0%	6%	50%	89%	44%	0%	67%	0%	78%
# > background	2	17	18	3	9	0	0	2	9	0	0	0	1	2	0	3	18	3
% > background	11%	94%	100%	17%	50%	0%	0%	11%	50%	0%	0%	0%	6%	11%	0%	17%	100%	17%
# > guideline	0	0	0			0		0				0			0		18	
% > guideline	0%	0%	0%			0%		0%				0%			0%		100%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.13: Water quality concentrations for KV-6, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	L/s	pH units	pH units	µS/cm	µS/cm	µS/cm	C	mg/L	%	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1/12/2011		7.85	7.59	**423**		**854**	0.0				2	**481**	**475**	**130**	**160**		**300**	**0.046**	<0.005
2/8/2011		8.11	7.82	258		**940**	0.0				1	**502**	**485**	**130**	**160**		**350**	**0.140**	<0.005
3/22/2011		7.73	7.61	**483**		**920**	0.5				2	**573**	**544**	**140**	**170**		**390**	**0.100**	<0.005
4/19/2011			7.69	**1127**		**955**	0.8				1	**564**	**566**	**130**	**160**		**380**	**0.089**	<0.005
5/25/2011	136	7.84	7.78	**446**		581	**12.1**				3	303	304	85	100		180		
6/22/2011	80	8.23	7.98	**588**		**829**	**10.5**				1	**470**	**464**	**100**	**120**		**290**	0.018	
7/13/2011	91	7.88	7.80		**730**	**748**	**12.8**				2	**407**	**418**	91	110		**270**	**0.043**	<0.005
8/17/2011	127	7.78	7.81		**772**	**788**	**8.1**				2	**444**	**441**	**110**	**130**		**280**		
9/24/2011	127	7.52	8.09		**842**	**848**	4.4				1	**447**	**451**	**120**	**150**		**289**	0.009	<0.005
10/29/2011	88	7.66	7.55		**970**	**929**	0.4	10.56	75	244	1	**511**	**527**	**120**	**150**		**356**	**0.063**	<0.050
11/21/2011	75	7.49	7.90			**896**	0.1	**9.64**	**66**		3	**497**	**493**	**133**	**162**		**342**	**0.035**	<0.005
12/14/2011	107	7.36	7.64		**913**	**906**	-0.1	12.78	87		4	**505**	**506**	**138**	**168**		**346**	**0.180**	<0.005
1/15/2012		7.30	7.59		**829**	**867**	0	11.10	76	283	2	**468**	**458**	**130**	**158**		**294**	**0.110**	<0.005
2/13/2012	77	7.21	8.04		**927**	**919**	-0.1	12.63	86	31	1	**525**	**545**	**139**	**170**		**329**	**0.130**	<0.005
3/11/2012	77	**7.10**	8.16		**938**	**914**	-0.1	13.14	90	293	1	**518**	**537**	**135**	**165**		**344**	**0.120**	<0.050
4/8/2012	62	7.69	7.77		**1022**	**927**	0.1	13.55	93	44	2	**483**	**502**	**131**	**159**		**312**	**0.120**	<0.005
5/1/2012	147	7.67	7.62		526	527	1.9	12.53	91	185	3	271	268	66	81	<0.50	196	**0.036**	<0.050
5/7/2012	105	7.93	7.75		507	539	2.3	13.33	97	221	3	281	288	76	93	1.1	185	**0.032**	<0.050
6/3/2012	89	7.92	7.97		**830**	**759**	**11**	14.70	134	344	<1	365	364	**98**	**120**	1.2	**278**	0.025	<0.050
7/4/2012	85	7.93	8.06		**875**	**883**	**13.1**	10.89	104	68	2	**545**	**459**	**96**	**118**	1.3	**353**	**0.059**	<0.050
8/1/2012	91	7.82	8.02		**960**	**866**	**12.9**	10.99	104	80	1	**502**	**420**	**106**	**129**	1	**341**	0.028	<0.050
9/23/2012	89	7.75	8.09		**1030**	**921**	**5.6**	11.12	89	75	2	**492**	**527**	**123**	**150**	1.2	**352**	0.012	<0.050
10/15/2012	76	7.56	8.03		**1056**	**941**	0.6	11.86	83	81	<1	**498**	**494**	**124**	**151**	1.2	**365**	**0.036**	<0.050
11/21/2012		8.00	8.06			**928**	0.1	12.00	82	**361**	3	**526**	**513**	**140**	**171**	**1.8**	**359**	**0.057**	<0.050
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	18	23	24	6	16	24	24	15	15	13	24	24	24	24	24	8	24	22	21
median	89	7.75	7.82	465	894	890	0.7	12.00	89	185.0	2	495	480	124	151	1.20	335	0.05	< 0.005
mean	96	7.71	7.85	554	858	841	4.0	12.05	91	177.7	2	466	460	116	142	1.16	312	0.07	< 0.026
standard deviation	24	0.28	0.19	300	162	126	5.2	1.35	16	119.9	1	83	82	22	27	0.36	59	0.05	< 0.023
minimum	62	7.10	7.55	258	507	527	-0.1	9.64	66	30.9	< 1	271	268	66	81	0.50	180	0.01	< 0.005
maximum	147	8.23	8.16	1127	1056	955	13.1	14.70	134	361.3	4	573	566	140	171	1.80	390	0.18	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	21
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	0%	0%	0%	13%	0%	0%	100%
# > background		1	0	5	14	21	8	1	1	1	0	20	20	20	20	1	21	17	0
% > background		4%	0%	83%	88%	88%	33%	7%	7%	8%	0%	83%	83%	83%	83%	13%	88%	77%	0%
# > guideline		0	0					0			0					0		19	0
% > guideline		0%	0%					0%			0%					0%		86%	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.13: Water quality concentrations for KV-6, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/12/2011	0.24			0.70	0.004	0.00021	**0.0047**	0.060	<0.000010	<0.000005	<0.05	**0.00080**	**150**	0.00060	**0.00124**	0.0002	0.25	**0.0066**	**0.0136**	**26**	**1.050**
2/8/2011	0.23		0.003	1.50	0.006	0.00020	**0.0075**	0.060	<0.000010	<0.000005	<0.05	**0.00073**	**161**	0.00030	**0.00165**	0.0001	0.40	**0.0080**	**0.0163**	**24**	**1.370**
3/22/2011	0.22		0.007	1.30	0.010	0.00019	**0.0087**	0.063	<0.000010	<0.000005	<0.05	**0.00065**	**183**	0.00040	**0.00166**	0.0003	**0.49**	0.0038	**0.0158**	**28**	**1.350**
4/19/2011	0.26		0.007	1.20	0.009	0.00021	**0.0082**	0.058	<0.000010	<0.000005	<0.05	**0.00074**	**180**	0.00050	**0.00160**	0.0004	0.40	0.0049	**0.0159**	**28**	**1.080**
5/25/2011			0.008	8.60	0.025	0.00040	**0.0058**	0.037	<0.000010	<0.000005	<0.05	**0.00189**	100	0.00030	**0.00035**	0.0011	0.36	**0.0081**	**0.0078**	13	**0.404**
6/22/2011			0.008	<0.50	0.008	0.00034	**0.0042**	0.055	<0.000010	<0.000005	<0.05	**0.00145**	**146**	0.00020	0.00016	0.0004	0.14	0.0044	**0.0118**	**26**	**0.288**
7/13/2011	<0.20		0.003	4.50	0.010	0.00038	**0.0050**	0.044	<0.000010	<0.000005	<0.05	**0.00147**	**127**	0.00030	0.00021	0.0006	0.18	**0.0060**	**0.0103**	**22**	**0.281**
8/17/2011			0.004	5.00	0.019	0.00032	**0.0049**	0.038	<0.000010	<0.000005	<0.05	**0.00185**	**138**	0.00030	**0.00034**	0.0007	0.25	**0.0085**	**0.0121**	**24**	**0.344**
9/24/2011	0.10		0.004	1.90	0.011	0.00028	**0.0053**	0.043	<0.000010	<0.000005	<0.05	**0.00215**	**141**	0.00030	**0.00044**	0.0004	**0.54**	0.0041	**0.0135**	**23**	**0.441**
10/29/2011	<0.20	0.30	0.003	0.80	0.005	0.00025	**0.0036**	0.053	<0.000010	<0.000005	<0.05	**0.00132**	**159**	<0.00010	**0.00243**	0.0003	0.30	0.0024	**0.0175**	**28**	**1.320**
11/21/2011	0.18	0.27	0.010	1.70	0.010	0.00032	**0.0060**	0.059	<0.000010	<0.000005	<0.05	**0.00140**	**153**	0.00020	**0.00242**	0.0007	0.37	**0.0155**	**0.0158**	**28**	**1.640**
12/14/2011	0.23	**1.20**	0.013	2.10	0.011	0.00039	**0.0070**	0.064	<0.000010	<0.000005	<0.05	**0.00123**	**159**	**0.00090**	**0.00234**	0.0025	**0.49**	**0.0075**	**0.0156**	**26**	**1.840**
1/15/2012	0.25	0.28	0.006	0.78	0.020	0.00026	**0.0062**	0.062	<0.000010	<0.000005	<0.05	**0.00114**	**149**	0.00060	**0.00187**	0.0012	**0.54**	**0.0160**	**0.0146**	**23**	**1.060**
2/13/2012	0.23	0.20	0.009	1.08	0.003	0.00017	**0.0103**	0.057	<0.000010	<0.000005	<0.05	**0.00090**	**167**	<0.0001	**0.00230**	0.0002	**0.57**	0.0039	**0.0166**	**26**	**1.330**
3/11/2012	0.27	<0.20	0.008	1.57	0.004	0.00018	**0.0102**	0.059	<0.000010	<0.000005	<0.05	**0.00082**	**163**	0.00010	**0.00213**	0.0002	**0.48**	0.0036	**0.0180**	**27**	**1.250**
4/8/2012	0.26	0.14	0.007	0.90	0.009	0.00018	**0.0097**	0.055	<0.000010	<0.000005	<0.05	**0.00078**	**151**	<0.0001	**0.00219**	0.0002	**0.51**	0.0031	**0.0175**	**26**	**1.070**
5/1/2012	**1.06**	0.11	0.021	**10.40**	0.041	0.00038	**0.0082**	0.038	0.000010	<0.000005	<0.05	**0.00378**	87	0.00017	**0.00145**	0.0012	**0.99**	**0.0135**	**0.0079**	13	**0.703**
5/7/2012	<0.05	**0.47**	0.018	8.55	0.029	0.00052	**0.0096**	0.042	<0.000010	<0.000005	<0.05	**0.00239**	88	0.00018	**0.00124**	0.0014	**0.87**	**0.0225**	**0.0077**	15	**0.719**
6/3/2012	<0.20	0.28	0.005	3.95	0.007	0.00029	**0.0037**	0.047	<0.000010	<0.000005	<0.05	**0.00073**	112	0.00019	0.00023	0.0008	0.15	0.0034	**0.0118**	**21**	**0.250**
7/4/2012	<0.20	0.22	0.006	2.55	0.008	0.00036	**0.0049**	0.045	<0.000010	<0.000005	<0.05	**0.00074**	**171**	<0.00010	0.00022	0.0009	0.21	0.0056	**0.0173**	**29**	**0.247**
8/1/2012	<0.20	0.30	0.006	2.86	0.007	0.00035	**0.0052**	0.046	<0.000010	<0.000005	<0.05	**0.00086**	**157**	<0.00010	0.00026	0.0004	0.19	0.0048	**0.0172**	**27**	**0.343**
9/23/2012	<0.20	0.23	0.007	2.81	0.007	0.00021	**0.0045**	0.048	<0.000010	<0.000005	<0.05	**0.00108**	**155**	<0.00010	**0.00069**	0.0003	0.31	0.0019	**0.0175**	**26**	**0.517**
10/15/2012	0.22	<0.20	0.004	2.00	0.004	0.00018	**0.0036**	0.050	<0.000010	<0.000005	<0.05	**0.00077**	**160**	0.00026	**0.00064**	0.0004	0.20	0.0027	**0.0170**	**24**	**0.449**
11/21/2012	**0.32**	<0.20	0.009	1.35	0.015	0.00041	**0.0065**	0.069	<0.000010	**0.0000080**	<0.05	**0.00132**	**165**	0.00013	**0.00194**	0.0012	**0.44**	**0.0233**	**0.0157**	**28**	**1.690**
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	21	15	23	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
median	0.22	0.23	0.0070	1.80	0.009	0.00028	0.0059	0.054	0.000010	0.000005	< 0.05	0.00111	154.0	0.00020	0.001345	0.00041	0.382	0.00524	0.016	25.5	0.8845
mean	0.25	0.31	0.0076	2.86	0.012	0.00029	0.0064	0.052	0.000010	0.000005	< 0.05	0.00129	146.7	0.00027	0.001250	0.00067	0.401	0.00767	0.014	24.1	0.8765
standard deviation	0.19	0.26	0.0045	2.73	0.009	0.00010	0.0022	0.009	0.000000	0.000001	< 0.00	0.00072	26.3	0.00020	0.000845	0.00055	0.213	0.00607	0.003	4.5	0.5176
minimum	< 0.05	0.11	0.0030	0.50	0.003	0.00017	0.0036	0.037	< 0.000010	< 0.000005	< 0.05	0.00065	86.7	< 0.00010	0.000161	0.00014	0.143	0.00189	0.008	13.2	0.2470
maximum	1.06	1.20	0.0211	10.40	0.041	0.00052	0.0103	0.069	0.000010	0.000008	< 0.05	0.00378	183.0	0.00090	0.002430	0.00248	0.991	0.02330	0.018	28.5	1.8400
# < detection limit	7	3	0	1	0	0	0	0	23	23	24	0	0	6	0	0	0	0	0	0	0
% < detection limit	33%	20%	0%	4%	0%	0%	0%	0%	96%	96%	100%	0%	0%	25%	0%	0%	0%	0%	0%	0%	0%
# > background	2	2	0	1	0	0	24	0	0	1	0	24	20	1	19	0	10	11	24	21	24
% > background	10%	13%	0%	4%	0%	0%	100%	0%	0%	4%	0%	100%	83%	4%	79%	0%	42%	46%	100%	88%	100%
# > guideline	0				0		16				0	24		0		1	0	20			12
% > guideline	0%				0%		67%				0%	100%		0%		4%	0%	83%			50%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.13: Water quality concentrations for KV-6, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/12/2011	<0.00001	0.0002	**0.0042**	0.007	0.42	0.00096	**4.23**	0.000016	1.61	0.25	**125**	0.000002	0.00001	<0.0005	**0.0046**	<0.0002	**0.123**	**0.0004**
2/8/2011	<0.00001	0.0002	**0.0043**	0.005	0.43	0.00082	3.75	<0.000005	1.48	0.27	**122**	0.000003	<0.00001	<0.0005	**0.0045**	<0.0002	**0.101**	<0.0001
3/22/2011	<0.00001	0.0002	**0.0047**	0.010	0.48	0.00088	**4.82**	0.000010	1.69	0.27	**139**	<0.000002	<0.00001	<0.0005	**0.0049**	<0.0002	**0.103**	<0.0001
4/19/2011	<0.00001	0.0002	**0.0047**	0.010	0.51	0.00087	**4.59**	<0.000005	1.70	0.27	**140**	<0.000002	<0.00001	<0.0005	**0.0049**	<0.0002	**0.104**	<0.0001
5/25/2011	<0.00001	**0.0004**	**0.0028**	0.012	0.51	0.00066	2.92	0.000020	0.95	0.16	74	0.000003	<0.00001	<0.0005	0.0021	<0.0002	**0.190**	<0.0001
6/22/2011	<0.00001	0.0002	**0.0021**	0.005	0.21	0.00078	2.16	0.000013	1.57	0.25	**135**	0.000008	<0.00001	<0.0005	**0.0043**	<0.0002	**0.207**	<0.0001
7/13/2011	<0.00001	0.0003	**0.0024**	0.008	0.17	0.00066	2.32	0.000007	1.43	0.22	**108**	0.000002	<0.00001	<0.0005	**0.0036**	<0.0002	**0.183**	<0.0001
8/17/2011	<0.00001	0.0002	**0.0032**	0.008	0.32	0.00074	3.20	0.000029	1.54	0.22	**117**	0.000003	<0.00001	<0.0005	**0.0040**	<0.0002	**0.226**	<0.0001
9/24/2011	<0.00001	0.0004	**0.0026**	0.007	0.41	0.00077	3.40	0.000026	1.41	0.24	**116**	<0.000002	0.00018	<0.0005	**0.0045**	<0.0002	**0.275**	<0.0001
10/29/2011	<0.00001	0.0002	**0.0055**	0.006	0.43	0.00082	4.00	0.000020	1.63	0.27	**143**	<0.000002	0.00013	<0.0005	**0.0042**	<0.0002	**0.218**	<0.0001
11/21/2011	<0.00001	0.0002	**0.0061**	0.008	0.47	0.00096	4.10	<0.000005	1.77	0.26	**131**	0.000003	**0.00055**	<0.0005	**0.0046**	<0.0002	**0.219**	<0.0001
12/14/2011	<0.00001	0.0002	**0.0064**	0.007	0.61	0.00094	4.10	0.000010	1.87	0.26	**122**	0.00001	0.00013	<0.0005	**0.0039**	<0.0002	**0.175**	<0.0001
1/15/2012	<0.00001	0.0002	**0.0053**	**0.024**	0.46	**0.00111**	**4.30**	0.000011	**2.43**	0.24	**138**	0.000003	**0.00050**	<0.0005	**0.0041**	<0.0002	**0.149**	<0.0001
2/13/2012	<0.00001	0.0002	**0.0060**	0.012	0.47	0.00091	**4.30**	<0.000005	1.60	0.24	**131**	0.0000020	<0.00020	<0.0005	**0.0042**	<0.0002	**0.139**	<0.0001
3/11/2012	<0.00001	0.0002	**0.0056**	0.014	0.50	0.00096	**4.20**	0.000008	1.70	0.25	**143**	0.0000040	<0.00020	<0.0005	**0.0034**	<0.0002	**0.119**	<0.0001
4/8/2012	<0.00001	0.0002	**0.0061**	0.008	0.43	0.00089	3.80	<0.000005	1.57	0.25	**131**	0.0000030	<0.00020	<0.0005	**0.0039**	<0.0002	**0.117**	<0.0001
5/1/2012	<0.00001	0.0002	**0.0044**	0.017	0.54	0.00055	2.47	0.000041	0.90	0.14	66	0.000005	<0.00020	0.0012	0.0017	<0.0002	**0.364**	<0.0001
5/7/2012	<0.00001	0.0003	**0.0044**	0.016	0.55	0.00052	2.68	**0.000063**	1.02	0.15	70	0.000006	<0.00020	0.0007	0.0021	<0.0002	**0.318**	0.0001
6/3/2012	<0.00001	0.0002	**0.0029**	0.014	0.33	0.00088	2.04	0.000010	1.75	0.21	**106**	<0.000002	<0.00020	0.0033	**0.0038**	<0.0002	**0.123**	<0.0001
7/4/2012	<0.00001	0.0003	**0.0021**	0.013	0.18	0.00076	2.46	0.000009	1.75	0.26	**152**	0.0000026	<0.00020	<0.0005	**0.0037**	<0.0002	**0.099**	<0.0001
8/1/2012	<0.00001	0.0003	**0.0028**	0.002	0.24	0.00075	2.62	0.000010	1.64	0.27	**133**	<0.000002	<0.00020	<0.0005	**0.0036**	<0.0002	**0.105**	<0.0001
9/23/2012	<0.00001	0.0002	**0.0041**	0.002	0.39	0.00085	3.11	<0.000005	1.53	0.27	**140**	<0.000002	<0.00020	<0.0005	**0.0040**	<0.0002	**0.163**	<0.0001
10/15/2012	<0.00001	0.0002	**0.0035**	0.004	0.41	0.00086	4.07	0.000005	1.45	0.27	**144**	0.000002	**0.00035**	<0.0005	**0.0039**	<0.0002	**0.099**	<0.0001
11/21/2012	<0.00001	0.0002	**0.0068**	0.006	0.44	0.00101	**4.20**	0.000046	1.77	0.26	**127**	0.000007	<0.00020	<0.0005	**0.0047**	0.00022	**0.173**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
median	< 0.00001	0.00021	0.00434	0.008	0.43	0.00085	3.78	0.000010	1.61	0.252	131	0.000003	0.00020	0.0005	0.0040	0.0002	0.1560	0.0001
mean	< 0.00001	0.00023	0.00429	0.009	0.41	0.00083	3.49	0.000016	1.57	0.240	123	0.000003	0.00016	0.0007	0.0039	0.0002	0.1705	0.0001
standard deviation	< 0.00000	0.00006	0.00145	0.005	0.12	0.00014	0.85	0.000015	0.31	0.038	23	0.000002	0.00015	0.0006	0.0008	0.0000	0.0721	0.0001
minimum	< 0.00001	0.00015	0.00210	0.002	0.17	0.00052	2.04	< 0.000005	0.90	0.143	66	< 0.000002	0.00001	< 0.0005	0.0017	< 0.0002	0.0988	< 0.0001
maximum	< 0.00001	0.00037	0.00677	0.024	0.61	0.00111	4.82	0.000063	2.43	0.274	152	0.000010	0.00055	0.0033	0.0049	0.0002	0.3640	0.0004
# < detection limit	24	0	0	0	0	0	0	6	0	0	0	7	17	21	0	23	0	22
% < detection limit	100%	0%	0%	0%	0%	0%	0%	25%	0%	0%	0%	29%	71%	88%	0%	96%	0%	92%
# > background	0	1	24	1	0	1	7	1	1	0	21	0	3	0	21	0	24	1
% > background	0%	4%	100%	4%	0%	4%	29%	4%	4%	0%	88%	0%	13%	0%	88%	0%	100%	4%
# > guideline	0	0	0			2		0				0			0		24	
% > guideline	0%	0%	0%			8%		0%				0%			0%		100%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.14: Water quality concentrations for KV-7, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/13/2011		8.40	7.90	212		699	0.1				<1	383	**396**	**140**	**180**		210	**0.240**	<0.005
2/9/2011		8.21	7.98	**632**		**763**	0.0				<1	**412**	349	**150**	**180**		**250**	**0.033**	<0.005
3/22/2011		8.02	7.66	**385**		**820**	0.1				<1	**495**	**487**	**160**	**200**		**280**	0.016	<0.005
4/19/2011			7.90	**435**		**813**	0.9				2	**489**	**465**	**140**	**170**		**280**	0.026	<0.005
5/13/2011	357	7.66	7.71	170		315	0.5				2	159	149	64	79		100	0.016	<0.005
6/22/2011	105	8.47	8.07	**442**		677	**8.1**				<1	**385**	380	**130**	**160**		200	**0.037**	0.006
7/20/2011		8.40	7.73		301	304	4.1				**72**	152	155	70	86		88		
8/18/2011	259	7.30	8.01		448	463	**5.3**				15	250	243	**110**	**130**		130	0.026	<0.500
9/23/2011	286	8.18	8.16		623	630	2.7				2	325	319	**140**	**170**		179	**0.130**	<0.005
10/24/2011	173	8.20	8.09		**722**	690	0.3	10.68	73	282	3	355	368	**140**	**170**		195	**0.038**	<0.005
11/26/2011	126	8.19	8.13			**734**	-0.1	13.39	92		<1	**417**	**409**	**147**	**180**		**235**	**0.037**	<0.005
12/14/2011		8.14	7.82		**742**	**724**	-0.1	12.93	89		3	**396**	**389**	**142**	**173**		**237**	**0.088**	<0.005
1/13/2012	154	7.80	8.12		**714**	**755**	0.0	12.00	82		2	**391**	**406**	**148**	**181**		**225**	**0.042**	<0.005
2/10/2012		7.88	8.26		**765**	**751**	-0.1	14.52	99	95	1	**407**	**426**	**150**	**183**		**276**	**0.053**	<0.005
3/10/2012		7.82	8.25			**768**	-0.1	16.10	110	61	<1	**421**	**400**	**150**	**183**		**251**	**0.043**	<0.050
3/11/2012		7.83			**786**		-0.1	15.13	104	57									
4/6/2012		7.86	8.16			**760**	0.0			69	<1	**391**	**410**	**148**	**180**		215	**0.031**	<0.005
5/1/2012	540	8.05	7.69		290	284	0.2	14.98	103	171	**45**	150	145	57	70	1.2	85	0.027	<0.050
5/7/2012	600	8.17	7.81		245	260	0.7	15.34	107	245	12	135	136	58	71	**1.4**	75	0.009	<0.050
6/1/2012	369	7.73	7.93		313	431	**6.8**				5	198	197				134		<0.050
7/5/2012		8.20	8.13		638	583	**7.2**	12.40	103	107	2	348	267	**114**	**140**	1.2	185	0.024	<0.050
7/16/2012	206																		
8/2/2012	258	8.06	8.09		618	577	**6.7**	12.95	106	115	3	326	308	**121**	**147**	0.8	173	0.030	<0.050
9/21/2012	270	8.01	8.08		671	602	3.8	12.58	96	119	2	296	316	**131**	**160**	1.3	174	0.007	<0.050
10/15/2012		7.80	8.10		**761**	674	-0.1	12.61	86	116	1	339	346	**138**	**168**	**1.7**	199	0.024	<0.050
11/19/2012		8.12	8.11		**717**	**716**	0.0	13.60	93	**428**	1	**385**	382	**153**	**187**	1.0	212	**0.034**	**0.063**
12/7/2012		**7.08**	8.10		**846**	**744**	0.1				3	**401**	388	**148**	**181**	1.1	**236**	**0.052**	<0.005
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	13	25	25	6	17	25	26	14	14	12	25	25	25	24	24	8	25	23	24
median	259	8.05	8.08	410	671	690	0.2	13.17	97	115.4	2	383	368	140	170	1	200	0.03	0.005
mean	285	7.98	8.00	379	600	621	1.8	13.52	96	155.4	7	336	329	127	155	1	193	0.05	0.043
standard deviation	151	0.32	0.18	169	199	176	2.8	1.51	11	110.9	16	105	104	32	39	0	61	0.05	0.100
minimum	105	7.08	7.66	170	245	260	-0.1	10.68	73	56.8	< 1	135	136	57	70	1	75	0.01	< 0.005
maximum	600	8.47	8.26	632	846	820	8.1	16.10	110	428.1	72	495	487	160	200	1.7	280	0.24	0.500
# < detection limit	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0.00	22
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	28%	0%	0%	0%	0%	0%	0%	0%	92%
# > background		1	0	4	8	11	5	0	0	1	2	12	9	20	20	2	9	13	2
% > background		4%	0%	67%	47%	44%	19%	0%	0%	8%	8%	48%	36%	83%	83%	25%	36%	57%	8%
# > guideline		0	0					0			2					0		19	2
% > guideline		0%	0%					0%			8%					0%		83%	8%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.14: Water quality concentrations for KV-7, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/13/2011	0.17			1.20	0.004	0.00017	0.0017	0.051	<0.000010	<0.000005	<0.05	**0.00030**	115	0.00060	0.00017	0.0003	0.08	0.0017	**0.0076**	**24**	0.181
2/9/2011	0.18		0.003	1.00	0.005	0.00033	0.0019	0.061	<0.000010	<0.000005	<0.05	**0.00065**	**129**	0.00040	0.00014	0.0003	0.07	0.0055	**0.0087**	**22**	0.161
3/22/2011	0.15		<0.0020	1.40	0.005	0.00028	0.0017	0.061	<0.000010	<0.000005	<0.05	**0.00084**	**151**	0.00050	0.00009	0.0012	0.03	0.0032	**0.0095**	**29**	0.122
4/19/2011	0.19		0.004	1.70	0.005	0.00016	0.0017	0.053	<0.000010	<0.000005	<0.05	**0.00035**	**155**	0.00030	0.00007	0.0002	0.04	0.0008	**0.0096**	**25**	0.094
5/13/2011	0.03		0.008	**19.40**	0.034	0.00020	0.0030	0.027	<0.000010	<0.000005	<0.05	**0.00079**	48	0.00040	0.00016	0.0023	0.27	0.0045	0.0028	9	0.126
6/22/2011	0.04		0.004	3.10	0.007	0.00034	0.0024	0.053	<0.000010	<0.000005	<0.05	**0.00058**	117	0.00020	0.00005	0.0006	0.07	0.0010	**0.0068**	**22**	0.034
7/20/2011			0.005	**12.70**	**0.946**	**0.00105**	**0.0179**	0.080	**0.000050**	**0.00004**	<0.05	**0.00411**	45	**0.00160**	**0.00214**	**0.0094**	**2.94**	**0.0648**	0.0032	10	**0.652**
8/18/2011	<2.00		0.003	6.80	0.098	0.00028	0.0031	0.047	<0.000010	<0.000005	<0.05	**0.00090**	75	0.00040	0.00026	0.0018	0.37	0.0057	0.0043	15	0.109
9/23/2011	0.08		0.003	2.50	0.017	0.00025	0.0024	0.049	<0.000010	<0.000005	<0.05	**0.00079**	100	0.00020	0.00015	0.0007	0.16	0.0012	**0.0071**	**19**	0.134
10/24/2011	0.12	0.02	<0.005	1.70	0.016	0.00023	0.0024	0.052	<0.000010	<0.000005	<0.05	**0.00086**	110	0.00020	**0.00042**	0.0008	0.20	0.0021	**0.0087**	**20**	**0.284**
11/26/2011	0.15	0.31	<0.0020	1.68	0.007	0.00019	0.0018	0.053	<0.000010	<0.000005	<0.05	**0.00073**	**127**	0.00020	**0.00056**	0.0004	0.08	0.0009	**0.0097**	**24**	**0.549**
12/14/2011	0.17	0.08	0.005	1.21	0.011	0.00020	0.0034	0.057	<0.000010	<0.000005	<0.05	**0.00075**	121	<0.0001	**0.00060**	0.0005	0.23	0.0027	**0.0090**	**23**	**0.564**
1/13/2012	0.19	0.36	0.005	1.48	0.004	0.00016	0.0033	0.055	<0.000010	<0.000005	<0.05	**0.00056**	120	<0.00010	**0.00059**	0.0002	0.18	0.0011	**0.0098**	**23**	**0.446**
2/10/2012	0.20	0.12	0.003	1.92	0.004	0.00015	**0.0035**	0.056	<0.000010	<0.000005	<0.05	**0.00046**	125	<0.0001	**0.00052**	0.0003	0.18	0.0011	**0.0102**	**23**	**0.367**
3/10/2012	0.28	<0.20	0.004	0.97	0.004	0.00016	**0.0036**	0.055	<0.000010	<0.000005	<0.05	**0.00040**	**128**	<0.00010	**0.00043**	0.0002	0.17	0.0010	**0.0107**	**25**	**0.297**
3/11/2012																					
4/6/2012	0.22	0.07	<0.0020	0.53	0.003	0.00015	0.0029	0.051	<0.000010	<0.000005	<0.05	**0.00030**	120	<0.00010	**0.00031**	0.0002	0.13	0.0008	**0.0104**	**23**	0.165
5/1/2012	<0.20	**0.80**	**0.061**	**18.00**	0.125	0.00031	**0.0102**	0.040	0.000014	<0.000005	<0.05	**0.00224**	45	0.00024	**0.00123**	**0.0034**	**1.15**	**0.0206**	0.0030	9	**0.670**
5/7/2012	<0.05	**0.57**	0.026	**14.50**	0.074	0.00024	**0.0041**	0.028	<0.000010	**0.0000080**	<0.05	**0.00343**	41	0.00012	**0.00041**	**0.0031**	**0.47**	**0.0075**	0.0024	8	0.195
6/1/2012	<0.20	0.25	0.009	<0.50	0.036	0.00037	0.0023	0.039	**0.000015**	<0.000005	<0.05	**0.00049**	58	0.00017	0.00016	**0.0039**	0.15	0.0037	0.0052	13	0.072
7/5/2012	<0.20	0.21	0.004	2.94	0.014	0.00029	0.0026	0.047	<0.000010	<0.000005	<0.05	**0.00045**	107	<0.00010	0.00010	0.0006	0.13	0.0015	**0.0068**	**20**	0.077
7/16/2012																					
8/2/2012	<0.20	0.28	0.005	2.47	0.018	0.00024	0.0027	0.051	<0.000010	<0.000005	<0.05	**0.00052**	99	<0.00010	0.00013	0.0007	0.15	0.0018	**0.0070**	**19**	0.090
9/21/2012	<0.20	0.32	0.005	3.41	0.011	0.00022	0.0023	0.049	<0.000010	<0.000005	<0.05	**0.00072**	90	0.00046	0.00012	0.0006	0.14	0.0008	**0.0062**	18	0.121
10/15/2012	<0.20	0.26	0.003	2.30	0.006	0.00029	0.0021	0.056	<0.000010	<0.000005	<0.05	**0.00126**	104	0.00010	0.00011	0.0010	0.09	0.0010	**0.0076**	**20**	0.106
11/19/2012	<0.20	**0.89**	0.007	1.13	0.009	0.00019	0.0017	0.060	<0.000010	<0.000005	<0.05	**0.00069**	117	<0.00010	0.00029	0.0004	0.07	0.0015	**0.0083**	**23**	**0.329**
12/7/2012	0.19	0.09	0.002	1.28	0.009	0.00039	0.0019	0.061	<0.000010	<0.000005	<0.05	**0.00134**	122	<0.00010	0.00019	0.0004	0.07	0.0023	**0.0084**	**24**	**0.295**
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0035			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	24	16	24	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
median	0.19	0.26	0.0040	1.70	0.009	0.00024	0.0024	0.053	0.000010	0.000005	< 0.05	0.000724	115.0	0.00020	0.00019	0.00062	0.145	0.00166	0.0076	22.2	0.1650
mean	0.24	0.30	0.0075	4.23	0.059	0.00027	0.0035	0.052	0.000012	0.000007	< 0.05	0.000980	102.7	0.00028	0.00038	0.00134	0.303	0.00554	0.0073	19.5	0.2496
standard deviation	0.38	0.25	0.0123	5.56	0.187	0.00018	0.0034	0.011	0.000008	0.000007	< 0.00	0.000937	32.8	0.00031	0.00045	0.00199	0.593	0.01300	0.0025	5.7	0.1908
minimum	0.03	0.02	< 0.0020	0.50	0.003	0.00015	0.0017	0.027	< 0.000010	< 0.000005	< 0.05	0.000298	40.7	0.00010	0.00005	0.00018	0.027	0.00075	0.0024	8.2	0.0336
maximum	2.00	0.89	0.0605	19.40	0.946	0.00105	0.0179	0.080	0.000050	0.000040	< 0.05	0.004110	155.0	0.00160	0.00214	0.00940	2.940	0.06480	0.0107	29.0	0.6700
# < detection limit	9	1	4	1	0	0	0	0	22	23	25	0	0	9	0	0	0	0	0	0	0
% < detection limit	38%	6%	17%	4%	0%	0%	0%	0%	88%	92%	100%	0%	0%	36%	0%	0%	0%	0%	0%	0%	0%
# > background	1	3	1	4	1	1	5	0	2	2	0	25	5	1	10	4	3	3	19	18	10
% > background	4%	19%	4%	16%	4%	4%	20%	0%	8%	8%	0%	100%	20%	4%	40%	16%	12%	12%	76%	72%	40%
# > guideline	0				2		2				0	25		0		4	2	7			0
% > guideline	0%				8%		8%				0%	100%		0%		16%	8%	28%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.14: Water quality concentrations for KV-7, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/13/2011	<0.00001	**0.0004**	**0.0018**	0.005	0.44	0.00088	3.55	0.000013	1.57	0.23	82	0.000002	<0.00001	<0.0005	0.0028	<0.0002	**0.070**	0.0002
2/9/2011	<0.00001	0.0004	0.0015	<0.002	0.41	0.00082	3.27	<0.000005	1.40	0.25	82	<0.000002	<0.00001	<0.0005	0.0029	<0.0002	**0.077**	<0.0001
3/22/2011	<0.00001	**0.0004**	**0.0015**	0.009	**0.92**	0.00092	**4.49**	0.000006	**2.05**	0.28	**112**	<0.000002	0.00001	<0.0005	0.0031	<0.0002	**0.142**	<0.0001
4/19/2011	<0.00001	**0.0004**	0.0014	0.004	0.49	0.00082	4.08	<0.000005	1.66	0.28	**101**	<0.000002	<0.00001	<0.0005	0.0030	<0.0002	**0.077**	<0.0001
5/13/2011	<0.00001	0.0002	**0.0020**	0.016	**0.67**	0.00027	2.14	0.000033	0.70	0.10	34	0.000002	0.00007	0.0007	0.0008	<0.0002	**0.108**	<0.0001
6/22/2011	<0.00001	**0.0004**	0.0010	0.002	0.38	0.00067	2.77	0.000007	1.47	0.24	**90**	0.000003	0.00003	<0.0005	0.0025	<0.0002	**0.081**	<0.0001
7/20/2011	0.00001	**0.0005**	**0.0068**	**0.181**	<0.3	0.00034	3.12	**0.000732**	0.60	0.11	<50	**0.000036**	<0.0002	**0.0240**	0.0008	**0.0026**	**0.370**	**0.0007**
8/18/2011	<0.00001	0.0003	**0.0018**	0.016	0.27	0.00053	2.90	0.000027	0.98	0.16	48	0.000005	<0.00001	0.0028	0.0012	<0.0002	**0.104**	<0.0001
9/23/2011	<0.00001	**0.0005**	0.0014	0.006	0.38	0.00074	3.10	0.000011	1.25	0.21	68	0.000003	0.0001	0.0005	0.0024	<0.0002	**0.107**	<0.0001
10/24/2011	<0.00001	**0.0004**	**0.0017**	0.017	0.45	0.00092	3.30	0.000016	1.34	0.23	82	0.000003	0.00006	0.0005	0.0025	<0.0002	**0.141**	<0.0001
11/26/2011	<0.00001	**0.0004**	**0.0026**	0.006	0.45	0.00093	3.90	0.000006	1.60	0.24	87	0.000002	0.00013	<0.0005	0.0027	<0.0002	**0.131**	<0.0001
12/14/2011	<0.00001	0.0004	**0.0026**	0.002	0.41	0.00099	3.60	0.000009	1.52	0.24	86	0.000005	0.00003	<0.0005	0.0026	<0.0002	**0.115**	<0.0001
1/13/2012	<0.00001	**0.0004**	**0.0026**	0.004	0.43	0.00099	3.90	<0.000005	1.44	0.24	**105**	0.000002	<0.0002	<0.0005	0.0026	<0.0002	**0.095**	<0.0001
2/10/2012	<0.00001	0.0003	**0.0025**	0.005	0.46	0.00089	3.60	<0.000005	1.53	0.24	89	<0.000002	<0.0002	<0.0005	0.0029	<0.0002	**0.083**	<0.0001
3/10/2012	<0.00001	**0.0004**	**0.0022**	0.008	0.48	0.00093	3.80	<0.000005	1.59	0.25	**102**	0.0000030	<0.0002	<0.0005	0.0023	<0.0002	**0.067**	<0.0001
3/11/2012																		
4/6/2012	<0.00001	0.0004	**0.0021**	0.003	0.44	0.00086	3.50	<0.000005	1.57	0.25	**91**	<0.000002	<0.00020	<0.0005	0.0028	<0.0002	**0.055**	<0.0001
5/1/2012	0.000010	0.0002	**0.0035**	**0.054**	0.66	0.00029	1.96	**0.000100**	0.65	0.10	28	0.00001	<0.00020	0.0041	0.0008	0.0005	**0.225**	**0.0004**
5/7/2012	<0.00001	0.0002	**0.0027**	0.018	0.52	0.00033	1.82	0.000040	0.61	0.09	24	0.000004	<0.00020	0.0015	0.0007	0.0002	**0.338**	0.0001
6/1/2012	<0.00001	**0.0004**	**0.0017**	0.011	0.49	0.00045	2.04	**0.000254**	1.77	0.14	47	0.000003	<0.00020	0.0008	0.0014	<0.0002	**0.059**	<0.0001
7/5/2012	<0.00001	**0.0004**	0.0011	0.006	0.28	0.00067	3.26	0.000008	1.37	0.20	70	0.0000022	<0.00020	0.0007	0.0018	<0.0002	**0.061**	<0.0001
7/16/2012																		
8/2/2012	<0.00001	**0.0004**	0.0012	<0.002	0.29	0.00071	3.18	<0.000005	1.36	0.21	68	0.000002	<0.00020	<0.0005	0.0018	<0.0002	**0.068**	<0.0001
9/21/2012	<0.00001	**0.0004**	0.0013	<0.002	0.33	0.00044	2.74	<0.000005	1.17	0.20	61	<0.000002	<0.00020	<0.0005	0.0018	<0.0002	**0.096**	<0.0001
10/15/2012	<0.00001	**0.0004**	0.0013	0.004	0.41	0.00078	3.31	<0.000005	1.25	0.24	83	<0.000002	0.00029	<0.0005	0.0021	<0.0002	**0.159**	<0.0001
11/19/2012	<0.00001	**0.0004**	**0.0023**	0.002	0.42	0.00106	3.59	<0.000005	1.51	0.24	**89**	<0.000002	<0.00020	<0.0005	0.0027	<0.0002	**0.107**	<0.0001
12/7/2012	<0.00001	0.0003	**0.0021**	<0.002	0.42	0.00088	3.70	0.000012	1.57	0.25	87	0.000003	<0.00020	<0.0005	0.0026	<0.0002	**0.178**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
median	0.00001	0.00036	0.00178	0.005	0.43	0.00082	3.30	0.000007	1.44	0.238	82	0.000002	0.00020	0.0005	0.0025	0.0002	0.1040	0.0001
mean	0.00001	0.00036	0.00210	0.015	0.45	0.00072	3.22	0.000053	1.34	0.208	75	0.000004	0.00013	0.0017	0.0021	0.0003	0.1245	0.0001
standard deviation	0.00000	0.00006	0.00115	0.036	0.14	0.00024	0.68	0.000151	0.37	0.058	24	0.000007	0.00009	0.0047	0.0008	0.0005	0.0803	0.0001
minimum	< 0.00001	0.00021	0.00104	0.002	0.27	0.00027	1.82	< 0.000005	0.60	0.087	24	< 0.000002	< 0.00001	< 0.0005	0.0007	< 0.0002	0.0551	< 0.0001
maximum	0.00001	0.00049	0.00680	0.181	0.92	0.00106	4.49	0.000732	2.05	0.278	112	0.000036	0.00029	0.0240	0.0031	0.0026	0.3700	0.0007
# < detection limit	23	0	0	4	1	0	0	10	0	0	1	8	17	16	0	22	0	21
% < detection limit	92%	0%	0%	16%	4%	0%	0%	40%	0%	0%	4%	32%	68%	64%	0%	88%	0%	84%
# > background	0	16	17	2	2	0	1	3	1	0	7	1	0	1	0	1	25	2
% > background	0%	64%	68%	8%	8%	0%	4%	12%	4%	0%	28%	4%	0%	4%	0%	4%	100%	8%
# > guideline	0	0	0			1		2				0			0		25	
% > guideline	0%	0%	0%			4%		8%				0%			0%		100%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.

light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.

dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.15: Water quality concentrations for KV-9A, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
10/27/2011		7.92	8.18		**953**	**920**	0.0	10.94	76	281	**30**	**557**	**532**				**225**		<0.005
11/28/2011		7.70	8.09			**989**	-0.1	**3.39**	**23**		9	**565**	**556**				**274**		<0.005
12/22/2011		**7.16**	8.10		**1044**	**1020**	-0.1	**6.78**	**46**		10	**586**	**579**				**302**		<0.005
1/23/2012		7.48	8.29		**1448**	**1140**	0.3	**9.62**	**67**		5	**648**	**661**				**333**		<0.005
2/16/2012	0																		
3/14/2012	0	**7.15**	8.09		**1271**	**1270**	-0.1	**5.45**	**37**	-38	**182**	**713**	**733**				**386**		<0.050
4/6/2012		7.52	8.08		**1495**	**1270**	-0.1	**8.16**	**56**	21	10	**721**	**751**				**380**		<0.005
5/2/2012		7.99	7.72		234	232	0.2	13.76	95	196	10	125	116				55		<0.050
6/4/2012	222	7.44	7.97		419	382	**9.3**	10.90	96	319	1	202	178				89		<0.050
7/7/2012	118	7.92	**8.36**		**753**	697	**13.3**	**9.71**	93	113	3	**398**	**415**				182		
8/3/2012	115	7.93	8.21		681	678	**10.5**	10.60	95	304	1	383	382				158		<0.050
9/23/2012	109	7.80	**8.32**			**729**	5.1	11.52	91	118	1	**395**	**400**				185		<0.050
10/14/2012	73	7.19	8.05		**983**	**950**	0.0	11.87	81	-2	3	**507**	**508**				**264**		<0.050
11/20/2012			8.04			**962**	0.1	**2.80**	**42**	345	9	**528**	**542**				**239**		**0.060**
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	7	12	13	0	10	13	13	13	13	10	13	13	13	0	0	0	13	0	12
median	109	7.61	8.09	-	968	950	0.1	9.71	76	156.7	9	528	532	-	-	-	239	-	0.050
mean	91	7.60	8.12	-	928	865	3.0	8.88	69	165.8	21	487	489	-	-	-	236	-	0.032
standard deviation	77	0.32	0.17	-	416	313	4.9	3.37	26	143.2	49	181	191	-	-	-	102	-	0.024
minimum	0	7.15	7.72	-	234	232	-0.1	2.80	23	-37.5	1	125	116	-	-	-	55	-	< 0.005
maximum	222	7.99	8.36	-	1495	1270	13.3	13.76	96	345.4	182	721	751	-	-	-	386	-	0.060
# < detection limit	0	0	0	-	0	0	0	0	0	0	0	0	0	-	-	-	0	-	11
% < detection limit	0%	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	-	-	0%	-	92%
# > background		2	2	-	7	9	3	7	6	0	2	10	10	-	-	-	8	-	1
% > background		17%	15%	-	70%	69%	23%	54%	46%	0%	15%	77%	77%	-	-	-	62%	-	8%
# > guideline		0	0					5			2					-		-	0
% > guideline		0%	0%					38%			15%					-		-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.15: Water quality concentrations for KV-9A, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
10/27/2011	0.18	**0.48**	0.024	5.10	**0.17**	0.00057	**0.0046**	0.082	**0.000020**	<0.000005	<0.05	**0.00039**	**164**	0.00030	**0.00064**	0.0020	**1.04**	0.0048	**0.0089**	**36**	**0.713**
11/28/2011	0.17	**0.62**	<0.0020	6.47	0.03	0.00050	**0.0040**	**0.103**	<0.000010	<0.000005	<0.05	**0.00042**	**162**	0.00030	**0.00113**	0.0010	**1.67**	0.0044	**0.0095**	**39**	**1.890**
12/22/2011	0.05	**0.64**	0.007	6.58	0.02	0.00048	**0.0049**	**0.104**	<0.000010	<0.000005	<0.05	**0.00036**	**167**	0.00010	**0.00129**	**0.0374**	**1.79**	0.0019	**0.0086**	**41**	**2.470**
1/23/2012	0.11	**0.79**	0.008	8.58	0.03	0.00042	0.0030	**0.108**	<0.000010	<0.000005	<0.05	**0.00106**	**185**	0.00010	**0.00180**	0.0011	**1.00**	0.0020	**0.0105**	**45**	**3.400**
2/16/2012																					
3/14/2012	<0.20	**1.28**	**0.064**	**11.50**	**0.31**	0.00089	**0.0459**	**0.151**	**0.000030**	**0.000014**	<0.05	**0.00212**	**196**	**0.00090**	**0.00286**	**0.0064**	**20.20**	**0.0520**	**0.0118**	**54**	**4.070**
4/6/2012	0.09	**1.23**	0.008	**9.35**	0.02	0.00058	**0.0071**	**0.093**	<0.000010	<0.000005	<0.05	**0.00056**	**199**	0.00020	**0.00191**	0.0014	**2.50**	0.0048	**0.0118**	**54**	**3.990**
5/2/2012	<0.20	**0.59**	0.025	**13.50**	0.05	0.00055	**0.0035**	0.026	<0.000010	<0.000005	<0.05	**0.00050**	37	<0.00010	0.00026	0.0023	**0.81**	**0.0163**	0.0019	8	**0.501**
6/4/2012	<0.20	0.24	0.006	5.65	0.01	**0.00110**	0.0020	0.025	<0.000010	<0.000005	<0.05	**0.00016**	60	<0.00010	0.00009	0.0016	0.16	0.0028	0.0029	13	0.086
7/7/2012					0.01	0.00094	**0.0049**	0.051	<0.000010	<0.000005	<0.05	**0.00027**	116	<0.00010	0.00027	0.0012	**0.56**	**0.0083**	**0.0060**	**27**	**0.370**
8/3/2012	<0.20	0.41	0.005	6.68	0.01	0.00076	**0.0040**	0.048	<0.000010	<0.000005	<0.05	**0.00028**	112	<0.00010	0.00020	0.0010	0.40	0.0046	**0.0059**	**25**	**0.340**
9/23/2012	<0.20	0.36	0.005	5.65	0.01	0.00070	**0.0041**	0.054	<0.000010	<0.000005	<0.05	**0.00022**	114	<0.00010	0.00022	0.0008	**0.47**	0.0048	**0.0061**	**27**	**0.415**
10/14/2012	<0.20	**0.53**	0.006	5.06	0.01	0.00064	**0.0046**	0.082	<0.000010	<0.000005	<0.05	**0.00032**	**149**	<0.00010	**0.00048**	0.0010	**0.74**	**0.0063**	**0.0082**	**33**	**0.945**
11/20/2012	<0.20	**0.80**	0.013	6.74	0.01	0.00027	**0.0096**	**0.154**	<0.000010	<0.000005	<0.05	**0.00043**	**152**	0.00072	**0.00256**	0.0007	**3.53**	**0.0097**	**0.0069**	**36**	**5.960**
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0035			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	12	12	12	12	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
median	0.20	0.60	0.008	6.63	0.022	0.0006	0.0046	0.082	0.000010	0.000005	< 0.05	0.000394	152.0	0.00010	0.000635	0.00123	1.000	0.0048	0.0082	35.9	0.9450
mean	0.17	0.66	0.014	7.57	0.053	0.0006	0.0078	0.083	0.000012	0.000006	< 0.05	0.000544	139.4	0.00025	0.001053	0.00445	2.683	0.0094	0.0076	33.7	1.9346
standard deviation	0.05	0.32	0.017	2.67	0.088	0.0002	0.0116	0.042	0.000006	0.000002	< 0.00	0.000524	49.8	0.00026	0.000957	0.01001	5.348	0.0134	0.0031	14.0	1.8856
minimum	0.05	0.24	0.002	5.06	0.005	0.0003	0.0020	0.025	< 0.000010	< 0.000005	< 0.05	0.000157	36.5	< 0.00010	0.000089	0.00067	0.159	0.0019	0.0019	8.1	0.0864
maximum	0.20	1.28	0.064	13.50	0.309	0.0011	0.0459	0.154	0.000030	0.000014	< 0.05	0.002120	199.0	0.00090	0.002860	0.03740	20.200	0.0520	0.0118	54.3	5.9600
# < detection limit	7	0	1	0	0	0	0	0	11	12	13	0	0	6	0	0	0	0	0	0	0
% < detection limit	58%	0%	8%	0%	0%	0%	0%	0%	85%	92%	100%	0%	0%	46%	0%	0%	0%	0%	0%	0%	0%
# > background	0	9	1	3	2	1	11	6	2	1	0	13	8	1	8	2	11	5	11	11	12
% > background	0%	75%	8%	25%	15%	8%	85%	46%	15%	8%	0%	100%	62%	8%	62%	15%	85%	38%	85%	85%	92%
# > guideline	0				2		3				0	12		0		2	6	10			6
% > guideline	0%				15%		23%				0%	92%		0%		15%	46%	77%			46%

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light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.15: Water quality concentrations for KV-9A, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10/27/2011	<0.00001	0.0003	**0.0016**	0.020	**0.73**	0.00066	**4.80**	0.000031	**3.05**	0.34	**102**	0.000006	0.00006	0.0037	0.0016	**0.0008**	**0.069**	<0.0001
11/28/2011	<0.00002	**0.0004**	**0.0018**	0.011	**0.91**	0.00082	**4.70**	0.000030	**3.10**	**0.37**	**102**	0.000009	0.00012	0.0014	0.0018	0.0003	**0.087**	<0.0001
12/22/2011	<0.00001	0.0003	**0.0106**	0.010	**1.33**	0.00062	**5.10**	0.000014	**3.83**	**0.41**	**117**	0.000008	0.00003	0.0006	0.0017	<0.0002	**0.065**	0.0001
1/23/2012	<0.00001	0.0003	**0.0027**	0.012	**1.77**	0.00038	**6.10**	0.000015	**4.99**	**0.44**	**122**	0.000014	<0.00020	0.0007	0.0019	<0.0002	**0.111**	0.0001
2/16/2012																		
3/14/2012	<0.00001	0.0003	**0.0050**	**0.056**	**2.11**	0.00051	**7.20**	**0.000393**	**6.52**	**0.52**	**135**	**0.000038**	<0.00020	**0.0114**	0.0016	**0.0022**	**0.157**	**0.0007**
4/6/2012	<0.00001	**0.0004**	**0.0040**	0.017	**2.27**	0.00014	**6.70**	0.000021	**6.52**	**0.52**	**153**	0.000015	<0.00020	0.0007	0.0016	<0.0002	**0.058**	0.0002
5/2/2012	<0.00001	0.0002	0.0011	0.020	**0.71**	0.00013	1.63	**0.000097**	0.68	0.08	18	0.000011	<0.00020	0.0015	0.0002	0.0003	**0.058**	<0.0001
6/4/2012	<0.00001	0.0002	0.0007	0.007	0.47	0.00028	1.95	0.000026	1.28	0.15	29	0.000006	<0.00020	<0.0005	0.0004	<0.0002	**0.024**	<0.0001
7/7/2012	<0.00001	0.0003	0.0010	0.010	0.41	0.00025	3.41	0.000046	**2.64**	0.30	68	0.000015	<0.00020	<0.0005	0.0012	<0.0002	**0.024**	<0.0001
8/3/2012	<0.00001	**0.0004**	0.0009	<0.002	0.37	0.00018	3.52	0.000009	**2.05**	0.28	59	0.000009	<0.00020	<0.0005	0.0012	<0.0002	**0.024**	<0.0001
9/23/2012	<0.00001	0.0003	0.0009	0.004	**0.66**	0.00022	3.35	0.000012	**2.41**	0.30	73	0.000006	<0.00020	<0.0005	0.0012	<0.0002	**0.023**	<0.0001
10/14/2012	<0.00001	0.0003	0.0012	0.006	**0.82**	0.00029	**4.27**	0.000014	**2.88**	**0.37**	**107**	0.000007	0.00028	<0.0005	0.0015	<0.0002	**0.041**	<0.0001
11/20/2012	<0.00001	**0.0004**	**0.0030**	0.011	**1.03**	0.00009	**5.06**	0.000015	**3.47**	**0.40**	**93**	0.000010	<0.00020	0.0005	0.0010	<0.0002	**0.053**	0.0002
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
median	< 0.00001	0.00032	0.00164	0.011	0.82	0.00028	4.70	0.000021	3.05	0.366	102	0.000009	0.00020	0.0006	0.00145	0.0002	0.0578	0.0001
mean	< 0.00001	0.00031	0.00265	0.014	1.05	0.00035	4.45	0.000056	3.34	0.344	91	0.000012	0.00018	0.0018	0.00129	0.0004	0.0611	0.0002
standard deviation	0.00000	0.00007	0.00273	0.014	0.64	0.00023	1.68	0.000104	1.78	0.128	40	0.000008	0.00007	0.0030	0.00051	0.0006	0.0393	0.0002
minimum	< 0.00001	0.00016	0.00070	0.002	0.37	0.00009	1.63	0.000009	0.68	0.080	18	0.000006	0.00003	< 0.0005	0.00020	< 0.0002	0.0231	< 0.0001
maximum	< 0.00002	0.00041	0.01060	0.056	2.27	0.00082	7.20	0.000393	6.52	0.522	153	0.000038	0.00028	0.0114	0.00187	0.0022	0.1570	0.0007
# < detection limit	13	0	0	1	0	0	0	0	0	0	0	0	9	5	0	9	0	8
% < detection limit	100%	0%	0%	8%	0%	0%	0%	0%	0%	0%	0%	0%	69%	38%	0%	69%	0%	62%
# > background	1	4	7	1	10	0	8	2	11	7	8	1	0	1	0	2	13	1
% > background	8%	31%	54%	8%	77%	0%	62%	15%	85%	54%	62%	8%	0%	8%	0%	15%	100%	8%
# > guideline	0	0	0			0		1				0			0		13	
% > guideline	0%	0%	0%			0%		8%				0%			0%		100%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.16: Water quality concentrations for KV-9, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011		8.23	7.74	163		673	0.2				<1	337	362				160		
5/12/2011	1,179	7.80	7.54	133		233	1.6				3	121	113				60		
7/14/2011	541	7.86	8.04		409	421	**13.4**				<1	234	233				86		
10/23/2011	155	8.06	7.99		650	621	1.0	10.85	**29**	273	<1	326	344				139		<0.005
11/25/2011		7.99	8.19			617	1.9	**9.37**	**68**		<1	341	373				149		<0.005
12/16/2011		7.36	7.91		589	593	2.0	**6.87**	**50**		<1	318	348				128		<0.005
1/14/2012		7.20	8.14		561	598	0.9	**8.10**	**57**	281	<1	327	327				124		<0.005
2/15/2012		7.58	8.24		589	590	1.1	**9.34**	**66**	22	<1	320	361				112		<0.005
3/15/2012		7.62	8.26		606	595	0.2	**9.06**	**62**	49	10	307	314				123		<0.050
4/8/2012	12	7.88	8.14		640	606	0.5	**9.65**	**67**	99	<1	313	329				132		<0.005
5/4/2012	1,574	7.30	8.06		462	237	1.2				9	123	119				53		<0.050
6/7/2012	430	7.78	8.20		456	400	**9.2**	**9.80**	85	300	<1	220	221				87		<0.050
7/7/2012	244	7.91	**8.35**		615	561	**12.1**	**9.06**	84	116	<1	323	273				135		<0.050
8/3/2012	239	7.88	8.23		532	527	**11.3**	**9.40**	86	280	<1	299	281				110		<0.050
9/22/2012	245	7.73	8.27			570	5.1	10.68	84	92	<1	310	311				129		<0.050
10/12/2012	137	**6.70**	**8.32**		**708**	631	2.1	**10.22**	75	183	<1	335	336				148		<0.050
11/24/2012			8.21			588					1	316	315				136		<0.050
12/8/2012		7.18	8.18		660	585	2.0	**10.07**	73		4	312	303				136		<0.005
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	10	17	18	2	13	18	17	13	13	10	18	18	18	0	0	0	18	0	15
median	244	7.78	8.19	148	589	589	1.9	9.40	68	149.7	1	315	315	-	-	-	129	-	< 0.050
mean	475	7.65	8.11	148	575	536	3.9	9.42	68	169.6	2	288	292	-	-	-	119	-	< 0.029
standard deviation	506	0.39	0.21	21	89	128	4.6	1.06	16	106.8	3	68	76	-	-	-	30	-	< 0.023
minimum	12	6.70	7.54	133	409	233	0.2	6.87	29	22.4	1	121	113	-	-	-	53	-	< 0.005
maximum	1574	8.23	8.35	163	708	673	13.4	10.85	86	300.4	10	341	373	-	-	-	160	-	< 0.050
# < detection limit	0	0	0	0	0	0	0	0	0	0	13	0	0	-	-	-	0	-	15
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	72%	0%	0%	-	-	-	0%	-	100%
# > background		1	2	0	1	0	4	11	7	0	0	0	0	-	-	-	0	-	0
% > background		6%	11%	0%	8%	0%	24%	85%	54%	0%	0%	0%	0%	-	-	-	0%	-	0%
# > guideline		0	0					7			0					-		-	0
% > guideline		0%	0%					54%			0%					-		-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.16: Water quality concentrations for KV-9, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011					0.006	0.00040	0.0014	**0.107**	<0.00001	<0.000005	<0.05	**0.00040**	96	0.00030	0.00009	0.0006	0.13	**0.0092**	0.0024	**24**	**0.253**
5/12/2011					0.027	**0.00183**	**0.0037**	0.019	<0.00001	<0.000005	<0.05	**0.00126**	34	0.00050	0.00013	**0.0044**	0.33	**0.0693**	0.0016	9	0.198
7/14/2011					0.008	**0.00139**	0.0026	0.035	<0.00001	<0.000005	<0.05	**0.00056**	66	0.00030	0.00005	0.0025	0.06	**0.0083**	0.0028	17	0.028
10/23/2011	0.1	0.07	<0.0050	4.70	0.008	0.00085	0.0019	0.063	<0.00001	<0.000005	<0.05	**0.00042**	95	0.00010	0.00006	0.0011	0.14	**0.0074**	0.0045	**22**	0.075
11/25/2011	0.15	0.30	<0.0020	4.35	0.034	0.00093	0.0034	**0.085**	<0.00001	<0.000005	<0.05	**0.00060**	95	<0.00010	0.00011	0.0022	0.36	**0.0402**	0.0031	**25**	0.212
12/16/2011	0.15	0.11	<0.0020	3.21	0.001	0.00054	0.0007	**0.087**	<0.00001	<0.000005	<0.05	**0.00020**	89	<0.00010	0.00004	0.0012	0.07	0.0006	0.0027	**23**	0.033
1/14/2012	0.15	0.14	<0.0020	2.83	0.005	0.00057	0.0007	**0.089**	<0.00001	<0.000005	<0.05	**0.00022**	93	<0.00010	0.00006	0.0014	0.06	0.0019	0.0027	**23**	0.029
2/15/2012	0.12	0.22	<0.0020	2.02	0.001	0.00050	0.0006	**0.083**	<0.00001	<0.000005	<0.05	**0.00018**	89	<0.00010	0.00005	0.0010	0.05	0.0011	0.0025	**24**	0.028
3/15/2012	<0.20	0.26	0.003	1.81	0.011	0.00066	0.0015	0.080	<0.00001	<0.000005	<0.05	**0.00030**	85	0.00010	0.00006	0.0011	0.17	**0.0146**	0.0027	**23**	0.079
4/8/2012	0.10	0.12	<0.0020	2.05	0.003	0.00043	0.0006	**0.092**	<0.00001	<0.000005	<0.05	**0.00023**	88	<0.00010	0.00005	0.0011	0.04	0.0006	0.0026	**23**	0.075
5/4/2012	0.21	0.33	0.025	**15.10**	0.038	**0.00159**	**0.0043**	0.024	<0.00001	<0.000005	<0.05	**0.00168**	35	<0.00010	0.00011	**0.0040**	**0.45**	**0.0784**	0.0015	9	**0.271**
6/7/2012	<0.20	0.21	0.005	5.50	0.007	**0.00139**	0.0020	0.038	<0.00001	<0.000005	<0.05	**0.00044**	63	<0.00010	0.00004	0.0017	0.06	**0.0085**	0.0028	15	0.025
7/7/2012	<0.20	0.24	0.005	5.52	0.010	**0.00130**	0.0024	0.051	<0.00001	<0.000005	<0.05	**0.00045**	93	<0.00010	0.00005	0.0018	0.07	0.0054	0.0038	**22**	0.025
8/3/2012	<0.20	0.29	0.003	6.62	0.003	**0.00099**	0.0024	0.050	<0.00001	<0.000005	<0.05	**0.00039**	85	<0.00010	0.00005	0.0015	0.06	0.0031	0.0038	**21**	0.023
9/22/2012	<0.20	0.24	0.004	5.93	0.005	0.00079	0.0023	0.052	<0.00001	<0.000005	<0.05	**0.00030**	88	<0.00010	0.00005	0.0010	0.10	0.0042	0.0040	**22**	0.025
10/12/2012	<0.20	0.26	<0.0020	4.63	0.003	0.00069	0.0018	0.065	<0.00001	<0.000005	<0.05	**0.00029**	95	<0.00010	0.00007	0.0014	0.09	0.0036	0.0040	**24**	0.043
11/24/2012	<0.20	0.22	0.004	2.65	0.001	0.00045	0.0007	**0.097**	<0.00001	<0.000005	<0.05	**0.00032**	88	0.00012	0.00005	0.0011	0.06	0.0009	0.0030	**24**	0.084
12/8/2012	0.04	0.19	0.005	2.71	0.059	**0.00112**	**0.0070**	**0.107**	<0.00001	<0.000005	<0.05	**0.00128**	87	<0.00010	0.00016	0.0023	**0.77**	**0.0700**	0.0027	**23**	**0.429**
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	15	15	15	15	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	0.20	0.22	0.0032	4.35	0.007	0.0008	0.0020	0.073	< 0.00001	< 0.000005	< 0.05	0.000394	87.9	0.00010	0.000057	0.00138	0.081	0.00639	0.0027	23.1	0.0586
mean	0.16	0.21	0.0047	4.64	0.013	0.0009	0.0022	0.068	< 0.00001	< 0.000005	< 0.05	0.000528	81.3	0.00015	0.000071	0.00174	0.170	0.01818	0.0030	20.6	0.1075
standard deviation	0.05	0.08	0.0058	3.29	0.016	0.0004	0.0016	0.028	0.00000	0.000000	0.00	0.000428	19.2	0.00011	0.000035	0.00103	0.191	0.02666	0.0008	5.0	0.1163
minimum	0.04	0.07	0.0020	1.81	0.001	0.0004	0.0006	0.019	< 0.00001	< 0.000005	< 0.05	0.000176	34.1	< 0.00010	0.000041	0.00057	0.040	0.00061	0.0015	8.7	0.0228
maximum	0.21	0.33	0.0250	15.10	0.059	0.0018	0.0070	0.107	< 0.00001	< 0.000005	< 0.05	0.001680	95.7	0.00050	0.000161	0.00439	0.767	0.07840	0.0045	25.2	0.4290
# < detection limit	7	0	7	0	0	0	0	0	18	18	18	0	0	12	0	0	0	0	0	0	0
% < detection limit	47%	0%	47%	0%	0%	0%	0%	0%	100%	100%	100%	0%	0%	67%	0%	0%	0%	0%	0%	0%	0%
# > background	0	0	0	1	0	7	3	8	0	0	0	18	0	0	0	2	2	9	0	14	3
% > background	0%	0%	0%	7%	0%	39%	17%	44%	0%	0%	0%	100%	0%	0%	0%	11%	11%	50%	0%	78%	17%
# > guideline	0				0		1				0	18		0		3	0	12			0
% > guideline	0%				0%		6%				0%	100%		0%		17%	0%	67%			0%

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light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.16: Water quality concentrations for KV-9, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/10/2011	<0.00001	0.0002	**0.0019**	<0.002	0.50	0.00004	2.25	<0.000005	1.81	0.21	49	0.000012	<0.00001	<0.0005	0.0011	<0.0002	**0.015**	<0.0001
5/12/2011	<0.00001	0.0002	**0.0250**	0.018	**0.80**	0.00005	1.82	**0.000264**	0.71	0.08	19	0.000028	0.00007	<0.0005	0.0002	<0.0002	**0.103**	<0.0001
7/14/2011	<0.00001	0.0002	0.0009	0.006	0.31	0.00010	2.62	**0.000050**	1.41	0.15	32	0.000017	0.00005	<0.0005	0.0005	<0.0002	**0.042**	<0.0001
10/23/2011	<0.00001	0.0003	0.0006	0.004	0.54	0.00022	3.10	**0.000063**	1.69	0.22	53	0.000009	<0.00001	<0.0005	0.0011	<0.0002	**0.031**	<0.0001
11/25/2011	<0.00001	0.0002	0.0006	0.009	0.60	0.00026	2.90	**0.000473**	1.89	0.20	53	0.000017	0.00005	0.0011	0.0011	0.0002	**0.045**	<0.0001
12/16/2011	<0.00001	0.0002	0.0003	<0.002	0.51	0.00022	2.60	<0.000005	1.73	0.20	43	0.000006	0.00004	<0.0005	0.0010	<0.0002	**0.016**	<0.0001
1/14/2012	<0.00001	0.0003	0.0004	0.002	0.58	0.00026	3.00	0.000012	**3.05**	0.19	51	0.000006	<0.0002	<0.0005	0.0010	<0.0002	**0.021**	<0.0001
2/15/2012	<0.00001	0.0002	0.0003	0.003	0.54	0.00014	2.60	0.000007	1.74	0.18	45	<0.000002	<0.00020	<0.0005	0.0011	<0.0002	0.013	<0.0001
3/15/2012	<0.00001	0.0002	0.0003	0.003	0.50	0.00021	2.40	**0.000153**	1.65	0.19	39	0.000008	**0.00040**	<0.0005	0.0011	<0.0002	**0.021**	<0.0001
4/8/2012	<0.00001	0.0003	0.0006	<0.002	0.50	0.00018	2.50	<0.000005	1.65	0.19	41	0.000005	<0.00020	<0.0005	0.0011	<0.0002	**0.026**	<0.0001
5/4/2012	<0.00001	0.0001	0.0011	0.020	**0.69**	0.00009	1.68	**0.000359**	0.71	0.08	17	0.000031	<0.00020	0.0013	0.0002	<0.0002	**0.101**	<0.0001
6/7/2012	<0.00001	0.0002	0.0006	0.003	0.45	0.00015	1.97	**0.000080**	1.31	0.15	31	0.0000121	<0.00020	<0.0005	0.0006	<0.0002	**0.037**	<0.0001
7/7/2012	<0.00001	0.0003	0.0006	0.004	0.46	0.00012	2.93	0.000032	**2.00**	0.21	47	0.0000169	<0.00020	0.0006	0.0009	<0.00020	**0.031**	<0.0001
8/3/2012	<0.00001	0.0003	0.0006	<0.002	0.41	0.00011	3.06	0.000013	1.75	0.20	40	0.0000120	<0.00020	<0.0005	0.0009	<0.00020	**0.028**	<0.0001
9/22/2012	<0.00001	0.0003	0.0006	0.002	0.56	0.00012	3.01	0.000012	1.81	0.22	48	0.0000080	<0.00020	<0.0005	0.0010	<0.00020	**0.025**	<0.0001
10/12/2012	<0.00001	0.0003	0.0006	<0.002	0.54	0.00012	3.20	0.000008	**1.98**	0.23	53	0.0000080	<0.00020	<0.0005	0.0011	<0.0002	**0.026**	<0.0001
11/24/2012	<0.00001	0.0003	0.0006	0.003	0.57	0.00006	2.66	0.000006	**1.99**	0.20	45	0.000008	<0.00020	<0.0005	0.0011	<0.0002	**0.021**	<0.0001
12/8/2012	<0.00001	0.0002	0.0012	0.015	0.60	0.00004	2.67	**0.000681**	1.87	0.20	49	0.000023	<0.00020	0.0017	0.0011	0.0002	**0.065**	0.0002
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
median	< 0.00001	0.00022	0.00061	0.003	0.54	0.00012	2.64	0.000022	1.75	0.198	45	0.000011	0.00020	0.0005	0.00104	0.0002	0.0271	0.0001
mean	< 0.00001	0.00023	0.00205	0.006	0.54	0.00014	2.61	0.000124	1.71	0.182	42	0.000013	0.00016	0.0006	0.00089	0.0002	0.0371	0.0001
standard deviation	0.000000	0.00005	0.00574	0.006	0.11	0.00007	0.45	0.000195	0.51	0.043	11	0.000008	0.00010	0.0003	0.00030	0.0000	0.0267	0.0000
minimum	< 0.00001	0.00014	0.00030	< 0.002	0.31	0.00004	1.68	< 0.000005	0.71	0.076	17	< 0.000002	< 0.00001	< 0.0005	0.00016	< 0.0002	0.0133	< 0.0001
maximum	< 0.00001	0.00030	0.02500	0.020	0.80	0.00026	3.20	0.000681	3.05	0.226	53	0.000031	0.00040	0.0017	0.00113	0.0002	0.1030	0.0002
# < detection limit	18	0	0	5	0	0	0	3	0	0	0	1	13	14	0	16	0	17
% < detection limit	100%	0%	0%	28%	0%	0%	0%	17%	0%	0%	0%	6%	72%	78%	0%	89%	0%	94%
# > background	0	0	2	0	2	0	0	8	4	0	0	0	1	0	0	0	17	0
% > background	0%	0%	11%	0%	11%	0%	0%	44%	22%	0%	0%	0%	6%	0%	0%	0%	94%	0%
# > guideline	0	0	0			0		5				0			0		15	
% > guideline	0%	0%	0%			0%		28%				0%			0%		83%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.17: Water quality concentrations for KV-38, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011		8.12	7.56	173			0.1				1.0	78	72	44	53		40		
5/25/2011		7.73	**7.39**	77			4.3				13.0	34	34	12	15		22		
7/14/2011		7.75	**7.37**	129	128		**5.7**				3.0	61	60	26	32		31		
10/30/2011	**2,367**	7.86	7.66	180	185		0.6	10.6	74	271	<1	87	78	41	50		41		<0.05
12/18/2011	205	7.56	7.72	182	183		0.0	13.0	89		<1.0	83	80				43		
1/18/2012	100	7.62	7.72	186	174		0.0	11.7	80	**369**	<1.0	80	84				43		<0.005
2/9/2012	169	7.84	7.93	180	186		0.1	14.1	97	172	<1.0	87	85	46	56		43		<0.005
3/9/2012	134	7.44	7.80	185	188		-0.1	12.7	87	0	1.8	88	85				42		<0.05
4/7/2012	107	8.20	7.90	188	217		0.1	15.7	108	210	<1.0	86	87				42		<0.005
5/6/2012	128	7.74	7.82	181	173		0.9	13.5	95	71	<1.0	86	84	44	54	<0.50	43		<0.005
6/1/2012	**998**	7.68	7.65	122	95		2.6				1.9	51	51				30		<0.05
7/2/2012	**1,545**	7.64	7.58	140	152		4.6	12.7	99	91	7.3	67	64	28	35	<0.50	35		<0.05
8/1/2012	668	**7.13**	7.73	178	198		4.9	13.5	105	105	<1.0	84	86				48		<0.05
9/20/2012	647	7.95	7.88	187			4.2	12.3	94	90	<1.0	85	87				53		<0.05
10/16/2012			7.76	184							<1.0	89	85	38	46	<0.50	50		<0.05
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	11	14	15	15	11	0	14	10	10	9	15	15	15	8	8	3	15	0	11
median	205	7.74	7.72	180.00	182.50	-	0.75	12.87	94.45	105.30	1.00	84.40	83.60	39.50	48.20	0.50	42.30	-	0.05
mean	643	7.73	7.70	164.80	170.87	-	2.00	12.97	92.72	153.35	2.47	76.39	74.79	34.94	42.63	0.50	40.38	-	0.03
standard deviation	737	0.27	0.17	32.69	34.31	-	2.25	1.38	10.63	114.33	3.35	16.13	15.69	11.87	14.26	0.00	8.14	-	0.02
minimum	100	7.13	7.37	77.00	94.69	-	-0.10	10.58	73.70	0.09	1.00	34.30	34.40	12.00	15.00	0.50	22.00	-	0.01
maximum	2367	8.20	7.93	188.00	217.30	-	5.70	15.71	107.70	369.40	13.00	89.10	87.20	45.80	55.80	0.50	53.40	-	0.05
# < detection limit	0	0	0	0	0	-	0	0	0	0	9	0	0	0	0	3	0	-	11
% < detection limit	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	60%	0%	0%	0%	0%	100%	0%	-	100%
# > background		1	2	0	0	-	1	0	0	1	0	0	0	0	0	0	0	-	0
% > background	0%	7%	13%	0%	0%	-	7%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	-	0%
# > guideline		0	0			-		0			0					0		-	0
% > guideline	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.17: Water quality concentrations for KV-38, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2/8/2011			0.006	<0.5	0.004	0.00024	0.0025	0.062	<0.00001	<0.000005	<0.05	0.00007	24	0.00040	0.00002	0.0001	0.03	0.0002	0.0011	4	0.005
5/25/2011			0.009	4.60	0.077	0.00043	**0.0050**	0.033	<0.00001	<0.000005	<0.05	**0.00078**	10	0.00030	0.00015	0.0016	0.20	**0.0103**	<0.0005	2	0.032
7/14/2011			0.004	2.80	0.039	0.00039	0.0031	0.042	<0.00001	**0.000009**	<0.05	**0.00029**	19	0.00040	0.00005	0.0013	0.07	0.0013	0.0007	4	0.009
10/30/2011	<0.2	0.20	0.005	0.90	0.006	0.00025	0.0023	0.060	<0.00001	<0.000005	<0.05	0.00009	27	<0.0001	0.00001	0.0002	0.02	0.0002	0.0011	5	0.004
12/18/2011					0.004	0.00022	0.0026	0.059	<0.00001	<0.000005	<0.05	0.00008	25	0.00020	0.00001	0.0003	0.02	0.0001	0.0011	5	0.003
1/18/2012	0.18	0.04	0.007	<0.50	0.003	0.00024	0.0026	0.061	<0.00001	<0.000005	<0.05	0.00008	25	0.00020	0.00001	0.0002	0.02	0.0004	0.0013	5	0.003
2/9/2012	0.27	0.04	0.008	0.92	0.003	0.00022	0.0025	0.057	<0.00001	<0.000005	<0.05	0.00008	27	<0.0001	0.00001	0.0002	0.01	0.0001	0.0011	5	0.002
3/9/2012	0.26	<0.20	0.010	<0.50	0.011	0.00025	0.0028	0.059	<0.00001	<0.000005	<0.05	0.00010	27	0.00010	0.00004	0.0003	0.04	0.0037	0.0012	5	0.006
4/7/2012	0.16	0.04	0.004	<0.50	0.002	0.00025	0.0026	0.056	<0.00001	<0.000005	<0.05	0.00008	26	<0.0001	0.00001	0.0002	0.01	0.0001	0.0011	5	0.002
5/6/2012	0.10	**0.51**	0.007	1.29	0.007	0.00027	0.0030	0.057	<0.000010	<0.0000050	<0.050	0.00011	26	<0.00010	0.00001	0.0005	0.03	0.0003	0.0011	5	0.004
6/1/2012	<0.20	0.23	0.010	2.70	0.036	0.00029	0.0030	0.042	<0.000010	<0.0000050	<0.050	**0.00042**	15	0.00011	0.00005	0.0013	0.07	0.0013	0.0006	3	0.008
7/2/2012	<0.20	<0.20	0.008	1.80	0.040	0.00027	0.0033	0.044	<0.000010	<0.0000050	<0.050	**0.00017**	21	0.00026	0.00007	0.0008	0.12	0.0018	0.0006	4	0.013
8/1/2012	<0.20	0.24	0.004	0.94	0.006	0.00027	0.0026	0.056	<0.000010	<0.0000050	<0.050	**0.00017**	26	<0.00010	0.00003	0.0004	0.03	0.0002	0.0009	5	0.007
9/20/2012	<0.20	<0.20	0.005	1.02	0.007	0.00026	0.0027	0.059	<0.000010	<0.0000050	<0.050	0.00014	26	<0.00010	0.00002	0.0004	0.03	0.0001	0.0008	5	0.006
10/16/2012	<0.20	0.22		0.72	0.065	0.00028	**0.0062**	0.069	<0.000010	<0.0000050	<0.050	**0.00031**	28	0.00019	0.00021	0.0013	0.38	0.0048	0.0010	5	0.044
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	11	11	13	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
median	0.20	0.20	0.01	0.93	0.01	0.00	0.00	0.06	0.00001	0.00	0.05	0.00	25.60	0.00	0.00	0.00	0.03	0.00	0.00	4.71	0.01
mean	0.20	0.19	0.01	1.41	0.02	0.00	0.00	0.05	0.00	0.00	0.05	0.00	23.44	0.00	0.00	0.00	0.07	0.00	0.00	4.35	0.01
standard deviation	0.04	0.13	0.00	1.20	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	5.12	0.00	0.00	0.00	0.10	0.00	0.00	0.84	0.01
minimum	0.10	0.04	0.00	0.50	0.00	0.00	0.00	0.03	0.00	0.00	0.05	0.00	10.40	0.00	0.00	0.00	0.01	0.00	0.00	2.03	0.00
maximum	0.27	0.51	0.01	4.60	0.08	0.00	0.01	0.07	0.00	0.00	0.05	0.00	27.90	0.00	0.00	0.00	0.38	0.01	0.00	5.10	0.04
# < detection limit	6	3	0	4	0	0	0	0	15	14	15	0	0	6	0	0	0	0	1	0	0
% < detection limit	55%	27%	0%	29%	0%	0%	0%	0%	100%	93%	100%	0%	0%	40%	0%	0%	0%	0%	7%	0%	0%
# > background	0	1	0	0	0	0	2	0	0	1	0	6	0	0	0	0	0	1	0	0	0
% > background	0%	9%	0%	0%	0%	0%	13%	0%	0%	7%	0%	40%	0%	0%	0%	0%	0%	7%	0%	0%	0%
# > guideline	0				0		1				0	6		0		0	0	3			0
% > guideline	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	40%	0%	0%	0%	0%	0%	20%	0%	0%	0%

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Table A.17: Water quality concentrations for KV-38, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2/8/2011	<0.00001	0.0003	0.0003	0.007	0.17	0.00062	3.57	<0.000005	0.99	0.09	11	<0.000002	<0.00001	<0.0005	0.0002	<0.0002	0.007	<0.0001
5/25/2011	<0.00001	0.0001	0.0009	**0.029**	0.32	0.00031	1.46	**0.000056**	0.30	0.03	<10	0.000003	<0.00001	0.0015	0.0001	<0.0002	**0.067**	<0.0001
7/14/2011	<0.00001	0.0001	0.0006	0.008	0.12	0.00039	2.21	0.000009	0.56	0.06	11	<0.000002	0.00004	<0.0005	0.0001	<0.0002	**0.026**	<0.0001
10/30/2011	<0.00001	0.0002	0.0002	0.003	0.16	0.00075	3.60	<0.000005	0.91	0.08	16	<0.000002	0.00010	<0.0005	0.0002	<0.0002	0.008	<0.0001
12/18/2011	<0.00001	0.0002	0.0003	0.004	0.16	0.00076	3.40	<0.000005	1.01	0.09	15	<0.000002	0.00004	<0.0005	0.0002	<0.0002	0.008	<0.0001
1/18/2012	<0.00001	0.0002	0.0002	0.009	0.19	0.00078	3.70	0.000022	1.04	0.09	17	<0.000002	<0.0002	<0.0005	0.0002	<0.0002	0.008	<0.0001
2/9/2012	<0.00001	0.0002	0.0002	0.007	0.18	0.00080	3.70	<0.000005	1.06	0.09	16	<0.000002	<0.0002	<0.0005	0.0002	<0.0002	0.007	<0.0001
3/9/2012	<0.00001	0.0002	0.0002	0.020	0.19	0.00080	3.70	0.000006	1.10	0.09	15	<0.000002	<0.0002	<0.0005	0.0002	<0.0002	0.010	<0.0001
4/7/2012	<0.00001	0.0002	0.0002	0.004	0.17	0.00080	3.50	<0.000005	1.13	0.09	15	<0.000002	<0.0002	<0.0005	0.0003	<0.0002	0.007	<0.0001
5/6/2012	<0.00001	0.0002	0.0003	0.006	0.26	0.00092	3.36	<0.000005	1.08	0.09	16	<0.0000020	<0.00020	<0.00050	0.0003	<0.00020	0.011	<0.00010
6/1/2012	<0.00001	0.0001	0.0009	0.010	0.23	0.00045	1.74	**0.000081**	0.61	0.06	10	<0.0000020	<0.00020	0.0006	0.0001	<0.00020	**0.039**	<0.00010
7/2/2012	<0.00001	0.0001	0.0006	0.006	0.08	0.00045	2.17	0.000017	0.51	0.06	14	<0.0000020	<0.00020	0.0008	0.0001	<0.00020	**0.015**	<0.00010
8/1/2012	<0.00001	0.0002	0.0004	<0.0020	0.10	0.00067	2.90	<0.000005	0.78	0.08	17	<0.0000020	<0.00020	<0.00050	0.0001	<0.00020	**0.016**	<0.00010
9/20/2012	<0.00001	0.0002	0.0003	0.003	0.15	0.00070	2.72	<0.000005	0.75	0.08	19	<0.0000020	<0.00020	<0.00050	0.0001	<0.00020	0.011	<0.00010
10/16/2012	<0.00001	0.0001	0.0006	**0.026**	0.15	0.00071	3.44	0.000014	0.78	0.09	20	0.000002	<0.00020	0.0024	0.0002	<0.00020	**0.022**	<0.00010
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
median	0.00	0.00	0.00	0.01	0.17	0.00	3.40	0.00	0.91	0.09	15.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
mean	0.00	0.00	0.00	0.01	0.17	0.00	3.01	0.00	0.84	0.08	14.80	0.00	0.00	0.00	0.00	0.00	0.02	0.00
standard deviation	0.00	0.00	0.00	0.01	0.06	0.00	0.77	0.00	0.25	0.02	3.10	0.00	0.00	0.00	0.00	0.00	0.02	0.00
minimum	0.00	0.00	0.00	0.00	0.08	0.00	1.46	0.00	0.30	0.03	10.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
maximum	0.00	0.00	0.00	0.03	0.32	0.00	3.70	0.00	1.13	0.09	20.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00
# < detection limit	15	0	0	1	0	0	0	8	0	0	1	13	12	11	0	15	0	15
% < detection limit	100%	0%	0%	7%	0%	0%	0%	53%	0%	0%	7%	87%	80%	73%	0%	100%	0%	100%
# > background	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	6	0
% > background	0%	0%	0%	13%	0%	0%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%
# > guideline	0	0	0			0		0				0			0		4	
% > guideline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	27%	0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH

Table A.18: Water quality concentrations for KV-41, 2011-2012.

Analytes	Discharge (Flow)	pH (field)	pH (lab)	Conductivity (field)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Total Suspended Solids	Hardness (from total)	Hardness (from dissolved)	Total Alkalinity	Alkalinity bicarbonate HCO3	Chloride	Dissolved Sulphate	Ammonia (N)	Nitrite (N)
Sample Date	**L/s**	**pH units**	**pH units**	**µS/cm**	**µS/cm**	**µS/cm**	**C**	**mg/L**	**%**	**mV**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
1/12/2011		7.98	7.51	161		246	0.2				4	123	115	52	64		69	<0.005	<0.005
2/8/2011		7.97	7.70	112		251	0.0				3	118	99	54	66		64	0.014	<0.005
3/22/2011		8.11	7.70	140		256	1.2				4	127	123	60	74		70	0.013	<0.005
4/19/2011			7.83	**331**		256	0.6				1	127	126	60	73		67	0.007	<0.005
5/13/2011		7.92	7.64	136		248	0.8				2	116	117	55	67		59	0.008	<0.005
6/21/2011	1,055	**8.52**	7.66	92		148	**5.3**				**70**	69	69	33	40		35	**0.032**	0.033
7/13/2011	1,075	7.92	7.67		167	160	**7.8**				**29**	78	77	37	45		37	**0.037**	0.021
8/17/2011	1,713	8.29	7.98			180	**5.2**				**41**	82	85	35	43		47	0.022	<0.500
9/17/2011	973	**7.03**	7.80		158	194	2.6				**34**	88	87	45	55		44	0.012	0.005
9/23/2011	767	8.04	7.91		189	190	4.0				**140**	90	87	44	54		45	0.023	0.018
10/30/2011	404	7.89	7.72		218	204	0.8	10.86	76	277	3	97	94	48	58		50	**0.043**	<0.05
11/20/2011		7.87	7.75		217	226	0.1	14.00	96	156	<1	110	98	54	66		61		<0.005
12/18/2011			7.70			221					3	110	111	50	61		56	<0.005	<0.005
12/18/2011	268	7.66	7.65		226	223	0.0	13.15	90		3	103	103	50	61		60	**0.048**	<0.005
1/17/2012	251	8.48	7.63		220	231	0.0	11.90	82	**351**	4	108	100	54	66		55	0.022	<0.005
2/13/2012		7.53	7.88		240	243	0.1	14.50	100	184	3	109	118	54	66		60	0.017	0.022
3/9/2012	182	7.46	7.98		244	245	0.0	13.38	92	60	2	115	113	57	70		60	0.014	<0.050
4/7/2012		7.69	7.95			254	0.1			209	<1	118	116	57	70		61	0.012	<0.005
5/1/2012	202	8.20	7.86		249	252	1.4	13.92	99	203	**53**	122	120	54	66	**2.4**	60	0.010	0.052
5/31/2012	1,656	7.78	7.62		98	123	4.1				**246**	60	51	29	35	1.1	26	**0.053**	<0.050
7/2/2012	1,958	7.79	7.49		164	154	**5.2**	12.51	99	81	**540**	96	67	33	40	1.1	35	**0.034**	0.052
7/8/2012		7.90	7.82		182	173	**6.0**	12.20	98	106	**197**	85	74	37	46		40	0.016	<0.050
8/1/2012	884	7.51	7.75		213	194	**6.4**	13.12	107	103	**166**	101	95	43	52	0.66	50	**0.034**	<0.050
9/21/2012	795	7.73	7.74		220	200	3.7	12.66	96	102	13	85	88	41	50	0.67	52	0.014	<0.050
10/16/2012	566	7.67	7.83		227	201	1.1	13.05	92	193	5	95	93	46	56	0.58	50	0.015	<0.050
11/18/2012		**6.84**	**7.04**		239	221	0.3	**8.60**	76		5	108	108	51	63	<0.50	56	0.013	**0.073**
11/18/2012		**6.84**	7.98		239	223	0.3	**8.60**	76		7	110	111	53	65	0.96	58	0.017	<0.050
12/6/2012		**6.76**	7.86		267	241	0.0			145	9	110	108	57	70	0.76	64	**0.071**	<0.005
guideline		6.5-9.0						6.5 - 9.5			25.7					120	309	0.019	0.060
background	8 - 711	7.17 - 8.49	7.44 - 8.30	275	699	714	5.2	10.3	72	349	20.7	384	389	93	113	1.3	221	0.031	0.056
n	15	26	28	6	19	28	27	14	14	13	28	28	28	28	28	9	28	27	28
median	795	7.83	7.75	138	220	222	0.8	12.86	94	156.1	5	108	100	51	62	0.76	56	0.016	0.022
mean	850	7.75	7.74	162	209	213	2.1	12.32	91	166.8	57	102	98	48	59	0.97	53	0.023	0.044
standard deviation	572	0.47	0.19	86	41	37	2.5	1.82	10	82.5	115	17	19	9	11	0.58	11	0.016	0.092
minimum	182	6.76	7.04	92	98	123	0.0	8.60	76	59.8	< 1	60	51	29	35	0.50	26	0.005	< 0.005
maximum	1958	8.52	7.98	331	267	256	7.8	14.50	107	351.2	540	127	126	60	74	2.40	70	0.071	0.500
# < detection limit	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	2	20
% < detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	11%	0%	7%	71%
# > background		5	1	1	0	0	6	2	0	1	10	0	0	0	0	1	0	8	2
% > background		19%	4%	17%	0%	0%	22%	14%	0%	8%	36%	0%	0%	0%	0%	11%	0%	30%	7%
# > guideline		0	0					2			10					0		11	2
% > guideline		0%	0%					14%			36%					0%		41%	7%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.18: Water quality concentrations for KV-41, 2011-2012.

Analytes	Nitrate (N)	Total Kjeldahl Nitrogen	Total Phosphate	Dissolved Organic Carbon	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)
Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1/12/2011	0.26			0.60	0.032	0.00036	0.0010	0.048	<0.00001	<0.000005	<0.05	0.00008	38	0.00080	0.00010	0.0007	0.08	0.0020	0.0018	6.6	0.011
2/8/2011	**0.33**		0.007	0.60	0.021	0.00030	0.0009	0.049	<0.00001	<0.000005	<0.05	0.00004	37	0.00040	0.00007	0.0003	0.04	0.0005	0.0018	6.2	0.006
3/22/2011	0.27		0.007	0.50	0.030	0.00024	0.0010	0.052	<0.00001	<0.000005	<0.05	0.00005	40	0.00050	0.00012	0.0005	0.07	0.0008	0.0017	6.9	0.012
4/19/2011	0.21		0.007	1.10	0.018	0.00023	0.0009	0.051	<0.00001	<0.000005	<0.05	0.00005	40	0.00040	0.00006	0.0004	0.03	0.0005	0.0015	6.8	0.006
5/13/2011	0.23		0.003	2.10	0.039	0.00030	0.0010	0.048	<0.00001	<0.000005	<0.05	0.00007	36	0.00040	0.00005	0.0008	0.06	0.0008	0.0016	6.4	0.006
6/21/2011	<0.02		0.007	1.30	**0.890**	0.00032	**0.0036**	0.065	**0.000030**	<0.000020	<0.05	**0.00019**	21	**0.00240**	**0.00129**	**0.0060**	**1.48**	0.0051	0.0017	4.2	0.068
7/13/2011	0.03		0.011	1.70	**3.520**	0.00074	**0.0114**	**0.125**	**0.000120**	**0.00006**	<0.05	**0.00052**	23	**0.00700**	**0.00463**	**0.0253**	**6.31**	**0.0195**	**0.0055**	5.0	0.205
8/17/2011	<2.00		0.004	2.40	**0.294**	0.00032	0.0025	0.059	0.000010	<0.000005	<0.05	**0.00022**	25	0.00070	**0.00043**	0.0025	**0.56**	**0.0066**	0.0014	4.8	0.027
9/17/2011	0.11		**0.033**	1.70	**0.245**	0.00025	0.0025	0.064	0.000010	<0.000005	<0.05	**0.00019**	27	0.00040	**0.00059**	0.0025	0.30	0.0033	0.0017	5.0	0.036
9/23/2011	0.10		**0.136**	1.00	**1.060**	0.00032	**0.0042**	**0.084**	**0.000060**	**0.000019**	<0.05	**0.00028**	27	**0.00220**	**0.00185**	**0.0090**	**1.50**	**0.0078**	0.0028	5.2	0.072
10/30/2011	<0.2	0.30	0.006	1.10	0.050	0.00029	0.0014	0.052	<0.00001	<0.000005	<0.05	0.00007	30	0.00020	0.00008	0.0005	0.06	0.0010	0.0016	5.5	0.006
11/20/2011	0.25	0.21	0.005	1.10	0.018	0.00028	0.0010	0.045	<0.00001	<0.000005	<0.05	0.00001	34	0.00010	0.00002	0.0004	0.02	0.0000	0.0018	6.3	0.002
12/18/2011	0.25		0.006	0.54	0.047	<0.00050	0.0009	0.047	<0.0001	<0.001000	<0.05	0.00006	34	**0.00100**	<0.000500	0.0006	0.07	0.0003	<0.0050	6.2	0.004
12/18/2011	0.26	0.04	0.006	<0.50	0.021	0.00022	0.0010	0.048	<0.00001	<0.000005	<0.05	0.00006	32	0.00010	0.00004	0.0004	0.03	0.0003	0.0015	5.7	0.003
1/17/2012	0.30	0.03	0.010	0.72	0.018	0.00023	0.0010	0.050	<0.00001	<0.000005	<0.05	0.00006	34	<0.00010	0.00005	0.0004	0.03	0.0005	0.0015	5.8	0.005
2/13/2012	0.25	0.10	0.007	0.50	0.024	0.00023	0.0009	0.050	<0.00001	<0.000005	<0.05	0.00004	34	0.00010	0.00004	0.0009	0.03	0.0004	0.0016	5.9	0.004
3/9/2012	**0.33**	<0.20	0.009	<0.50	0.023	0.00022	0.0009	0.051	<0.00001	<0.000005	<0.05	0.00005	36	0.00010	0.00006	0.0008	0.04	0.0005	0.0017	6.3	0.006
4/7/2012	0.31	0.04	0.003	<0.50	0.011	0.00027	0.0008	0.049	<0.00001	<0.000005	<0.05	0.00005	36	<0.00010	0.00002	0.0003	0.02	0.0005	0.0016	6.6	0.003
5/1/2012	**2.63**	0.17	**0.065**	2.12	**0.344**	0.00053	0.0027	0.071	**0.000025**	0.0000060	<0.05	**0.00023**	38	0.00073	**0.00060**	**0.0036**	**0.75**	**0.0099**	0.0020	6.9	0.047
5/31/2012	<0.20	**0.44**	**0.250**	3.63	**1.000**	0.00036	**0.0043**	**0.109**	**0.000082**	0.0000059	<0.05	**0.00061**	17	**0.00198**	**0.00212**	**0.0094**	**2.91**	**0.0114**	0.0022	4.1	0.158
7/2/2012	**0.39**	<0.20	**0.652**	2.21	**2.330**	0.00047	**0.0091**	**0.202**	**0.000175**	**0.0000595**	<0.05	**0.00113**	28	**0.00463**	**0.00523**	**0.0247**	**7.54**	**0.0296**	0.0032	6.5	**0.414**
7/8/2012	<0.20		**0.302**	0.57	**0.723**	0.00037	**0.0045**	**0.111**	**0.000062**	**0.0000262**	<0.05	**0.00051**	26	**0.00140**	**0.00180**	**0.0088**	**2.34**	**0.0114**	0.0019	4.9	0.180
8/1/2012	<0.20	0.34	**0.181**	0.94	**0.715**	0.00038	**0.0036**	**0.107**	**0.000058**	**0.0000140**	<0.05	**0.00040**	30	**0.00132**	**0.00161**	**0.0076**	**1.94**	**0.0095**	0.0023	6.0	0.108
9/21/2012	<0.20	<0.20	0.018	0.97	0.100	0.00026	0.0018	0.055	<0.00001	<0.000005	<0.05	0.00012	26	0.00015	0.00014	0.0009	0.11	0.0013	0.0013	4.8	0.009
10/16/2012	<0.20	0.22	0.008	0.58	0.033	0.00025	0.0015	0.055	<0.00001	<0.000005	<0.05	0.00008	30	0.00014	0.00006	0.0007	0.06	0.0008	0.0015	4.9	0.007
11/18/2012	<0.20	**0.66**	0.014	0.62	0.053	0.00026	0.0013	0.055	<0.00001	<0.000005	<0.05	0.00009	34	0.00041	0.00010	0.0010	0.11	0.0028	0.0015	6.0	0.010
11/18/2012	**0.42**		0.013	<0.50	0.042	0.00025	0.0012	0.052	<0.00001	<0.000005	<0.05	0.00007	34	0.00044	0.00009	0.0010	0.09	0.0016	0.0015	6.1	0.008
12/6/2012	0.27	**0.65**	0.018	3.06	0.071	0.00030	0.0014	0.058	<0.00001	<0.000005	<0.05	0.00016	34	0.00030	0.00016	0.0025	0.15	**0.0091**	0.0016	6.3	0.014
guideline	3.00				0.10		0.0050				1.50	0.00016		0.00890	0.0025	0.0024	1.00	0.0032			1.0
background	0.31	0.44	0.027	9.26	0.15	0.00096	0.0034	0.082	0.000015	0.000007	0.05	0.00016	126	0.00088	0.00029	0.0028	0.41	0.0058	0.0054	18	0.243
n	28	15	27	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
median	0.25	0.20	0.0090	0.96	0.048	0.00030	0.0013	0.053	0.00001	0.000005	< 0.05	0.000081	33.7	0.00041	0.000110	0.00091	0.082	0.00145	0.0017	6.0	0.0097
mean	0.38	0.25	0.0662	1.20	0.420	0.00032	0.0024	0.068	0.00003	0.000047	< 0.05	0.000196	31.4	0.00102	0.000781	0.00401	0.953	0.00492	0.0020	5.8	0.0514
standard deviation	0.56	0.20	0.1413	0.85	0.796	0.00012	0.0025	0.034	0.00004	0.000187	0.00	0.000244	5.7	0.00154	0.001338	0.00661	1.870	0.00686	0.0010	0.8	0.0910
minimum	< 0.02	0.03	0.0030	0.50	0.011	0.00022	0.0008	0.045	< 0.00001	< 0.000005	< 0.05	0.000007	17.4	< 0.00010	0.000019	0.00025	0.016	0.00005	0.0013	4.1	0.0020
maximum	2.63	0.66	0.6520	3.63	3.520	0.00074	0.0114	0.202	0.00018	0.001000	< 0.05	0.001130	39.7	0.00700	0.005230	0.02530	7.540	0.02960	0.0055	6.9	0.4140
# < detection limit	9	3	0	4	0	1	0	0	18	21	28	0	0	2	1	0	0	0	1	0	0
% < detection limit	32%	20%	0%	14%	0%	4%	0%	0%	64%	75%	100%	0%	0%	7%	4%	0%	0%	0%	4%	0%	0%
# > background	6	3	7	0	10	0	7	6	9	7	0	10	0	8	11	8	9	9	1	0	1
% > background	21%	20%	26%	0%	36%	0%	25%	21%	32%	25%	0%	36%	0%	29%	39%	29%	32%	32%	4%	0%	4%
# > guideline	0				10		2				0	10		0		11	7	11			0
% > guideline	0%				36%		7%				0%	36%		0%		39%	25%	39%			0%

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.18: Water quality concentrations for KV-41, 2011-2012.

Analytes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1/12/2011	<0.00001	0.0003	0.0005	0.019	0.22	0.00093	3.63	0.000040	1.11	0.096	21	0.000003	0.00019	0.0007	0.0007	0.0003	0.011	**0.0003**
2/8/2011	<0.00001	0.0002	0.0004	0.007	0.20	0.00089	3.16	<0.000005	1.02	0.094	19	<0.000002	<0.00001	0.0008	0.0006	<0.0002	0.008	<0.0001
3/22/2011	<0.00001	0.0003	0.0004	0.007	0.20	0.00100	3.47	0.000010	1.10	0.097	23	<0.000002	<0.00001	0.0007	0.0007	<0.0002	0.008	<0.0001
4/19/2011	<0.00001	0.0003	0.0004	0.006	0.20	0.00107	3.45	<0.000005	1.09	0.102	20	<0.000002	<0.00001	<0.0005	0.0007	<0.0002	0.007	<0.0001
5/13/2011	<0.00001	0.0003	0.0005	0.005	0.23	0.00081	3.38	0.000011	1.10	0.088	22	0.000002	0.00001	0.0014	0.0007	<0.0002	0.009	<0.0001
6/21/2011	<0.00001	0.0002	**0.0036**	**0.064**	<0.30	0.00047	3.03	**0.000105**	0.50	0.061	<50	0.000021	<0.00020	**0.0250**	0.0003	**0.0025**	**0.017**	**0.0003**
7/13/2011	0.00003	**0.0005**	**0.0121**	**0.165**	0.50	0.00053	**6.86**	**0.000520**	0.60	0.072	<50	**0.000048**	<0.00020	**0.1000**	0.0007	**0.0089**	**0.047**	**0.0007**
8/17/2011	<0.00001	0.0002	0.0014	**0.041**	0.14	0.00056	2.80	**0.000060**	0.62	0.071	18	0.000005	<0.00001	**0.0087**	0.0002	**0.0009**	**0.019**	<0.0001
9/17/2011	<0.00001	0.0002	0.0013	**0.029**	0.18	0.00072	3.00	**0.000093**	0.74	0.080	17	0.000006	0.00004	**0.0065**	0.0004	**0.0008**	**0.017**	0.0001
9/23/2011	<0.00001	0.0002	**0.0042**	**0.077**	0.28	0.00063	**4.20**	**0.000261**	0.76	0.082	16	0.000016	0.00011	**0.0320**	0.0004	**0.0032**	**0.023**	**0.0009**
10/30/2011	<0.00001	0.0002	0.0004	0.007	0.20	0.00084	3.10	0.000012	0.95	0.089	19	<0.000002	0.00007	0.0013	0.0004	<0.0002	0.006	<0.0001
11/20/2011	<0.00001	0.0003	0.0002	0.004	0.20	**0.00112**	3.70	<0.000005	1.12	0.085	21	<0.000002	0.00005	<0.0005	0.0000	<0.0002	0.003	<0.0001
12/18/2011	<0.00005	<0.00100	**0.0020**	<0.01	0.17	0.00090	3.31	<0.00002	1.04	0.091	17	<0.00005	<0.00500	<0.005	0.0005	<0.005	0.007	<0.0005
12/18/2011	<0.00001	0.0002	0.0003	0.005	0.17	0.00103	3.00	0.000008	0.97	0.089	18	<0.000002	0.00002	0.0008	0.0004	<0.0002	0.005	<0.0001
1/17/2012	<0.00001	0.0002	0.0002	0.007	0.19	**0.00117**	3.50	0.000006	1.02	0.090	22	<0.000002	<0.00020	<0.0005	0.0005	<0.0002	0.006	<0.0001
2/13/2012	<0.00001	0.0002	0.0004	0.006	0.19	0.00103	3.00	<0.000005	1.07	0.092	18	<0.000002	<0.00020	<0.0005	0.0006	<0.0002	0.005	<0.0001
3/9/2012	<0.00001	0.0002	0.0004	0.008	0.22	**0.00117**	3.40	0.000006	1.82	0.089	21	<0.000002	<0.00020	<0.0005	0.0005	<0.0002	0.007	<0.0001
4/7/2012	<0.00001	0.0003	0.0003	<0.002	0.21	0.00108	3.10	<0.000005	1.37	0.095	21	<0.000002	<0.00020	<0.0005	0.0006	<0.0002	0.006	<0.0001
5/1/2012	<0.00001	0.0003	**0.0016**	**0.041**	0.36	**0.00109**	3.55	0.000035	1.50	0.097	22	0.000010	<0.00020	**0.0077**	0.0009	**0.0015**	**0.018**	**0.0011**
5/31/2012	<0.00001	0.0002	**0.0059**	**0.243**	0.35	0.00046	3.00	0.000022	0.62	0.061	<10	0.000027	<0.00020	**0.0213**	0.0004	**0.0038**	**0.042**	**0.0004**
7/2/2012	<0.00001	0.0003	**0.0137**	**0.681**	0.39	0.00059	**5.38**	**0.000312**	0.71	0.081	14	**0.000050**	<0.00020	**0.0480**	0.0008	**0.0096**	**0.080**	**0.0006**
7/8/2012	<0.00001	0.0002	**0.0044**	**0.226**	0.26	0.00061	3.42	**0.000200**	0.64	0.076	14	0.000021	<0.00020	**0.0212**	0.0004	**0.0029**	**0.036**	**0.0003**
8/1/2012	<0.00001	0.0001	**0.0042**	**0.172**	0.24	0.00068	3.91	**0.000162**	0.94	0.089	18	0.000018	<0.00020	**0.0171**	0.0004	**0.0026**	**0.029**	0.0002
9/21/2012	<0.00001	0.0002	0.0005	0.011	0.15	0.00084	2.54	0.000006	0.78	0.083	18	<0.000002	<0.00020	0.0023	0.0002	<0.0002	0.011	<0.0001
10/16/2012	<0.00001	0.0002	0.0004	0.010	0.17	0.00087	3.23	0.000007	0.80	0.086	20	<0.000002	**0.00082**	0.0014	0.0003	<0.0002	0.008	<0.0001
11/18/2012	<0.00001	0.0002	0.0006	0.010	0.20	0.00091	3.18	0.000005	1.09	0.093	20	0.000004	<0.00020	0.0016	0.0004	<0.0002	0.012	<0.0001
11/18/2012	<0.00001	0.0002	0.0005	0.015	0.19	**0.00111**	3.51	0.000005	1.09	0.088	20	0.000002	<0.00020	0.0014	0.0004	<0.0002	**0.014**	<0.0001
12/6/2012	<0.00001	0.0002	0.0007	0.019	0.54	0.00096	3.07	0.000027	1.35	0.096	23	<0.000002	<0.00020	0.0021	0.0005	0.0002	**0.018**	<0.0001
guideline	0.00026	0.0730	0.0960			0.00100		0.000100				0.000800			0.0150		0.017	
background	0.00001	0.0004	0.0015	0.020	0.66	0.00109	4.10	0.000047	1.95	0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003
n	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
median	0.00001	0.00023	0.00053	0.010	0.20	0.00090	3.35	0.000012	1.02	0.0890	20	0.000002	0.00020	0.0015	0.00044	0.0002	0.0107	0.0001
mean	0.00001	0.00026	0.00219	0.068	0.24	0.00086	3.50	0.000070	0.98	0.0861	21	0.000011	0.00033	0.0111	0.00049	0.0016	0.0170	0.0003
standard deviation	0.00001	0.00016	0.00342	0.139	0.10	0.00022	0.84	0.000121	0.30	0.0103	9	0.000015	0.00093	0.0210	0.00020	0.0025	0.0168	0.0003
minimum	< 0.00001	0.00014	0.00016	< 0.002	0.14	0.00046	2.54	< 0.000005	0.50	0.0606	10	< 0.000002	< 0.00001	< 0.0005	0.00004	< 0.0002	0.0025	< 0.0001
maximum	0.00005	0.00100	0.01370	0.681	0.54	0.00117	6.86	0.000520	1.82	0.1020	50	0.000050	0.00500	0.1000	0.00090	0.0096	0.0801	0.0011
# < detection limit	27	1	0	2	1	0	0	6	0	0	3	14	20	7	0	16	0	18
% < detection limit	96%	4%	0%	7%	4%	0%	0%	21%	0%	0%	11%	50%	71%	25%	0%	57%	0%	64%
# > background	2	2	9	10	0	5	3	8	0	0	0	3	2	11	0	11	12	9
% > background	7%	7%	32%	36%	0%	18%	11%	29%	0%	0%	0%	11%	7%	39%	0%	39%	43%	32%
# > guideline	0	0	0			9		6				0			0		9	
% > guideline	0%	0%	0%			32%		21%				0%			0%		32%	

Bold - value greater than background, or less than background for dissolved oxygen and pH.
light grey - value greater than guideline, or less than guideline for dissolved oxygen and pH.
dark grey - value greater than 2x guideline, or less than 2x guideline for dissolved oxygen and pH.

Table A.19: Comparison of 95th percentile for reference stations with and without KV-60.

Parameter	95th with KV-60	95th without KV-60
Laboratory Measures		
Non-Metals and Nutrients		
Hardness (from total)	378.1	383.5
Hardness (from dissolved)	379.2	388.5
Dissolved Sulphate	220.05	220.85
Total Suspended Solids	23.3	20.7
Nitrite (N)	0.050	0.056
Nitrate (N)	0.3151	0.3133
Total Kjeldahl Nitrogen	0.450	0.435
Dissolved Organic Carbon	9.674	9.255
Total Phosphate	0.0278	0.0271
Total Alkalinity	92.6	93.0
Alkalinity bicarbonate HCO3	112.8	113.3
Ammonia (N)	0.0305	0.0308
Specific Conductance (lab)	704	714
Chloride	1.26	1.32
pH (lab)	8.35	8.30
Total Metals		
Total Aluminum (Al)	0.182	0.153
Total Antimony (Sb)	0.00096	0.00096
Total Arsenic (As)	0.00397	0.00342
Total Barium (Ba)	0.099	0.082
Total Beryllium (Be)	0.000017	0.000015
Total Bismuth (Bi)	0.000008	0.000007
Total Boron (B)	0.05	0.05
Total Cadmium (Cd)	0.00039	0.00016
Total Calcium (Ca)	123.7	125.5
Total Chromium (Cr)	0.000878	0.000875
Total Cobalt (Co)	0.00050	0.00029
Total Copper (Cu)	0.00363	0.00280
Total Iron (Fe)	0.4412	0.4085
Total Lead (Pb)	0.00821	0.00579
Total Lithium (Li)	0.00521	0.00537
Total Magnesium (Mg)	21.79	18.40
Total Manganese (Mn)	0.201	0.243
Total Mercury (Hg)	0.00001	0.00001
Total Molybdenum (Mo)	0.00155	0.00035
Total Nickel (Ni)	0.0029	0.0015
Total Phosphorus (P)	0.0203	0.0202
Total Potassium (K)	0.719	0.660
Total Selenium (Se)	0.00118	0.00109
Total Silicon (Si)	4.10	4.10
Total Silver (Ag)	0.000092	0.000047
Total Sodium (Na)	1.92	1.95
Total Strontium (Sr)	0.348	0.354
Total Sulphur (S)	85.3	89.1
Total Thallium (Tl)	0.000038	0.000034
Total Tin (Sn)	0.00031	0.00033
Total Titanium (Ti)	0.0050	0.0048
Total Uranium (U)	0.00315	0.00326
Total Vanadium (V)	0.00062	0.00052
Total Zinc (Zn)	0.0208	0.0138
Total Zirconium (Zr)	0.00031	0.00027
Field Measures		
Discharge (Flow)	662	711
Temperature (field)	5.7	5.2
Dissolved Oxygen (field) mg/L	15.63	15.72
Dissolved Oxygen (field) %	109	109
Conductivity (field)	256	275
Specific Conductance (field)	680	699
pH (field)	8.49	8.49
ORP (field)	349.1	349.4

Table A.20: Ammonia guidelines determined by pH and temperature, based on table within CCME guideline. Shading denotes concentration greate than guideline.

Station	Date	Temperature	pH	Ammonia	Guideline
KV-6	1/12/2011	0.0	7.85	0.046	2.33
	2/8/2011	0.0	8.11	0.14	2.33
	3/22/2011	0.5	7.73	0.1	2.33
	4/19/2011	0.8	-	0.089	-
	5/25/2011	12.1	7.84	-	-
	6/22/2011	10.5	8.23	0.018	1.04
	7/13/2011	12.8	7.88	0.043	0.715
	8/17/2011	8.1	7.78	-	-
	9/24/2011	4.4	7.52	0.009	4.84
	10/29/2011	0.4	7.66	0.063	7.32
	11/21/2011	0.1	7.49	0.035	7.32
	12/14/2011	-0.1	7.36	0.18	7.32
	1/15/2012	0.0	7.30	0.11	7.32
	2/13/2012	-0.1	7.21	0.13	23.1
	3/11/2012	-0.1	7.10	0.12	23.1
	4/8/2012	0.1	7.69	0.12	7.32
	5/1/2012	1.9	7.67	0.036	7.32
	5/7/2012	2.3	7.93	0.032	2.33
	6/3/2012	11	7.92	0.025	1.04
	7/4/2012	13.1	7.93	0.059	0.715
	8/1/2012	12.9	7.82	0.028	0.715
	9/23/2012	5.6	7.75	0.012	1.54
	10/15/2012	0.6	7.56	0.036	7.32
	11/21/2012	0.1	8.00	0.057	2.33
KV-7	1/13/2011	0.1	8.40	0.24	0.749
	2/9/2011	0	8.21	0.033	2.33
	3/22/2011	0.1	8.02	0.016	2.33
	4/19/2011	0.9	-	0.026	-
	5/13/2011	0.5	7.66	0.016	7.32
	6/22/2011	8.1	8.47	0.037	0.343
	7/20/2011	4.1	8.40	-	-
	8/18/2011	5.3	7.30	0.026	4.84
	9/23/2011	2.7	8.18	0.13	1.54
	10/24/2011	0.3	8.20	0.038	2.33
	11/26/2011	-0.1	8.19	0.037	2.33
	12/14/2011	-0.1	8.14	0.088	2.33
	1/13/2012	0	7.80	0.042	2.33
	2/10/2012	-0.1	7.88	0.053	2.33
	3/10/2012	-0.1	7.82	0.043	2.33
	3/11/2012	-0.1	7.83	-	2.33
	4/6/2012	0	7.86	0.031	2.33
	5/1/2012	0.2	8.05	0.027	2.33
	5/7/2012	0.7	8.17	0.0092	2.33
	6/1/2012	6.8	7.73	-	1.54
	7/5/2012	7.2	8.20	0.024	1.54
	8/2/2012	6.7	8.06	0.03	1.54
	9/21/2012	3.8	8.01	0.0074	1.54
	10/15/2012	-0.1	7.80	0.024	2.33
	11/19/2012	0	8.12	0.034	2.33
	12/7/2012	0.05	7.08	0.052	23.1
KV-41	1/12/2011	0.2	7.98	< 0.005	2.33
	2/8/2011	0	7.97	0.014	2.33
	3/22/2011	1.2	8.11	0.013	2.33
	4/19/2011	0.6	-	0.007	-
	5/13/2011	0.8	7.92	0.008	2.33
	6/21/2011	5.3	8.52	0.032	0.502
	7/13/2011	7.8	7.92	0.037	1.04
	8/17/2011	5.2	8.29	0.022	0.502
	9/17/2011	2.6	7.03	0.012	15.3
	9/23/2011	4	8.04	0.023	1.54
	10/30/2011	0.8	7.89	0.043	2.33
	11/20/2011	0.1	7.87	-	-
	12/18/2011	-	-	< 0.005	-
	12/18/2011	0	7.66	0.048	7.32
	1/17/2012	0	8.48	0.022	0.749
	2/13/2012	0.1	7.53	0.017	7.32
	3/9/2012	0	7.46	0.014	7.32
	4/7/2012	0.1	7.69	0.012	7.32
	5/1/2012	1.4	8.20	0.01	2.33
	5/31/2012	4.1	7.78	0.053	1.54
	7/2/2012	5.2	7.79	0.034	1.54
	7/8/2012	6	7.90	0.016	1.54
	8/1/2012	6.4	7.51	0.034	4.84
	9/21/2012	3.7	7.73	0.014	4.84
	10/16/2012	1.1	7.67	0.015	7.32
	11/18/2012	0.3	6.84	0.013	23.1
	11/18/2012	0.3	6.84	0.017	23.1
	12/6/2012	0.02	6.76	0.071	23.1

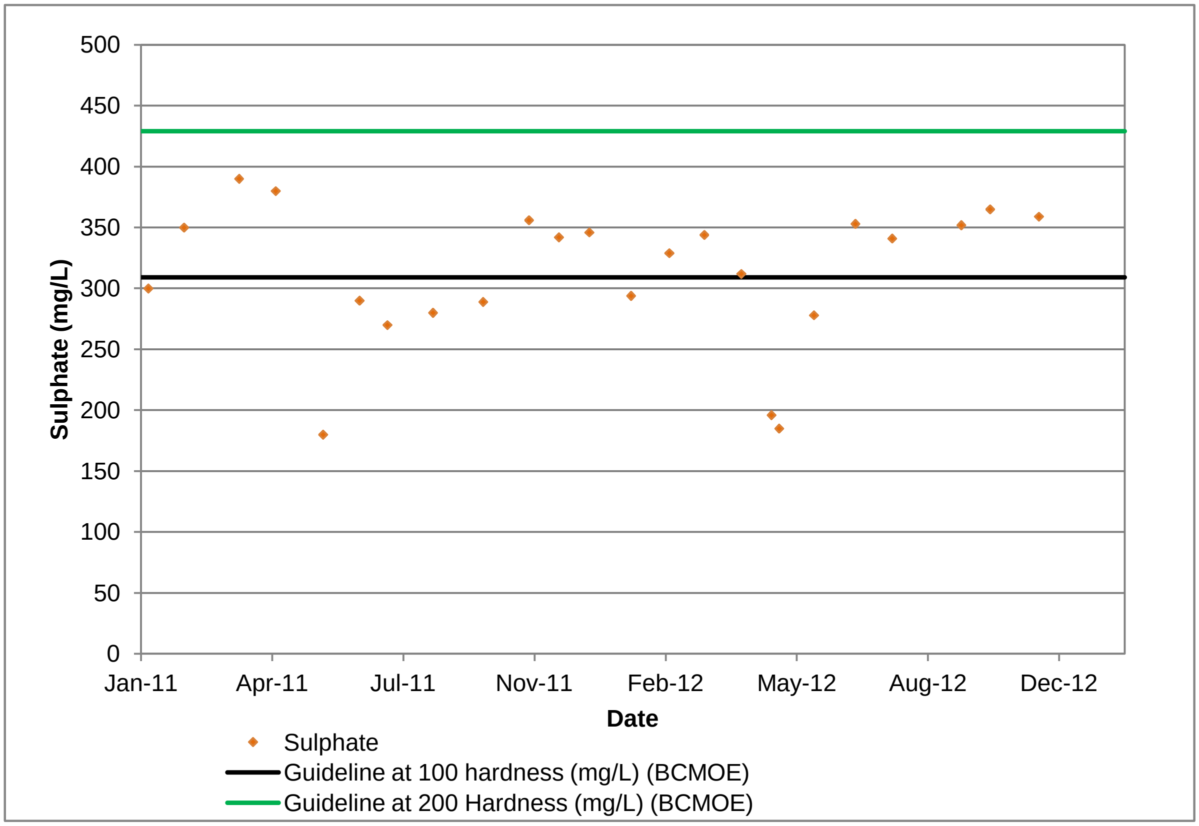


Figure A.1: Sulphate values for station KV-6, UKHM 2011-2012.

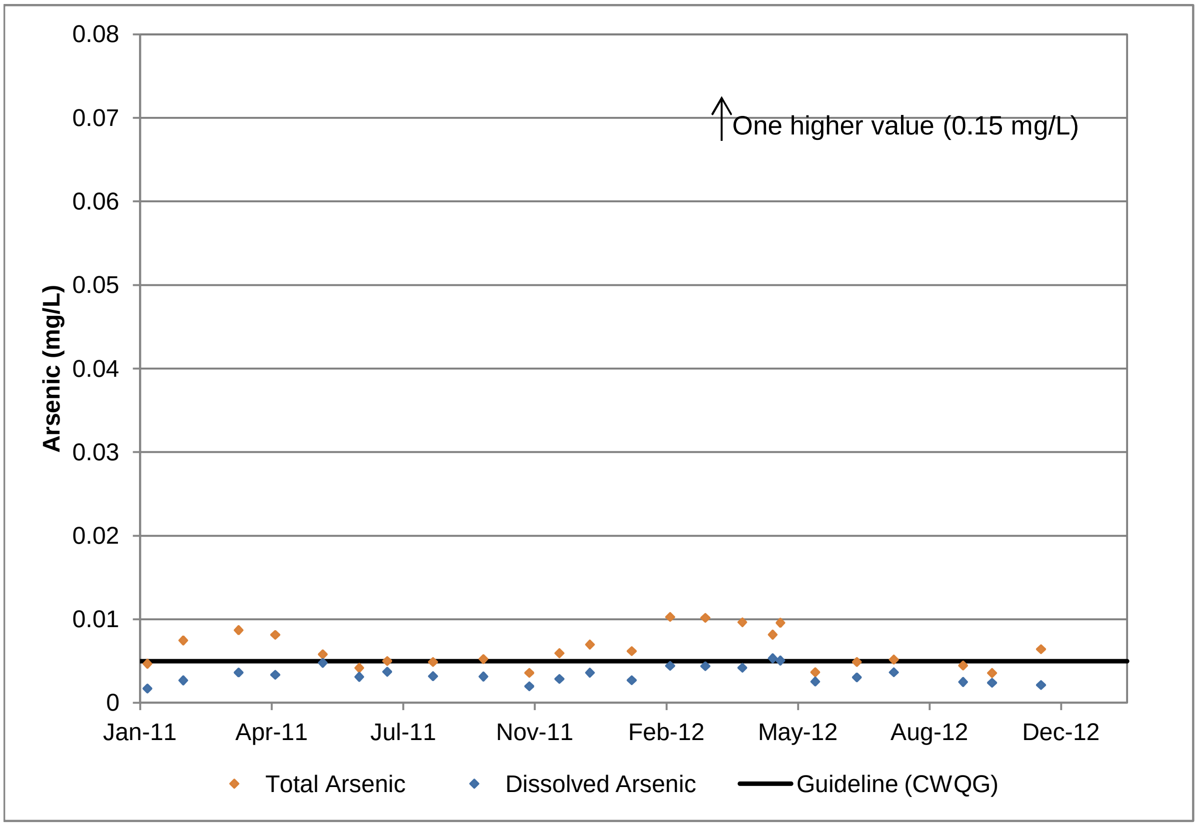


Figure A.2: Arsenic values for station KV-6, UKHM 2011-2012.

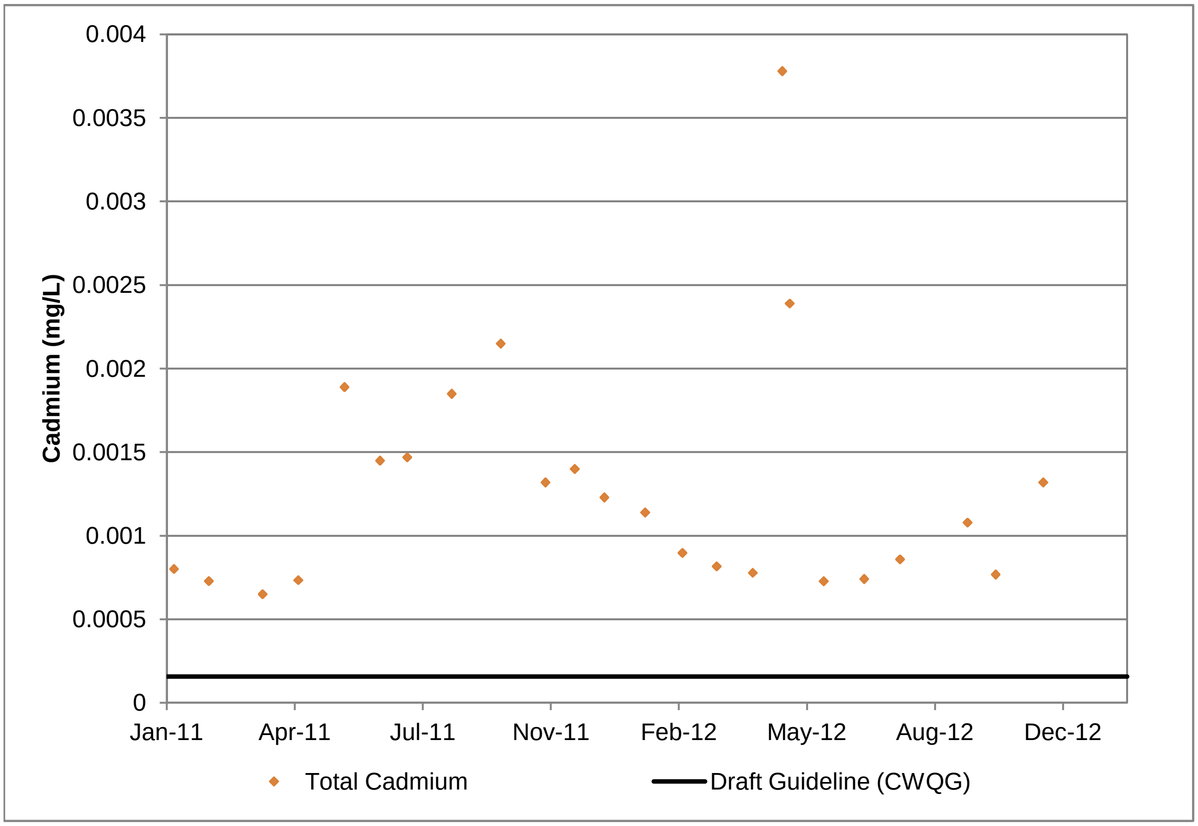


Figure A.3: Cadmium values for station KV-6, UKHM 2011-2012.

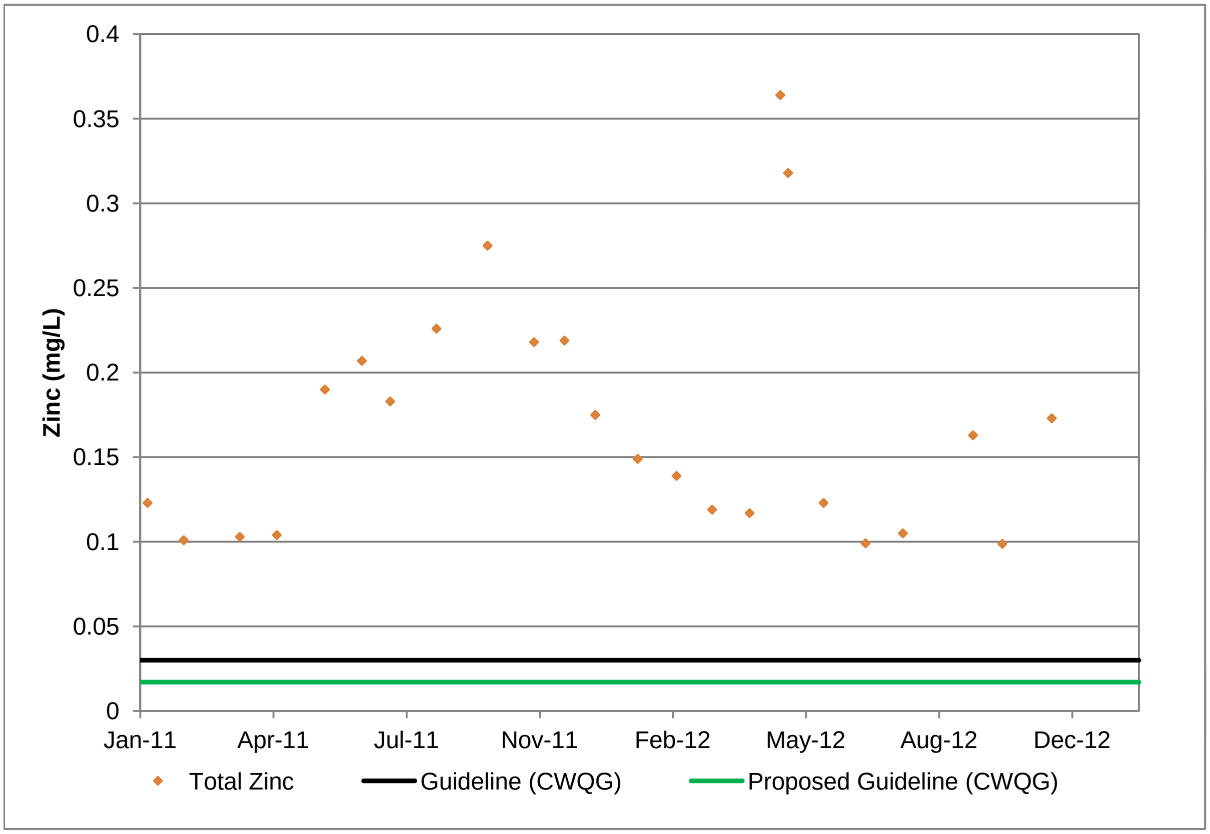


Figure A.4: Zinc values for station KV-6, UKHM 2011-2012.

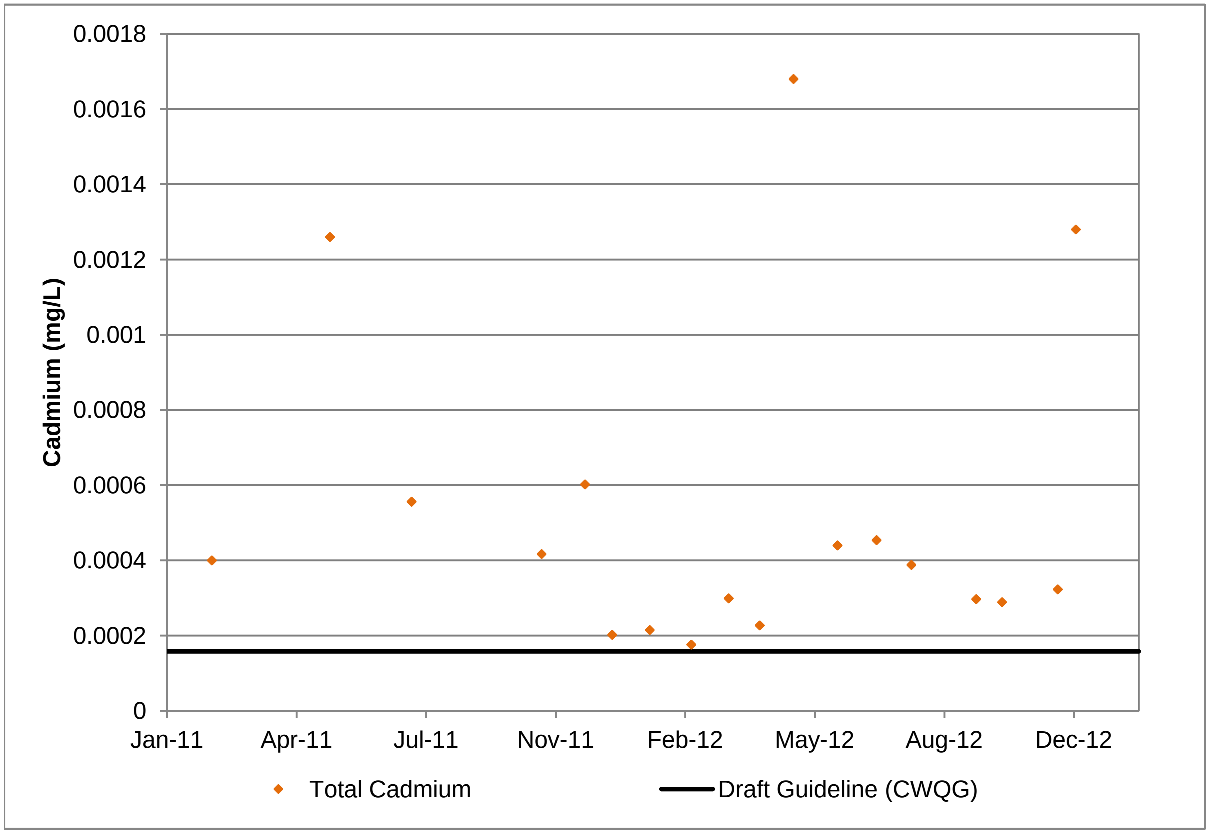


Figure A.5: Cadmium values for station KV-9, UKHM 2011-2012.

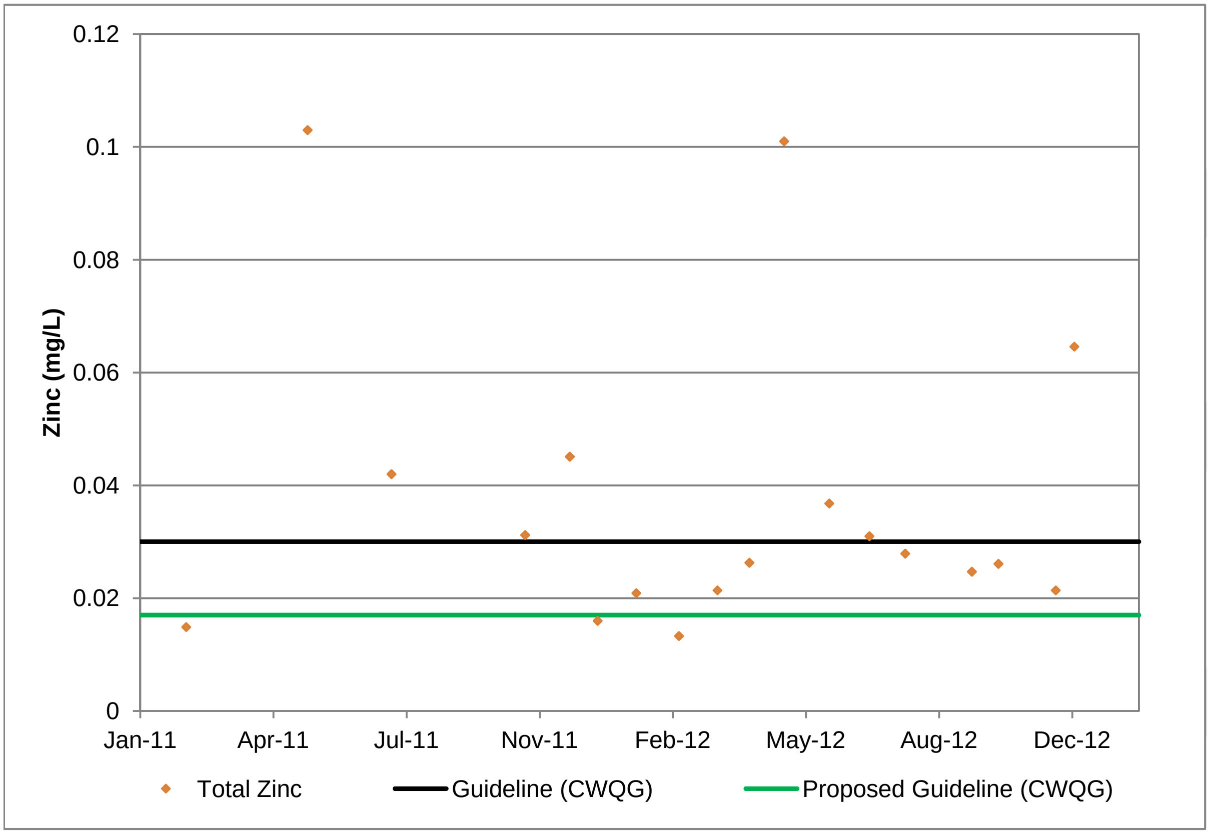
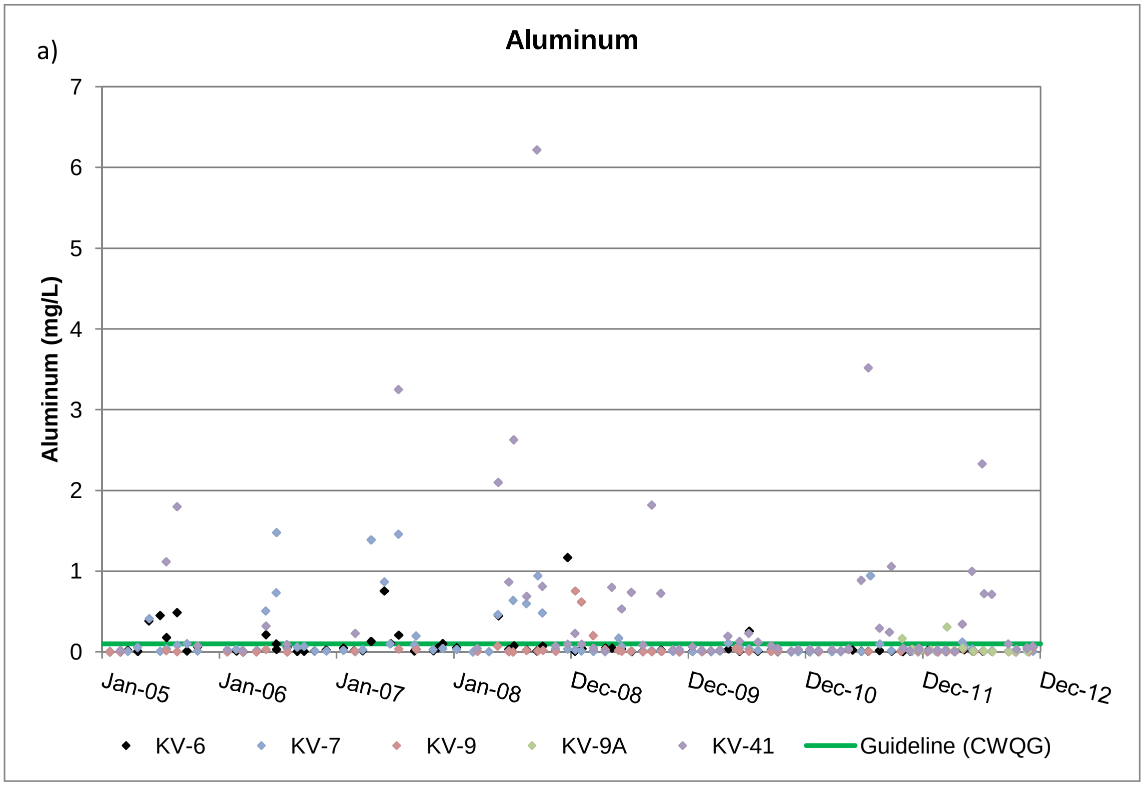


Figure A.6: Zinc values for station KV-9, UKHM 2011-2012.



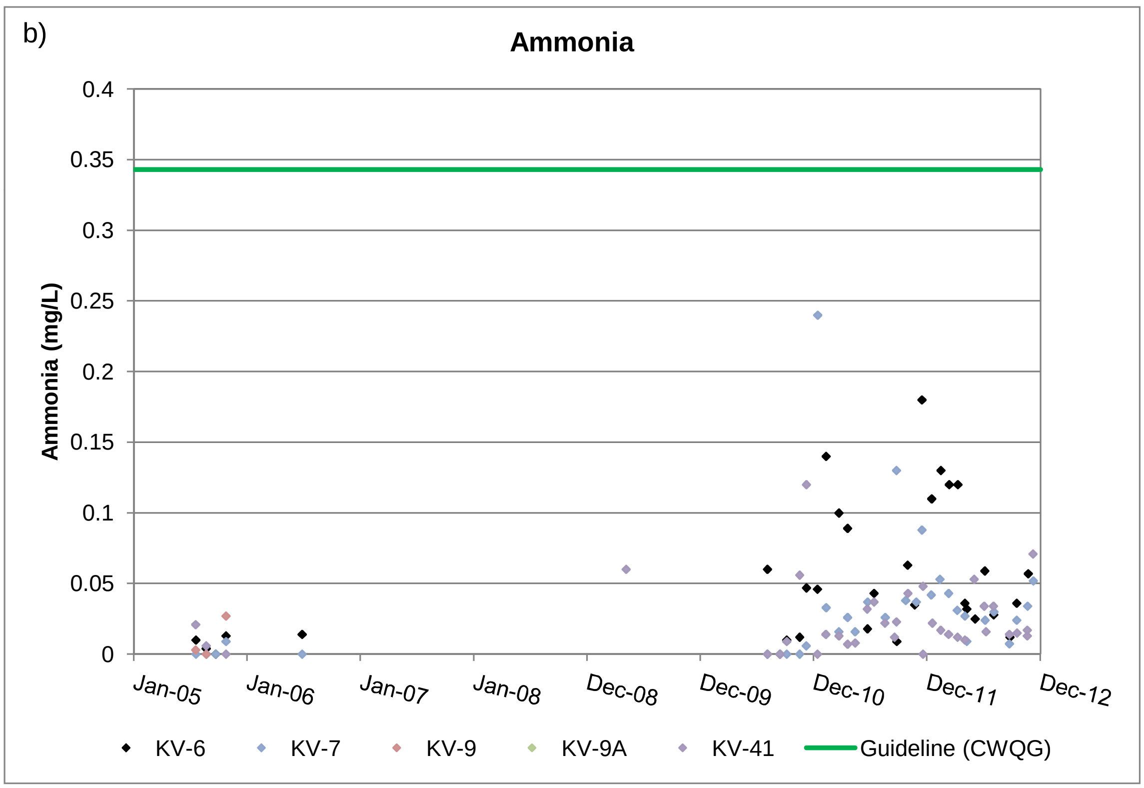
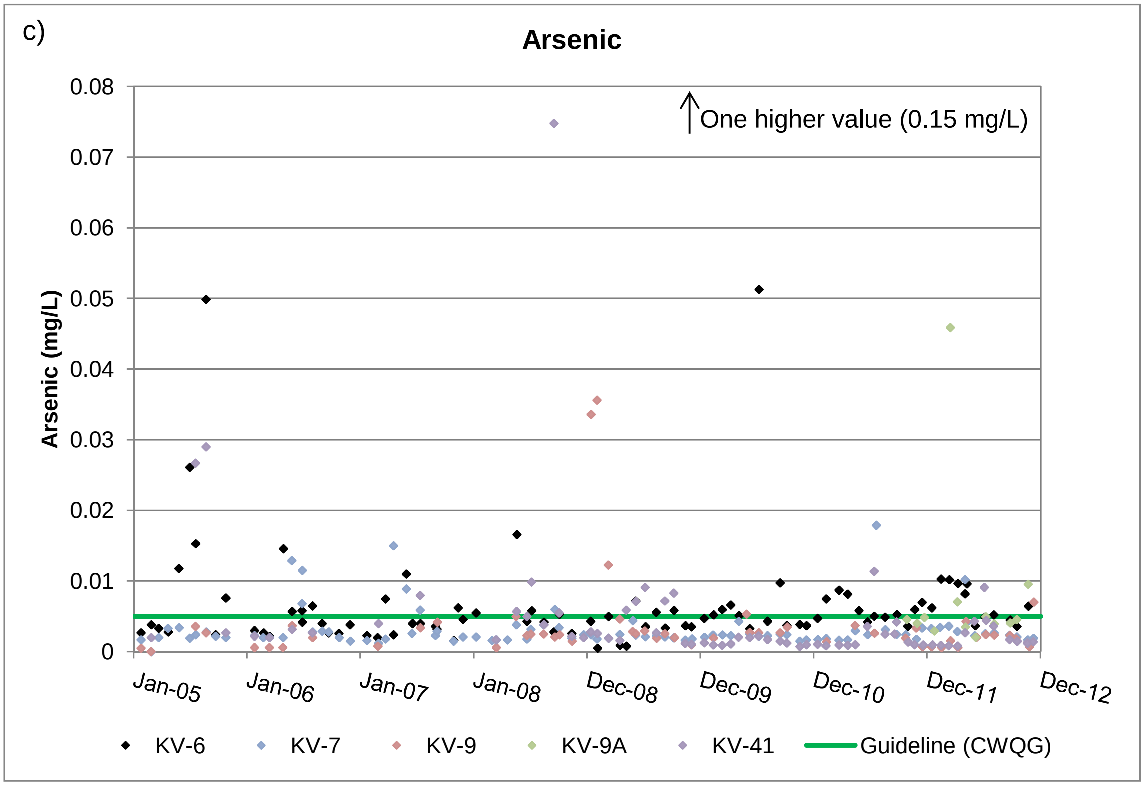
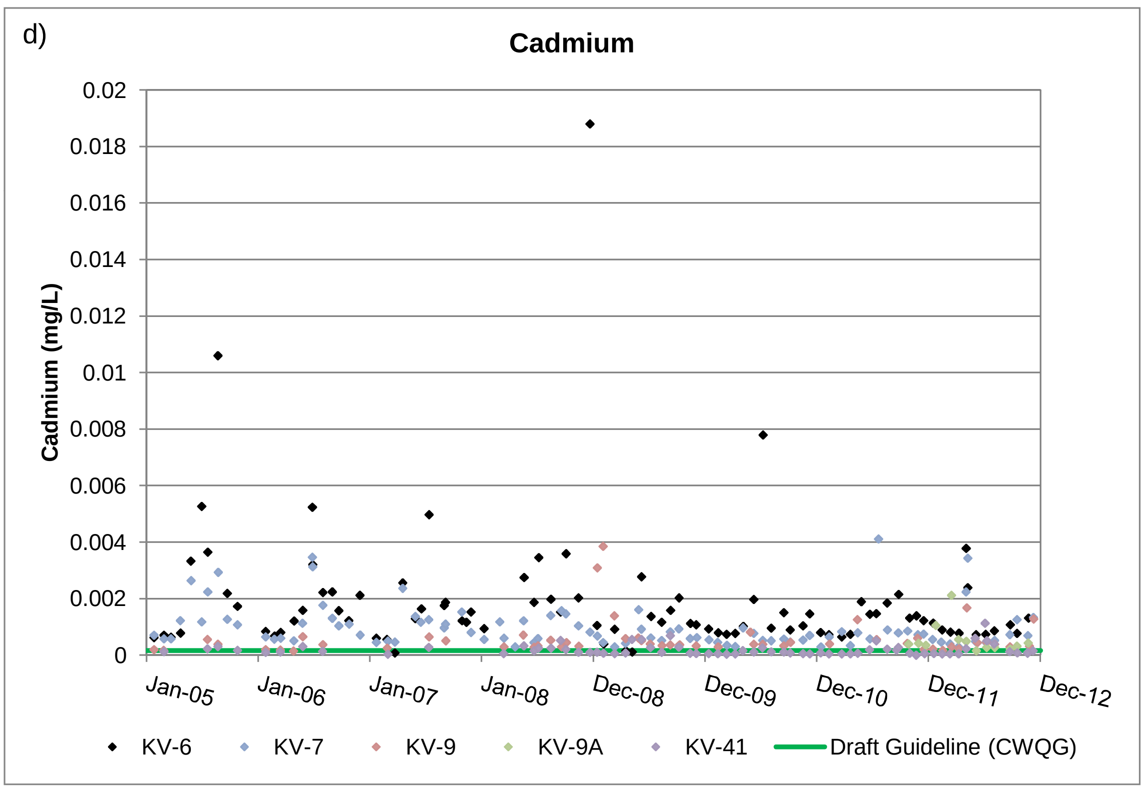


Figure A.7: Concentrations of analytes greater than background but less than guidelines ove time (2005-2011) at UKHM mine-exposed stations.





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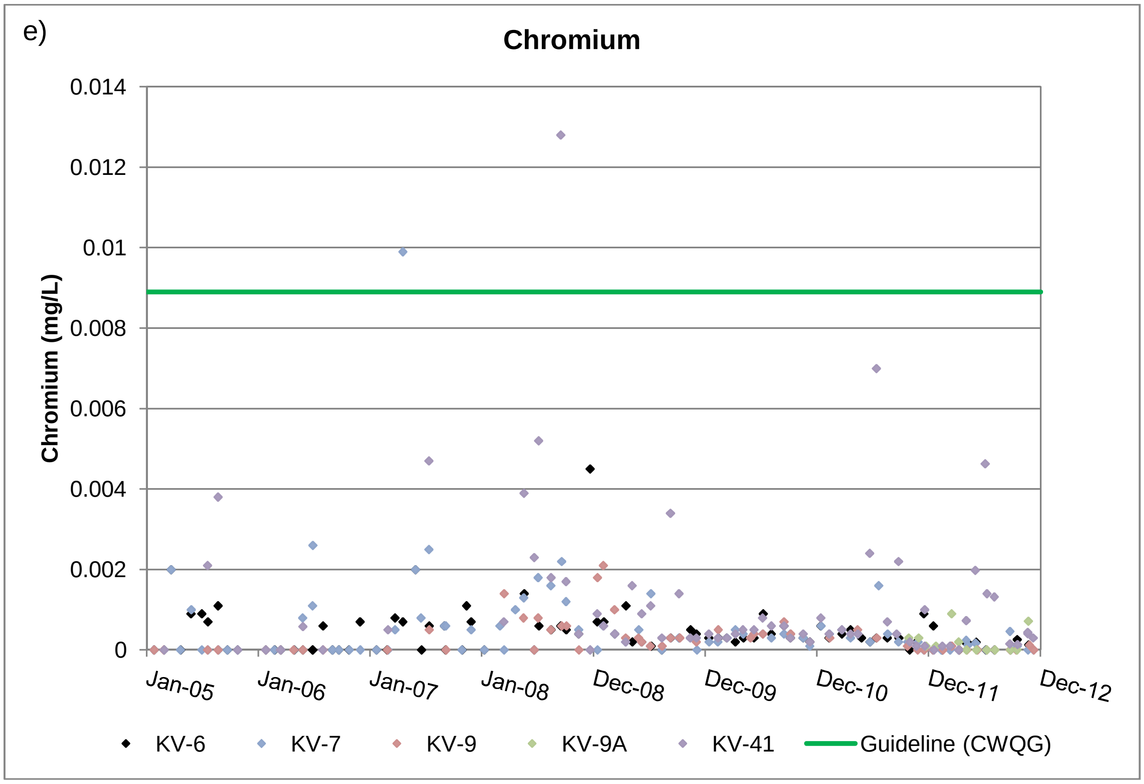

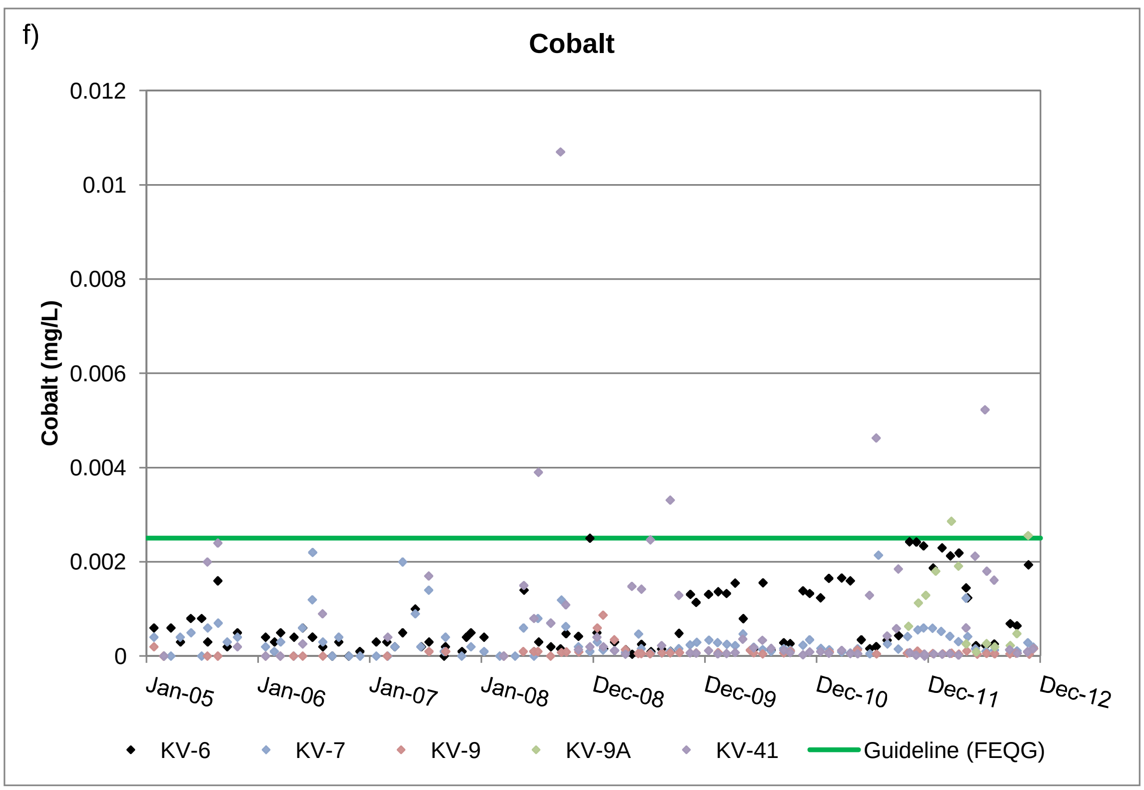

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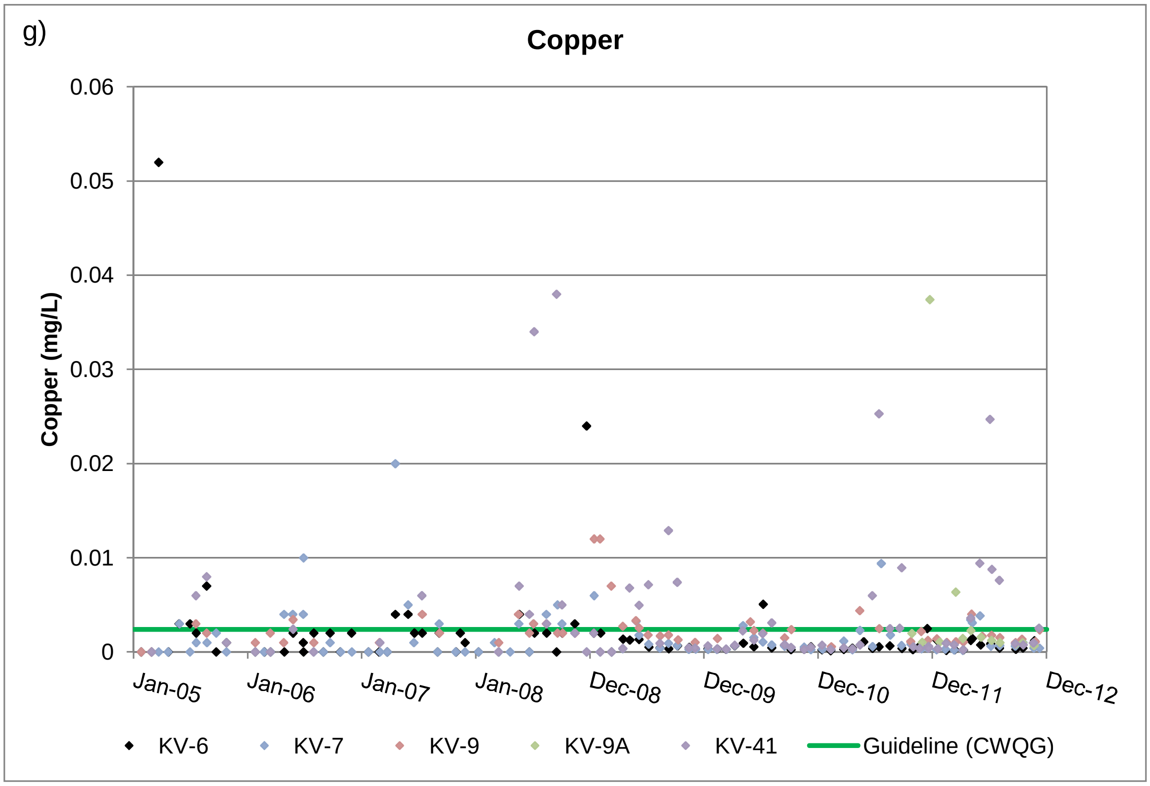

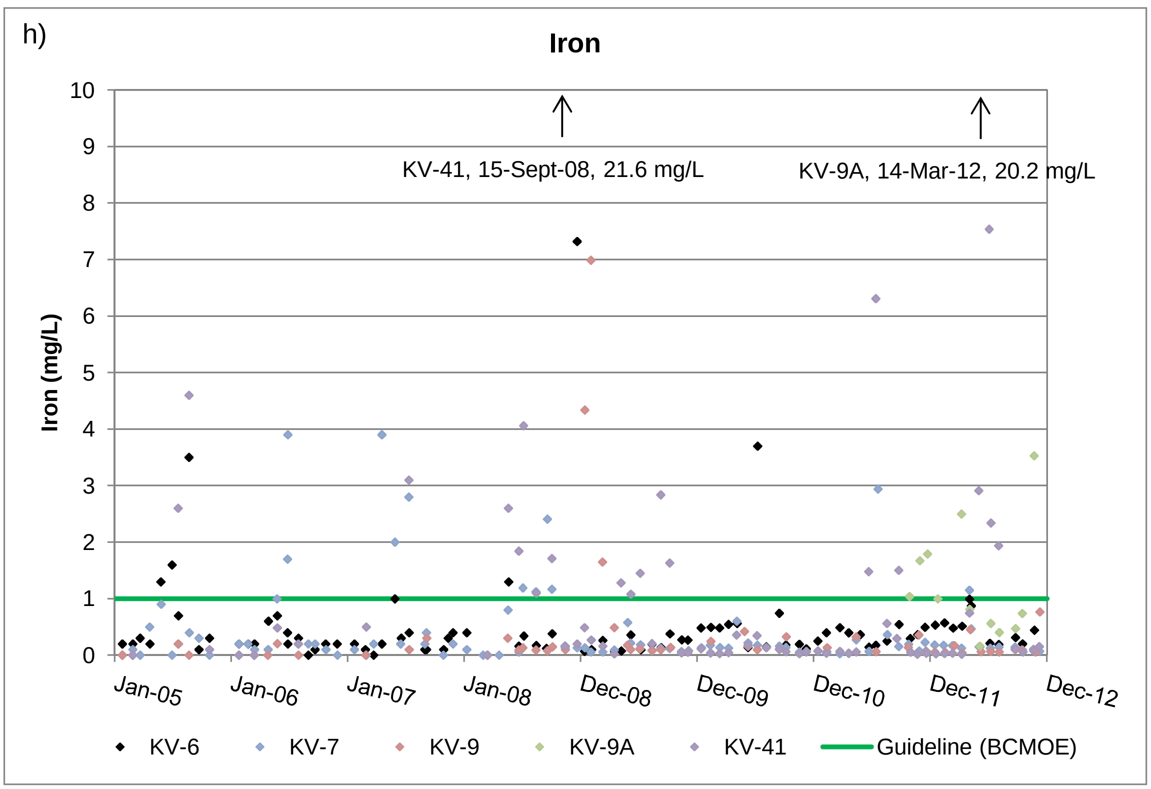

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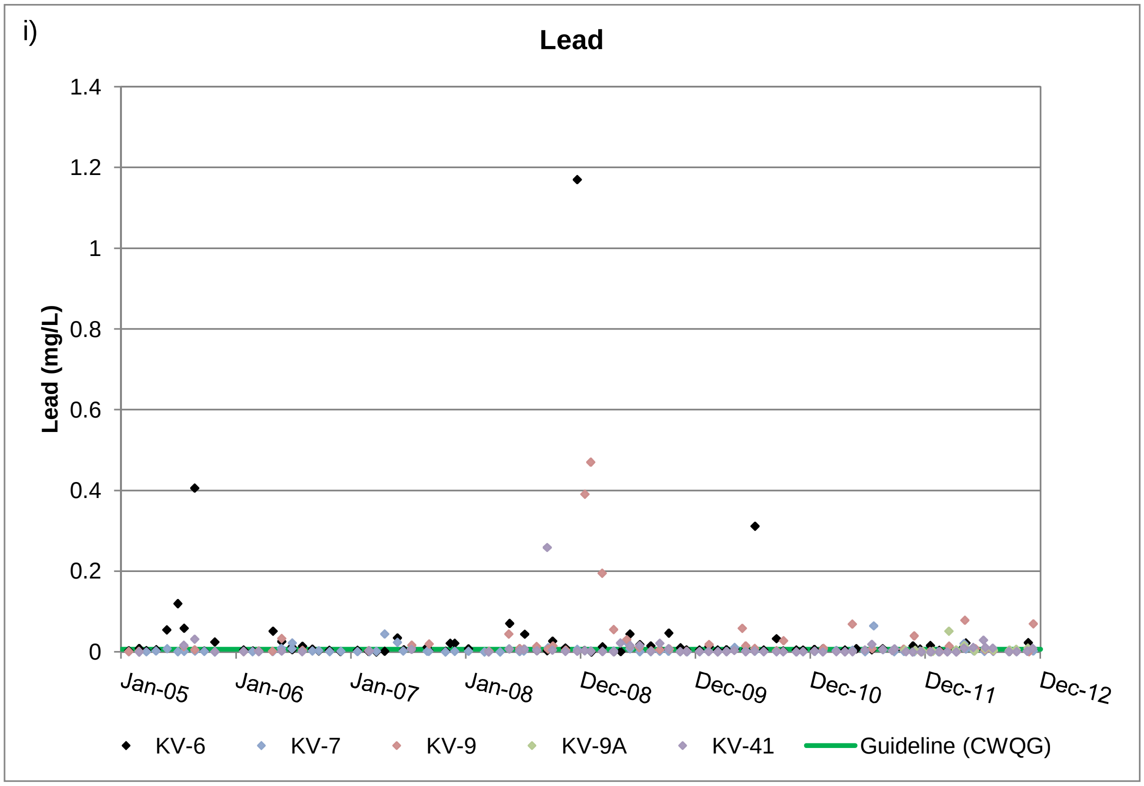


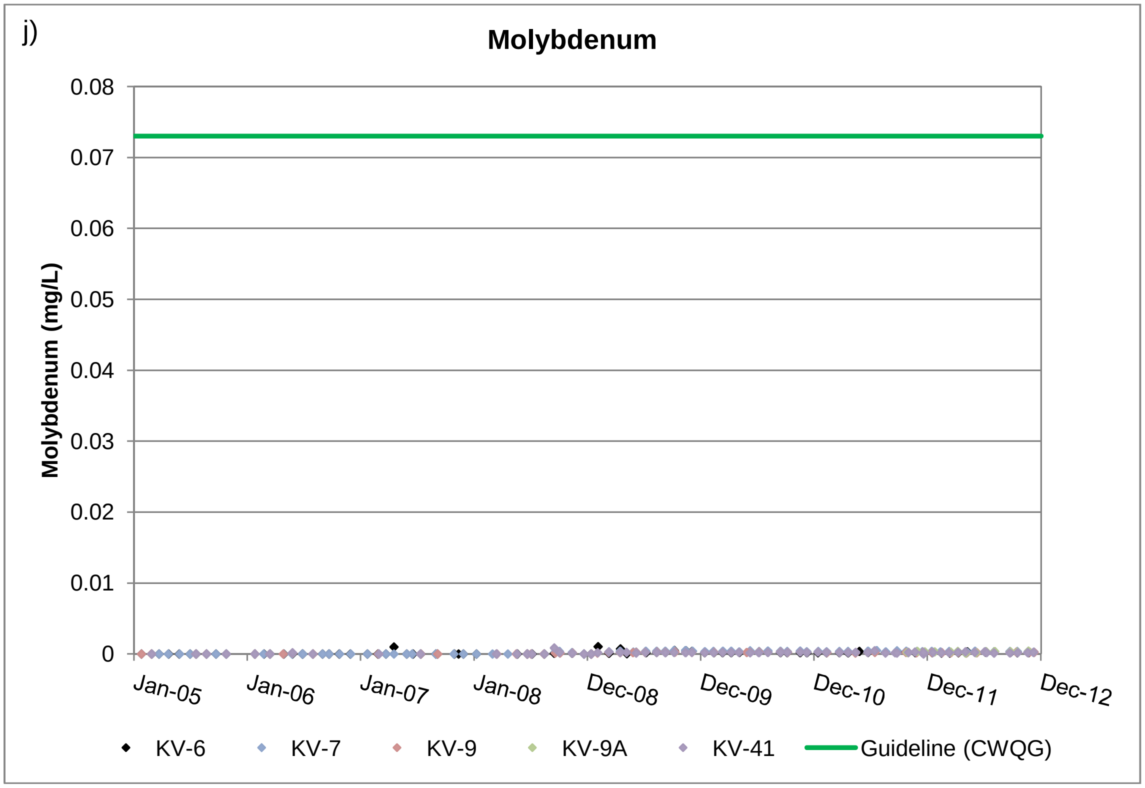
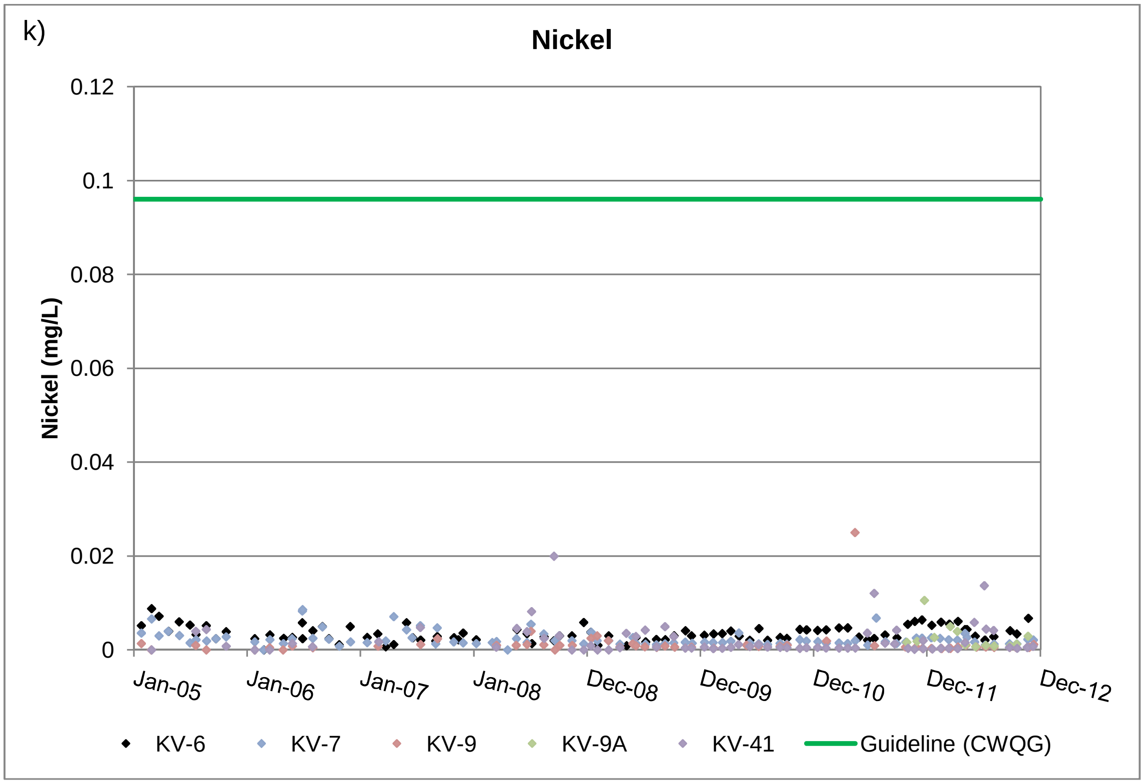


Figure A.7: Concentrations of analytes greater than background but less than guidelines ove time (2005-2011) at UKHM mine-exposed stations.



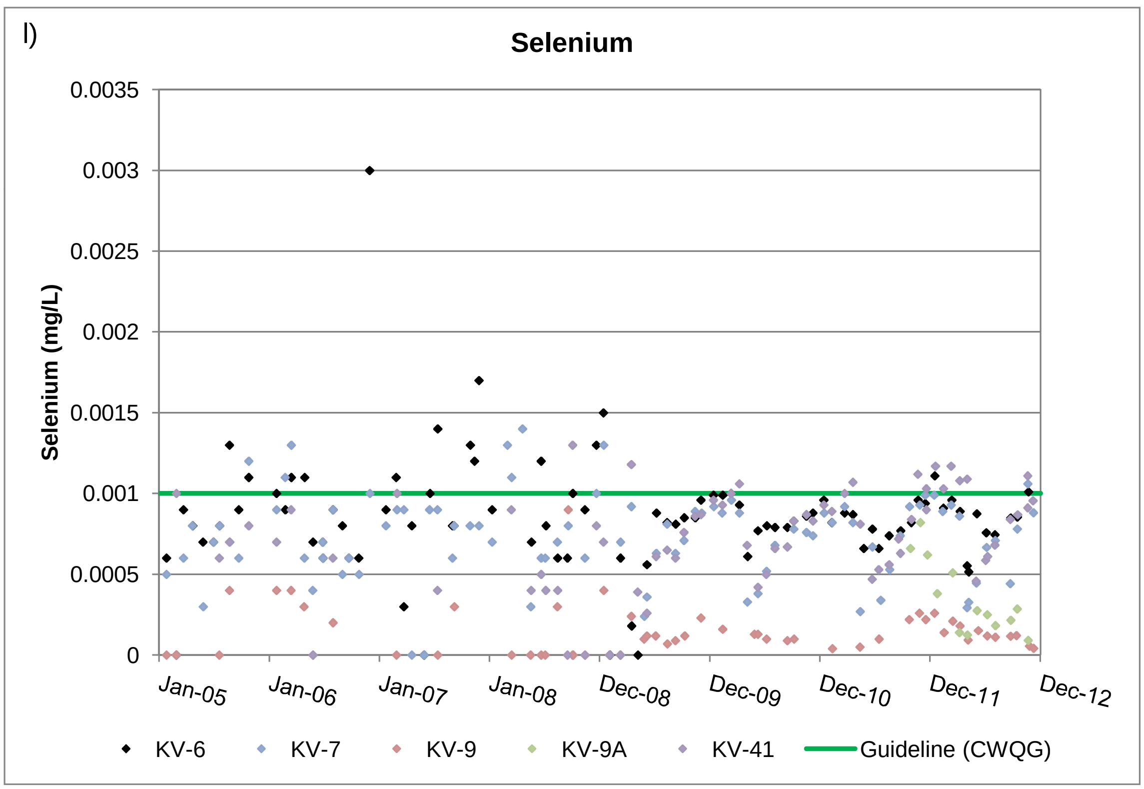
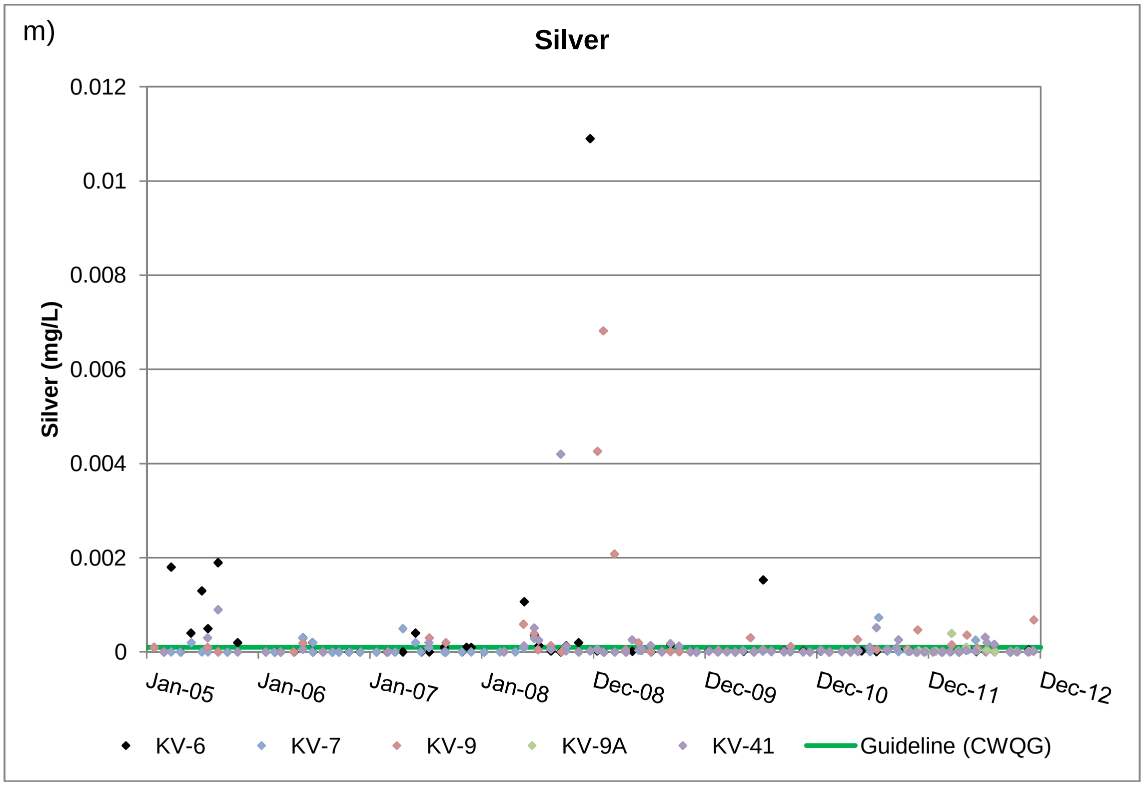


Figure A.7: Concentrations of analytes greater than background but less than guidelines ove time (2005-2011) at UKHM mine-exposed stations.



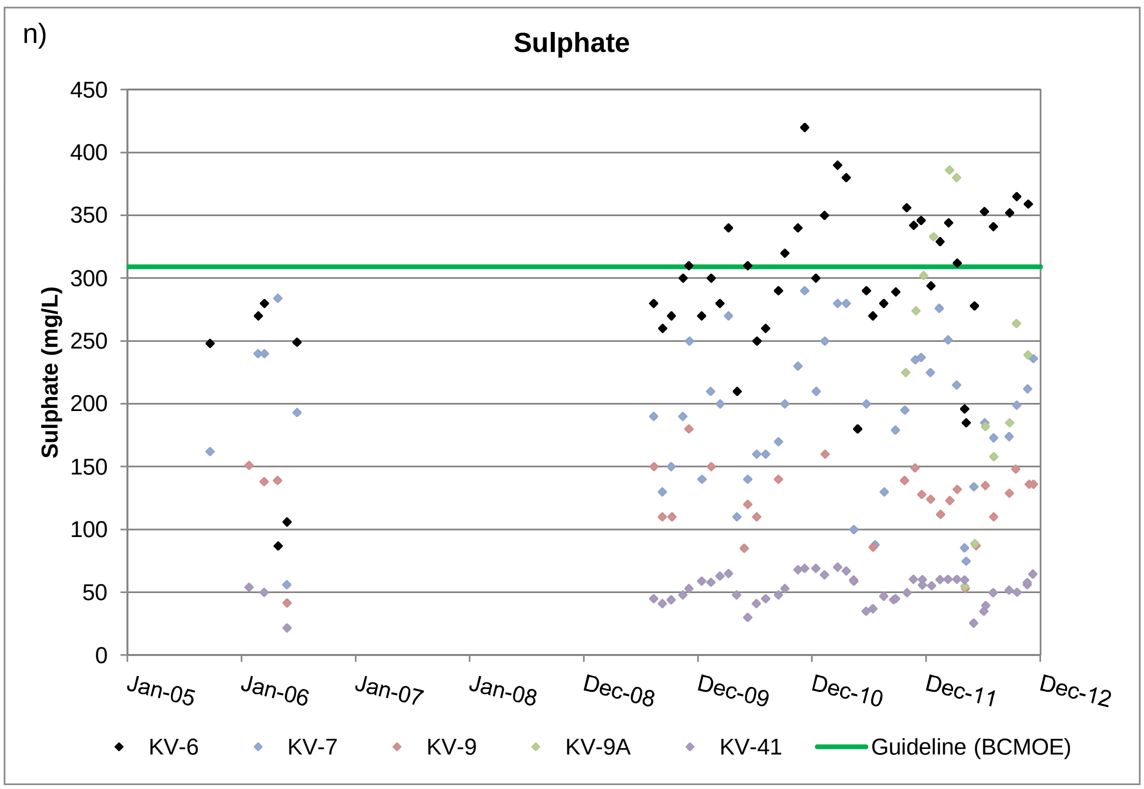


Figure A.7: Concentrations of analytes greater than background but less than guidelines ove time (2005-2011) at UKHM mine-exposed stations.

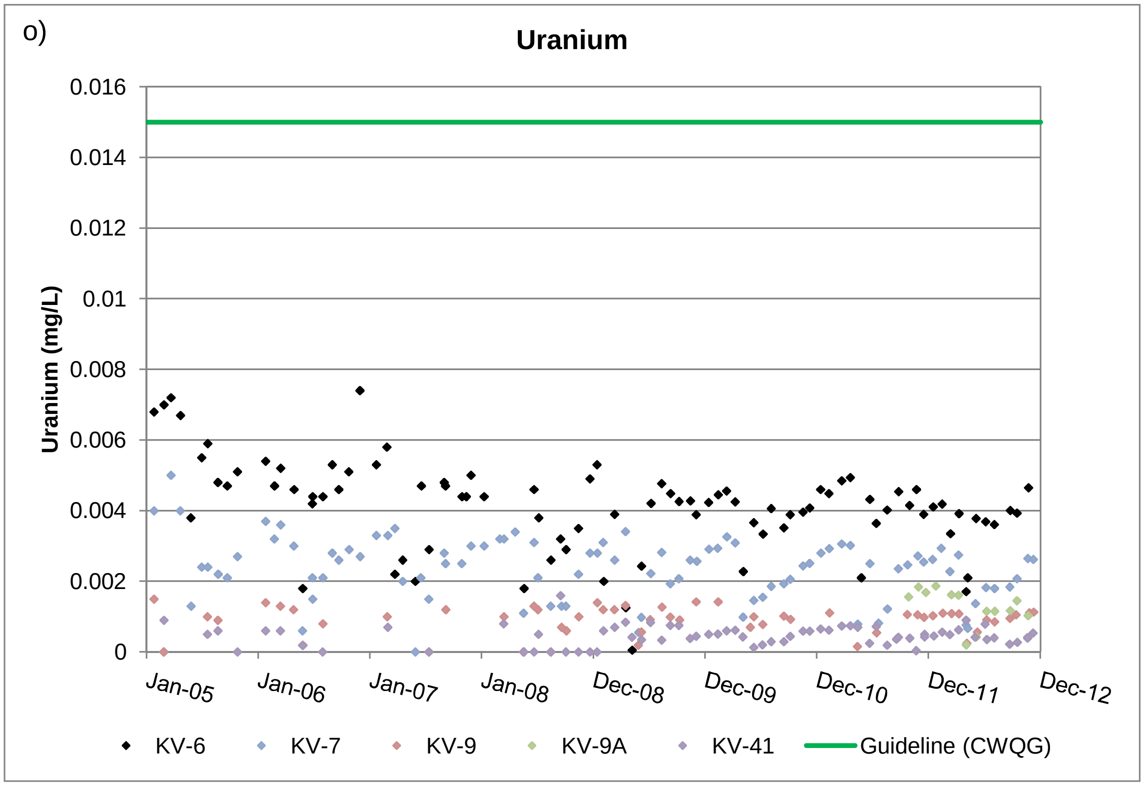


Figure A.7: Concentrations of analytes greater than background but less than guidelines ove time (2005-2011) at UKHM mine-exposed stations.

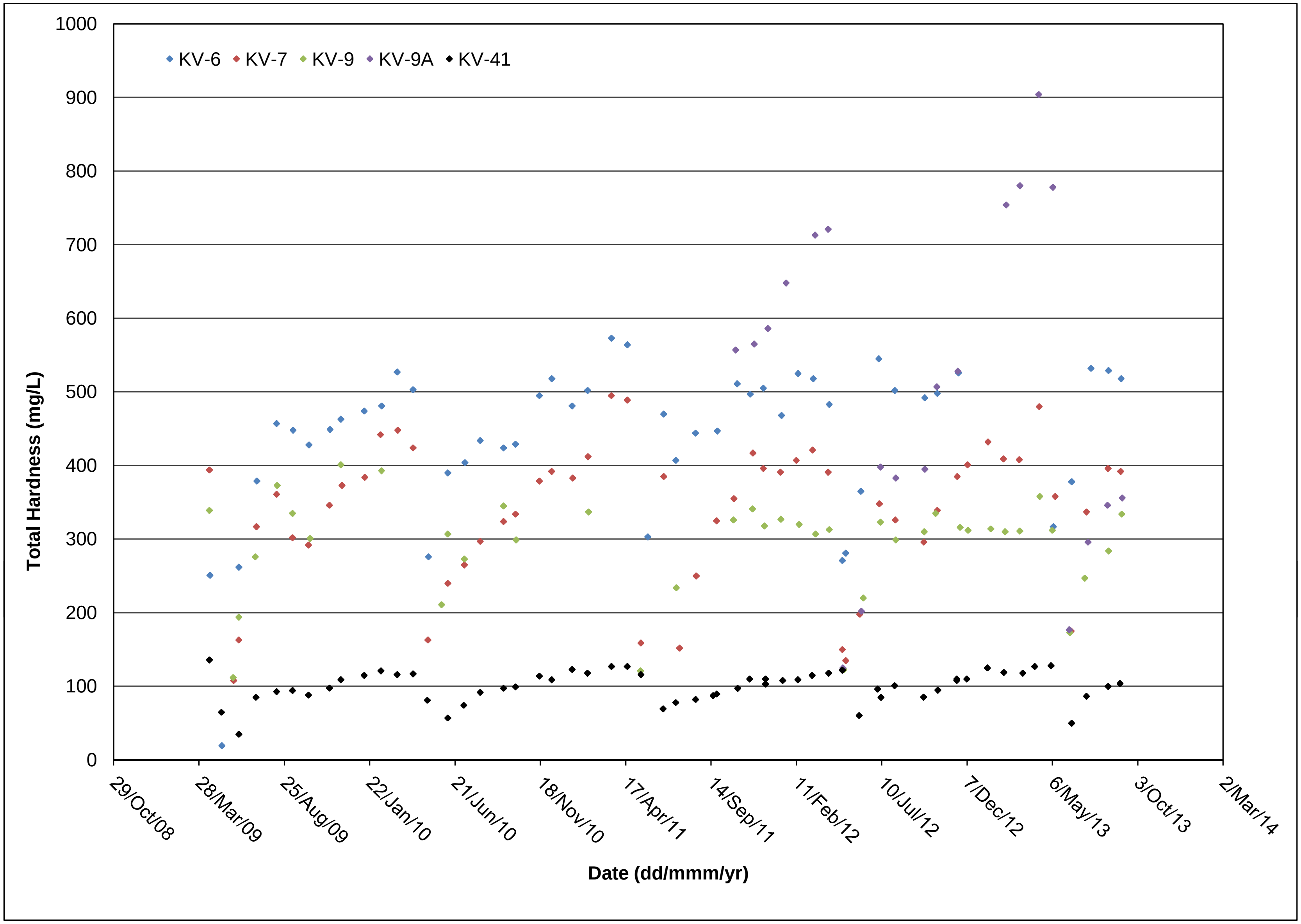


Figure A.8: Hardness concentrations at mine-exposed stations overtime, UKHM 2009-2013.

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Memorandum

To: Jim Harrington, President Alexco Environmental Group

Kai Woloshyn, Project Manager, Access Consulting Group

From: Cynthia Russel, Minnow Environmental Inc.

Date: November 13, 2013

Re: Proposed Water Quality Benchmarks for Closure Evalutation

---

At a recent workshop in Whitehorse (October 17, 2013), Minnow presented information on the selection of final contaminants of concern (COC's). The confirmed COC's for the UKHM district are cadmium and zinc as described in our memo of October 25, 2013. During our presentation we also identified proposed numeric water quality goals or benchmarks for both cadmium and zinc. These benchmarks are not intended to represent site specific water quality guidelines but rather are provided as an evaluation tool for assessing closure options from a water quality perspective. As stated at our presentation, concentrations of cadmium and zinc are not expected to achieve Canadian Water Quality Guidelines (CWQG) in Christal or Flat[1] creeks in the foreseeable future and as such water quality goals will need to be developed in consultation with the various stake holders once a final closure option is selected.

The proposed water quality benchmarks are based on the predicted range of concentrations (i.e. concentrations achievable under the proposed closure options), the resident biota found within UKHM receiving waters (Flat Creek, Christal Creek, Lightning Creek and the South McQuesten River) and known toxicity thresholds for these species[2]. The water quality benchmarks proposed at the October workshop have been revised based on revised predicted concentrations (Interralogic 2013a, b, c) and comments received from Nacho Nyak Dun First Nation. The revised water quality goals are as follows:

---

[1] It is expected that water quality within Lightning Creek will achieve CWQG in the future.
[2] In instances where toxicity data is not available for a specific species similar species were used as a surrogate for evaluating potential toxicity. For example, limited information is available for Arctic grayling (i.e. acute toxicity only) so chronic rainbow trout data was incorporated into the evaluation of goals.

- zinc – 0.075 mg/L
- cadmium - 0.0003 mg/L

Depending on the hardness of the receiving waters, these goals should provide protection for resident species and will also provide protection for Chinook salmon, Arctic grayling[3], less sensitive species and possibly slimy sculpin[4] (Tables 1 and 2). The hardness in Christal and Flat creeks is consistently greater than 100 mg/L and frequently greater than 200 mg/L (Figure 1). However, the highest concentrations of cadmium and zinc tend to occur during the periods of lowest hardness (Figure 2 and 3). Therefore, the toxicity thresholds listed for 100 mg/L hardness should be used as the benchmark. It is unclear if, when remediation is complete, the pattern of lower hardness and higher seasonal concentrations will continue.

The proposed water quality benchmarks will not allow for protection of the most sensitive species in either Christal or Flat Creek (i.e., these species would not be expected to recolonize these creeks; Tables 1 and 2).

The water quality benchmarks presented herein are based on long-term exposure data and as such should be used to evaluate predicted median concentrations.

[3] The toxicity information for Arctic graying is not contained in Tables 1 or 2 as it is based on LC50 values that were used in the derivation of the short-term guidelines for cadmium (Buhl and Hamilton 1991) and considered in the evaluation of the CCME zinc guideline (Buhl and Hamilton 1990). The reported LC50 is 0.005 mg/L for cadmium and 0.171 mg/L (geometric mean of observed effect thresholds) for zinc at 50 mg/L hardness. In developing the water quality benchmarks contained herein, chronic toxicity information for other sensitive salmonids such as rainbow trout was considered. It is assumed that if ambient concentrations of cadmium and zinc are protective of rainbow trout that they will also be protective of Arctic grayling.

[4] Toxicity values reported for mottled sculpin are less than the proposed water quality benchmark for zinc (Table 1). However, slimy sculpin is the resident species and it is not know if this species would be as sensitive as mottled sculpin. Slimy sculpin were found at KV-6 and KV-9 (76 and 40 individuals respectively) in 2012 where concentrations of greater than 0.10 mg/L zinc are known to occur but also where hardness concentrations tend to be above 200 mg/L. Thus, it is unclear whether a zinc concentration of 0.075 mg/L will be protective of slimy sculpin.

References

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Interralogic Inc. 2013c. Chemical Mass Load Model for Lightning Creek: Description and Results: 2013 Update. Draft Report November 5, 2013. Prepared for Access Consulting, Whitehorse, YT.

Minnow 2010. Aquatic Impact Assessment Related to Current and Future Zinc, Cadmium and Sulphate Concentrations at Faro Mine. Prepared for Assessment and Abandoned Mines Branch, Energy Mines and Resources, Government of Yukon, Whitehorse, Yukon February 2010 – project number 2271.

Table 1: Lowest effect endpoint reported for each freshwater species after a long-term exposure to zinc (adapted from Minnow 2010) relative to a proposed water quality benchmark for zinc of 0.075

Species Common Name	Scientific Name	Duration	Endpoint	Observed Effect	Hardness-Adjusted Effect Concentration: Effect Concentration (mg/L) at 50 mg/L Hardness [a]	Effect Concentration (mg/L) at 100 mg/L Hardness [a]	Effect Concentration (mg/L) at 200 mg/L Hardness a	Effect Concentration (mg/L) at 300 mg/L Hardness [a]	Authors	Year
Green algae	*Pseudokirchneriella subcapitata*	7 d	EC10	Growth	0.0011	0.0011	0.0011	0.0011	Chiaaudani and Vighi	1978
Mayfly	*Epeorus latifolium*	4 weeks	IC10	emergence	0.0094	0.0169	0.0303	0.0427	Hatakeyama	1989
Water flea	*Ceriodaphnia dubia*	4 weeks	LOEC	Reproduction - Number of young per adult	0.014	0.026	0.046	0.065	Belanger et Cherry	1990
Green alga	*Chlorella vulgaris*	72 h	EC50	biomass	0.034	0.034	0.034	0.034	Muyssen and Janssen	2001
Water flea	*Daphnia magna*	50 d	MATC	Reproduction - Brood size	0.0210	0.0378	0.0679	0.0957	Paulauskis and Winner	1988
Snail	*Potamopyrgus jenkinsi*	12 weeks	MATC	Growth	0.034	0.061	0.110	0.156	Dorgelo et al.	1995
Chironomids	*Tanytarsus dissimilis*	10 d	LC50	Mortality	0.0389	0.0700	0.1257	0.1772	Anderson et al	1980
Rotifer	*Brachionus havanaensis*	18 d	EC10	Population growth inhibition	0.0782	0.0782	0.0782	0.0782	Juarez-Franco et al	2007
Green alga	*Chlorella pyrenoidosa*	24 h	MATC	Cell density	0.0500	0.0898	0.1615	0.2275	Lin et al	2007
Rainbow trout	*Oncorhynchus mykiss*	30 d	LC10	Mortality	0.0507	0.0911	0.1638	0.2309	De Schamphelaere and Janssen	2004
Green algae	*Scenedesmus quadricauda*	15 d	IC10	Growth	0.0961	0.0961	0.0961	0.0961	Starodub et al.	1987
Chironomids	*Chironomus riparius*	11 weeks	LOEC	Development	0.100	0.100	0.100	0.100	Timmermans et al.	1992
Mottled sculpin	*Cottus bairdi*	30 d	LC50	Mortality	0.033	0.059	0.106	0.149	Brinkman and Woodling	2005
Green hydra	*Hydra viridissima*	7 d	EC10	Population growth inhibition	0.1134	0.2038	0.3664	0.5163	Holdway et al	2001
Chinook salmon	*Oncorhynchus tshawytscha*	200 h	LC10	Mortality	0.131	0.236	0.424	0.597	Chapman	1978
Amphipod	*Hyalella azteca*	7 d	LC50	Mortality	0.133	0.239	0.429	0.605	Borgmann et al	2005
Duckweed	*Lemna minor*	7 d	IC10	Growth	0.318	0.318	0.318	0.318	Dirilgen and Inel	1994
Brook Trout	*Salvelinus fontinalis*	24 w	MATC	egg fragility	0.187	0.336	0.604	0.852	Holcombe et al.	1979
Pink hydra	*Hydra vulgaris*	7 d	EC10	Population growth inhibition	0.3863	0.6943	1.2481	1.7588	Holdway et al	2001
Common duckmeat	*Spirodela polyrrhiza*	4 d	IC50	Growth	0.935	0.935	0.935	0.935	Gaur et al.	1994
Cutthroat trout	*Oncorhynchus clarkii*	14 d	LC10	Mortality	0.547	0.983	1.768	2.491	Nehring and Goettl	1974
Bryozoan	*Pectinatella magnifica*	96 h	LC10	Mortality	0.693	1.245	2.239	3.155	Pardue	1980
Star duckweed	*Lemna trisulca*	14 d	EC50	final yield (oven dry weight)	0.699	1.256	2.258	3.183	Huebert and Shay	1992
Atlantic salmon	*Salmo salar*	14 d	LC50	Mortality	0.700	1.258	2.262	3.187	Hodson and Sprague	1975
Snail	*Physa gyrina*	30 d	LC50	Mortality	1.018	1.830	3.289	4.635	Nebeker et al.	1986
Bryozoan	*Plumatella emarginata*	96 h	LC10	Mortality	1.053	1.893	3.402	4.794	Pardue	1980
Bryozoan	*Lophopodella carteri*	96 h	LC50	Mortality	1.241	2.230	4.008	5.649	Pardue	1980
Diatom	*Cyclotella meneghiniana*	5 d	LC10	Growth rate	1.327	2.386	4.288	6.043	Cairns et al.	1978
Mayfly	*Rhithrogena hageni*	10 d	EC10	Mortality	2.288	4.113	7.392	10.417	Brinkman and Johnston	2008
Green alga	*Chlamydomonas sp.*	10 d	LC10	Growth rate	3.968	7.133	12.821	18.068	Cairns et al.	1978
Crayfish	*Orconectes virilis*	14 d	LC10	Mortality	17.249	31.006	55.733	78.540	Mirenda	1986

[a] If reported toxicity applied to a different water hardness than that shown, a hardness-adjusted toxicity value was calculated using the following equation: EXP(LN(effect conc)-(0.846)*(LN(measured water hardness)-LN(desired water hardness)))

[b] CCME (2008) proposed cadmium guideline is hardness-dependent and calculated as: $e^{\{1.049[\ln(\text{hardness})]-2\}}$

NR - not reported

- sensitive algae and invertebrates (green)
- Chinook salmon (light blue)
- sensitive salmonid (pink)
- less sensitive biota (orange)

- (yellow) **not** protected at water quality benchmark of 0.075 mg/L zinc
- (blue) protected at water quality benchmark of 0.075 mg/L zinc

Table 2: Lowest effect endpoint reported for each freshwater species after a long-term exposure to cadmium (adapted from Minnow 2010) relative to a proposed water quality benchmark of 0.0003 mg/L cadmium.

Species Common Name	Scientific Name	Duration	Endpoint	Observed Effect	Hardness-Adjusted Effect Concentration				Authors	Year
					Effect Concentration (mg/L) at 50 mg/L Hardness [a]	Effect Concentration (mg/L) at 100 mg/L Hardness [a]	Effect Concentration (mg/L) at 200 mg/L Hardness [a]	Effect Concentration (mg/L) at 300 mg/L Hardness [a]		
Water flea	*Daphnia magna*	7 d	EC10	Reproduction - Brood size	0.00004	0.00008	0.00016	0.00024	Barata and Baird	2000
Water flea	*Ceriodaphnia reticulata*	7 d	MATC	Reproduction - Number of young per adult	0.00009	0.00018	0.00036	0.00054	Elnabarawy et al	1986
Amphipod - scud	*Hyalella azteca*	28 d	IC25	Biomass, decrease in	0.00009	0.00018	0.00036	0.00055	Ingersoll and Kemble	2001
Rainbow trout	*Oncorhynchus mykiss*	65 wks	MATC	Reproduction - delay in oogenesis	0.00018	0.00036	0.00072	0.00110	Brown et al	1994
Midge	*Chironomus tentans*	60 d	IC25	Hatching success	0.001	0.001	0.003	0.004	Ingersoll and Kemble	2001
Mottled sculpin	*Cottus bairdi*	21 d	EC50	Biomass, decrease in	0.00084	0.00170	0.00346	0.00523	Besser et al.	2007
Atlantic salmon	*Salmo salar*	496 d	LOEC/L	Weight and Length	0.00085	0.00173	0.00351	0.00532	Rombough and Garside	1982
Bull trout	*Salvelinus confluentus*	55 d	MATC	Growth	0.00091	0.00184	0.00375	0.00567	Hansen et al.	2002
Green hydra	*Hydra viridissima*	7 d	NOEC/L	Population growth inhibition	0.0010	0.0021	0.0043	0.0066	Holdway et al.	2001
Amphipod - gammarid	*Echinogammarus meridionalis*	6 d	LOEC/L	Feeding inhibition	0.0012	0.0024	0.0048	0.0073	Pestana et al.	2007
Amphipod - gammarid	*Gammarus pulex*	5 d	LOEC/L	Mortality	0.0013	0.0027	0.0055	0.0084	Felten et al.	2007
Brown trout	*Salmo trutta*	30 d	IC20	Biomass, decrease in	0.0015	0.0031	0.0062	0.0094	Brinkman and Hansen	2007
Brook Trout	*Salvelinus fontinalis*	126 d	MATC	Biomass, decrease in	0.002	0.005	0.009	0.014	Eaton et al.	1978
Coho salmon	*Oncorhynchus kisutch*	27 d	MATC	Biomass, decrease in	0.0023	0.0048	0.0097	0.0146	Eaton et al.	1978
Chinook salmon	*Oncorhynchus tshawytscha*	8 d	LC10	Mortality	0.0027	0.0054	0.0110	0.0166	Chapman	1978
Water flea	*Daphnia pulex*	14 d	MATC	Reproduction - Number of young per adult	0.0028	0.0056	0.0114	0.0172	Elnabarawy et al	1986
Green algae	*Ankistrodesmus falcatus*	96 h	NOEC/L	Growth	0.0042	0.01	0.02	0.03	Baer et al.	1999
Water flea	*Ceriodaphnia dubia*	14 d	MATC	Reproduction	0.006	0.012	0.025	0.038	Suedel et al	1997
White Sucker	*Catostomus commersoni*	40 h	MATC	Biomass, decrease in	0.0079	0.0161	0.0327	0.0494	Eaton et al.	1978
Northern pike	*Esox lucius*	35 d	MATC	Biomass, decrease in	0.0082	0.0167	0.0340	0.0515	Eaton et al.	1978
Lake Trout	*Salvelinus namaycush*	41 d	MATC	Biomass, decrease in	0.0082	0.0167	0.0340	0.0515	Eaton et al.	1978
Marsh snail	*Lymnaea palustris*	4 weeks	EC50	Growth	0.0098	0.0200	0.0407	0.0616	Coeurdassier et al.	2003
Great pond snail	*Lymnaea stagnalis*	4 weeks	NOEC/L	Growth	0.01	0.03	0.06	0.08	Coeurdassier et al.	2003
Midge	*Chironomus riparius*	17 d	MATC	Mortality	0.0238	0.0484	0.0983	0.1489	Pascoe et al.	1989
Duckweed	*Lemna minor*	7 d	EC50	Growth rate	0.063	0.127	0.259	0.392	Drost et al.	2007
Northwestern salamander	*Ambystoma gracile*	24 d	MATC	Weight	0.1083	0.2200	0.4471	0.6769	Nebeker et al	1995

[a] If reported toxicity applied to a different water hardness than that shown, a hardness adjusted toxicity value was calculated using the following equation: EXP(LN(effect conc)-(1.023)*(LN(measured water hardness)-LN(desired water hardness)))

[b] CCME (2008) proposed cadmium guideline is hardness-dependent and calculated as: $e^{\{0.7409[\ln(hardness)]-4.939\}}$

sensitive algae and invertebrates

Chinook salmon

sensitive salmonid

less sensitive biota

not protected at water quality benchmark of 0.0003 mg/L cadmium

protected at water quality benchmark of 0.0003 mg/L cadmium

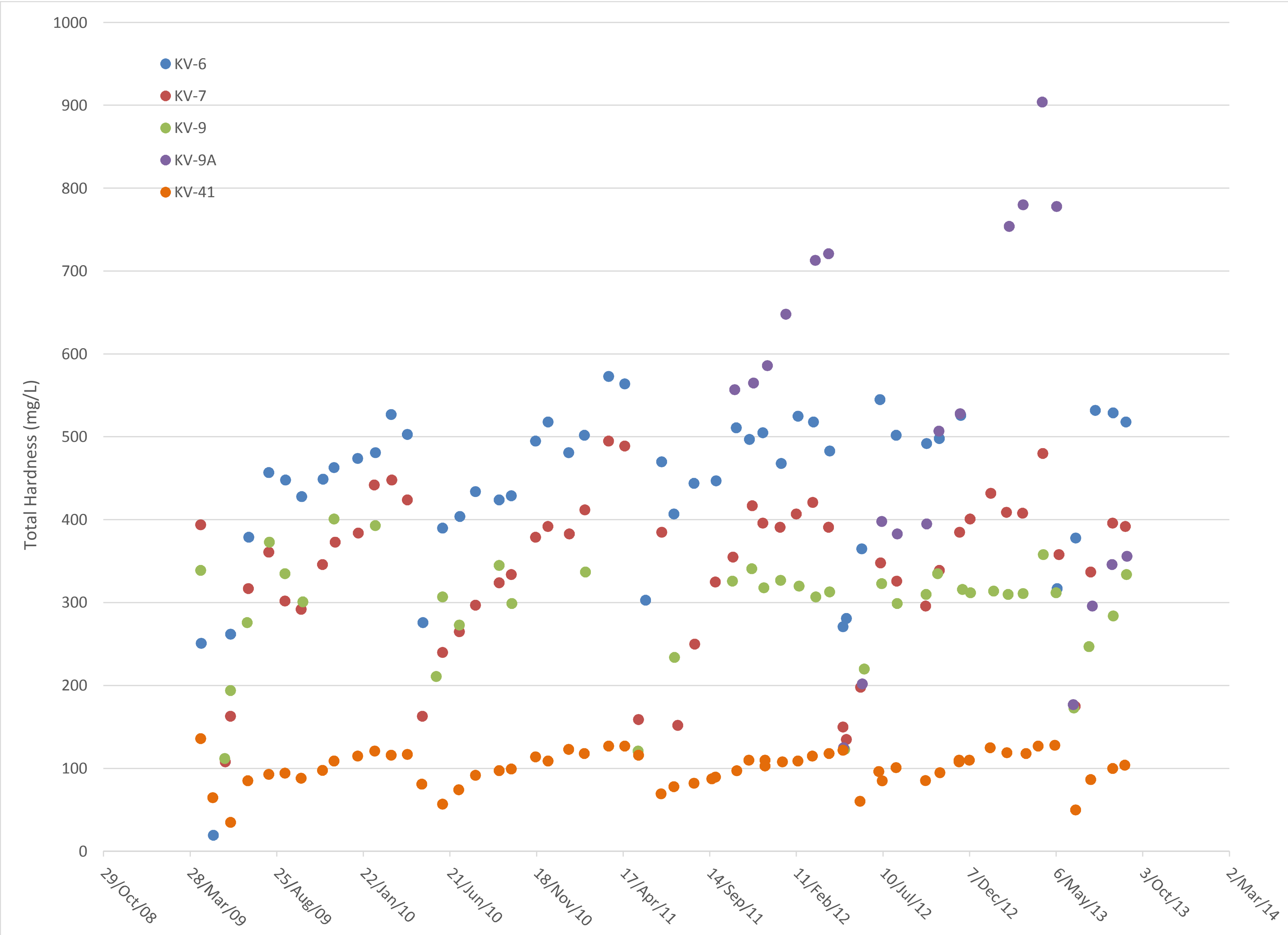

Figure 1: Hardness concentrations at mine-exposed UKHM monitoring stations, 2009 to 2013

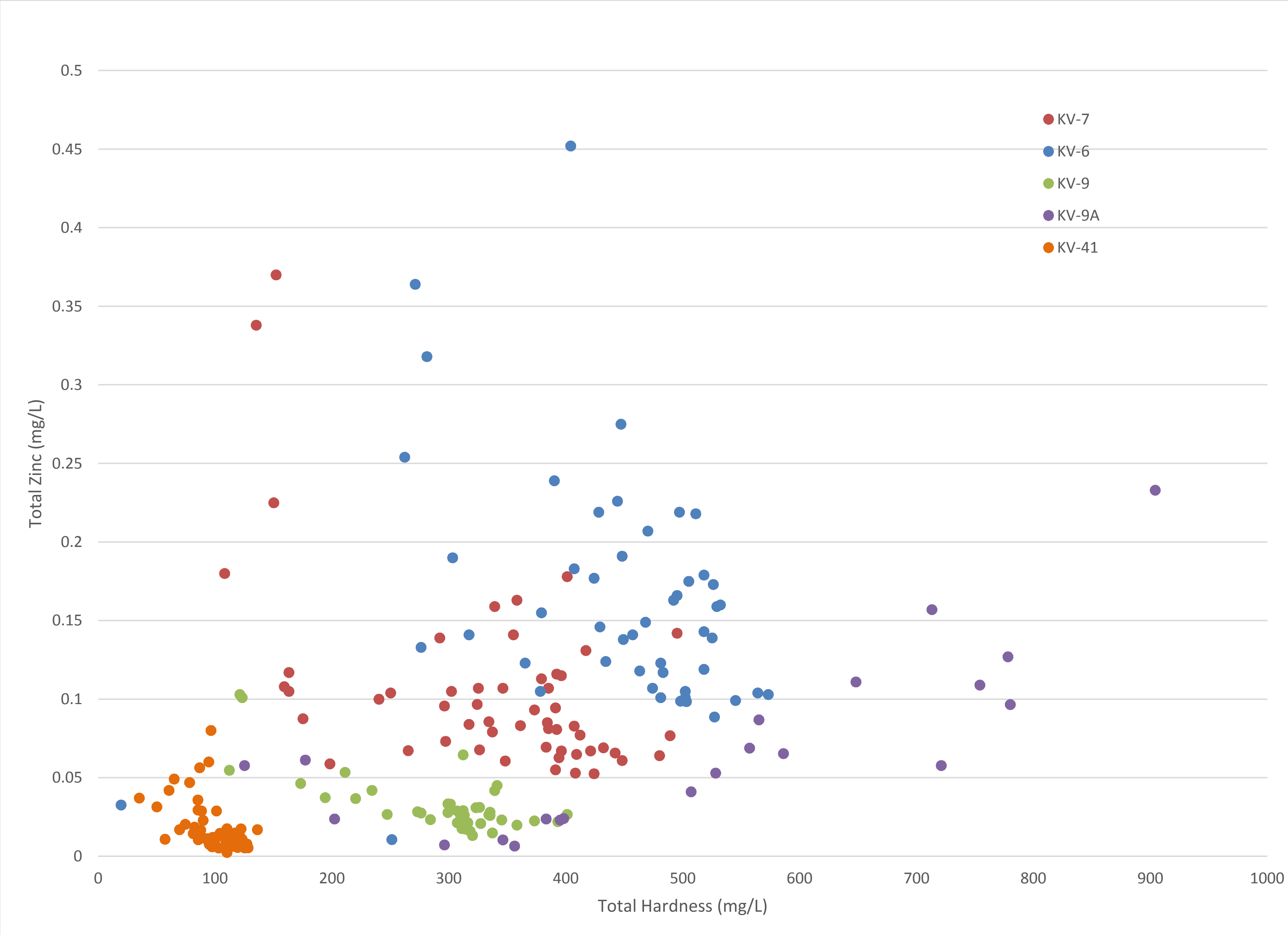

Figure 2: Zinc concentrations versus hardness at mine-exposed UKHM monitoring stations, 2009 to 2013

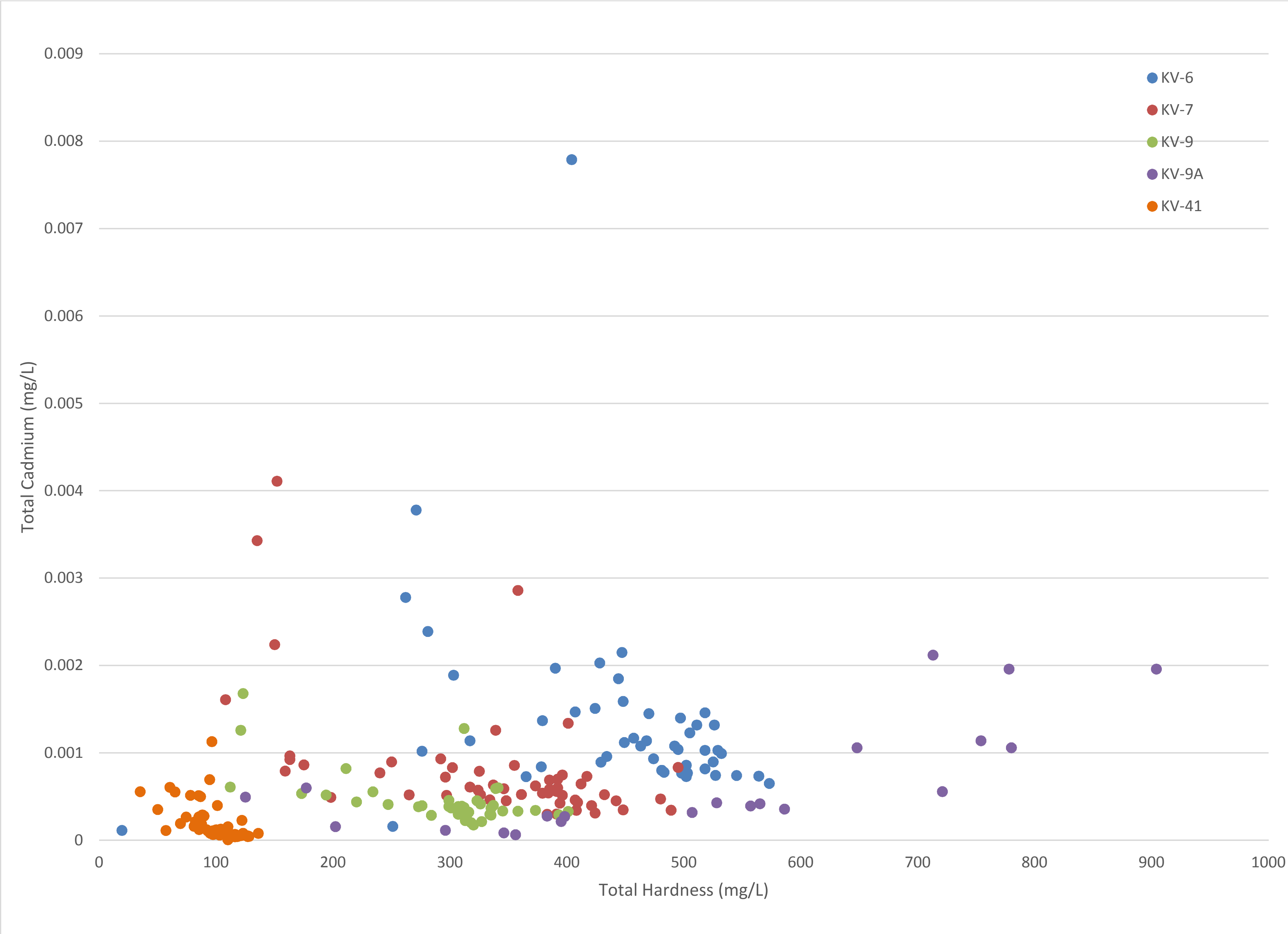

Figure 3: Cadmium concentrations versus hardness at mine-exposed UKHM monitoring stations, 2009 to 2013

DRAFT REPORT

Natural Attenuation Evaluation Summary Report

United Keno Hill Mines
Elsa, YT

Prepared for:

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Project No: 102003

November 2013

TABLE OF CONTENTS

Section No. **Page No.**

LIST OF FIGURES

LIST OF TABLES

Table No. **Page No.**

1 INTRODUCTION

1.1 REPORT OBJECTIVES

The Natural Attenuation Project is a multi-disciplinary, multi-year scientific study that has been developed and implemented to support the Elsa Reclamation and Development Company (ERDC) closure obligations at the Keno Hill Silver District (KHSD) near Elsa, Yukon Territory (YT). This Summary Report was written to provide a concise summary and point of reference for project-related activities conducted since 2009. This report relies on, and condenses, the significant amount of scientific work done by ERDC and Interralogic in collaboration with the Edmonton Waste Management Centre of Excellence, Sherriff Environmental, and Queen's University, as well as previous and parallel work conducted in the area. This report summarizes and brings together the wide variety of data from the diverse disciplines addressed and then focuses conclusions on issues and findings most relevant to closure issues that will be faced during the options evaluation and selection process.

1.2 PROJECT OBJECTIVES

The purpose of the Natural Attenuation Project is to evaluate the technical suitability of a managed natural attenuation approach as a closure option, or as part of a closure option, for the No Cash Creek mines (No Cash 500, Ruby, and Bermingham), Husky SW, Sadie Ladue, and Silver King adit discharges. The option selection process will evaluate the other factors beyond technical feasibility that may affect the use of natural attenuation processes in the closure of mine components in the KHSD. The technical suitability of natural attenuation as a closure option depends on meeting criteria that were developed in consultation with interested parties (team) including:

- ERDC/Alexco Resource Corp.
- AANDC
- Environment Canada
- First Nation of Na-Cho Nyak Dunn (FNNND)
- Yukon Government

Plans for field work were developed and initiated in 2010 and are currently ongoing. The natural attenuation evaluation was conducted through the following iterative/phased approach:

- Evaluation of available historical water quality data for the target sites

- Development and execution of initial phase of field and laboratory activities
- Interpretation of data and presentation of results and conclusions to team members
- Incorporation of team input to develop the next season's field and laboratory activities
- Report development to inform the closure options process.

The technical objectives of natural attenuation relate to the observed decrease in metals (specifically zinc and cadmium) concentrations in adit discharge water, as it flows along the stream course. The observations along No Cash Creek indicated significant attenuation of zinc and cadmium in a relatively short stream reach. The technical goal was to understand the nature of the natural attenuation mechanisms, its seasonality, if there were any environmental constraints or limitations, the sustainability of the processes, and its reliability as part of a potential closure option for the target areas. The technical tasks involved work by field samplers, ecologists, hydrologists, geochemists, mineralogists, microbiologists, water treatment experts, engineers, and others. These technical tasks are described in the specific target area sections below.

1.3 PROJECT OVERVIEW

Reclamation and closure studies of historical United Keno Hill Mines (UKHM) facilities in the KHSD are ongoing. Detailed descriptions of the current environmental issues in the KHSD, as well as climate and general site conditions are provided in ERDC (2006) and Access (2011). The geology is summarized in Cathro (2006) and Interralogic (2012a) which also contains a list of references with more detailed KHSD geology. The KHSD contains over 65 silver ore deposits and prospects that were first mined in 1913. Most mining operations took place on the north-facing slopes of Galena Hill and also in areas to the east on Keno Hill (Figure 1). Both the Galena Hill and Keno Hill mines are within the South McQuesten River watershed. Many of the smaller watercourses, including those draining the northwest side of Galena Hill, terminate in wetlands in the South McQuesten River valley prior to reaching the South McQuesten River (Figure 1). Elevated metal concentrations occur in surface waters and sediments of many of the drainages associated with past mining operations (Kwong et al., 1994; 1997).

There are ten adits/shafts in the KHSD that are known point sources of metal loads to the surface environment. These are listed below with the common name in parentheses:

- Silver King 100 (Silver King Adit)
- Galkeno 300
- Galkeno 900
- No Cash 500 (No Cash Adit)
- Bermingham 200
- Ruby 400
- Onek 400
- Sadie Ladue 600 (Sadie Ladue Adit)
- Keno 700
- Husky SW (Husky SW Shaft[1])

Zinc and cadmium are the metals of concern in the adit discharges of this area, although variable concentrations of manganese and iron are also present in some adit discharges.

The average adit outflows and selected metal concentrations of the 10 known point source adits in the KHSD are summarized in Table 1. Of these metals, only zinc and cadmium have been identified as contaminants of concern in the KHSD (Minnow 2013a). Six of these adits, Silver King 100, No Cash 500, Bermingham 200, Ruby 400, Husky SW Shaft, and Sadie Ladue 600, are located upstream of areas with the potential to attenuate chemical mass in the adit discharge through natural processes.

The mechanisms of natural attenuation have been evaluated and described by Interralogic (2010, 2012a) specifically for the No Cash Adit discharge, which is a significant zinc source in the KHSD (Table 1). For the purpose of this investigation, the Ruby and Bermingham adits are included under the No Cash description because they drain into No Cash Creek (NCC) and become part of its combined flow. The No Cash 500 adit provides the majority of zinc and cadmium to the No Cash bog, although the Bermingham adit is a significant secondary source of cadmium (Table 1). The remaining adits, specifically Galkeno 300, Onek 400, Galkeno 900,

[1] While Husky SW Shaft is technically a shaft, it passively drains like an adit and will be included in the discussion as an adit for the purpose of this report.

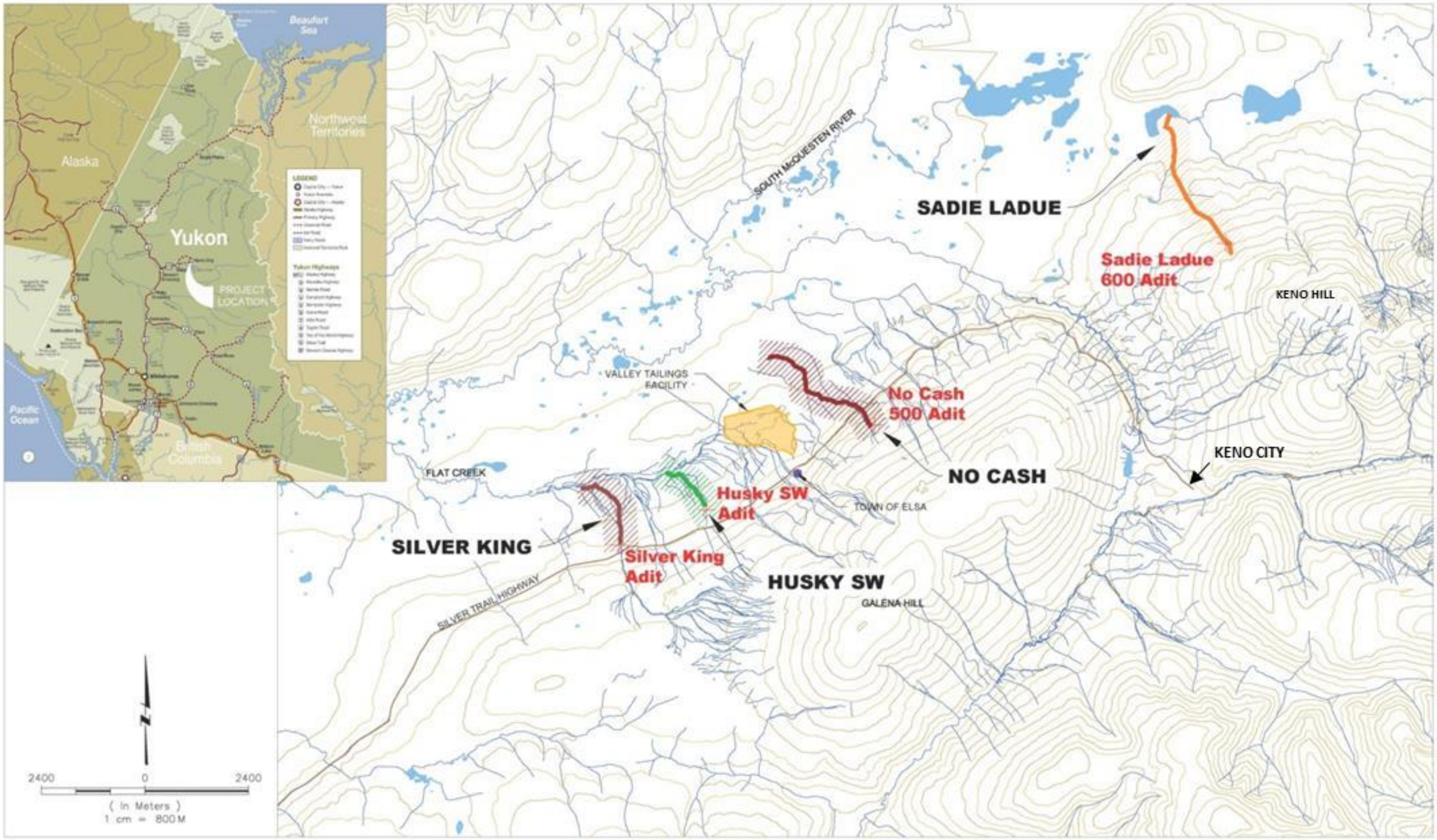
and Keno 700, are not suitable for natural attenuation as a closure option because of overly-elevated zinc/cadmium concentrations, unfavorable hydrologic flow characteristics, and/or the adit discharge does not flow through wetlands where attenuation processes are most effective. The Galkeno 300, Galkeno 900, and Silver King 100 adit discharges are currently collected and actively treated to reduce metal loads. According to the most recent water treatment records, the water treatment systems remove about 80 percent of the total zinc load in the KHSD.

Table 1 - Average adit flows and metals concentrations at the discharging adits[a]

Parameter		Galkeno 300	Onek 400[b]	**No Cash 500[c]**	Galkeno 900	Keno 700	**Silver King 100**	Sadie Ladue 600	**Husky SW**	Bermingham	Ruby
Average Adit Flow (2004 – 2010) (L/s)		9.2	2.3	**5.5**	3.1	3.4	**5.6**	7.6	**0.4**	2.0	1.0
Zn	Concentration (mg/L)	125	85	**13.2**	6	3.5	**1.65**	0.9	**1.3**	3.7	1.5
	Load (kg/yr)	36266	6165	**2260**	587	375	**291**	216	**16**	231	38
	Percent of Total Load	78.1%	13.3%	**4.9%**	1.3%	0.8%	**0.6%**	0.5%	**0.0%**	0.5%	0.1%
Al[d]	Concentration (mg/L)	0.11	0.02	**0.09**	0.02	0.03	**0.19**	0.08	**0.17**	0.09	0.28
	Load (kg/yr)	32	2	**20**	2	3	**34**	19	**2**	7	7
	Percent of Total Load	25.2%	1.3%	**15.5%**	1.6%	2.2%	**26.5%**	15.1%	**1.7%**	5.7%	5.3%
As	Concentration (mg/L)	0.160	0.058	**0.015**	0.087	0.034	**0.079**	0.004	**0.018**	0.043	0.049
	Load (kg/yr)	46.4	4.2	**2.7**	8.5	3.6	**14.0**	0.8	**0.2**	2.2	1.3
	Percent of Total Load	55.2%	5.0%	**3.2%**	10.1%	4.3%	**16.6%**	1.0%	**0.3%**	2.7%	1.5%
Cd	Concentration (mg/L)	0.330	1.671	**0.141**	0.001	0.013	**0.010**	0.004	**0.014**	0.182	0.018
	Load (kg/yr)	96	121	**26**	0.1	1.4	**2**	1.1	**0**	13	0.5
	Percent of Total Load	36.7%	46.4%	**10.1%**	0.1%	0.5%	**0.7%**	0.4%	**0.1%**	4.9%	0.2%
Cr[d]	Concentration (mg/L)	0.0017	0.0008	**0.0007**	0.0014	0.0020	**0.0014**	0.0007	**0.0010**	0.0006	0.0009
	Load (kg/yr)	0.49	0.05	**0.12**	0.14	0.21	**0.25**	0.17	**0.01**	0.04	0.03
	Percent of Total Load	32.5%	3.6%	**8.2%**	9.0%	14.1%	**16.3%**	11.0%	**0.8%**	2.6%	1.7%
Cu[d]	Concentration (mg/L)	0.012	0.018	**0.032**	0.002	0.002	**0.025**	0.004	**0.005**	0.006	0.005
	Load (kg/yr)	3.5	1.3	**5.5**	0.2	0.2	**4.4**	1.0	**0.1**	0.6	0.1
	Percent of Total Load	20.6%	7.8%	**32.5%**	0.9%	1.4%	**26.2%**	5.8%	**0.4%**	3.6%	0.8%
Mn	Concentration (mg/L)	154.00	8.45	**10.57**	17.90	0.17	**2.90**	0.04	**5.20**	1.30	3.00
	Load (kg/yr)	44680	613	**1956**	1750	18	**512**	11	**66**	80	64
	Percent of Total Load	89.8%	1.2%	**3.9%**	3.5%	0.0%	**1.0%**	0.0%	**0.1%**	0.2%	0.1%
Pb	Concentration (mg/L)	0.033	0.008	**0.011**	0.002	0.005	**0.001**	0.008	**0.011**	0.022	0.034
	Load (kg/yr)	9.6	0.6	**1.9**	0.2	0.5	**0.2**	1.8	**0.1**	1.8	0.1
	Percent of Total Load	56.7%	3.5%	**11.4%**	1.3%	2.9%	**1.5%**	10.9%	**0.8%**	10.4%	0.5%

[a] Compiled from flow rates and metals concentrations measured by Alexco personnel on behalf of ERDC. Gray shading indicates adits with water treatment systems; **BOLD** indicates potential natural attenuation site.
[b] Assumes an average flow rate of 2.3 L/s although this value varies significantly seasonally.
[c] "Non-detects" included in calculations at one-half the detection limit.

Figure 1 - Site Map and Attenuation Area Location



1.4 NATURAL ATTENUATION TARGET AREAS

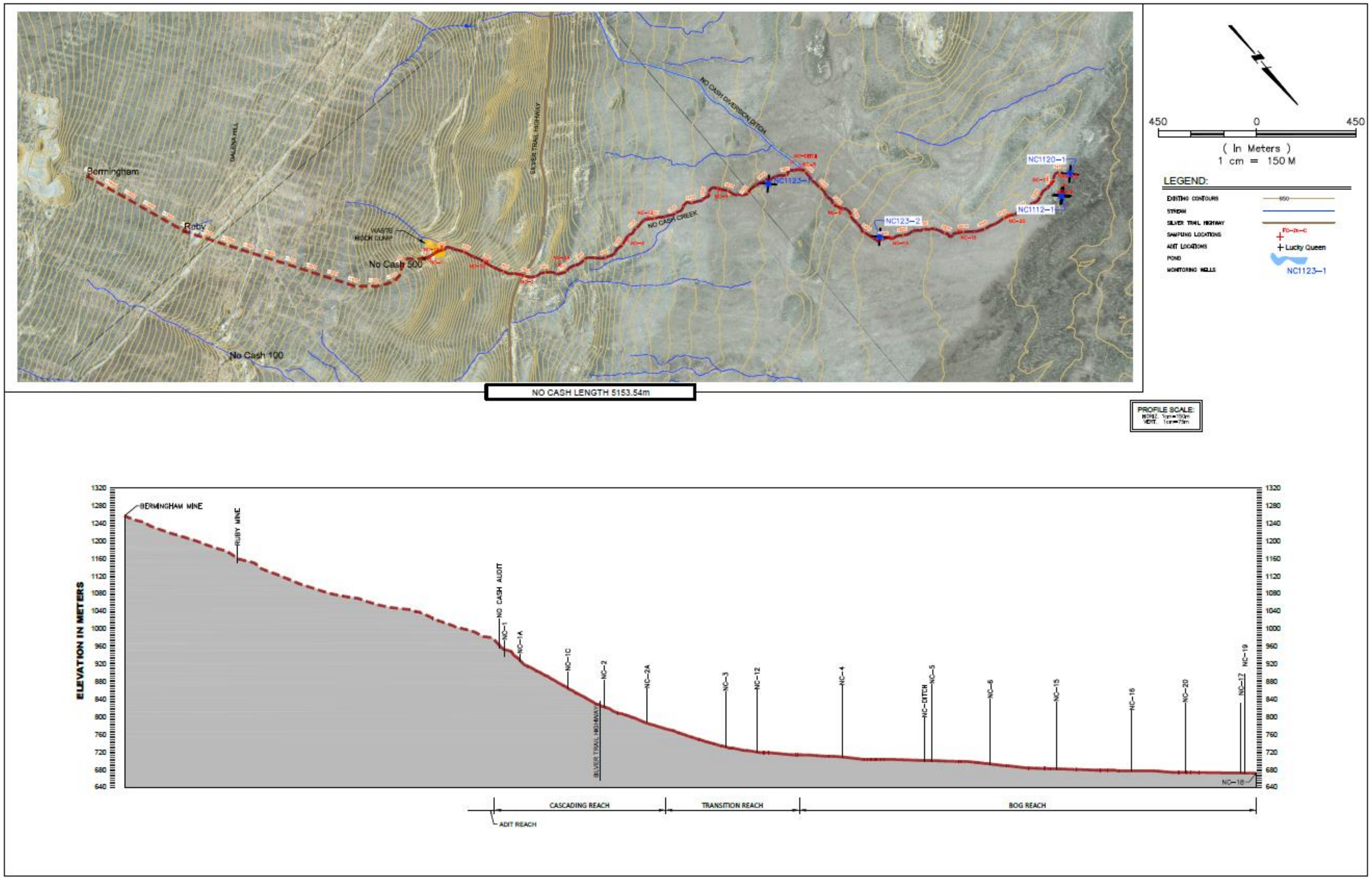
The areas originally targeted for evaluation for natural attenuation were NCC, Husky SW, Silver King, and Sadie Ladue. Each of these had low to moderate zinc mass loading, low to moderate flow, had a hillside (i.e., faster moving) reach where aeration could occur, and also flowed through peaty areas. These criteria indicated the potential for natural attenuation similar to that observed at NCC and were therefore included for evaluation. The Sadie Ladue adit, located on the northwest flank of Keno Hill, was removed for further consideration after initial surveys in 2010 indicated significant quantities of dispersed tailings materials were distributed along much of the length of the stream both within and outside the channel (Interralogic, 2011a). This distributed source of metals and the initial water quality data indicated no significant natural attenuation of metals was occurring in this drainage, or, if natural attenuation was taking place, it was being masked by ongoing mass loading by the dispersed tailings. Sadie Ladue is not discussed further in this report although all data are presented in Interralogic (2012a).

NCC, Husky SW, and Silver King areas all drain historical mine adits located on the northwest flank of Galena Hill near Elsa, and flow down Galena Hill toward the S. McQuesten River Valley (Figure 1). Distances, elevations and water sampling locations are marked on the figures for each watercourse.

1.4.1 NO CASH CREEK AREA

The NCC drainage is located on the northwest side of Galena Hill (Figure 1). Figure 2 shows a plan view and profile section of the drainage from the adit to the terminal pond. NCC is a natural stream that receives water from the historic No Cash, Ruby, and Bermingham mines via the No Cash 500, Ruby 400, and Bermingham 200 level adits, respectively. At each adit, water is discharged directly from the adit and additionally through a culvert from the adit onto the surrounding waste rock (No Cash 500 example shown in Figure 3). The discharge water flows across a waste rock bench and cascades down the side of the waste rock and enters NCC about 0.5 km downstream of the natural headwater source of NCC (Figure 2). Measured flow rates at the surface water monitoring location KV21, where NCC passes the Silver Trail Highway, have ranged from 3 to 15 L/s, based on sampling conducted during July of 2007, 2008, and 2009 (Access 2011).

Figure 2 - No Cash Plan and Profile



Downstream of the confluence of the 500-adit discharge and NCC (which is carrying discharge from the Ruby and Bermingham mines), the channel flows in a northwesterly direction, crossing the Silver Trail Highway in a culvert, and through boreal forest on Galena Hill (Figure 4). It then intersects the No Cash Diversion Ditch and then runs through a poorly drained valley containing extensive areas of heavily-vegetated peat bog/marsh. A series of other seeps and disconnected streams drain Galena Hill parallel to NCC, toward a large peat bog in the South McQuesten River valley (Figure 5).

NCC is not a direct tributary of any other streams but instead terminates in a small pond in a low lying boggy area of the valley approximately 2 km south of the South McQuesten River. Much of the NCC drainage and surrounding wetland area is underlain by thick deposits of peat (up to just over 3 m thickness observed in NCC drill holes), glacial-related sediments and discontinuous permafrost of variable extent and thickness. While there are seeps along the south and east sides of the South McQuesten River that may be down gradient of the terminus of NCC, there is no surface connection between the two areas due to a topographic high north of the terminal pond of NCC. The seep survey of the South McQuesten River did not show any elevated mine-related constituents to be present on the south bank seeps (Interralogic, 2010).

Adit water from the No Cash mine contains elevated levels of metals, namely cadmium, manganese, and zinc, as well as sulphate (Kwong et al. 1994; 1997; MERG 2000; ERDC 2006). The sources of these constituents are oxidative dissolution of metal sulphide minerals and dissolution of metal carbonate and silicate minerals associated with mineralized zones of the No Cash mine. Oxidative dissolution of sulphide minerals has not resulted in acid mine drainage from the No Cash Adit due to high levels of carbonate (mostly calcite) in the major lithologic units that host the mineralization (Kwong et al. 1994; 1997). Major lithologic units in this mine include the Keno Hill Quartzite (Mississippian Era), and Earn Group metavolcanics and metasediments (Devonian-Mississippian Eras). Kwong et al. (1994) reports net neutralization potentials (NNP) ranging from 105 to 934 kg $CaCO_3$/tonne for these rock types. Rock types with NNPs in that range have a very low probability of generating acid rock drainage; except possibly in localized areas of high sulphide mineral content. Water flowing directly from the adit and upper NCC has pH values between 7 and 8.3, and alkalinity measurements of 85 to 286 mg/L $CaCO_3$ equivalent. These high alkalinities are indicative of a strong influence of carbonate mineralogy on water chemistry (Kwong et al.1994; 1997; MERG 2000).

Figure 3 - Sampling at No Cash Adit - October, 2010

Figure 4 - No Cash Creek Cascading Reach

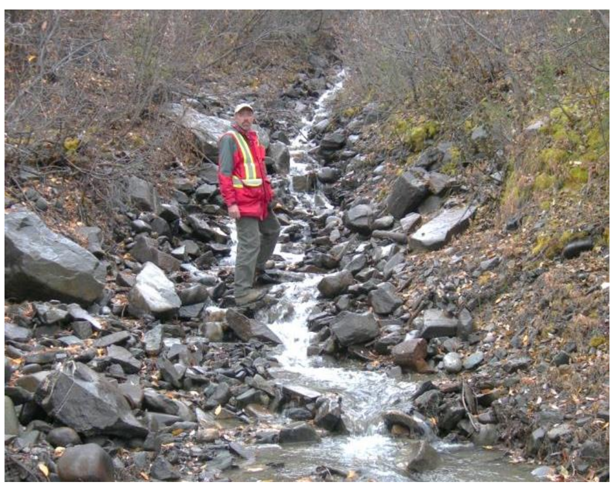


Figure 5 - No Cash Bog

1.4.2 HUSKY SW AREA

The Husky SW site (Figure 6) conditions are similar to those of the No Cash drainage, where natural attenuation processes are effective for improving water quality. The Husky SW mine site comprises a group of historical structures, a waste rock pile, a low-grade stockpile, and fill material. Seepage from the shaft is conveyed beneath the fill material to a dilapidated crib structure (Figure 7) from which water flows into a narrow surface drainage (Figure 8). From this point, the discharge flows northward down Galena Hill toward Flat Creek similar to that of NCC except: 1) the high-energy, cascading reach present at No Cash does not exist downstream of the Husky SW area and, 2) the Husky SW drainage connects with Flat Creek (Figure 9), whereas NCC ends at a terminal pond. However, the extensive forested slope and peat bog area along Husky Creek (Figure 10) are similar to the No Cash bog area.

The water quality of the Husky SW adit seepage is similar to that of the No Cash adit, with elevated zinc, manganese, cadmium, and sulfate. However, zinc and cadmium concentrations are an order of magnitude lower at Husky SW (Table 1). The water is circumneutral with a pH between 7.5 and 8.0 and alkalinity between 250 and 300 mg/L as $CaCO_3$. So while other metals and major ion concentrations are similar to those observed at No Cash, the flow from Husky SW adit is about an order of magnitude lower, resulting in an overall much lower mass loading from Husky SW.

Figure 6 - Husky SW Plan and Profile

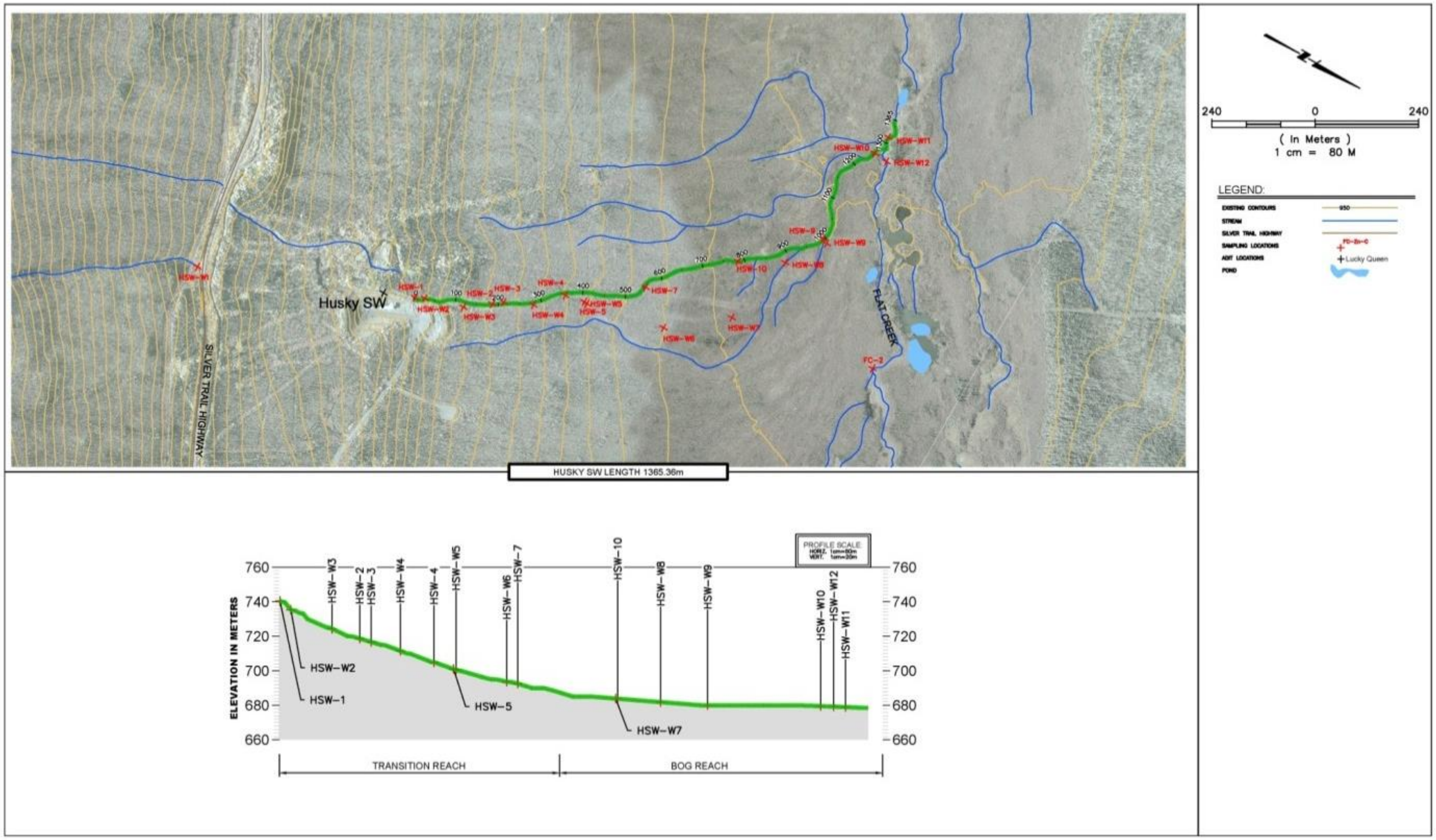


Figure 7 - Husky SW Crib Structure and Flow

Figure 8 - Sampling the Transition Reach of Husky SW

Figure 9 - Intersection of Husky SW and Flat Creek Drainages

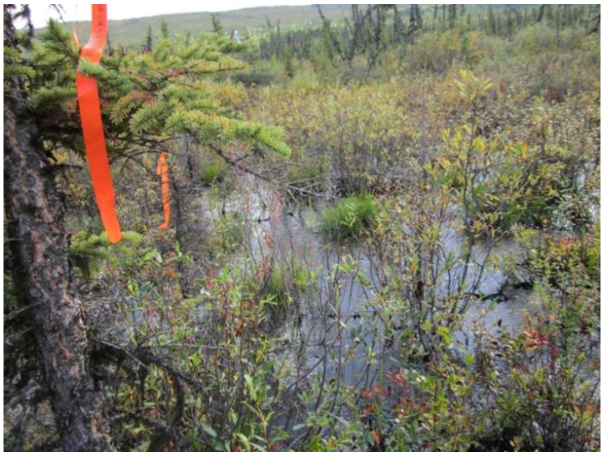


Figure 10 - Husky SW Bog Reach

1.4.3 SILVER KING AREA

The Silver King mine is located west of Elsa about 4 km where the Silver Trail Highway crosses Galena Creek (Figure 11). The mine workings straddle the highway, with the open pit, the 75-level adit, vents and other structures on the south side of the highway; and waste rock (Figure 12), the 100-level adit, various historical structures, lime treatment system/ponds, and the treatment plant outflow on the north side of the highway. The treated water is discharged to ground surface north of the treatment area and west of Galena Creek.

The Silver King 100 adit and drainage has site conditions that are similar to those at the Husky SW drainage where natural attenuation reduces metal concentrations along the stream reach. Similar to Husky SW, the mine is lower on Galena Hill and has no cascading section, but is located in the transition area between the cascading and bog reaches. Flow from the Silver King Mine is treated, and currently discharges at the base of the northernmost waste rock dump into forested and permafrost ground. The treated discharge then flows parallel to Galena Creek in a narrow channel that exhibits thermokarst features, particularly in the autumn when flow is often observed percolating up out of the ground and subsequently disappearing again (Figure 13). The treated discharge stream then intermingles with a complex of braided channels associated with Flat Creek (Figure 14).

Nine samples were collected along the treatment system decant discharge stream downslope of Silver King Adit (Access 2008). Laboratory results from these samples suggested that natural attenuation was occurring along the flow path as shown by further reductions in metals concentration compared to what was achieved by the active lime treatment system, but also indicated areas of complex flow paths and hydrogeochemical processes were occurring near the confluence of Galena Creek and Flat Creek. A more thorough investigation of water quality trends and soils characterization was conducted to develop a baseline dataset. The following sections describe the data collection and results, followed by an assessment of how conditions in the Silver King area compare to the NCC area as a potential natural attenuation area.

The water quality of the Silver King adit seepage is similar to that of No Cash adit, with elevated zinc, manganese, cadmium, and sulfate but with lower zinc, manganese and cadmium concentrations at Silver King. The water is circumneutral with a pH between 7.5 and 8.0 and alkalinity between 250 and 300 mg/L as $CaCO_3$. The flow rate is similar to the No Cash adit at around 5 – 6 L/s.

Galena Creek chemistry is generally good quality above the mine but reflects the presence of the mine workings and waste rock adjacent to the Creek as it passes by. Relatively small increases in metals concentrations such as zinc and cadmium are accompanied by small increases in sulfate in the creek water downstream of the mine. pH is circumneutral and alkalinity present at 50 to 250 mg/L as $CaCO_3$.

Figure 11 - Silver King Plan and Profile

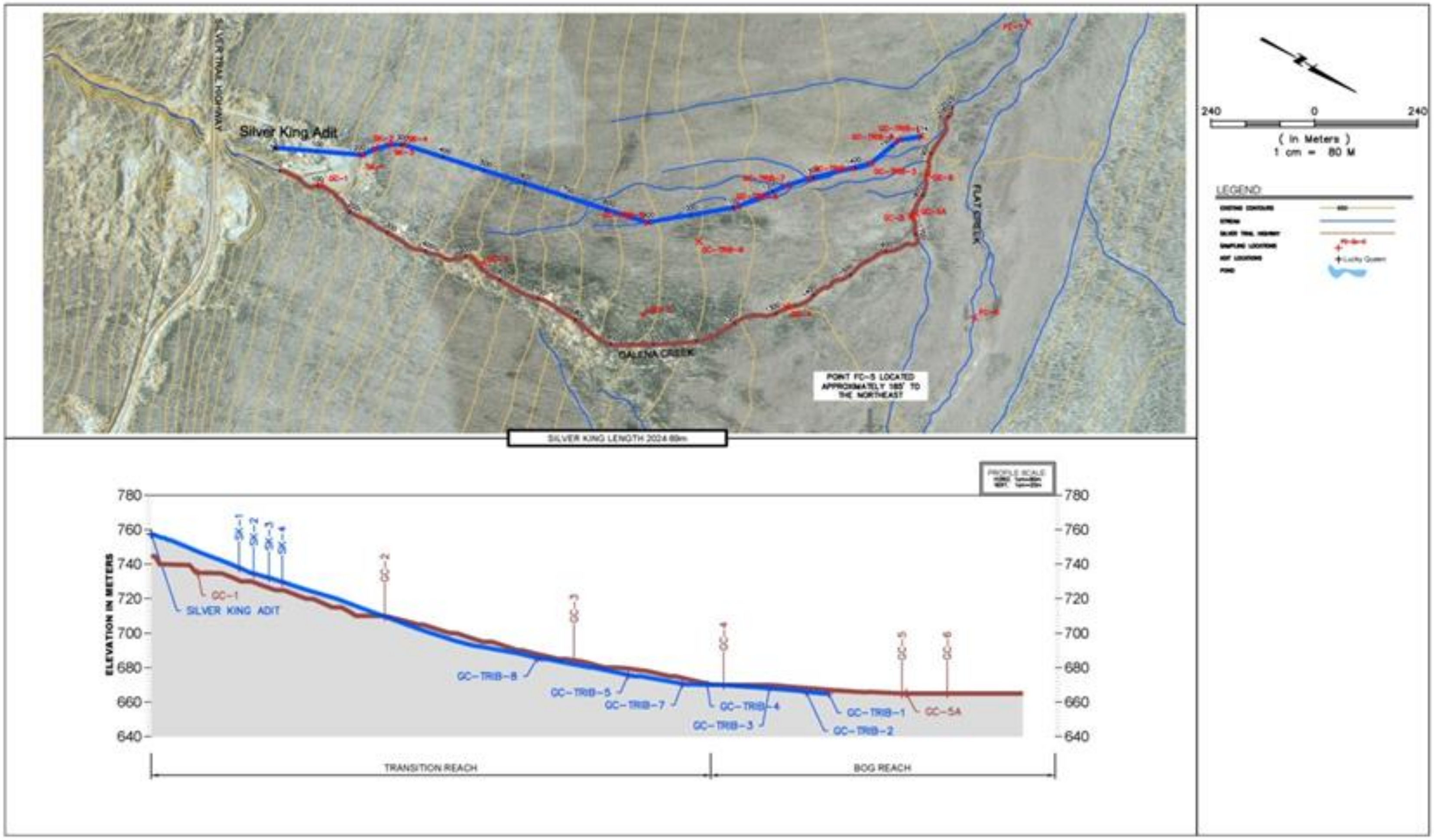


Figure 12 - Wooded Area North of Silver King 100

Figure 13 - Thermokarst Features in Silver King Drainage

Figure 14 - Silver King Bog Reach

2 STUDY METHODS

Project design was conducted in year-to-year phases. The initial work design was based on a review of historical data and publications including, but not limited to, the investigation conducted in 2009 and reported in Interralogic (2010). Peer review comments provided by Dr. Kwong (personal communication 2010), who has conducted geochemical and natural attenuation research in the KHSD, were also used to design the investigations. Results from previous year's work, and feedback from team members, were also used to guide subsequent year's field work and technical analysis. A list of completed (or ongoing monitoring) field studies is presented below.

- Geochemistry of Natural Attenuation
  - Peat sampling and analysis including carbon-14 age dating at NCC
  - Soil sampling and geochemical analysis (NCC, Husky SW, Silver King)
  - Soil water sampling and analysis (NCC, Husky SW, Silver King)
  - Sediment sampling and geochemical analysis (NCC, Husky SW, Silver King)
  - Water sampling and analysis (NCC, Husky SW, Silver King)
  - Seasonal (winter and freshet) water sampling (NCC, Husky SW)
  - Ice sampling (NCC, Husky SW)
  - Microbial evaluation of NCC attenuation and Galkeno 900 bioreactor

  - Detailed mineralogical assessment of attenuation-related mineral phases including optical petrography, scanning electron microscopy, electron microprobe analysis, and high energy synchrotron x-ray elemental and mineralogical analyses (NCC, Husky SW)
  - Metal mineral phase stability testing (NCC)
- NCC Surface Water Pathway Evaluation
  - Summer survey
  - Winter survey
  - Freshet survey
- NCC Groundwater Pathway Evaluation
  - Well Installation
  - Well monitoring (ongoing)
- NCC Surface Peat and Vegetation Sampling
  - Peat thickness/accumulation study including carbon-14 age dating
  - Peat chemistry variations with depth
  - Vegetation sampling (completed as part of KHSD wide study of soil and vegetation metal study (Access, 2012, 2013))
- Closure support
  - Engineering survey of NCC
  - Hydrologic, geochemical, and closure conceptual model development

Table 2 shows the schedule of the field program at each area by year and field element.

Table 2 - Summary of Field Activities at Natural Attenuation Targe Areas

Event	Date	No Cash Creek	Husky Southwest	Silver King	Sadie Ladue
Surface Water Sampling	May-2007			✓	
	June-2007				✓
	July-2009				
	September-2009				
	October-2010	✓	✓	✓	✓
	March-2011	✓	✓		
	May-2011	✓	✓	✓	
	August-2011	✓	✓	✓	
	January-2012	✓			
	July-2012	✓	✓		
	February-2013	✓	✓		
Ice Sampling	March-2011	✓	✓		
	January-2012	✓			
Stream Sediment Sampling (Alluvium & Peat)	October-2010	✓	✓	✓	✓
Soil Sampling	October-2010	✓	✓	✓	
Pore Water Sampling	October-2010	✓	✓	✓	✓
Vegetative Sampling	2012	✓	✓	✓	✓
Monitoring Wells	2010	✓			
Microbial Sampling	2011	✓			
Precipitate Sampling	2012	✓	✓		
Peat (Carbon-14) Sampling	2012	✓			
Engineering Survey	2012	✓			

Surface water samples were collected at sampling locations in the three natural attenuation areas to represent spatial, temporal, and seasonal changes in water chemistry. Industry standard field practices were implemented in collecting grab samples directly from flowing creek water. Samples were filtered in the field and field parameters measured. Total and dissolved metals were analyzed using a certified laboratory. Standard quality assurance methods were implemented including the collection of field and laboratory blanks and duplicates.

Groundwater wells were installed in the NCC area to monitor water levels and to collect groundwater quality samples. Industry standard methods were used in well installation and well purging and sampling.

Channel sediment, alluvium, and peat samples were collected in all areas with as many as possible being collected at the locations where water samples were also collected. Sampling locations are shown in Figure 2, Figure 6, and Figure 11, with stream profiles to indicate sample locations with respect to stream reaches. Alluvium and peat samples were collected from stream banks except for C-14 samples, which were collected from a test pit excavated in the central area of the NCC bog. In some cases peat and alluvium were mixed with vegetation and root mats. Samples of precipitate, where present, were collected from the stream bed sediments.

Analytical results for sediment, soil, and peat samples collected include:

- Multi-element analysis (aqua regia digestion followed by ICP-AES/MS analysis)
- Acid base accounting parameters (sulphur species, carbonate neutralizing potential (NP), paste pH)
- Mineral stability testing
- X-ray diffraction (XRD) analysis
- Optical microscopy
- Scanning electron microscopy, and electron microprobe analysis
- Synchrotron-based X-ray analysis
- C-14 age date analysis

2.1 ANALYSIS OF ZINC AND CADMIUM GEOCHEMISTRY AND MINERALOGY

Polished thin sections were prepared from sediment samples collected along the NCC reach in 2011 and 2012. A smaller suite of thin section samples were prepared from sediments collected along the water course of Husky SW in 2012. These were examined by a range of electron-, laser- and X-ray-based analytical techniques to determine the element associations, the mineralogy and major hosts of zinc within the sediments.

Electron microprobe (EMP) analyses were used to collect major element maps (zinc, manganese, iron, sulphur, silicon) across zinc-bearing grains in the thin sections (typically a few hundred microns in diameter) to show element association, while line scans were run across grains to demonstrate changes in element composition. Spot analyses were obtained to determine major element concentrations and extract element ratios to yield insights into possible mineralogical hosts of zinc. The detection limit of this technique is ≥ 600 mg/kg depending on the element and although it can yield accurate concentration measurements, it is best suited to the analysis of major elements (Sherriff, 2012). This made mapping the cadmium distribution difficult, partly due to the short counting times necessitated by timely map collection, however, spot analyses were able to determine cadmium concentrations in some samples. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is considerably more sensitive than EMP and was used to obtain major and trace element information in transects run across grains of interest in the thin section samples.

Synchrotron-based X-ray analytical tools were used to probe the zinc and cadmium associations in the No Cash and Husky SW samples. X-ray absorption near edge structure (XANES) spectroscopy was performed to determine the speciation of zinc and cadmium in selected bulk sediment samples from NCC and Husky SW. This technique is element specific (i.e. it only "sees" zinc- or cadmium-bearing phases in the sample) and works by collecting the XANES spectra of a range of zinc- and cadmium-bearing mineral phases and sorption complexes and matching these in various proportions to produce the best fit to the sample XANES spectrum. Micro-focused synchrotron-based X-ray techniques were also applied to the thin sections. Prior to such work, the thin sections were inspected by scanning electron microscopy coupled with energy dispersive X-ray analysis (SEM-EDX) in order to identify zinc-rich grains to investigate further at the synchrotron. At the synchrotron, micro-X-ray fluorescence (μ-XRF) maps were collected to image the distribution of major elements within the sample, primarily concentrating on manganese, iron and zinc, with more recent work including cadmium. Using these maps, areas of variable (high, mid, low) zinc concentrations were targeted for further examination by micro-X-ray diffraction (μ-XRD) alongside zinc and cadmium μ-XANES. Micro-XRD analysis is similar to conventional XRD, except a much smaller X-ray beam spot size is used (*ca.* 5 x 9 μm), allowing minerals present at <5 wt.% in the bulk sample to be detected that would otherwise be missed by bulk XRD. For good diffraction to occur, the crystallites in the sample should be randomly oriented and at least an order of magnitude smaller than the beam diameter. In this sense, the mineral spot under the beam acts like the powdered samples used in conventional XRD analysis. Thus, synchrotron-based μ-XRD is best suited for nanocrystalline materials and will not work well for coarser mineral crystals which are unlikely to diffract under the microfocused monochromatic X-ray beam. Further details regarding synchrotron-based analysis of environmental materials are well described in recent review papers by Lombi and Susini (2009), Lanzirotti et al. (2010), and Jamieson and Gault (2012).

Mineral liberation analysis (MLA) was also used to construct mineralogical maps of portions of the thin section samples. MLA employs SEM imaging, EDX spot analyses and proprietary software to characterize the variety of minerals present in the sample. Thousands of mineral particles are first sorted based on their back-scattered electron intensity then an EDX spectrum is rapidly collected for each different particle. These particle EDX spectra are matched offline against a mineral reference database, building a mineralogical map of the portion of the thin section analyzed. This makes it possible to find zinc hosts that may have been overlooked by other analytical methods, and also has the potential to measure the relative proportions of metal-bearing minerals, assuming that the metal concentration in each library phase is well constrained.

3 RESULTS

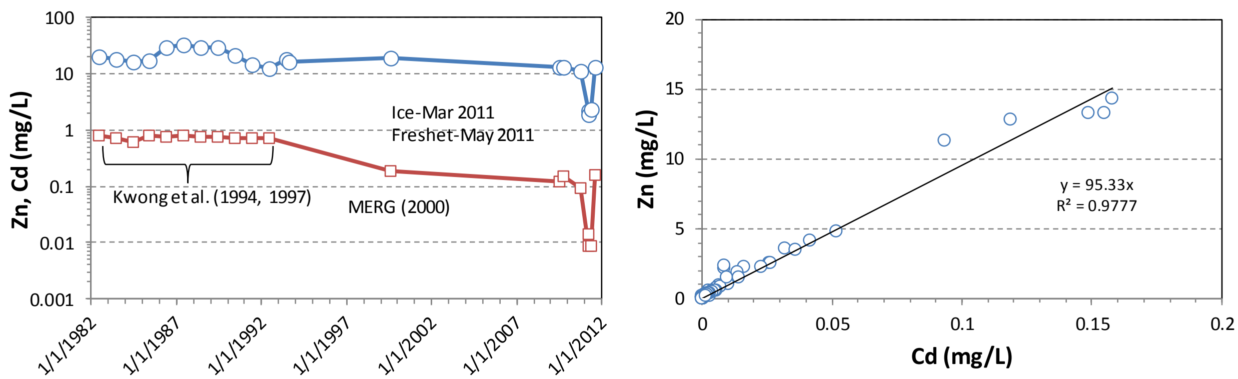
3.1 WATER CHEMISTRY

3.1.1 NO CASH CREEK

No Cash 500 adit discharge water has a Ca-HCO_3-SO_4 composition with pH typically from 7.2 to 8.0. The adit discharge contains elevated concentrations of cadmium, manganese, and zinc. The concentration of zinc has decreased over time from a high of 32 mg/L in 1987 shortly after mining ceased to a typical range of 11 to 13 mg/L in 2009 to 2011 (Figure 15). Cadmium concentrations have decreased from a high of 0.8 mg/L in 1982 to 1987 to 0.1 to 0.2 mg/L in 2009 to 2011. This pattern is not atypical of abandoned mine discharges. Younger (1997) showed that mass loading (as acidity) in abandoned mine drainage starts off relatively high (termed “vestigial”) related to flooding of mine voids and release of readily soluble reaction products. This is typically followed by a "juvenile" phase of relatively lower concentrations related to long-term, slower primary reactions, which are slowed by factors such as loss of source mineral phases, formation of secondary mineral coatings, or burial or saturation of potential source phases.

Data from water samples collected in the adit and also from downstream locations indicate a high degree of correlation between zinc and cadmium (Figure 15), implying that the samples have a similar origin within the mine workings, and similar processes control their environmental fate and transport. Sphalerite is a major ore mineral in the KHSD and is presumed to be the primary source of zinc and cadmium through oxidative dissolution processes in the workings of No Cash Mine and the other mines being evaluated.

Figure 15 - Historical Zinc and Cadmium Concentrations in No Cash Adit Discharge



Trends in metals (zinc, cadmium, manganese, and iron), sulphate, and bicarbonate with distance from the No Cash 500 adit are shown in Figure 16. Total and dissolved concentrations for most metals (except for iron) are very similar, indicating that suspended particulates are not a major component of the water quality analyses. The concentrations of zinc and cadmium (Figure 16) decrease rapidly with distance from the adit particularly within the first kilometer. The zinc concentration shows about a 100-fold decrease and cadmium concentration shows a 100- to 1000-fold decrease along the total flow path, depending on the sample set. Concentrations during winter (March 2011, January 2012 and February 2013 samples) and during freshet (May 2011 samples) are typically about half of the summer/fall concentration at the adit but still show decreases with distance from the adit that are similar to decreases that occur in other times of the year (summer and fall). Overall, there appears to be no distinct seasonality effect to the extent and magnitude of decreases in metal concentrations in our data sets for zinc and cadmium; rather, these metals removal trends occur for all seasons. The median zinc and cadmium concentrations in the terminal pond at the end of the NCC reach are slightly above the CCME guidelines, but are in line with the proposed water quality benchmarks and well below the KHSD water use licence effluent quality standards (Table 3).

Table 3 - Zinc and cadmium concentrations in terminal pond at end of NCC reach

	Zinc (mg/L)	Cadmium (mg/L)
Range	0.047 - 0.067	0.0001 - 0.0005
Average	0.054	0.00028
Median	0.052	0.00026
QZ12-057 EQS[a]	0.5	0.05
Proposed KHSD benchmark[b]	0.075	0.0003
CCME-PAL[c]	0.03	0.000158[d]

[a] Quartz mining water licence – effluent quality standard

[b] Proposed water quality benchmarks for site closure evaluation (Minnow, 2013b)

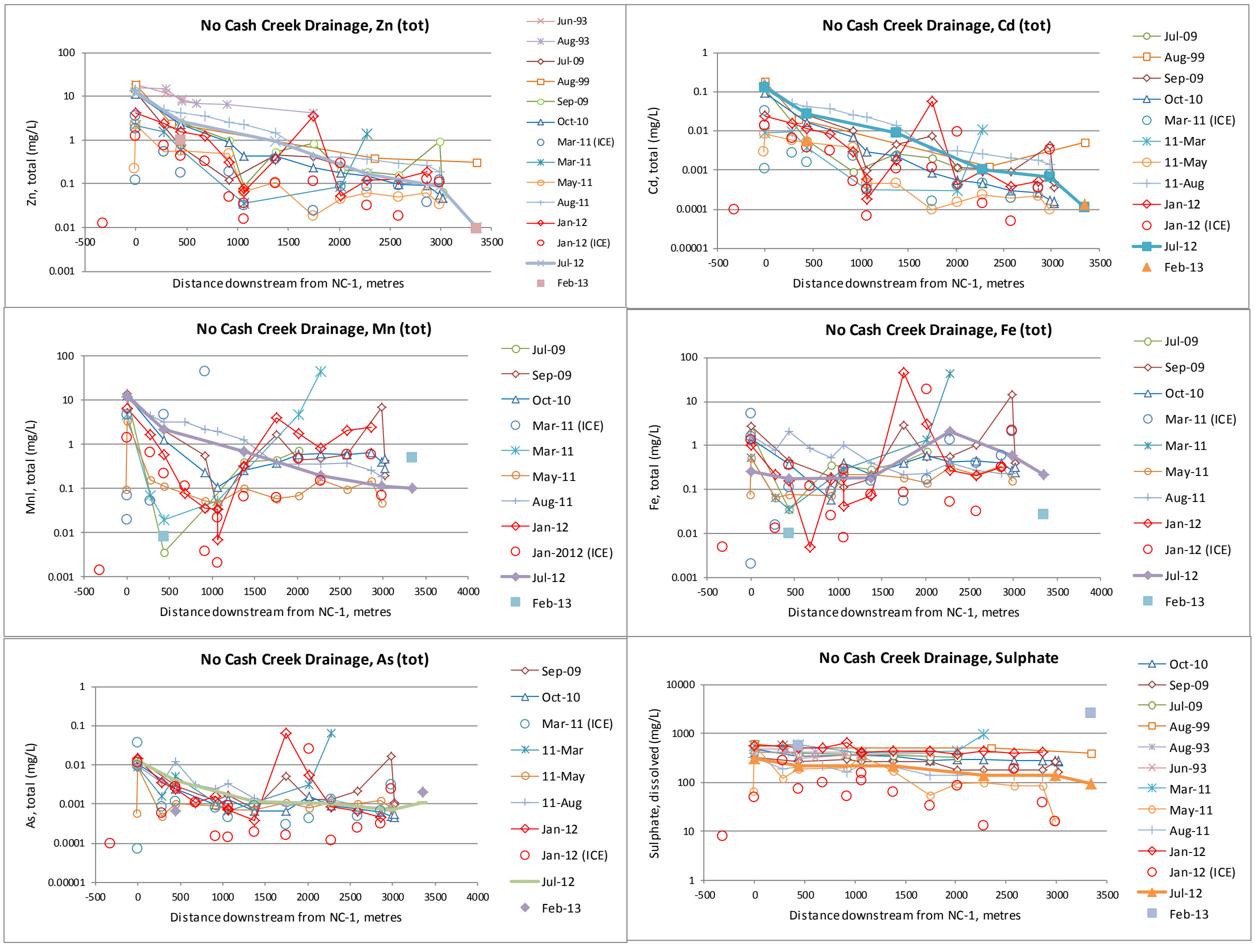
[c] Canadian Council of Ministers of the Environment – Protection of Aquatic Life

[d] Based on draft cadmium October 2012 CCME-PAL guideline at 100 mg/L hardness (NCC waters typically >100 mg/L hardness)

Manganese and iron concentrations also decrease initially within the first kilometer from the adit (Figure 16), then increase slightly or remain approximately constant with further distance, but maintain concentrations that are 1 to 2 orders of magnitude less than in adit discharge. Iron concentrations show more variability than manganese concentrations along the entire length of NCC. The dissolved iron concentrations are high given the neutral pH conditions, implying it may be at least present partially as ferrous iron that persists metastably until oxidized to ferric iron. Slower ferrous iron oxidation is observed in natural environments where organic carbon is present. Dissolved iron concentrations are also generally lower than total iron concentrations, indicating that a significant fraction of the iron is transported as particulates, which might also suggest that a significant fraction of the "dissolved" iron (<0.45 µm filtered) is nanoparticulate. Overall, manganese concentrations show an average of a 20-fold decrease. In contrast to the metals, sulphate concentrations decrease by only about 20 to 80% with distance from the adit (Figure 16), and bicarbonate generally shows little variation (Figure 16).

Sulphate is assumed to be conservatively transported for the most part with the exception of slow flowing areas in the bog where sulphate reduction may be observed; hence, the small decreases in concentration observed with distance for sulphate are expected to be due to dilution from groundwater and side channel inflows. While these dilution effects will also cause small decreases in metal concentrations, the much larger decreases in zinc, cadmium, and manganese concentrations relative to sulphate indicate that geochemical attenuation/precipitation processes are also involved.

Figure 16 - Selected water chemistry trends along the No Cash Creek drainage (note logarithmic scale on y-axis)



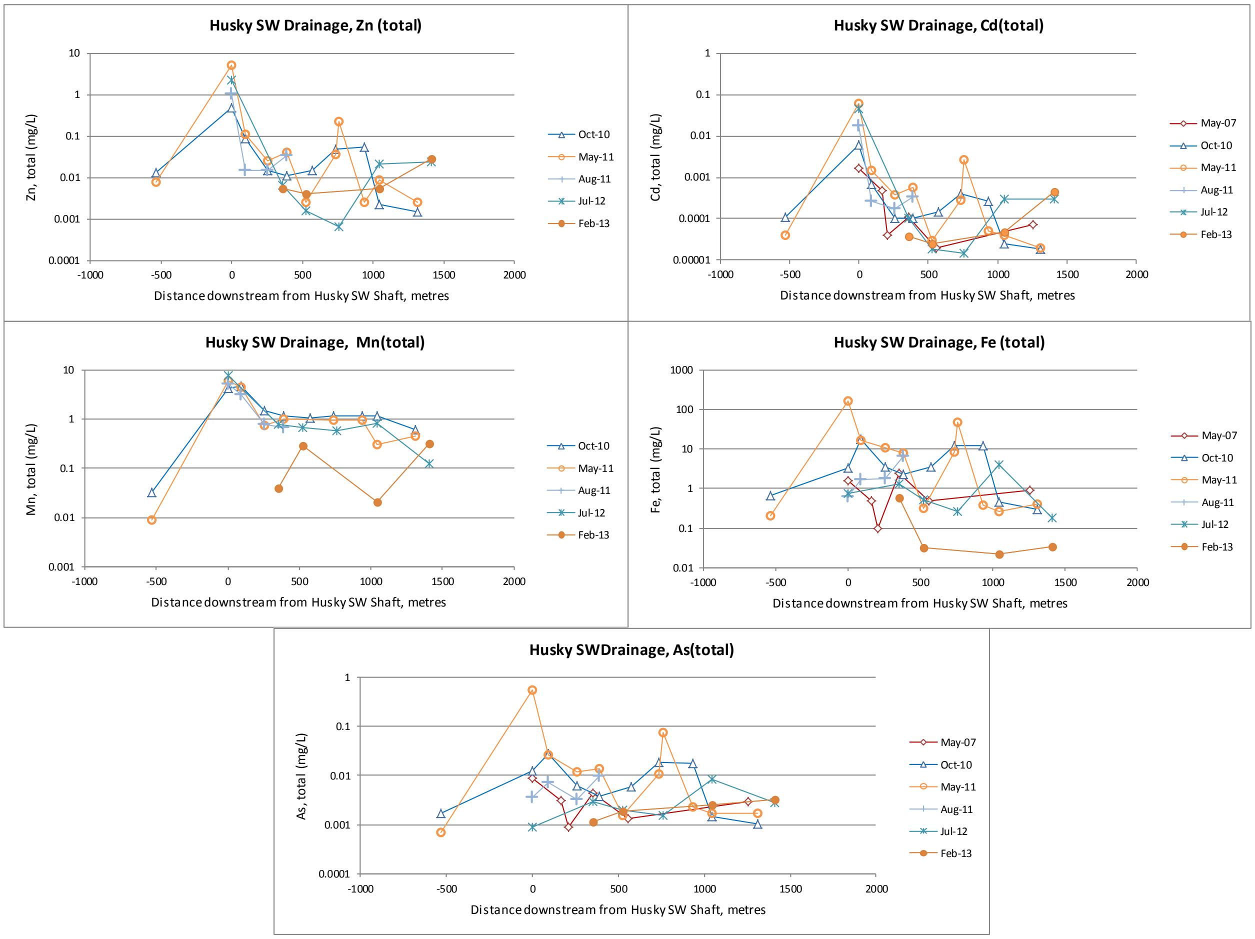
3.1.2 HUSKY SW

Six sampling events were conducted along the Husky SW drainage, from 2007 through 2013. Water samples were collected along Husky SW Creek between the Husky SW crib structure and the confluence with Flat Creek. Field parameters were measured at each location. Figure 17 shows key metals concentrations along the Husky SW drainage.

Husky SW Creek has sections that split and braid. During sampling, the main stream of this creek was not always apparent, and in some cases samples were collected from parallel drainages. The difficulty in tracing the main drainage resulted in sporadic increases and decreases in metal concentrations in lab results. The graphs in Figure 17 suggest a continuous flow path exists between subsequent samples down the flow path due to the line drawn between data points. In the case of Husky SW, however, this may be inaccurate because multiple flow paths exist on the hillside below the mine area.

Samples collected within the first 500m of the adit indicate strong attenuation of metals including zinc, cadmium, and manganese. Zinc and cadmium concentrations decrease over this reach from two to three orders of magnitude and manganese decreases about one order of magnitude. Downstream sampling locations show inconsistent and sometimes higher concentrations of many metals than upstream samples suggesting an unclear or mixed flow path.

Figure 17 – Selected analyte trends along the Husky SW drainage



3.1.3 SILVER KING

Twenty water sampling stations were located along two profiles; the Galena Creek profile which follows Galena Creek on a westerly then easterly arc toward Flat Creek, and the Silver King profile which follows the fall line north directly toward Flat creek. The Silver King profile includes the decant water discharge area and tributaries to Galena Creek. In addition to the 2007 sampling round, five additional rounds of sampling were conducted: October 2010, May 2011, August 2011, July 2012, and a winter event in February 2013. Field parameters were measured at all locations.

Figure 18 shows the metals concentrations along the Galena Creek profile. The Galena Creek profile shows effects of the Silver King operations including waste rock and potential mine (groundwater) seepage. Zinc concentrations along Galena Creek increase between near the mine area but then decrease gradually with distance along the creek.

Figure 19 shows the Silver King treated water profile. The treated water decant discharges immediately north of the site at the base of the waste rock dump into the forested area. Zinc concentrations decline with increasing distance from the discharge pipe by a factor of about 4 within 100 m of the pipe. Tributaries located downstream of the discharge pipe (and mine area in general) showed highly variable chemistry including some areas that were elevated compared to initial concentrations at the pipe discharge. This was also observed at the Husky SW site where multiple flow paths preclude an assumption of a single, continuous flow path.

Figure 18 - Selected water chemistry trends along the Galena Creek drainage

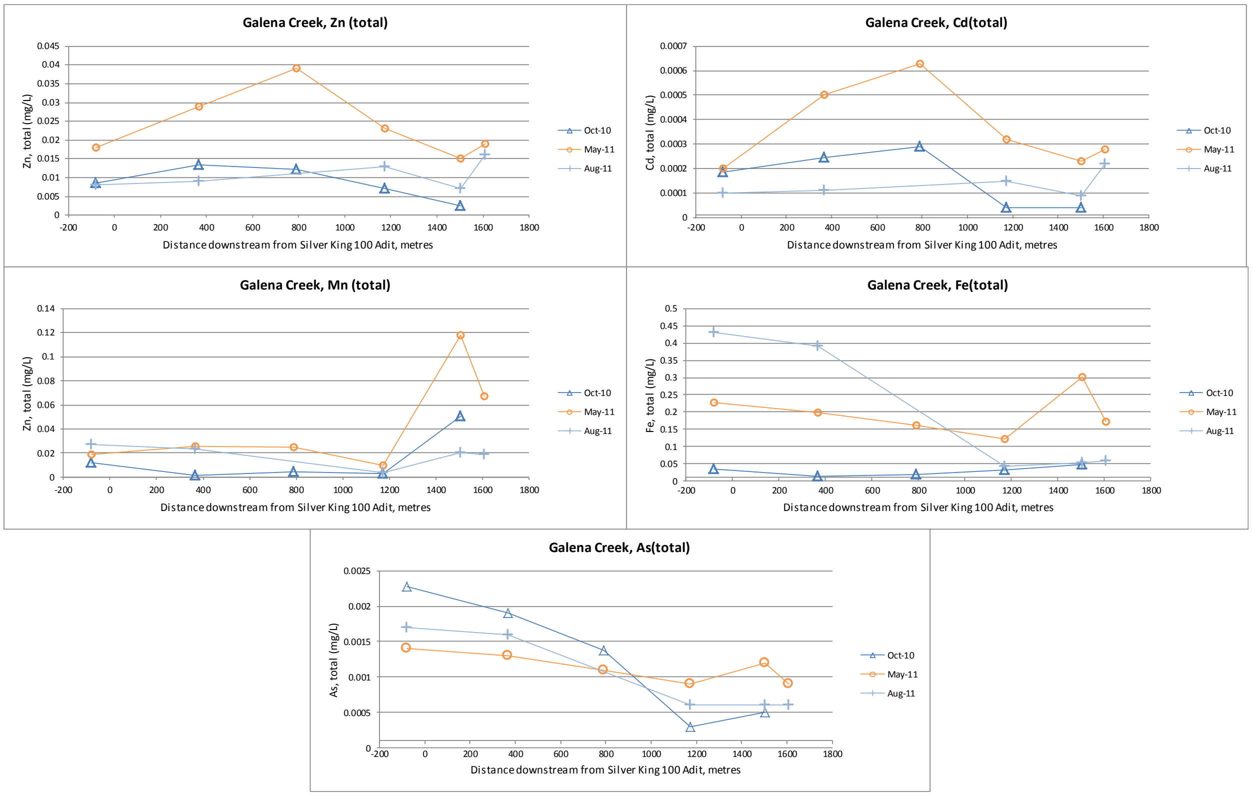
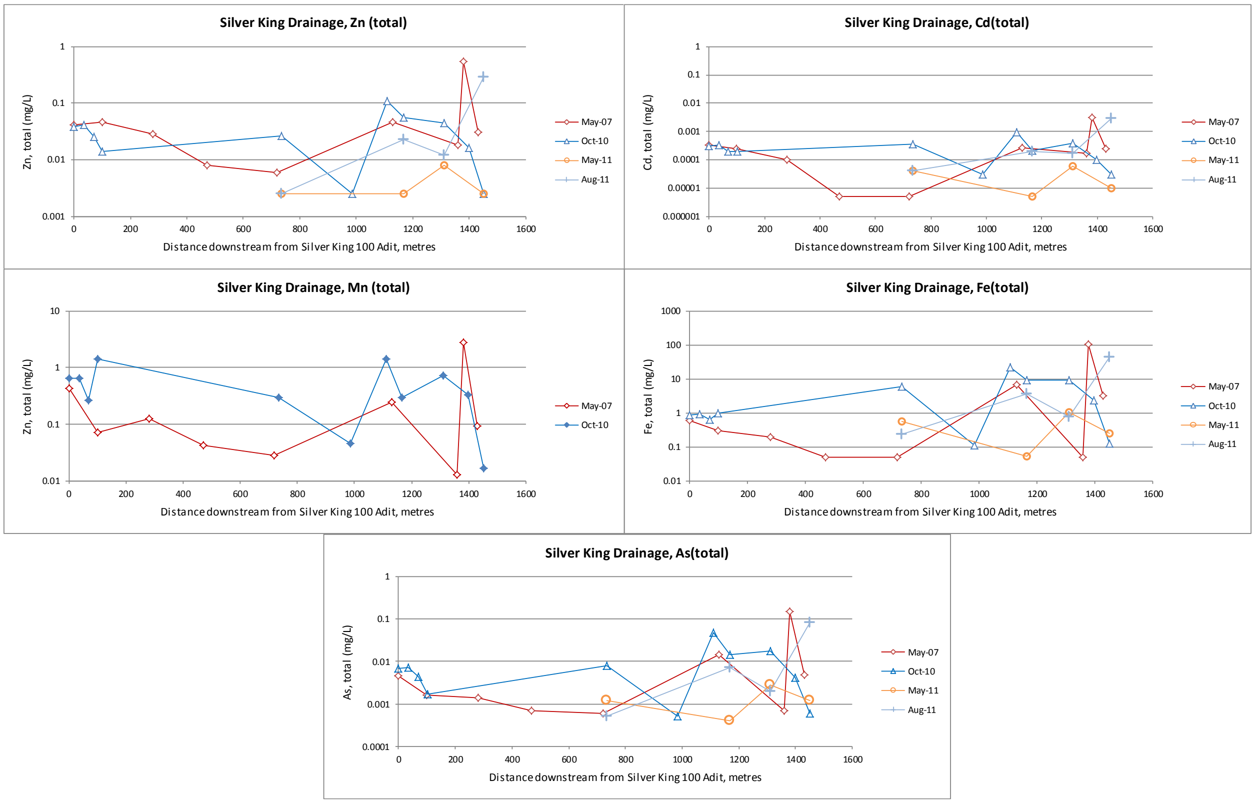


Figure 19 - Selected water chemistry trends along the Silver King decant drainage



3.2 SOLID PHASE GEOCHEMISTRY

3.2.1 NO CASH CREEK

3.2.1.1 GEOCHEMICAL AND MINERALOGICAL CONTROLS ON ZINC AND CADMIUM ATTENUATION

Field data indicate that the zinc and cadmium attenuation is occurring along the entire reach of NCC. Approximately 90% of the zinc and cadmium is sequestered in the initial "cascading" part of the NCC reach. The watercourse then transitions to a low energy, slower flowing stream that passes through an organic-rich wetland. The peaty sediments in this "bog" reach act as a polishing step to the initial attenuation, resulting in an overall removal of >99% of zinc and cadmium from adit discharge water.

3.2.1.2 ZINC AND CADMIUM SEQUESTRATION IN UPPER "CASCADING" REACH

Imaging of 23 thin sections by backscattered electrons using SEM and EMP revealed a preponderance of lithic, and occasionally organic particles that were partially or fully encrusted with banded manganese-zinc-rich coatings (Figure 20; Sherriff 2011a-e, 2012, 2013). These were most noticeable in samples collected close to the adit. The abundance of such colloform coatings declined with distance downstream, and were often found in downstream sediments as detached colloform material rather than grain rims, suggesting that this material has travelled downstream from its precipitation locus near the adit (Sherriff, 2013). EMP and LA-ICP-MS line scans, in addition to synchrotron μ-XRF maps, indicated that manganese, zinc and cadmium concentrations were closely correlated in these coatings (Figure 21), which appeared to be the most visible source of zinc and cadmium in the thin sections. Zinc and cadmium were relatively poorly correlated with iron, although arsenic and iron concentrations appeared to be closely related (Figure 21). Hundreds of spot EMP analyses on the manganese-zinc-rich colloform coatings in samples resulted in a typical manganese/zinc molar ratio of 1.5 – 4, with linear regression lines of such data revealing a manganese/zinc trend of ~3 (Sherriff 2011e, 2013). This is similar to the mean manganese/zinc molar ratio of the bulk sediments (2.9), suggesting that the colloform coatings are the major repository of zinc in the sediments. The relatively low and consistent manganese/zinc ratio suggests that the zinc may be structurally incorporated in a zinc-bearing mineral. By contrast, the manganese/cadmium molar ratios were much higher and more variable, typically ranging between 170 and 600 (Sherriff, 2012, 2013), making a cadmium mineralogical control unlikely.

Synchrotron-based μ-XRD and zinc and cadmium μ-XANES were employed to obtain direct information on the mineralogy and zinc and cadmium speciation within these colloform grain coatings. The only zinc-bearing phases that were consistently identified across numerous colloform coatings were hydrohetaerolite ($Zn_2Mn_4O_8.H_2O$) and hetaerolite ($ZnMn_2O_4$) (Gault et al., 2012, 2013; Figure 22 and Figure 23). Birnessite (nominally $(Na,K,Ca)MnO_2.xH_2O$) was also tentatively identified. Zinc μ-XANES identified hetaerolite and hydrozincite ($Zn_5(CO_3)_2(OH)_6$) as the major mineralogical hosts of zinc, while zinc sorbed and/or co-precipitated with ferrihydrite ($Fe_{10}O_{14}(OH)_2 \cdot xH_2O$) was also well fitted (Figure 23). No clear trends with sample depth or distance downstream could be discerned from the zinc μ-XANES data. It should be noted that only randomly oriented nanocrystalline phases will diffract under μ-XRD conditions; crystallites similar in size to the μ-X-ray beam (~5 x 9 μm) will not diffract well, if at all, perhaps explaining the lack of hydrozincite and birnessite detected by μ-XRD, while ferrihydrite is poorly crystalline and diffracts only weakly. MLA analysis of complementary thin section samples collected proximal to the adit also identified zinc-manganese-oxides as the primary zinc host by surface area, followed by zinc-bearing birnessite and an unidentified zinc-bearing multi-element aluminosilicate, hypothesized to reflect a mixture of clay minerals (e.g. illite) and iron/manganese (oxyhydr)oxides.

Interpretation of the cadmium μ-XANES data was limited by the spectral similarity of a range of cadmium sorption complexes, however, the XANES patterns for cadmium-bearing minerals such as otavite ($CdCO_3$) and CdS were unique, thus the likely mineralogical hosts of cadmium could be distinguished from cadmium sorbed on mineral substrates. The cadmium μ-XANES collected from cadmium-bearing colloform coatings indicated that cadmium was present as a sorption complex, in line with the EMP data.

Figure 20 - Backscattered (a, b) SEM and (c) EMP images of colloform manganese-zinc-rich coatings on lithic and organic grains observed in No Cash Creek thin sections. Numbers in images (a) and (b) indicate points where energy dispersive X-ray spectra were collected, while the distribution of zinc, manganese, iron, sulphur, and silicon is mapped in (c)

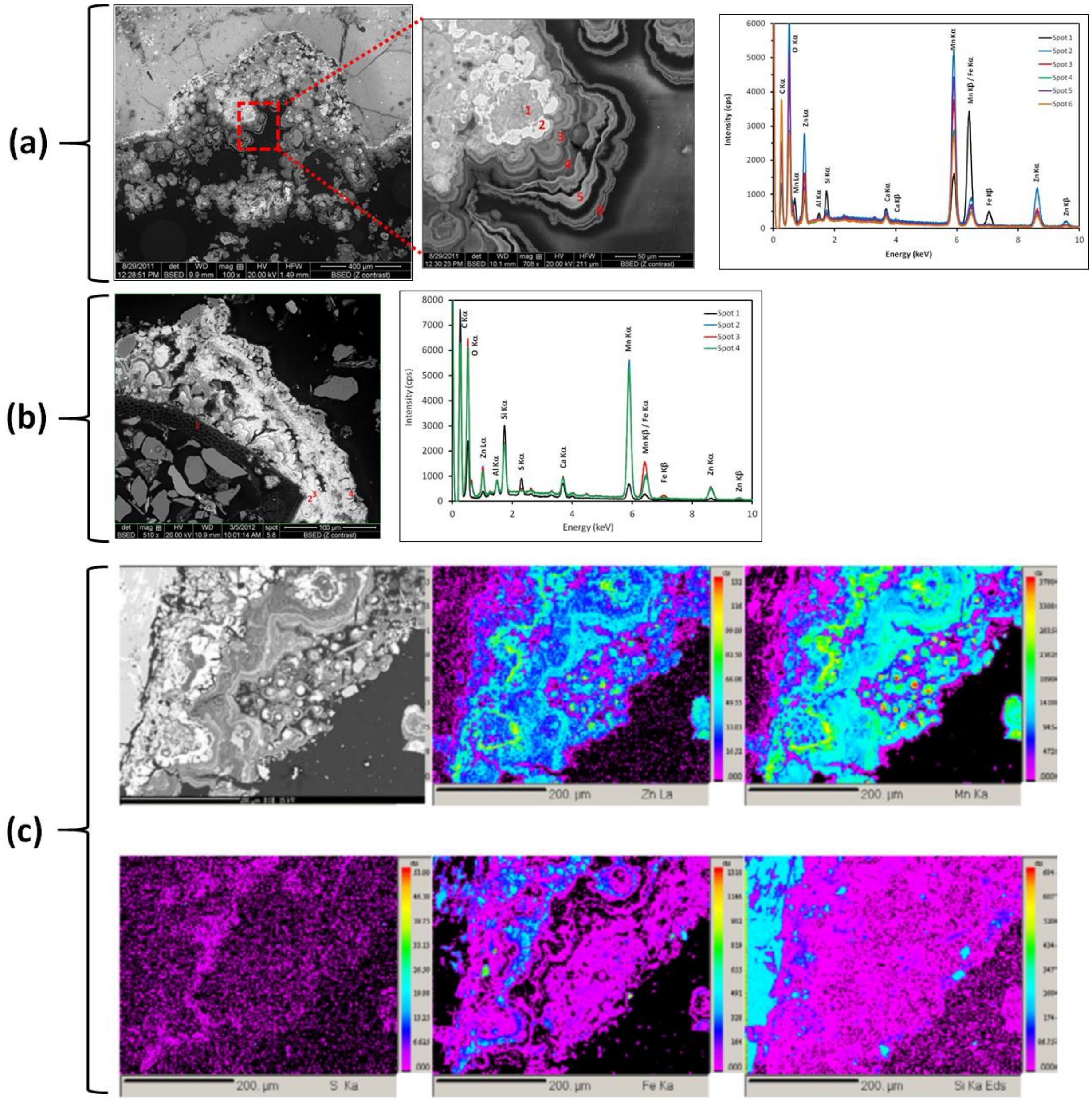


Figure 21 - (a) EMP and (b) LA-ICP-MS line scans across colloform particle coatings observed in No Cash Creek thin sections. Note the close correlation between manganese, zinc and cadmium. Little correspondence was observed between cadmium, zinc and iron, although arsenic concentrations appeared to follow those of iron.

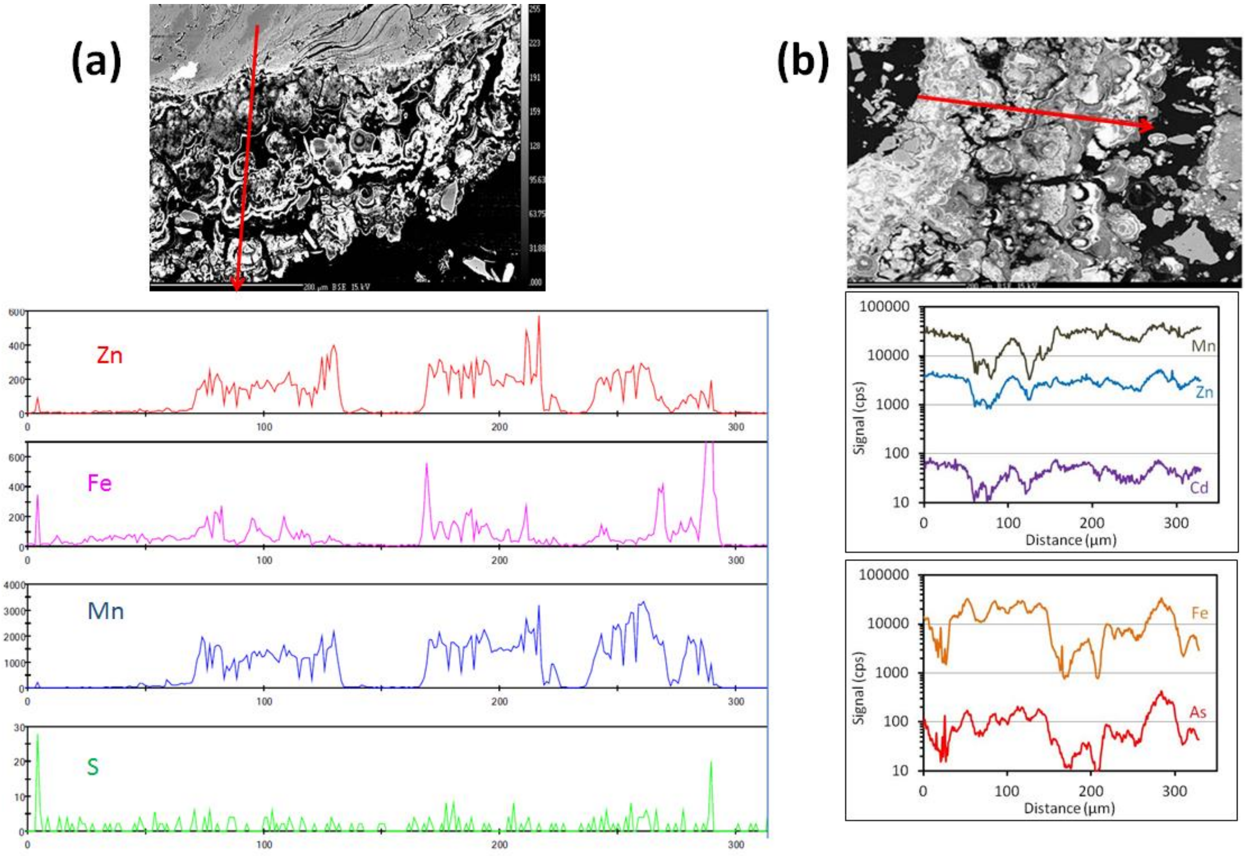


Figure 22 - (a) Backscattered electron and (b) associated synchrotron-based μ-XRF tricolor element map showing the distribution of iron (red), manganese (green) and zinc (blue) in a colloform rim on a lithic particle in a thin section sediment sample collected close to the No Cash Creek adit. Numbers denote points where (c) μ-XRD measurements were collected, which indicated that hydrohetaerolite ($Zn_2Mn_4O_8.H_2O$) was the primary nanocrystalline phase present in the manganese-zinc-rich coating.

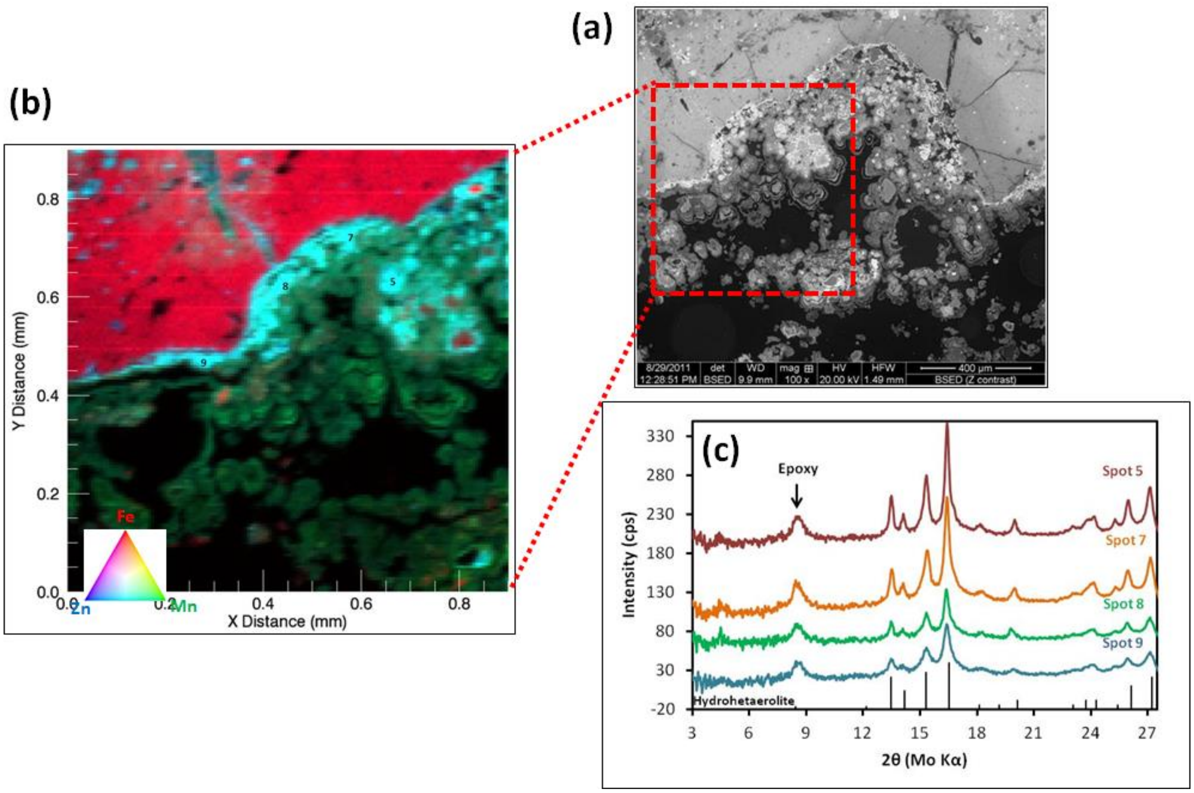
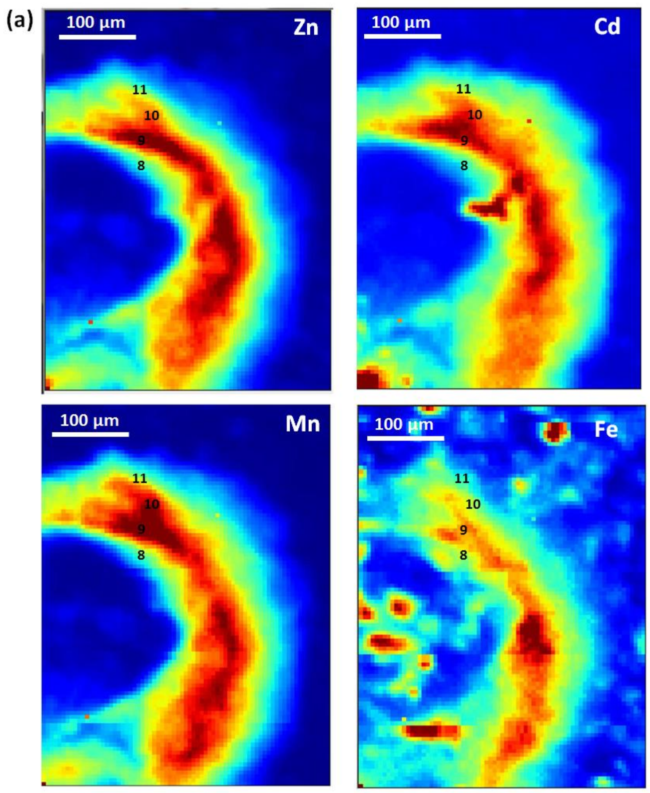
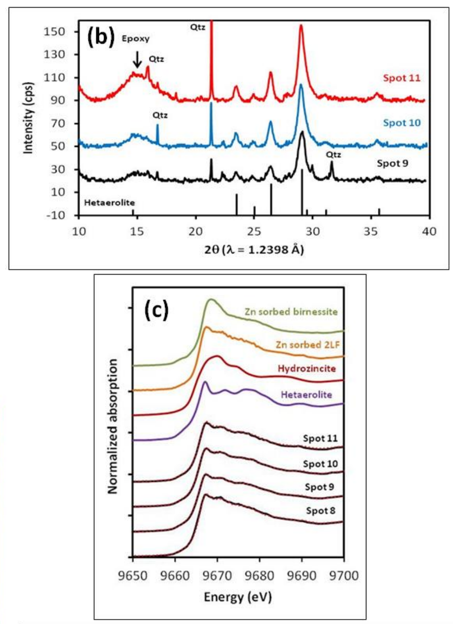


Figure 23 - (a) Synchrotron-based µ-XRF maps of zinc, cadmium, manganese and iron distribution in the colloform rim imaged by backscattered electrons in Figure 20 (b). Numbers denote spots where (b) µ-XRD and (c) zinc µ-XANES measurements were taken. Red dotted lines to sample µ-XANES data represent the best fit listed in (d)





(d)	Hetaerolite	Hydrozincite	Sorbed ferrihydrite	Sorbed birnessite
Spot 8	12%	-	83%	-
Spot 9	44%	32%	24%	-
Spot 10	40%	20%	32%	8%
Spot 11	33%	14%	44%	11%

While zinc and cadmium were predominantly associated with oxidized phases in the colloform coatings, sphalerite ((Zn,Fe)S) grains were also observed occasionally (Figure 24). These appeared to be primarily detrital based on particle morphology and the presence of weathering rims, however, small spheres (1 – 3 μm diameter) of putatively biogenic sphalerite were also observed in one sample collected at 8" depth (Gault et al., 2012, 2013; #38NC12). These were associated with organic structures, perhaps suggesting the presence of micro-niches of microbial sulphate reduction, which may offer added redundancy in zinc (and cadmium) sequestration should reducing conditions develop deeper in the sediment column and further downgradient into the No Cash wetland area.

Zinc and cadmium XANES analyses were also performed on the bulk sediments to evaluate the average speciation in the sediments. Only the adit sediment had a high enough cadmium concentration for cadmium K-edge XANES to be collected, and this was again indicative of a cadmium sorption complex. Zinc bulk XANES were obtained from sediments collected along the watercourse (Figure 25, Table 4). Close to the adit, the data were best fitted with zinc sorbed on ferric oxyhydroxides and birnessite with additional hetaerolite and hydrozincite contributions. Moving downstream zinc was still associated with ferric oxyhydroxides, while zinc-humate complexes became more prominent components as the creek moved into the more organic rich, boggy portion of its reach.

Figure 24 - (a) Backscattered electron image of small (1 – 3 µm diameter) electron dense particles within an apparent organic (cellulose?) matrix found in a No Cash Creek thin section. Red numbers denote spots where (b) energy dispersive spectra were collected, indicating the dominance of zinc and sulphur. (c) Corresponding synchrotron-based µ-XRF maps of zinc, cadmium, manganese and iron distribution and (d) zinc µ-XANES and (e) cadmium µ-XANES point analyses, which suggest the zinc and cadmium is present as sulphide phases.

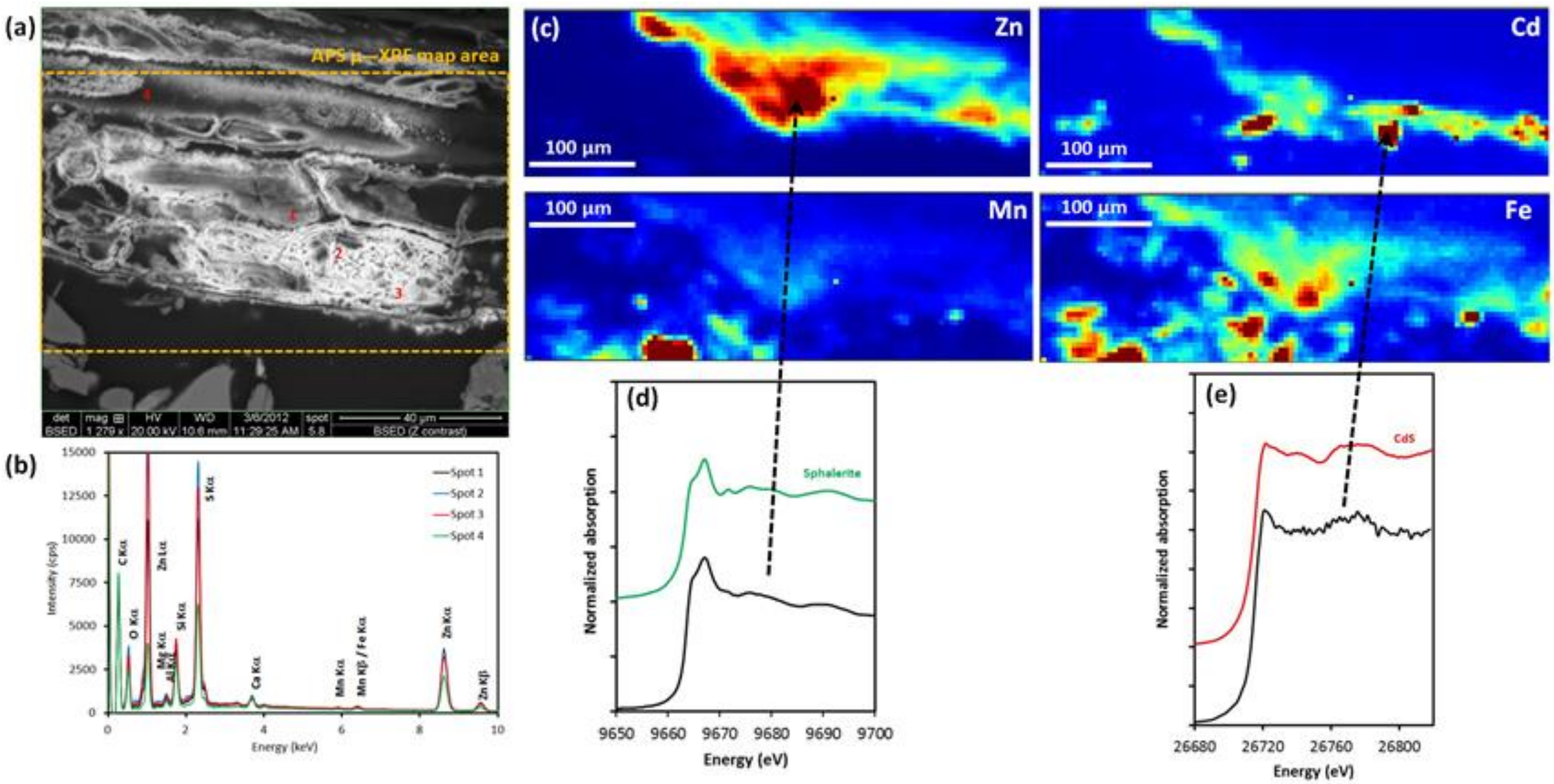


Figure 25 - (a) Zinc K-edge XANES spectra of model zinc-bearing phases used in fitting sample spectra. (b) Zinc K-edge XANES spectra collected for bulk No Cash Creek sediments. Black, solid lines represent sample data and red, dotted lines the best fit listed in Table 4.

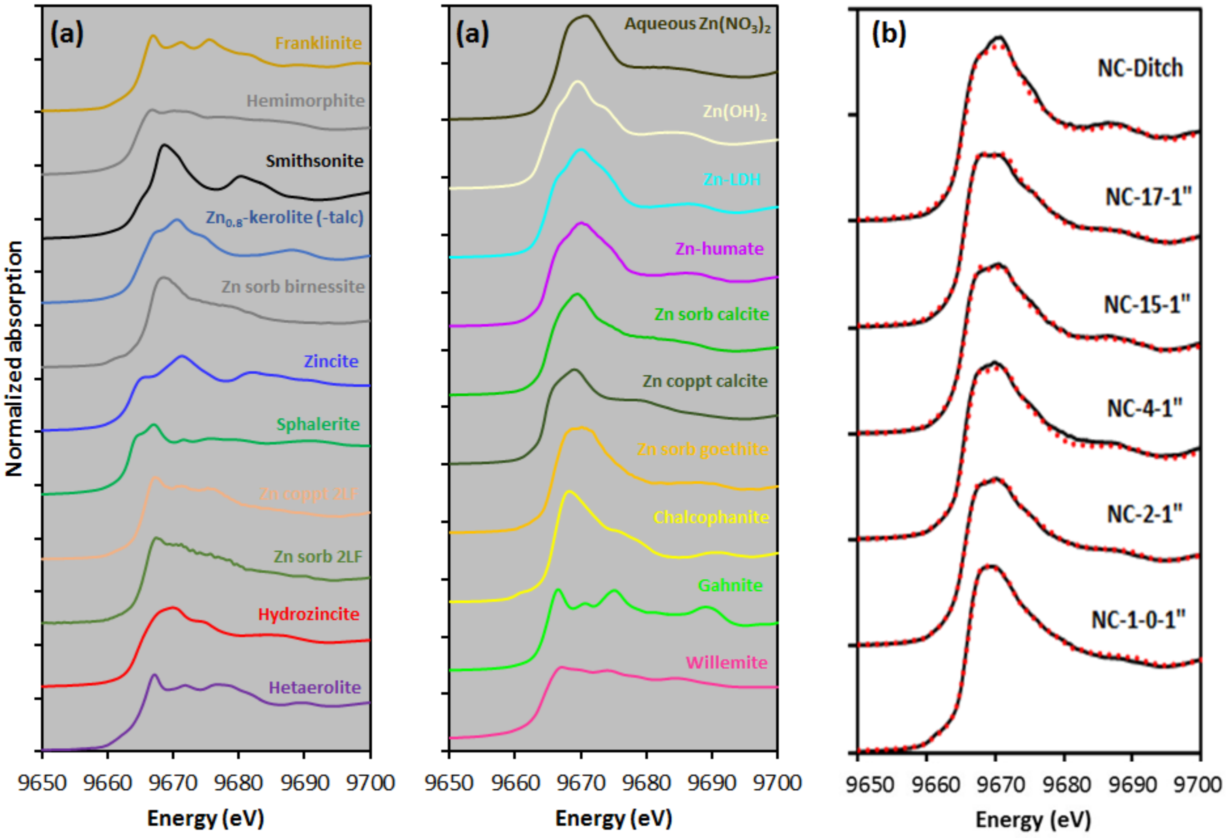


Table 4 - Best fits for bulk zinc K-edge XANES data collected for No Cash Creek bulk surficial sediment samples[a]

		Proportion of Zn present as:										
	Zn (mg/kg)	Coppt 2LF[b]	Sorbed 2LF	Sorbed goethite	Zn-humate	Sorbed birnessite	Hetaerolite	Chalcophanite	Sorbed calcite	Hydrozincite	Sphalerite	$Zn_{0.8}$-kerolite (-talc)
NC-1-0-1"	41,100	-	24	49	-	29	-	-	-	-	-	-
NC-2-1"	3,800	-	17	26	17	-	17	-	-	23	-	-
NC-4-1"	3,540	32	-	28	15	-	-	-	24	-	-	-
NC-15-1"	2,020	-	38	11	42	-	-	-	-	-	7	-
NC-17-1"	1,760	44	-	37	-	-	-	-	20	-	-	-
NC-ditch	186	11	-	-	71	-	-	11	-	-	-	6

[a] The components were not forced to sum to 100% during the fitting process (typically 97 – 103%)
[b] "2LF" denotes 2-line ferrihydrite; "coppt" indicates "co-precipitated with"

3.2.1.3 ZINC AND CADMIUM SEQUESTRATION IN LOWER "BOG" REACH

Approximately 1,000 m downstream of the adit, NCC transitions from its steep "cascading" reach into the much flatter "bog" reach as it travels through a peaty wetland. In the subsequent 2,500 m of the bog reach, aqueous zinc and cadmium concentrations decline further as this portion of the watercourse acts as a polishing step to the rapid zinc and cadmium removal observed upstream. It is hypothesized that the zinc and cadmium are removed via sorption on the peat, although co-precipitation with iron/manganese (oxyhydr)oxides and reductive precipitation as sulphide-bearing phases are also possible. Visual and smell-based observations of black sulphides in quiescent sediments along the saturated bog areas have also been noted throughout the No Cash wetland areas.

Column experiments using peat collected from the NCC wetland have been conducted to assess the role of peat in zinc and cadmium attenuation (Alexco Environmental Group, 2011). Two metre columns were packed with peat from the No Cash area and operated under (i) Column experiments using peat collected from the NCC wetland have been conducted to assess the role of peat in zinc zinc and cadmium attenuation (Alexco Environmental Group, 2011). Two metre columns were packed with peat from the No Cash area and operated under (i) saturated conditions, where water flowed upwards from the bottom, filling the column and was sampled at the top; and (ii) unsaturated conditions, where water was added to the top and allowed to percolate through the column before collection at the base. Water from the Galkeno 900 adit was passed through the columns, which contained initial zinc and cadmium concentrations of 5.76 and 0.0014 mg/L, respectively. Two pore volumes of water were passed through the columns per week and 54 pore volumes were run in total. Zinc and cadmium removal by the peat column was >99% and 94%, respectively, for both saturated and unsaturated experiments for the entirety of the experiment. Significant manganese removal (94%) was also observed for the unsaturated column, with minimal loss of sulphate (<2%), suggesting that aerobic processes such as co-precipitation with manganese (oxyhydr)oxides may have been the primary driver of zinc and cadmium removal, alongside sorption on organic matrices. In the saturated column, manganese removal was much less pronounced (16%), while 22% of the sulphate was removed, indicating that microbial sulphate reduction and the associated precipitation of zinc and cadmium as sulphide phases may be a prominent sequestration process in this column.

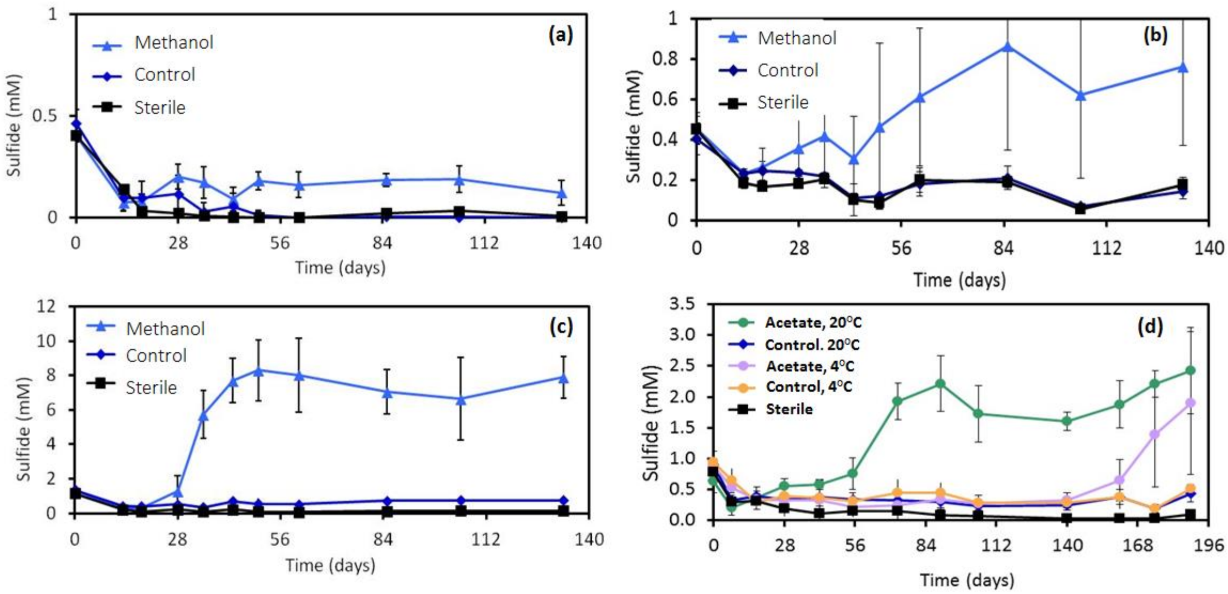
Similar attenuation of cadmium and zinc has been observed in twinned wells in the Valley Tailings Facility screened above and below the peat layer that underlies the tailings. Here, groundwater concentrations of zinc and cadmium are more than three orders of magnitude lower beneath the peat layer than in the tailings porewater (SRK, 2009). This was recorded in an area where tailings have been present for at least 50 years with zinc and cadmium tailings porewater concentration orders of magnitude higher than those in the lower reach of NCC, demonstrating the longevity of the natural metal attenuation offered by this peat layer. The penetration depth of metal contamination into the peat layer is typically <0.5 m (Interralogic, 2012b).

3.2.1.4 MICROBIOLOGY OF NO CASH CREEK SEDIMENTS

Sediments were collected near the No Cash 500 level adit and approximately 250 m downstream for microbiological examination. They were incubated under anoxic conditions in the presence of a variety of organic electron donors in order to assess the importance of such substrates to the onset of microbial sulphate reduction (Londry, 2013). Similar experiments were also conducted at 4 and 20°C to evaluate the role of temperature. Minimal microbial sulphate reduction was observed in both the adit and downstream sediments (Figure 26), ascribed to the high sedimentary metal concentrations which may hinder microbial activity. The addition of an electron donor such as methanol or acetate enhanced the extent of sulphate reduction, while colder temperatures delayed the onset of sulphate reduction by approximately 3 months (Figure 26d), but once established, the rates of sulphate reduction at both 4°C (1.8 mg/L/d) and 20°C (2.2 mg/L/d) were comparable (Londry, 2013). That organic electron donor amendment was required to initiate marked microbial sulphate reduction suggests that the sediments were deficient in the labile organic carbon required to drive this process, however, the work did show that a small community of sulphate-reducing bacteria was present in the NCC sediments. This was reflected in the 16S rRNA profiling work, which indicated that 0.4 – 0.8% of the 16S rRNA gene pyrotags were matched to the Deltaproteobacteria, known to host a wide range of sulphate-reducing bacteria. *Thiobacillus* (9%) species were prominent in the adit surface sediment, suggesting that metal oxidation is likely an important biogeochemical reaction occurring at this site. Psychrophilic *Polaromonas* (9%) species were also prominent in the adit sediment samples, and their presence is consistent with the culturing experiment results that demonstrated sulphate reduction at 4°C.

Given the low abundance of sulphate-reducing bacteria in these sediments, it is unlikely they play a significant role in zinc and cadmium sequestration in the aerobic, upper cascading reach of NCC, but microbial sulphate reduction is likely an active process and an important mechanisms of zinc and cadmium attenuation in the shallower, peaty bog portion of NCC.

Figure 26 - Sulfide production in cultures established from the No Cash Creek (a) adit surface sediment, (b) adit 18" depth sediment, and (c,d) sediment collected 250 m downstream of the adit



3.2.1.5 STABILITY TESTING OF NO CASH CREEK SEDIMENT

Although the streambed precipitates appear durable under the prevailing geochemical conditions (Interralogic, 2012a), future potential changes in temperature, pH or redox conditions along NCC could possibly change their stability. In this work, precipitate collected from close to the No Cash 500 adit was subjected to a variety of environmental stresses, ranging from changes in temperature and pH, to more aggressive (and less likely) tests such as strongly reducing conditions. Such information will help frame the geochemical window of stability for these precipitates, and aid future monitoring and adaptive management programs by identifying geochemical conditions under which metal remobilization might be expected.

Sediment was collected within a few metres of the No Cash 500 adit, mixed with water collected further downstream, and subjected to shake flask style experiments (Gault and Jamieson, 2013). The sediment-water slurry was mixed at 200 rpm on an orbital shaker at 4°C for 48 h, then a sample was taken to establish the baseline analyte conditions. An environmental variable (Table 5) was then changed, the sample shaken for a further 48 h, and a final sample collected to examine the impact of the environmental variable on the mobility of zinc and cadmium.

A temperature rise of 5°C resulted in the mobilization of some zinc and cadmium, whereas a rise of 10°C caused a reduction in soluble zinc concentrations and had negligible impact on cadmium (Figure 27). Such contrasting results are likely due to the competing effects of enhanced mineral dissolution rates and lowered metal carbonate solubility with increasing temperature. Threefold and twofold rises in zinc and cadmium concentrations, respectively, were noted at the end of a rapid freeze thaw experiment. This was attributed to enhanced CO_2 solubility during the cooling step of the experiment, which likely drove the 0.5 pH unit drop observed and promoted partial metal carbonate dissolution and desorption of zinc and cadmium from iron/manganese (oxyhydr)oxide surfaces.

Equilibrium pH increases of 0.5 and 1.2 pH units (from a starting point of pH ~7.2) caused marked drops in dissolved zinc and cadmium due to precipitation as/with metal hydroxide and carbonate phases (Figure 27). Lower pH systems were not examined directly since the NCC watercourse is well buffered and not expected to become acidic. Experiments were conducted that involved some removal of alkalinity (up to 56%), resulting in reductions in aqueous zinc and cadmium levels (Figure 27).

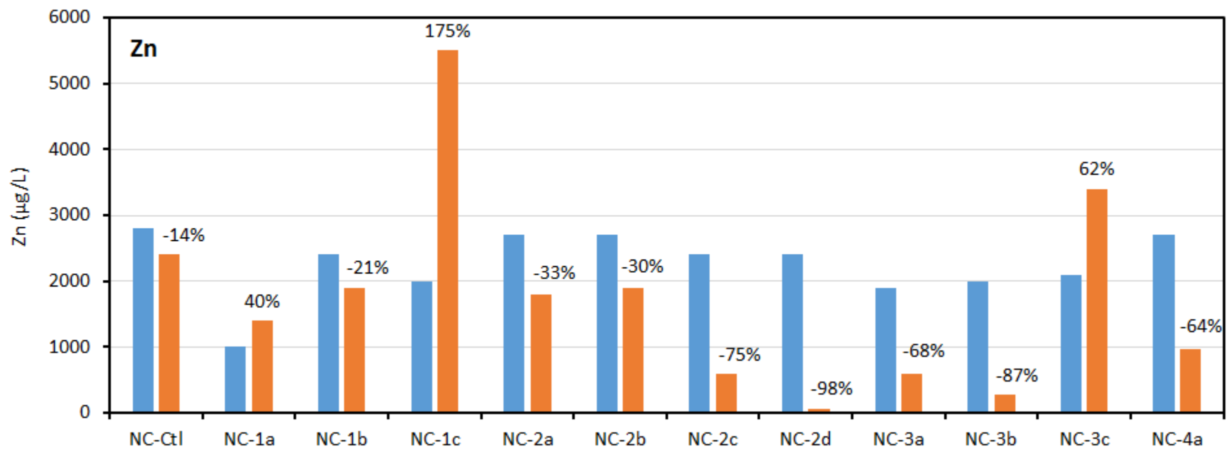
Table 5 - Stability test environmental variables.

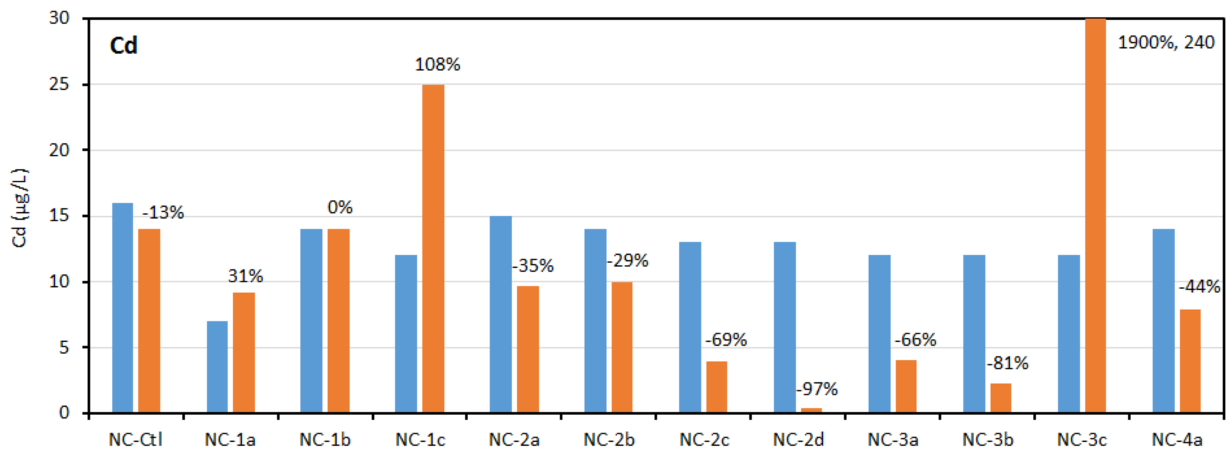
Test ID	Variable	Description
NC-1a	Temperature	Increase temperature by 5° C
NC-1b	Temperature	Increase temperature by 10° C
NC-1c	Temperature	Freeze/thaw
NC-2a	pH/alkalinity	Titrate out 33% of alkalinity
NC-2b	pH/alkalinity	Titrate out 66% of alkalinity
NC-2c	pH/alkalinity	Raise pH by 1 standard unit
NC-2d	pH/alkalinity	Raise pH by 2 standard unit
NC-3a	Redox	Oxidation – bubble with air
NC-3b	Redox	Mild anoxia – lower dissolved O_2 concentration by bubbling with N_2
NC-3c	Redox	Reduction – add sodium dithionite to create reducing conditions
NC-4a	Biological activity	Inhibit biological activity

Bubbling with air or nitrogen, intended to simulate strongly aerobic and mildly anoxic conditions, respectively, caused diminutions in soluble zinc and cadmium concentrations (Figure 27), likely due to the removal of dissolved CO_2 which would have favoured the precipitation of metal carbonate phases. Amendment with 50 mM sodium dithionite, designed to stimulate reducing conditions, resulted in extensive mobilization of manganese (from <0.001 mg/L to 300 mg/L) and cadmium (from 0.012 mg/L to 0.24 mg/L), and more moderate solubilisation of zinc (from 2.1 mg/L to 3.4 mg/L). While the establishment of manganese-reducing conditions was clear from the dissolved manganese concentrations, the lack of soluble iron suggests that iron(III)-reducing conditions were not attained.

The maximum cadmium and zinc concentrations released to solution in these experiments was relatively minor, equivalent to 0.2% and <0.05% of the sedimentary cadmium and zinc content. The freeze-thaw experiment caused the largest release of zinc to solution, alongside a marked rise in cadmium, however, freeze-thawing in the field occurs over longer timescales and may not have been representatively simulated in this experiment. Observations from the field data indicate somewhat lower-than-average metals concentrations in liquid water sampled during winter events. Freshet waters generally have the lowest metals concentration and the late summer water have the highest overall concentrations of metals.

Figure 27 - Changes in selected analyte concentrations for stability experiments NC-Ctl (no environmental changes), NC-1a (+5°C temp rise), NC-1b (+10°C temp rise), NC-1c (freeze-thaw), NC-2a and NC-2b (alkalinity lowered), NC-2c and NC-2d (pH increased), NC-3a (bubbling with air), NC-3b (bubbling with nitrogen), NC-3c (dithionite reduction), and NC-4a (azide microbiocide). Blue and orange bars indicate analyte concentration after 48 h of baseline equilibration and a further 48 h after the environmental variable was changed, respectively. Data label above orange bars indicates percentage change; for NC-3c, additional number indicates analyte concentration, which was off-scale in this expt. Where no data are shown, the analyte was below the limit of detection





Most cadmium mobilization and a sizeable increase in dissolved zinc were observed when manganese-reducing conditions were imposed on the sediment. This is in line with zinc and cadmium XANES data which suggest that a sizeable portion of the solid phase zinc is sorbed on manganese oxyhydroxides, while cadmium is also present as a sorption complex (Gault et al., 2013). The limited zinc remobilization (<0.02% of the sedimentary zinc inventory) likely reflects re-sorption of the zinc onto other mineral phases such as ferric oxyhydroxides that appear not to have been targeted by the dithionite reagent. Thus, although a pulse of elevated zinc and cadmium concentrations might be expected during manganese- (and iron(III)-) reducing conditions, re-adsorption on secondary mineral assemblages, and precipitation as authigenic sulfide minerals under subsequent sulfate-reducing conditions would be expected to limit dissolved zinc and cadmium concentrations. Given the low organic carbon concentrations in the No Cash sediments (<0.5 wt. %; Interralogic, 2011b), it seems unlikely that such reducing conditions would develop, while a pulse of reducing water emanating from the mine is also thought implausible, making such a scenario a very extreme event. Any zinc and cadmium that is released under reducing conditions that diffuses up the sediment column towards the surface would also be expected to be scavenged by the manganese (and iron) oxyhydroxides that would re-precipitate upon meeting the oxidizing surface conditions.

3.2.2 HUSKY SW

3.2.2.1 GEOCHEMICAL AND MINERALOGICAL CONTROLS ON ZINC AND CADMIUM SEQUESTRATION

The majority of zinc-rich areas in the Husky SW thin sections were present as discrete particles or bands within particles (Gault et al., 2012; Sherriff 2012, 2013). Colloform coatings on grains were observed only occasionally, although a few of the discrete manganese-zinc-bearing particles had a colloform appearance, perhaps suggesting they had become detached from the particles around which they formed. Zinc and cadmium concentrations followed those of manganese most closely (Figure 28 - Figure 30), often in particles that appeared to show successive manganese- and iron-rich banding (e.g. Figure 28). Birnessite, goethite (FeO(OH)), and possibly manganite (MnO(OH)) were the most common nanocrystalline phases identified by μ-XRD, while zinc μ-XANES were generally best fitted with a mixture of zinc hosted in hetaerolite and co-precipitated with calcite ($CaCO_3$) and/or ferrihydrite (Figure 31; Gault et al., 2013). SEM-EDX, EMP and LA-ICP-MS spot analyses showed that the manganese/zinc ratios in the zinc-bearing particles were much higher for samples from Husky SW compared with NCC, in line with bulk sediment manganese/zinc ratios (Sherriff, 2012, 2013). The tentative identification of birnessite and other manganese oxide phases in the Husky SW samples is likely responsible for the higher manganese/zinc ratio observed for these samples, and might suggest that zinc sorption complexes are more prevalent for the Husky SW samples. Detrital sphalerite was also observed occasionally, but the small spherules of biogenic sphalerite were absent from the few Husky SW thin sections examined to date. Similar to NCC, multiple cadmium µ-XANES point analyses suggested cadmium was present as a sorption complex, but the similarity of the standard spectra precluded a more detailed examination of cadmium speciation.

Zinc and cadmium XANES spectroscopy were also performed on bulk sediments collected from Husky SW (Gault et al., 2013). The cadmium concentration was only high enough in the Husky SW adit sediment for cadmium XANES analysis, which again indicated that cadmium was likely present as a sorption complex. Relatively poor fits were obtained for the bulk zinc XANES, suggesting a model zinc phase was missing from our standard library, however, zinc sorbed on ferric oxyhydroxides comprised a sizeable fraction of the zinc inventory in most of the sediments analyzed. Chalcophanite ($(Zn,Fe,Mn)Mn_3O_7.3H_2O$) accounted for up to a third of the zinc speciation in the adit sediment, while moving downstream, zinc complexed with humic acid became more prominent, perhaps reflecting more organic-rich conditions.

Figure 28 - (a) EMP images of banded iron- and manganese-rich areas within particles in a Husky SW thin section sample collected close to the adit. The distribution of zinc, manganese, sulphur and iron are also mapped. The red arrow indicates where (b) the EMP linescan was conducted, showing a close correlation between manganese and zinc concentrations.

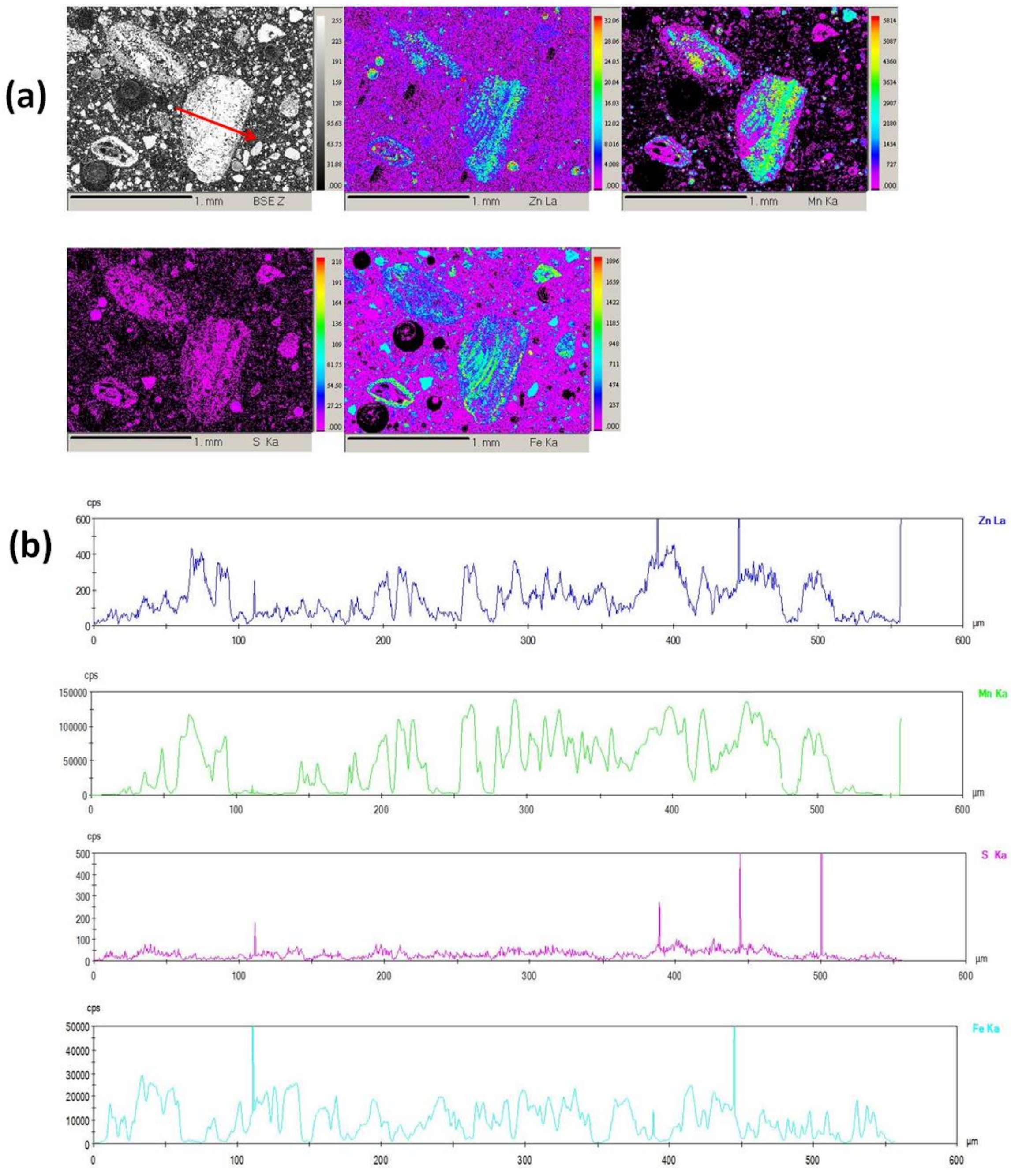


Figure 29 - (a) Backscattered electron image of a zinc-bearing particle in a Husky SW thin section sample collected close to the adit. (b) LA-ICP-MS raster line scan demonstrating the correlation between manganese, zinc and cadmium concentrations. Lead and arsenic concentrations also appear to follow those of iron.

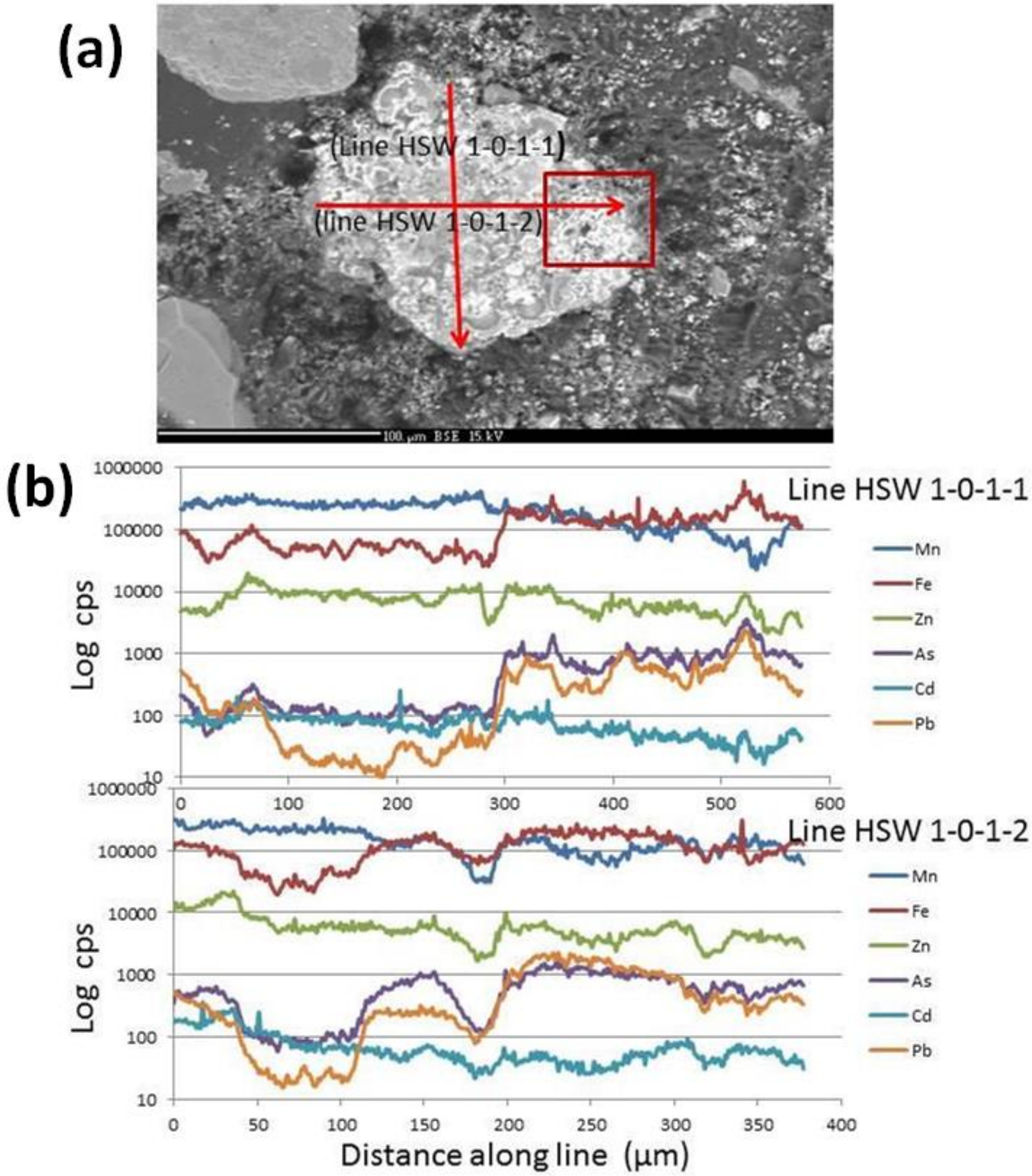


Figure 30 - Synchrotron-based μ-XRF imaging of the distribution of zinc, manganese and iron in a particle in a Husky SW thin section sample collected close to the adit.

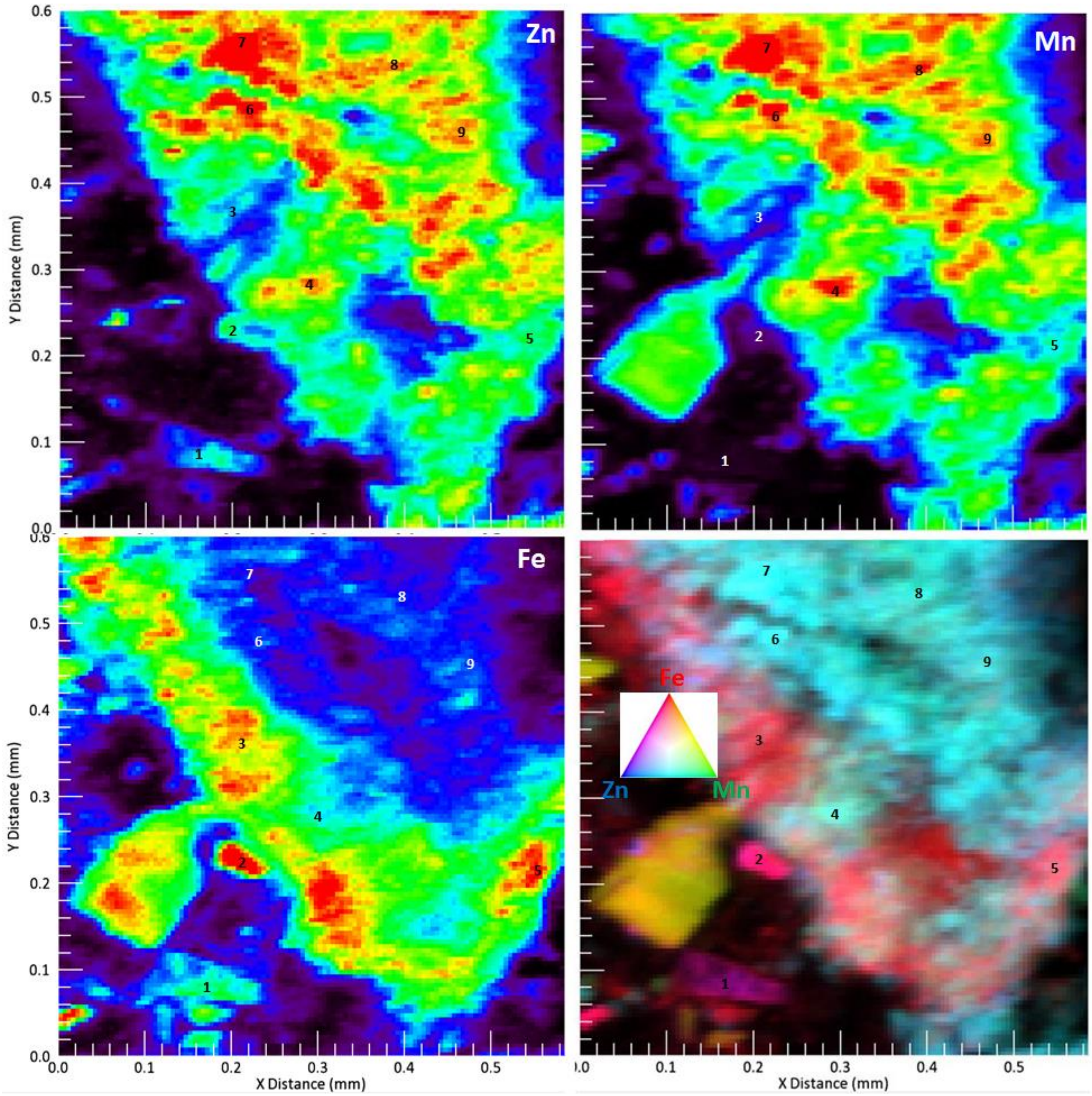
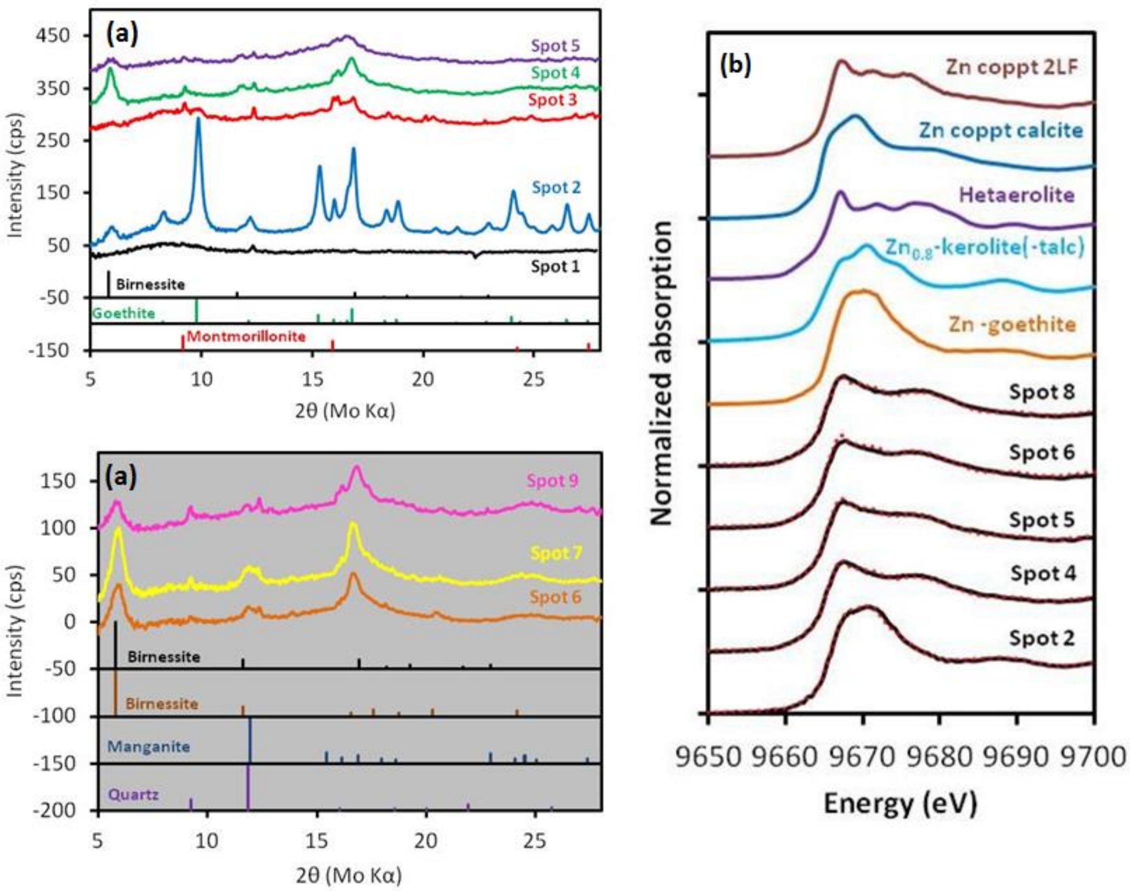


Figure 31 - Synchrotron based (a) μ-XRD and (b) zinc μ-XANES collected for the spots marked in Figure 30 for a Husky SW thin section sample collected close to the adit. The solid, black lines in (b) represent the sample data and dashed, red lines the best fit based on the combination listed in (c).



(c)	Proportion of Zn present as:				
	Hetaerolite	Coppt calcite	Coppt 2LF[b]	Sorbed goethite	$Zn_{0.8}$-kerolite (-talc)
HSW-1-0"					
Spot 2	-	-	-	72	26
Spot 4	49	32	19	-	-
Spot 5	40	25	34	-	-
Spot 6	56	29	16	-	-
Spot 8	62	38	-	-	-

3.3 VEGETATION METAL ACCUMULATION

A baseline study of metal concentrations in soil and vegetation samples collected in the KHSD was initiated in 2011, comprising two sampling seasons during the summers of 2011 and 2012 (Access, 2012, 2013). Alongside soil samples, leaves were collected from willow (*Salix* sp.) and Labrador Tea (*Ledum* sp.). These plant species were selected due to (1) their common occurrence across the KHSD; (2) their consumption by local wildlife that may in turn be consumed by humans (e.g. moose); (3) their use in traditional medicine; and (4) their ability to tolerate elevated metal concentrations in soils allowing them to grow along mine drainage impacted watercourses. Sampling sites included the natural attenuation study areas of No Cash Creek, Silver King and Husky SW, alongside off-claim control areas for use as background comparators. Only one bog blueberry (*Vaccinium uliginosum*) and one scrub birch (*Betula glandulosa*) leaf sample were collected near the NCC, Husky SW and Silver King watercourses, and no samples were collected at control sites, so these sparse data are not discussed further here.

3.3.1 NO CASH CREEK

Zinc concentrations in willow leaves collected along the reach of NCC (62 – 1820 mg/kg) were two to forty-nine fold higher than the average zinc concentration in willow leaves from the control sites (37 mg/kg). Cadmium concentrations in NCC willow leaves ranged from marginally above (1.1 mg/kg) to thirty-four times (34 mg/kg) the control site average concentration (1 mg/kg). Values for arsenic and lead followed similar trends. By contrast, metal concentrations in Labrador Tea leaves collected along NCC showed more limited extremes, ranging between two (17 mg/kg zinc) and eight (0.065 mg/kg cadmium) fold higher than the average metal concentrations of control site Labrador Tea leaves (8.9 mg/kg zinc; 0.008 mg/kg cadmium). This reflects the ability of willow species to hyperaccumulate cadmium and accumulate zinc.

3.3.2 HUSKY SW

Similar trends were observed in samples collected along the Husky SW watercourse. Willow leaf zinc (16 – 540 mg/kg) and cadmium (0.1 – 16 mg/kg) concentrations were up to fifteen and sixteen fold higher than the respective control site willow leaf average levels. However, the zinc and cadmium concentrations in Labrador Tea leaves collected in the Husky watershed were generally comparable to the control site average concentration.

3.3.3 SILVER KING

Zinc concentrations in willow leaves collected near the Silver King adit (59 – 210 mg/kg) exceeded the control site willow leaf average by two to six fold, while only one Silver King willow leaf sample (4.3 mg/kg) exceeded the cadmium control average. The highest willow leaf zinc and cadmium concentrations were found closest to the adit, and exceeded the associated soil metal concentrations, illustrating the (hyper)accumulator characteristics of willow species. The metal concentrations in Labrador Tea leaf samples collected near the Silver King adit were similar to those collected at the control sites. Willow leaves collected further downstream in Galena Creek also showed elevated zinc and cadmium concentrations that were up to five and seven times higher than the control sites, respectively. Willow leaves obtained from the tributary channels to Galene Creek generally contained similar metal concentrations to the control samples. Labrador Tea leaves exhibited background metal concentrations, regardless of their sample location within the Galena Creek watershed.

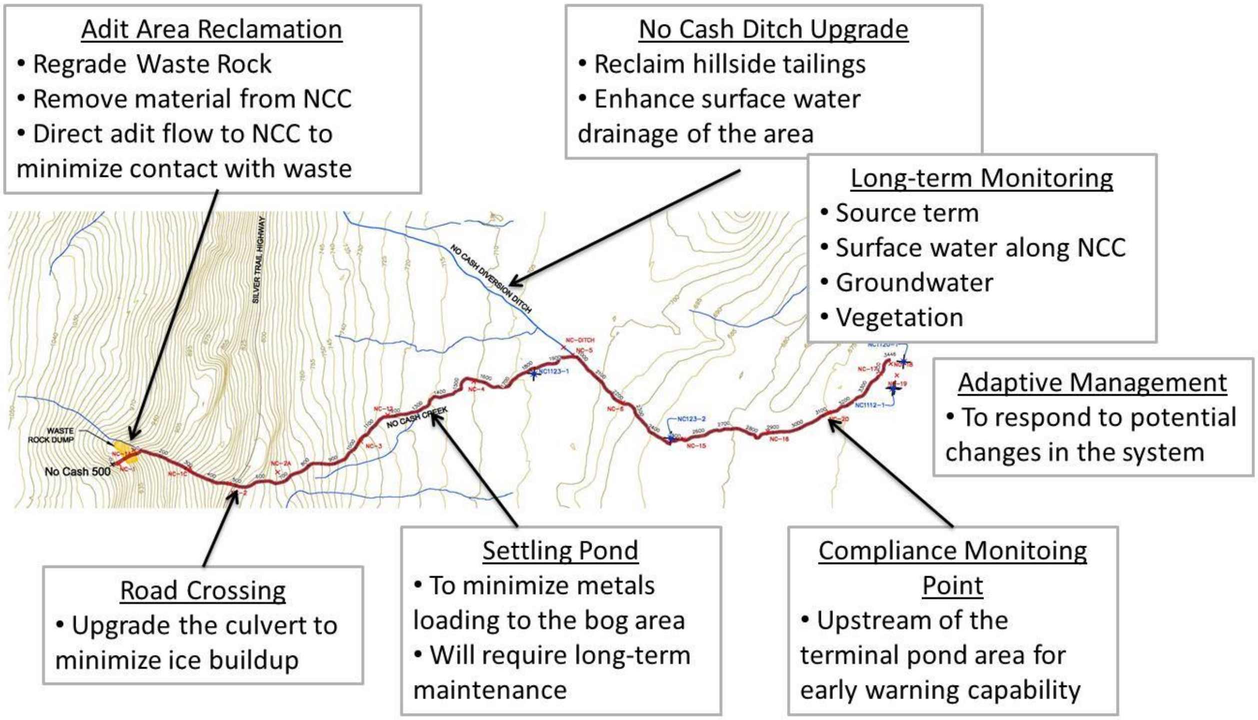
3.4 PRELIMINARY ENGINEERING SURVEY AND CLOSURE CONCEPTUAL MODEL

Figure 32 illustrates the closure conceptual model of the NCC natural attenuation area. This model summarizes the key closure concepts and considerations that could be incorporated into a designed natural attenuation treatment system. Some of the closure concepts are not exclusive to a natural attenuation closure scenario but were included below because they would be part of the natural-attenuation closure plan. The recommended engineering design should include:

1. Adit reclamation activities to effectively minimize mass load and control flow including:
    a. refurbishing the adit portal and discharge area to achieve safety goals. The refurbishment requirements for a natural attenuation scenario would include integration of a suitable flow capture structure (item “c” below).
    b. establish a flat discharge area near the adit to encourage local mineral precipitation reactions and to allow removal of precipitated solids
    c. design of an effective adit-flow capture and conveyance structure

   d. regrading of the waste rock dump and removing waste rock from the NCC channel to eliminate the waste rock as a potential direct source of additional metals mass.
2. Road crossing refurbishment to minimize ice-damming, scour, and road damage. Maintaining a consistent flow through potential bottlenecks will limit surges to the downstream natural attenuation areas.
3. No Cash Ditch refurbishment:
   a. Channel stabilization
   b. Reclamation of the catchment area to minimize metals loading to the ditch (and therefore to NCC)
4. Additional settling pond installation to capture particulate metals mass and minimize metals loading to the lower NCC. This could be a location for long term maintenance/sediment removal if desired or shown to be necessary by monitoring.
5. Long-term monitoring of the system at key locations along the flow path:
   a. Source term flow and chemistry at the adit
   b. Surface water chemistry along NCC at selected locations
   c. Groundwater chemistry in monitoring wells
   d. Vegetation (health and metals uptake)
6. Adaptive management to learn and react to the system as it is implemented and to potential changes in the future. Potential adaptive management activities include:
   a. Additional or reduced monitoring type and frequency
   b. Design adaptations to increase performance of engineered facilities such as settling ponds, conveyance structures, and water spreading areas. These would be considered on a case-by-case basis to considering cost-benefit and potential effects of additional disturbance due to access and construction.
   c. Short- or long-term active treatment with mobile units in response to upsets or long-term changes in the source term
   d. Alternative short or long-term passive treatment system (e.g. bioreactors)

Figure 32 - Natural Attenuation Closure Concepts for No Cash Creek



4 SUMMARY OF FINDINGS

4.1 NATURAL ATTENUATION PROCESSES

The primary hydrologic and (bio)geochemical processes responsible for metals attenuation are summarized in the following two sections. As the most intensively studied system, most attention is focused on NCC, however, the hydrological and (bio)geochemical processes that aid the natural attenuation of zinc and cadmium are similar at NCC and Husky SW. Since the adit water discharging from Silver King is already treated by a conventional lime water treatment plant, the processes responsible further attenuation of zinc and cadmium observed downstream are harder to discern, but are expected to be broadly similar.

4.1.1 HYDROLOGIC

Figure 33 illustrates the hydrologic mechanisms model of the NCC natural attenuation area. This model summarizes the key surface and groundwater processes related to metals attenuation and corresponding closure issues. These issues are described below and correspond to numbered points on the profile in Figure 33.

1. **Adit Reach (surface water)/Upper Hydrologic Area (groundwater) -** Water discharging from the adit spreads out on the waste rock bench and iron and manganese precipitates are formed as mats and sediment. The water cascades down the sides of the waste rock slopes and joins the NCC. Groundwater recharge occurs on Galena Hill, including from NCC where permafrost is not present. Minor increases in flow from the adit occur during freshet resulting in a slightly larger wet area on the waste rock bench. Winter conditions result in no surface flow from the adit portal, however, small flows were observed emanating from the waste rock lower on the slope.
2. **Cascading Reach (surface water)/Upper Hydrologic Area (groundwater) -** Cascading water results in highly aerated water and oxidized conditions, even during the winter months. Freshet flows are significantly higher yet still confined to the well-defined creek channel. Hydrologic conditions are very well suited to precipitation of metal oxyhydroxides. Depth to groundwater is generally shallower in the valley than on hillsides and mine workings.
3. **Transition and Bog Reaches (surface water)/Middle-Lower Hydrologic Area (groundwater) -** Braided and intermittent stream patterns dominate in these reaches Permafrost is ubiquitous in the bog reach. The resulting low-permeability permafrost horizon separates the shallow active zone and surface water flow from the deeper aquifer in the glacial sediments below. Freshet melt conditions result in the bog area becoming completely saturated and with larger areas of standing water in the lowlands. Winter conditions result in ice damming and complete blockage of the NCC channel in some areas, with flow being forced into shallow sediments beneath the ice. Bedrock groundwater discharges into the valley fill glacial sediments and generally flows toward the South McQuesten River.
4. **The surface expression of the Terminal Pond Area -** The NCC ends at the terminal pond, where the NCC water evaporates and infiltrates. Groundwater in this area is assumed to flow in a northerly direction toward the South McQuesten River. Groundwater monitoring wells completed in the terminal pond area show no chemical impacts from NCC infiltration; metals concentrations are low in the NCC terminal pond and groundwater is good quality.
5. **Terminal Pond to South McQuesten River -** Hummocky/thermokarst terrain between the terminal pond and the South McQuesten River has no developed surface drainage

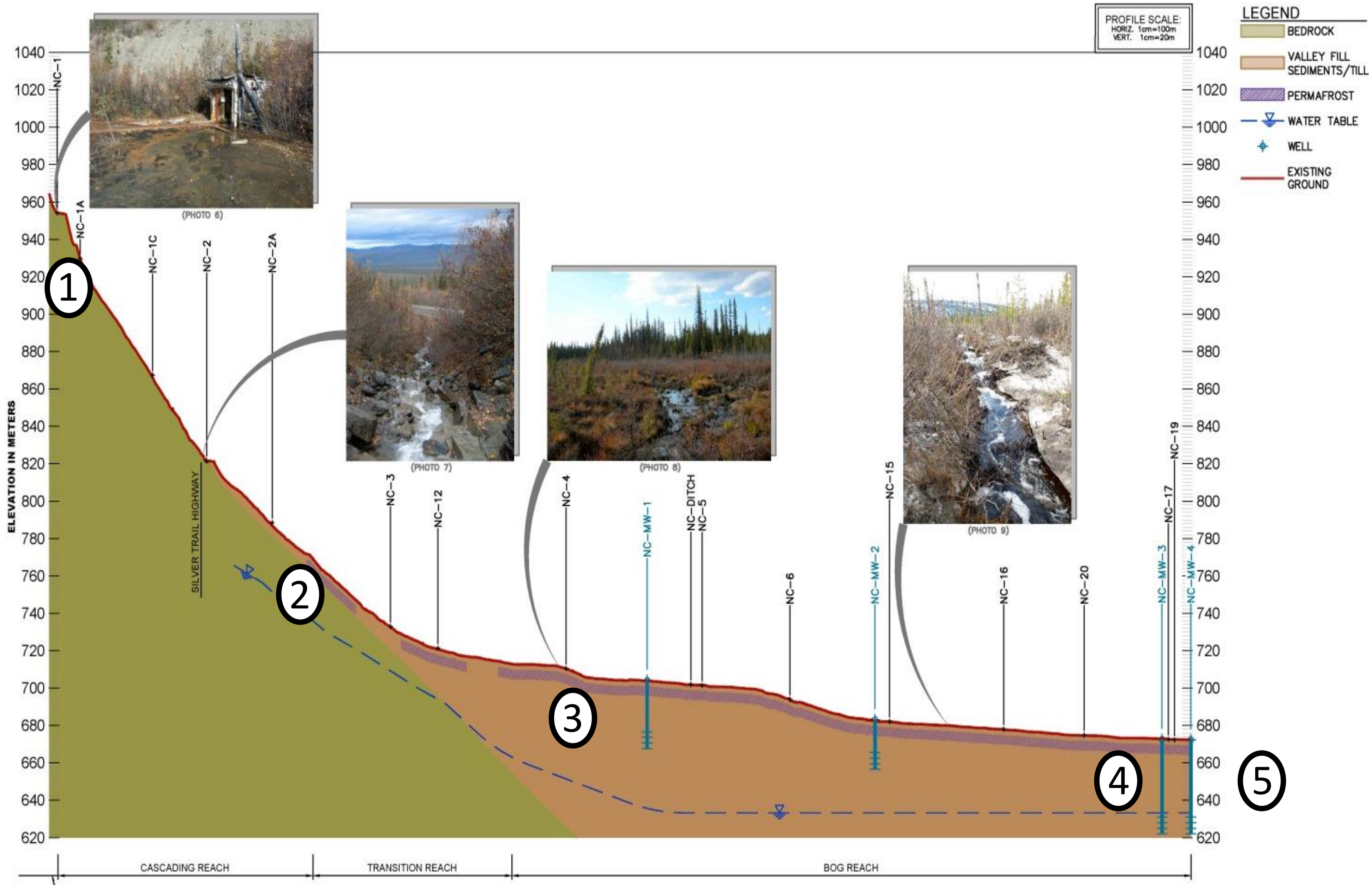
pattern and limited, if any significant runoff. The area is characterized by thick forest and well drained soils where infiltration of snowmelt recharges the glacial sediments below. The South McQuesten River serves as the discharge area for the basin for both groundwater and surface water.

4.1.2 (BIO)GEOCHEMICAL

The key geochemical mechanisms responsible for metals attenuation and relationship to potential closure issues are described below and correspond generally to numbered points on the profile in Figure 33.

1. Iron, manganese and zinc (oxyhydr)oxide minerals, notably ferrihydrite, birnessite and (hydro)hetaerolite, precipitate out of adit discharge water quickly resulting in significant dark orange/black sediment near the adit portal. These mineral reactions occur regardless of hydrologic or seasonal variability. Zinc is present as authigenic zinc-bearing mineral phases ((hydro)hetaerolite, hydrozincite), or co-precipitated/sorbed on iron and manganese oxyhydroxides. Cadmium is almost exclusively present as a sorption complex and although the sorbent could not be directly elucidated, the strong correlation between cadmium and zinc in the sediments suggests they have similar mineralogical hosts (likely iron and manganese oxyhydroxides). Surficial sediments, as well as buried sediments are of similar mineralogy and environmental stress testing of these sediments has indicated that elevated temperatures, pH and lowered alkalinity do not significantly impact the precipitate stability. A switch to reducing conditions in the stability testing did result in marked zinc and cadmium release to solution, however, the low organic carbon content of sediment in the adit reach/upper hydrologic area effectively restricts the development of such conditions within the sediment column. Furthermore, microbiological testing of these sediments indicated they had limited populations of metal- and sulphate-reducing bacteria.
2. Zinc and other metals continue to come out of solution along the cascading reach of the stream as oxyhydroxide phases. Geochemical mechanisms continue during hydrologic or seasonal variability. Suspended metals transport (as sediment and precipitated solids) occurs due to the high energy of NCC in this reach.

Figure 33 - No Cash Creek Hydrologic Profile



3. Similar geochemical reactions occur in the bog reach as in the upper, higher-energy reaches. However, the transition to a higher organic carbon content in stream sediment and surrounding soil horizons results in increased microbial activity and provides additional potential metals attenuation through sulphate reduction and metal-sulphide precipitation (e.g. sphalerite). Small (1 – 3 µm diameter) sphalerite granules have been identified in association with organic material in sediment thin sections and also in the peat itself. The increase in organic material (peat, wood, grasses, etc) also serve as important potential nucleation sites and micro-environments for supporting manganese and iron mineral precipitation reactions. Column experiments indicated that the NCC peat material is a highly effective sorbent, both in saturated and unsaturated conditions. It removed 99% of zinc and 94% of cadmium from 54 pore volumes of water pumped through peat-filled columns. As such, the peat bog may be viewed as a polishing step to the initial massive metals removal further upstream, adding redundancy to the natural attenuation process. Seasonal and hydrologic variability do not adversely affect the metals attenuation in this reach. Carbon accumulation in the bog is robust and consistent with observations from other comparable bogs, with carbon generation being more than sufficient for sustainable attenuation of all zinc generated from the No Cash Adit.
4. The terminal pond area shows very limited accumulation of metal precipitates as sediment. Total soluble zinc concentrations decline to a relatively constant low at about 0.1 mg/L approximately 1 km upstream of the terminal pond.
5. Elevated concentrations of total or dissolved metals are not observed in the monitoring wells adjacent to the terminal pond.

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Memorandum

To: Alexco Resource Corp.

From: Catherine Henry

CC: Kai Woloshyn

Date: November 14, 2013

Re: Meteorological Data Summary, Keno, YT

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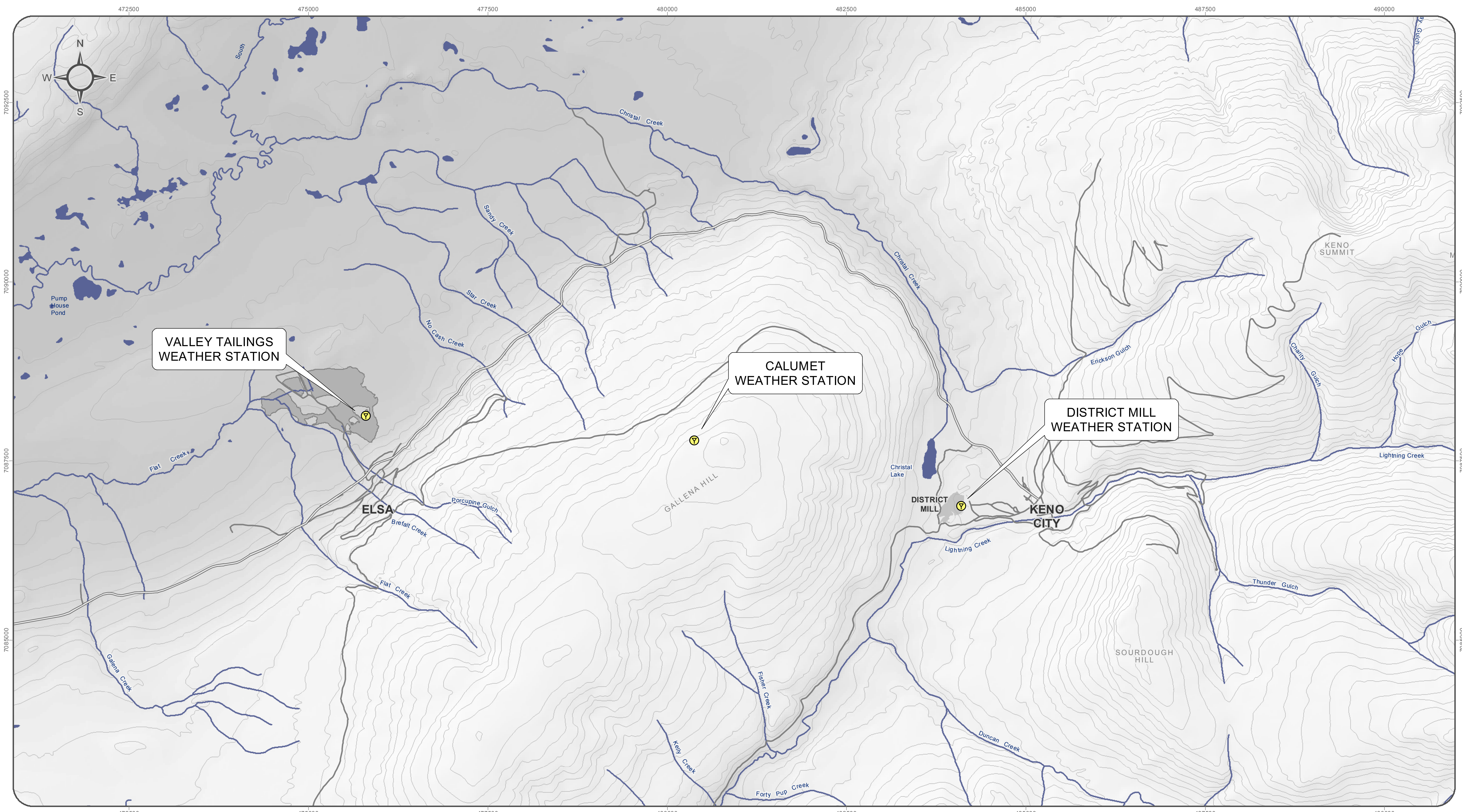
1. Introduction

This memo describes the meteorological data collected since 2007 at the Calumet weather station, since 2011 at the District Mill meteorological station and since 2012 at the Valley Tailings meteorological station. The three weather stations are shown on Figure 1 below.



Quartz claim boundaries current as of February 24th, 2011. Ownership data current as of December 20th, 2010. Data source: http://geomaticsyukon.ca.

Datum: NAD 83; Map Projection: UTM Zone 8N

1:50,000 (when printed on 11 x17 inch paper)

0 1 2 3 Kilometers

Weather Station
Highway
Secondary Road
Contours (100 ft)
Watercourse
Waterbody

ALEXCO

ACCESS

FIGURE 1
KENO METEOROLOGICAL STATIONS

NOVEMBER 2013

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(*14/11/2013/10:51 AM*)

2. CALUMET WEATHER STATION

An automated Onset HOBO meteorological station (Calumet Weather Station) was installed on Galena Hill above the Hector adit at 1,380 masl in June 2007. See Appendix I for the list of components.

2.1. OBSERVATIONS AND EQUIPMENT CONDITION 2013

- The station was commissioned on June 15, 2007, and logs air temperature, relative humidity, barometric pressure, rainfall, wind speed and direction at a height of 3 meters, solar radiation, and soil temperature at a 15-minute interval.
- The station was down between April 15 and June 3, 2013.
- The wind sensor experienced occasional icing during the winter months and extended periods of zero wind speed were invalidated. Also note that winter wind speeds may occasionally be underestimated due to the presence of ice on the sensor, but these occurrences cannot be detected in the data record.
- No total precipitation gauge or snowfall conversion adaptor is installed at this time, therefore only rainfall was measured. Note that instances of rainfall recorded at temperatures below zero are likely due to snowmelt.

2.2. METHODS AND RESULTS

Monthly averages were calculated from 15-minute values recorded by the data logger. Average temperature and total rainfall are presented in Table 1 below.

Table 1 Monthly statistics for average temperature and total rainfall collected at Calumet Station

	Average Temperature (°C)							Total Rainfall (mm)						
	2007	2008	2009	2010	2011	2012	2013	2007	2008	2009	2010	2011	2012	2013
January	-	-17.18	-18.84	-14.08	-16.78[3]	-18.71[4]	-16.90	-	-	-	-	-	-	-
February	-	-16.99	-16.95	-9.09	-15.88[3]	-9.94[4]	-10.81	-	-	-	-	1.8[3]	[9]	-
March	-	-11.04	-16.39	-9.21	-12.92[3]	-12.92[4]	-14.45	-	-	-	-	0.5[3]	[9]	0.6
April	-	-4.93	-4.75	-2.01	-3.77[3]	-1.88[4]	-12.32	-	1	-	1.3[3]	2.8[3]	[9]	0.2
May	-	3.31	3.66	5.35	4.41[3]	1.61[4]	n/a	-	25.4	21.8	32.3[3]	15.5[3]	[9]	n/a
June	*11.25*[1]	8.70	9.58	8.68	8.82[3]	7.76[4]	11.59	*55.2*[1]	44.6	*11.8*[7]	56.7[3]	121.8[3]	[9]	45.2
July	11.80	8.17	12.45	10.50	3.80[3]	7.84[4]	11.11	108.8	108.4	*22.8*[8]	137.7[3]	135.9[3]	*27.8*[10]	39.2
August	9.63	5.54	7.47	9.61	[2]	8.33[5]	10.58	54.8	110.2	89.4	140.0[3]	[9]	45.0	35.6
September	1.12	2.27	3.58	2.40	[2]	3.39	3.33	57.6	61.4	50.4	78.0[3]	[9]	17.4	64.6
October	-6.53	-7.20	-4.73	-4.86	[2]	-8.16	-2.52	-	12.6	-	16.0[3]	[9]	1.6	14.6
November	-9.41	-10.17	-11.94	-11.19	-17.39[4]	-18.44	[6]	-	-	-	-	-	0.2	[6]
December	-16.19	-18.34	-11.16	-17.72	-11.78[4]	-18.83		-	-	-	-	-	0	

Notes:
Values in grey italics indicate a partial month
[1] Station commissioned June 15, 2007
[2] Temperature probe malfunction – no proxy data available
[3] Calculated from MAYO A data
[4] Sensor occasionally offline but most data complete
[5] Sensor replaced August 7th

Notes:
[6] Last download on November 2, 2013.
[7] Rainfall gauge malfunction on June 11; total rainfall provided for June 1-11
[8] Rainfall gauge back online; total rainfall provided for July 7-31
[9] Tipping bucket malfunction – no proxy data available
[10] Tipping bucket repaired July 4th; total rainfall provided for July 4-31

3. DISTRICT MILL WEATHER STATION

The District Mill Campbell Scientific automated meteorological station is located above the dry stack tailings facility and below the old Keno City dump near Keno, YT (UTM coordinates: 08 V 048409 7086872, elevation: 936m).

3.1. OBSERVATIONS AND EQUIPMENT CONDITION 2013

- The Campbell Scientific Meteorological Station was commissioned on June 2, 2011 and includes sensors for the measurement of temperature, relative humidity, rainfall, wind speed and wind direction at a height of 10 meters (a list of components and a photo are shown in Appendix I).

- Relative humidity readings were found to be invalid from time of commissioning until May 7, 2012, at which time the problem was corrected by sending a revised program to the datalogger.

- A pyranometer (model SP Lite2) was installed on December 13, 2012, and the datalogger program was revised to incorporate hourly solar radiation readings and an evapotranspiration (ET) instruction. The ET instruction uses temperature, relative humidity, wind speed, solar radiation, latitude, longitude and altitude to calculate an evaporation rate for a short grass crop. This is only an approximation of actual evaporation at site, which varies locally depending on surface type and micro topography. Note that if one of the parameters listed above is invalid, the ET calculation also has to be invalidated.

- The wind sensor experienced occasional icing during the winter months and extended periods of zero wind speed were invalidated. Also note that winter wind speeds may occasionally be underestimated due to the presence of ice on the sensor, but these occurrences cannot be detected in the data record.

- No total precipitation gauge or snowfall conversion adaptor was installed in 2011 or 2012, therefore only rainfall was measured. Note that instances of rainfall recorded at temperatures below zero are likely due to snowmelt. A snowfall converter was installed on October 15, 2013 and will record total precipitation going forward.

3.2. METHODS AND RESULTS

Monthly averages were calculated from hourly values recorded by the data logger for the following parameters: temperature, daily maximum temperature, daily minimum temperature, relative humidity, wind speed, maximum wind speed and solar radiation. Monthly extreme maximum temperature, extreme minimum temperature, maximum wind speed, total rainfall and total evapotranspiration are also shown in Table 2 below.

Since the pyranometer was only installed in December 2012, no evapotranspiration data was calculated for 2011 or 2012 and estimates for evapotranspiration were developed from the 1996 data set using a computer program known as WREVAP which was developed by Environment Canada's National Hydrology Research Institute. As of 2013, evapotranspiration is calculated in the datalogger program from local meteorological parameters. Table 3 presents the comparison between the 2013 and the 1996 evapotranspiration data sets. It shows that the 1996 WREVAP evapotranspiration values may overestimate the local evapotranspiration, although more years of local evapotranspiration data will allow a more reliable comparison.

Table 2 Monthly statistics for meteorological parameters collected at District Mill Station

Month	Extreme Maximum Temperature (°C)	Average Maximum Temperature (°C)	Average Temperature (°C)	Average Minimum Temperature (°C)	Extreme Minimum Temperature (°C)	Average Relative Humidity (%)	Total Rain (mm)	Average Wind Speed (m/s) [1]	Extreme Maximum Wind Speed (m/s) [1]	Average Solar Radiation (W/m²)	Total Evapo-transpiration (mm)
Jun -11[2]	24.72	18.59	11.96	6.30	-2.56	n/a	n/a	1.35	9.14	n/a	n/a
Jul-11	25.67	18.50	12.91	8.00	5.09	n/a	n/a	1.15	8.02	n/a	n/a
Aug-11	22.32	15.58	9.78	5.37	1.93	n/a	n/a	1.18	9.15	n/a	n/a
Sep-11	17.97	11.29	6.07	1.85	-2.47	n/a	n/a	1.43	11.36	n/a	n/a
Oct-11	7.20	0.20	-2.74	-5.41	-9.84	n/a	*2.60*[3]	0.94	13.12	n/a	n/a
Nov-11	-4.23	-16.79	-19.54	-22.47	-34.99	n/a	0.00	0.58	12.05	n/a	n/a
Jan-12	-0.96	-19.10	-23.13	-26.79	-37.32	n/a	0.00	*0.59*	*9.51*	n/a	n/a
Feb-12	2.77	-6.77	-10.00	-13.07	-26.78	n/a	0.10 [4]	*1.38*	*15.62*	n/a	n/a
Mar-12	5.33	-7.69	-13.37	-18.00	-27.80	n/a	0.00	*0.97*	*9.24*	n/a	n/a
Apr-12	9.69	6.13	0.96	-3.87	-15.92	n/a	0.60 [4]	1.37	10.27	n/a	n/a
May-12	17.78	10.73	6.31	1.91	-3.47	*51.81* [5]	18.30	1.78	10.60	n/a	n/a
Jun-12	27.62	18.41	13.46	8.29	4.42	56.35	21.70	1.44	10.26	n/a	n/a
Jul-12	25.14	18.07	12.75	7.73	1.64	69.26	85.80	1.36	12.99	n/a	n/a
Aug-12	21.72	16.31	11.25	6.56	-0.89	67.79	47.00	1.62	9.41	n/a	n/a
Sep-12	20.24	10.33	5.90	2.08	-5.22	69.51	36.40	1.84	14.27	n/a	n/a
Oct-12	7.60	-3.95	-7.35	-10.32	-20.62	79.54	7.60	1.13	10.37	n/a	n/a
Nov-12	-8.98	-19.55	-21.90	-24.32	-33.36	81.43	0.00	0.94	9.36	n/a	n/a
Dec-12	-3.36	-21.30	-23.44	-25.58	-36.32	81.34	0.00	*0.26*	*5.93*	*1.01* [6]	*0.05* [7]
Jan-13	-1.59	-17.06	-20.01	-23.08	-41.48	82.92	0.00	*0.76*	*14.48*	1.06	0.81
Feb-13	1.54	-9.10	-12.52	-15.46	-23.74	88.36	0.30 [4]	*0.85*	*12.25*	10.26	1.27
Mar-13	3.26	-7.52	-13.16	-17.99	-29.96	64.08	3.90	*1.59*	*12.47*	95.82	6.33

Month	Extreme Maximum Temperature (°C)	Average Maximum Temperature (°C)	Average Temperature (°C)	Average Minimum Temperature (°C)	Extreme Minimum Temperature (°C)	Average Relative Humidity (%)	Total Rain (mm)	Average Wind Speed (m/s) [1]	Extreme Maximum Wind Speed (m/s) [1]	Average Solar Radiation (W/m^2)	Total Evapo-transpiration (mm)
Apr-13	6.07	-2.76	-7.94	-13.69	-25.07	54.50	8.20	2.44	12.93	190.02	14.48
May-13	23.31	10.20	5.27	0.23	-9.46	61.83	39.60	1.77	11.76	215.44	21.70
Jun-13	30.51	19.97	14.27	8.30	1.84	58.72	57.30	1.82	12.87	234.69	29.79
Jul-13	24.93	19.40	14.01	8.60	2.25	62.67	46.90	1.75	16.14	211.00	27.10
Aug-13	27.34	18.54	12.98	8.01	-0.38	66.30	51.90	1.49	11.05	156.25	21.38
Sep-13	16.11	9.69	5.81	2.26	-3.74	77.52	59.70	1.54	10.99	79.69	10.88
Oct-13	8.25	1.61	-1.32	-4.21	-10.10	86.75	44.60	1.11	11.62	35.75	4.26

Notes: *Values in grey italics indicate a partial month*
[1]January 2012 has 25 days of complete wind data
February 2012 has 28 days of complete wind data
March 2012 has 30 days of complete wind data
December 2012 has 15 days of complete wind data

[2] June 2011 has 29 days of complete data (station commissioned on June 2)
[3] 16 days of complete rain data
[4] Rainfall recorded at temperatures below zero may be due to snowmelt
[5] 25 days of complete RH data
[6] 18 days of complete solar radiation data
[7] 7 days of complete evapotranspiration data

Table 3 Evapotranspiration Data Sets Comparison

Month	2013	1996 WREVAP
January	0.81	0
February	1.27	0
March	6.33	0
April	14.48	10
May	21.70	42
June	29.79	43
July	27.10	44
August	21.38	20
September	10.88	20
October	4.26	0
November	n/a	0
December	n/a	0
Annual Total	138.00*	179

**Partial total*

4. VALLEY TAILINGS WEATHER STATION

The Valley Tailings Onset HOBO automated meteorological station is located near the valley tailings at UTM coordinates: 08 V 0475799 7088130 and at an elevation of 718m. See Appendix I for the list of components and a photo.

4.1. OBSERVATIONS AND EQUIPMENT CONDITION 2013

- The HOBO meteorological station was commissioned on October 19, 2012 and includes sensors for the measurement of temperature, relative humidity, rainfall, barometric pressure, soil water content, wind speed and wind direction at a height of 3 meters.

- The tipping bucket can only record rainfall (not total precipitation), so little or no data can be collected during the winter months. As the air temperature started to rise above 0°C in May 2013, it was noted that still no rain was being recorded. This observation triggered an inspection of the tipping bucket and the tipping mechanism was found to be obstructed. The obstruction was removed on May 16, 2013, and the tipping bucket is now functioning properly.

- The wind sensor experienced frequent icing during the winter months and extended periods of zero wind speed in combination with wind gusts of less than 1 m/s were invalidated. Similarly, extended periods with identical wind directions were also invalidated. Also, note that winter wind speeds may be underestimated due to the presence of ice on the sensor, but these occurrences cannot be detected in the data record.

- The logging interval was changed to 15 minutes on May 16, 2013, as this interval is sufficient for the purposes of this meteorological station and requires less datalogger memory.

4.2. METHODS AND RESULTS

Monthly averages from installation to October 2013 inclusively were calculated from 10-minute or 15-minute values recorded by the datalogger for the following parameters: temperature, daily maximum temperature, daily minimum temperature, relative humidity, wind speed, gust speed, barometric pressure and solar radiation. Monthly extreme maximum temperature, extreme minimum temperature, maximum and minimum relative humidity, maximum gust speed and total rainfall are also shown in Table 4 below. Note that the barometric pressure has not been corrected for elevation and therefore represents the absolute pressure.

Table 4 Monthly Statistics for Meteorological Parameters Collected at the Valley Tailings Meteorological Station

Month	Extreme Minimum Temp.(°C)	Average Minimum Temp. (°C)	Average Temp. (°C)	Average Maximum Temp. (°C)	Extreme Maximum Temp. (°C)	Average Relative Humidity (%)	Maximum Relative Humidity (%)	Minimum Relative Humidity (%)	Total Rain (mm)[2]	Average Wind Speed (m/s)[3]	Average Maximum Wind Speed (m/s)[3]	Extreme Maximum Wind Speed (m/s)[3]	Average Barometric Pressure (mbar)	Average Solar Radiation (W/m^2)	Soil Average Water Content (%)[4]
Oct-2012[1]	*-23.84*	*-20.12*	*-15.71*	*-9.71*	*-4.05*	*81.92*	*89.16*	*70.76*	n/a	*0.51*	*1.39*	*7.81*	*939.06*	*34.14*	n/a
Nov-2012	-40.71	-27.24	-23.77	-20.42	-8.07	82.04	90.97	69.24	n/a	*0.59*	*1.66*	*7.81*	932.15	7.72	n/a
Dec-2012	-44.20	-29.97	-26.29	-22.98	-3.99	82.75	97.20	71.67	n/a	*0.52*	*1.75*	*6.04*	926.06	1.48	n/a
Jan-2013	-45.56	-25.98	-21.58	-17.72	0.74	84.73	94.43	72.60	n/a	*0.94*	*2.10*	*14.61*	929.62	4.78	n/a
Feb-2013	-24.88	-16.72	-12.96	-8.80	2.40	90.08	96.67	81.42	n/a	*0.90*	*2.09*	*10.83*	919.93	23.70	n/a
Mar-2013	-33.45	-21.40	-13.93	-5.74	5.57	68.05	92.35	53.08	n/a	*0.84*	*2.00*	*13.85*	931.80	93.31	n/a
Apr-2013	-25.05	-14.66	-7.17	-0.87	8.37	53.23	81.57	39.58	n/a	*2.01*	*4.10*	*16.62*	930.07	171.18	n/a
May-2013	-8.36	0.10	6.08	11.66	23.35	62.90	95.00	40.13	*4.80*	*1.42*	*3.26*	*11.84*	928.76	186.87	12.3
Jun-2013	1.64	8.20	15.63	22.00	32.82	58.66	84.24	42.04	46.20	1.50	3.45	22.66	930.76	215.51	8.0
Jul-2013	1.59	8.95	15.68	21.90	29.32	60.65	87.50	38.38	25.40	1.39	3.22	16.12	931.69	194.18	6.9
Aug-2013	-1.90	6.94	13.85	20.49	29.49	68.65	95.18	44.98	43.00	*0.93*	*2.45*	*13.60*	926.92	144.34	9.6
Sep-2013	-2.45	2.00	6.39	10.85	18.06	80.70	98.19	60.89	64.80	*1.19*	*2.83*	*17.38*	921.41	71.21	14.4
Oct-2013	-11.22	-5.32	-1.54	2.56	9.11	91.89	99.04	68.02	49.40	*0.61*	*1.86*	*11.58*	927.19	32.16	12.2

Notes: *Values in grey italics indicate a partial month*

[1] Station was commissioned on October 19 so October 2012 has 12 days of complete data

[2] May2013 has 14 days of compete rain data

[3] October 2012 has 2 days of complete and 11 days of partial wind data
November 2012 has 5 days of complete and 24 days of partial wind data
December 2012 has 2 days of complete and 16 days of partial wind data and
January 2013 has 5 days of complete and 16 days of partial wind data
February 2013 has 2 days of complete and 26 days of partial wind data
March 2013 has 4 days of complete and 27 days of partial wind data
April 2013 has 14 days of complete and 16 days of partial wind data
May 2013 has 15 days of complete and 16 days of partial wind data
June 2013 has 29 days of complete and 1 day of partial wind data
August 2013 has 29 days of complete and 2 days of partial wind data
September 2013 has 15 days of complete and 15 days of partial wind data
October 2013 has 6 days of complete and 25 days of partial wind data

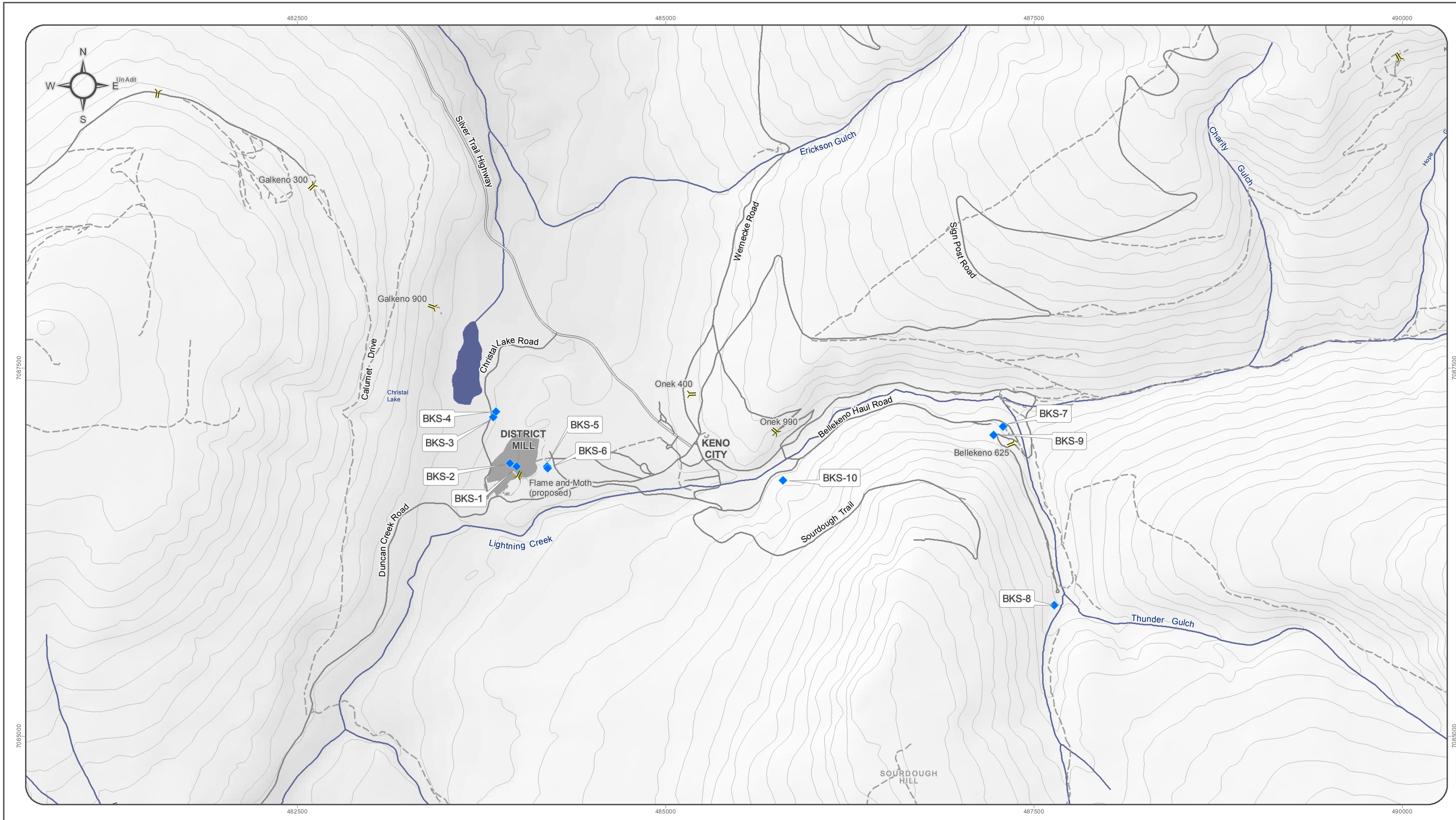
[4] Negative values were reported from Oct to April and were invalidated – soil assumed to be frozen

5. SNOW SURVEYS

Alexco also conducted manual snow surveys in 2011, 2012 and 2013 at ten monitoring stations in order to adequately represent the varying snow conditions as a function of aspect, elevation, etc. Snow water equivalent (SWE) results are presented in Table 5 below and the station locations are shown of Figure 2.

Table 5 Snow Survey SWE Results

Station	Description	Jan 2011 SWE (cm)	Feb 2011 SWE (cm)	Mar 2011 SWE (cm)	Jan 2012 SWE (cm)	Feb 2012 SWE (cm)	Mar 2012 SWE (cm)	April 2012 SWE (cm)	Jan 2013 SWE (cm)	Feb 2013 SWE (cm)	Mar 2013 SWE (cm)	April 2013 SWE (cm)
BKS-1	tall spruce up hill near dry stack	7.6	7.6	5.1	6.	16.1	18.7	8.7	7.3	11.3	13.0	15.0
BKS-2	log pile near dry stack	7.6	7.6	7.6	12.2	13.6	9.3	20.8	9.3	10.7	11.7	13.8
BKS-3	Between 1 and 2 marker on CLR road	7.6	10.2	7.6	9.6	12.5	4.4	7.7	7.3	10.0	14.3	14.7
BKS-4	down road from BKS 3, closer to #2 CLR marker	7.6	7.6	7.6	8.5	17.6	12.3	8.8	9.3	11.7	18.3	14.3
BKS-5.0	Keno dump area. Near scrub trees	5.1	7.6	5.1	13.7							
BKS-5.1	Keno dump area. Near scrub trees	-	-	-		11.3	12.2	9.6	6.7	9.7	13.3	13.0
BKS-6	Keno dump area. On sloping hillside	2.5	2.5	0	11.2	12.6	14.8	19.8	6.7	9.2	12.0	11.3
BKS-7	Up hill from Bellekeno treatment pond	7.6	10.2	7.6	12.5	13.6	4.8	8.5	6.7	11.0	10.3	13.7
BKS-8	Far end of Bellekeno East. Nr explosive storage shed	7.6	7.6	5.1	9.9	13.8	17.6	19.5	8.0	10.0	18.5	19.7
BKS-9	At BKR 16 marker. Slightly up on hillside	7.6	10.2	10.2	12.4	13.3	17.1	0.00	7.3	10.0	15.0	14.0
BKS-10	Near BKR 8 pull out. Up on hillside	10.1	7.6	5.1	13.3	16.5	27.7	10.7	9.3	10.0	12.3	14.3
Mean	-	7.112	7.874	6.096	10.93	14.09	13.87	11.43	7.79	10.36	13.87	14.38



Quartz claim boundaries current as of February 24th, 2011. Ownership data current as of December 20th, 2010. Data source: http://geomaticsyukon.ca.

Datum: NAD 83; Map Projection: UTM Zone 8N

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0 500 1,000 1,500 2,000 Meters

Snow Monitoring Station
Adit
Highway
Secondary Road
Track
Contours (100 ft)
Watercourse
Waterbody

ALEXCO
ACCESS

FIGURE 2
KENO SNOW SURVEY STATIONS

NOVEMBER 2013

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APPENDIX I: METEOROLOGICAL STATIONS COMPONENTS

Galena Hill HOBO Meteorological Station

Component	Model	Serial Number
Datalogger	HOBO Weather Logger	1153440
Temp & RH Sensor	S-THB-XXXX	10064003
Soil Temp Sensor	S-TMB-XXXX	985390
Pyranometer	S-LIB-XXXX	1048627
Rain Gauge	S-RGB-M002	1017667
Wind Speed & Direction Sensor	S-WCA-XXXX	1254995
BP Sensor	S-BPA-XXXX	1037089

District Mill Campbell Scientific Meteorological Station

Component	Model	Serial Number
Air Temperature and Relative Humidity Sensor	HMP45C212	n/a
Tipping Bucket Rain Gauge	TE525M	45303-910
Wind Speed and Direction Sensor	05103AP-10-L	WM105907
Solar Panel	SX320J	T21008289B30EC8
Datalogger	CR800	16119
Battery	PS-12120 F2	06299-HC
Pyranometer	SP Lite2	125766

Valley Tailings HOBO Meteorological Station

Component	Model	Serial Number
Datalogger	U30 NRC	10231016
Input Expander kit		
Solar Panel	6W	
AC Power Adaptor	120V - 60Hz	
HOBOware	Pro	2580 2976 6309 4793
Temp & RH Sensor	THB-M002	10220040
Solar Radiation Shield	RS3	
Pyranometer	LIB-M003	10191222
Rain Gauge	RGB-M002	10222664
Light Sensor Bracket	LBB	
Light Sensor Level	LLA	
Wind Speed & Direction Sensor	WSET-A	10233230
Full Cross Arm	CAA	
BP Sensor	BPB-CM50	10212093
Soil Moisture Sensor	SMC-M005	10225679
Tripod	TPA-KIT 3m	

District Mill Campbell Scientific Meteorological Station

Valley Tailings HOBO Meteorological Station

3 Calcite Business Centre, 151 Industrial Road
Whitehorse, Yukon Y1A 2V3
Phone (867) 668-6463 Fax (867) 633-4882
www.accessconsulting.ca

Memorandum

To: Kai Woloshyn, Alexco Resource Corp.

From: Anthony Bier, Access Consulting Group

Date: November 12, 2013

Re: Keno Hill Silver District Continuous Discharge Monitoring

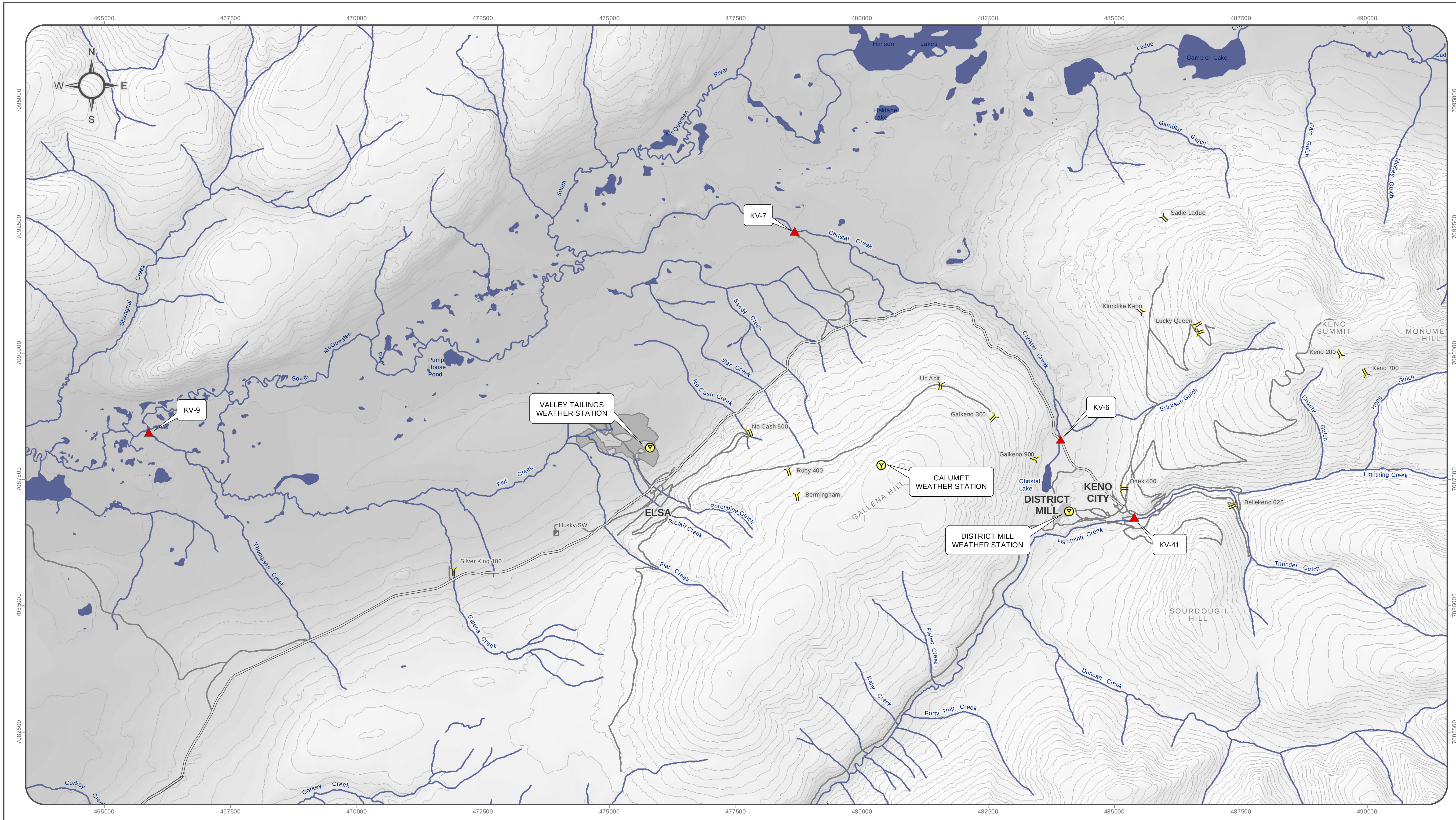
1 INTRODUCTION

This memo describes the discharge data for water monitoring locations KV-6(Christal Creek at Silver Trail Highway) and KV-7 (Christal Creek at Hanson Road), KV-9 (Flat Creek near the mouth) and KV-41 (Lighting Creek upstream of the Keno City Bridge shown on Figure 1. Water level has been monitored at KV-7 and KV-41 since 2004 with data processing performed by Clearwater Consultants Ltd. (Clearwater) into 2009 (Memorandum CCL-UKHM-1 and CCL-UKHM-2). A new station was set-up at KV-6 in the summer of 2011 including the installation of a stilling well with Solinst water level recorder on July 20th 2011. Flat Creek near the mouth (KV-9) is just above the confluence with the McQuesten River and is the watershed in which the old Elsa townsite is located and the current Alexco camp and administration offices. Continuous water level data for this site exists for 2004-2008 and from 2008 to present.

2 METHODS

Continuous water levels are recorded during the open water season at fifteen or thirty minute intervals using Solinst water level recorders. Discharge measurements and staff gauge observations are taken at regular intervals during the open water season, approximately once per month. Occasionally, salt slugs are used to determine flow when conditions do not permit regular velocity-area discharge measurements. These data have been used together to develop rating curves which facilitate the translation of continuous water level data into continuous discharge. Discharge measurements are taken in winter when conditions permit using the salt dilution gauging method.

For the period 2004 – 2009, Clearwater Consultants Ltd. (Clearwater) processed the water level data to produce a flow record on behalf of Access Consulting Group (ACG). Clearwater have patched the data record over the winter months when gauging data were not collected, and have shown through regional analysis that this practice gives realistic values for the purpose of calculating mean and annual and monthly runoff (CCL, 2008) These data are summarized in memorandums CCL-UKHM-1 and CCL-UKHM-2.



National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Quartz claim boundaries current as of February 24th, 2011. Ownership data current as of December 20th, 2010. Data source: http://geomaticsyukon.ca.

Datum: NAD 83; Map Projection: UTM Zone 8N

1:70,000 (when printed on 11 x17 inch paper)

0 1 2 3 Kilometers

Water Quality Monitoring Station
Weather Station
Adit
Shaft
Highway
Secondary Road
Contours (100 ft)
Watercourse
Waterbody

ALEXCO
ACCESS

FIGURE 1

KENO HILL SILVER DISTRICT CONTINUOUS DISCHARGE LOCATIONS

NOVEMBER 2013

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(*Last edited by: mducharme; 15/11/2013/08:31 AM*)

Data at these sites have been collected by ACG and more recently by Alexco with assistance from ACG. ACG has compiled the data since 2010.

3 RESULTS

Below the mean monthly discharge records are presented for KV-6, KV-7, KV-9 and KV-41. Typically, continuous data is available from May to October. In some years Clearwater Consultants Ltd. were able to fill the winter months. From 2010-2013, winter months are not computed. Appendix A includes hydrographs For KV-6, KV-7, KV-9 and KV-41 as well as the continuous stage records with spot measurements included for reference. 2012 and 2013 data were processed using Aquatic Informatics Aquarius Time-Series software.

3.1 KV-6 CHRISTAL CREEK ABOVE SILVER TRAIL HIGHWAY

The hydrometric station on Christal Creek at KV-6 is above the Silver Trail highway and several hundred meters downstream of Christal Lake. That catchment area is 6.1 km^2 with a median elevation of 1002 m. ACG revised these numbers using GIS software in 2012. Based on the methods used in Clearwater report CCL-UHKM-1 (2008) the mean annual runoff estimate (MAR) was revised to 243mm or 1,482,300 m^3/yr.

A Solinst water level recorder was deployed at KV-6 in a stilling well on July 20th 2011 and retrieved on October 23rd 2011. Instantaneous discharge measurements have been collected since June 2008 on a monthly basis as often as possible. There was one discharge measurement taken during the continuous water level record but not staff gauge was installed.

The 2012 Solinst Level Logger record begins May 1st and extends till mid-October. Ice begins to affect the pressure readings on October 10th making water levels following that unreliable (Figure 2, Appendix A). A staff gauge was installed along with the Level Logger on May 1st with a corresponding BaroLogger (barometric pressure data logger). After mid-July the record becomes unreliable due to a ponding effect (Figure 2, Appendix A).

In 2013 the KV-6 station was moved upstream due to the ponding encountered in 2012, but due to infrequent measurements a continuous record could not be produced. Furthermore, the station was moved again in September 2013 to a more stable reach. The reach of the stream between Christal Lake and the Silver Trail Highway is not ideal for rating curve development, but with continued efforts a continuous record should be available for 2014.

Table 1 shows instantaneous discharge measurements taken since 2008 at KV-6. Figure 2 (Appendix A) shows the discharge time series for 2012.

Table 1 - Instantaneous discharge measurements at KV-6, Christal Creek below Christal Lake (m^3/s)

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2008						0.064	0.13	0.119	0.08	0.161		
2009						0.124	0.101	0.114	0.103	0.033		
2010					0.071		0.094	0.061	0.141	0.094		
2011					0.136	0.08	0.091		0.127	0.088	0.075	0.107
2012		0.077		0.062	0.126	0.089	0.095	0.091	0.089	0.076		
2013						0.123	0.082	0.079	0.091	0.093		
Mean[1]	0.092	0.077	0.07	0.062	0.111	0.096	0.099	0.093	0.105	0.091	0.075	0.107

1 - Grey numbers are estimates.

3.2 KV-7 CHRISTAL CREEK AT HANSON-MCQUESTEN LAKES ROAD BRIDGE

Christal Creek at KV-7 drains an area 35.8 km^2 with a median elevation of 970 m and includes KV-6 and Christal Lake. There are quite a number of old workings within the watershed including Galkeno 300, Galkeno 900, Brewis Red Lake, Lucky Queen, Klondike Keno and, arguably Onek 400.

The 2011 updated MAR for Christal Creek at KV-7 is 205 mm or 0.283 m^3/s, somewhat lower than calculated in 2008; 221 mm and 0.304 m^3/s (CCL-UKHM-1). This result is also somewhat lower than the MAR estimates based on the initial hydrology study found in UKM/96/01 of 230mm.

Cleawater has summarized the data for 2004 - 2009 (CCL 2008; 2009). Data for 2010 and 2011 have been processed by ACG following the same methodology as Clearwater. ACG has processed data at this site using Aquarius time series software in 2012 and 2013. Mean monthly discharge is shown since 2003 at KV-7 in

Table 2. Figure 3, Figure 4, Figure 5, and Figure 6 show the discharge time series for 2010, 2011, 2012 and 2013, respectively (Appendix A).

Table 2 – Mean Monthly Discharge at KV-7, Christal Creek at Hanson-McQuesten Road Bridge (m^3/s)

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2003								0.42	0.51			
2004			0.15	0.166	1.153	0.314	0.119	0.112	0.163	0.135	0.103	0.101
2005		0.122	0.112	0.391	1.54	0.264	0.294	0.398	0.335	0.259	0.189	0.15
2006	0.166	0.138	0.12	0.124	1.089	0.519	0.397	0.278	0.415	0.368	0.203	0.142
2007	0.151	0.12			0.757	0.327	0.54	0.218	0.335	0.154		
2008								0.43	0.333	0.352		0.134
2009	0.079	0.068	0.048	0.074	1.123	0.338	0.102	0.183	0.368			
2010					0.309	0.24	0.359	0.23	0.232	0.186		
2011					1.260	0.142	0.503	0.419	0.268		0.173	0.126
2012	0.154	0.078		0.014	0.730	0.258	0.400	0.217	0.267	0.200		
2013	0.075	0.063	0.086	0.118		0.285	0.126	0.080	0.177	0.266		
Mean	0.125	0.098	0.103	0.148	0.995	0.299	0.316	0.271	0.309	0.240	0.167	0.131

Note: Grey numbers are discrete discharge measurements.

3.3 KV-9 FLAT CREEK NEAR THE MOUTH

Flat Creek headwaters originate on the Northwest face of Galena Hill above the Elsa town site. Flat Creek at KV-9 also drains Thompson, Galena, Porcupine and Brefault Creeks. Adits within the Flat creek water shed include, but are not limited to, Silver King and Husky Southwest. The Valley Tailings facility is also situated within the Flat Creek watershed. The total drainage area of Flat Creek is 56.5 km^2.

Station KV-9 is located just above the confluence with the South McQuesten River approximately 10km east of Elsa. Mean monthly discharges values from spot flows for KV-9 are presented

Table 3. Figure 7, Figure 8, Figure 9 and Figure 10 show the discharge time series for 2010, 2011, 2012 and 2013, respectively (appendix A).

Table 3 – Mean Monthly Discharge at KV-9, Flat Creek near the Mouth (m³/s)

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2004								0.116	0.099	0.11	0.046	0.034
2005	0.03	0.028	0.126	0.273	2.077	1.017	0.282	0.34	0.33	0.28		
2008								0.545	0.375	0.448	0.129	0.09
2009	0.053	0.029	0.02	0.01	2.155	0.51	0.088	0.092	0.364			
2010						0.133	0.171	0.086	0.118	0.099		
2011					1.97	0.349	0.927	0.756	0.364	0.299		
2012							0.556	0.232	0.375	0.299		
2013					1.496	0.701	0.182	0.081	0.115			
Mean	0.042	0.029	0.073	0.099	1.925	0.542	0.368	0.281	0.268	0.256	0.088	0.062

3.4 KV-41 LIGHTNING CREEK AT KENO CITY BRIDGE

Lightning Creek at KV-41 has a catchment area of 58.98 km² and a median catchment elevation of approximately 1400 m. Lightning Creek originates to the east of Keno City and drains the southern flank of Keno Hill and the Northern flank of Mount Hinton. Lightning Creek flows to the south of Galena hill into Duncan Creek. Within the Lightening Creek watershed are multiple adits including Keno 200 and 700, multiple old surface workings, active mining at Bellekeno East and placer mining on Thunder Gulch.

Hydrometric station KV-41 is located on Lightning Creek above the Keno City Bridge and downstream of the Bellekeno mine and local placer mining activity. Ice-free continuous water level data extends from late May to early October after which ice begins to affect water level readings and the stage-discharge relationship.

Table 4 shows the update mean monthly discharge record with winter months filled in with spot measurements. Figure 11, Figure 12 and Figure 13 show the discharge time series for 2010, 2011 and 2012, respectively (Appendix A). Due to a logger problem in 2013 the continuous record only extends to June 16th and these data have not been processed at this time.

Table 4 – Mean Monthly Discharge at KV-41, Lightening Creek above Keno City Bridge (m^3/s)

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2004								0.433	0.315	0.240	0.153	0.125
2005	0.098	0.067	0.056	0.130	1.802	1.418	0.989	1.111	0.958	0.637	0.452	0.299
2006	0.219	0.192	0.194	0.272	0.793	1.994	1.326	0.921	1.083	0.889	0.554	0.447
2007					1.231	1.926	1.193					
2008								1.136	0.770	1.030		
2009		0.110	0.128	0.069	1.595	1.628						
2010					1.172	1.383	1.007	0.760	0.570	0.457		
2011						1.206	1.826	1.542	0.926			0.268
2012	0.251	0.159	0.182			2.096	1.404	0.707	0.869	0.566		
Mean	0.189	0.132	0.140	0.157	1.319	1.664	1.291	0.944	0.784	0.637	0.386	0.285

Note: Grey numbers are discrete discharge measurements.

APPENDIX A

HYDROGRAPHS

Figure 2 – Discharge at KV-6, Christal Creek below Christal Lake, 2012 open water season

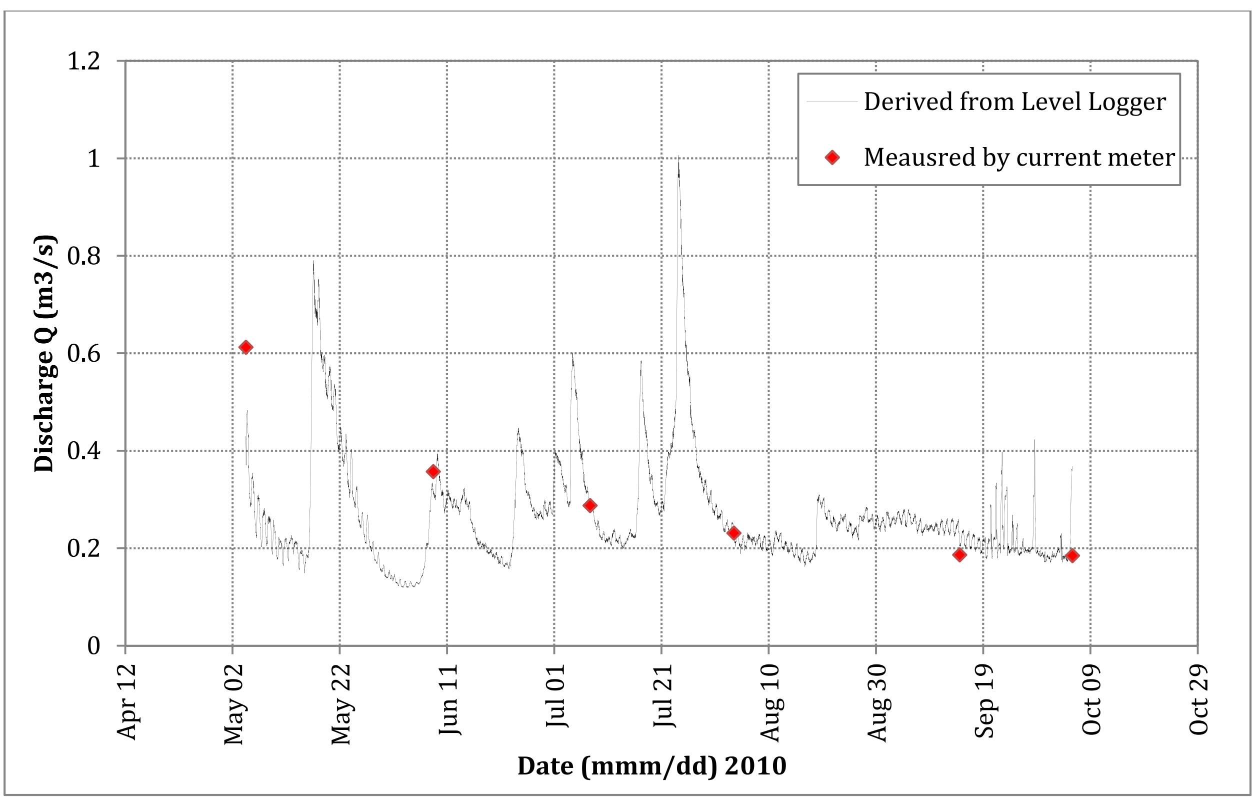

Figure 3 - Discharge at KV-7, Christal Creek at Hansen Road 2010

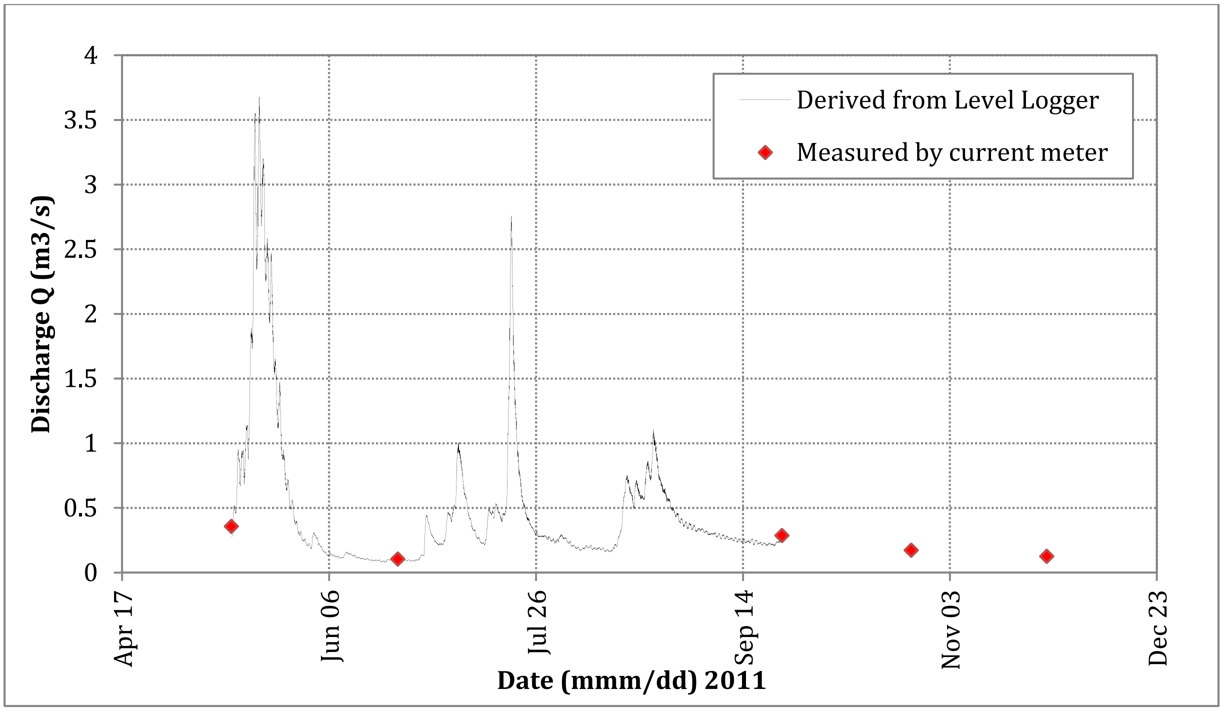

Figure 4 - Discharge at KV-7, Christal Creek at Hansen Road 2011

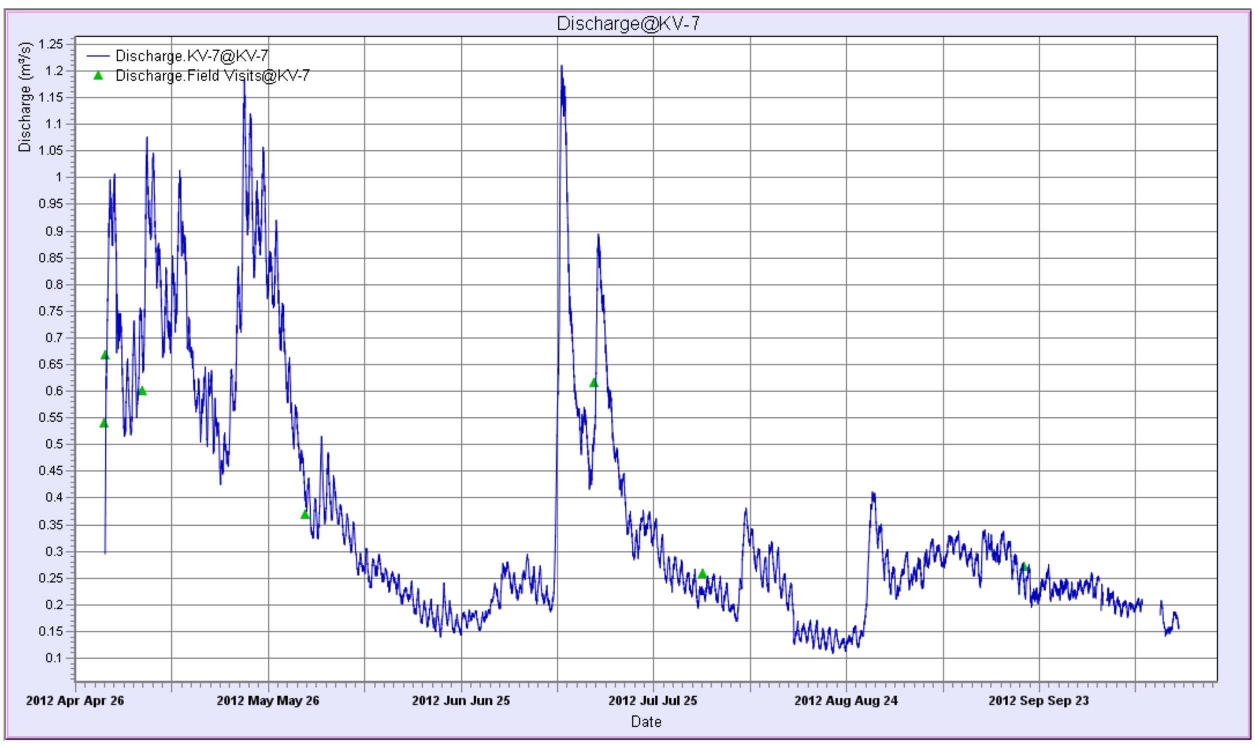

Figure 5 – Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2012 open water season

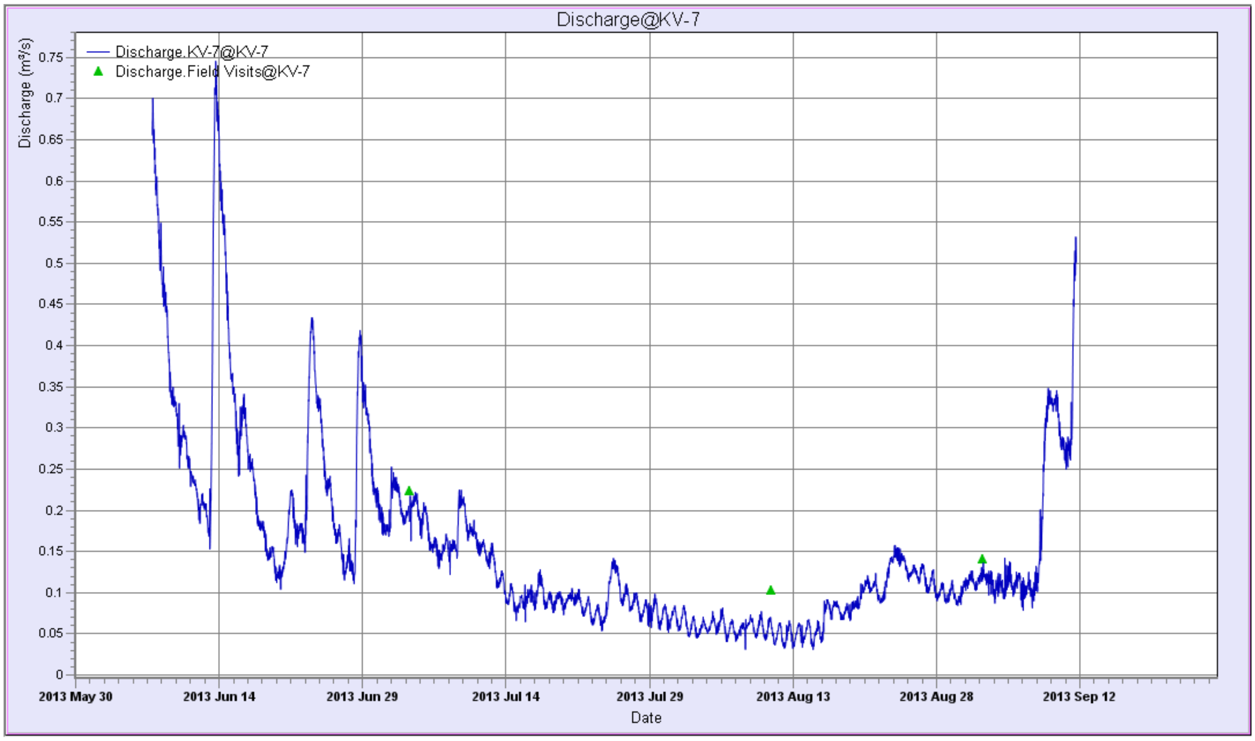

Figure 6 - Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2013 open water season

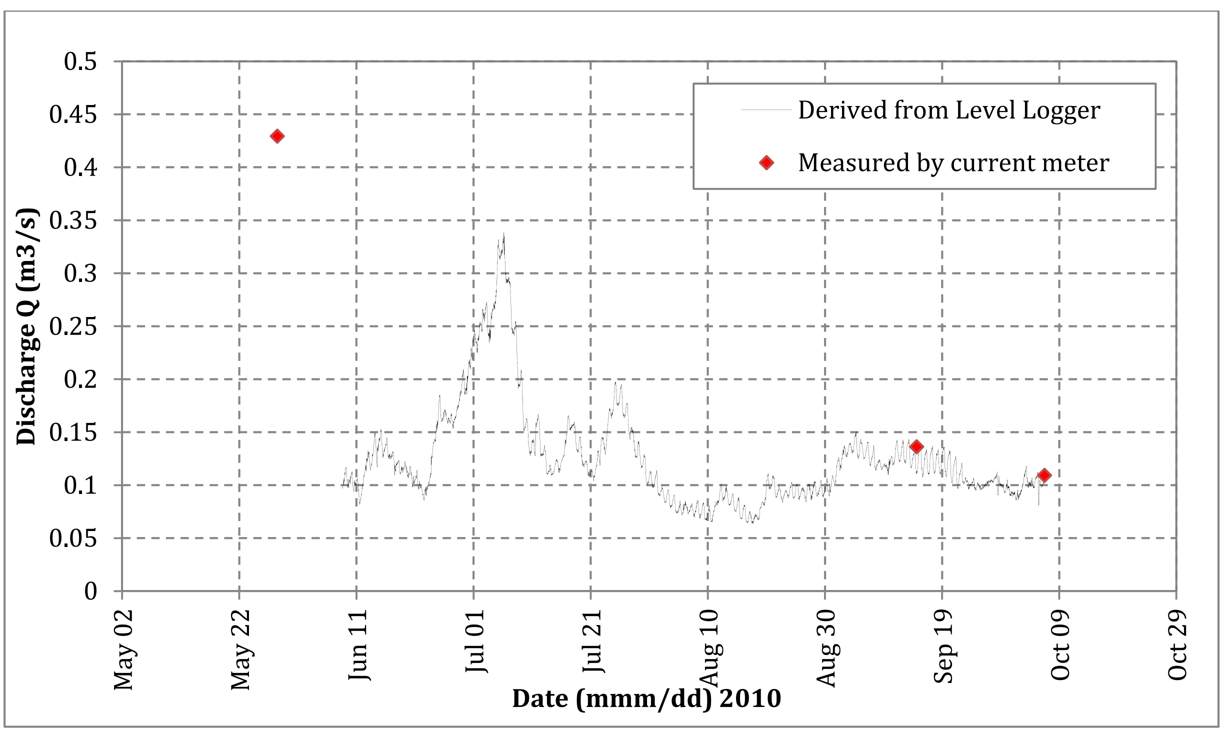

Figure 7 - Discharge at KV-9, Flat Creek 2010

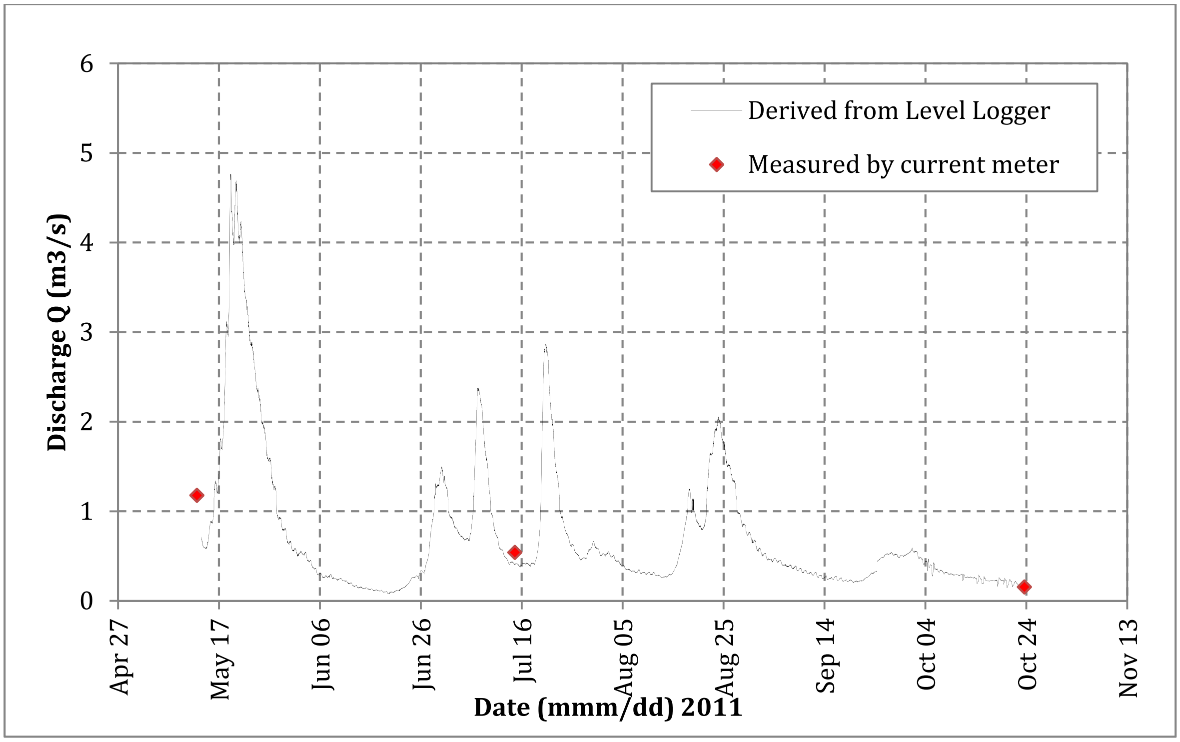

Figure 8 - Discharge at KV-9, Flat Creek 2011

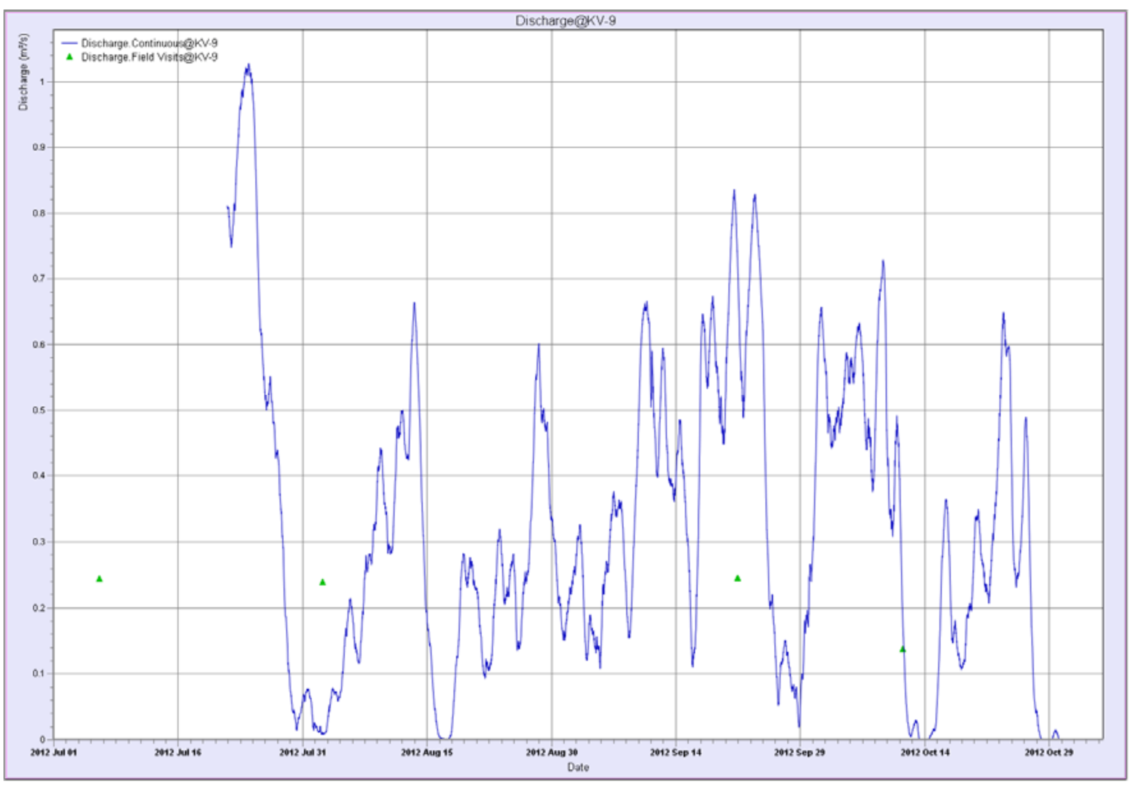

Figure 9 - Discharge at KV-9, Flat creek near the mouth, 2012 open water season

Figure 10 - Discharge at KV-9, Flat creek near the mouth, 2013 open water season

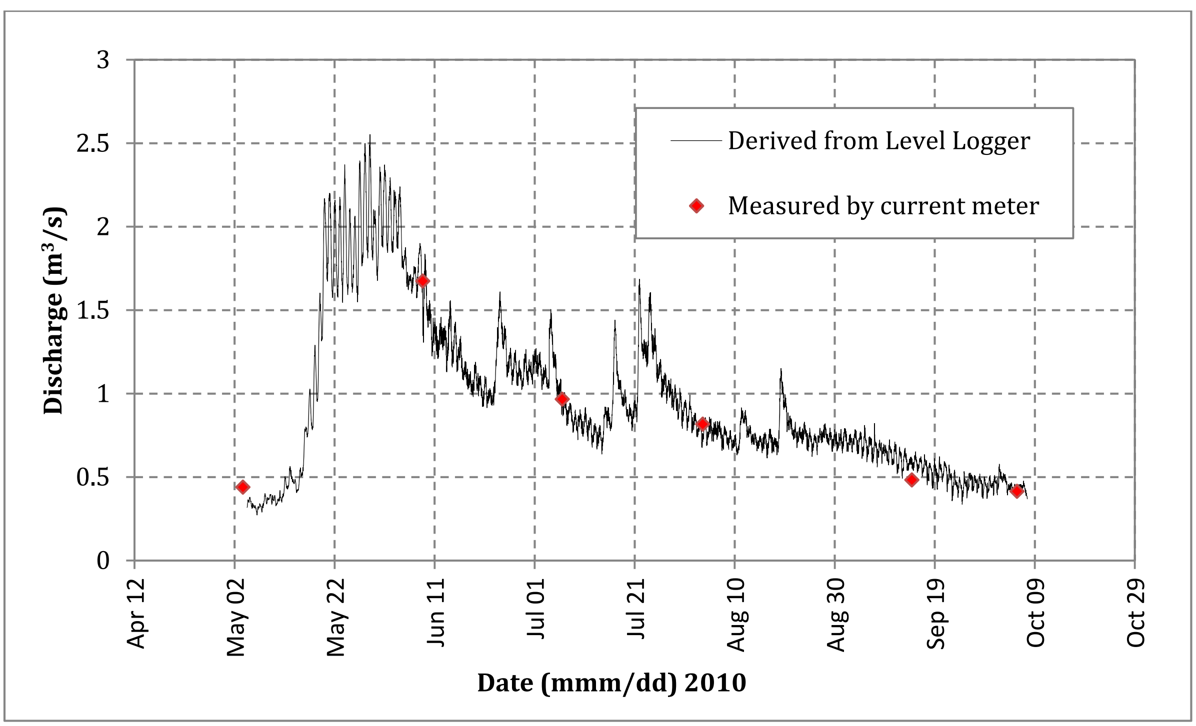

Figure 11 - Discharge at KV-41, Lightening Creek 2010

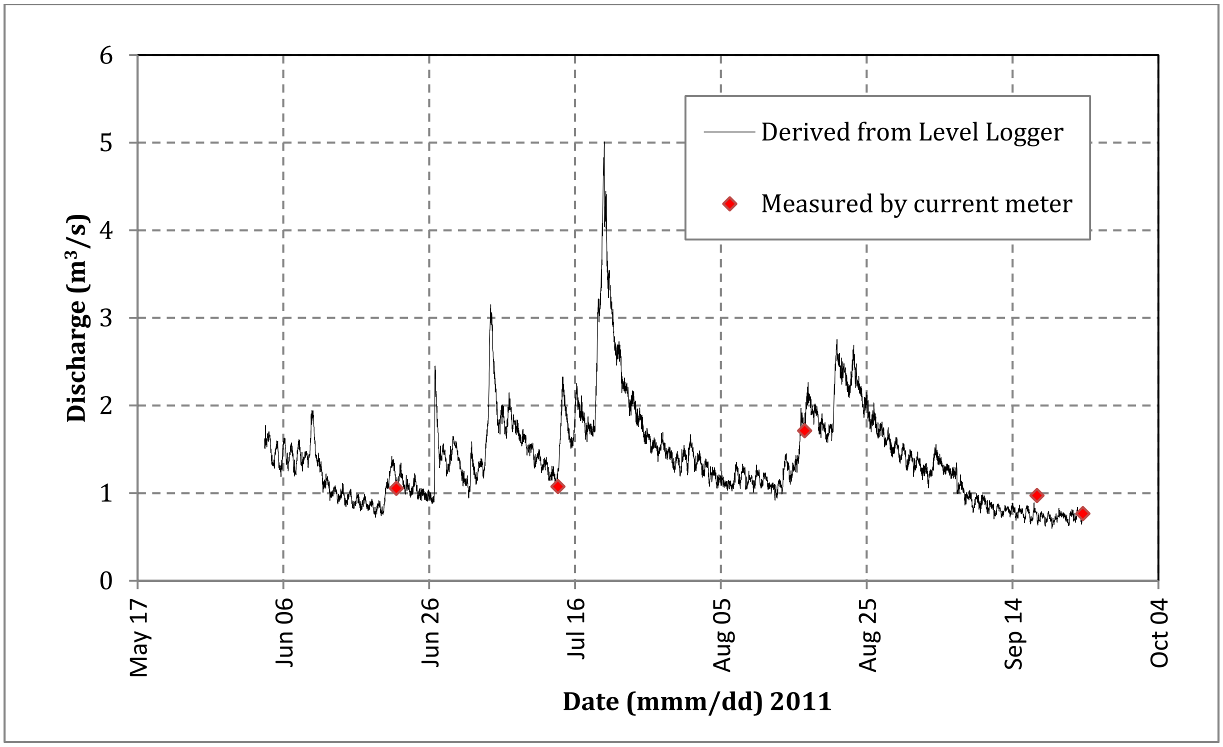

Figure 12 - Discharge at KV-41, Lightening Creek 2011

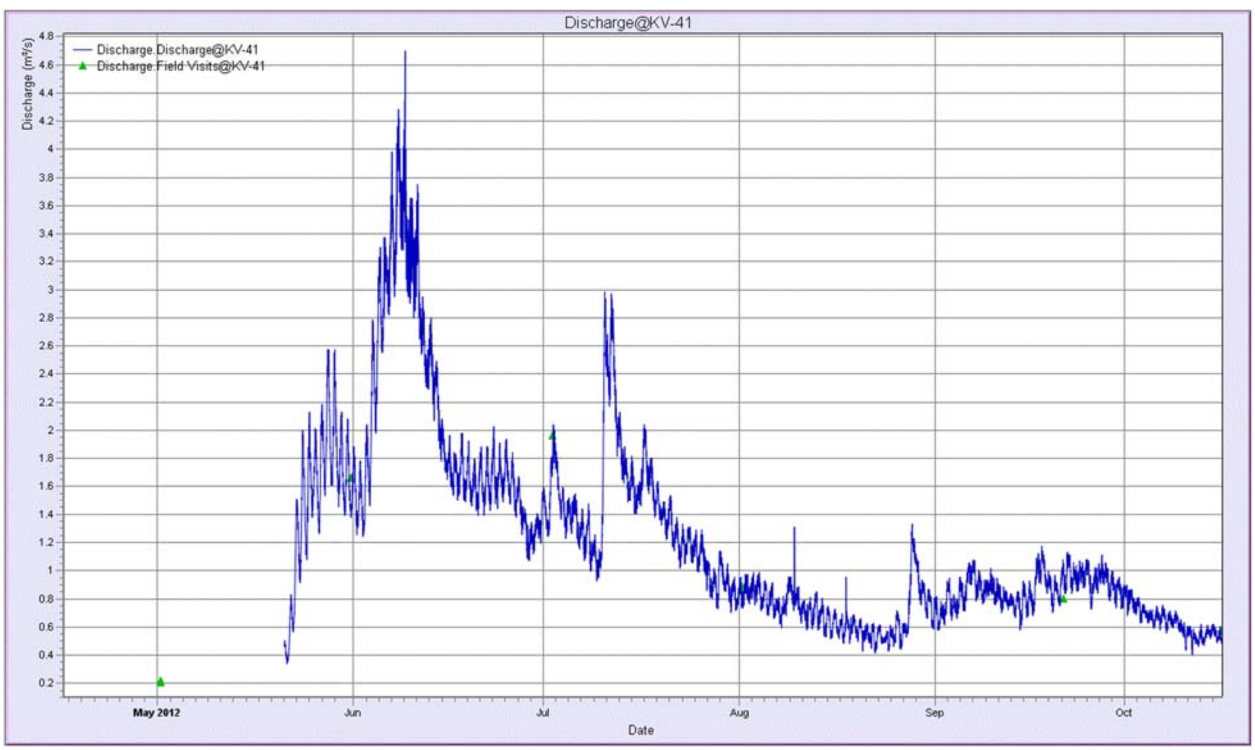

Figure 13 – Discharge at KV-41, Lightening Creek above Keno City Bridge, 2012 open water season