Appendix II-1

Sources of Dissolved Ions to the Process Kimberlite Containment Facility at Diavik Diamond Mines Inc.

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September 2015

Table of Contents

List of Figures

List of Tables

1.0 INTRODUCTION

A mass balance study of the processed kimberlite containment (PKC) pond found that total concentrations of major cations, SO_4, Cl, Mo, U, B and Cd in the surface water of the PKC pond had increased from January 2002 to December 2008 (Moncur Groundwater, 2009). Although concentrations of total ions in the PKC Pond water were increasing, the water did not exceed existing discharge criteria.

A water balance study in 2009 found that water from the processing plant was used for the tailings slurry which contains both recycled PKC pond water (~57 %) and fresh water from Lac de Gras (~24 %) (Table 1; Figure 1). Tailings deposited in the PKC pond settle gravimetrically on the pond bottom leaving standing water in the PKC pond to be decanted and recycled back to the processing plant. A series of collection ponds on site used to control surface water runoff and seepage, including Ponds 4 and 5 that collect seepage from the PKC facility, were periodically pumped into the PKC pond. Total volume of monthly discharge water removed from the ponds to the PKC pond was measured, but there was no record of the volumes from the individual ponds. Pond Waters discharged to the PKC pond make up approximately 15 % of the total input (Table 1; Figure 1). Treated sewage waste water was also directed to the PKC pond. The monthly volume of treated sewage effluent discharged to the PKC pond made up approximately 2 % of the total water volume (Table 1; Figure 1). The calculated total discharge to the PKC pond represents only the diverted inputs and does not include precipitation directly on the pond, surface water inflow, or possible groundwater inputs.

Table 1: Average percent of water discharged to the PKC Pond from 2002 to 2008. (Revised from Moncur Groundwater, 2009).

2002 to 2008	Recycled PKC	Fresh Water LDG	Collection Ponds	Treated Sewage
Total Discharge to PKC Pond (%)	57 % ± 20 %	24 % ± 20 %	15 % ± 16 %	2 % ± 0.5 %

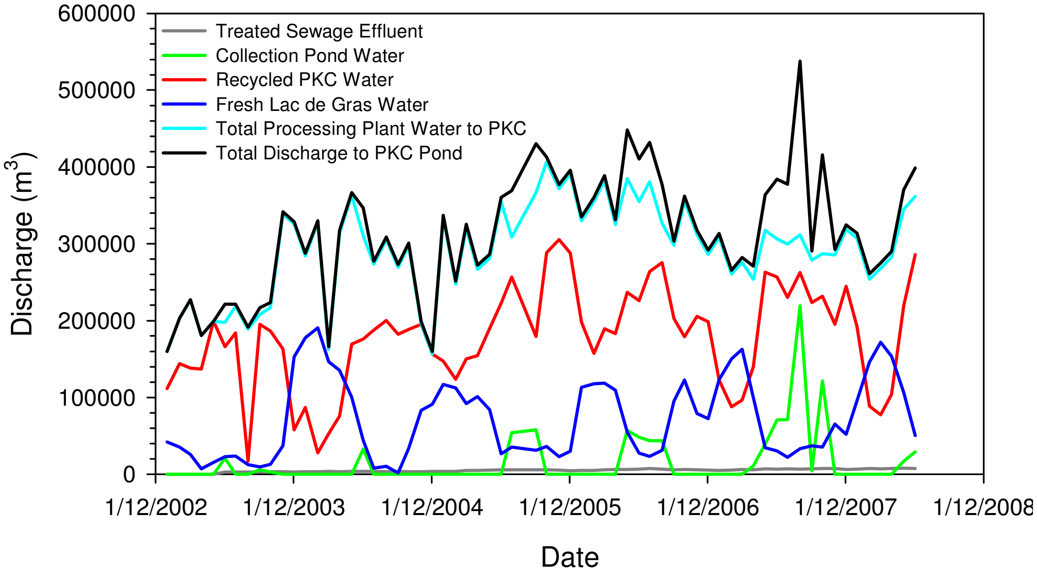


Figure 1: Discharge of water to the PKC Pond. The total processing plant water discharge is the sum of recycled PKC water and fresh Lac de Gras water (Revised from Moncur Groundwater, 2009). Total discharge to the PKC is a sum of all discharge streams to the PKC Pond

The increasing trends of major cations and metals in the PKC pond water did not appear to be directly related to changes in the amount of precipitation in the region. Loadings calculated to the PKC pond indicated three different types/sources of parameters, including those where the source of loadings was mainly from both the Collection Ponds and recycled Process Effluent (e.g. Cl, SO_4, Na and K); those originating primarily from the recycled Process Effluent (e.g. of Cd, Mo and Ni); and those whose source was mainly from the Collection Ponds (e.g. U). Overall, the main source of loadings appeared to be from the recycled PKC line (Moncur Groundwater, 2009). The source of major cations, metals and sulfate to the system was likely due to the weathering of fine processed kimberlite (FPK) in the PKC pond. The abundance of secondary minerals phases forming in the impoundment provide evidence that weathering was occurring. Seasonal cycling in the PKC pond showed that the maximum concentrations occurred in the winter possibly due to freeze out. Since 2009 a number of studies have been done to address weathering of FPK and the subsequent release of dissolved constituents to pore waters (Moncur et al., 2011; Moncur and Smith, 2012; Moncur and Smith 2014; Smith and Moncur, 2014; Moncur et al., 2015).

2.0 OBJECTIVE

The original objective of this project was to conduct a quantitative mass balance of the PKC Pond using data on the volumes and geochemical and isotopic composition of each of the inflow waters. However, since 2009 changes in on-site water management have made some of the parameters required for the water balance poorly defined and difficult to quantify. For example the seepage from the PKC facility to Ponds 4 and 5 has increased, de-watering wells have been installed in the PKC retaining dam to divert seepage water back into the PKC Pond, PKC Pond water has been transferred out of the PKC facility, and water from the North Inlet has been introduced to the PKC system. Given these changes in data availability, the objective of this project was revised to identifying the main sources of major ions and dissolved metal(oid)s to the PKC Pond. As mentioned previously, the PKC line was the greatest source of loading to the pond, but weathering of FPK material within the pond and adjacent beach areas could also be a significant source of solutes (Moncur Groundwater, 2009). This project focuses on using a multi-parameter approach that includes water geochemistry, isotopic labelling and mineralogy to evaluate the contribution of different sources of solutes to the PKC pond.

This study compared the geochemical and isotopic composition of water sampled from the PKC pond with data for the potential sources of solutes including:

- PKC End of Pipe (tailings discharge)
- Weathering of FPK material
    - Submerged FPK
    - Saturated FPK
    - Unsaturated FPK
    - Frozen FPK
- Treated Sewage
- Lac de Gras

The potential contribution from weathering of FPK material was evaluated using data from water samples from different geochemical zones within the FPK material (e.g. submerged, FPK, saturated FPK, unsaturated FPK, frost FPK) and using elemental, isotopic and mineralogical data for solid samples of FPK material.

3.0 METHODS

Data used for this report was collected during previous studies (Moncur et al., 2011; Moncur and Smith, 2012; Moncur and Smith, 2014). Surface water samples were collected from the PKC Pond, End of Pipe (EOP; tailings discharge), treated sewage, and Lac de Gras. Groundwater and porewater was collected from the East Beach of the PKC, FPK submerged under the PKC Pond (Barge), dewatering wells located between the PKC dam and Ponds 4 and 5, and underground seeps.

4.0 RESULTS AND DISCUSSION

4.1 Processed Kimberlite Containment (PKC) Pond

Water samples are collected monthly from the PKC Pond by DDMI’s Environment Team. These samples are analyzed for field parameters (pH, temperature, EC), major ions and dissolved and total metals. Figure 2 shows dissolved major ions and metals in the PKC Pond from 2002 to 2012. Similar to trends observed in Moncur Groundwater (2009), EC, concentration of TDS, major cations, SO_4, Cl and Ni have continued to increase since 2009

(Figure 2). Dissolved concentrations of Se, U, Mo, Zn and Cd also continue to increase in 2009 but all show a decrease in 2011. Water chemistry from the PKC Pond analyzed since 2012 should be examined to determine if concentration continue to decrease. Boron concentrations also show a decrease in 2011 but it appears to be due to analytical uncertainties.

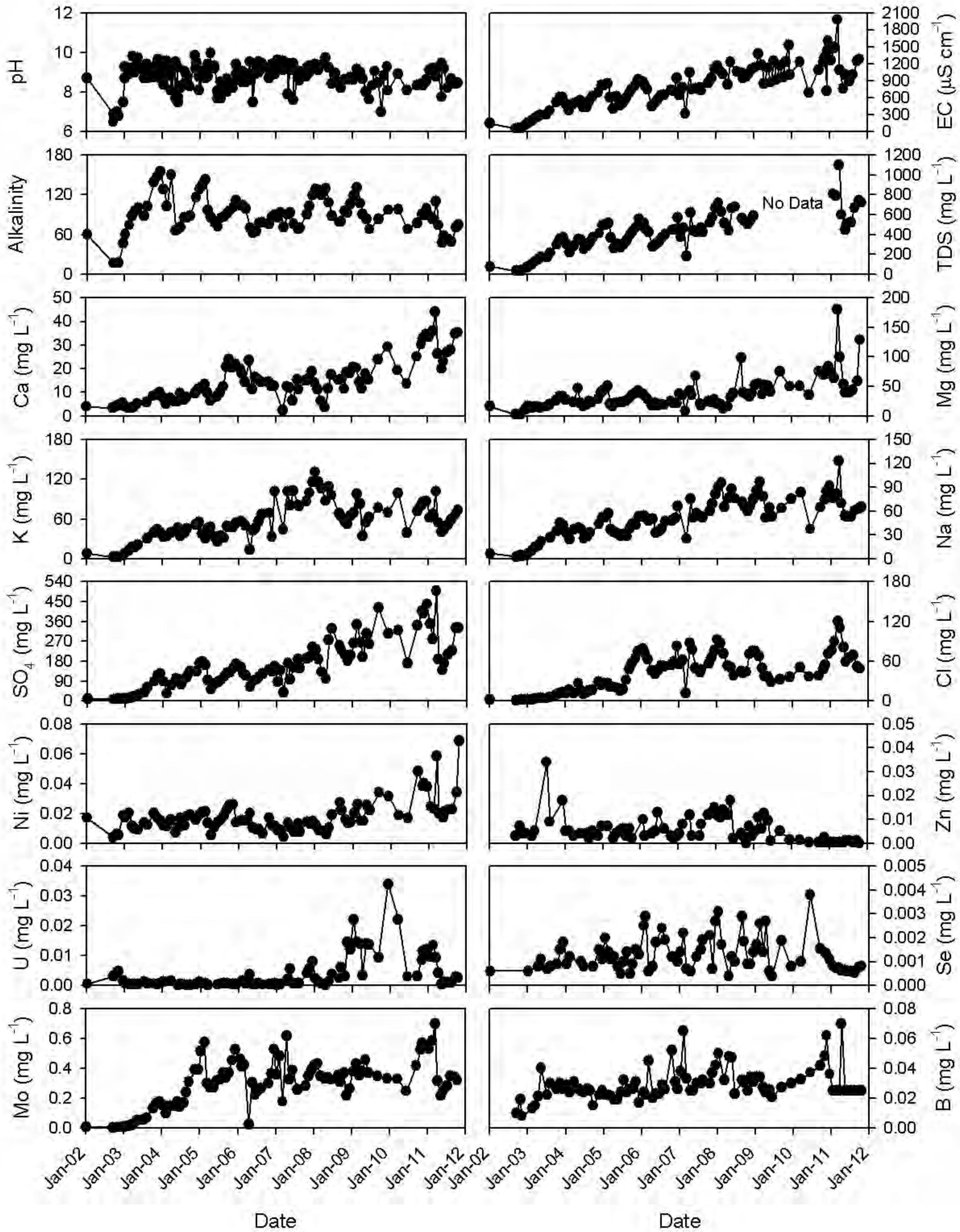


Figure 2: **Time series of dissolved major anions and cations, dissolved metal(oid)s, electrical conductivity (EC), total dissolved solids (TDS), and pH measured in the PKC Pond water from 2002 to 2012.**

The desktop study conducted by Moncur Groundwater (2009) anticipated that weathering of the unsaturated FPK was likely responsible for the loading of major ions and some metals to the PKC Pond. Since this report, a number of studies have focused on FPK weathering and the subsequent release of dissolved ions to the porewater (Moncur et al., 2011; Moncur and Smith, 2012; Moncur and Smith 2014; Smith and Moncur, 2014; Moncur et al., 2015). These studies found that the weathering and dissolution of minerals in the FPK were the principal contributors of dissolved ions to the PKC Pond water (Figure 3).

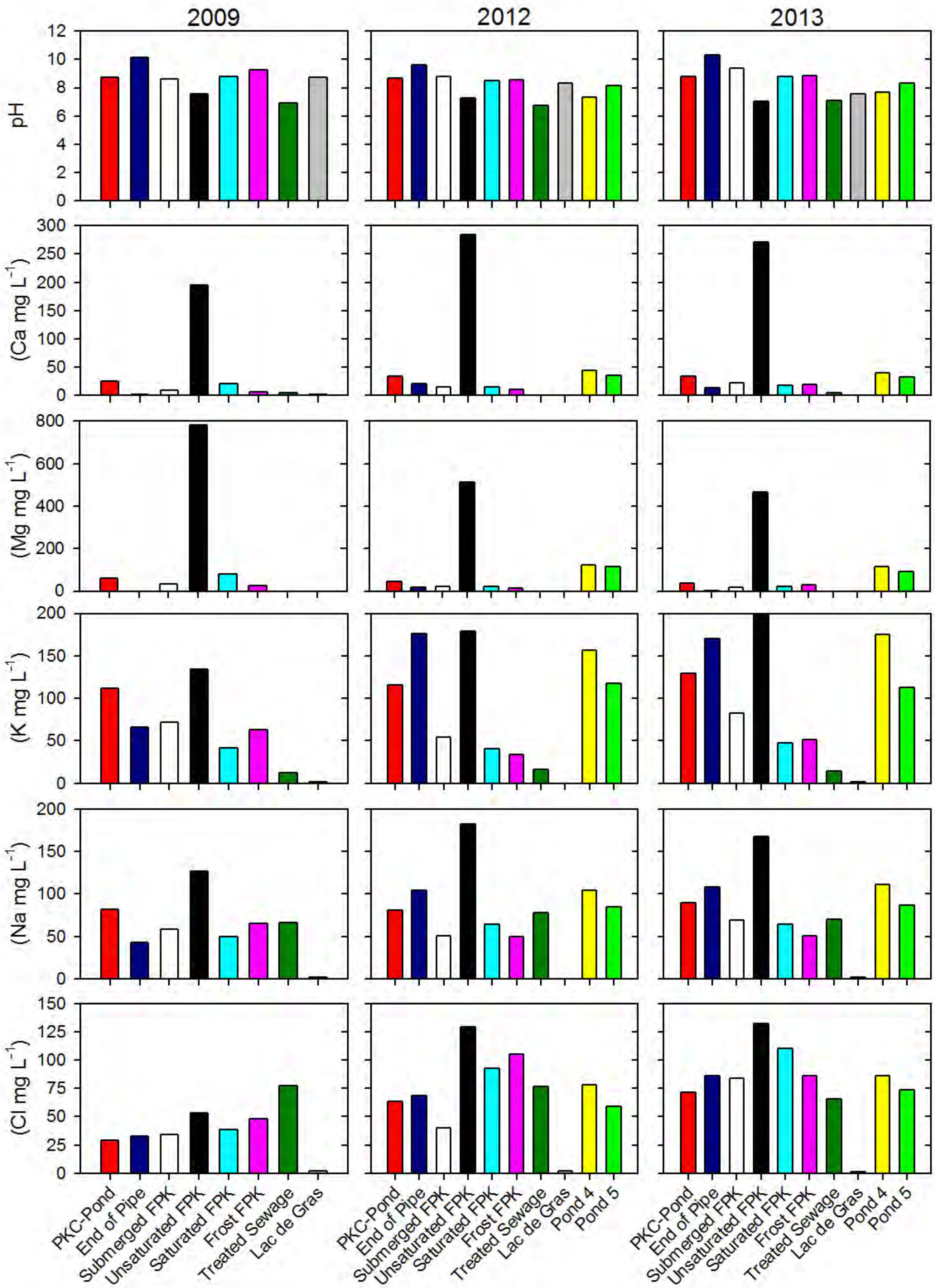


Figure 3: Bar plots showing pH and concentrations of major cations and chloride in various water types at DDMI during 2009, 2012 and 2013.

Distinct differences in the average pH, Eh and concentrations of dissolved ions from the unsaturated zone, saturated zone and the frost zone are shown in Table 2. Differences in Eh measurements indicate oxidizing conditions in the unsaturated zone that become progressively more reduced with depth into the frost zone. The shift towards more reduced conditions with depth corresponds with a shift towards increasing pH values. Average dissolved concentration of sulfate, most major cations and metals decreased by almost an order of magnitude from the unsaturated zone to the saturated zone. The concentrations of dissolved ions were also lower in the frost zone than in the saturated zone. Porewater samples collected from piezometers installed below the ponded water at the Barge, have water concentrations similar to the frost zone. Ion data show minimal variation between the three zones include Cl, K and some low concentration metals. The lower concentrations observed in the frost zone may be due to freeze-out processes. At the Barge location, ponded PKC water overlies the FPK acting as an oxygen barrier resulting in low dissolved ion concentrations in the porewaters, similar to concentration observed in the frost zone porewater.

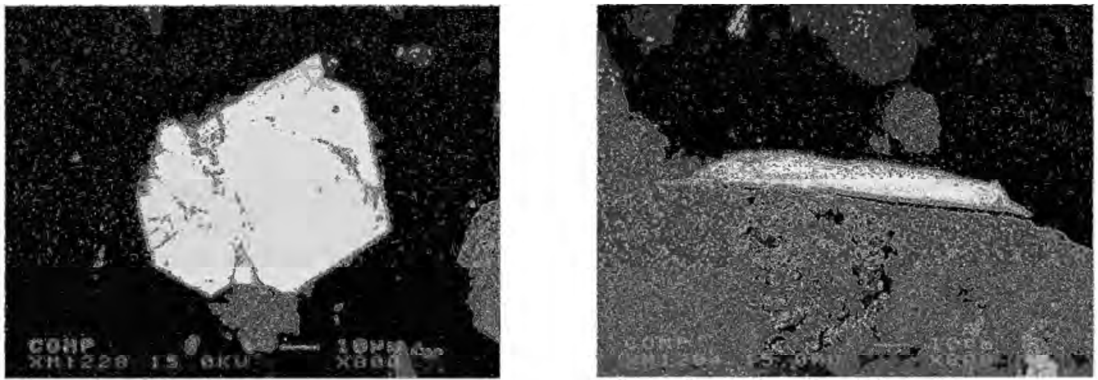
Table 2: Average, maximum, minimum concentrations of dissolved ions measured from the unsaturated zone (UZ), saturated zone (SZ), frost zone (FZ), and submerged processed kimberlite in the PKC Pond. Number of samples is represented by n.

Zone		pH	Eh	Alkalinity	Ca	Mg	SO_4	Fe	Ni
			(mV)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(µg/L)
UZ	N	78	76	73	83	83	78	83	83
UZ	Mean	**7.43**	**215**	**43**	**243**	**545**	**2896**	**247**	**260**
UZ	median	7.64	231	33	249	445	2185	54	161
UZ	Max	9.49	546	224	745	2441	11768	2963	2953
UZ	Min	3.19	-111	<dl	2.3	3.7	19	<dl	1.1
SZ	N	45	43	43	44	45	44	44	44
SZ	Mean	**8.77**	**181**	**52**	**22**	**74**	**359**	**54**	**32**
SZ	median	8.785	219	51	12	20	120	18	7.6
SZ	Max	10.23	447	105	166	594	3071	968	348
SZ	Min	7.215	-136	13	<dl	2.5	15	<dl	<dl
FZ	N	24	24	24	24	24	24	24	24
FZ	Mean	**8.96**	**83**	**59**	**8**	**16**	**85**	**22**	**8.8**
FZ	median	9.02	141	49	7	13	64	7.6	4.9
FZ	Max	9.85	318	110	19	65	295	230	48
FZ	Min	7.41	-184	19	1.0	0.2	14	<dl	1.1
Barge	N	24	22	24	24	24	24	24	24
Barge	Mean	**8.99**	**381**	**74**	**11**	**26**	**199**	**63**	**9.8**
Barge	median	9.04	400	70	10	26	192	9.1	9.6
Barge	Max	9.63	459	137	22	58	437	821	34
Barge	Min	7.89	197	14	1.6	7.0	46	<DL	1.8

4.2 Sources

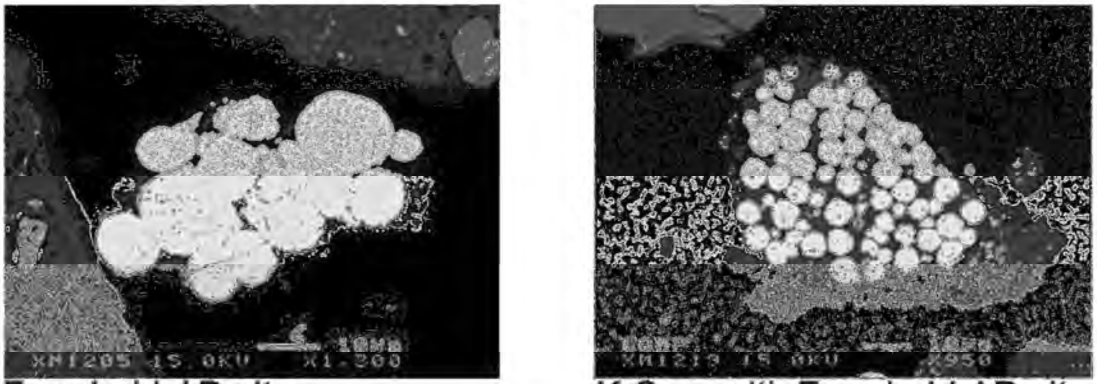
4.2.1 Sulfate and Trace Metal(oid)s

The principal source of SO_4 in the PKC Pond is from the oxidation of pyrite [FeS_2] that is incorporated in mudstone xenoliths within the kimberlite. Jambor (1997) found the average content of pyrite in 72 kimberlite samples was 0.23 wt.%. The average pyrite content in 21 FPK samples collected from the East Beach was 0.5 wt.% (Paktunc and Thibault, 2010). Within the East Beach FPK, most of the observed pyrite was framboidal in habit although a minority had a massive appearance (Paktunc and Thibault, 2010) (Figure 4). A few grains of pyrrhotite [$Fe_{(1-x)}S$] were observed but its abundance was insignificant. The only other primary sulfate mineral observed in the FPK was a relatively insoluble Ba-SO_4 phase in trace quantities. Secondary gypsum [$CaSO_4$•$2H_2O$] was identified in the FPK by Wilson et al., 2009, interpreted to be a product of sulfide oxidation.



Massive Pyrite

Massive Pyrrhotite



Framboidal Pyrite

K-Spar with Framboidal Pyrite

Figure 4: Photos showing sulfide minerals observed in the FPK facility. Many of the sulfide minerals observed were encased in Al-silicate minerals, limiting reactivity. Therefore, measurements of total sulfur are an overestimation for the amount of sulfide minerals in the FPK available to oxidize.

The $\delta^{34}S$ values of the various rock types in the FPK material and country rock, and the $\delta^{34}S$ and $\delta^{18}O$-SO_4 composition of the different water types collected from the mine site can be used to improve our understanding of the sources of SO_4 to in the PKC pond (Figure 5). Negative $\delta^{34}S$ values are typical of diagenetic environments where reduced sulfur compounds are formed, with the most common reaction product being pyrite (Clark and Fritz, 1997). Positive $\delta^{34}S$ values may indicate dissolution of evaporitic minerals or bacterial sulfate reduction is occurring (Mayer, 2005). The potential sources of SO_4 to the porewaters and PKC Pond include dissolution of sulfate minerals inherent in the kimberlite or oxidation of sulfides. An earlier study at the nearby Ekati Mine by Rollo and Jamieson (2006) suggested that elevated SO_4 concentrations in the FPK porewater was due to dissolution of a Ca-SO_4 mineral, however, this mineral phase was not identified in the FPK at DDMI. The $\delta^{34}S$ composition of Lac de Gras was +1.4 ‰, typical of sulfates in soil (Mayer, 2005) and considered background. Sulfide mineralization in the underground workings in A154 granite was analyzed for $\delta^{34}S$ and had a signature of -2.0 ‰. Water collected from seeps in underground workings from A154 and A418 pipes had a $\delta^{34}S$ values ranging from -1.5 to 1.1, showing a mixture of SO_4 from Lac de Gras and oxidation of sulfide minerals in the country rock (Figure 5). Water collected from basal drains of the Type 1 and 3 waste-rock test piles had $\delta^{34}S$ values ranging from -3.0 to -6.2 ‰, similar to sulfide mineralization in the underground workings. The $\delta^{34}S$ of sulfide from the unprocessed kimberlite was -22.0 to -20 ‰ and the mudstone ranged from -20.4 to -46.4 ‰. $\delta^{34}S$ values from the FPK porewater overlap the ranges for unprocessed kimberlite and mudstone with values ranging from -15.3 to -21.8‰. The similarity between the FPK porewater and the unprocessed kimberlite and mudstone indicate minimal fractionation between the solid phase and dissolved phase which is consistent with previous studies (Taylor et al., 1984; Edraki et al., 2005). The $\delta^{34}S$ values measured in the PKC Pond was strongly depleted (-19‰) suggesting that the primary source of dissolved SO_4 is sulfide oxidation. Although Pond 4 and 5 interception wells are in contact with waste rock, the $\delta^{34}S$ values of the water were -17 and -17.2 ‰, respectively, indicating that the main source of SO_4 is derived from oxidation of sulfides in the kimberlite and mudstone. The +2 ‰ difference between the PKC Pond and Pond 4 and 5 waters may be due to some SO_4 from the waste rock. The treated sewage has a $\delta^{34}S$ value similar to Lac de Gras (Figure 5).

During weathering of the FPK and waste rock, elevated concentrations of dissolved SO_4 can be released. Both rock types have distinct $\delta^{34}S$ isotopic signatures. Effluent from the FPK has a $\delta^{34}S$ value of approximately -17 ‰ and the waste rock effluent has a value of approximately -5 ‰. At the DDMI mine site, the application of stable sulfur isotopes can identify the source of SO_4 in waters and determine mixing between SO_4 derived from FPK and waste rock.

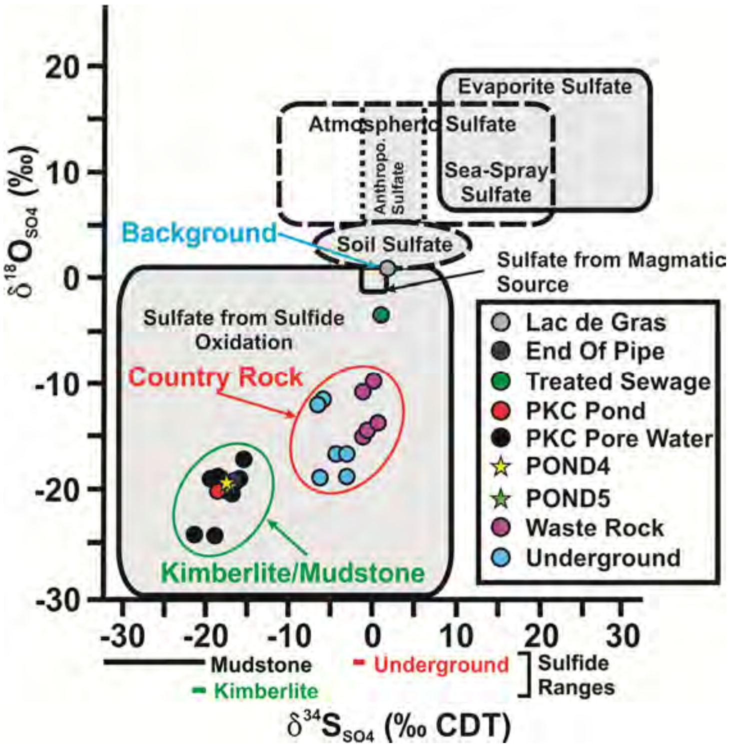


Figure 5: Plot showing distribution of δ^{34}S values versus δ^{18}O-SO_4 for different water-types at DDMI. Lines below the plot represent the range of δ^{34}S measured from sulfide minerals in the specific rock-type. CDT: Cañon Diablo Triolite.

The highest concentration of dissolved SO_4 was in the unsaturated FPK (Figure 6). The PKC Pond, EOP, submerged (Barge) and saturated FPK all had similar dissolved SO_4 concentrations. Pond 4 and 5 interception wells had slightly higher dissolved SO_4 concentrations then the PKC Pond likely due to an addition SO_4 input from interaction with the waste rock, consistent with δ^{34}S results. The lowest dissolved SO_4 concentrations were observed in Lac de Gras and the treated sewage.

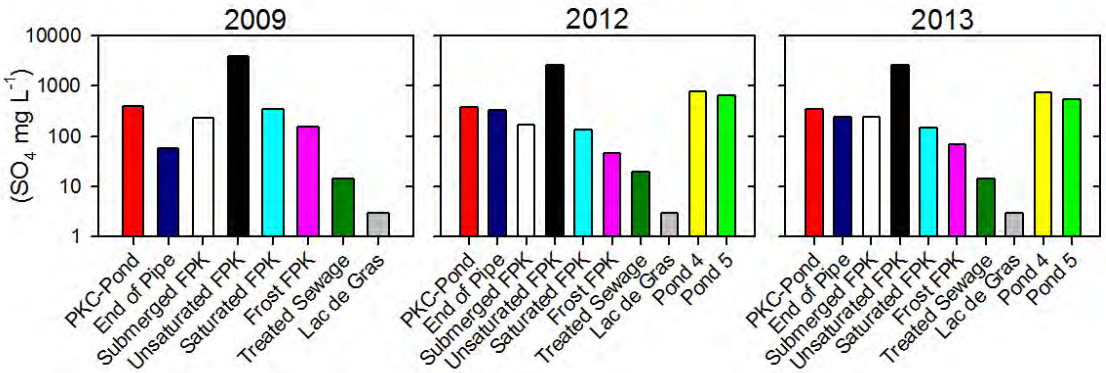


Figure 6: Concentrations of sulfate in various water types at DDMI during 2009, 2012 and 2013.

Microprobe analyses of pyrite from the East Beach FPK (Paktunc and Thibault, 2010) found that the massive pyrite was close to pure FeS_2 end-members, whereas the framboidal pyrite often contained variable concentrations of Mn, Ni, Cu, and As (Table 3). Pyrite can commonly contain other trace elements such as Co, Ni, Zn, Se, and Pb (Deditius et al., 2011). Oxidation of framboidal pyrite in the FPK is likely the main contributor of the low As, Cu, Se and Mn concentrations observed in the PKC Pond water (Figure 7). During microprobe analyses, concentrations of As and Cu were not detected in any other mineral phases (Paktunc and Thibault, 2010).

Table 3: Representative analyses of massive and framboidal pyrite, revised after Paktunc and Thibault (2010).

Element	Massive Pyrite (wt.%)	Framboidal Pyrite (wt.%)
Fe	47	44
S	53.8	52.5
Mn	0.0	1.0
Ni	0.0	0.4
Cu	0.0	0.3
As	0.0	0.1

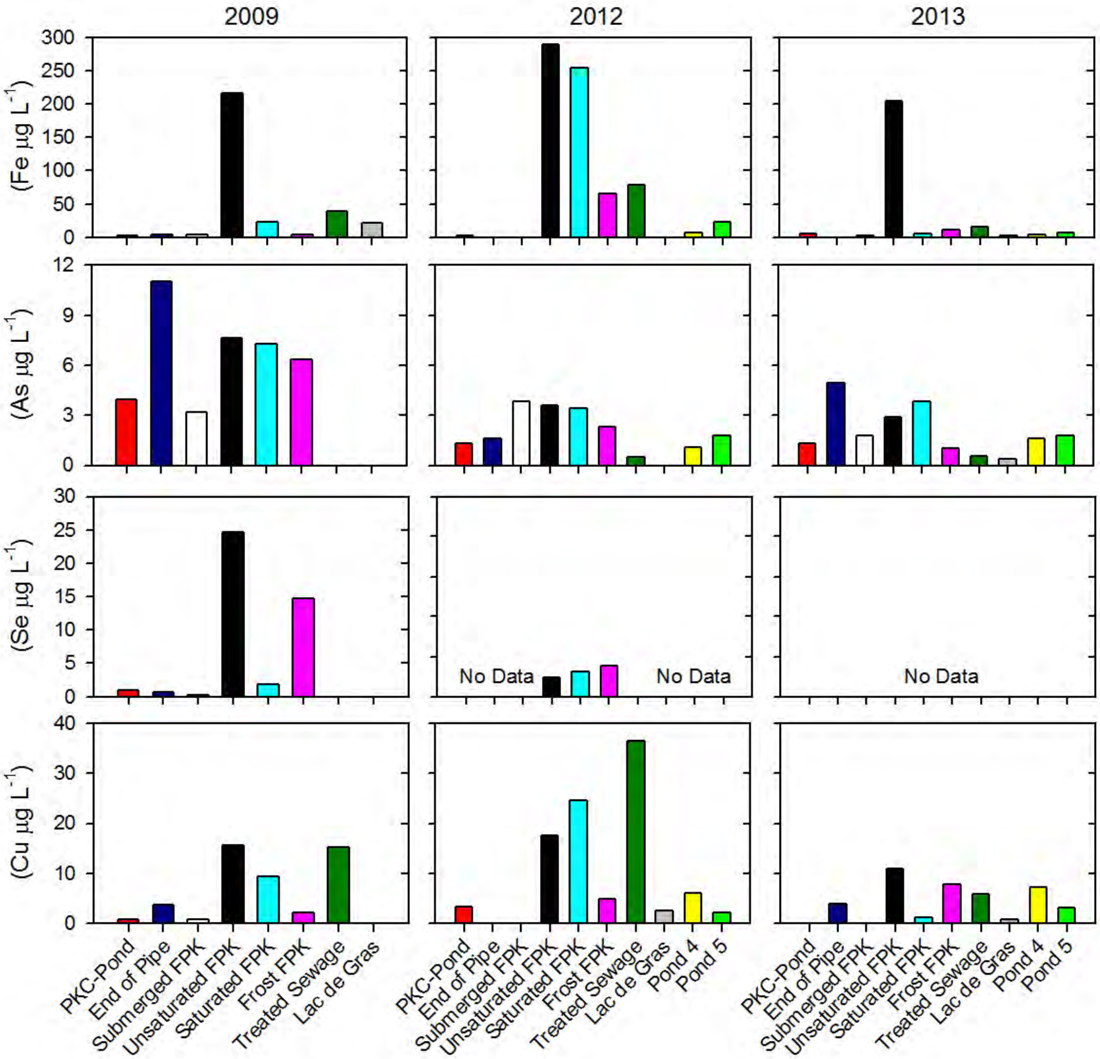


Figure 7: Concentrations of Fe, As, Se and Cu in various water types at DDMI during 2009, 2012 and 2013.

Dissolved Ni and Co concentrations in the kimberlite were greater relative to other rock types at DDMI (Figure 8), with similar concentrations to those from other diamond mines (Smith et al., 1985; Mitchel, 1986). Solid-phase concentrations of Ni and Co group in a distinct cluster relative to mudstones and country rock. Within the FPK, the principal source of Ni and Co is olivine (Jambor, 2007; Paktunc and Thibault, 2010) (Table 4). FPK samples collected from the saturated zone of the East Beach exhibited olivine with pristine grain boundaries, however, samples collected from the unsaturated zone near surface contained altered olivine grain boundaries showing partial dissolution (Figure 9). Olivine contained high concentrations of Ni ranging from 1800 to 4300 ppm (Paktunc and Thibault, 2010). The dissolution of olivine would release Ni and Co to the pore water. Figure 10 shows that the highest concentration of dissolved Ni and Co was found in the unsaturated FPK.

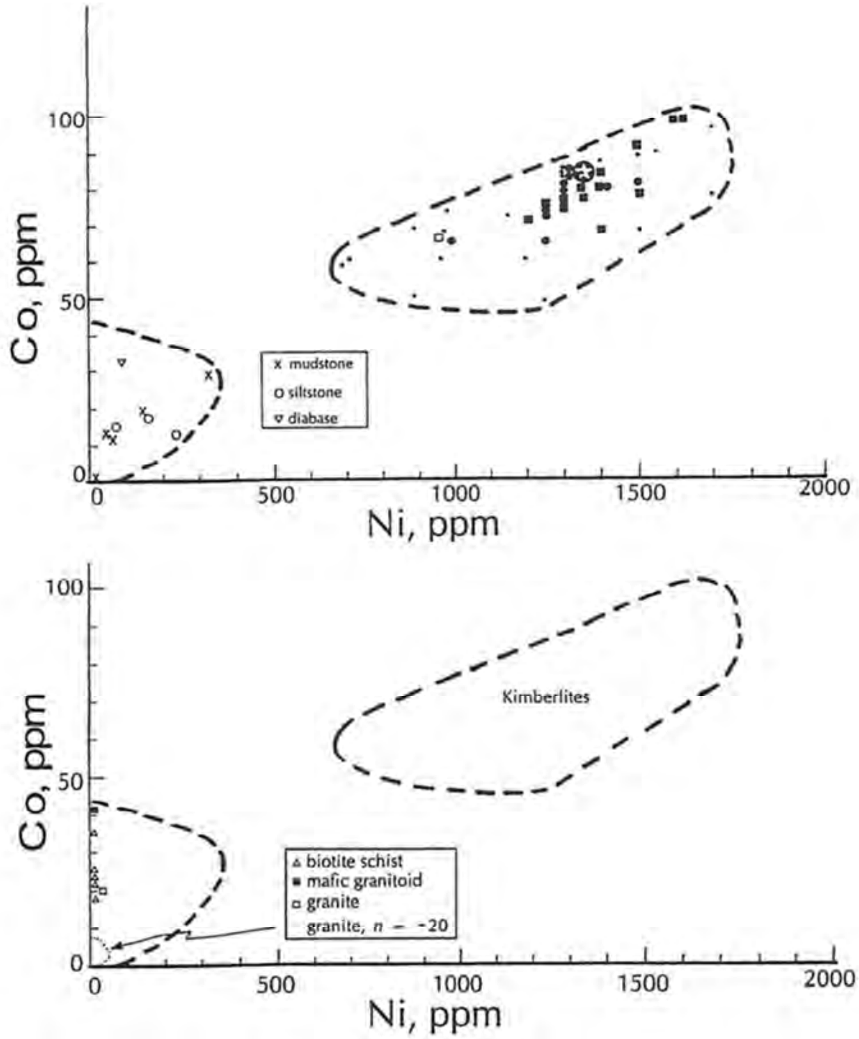


Figure 8: Plots of Ni versus Co concentrations form from whole-rock analyses of different rock types from Diavik, including kimberlite, mudstone, and the country rock (revised after Jambor, 1997). In the upper diagram, the open square inside the field for kimberlite represents the average concentrations for kimberlite according to Mitchel (1986). And the star symbol is the average for 10 southern African kimberlites from Smith et al. (1985).

Table 4: Representative analyses of olivine, chromite and pyrope, revised after Paktunc and Thibault (2010).

Element	Olivine (wt.%)	Chromite (wt.%)	Pyrope (wt.%)
SiO_2	41.09	0.13	41.73
Mg	50.67	15.29	19.94
Ca	0.04	0.03	5.25
Al	0.00	9.44	19.81
Fe	8.15	20.29	7.57
Ni	0.37	0.11	0.00
Cr	0.00	52.88	5.07

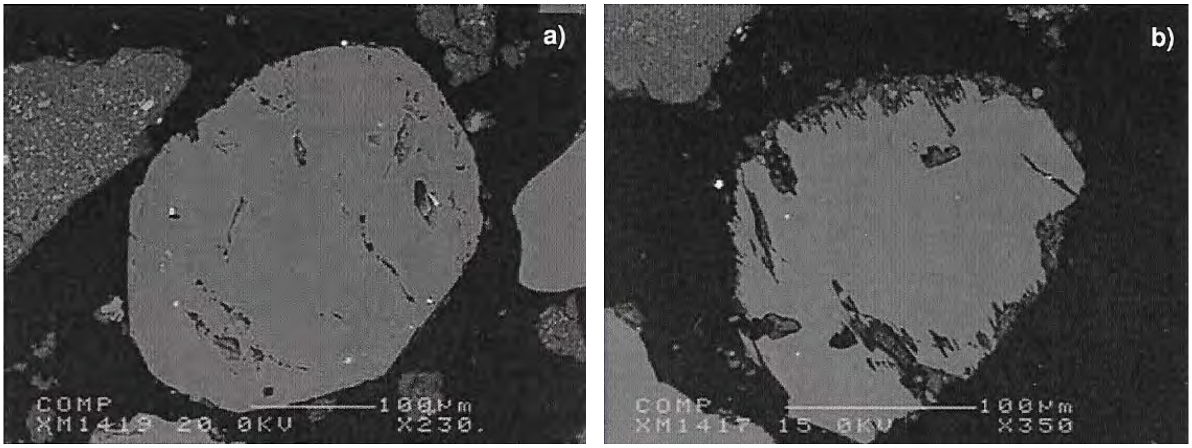


Figure 9: BSE images from the FPK showing (a) free olivine grain with white euhedral chromite inclusions, (b) olivine grain showing partial dissolution features due to weathering (after Paktunc and Thibault, 2010).

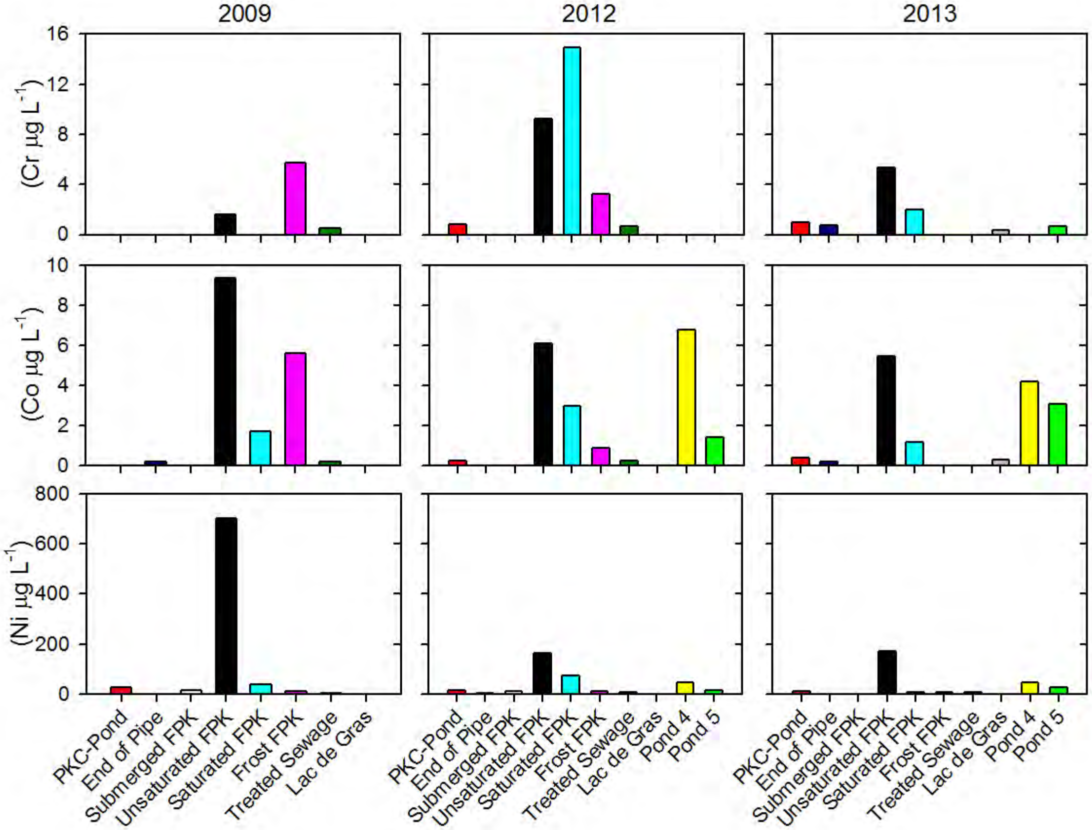


Figure 10: Concentrations of Cr, Co and Ni in various water types during 2009, 2012 and 2013.

The main sources of Cr in the FPK are spinel, Cr-pyrope, and inclusions of chromite hosted in olivine (Paktunc and Thibault, 2010) (Table 4; Figures 9 and 11). The highest concentration of dissolved Cr was observed in the FPK pore water, however concentrations in the PKC Pond were minimal (Figure 10).

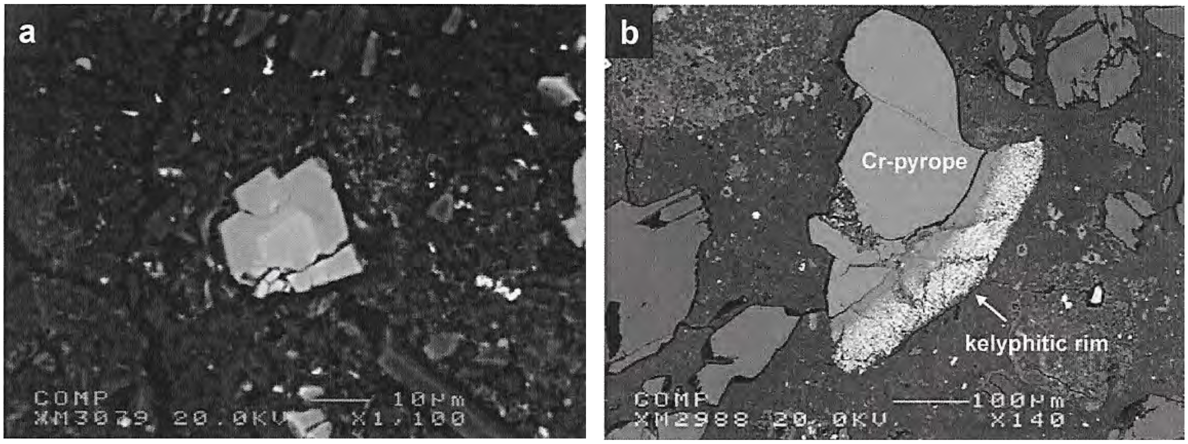


Figure 11: BSE images from the PK showing (a) zoned spinel grain with a chromite core and a titanian spinel rim, (b) Cr-pyrope grain with kelyphitic rim consisting of a phlogopite and spinel intergrowth (after Paktunc and Thibault, 2010).

The highest concentration of dissolved Fe was observed in the FPK pore water (Figure 7). The primary source of Fe in the FPK is from pyrite oxidation, although the dissolution of olivine, pyrope, chromite and biotite (20.5 wt.% Fe) could contribute to dissolved Fe concentrations (Tables 3 and 4). Concentration of dissolved Fe in the PKC Pond were low, typically <5 µg/L. The near neutral pH and oxic conditions in the PKC Pond would cause dissolved Fe to precipitate out of solution. Speciation modeling by Moncur et al. (2011) and Moncur and Smith (2014) found that most pore water and surface waters in the PKC Facility were saturated or supersaturated with respect to Fe oxyhydroxide mineral phases.

Although some elevated concentrations of As, Se, Cu, Ni, Co, Cr, Fe were observed in the FPK pore water, dissolved concentrations of these metal(oid)s remained low or near/below detection in the PKC Pond water, likely due to dilution and sorption.

PKC Pond waters contained some dissolved concentrations of U, however porewater from the FPK and EOP rarely contained U concentrations above analytical detection limits. In contrast, Pond 4 and 5 interception wells contained elevated dissolved U concentrations ranging from 28 to 279 µg/L (Figure 12). The primary source of U to the Pond waters would be interaction with the waste rock during seepage. Effluent from the waste rock Test Pile contained effluent with dissolved U concentrations similar to those observed in Ponds 4 and 5 interception wells.

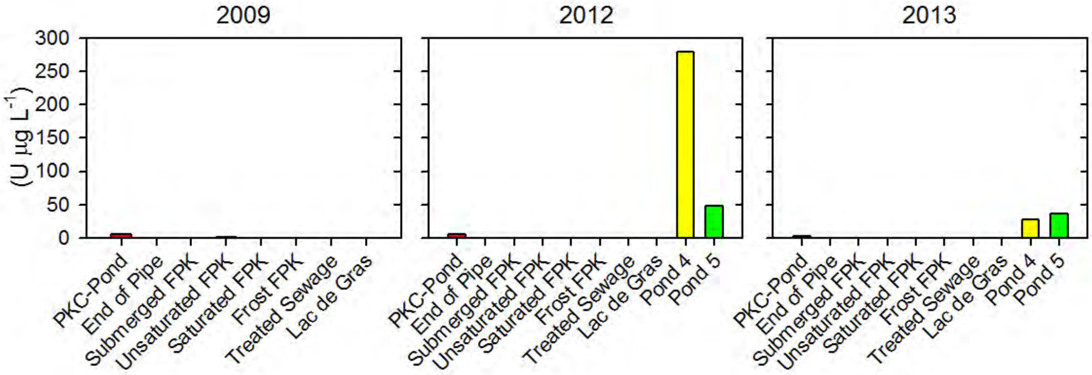


Figure 12: Concentrations of U in various water types during 2009, 2012 and 2013.

4.2.2. Molybdenum

Molybdenum concentrations and isotopic compositions ($\delta^{98/95}$Mo) were determined for the PKC Pond, its inflow waters, FPK porewater, effluent from waste rock piles, Lac de Gras and Ponds 4 and 5 interception wells (Table 5). In addition, a solid-phase sample of kimberlite was analyzed by total acid digestion to obtain a $\delta^{98/95}$Mo signature that can be compared with water samples taken underground adjacent to kimberlite pipes A154 and A418. Molybdenum isotope analysis is a very recent development and may be used to help identify Mo sources and processes controlling Mo concentrations. The $\delta^{98/95}$ Mo values in water are affected by absorption and biological processes.

Table 5: Molybdenum concentrations and $\delta^{98/95}$Mo compositions of the water and solid phase samples.

Location	**Mo (µg/L)**	**$\delta^{98/95}$Mo (‰)**
End of Pipe	260	0.00
Treated Sewage	3	0.59
PKC Pond	426	-0.11
FPK Porewater (PKC1-M)	442	-1.13
Barge porewater (Barge-45)	250	0.00
Waste rock (1BXXdrn13)	6	0.79
Waste rock (3BSXdrn15)	28	0.68
Lake de Gras	0.60	0.07
Pond 4	350	0.57
Pond 5	370	0.84
Kimberlite	n/a	-1.97
A154 underground (A154-U39)	39	0.12
A418 underground (A418-U40)	31	-0.68
A154 underground (A154-U65)	18	-0.03
A154 underground (A154-U24)	9	0.17
A418 underground (A418-9150 inflow)	35	-0.90

Molybdenum concentrations in water sample from Lac de Gras are low (0.60 µg/L) with a $\delta^{98/95}$Mo signature of 0.07‰ (Figure 13). The Lac de Gras $\delta^{98/95}$Mo signature is slightly more negative than the range of published values for lakes (0.78‰ – 2.82‰; Dahl et al., 2010) but within the range reported for rivers (-0.13‰ – 2.40‰; Voegelin et al., 2012; Archer and Vance, 2008; Pearce et al., 2010; Scheiderich et al., 2010; Neubert et al., 2011).

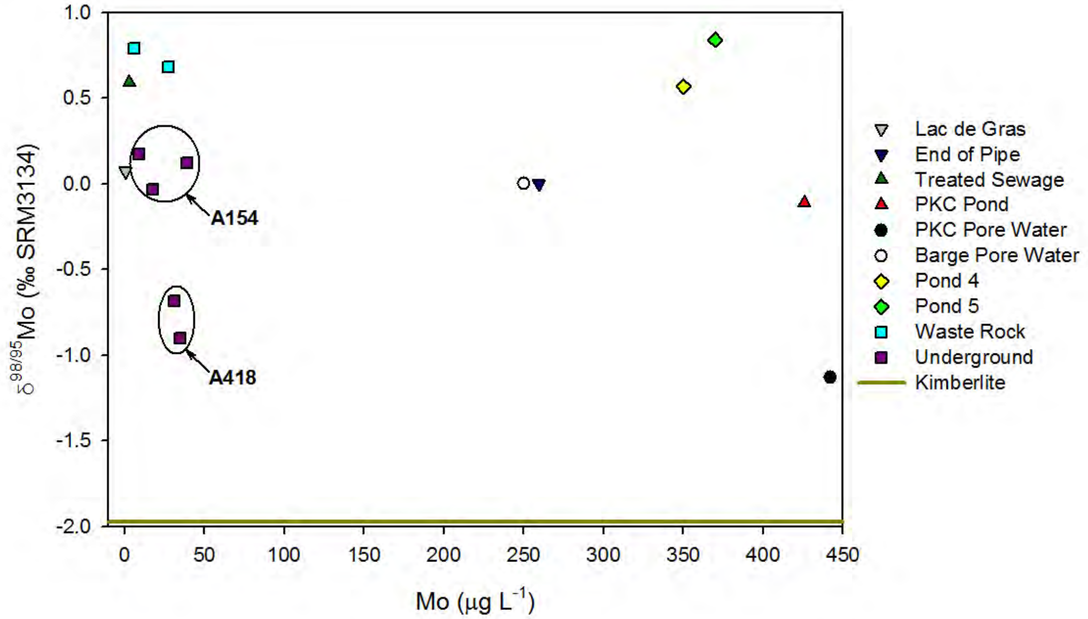


Figure 13: Cross-plot of molybdenum concentrations and $\delta^{98/95}$Mo compositions of the analyzed natural and process-affected samples.

Seepage from drill holes in the A154 and A418 underground have slightly elevated Mo concentrations compared to Lac de Gras (average values of 22 µg/L and 33 µg/L respectively). The seepage samples cluster in groups by pipe indicating that there may be different processes affecting the $\delta^{98/95}$Mo signatures of each pipe. Samples from A154 had a $\delta^{98/95}$Mo signature (average value of 0.09‰) similar to Lac de Gras, suggesting infiltration of lake water into the pipe. A418 samples had higher Mo concentrations and more negative signatures relative to the lake water (average value of -0.79‰) suggesting some of the Mo may have originated from interactions with kimberlite (-1.97‰). Although the differences are likely due to different degrees of dilution from lake water, other processes that may affect the $\delta^{98/95}$Mo signatures of the A154 and A418 underground seepage are adsorption, precipitation and/or biological cycling.

The effluent from the waste rock piles had low Mo concentrations (average value of 17 µg/L) suggesting that waste rock weathering is not a significant source of Mo to the PKC Pond. The $\delta^{98/95}$Mo signature of waste rock is more positive (0.74‰) than the other water samples and the kimberlite. This suggests that $\delta^{98/95}$Mo isotopic signatures may be useful in differentiating waters that have interacted with waste rock from those that have been in contact with kimberlite.

The PKC pond free-water sample had higher Mo concentrations (426 µg/L) compared with most other samples. The $\delta^{98/95}$Mo signature of the PKC pond is slightly depleted relative to Lac de Gras. This slightly depleted signature of PKC pond water was likely derived by interactions with FPK. The FPK porewater sample collected from the unsaturated zone on the East Beach is the only sample with a higher Mo concentration than the PKC pond free-water (442 µg/L). This sample also had a more negative $\delta^{98/95}$Mo signature (-1.13‰) resembling the kimberlite isotopic signature.

The samples collected from the end of pipe and from the saturated porewater from the tailings pond sediments near the barge show very similar Mo concentrations and isotopic compositions. The concentrations of the end of pipe and barge porewater samples have lower concentrations of Mo than the PKC pond free-water (260 µg/L and 250 µg/L respectively) but the $\delta^{98/95}$Mo signatures are only very slightly enriched relative to the PKC pond (0.00‰ for both samples). Molybdenum concentrations in porewater and end of pipe tailings may be lower than in the free-water zone due to contact with mineral surfaces to which Mo can become adsorbed (Barling et al., 2001, Siebert et al., 2003, Kashiwabara et al., 2009). The degree of fractionation associated with adsorption of Mo to mineral surfaces depends on the mineral phase (Goldberg et al., 2009).

Water samples collected from interception wells at Pond 4 and Pond 5 had Mo concentrations lower than the PKC Pond free water but not as low as the end of pipe and barge porewater samples. The isotopic signatures of Pond 4 and Pond 5 are similar to each other (0.57‰ and 0.84‰ respectively) and also resemble that of the waste rock porewater samples suggesting possible interaction with waste rock during seepage from the PKC Pond.

The concentrations of Mo in the PKC Pond over the 2009 to 2013 period appear to show a slightly decreasing trend over time (Figure 14). A corresponding decrease is observed in the FPK porewater sampled from the unsaturated zone on the East Beach and the FPK porewater sampled from the saturated zone also on the East Beach. Samples from the end of pipe and from the submerged FPK, representing porewater samples collected from sediments near the Barge, do not have clear concentration trends over time. Lac de Gras consistently had low Mo concentrations over the 2009 to 2013 period, as does treated sewage, suggesting that the Mo in the PKC pond does not originate from sewage. Molybdenum concentrations in Pond 4 and Pond 5 interception wells appear to be fairly constant over the 2012 to 2013 period.

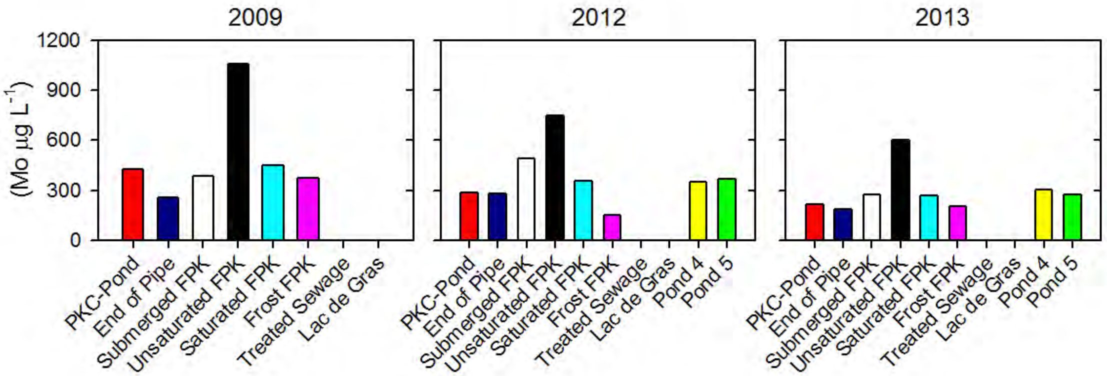


Figure 14: Concentrations of molybdenum in various water types at DDMI during 2009, 2012 and 2013.

4.2.3 Boron

Boron concentrations and isotopic signatures (δ^{11}B) were determined for the PKC Pond water, inflow waters, and from porewater, effluent and seepage samples can be used to characterize weathering products of FPK or kimberlite material (Table 6; Figure 15). δ^{11}B is an emerging stable isotope tracer that has been used to identify water-rock interactions (Gonfiantini and Pennisi, 2006), tracing anthropogenic (i.e. sewage, landfill leachate; Barth, 1998) and natural sources of B.

The highest B concentrations were measured in the effluent from the waste rock piles (average value of 216 µg/L) (Table 6). All other water samples had low B concentrations (range of 3-50 µg/L). The B concentrations in porewater and underground seepage samples were lower than the waste rock effluent but higher than the other water samples (range of 27-145 µg/L). Acid digestion of the kimberlite sample found significant concentrations of B in the rock material, suggesting that water-rock interaction with kimberlite and waste rock can release B to porewater. Unfortunately, reliable δ^{11}B signatures were not obtained for the Lac de Gras or underground seep samples due to high analytical uncertainty for these samples. As a result, at this time we were unable to compare the δ^{11}B composition of the PKC Pond water with these potential sources.

Table 6: Boron concentrations and $\delta^{11}B$ compositions of the analyzed natural and process-affected samples.

Location	B (µg/L)	$\delta^{11}B$ (‰)
End of Pipe	145	4.4
Treated Sewage	75	5.4
PKC Pond	85	6.3
FPK Porewater (PKC1-S)	29	4.8
Barge porewater (Barge-25)	105	7.2
Barge porewater (Barge-65)	129.4	8.6
Waste rock (1BXXdrn13)	192	10.3
Waste rock (3BSXXdrn15)	240	9.9
Lake de Gras	3	n/a
Pond 4	41	n/a
Pond 5	27	n/a
Kimberlite	547	n/a
Pit 154 (A154-U39)	50	n/a
Pit 418 (A418-U40)	37	n/a
Pit 154 (A154-U65)	50	n/a
Pit 154 (A154-U24)	29	n/a

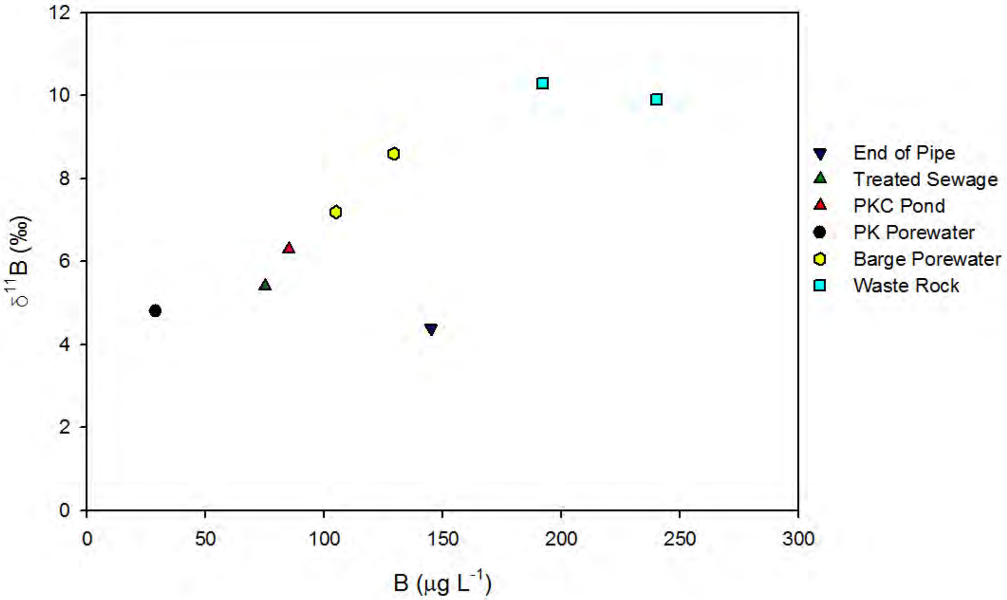


Figure 15: Cross-plot of boron concentrations and $\delta^{11}B$ compositions of the analyzed natural and process-affected samples.

Given the analytical uncertainty for $\delta^{11}B$ analysis (±2‰) there is not a very large range in samples despite a large range in B concentrations (Figure 15). The PKC pond had a B concentration of 85 µg/L and an isotopic composition of 6.3‰. The porewater in saturated sediments near the barge had higher concentrations of B (average value of 117 µg/L) and slightly more positive δ^{11}B signatures (average value of 7.9‰) than the overlying PKC Pond water. The end of pipe sample had a higher B concentration (145 µg/L) and more negative δ^{11}B signature (4.4‰) than the PKC Pond, FPK porewater or waste rock effluent. The concentration and δ^{11}B values for the PKC Pond could indicate addition of B from the barge porewater or weathering of waste rock. Additional δ^{11}B data for background surface waters (e.g. Lac de Gras) and kimberlite (solid phase) would be needed to evaluate their relative contribution.

The FPK porewater has lower B concentrations (29 µg/L) and more negative δ^{11}B (4.8‰) values than the PKC Pond. The lower B concentration in the FPK porewater could indicate a process removing boron (e.g. adsorption to mineral surfaces), or dilution by runoff/precipitation and/or nearby discharge of treated sewage (Figure 15).

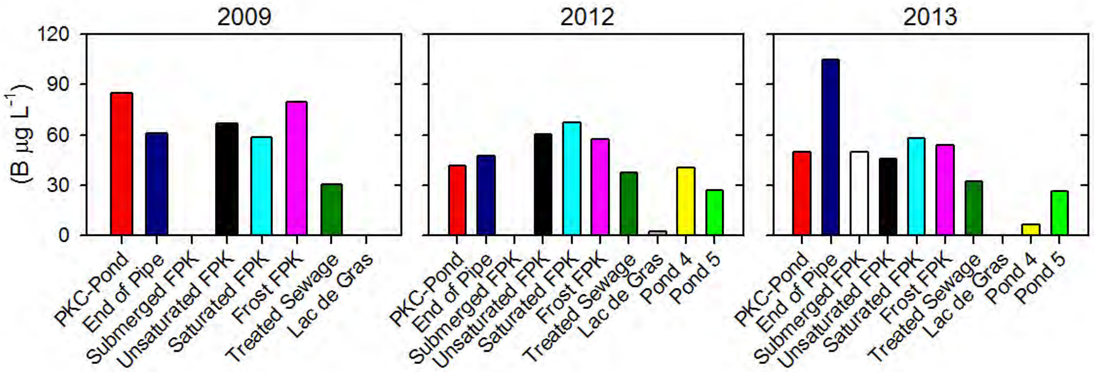


Figure 16: Concentrations of boron in various water types at DDMI during 2009, 2012 and 2013.

There do not appear to be any clear trends of increasing or decreasing B concentrations in any of the potential source waters throughout the 2009 to 2013 period (Figure 16). The time-series data does show the concentrations in the PKC Pond and source waters contributions, particularly the end of pipe samples, varied greatly. In general, B concentrations in treated sewage are consistently lower than those in the PKC Pond or porewater samples suggesting that this is probably not a significant source of B to the pond. The potential sources with B concentrations similar or greater than the PKC Pond are those where water-rock interaction with kimberlite or waste rock occur, and these are the most likely contributors of B to the pond.

4.2.4 Nitrogen

Nitrogen isotopes are a useful indicator of water source and biogeochemical processes. Potential sources of N at the mine site include wastewater disposal and explosives (Bailey et al., 2013).

Treated sewage sample had $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ signatures that plot near the range expected for sewage and manure (7.2‰ and 0.9‰ for $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ respectively) (Mayer, 2005) (Figure 17).

Samples of explosives used at Diavik are within typical ranges for fertilizers and explosives ($\delta^{15}N$ =0‰).

The $\delta^{15}N$ and $\delta^{18}O$ of nitrate measured in the PKC Pond are similar to the porewater samples from the barge areas (B-25 and B-65). Many of the other potential source waters plot along a mixing line between sewage and Diavik explosives. The underground seep samples from near the kimberlite pipes also indicate some influence from explosives (9.7‰ and 10.8‰ for $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ respectively at A154 and average values of 12.1‰ and 32.2‰ for $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ respectively at A418). The sample with the $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ signature most like explosives is the end of pipe sample (6.0‰ and 22.2‰ for $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ respectively). This would be expected because this sample is less influenced by other $\delta^{15}N$ and $\delta^{18}O\text{-}NO_3$ sources, such as those originating from treated sewage. The waste rock porewater samples show $\delta^{15}N$ signatures similar to explosives (average value of 3.375‰) but $\delta^{18}O\text{-}NO_3$ values that are depleted relative to the signature of Diavik explosives (average value of 8.9‰) indicating possible biogeochemical processes, such as nitrification.

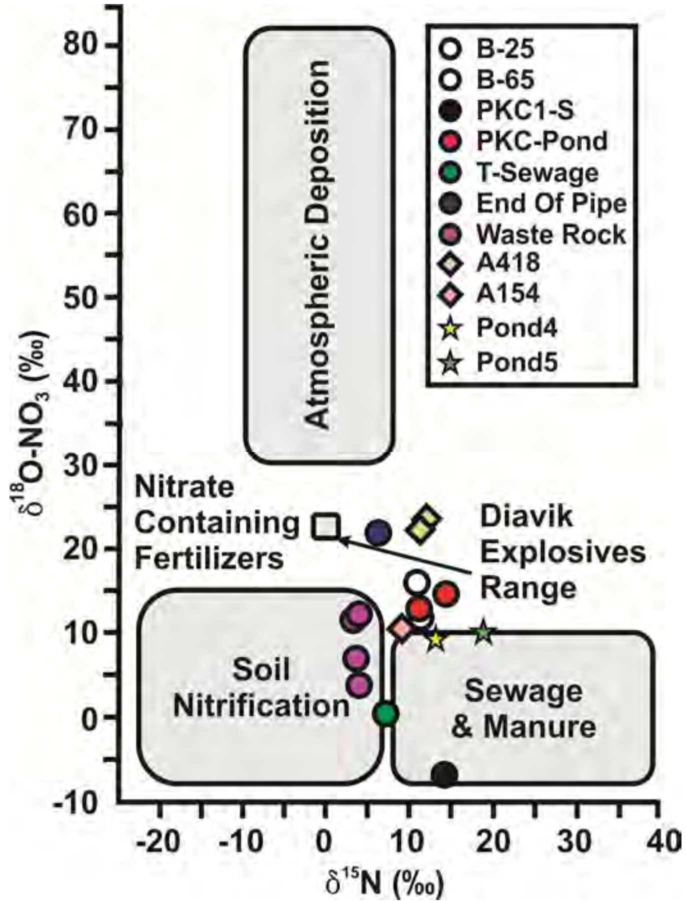


Figure 17: Cross-plot of δ^{15}N and δ^{18}O-NO_3 compositions of the analyzed natural and process-affected samples. B-25 and B-65 are porewater samples from the barge area. A418 and A154 are underground seepage from near the kimberlite pipes.

FPK porewater (PKC1-S) has a δ^{15}N composition within the range of the other samples (14.0‰) but a δ^{18}O-NO_3 composition that is very depleted relative to the other samples analyzed (-26.0‰). The reason for the depleted δ^{18}O-NO_3 signature of the FPK porewater sample remains unclear however processes such as nitrification in the oxygen-rich unsaturated zone may provide possible explanations.

Over the 2009 and 2013 monitoring period there were minimal variations in the concentration of NO_3 in treated sewage (Figure 18). In contrast, the NO_3 concentrations in the PKC pond and at the end of pipe have increased consistently over time. The NO_3 concentrations in the PKC pond, end of pipe and Pond 4 and Pond 5 samples are elevated relative to the treated sewage indicating that sewage alone cannot account for the NO_3 loading to the pond. The isotope labelling suggest the main sources of NO_3 in the PKC pond are a mixture of NO_3 originating from explosives used on-site and NO_3 from sewage. Recycling of pond water has caused this increase to be observed at the end of pipe. NO_3 concentrations in Pond 4 and Pond 5 also appear to be increasing slightly over time, corresponding to the increase at the PKC pond.

The unsaturated FPK porewater shows variations in NO_3 concentration over time, possibly related to changes in the location of treated sewage discharge relative to the sampling location.

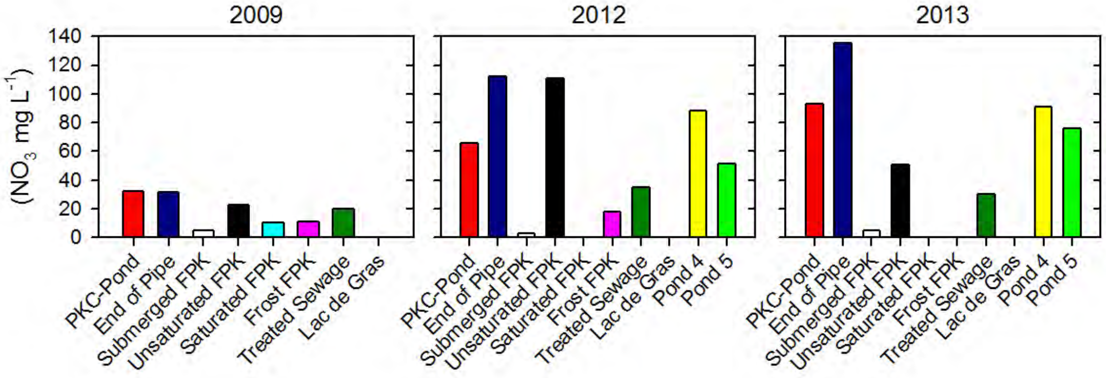


Figure 18: Concentrations of NO_3 in various water types at DDMI during 2009, 2012 and 2013.

4.3 Water Isotopes – $\delta^{18}O$ and δ^2H

The stable water isotopes can be used to identify different sources of water, or differences in the degree of evaporative enrichment. Stable isotopes of $\delta^{18}O$ and δ^2H measured in water collected from the PKC Pond and groundwater collected from piezometers installed in the East Beach and Barge sites show systematic differences in the stable water isotope labeling of groundwaters and surface waters in the vicinity of the PKC pond (Figure 19). The global meteoric water line (GMWL; Craig 1961) and a local meteoric water line (LMWL) from Snare Rapids (based on data from 1997-2007) located 300 km west of Diavik (63.52°N, 116.00°W, 241 masl) (Canadian Network for Isotopes in Precipitation Station, 2007) are included for comparison. Local precipitation will plot along the LMWL and groundwater will typically have an oxygen and hydrogen signature similar to the weighted mean average of precipitation; here about -20 ‰ in oxygen. Surface water having undergone evaporation typically plots along a Local Evaporation Line (LEL) with a lower slope than the LMWL.

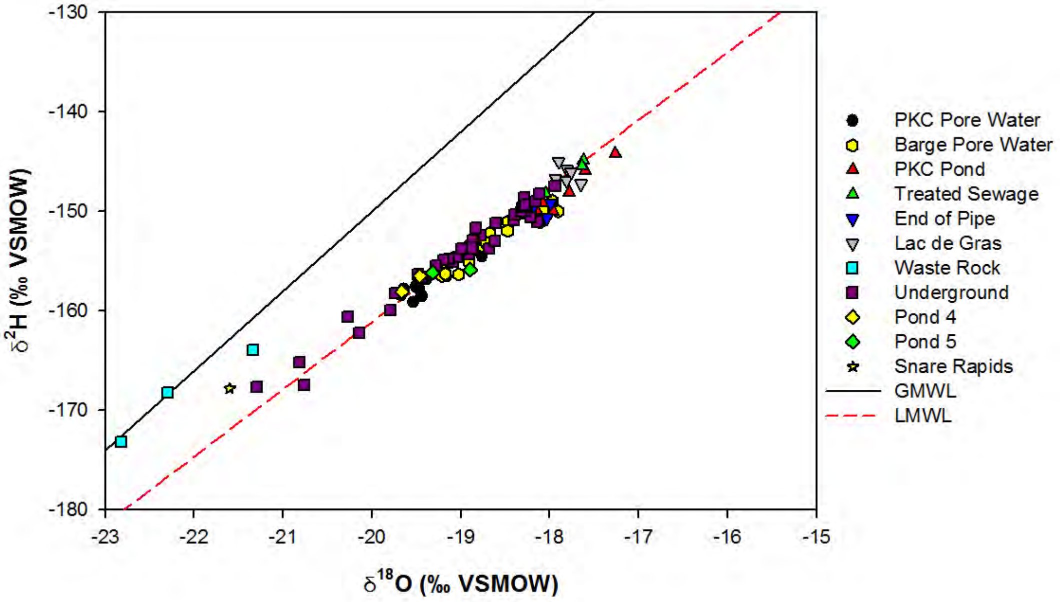


Figure 19: Plot showing stable isotopes δ^{18}O versus δ^{2}H of groundwater collected from different water types at DDMI. GMWL: Global Meteoric Waterline; LMWL: Local Meteoric Water Line; VSMOW: Vienna Standard Mean Ocean Water.

Most of the water samples plot along the LMWL indicating little evaporative enrichment. The PKC piezometers are the most negative with values close to what would be expected for local groundwater. The barge wells are more positive, possibly indicating mixing between local groundwater and the overlying PKC Pond water. Water that has undergone evaporation will start to plot below the LMWL along a LEL. The more evaporated the water, the farther along the line (more to the upper right) the water will plot. The only samples that show much evaporative enrichment are from the PKC pond. The surface water samples from the PKC Pond just below the LMWL, along a LEL with a high slope, which is typical of high latitude regions (Gibson et al., 2005). The intercept of the LEL with the LMWL is indicative of the composition of the inflow water. The PKC pond evaporation line intercepts with the LMWL at about -18 ‰ similar to the end of pipe and barge wells.

Mixing of surface waters and groundwaters is indicated by the intermediate δ^{18}O and δ^{2}H composition found in some of the Barge PKC well samples. For example, Sample Barge-10, collected 1.2 m below the PKC Pond bottom, plots adjacent to the pond water indicating that this porewater is being actively exchanged with the overlying pond. Sample Barge-25, Barge-65 and PKC3-d all plot between the groundwater and surface water clusters suggesting that water from these piezometers is a mixture of pond water and deeper groundwater, the latter having an isotopic composition falling on a mixing line between pond water and mean annual precipitation at Snare Rapids (δ^{18}O=-21.6‰, δ^{2}H=-167.8‰) (star symbol on Figure 19).

The waste rock effluent samples are distinct from the others, and plot along the GMWL (Figure 19). These samples were sampled in the summer, but their very negative δ^{18}O and

δ^2H signatures and higher deuterium-excess (plotting above the LMWL) are consistent with recharge from snow.

5.0 CONCLUSIONS

The following conclusions were made:

- Since 2009, dissolved concentration of major cations, SO_4, Cl, Ni and electrical conductivity have continued to increase in the PKC Pond water.
- Dissolved concentrations of Se, U, Mo, Zn and Cd also continue to increase in in the PKC Pond water but all show a short-term decrease in 2011.
- Boron concentrations decrease in 2011 but it appears to be due to analytical uncertainties.
- The time-series data show large variations in the concentrations of some ions in the various inflows to the PKC pond. This indicates that loading to the pond has strong temporal variations related to changes in onsite activities. In particular, there were large variations in the concentrations of different parameters in the end-of-pipe samples and the unsaturated zone porewater samples.
- Within the FPK redox values are oxidizing in the unsaturated zone and become progressively more reduced with depth into the frost zone. The average dissolved concentration of SO_4, most major cations and metals decreased by almost an order of magnitude from the unsaturated zone to the saturated zone. The concentrations of dissolved ions were also lower in the frost zone than in the saturated zone. Porewater samples collected from the Barge piezometers, installed below the ponded water, have water concentrations similar to the frost zone.
- The lower concentrations observed in the frost zone may be due to freeze-out processes. At the Barge location, ponded PKC water overlying the FPK acts as an oxygen barrier resulting in low dissolved ion concentrations in the porewaters. The subaqueous disposal and freezing of the FPK material limits the ingress of atmospheric O_2 subsequently limiting the release of dissolved concentrations of metals and SO_4 to the adjacent porewater.
- The principal source of dissolved SO_4 in the PKC Pond water is from the oxidation of pyrite that is incorporated in mudstone xenoliths within the kimberlite
- The Precambrian waste rock and FPK have distinct δ^{34}S isotopic signatures. Effluent from the FPK has a δ^{34}S value of approximately -17 ‰ and the waste rock effluent has a value of approximately -5 ‰. At the DDMI mine site, the application of stable sulfur isotopes can identify the source of SO_4 in waters and determine mixing between SO_4 derived from FPK and waste rock.
- Oxidation of framboidal pyrite in the FPK is the main contributor of the low As, Cu, Se and Mn concentrations observed in the PKC Pond water

- Olivine dissolution releases dissolved Ni and Co to the FPK pore water, with the highest concentration was found in the unsaturated FPK.
- The main sources of Cr in the FPK are spinel, Cr-pyrope, and inclusions of chromite inclusion hosted in olivine.
- The primary source of Fe in the FPK is from pyrite oxidation, with some release from the dissolution of olivine, pyrope, chromite and biotite.
- Kimberlite and mudstone are not a major source of dissolved U to the PKC Pond. The primary source of U to the PKC Pond waters is the interaction of pond seepage water with waste rock that is pumped back into the PKC Pond.
- The effluent from the waste rock piles had low molybdenum concentrations (average value of 17 µg/L) indicating that weathering of the FPK is the primary source of Mo to the PKC Pond.
- The $\delta^{98/95}$Mo signature of waste rock effluent is more positive than PKC Pond water and kimberlite, suggesting that $\delta^{98/95}$Mo isotopic signatures would be useful in differentiating waters that have interacted with waste rock from those that have been in contact with kimberlite.
- Isotope labelling of NO_3 in the PKC pond are a mixture of NO_3 originating from explosives used on-site and NO_3 from sewage. Recycling of pond water has likely caused an increase of NO_3 from the EOP. Nitrate concentrations in Pond 4 and Pond 5 also appear to be increasing slightly over time, corresponding to the increase at the PKC pond.
- Despite these variations in PKC Pond chemistry, the geochemical composition and isotopic labelling of the PKC Pond water indicate that many of the increasing trends in ions are consistent with weathering of FPK.

6.0 CLOSURE

Alberta Innovates-Technology Futures and Lianna Smith Consulting are pleased to present the findings of this investigation into the source of Dissolved Ions to the Processed Kimberlite Containment Facility at Diavik Diamond Mines Inc. We look forward to any comments regarding this report and future investigations. Constructive review of this report was provided by John Gibson.

Sincerely,

Michael Moncur, M.Sc., Research Hydrogeologist	S. Jean Birks, PhD. Research Hydrogeologist
Lianna Smith, M.Sc., P.Geol. Research Hydrogeochemist	Emily Taylor, M.Sc., G.I.T. Research Hydrogeologist

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Appendix II-2

Technical Memorandum – CPK Tank Construction

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Technical Memorandum

To	Gord Macdonald
cc	
From	Lianna Smith (Lianna Smith Consulting)
Reference	CPK tank construction
Date	14 Jul 2015

1 Background

Processed kimberlite (PK) tank and laboratory experiments were initiated to evaluate the geochemical evolution of fine PK (FPK) exposed to ambient conditions. The objective of the program is to more confidently predict water quality within and/or discharging from the PKC post-closure.

In addition to FPK, coarse PK (CPK) is produced during ore processing. CPK consists of the >1mm fraction and is used for construction material within the PKC facility (e.g. liner cover), or is stockpiled within the PKC facility.

In 2012 four 5700 L tanks were filled with FPK and instrumented to provide detailed data about the geochemical evolution of FPK exposed to ambient conditions. On June 27, 2015, two 5700 L tanks were filled with CPK and instrumented data to provide detailed data about the evolution of CPK exposed to ambient conditions.

2 CPK tank construction and instrumentation

One partial load, approximately 50 tonnes, of CPK was delivered directly from the Process Plant to the tank experiment area on Friday June 26. The CPK appeared to have a fairly high granite component (~10%). In discussion with various Process Plant and Operations personnel, the granite content appears to be representative of recent years, and was attributed to country rock ravelling from the open pit/open sky onto the ore that is mined from underground.

The tanks are 1.7 m high and 2 m in diameter. Both tanks were filled with the CPK from the same delivery load to provide duplicate profiles. The same instruments were installed in the CPK tanks as in the FPK tanks: thermistors, gas sampling lines (for O_2 and CO_2), soil water solution samplers (SWSS), moisture content and electrical conductivity sensors (ECH$_2$O probes) and tensiometers. A drain at the bottom of each tank directs the drainage water to a sample cell for geochemical sampling and a tipping bucket for continuous flow measurements. The instrument distribution was the same as for FPK tanks, with the exceptions of the ECH2O probes, which were co-located with the SWSS in the CPK tanks based on the expectation that the CPK will more readily drain. A slurry of silica flour was installed around the

SWSS in the CPK tanks to provide good contact between the ceramic cup and the CPK. A silica flour slurry was not necessary for the FPK tanks because the FPK contained sufficient fine-grained material for hydraulic connection between the SWSS and the FPK.

Figure 1a illustrates the as-built instrument distributions for the two CPK tanks, and Figure 1b illustrates the as-built instrument distributions for the three FPK tanks with water tables at 1.7 m depth.

The CPK was placed in the tanks by a loader in lifts of approximately 25 cm. The instruments were placed by hand at each lift and leads were secured to a central pipe. The central pipe was back-filled with CPK after construction. Photos of the CPK tank instrument installation is provided in Figures 2-6.

3 CPK tank sampling and monitoring

Sampling and monitoring the CPK tanks will follow the same schedule as the FPK tanks, and will be performed by the Environment Technicians. The Test Pile researchers have provided additional assistance.

4 Laboratory static and kinetic testing and mineralogical analysis

CPK (“CPK1”) from the same load that was used to fill the tanks was sent to SGS Burnaby for static and kinetic testing, per PO#K37173. Additional CPK (“CPKS”) was collected from the liner cover on the south cell of the PKC. CPKS was collected to compare CPK collected at different times (i.e. processed from different parts of the mine and exposed to ambient conditions for different amounts of time). Static tests will be conducted on both CPK1 and CPKS. Kinetic tests will be conducted on CPK1, and possibly CPKS, pending static test results.

Static testing will include: acid-base accounting, SO4-S, Sulfide-S, Carbonate neutralization potential, whole rock analysis (including metals), shake-flask extraction, surface area and grain size analyses. The kinetic tests will consist of standard humidity cell testing for up to 80 weeks. The humidity cell data will be reviewed regularly and terminated if release rates stablize prior to 80 weeks.

XRD analysis will be conducted collaboratively by CANMET and me. Additional particle analysis to determine the amount of granite may be conducted.

5 Outstanding items

On-going monitoring of the FPK tanks has identified issues with sample cell integrity and datalogger battery life. The sample cells are made of acrylic and all cells installed for the FPK tanks burst in the spring due to freeze/thaw cycles. Customized Savillex-brand PFA cells and/or Nalgene-brand HDPE cells are recommended to replace the acrylic cells for all tanks. Quotations for the customized cells have been requested but not yet received. The supplier 12V batteries did not hold charge, and appears to be a common issue with 12V batteries of that size. Marine-grade 12V batteries have been recommended to replace the supplier 12V batteries. An order request for the sample cells and batteries will be placed through David Wells.

Fig 1a. CPK as-built instrumentation

Gas lines	ECH2O	Tensio	SWSS	Therm
0.1				0
0.2	0.25	0.25	0.25	0.25
0.3				
0.4				
0.5	0.5	0.5	0.5	0.5
0.7		0.75		0.75
0.9				
	1.0	1.0	1.0	1.0
1.1				
1.3				1.25
1.5	1.5	1.5	1.5	1.5
				1.65
1.7	1.7		1.7	1.7

1.7 m = Bottom of tank

Fig 1b. FPK as-built instrumentation.

Gas lines	ECH2O	Tensio	SWSS	Therm
0.1				0
0.2	0.25	0.25	0.25	0.25
0.3				
0.4				
0.5	0.5	0.5	0.5	0.5
0.7	0.75	0.75		0.75
0.9				
	1.0	1.0	1.0	1.0
1.1				
1.3				1.25
1.5	1.5	1.5	1.5	1.5
				1.65
1.7			1.7	1.7

1.7 m = Bottom of tank

Fig. 2. CPK tanks before CPK and instrument installation

Fig. 3. Central pipe with gas lines and thermistors attached.

Fig. 4. Installing SWSS. Silica flour slurry was placed around porous ceramic cup to establish good contact between the ceramic cup and the CPK.

Fig 5. Installing 0.25 m tensiometer in filled CPK tank.

Fig. 6. Completed drain line from tank directing flow to sample cell and tipping bucket flow gauge. Tipping buckets from both CPK tanks are wired to one Data Dolphin datalogger.

Appendix II-3

Reclamation of Disturbed Sites at Diavik Diamond Mine – 2015 Annual Report

RECLAMATION OF DISTURBED SITES AT DIAVIK DIAMOND MINE

2015 ANNUAL REPORT

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December 2015

1. BACKGROUND

Exploration and mining for metals and minerals has been increasing at a rapid rate in Canada and around the world. Industrial development is often occurring at a faster pace than reclamation techniques, especially in the arctic. Following their discovery in the mid 1990s, diamonds have been mined in the Canadian north, which has led to various disturbances, including removal of soil, road construction, infrastructure development and creation of waste rock piles. These activities leave areas partially or completely devoid of soil and vegetation, making them unstable, visually unappealing, vulnerable to wind and water erosion and unable to provide food or habitat for fauna.

Concerns over mining impacts on wildlife, human health and the environment have prompted government agencies to require reclamation of mining disturbances to viable and sustainable ecosystems to protect resource function and integrity. Without reclamation, these areas could take hundreds to thousands of years to recover naturally due to the harsh environmental conditions (e.g. short growing season, high winds, low temperature, low rainfall) (Billings 1987, Forbes and Jefferies 1999). Despite decades of research, knowledge of effective reclamation strategies for severely disturbed sites is poor. Development of innovative, cost effective and sustainable methods to reclaim disturbed land is imperative.

From 2004 to 2009, research was conducted at Diavik Diamond Mine, examining effectiveness of amendments and substrates for improving soil and native plant community development (Drozdowski et al. 2012, Naeth and Wilkinson 2014). In northern environments with limited access, reclamation must maximize use of onsite waste materials and minimize use of external materials. Anthroposols are soils that have been altered or created by human activity, often during land reclamation (Naeth et al. 2012). Several materials and amendments showed promise for soil building, others were less successful. Organic matter or fertilizer enhanced revegetation on some substrates. Planting native propagules was essential as native species are slow growing with low colonization rates (Drozdowski et al. 2012, Naeth and Wilkinson 2014). Micro topographic variability was observed to enhance reclamation but little quantitative research has addressed mechanisms by which it affects germination, establishment, recruitment and plant community development. Processed kimberlite contained high levels of metals including cadmium, chromium and nickel and it is not known if native plants, potential forage for wildlife, growing in this substrate uptake metals into their tissue. Research is needed to better understand the mechanisms associated with these successes and failures as they relate to ecological process development in the naturally harsh conditions and substrates of the north. Whether these changes are sustainable beyond the first few years after reclamation must be addressed, particularly whether management is required.

Assisted revegetation is a common reclamation technique to accelerate plant establishment and growth on disturbed sites. However, effective methods for arctic environments have yet to be developed, as revegetation in the north is often complicated by limited access to equipment and lack of available resources. Only a few suppliers carry native seeds for arctic and alpine species, and they are often of too small quantities and/or consist of grasses and legumes which lack the diversity necessary for large scale revegetation projects (Forbes and Jefferies 1999, Matheus and Omtzigt 2012). To develop self sustaining communities that are structurally and functionally integrated with surrounding heath-lichen tundra, new revegetation techniques are required for shrub, moss and lichen species.

Shrubs, both erect and dwarf, provide most of the vegetation cover in many tundra communites. Shrub cuttings have potential to provide a more consistent source of plant material than seed for reclaiming large areas in a timely manner. Methods, however, are required to reliably root large quantities of cuttings under arctic conditions. Few comprehensive studies have rigourously tested a variety of factors for multiple shrub species to determine the most practical methods to induce root development on a species specific basis (e.g. Houle and Babeux 1998, Holloway and Peterburs 2009). Improved method development for shrub cuttings could be used to inform and improve current reclamation and revegetation guidelines in the north as use of shrubs is currently limited by high costs and lack of understanding of their requirements.

Cryptogamic species, mosses and lichens, are critical in northern ecosystems. Moss and lichen are important components of tundra biological crusts, regulating surface temperature and water and providing erosion control and slope stability (Gold 1998, Van der Wal et al. 2001). Moss and lichen crusts may be most important early in succession with benefits in surface layers for seed and seedlings and may act as nurse species, directly facilitating later communities (Gold 1998, Forbes and Jeffries 1999, Bowker 2007). They are important indicators of ecosystem health whose presence or absence can indicate level of disturbance, hydrologic regime, acidity and nutrient concentrations (Gignac et al. 1991, Forbes 1994). They provide critical habitat and forage for northern fauna, including birds, rodents and caribou (Batzli and Sobaski 1980, Thompson and McCourt 1981). Mosses and lichens are of cultural importance; First Nations have been using them for thousands of years (Andre and Fehr 2002). Despite their significance, little is known about revegetation methods.

2. RESEARCH GOAL AND OBJECTIVES

The goal of this research program is to build on past research to develop methods to reclaim disturbed sites at Diavik Diamond Mine in the Canadian subarctic. The program has three focus areas: patch revegetation to maximize limited resources such as micro sites and organic matter; native shrub, moss and lichen propagation to build diverse plant communities that provide food and habitat for wildlife; and long term monitoring for continued evaluation of reclamation success. Results from reclamation research over the past decade, at Diavik Diamond Mine and other severely disturbed sites including oil sands and limestone quarries, will add to the collective findings and expedite results at Diavik.

2.1 Development Of Anthroposols For Revegetation

The objective of this component of the research program is to develop suitable reclamation substrates for sustainable soil and plant community development on disturbed sites at Diavik Diamond Mine. Soil like substrates are the foundation for successful initial plant establishment and growth and long term soil and plant community development. Research is being conducted by PhD student Valerie Miller in the field and greenhouse.

Specific objectives are as follows.

- Evaluate substrate amendment combinations for anthroposols and sustainable development.
- Evaluate micro topographic influences on revegetation.
- Evaluate short term management options for erosion.
- Evaluate amendments for potential to enhance soil water content and retention.
- Evaluate plant uptake of metals from processed kimberlite used as a reclamation substrate.
- Elucidate mechanisms by which ecosystem development triggers and trajectories are influenced by reclamation choices of substrate, management and plant species selection.

2.2 Development Of Plant Material For Revegetation

The objective of this component of the research program is to develop and improve methods for collection, propagation and dispersion of native shrub, moss and lichen species for revegetation of disturbances in harsh environments such as those at Diavik Diamond Mine. Research is being conducted by PhD student Sarah Ficko and MSc student Jasmine Lamarre. Research is being conducted in growth chambers and in the field.

Specific objectives are as follow for shrubs

- Evaluate time of collection on cutting shoot and root development.
- Evaluate common horticulture practices such as soaking length and rooting hormones on shoot and root development.
- Evaluate alternative practices such as willow water and smoke water on shoot and root development.
- Evaluate the ability of shrub cuttings to develop and survive in reclamation substrates.
- Develop recommendations for reclamation methods to improve shrub establishment.

Specific objectives are as follows for biological crust (lichen and moss).

- Evaluate growth media for common lichen and bryophyte species.
- Evaluate propogation techniques for lichen and bryophyte establishment and growth.
- Evaluate erosion control material promotion of lichen and bryophyte propagation, establishment and growth.
- Develop recommendations for collection and propagation of lichens and mosses for use in reclamation.

2.3 Long Term Development of Reclaimed Communities

In 2014, ten years had passed since reclamation plots were established at Diavik Diamond Mine as part of a long term research program. The research site has not been monitored since 2009 and sufficient time has passed for potentially significant changes in soil and plant community development. In the first five years following reclamation, major changes in soil properties and plant abundance and diversity occurred depending on the reclamation substrate and amendment used. At the last monitoring, many reclamation treatments appeared to be on a trajectory to a self sustaining tundra community, while others were clearly in arrested successional stages and the likelihood of further significant changes was low (Drozdowski et al. 2012, Naeth and Wilkinson 2014).

Assessing and quantifying long term ecosystem development trajectories will add considerably to the knowledge base for northern reclamation and will facilitate assessment of sustainability of reclamation treatments. Specific objectives of this research program are to determine if the best performing treatments at 5 years after reclamation are still best ten years after reclamation, if plant abundance and diversity are increasing, if phytotoxic soil properties are being ameliorated, and if a soil biological crust is developing and evolving.

3. RESEARCH ACTIVITIES IN 2015 AND PRELIMINARY RESULTS

3.1 Development Of Anthroposols For Revegetation

3.1.1 Greenhouse Experiment 1

The first greenhouse experiment was conducted in 2013 and assessed effectiveness of substrates and substrate amendment combinations for plant establishment and growth. The experiment consisted of 6 substrates x 7 organic amendments and a control x 2 nutrient treatments for 96 treatment combinations. Treatments were seeded with the grasses *Elymus trachycaulus* ssp. *trachycaulus* var. Adanac (slender wheat grass), *Festuca saximontana* var. *saximontana* (rocky mountain fescue) and *Poa glauca* var. Tundra (glaucous blue grass). Substrates were processed kimberlite, a mixture of glacial till and lake sediment (till-sediment), crushed rock and three combinations of processed kimberlite and till-sediment. Organic amendments were sewage, salvaged soil (soil), sewage and soil, peat, peat and soil, Black Earth (commercial product) and biochar. All combinations were assessed with and without nitrogen and phosphorus fertilizer.

Data analyses were conducted in 2015. A manuscript is in preparation for a peer reviewed journal publication to be submitted in 2016. Valerie Miller presented preliminary results from the research at the Canadian Land Reclamation Association national conference in Winnipeg, the Yellowknife Geosciences Forum in Yellowknife, the Canadian Circumpolar Institute Northern Research Day in Edmonton and the Land Reclamation International Graduate School (LRIGS) Lecture Series in Edmonton.

All plant species established and survived in most treatments. Plant emergence was most successful in unamended crushed rock. Plant height was greater and health was better when the amendment was soil, sewage or peat. Crushed rock appears to be an effective substrate especially for plant density; however, its long term suitability is uncertain due to lack of fine materials and little nutrients. Addition of organic amendments appeared to increase plant density and growth (biomass, height) relative to no amendment, exception for biochar and Black Earth (Figures 1, 2, 3). Amendment selection depends on the final reclamation goal, whether high plant density or large plants are desired. Addition of fertilizer does not appear to have an effect on plant density but it does affect plant growth, especially when peat is used as the amendment. It is important to test in the field when there is less water present in the system to potentially leach any applied fertilizer. Some effects may be species specific, for example only

Elymus trachycaulus produced seed when amended with sewage. Detailed statistical analyses are continuing and will provide a better understanding of the effects of substrates and amendments and an exploration of interactions.

3.1.2 Greenhouse Experiment 2

The second greenhouse experiment was composed of three small scale water holding capacity experiments. Hydrogel was added to substrates alone and wetted to the point of saturation. The amount of water (by weight) present was measured over time (5 to 10 days depending on whether it was still decreasing) to better understand maximum water holding capacity and water retention. These mixtures of substrate and hydrogel were then rewetted and amount of water measured over time. In the final experiment, substrates and amendments, including hydrogel, were combined and amount of water present was measured over time to compare effectiveness of hydrogel to increase soil water content and retention to that of organic amendments. It was completed in fall 2014 and in 2015 data analyses commenced.

Amendment addition improved water holding capacity; the more amendment added, the greater the water holding capacity. Hydrogel appeared to increase water holding capacity the most. Processed kimberlite held most water with or without amendments, crushed rock held least water without amendments, but increased more than till-sediment and there appeared to be no effect on till-sediment.

3.1.3 Greenhouse Experiment 3

The third greenhouse experiment assessed vegetation response under water limited conditions. The first part focused on effect of water stress on vegetation growth over eight weeks. The second part focused on effect of water stress on germination over four weeks. The experiments consisted of 3 substrates x 5 amendments x 3 rates (5, 10, 20 % by volume) plus 3 controls for 48 treatment combinations. Pots were seeded with *Elymus trachycaulus*. Plants were monitored weekly for density, height, health, physiological stage of development, number of leaves. Emergence (density) was monitored every 3 to 4 days in the experiment investigating effects of treatment on germination. Above and below ground biomass was clipped, dried and weighed in at the end of the experiment winter 2015.

Data are being analyzed. Initial observations indicate till-sediment has less germination and crushed rock and processed kimberlite had similar germination. There did not appear to be major differences between amendments, but all were greater with amendment than without. For growth and density, till-sediment seemed to be the least successful and crushed rock and processed kimberlite were similar. Sewage increased density and growth the most and hydrogel seemed to have no effect.

3.1.4 Large Scale Field Experiment

A field experiment was established in 2013 and 2014 on the old magazine storage site at Diavik Diamond Mine to examine the role of micro topography, erosion control and amendments in developing substrates to enhance and sustain native plant species. Each micro topography, amendment and erosion control treatment was combined on each substrate, with 8 micro topography types x 3 organic amendments x 2 erosion control methods = 48 combinations x 3 substrates = 144 treatment combinations x 6 replicates = 864 plots.

Three blocks were constructed in 2008 for a previous research project, each divided into processed kimberlite, till-sediment or crushed rock plots. In 2013, 1 by 1 m sub plots were delineated in each substrate in each block. Micro topographic treatments were small and large mounds, small and large depressions, small and large boulder piles, furrows and flats. Organic matter treatments were no organic matter, added sewage and added salvaged soil. Two erosion control treatments were added Soil Lynx™ or no addition. HOBO data loggers and sensors were installed to monitor soil temperature and soil water throughout the experiment. Seeds of 12 native grasses and forbs, wild collected in the Northwest Territories, were sown.

In the last week of July and the first week of August 2015 species density, health, physiological stage, height and cover were assessed in 0.75 x 0.75 m quadrats. Cover was visually assessed as live, dead, moss and lichens, litter, bare ground and rocks. Evidence of wildlife use, such as feces, tracks and chewed plants, was recorded. Soil was sampled and will be analyzed for pH, electrical conductivity, cation exchange capacity, total and organic carbon and texture. Data are being analyzed. Initial observations indicate that crushed rock had the most plants followed by till-sediment, then processed kimberlite (Photo 1). Plants appear to grow larger and more densely in depressions and sewage resulted in greatest cover and density (Photos 2, 3). There was no easily observable difference with Soil Lynx. Plant density appeared to be affected by micro topography and locations of water pooling especially in till-sediment.

3.1.5 Small Scale Field Experiment

The small scale experiment established in 2014 to examine erosion control methods was assessed in early August 2015. Treatments were Soil Lynx™, jute treated with Soil Lynx™, Soil

Lynx™ and treated jute, coconut erosion control blanket and an untreated control. Plots were 1 by 1 m on substrates processed of kimberlite, till-sediment and crushed rock. Plots were seeded with six native grass species. Plots were assessed using the same methods as in the primary field experiment. Initial observations do not indicate major differences among treatments; however, the erosion control blanket appears to have slightly more plants (Photo 4).

3.1.6 Metal Assessment Field Experiment

Plots were established in 2014 to investigate plant uptake of metals from processed kimberlite. A 2 x 2 m area of fresh fine processed kimberlite was established at the former ammonium nitrate storage site and divided into twenty 50 x 50 cm plots. Native plant species were randomly assigned to the plots for a total of five replicate plots per species. The species were *Elymus trachycaulus, Poa glauca, Festuca saximontana* and *Oxytropis campestris*.

Plots were assessed in early August 2015. While seed of all four species germinated, plants were very small and most plants were dead or dying. All biomass was collected but there was not a sufficient amount for laboratory analyses. Each plot had approximately 0.2 g of biomass and a minimum of 1 g was required. Seeding rates were high and it is unlikely that higher rates would have resulted in more biomass; soil and ambient conditions were not sufficient for plant growth. Three composite soil samples from the 0 to 20 cm depth (rooting zone) were collected but not submitted to the laboratory for metal determination as biomass was not submitted.

3.2 Development Of Plant Material For Revegetation

3.2.1 Shrub Cuttings

Shrub cuttings have high potential to create a consistent source of plant material to reclaim large areas in a timely manner. Growth chamber experiments were conducted to investigate methods to accelerate root initiation and development on cuttings from eight dominant tundra species at Diavik Diamond Mine procured at different times of year. In 2015, spring cuttings were collected in May from *Arctostaphylos rubra* (red bearberry), *Betula glandulosa* (bog birch), *Empetrum nigrum* (crowberry), *Ledum* decumbens ssp. *decumbens* (marsh labrador tea), *Loiseleuria procumbens* (alpine azalea), *Salix* sp. (willow), *Vaccinium uliginosum* (bog bilberry) and *Vaccinium vitis idaea* (bog cranberry). All species were common at Diavik and hence their desirability in the revegetated plant community. Two sets of *Ledum* decumbens ssp. *decumbens* were collected four days apart to investigate effect of emergence from dormancy on root initiation and development. Cuttings were treated with one of six soaking lengths (0, 1, 3, 5, 10, 20 days) and one of four rooting hormone concentrations (0, 0.1, 0.4, 0.8 %) with nine replicates per treatment, prior to planting in commercial potting soil.

Cuttings from each species were assessed for shoot health after 30 and 60 days and for number of roots and root growth patterns after 60 days. Spring results will be compared to data 2013 and 2014 from summer and fall cuttings. Preliminary results from different times of year (spring, summer, fall) indicate all species have capacity to develop roots and there are species specific factors, including time of year, influencing rooting behavior (Table 1; Photos 5, 6). Analysis is underway to determine trends and patterns in root initiation and development.

Sarah Ficko presented preliminary results from this research at conferences. The events were the Association of Canadian Universities for Northern Studies (ACUNS) Student Conference in Calgary, the University of Alberta Forest Industry Lecture Series in Edmonton and the Land Reclamation International Graduate School (LRIGS) Lecture Series in Edmonton.

3.2.2 Biological Soil Crust Growth Chamber Experiment

In 2015, a growth chamber experiment evaluating dispersal and propagation technique effects on composition and function of biological soil crusts was established. The objective was to assess methods to disperse and maintain biological soil crusts on tundra soil (natural substrate) and crushed rock and investigate methods to determine survival for eventual reclamation application. Five replicates per treatment were set up on 2 cm of substrate in 10 x 10 cm dishes in a growth chamber for 6 weeks. Factors were watering (0, 1, 2, 3, 5, 10 days), species composition (none, 6 g sieved mix, 6 g unsieved mix, 4 g *Flavocetraria cuculata*), autoclaving and not autoclaving and jute and no jute. Temperature and light were determined from Diavik meteorological data. Pictures were taken weekly with a high resolution digital camera and analyzed using SamplePoint an image analysis program for changes in lichen cover over time.

Preliminary results indicate watering every three days and mixed biological soil crust material had better survival compared to more frequent watering and an individual lichen species. Further analysis will be conducted to determine recommendations on conditions for future growth chamber experiments.

3.2.3 Biological Soil Crust Field Experiment

A field experiment established in summer 2014 to investigate methods of dispersing and containing biological soil crust material when transplanted onto crushed rock, till-sediment and processed kimberlite was assessed in August 2015 (Photo 7). As lichens are the main visible component in biological crusts, monitoring focused on presence or absence of mosses and 14 species or genus of lichens including *Cetraria* species (Iceland lichens), *Cladonia* species (cladonia lichens), *Cladonia* ssp. *cladina* (reindeer lichen), *Dactylina arctica* (arctic finger lichen), *Flavocetraria cuculata* (curled snow lichen), *Flavocetraria nivalis* (crinkled snow lichen), *Masonhalea richardsonii* (arctic tumbleweed), *Sphaerophorus globulus* (coral lichen), *Stereocaulon* species (easter lichens), *Thamnolia vermicularis* (whiteworm lichen), foliose lichens, brown and yellow hair lichens. Observations were recorded for each treatment such as if jute was intact; debris such as leaf litter, *Epilobium latifolium* (common fireweed) seeds and pieces of siliques or woody debris were noted. Pictures were taken of individual plots and groups on different substrates to help monitor changes over time.

General observations indicated that plots with jute appeared to have a more even distribution of lichens, lichens from most species were observed to have blown onto control plots (small quantities) where lichens were not placed initially. Micro topography is likely an important factor in retention of lichens and biological soil crust material on all substrates but especially ones with less micro topographic variability such as processed kimberlite. Plots with erosion control blanket alone had lichens mostly in dips and not on any bumps. Lichens were frequently associated with tundra soil when present even if some had blown away and were often observed around the rock borders of the plots. Statistical analysis is currently being conducted to determine differences between treatments over time.

3.2.4 Biological Soil Crust Multiple Field Site Experiment

A field experiment to investigate bryophyte propagation methods was established at two research sites in 2014, Diavik Diamond Mine and Heiðmörk recreational area, near Reykjavik, Iceland. The experimental design was the same at each site. Bryophytes collected near respective field sites were identified and quantified prior to treatment application. Three sizes of propagation materials were tested, including small, dust sized moss fragments; medium, leaf or stem sized moss fragments; and large, individual moss strands. All sizes were assessed with and without erosion control material on substrates of crushed rock, till-sediment and processed kimberlite. In 2015 cover and density were assessed in June and August. Photographs were taken of each plot with a high resolution camera to monitor changes over time. Cover of mosses was digitally quantified using SamplePoint, an image analysis program (Booth et al. 2006).

At Diavik, the effect of wind erosion on unamended treatments was severe, with a large amount of propagation material lost. Preliminary results from the first growing season show increased cover of remaining propagation material in all size treatments on all substrates with erosion control material (Table 2; Photos 8, 9). Final species identification revealed that 12 of the 18 bryophytes species planted showed signs of propagation. Most new growth occurred on crushed rock substrate. The large size fragmentation showed the most regrowth, followed by medium then small; however, results do not differ greatly. Survival of material varied and further analysis with SamplePoint is required to more accurately compare effectiveness of size treatments during the first growing season. Preliminary laboratory screening results show a slight increase in effectiveness of small and medium size fragments.

Statistical analyses are currently in progress. Jasmine Lamarre presented preliminary results from this research at the Society for Ecological Restoration 6th World Conference in Manchester, United Kingdom and at the University of Alberta Northern Research Day, the Forestry Industry Lecture Series and the Land Reclamation International Graduate School Lecture Series, all in Edmonton.

3.3 Long Term Development of Reclaimed Communities

Field work for this component was completed in 2014. Data were entered into a spreadsheet and quality checked in 2015 in preparation for analysis. Analyses will be conducted in 2016.

4. RESEARCH PLANS FOR 2016

4.1 Reporting

An annual report including activities and preliminary results from all components of the research program will be provided to Diavik by December 31 2016. Jasmine Lamarre will complete her thesis on moss establishment on reclaimed sites at Diavik in January 2016. A copy of her thesis will be provided to Diavik and include management recommendation and suggested areas for further research.

4.2 Development Of Anthroposols For Revegetation

In 2016, Valerie Miller will analyze the data from the greenhouse experiments and manuscripts prepared for publication in peer reviewed scientific journals. Based on the results of the completed experiments, an additional greenhouse experiment may be conducted in 2016 to address any outstanding questions.

In summer 2016, Valerie will assess the field experiments examining micro topography, erosion control and amendments and different methods of erosion control for the final year. Vegetation will be monitored during peak plant production and species density, health, physiological stage, height (mean, minimum, maximum) and cover will be assessed. Cover will be visually estimated for live and dead vegetation, moss, lichen, litter, bare ground and rocks. Evidence of wildlife use will be recorded. Based on assessment of previously collected soil data, some sampling may be conducted in 2016 to characterize additional parameters in treatments. Data will be analyzed following the field season.

In 2016 plant uptake of metals when grown in processed kimberlite will be assessed in plant growth facilities at the University of Alberta. Under controlled conditions, including adequate soil water, biomass should be greatly increased relative to field conditions. Treatments will include processed kimberlite alone and as mixes of processed kimberlite with till-sediment and crushed rock. The latter are likely more plausible reclamation scenarios as growth in pure processed kimberlite has consistently been poor in the field and under ambient conditions. Each treatment will be replicated 10 times. The four plant species (*Elymus trachycaulus, Poa glauca, Festuca saximontana*, a native legume) will be sown in each pot at a rate high enough to ensure initial establishment of at least 5 plants. All plant biomass will be collected from individual treatments at the end of the experiment and 3 to 5 composite samples submitted to the laboratory for analysis of tissue. The length of the experiment will depend on plant growth, likely being 8 to 12 weeks based on past greenhouse research with these types of substrates. Samples of each species will be analyzed for aluminum, antimony, arsenic, barium, beryllium, bismuth, cadmium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, sulfur, thallium, tin, titanium, uranium, vanadium and zinc concentrations by inductively coupled plasma mass spectrometry and inductively coupled plasma optical emission spectrometry.

Soil will be sampled from each treatment at the beginning of the experiment and submitted to the laboratory for determination of the same metals listed for plant tissue. Soil concentrations are required to determine the source of any metals in plant tissue.

Based on results of these analyses, plant tissue may be collected from the same species in the plots established in 2004 and/or 2014 on weathered fine processed kimberlite. Once known that there is uptake, these samples will provide an understanding of the period of time over which metal uptake from processed kimberlite may remain an issue.

4.3 Development Of Plant Material For Revegetation

In winter 2016, Sarah Ficko will focus on analysis of data from all completed shrub cutting experiments. Depending on these results, additional shrub cuttings may be collected in 2016 to investigate root initiation and development when grown in common substrates available at Diavik, including processed kimberlite, crushed rock and till-sediment. These results would be compared to previous growth chamber experiments to add to recommendations for accelerating revegetation of disturbed areas at Diavik.

The biological soil crust field research plots will be assessed in August 2016 to determine treatment effects on species composition, growth and cover after two years. Plots will be monitored visually and with photos and compared to previous results. A pilot experiment to assess dispersal of different fragment sizes of biological soil crust material will be set up in summer 2016 on the original land reclamation plot site. Understanding how fragment size affects erosion of lichen by wind is useful in reclamation to understand if it is necessary to anchor them when placing in the field or if larger sizes will be more stable and able to remain on the plots without assistance. Understanding how much movement lichens have by wind is useful for considering dispersal strategies for larger quantities of lichens in future for reclamation of a large site far from any source material. Biological soil crust material was previously collected in summer and fall 2014 and stored in a freezer. Treatments will be 100 g of four fragment sizes, sieved through 1, 3 and 5 cm mesh and unsieved. Sieved material will be spray painted following fragmentation to separate treatments. All material will be placed in a 50 x 50 cm plot on processed kimberlite, which is the substrate with the most dispersal based on visual observations. Plots will be photographed for cover at the beginning and then reassessed after 24 hours for immediate dispersal and again after two or four weeks. Assessment will include visual inspection of dispersal patterns, photographs to determine percent displaced and measurements of dispersal distance in concentric circles at 50 cm, and 1, 5, 10, 20 and 50 m from each treatment. Data from the laboratory lichen dispersion experiment will be analyzed and results prepared for publication.

4.4 Long Term Development of Reclaimed Sites

Data analyses will be conducted in winter 2016 and a scientific manuscript prepared for consideration for publication in a peer reviewed journal.

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Table 1. Percentage of cuttings that rooted after 60 days for summer, fall and spring collected cuttings across treatments.

Species	Rooting (%)				
	Experiment 1			Experiment 2	
	Summer	Fall	Spring	Summer	Fall
Harvest Date (days)	60	60	60	60	60
Arctostaphylos rubra	0[a]	3	0	-	1
Betula glandulosa	0	11	0**	-	1
Empetrum nigrum	2	0	6	12	39
Ledum decumbens	2*	3	8	11	10
Loiseleuria procumbens	4	6	0**	8	2
Salix sp.	30*	83	88	-	94
Vaccinium uliginosum	2*	4	2	0	17
Vaccinium vitis-idaea	55	8	9	8	20

* Does not include IBA 0.4 % treatment
** One cutting rooted

Table 2. Bryophyte cover and survival in propagation treatments over two growing seasons.

Substrate	Treatment (fragment size)	Cover (%)				Survival (%)	
		2014		2015		2014-2015	
		Total	Live	Total	Live	Total	Live
Crushed Rock	Large	72.2	6.4	57.0	5.5	78.9	85.9
	Large + Cloth	87.8	3.5	80.0	7.9	91.1	225.7
	Medium	35.2	2.5	16.0	3.7	45.5	146.0
	Medium + Cloth	40.0	1.9	25.0	2.3	62.5	123.0
	Small	8.7	0.8	9.2	1.6	105.7	201.3
	Small + Cloth	45.4	1.3	32.5	2.5	71.6	200.0
Till-Sediment	Large	77.2	6.2	46.5	0.8	60.2	12.1
	Large + Cloth	87.2	4.3	72.0	3.5	82.6	81.4
	Medium	10.2	0.3	2.2	0.0	21.6	0.0
	Medium + Cloth	78.9	4.6	28.8	1.3	36.5	28.3
	Small	5.0	0.3	2.4	0.0	48.0	0.0
	Small + Cloth	57.9	2.7	26.5	1.2	45.8	44.8
Processed Kimberlite	Large	28.4	1.0	7.1	0.0	25.0	0.0
	Large + Cloth	90.7	3.3	85.4	0.4	94.2	13.0
	Medium	4.3	0.2	1.6	0.0	37.2	0.0
	Medium + Cloth	90.0	3.0	79.3	0.5	88.1	16.0
	Small	2.9	0.0	2.6	0.0	88.3	0.0
	Small + Cloth	85.8	2.2	71.8	1.1	83.7	50.5

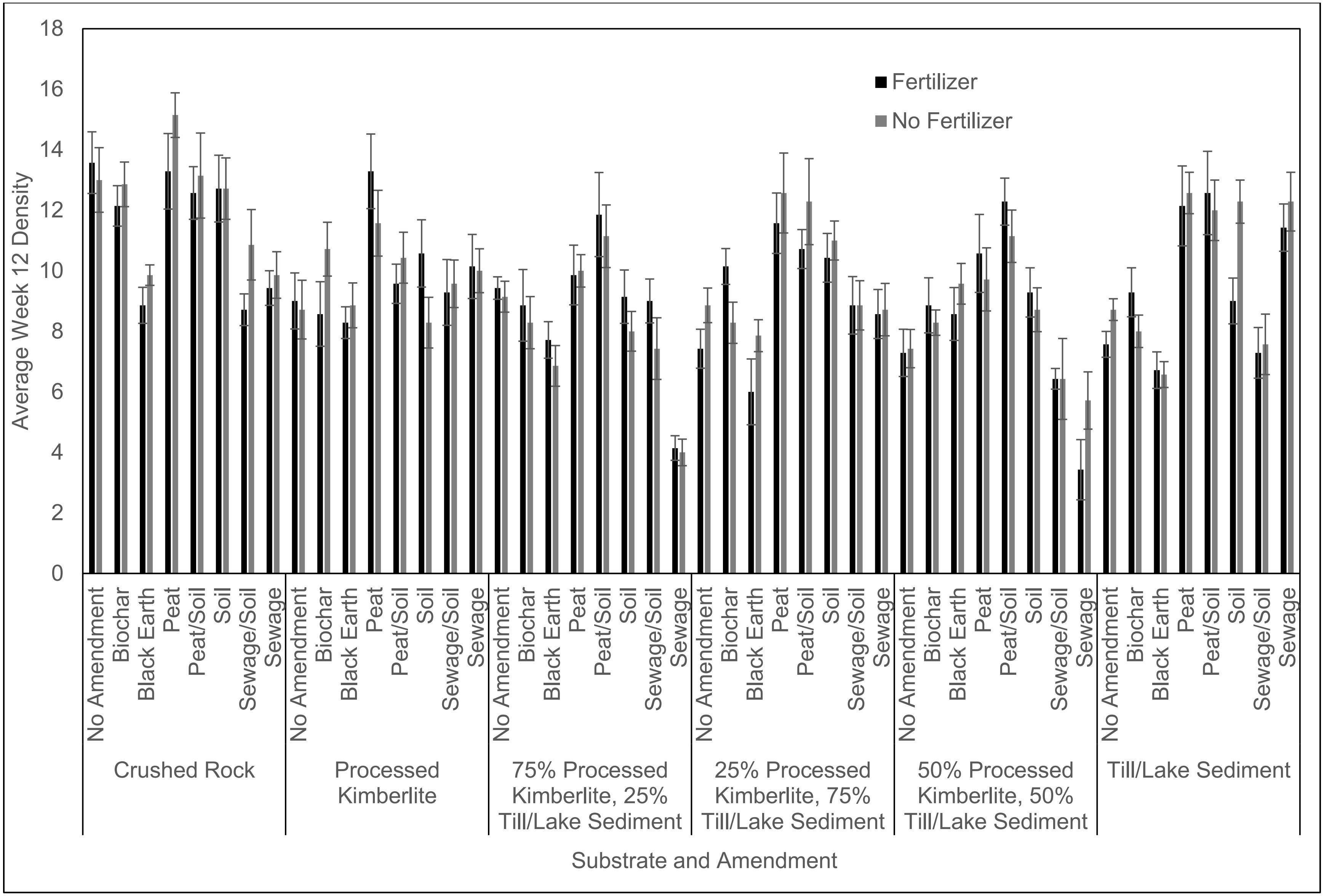

Figure 1. Average number of plants (mean ± SE) in week 12 by treatment.

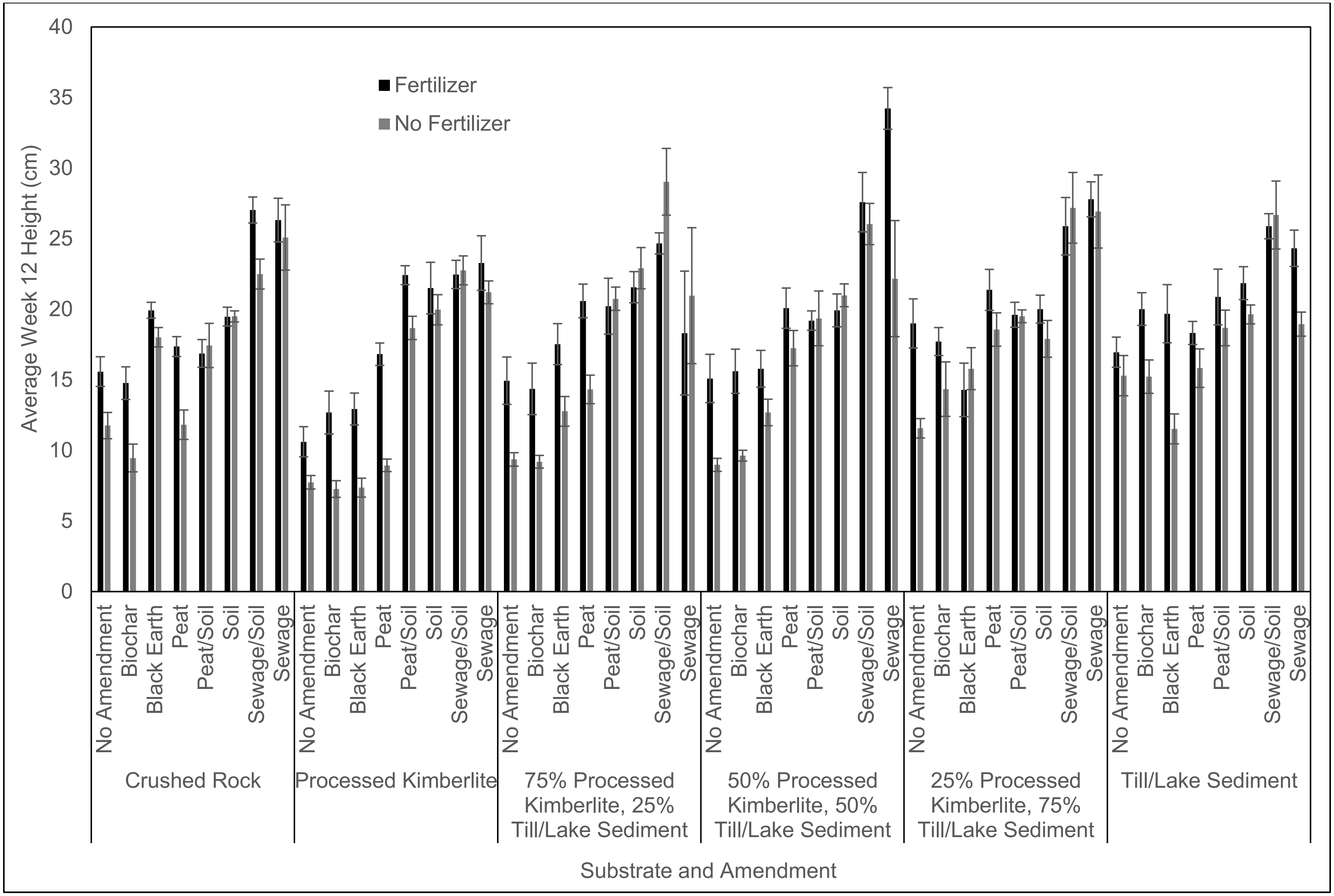

Figure 2. Average height of plants (mean ± SE) in week 12 by treatment.

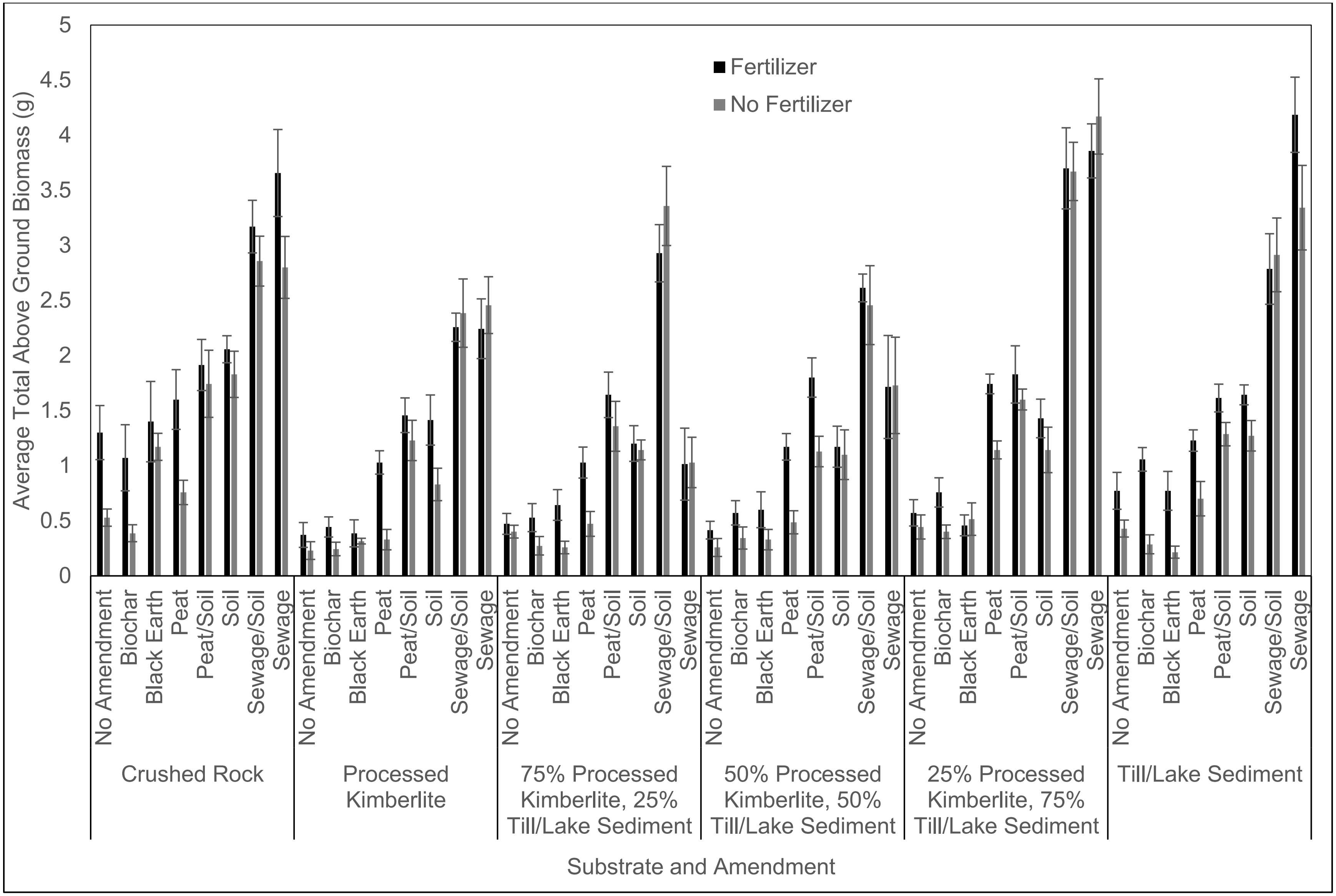

Figure 3. Average above ground biomass (mean ± SE) in week 12 by treatment.

Photo 1. Plants readily established in crushed rock treatments.

Photo 2. Good plant growth in large boulder crushed rock sewage treatment.

Photo 3. Grass establishment in depression processed kimberlite treatment.

Photo 4. Arctic hare in crushed rock erosion control blanket treatment.

Photo 5. *Betula glandulosa* spring cuttings show low root initiation and growth.

Photo 6. Good root initiation and growth on spring *Salix* cutting.

Photo 7. Biological soil crust field experiment set up on till-sediment

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Photo 8. Regenerating moss slurry on crushed rock. Cheese cloth was applied as an erosion control technique.

Photo 9. Moss regrowth under erosion control material.

Appendix II-4

Diavik Waste Rock Research Project - 2015 Annual Report

DIAVIK WASTE ROCK RESEARCH PROJECT

2015 Annual Report

Submitted to:

Diavik Diamond Mines Inc.

International Network for Acid Prevention

Mine Environment Neutral Drainage (MEND)

Research Partners:

University of Waterloo

University of Alberta

University of British Columbia

Carleton University

January 2016

Introduction

The Diavik Waste Rock Research Project has involved collaboration between the University of Waterloo, the University of Alberta, the University of British Columbia, Carleton University and Diavik Diamond Mines (2012) Inc. (DDMI). The research partnership has been funded through cash and in-kind support provided by DDMI, the International Network for Acid Prevention (INAP), and the Mine Environment Neutral Drainage (MEND) program, which has been matched by two NSERC Collaborative Research and Development grants (CRD; Blowes PI; awarded in 2005 and 2010). Additional funding has been provided by a Canada Foundation for Innovation grant (J.F. Barker PI; Blowes Co-PI).

At the Diavik Diamond Mine Inc. (Diavik) mine, open pit mining has led to the development of a permanent 120 Mt stockpile (the North Country Rock Stockpile), approximately 80 m high, to retain the excavated country rock that surrounded the diamond-bearing kimberlite pipes. The country rock consists of granite, pegmatitic granite, biotite schist, and diabase. The mean sulphide content of the granite is 0.01 wt.% S with a maximum sulphide content of 0.1 wt.% S (Diavik, 1997). The biotite schist is the major source of sulphide-sulfur (mean sulphide content of 0.16 wt.% S, maximum of 0.56 wt.% S). The country rock contains a low concentration of carbonate minerals, the principal neutralizing minerals for acid released by sulphide oxidation.

Diavik has developed a management plan to minimize environmental effects of the country rock stockpiles. The plan involves the segregation of waste rock into three types on the basis of sulfur content: Type I (<0.04 wt.% S, primarily granite); Type II (0.04-0.08 wt.% S, granite with minimal biotite schist), and Type III (>0.08 wt.% S, granite with greater amounts of biotite schist). Type I rock is considered to be of no or low acid generating potential. In practice, very little rock was categorized as Type II. Type III rock is potentially acid generating. Diavik plans to place a reclamation cover on the Type III stockpile, which consists of a 1-m low permeability till layer overlain by a 3-m non-acid generating waste-rock cover. Cover placement on the North Country Rock Stockpile is anticipated to begin in 2018.

The primary objectives of the Diavik Waste Rock Research Project are to:

1) *provide an improved understanding of the processes and waste rock characteristics controlling the rate and extent of sulfide mineral oxidation in waste rock piles, and including processes specific to a northern, permafrost environment,*
2) *provide an improved understanding of the transport processes that control solute loading to the receiving environment, and*
3) *provide improved methods for scaling laboratory-derived leach rates to field-scale waste rock piles.*

These objectives have been addressed through several key project elements:

1) *Implementation of 36 long-term humidity cell experiments with Diavik waste-rock including Type I, Type II, and Type III rock at room temperature and in a cold room. A subset of the humidity cells was dismantled after approximately 8 years of operation for detailed microbiology and mineralogical work. The remainder were decommissioned in 2015, and mineralogical and microbiological characterization is underway.*
2) *Construction and monitoring of three fully-instrumented, test-scale waste-rock piles (test piles) including a Type I pile, a Type III pile and a Covered pile.*

3) *Construction and monitoring of six 2-m scale active zone lysimeter (AZL) experiments including duplicate Type I, Type III and Covered experiments.*
4) *Deconstruction of one Covered AZL for detailed physical observations along with particle size distribution and microbial and mineralogical sampling.*
5) *Instrumentation and monitoring of the North Country Rock Stockpile including five bore-holes ranging from 30 to 80 m in depth.*
6) *Deconstruction of the Type I test pile for detailed physical observations along with sampling for particle size distribution and microbial and mineralogical sampling.*

Overall Progress

The Diavik project has been guided by a series of research questions. These questions along with a summary of the work completed and conclusions are highlighted below with reference to the relevant journal, conference proceedings and student thesis. A full list of publications is provided at the end of this document.

1. *What strategies are needed to understand and describe the coupling of heat and advective gas transport processes that are observed in the test piles?*

Measurements of thermal properties and gas transport properties of the test piles and North Country Rock Stockpile are collected on an ongoing basis. Temperature readings are collected at 6 hour intervals at multiple locations throughout the test piles and in the full-scale boreholes. Thermal conductivity of the rock is measured two or three times per year at a number of locations within the test piles and full-scale pile. Concentrations of oxygen and carbon dioxide are measured daily to bi-weekly, and gas-pressure measurements are collected at a subset of sampling locations on the Type III and Covered test-piles once per minute. Weather, including wind speed and wind direction at the test piles site, is also monitored. Data interpretation includes a variety of analytical and numerical techniques. In particular, the investigation is proceeding along two tracks. The first involves statistical analysis of the data set to determine the relationship between pressure, wind and temperature profiles (Amos et al., 2009; Chi 2011; Chi et al., 2013). A model coupling gas transport and heat transport has been developed. Simulations have been compared to field measurements made at the Diavik site (Pham 2013; Pham et al., 2012). Simulations indicate that wind-driven gas transport results in the development of a more extensive active zone near the batters of the windward side of the North Country Rock Stockpile. The bulk of the pile remains frozen. The simulations also indicate that the proposed closure cover, 1 m till layer beneath a 3-m waste-rock cover, will limit the extent of the active layer to above the cover.

2. *What mechanisms control the flow of water through an unsaturated, coarse grained waste rock test pile where interior temperatures fall below the freezing point of water for a number of months each year? How much water can percolate downward within the active zone that forms each summer? How will flow mechanisms be modified should a permanent frozen core develop?*

Mechanisms of water flow into and within the test piles are monitored and measured by a number of means. Water flow from the test pile basal drains, test pile basal lysimeters, and AZLs are measured continuously; soil tension is continuously monitored throughout the unfrozen period in the upper 2 m of the test piles and AZLs; and soil moisture is continuously monitored in the test piles and operational-scale piles. Monitoring of the migration of blasting residuals, nitrate, ammonia, chloride and perchlorate, was used to identify the first flush through the test piles and AZLs. This information was used to provide and independent estimate of pore water velocities. In addition, large-scale permeameters have been constructed and tested to determine hydraulic properties of the waste rock at a scale similar to the representative elementary volume (REV) of Diavik waste rock. Basal heat trace was turned off in the Covered Test Pile to allow measurements of natural cooling. Monitoring of the thermal conditions in the Covered pile indicated gradual cooling of the centre of the pile, which now remains frozen throughout the year, a prolonged period of frozen conditions in the till layer of cover, and lower temperatures in the Type I layer of the cover. Monitoring of the Covered test pile effluent indicates a sharp decline in the volume of effluent when it cooled below 0^{o}C internally.

In 2014, the Type I uncovered test pile was deconstructed for detailed sample collection for physical and geochemical characterization of the weathered waste-rock pile. In addition, the distribution of ice was mapped. Observations indicate a large zone of ice formation in the bottom meter of the pile and spreading of the ice toward the edges of the pile.

A small-scale tracer test was initiated in July 2013 on the Covered test pile to better define water-flow pathways adjacent to the till layer located beneath the Type I cover. Monitoring continues as no tracer has yet arrived at the monitoring station. A comprehensive characterization of the seasonal hydrologic responses of Type I and Type III test piles, spanning 2007 -2013, has been completed (Fretz, 2013; Krentz, 2014). Results also demonstrated the applicability of a modified Penman-Monteith approach for prediction of infiltration into waste rock. This method updates an approach developed by Neuner (2007) to describe the 2006 - 2007 infiltration rates. Momeyer (M.Sc., 2014) has shown an alternate modification to the Penman Monteith equation, using a different sub-set of physical parameters, also replicates the net infiltration recorded at the active zone lysimeters. An interpretation of the 2008 tracer test at the Type III pile has now been conducted (Krentz, 2014), providing estimates of matrix flow rates, wetting front movement, and quantifying a minor component of preferential flow. Peak tracer breakthrough concentrations occurred in 2011. Monitoring continues in order to define the tail of the breakthrough curve, providing insight to rates of mass retention within and release from the lower permeability zones of a waste-rock pile. Krentz (2014) has also quantified the relative contributions of rainfall and snowmelt infiltration through the batters of the Type III pile, and through the cover of the Covered Pile.

3. *To what extent does the thermal state within the piles control the observed variation in the rates of oxidative dissolution of sulfide minerals and rates of dissolution of carbonates and aluminosilicate minerals? What are the impacts of these changes on water quality?*

Geochemical parameters are measured two to three times per week (when water is present) through the field season from May to November, from a number of locations. Water samples for geochemical analysis are collected from basal drain effluent, basal lysimeter effluent, AZL effluent, and from suction lysimeters within the test piles. Suction lysimeters have also been installed in the full-scale waste rock pile. Rock samples were obtained from the full-scale rock pile in 2012 and 2013. Rock samples from within one test pile were collected in Year 4 during the deconstruction project. In addition, the humidity cell experiments were conducted at room temperature and 4 °C. Water and mineralogical samples from these experiments were analysed by Bailey (2013). Sinclair (2014) has demonstrated that water flow at the base of the piles is initially dominated by flow through the short flow paths along the batters of the piles early in the year followed by flow through the longer flow paths through the core of the pile as the flow season progresses. Integration of the flow path analysis with an assessment of the temperature dependence of the reaction rates indicates that the effects of temperature on flow rates has a greater impact on water quality than the effect on reaction rates.

4. *What laboratory procedures and interpretation approaches are required to develop refined long-term estimates of the magnitude and timing of solute loads derived from waste rock piles?*

Humidity cell experiments were operated from 2004 to 2015, to monitor long-term trends in water chemistry (Langman, 2014). The reactive transport model MIN3P is being applied to the data record to assist in the development of a conceptual model for the dependence sulfide oxidation rates on temperature, sulfide content and particle surface area (Stanton et al., 2012; Wilson et al., 2015). This model will be applied to the larger scale field experiments to further develop and refine procedures for estimating long-term solute loads. A subset of humidity cell experiments was dismantled in 2014 for microbiological and mineralogical analysis. These analysis were completed in 2014, including DNA extractions, MPN enumerations, PCR, optical mineralogy, XRD, XRF, and synchrotron x-ray analysis spectroscopy. The remaining humidity cells were dismantled in 2015. Additional analyses are underway.

Samples collected throughout the deconstruction of the Type I test pile have indicated significant geochemical heterogeneity and spatial variation in weathering patterns, geochemical parameters and solute loadings despite the low-sulfide characteristic of the pile. These data indicate the need to consider spatial heterogeneity at the field scale and also provide the necessary information for testing the sensitivity of scaling methods.

5. *What role do the microorganisms that colonize waste rock piles in which the interior temperatures fall below the freezing point of water play in the biogeochemical evolution of water chemistry?*

Water samples for microbiological analysis are collected from test piles basal drains, basal lysimeters and the AZLs throughout the field season. From 2006 to 2010, solid iron-sulfide samples were placed within the test piles and retrieved on an annual basis for microbiological analysis. Water samples from humidity cell experiments are also analysed for microbial populations. Samples are analysed using the most probable number technique (MPN), and molecular techniques. Work to date has shown a progression from neutrophilic to acidophilic populations and has also been able to identify microbial consortia involved in sulfide oxidation within the waste rock, and in cycling of nitrogen compounds in the test-pile effluent (Bailey, 2013). In 2013 and 2014 a series of solid samples were collected at various scales for microbial analysis including MPN enumerations, DNA extractions and PCR analysis. Solid samples have been obtained from decommissioned humidity cells, the deconstructed Covered AZL, and the deconstructed Type I AZL.

6. *How should existing numerical models of flow and reactive transport in unsaturated porous media be modified to simulate the hydrologic and geochemical behaviour observed in the test piles under Arctic conditions?*

Development of flow and reactive transport models depends on a thorough understanding of the coupling between hydrological, geochemical, heat and gas transport processes. A substantial data set based on field and laboratory measurements has been collected and additional data, including measurements on the North Country Rock Stockpile, continue to be collected. Data interpretation and development of conceptual models of flow and reactive transport processes are underway. Reactive transport modeling has begun on humidity cell experiments and is progressing to larger scales.

7. *How effective is a thermal blanket (Type I, non-acid generating waste rock cover and a lower-permeability layer (a till layer beneath the thermal cover) in modifying long-term hydrologic, thermal, and geochemical conditions inside a waste rock test pile?*

Research in Phase I of this study, 2004 to 2010, demonstrated that the cover design effectively limits heat transport, but as a result of warming from instrument heat trace within the test pile the test pile core remained unfrozen. In 2011 the instrument heat trace was turned off to allow natural cooling of the test pile interior. Continued monitoring has indicated gradual cooling of the centre of the pile, which now remains frozen throughout the year, a prolonged period of frozen conditions in the till layer of cover, and lower temperatures in the Type I layer of the cover. Numerical models of gas and thermal transport of full-scale waste-rock piles indicate that a cover design similar to that of the Covered test pile can limit the depth of the active freeze-thaw layer to within the Type I cover, both in the short term and under a predicted warming scenario (Pham et al., 2011; Pham et al., 2012).

8. *To what degree could inter-annual and decadal climate variations in northern Canada modify the hydrologic and geochemical behaviour of mine waste stockpiles, with consequent impacts on environmental loadings? How robust are current design concepts?*

Modelling of heat transport at the operational scale indicate that the cover design is sufficiently robust to withstand predicted climate warming over the next century (Pham et al., 2012). Models are being developed to couple heat, gas transport, hydrological and geochemical parameters. When these models are complete they will be used to predict long term loading rates and the potential changes in these rates due to climate forcing.

2015 Project Highlights

Bromide tracer test

In 2006 a bromide tracer was applied to the crest of the Type III test pile in the form of an artificial rain event. Recovery of bromide in the basal drain effluent peaked in 2011 but continued to report through 2015 (Figure 1). Total bromide recovery accounted for approximately 44% of the mass applied to the top of the pile (Figure 1). These results indicate that residence time of the pore water travelling though the core of the test pile is approximately 6 years with an average velocity of 0.3 to 0.5 m/month when the pile is thawed. Additionally, the low mass recovered, i.e. 44%, suggests a complex dual porosity flow domain where much of the mass is retained in slow flowing areas of the pile. This information will be used in the development of flow and solute transport models to describe water flow and solute loadings in the Diavik waste rock.

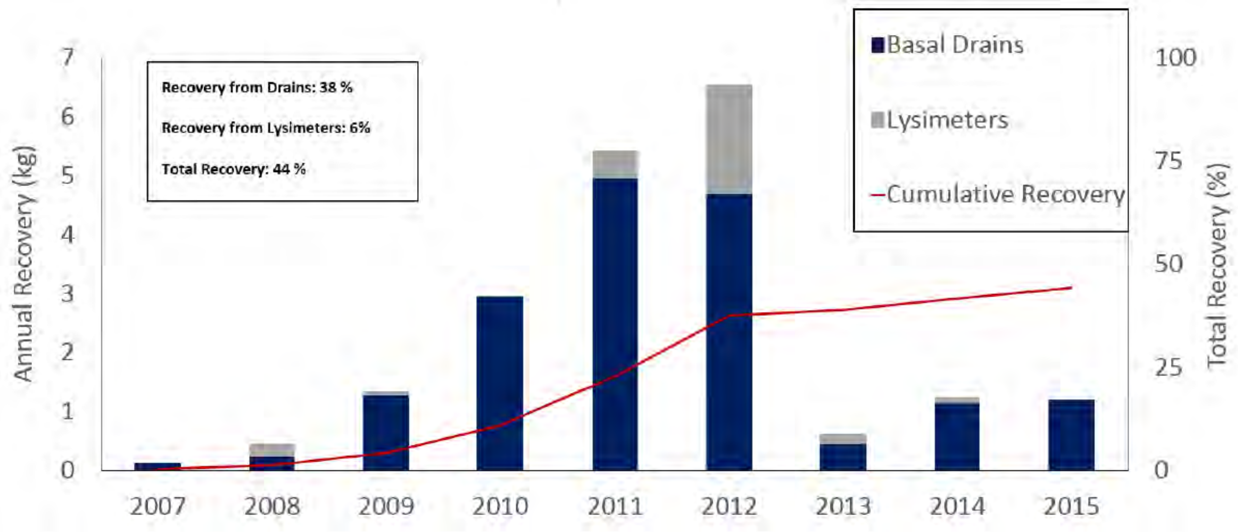

Figure 1. Bromide recovery from the Type III test pile south basal drain.

Geochemical evolution in test piles

Soil water solution samplers (SWSS) collect water samples from the fine-grained unsaturated matrix material within the test piles. During construction these instruments were installed at depth ranging from 2 m to 9 m on multiple faces of the test pile. Samples were collected approximately bi-weekly while thawed conditions existed within the test piles, from approximately late June to early October each year. Figures 2 and 3 below show concentrations of blasting residuals and geochemical parameters with depth through the Type III test pile. Values shown are average annual concentrations of SWSS data at depths from 2 to 9 m. Values shown at 12 m are from the basal collection lysimeters located approximately beneath the SWSS.

Profiles of tracers including bromide and blasting residuals, chloride, nitrate, and ammonia, show elevated concentrations in early years, i.e. 2008 and subsequent flushing of the tracers in later years (Figure 2). By 2015 concentrations of these tracers are all very low. The decrease in these concentrations indicates wetting-up of the test pile and the first flush of the matrix pore water. The first flush dissolves and transports the elements and compounds that remain on the waste rock as a result of the blasting process.

Similarly, profiles of other geochemical parameters, including pH, alkalinity, aluminum, iron, nickel and sulfate, show a significant evolution with time. Initially, pH is near neutral, alkalinity is approximately 10 mg/L $CaCO_3$, and aluminum, iron, nickel relatively low throughout the pile and sulfate concentrations are approximately 2000 mg/L. These initial conditions indicate sulfide oxidation with sufficient buffering by carbonate minerals to maintain the pH near neutral. In subsequent years pH values drop and alkalinity becomes depleted, indicating depletion of the carbonate phases, and metal concentrations are elevated with the acidic conditions.

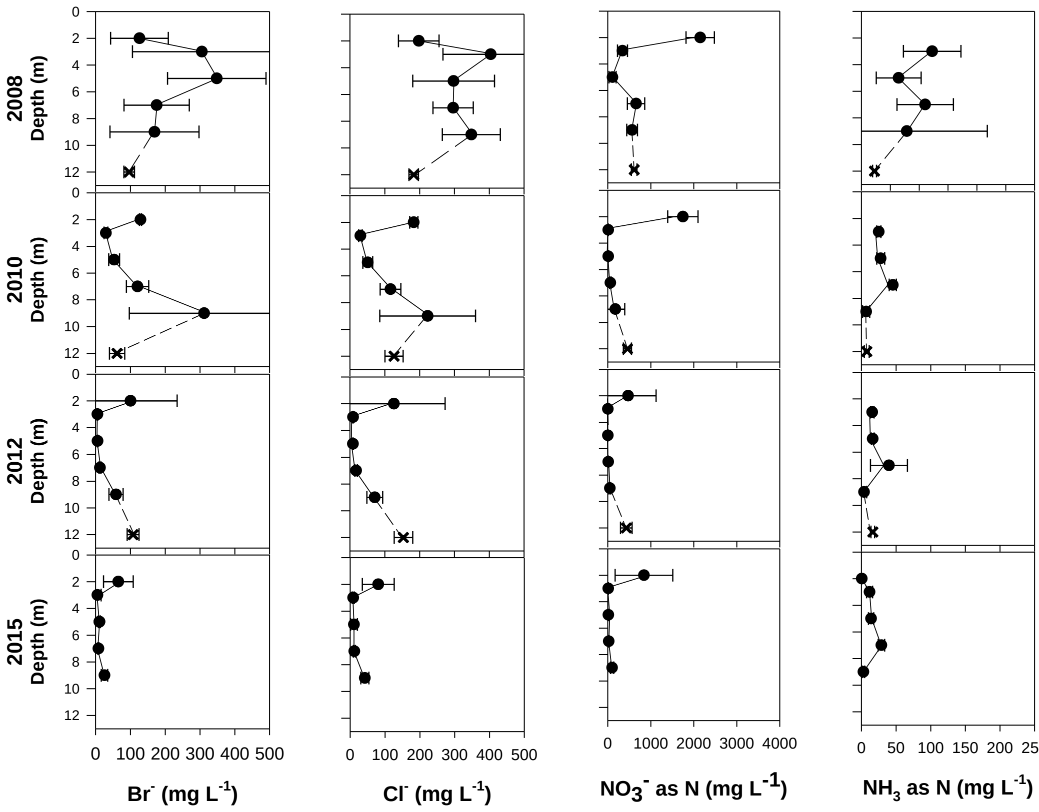

Figure 2. Evolution of blasting residuals in the matrix pore water of the Type III test pile.

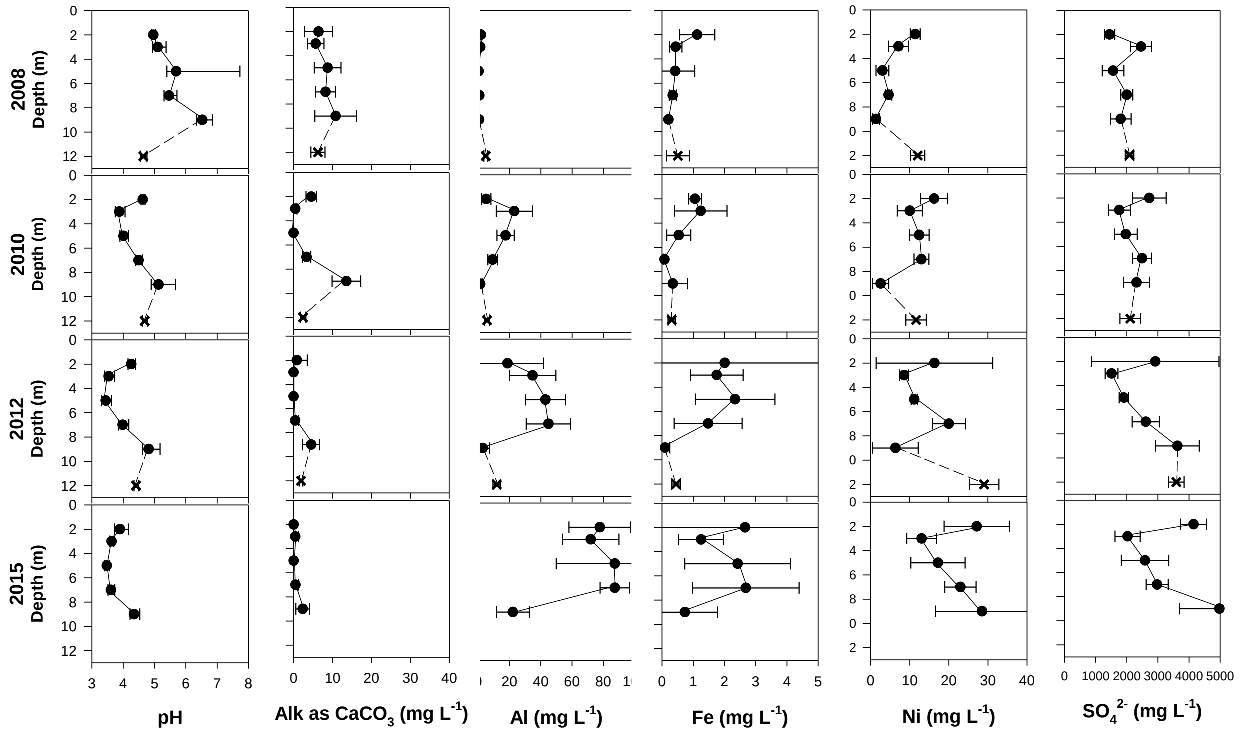

Figure 3. Evolution of pore-water chemistry in the Type III test pile.

Variations in solute release rates

Figure 4 shows sulfate concentrations and sulfate loading from the Type I, Type III and Covered test piles with the number of active days, which indicates the days when the pile was sufficiently thawed to report water to the basal drains. The Type I and Type III test piles show seasonal fluctuations reflecting the various contributions from fast flowing flow paths in the batters of the pile during snow melt and slow flowing flow paths in the core of the pile throughout the late summer and fall. Type III concentrations are significantly higher than Type I as is expected and loadings in both piles are proportional to concentrations. Covered pile concentrations do not show seasonal fluctuations due to the insulating effects of the cover that minimized the temperature fluctuations within the pile. Initially, i.e. up to approximately 1100 active days, heat trace was turned on in the base of the pile that artificially elevated the internal temperature and ensured flow through the pile. After the heat trace was turned off flow through the pile quickly stopped as the pile internal temperature dropped below 0 °C. Although the concentrations in the small volume of water reporting to the drain remains high, the load is drastically reduced as the flow rate is minimal.

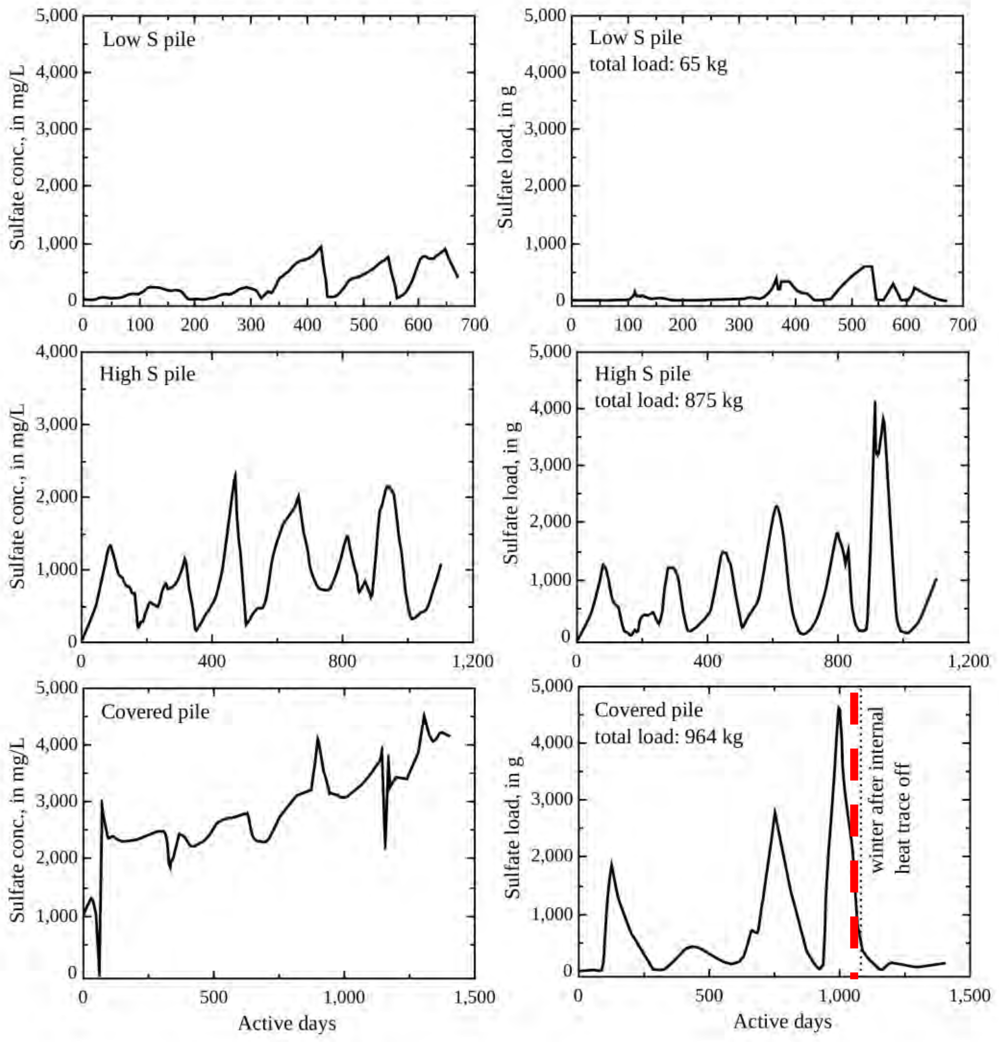

Figure 4. Sulfate concentrations (left column) and sulfate loading (right column) from the Type I test pile (top row), Type III test pile (middle row) and Covered test pile (bottom row).

Tonalite sulfate release rates

Tonalite humidity cell experiments were conducted to evaluate the potential leaching of the tonalite material that is planned to be used as a cover on the North Country Rock Stockpile. The experiments were conducted over an 80 week period and are compared here to the first 8o weeks of the Type III and Type I humidity cell experiments for reference (Figure 5). Throughout the 80 week tonalite experiments the pH remains near neutral. A small amount of alkalinity remains and calcium concentration are approximately 1 mg/L, similar to what is observed in the Type I humidity cell experiments, suggesting that carbonate minerals have not been depleted. Concentration of metals including iron, magnesium, nickel, zinc are low, well below those observed for Type III waste rock and generally below Type I waste rock as well. These results suggest that the tonalite material is a suitable choice for cover material.

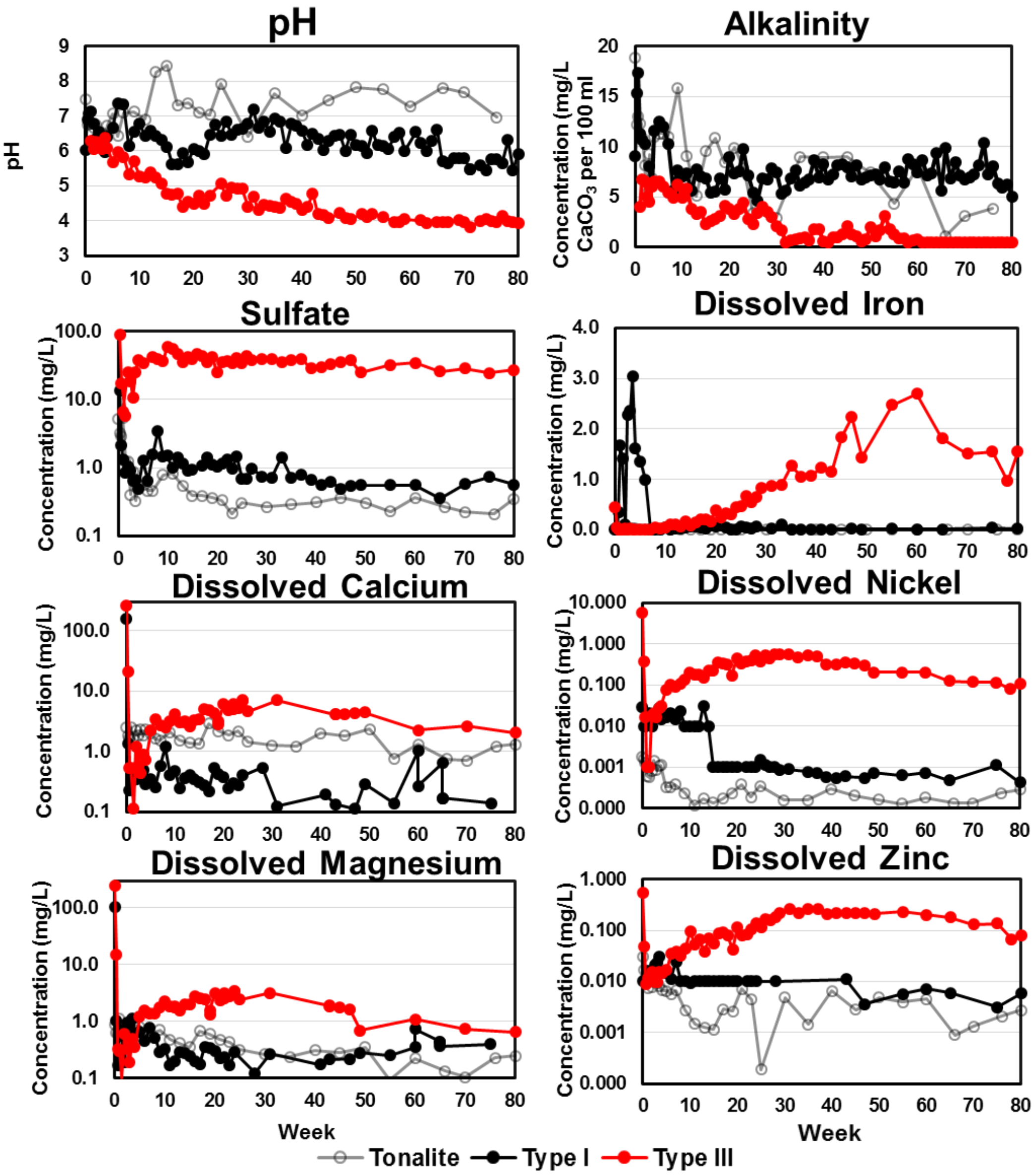

Figure 5. Geochemical parameters from first 8o weeks of humidity cell experiments on Type III, Type I and tonalite rock.

Reactive transport simulations of humidity cells

Humidity cell experimental results were simulated using the reactive transport model MIN3P. The model simulated the oxidation of sulfide minerals, their dependence on temperature and sulfide mineral content, and resulting sulfate and metals release from the humidity cells. Sulfide oxidation dependent on oxygen and ferric iron concentrations was simulated using the shrinking core model, which represents oxidant diffusion through a weathered rim to the reactive particle surface on the sulfide mineral. Simulations of humidity cells with varying sulfide content, i.e. Type I vs Type III, and varying temperature, i.e. room temperature vs cold room, are simulated using an identical conceptual model and the same set of calibrated parameters, with only measured parameters such as temperature and sulfide content varying between simulations. Results show that this unified conceptual model and parameter set can adequately describe the observed data (Figure 6), providing confidence in the conceptual approach. These simulations will form the basis for simulating the field scale experiments including the AZLs and test piles.

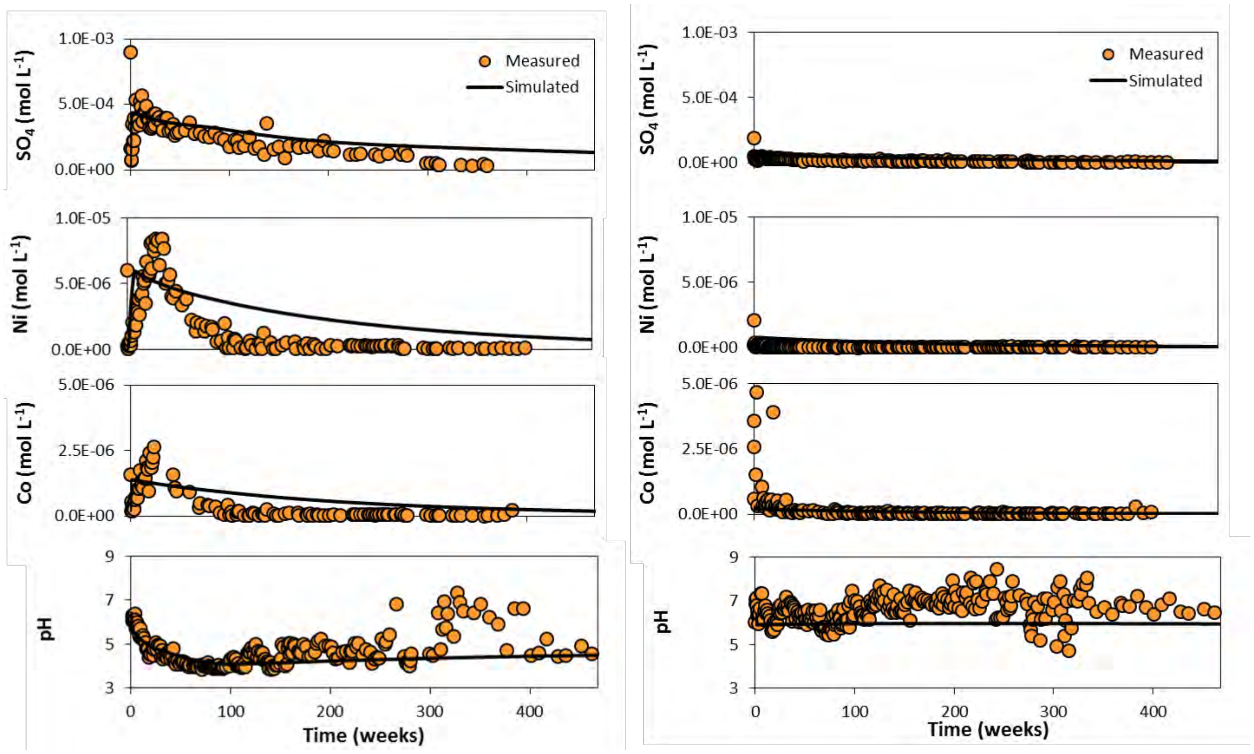

Figure 6. Simulation results of Type III (left column) and Type I (right column) humidity cell experiments.

Type I test pile deconstruction

In 2014 the Type I test pile was deconstructed and hundreds of samples were collected to characterize the geochemistry and physical parameters of the test pile in three-dimensions. Samples were collected from 2 or 3 m deep trenches sloped at a 3:1 horizontal to vertical ratio to ensure slope stability and facilitate personnel access (Figure 7). Samples were collected for microbial analysis, pore water chemistry, mineralogy, volumetric moisture content and grain size and in addition the trenches were surveyed for ice formation and 3-D photogrammetry was performed.

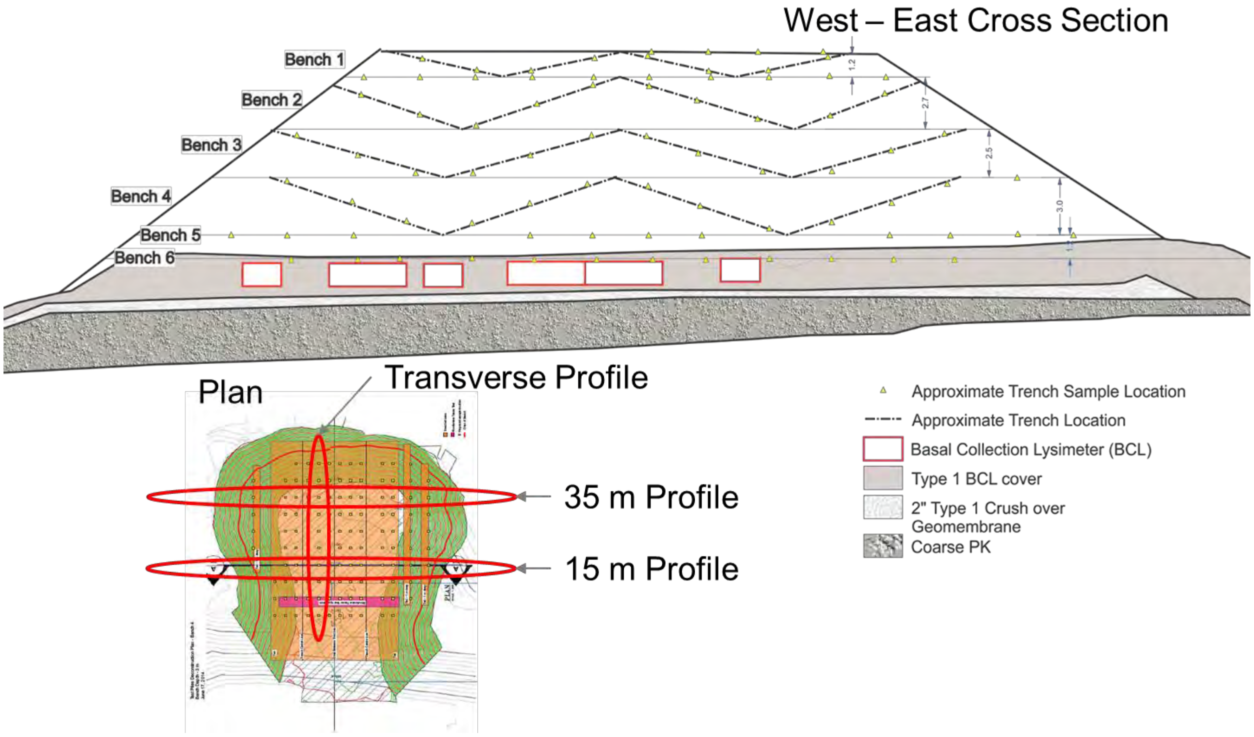

Figure 7. Cross-sectional and plan view of Type III test pile deconstruction samples.

An example of the data collected is presented in Figure 8, including NP:AP ratio, pH, nickel, zinc, alkalinity and sulfate. Each profile plot is produced by contouring measured data from approximately 50 sample points. The results from the 15 m profile show significant heterogeneity in the waste-rock despite it all being of Type I classification. NP:AP ratios vary from above 10, indicating non-acid generating rock to near 0 indicating potentially acid generating rock. In general, zones of potentially acid generating rock correspond to areas of acidic pH, depleted alkalinity, and elevated concentrations of sulfate and metals. These results show that although the Type I rock is relatively uniform in composition, and has relatively low sulfide content, zones of acid production can occur.

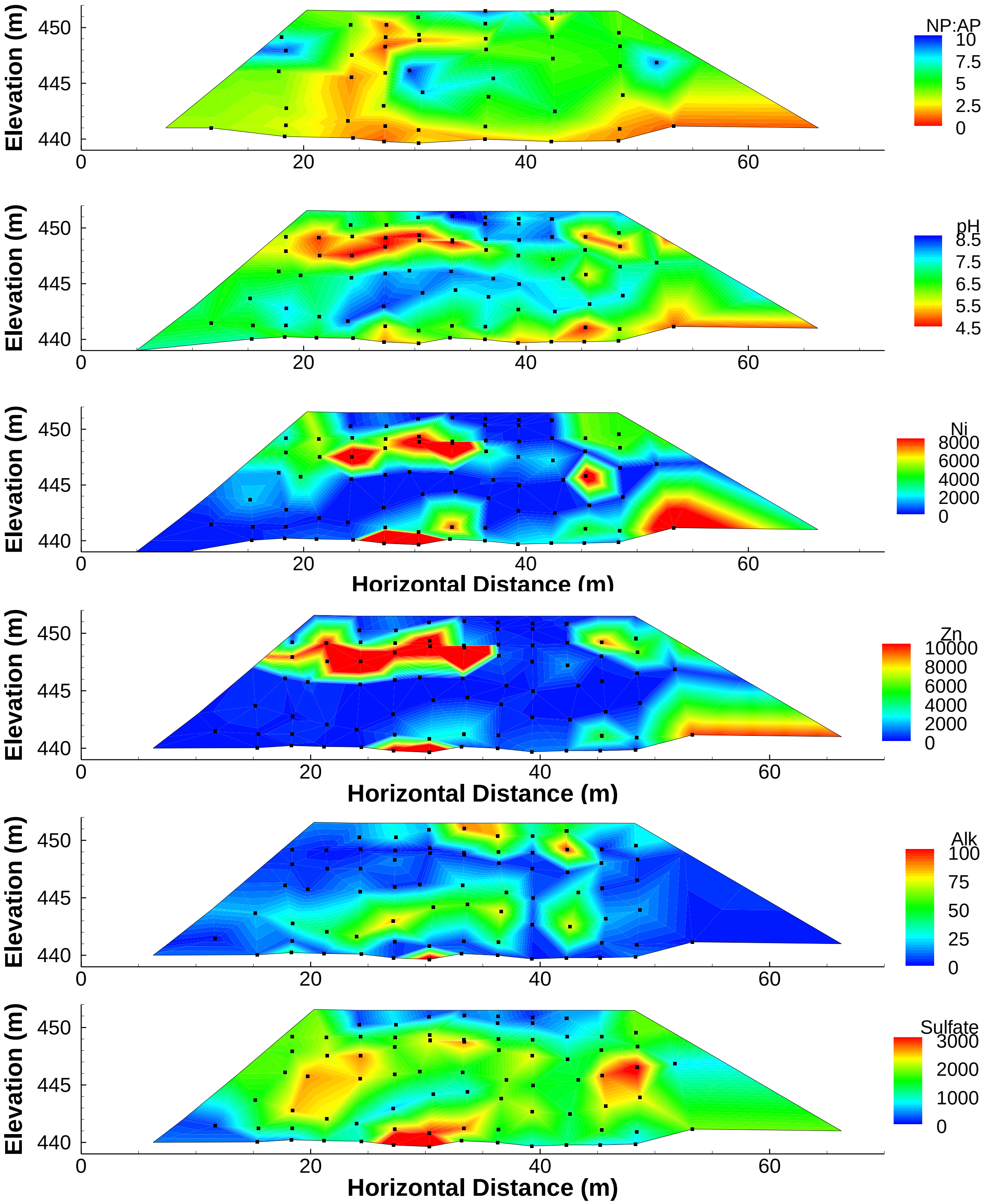

Figure 8. Two-dimensional cross section of the Type I test pile along the 15 m profile (see Figure 7).Black dots represent sample collection points.

Full-scale waste rock pile

Five instrumentation strings have been installed in drill-holes in the North Country Rock Stockpile. These include four approximately 30 to 40 m deep holes and one 80 m deep hole. Each hole is fitted with thermistors, soil moisture probes, gas sampling lines, and SWSS. Soil moisture data at depths below approximately 10 m show no response due to the frozen state of the pile below this depth (Figure 9). Above this, moisture probes show an initial response each year as the thaw front reaches a particular depth. This is seen for instrumentation string FD4 at the 3 and 5 m depths. At these locations a wetting front is observed early in the season at the 3 m depth in all years shown and later in the season for the 5 m depth, but not in all years. Temperatures show a comparable trend with shallow depths, 3 and 5 m for FD4, thawing each season while deeper points remain frozen. Gas sampling has shown that the pile remains at atmospheric oxygen levels indicating relatively rapid gas transport rates compared to sulfide oxidation rates. SWSS data has been difficult to collect due to the frozen state of the pile.

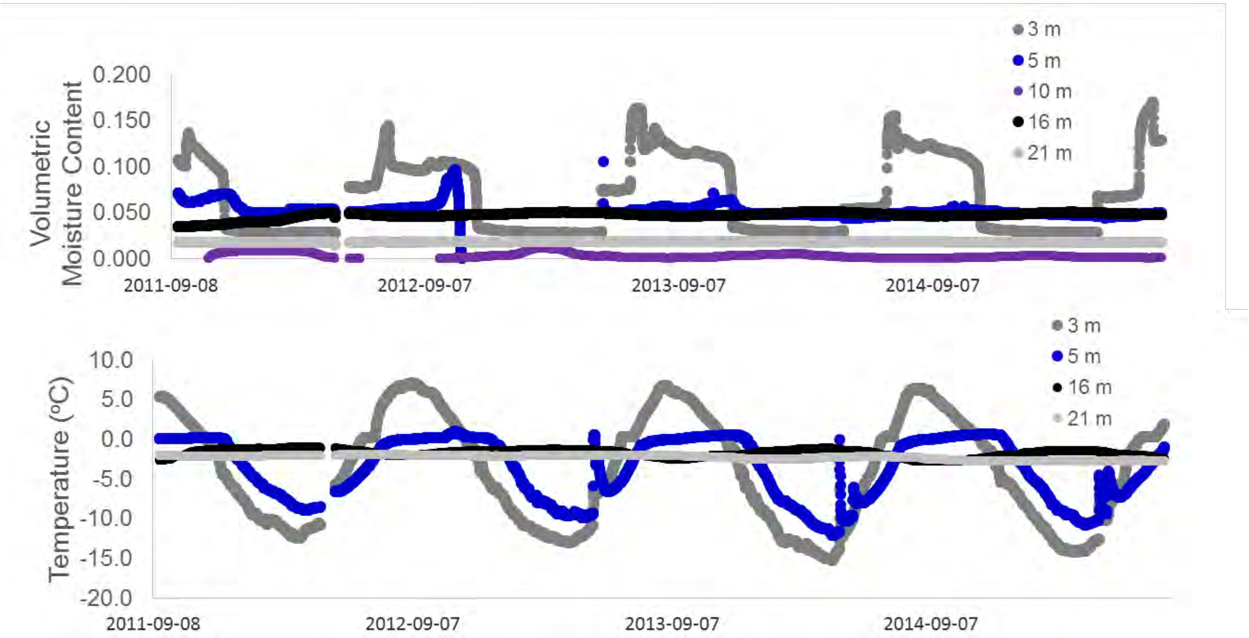

Figure 9. Volumetric moisture content and temperature from full-scale instrumentation string FD4.

Outcomes

Over the duration of the Diavik Waste Rock Project the university partners have trained six PhD students, 16 MSc students, and eight post-doctoral fellows. These trainees have gone on to positions within industry, government agencies and academics. In addition, many technical staff have participated in the project and over 50 undergraduate co-op students have gained important experience taking part in the project, including both laboratory and field experience. Many of these undergraduate students have gone on the graduate degrees in several fields of study or work for industry.

The project team has produced 17 refereed journal publications, 28 conference proceedings, including many at ICARD and MEND sponsored symposium, and 11 students have published graduate theses (See reference list). These publications cover a broad range of topics within the project and provide a wealth of information to industry practitioners and academics.

Table 1. HQP Training, Diavik Waste Rock Research Project

PhD Students		**M.Sc./M.A.Sc. Students**	
Brenda Bailey	BC MME	Laurier Collette	ongoing
Nam Pham	Soil Vision - Saskatoon	Xiaotong Chi	AMEC - Ontario
Ashley Stanton	U of Guelph	Nate Fretz	Golder - BC
David Wilson	ongoing	Mike Gupton	Entrepreneur - Manitoba
Steve Holland	U of Waterloo	Stacey Hannam	Rio Tinto - Austalia
David Barsi	ongoing	Renata Klassen	Tetra Tech - EBA
Post-doctoral Fellows		Andrew Krentz	BGC Engineering - BC
Jeff Langman	U of Idaho	Steven Momeyer	CH2M Hill - Yukon
Matt Lindsay	U of Saskatchewan	Mandy Moore	Burnside Engineeing- Ontario
Romy Matthies	U of Newcastle	Sivaram Mullapudi	SNC Lavalin
Peter Nason	ongoing	Matthew Neuner	Golder - Alberta
Nam Pham	Soil Vision - Saskatoon	Jared Penney	U of Waterloo
Sung-Wook Jeen	Chongbok U – South Korea	Sean Sinclair	Diavik
Richard Amos	Carleton University	Lianna Smith	U of Waterloo/Diavik
Lukas Arenson	BGC Engineering - BC	Colleen Atherton	ongoing
		Jordan Zak	ongoing

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Appendix II-5

Characterization of Extra Fine Processed Kimberlite Tailings from the Diavik *D*iamond Mine Processed Kimberlite Containment Pond

Characterization of Extra Fine Processed Kimberlite Tailings from the Diavik Diamond Mine Processed Kimberlite Containment Pond

Final Report

Submitted to:

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Submitted by:

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January 18, 2016

EXECUTIVE SUMMARY

This study was designed to physically, chemically and toxicologically characterize the extra fine processed kimberlite tailings (EFPKTs) that have accumulated at the center of the Diavik Containment Pond located at the Diavik Diamond Mine, NT. The goal was to determine the effects that the whole EFPKTs, EFPKTs pore water (isolated from EFPKTs) and EFPKTs leachate (created from the tailings) would have on aquatic species representing a variety of trophic levels. The EFPKTs itself was tested as whole tailings using two benthic species, *Chironomus dilutus* and *Hyalella azteca*, which are routinely used in standardized sediment toxicity tests. In addition, *Hyalella azteca* were exposed to EFPKTs pore water and leachate, and to Containment Pond surface water. EFPKTs pore water and leachate were also tested with an algal species, *Pseudokirchneriella subcapitata* (pore water and leachate), a daphnid species, *Daphnia pulex* (pore water only), and a fish species, *Onchorhynchus mykiss* (leachate only). In addition, *P. subcapitata* and *D. pulex* bioassays were conducted with pore water extracted from the tailings to represent a worst-case exposure scenario. The water used as overlying water in the whole tailings tests and as leachate extraction water was formulated (i.e., reconstituted) to simulate the characteristics of Diavik Containment Pond Water (CPW).

Whole EFPKTs, extracted pore water and leachate produced from the EFPKTs had mixed effects on the aquatic organisms used in this study. Biological endpoints such as growth and survival were reduced in the highest concentrations of whole tailings, tailings pore water, or tailings leachate tested for some organisms and test durations, but the differences were often not statistically significant compared to the respective controls. However, whole EFPKTs clearly reduced *C. dilutus* survival. For *H. azteca*, the interpretation of response was complicated by stress accompanying exposure to CWP and uncontaminated RCPW compared to Saskatoon municipal water, but test results suggest that exposure to whole EFPKTs reduced animal survival (although not statistically significantly). Isolated pore water affected *D. pulex* in the acute 4-d test (reduced survival) and the chronic 21-d tests (reduced survival and reproduction; response was possibly complicated by the presence of waste water treatment polymers). Leachate demonstrated no statistically significant effects on *D. pulex* (4-d acute test) and *H. azteca* (10-d test), and was clearly not toxic to rainbow trout (*O. mykiss*; acute 4-d and chronic 28-d leachate exposures). From review of all data generated, the main constituents of toxicological concern in the whole EFPKTs appeared to be nitrogenous substances (specifically ammonia and nitrite). This is supported by the reduced toxicity of isolated pore water and leachate compared to whole EFPKTs. Isolated pore water and leachate were aerated prior to testing and as a result had substantially lower concentrations of ammonia compared to unmanipulated EFPKTs pore water. Based on their relative ease of extraction using dilute acid, metals such as chromium and nickel are potentially available through both aqueous and dietary routes of exposure for deposit feeders such as *C. dilutus* and could possibly contribute to toxicity in some cases.

TABLE of CONTENTS

LIST OF TABLES

1.0 Introduction

In early April 2015, a request was made by Diavik personnel to prepare a proposal for characterization of a material from Diavik's processed kimberlite containment facility. The request suggested that the general project scope should be comparable to that used for a previous study conducted by the University of Saskatchewan (U of S) Toxicology Centre for Diavik a decade ago (de Rosemond and Liber, 2005). The current request asked for a proposal to physically, chemically and toxicologically characterize the extra fine processed kimberlite tailings (EFPKTs) that have accumulated at the center of the Diavik Containment Pond at the Diavik Diamond Mine, NT. This material has a unique consistency best characterized as a paste, somewhat fluid in nature. The requested information would be used by Diavik in the preparation of the company's site closure plan and for addressing concerns from a panel of Traditional Knowledge Elders.

The suitability of any sediment or substrate, and the associated sediment pore water and overlying water, to support aquatic life will depend on the physical and chemical characteristics of those materials, and on their associated toxicological properties. Based on the review of a report describing earlier work on the EFPKTs material in question (Moncur et al., 2011), it appeared that the composition of this material might be toxic to some forms of aquatic life (based on available data). Furthermore, the addition of wastewater treatment polymers (flocculants and coagulants) to the original effluent/tailings may contribute to pore water toxicity if excess polymers were added. Earlier research has shown that diamond mine effluents containing wastewater treatment polymers can be toxic to aquatic organisms at environmentally realistic concentrations (Rosemond and Liber, 2004).

In order to determine if the EFPKTs released to the Diavik Containment Pond will provide a suitable substrate or habitat for aquatic organisms, a series of physical and chemical analyses, leaching tests, and a battery of toxicity tests were conducted. Chemical analysis was used to determine the chemical characteristics of the tailings and associated waters, as well as of the EFPKTs leachate and the test waters of all toxicological assessments. Tests with leachate were used to determine if contaminants, such as some metals, could be released from the solid phase of the EFPKTs over time. The toxicological properties of the different solid and liquid phases were evaluated by conducting a series of toxicity tests using a range of organisms from different trophic levels. Once toxicity of the solid and aqueous phases (e.g., pore water) to aquatic organisms had been established, data were used to identify the toxic component(s) of the pore water so that sound communication and management decisions can be made. Photographs of the experimental facilities, toxicity tests and experimental organisms are presented in Appendix A.

1.1 Objective

The objective of this study was to determine the physical and chemical characteristics of extra fine processed kimberlite tailings (EFPKTs) and to identify the toxicological properties of the EFPKTs, the pore water extracted from the EFPKTs, and the leachate generated from aqueous "extraction" of the EFPKTs from the Diavik Diamond Mine's Containment Pond.

2.0 Methods and Materials

2.1 Tailings collection

Extra fine processed kimberlite tailings were collected by Diavik personnel and shipped to the Toxicology Centre, University of Saskatchewan. The first and main batch of EFPKTs (Batch 1) arrived in twelve 20-L buckets on May 28, 2015. An extra bucket in the shipment contained approximately 15 L of surface water collected from the same containment pond as the EFPKTs. A second batch of EFPKTs (Batch 2) was collected by Diavik personnel and shipped to the Toxicology Centre, University of Saskatchewan, for use in the chronic fish toxicity test (a 28-d, materials-intensive test). The second batch arrived in five 20-L buckets on October 21, 2015. Again, an extra bucket in the shipment contained approximately 15 L of surface water collected from the same containment pond as the EFPKTs.

2.2 Tailing manipulations and chemistry

2.2.1 Tailings manipulations

Prior to subsampling the EFPKTs for chemical and physical analysis, and for use in bioassays, the material in each bucket was well homogenized. One half of each bucket was then poured into each of two pre-cleaned 200-L high density polyethylene (HPDE) barrels. This was repeated for each of the 12 buckets. The EFPKTs in each 200-L barrel were subsequently homogenized and redistributed into the original buckets. This homogenized material was used for all tests and assessments. Buckets were again stored at 4 ± 1 ºC until used.

A substantial volume of overlying water was required to conduct the various toxicity tests (e.g., overlying water for whole tailings tests and water for dilution series in the pore water and leachate tests). Therefore, reconstituted water was formulated to mimic characteristics of the surface water received from Diavik. The reconstituted Containment Pond water (RCPW) used for EFPKTs manipulations was made to resemble, as close as possible, the Diavik Containment Pond water (CWP, Table 1; majority of analyses performed by the University of Saskatchewan Toxicology Centre, Saskatoon, SK). The EFPKTs pore water and leachate were also isolated for comparison of water quality to both the CPW and RCPW (summarized in Table 2).

Formulated water consisted of the following constituents added to deionized water: KNO_3, KCl, NaCl, $NaHCO_3$, Na_2SO_4, $CaSO_4{\cdot}2H_2O$, $MgSO_4{\cdot}7H_2O$, augmented with NaBr for the *Hyalella azteca* tests, or Na_2SeO_4 and vitamin B_{12} for the *Daphnia pulex* tests, as per Environment Canada guidance (Environment Canada, 2000).

Pore water was collected by centrifuging EFPKTs at 4,000 rpm for 20 min. The supernatant of the EFPKTs was then decanted, aerated overnight and filtered through 0.45-μm membrane filters (Supor®-450, Pall Corporation, Ann Arbor, MI, USA). Pore water was stored at 4 ± 1 ºC until bioassays were initiated (within 3–5 days (d) of pore water collection).

Leachate was created by combining a 2:1 volume of RCPW and EFPKTs in 1-L HDPE containers. The mixture was placed on a Wrist Action® shaker (Burrell Scientific, Pittsburgh, PA, USA) and vigorously mixed for 2 hours (h). The mixtures were immediately centrifuged at 6,500 rpm. The supernatant was then decanted and processed as described for the pore water.

2.2.2 *Analysis of EFPKTs and tailings manipulations*

Duplicate EFPKTs subsamples from Batch 1 were sent to AGAT (Edmonton, AB) for mineralogy assessment using X-ray diffraction (XRD) analysis.

In addition, five subsamples (Batch 1) and three additional subsamples (Batch 2) were sent to Maxxam Labs (Saskatoon, SK) for analysis of moisture content, total organic carbon (TOC) content (LECO CNS2000, LECO Corporation, Saint Joseph, MI, USA), particle size distribution (by hydrometer, following Carter and Gregorich, 2007), and cation exchange capacity (Carter and Gregorich, 2007). Separate samples of CPW, pore water and leachate (Batches 1 and 2) were also analyzed by Maxxam Labs for dissolved organic carbon (DOC) (Rice et al., 2012) and total dissolved solids (TDS).

Subsamples were also collected from the homogenized material (Batch 1), then frozen, freeze dried and digested using 1-M HCl to extract the more bioavailable metals and trace elements from the tailings. Metals/trace element analysis was performed on the HCl extract at the Toxicology Centre using inductively coupled plasma-mass spectrometry (ICP-MS Triple Quad [TQ], Agilent Technologies, Santa Clara, CA, USA) for a suite of 24 metals/trace elements which included aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), strontium (Sr), thalium (Tl), tin (Sn), titanium (Ti), uranium (U), vanadium (V), and zinc (Zn).

Routine water quality variables were assessed for all CPW, EFPKTs pore water and leachate, and RCPW samples, and for all experimental test solutions. These included total hardness, alkalinity, conductivity, ammonia, and pH. Solution pH was measured with an Orion Model 370 pH meter (Orion Research Inc., Cambridge, MA, USA). Total hardness and alkalinity were measured using a HACH Digital Titrator (model 16900, Hach Company, Love Land, CO, USA). Conductivity was measured with an Orion Model 170 Conductivity Meter.

Subsamples of surface water (CPW, the water-only bucket, Batch #1) were also analyzed for major ions by ion chromatography (major cations K, Na, Ca, Mg, Li and NH_3; and major anions F, Cl, Br, NO_2, NO_3, SO_4 and PO_4) to inform formulation of the RCPW. Results are reported in Table 1 for major ions (mg/L) and in Table 3 for metals and trace elements (µg/L).

2.3 Bioassays

A complete list of bioassays performed during this project is presented in Table 4.

2.3.1 Pseudokirchneriella subcapitata

Psuedokirchneriella subcapitata (strain #37) was obtained from the Canadian Phycological Culture Centre (University of Waterloo, Waterloo, ON), and cultured according to the Environment Canada (2007) protocol. The alga culture was maintained in log-phase growth in 1-L Erlenmeyer flasks containing 250 mL of culture media under 24-h light in a temperature controlled (24 ± 1 ºC) environmental chamber.

The 72-h algal growth inhibition tests (Environment Canada 1992a) were conducted in 10-mL beakers, rather than 96-well micro-plates, to ensure sufficient water volumes were available for analysis of routine water quality parameters, and for metals/trace element analysis via ICP-MS TQ. Two sets of 72-h algal tests were conducted with a 0.5x serial dilution (100 % to 3.12 %) of pore water or leachate, with five replicates for each dilution of each test solution. Dilutions were all made with RCPW (characterized in Table 1). Controls for each test consisted of algae grown in RCPW. Three extra replicates of the control and all treatments were used to measure water quality variables and metal/trace element concentrations at the beginning of the test (t = 0 h). Each 10-mL beaker consisted of 5 mL of test solution (pore water or leachate), 0.25 mL of nutrient media spike, and 0.25 mL of algal culture. The initial algae concentration for both tests was ~10,000 cells per mL. At the end of each algal test (t = 72 h), the concentration of algae cells in each beaker was counted using a hemacytometer (Bright Line™, Sigma-Aldrich, St. Louis MO, USA). For the algae bioassay to be successful, the control had to have a minimum of 16 cell divisions and a coefficient of variation (CV) ≤ 20 % (Environment Canada, 1992a). A summary of the various water chemistry analyses performed for this test is presented in Table 5.

2.3.2 Daphnia pulex

Daphnia pulex were cultured and tested in a temperature-controlled (24 ± 1 °C) environmental chamber with a 16-h light:8-h dark photoperiod. Cultures were maintained according to an Environment Canada (2000) protocol and fed a mixed diet of *P. subcapitata* and a combination of yeast, Cerophyll™, and trout chow (mixed into RCPW). *Daphnia pulex* were cultured in RCPW enriched with 2 µg/L of Se (IV) and 2 µg/L of vitamin B_{12}. All test solutions were similarly enriched with Se and vitamin B_{12}.

Acute (48-h) *D. pulex* bioassays were conducted according to the established test method for *Daphnia* (Environment Canada, 2000). Acute bioassays were conducted in 300-mL tall-form glass beakers using leachate and pore water (separate tests). Acute bioassays were conducted with five replicates per control and treatment, each containing 10 randomly selected neonates (<24 h old). The animals were not fed for the duration of the bioassay. Bioassays were considered acceptable if at least 80 % of the control organisms survived (Environment Canada, 2000). A summary of the various water chemistry analyses performed for this test is presented in Table 6 (sampling regime based on ASTM [2012] guidance).

There is currently no Canadian guidance for conducting chronic toxicity tests using *D. pulex*. Therefore, a protocol for *D. magna* life-cycle toxicity tests (ASTM, 2012) was followed. The chronic (21-d) *D. pulex* bioassay consisted of ten replicates of single neonates (<24-h old) each placed in 30 mL of either control (RCPW) or a 0.5x serial dilution of pore water (100 % to 3.12%; diluted with RCPW). Test solutions were renewed every third day and test beakers were fed with 0.200 mL of *P. subcapitata* daily. Chronic toxicity tests were terminated after 21 days. For a *D. magna* test to be considered successful, 80% of the control organisms should survive to day 21 and surviving adults should produce at least 60 neonates per adult (ASTM, 2012). However, there is no guidance for the level of reproduction recommended for *D. pulex*. A summary of the various water chemistry analyses performed for this test is presented in Table 7 (sampling regime based on ASTM, 2012 guidance).

2.3.3 Chironomus dilutus

The chironomid, *C. dilutus*, was cultured and tested in a temperature-controlled (24 ± 1 ºC) environmental chamber with a 16-h light:8-h dark photoperiod. Organisms were cultured according to an Environment Canada (1997) protocol.

A 10-d bioassay with *C. dilutus* was conducted according to an established Environment Canada test method (1997). Water renewals (75%) occurred on days 3 and 6 with minimal disturbance to the surface of the EFPKT or sand-EFPKT mixtures. Bioassays were conducted in 300-mL tall-form glass beakers. Test beakers contained 100 mL of whole EFPKT and ~150 mL of RCPW. Control beakers consisted of 100 mL of pre-cleaned silica sand (250–425 µm diameter) and ~150 mL of RCPW. Five additional mixtures of sand and EFPKT were also tested (6.25%, 12.5%, 25%, 50% and 100% EFPKT by volume).

Beakers were placed in an environmental chamber 24 h prior to test initiation and individually covered with plastic petri dishes. Gentle aeration was introduced at this time. On day 0, ten 14-d-old *C. dilutus* larvae were added to each beaker. Slurried TetraMin® (Rolf C. Hagen Inc., Montreal, QC) fish food (6.3 mg d.w.) was added to each beaker on day 0 and every other day. Temperature, DO, pH, alkalinity, hardness, ammonia, and conductivity were measured in a subset of three beakers per treatment on days 0, 3, 6 and 10 during the bioassay. On day 10 the bioassay was terminated and the beakers sieved to retrieve all surviving larvae. The live animals in each beaker were counted, placed on an appropriately labeled aluminum pan, and dried at 60 ºC for 48 h. The dried animals were then weighed and the mean dry weight (d.w.) per animal calculated. Bioassays were considered acceptable if at least 80% of the control organisms survived and if the mean weight per animal was >0.07 mg d.w. (Environment Canada, 1997). A summary of the various water chemistry analyses performed for this test is presented in Table 8.

2.3.4 Hyalella azteca

The amphipod, *H azteca*, was cultured and tested in a temperature controlled (24 ± 1°C) environmental chamber with a 16-h light:8-h dark photoperiod. Organisms were cultured according to an Environment Canada (2013) protocol, and slowly acclimated to RCPW with the addition of 2.06 mg/L of sodium bromide for one week prior to the initiation of bioassays.

Ten-d bioassays with *H. azteca* were conducted according to an established Environment Canada (2013) test method in 300-mL tall-form beakers with water renewal in all tests occurring on days 4 and 7, or on days 3 and 6. For each test, beakers were placed in an environmental chamber 24 h prior to test initiation and individually covered with plastic petri dishes. Gentle aeration was introduced at this time. On day 0, ten 7- to 14-d-old *H. azteca* were added to each of the test beakers. Bioassays consisted of five replicates for each EFPKT manipulation and associated controls.

Additional test conditions included:

- Tests initiated on July 27, 2015 (whole EFPKT and pore water) were fed 6.3 mg d.w. per beaker of TetraMin® fish food every other day. These tests did not meet the test criterion of 80% survival in the controls and results are not reported herein.
- The test initiated on August 18 (pore water) used the same water change and feeding regimen as described above with the addition of sodium bromide (NaBr) to each dilution. This test did not meet the 80% survival criterion and results are not reported herein.
- A fourth test was initiated (leachate) with the same feeding, water change and NaBr additions as above, however, a new reconstituted water was made using 50% ultra-pure de-ionized water and 50% carbon-filtered, bio-filtered Saskatoon municipal water as the base water. This test did not meet the 80% control survival criterion and results are not reported herein.
- A control experiment was conducted, with the original RCPW and prewashed sand. Different feeding and water change regimes were tested to determine the optimum feeding strategy for survival of control animals. The results are not reported herein.
- Based on the results of the control experiment, a fifth test (leachate) was initiated on October 5, with 1.0 mg (d.w.) TetraMin® fed daily and 0.5 mL *P. subcapitata* fed every other day to each test vessel. This test did not meet the 80% control survival criterion and it was concluded that the RCPW was not a good culture medium for *H. azteca*.
- A final test, outlined in Table 9, was conducted with the same feeding, water change and NaBr additions as the fifth test. The results of this test are reported herein. A summary of the various water chemistry analyses performed for this test is presented in Table 8.

2.3.5 Oncorhynchus mykiss

The 96-h and 28-d *O. mykiss* (rainbow trout) leachate bioassays were performed according to an Environment Canada (2000) protocol with minor modifications. Rainbow trout eyed eggs were obtained from Trout Lodge (Sumner, WA, USA), and upon hatching were slowly acclimated to RCPW for one week (12 °C) prior to testing. The chronic test (28-d) was initiated after that one week of acclimation. Ten (~6–7 d old) rainbow trout larvae were placed in 1,000-mL glass beakers containing 950-mL of control water (RCPW), or a 0.5x serial dilution (100 to 3.12%) of leachate (six treatments) with five replicates per treatment. Leachate consisted of 1/3 leachate from Batch 1 EFPKTs and 2/3 leachate from Batch 2 EFPKTs. The 96-h acute test was conducted following the same protocol as the 28-d bioassay, however, rainbow trout were added to test solutions <24-h after swim-up, approximately 14-d after hatching occurred. Both bioassays were conducted at 12 °C and test beakers were fed with fine trout chow twice daily after swim-up. Water changes for the chronic test occurred every second day until day 14, and then every day throughout the remainder of the test. The water was changed on day 2 of the acute test. Dissolved oxygen, temperature, and ammonia were measured daily. Summaries of the various water chemistry analyses performed for these tests are presented in Tables 10 and 11.

2.4 Statistical analysis

Median lethal concentrations (LC_{50}s) were calculated using the trimmed Spearman-Karber method (Hamilton et al., 1977). Inhibitory effects concentration estimates were determined using the Inhibition Concentration (IC_p) approach (Norberg-King, 1993). Confidence intervals were calculated using a bootstrap procedure that sub-sampled the original data set 99 times to obtain a robust estimate of the standard error (US EPA, 1993). For data that were normally distributed and homoscedastic, statistical differences were identified using a one-way analysis of variance (ANOVA) followed by Dunnett's test. Where tests for normality or equal variance failed, statistical differences were determined using Kruskal-Wallis one-way ANOVA on ranks followed by a Dunn's test for multiple comparisons.

3.0 Results

3.1 Analysis of EFPKTs and EFPKTs manipulations

3.1.1 Bulk clay and X-ray diffraction (XRD) minerology

The combined bulk and clay XRD results indicate that the EFPKTs samples consisted mainly of chlorite (25.5%), calcite (17.5%) and smectite (18.5%). Smaller amounts of illite (12.5%), biotite (7.5%), quartz (7%), plagioclase feldspar (4%), potassium feldspar (3.5%), pyrite (1.5%), and aragonite (2%) were also detected. Physical analysis indicated that clay (clay loam) comprised 26.7% of the total sample volume.

3.1.2 EFPKTs physicochemistry

The EFPKTs physicochemistry was very similar among the five Batch 1 and three Batch 2 subsamples submitted for analysis indicating good homogenization of EFPKTs prior to toxicity testing. The following results apply to the Batch 1 analysis: Average percent sand, silt and clay content (standard deviation in brackets) measured by the hydrometer method were 22% (1%), 50% (1%) and 29% (1%), respectively, indicating a high clay/silt content. The moisture content was 58% (2%), the total organic content was low at 0.60% (0.02%), and the cation exchange capacity of the samples was 58 (1) cmol+/Kg.

The following results apply to the Batch 2 analysis: Average percent sand, silt and clay content (standard deviation in brackets) measured by the hydrometer method were 22% (11%), 33% (1%) and 45% (11%), respectively (Batch 2 thus had lower silt and higher clay content than Batch 1). The moisture content was 46% (11%), the total organic content was low at 1.00% (0.20%), and the cation exchange capacity was 61 (3) cmol+/Kg.

3.1.3 Metal and trace element analysis of test materials

Total metals/elements analysis (weak acid extraction) are presented in Table 3 and compared against available benchmarks from multiple Canadian jurisdictions. The measured values for metals/trace elements in the instrumental standard 1640a were found to be 95.1 ± 4.1% of the certified values. However, the measured concentrations of trace elements in PACS 2 (marine sediment certified reference material, National Research Council of Canada, Ottawa, ON) were on average (±SD) only 29.9 ± 24.1% of the certified values. This discrepancy arose because the HCl extraction procedure used in this study was less aggressive than the extraction method (complete sediment digestion) used to derive the certified metals data for the PACS 2 sediment. The data summarized in Table 3 reveal that, despite the weaker substrate extraction procedure used, the Canadian sediment quality guidelines were exceeded for Cr and Ni.

The concentrations of selected dissolved metals/elements in the site water (overlying water, CPW), pore water and leachates are presented in Table 3 and Appendix B (test-specific data). In general, all three media were similarly elevated in the same elements, but there was no clear pattern regarding which medium (pore, leachate or surface water) had the highest levels of trace elements. The most abundant dissolved elements in these media were generally strontium (812–860 μg/L), molybdenum (177–398 μg/L), boron (62–86 μg/L), barium (17–47 μg/L), iron (8–37 μg/L), and nickel (3.7–10.0 μg/L). The trace element data for pore water (Table 3) and for all toxicity tests (Appendix A) were screened against available Canadian Council of Ministers of the Environment (CCME) benchmarks for the protection of aquatic life (CCME 1999; aluminum, boron, cadmium, copper, iron, lead, nickel, mercury, molybdenum, selenium, silver, uranium, and zinc). Strontium data were compared to the benchmark suggested by McPherson et al. (2014). Pore water in whole tailings tests displayed the greatest number of exceedances (Al, Cd, Cu, Fe, Hg, Ni, Se, Mo and Zn) with overlying water, isolated pore water, and leachate having fewer trace elements exceeding Table 3 guidelines.

3.1.4 General water chemistry and major ions

The water quality characteristics of surface water (CPW), pore water, and leachate are presented in Tables 1 and 2 (Batch 1). In general, CPW water had low alkalinity (49 ± 1 mg/L), but moderate hardness (171 ± 4 mg/L), potassium (149.9 ± 0.4 mg/L), sodium (111.2 ± 0.3 mg/L), sulfate (293.3 ± 1.0 mg/L), and nitrate (125.3 ± 0.7 mg/L), and high conductivity (1282 ± 1 µS/cm). These variables showed the same trends in the isolated EFPKTs pore water, although nitrate was lower in pore water (35 mg/L) compared to CPW.

Day 0 leachate and pore water chemistry data (isolated from EFPKTs Batch #1 and aerated a minimum of 24 h prior to testing) compiled across bioassays (conducted over a 6- and 12-week period, respectively; Table 27) demonstrate stability of variables among "batches" of pore water and leachate isolated from refrigerated EFPKTs.

3.2 Bioassays

3.2.1 Pseudokirchneriella subcapitata

Water chemistry data for the *P. subcapitata* tests are presented in Table 12 (leachate) and Table 13 (pore water). Metal and trace element data are presented in Appendix B, Table B1 (leachate) and Table B2 (pore water).

The controls for the two tests had the required minimum of 16 cell divisions and a CV (23.7%) similar to the CV (≤ 20 %) required by the test protocol. Stimulatory effects (enhanced growth) were observed for the two highest dilutions of pore water (3.12% and 6.25% pore water) (Table 14) with growth declining (growth inhibition) relative to the control group at 12.5% pore water and higher (Table 14). The IC_{50} could not be calculated because growth inhibition did not exceed 50% even in the 100% pore water treatment. The IC_{20} was 12.8% pore water, with a standard deviation of 8.7 and 95% confidence limits of 5.6 to 32.0% pore water. A statistical difference was detected between the control group and one or more of the various treatments using a Kruskal-Wallis one-way ANOVA on ranks ($p = 0.019$). Nevertheless, a subsequent *post-hoc* test (Dunn's test) failed to find a significant difference between the control group and any of the treatments.

For the leachate test, stimulatory effects (enhanced growth) were observed for concentrations up to and including 50% leachate (Table 14), before growth declined to slightly less than that of the control. However, the mean number of cell divisions was not significantly different between the 100% leachate and the control group ($p = 0.262$). The IC_{20} was 88.2% with a standard deviation of 7.6%. Confidence limits could not be calculated.

3.2.2 Daphnia pulex

In the acute 48-h test using pore water (water chemistry data in Table 15; metal/trace element data in Table B3), mortality was observed in only the highest concentration of pore water (100%) which displayed 80 ± 10% survival (Table 16), which was significantly different from the control ($p < 0.001$).

Acute toxicity was not observed in the acute 48-h test using leachate ($p = 0.100$) (water chemistry data in Table 17; metal/trace element data in Table B4), with survival in all leachate dilutions being similar to or higher than in the controls (Table 16).

Water chemistry data for the 21-d *D. pulex* reproduction test are presented in Table 18 and metal/trace element data are presented in Table B5. *Daphnia pulex* displayed a U-shaped concentration-response pattern in the 21-d chronic test for both reproduction and survival (Table 19) when exposed to EFPKTs pore water. Compared to the recommended number of neonates per animal for *D. magna* (60 per animal, ASTM, 2012), reproduction was good (number of neonates per animal in brackets) for the control (51) and 3.12% treatment (54.7), before declining in the 6.25% (40.5), 12.5% (15), and 25% (23) treatments, and then increasing in the 50% (59) and 100% pore water (64) treatments. Survival (percent survival in brackets) followed a similar pattern to reproduction: Control (90%), 3.12% (90%), 6.25% (40%), 12.5% (10%), 25% (20%), 50% (60%), and 100% (90%). Because the number of replicates containing surviving adults varied among treatments as a result of differential survival (i.e., reproduction was based on the number of neonates produced only by adult animals surviving until the end of the test), non-parametric statistical analysis was required to assess differences in reproduction. A statistical difference was detected between the treatments and the control based on a Kruskal-Wallis one-way ANOVA on ranks. However, a Dunn’s test for multiple comparisons found no statistical differences between any of the treatments (excluding the 12.5% treatment, which had only one replicate with surviving adults) and the control group ($p > 0.05$).

3.2.3 Chironomus dilutus

Water chemistry data for the 10-d *C. dilutus* whole EFPKTs exposure test are presented in Table 20; metal/trace element data for that test are presented in Tables B6 and A7. Increased mortality was observed for *C. dilutus* larvae in the 50% and 100% EFPKTs treatments (Table 21); however, only survival in the 100% EFPKTs was significantly less than in the controls ($p < 0.05$). The LC_{50} (lower and upper 95% confidence limits) was 92.3% (70.2–121.5) EFPKTs. The IC_{20} and IC_{50} could not be calculated because growth of the surviving larvae was not significantly inhibited, even in the 100% EFPKTs ($p = 0.059$).

3.2.4 Hyalella azteca

Water chemistry and metal/trace element data for this test are presented in Tables 22 (water chemistry), B8 (overlying water trace element concentrations) and B9 (pore-water trace element concentrations). After various attempts (described above), it was concluded that it was not possible to achieve ≥80 % survival of *H. azteca* in 10-d exposures using RCPW as overlying water. However, the negative control (dechlorinated, biofiltered municipal water and sand substrate) achieved 82% survival. A statistical difference in survival was detected between the treatments ($p = 0.038$; this test does not identify where the differences lie) and the negative control (one-way ANOVA), but no statistical differences were observed between treatments and the negative control for survival ($p = 0.081$, likely due to variability in survival within treatments) when compared using a Tukey *post-hoc* test (survival data presented in Table 23). The negative control animals were significantly larger ($p < 0.001$) than animals in all other treatments including the positive control (RCPW) and the sand substrate (positive control animals were 53% smaller than negative control animals). Animal size was not significantly different between any of the treatments and the positive control (RCPW and sand) (p = 0.480–1.000). The smallest animals (67.5% smaller than the negative control animals) were from the treatment containing both EFPKT substrate and CPW (Batch 1).

3.2.5 Oncorhynchus mykiss

Water chemistry and trace element data for the acute 4-d survival test are presented in Tables 24 and B10, respectively. No acute toxicity was observed in any leachate treatment in the 4-d survival test with *O. mykiss* fry, with 100% of animals surviving in the treatments and the control (therefore, these data were not presented in a table).

Water chemistry and metal/trace element data for the *O. mykiss* 28-d survival and growth test are presented in Tables 25 and B11, respectively. No acute toxicity was observed in the controls and the 25%, 50% and 100% leachate treatments (Table 26) in the 28-day survival and growth test. A Kruskal-Wallis one-way ANOVA on ranks detected a statistical difference between the treatments and the control (likely because of the response in the 12.5% treatment), but a statistical difference was not detected when followed up with a Dunn's test. The final mean biomass of the fish exposed to 100% leachate was significantly greater than that of the control fish ($p = 0.001$) and the fish in the 3.12% to 2% dilution treatments (one-way ANOVA followed by a Tukey test for multiple comparisons, p = 0.008–0.022). The total length of fish (tip of snout to tip of tale) was not significantly different among treatments and the control ($p = 0.121$).

4.0 Discussion

Whole EFPKTs, extracted pore water and leachate produced from the EFPKTs had mixed effects on the aquatic organisms used in this study. Biological endpoints such as growth and survival were reduced in the highest concentrations of whole tailings, pore water, or leachate tested for some organisms and test durations, but the differences were often not statistically significant compared to the respective controls. For fish, leachate demonstrated no statistically significant long-term effects on *O. mykiss* alevin and fry. For benthic invertebrates, whole (100%) EFPKTs clearly reduced *C. dilutus* larvae survival. From review of all data generated, the main constituents of toxicological concern in the EFPKTs appeared to be nitrogenous substances (e.g., ammonia and nitrite), and possibly some metals. Ammonia was elevated in the pore water extracted from the EFPKTs (42.00 ± 0.33 mg-N/L), and after aeration ranged from approximately 7.69 to 11.14 mg/L in the various tests. The toxicity of ammonia to most aquatic organisms is dependent upon the portion of total ammonia that is unionized (CCME, 1999). The fraction of unionized ammonia is largely dependent upon the pH, and, to a small extent, the temperature of the solution (Emerson et al., 1975). In the bioassays conducted, the initial pH of isolated leachate and pore water was similar with mean values of 7.72 ± 0.16 and 7.62 ± 0.16, respectively (Table 27) in the bioassays conducted. The fraction of unionized ammonia increases exponentially as the pH of a solution increases above 6.0 (Emerson et al., 1975). Therefore, it is highly likely that some of the toxic effects observed in this study were due to the concentration of ammonia. In addition, nitrite (29.95 mg/L) in EFPKTs pore water was highly elevated compared to CCME guidelines (0.197 mg NO_2/L). Although deposit-feeding midge larvae are relatively tolerant of ammonia (Schubauer-Berigan et al., 1995), whole tailings toxicity to this organism was likely due to a combination of high ammonia and nitrite, with the additional possibly of some dietary exposure to metals (e.g., Cr and Ni), which were found to be easily extractable from the whole tailings.

4.1 Bioassays

4.1.1 Pseudokirchneriella subcapitata

The growth of *P. subcapitata* (Table 14) was not statistically affected by either the EFPKTs pore water or leachate. However, cell growth might have been promoted in the intermediate pore water and leachate concentrations due to greater abundance of nutrients relative to the control solutions. Growth promotion was also observed in a previous assessment of Diavik pore water and leachates (de Rosemond and Liber, 2005). *P. subcapitata* cell division was reduced at higher pore water and leachate concentrations. Of the trace elements exceeding their respective guideline (Table 28), Mo was negatively correlated with cell division (r = -0.809, p = 0.0277) in the pore water test, but not in the leachate test (p >0.05). It could be a case of the Mo anion competing with the orthophosphate anion for uptake in the highest concentrations of leachate and pore water, but again, the differences in growth were not significant. Although the addition of nitrogen can have stimulatory effects on algae, total ammonia (ammonia/ammonium), nitrate and nitrite can cause inhibitory effects if they become sufficiently elevated (Rao and Sridharan, 1980). Nevertheless, green alga (Chlorophyceae), which includes *P. subcapitata*, are very tolerant of high total ammonia concentrations (the more toxic of the three nitrogen forms for algae), with optimal concentrations in the range of 138 mg/L and inhibitory concentrations occurring around 429 mg/L (Collos and Harrison, 2014). Therefore, toxicity due to elevated ammonia/ammonium was unlikely for *P. subcapitata*. The guideline for mercury was exceeded for the majority of concentrations tested (including the controls), but the measured concentrations did not increase with increasing concentration of pore water or leachate and can thus not be responsible for the observed effects.

4.1.2 Daphnia pulex

Neither pore water nor leachate were acutely toxic to *D. pulex* over the short-term (i.e., 48 h). Similarly, undiluted pore water did not affect survival or reproduction of *D. pulex* over the 21-d exposure duration. However, intermediate dilutions of pore water appeared to reduce survival (6.25 to 50% pore water) and reproduction (6.25 to 25% pore water). The reason for this is unclear as no measured variable(s) showed the same pattern (i.e., all metals/trace elements and ammonia concentrations decreased with increasing dilution of pore water or leachate with RCPW). It is speculated that residual wastewater treatment polymers could have something to do with this, but there is no easily implemented analytical method for quantifying the presence of such compounds in the pore water and leachate.

4.1.3 Chironomus dilutus

The *C. dilutus* bioassay results indicate that 100% EFPKTs was not a suitable substrate/habitat for this organism. The larvae were observed to readily burrow in all treatments, and the lack of an effect on growth suggests that substrate consistency (potentially affecting burrowing or nutrition due to incidental ingestion of small EFPKTs particles) was not an issue. However, this is speculative. Elevated nitrogenous compounds such as nitrite and ammonia were likely factors affecting survival in the whole EFPKTs. Ammonia concentrations in the overlying water in the control and treatments (1.82–3.95 mg-N/L, Table 20) were above CCME guidelines (0.244–0.395 mg N/L) for the range of pHs observed. In addition, pore water extracted from the EFPKTs was highly elevated in ammonia (42.00 ± 0.33 mg-N/L, unaerated pore water) and highly elevated in nitrite (29.95 mg NO_2/L; approx. 152-fold higher than the CCME guideline). *Chironomus dilutus* are known to be tolerant of elevated ammonia concentrations. For example, the total ammonia LC_{50} for *C. dilutus* was found to be very high (186 mg-N/L) at a test pH (pH 7.65) similar to that of the present study (Schubauer-Berigan et al., 1995). However, the 48-h nitrite LC_{50} was found to be 51.2 mg NO_2/L for *C. dilutus* at pH ~7.8–8.0 in exposures performed by the Great Lakes Environmental Center (2010). It is likely that the LC_{50} for nitrite would be lower for a 10-d exposure duration. Therefore, ammonia and nitrite in combination (not tested in the above studies) were likely responsible for most of the observed toxicity in the 100% EFPKTs treatment. Various metals/trace elements measured in the pore water were above the guidance values listed in Table 28. Those metals/trace elements present at concentrations above guidance values, and which showed a monotonic increase in concentration with increasing concentration of EFPKTs, included Al, Fe and Mo. It is therefore possible that these elements might have contributed to some of the observed toxicity. However, Mo has been demonstrated to be relatively non-toxic to *C. dilutus* (Liber et al., 2011).

4.1.4 Hyalella azteca

The RCPW was formulated to mimic the site water received with the EFPKT samples, less any contaminants of potential concern. However, whether acclimated to the RCPW or not, animal survival in the controls repeatedly did not meet the required 80%. It is unclear what individual or combination of constituents was the problem, or what necessary compounds(s) were missing. Exposure to actual CPW, pore water or leachate with sand substrate produced survival and growth results similar to the RCPW control (Table 23, no statistical differences). Exposure to 100% EFPKTs and overlying water consisting of either RCPW or CPW produced the lowest survival and the smallest animals of the various treatment combinations. This suggests that exposure to whole tailings was more stressful than exposure to either pore water or leachate in the presence of sand substrate. Once pore water was isolated, it was aerated for at least 24 h prior to toxicity testing. Aeration reduced ammonia concentrations in the pore water. Therefore, *H. azeteca* were likely exposed to higher concentrations of dissolved ammonia in whole EFPKTs compared to isolated pore water. This, in combination with either RCPW and CPW (which were clearly stressful to *H. azteca*), was likely responsible for the greater toxicity observed in these particular combinations of overlying water source and substrate. Several metals/trace elements were above CCME or other jurisdiction guidelines (Table 28), with Mo particularly elevated. However, similar to *C. dilutus*, *H. azteca* has been shown to be relatively insensitive to Mo exposure (10-d LC_{50} > 1488 mg/L, Liber et al., 2011).

4.1.5 Oncorhynchus mykiss

Fish are sensitive to increases in ammonia. For example, the acute (96-h LC_{50}) for total ammonia to *O. mykiss* range from 11 to 48 mg-N/L for 1-day-old fry to 4-year-old adults (Thurston and

Russo, 1983), with similar LC_{50} values for 12- and 35-day tests (Thurston et al., 1983). However, although the EFPKTs leachate was elevated in ammonia (up to 5.76 mg-N/L in 100% leachate), *O. mykiss* were unaffected by both short- and long-term exposure to 100% EFPKTs leachate. Similar to the survival and reproduction trends observed in the *D. pulex* 21-d exposure test, there was a decrease in survival in the mid-dilution concentrations. Nevertheless, the effect was slight and not statistically significant.

4.2 Analysis of EFPKTs and EFPKTs manipulations

Based on the weak acid extraction of metals/trace elements (Table 3), Cr and Ni concentrations were elevated in whole EFPKTs and likely available to *H. azteca* and *C. dilutus* in this study, likely through both aqueous and dietary exposure. Exceedances of Canadian interim sediment quality guidelines (ISQGs) and probable effect level (PEL) guidelines by these trace elements do not necessarily confirm that each metal/trace element is sufficiently elevated to cause toxicological effects, but the likelihood of toxicity is greater because HCl-extracted metals represent a more bioavailable metal pool compared to a metals pool requiring more aggressive extractions for release from the solid phase. Therefore, these elements have the potential for uptake by organisms exposed to the solid EFPKTs.

The similarities between the CPW and pore water chemistry suggest that a variety of constituents in the surface water of the tailings pond are at or near equilibrium with their concentrations in the pore water of the surficial tailings in the containment pond. Only Cd, Hg and Mo were elevated above aqueous guidelines in CPW and pore water. The guideline for Cd is very low (sub-parts per billion) and did not display trends consistent with the patterns of toxicity observed in the bioassays.

4.3 Conclusions

Whole EFPKTs, extracted pore water and leachate produced from the EFPKTs had mixed effects on the aquatic organisms used in this study. Biological endpoints such as growth and survival were reduced in the highest concentrations of tailings, pore water, or leachate tested for some organisms and test durations, but the differences were often not statistically significant compared with the respective controls. Whole EFPKTs clearly reduced *C. dilutus* survival. For *H. azteca*, the interpretation of response was complicated by stress accompanying exposure to CWP and uncontaminated RCPW compared to Saskatoon municipal water, but test results suggest that exposure to whole EFPKTs reduced animal survival (although not statistically significant). Isolated pore water affected *D. pulex* in the acute 4-d (reduced survival) and chronic 21-d tests (reduced survival and reproduction; response was likely complicated by the presence of waste water treatment polymers). Leachate demonstrated no statistically significant effects on *D. pulex* (4-d acute test) and *H. azteca* (10-d test), and was clearly not toxic to fish (*O. mykiss*; acute 4-d and chronic 28-d leachate exposures). From review of all data generated, the main constituents of toxicological concern in the whole EFPKTs appeared to be nitrogenous substances, especially ammonia and nitrite. This is supported by the reduced toxicity of isolated pore water and leachate compared to whole EFPKTs. Isolated pore water and leachate were aerated prior to testing and as a result had substantially lower concentrations of ammonia compared to unmanipulated EFPKTs pore water. Based on their relative ease of extraction using dilute acid, metals such as chromium and nickel are potentially available through both aqueous and dietary routes of exposure for deposit feeders such as *C. dilutus*, and could possibly have contributed to toxicity.

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Table 1. Water quality characteristics of Reconstituted Diavik Containment Pond water (RCPW) and of actual Containment Pond water (CPW) (mean ± SD).

Parameter	DL[a]	RCPW	CPW[b]
Alkalinity (mg/L as $CaCO_3$)	5	49 ± 1	49 ± 1.41
Ammonia (ammonium mg/L)	0.02	–	**17.23 ± 0.14**
Hardness (mg/L as $CaCO_3$)	5	194 ± 3	171 ± 4.24
pH	0.01	8.21 ± 0.01	7.24 ± 0.02
Conductivity (µs/cm)	10	1286 ± 4	1282 ± 0.71
Calcium (mg/L)	2	30.8 ± 0.1	32.3 ± 0.4
Chloride (mg/L)	0.02	94.0 ± 0.6	88.66 ± 0.96
Potassium (mg/L)	1	132 ± 1	149.9 ± 0.4
Magnesium (mg/L)	1	39 ± 0	32.4 ± 0.1
Sodium (mg/L)	1	102 ± 1	111.2 ± 0.3
Sulfate (mg/L)	6	301 ± 2	293.3 ± 1.0
Nitrite (mg/L)	0.02	BDL	**3.32 ± 0.69**
Nitrate (mg/L)	0.02	124.50 ± 0.71	125.3 ± 0.7
Orthophosphate (P) (mg/L)	0.030	–	0.036 ± 0.002[c]
Total dissolved solids (TDS mg/L)	10	950 ± 212	795 ± 7
Total organic carbon (mg/L)	0.50	<0.50	2.6 ± 0.1

[a] DL = Analytical detection limit.
BDL = Below detection limit.
[b] Batch 1
[c] Batch 2

Table 2. Mean (± SD) water quality characteristics of pore water samples and leachate samples isolated from EFPKTs collected from the Diavik Containment Pond, Diavik Diamond Mine, NT.

Parameter	DL	Pore water Batch 1	Leachate Batch 1	Leachate Batch 2
Alkalinity (mg/L as CaCO3)	5	41 ± 1	50 ± 1	60 ± 9
Ammonia (mg-N/L)	0.02	**42.00 ± 0.33**[a]	**5.5 ± 0.3**	**2.1 ± 0.2**
Hardness (mg/L as CaCO3)	5	165 ± 1	126 ± 1	227 ± 1
pH	0.01	7.70 ± 0.03	7.7 ± 0.01	8.2 ± 0.03
Conductivity (µs/cm)	10	1596 ± 1	1348 ± 1	1419 ± 2
Calcium (mg/L)	0.25	30.46 ± 0.56	44.46 ± 0.14	28.46 ± 0.12
Potassium (mg/L)	0.25	185.52 ± 0.62	198.22 ± 7.61	158.36 ± 1.93
Magnesium (mg/L)	0.125	13.48 ± 0.07	26.18 ± 0.32	46.00 ± 0.37
Sodium (mg/L)	0.1	130.8 ± 0.5	130.8 ± 1.1	116.0 ± 1.02
Sulfate (mg/L)	0.02	328.97 ± 3.27	400 ± 0[b]	320 ± 0[b]
Orthophosphate (P) (mg/L)	0.040	<0.040	0.035 ± 0.000[c]	0.035 ± 0.001[c]
Nitrate (mg/L)	0.02	35.28 ± 0.42	21 ± 1[d]	25 ± 3[d]
Nitrite (mg/L)	0.02	**29.95 ± 0.15**	**1.1 ± 0.1**	**1.1 ± 0.7**
Total dissolved solids (TDS mg/L)	0.50	1100 ± 0	720 ± 28	685 ± 49
Total organic carbon (mg/L)	10.0	5.1 ± 0.1	1.9 ± 0.1	1.4 ± 0.2

[a] Reduced to 9.3 ± 0.4 mg/L after aeration overnight.

[b] Detection limit was 5.0 mg/L.

[c] Detection limit was 0.030 mg/L for these samples.

[d] Detection limit was 0.20 mg/L.

Table 3. Mean concentrations of 1-M HCl-extracted metals/trace elements (mg/kg) in EFPKTs and dissolved trace elements (µg/L) in overlying water, EFPKTs leachate and EFPKTs pore water from the Containment Pond, Diavik Diamond Mine, NT.

Element	DL[a]	Sediment Batch 1	Containment Pond Batch 1	Leachate Batch 1	Pore water Batch 1
Aluminum	0.03	1679 ± 8	15.11 ± 8.81	0.53 ± 0.00	2.30 ± 0.06
Antimony	0.0016	0.03 ± 0.00	1.78 ± 0.03	3.08 ± 0.01	3.22 ± 0.07
Arsenic	0.02	1.92 ± 0.03[b]	1.00 ± 0.06	1.01 ± 0.03	1.59 ± 0.04
Barium	0.037	570.28 ±1.98	12.10 ± 0.37	46.55 ± 0.36	19.12 ± 0.35
Beryllium	0.0097	0.09 ± 0.00	BDL[b]	BDL	BDL
Boron	0.24	3.77 ± 0.33	59.13 ± 5.10	86.20 ± 1.95	83.15 ± 4.07
Cadmium	0.002	0.16 ± 0.01	**0.18** ± 0.00 [c]	**0.13** ± 0.01	**0.26** ± 0.01
Chromium	0.0092	**72.11 ± 0.26**	4.01±0.84	2.32±1.13	4.03±1.62
Cobalt	0.0018	13.86 ± 2.59	0.14 ± 0.00	0.15 ± 0.01	0.04 ± 0.00
Copper	0.025	16.14 ± 0.22	0.37 ± 0.00	0.47 ± 0.01	0.19 ± 0.04
Iron	0.01	9285.66 ± 255.31	30.52 ± 14.97	8.11 ± 4.50	17.05 ± 3.44
Lead	0.008	5.48 ± 0.23	0.02 ± 0.00	0.03 ± 0.00	0.02 ± 0.00
Manganese	0.002	296.29 ± 1.91	1.01 ± 0.24	4.94 ± 0.11	1.69 ± 0.08
Mercury	0.018	BDL	**0.07** ± 0.00	**0.06** ± 0.00	**0.07** ± 0.00
Molybdenum	0.013	1.03 ± 0.03	**401.96** ± 3.30	**176.90** ± 13.01	**404.49** ± 6.01
Nickel	0.0089	**330.32 ± 41.94**	8.81 ± 0.19	9.96 ± 0.35	3.70 ± 0.14
Selenium	0.025	0.14 ± 0.01	0.28 ± 0.10	0.56 ± 0.11	0.46 ± 0.01
Silver	0.009	0.03 ± 0.00	BDL	BDL	BDL
Strontium	0.023	410.99 ± 1.71	862.12 ± 9.34	834.09 ± 63.42	812.47 ± 6.64
Thallium	0.003	0.06 ± 0.01	0.03 ± 0.00	0.04 ± 0.00	0.02 ± 0.00
Titanium	0.045	141.02 ± 2.76	1.06 ± 0.41	0.04 ± 0.04	0.17 ± 0.10
Uranium	0.0007	3.59 ± 0.05	0.01 ± 0.01	0.07 ± 0.00	0.01 ± 0.00
Vanadium	0.006	12.85 ± 0.13	2.00 ± 0.03	1.18 ± 0.03	1.51 ± 0.07
Zinc	0.013	17.89 ± 0.79	0.69 ± 0.60	1.93 ± 1.10	4.14 ± 0.48

[a] DL: Analytical detection limit.

[b] Bold indicates value is above the available ISQG or LEL guideline value in Table 28.
Underline indicates that the value is above the available PEL guideline value in Table 28.

[c] BDL = Below detection limit.

Table 4. Summary of bioassays performed using EFPKTs media collected from Containment Pond, Diavik Diamond Mine, NT.

Test species	Manipulation	Date test initiated	Length of test
Chironomus dilutus	Whole tailings	24-Jun	10-d
Hyalella azteca	Whole tailings	27-Jul	10-d
Hyalella azteca	Pore water	27-Jul	10-d
Hyalella azteca	Pore water	18-Aug	10-d
Hyalella azteca	Leachate	01-Sep	10-d
Hyalella azteca	Whole tailings	04-Sep	10-d
Hyalella azteca	Leachate	05-Oct	10-d
Hyalella azteca	Combination test [a]	26-Oct	10-d
Pseudokirchneriella subcapitata	Pore water	05-Oct	72-h
Pseudokirchneriella subcapitata	Leachate	05-Oct	72-h
Daphnia pulex	Pore water	12-Jul	48-h
Daphnia pulex	Pore water	20-Aug	21-d
Daphnia pulex	Leachate	12-Aug	48-h
Oncorhynchus mykiss	Leachate	29-Oct	96-h
Oncorhynchus mykiss	Leachate	23-Oct	28-d

[a] A more detailed breakdown of this test is presented in Table 9.

Table 5. Summary of water quality sample collection for the 72-h *Pseudokirchneriella subcapitata* pore-water and leachate bioassays.

	Hours			
Variable	0 [a]	24	48	72
Dissolved oxygen (mg/L)	●			●
Temperature (°C)	●			●
pH	●			●
Conductivity (µS/cm)	●			●
Alkalinity (mg/L as $CaCO_3$)	●			●
Hardness (mg/L as $CaCO_3$)	●			●
Ammonia (mg/L)	●			●
ICP-MS	●			●

● Denotes complete sample analysis.

[a] Only the control and 12.5%, 50% and 100% concentrations of pore water and leachate were analyzed on day 0.

Table 6. Summary of water quality sample collection for the 48-h *Daphnia pulex* pore-water and leachate bioassays.

	Hours		
Variable	0	24	48
Dissolved oxygen (mg/L)	●		●
Temperature (°C)	●		●
pH	●		●
Conductivity (µS/cm)	●		●
Alkalinity (mg/L as $CaCO_3$)	●		●
Hardness (mg/L as $CaCO_3$)	●		●
Ammonia (mg/L)	●		●
ICP-MS	●		●

● Denotes complete sample analysis.

Table 7. Summary of water quality sample collection for the 21-day *Daphnia pulex* pore-water bioassay.

	Days																					
Variable	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Dissolved oxygen (mg/L)	●			●			●			●			●			●			●			●
Temperature (°C)	●			●			●			●			●			●			●			●
pH	●			●			●			●			●			●			●			●
Conductivity (µS/cm)	●			●			●			●			●			●			●			●
Alkalinity (mg/L as $CaCO_3$)	●			●			●			●			●			●			●			●
Hardness (mg/L as $CaCO_3$)	●			●			●			●			●			●			●			●
Ammonia (mg/L)	●			●			●			●			●			●			●			●
ICP-MS	●			◊			◊			◊			●			◊			◊			●

● Denotes complete sample analysis.

◊ Denotes samples archived for potential future analysis.

Table 8. Summary of water quality sample collection for the 10-d bioassays with *Chironomus dilutus* and *Hyalella azteca*.

	Days										
Variable	0	1	2	3	4	5	6	7	8	9	10
Dissolved oxygen (mg/L)	●			●			●				●
Temperature (°C)	●			●			●				●
pH	●			●			●				●
Conductivity (µS/cm)	●			●			●				●
Alkalinity (mg/L as $CaCO_3$)	●			●			●				●
Hardness (mg/L as $CaCO_3$)	●			●			●				●
Ammonia (mg/L)	●			●			●				●
ICP-MS	●			◊			◊				●

● Denotes complete sample analysis.

◊ Denotes samples archived for potential future analysis.

Table 9. Summary of final *Hyalella azteca* bioassays conducted on Oct. 26, 2015 with EFPKTs media collected from the Containment Pond, Diavik, Diamond Mine, NT.

Water type	Sediment type	NaBr Addition
Reconstituted Containment Pond water	Control Sand	2.0 mL
Reconstituted Containment Pond water	100% EFPKT	2.0 mL
Saskatoon municipal water	Control Sand	2.0 mL
Saskatoon municipal water	100% EFPKT	2.0 mL
Diavik Containment Pond water	Control Sand	none
Diavik Containment Pond water	100% EFPKT	None
100% Leachate	Control Sand	None
50% Pore water	Control Sand	1.0 mL
100% Pore water	Control Sand	None

Table 10. Summary of water quality sample collection for the 96-h *Oncorhynchus mykiss* leachate bioassay.

	Hours				
Variable	0	24	48	72	96
Dissolved oxygen (mg/L)	●		●		●
Temperature (°C)	●		●		●
pH	●		●		●
Conductivity (µS/cm)	●		●		●
Alkalinity (mg/L as $CaCO_3$)	●		●		●
Hardness (mg/L as $CaCO_3$)	●		●		●
Ammonia (mg/L)	●		●		●
ICP-MS	●		◊		●

● Denotes complete sample analysis.

◊ Denotes samples archived for potential future analysis.

Table 11. Summary of water quality sample collection for the 28-day early life stage *Oncorhynchus mykiss leachate* bioassay.

	Days																												
Variable	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Dissolved oxygen (mg/L)	●		●		●		●		●		●		●		●		●	●	●	●	●	●	●	●	●	●	●	●	●
Temperature (°C)	●		●		●		●		●		●		●		●		●	●	●	●	●	●	●	●	●	●	●	●	●
pH	●				●								●				●								●				●
Conductivity (µS/cm)	●				●								●				●								●				●
Alkalinity (mg/L as $CaCO_3$)	●				●								●				●								●				●
Hardness (mg/L as $CaCO_3$)	●				●								●				●								●				●
Ammonia (mg/L)	●	●			●		●		●		●		●		●		●	●	●	●	●	●	●	●	●	●	●	●	●
ICP-MS	●				◊								●				◊								◊				●

● Denotes complete sample analysis.
◊ Denotes samples archived for potential future analysis.

Table 12. Test conditions for the 72-h *Pseudokirchneriella subcapitata* growth bioassay conducted with leachate isolated from the EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

			% EFPKTs leachate					
Variable		Control	3.12	6.25	12.5	25	50	100
Dissolved oxygen (mg/L)	Initial	8.19	-	-	8.11	-	8.08	8.19
	Final	8.08	8.07	8.06	8.05	8.04	7.99	7.98
Temperature (°C)	Initial	24.1	-	-	24.3	-	24.3	24.3
	Final	24.8	24.6	24.8	25	25.1	24.8	24.8
pH	Initial	8.18	-	-	8.14	-	8.05	8.01
	Final	9.33	9.12	9.27	9.23	9.14	9.05	8.88
Conductivity (µS/cm)	Initial	1329	-	-	1367	-	1438	1538
	Final	1321	1362	1383	1381	1414	1432	1528
Alkalinity (mg/L as $CaCO_3$)	Initial	80	-	-	84	-	58	48
	Final	52	100	88	88	84	80	56
Hardness (mg/L as $CaCO_3$)	Initial	240	-	-	224	-	208	186
	Final	248	252	260	244	248	202	192
Ammonia (mg-N/L)	Initial	0.10	-	-	0.76	-	2.20	4.39
	Final	0.05	0.06	0.04	0.07	0.06	0.98	3.29

Table 13. Test conditions for the 72-h *Pseudokirchneriella subcapitata* growth bioassay conducted with pore water extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

			% EFPKTs pore water					
Variable		Control	3.12	6.25	12.5	25	50	100
Dissolved oxygen	Initial	8.24	-	-	8.12	-	8.11	8.09
(mg/L)	Final	8.24	8.18	8.19	8.05	8.01	7.86	7.96
Temperature	Initial	23.8	-	-	24.1	-	24.3	24.3
(°C)	Final	24.4	24.6	24.7	24.8	24.9	24.6	24.7
	Initial	8.2	-	-	8.2	-	8.14	8.05
pH	Final	9.6	9.33	9.2	9.18	9.31	8.86	8.5
Conductivity	Initial	1320	-	-	1391	-	1521	1713
(µS/cm)	Final	1338	1378	1363	1387	1446	1539	1709
Alkalinity	Initial	60	-	-	76	-	48	36
(mg/L as CaCO3)	Final	92	100	80	84	64	56	28
Hardness	Initial	224	-	-	220	-	216	204
(mg/L as CaCO3)	Final	244	244	240	232	244	220	212
Ammonia	Initial	0.061	-	-	1.1224	-	4.392	7.686
(mg-N/L)	Final	0.0854	0.061	0.061	0.0366	0.8296	2.928	6.71

Table 14. Mean (± SD) number of cell divisions in the 72-h *Pseudokirchneriella subcapitata* bioassays conducted with pore water and leachate extracted from EFPKTs collected from Diavik Containment Pond, Diavik Diamond Mine, NT.

EFPKT Manipulation	Concentration of solution (%)	Mean cell growth	Coefficient of Variation (%)	Mean (± SD) cell divisions
Pore water	Control	634,000	21.3	51 ± 18
	3.12	831,000	14.8	61 ± 12
	6.25	664,500	25.5	61 ± 15
	12.5	593,750	37.4	43 ± 22
	25	487,500	35.1	35 ± 16
	50	475,625	36.2	34 ± 9
	100	414,500	38.7	28 ± 7
Leachate	Control	553,500	23.6	46 ± 19
	3.12	644,000	30.6	51 ± 21
	6.25	704,000	33.0	49 ± 14
	12.5	719,500	27.5	61 ± 18
	25	784,000	40.4	68 ± 32
	50	812,500	37.3	65 ± 24
	100	520,500	22.7	38 ± 7

Table 15. Water chemistry for the 48-h *Daphnia pulex* bioassays in pore water extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

		% EFPKTs pore water					
Variable[a]	Control	3.12%	6.25%	12.50%	25%	50%	100%
Dissolved oxygen (mg/L)	7.89 ± 0.06	7.89 ± 0.04	7.86 ± 0.03	7.81 ± 0.07	7.83 ± 0.03	7.80 ± 0.01	7.83 ± 0.03
Temperature (°C)	24.6 ± 0.12	24.7 ± 0.25	24.7 ± 0.23	24.9 ± 0.08	24.8 ± 0.15	24.9 ± 0.19	24.9 ± 0.12
pH	7.78 ± 0.04	7.71 ± 0.02	7.70 ± 0.02	7.72 ± 0.02	7.75 ± 0.03	7.72 ± 0.02	7.66 ± 0.04
Conductivity (µS/cm)	1319 ± 11	1309 ± 7	1309 ± 13	1322 ± 13	1331 ± 6	1358 ± 8	1403 ± 13
Alkalinity (mg/L as $CaCO_3$)	65 ± 2	62 ± 1	60 ± 2	59 ± 1	58 ± 3	49 ± 5	48 ± 3
Hardness (mg/L as $CaCO_3$)	213 ± 5	211 ± 5	211 ± 6	206 ± 4	193 ± 2	170 ± 2	121 ± 1
Ammonia (mg-N/L)	0.09 ± 0.01	0.42 ± 0.02	0.76 ± 0.03	1.42 ± 0.17	2.50 ± 0.33	5.04 ± 0.25	10.5 ± 1.4

[a] Values presented are the mean (± SD) of the values measured at the start and end of the test.

Table 16. Mean survival (± SD) in the 48-h *Daphnia pulex* bioassays conducted with pore water and leachate extracted from EFPKT collected from the Containment Pond at the Diavik Diamond Mine, NT.

EFPKT Manipulation	Concentration of solution (%)	Survival (%)
Pore water	Control	100
	3.12	100
	6.25	100
	12.5	100
	25	98 ± 4.4
	50	98 ± 4.4
	100	80 ± 10
Leachate	Control	94 ± 5.4
	3.12	92 ± 8.3
	6.25	100
	12.5	100
	25	100
	50	96 ± 8.9
	100	94 ± 8.9

Table 17. Water chemistry for the 48-h *Daphnia pulex* bioassay with leachate extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

		% EKPFT					
Variable[a]	Control	3.12%	6.25%	12.50%	25%	50%	100%
Dissolved oxygen (mg/L)	7.92 ± 0.04	7.89 ± 0.03	7.93 ± 0.03	7.89 ± 0.04	7.81 ± 0.06	7.80 ± 0.06	7.81 ± 0.01
Temperature (°C)	24.4 ± 0.26	24.4 ± 0.23	24.3 ± 0.12	24.4 ± 0.21	24.5 ± 0.24	24.5 ± 0.18	24.5 ± 0.08
pH	7.78 ± 0.09	7.85 ± 0.09	7.88 ± 0.08	7.85 ± 0.10	7.83 ± 0.09	7.80 ± 0.09	7.74 ± 0.09
Conductivity (µS/cm)	1240 ± 5	1259 ± 6	1263 ± 3	1271 ± 6	1281 ± 4	1303 ± 5	1347 ± 4
Alkalinity (mg/L as $CaCO_3$)	62 ± 5	63 ± 2	62 ± 2	60 ± 2	59 ± 2	55 ± 2	51 ± 1
Hardness (mg/L as $CaCO_3$)	186 ± 10	189 ± 6	189 ± 4	186 ± 2	178 ± 3	161 ± 4	127 ± 2
Ammonia (mg-N/L)	0.08 ± 0.02	0.30 ± 0.01	0.52 ± 0.03	0.82 ± 0.15	1.69 ± 0.14	3.3 ± 0.5	7.0 ± 0.3

[a] Values presented are the mean (± SD) of the mean values measured over the 10-d period (*n* = 4).

Table 18. Water chemistry for the 21-d *Daphnia pulex* bioassay with pore water extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

		% EFPKTs pore water					
Variable	Control	3.12%	6.25%	12.50%	25%	50%	100%
Dissolved oxygen (mg/L)	8.14 ± 0.25	8.24 ± 0.35	8.37 ± 0.42	8.44 ± 0.34	8.35 ± 0.29	8.16 ± 0.27	8.18 ± 0.25
Temperature (°C)	23.8 ± 0.35	23.9 ± 0.30	23.8 ± 0.27	23.8 ± 0.34	23.9 ± 0.32	23.9 ± 0.36	23.9 ± 0.36
pH	8.04 ± 0.14	8.09 ± 0.18	8.06 ± 0.24	8.06 ± 0.26	8.01 ± 0.22	7.95 ± 0.15	7.87 ± 0.15
Conductivity (μS/cm)	1412 ± 107	1448 ± 91	1452 ± 107	1456 ± 112	1454 ± 80	1568 ± 97	1703 ± 149
Alkalinity (mg/L as $CaCO_3$)	69 ± 13	66 ± 7	65 ± 7	64 ± 5	58 ± 6	59 ± 10	51 ± 8
Hardness (mg/L as $CaCO_3$)	218 ± 17	225 ± 18	214 ± 16	217 ± 17	204 ± 30	208 ± 18	191 ± 33
Ammonia (mg-N/L)	0.23 ± 0.14	0.57 ± 0.30	0.71 ± 0.28	0.99 ± 0.57	2.32 ± 0.52	4.92 ± 0.83	10.22 ± 1.40

Table 19. Survival and reproduction (mean ± SD number of neonates per replicate) in the 21-d *Daphnia pulex* bioassay conducted with pore water extracted from EKFPTs collected from the Diavik Containment Pond, Diavik Diamond Mine, NT.

		Concentration of pore water (%)					
Endpoint	Control	3.12	6.25	12.5	25	50	100
Survival (%)	90	90	40	10	20	60	90
Neonates per replicate	51 ± 9	55 ± 9	41 ± 9	15	34 ± 5	59 ± 10	64 ± 13

Table 20. Test conditions for the 10-d *Chironomus dilutus* bioassay conducted with whole EFPKT collected from the Diavik Containment Pond at the Diavik Diamond Mine, NT.

		% Whole EFPKT				
Variable [a]	Control	6.25	12.5	25	50	100
Dissolved oxygen (mg/L)	7.73 ± 0.29	7.81 ± 0.19	7.80 ±0.34	7.89 ± 0.16	7.88 ± 0.16	7.59 ± 0.58
Temperature (°C)	24.3 ± 0.15	24.3 ± 0.22	24.3 ± 0.23	24.2 ± 0.50	24.5 ± 1.12	24.2 ± 0.29
pH	7.87 ± 0.12	8.03 ± 0.13	8.09 ± 0.15	8.07 ± 0.16	8.06 ± 0.15	8.07 ± 0.12
Conductivity (µS/cm)	1374 ± 52	1387 ± 59	1409 ± 62	1398 ± 54	1410 ± 52	1394 ± 46
Alkalinity (mg/L as $CaCO_3$)	85 ± 12	97 ± 17	102 ± 21	97 ± 23	97 ± 22	90 ± 24
Hardness (mg/L as $CaCO_3$)	232 ± 36	238 ± 15	248 ± 19	238 ± 17	237 ± 18	206 ± 12
Ammonia (mg-N/L)	2.85 ± 2.08	1.82 ± 1.59	2.15 ± 1.89	1.91 ± 1.51	2.29 ± 0.88	3.95 ± 1.81

[a] Values presented are the mean (± SD) of the mean values measured over the 10-d period (*n* = 4).

Table 21. Survival (± SD) and mean (± SD) biomass (dry weight) of *Chironomus dilutus* larvae in a 10-d bioassay conducted with EFPKTs from the Containment Pond, Diavik Diamond Mine, NT.

		% EFPKT				
Endpoint	Control	6.25	12.5	25	50	100
Survival (%)	82.0 ± 20.1	76.0 ± 18.2	84.0 ± 8.9	82.0 ± 19.2	64.0 ± 18.2	38.0 ± 23.9*
Biomass (mg d.w. per animal)	0.10 ± 0.06	0.23 ± 0.14	0.15 ± 0.03	0.11 ± 0.02	0.12 ± 0.05	0.19 ± 0.08

* Statistically significant.

Table 22. Water chemistry in the final *Hyalella azteca* 10-d bioassay conducted with different EFPKT media from the Containment Pond, Diavik Diamond Mine, NT.

Overlying medium	Reconstituted Containment Pond water		Saskatoon municipal water		Containment Pond water		50% pore water	100% pore water	100% leachate
Test substrate	Sand	100% EFPKT	Sand	100% EFPKT	Sand	100% EFPKT	Sand	Sand	Sand
Variable[b]									
Dissolved oxygen (mg/L)	8.06 ± 0.13	8.03 ± 0.14	8.14 ± 0.33	7.87 ± 0.15	8.04 ± 0.15	7.80 ± 0.12	8.02 ± 0.10	7.99 ± 0.11	7.93 ± 0.10
Temperature (°C)	22.8 ± 1.09	22.7 ± 1.12	22.7 ± 1.04	23.1 ± 0.78	22.8 ± 1.21	23.0 ± 1.17	23.0 ± 0.91	23.0 ± 1.12	23.1 ± 1.01
pH	8.13 ± 0.13	8.08 ± 0.08	8.47 ± 0.08	8.29 ± 0.09	7.65 ± 0.14	7.91 ± 0.08	7.95 ± 0.09	7.80 ± 0.07	7.83 ± 0.06
Conductivity (µS/cm)	1477 ± 95	1494 ± 48	541 ± 23	737 ± 74	1322 ± 55	1478 ± 80	1607± 173	1822 ± 204	1610 ± 126
Alkalinity (mg/L as $CaCO_3$)	70 ± 5	66 ± 4	148 ± 8	104 ± 12	32 ± 7	52 ± 11	58 ± 4	47 ± 3	52 ± 3
Hardness (mg/L as $CaCO_3$)	248 ± 17	228 ± 11	222 ± 14	151 ± 13	212 ± 13	220 ± 34	229 ± 25	226 ± 31	200 ± 17
Ammonia (mg-N/L)	0.21 ± 0.28	2.68 ± 1.67	017 ± 0.20	2.45 ± 1.91	0.50 ± 1.28	2.48 ± 1.98	5.63 ± 0.76	11.14 ± 0.81	6.77 ± 1.24

Table 23. Mean survival (± SD) and growth (± SD) (dry weight) of *Hyalella azteca* in the final 10-d bioassay conducted with different manipulations of EFPKTs from the Containment Pond, Diavik Diamond Mine, NT.

Overlying medium	Reconstituted Containment Pond water		Saskatoon municipal Water		Containment Pond water		50% pore water	100% pore water	100% leachate
Test substrate	Sand	100% EFPKTs	Sand	100% EFPKTs	Sand	100% EFPKTs	Sand	Sand	Sand
<u>Endpoint</u>									
Survival (%)	70 ± 20	44 ± 26	82 ± 24	74 ± 13	58 ± 15	46 ± 17	72 ± 19	76 ± 13	68 ± 23
Biomass (µg d.w. per animal)	20.3 ± 5.7*	18.9 ± 6.9*	43.0 ± 3.8	22.7 ± 3.2*	26.0 ± 1.8*	14.0 ± 4.2*	22.3 ± 7.5*	24.0 ± 2.7*	20.9 ± 9.7*

* Significantly different from the positive control ($p \leq 0.05$).

Table 24. Water chemistry for the 96-h *Oncorhynchus mykiss* survival bioassay conducted with leachate extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

		% EFPKT leachate					
Variable	Control	3.12	6.25	12.5	25	50	100
Dissolved oxygen (mg/L)	9.12 ± 0.72	9.04 ± 0.70	8.68 ± 1.03	9.08 ±0.70	8.39 ± 1.21	9.06 ± 0.64	8.91 ± 0.72
Temperature (°C)	13.4 ± 0.42	13.2 ± 0.27	13.2 ± 0.19	13.2 ± 0.20	13.1 ± 0.27	13.1 ± 0.28	13.1 ± 0.29
pH	7.45 ± 0.27	7.39 ± 0.22	7.41 ± 0.20	7.42 ± 0.18	7.38 ± 0.16	7.48 ± 0.24	7.45 ± 0.18
Conductivity (µS/cm)	1313 ± 51	1321 ± 50	1322 ± 48	1333 ± 40	1349 ± 39	1376 ± 18	1460 ± 20
Alkalinity (mg/L as $CaCO_3$)	53 ± 11	58 ± 12	62 ± 6	63 ± 6	62 ± 7	64 ± 6	67 ± 5
Hardness (mg/L as $CaCO_3$)	209 ± 7	213 ± 9	213 ± 7	212 ± 8	214 ± 7	216 ± 6	229 ± 7
Ammonia (mg-N/L)	1.06 ± 0.88	1.10 ± 0.98	1.49 ± 1.13	1.62 ± 1.09	2.18 ± 1.02	3.50 ± 1.13	5.60 ± 1.19

Table 25. Water chemistry for the 28-d *Oncorhynchus mykiss* survival bioassay conducted with leachate extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT.

		% EFPKT					
Variable	Control	3.12	6.25	12.5	25	50	100
Dissolved oxygen (mg/L)	9.25 ± 0.57	9.15 ± 0.43	9.13 ± 0.51	9.11 ± 0.46	8.98 ± 0.78	9.18 ± 0.38	8.83 ± 0.71
Temperature (°C)	13.4 ± 0.32	13.2 ± 0.2	13.1 ± 0.19	13.1 ± 0.21	13.1 ± 0.25	13.0 ± 0.29	13.0 ± 0.28
pH	7.70 ± 0.13	7.66 ± 0.10	7.67 ± 0.09	7.59 ± 0.15	7.63 ± 0.15	7.59 ± 0.15	7.59 ± 0.17
Conductivity (µS/cm)	1289 ± 42	1304 ± 31	1308 ± 33	1315 ± 29	1338 ± 23	1370 ± 20	1463 ± 83
Alkalinity (mg/L as $CaCO_3$)	66 ± 6	66 ± 5	66 ± 4	66 ± 5	67 ± 7	68 ± 6	69 ± 5
Hardness (mg/L as $CaCO_3$)	209 ± 6	210 ± 7	211 ± 8	211 ± 7	212 ± 6	215 ± 8	221 ± 14
Ammonia (mg-N/L)	1.93 ± 0.96	1.99 ± 1.01	1.99 ± 1.14	2.29 ± 1.14	2.89 ± 1.17	3.79 ± 1.25	5.76 ± 1.39

Table 26. Mean survival, length (mm) and growth (dry weight) of *Oncorhynchus mykiss* in a 28-d bioassay conducted with leachate extracted from EFPKTs collected from the Containment Pond, Diavik Diamond Mine, NT. All data are ± SD.

		% EFPKT					
Endpoint	Control	3.12	6.25	12.5	25	50	100
Surivial (%)	100	98 ± 4.9	96 ± 5.4	86 ± 8.3	100	100	100
Length (mm)	33.1 ± 2.0	33.5 ± 1.6	33.4 ± 1.8	33.4 ± 1.9	33.7 ± 1.8	34.2 ± 1.8	34.4 ± 1.9
Biomass (mg per animal d.w.)	48.2 ± 10.9	50.4 ± 9.7	50.2 ± 13.2	50.5 ± 11.1	51.0 ± 11.9	53.7 ± 12.3	58.1 ± 12.8

Table 27. Time zero 100% leachate and pore-water water quality metrics from multiple tests run with Diavik Containment Pond water, Diavik Diamond Mine, NT

Variable	Leachate [a]	Pore water [b]
pH	7.72 ± 0.16	7.62 ± 0.16
Conductivity (µS/cm)	1454 ± 81	1483 ± 96
Alkalinity (mg/L as CaCO3)	51 ± 2	47 ± 6
Hardness (mg/L as CaCO3)	159 ± 30	142 ± 23
Ammonia (mg-N/L)	7.02 ± 1.28	11.18 ± 1.18

[a] Values presented are the mean (± SD) of the mean starting test values (t = 0) measured in *H. azteca* experiments 4 and 6 (not reported), *D. pulex* 48-h test, and *P. subcapitata* 72-h test, all of which spanned a 5-week period from September 1 to October 5, 2015.

[b] Values presented are the mean (± SD) of the mean starting test values (t = 0) measured in *H. azteca* experiments 2 and 3 (not reported), *D. pulex* 48-h and 21-d tests, and *P. subcapitata* 72-h test, all of which spanned a twelve-week period from July 12 to October 5, 2015.

Table 28. Selected water and sediment quality guidelines used in Canada.

	Water (µg/L)		**Sediment** (mg/kg d.w.)			
	CCME[a]		CCME/OMOEE		Thompson et al. (2005)	
	Short-term	Long-term	ISQG[b]	PEL[c]	LEL	LEL
Aluminum		100				
Antimony						
Arsenic		5	5.9	17.0		
Barium						
Beryllium						
Boron	29,000	1,500				
Cadmium	1	0.09	0.60	3.5		
Chromium (total)			37.3	90.0		
Cobalt						
Copper		4	35.7	197.0		
Iron (%)		300	2[d]	4[d]		
Lead		7	35.0	91.3		
Manganese			460[d]	1,100[d]		
Mercury		0.026	0.170	0.486		
Molybdenum		73			8.3	13.8
Nickel		150	16[d]	75[d]	21	23.4
Selenium		1	2.0[e]			
Silver		0.25				
Strontium		10,700[f]				
Thallium		0.8				
Tin						
Titanium						
Uranium	33	15			32	104.4
Vanadium					27.3	35.2
Zinc		30	123	315		
Ammonia		variable				
Chloride	640000	120,000				
pH		6.5 to 9.0				
Nitrate	550000	13,000				
Nitrite (NO_2-N/L)		60				
Nitrite (NO_2/L)		197				
Sulphate						
TDS						

[a] CCME (1999).

[b] Interim sediment quality guideline.

[c] Probable effect level.

[d] Lowest effect level (left column) and severe effect level (right column) (OMOEE, 1993).

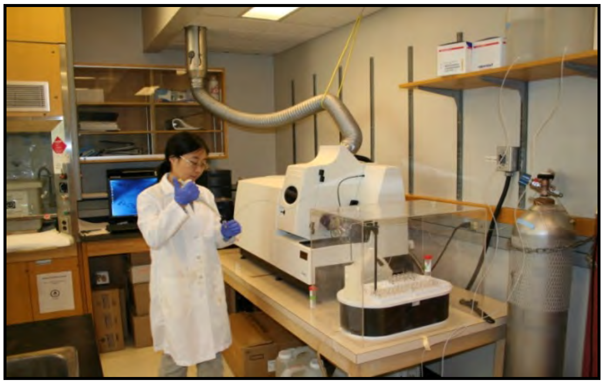
[e] Alert concentration (BC MOE, 2014).

[f] Chronic exposure guideline (McPherson et al., 2014).

APPENDIX A
Photographs of experimental facilities, toxicity tests and experimental organisms

Test Chamber used for Experiments

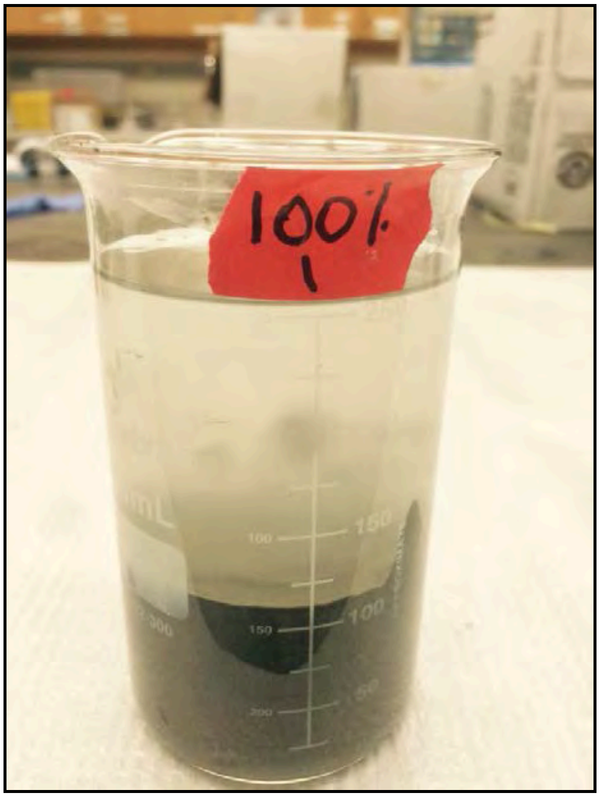
Metal/Trace Element Analysis Lab



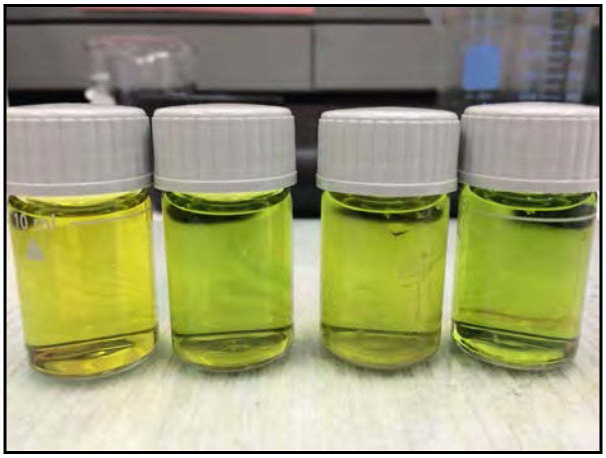
Routine Water Quality Analysis Lab

Aquatic Facility used for Holding Fish

Extra Fine Processed Kimberlite Tailings

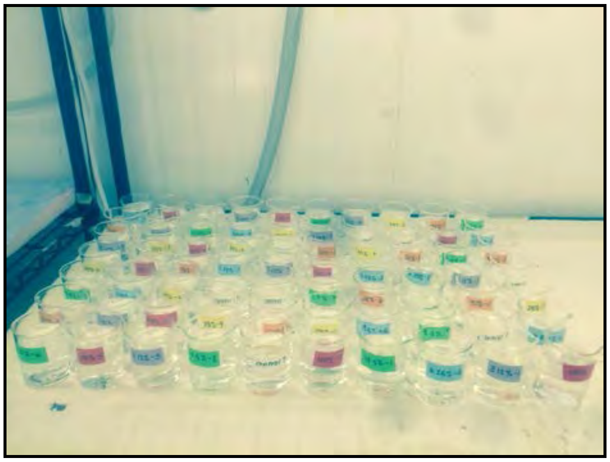


Algae Toxicity Test



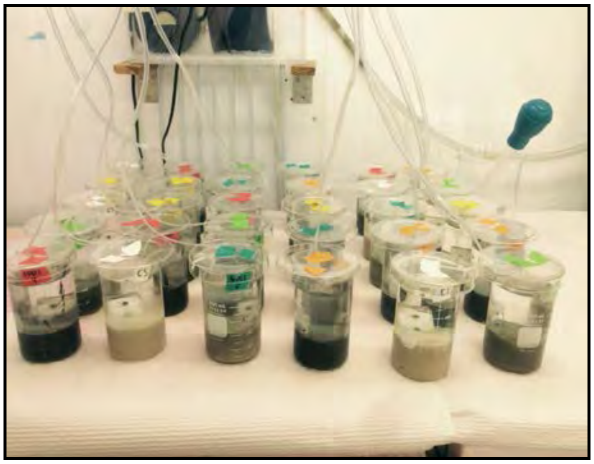
Pseudokirchneriella subcapitata

Daphnia Toxicity Test



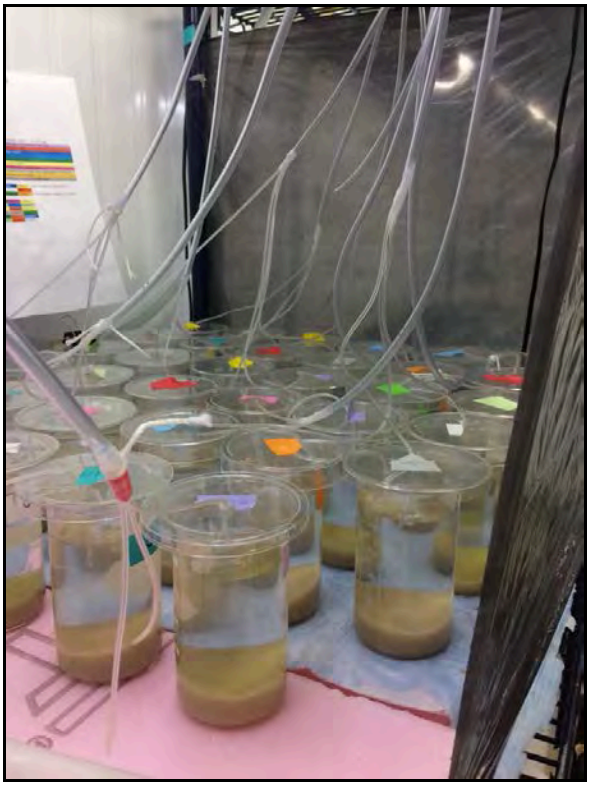
Daphnia pulex

Chironomid Toxicity test



Chironomus dilutus

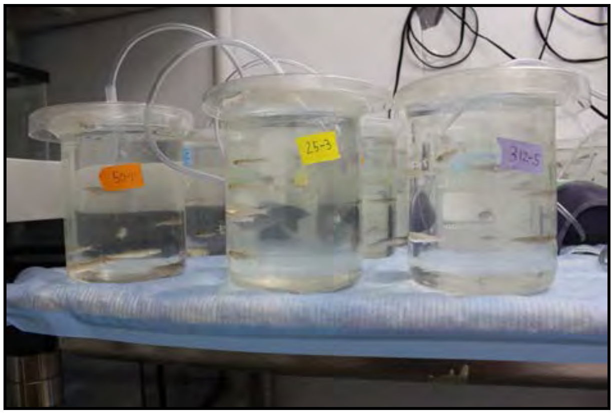
Hyalella Toxicity Test



Hyalella azteca

Rainbow Trout Toxicity Test

Oncorhynchus mykiss



Appendix B. Detailed metal/trace element data for all toxicity tests

Table B1. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Pseudokirchneriella subcapitata* 72-hr leachate bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		Control	3.12%	6.25%	12.50%	25%	50%	100%
Be	0.002	initial	0.01 ± 0.01	0.01 ± 0.01	<LOD	<LOD	0.00 ± 0.01	<LOD	<LOD
	0.005	final	0.02 ± 0.00	0.01 ± 0.00	<LOD	<LOD	<LOD	<LOD	<LOD
B	0.059	initial	558.43 ± 33.23	624.98 ± 4.26	657.51 ± 54.44	592.91 ± 22.43	581.02 ± 7.53	604.52 ± 8.01	528.04 ± 5.30
	0.103	final	713.71 ± 16.29	706.76 ± 36.06	661.00 ± 24.59	619.65 ± 1.12	612.82 ± 104.72	569.48 ± 13.26	487.16 ± 20.82
Al	0.019	initial	12.77 ± 11.65	7.32 ± 3.45	18.46 ± 21.40	7.05 ± 1.02	11.19 ± 6.89	20.20 ± 5.61	31.45 ± 10.66
	0.026	final	42.51 ± 15.63	13.13 ± 2.50	**60.58 ± 74.53**	23.93 ± 11.94	19.23 ± 8.61	16.09 ± 10.61	17.85 ± 11.29
Ti	0.013	initial	0.15 ± 0.07	0.14 ± 0.12	0.18 ± 0.16	0.45 ± 0.41	0.16 ± 0.13	0.35 ± 0.20	0.37 ± 0.12
	0.145	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
V	0.004	initial	0.12 ± 0.04	0.28 ± 0.17	0.21 ± 0.08	0.53 ± 0.34	0.46 ± 0.14	0.63 ± 0.17	1.02 ± 0.09
	0.007	final	0.29 ± 0.34	0.13 ± 0.06	0.20 ± 0.02	0.29 ± 0.07	0.34 ± 0.02	0.44 ± 0.09	0.82 ± 0.08
Cr	0.022	initial	13.99 ± 4.62	37.87 ± 26.31	14.99 ± 3.49	26.10 ± 12.79	21.77 ± 19.60	37.51 ± 38.52	14.82 ± 8.04
	0.051	final	14.12 ± 10.38	10.38 ± 1.96	10.82 ± 1.65	12.05 ± 10.89	14.34 ± 4.86	10.81 ± 2.10	9.38 ± 1.33
Mn	0.012	initial	55.43 ± 1.62	58.50 ± 1.08	56.64 ± 0.81	58.84 ± 2.38	57.24 ± 1.86	56.81 ± 1.29	85.54 ± 4.73
	0.049	final	22.13 ± 7.00	30.92 ± 10.65	20.51 ± 12.22	20.09 ± 6.96	17.50 ± 20.78	11.33 ± 10.57	12.60 ± 10.31
Fe	0.016	initial	42.70 ± 16.35	112.66 ± 83.06	42.52 ± 8.28	71.63 ± 31.52	57.38 ± 43.29	108.18 ± 108.79	48.00 ± 18.66
	0.020	final	65.53 ± 54.93	42.42 ± 16.39	36.96 ± 8.46	36.27 ± 31.55	33.13 ± 3.30	27.02 ± 3.97	46.24 ± 47.50
Co	0.001	initial	0.29 ± 0.01	0.29 ± 0.02	0.30 ± 0.03	0.39 ± 0.17	0.32 ± 0.01	0.42 ± 0.06	0.45 ± 0.00
	0.002	final	0.57 ± 0.23	0.25 ± 0.05	0.25 ± 0.02	0.29 ± 0.01	0.32 ± 0.04	0.38 ± 0.03	0.41 ± 0.03
Ni	0.010	initial	0.82 ± 0.12	1.69 ± 0.64	2.30 ± 1.09	7.78 ± 9.06	4.44 ± 0.33	8.22 ± 3.99	11.80 ± 0.41
	0.024	final	1.96 ± 1.24	1.17 ± 0.29	1.42 ± 0.31	1.68 ± 0.21	3.23 ± 0.65	4.28 ± 1.14	9.61 ± 3.51
Cu	0.004	initial	1.11 ± 1.12	0.57 ± 0.04	0.85 ± 0.24	0.71 ± 0.28	1.24 ± 1.01	0.84 ± 0.33	0.50 ± 0.06
	0.015	final	1.48 ± 0.79	0.61 ± 0.02	0.84 ± 0.13	0.73 ± 0.21	0.72 ± 0.03	0.75 ± 0.03	0.72 ± 0.03
Zn	0.111	initial	18.69 ± 8.18	14.10 ± 2.12	11.91 ± 1.40	10.07 ± 1.69	11.36 ± 2.50	13.54 ± 3.35	12.07 ± 0.60
	0.018	final	**470.85 ± 401.65**	8.12 ± 1.05	9.82 ± 4.70	7.70 ± 1.26	8.18 ± 1.97	8.36 ± 3.22	**41.65 ± 55.81**
As	0.012	initial	0.06 ± 0.02	0.11 ± 0.01	0.10 ± 0.01	0.20 ± 0.02	0.35 ± 0.05	0.57 ± 0.05	1.14 ± 0.02
	0.004	final	0.12 ± 0.06	0.11 ± 0.02	0.16 ± 0.03	0.26 ± 0.05	0.34 ± 0.02	0.60 ± 0.06	1.14 ± 0.09
Se	0.044	initial	0.22 ± 0.04	0.31 ± 0.02	0.40 ± 0.04	0.42 ± 0.08	0.45 ± 0.06	0.64 ± 0.07	0.86 ± 0.13
	0.022	final	0.28 ± 0.03	0.62 ± 0.45	0.42 ± 0.03	0.37 ± 0.00	0.40 ± 0.01	0.63 ± 0.02	0.74 ± 0.09
Sr	0.002	initial	35.53 ± 0.59	66.41 ± 0.59	97.41 ± 1.03	157.71 ± 1.75	276.85 ± 3.47	508.96 ± 5.13	1114.10 ± 4.49
	0.017	final	33.64 ± 1.10	61.51 ± 3.84	89.06 ± 1.28	150.10 ± 3.08	271.44 ± 3.60	472.89 ± 4.17	915.36 ± 11.37

Mo	0.001	initial	2.44 ± 0.48	10.06 ± 2.08	13.89 ± 0.29	25.23 ± 0.98	47.48 ± 1.12	**91.55 ± 4.26**	**177.65 ± 2.66**
	0.005	final	6.40 ± 3.49	8.29 ± 0.83	13.76 ± 0.19	25.36 ± 0.90	50.81 ± 1.81	**91.27 ± 1.19**	**178.09 ± 2.86**
Ag	0.003	initial	0.004 ± 0.004	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.00002	final	0.0003 ± 0.0005	<LOD	0.003 ± 0.005	0.002 ± 0.003	0.001 ± 0.001	0.01 ± 0.01	0.002 ± 0.003
Cd	0.005	initial	0.02 ± 0.01	0.04 ± 0.02	0.00 ± 0.00	0.02 ± 0.01	0.06 ± 0.03	0.08 ± 0.03	**0.11 ± 0.01**
	0.008	final	2.77 ± 2.57	0.01 ± 0.02	0.02 ± 0.02	0.03 ± 0.02	0.07 ± 0.10	0.02 ± 0.02	0.07 ± 0.03
Sb	0.002	initial	0.04 ± 0.02	0.17 ± 0.01	0.40 ± 0.02	0.63 ± 0.05	1.08 ± 0.02	2.33 ± 0.05	3.82 ± 0.05
	0.004	final	0.17 ± 0.04	0.23 ± 0.01	0.42 ± 0.05	0.62 ± 0.06	1.08 ± 0.03	2.18 ± 0.06	3.42 ± 0.11
Ba	0.011	initial	1.20 ± 0.04	3.06 ± 0.19	4.99 ± 0.22	8.54 ± 0.21	15.32 ± 0.38	28.87 ± 0.55	55.39 ± 0.25
	0.028	final	1.58 ± 0.19	3.81 ± 0.42	5.03 ± 0.32	8.71 ± 0.56	15.87 ± 0.29	27.27 ± 0.27	53.26 ± 1.92
Hg	0.008	initial	**0.14 ± 0.04**	**0.12 ± 0.01**	**0.08 ± 0.01**	**0.06 ± 0.02**	**0.06 ± 0.03**	**0.07 ± 0.00**	**0.13 ± 0.02**
	0.003	final	**2.44 ± 3.79**	**0.10 ± 0.02**	**0.06 ± 0.01**	**0.06 ± 0.01**	**0.06 ± 0.04**	**0.05 ± 0.03**	**0.08 ± 0.01**
Tl	0.0004	initial	0.02 ± 0.01	0.04 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.05 ± 0.00	0.07 ± 0.01
	0.003	final	0.04 ± 0.02	0.05 ± 0.01	0.03 ± 0.00	0.03 ± 0.01	0.04 ± 0.01	0.05 ± 0.00	0.07 ± 0.01
Pb	0.001	initial	0.58 ± 0.79	0.14 ± 0.03	0.12 ± 0.03	0.17 ± 0.04	0.16 ± 0.04	0.35 ± 0.20	0.07 ± 0.06
	0.001	final	0.16 ± 0.13	0.20 ± 0.06	0.18 ± 0.05	0.15 ± 0.05	0.28 ± 0.15	0.24 ± 0.07	0.16 ± 0.10
U	0.0002	initial	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.01	0.01 ± 0.00	0.03 ± 0.00	0.04 ± 0.01	0.08 ± 0.01
	0.0003	final	0.02 ± 0.02	0.01 ± 0.00	0.02 ± 0.01	0.02 ± 0.00	0.03 ± 0.01	0.10 ± 0.10	0.08 ± 0.01

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of 1640a was 96.32 ± 3.31 % (*n*=3,4) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 107.93 ± 0.79 % (*n*=1,1).

Table B2. Mean concentrations (µg L-1) of total dissolved trace elements in *Pseudokirchneriella subcapitata* 72-hr pore water bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		**Control**	**3.12%**	**6.25%**	**12.50%**	**25%**	**50%**	**100%**
Be	0.003	initial	0.02 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	<LOD	0.004 ± 0.003
	0.003	final	0.01 ± 0.00	<LOD	<LOD	<LOD	0.004 ± 0.004	<LOD	0.004 ± 0.005
B	0.081	initial	512.04 ± 25.00	577.98 ± 17.22	564.16 ± 17.14	595.42 ± 25.60	560.19 ± 21.69	530.55 ± 51.95	460.97 ± 8.67
	0.111	final	645.35 ± 53.73	717.14 ± 48.02	661.44 ± 42.22	597.22 ± 47.12	578.78 ± 45.18	542.96 ± 15.42	449.43 ± 19.99
Al	0.054	initial	**108.73 ± 179.38**	7.68 ± 1.90	**103.31 ± 113.39**	8.43 ± 3.47	8.65 ± 4.44	10.39 ± 2.40	64.09 ± 30.41
	0.009	final	18.38 ± 10.33	13.77 ± 2.36	17.88 ± 13.54	37.43 ± 21.59	21.87 ± 3.34	16.03 ± 3.54	8.15 ± 1.80
Ti	0.034	initial	0.42 ± 0.40	0.35 ± 0.24	0.22 ± 0.11	0.07 ± 0.04	0.22 ± 0.09	0.36 ± 0.21	0.33 ± 0.11
	0.001	final	0.14 ± 0.14	0.10 ± 0.09	0.10 ± 0.17	0.26 ± 0.32	0.17 ± 0.17	0.18 ± 0.17	0.23 ± 0.27
V	0.002	initial	0.23 ± 0.06	0.18 ± 0.10	0.24 ± 0.09	0.30 ± 0.12	0.30 ± 0.04	0.53 ± 0.12	0.68 ± 0.05
	0.125	final	0.10 ± 0.04	0.12 ± 0.02	0.17 ± 0.05	0.16 ± 0.03	0.24 ± 0.02	0.36 ± 0.03	0.67 ± 0.16
Cr	0.008	initial	27.76 ± 14.92	21.31 ± 13.91	12.76 ± 2.57	27.34 ± 14.60	11.35 ± 3.76	16.04 ± 4.74	13.27 ± 5.64
	0.051	final	13.85 ± 9.69	11.81 ± 2.97	15.30 ± 2.22	13.05 ± 6.19	14.53 ± 11.13	11.99 ± 0.52	10.37 ± 3.47
Mn	0.003	initial	55.42 ± 1.78	57.78 ± 0.81	59.51 ± 2.61	58.22 ± 0.68	57.40 ± 0.24	69.07 ± 9.65	74.24 ± 12.27
	0.016	final	22.20 ± 8.12	18.51 ± 13.92	15.07 ± 6.06	18.09 ± 15.57	9.91 ± 0.55	18.66 ± 16.05	12.29 ± 8.17
Fe	0.005	initial	97.04 ± 53.11	64.41 ± 36.45	36.62 ± 2.31	85.52 ± 26.22	36.80 ± 12.29	44.26 ± 9.89	50.20 ± 14.89
	0.009	final	37.62 ± 21.08	34.42 ± 9.12	45.77 ± 8.97	38.70 ± 17.71	34.67 ± 13.61	41.56 ± 4.40	44.46 ± 20.96
Co	0.001	initial	0.26 ± 0.04	0.27 ± 0.03	0.33 ± 0.01	0.33 ± 0.02	0.34 ± 0.01	0.43 ± 0.01	0.56 ± 0.05
	0.002	final	0.26 ± 0.09	0.26 ± 0.01	0.26 ± 0.01	0.30 ± 0.02	0.30 ± 0.05	0.34 ± 0.02	0.42 ± 0.03
Ni	0.033	initial	0.90 ± 0.32	2.28 ± 1.36	4.30 ± 0.33	5.35 ± 0.85	6.85 ± 1.36	10.90 ± 0.41	24.15 ± 5.13
	0.010	final	0.80 ± 0.30	2.18 ± 1.02	3.02 ± 0.06	2.52 ± 0.65	4.22 ± 0.39	7.32 ± 0.85	15.06 ± 2.72
Cu	0.006	initial	0.52 ± 0.10	0.63 ± 0.31	1.45 ± 0.71	0.75 ± 0.21	3.76 ± 4.08	0.95 ± 0.07	0.83 ± 0.03
	0.021	final	0.60 ± 0.13	0.94 ± 0.41	0.97 ± 0.02	0.79 ± 0.20	1.00 ± 0.12	1.08 ± 0.01	0.93 ± 0.11
Zn	0.003	initial	10.98 ± 2.60	10.18 ± 7.17	**37.30 ± 33.75**	15.31 ± 7.04	11.54 ± 1.43	12.36 ± 1.68	15.68 ± 3.78
	0.087	final	16.62 ± 18.78	9.42 ± 1.92	9.72 ± 1.15	7.91 ± 1.37	8.02 ± 0.84	10.62 ± 0.97	12.77 ± 5.36
As	0.010	initial	0.05 ± 0.02	0.12 ± 0.05	0.17 ± 0.04	0.29 ± 0.03	0.46 ± 0.03	0.90 ± 0.05	1.88 ± 0.11
	0.011	final	0.03 ± 0.01	0.10 ± 0.05	0.17 ± 0.03	0.31 ± 0.05	0.50 ± 0.07	0.96 ± 0.07	1.86 ± 0.11
Se	0.020	initial	0.24 ± 0.12	0.33 ± 0.12	0.38 ± 0.11	0.44 ± 0.07	0.50 ± 0.07	0.66 ± 0.18	0.74 ± 0.14
	0.039	final	0.18 ± 0.08	0.30 ± 0.07	0.31 ± 0.06	0.38 ± 0.03	0.40 ± 0.14	0.53 ± 0.06	0.65 ± 0.01

Sr	0.002	initial	34.53 ± 1.66	71.63 ± 18.27	105.73 ± 2.85	172.85 ± 1.61	309.91 ± 2.23	549.71 ± 6.25	1209.69 ± 20.64
	0.005	final	31.54 ± 0.86	69.62 ± 2.47	96.84 ± 0.24	165.50 ± 4.06	303.34 ± 14.38	531.71 ± 10.89	1058.90 ± 7.24
Mo	0.004	initial	4.12 ± 1.83	20.01 ± 5.08	30.08 ± 1.22	58.28 ± 1.78	**109.58 ± 0.55**	**203.78 ± 1.61**	**422.67 ± 10.03**
	0.003	final	3.41 ± 2.20	16.72 ± 0.39	28.72 ± 0.42	56.81 ± 4.72	**107.65 ± 5.41**	**196.03 ± 5.21**	**400.28 ± 3.01**
Ag	0.003	initial	0.01 ± 0.01	0.01 ± 0.01	<LOD	<LOD	<LOD	<LOD	<LOD
	0.005	final	<LOD	0.01 ± 0.01	0.01 ± 0.01	<LOD	<LOD	0.01 ± 0.01	<LOD
Cd	0.005	initial	0.03 ± 0.00	0.02 ± 0.28	**0.36 ± 0.13**	0.06 ± 0.02	0.06 ± 0.01	**0.13 ± 0.03**	**0.22 ± 0.04**
	0.010	final	**0.41 ± 0.67**	0.02 ± 0.01	**0.22 ± 0.03**	0.05 ± 0.03	0.04 ± 0.01	0.04 ± 0.03	0.07 ± 0.03
Sb	0.001	initial	0.04 ± 0.01	0.38 ± 0.03	0.30 ± 0.01	0.79 ± 0.02	1.04 ± 0.03	1.78 ± 0.07	3.68 ± 0.13
	0.002	final	0.12 ± 0.04	0.46 ± 0.06	0.35 ± 0.05	0.84 ± 0.02	1.12 ± 0.01	1.88 ± 0.07	3.51 ± 0.03
Ba	0.010	initial	1.31 ± 0.22	3.33 ± 1.03	5.18 ± 0.45	8.54 ± 0.23	15.79 ± 0.31	28.04 ± 0.40	57.10 ± 1.21
	0.047	final	1.42 ± 0.29	4.80 ± 0.94	5.73 ± 0.29	9.16 ± 0.44	16.77 ± 1.22	31.03 ± 0.96	62.63 ± 0.99
Hg	0.008	initial	**0.18 ± 0.07**	**0.09 ± 0.39**	**0.32 ± 0.40**	**0.33 ± 0.40**	**0.07 ± 0.02**	**0.11 ± 0.03**	**0.13 ± 0.02**
	0.033	final	**0.39 ± 0.27**	**0.16 ± 0.07**	**0.10 ± 0.02**	**0.11 ± 0.03**	**0.08 ± 0.01**	**0.11 ± 0.01**	**0.14 ± 0.02**
Tl	0.001	initial	0.03 ± 0.01	0.02 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.04 ± 0.00	0.05 ± 0.01
	0.004	final	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.01	0.05 ± 0.01	0.06 ± 0.01
Pb	0.001	initial	0.15 ± 0.10	0.22 ± 0.04	0.21 ± 0.05	0.16 ± 0.02	0.13 ± 0.07	0.14 ± 0.06	0.19 ± 0.14
	0.004	final	0.13 ± 0.10	0.21 ± 0.12	0.27 ± 0.03	0.12 ± 0.02	0.12 ± 0.02	0.17 ± 0.03	0.13 ± 0.03
U	0.0002	initial	0.01 ± 0.00	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.02	0.02 ± 0.00	0.03 ± 0.00	0.05 ± 0.01
	0.001	final	0.01 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.14 ± 0.22	0.03 ± 0.01	0.04 ± 0.02	0.05 ± 0.01

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 95.08 ± 2.87 % (*n*=3,3) for these samples. . The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 109.50 ± 0.61 % (*n*=1,1).

Table B3. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Daphnia pulex* 48-hr pore water bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		Control	3.12%	6.25%	12.50%	25%	50%	100%
Be	0.013	initial	0.02 ± 0.00	0.01 ± 0.00	<LOD	<LOD	<LOD	<LOD	<LOD
	0.013	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
B	0.075	initial	12.61 ± 0.51	24.73 ± 5.12	23.23 ± 0.24	36.99 ± 0.80	41.87 ± 1.05	69.33 ± 0.98	112.70 ± 1.81
	0.075	final	13.78 ± 0.28	24.63 ± 3.71	25.75 ± 3.48	37.48 ± 1.52	41.41 ± 0.78	68.02 ± 1.29	110.86 ± 1.41
Al	0.028	initial	0.26 ± 0.25	0.70 ± 0.25	0.47 ± 0.38	0.84 ± 0.46	0.34 ± 0.14	2.78 ± 3.02	1.66 ± 1.07
	0.028	final	0.48 ± 0.16	1.13 ± 1.04	1.06 ± 1.00	0.46 ± 0.07	0.36 ± 0.06	2.09 ± 1.54	1.36 ± 1.09
Ti	0.074	initial	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.074	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
V	0.004	initial	0.08 ± 0.02	0.17 ± 0.12	0.15 ± 0.07	0.13 ± 0.01	0.21 ± 0.01	0.34 ± 0.02	0.60 ± 0.02
	0.004	final	0.06 ± 0.01	0.09 ± 0.02	0.10 ± 0.02	0.15 ± 0.02	0.22 ± 0.04	0.33 ± 0.01	0.62 ± 0.03
Cr	0.017	initial	2.58 ± 0.50	2.39 ± 0.10	2.31 ± 0.31	3.02 ± 0.66	1.29 ± 0.77	2.45 ± 0.19	2.12 ± 0.18
	0.017	final	2.31 ± 0.29	3.56 ± 2.74	1.86 ± 0.20	2.19 ± 0.19	2.00 ± 0.16	1.87 ± 0.17	1.66 ± 0.69
Mn	0.008	initial	0.30 ± 0.01	0.48 ± 0.02	0.66 ± 0.02	1.10 ± 0.03	1.96 ± 0.13	3.77 ± 0.08	7.38 ± 0.16
	0.008	final	0.31 ± 0.02	0.49 ± 0.01	0.68 ± 0.01	1.10 ± 0.01	1.90 ± 0.03	3.73 ± 0.04	7.29 ± 0.06
Fe	0.003	initial	14.21 ± 2.71	13.60 ± 1.14	12.90 ± 1.50	15.99 ± 3.26	6.48 ± 4.11	13.49 ± 1.33	11.38 ± 1.12
	0.003	final	11.95 ± 1.90	13.99 ± 6.52	9.80 ± 0.97	11.75 ± 0.98	10.02 ± 0.53	8.24 ± 2.21	6.70 ± 2.21
Co	0.001	initial	0.08 ± 0.02	0.07 ± 0.00	0.07 ± 0.01	0.08 ± 0.00	0.11 ± 0.01	0.14 ± 0.01	0.23 ± 0.01
	0.001	final	0.07 ± 0.02	0.07 ± 0.00	0.07 ± 0.01	0.08 ± 0.01	0.10 ± 0.00	0.14 ± 0.00	0.23 ± 0.00
Ni	0.036	initial	0.35 ± 0.07	0.74 ± 0.06	1.03 ± 0.06	1.78 ± 0.08	3.30 ± 0.22	6.30 ± 0.14	12.09 ± 0.26
	0.036	final	0.39 ± 0.14	0.81 ± 0.10	0.99 ± 0.04	1.73 ± 0.05	3.25 ± 0.09	6.26 ± 0.11	12.03 ± 0.11
Cu	0.018	initial	0.18 ± 0.04	0.23 ± 0.04	0.26 ± 0.02	0.24 ± 0.01	0.21 ± 0.03	0.30 ± 0.01	0.42 ± 0.00
	0.018	final	0.21 ± 0.02	0.29 ± 0.05	0.31 ± 0.06	0.27 ± 0.01	0.25 ± 0.04	0.37 ± 0.05	0.55 ± 0.21
Zn	0.213	initial	15.18 ± 3.00	15.71 ± 5.03	14.32 ± 2.49	13.67 ± 4.48	12.70 ± 1.65	8.01 ± 0.68	6.22 ± 0.79
	0.213	final	12.42 ± 4.79	9.58 ± 0.44	9.69 ± 1.15	12.08 ± 1.79	8.09 ± 0.52	7.24 ± 1.48	6.93 ± 1.24
As	0.337	initial	<LOD	<LOD	<LOD	<LOD	0.51 ± 0.04	0.94 ± 0.05	1.97 ± 0.06
	0.337	final	<LOD	<LOD	<LOD	<LOD	0.45 ± 0.01	0.96 ± 0.02	2.00 ± 0.02
Se	0.006	initial	**29.07 ± 5.38**	**28.79 ± 0.29**	**29.32 ± 0.41**	**29.65 ± 0.30**	**29.72 ± 0.37**	**29.28 ± 0.61**	**27.68 ± 0.57**
	0.006	final	**28.59 ± 4.83**	**28.96 ± 0.18**	**29.27 ± 0.01**	**29.25 ± 0.40**	**29.50 ± 0.26**	**28.87 ± 0.21**	**27.79 ± 0.37**
Sr	0.017	initial	28.44 ± 0.06	47.77 ± 0.17	67.40 ± 0.21	109.80 ± 1.61	214.70 ± 12.23	378.74 ± 5.28	720.86 ± 6.06
	0.017	final	29.58 ± 1.02	49.00 ± 0.74	69.45 ± 1.14	110.57 ± 0.16	208.11 ± 2.06	384.18 ± 2.33	732.64 ± 3.54
Mo	0.002	initial	0.46 ± 0.09	10.26 ± 0.30	20.15 ± 0.09	41.52 ± 0.68	**86.82 ± 5.69**	**166.11 ± 2.25**	**356.17 ± 1.71**
	0.002	final	0.77 ± 0.16	10.64 ± 0.34	20.24 ± 0.22	41.49 ± 0.03	**81.83 ± 1.40**	**163.50 ± 0.66**	**354.22 ± 3.60**

Ag	0.003	initial	0.01 ± 0.01	<LOD	0.004 ± 0.001	<LOD	<LOD	<LOD	<LOD
	0.003	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cd	0.004	initial	0.01 ± 0.00	0.01 ± 0.01	0.02 ± 0.00	0.03 ± 0.00	0.05 ± 0.01	**0.09 ± 0.01**	**0.17 ± 0.01**
	0.004	final	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.02 ± 0.01	0.05 ± 0.01	**0.08 ± 0.01**	**0.17 ± 0.02**
Sb	0.011	initial	0.02 ± 0.00	0.15 ± 0.01	0.27 ± 0.01	0.52 ± 0.01	1.06 ± 0.07	2.00 ± 0.05	4.00 ± 0.07
	0.011	final	0.01 ± 0.00	0.13 ± 0.01	0.25 ± 0.01	0.51 ± 0.01	1.00 ± 0.02	2.01 ± 0.01	3.91 ± 0.03
Ba	0.017	initial	0.57 ± 0.02	2.49 ± 0.06	4.20 ± 0.13	7.48 ± 0.21	15.19 ± 0.76	28.94 ± 0.61	58.21 ± 0.48
	0.017	final	0.92 ± 0.05	2.63 ± 0.13	4.66 ± 0.50	7.70 ± 0.10	14.08 ± 0.13	28.32 ± 0.14	57.47 ± 0.07
Hg	0.017	initial	**0.08 ± 0.03**	**0.04 ± 0.01**	**0.04 ± 0.01**	**0.04 ± 0.00**	**0.04 ± 0.00**	**0.05 ± 0.01**	**0.09 ± 0.02**
	0.017	final	<LOD	<LOD	<LOD	0.02 ± 0.00	0.02 ± 0.00	**0.05 ± 0.01**	**0.07 ± 0.01**
Tl	0.001	initial	0.01 ± 0.00	0.005 ± 0.001	0.004 ± 0.001	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00
	0.001	final	0.004 ± 0.001	0.005 ± 0.001	0.004 ± 0.001	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00
Pb	0.001	initial	0.05 ± 0.01	0.07 ± 0.01	0.08 ± 0.01	0.04 ± 0.01	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.00
	0.001	final	0.08 ± 0.05	0.07 ± 0.01	0.09 ± 0.01	0.05 ± 0.01	0.04 ± 0.00	0.06 ± 0.00	0.06 ± 0.01
U	0.002	initial	0.003 ± 0.000	0.003 ± 0.001	0.004 ± 0.000	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.05 ± 0.00
	0.002	final	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.06 ± 0.00

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of 1640a was 96.21 ± 1.83 % (*n*=5) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 103.57 % (*n*=1).

Table B4. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Daphnia pulex* 48-hr leachate bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		Control	3.12%	6.25%	12.50%	25%	50%	100%
Be	0.004	initial	0.02 ± 0.00	0.01 ± 0.00	0.01 ± 0.01	0.01 ± 0.00	<LOD	<LOD	0.03 ± 0.04
	0.004	final	<LOD	0.01 ± 0.01	0.01 ± 0.01	0.03 ± 0.06	<LOD	<LOD	<LOD
B	0.648	initial	<LOD	4.00 ± 0.26	6.19 ± 0.39	11.05 ± 0.28	27.26 ± 10.90	40.14 ± 0.31	79.93 ± 1.01
	0.648	final	9.23 ± 2.88	17.33 ± 1.26	16.39 ± 2.82	19.30 ± 3.56	29.65 ± 2.70	49.96 ± 2.28	87.19 ± 4.70
Al	0.006	initial	1.89 ± 1.89	1.84 ± 1.23	0.26 ± 0.05	0.51 ± 0.29	0.43 ± 0.27	0.77 ± 0.65	0.94 ± 0.83
	0.006	final	0.53 ± 0.04	0.43 ± 0.03	1.28 ± 0.46	0.74 ± 0.20	1.21 ± 0.60	1.53 ± 1.01	0.53 ± 0.17
Ti	0.133	initial	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.133	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
V	0.001	initial	0.22 ± 0.02	0.33 ± 0.02	0.40 ± 0.17	0.40 ± 0.01	0.59 ± 0.14	0.73 ± 0.02	1.10 ± 0.01
	0.001	final	0.31 ± 0.07	0.36 ± 0.06	0.48 ± 0.07	0.42 ± 0.08	0.50 ± 0.03	0.69 ± 0.03	1.15 ± 0.14
Cr	0.228	initial	2.95 ± 0.68	4.93 ± 4.04	2.07 ± 0.38	1.73 ± 0.30	1.43 ± 0.45	2.61 ± 0.75	1.53 ± 0.47
	0.228	final	2.35 ± 0.85	1.16 ± 0.16	2.41 ± 0.38	2.00 ± 0.46	3.11 ± 2.08	3.61 ± 1.17	4.82 ± 4.46
Mn	0.002	initial	1.70 ± 0.02	1.46 ± 0.02	1.53 ± 0.10	1.62 ± 0.03	2.21 ± 0.42	3.00 ± 0.28	4.25 ± 0.06
	0.002	final	0.85 ± 0.09	0.75 ± 0.06	0.87 ± 0.07	0.70 ± 0.42	0.52 ± 0.23	0.65 ± 0.10	4.43 ± 0.29
Fe	0.009	initial	11.24 ± 4.18	19.33 ± 15.83	7.71 ± 2.48	6.55 ± 0.40	5.36 ± 1.97	26.47 ± 30.46	6.25 ± 2.23
	0.009	final	9.62 ± 3.84	4.43 ± 0.67	10.31 ± 2.11	8.19 ± 1.25	15.60 ± 12.08	42.68 ± 54.90	21.59 ± 21.05
Co	0.004	initial	0.15 ± 0.01	0.15 ± 0.02	0.15 ± 0.02	0.13 ± 0.02	0.14 ± 0.05	0.17 ± 0.03	0.21 ± 0.02
	0.004	final	0.12 ± 0.01	0.13 ± 0.00	0.14 ± 0.00	0.12 ± 0.00	0.15 ± 0.05	0.14 ± 0.00	0.24 ± 0.03
Ni	0.009	initial	0.56 ± 0.13	0.90 ± 0.04	0.84 ± 0.08	1.32 ± 0.12	2.88 ± 0.99	4.58 ± 0.54	8.17 ± 0.39
	0.009	final	0.41 ± 0.14	0.55 ± 0.05	1.37 ± 0.22	1.52 ± 0.27	3.47 ± 1.23	4.93 ± 0.22	10.89 ± 3.27
Cu	0.015	initial	0.26 ± 0.02	0.26 ± 0.03	0.23 ± 0.02	0.22 ± 0.06	0.26 ± 0.02	0.33 ± 0.05	0.44 ± 0.05
	0.015	final	0.20 ± 0.02	0.19 ± 0.01	0.30 ± 0.03	0.24 ± 0.04	0.38 ± 0.10	0.39 ± 0.03	0.76 ± 0.39
Zn	0.547	initial	2.52 ± 0.37	3.16 ± 0.13	2.30 ± 0.40	2.18 ± 0.16	2.18 ± 0.38	2.45 ± 0.80	1.56 ± 0.49
	0.547	final	2.51 ± 0.11	2.46 ± 0.12	4.64 ± 1.93	3.19 ± 0.96	6.22 ± 3.60	4.09 ± 0.49	3.24 ± 0.95
As	0.020	initial	0.09 ± 0.01	0.09 ± 0.01	0.14 ± 0.01	0.21 ± 0.07	0.42 ± 0.18	0.59 ± 0.03	1.12 ± 0.03
	0.020	final	0.03 ± 0.01	0.05 ± 0.01	0.07 ± 0.01	0.13 ± 0.03	0.31 ± 0.01	0.57 ± 0.04	1.09 ± 0.03
Se	0.108	initial	**2.58 ± 0.15**	**2.78 ± 0.11**	**2.68 ± 0.07**	**2.70 ± 0.14**	**3.07 ± 1.02**	**2.84 ± 0.09**	**2.95 ± 0.10**
	0.108	final	**2.63 ± 0.06**	**2.77 ± 0.04**	**2.60 ± 0.15**	**2.70 ± 0.10**	**3.04 ± 1.09**	**2.86 ± 0.08**	**2.79 ± 0.05**
Sr	0.017	initial	28.39 ± 0.15	48.34 ± 0.90	69.75 ± 1.54	110.15 ± 2.24	267.04 ± 100.21	389.70 ± 8.33	726.81 ± 7.26

	0.017	final	32.05 ± 2.65	49.70 ± 0.47	68.29 ± 1.02	109.27 ± 1.48	210.90 ± 3.88	379.91 ± 3.80	726.09 ± 10.98
Mo	0.005	initial	0.53 ± 0.10	5.13 ± 0.63	9.30 ± 0.26	17.99 ± 0.30	47.15 ± 20.64	72.20 ± 1.14	**139.64 ± 1.20**
	0.005	final	0.54 ± 0.07	4.77 ± 0.06	9.14 ± 0.24	18.19 ± 0.33	35.33 ± 0.78	70.15 ± 0.50	**138.68 ± 0.69**
Ag	0.006	initial	0.06 ± 0.00	0.06 ± 0.00	0.05 ± 0.01	0.03 ± 0.03	<LOD	<LOD	0.01 ± 0.00
	0.006	final	0.02 ± 0.00	0.02 ± 0.00	0.01 ± 0.01	<LOD	<LOD	<LOD	0.03 ± 0.05
Cd	0.008	initial	0.06 ± 0.01	0.05 ± 0.01	0.05 ± 0.00	0.04 ± 0.03	0.03 ± 0.01	0.04 ± 0.01	0.07 ± 0.00
	0.008	final	0.01 ± 0.00	0.02 ± 0.01	0.02 ± 0.02	0.01 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.06 ± 0.02
Sn	0.011	initial	0.08 ± 0.01	0.10 ± 0.01	0.10 ± 0.01	0.08 ± 0.03	0.04 ± 0.01	0.04 ± 0.02	0.02 ± 0.00
	0.011	final	0.04 ± 0.01	0.06 ± 0.01	0.05 ± 0.01	0.04 ± 0.00	0.04 ± 0.01	0.04 ± 0.01	0.02 ± 0.01
Sb	0.003	initial	0.08 ± 0.01	0.16 ± 0.01	0.26 ± 0.01	0.44 ± 0.02	1.10 ± 0.44	1.66 ± 0.05	3.27 ± 0.03
	0.003	final	0.03 ± 0.00	0.14 ± 0.01	0.23 ± 0.01	0.42 ± 0.03	0.84 ± 0.04	1.67 ± 0.03	3.39 ± 0.06
Ba	0.060	initial	1.28 ± 1.22	2.16 ± 0.03	4.08 ± 0.49	6.92 ± 0.20	17.64 ± 7.65	26.83 ± 0.41	52.59 ± 0.17
	0.060	final	0.96 ± 0.32	2.40 ± 0.08	3.86 ± 0.12	6.89 ± 0.13	13.28 ± 0.26	25.69 ± 0.38	51.31 ± 0.52
Hg	0.002	Initial	**0.04** ± 0.02	**0.03** ± 0.01	**0.03** ± 0.01	**0.03** ± 0.00	0.02 ± 0.02	**0.03** ± 0.01	**0.05** ± 0.01
	0.002	final	0.01 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	**0.03** ± 0.00	**0.03** ± 0.01
Tl	0.003	initial	0.08 ± 0.01	0.07 ± 0.00	0.07 ± 0.01	0.05 ± 0.03	0.03 ± 0.00	0.04 ± 0.01	0.07 ± 0.00
	0.003	final	0.02 ± 0.00	0.03 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.05 ± 0.01
Pb	0.007	initial	0.21 ± 0.02	0.19 ± 0.01	0.15 ± 0.01	0.14 ± 0.03	0.13 ± 0.02	0.15 ± 0.04	0.13 ± 0.02
	0.007	final	0.13 ± 0.00	0.09 ± 0.00	0.22 ± 0.15	0.12 ± 0.08	0.17 ± 0.08	0.16 ± 0.04	0.14 ± 0.01
U	0.001	initial	0.07 ± 0.01	0.06 ± 0.00	0.06 ± 0.00	0.04 ± 0.03	0.02 ± 0.01	0.04 ± 0.01	0.07 ± 0.00
	0.001	final	0.03 ± 0.00	0.03 ± 0.00	0.02 ± 0.01	0.01 ± 0.00	0.03 ± 0.00	0.04 ± 0.01	0.07 ± 0.00

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of 1640a was 96.53 ± 3.63 % (*n*=5) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 109.66 % (*n*=1).

Table B5. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Daphnia pulex* 21-d pore water bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		Control	3.12%	6.25%	12.5% ¹	25%	50%	100%
Be	0.011	initial	0.02 ± 0.01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.011	middle	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.054	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
B	0.164	initial	3.11 ± 0.60	5.08 ± 0.39	8.16 ± 0.75	14.46 ± 1.37	26.15 ± 0.82	44.77 ± 1.22	86.68 ± 0.81
	0.164	middle	4.42 ± 0.76	8.57 ± 2.71	10.93 ± 1.37	19.78 ± 1.87	30.31 ± 1.61	56.12 ± 3.42	110.01 ± 5.36
	0.569	final	3.96 ± 1.08	11.57 ± 1.98	12.67 ± 0.70	16.40	26.76 ± 1.39	48.23 ± 1.62	90.49 ± 9.32
Al	0.287	initial	10.86 ± 11.23	4.08 ± 2.47	2.97 ± 1.67	2.24 ± 0.42	1.52 ± 1.03	1.80 ± 0.72	5.23 ± 2.88
	0.287	middle	4.31 ± 0.31	3.97 ± 0.73	4.07 ± 1.37	14.79 ± 12.95	3.40 ± 0.97	4.38 ± 1.79	2.92 ± 0.70
	0.245	final	11.68 ± 7.74	2.11 ± 0.06	5.25 ± 2.45	4.01	4.34 ± 2.59	4.79 ± 2.49	4.43 ± 2.85
Ti	0.040	initial	0.05 ± 0.07	0.06 ± 0.03	<LOD	<LOD	0.05 ± 0.07	0.10 ± 0.04	0.24 ± 0.02
	0.040	middle	<LOD	0.04 ± 0.02	<LOD	<LOD	0.06 ± 0.01	0.13 ± 0.05	0.12 ± 0.06
	0.037	final	0.04 ± 0.03	0.06 ± 0.01	0.10 ± 0.06	0.04	0.06 ± 0.04	0.10 ± 0.05	0.19 ± 0.05
V	0.002	initial	0.19 ± 0.02	0.20 ± 0.04	0.21 ± 0.04	0.24 ± 0.02	0.28 ± 0.04	0.46 ± 0.02	0.81 ± 0.01
	0.002	middle	0.08 ± 0.01	0.12 ± 0.04	0.11 ± 0.02	0.15 ± 0.01	0.22 ± 0.02	0.38 ± 0.03	0.68 ± 0.04
	0.008	final	0.08 ± 0.02	0.11 ± 0.03	0.13 ± 0.02	0.14	0.23 ± 0.02	0.37 ± 0.04	0.63 ± 0.05
Cr	0.049	initial	1.87 ± 0.47	3.68 ± 2.74	1.72 ± 0.20	3.65 ± 3.27	1.23 ± 0.38	1.89 ± 1.24	3.31 ± 3.00
	0.049	middle	0.89 ± 0.14	1.22 ± 0.31	1.49 ± 0.45	1.79 ± 1.49	2.07 ± 1.38	2.00 ± 0.95	2.02 ± 1.51
	0.029	final	4.75 ± 1.06	2.75 ± 0.44	2.86 ± 0.99	2.67	3.51 ± 0.14	5.48 ± 2.78	5.11 ± 2.59
Mn	0.007	initial	0.10 ± 0.01	0.22 ± 0.05	0.12 ± 0.10	0.56 ± 0.05	1.41 ± 0.01	2.65 ± 0.11	5.06 ± 0.19
	0.007	middle	0.29 ± 0.04	0.27 ± 0.16	0.12 ± 0.02	0.17 ± 0.07	0.19 ± 0.12	0.97 ± 1.29	0.41 ± 0.17
	0.022	final	0.61 ± 0.17	0.65 ± 0.11	0.49 ± 0.20	0.23	0.40 ± 0.12	0.56 ± 0.19	0.52 ± 0.06
Fe	0.047	initial	7.87 ± 2.78	25.94 ± 27.61	7.57 ± 2.72	13.60 ± 10.58	4.76 ± 2.20	6.51 ± 3.90	12.42 ± 12.05
	0.047	middle	3.34 ± 0.91	5.45 ± 0.83	4.66 ± 1.61	3.46 ± 1.90	5.13 ± 2.58	6.31 ± 0.95	5.05 ± 3.17
	0.068	final	19.08 ± 5.50	11.50 ± 0.73	11.73 ± 4.66	10.29	13.83 ± 0.66	25.86 ± 13.33	21.02 ± 11.32
Co	0.007	initial	0.12 ± 0.01	0.12 ± 0.01	0.11 ± 0.01	0.12 ± 0.01	0.13 ± 0.01	0.14 ± 0.00	0.20 ± 0.00
	0.007	middle	0.08 ± 0.01	0.09 ± 0.00	0.08 ± 0.01	0.06 ± 0.00	0.09 ± 0.01	0.22 ± 0.19	0.14 ± 0.01
	0.003	final	0.05 ± 0.01	0.08 ± 0.01	0.07 ± 0.01	0.07	0.08 ± 0.01	0.07 ± 0.00	0.09 ± 0.00
Ni	0.105	initial	0.18 ± 0.07	0.62 ± 0.31	0.71 ± 0.06	1.43 ± 0.18	2.63 ± 0.07	5.21 ± 0.31	9.99 ± 0.40
	0.105	middle	0.34 ± 0.07	0.54 ± 0.03	0.89 ± 0.07	1.97 ± 0.08	3.60 ± 0.02	11.36 ± 6.54	14.51 ± 0.84
	0.095	final	0.39 ± 0.11	0.66 ± 0.19	0.85 ± 0.11	1.49	3.21 ± 0.19	7.00 ± 0.85	12.20 ± 0.61
Cu	0.005	initial	0.28 ± 0.15	0.24 ± 0.02	0.22 ± 0.03	0.29 ± 0.10	0.24 ± 0.05	0.24 ± 0.02	0.47 ± 0.06
	0.005	middle	0.14 ± 0.03	0.17 ± 0.01	0.14 ± 0.01	0.21 ± 0.09	0.20 ± 0.01	0.39 ± 0.17	0.46 ± 0.03

	0.015	final	0.12 ± 0.02	0.20 ± 0.04	0.84 ± 1.17	0.19	0.32 ± 0.14	0.31 ± 0.09	0.36 ± 0.04
Zn	0.011	initial	2.87 ± 0.28	2.83 ± 0.59	2.37 ± 0.12	2.69 ± 0.50	2.42 ± 0.12	2.23 ± 0.49	1.88 ± 0.53
	0.011	middle	1.89 ± 0.11	1.75 ± 0.29	1.70 ± 0.15	2.69 ± 0.35	1.87 ± 0.21	2.08 ± 0.45	1.64 ± 0.19
	0.016	final	2.39 ± 0.26	2.30 ± 0.19	2.67 ± 0.16	2.54	5.01 ± 2.54	5.46 ± 0.42	4.57 ± 0.38
As	0.020	initial	0.03 ± 0.01	0.09 ± 0.01	0.14 ± 0.01	0.26 ± 0.03	0.51 ± 0.02	1.06 ± 0.04	2.12 ± 0.08
	0.020	middle	<LOD	0.06 ± 0.01	0.11 ± 0.02	0.24 ± 0.05	0.51 ± 0.01	1.12 ± 0.14	2.02 ± 0.17
	0.016	final	0.02 ± 0.01	0.06 ± 0.01	0.10 ± 0.01	0.18	0.50 ± 0.02	0.99 ± 0.02	1.91 ± 0.11
Se	0.013	initial	**3.31 ± 0.24**	**4.01 ± 1.11**	**3.06 ± 0.17**	**3.54 ± 0.16**	**3.24 ± 0.04**	**3.31 ± 0.06**	**3.40 ± 0.13**
	0.013	middle	**2.74 ± 0.26**	**3.23 ± 0.29**	**2.89 ± 0.08**	**3.03 ± 0.06**	**3.38 ± 0.13**	**3.66 ± 0.22**	**3.55 ± 0.31**
	0.039	final	**3.60 ± 0.39**	**3.06 ± 0.25**	**2.73 ± 0.03**	**2.50**	**2.53 ± 0.14**	**4.02 ± 0.35**	**4.11 ± 0.18**
Sr	3.224	initial	31.62 ± 0.36	61.69 ± 4.00	81.05 ± 3.58	136.60 ± 0.44	258.13 ± 9.47	531.37 ± 5.86	1005.71 ± 39.36
	3.224	middle	34.20 ± 3.16	68.01 ± 1.88	100.51 ± 7.28	184.95 ± 7.37	334.25 ± 6.24	690.32 ± 109.67	1322.92 ± 49.66
	0.013	final	37.67 ± 3.42	61.86 ± 7.77	82.57 ± 8.66	119.00	245.11 ± 5.81	476.18 ± 2.56	852.22 ± 18.95
Mo	0.012	initial	0.57 ± 0.06	13.04 ± 0.66	23.71 ± 1.02	48.07 ± 0.39	**93.89 ± 1.98**	**201.35 ± 2.38**	**426.64 ± 21.00**
	0.012	middle	1.32 ± 0.19	14.54 ± 0.31	27.04 ± 1.87	54.49 ± 0.84	**106.01 ± 2.30**	**234.98 ± 39.12**	**503.75 ± 14.80**
	0.217	final	0.16 ± 0.16	12.44 ± 1.22	23.67 ± 2.66	41.54	**94.56 ± 4.30**	**194.57 ± 2.00**	**399.00 ± 18.21**
Ag	0.003	initial	0.01 ± 0.00	0.01 ± 0.00	0.004 ± 0.000	0.01 ± 0.01	0.003 ± 0.001	<LOD	<LOD
	0.003	middle	<LOD	0.01 ± 0.00	<LOD	<LOD	<LOD	<LOD	0.003 ± 0.001
	0.001	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cd	0.075	initial	<LOD	<LOD	<LOD	<LOD	<LOD	**0.11 ± 0.00**	**0.23 ± 0.01**
	0.075	middle	<LOD	<LOD	<LOD	<LOD	<LOD	**0.13 ± 0.00**	**0.25 ± 0.04**
	0.013	final	<LOD	<LOD	0.02 ± 0.01	0.02	0.04 ± 0.01	**0.10 ± 0.02**	**0.16 ± 0.01**
Sb	0.014	initial	<LOD	0.13 ± 0.01	0.24 ± 0.02	0.46 ± 0.02	0.88 ± 0.00	1.83 ± 0.02	3.59 ± 0.18
	0.014	middle	<LOD	0.15 ± 0.00	0.27 ± 0.02	0.50 ± 0.02	1.03 ± 0.02	2.26 ± 0.13	4.43 ± 0.11
	0.003	final	<LOD	0.13 ± 0.02	0.27 ± 0.02	0.45	1.01 ± 0.10	2.07 ± 0.03	3.94 ± 0.27
Ba	0.012	initial	0.46 ± 0.03	1.90 ± 0.10	3.32 ± 0.21	5.81 ± 0.31	11.27 ± 0.67	18.19 ± 0.64	36.80 ± 0.43
	0.012	middle	0.48 ± 0.09	2.32 ± 0.01	3.53 ± 0.41	7.83 ± 0.02	12.90 ± 0.42	27.75 ± 4.10	54.42 ± 1.51
	0.008	final	0.99 ± 0.05	3.16 ± 0.26	6.30 ± 0.42	7.86	15.12 ± 0.72	32.42 ± 0.43	61.26 ± 2.43
Hg	0.014	initial	**0.10 ± 0.05**	**0.09 ± 0.01**	**0.06 ± 0.02**	**0.07 ± 0.01**	**0.06 ± 0.01**	**0.06 ± 0.01**	<LOD
	0.014	middle	<LOD	<LOD	<LOD	0.01 ± 0.00	**0.03 ± 0.00**	**0.05 ± 0.01**	**0.08 ± 0.01**
	0.011	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Tl	0.001	initial	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.03 ± 0.00
	0.001	middle	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.03 ± 0.01	0.05 ± 0.00
	0.002	final	0.01 ± 0.00	0.003 ± 0.001	0.004 ± 0.001	0.004	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00
Pb	0.002	initial	0.12 ± 0.01	0.12 ± 0.05	0.09 ± 0.01	0.10 ± 0.02	0.09 ± 0.01	0.06 ± 0.00	0.05 ± 0.03
	0.002	middle	0.02 ± 0.00	0.04 ± 0.01	0.03 ± 0.00	0.06 ± 0.00	0.04 ± 0.00	0.04 ± 0.01	0.04 ± 0.00

	0.003	final	0.02 ± 0.00	0.01 ± 0.00	0.01 ± 0.01	0.01	0.02 ± 0.02	0.03 ± 0.01	0.03 ± 0.00
U	0.001	initial	0.002 ± 0.001	0.003 ± 0.000	0.006 ± 0.002	0.01 ± 0.001	0.01 ± 0.00	0.03 ± 0.00	0.06 ± 0.00
	0.001	middle	0.001 ± 0.001	0.003 ± 0.000	0.005 ± 0.001	0.01 ± 0.005	0.02 ± 0.00	0.04 ± 0.00	0.07 ± 0.00
	0.001	final	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.01	0.04 ± 0.00	0.04 ± 0.00	0.07 ± 0.00

[1] **Only one sample on final day due to mortality of the remainder**

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of 1640a was 98.85 ± 5.52 % (*n*=5) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 106.85 % (*n*=1).

Table B6. Mean concentrations (μg L^{-1}) of total dissolved trace elements in *Chironomus dilutus* 10-d whole sediment bioassay bulk overlying test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		Control	6.25%	12.50%	25%	50%	100%
Be	0.054	initial	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.010	final	0.01 ± 0.00	<LOD	<LOD	<LOD	<LOD	<LOD
B	0.569	initial	20.33 ± 1.91	21.21 ± 1.29	21.96 ± 2.16	28.59 ± 3.05	37.65 ± 4.92	46.01 ± 0.74
	0.238	final	20.55 ± 2.37	32.63 ± 2.48	44.26 ± 6.21	44.43 ± 11.10	65.31 ± 2.69	72.45 ± 6.55
Al	0.245	initial	3.25 ± 0.04	1.72 ± 0.57	1.69 ± 0.91	1.18 ± 0.27	0.81 ± 0.04	0.97 ± 0.20
	0.030	final	1.50 ± 0.93	0.98 ± 0.58	0.36 ± 0.08	0.34 ± 0.15	0.31 ± 0.05	0.42 ± 0.15
Ti	0.037	initial	0.05 ± 0.04	0.09 ± 0.08	0.08 ± 0.09	0.06 ± 0.02	<LOD	0.05 ± 0.02
	0.045	final	0.16 ± 0.01	0.09 ± 0.04	<LOD	0.05 ± 0.01	<LOD	0.05 ± 0.02
V	0.008	initial	0.47 ± 0.06	0.25 ± 0.05	0.24 ± 0.01	0.25 ± 0.01	0.34 ± 0.17	0.29 ± 0.02
	0.006	final	1.13 ± 0.41	0.83 ± 0.19	0.82 ± 0.06	0.71 ± 0.04	0.92 ± 0.26	0.82 ± 0.01
Cr	0.029	initial	0.34 ± 0.05	0.37 ± 0.02	1.41 ± 1.85	0.39 ± 0.03	0.39 ± 0.11	0.48 ± 0.22
	0.009	final	1.73 ± 0.14	1.45 ± 0.54	2.50 ± 0.52	2.61 ± 0.40	2.87 ± 1.20	2.07 ± 0.10
Mn	0.022	initial	1.79 ± 1.22	3.01 ± 1.59	3.60 ± 3.29	1.57 ± 1.41	0.81 ± 0.11	0.29 ± 0.36
	0.002	final	2.91 ± 1.92	1.90 ± 0.82	6.73 ± 5.37	5.57 ± 1.55	5.85 ± 0.83	6.69 ± 1.99
Fe	0.068	initial	2.21 ± 0.29	3.33 ± 3.21	11.11 ± 16.74	1.74 ± 0.31	1.59 ± 0.65	1.76 ± 0.54
	0.010	final	10.15 ± 1.92	7.13 ± 3.18	11.63 ± 1.12	10.76 ± 1.52	11.99 ± 3.86	10.48 ± 0.46
Co	0.003	initial	0.02 ± 0.00	0.19 ± 0.06	0.21 ± 0.11	0.14 ± 0.08	0.12 ± 0.01	0.07 ± 0.04
	0.002	final	0.14 ± 0.01	0.46 ± 0.12	0.55 ± 0.06	0.52 ± 0.06	0.50 ± 0.01	0.40 ± 0.13
Ni	0.095	initial	0.23 ± 0.24	21.72 ± 4.23	22.62 ± 3.16	22.05 ± 3.12	21.65 ± 2.94	18.32 ± 1.14
	0.009	final	1.09 ± 0.17	39.09 ± 0.19	47.82 ± 1.83	47.13 ± 0.82	48.25 ± 2.46	40.73 ± 4.86
Cu	0.015	initial	1.58 ± 0.38	0.85 ± 0.12	1.09 ± 0.66	0.76 ± 0.18	0.65 ± 0.06	0.61 ± 0.05
	0.025	final	**6.66 ± 3.04**	2.37 ± 0.50	2.37 ± 0.05	2.19 ± 0.04	2.35 ± 0.07	1.93 ± 0.40
Zn	0.016	initial	6.74 ± 1.99	5.30 ± 0.94	8.42 ± 0.88	11.61 ± 5.94	6.97 ± 0.81	9.37 ± 4.39
	0.013	final	7.00 ± 3.03	4.06 ± 1.20	3.99 ± 0.60	3.86 ± 0.22	3.42 ± 0.60	4.29 ± 0.41
As	0.016	initial	0.33 ± 0.02	0.51 ± 0.08	0.62 ± 0.05	0.57 ± 0.04	0.68 ± 0.08	0.70 ± 0.07
	0.020	final	0.53 ± 0.09	0.48 ± 0.11	0.57 ± 0.03	0.51 ± 0.03	0.50 ± 0.06	0.64 ± 0.14
Se	0.039	initial	0.06 ± 0.03	0.08 ± 0.01	0.09 ± 0.04	0.15 ± 0.02	0.18 ± 0.06	0.18 ± 0.01
	0.026	final	0.31 ± 0.07	0.27 ± 0.07	0.25 ± 0.10	0.26 ± 0.04	0.31 ± 0.06	0.37 ± 0.10
Sr	0.013	initial	62.92 ± 0.64	192.70 ± 36.93	242.57 ± 37.46	313.18 ± 33.56	397.10 ± 70.21	519.49 ± 42.19
	0.023	final	71.36 ± 12.27	235.30 ± 19.89	347.60 ± 24.25	419.31 ± 28.79	513.42 ± 30.65	608.98 ± 43.54
Mo	0.217	initial	0.63 ± 0.28	3.86 ± 0.67	7.18 ± 0.83	13.67 ± 2.08	26.94 ± 4.75	51.85 ± 8.09

	0.013	final	0.73 ± 0.13	3.97 ± 0.19	8.61 ± 1.01	13.55 ± 1.63	25.31 ± 1.32	51.12 ± 7.81
Ag	0.001	initial	<LOD	<LOD	0.02 ± 0.03	<LOD	<LOD	<LOD
	0.009	final	0.06 ± 0.01	0.02 ± 0.03	<LOD	<LOD	<LOD	<LOD
Cd	0.013	initial	0.02 ± 0.01	<LOD	0.01 ± 0.00	0.01 ± 0.01	0.02 ± 0.00	0.02 ± 0.00
	0.002	final	0.04 ± 0.00	0.02 ± 0.01	0.01 ± 0.00	0.02 ± 0.00	0.03 ± 0.01	0.05 ± 0.00
Sb	0.008	initial	0.04 ± 0.03	0.26 ± 0.02	0.41 ± 0.06	0.68 ± 0.11	1.09 ± 0.21	1.78 ± 0.25
	0.002	final	0.07 ± 0.02	0.26 ± 0.02	0.48 ± 0.07	0.61 ± 0.08	0.89 ± 0.01	1.41 ± 0.13
Ba	0.011	initial	6.88 ± 0.18	78.13 ± 12.20	78.89 ± 12.18	71.57 ± 8.91	63.70 ± 8.87	54.43 ± 3.25
	0.037	final	10.36 ± 3.12	93.44 ± 5.88	99.33 ± 3.55	95.41 ± 6.57	83.02 ± 5.91	68.94 ± 4.42
Hg	0.01	Initial	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.01	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Tl	0.002	initial	0.03 ± 0.00	0.04 ± 0.00	0.04 ± 0.01	0.04 ± 0.00	0.06 ± 0.01	0.06 ± 0.01
	0.003	final	0.06 ± 0.01	0.05 ± 0.01	0.05 ± 0.00	0.04 ± 0.01	0.06 ± 0.01	0.05 ± 0.01
Pb	0.003	initial	0.02 ± 0.01	0.01 ± 0.00	0.02 ± 0.02	0.01 ± 0.00	0.01 ± 0.02	0.01 ± 0.00
	0.008	final	0.14 ± 0.12	0.03 ± 0.02	0.03 ± 0.00	0.02 ± 0.00	0.03 ± 0.01	0.02 ± 0.00
U	0.001	initial	0.10 ± 0.01	0.15 ± 0.02	0.17 ± 0.03	0.18 ± 0.03	0.15 ± 0.03	0.12 ± 0.01
	0.001	final	0.14 ± 0.02	0.29 ± 0.05	0.37 ± 0.02	0.38 ± 0.01	0.34 ± 0.00	0.31 ± 0.02

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 99.35 ± 2.52 % (*n*=5) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 100.87 % (*n*=1).

Table B7. Mean concentrations (µg L-1) of total dissolved trace elements in pore water (peeper data) in *Chironomus dilutus* 10-d whole sediment bioassay with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		**Control**			**6.25%**			**12.50%**			**25%**			**50%**			**100%**		
Be	0.004	Initial	0.25	±	0.24	0.27	±	0.09	0.03	±	0.00	0.03	±	0.01	0.01	±	0.02	0.04	±	0.02
	0.004	Final	0.05	±	0.07	0.06	±	0.09	<LOD			<LOD			0.04	±	0.06	0.03	±	0.02
B	0.018	Initial	191.84	±	24.89	265.61	±	18.20	286.84	±	384.45	265.72	±	162.69	453.61	±	31.38	190.55	±	39.99
	0.018	Final	33.70	±	2.73	43.24	±	3.45	50.49	±	4.26	41.42	±	1.79	67.64	±	3.37	66.47	±	2.17
Al	0.020	Initial	**209.81**	**±**	**115.79**	**281.95**	**±**	**4.74**	**592.28**	**±**	**144.13**	**304.03**	**±**	**62.96**	**243.37**	**±**	**50.36**	**548.32**	**±**	**600.77**
	0.020	Final	43.79	±	7.63	36.19	±	10.12	46.45	±	11.74	55.77	±	1.33	34.06	±	5.59	**126.78**	**±**	**10.11**
Ti	0.113	Initial	1.54	±	1.25	4.04	±	1.41	313.26	±	435.87	7.15	±	0.05	4.67	±	0.80	34.37	±	44.10
	0.113	Final	1.96	±	0.04	2.18	±	1.16	1.99	±	0.11	3.41	±	0.11	1.89	±	0.13	13.88	±	0.30
V	0.009	Initial	1.77	±	0.34	1.11	±	0.34	16.11	±	20.74	0.98	±	0.26	1.28	±	0.09	2.95	±	1.62
	0.009	Final	1.21	±	0.31	2.36	±	1.04	8.37	±	8.79	0.84	±	0.09	0.90	±	0.19	1.70	±	0.17
Cr	0.026	Initial	6.47	±	0.78	4.74	±	0.72	100.90	±	116.05	10.08	±	4.95	6.50	±	0.08	18.64	±	10.48
	0.026	Final	28.47	±	9.57	21.60	±	7.07	33.68	±	18.73	25.56	±	4.99	20.11	±	0.30	15.60	±	4.41
Mn	0.009	Initial	62.92	±	77.71	93.63	±	126.12	425.55	±	280.04	10.78	±	1.20	88.47	±	33.42	32.21	±	24.41
	0.009	Final	41.49	±	1.12	18.91	±	7.57	24.11	±	5.41	20.48	±	3.42	7.88	±	0.81	15.73	±	1.75
Fe	0.015	Initial	92.23	±	70.09	142.82	±	2.18	165.19	±	0.00	170.55	±	24.30	127.73	±	6.15	**1013.70**	**±**	**1258.30**
	0.015	Final	**380.08**	**±**	**203.37**	130.15	±	14.48	172.36	±	44.43	195.04	±	11.74	179.15	±	23.96	**426.02**	**±**	**23.71**
Co	0.002	Initial	0.16	±	0.03	0.41	±	0.04	15.61	±	21.73	0.43	±	0.05	0.27	±	0.04	1.99	±	2.56
	0.002	Final	0.26	±	0.08	0.50	±	0.11	0.68	±	0.46	0.68	±	0.06	0.76	±	0.40	0.94	±	0.30
Ni	0.017	Initial	2.10	±	0.11	20.57	±	0.70	**287.76**	**±**	**387.20**	20.56	±	1.76	10.30	±	2.87	40.26	±	35.93
	0.017	Final	3.00	±	0.94	38.51	±	13.15	45.38	±	23.35	45.79	±	0.49	38.22	±	2.87	26.62	±	7.54
Cu	0.011	Initial	**8.38**	**±**	**2.45**	3.30	±	0.32	**14.41**	**±**	**15.39**	**3.92**	**±**	**0.73**	**4.99**	**±**	**2.60**	**8.28**	**±**	**7.51**
	0.011	Final	**9.01**	**±**	**1.88**	**4.11**	**±**	**2.27**	**4.01**	**±**	**0.37**	**9.14**	**±**	**8.08**	3.12	±	0.46	2.40	±	0.04
Zn	0.144	Initial	**21.01**	**±**	**10.32**	**26.34**	**±**	**24.23**	**37.06**	**±**	**37.03**	15.27	±	3.18	18.37	±	7.37	**25.67**	**±**	**25.36**
	0.144	Final	20.62	±	5.33	8.91	±	5.52	18.44	±	8.12	11.34	±	0.22	11.08	±	6.45	8.63	±	1.26
As	0.064	Initial	1.24	±	0.24	0.82	±	0.14	1.89	±	1.21	0.51	±	0.14	0.71	±	0.20	1.30	±	0.22
	0.064	Final	0.86	±	0.07	0.67	±	0.20	0.59	±	0.22	0.69	±	0.16	0.83	±	0.08	0.86	±	0.16
Se	0.044	Initial	0.49	±	0.07	0.46	±	0.03	0.46	±	0.30	0.29	±	0.03	**5.14**	**±**	**6.75**	0.31	±	0.09
	0.044	Final	0.40	±	0.25	0.34	±	0.23	0.22	±	0.11	0.28	±	0.12	0.38	±	0.10	0.36	±	0.05
Sr	0.001	Initial	206.31	±	1.64	571.18	±	163.50	720.74	±	80.57	410.15	±	75.95	734.76	±	60.08	759.08	±	42.68

	0.001	Final	97.34 ± 6.65	306.06 ± 45.90	362.70 ± 77.01	370.89 ± 9.59	549.29 ± 38.86	683.89 ± 32.37
Mo	0.004	Initial	3.58 ± 0.01	25.59 ± 4.86	42.57 ± 10.98	31.26 ± 8.15	**92.41 ± 44.01**	**173.99 ± 61.85**
	0.004	Final	3.98 ± 1.55	10.60 ± 2.00	16.59 ± 6.06	17.34 ± 0.50	35.14 ± 5.33	72.31 ± 2.55
Ag	0.010	Initial	0.11 ± 0.07	0.07 ± 0.03	0.19 ± 0.19	<LOD	0.03 ± 0.00	0.01 ± 0.00
	0.010	Final	0.01 ± 0.03	0.02 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.01	0.07 ± 0.08
Cd	0.001	Initial	**0.15 ± 0.10**	**0.10 ± 0.00**	**0.13 ± 0.12**	0.04 ± 0.00	**0.05 ± 0.03**	**0.15 ± 0.01**
	0.001	Final	**0.10 ± 0.00**	0.04 ± 0.01	0.03 ± 0.03	0.03 ± 0.01	0.05 ± 0.04	**0.14 ± 0.07**
Sn	0.007	Initial	0.30 ± 0.10	0.11 ± 0.05	0.26 ± 0.03	0.05 ± 0.03	0.11 ± 0.03	0.20 ± 0.07
	0.007	Final	0.37 ± 0.24	0.42 ± 0.45	1.68 ± 1.17	0.60 ± 0.17	0.05 ± 0.01	0.11 ± 0.06
Sb	0.002	Initial	0.27 ± 0.05	1.30 ± 0.34	1.19 ± 0.83	1.22 ± 0.20	2.87 ± 0.56	3.70 ± 0.64
	0.002	Final	0.24 ± 0.15	0.58 ± 0.17	0.78 ± 0.34	0.73 ± 0.01	1.30 ± 0.26	2.12 ± 0.21
Ba	0.009	Initial	28.35 ± 2.20	55.35 ± 6.87	61.21 ± 0.00	43.77 ± 0.05	51.05 ± 0.05	70.32 ± 34.72
	0.009	Final	17.52 ± 1.24	81.29 ± 15.33	82.16 ± 31.18	89.39 ± 0.00	63.40 ± 6.27	52.97 ± 3.88
Hg	0.017	Initial	**0.29 ± 0.09**	**0.12 ± 0.02**	**0.15 ± 0.01**	**0.06 ± 0.02**	**0.11 ± 0.02**	**0.10 ± 0.04**
	0.017	Final	**0.05 ± 0.02**	**0.03 ± 0.01**	**0.03 ± 0.01**	**0.04 ± 0.03**	0.02 ± 0.00	**0.06 ± 0.02**
Tl	0.005	Initial	0.20 ± 0.03	0.17 ± 0.01	0.15 ± 0.09	0.10 ± 0.01	0.09 ± 0.04	0.07 ± 0.01
	0.005	Final	0.13 ± 0.03	0.10 ± 0.02	0.08 ± 0.02	0.07 ± 0.02	0.10 ± 0.02	0.13 ± 0.06
Pb	0.002	Initial	0.93 ± 0.57	3.15 ± 3.46	3.86 ± 4.77	1.94 ± 1.95	0.89 ± 0.11	1.20 ± 0.52
	0.002	Final	0.93 ± 0.28	0.45 ± 0.38	0.79 ± 0.17	0.44 ± 0.04	0.51 ± 0.10	0.83 ± 0.16
U	0.0003	Initial	3.19 ± 0.88	1.62 ± 1.60	7.85 ± 3.36	0.38 ± 0.21	0.65 ± 0.48	0.36 ± 0.27
	0.0003	Final	0.67 ± 0.11	0.57 ± 0.14	0.52 ± 0.12	0.40 ± 0.01	0.37 ± 0.01	0.39 ± 0.04

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 95.71 ± 0.98 % (*n*=5) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 107.47 % (*n*=1).

Table B8. Mean concentrations (μg L^{-1}) of total dissolved trace elements in *Hyallela azteca* 10-d bioassay overlying test water conducted with different EFPKT media from the Containment Pond, Diavik Diamond Mine, NT.

			Reconstituted water		**Dechlorinated municipal water**	
	Detection limit		**Sand**	**100 % EFPKT**	**Sand**	**100 % EFPKT**
Be	0.015	initial	0.08 ± 0.03	<LOD	0.04 ± 0.01	<LOD
	0.022	final	0.10 ± 0.05	<LOD	0.04 ± 0.01	<LOD
B	0.227	initial	16.06 ± 0.65	35.50 ± 0.48	28.58 ± 1.12	44.83 ± 3.66
	0.100	final	21.03 ± 1.42	86.29 ± 4.43	41.83 ± 9.01	98.30 ± 3.82
Al	0.001	initial	4.27 ± 4.85	2.76 ± 3.00	9.32 ± 2.77	30.07 ± 50.05
	0.163	final	19.63 ± 5.87	1.92 ± 0.83	33.30 ± 1.55	1.83 ± 0.66
Ti	0.074	initial	<LOD	0.52 ± 0.82	<LOD	0.11 ± 0.13
	0.070	final	0.24 ± 0.34	<LOD	<LOD	0.09 ± 0.03
V	0.007	initial	0.12 ± 0.01	0.51 ± 0.02	0.23 ± 0.01	0.56 ± 0.04
	0.005	final	0.21 ± 0.02	0.41 ± 0.06	0.31 ± 0.02	0.42 ± 0.02
Cr	0.016	initial	0.51 ± 0.06	1.21 ± 0.29	0.93 ± 0.19	2.15 ± 0.11
	0.024	final	0.52 ± 0.11	0.47 ± 0.09	1.45 ± 0.21	0.45 ± 0.07
Mn	0.004	initial	3.80 ± 0.08	5.60 ± 0.78	4.74 ± 0.54	3.99 ± 0.19
	0.015	final	1.17 ± 0.45	3.97 ± 1.54	0.18 ± 0.06	0.81 ± 0.46
Fe	0.016	initial	1.56 ± 0.18	6.14 ± 5.89	3.28 ± 0.58	8.01 ± 4.84
	0.011	final	9.13 ± 9.87	2.15 ± 0.36	6.15 ± 2.08	2.41 ± 0.72
Co	0.004	initial	0.02 ± 0.00	0.25 ± 0.03	0.09 ± 0.00	0.20 ± 0.01
	0.003	final	0.05 ± 0.02	0.19 ± 0.03	0.09 ± 0.00	0.11 ± 0.02
Ni	0.086	initial	0.24 ± 0.05	12.66 ± 1.58	1.24 ± 0.06	12.76 ± 1.16
	0.103	final	0.46 ± 0.40	24.48 ± 1.82	1.44 ± 0.11	20.28 ± 0.53
Cu	0.004	initial	1.15 ± 1.61	0.14 ± 0.00	1.71 ± 0.08	0.69 ± 0.09
	0.009	final	1.22 ± 0.16	0.93 ± 0.11	2.68 ± 0.17	1.17 ± 0.00
Zn	0.031	initial	5.26 ± 0.77	4.52 ± 0.63	5.04 ± 0.75	3.96 ± 0.89
	0.091	final	6.49 ± 1.43	5.03 ± 0.33	6.65 ± 1.47	6.61 ± 1.15
As	0.007	initial	0.13 ± 0.03	0.51 ± 0.04	0.33 ± 0.01	0.78 ± 0.04
	0.017	final	0.23 ± 0.05	0.52 ± 0.04	0.44 ± 0.04	0.63 ± 0.04
Se	0.049	initial	0.11 ± 0.01	0.20 ± 0.01	0.44 ± 0.02	0.46 ± 0.02
	0.016	final	0.18 ± 0.01	0.38 ± 0.11	0.44 ± 0.03	0.38 ± 0.09
Sr	0.012	initial	36.01 ± 0.55	385.04 ± 30.02	277.90 ± 2.01	421.11 ± 14.79

	0.010	final	48.39 ± 3.48	739.20 ± 20.59	298.14 ± 17.97	494.13 ± 25.69
Mo	0.004	initial	0.40 ± 0.11	53.12 ± 7.48	1.68 ± 0.07	43.89 ± 6.04
	0.009	final	0.37 ± 0.00	**88.93 ± 1.62**	2.11 ± 0.10	**87.34 ± 4.71**
Ag	0.003	initial	0.01 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.004 ± 0.000
	0.001	final	0.02 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
Cd	0.004	initial	0.01 ± 0.00	0.03 ± 0.01	0.004 ± 0.001	0.02 ± 0.00
	0.004	final	0.02 ± 0.00	0.06 ± 0.01	0.01 ± 0.00	0.05 ± 0.01
Sb	0.002	initial	0.01 ± 0.00	1.05 ± 0.09	0.14 ± 0.01	1.04 ± 0.16
	0.018	final	0.02 ± 0.00	1.87 ± 0.04	0.16 ± 0.01	2.13 ± 0.10
Ba	0.008	initial	2.09 ± 0.17	35.06 ± 2.77	48.09 ± 0.51	58.41 ± 3.28
	0.005	final	5.12 ± 0.97	62.76 ± 4.09	50.28 ± 3.71	60.00 ± 6.67
Hg	0.011	initial	**0.05 ± 0.02**	**0.03 ± 0.00**	**0.03 ± 0.00**	0.02 ± 0.01
	0.005	final	**0.09 ± 0.03**	**0.05 ± 0.00**	**0.04 ± 0.00**	**0.04 ± 0.00**
Tl	0.001	initial	0.02 ± 0.02	0.06 ± 0.01	0.01 ± 0.00	0.05 ± 0.00
	0.001	final	0.03 ± 0.02	0.07 ± 0.00	0.01 ± 0.00	0.05 ± 0.00
Pb	0.004	initial	0.09 ± 0.01	0.07 ± 0.01	0.03 ± 0.00	0.02 ± 0.00
	0.002	final	0.11 ± 0.01	0.06 ± 0.01	0.03 ± 0.01	0.03 ± 0.00
U	0.001	initial	0.04 ± 0.00	0.09 ± 0.01	1.42 ± 0.03	0.32 ± 0.03
	0.0004	final	0.09 ± 0.02	0.18 ± 0.01	1.63 ± 0.08	0.34 ± 0.01

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 98.47 ± 1.45 % (*n*=4) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 97.77 % (*n*=1).

Table B8 Continued. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Hyallela azteca* 10-d bioassay overlying test water conducted with different EFPKT media from the Containment Pond, Diavik Diamond Mine, NT.

			Site Water		100 % Leachate	50% Pore water	100 % Pore water
	Detection limit		Sand	100 % EFPKT	Sand	Sand	Sand
Be	0.015	initial	<LOD	0.02 ± 0.00	<LOD	<LOD	<LOD
	0.022	final	<LOD	0.02 ± 0.01	<LOD	<LOD	<LOD
B	0.227	initial	43.93 ± 0.75	62.18 ± 3.89	70.44 ± 1.63	50.35 ± 0.03	77.35 ± 1.53
	0.100	final	63.98 ± 5.21	101.89 ± 6.05	110.34 ± 0.88	79.25 ± 6.93	136.17 ± 15.58
Al	0.001	initial	1.68 ± 0.56	8.04 ± 11.09	1.42 ± 0.33	1.77 ± 0.12	2.40 ± 0.36
	0.163	final	5.51 ± 2.96	1.13 ± 0.13	8.37 ± 1.21	16.04 ± 1.97	9.86 ± 4.09
Ti	0.074	initial	0.12 ± 0.08	0.19 ± 0.10	0.10 ± 0.02	0.09 ± 0.08	0.18 ± 0.11
	0.070	final	0.11 ± 0.01	0.11 ± 0.02	0.14 ± 0.13	0.12 ± 0.02	0.18 ± 0.04
V	0.007	initial	0.51 ± 0.01	0.66 ± 0.06	0.65 ± 0.01	0.30 ± 0.04	0.49 ± 0.02
	0.005	final	0.47 ± 0.01	0.37 ± 0.02	0.66 ± 0.01	0.34 ± 0.02	0.46 ± 0.03
Cr	0.016	initial	1.54 ± 0.96	1.90 ± 1.45	0.87 ± 0.35	1.10 ± 0.98	1.26 ± 1.06
	0.024	final	0.51 ± 0.00	0.68 ± 0.32	0.59 ± 0.08	1.22 ± 0.57	1.42 ± 0.34
Mn	0.004	initial	15.54 ± 1.35	8.82 ± 0.59	5.73 ± 0.14	6.68 ± 0.28	10.08 ± 0.25
	0.015	final	5.16 ± 2.84	2.92 ± 1.22	0.32 ± 0.17	1.28 ± 1.24	1.43 ± 0.51
Fe	0.016	initial	5.03 ± 2.29	8.99 ± 6.57	2.78 ± 2.21	3.11 ± 2.26	3.83 ± 2.90
	0.011	final	2.56 ± 0.39	3.49 ± 1.85	4.64 ± 3.09	5.01 ± 1.43	5.11 ± 0.42
Co	0.004	initial	0.22 ± 0.01	0.28 ± 0.02	0.10 ± 0.00	0.10 ± 0.00	0.19 ± 0.01
	0.003	final	0.11 ± 0.01	0.15 ± 0.02	0.07 ± 0.00	0.09 ± 0.01	0.14 ± 0.01
Ni	0.086	initial	9.65 ± 0.13	14.88 ± 0.80	8.08 ± 0.35	5.71 ± 0.11	11.47 ± 0.62
	0.103	final	9.83 ± 0.47	25.66 ± 1.08	8.54 ± 0.27	6.26 ± 0.66	13.86 ± 0.68
Cu	0.004	initial	0.43 ± 0.05	0.24 ± 0.02	0.33 ± 0.01	0.41 ± 0.03	0.58 ± 0.01
	0.009	final	1.14 ± 0.06	0.91 ± 0.00	1.16 ± 0.07	1.37 ± 0.35	1.90 ± 0.16
Zn	0.031	initial	5.88 ± 0.73	4.40 ± 0.29	5.86 ± 0.58	5.51 ± 0.67	9.06 ± 6.96
	0.091	final	6.17 ± 1.27	4.94 ± 0.33	5.77 ± 0.68	6.96 ± 0.77	6.23 ± 0.79
As	0.007	initial	1.04 ± 0.06	1.21 ± 0.05	1.12 ± 0.05	0.93 ± 0.03	1.71 ± 0.02
	0.017	final	0.96 ± 0.11	0.78 ± 0.10	1.16 ± 0.10	0.99 ± 0.18	2.06 ± 0.19
Se	0.049	initial	0.85 ± 0.05	0.82 ± 0.01	0.36 ± 0.03	0.22 ± 0.03	0.39 ± 0.07
	0.016	final	**1.15 ± 0.12**	0.95 ± 0.07	0.65 ± 0.25	0.36 ± 0.10	0.69 ± 0.27

Sr	0.012	initial	907.99	±	7.53	970.32	±	11.31	882.27	±	11.81	497.71	±	8.36	955.45	±	4.91
	0.010	final	1044.88	±	31.26	1232.73	±	19.29	1130.77	±	28.84	643.19	±	87.52	1380.11	±	88.64
Mo	0.004	initial	**183.20**	**±**	**3.94**	**227.71**	**±**	**1.84**	**163.67**	**±**	**2.49**	**166.04**	**±**	**3.43**	**369.93**	**±**	**3.28**
	0.009	final	**212.29**	**±**	**5.61**	**262.48**	**±**	**2.14**	**210.03**	**±**	**5.09**	**223.28**	**±**	**31.90**	**523.47**	**±**	**36.09**
Ag	0.003	initial	0.01	±	0.00	0.01	±	0.00	0.003	±	0.001	0.004	±	0.002	<LOD		
	0.001	final	0.005	±	0.000	0.01	±	0.00	0.01	±	0.00	0.01	±	0.00	0.01	±	0.00
Cd	0.004	initial	**0.09**	**±**	**0.01**	**0.11**	**±**	**0.01**	**0.09**	**±**	**0.01**	0.08	±	0.01	**0.17**	**±**	**0.01**
	0.004	final	**0.12**	**±**	**0.01**	**0.13**	**±**	**0.01**	**0.12**	**±**	**0.00**	**0.14**	**±**	**0.02**	**0.29**	**±**	**0.02**
Sb	0.002	initial	2.02	±	0.08	2.82	±	0.04	2.94	±	0.06	1.71	±	0.04	3.38	±	0.06
	0.018	final	2.39	±	0.07	3.12	±	0.06	3.79	±	0.12	2.25	±	0.31	4.87	±	0.27
Ba	0.008	initial	65.34	±	1.08	61.27	±	1.38	46.31	±	0.57	22.23	±	0.18	43.33	±	0.25
	0.005	final	78.89	±	2.67	75.63	±	1.91	61.77	±	1.69	31.86	±	4.54	69.36	±	3.81
Hg	0.011	initial	**0.03**	**±**	**0.00**	**0.05**	**±**	**0.00**	**0.05**	**±**	**0.00**	**0.03**	**±**	**0.00**	**0.06**	**±**	**0.01**
	0.005	final	**0.03**	**±**	**0.00**	**0.09**	**±**	**0.01**	**0.06**	**±**	**0.00**	**0.05**	**±**	**0.01**	**0.09**	**±**	**0.01**
Tl	0.001	initial	0.02	±	0.00	0.06	±	0.00	0.06	±	0.00	0.02	±	0.00	0.03	±	0.00
	0.001	final	0.03	±	0.00	0.07	±	0.00	0.07	±	0.00	0.03	±	0.00	0.05	±	0.00
Pb	0.004	initial	0.05	±	0.00	0.03	±	0.01	0.05	±	0.01	0.07	±	0.00	0.06	±	0.00
	0.002	final	0.05	±	0.01	0.02	±	0.00	0.05	±	0.00	0.08	±	0.01	0.08	±	0.00
U	0.001	initial	0.19	±	0.01	0.05	±	0.00	0.11	±	0.01	0.08	±	0.01	0.13	±	0.01
	0.0004	final	0.11	±	0.01	0.20	±	0.01	0.11	±	0.02	0.08	±	0.04	0.11	±	0.02

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 98.47 ± 1.45 % (*n*=4) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 97.77 % (*n*=1).

Table B9. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Hyallela azteca* pore water (peeper data) from the 10-d bioassay conducted with different EFPKT media from the Containment Pond, Diavik Diamond Mine, NT.

Site Whole Sediment

	DL		**Barnstead Recon. Water**	**Dechlorinated Water**	**Site Water**
Be	0.007	initial	<LOD	0.01 ± 0.01	0.03 ± 0.04
	0.010	final	<LOD	<LOD	<LOD
B	0.212	initial	69.87 ± 13.55	92.74 ± 9.95	88.72 ± 10.17
	0.372	final	17.09 ± 0.17	20.88 ± 2.22	19.66 ± 1.14
Al	0.151	initial	**72.93 ± 29.48**	**1024.53 ± 1339.71**	**216.28 ± 106.28**
	0.251	final	11.67 ± 2.40	13.10 ± 9.38	**63.74 ± 68.43**
Ti	0.066	initial	4.91 ± 2.13	91.35 ± 120.07	18.29 ± 9.70
	0.073	final	0.94 ± 0.14	1.28 ± 0.85	5.48 ± 5.77
V	0.001	initial	1.35 ± 0.30	5.95 ± 6.37	2.05 ± 0.88
	0.015	final	0.17 ± 0.04	0.21 ± 0.03	0.39 ± 0.31
Cr	0.009	initial	3.62 ± 0.52	27.52 ± 34.16	20.19 ± 20.78
	0.028	final	0.55 ± 0.03	0.62 ± 0.22	2.02 ± 1.88
Mn	0.015	initial	5.95 ± 1.79	59.41 ± 76.33	19.32 ± 7.37
	0.036	final	1.31 ± 0.09	1.11 ± 0.82	5.11 ± 4.67
Fe	0.024	initial	190.16 ± 50.18	**3041.94 ± 3967.96**	**828.50 ± 412.39**
	0.236	final	35.57 ± 1.18	50.12 ± 45.83	**206.75 ± 196.88**
Co	0.005	initial	0.36 ± 0.04	5.17 ± 6.72	1.24 ± 0.78
	0.005	final	0.06 ± 0.01	0.06 ± 0.05	0.32 ± 0.33
Ni	0.089	initial	11.15 ± 4.88	**87.71 ± 110.17**	35.62 ± 19.40
	0.047	final	1.93 ± 0.13	2.36 ± 1.29	7.22 ± 6.82
Cu	0.010	initial	0.52 ± 0.12	**3.21 ± 3.80**	1.14 ± 0.64
	0.013	final	0.07 ± 0.01	0.10 ± 0.05	0.27 ± 0.23
Zn	0.039	initial	1.91 ± 0.93	6.67 ± 5.07	**35.65 ± 46.89**
	0.046	final	0.42 ± 0.10	0.40 ± 0.05	0.71 ± 0.48
As	0.015	initial	1.28 ± 0.46	2.03 ± 0.66	1.64 ± 0.44
	0.029	final	0.14 ± 0.01	0.16 ± 0.02	0.21 ± 0.01
Se	0.020	initial	0.43 ± 0.02	0.39 ± 0.05	**0.92 ± 0.55**

	0.029	final	0.06	±	0.00	0.05	±	0.04	0.19	±	0.06
Sr	0.002	initial	694.17	±	27.89	374.19	±	37.83	818.78	±	161.48
	0.021	final	176.36	±	34.45	78.27	±	15.17	239.60	±	9.21
Mo	0.011	initial	**148.22**	**±**	**61.15**	**172.65**	**±**	**32.06**	**250.95**	**±**	**26.89**
	0.313	final	24.27	±	2.32	20.11	±	2.75	48.70	±	1.39
Ag	0.003	initial		<LOD		0.01	±	0.01	0.01	±	0.01
	0.013	final		<LOD			<LOD			<LOD	
Cd	0.003	initial	0.08	±	0.01	0.08	±	0.02	**0.14**	**±**	**0.03**
	0.013	final	0.01	±	0.00		<LOD		0.02	±	0.00
Sb	0.006	initial	3.28	±	0.69	3.12	±	0.75	3.33	±	0.23
	0.011	final	0.49	±	0.05	0.50	±	0.04	0.54	±	0.01
Ba	0.017	initial	40.92	±	2.38	107.93	±	84.84	58.75	±	2.64
	0.015	final	7.02	±	0.11	8.91	±	1.66	12.10	±	6.74
Hg	0.004	initial	**0.17**	**±**	**0.01**	**0.27**	**±**	**0.05**	**0.48**	**±**	**0.25**
	0.072	final		<LOD			<LOD			<LOD	
Tl	0.002	initial	0.03	±	0.02	0.03	±	0.02	0.05	±	0.03
	0.010	final		<LOD			<LOD			<LOD	
Pb	0.004	initial	0.17	±	0.11	0.74	±	0.86	0.53	±	0.51
	0.006	final		<LOD		0.01	±	0.00	0.04	±	0.05
U	0.0002	initial	0.07	±	0.04	0.50	±	0.59	0.10	±	0.02
	0.006	final	0.02	±	0.01	0.03	±	0.01	0.04	±	0.04

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 96.34 ± 6.06 % (*n*=2,2) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 105.86 ± 0.20 % (*n*=1,1).

Table B10. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Oncorhynchus mykiss* 4-d leachate bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		**Control**	**3.12%**	**6.25%**	**12.50%**	**25%**	**50%**	**100%**
Be	0.031	initial	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.031	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
B	0.123	initial	20.30 ± 0.63	21.88 ± 0.12	23.79 ± 0.34	28.80 ± 0.85	29.59 ± 7.88	40.10 ± 0.27	79.12 ± 2.23
	0.123	final	7.22 ± 0.85	7.77 ± 0.22	10.65 ± 0.64	17.23 ± 1.83	26.10 ± 2.05	41.66 ± 4.06	99.20 ± 18.09
Al	0.189	initial	0.77 ± 0.30	1.04 ± 0.43	1.75 ± 1.17	0.86 ± 0.12	1.10 ± 0.25	0.84 ± 0.15	1.78 ± 1.35
	0.189	final	0.58 ± 0.21	0.67 ± 0.02	2.37 ± 3.21	1.15 ± 0.74	0.76 ± 0.05	1.32 ± 1.16	0.65 ± 0.09
Ti	0.143	initial	0.03 ± 0.03	0.05 ± 0.06	0.11 ± 0.20	0.03 ± 0.02	0.05 ± 0.09	0.05 ± 0.02	0.09 ± 0.07
	0.143	final	0.03 ± 0.03	0.06 ± 0.03	0.08 ± 0.02	0.09 ± 0.06	0.07 ± 0.05	0.10 ± 0.08	0.15 ± 0.06
V	0.007	initial	0.06 ± 0.02	0.11 ± 0.01	0.13 ± 0.01	0.19 ± 0.01	0.33 ± 0.01	0.63 ± 0.02	1.17 ± 0.10
	0.007	final	0.05 ± 0.01	0.11 ± 0.02	0.14 ± 0.00	0.23 ± 0.01	0.43 ± 0.04	0.76 ± 0.08	1.47 ± 0.03
Cr	0.033	initial	0.76 ± 0.56	1.17 ± 0.85	0.37 ± 0.03	1.32 ± 0.43	0.38 ± 0.09	0.32 ± 0.04	0.37 ± 0.05
	0.033	final	0.43 ± 0.09	0.43 ± 0.07	0.53 ± 0.13	0.39 ± 0.00	0.41 ± 0.03	0.43 ± 0.01	0.45 ± 0.08
Mn	0.016	initial	1.46 ± 0.05	1.70 ± 0.01	1.97 ± 0.17	2.29 ± 0.03	3.41 ± 0.55	5.35 ± 0.02	7.90 ± 0.19
	0.016	final	0.26 ± 0.05	0.39 ± 0.18	0.36 ± 0.11	0.47 ± 0.21	0.58 ± 0.19	0.46 ± 0.19	4.76 ± 2.03
Fe	0.043	initial	3.61 ± 2.07	4.76 ± 3.41	4.40 ± 4.72	5.41 ± 1.96	3.53 ± 3.24	1.79 ± 0.50	4.02 ± 4.49
	0.043	final	1.95 ± 0.17	19.97 ± 31.07	2.46 ± 0.35	4.26 ± 2.51	1.71 ± 0.20	3.83 ± 3.32	1.97 ± 0.36
Co	0.006	initial	<LOD	0.01 ± 0.00	0.03 ± 0.00	0.04 ± 0.00	0.08 ± 0.01	0.15 ± 0.00	0.30 ± 0.01
	0.006	final	0.01 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.04 ± 0.01	0.04 ± 0.01	0.09 ± 0.02	0.20 ± 0.04
Ni	0.445	initial	<LOD	<LOD	<LOD	0.09 ± 0.07	2.06 ± 0.12	6.69 ± 0.10	15.30 ± 0.86
	0.445	final	<LOD	<LOD	<LOD	<LOD	1.10 ± 0.11	4.28 ± 0.83	12.14 ± 0.37
Cu	0.015	initial	0.10 ± 0.01	0.11 ± 0.03	0.10 ± 0.01	0.15 ± 0.04	0.12 ± 0.01	0.17 ± 0.02	0.27 ± 0.01
	0.015	final	0.70 ± 0.20	0.54 ± 0.05	0.64 ± 0.06	0.63 ± 0.03	0.66 ± 0.10	0.71 ± 0.01	0.81 ± 0.10
Zn	0.065	initial	4.77 ± 0.50	5.18 ± 0.61	6.30 ± 1.17	6.19 ± 1.33	6.11 ± 0.66	5.34 ± 1.25	5.33 ± 1.16
	0.065	final	5.21 ± 0.42	4.37 ± 0.19	5.97 ± 1.39	5.34 ± 0.13	6.56 ± 1.38	4.78 ± 0.16	5.32 ± 0.10
As	0.016	initial	0.02 ± 0.01	0.06 ± 0.02	0.11 ± 0.01	0.21 ± 0.03	0.41 ± 0.01	0.83 ± 0.09	1.60 ± 0.06
	0.016	final	0.16 ± 0.04	0.22 ± 0.03	0.27 ± 0.03	0.38 ± 0.02	0.63 ± 0.04	1.01 ± 0.09	1.95 ± 0.07
Se	0.051	initial	0.15 ± 0.08	0.14 ± 0.03	0.20 ± 0.06	0.14 ± 0.06	0.19 ± 0.06	0.33 ± 0.06	0.45 ± 0.07
	0.051	final	0.16 ± 0.02	0.17 ± 0.04	0.18 ± 0.05	0.18 ± 0.04	0.19 ± 0.01	0.26 ± 0.02	0.42 ± 0.07
Sr	0.016	initial	32.23 ± 0.37	61.27 ± 0.61	88.83 ± 0.52	145.13 ± 1.63	269.21 ± 5.17	511.89 ± 4.22	973.79 ± 37.83
	0.016	final	40.84 ± 0.48	66.96 ± 3.77	92.00 ± 6.18	147.07 ± 3.15	280.58 ± 9.03	471.47 ± 44.13	941.92 ± 12.06
Mo	0.016	initial	0.18 ± 0.06	4.88 ± 0.12	9.30 ± 0.15	18.79 ± 0.27	36.78 ± 0.80	**75.96 ± 1.15**	**149.83 ± 4.64**
	0.016	final	0.21 ± 0.03	4.70 ± 0.67	9.01 ± 1.07	18.55 ± 0.45	37.94 ± 1.87	**69.54 ± 7.71**	**146.32 ± 1.50**

Ag	0.004	initial	0.01 ± 0.01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.004	final	0.004 ± 0.001	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cd	0.006	initial	<LOD	<LOD	0.01 ± 0.00	0.02 ± 0.00	0.02 ± 0.01	0.04 ± 0.00	**0.09 ± 0.01**
	0.006	final	0.01 ± 0.00	0.01 ± 0.01	0.01 ± 0.00	0.02 ± 0.01	0.03 ± 0.01	0.05 ± 0.01	**0.10 ± 0.00**
Sb	0.069	initial	0.01 ± 0.00	0.11 ± 0.00	0.21 ± 0.01	0.41 ± 0.01	0.81 ± 0.01	1.67 ± 0.00	3.24 ± 0.21
	0.069	final	0.01 ± 0.00	0.10 ± 0.02	0.19 ± 0.02	0.38 ± 0.01	0.81 ± 0.06	1.46 ± 0.16	3.00 ± 0.04
Ba	0.012	initial	0.40 ± 0.02	1.91 ± 0.02	3.42 ± 0.11	6.28 ± 0.02	12.12 ± 0.28	24.59 ± 0.21	46.39 ± 4.17
	0.012	final	0.83 ± 0.22	2.07 ± 0.32	3.18 ± 0.36	5.96 ± 0.06	11.27 ± 0.46	20.39 ± 2.15	40.75 ± 0.36
Hg	0.012	initial	0.07 ± 0.04	0.03 ± 0.01	0.02 ± 0.00	0.02 ± 0.00	**0.03 ± 0.01**	**0.03 ± 0.01**	**0.04 ± 0.00**
	0.012	final	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.00	0.02 ± 0.00	**0.03 ± 0.01**
Tl	0.000	initial	0.01 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.05 ± 0.00
	0.0003	final	0.005 ± 0.000	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.05 ± 0.00
Pb	0.000	initial	0.09 ± 0.00	0.09 ± 0.01	0.09 ± 0.00	0.09 ± 0.01	0.20 ± 0.16	0.08 ± 0.00	0.08 ± 0.00
	0.000	final	0.10 ± 0.01	0.08 ± 0.01	0.09 ± 0.00	0.08 ± 0.01	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.01
U	0.003	initial	<LOD	0.01 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	0.09 ± 0.00	0.18 ± 0.00	0.34 ± 0.02
	0.003	final	<LOD	0.01 ± 0.00	0.01 ± 0.00	0.03 ± 0.01	0.06 ± 0.01	0.12 ± 0.01	0.24 ± 0.02

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 99.25 ± 2.06 % (*n*=5) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 102.77 % (*n*=1).

Table B11. Mean concentrations (µg L^{-1}) of total dissolved trace elements in *Oncorhynchus mykiss* 28-d leachate bioassay test water made with sediment sourced from Containment Pond, Diavik Diamond Mine, NT.

	DL		**Control**	**3.12%**	**6.25%**	**12.50%**	**25%**	**50%**	**100%**
Be	0.015	initial	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.086	middle	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.086	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
B	0.227	initial	8.54 ± 0.28	10.19 ± 1.39	11.49 ± 0.28	16.25 ± 1.72	23.41 ± 0.38	36.71 ± 2.12	69.66 ± 4.62
	0.107	middle	1.86 ± 0.15	3.50 ± 0.16	5.66 ± 0.36	10.48 ± 1.30	19.40 ± 1.19	33.10 ± 3.34	70.70 ± 1.40
	0.107	final	0.92 ± 0.34	2.59 ± 0.23	4.93 ± 0.21	9.39 ± 1.52	17.86 ± 0.77	32.65 ± 3.05	66.67 ± 1.00
Al	0.001	initial	0.63 ± 0.16	1.34 ± 1.35	1.04 ± 0.44	1.75 ± 1.51	0.74 ± 0.14	0.72 ± 0.09	0.91 ± 0.05
	0.244	middle	0.31 ± 0.13	0.64 ± 0.47	0.35 ± 0.03	1.29 ± 1.66	0.44 ± 0.09	0.38 ± 0.12	0.76 ± 0.54
	0.244	final	1.94 ± 1.23	2.41 ± 0.56	1.86 ± 0.57	1.85 ± 1.08	1.82 ± 0.43	2.21 ± 0.68	1.94 ± 0.50
Ti	0.074	initial	<LOD	<LOD	<LOD	0.16 ± 0.24	0.06 ± 0.01	0.08 ± 0.00	0.07 ± 0.01
	0.081	middle	0.04 ± 0.03	0.01 ± 0.02	0.05 ± 0.04	0.03 ± 0.02	0.04 ± 0.01	0.03 ± 0.02	0.08 ± 0.01
	0.081	final	0.03 ± 0.04	0.05 ± 0.03	0.01 ± 0.02	0.12 ± 0.14	0.07 ± 0.01	0.09 ± 0.03	0.09 ± 0.06
V	0.007	initial	0.04 ± 0.00	0.07 ± 0.00	0.12 ± 0.03	0.21 ± 0.04	0.32 ± 0.00	0.59 ± 0.04	1.16 ± 0.02
	0.175	middle	<LOD	<LOD	<LOD	<LOD	0.27 ± 0.02	0.55 ± 0.04	1.15 ± 0.03
	0.175	final	<LOD	<LOD	<LOD	<LOD	0.22 ± 0.01	0.41 ± 0.02	0.84 ± 0.00
Cr	0.016	initial	1.87 ± 0.76	1.68 ± 0.53	3.48 ± 3.89	2.12 ± 0.64	2.19 ± 0.81	2.07 ± 0.87	2.25 ± 0.44
	0.026	middle	0.16 ± 0.03	0.24 ± 0.13	0.20 ± 0.04	0.17 ± 0.02	0.16 ± 0.05	0.30 ± 0.17	0.22 ± 0.01
	0.026	final	0.68 ± 0.29	1.06 ± 0.22	0.64 ± 0.10	0.50 ± 0.06	0.66 ± 0.06	0.87 ± 0.27	0.79 ± 0.10
Mn	0.004	initial	2.27 ± 0.06	2.50 ± 0.01	2.70 ± 0.06	3.20 ± 0.26	3.84 ± 0.04	5.03 ± 0.13	8.29 ± 0.11
	0.026	middle	0.89 ± 0.37	2.42 ± 0.64	1.92 ± 0.74	2.59 ± 0.38	4.09 ± 0.69	6.01 ± 0.25	9.06 ± 0.67
	0.026	final	2.16 ± 0.70	2.95 ± 0.78	3.15 ± 0.40	4.26 ± 0.85	5.58 ± 0.22	6.96 ± 0.81	10.39 ± 0.29
Fe	0.016	initial	7.73 ± 3.25	6.59 ± 2.18	13.78 ± 15.56	12.65 ± 9.58	8.25 ± 2.77	8.19 ± 3.69	8.97 ± 1.68
	0.015	middle	1.78 ± 0.30	1.87 ± 0.45	1.63 ± 0.04	45.13 ± 74.83	1.76 ± 0.32	2.32 ± 1.21	1.86 ± 0.77
	0.015	final	10.62 ± 7.77	6.63 ± 1.24	5.66 ± 2.04	6.71 ± 5.70	5.06 ± 0.48	5.78 ± 0.94	5.74 ± 1.45
Co	0.004	initial	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.05 ± 0.01	0.07 ± 0.00	0.13 ± 0.01	0.28 ± 0.00
	0.019	middle	<LOD	0.003 ± 0.005	0.003 ± 0.003	0.02 ± 0.00	0.06 ± 0.01	0.10 ± 0.01	0.21 ± 0.02
	0.019	final	0.003 ± 0.004	0.01 ± 0.01	0.02 ± 0.00	0.04 ± 0.01	0.06 ± 0.00	0.10 ± 0.01	0.21 ± 0.01
Ni	0.086	initial	<LOD	<LOD	0.39 ± 0.09	1.52 ± 0.32	3.30 ± 0.06	6.62 ± 0.37	14.70 ± 0.36
	0.023	middle	<LOD	<LOD	0.01 ± 0.02	0.97 ± 0.13	2.74 ± 0.16	6.03 ± 0.70	13.87 ± 0.44
	0.023	final	<LOD	<LOD	<LOD	0.80 ± 0.10	2.49 ± 0.21	5.55 ± 0.45	12.15 ± 0.37
Cu	0.004	initial	0.08 ± 0.00	0.08 ± 0.01	0.10 ± 0.02	0.12 ± 0.01	0.12 ± 0.01	0.16 ± 0.01	0.26 ± 0.03
	0.026	middle	0.74 ± 0.02	0.70 ± 0.06	0.68 ± 0.03	0.73 ± 0.11	0.72 ± 0.04	0.78 ± 0.04	0.90 ± 0.05

	0.026	final	1.18 ± 0.28	1.08 ± 0.06	1.15 ± 0.19	1.23 ± 0.11	2.01 ± 1.12	1.31 ± 0.05	1.42 ± 0.15
Zn	0.031	initial	5.58 ± 0.32	5.10 ± 0.84	4.77 ± 0.71	5.40 ± 0.63	4.40 ± 0.30	4.85 ± 0.25	4.79 ± 1.10
	0.129	middle	5.26 ± 0.02	6.68 ± 0.81	6.43 ± 0.26	5.92 ± 0.79	5.71 ± 1.10	6.29 ± 0.29	6.03 ± 0.74
	0.129	final	6.79 ± 1.00	6.65 ± 0.39	5.87 ± 1.08	7.39 ± 0.89	7.23 ± 0.03	6.16 ± 0.41	6.30 ± 0.70
As	0.007	initial	<LOD	0.06 ± 0.01	0.12 ± 0.01	0.19 ± 0.01	0.40 ± 0.03	0.76 ± 0.05	1.52 ± 0.06
	0.129	middle	<LOD	<LOD	<LOD	0.22 ± 0.04	0.42 ± 0.05	0.76 ± 0.07	1.68 ± 0.09
	0.129	final	<LOD	<LOD	<LOD	0.21 ± 0.04	0.47 ± 0.05	0.71 ± 0.09	1.41 ± 0.05
Se	0.049	initial	0.06 ± 0.02	0.08 ± 0.02	0.07 ± 0.02	0.09 ± 0.02	0.11 ± 0.01	0.19 ± 0.01	0.36 ± 0.05
	0.063	middle	0.10 ± 0.02	0.07 ± 0.01	0.10 ± 0.02	0.12 ± 0.07	0.14 ± 0.02	0.18 ± 0.03	0.26 ± 0.04
	0.063	final	<LOD	0.09 ± 0.02	0.10 ± 0.02	0.13 ± 0.02	0.16 ± 0.01	0.19 ± 0.05	0.33 ± 0.07
Sr	0.012	initial	28.55 ± 0.33	54.82 ± 0.61	79.01 ± 1.59	133.00 ± 5.35	258.07 ± 4.05	442.94 ± 23.00	890.80 ± 3.99
	0.014	middle	37.10 ± 0.63	61.31 ± 1.21	88.11 ± 2.60	142.71 ± 7.61	256.38 ± 7.00	437.81 ± 26.40	859.47 ± 10.94
	0.014	final	37.02 ± 1.10	63.33 ± 0.95	92.02 ± 0.94	145.16 ± 7.48	271.00 ± 5.94	455.62 ± 36.45	862.44 ± 2.37
Mo	0.004	initial	0.33 ± 0.03	4.74 ± 0.06	8.73 ± 0.70	17.45 ± 0.43	34.40 ± 0.79	64.15 ± 3.66	**132.50 ± 0.47**
	0.092	middle	<LOD	4.00 ± 0.22	8.48 ± 0.33	17.58 ± 1.53	33.78 ± 0.92	62.20 ± 4.32	**129.18 ± 1.27**
	0.092	final	<LOD	3.74 ± 0.05	7.84 ± 0.35	15.39 ± 1.00	29.91 ± 0.90	54.97 ± 4.62	**109.88 ± 0.81**
Ag	0.003	initial	0.02 ± 0.03	0.003 ± 0.000	0.004 ± 0.001	0.004 ± 0.002	0.005 ± 0.001	0.004 ± 0.001	0.004 ± 0.002
	0.007	middle	0.01 ± 0.00	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.007	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cd	0.004	initial	0.001 ± 0.002	<LOD	0.004 ± 0.002	0.01 ± 0.00	0.02 ± 0.00	0.04 ± 0.01	0.07 ± 0.01
	0.002	middle	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.002	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Sb	0.002	initial	0.01 ± 0.00	0.09 ± 0.00	0.17 ± 0.01	0.36 ± 0.02	0.69 ± 0.01	1.29 ± 0.07	2.70 ± 0.02
	0.015	middle	<LOD	0.10 ± 0.00	0.21 ± 0.01	0.44 ± 0.05	0.85 ± 0.02	1.49 ± 0.12	3.22 ± 0.06
	0.015	final	<LOD	0.09 ± 0.01	0.21 ± 0.01	0.40 ± 0.04	0.77 ± 0.00	1.42 ± 0.15	2.97 ± 0.06
Ba	0.008	initial	0.39 ± 0.04	1.80 ± 0.01	3.01 ± 0.10	6.02 ± 0.46	11.32 ± 0.15	19.95 ± 1.37	41.86 ± 0.34
	0.030	middle	0.48 ± 0.04	1.95 ± 0.08	3.49 ± 0.11	6.58 ± 0.33	12.11 ± 0.30	22.40 ± 1.95	46.33 ± 0.33
	0.030	final	0.54 ± 0.08	2.15 ± 0.06	3.90 ± 0.17	7.06 ± 0.29	13.18 ± 0.41	24.50 ± 2.08	49.00 ± 0.38
Hg	0.011	initial	<LOD	<LOD	<LOD	0.01 ± 0.00	0.02 ± 0.01	**0.04 ± 0.01**	**0.05 ± 0.01**
	0.093	middle	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	0.093	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Tl	0.001	initial	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.05 ± 0.00
	0.007	middle	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.03 ± 0.00
	0.007	final	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.03 ± 0.00
Pb	0.004	initial	0.06 ± 0.00	0.06 ± 0.00	0.06 ± 0.00	0.07 ± 0.01	0.06 ± 0.00	0.06 ± 0.00	0.06 ± 0.00
	0.025	middle	<LOD	0.04 ± 0.03	<LOD	<LOD	<LOD	<LOD	<LOD

	0.025	final	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.00	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.02 ± 0.02
U	0.001	initial	<LOD	0.01 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	0.07 ± 0.00	0.12 ± 0.01	0.25 ± 0.00
	0.005	middle	<LOD	<LOD	<LOD	<LOD	0.02 ± 0.00	0.08 ± 0.01	0.19 ± 0.02
	0.005	final	<LOD	<LOD	<LOD	<LOD	0.01 ± 0.00	0.03 ± 0.01	0.09 ± 0.01

The instrumental certified reference material is 1640a, trace elements in natural water, obtained from the National Institute of Standards and Technology. Measured recovery of the reference material was 94.76 ± 1.99 % (*n*=5,6) for these samples. The instrumental certified reference material specific to mercury is 1641d, mercury in water, also obtained from the National Institute of Standards and Technology. Measured recovery of 1641d was 105.53 ± 5.91% (*n*=1,1).