Appendix C. Site C PAG Contact RSEM Surface Water Quality Monitoring Time Series Plots – RSEM R6 Monthly and 5 in 30-day Data

Figure 89. 2017 Peace River and RSEM R6 *In-Situ* (Peace River) and Lab (R6 pond) Specific Conductivity.

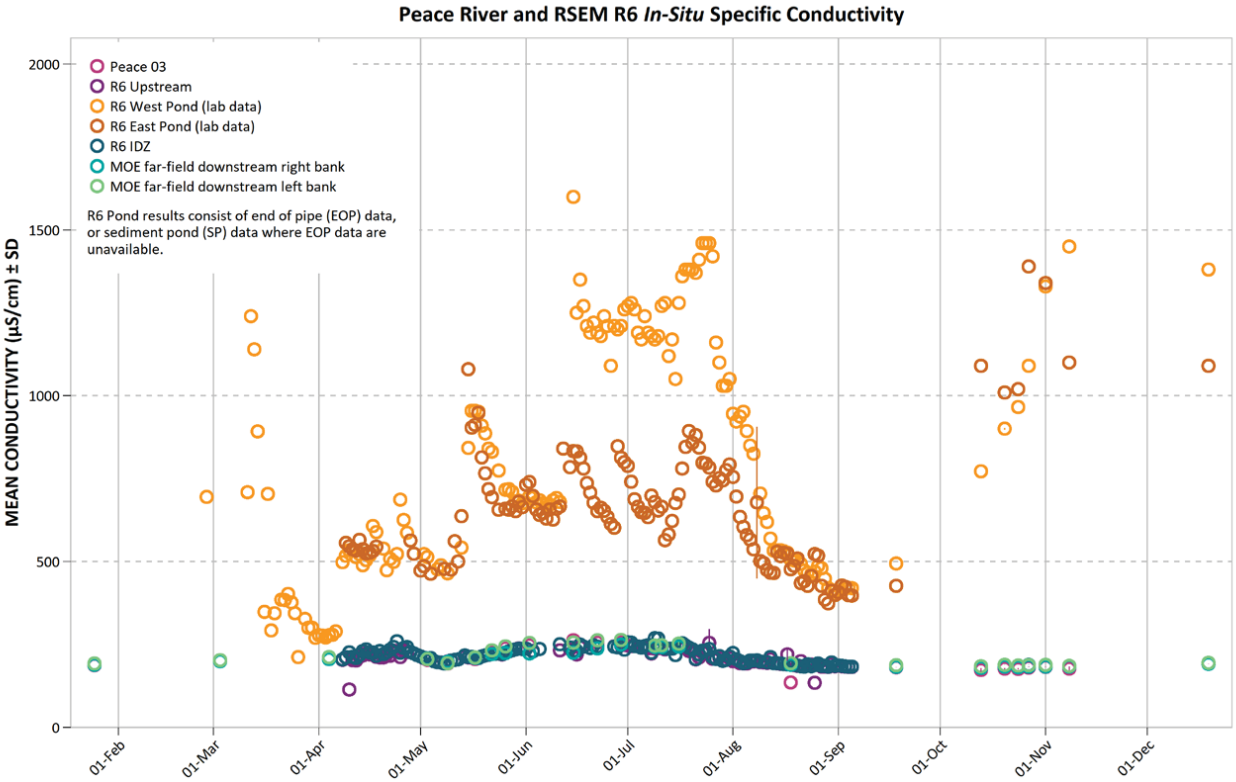


Figure 90. 2017 Peace River and RSEM R6 Lab Specific Conductivity.

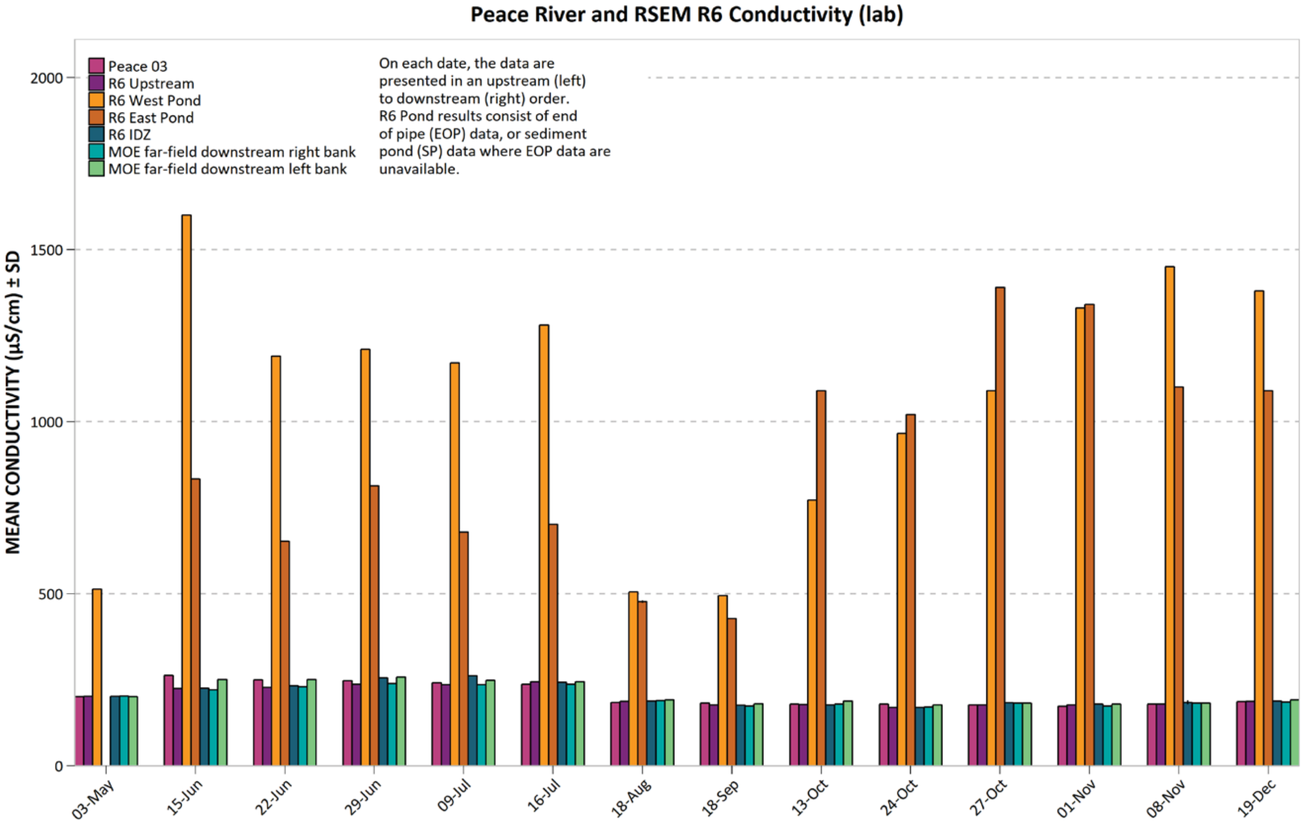


Figure 91. 2017 Peace River and RSEM R6 Hardness (as $CaCO_3$).

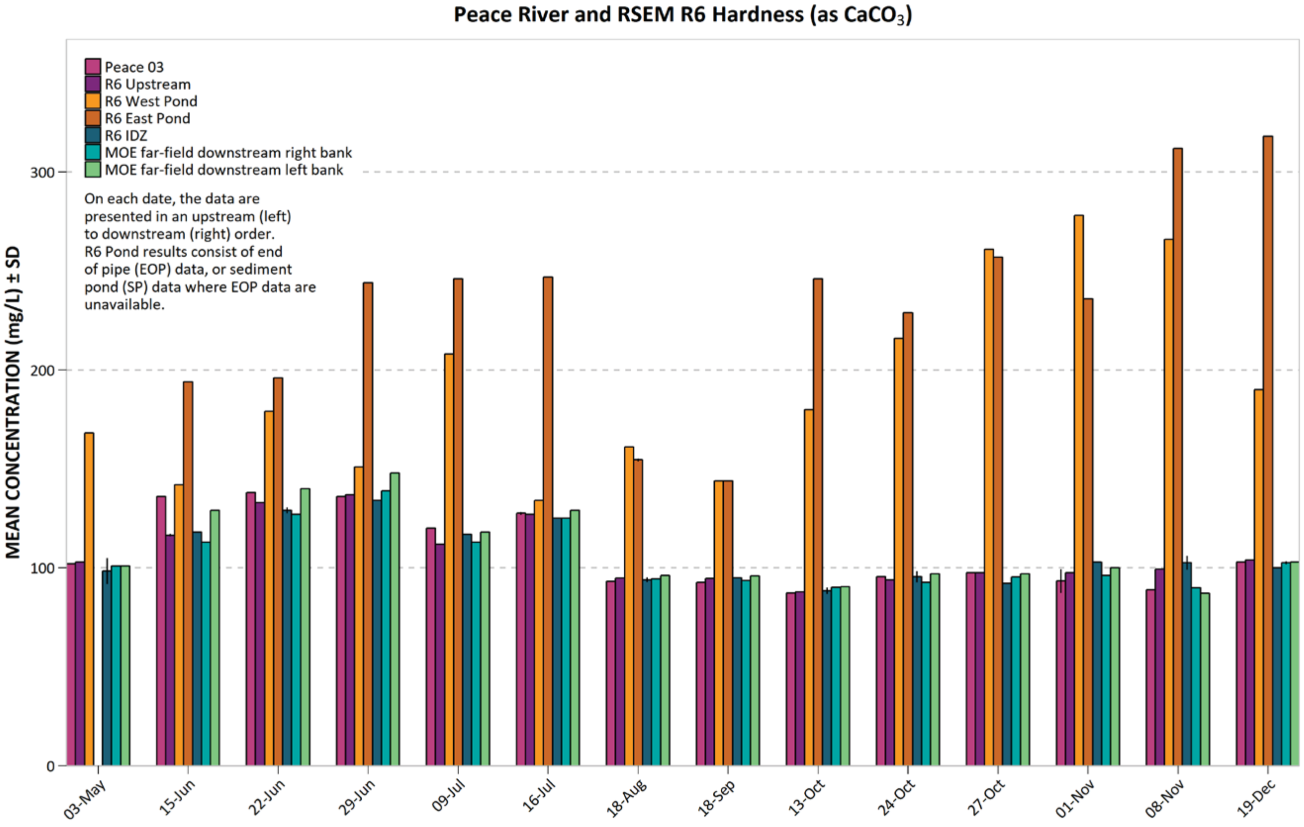


Figure 92. 2017 Peace River and RSEM R6 Total Dissolved Solids.

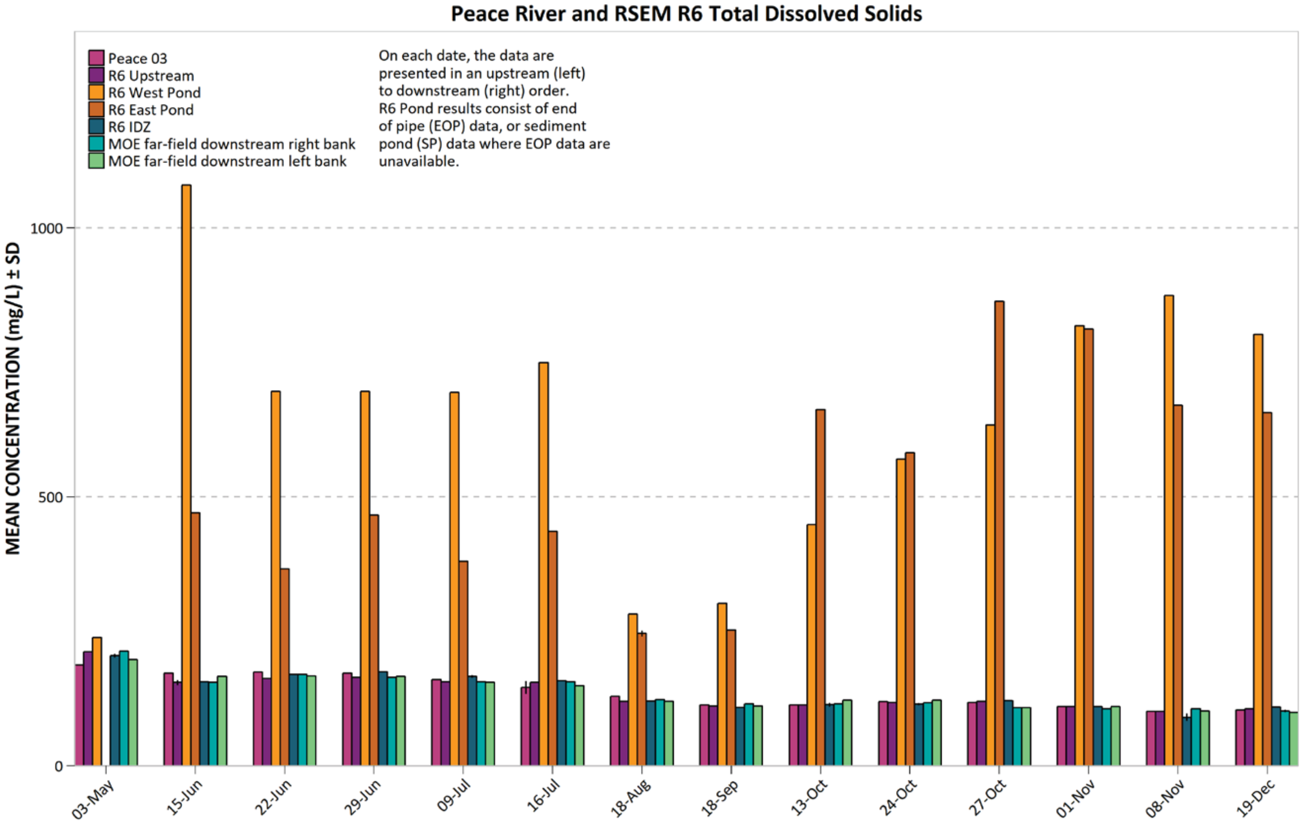
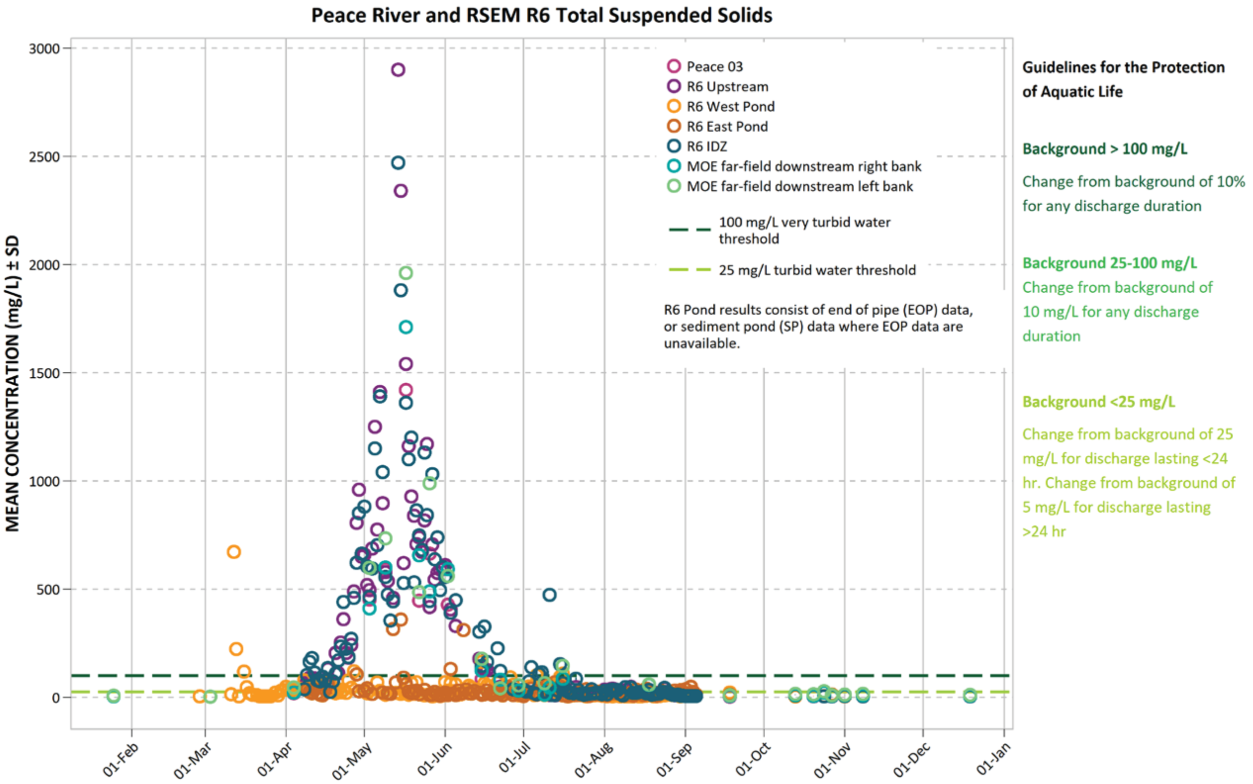


Figure 93. **2017 Peace River and RSEM R6 Total Suspended Solids.**



At the Peace River sampling locations, the concentration of total suspended solids (TSS) is obtained preferentially from laboratory data, however if laboratory data are unavailable, TSS is calculated from *in-situ t*urbidity data using site specific TSS:Turbidity relationships.

Figure 94. 2017 Peace River and RSEM R6 *In-Situ* (Peace River) and lab (R6 pond) Turbidity.

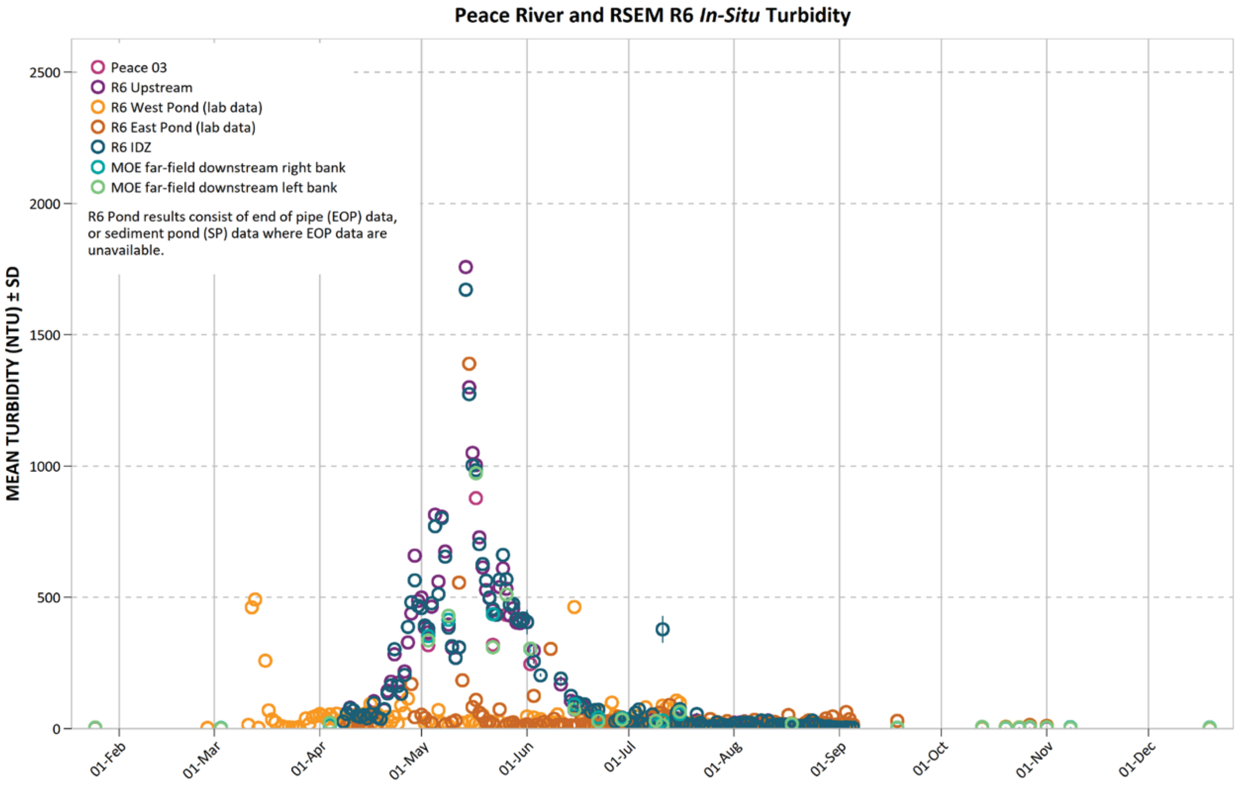


Figure 95. 2017 Peace River and RSEM R6 *In-Situ* (Peace River) and lab (R6 pond) pH.

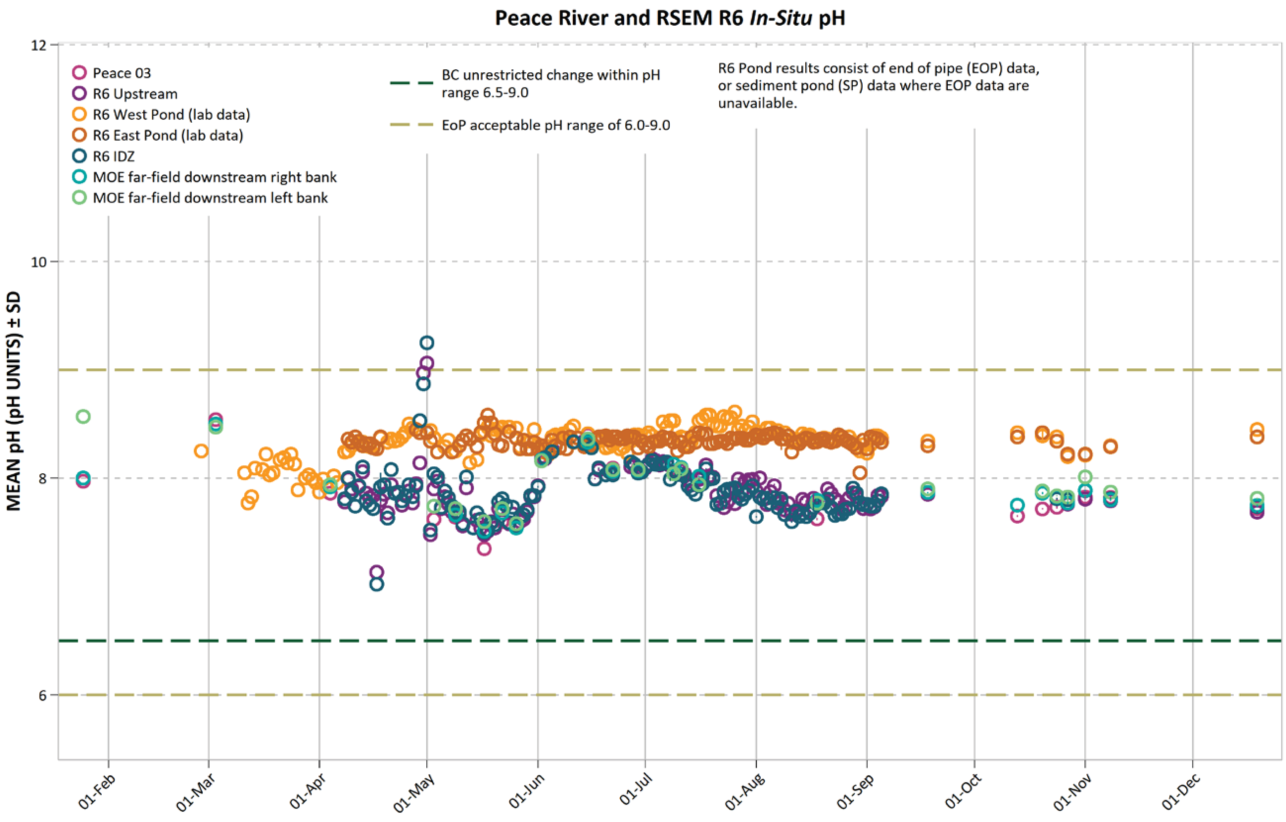


Figure 96. 2017 Peace River and RSEM R6 pH (lab).

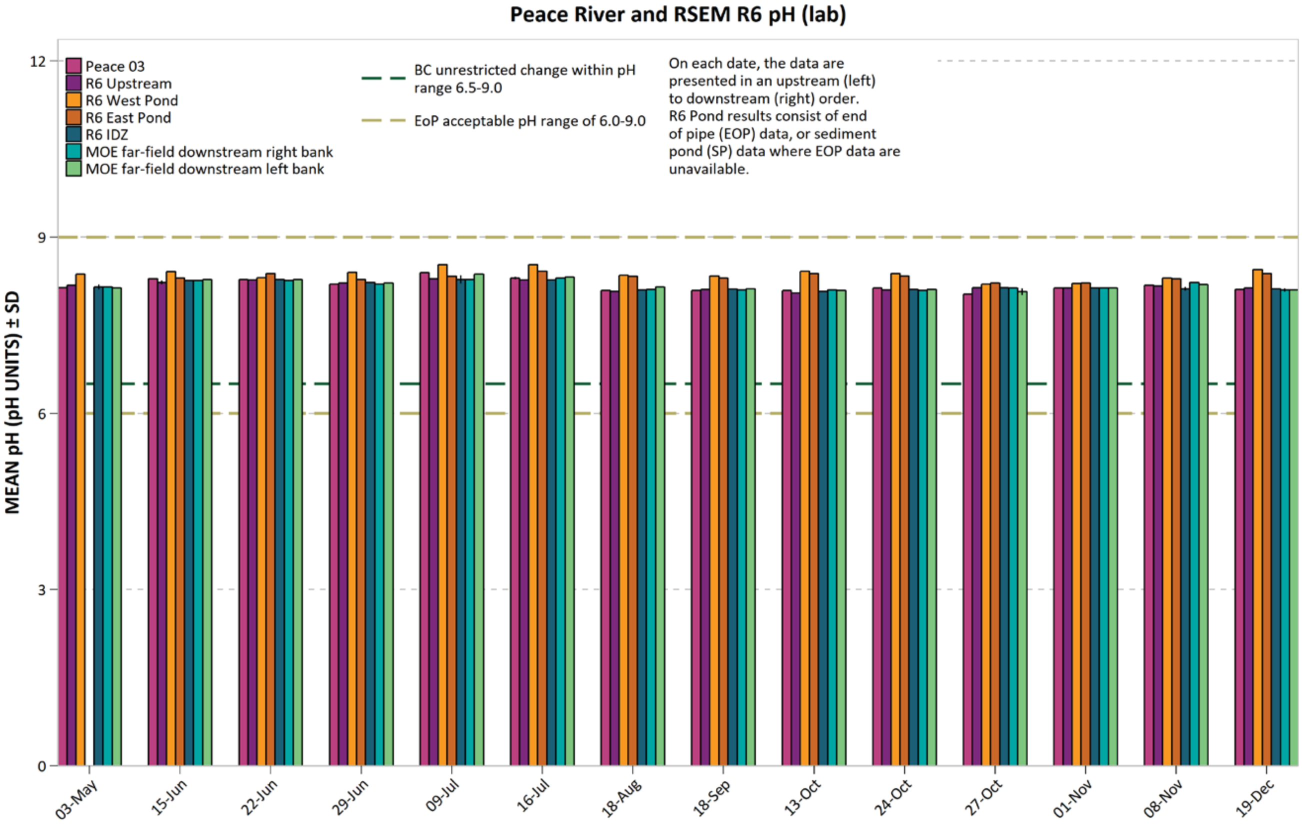


Figure 97. 2017 Peace River and RSEM R6 Total Alkalinity (as $CaCO_3$).

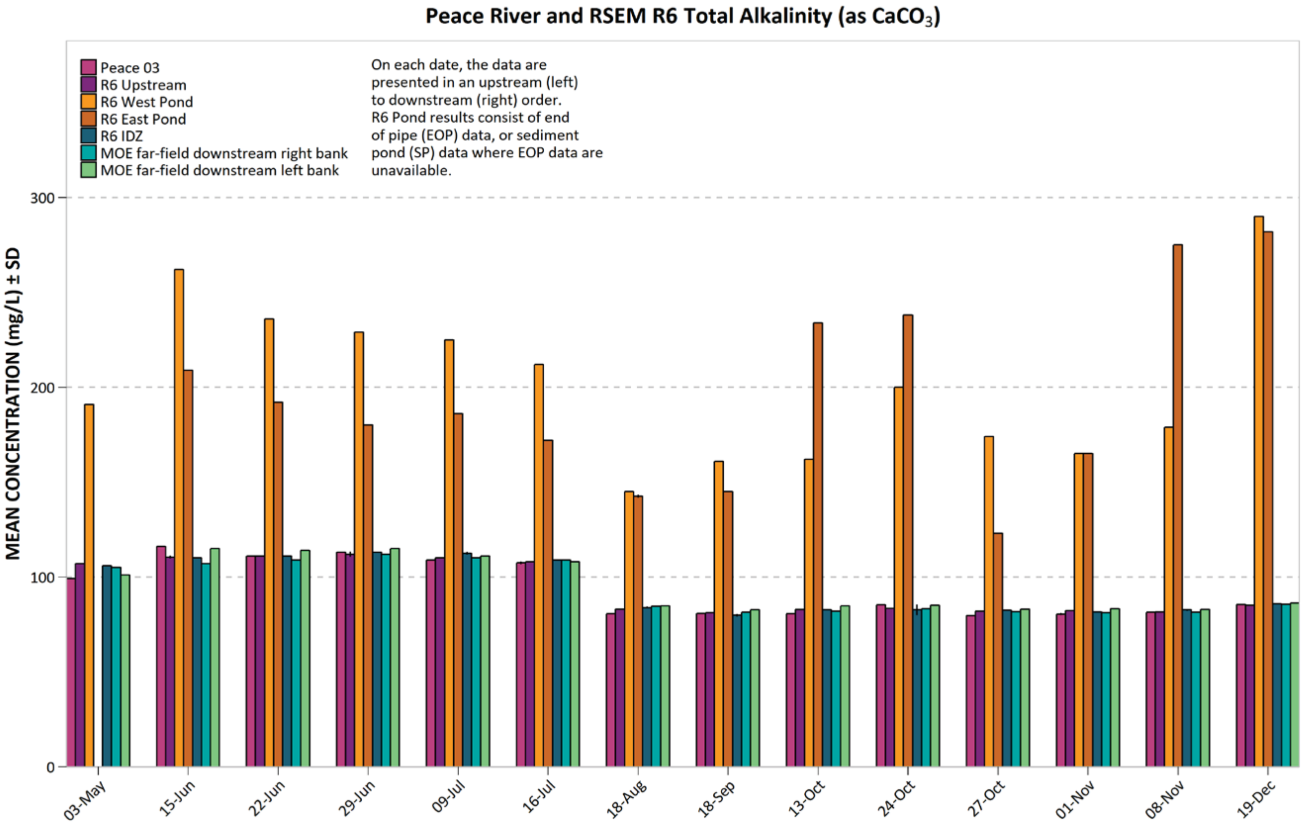


Figure 98. **2017 Peace River and RSEM R6 Total Ammonia (as N).**

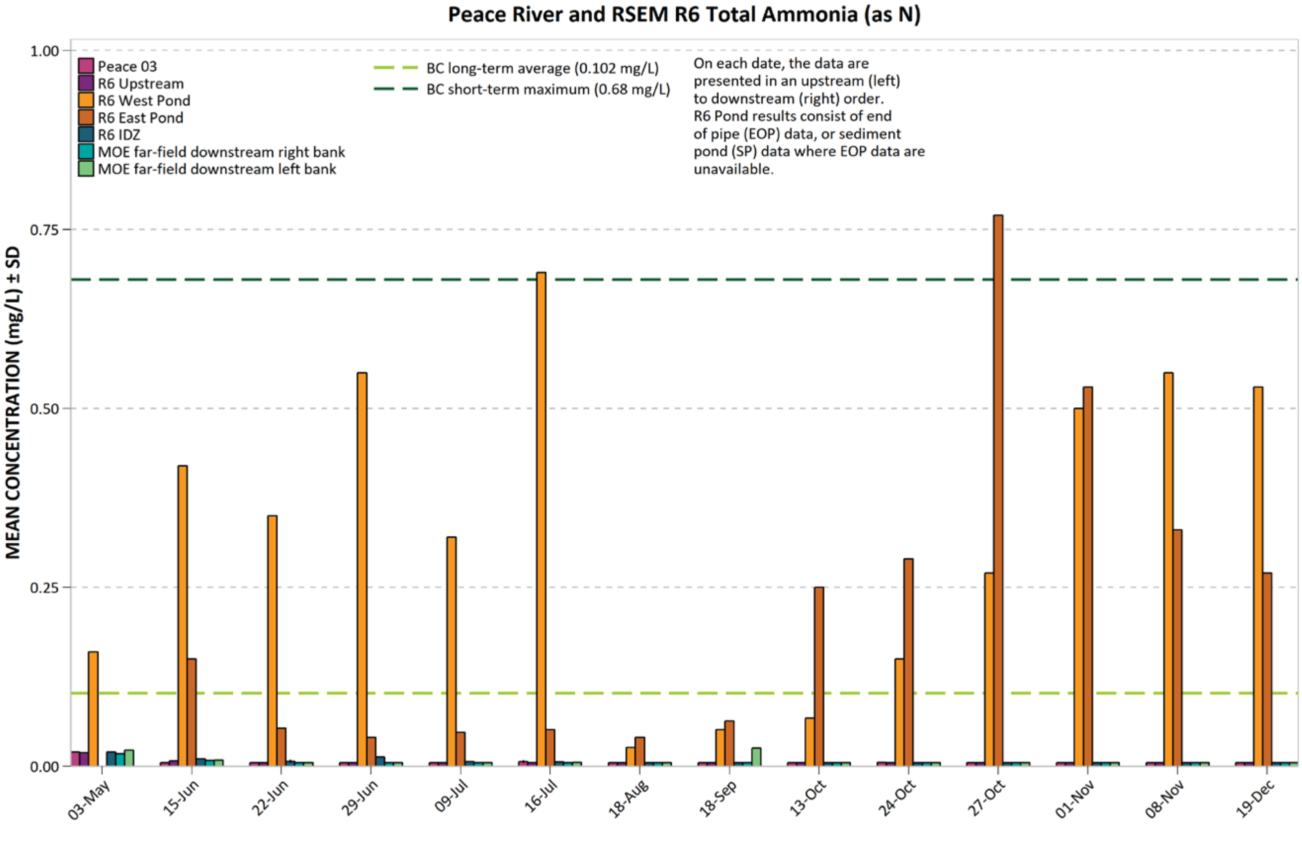
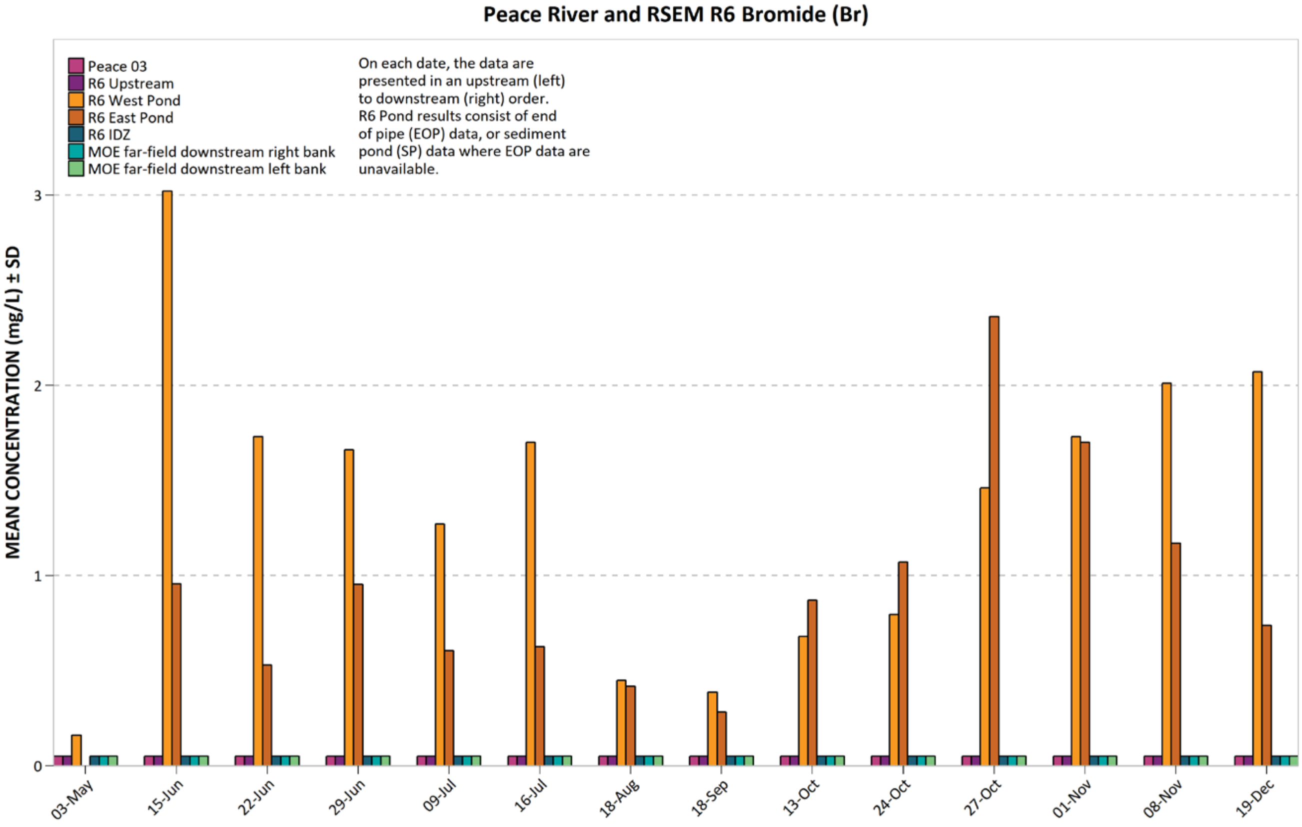
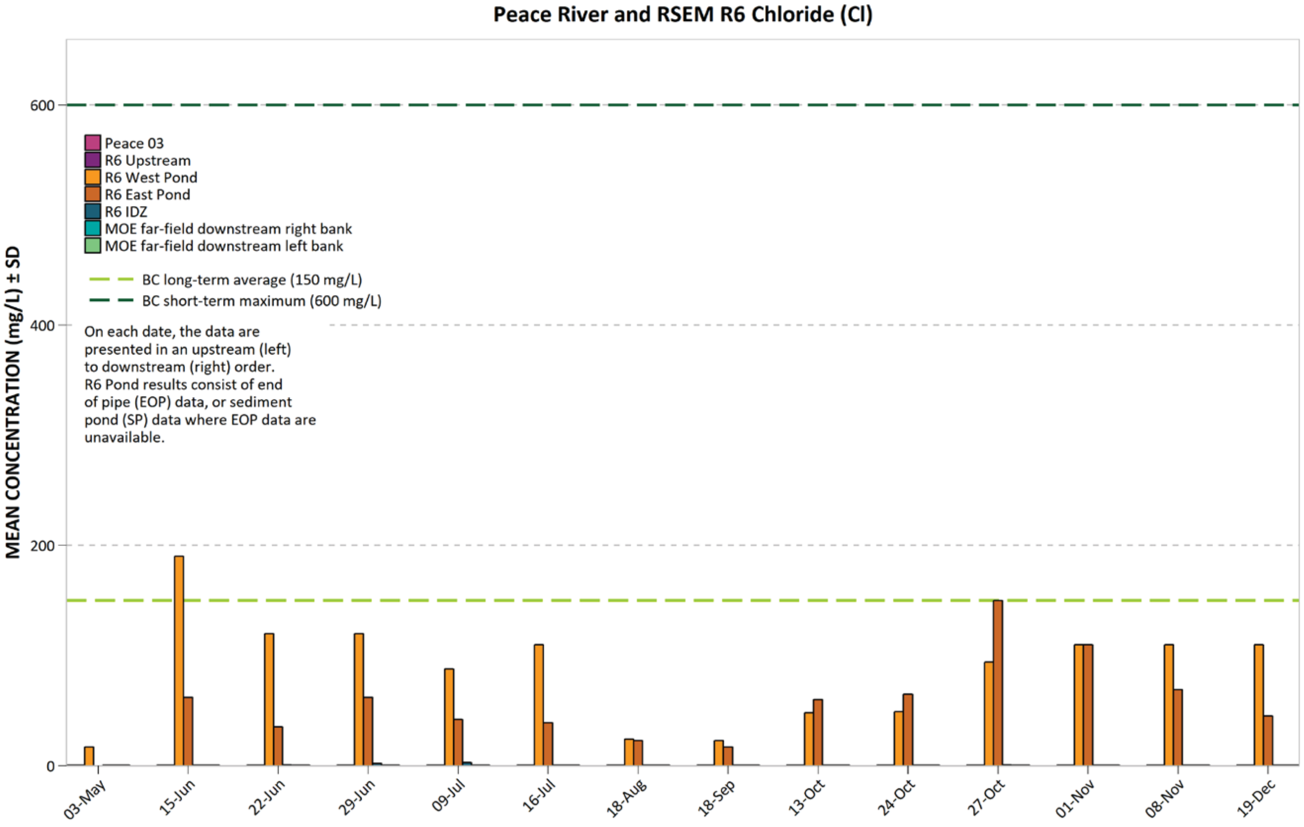


Figure 99. 2017 Peace River and RSEM R6 Bromide.



All Peace River data are <MDL.

Figure 100. 2017 Peace River and RSEM R6 Chloride.



All Peace River data are less than the ALS MDL of 0.5 mg/L.

Figure 101. 2017 Peace River and RSEM R6 Dissolved Orthophosphate.

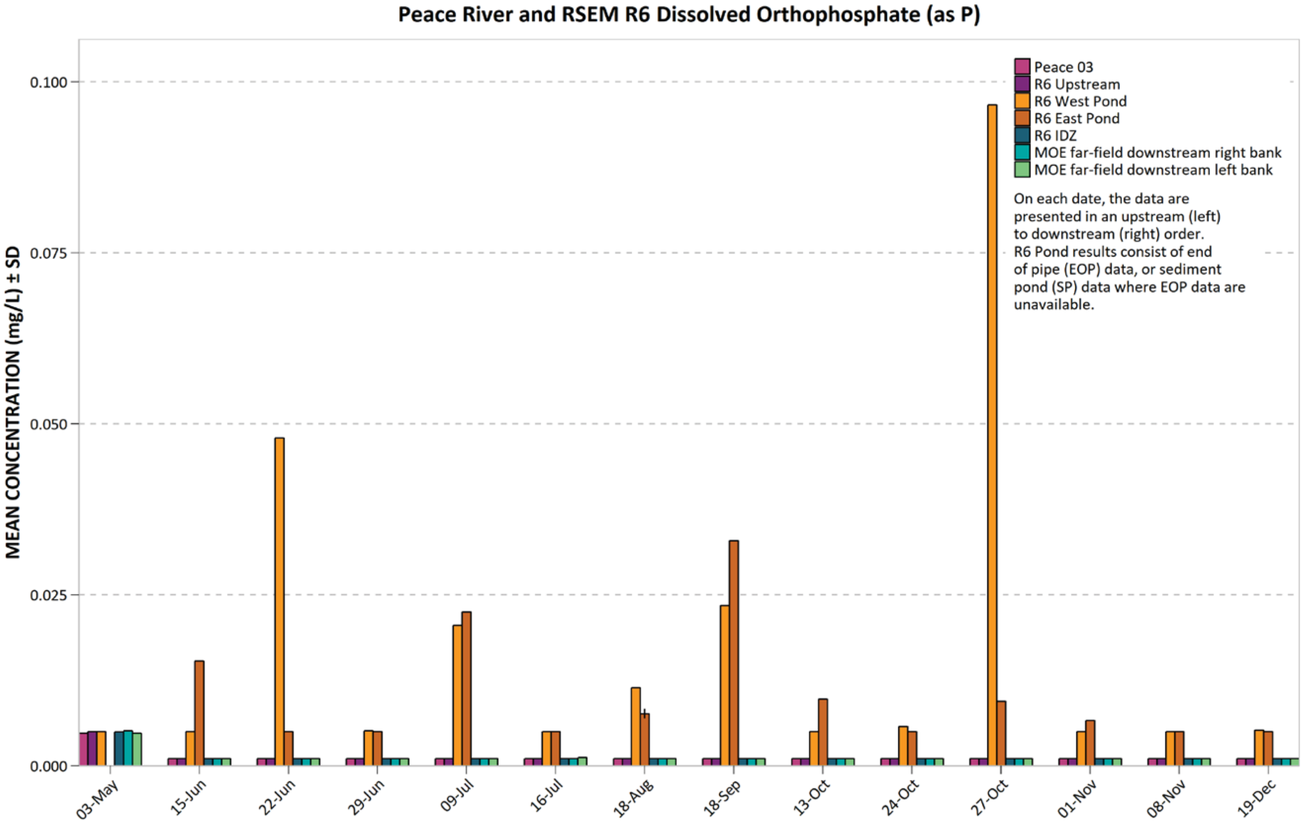


Figure 102. 2017 Peace River and RSEM R6 Fluoride.

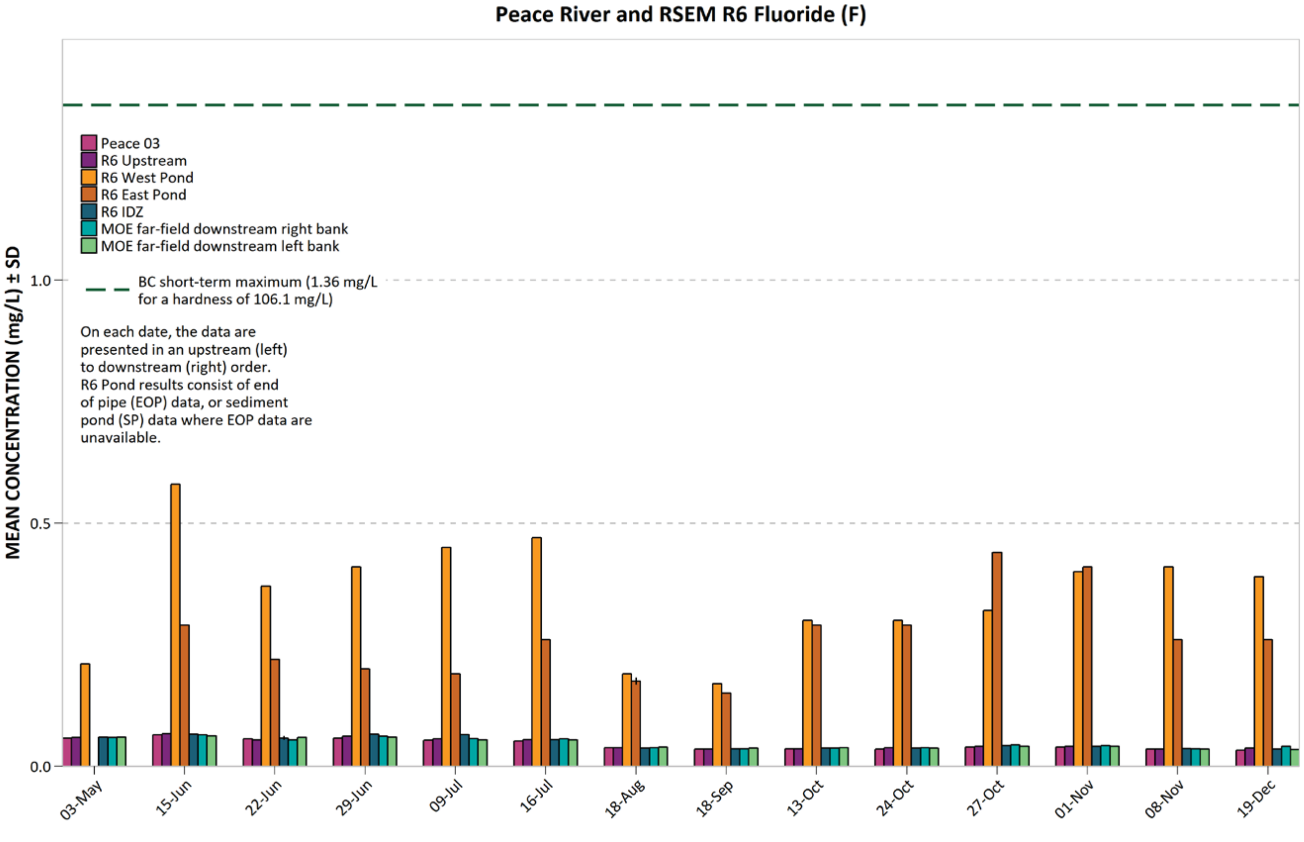


Figure 103. 2017 Peace River and RSEM R6 Nitrate (as N).

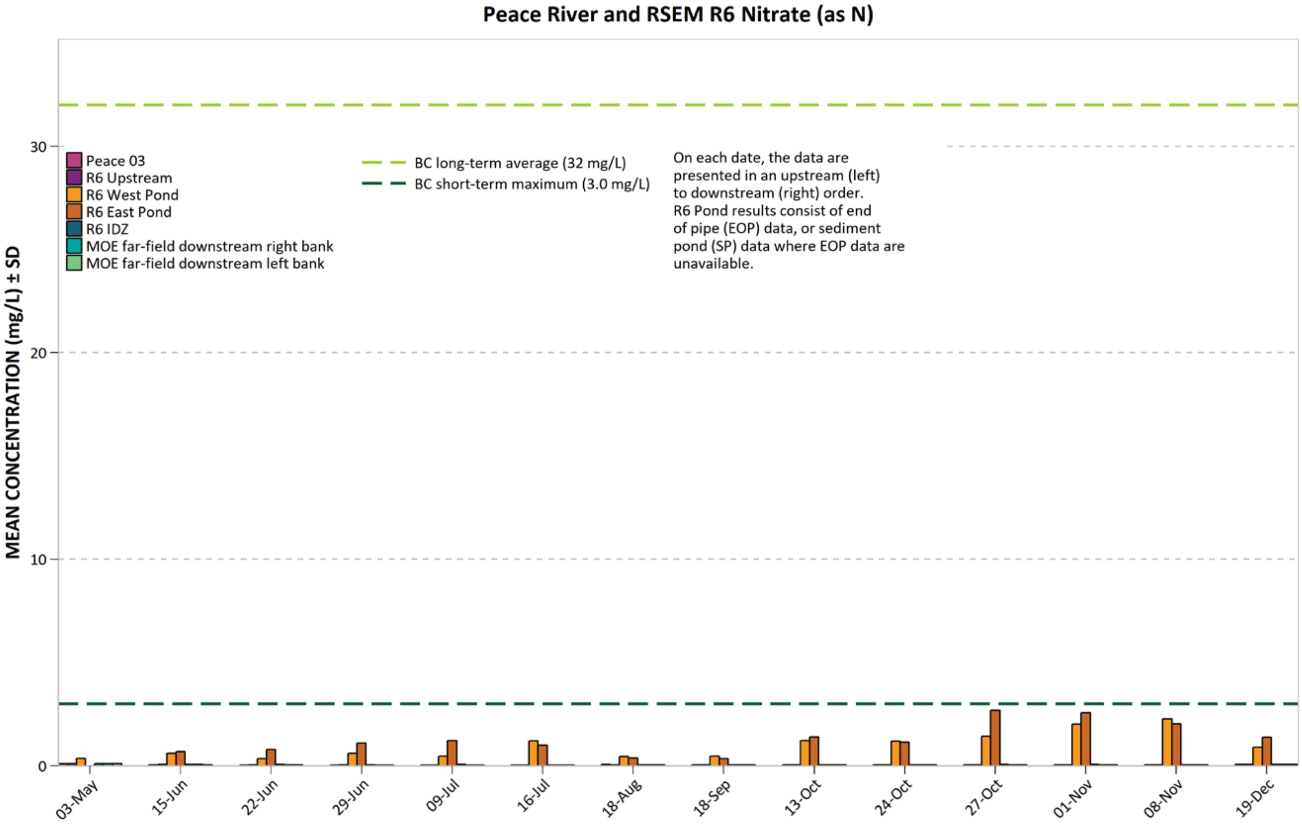
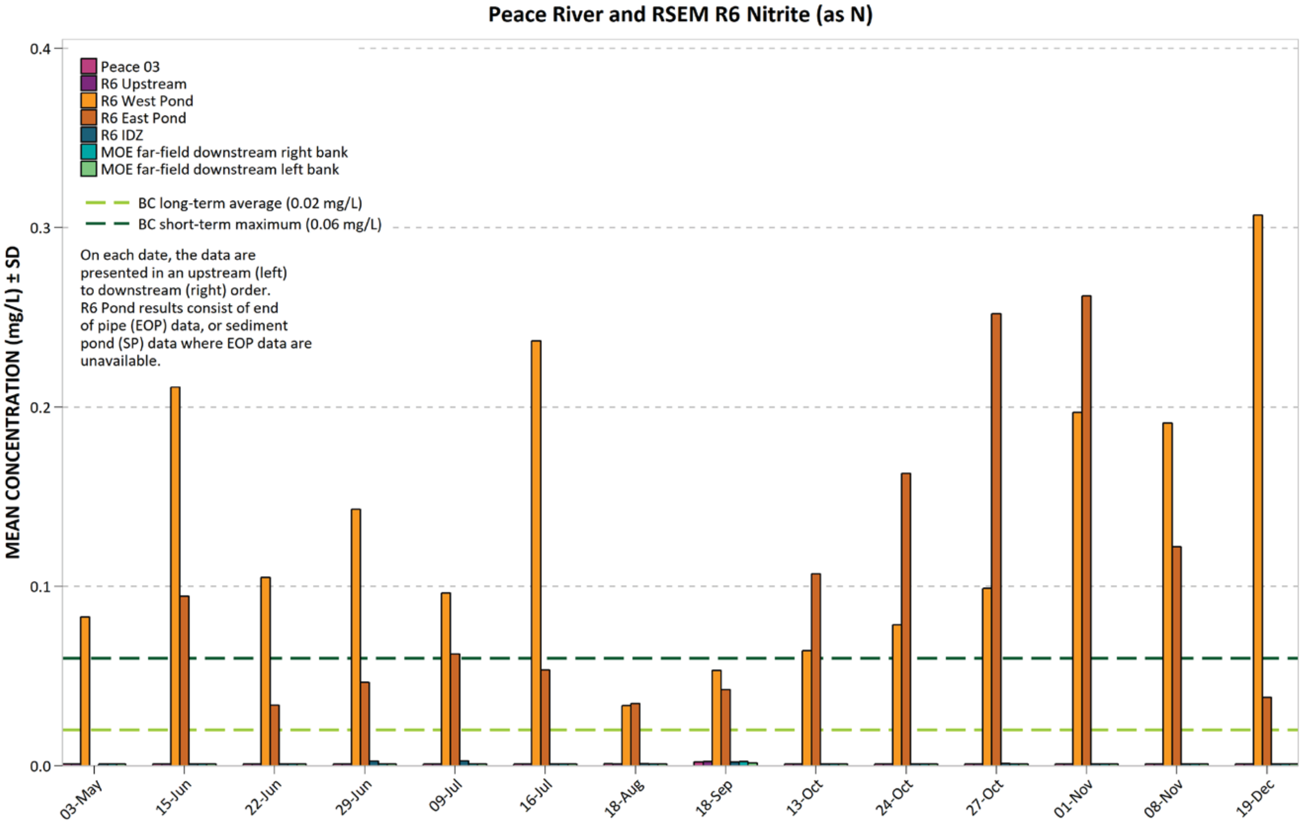


Figure 104. 2017 Peace River and RSEM R6 Nitrite (as N).



Note: BC WQG for nitrite are chloride dependent, and therefore guidelines depicted in the plot are applicable for Peace River sites only. Based on the range of chloride values observed in the R6 pond, the applicable BC Maximum and 30-day guidelines are 0.6 mg/L and 0.2 mg/L, respectively.

Figure 105. 2017 Peace River and RSEM R6 Sulfate (SO_4).

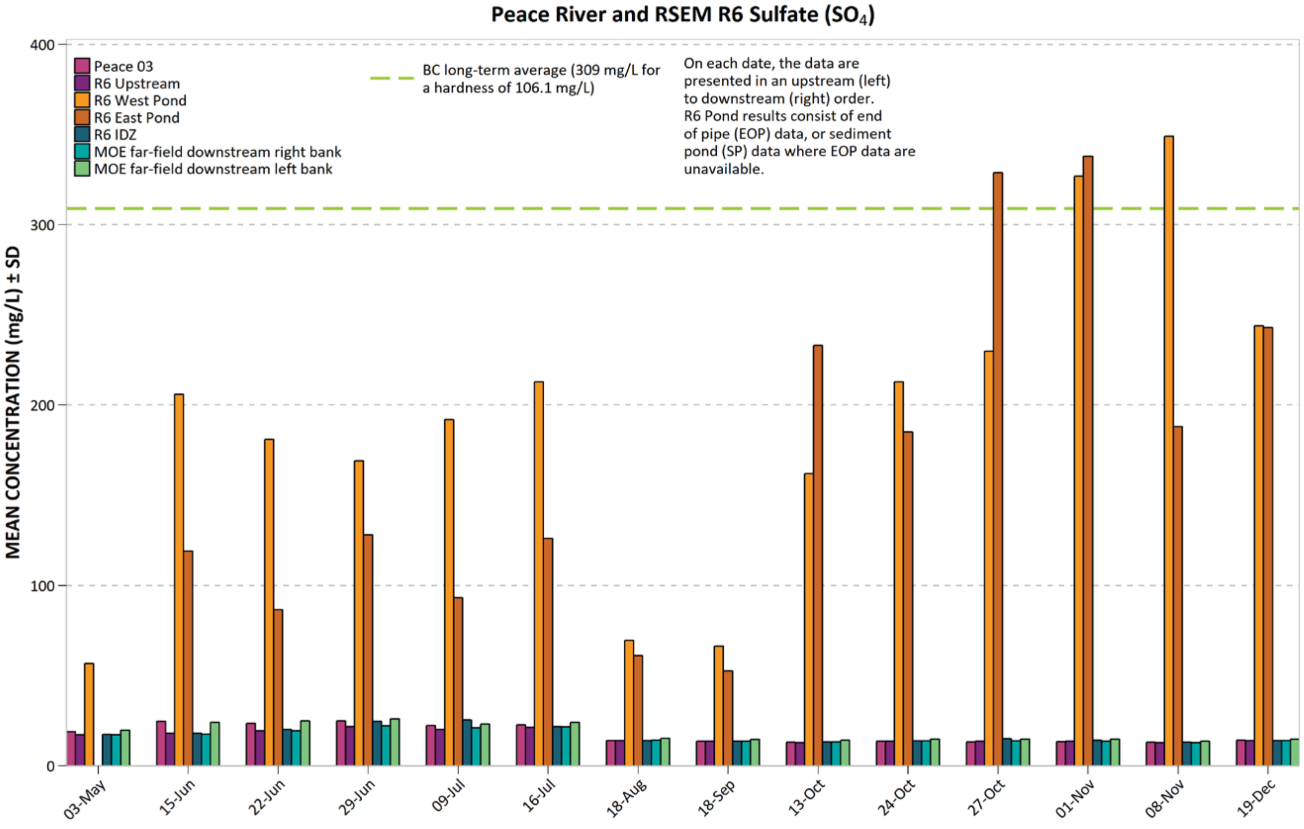


Figure 106. 2017 Peace River and RSEM R6 Dissolved Organic Carbon

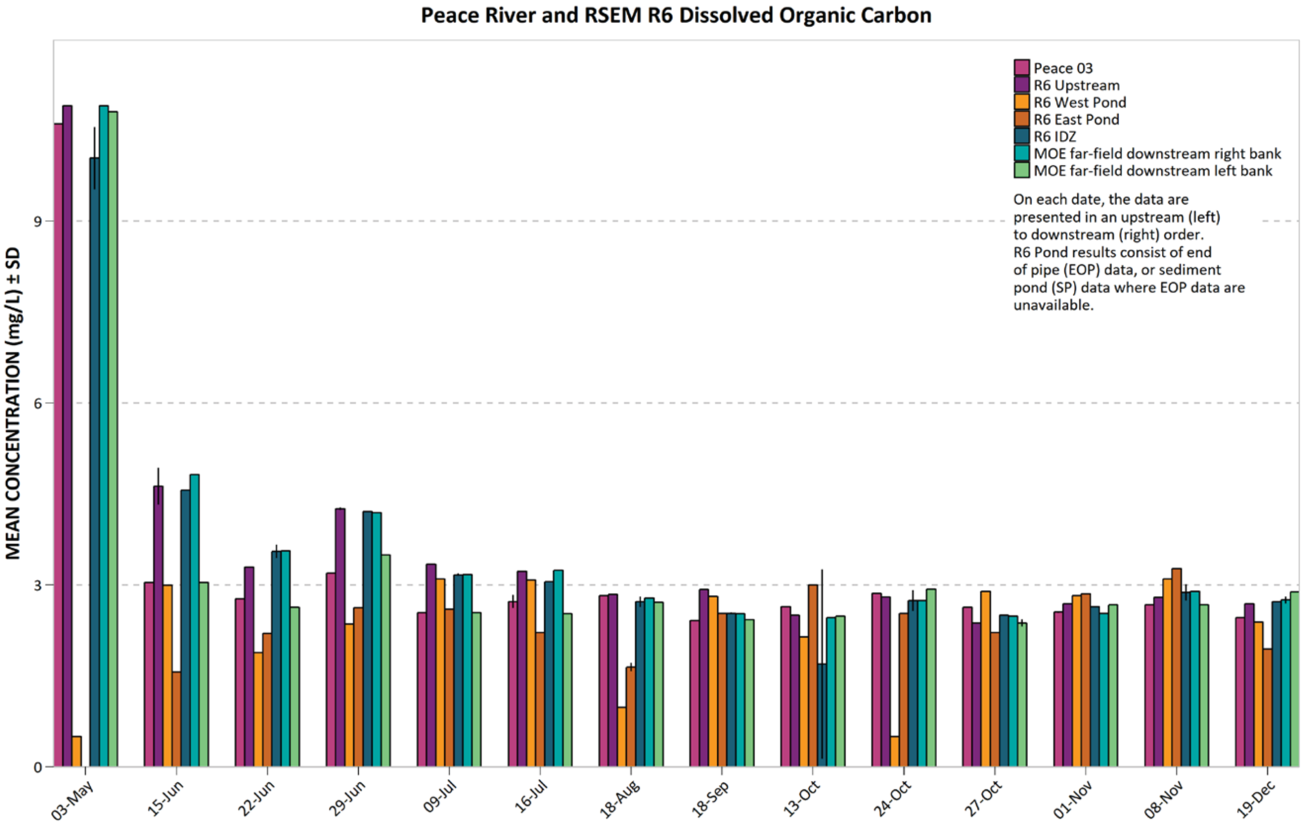
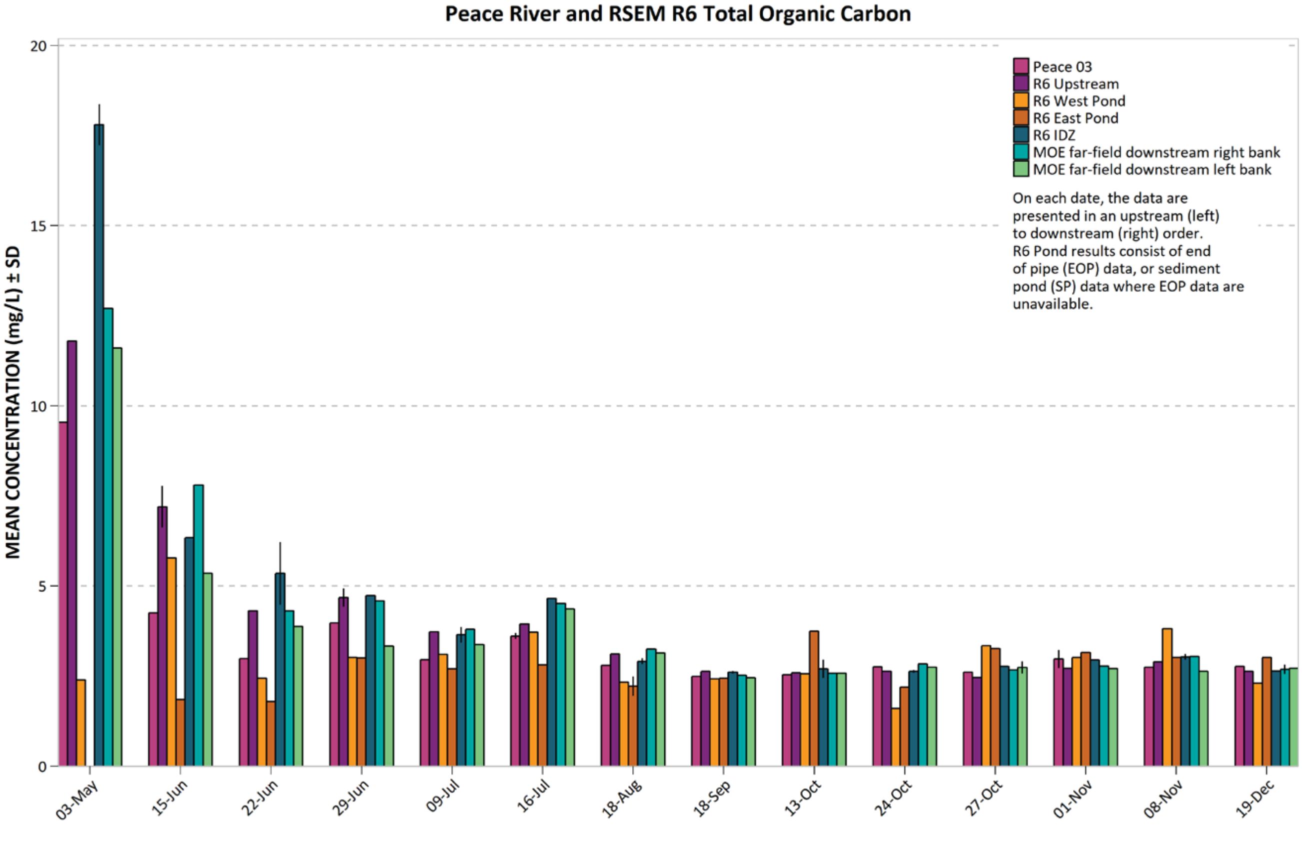


Figure 107. 2017 Peace River and RSEM R6 Total Organic Carbon.



On each date, the data are presented in an upstream (left) to downstream (right) order. R6 Pond results consist of end of pipe (EOP) data, or sediment pond (SP) data where EOP data are unavailable.

Figure 108. 2017 Peace River and RSEM R6 Total Aluminum (Al).

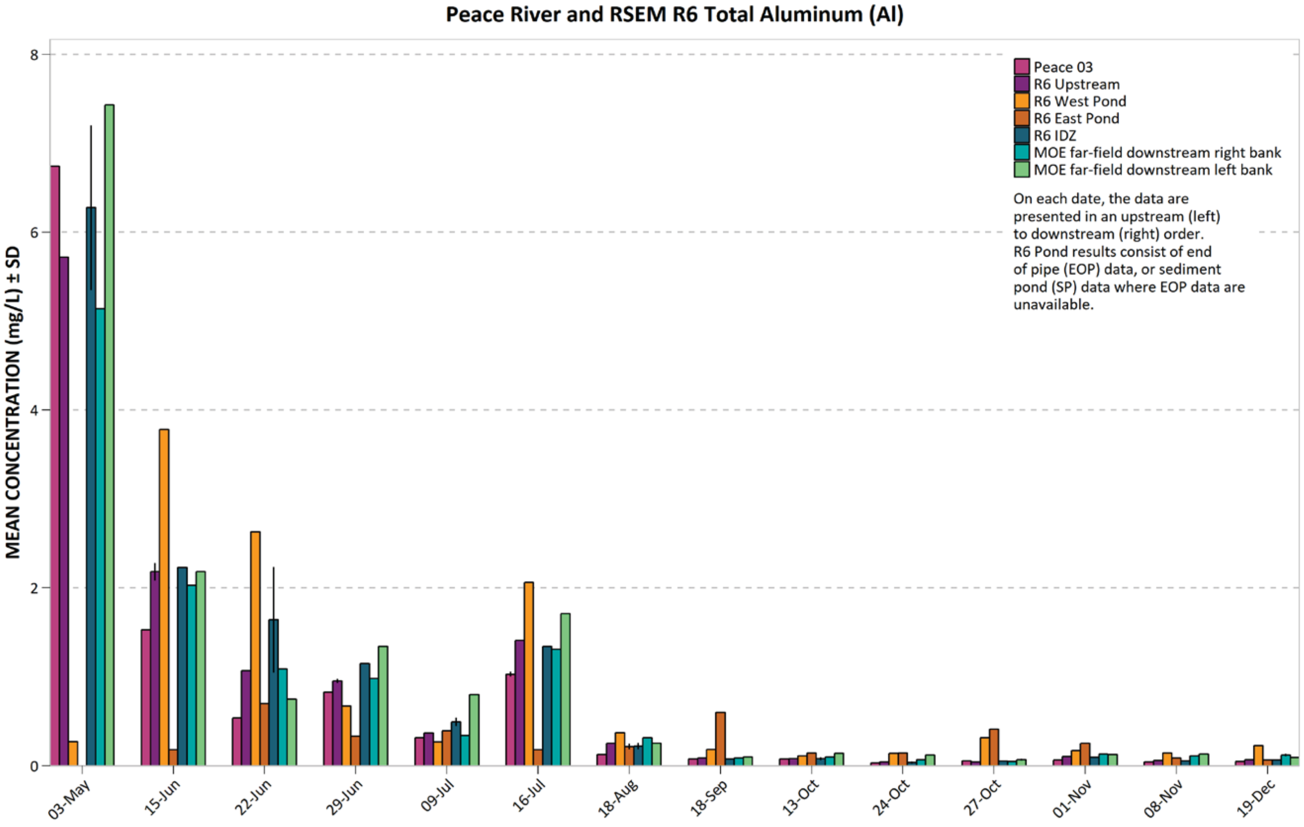
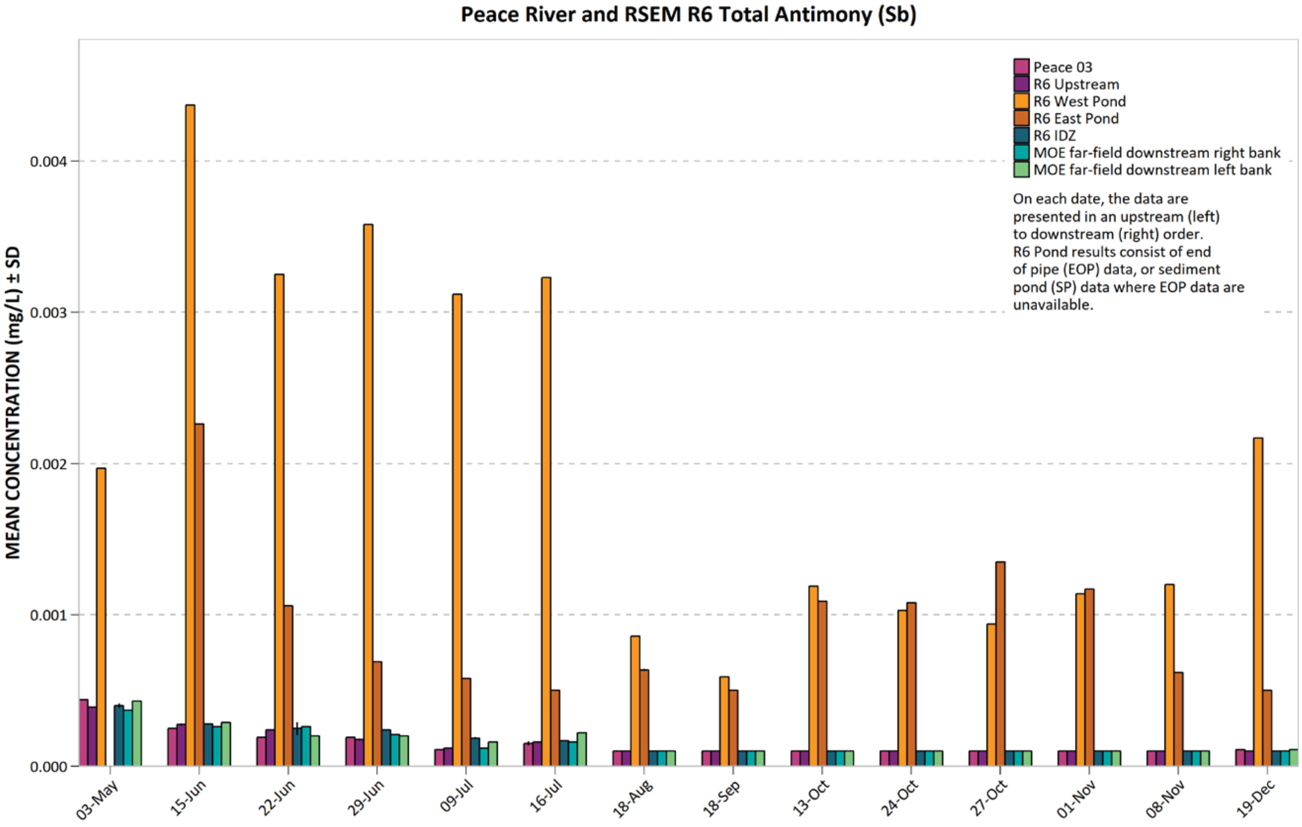


Figure 109. 2017 Peace River and RSEM R6 Total Antimony (Sb).



On each date, the data are presented in an upstream (left) to downstream (right) order. R6 Pond results consist of end of pipe (EOP) data, or sediment pond (SP) data where EOP data are unavailable.

Figure 110. 2017 Peace River and RSEM R6 Total Arsenic (As).

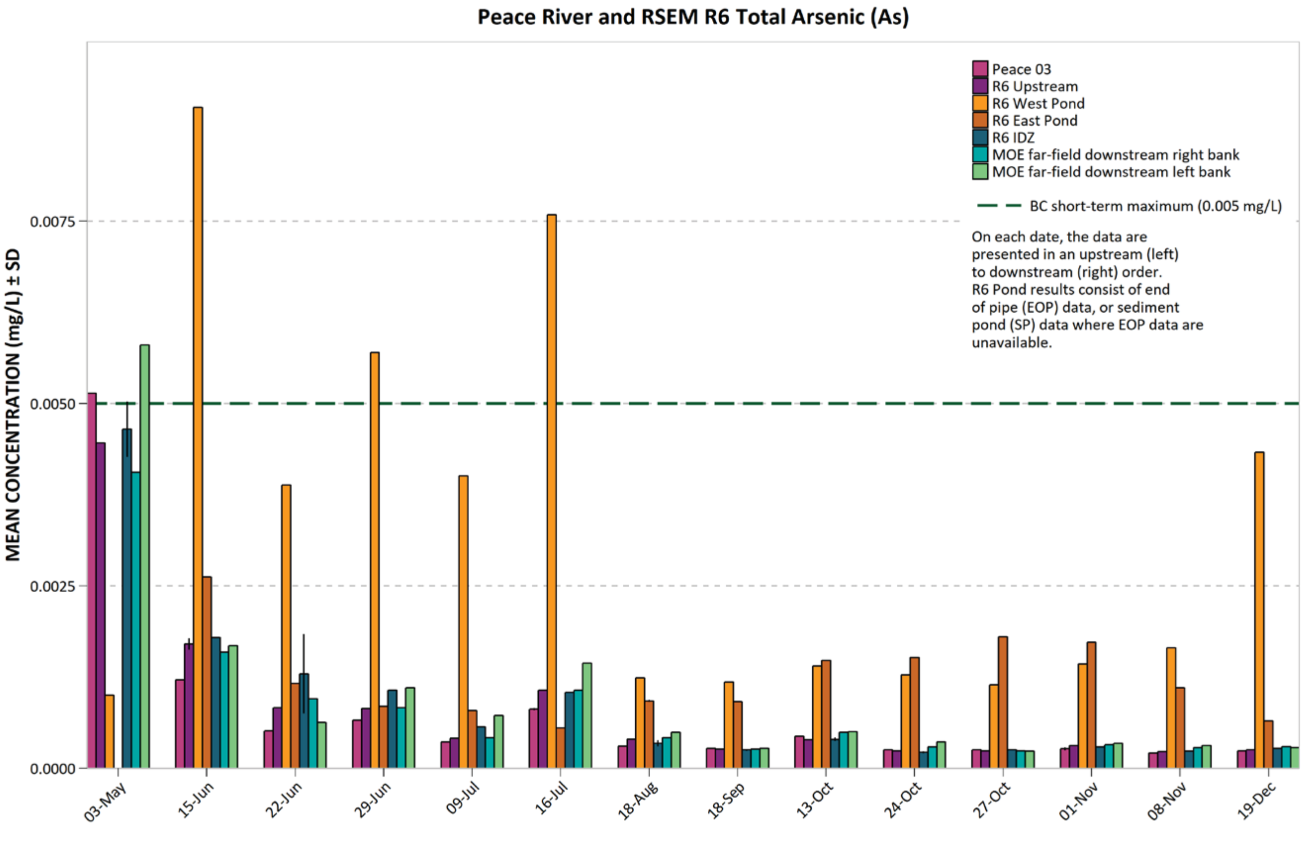


Figure 111. 2017 Peace River and RSEM R6 Total Barium (Ba).

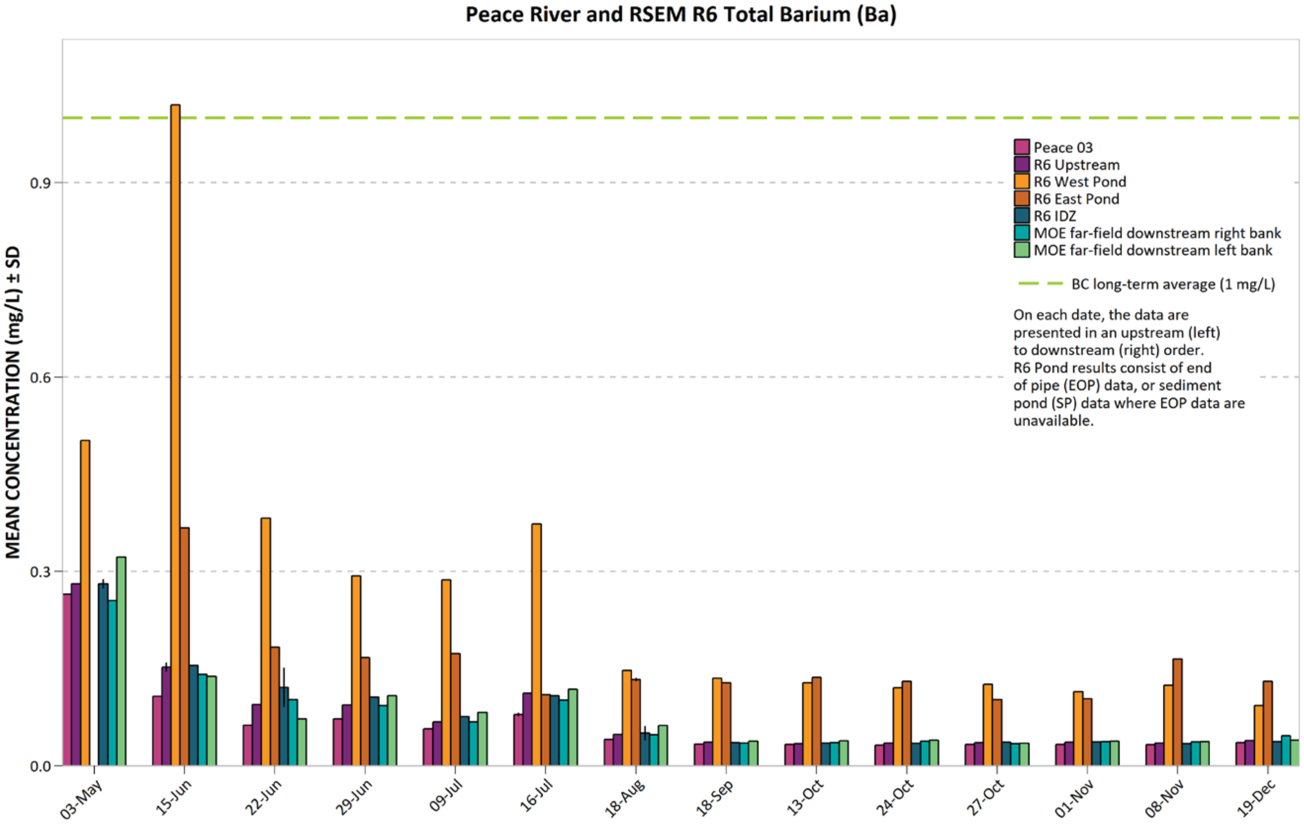
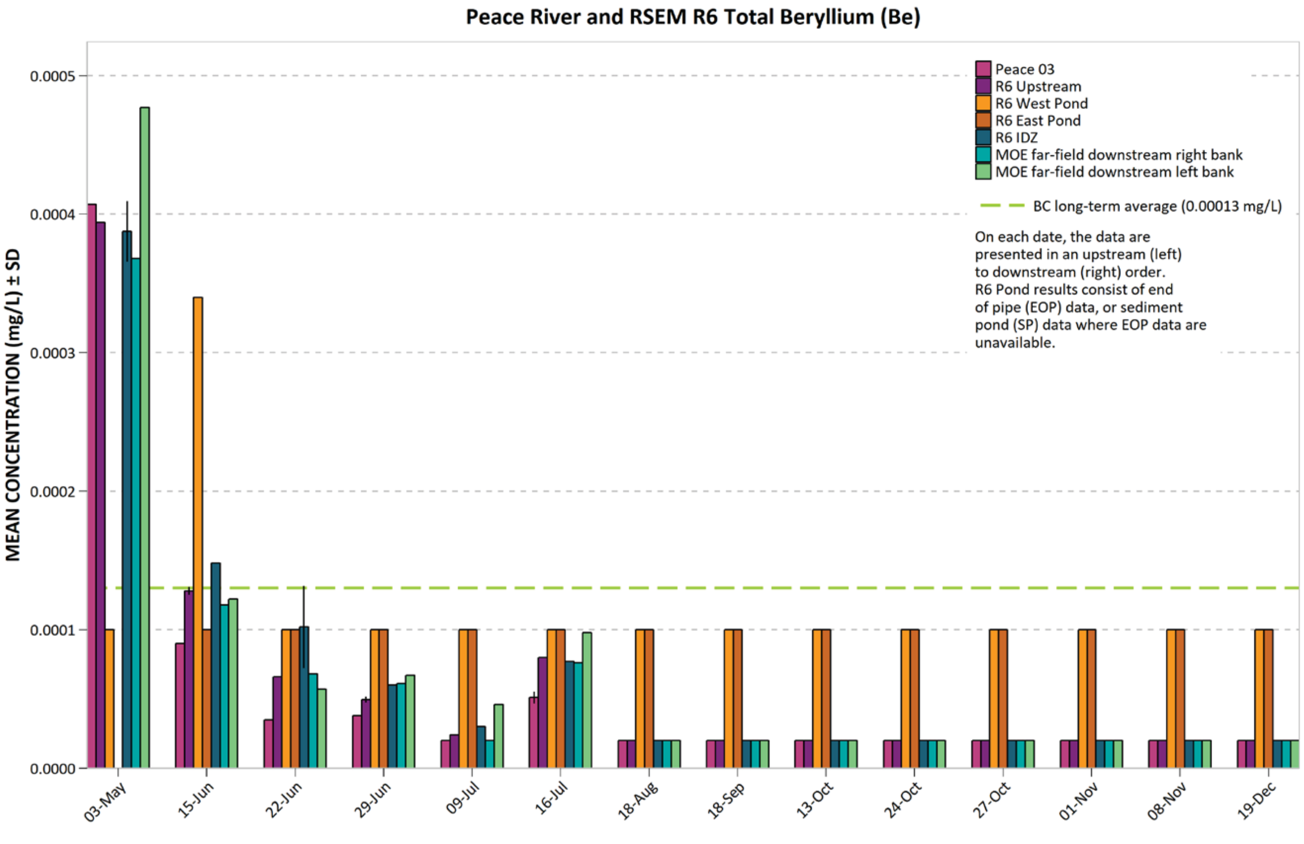
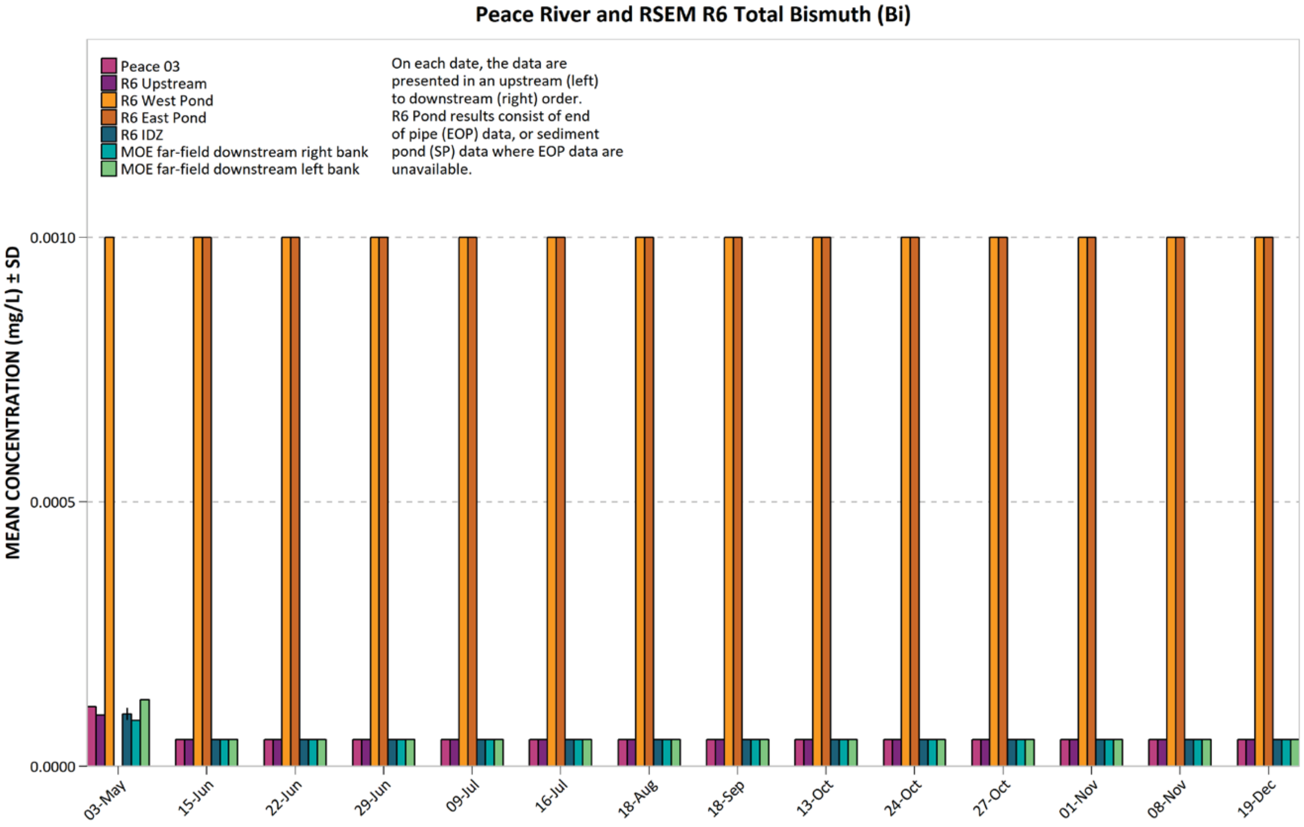


Figure 112. 2017 Peace River and RSEM R6 Total Beryllium (Be).



On each date, the data are presented in an upstream (left) to downstream (right) order. R6 Pond results consist of end of pipe (EOP) data, or sediment pond (SP) data where EOP data are unavailable.

Figure 113. 2017 Peace River and RSEM R6 Total Bismuth (Bi).



All R6 pond data are <MDL and most of the Peace River data are <MDL Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits..

Figure 114. 2017 Peace River and RSEM R6 Total Boron (B).

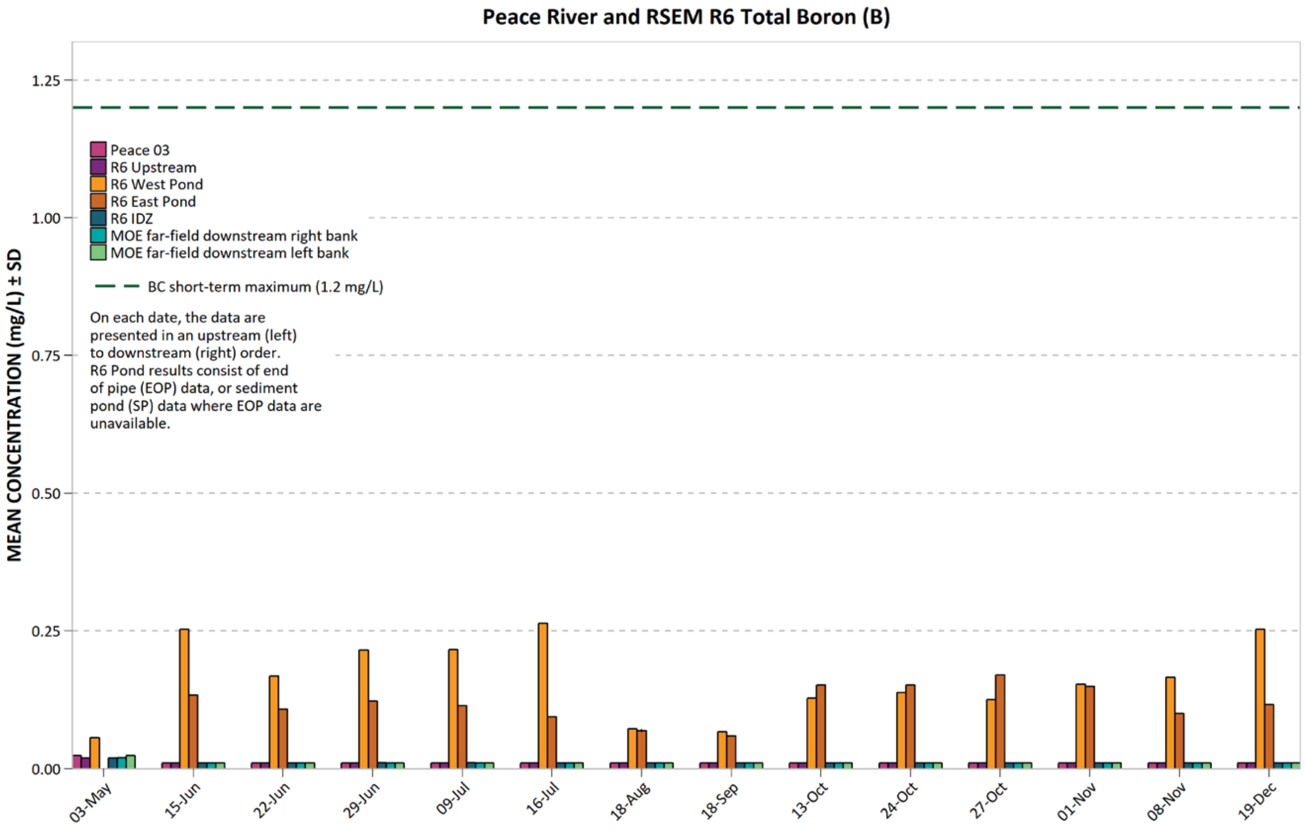


Figure 115. Peace River and RSEM R6 Total Cadmium (Cd).

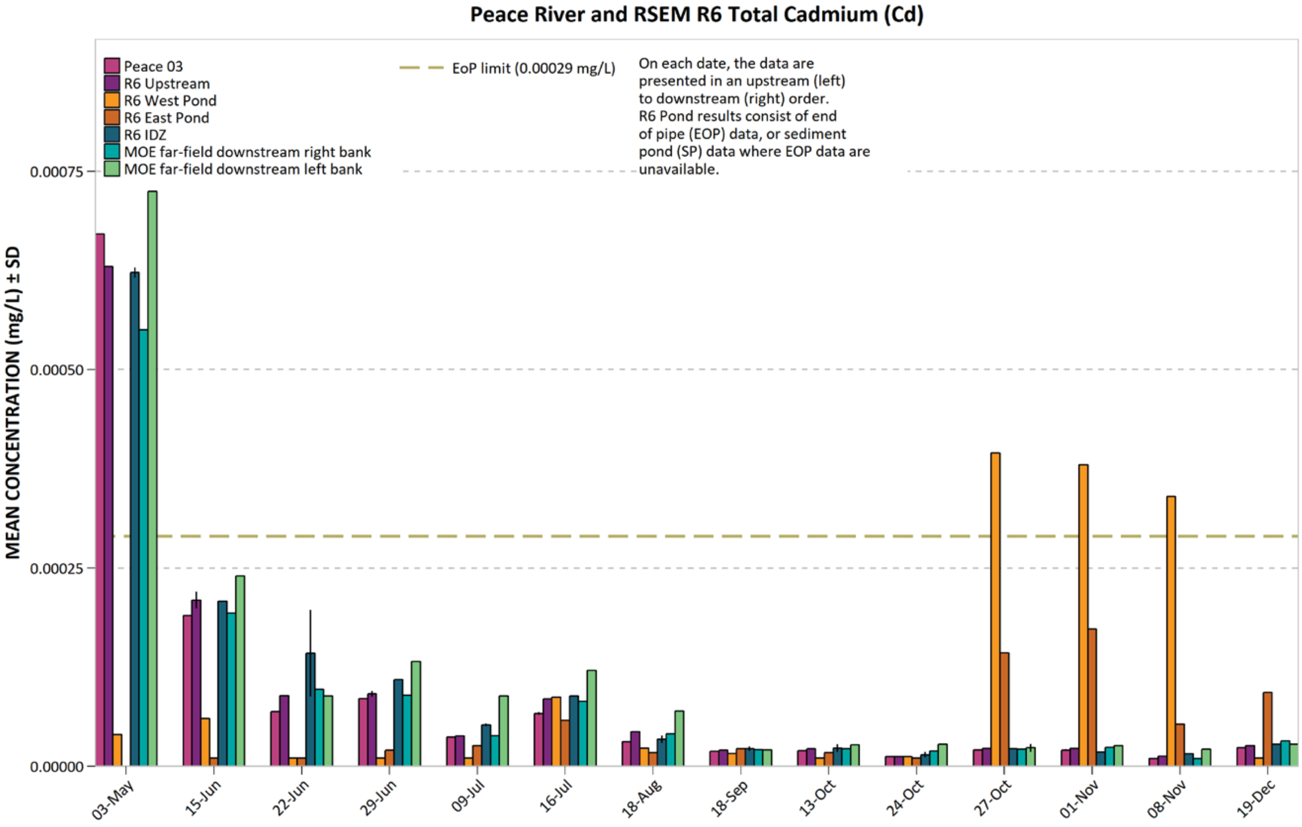


Figure 116. 2017 Peace River and RSEM R6 Total Calcium (Ca).

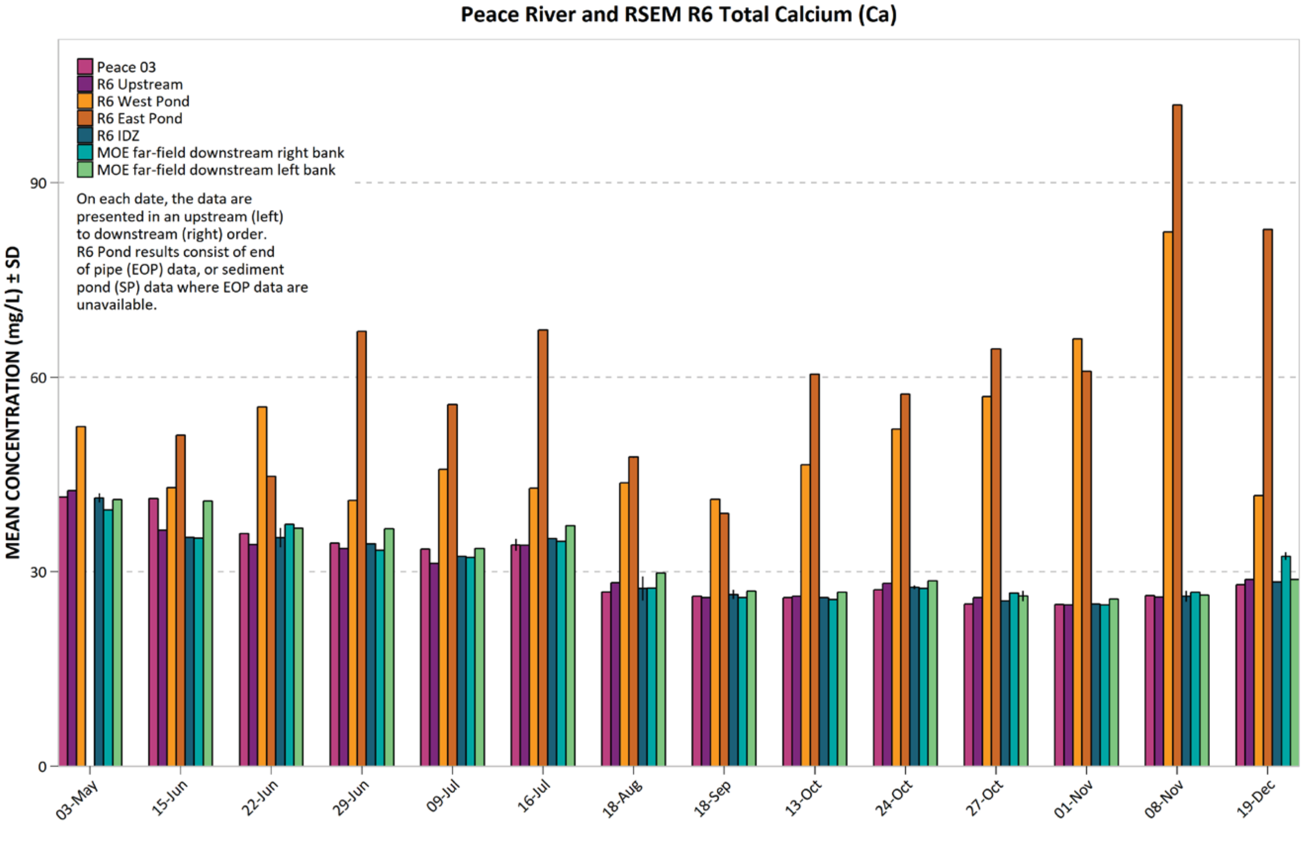


Figure 117. 2017 Peace River and RSEM R6 Total Chromium (Cr).

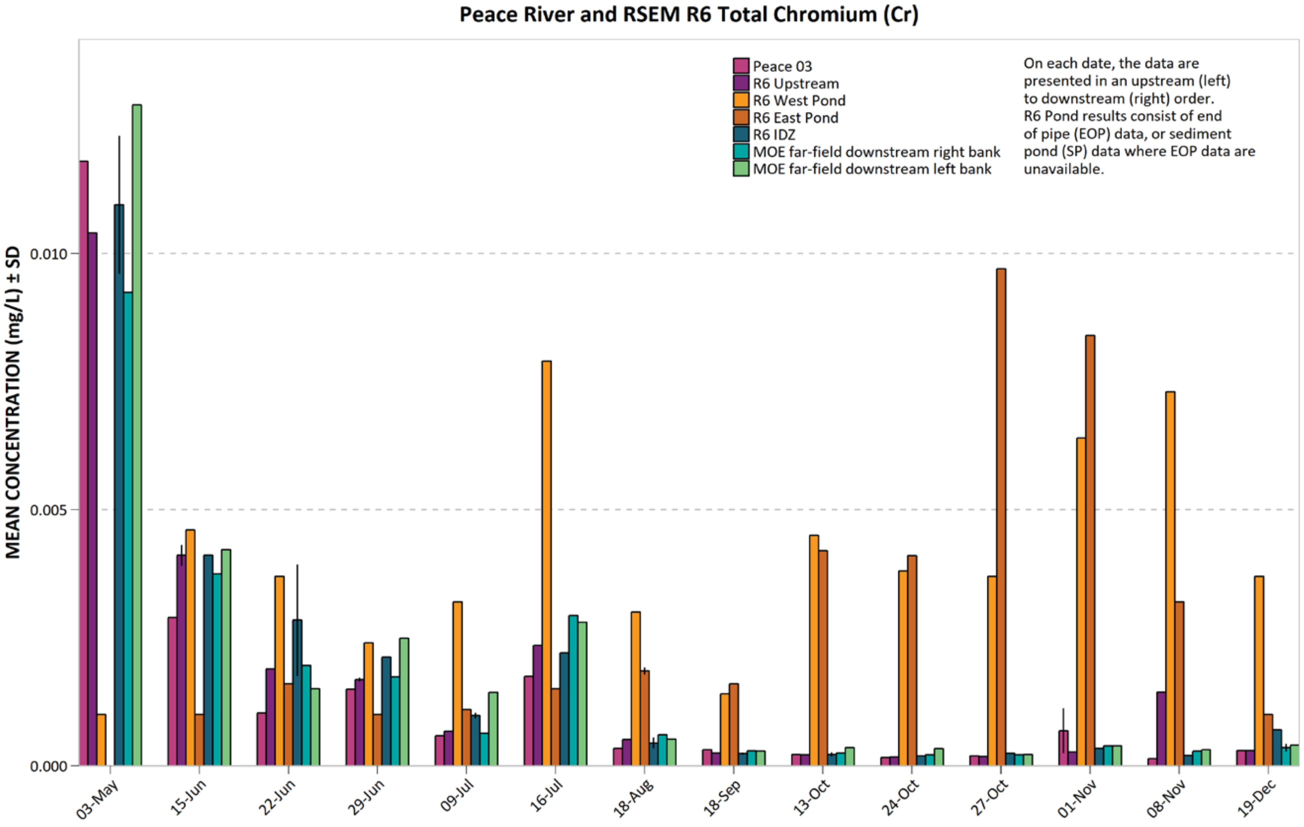


Figure 118. Peace River and RSEM R6 Total Cobalt (Co).

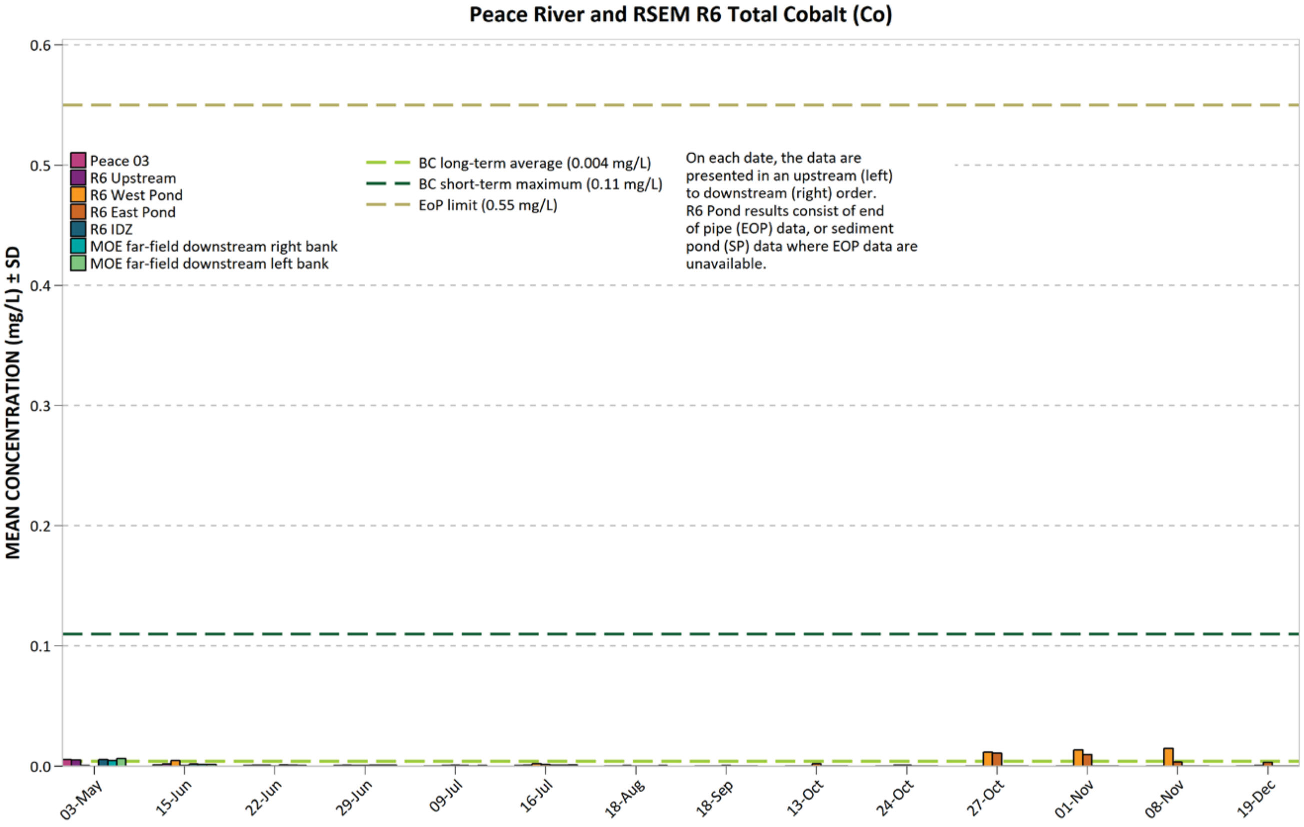


Figure 119. Peace River and RSEM R6 Total Copper (Cu).

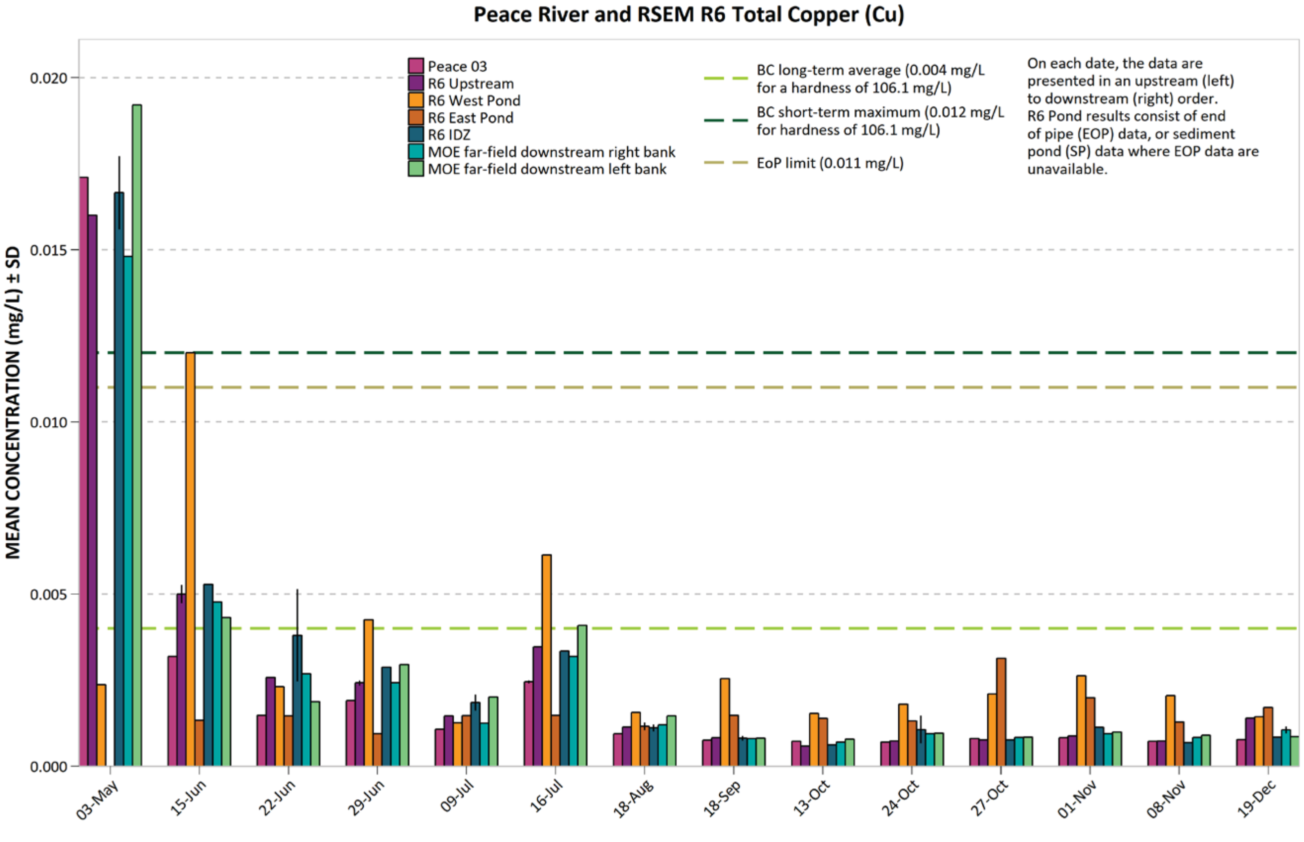


Figure 120. Peace River and RSEM R6 Total Iron (Fe).

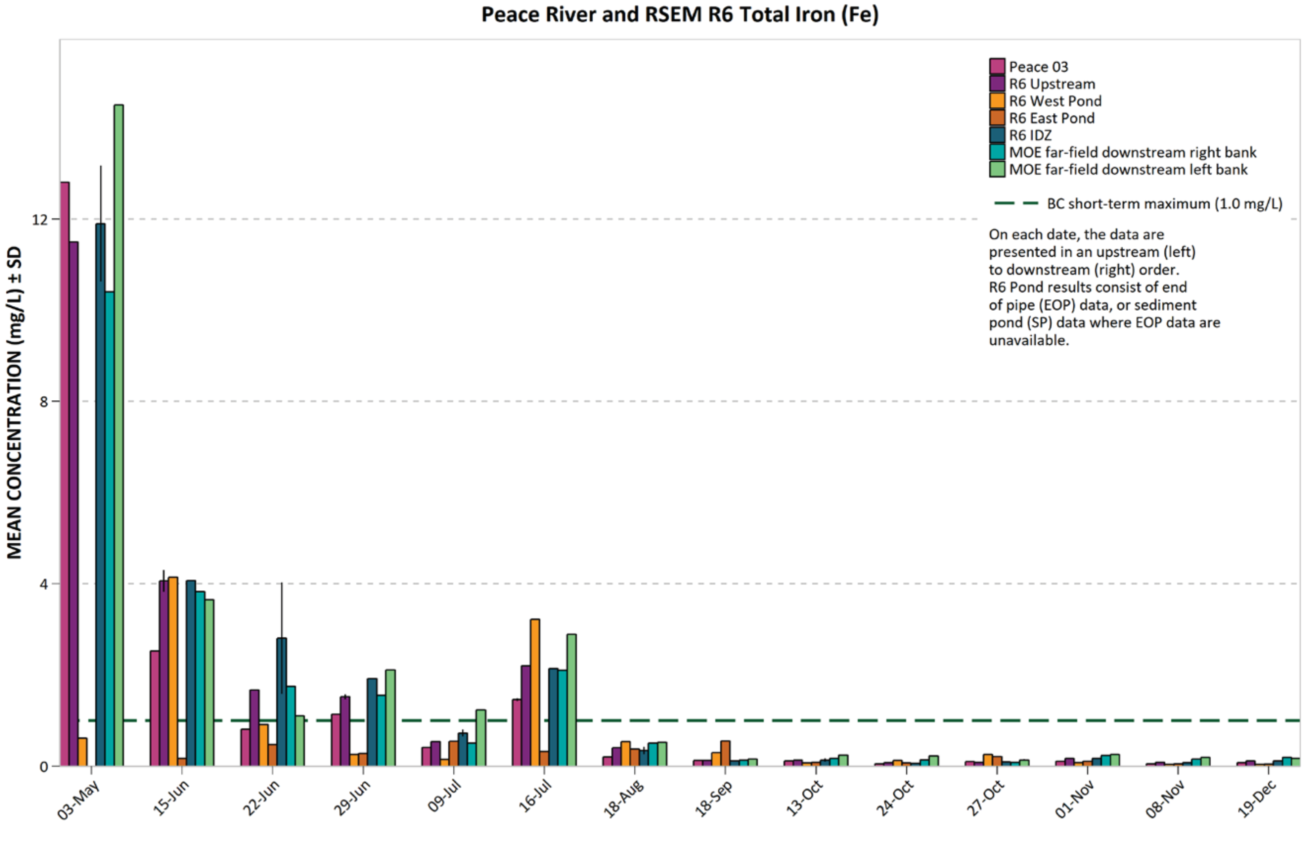


Figure 121. 2017 Peace River and RSEM R6 Total Lead (Pb).

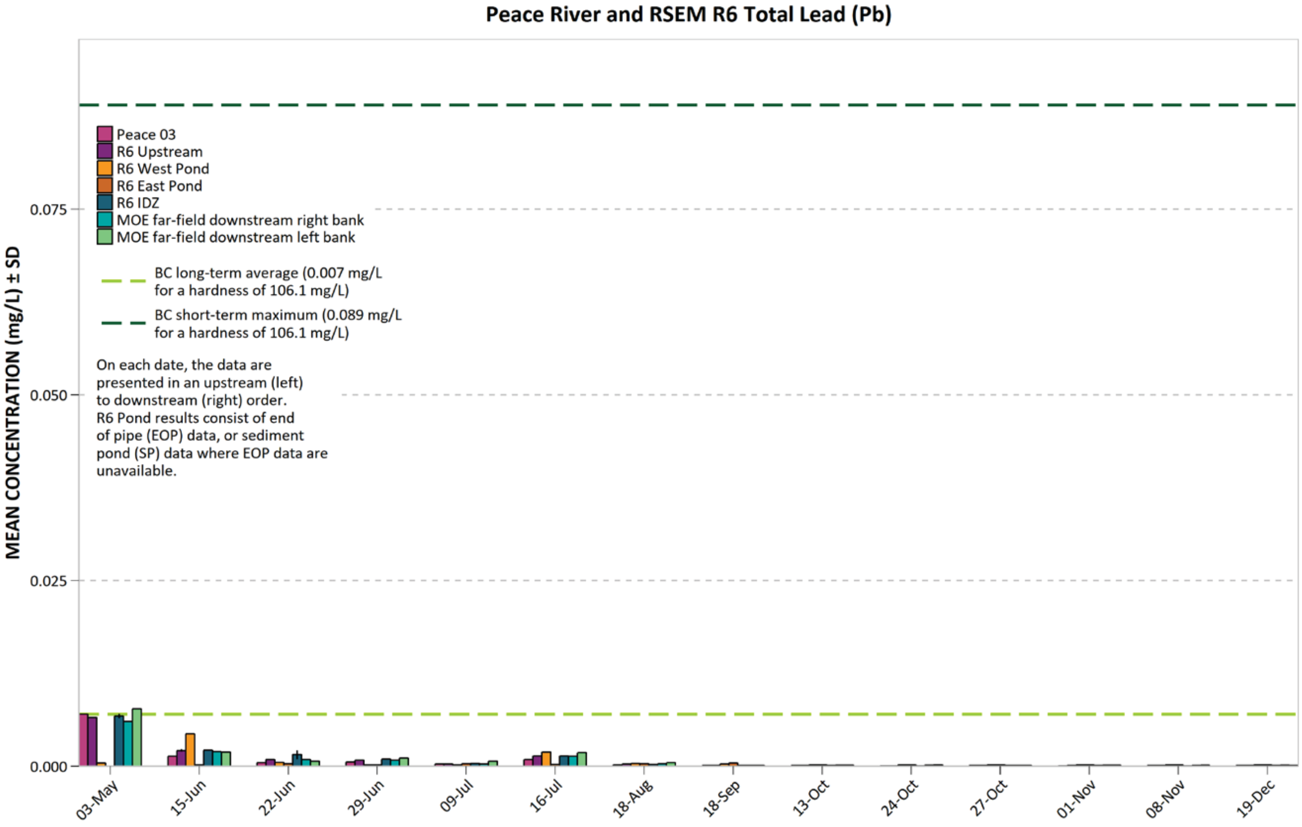


Figure 122. 2017 Peace River and RSEM R6 Total Lithium (Li).

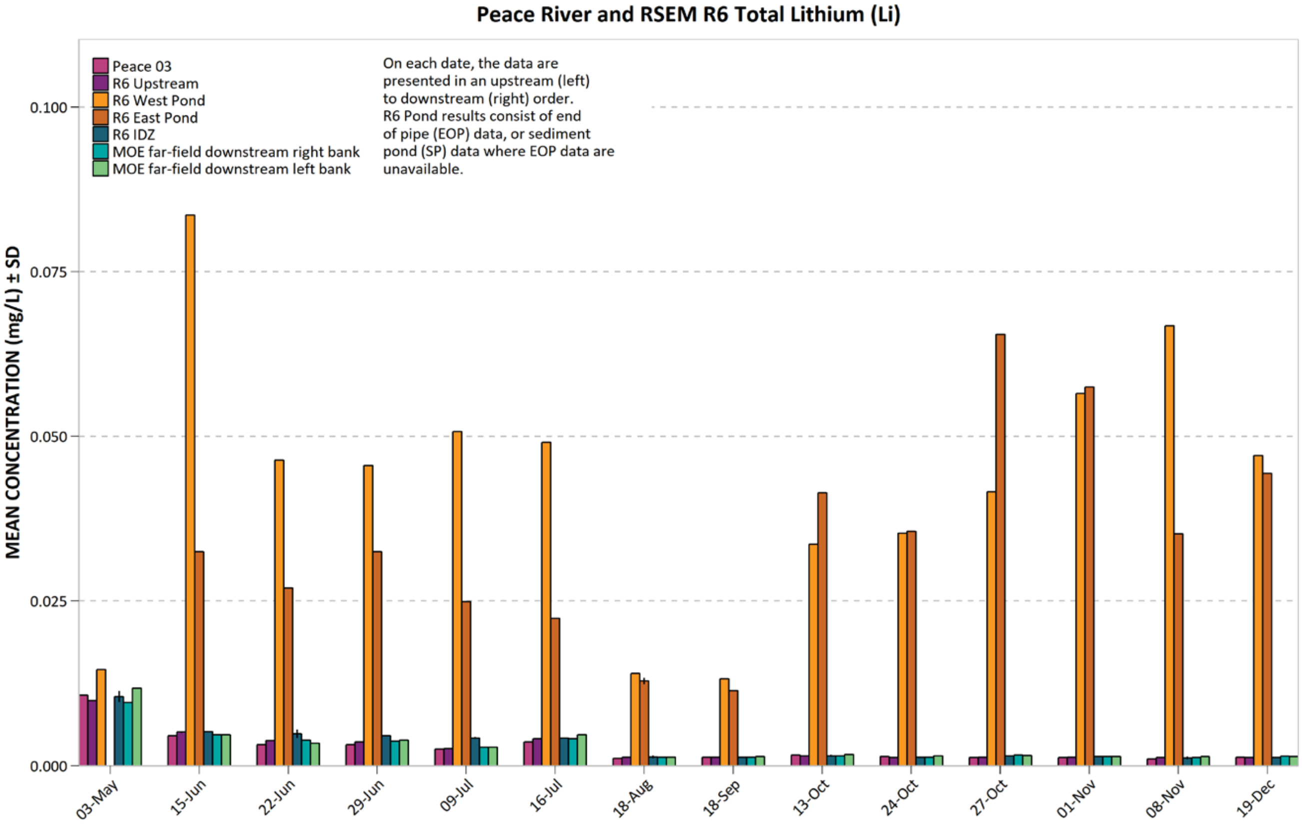


Figure 123. 2017 Peace River and RSEM R6 Total Magnesium (Mg).

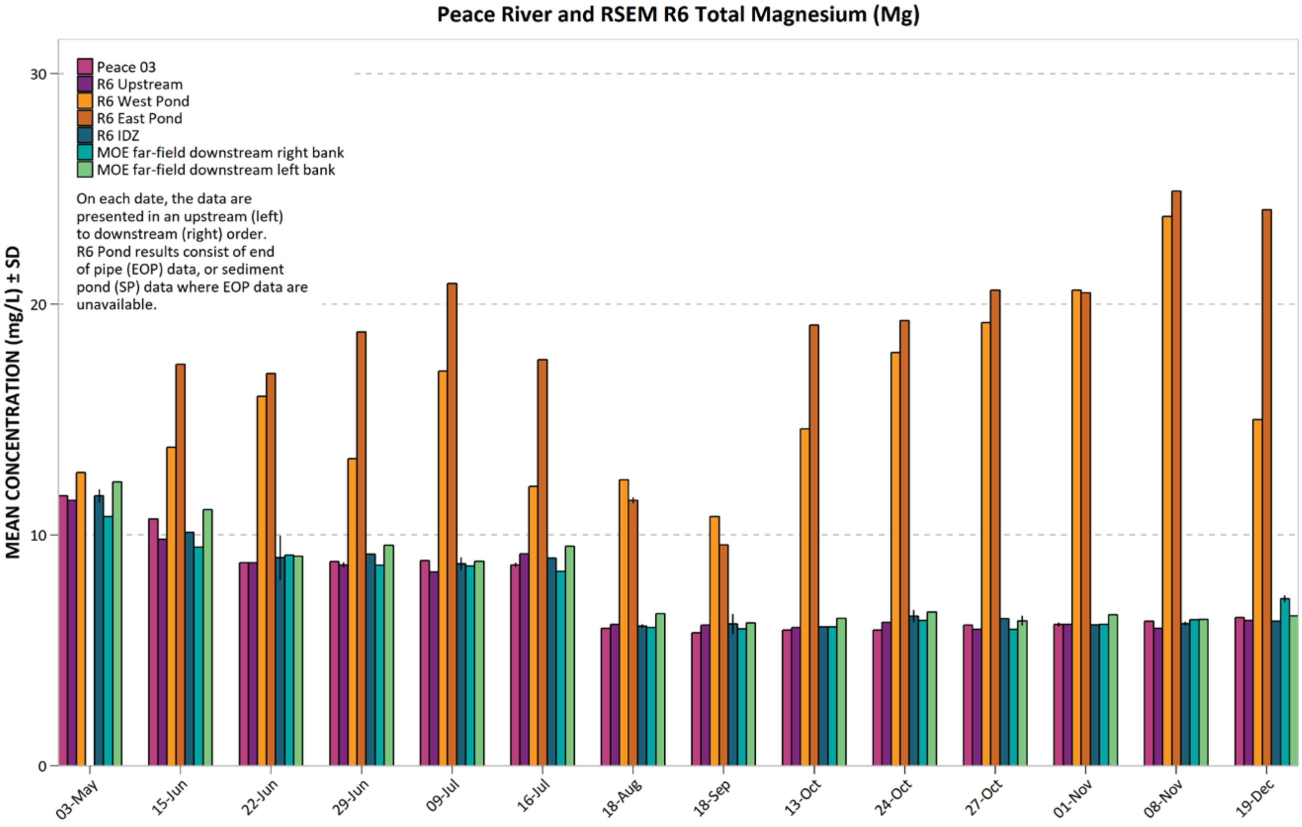


Figure 124. Peace River and RSEM R6 Total Manganese (Mn).

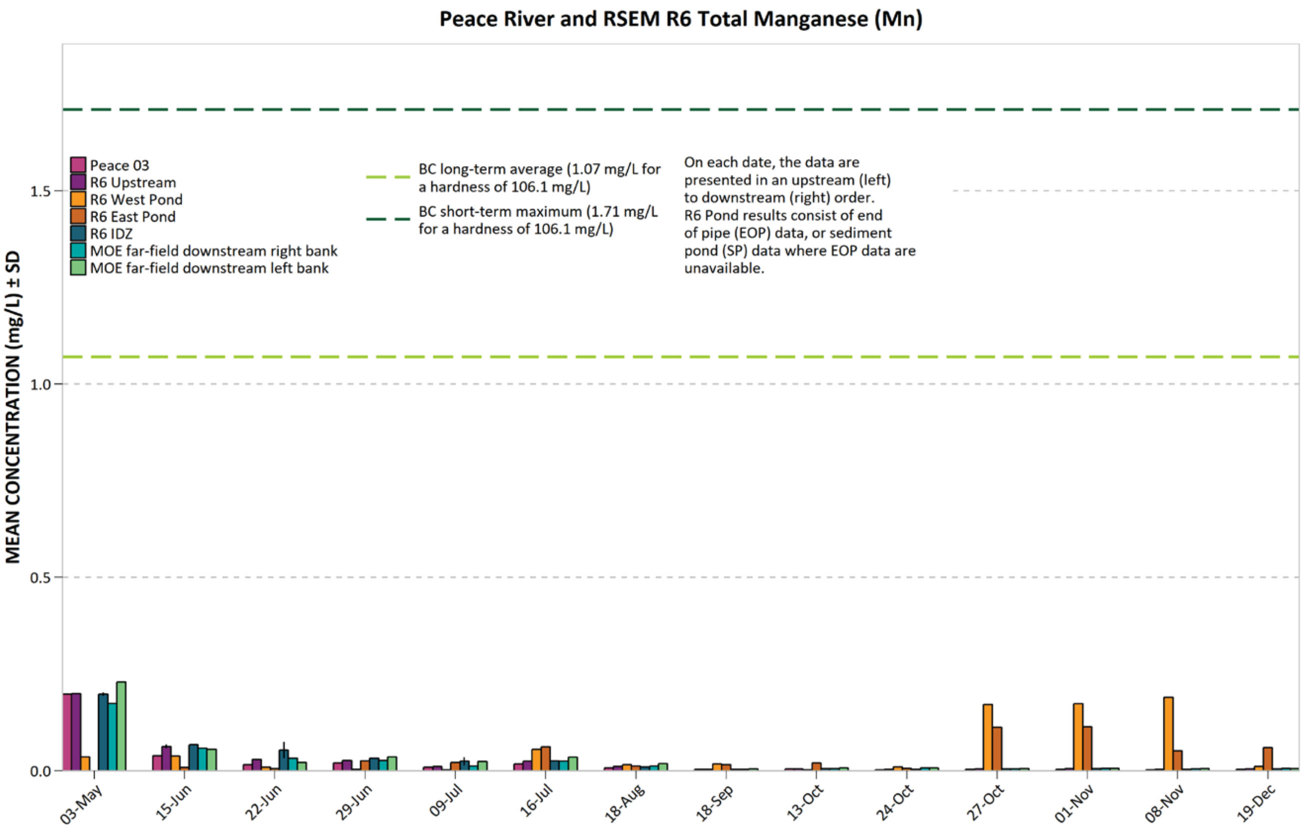


Figure 125. 2017 Peace River and RSEM R6 Total Mercury (Hg).

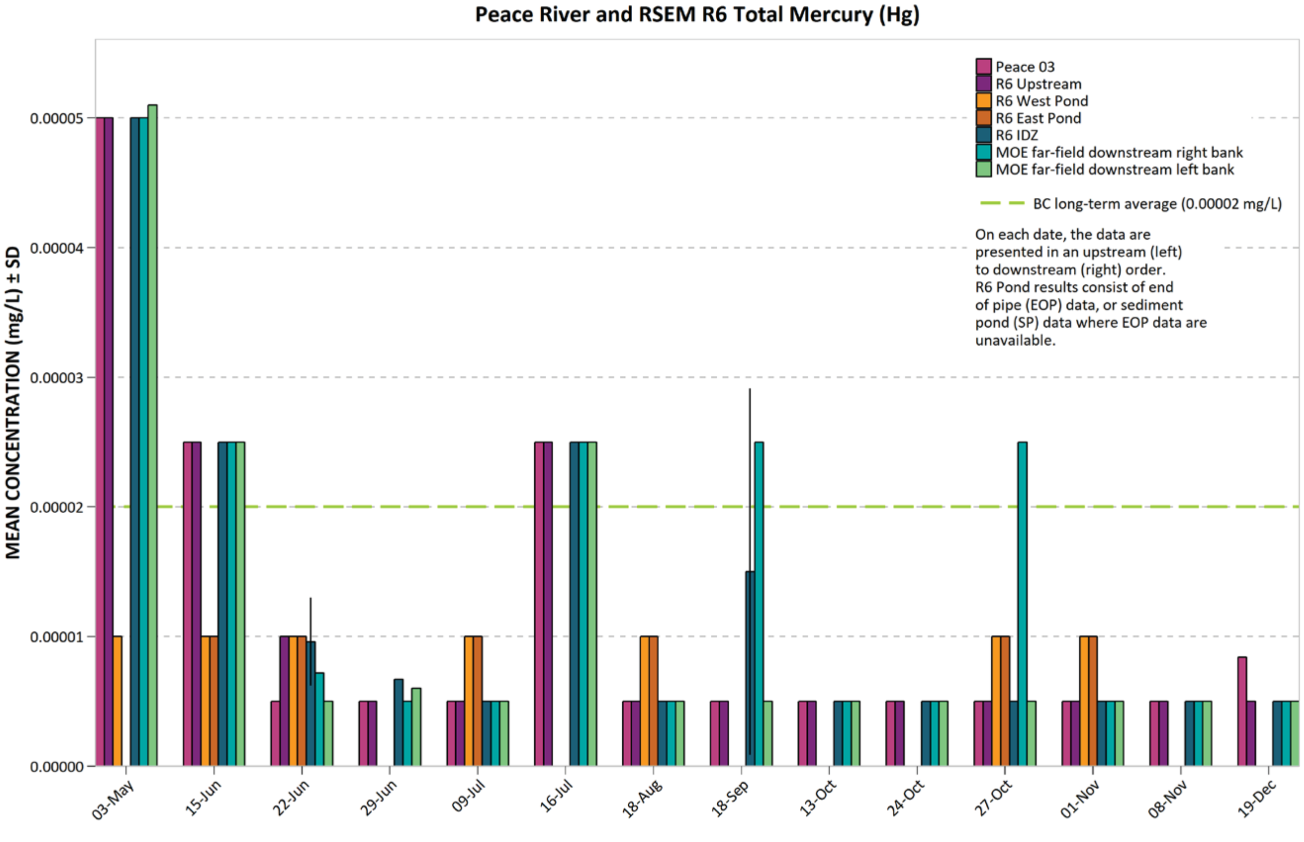


Figure 126. 2017 Peace River and RSEM R6 Total Molybdenum (Mo).

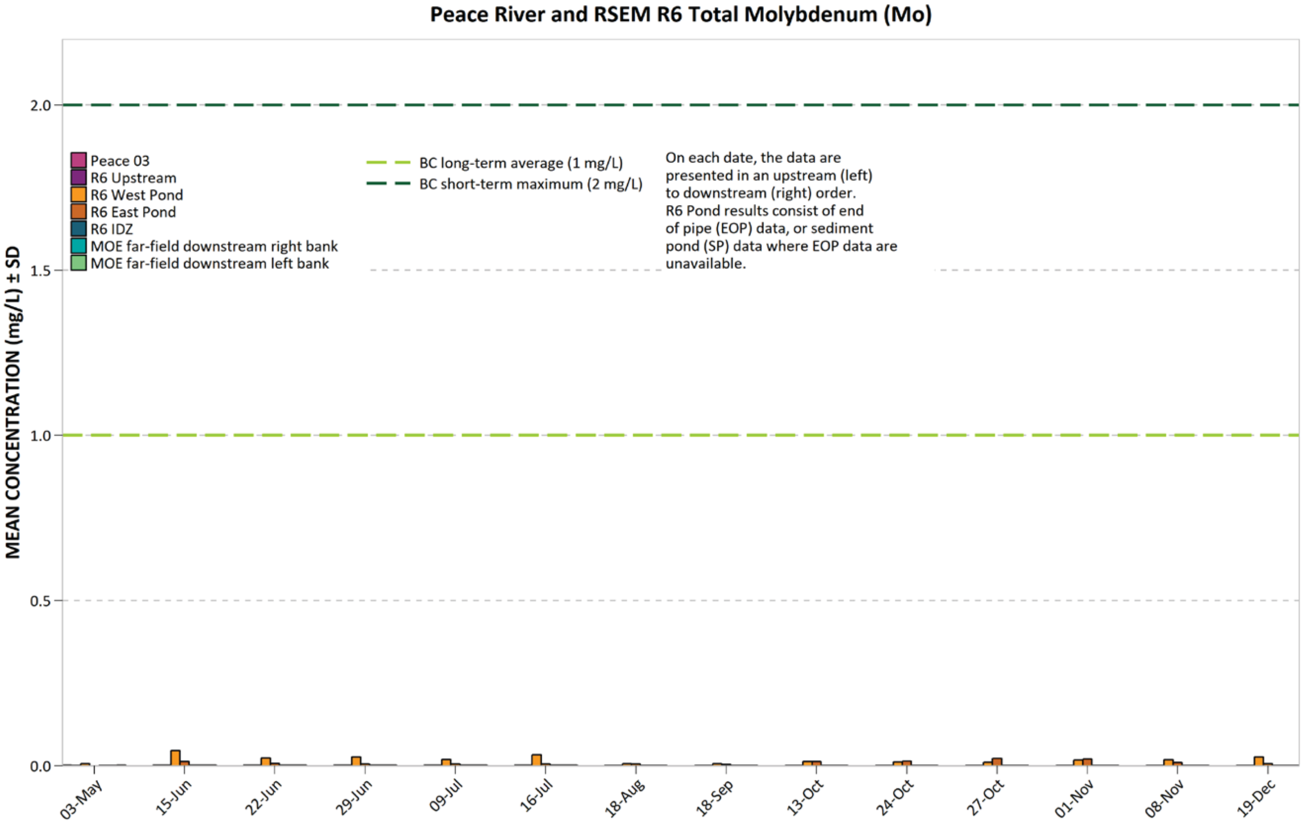


Figure 127. 2017 Peace River and RSEM R6 Total Nickel (Ni).

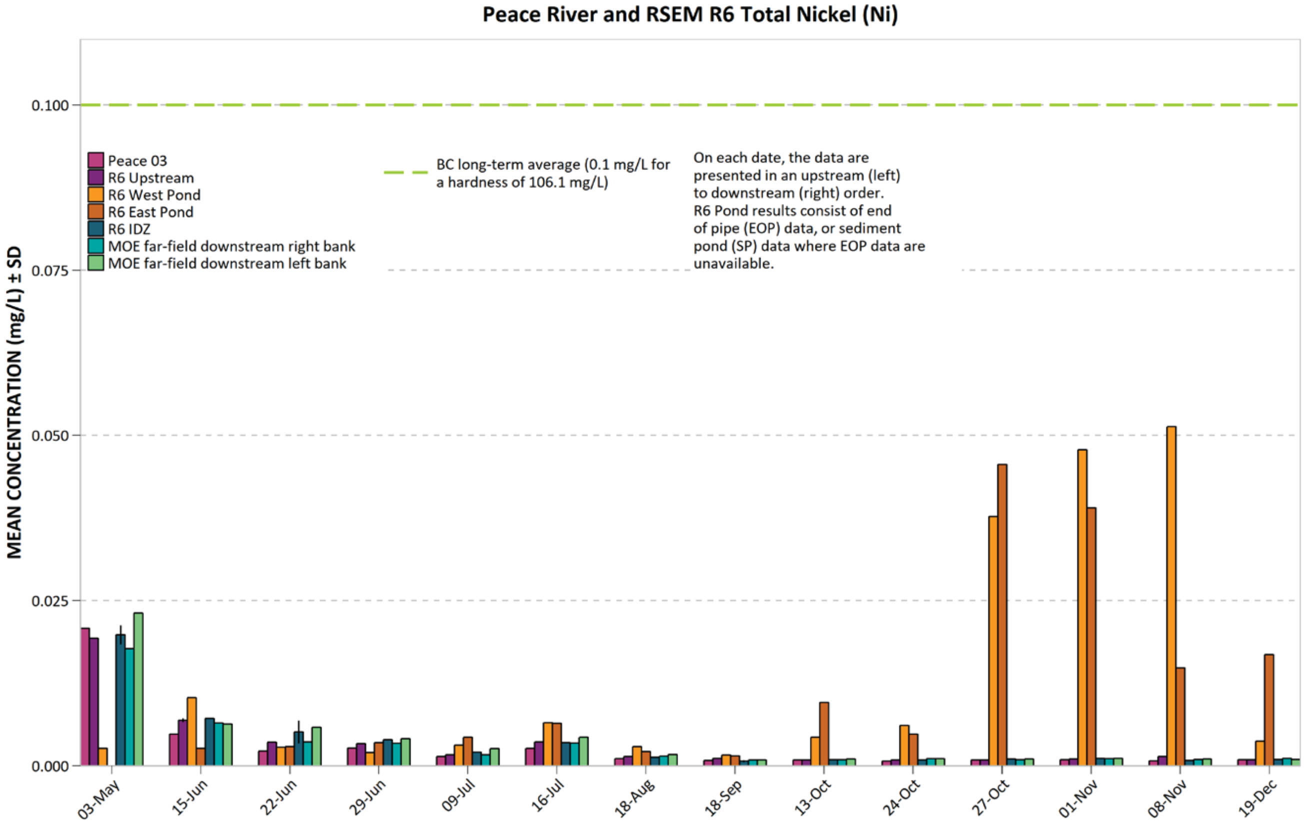


Figure 128. 2017 Peace River and RSEM R6 Total Potassium (K).

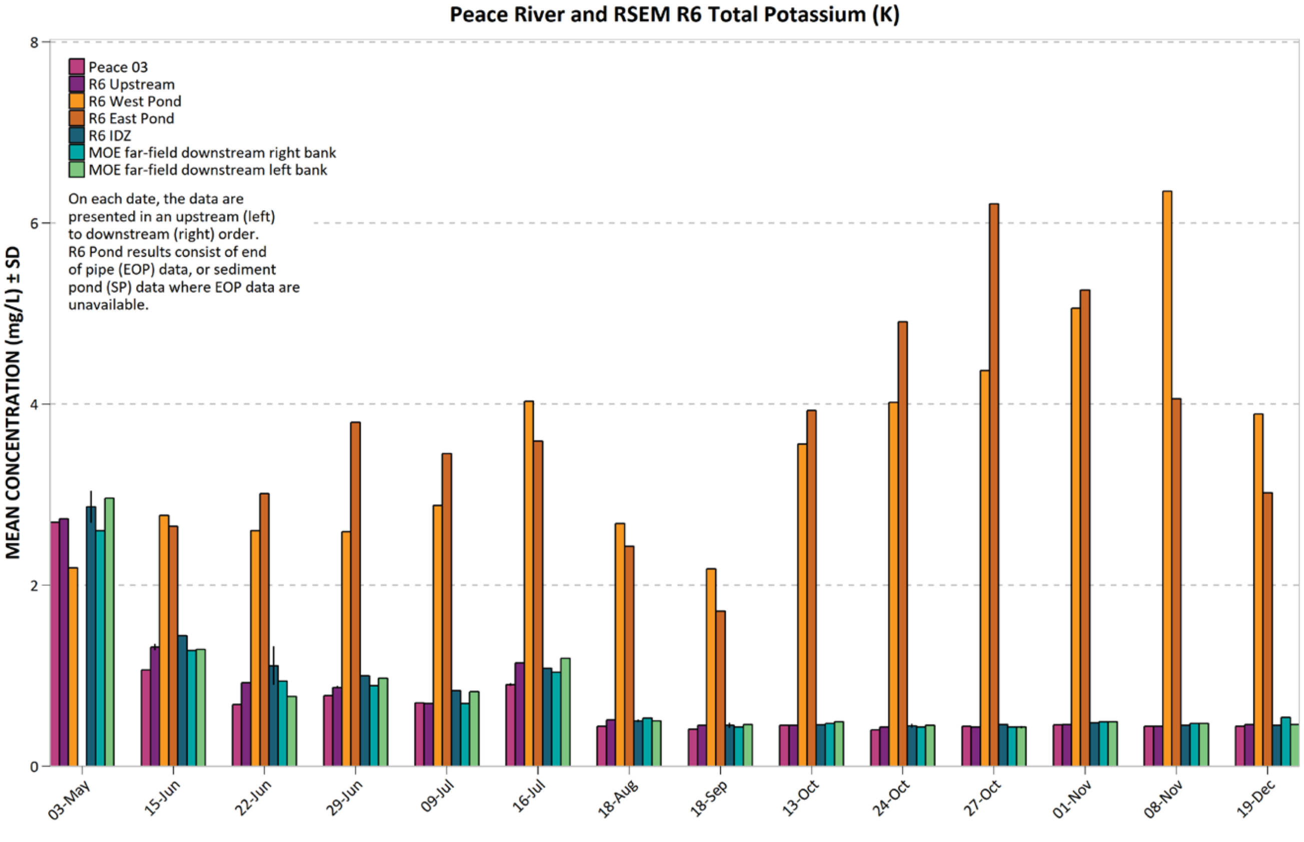


Figure 129. Peace River and RSEM R6 Total Selenium (Se).

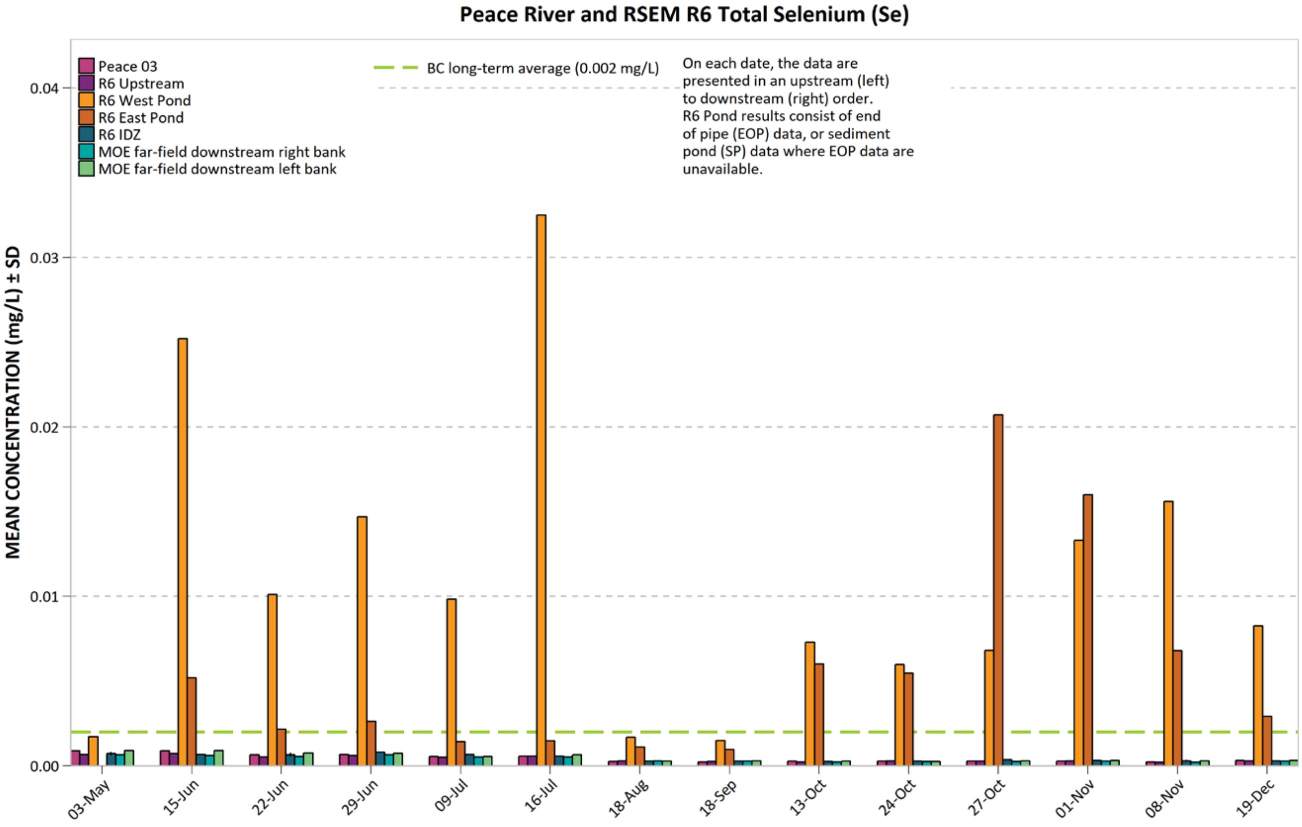


Figure 130. Peace River and RSEM R6 Total Silicon (Si)

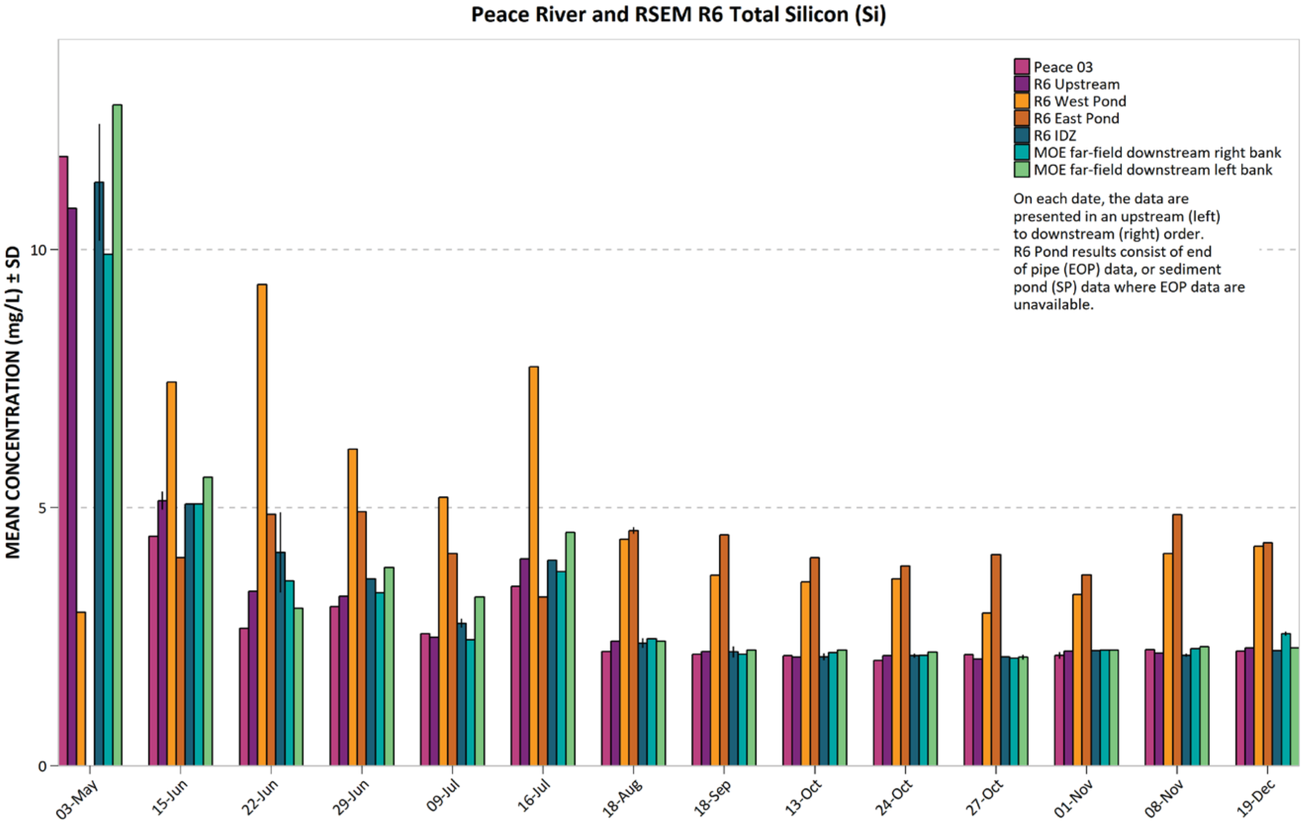


Figure 131. Peace River and RSEM R6 Total Silver (Ag).

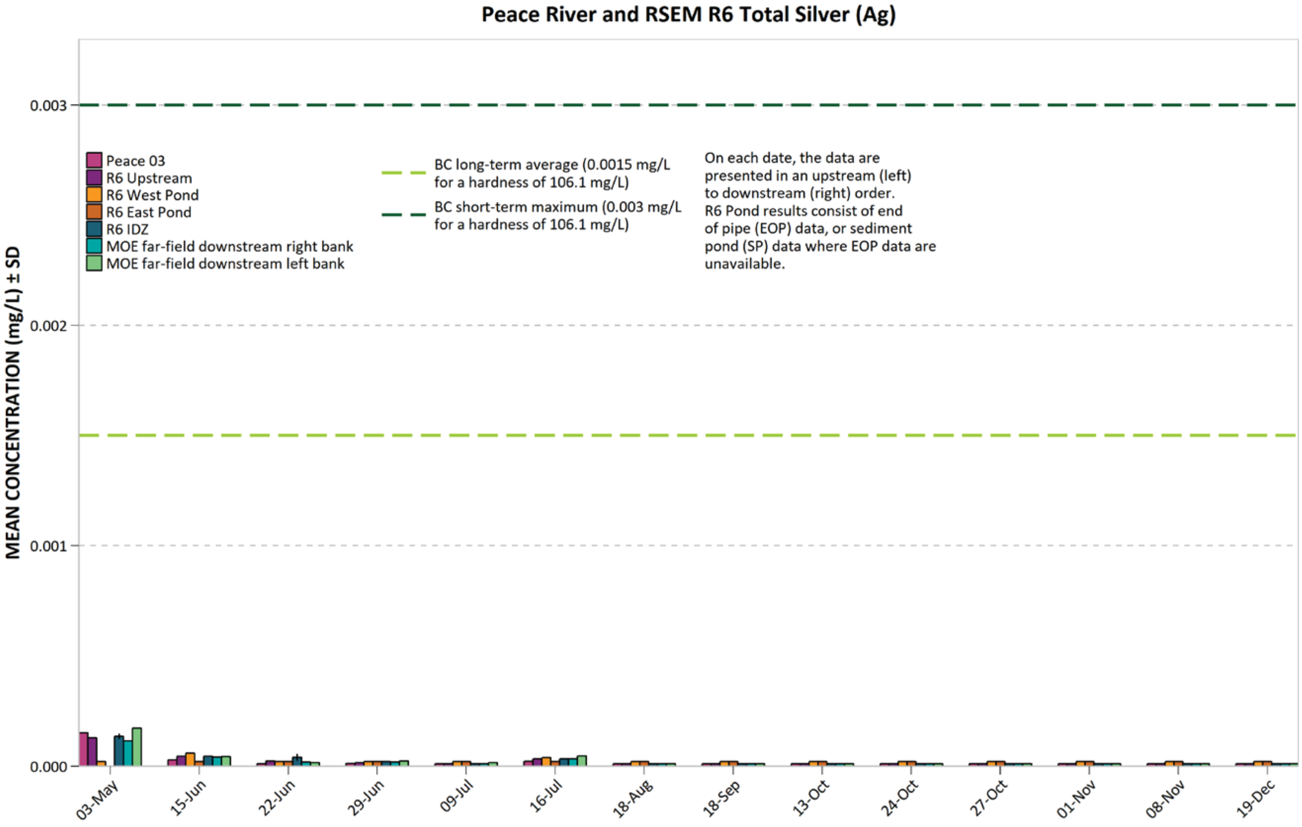


Figure 132. Peace River and RSEM R6 Total Sodium (Na).

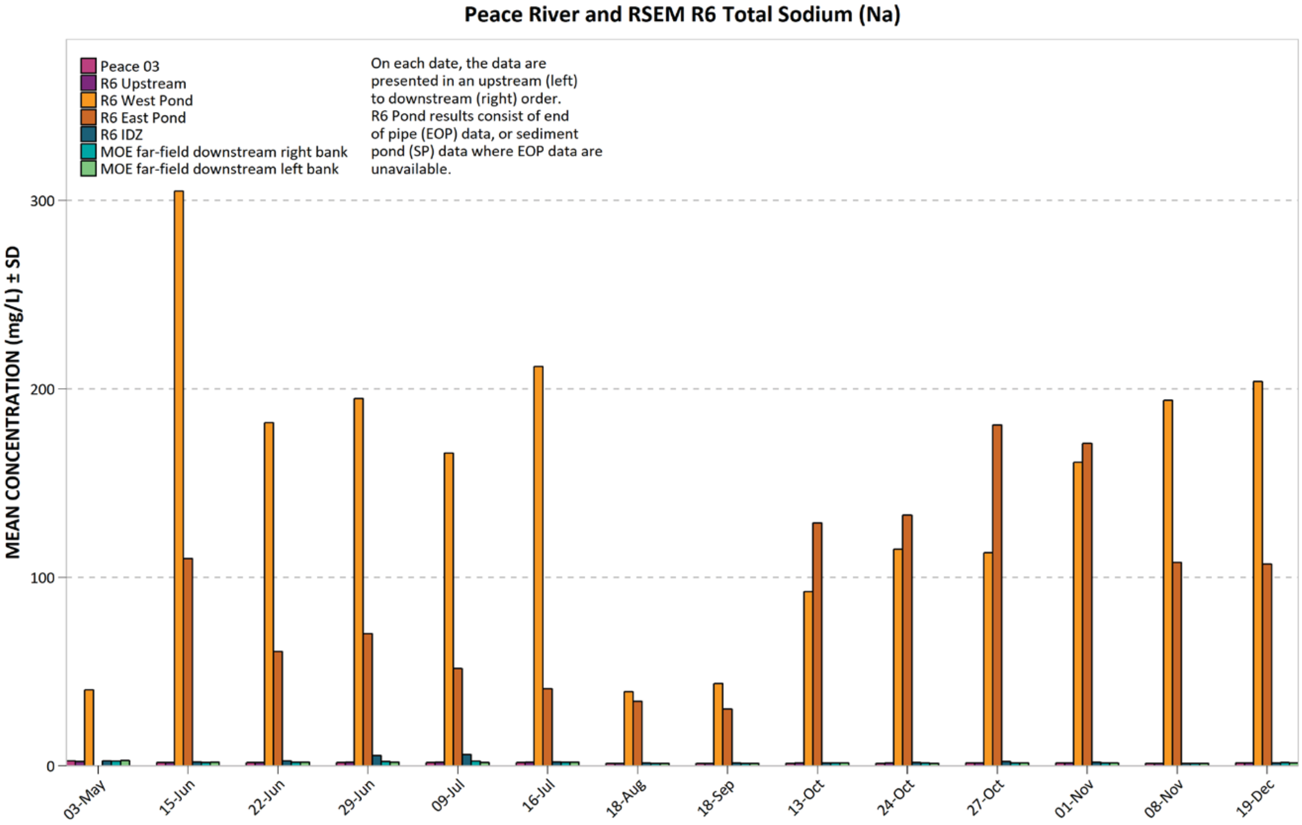


Figure 133. Peace River and RSEM R6 Total Strontium (Sr).

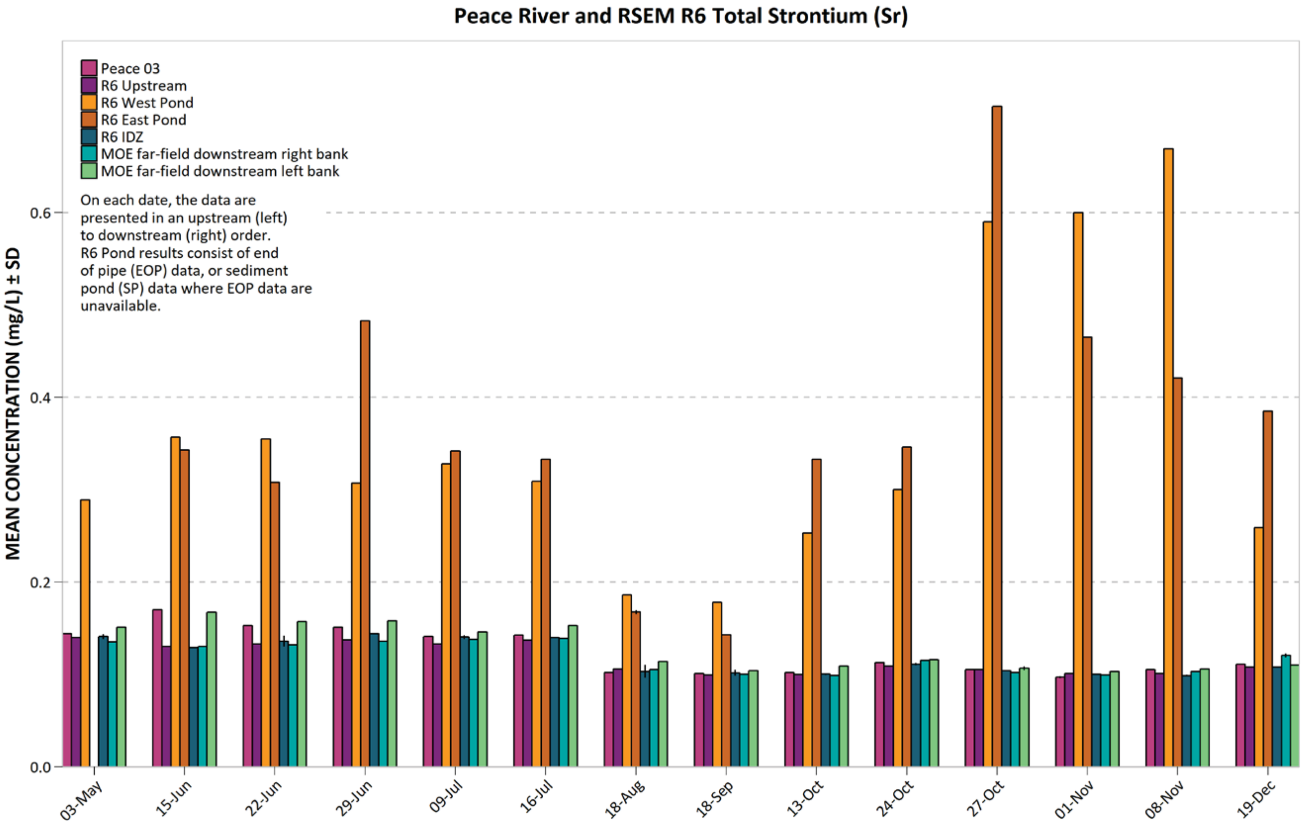


Figure 134. Peace River and RSEM R6 Total Sulfur (S).

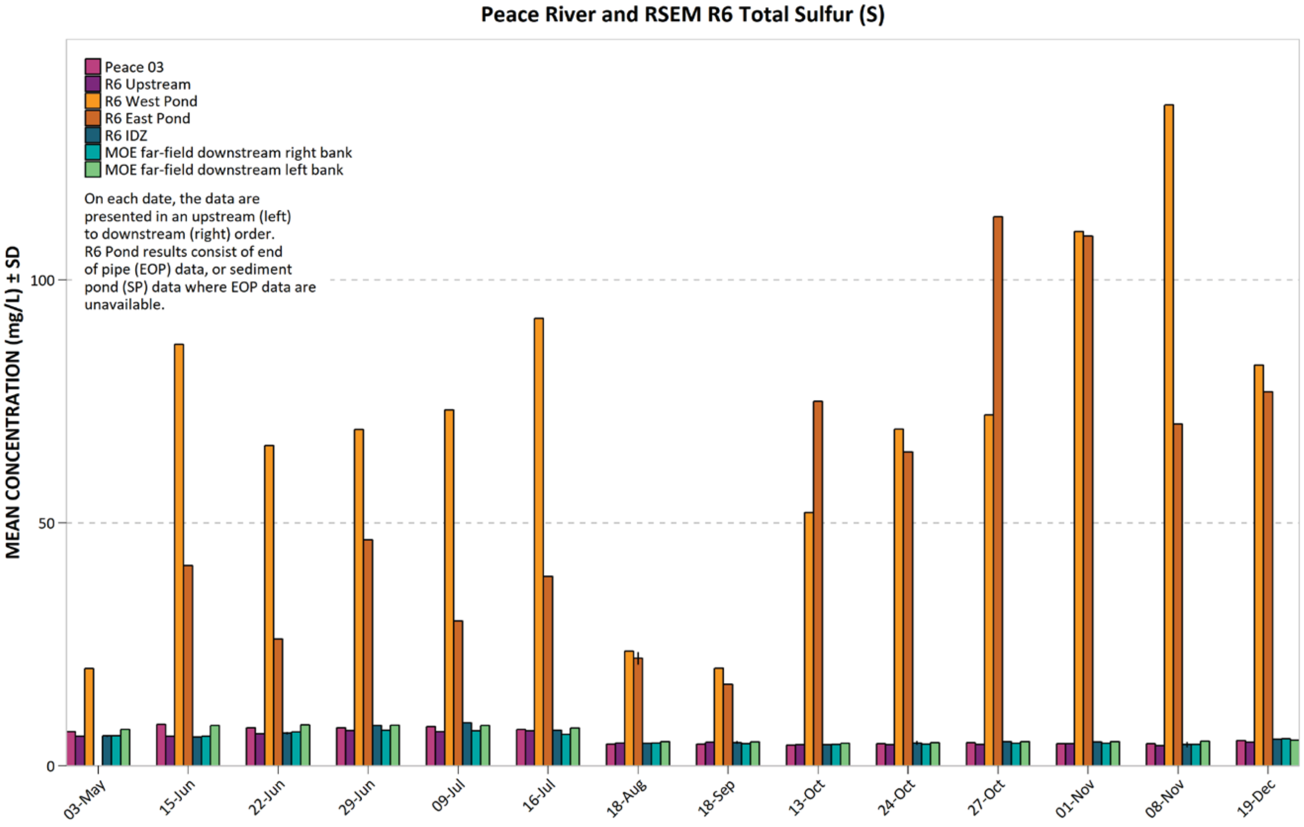


Figure 135. Peace River and RSEM R6 Total Thallium (Tl).

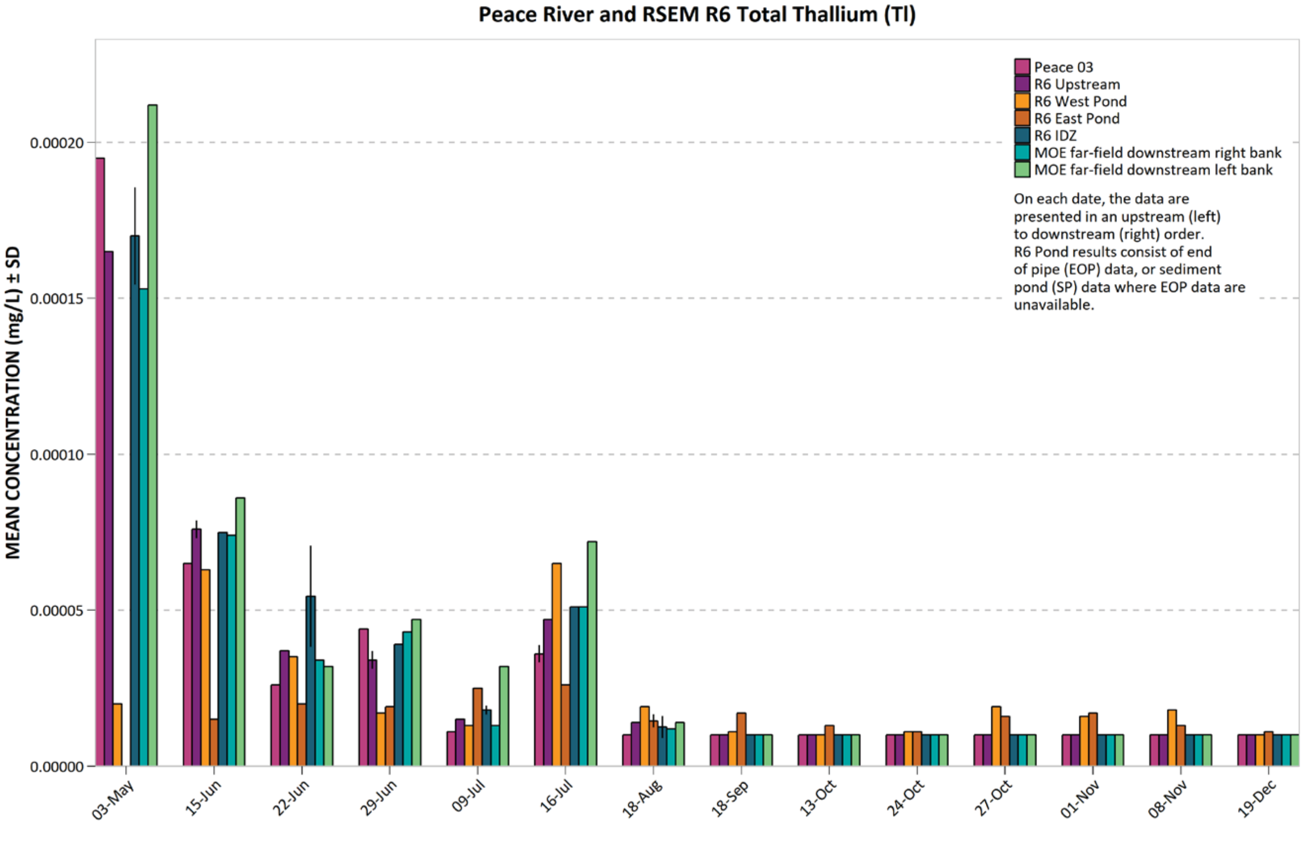
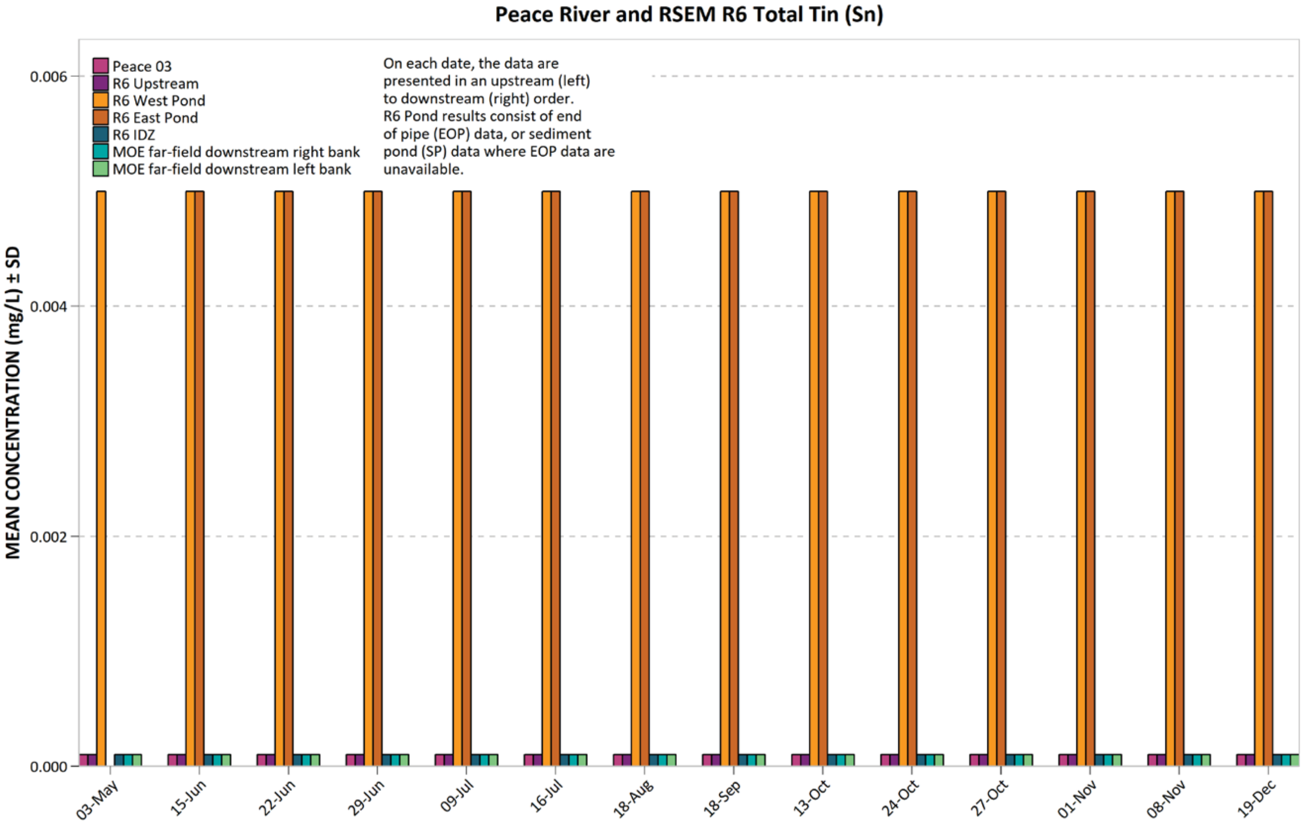


Figure 136. Peace River and RSEM R6 Total Tin (Sn).



All R6 pond data and Peace River data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 137. Peace River and RSEM R6 Total Titanium (Ti).

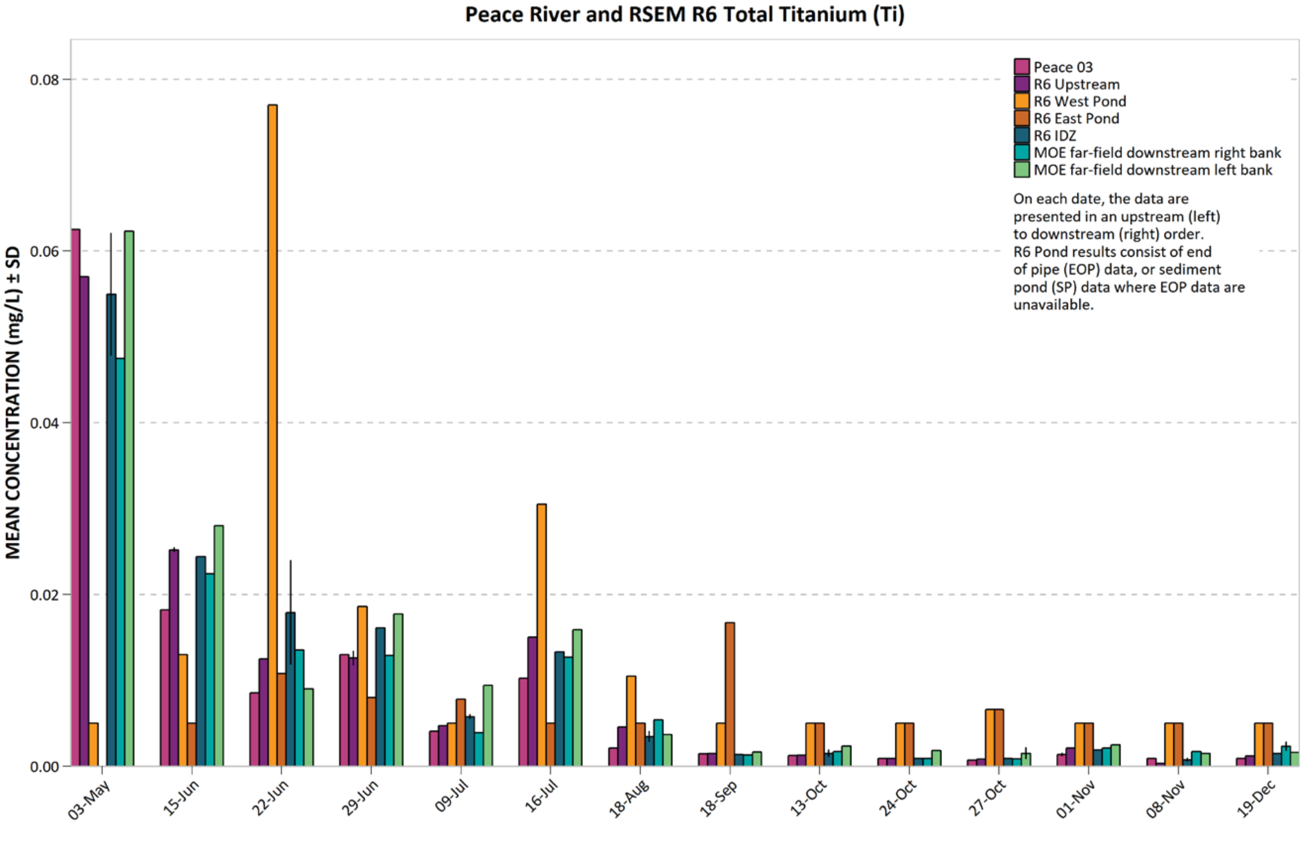
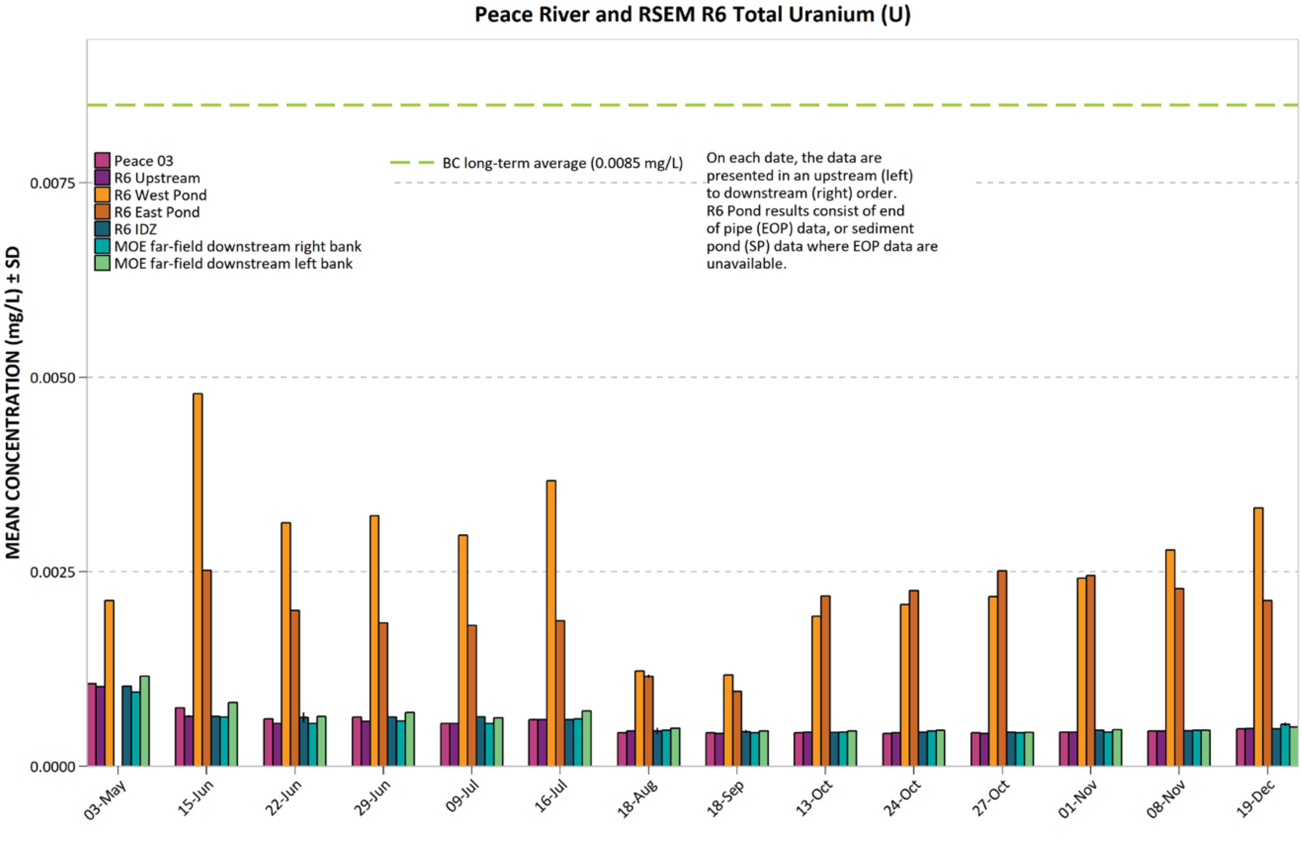


Figure 138. Peace River and RSEM R6 Total Uranium (U).



On each date, the data are presented in an upstream (left) to downstream (right) order. R6 Pond results consist of end of pipe (EOP) data, or sediment pond (SP) data where EOP data are unavailable.

Figure 139. Peace River and RSEM R6 Total Vanadium (V).

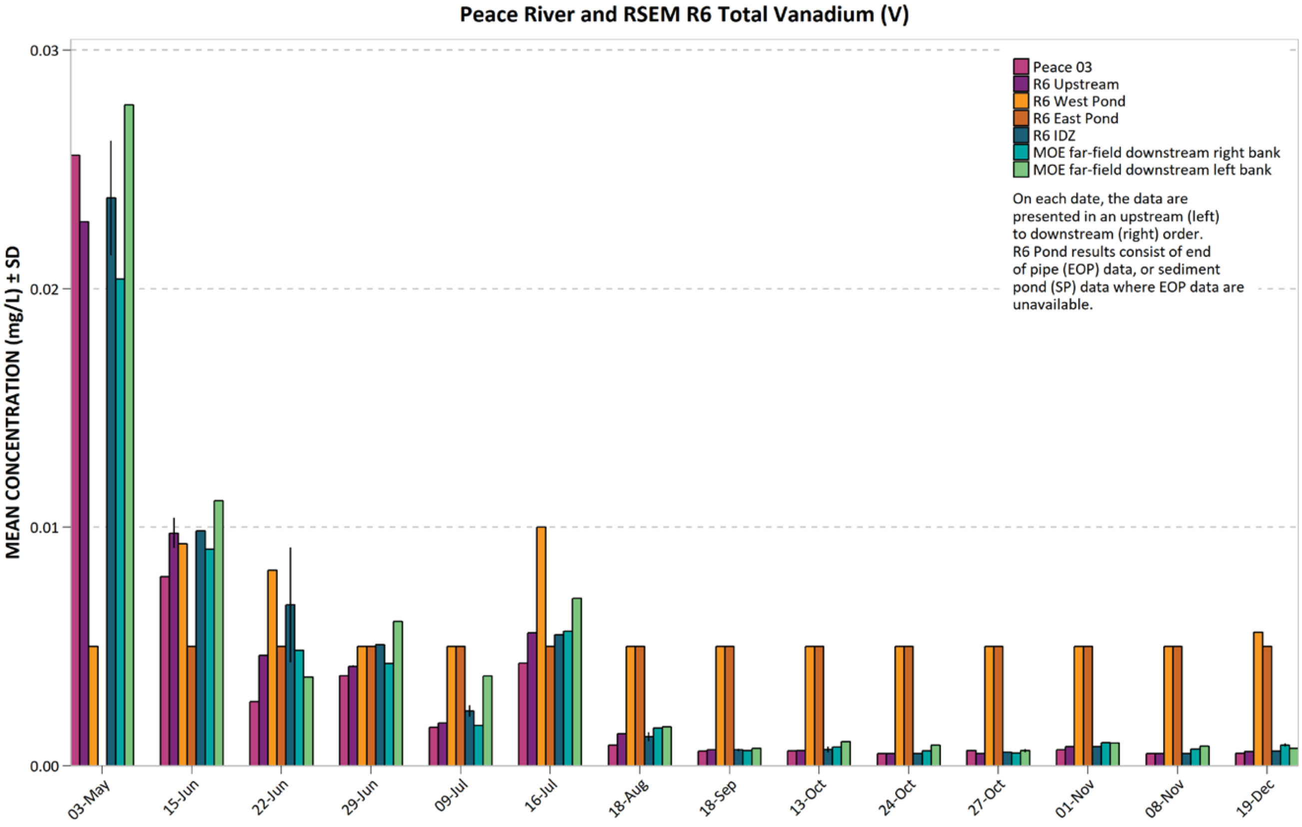


Figure 140. Peace River and RSEM R6 Total Zinc (Zn).

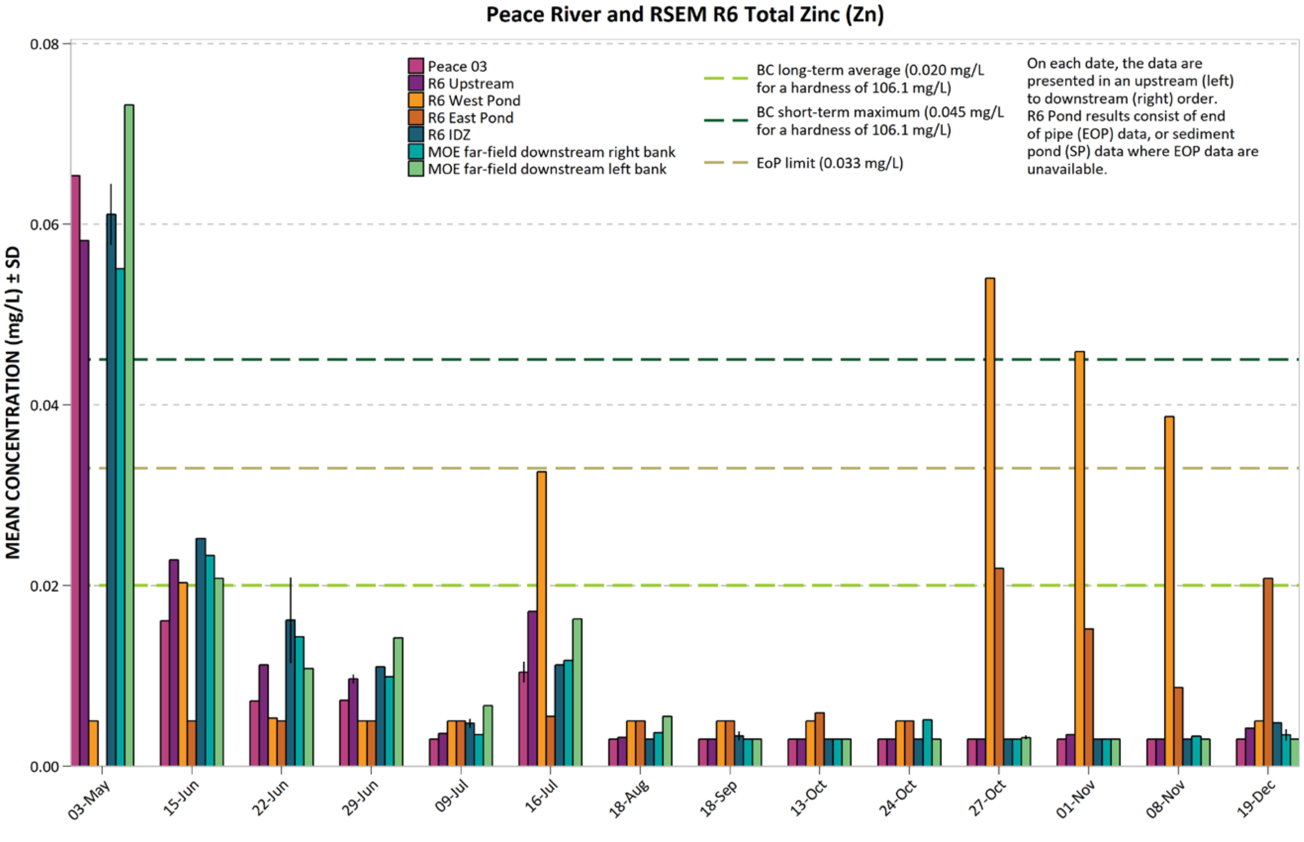


Figure 141. Peace River and RSEM R6 Total Zirconium (Zr).

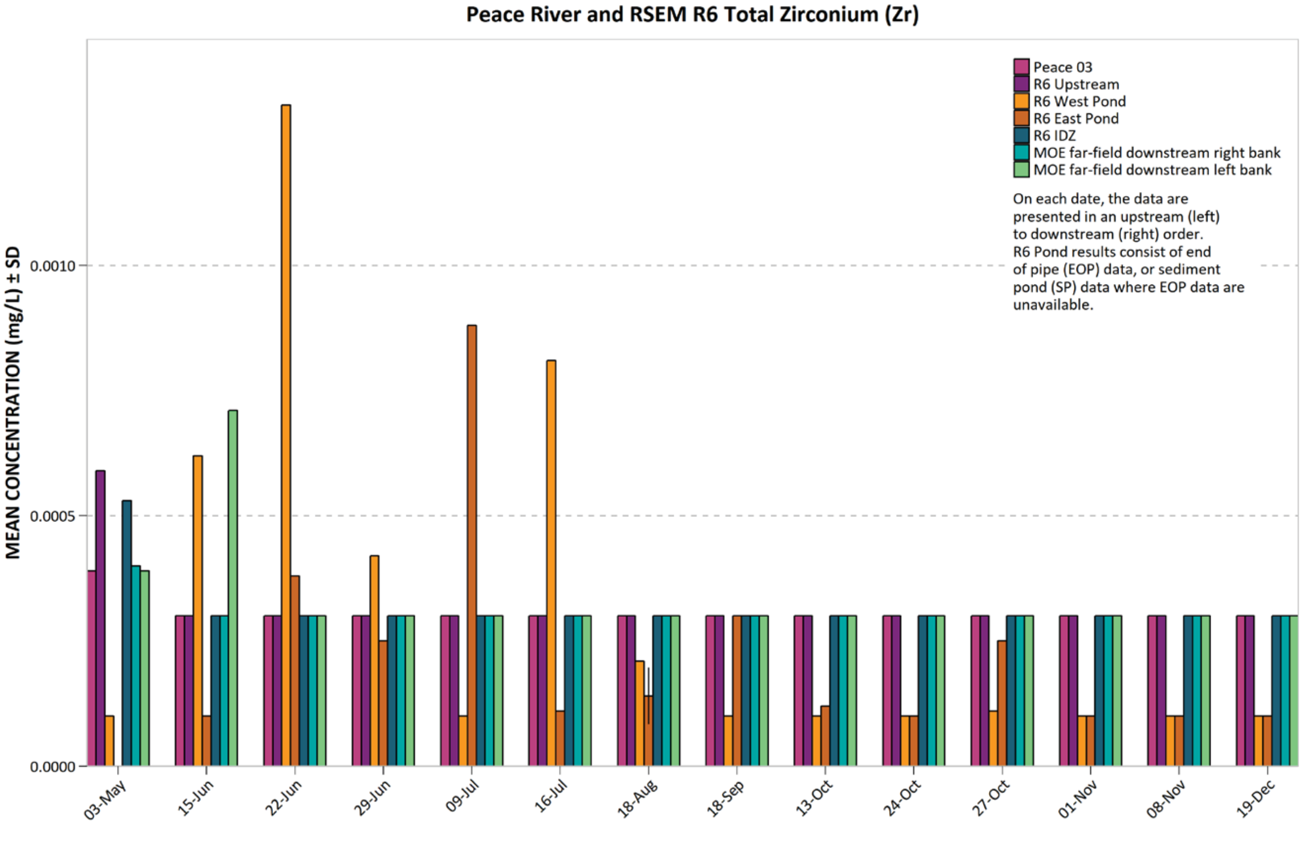


Figure 142. Peace River and RSEM R6 Dissolved Aluminum (Al).

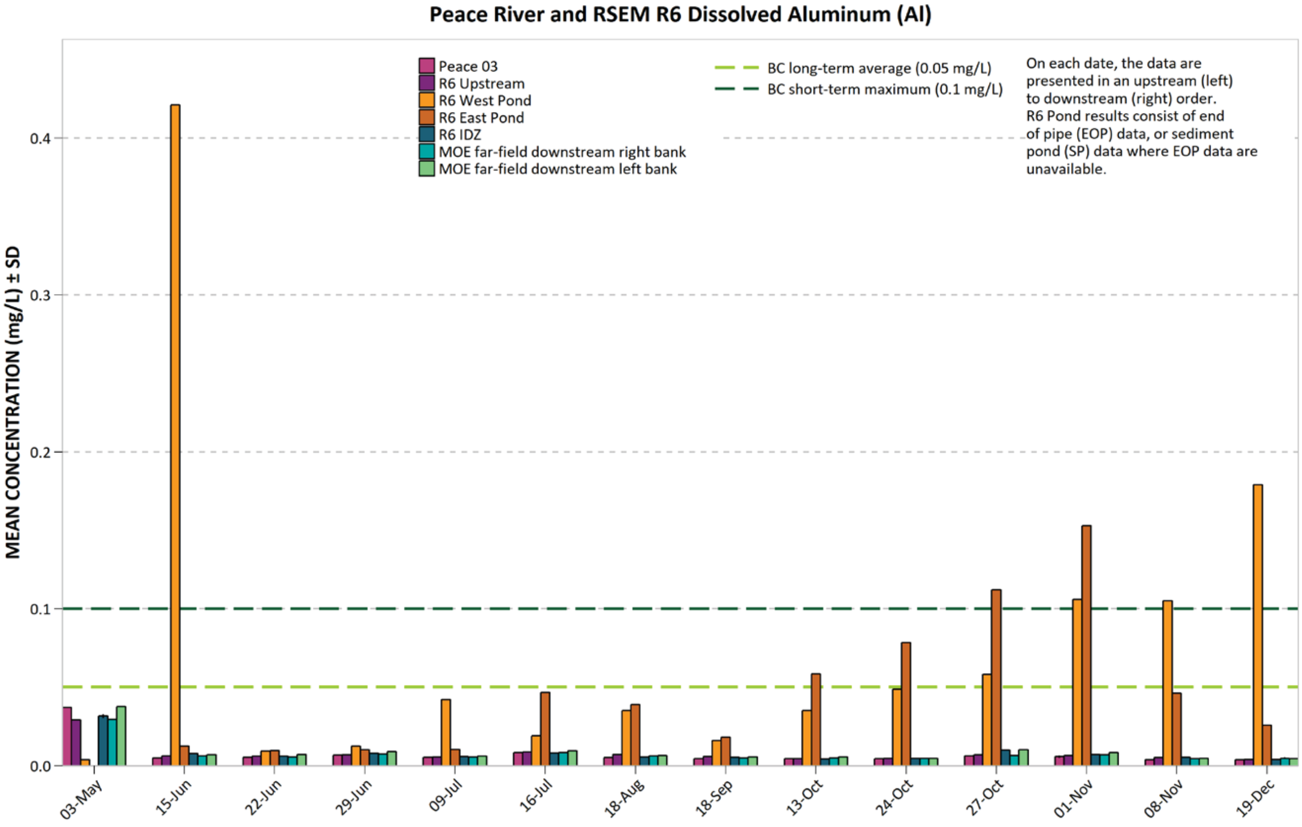


Figure 143. 2017 Peace River and RSEM R6 Dissolved Antimony (Sb).

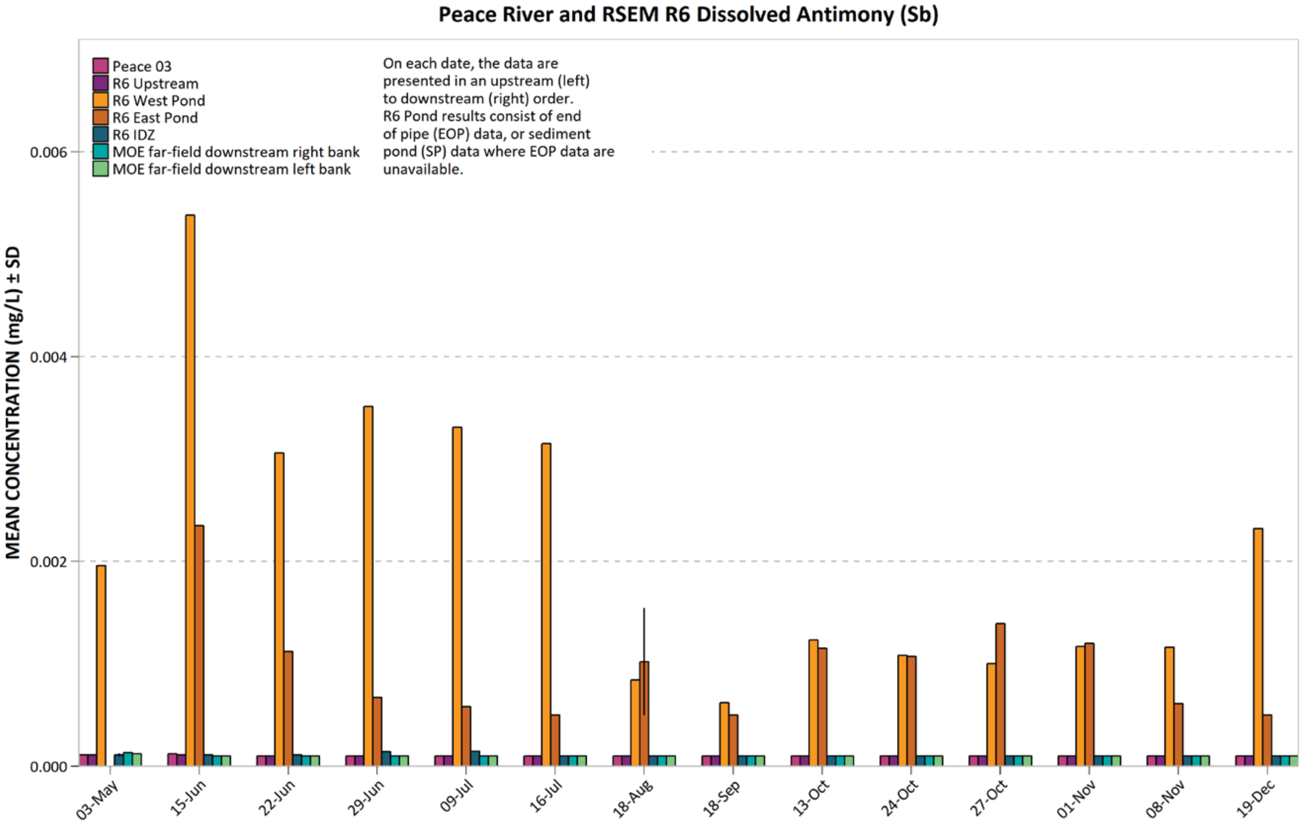


Figure 144. 2017 Peace River and RSEM R6 Dissolved Arsenic (As).

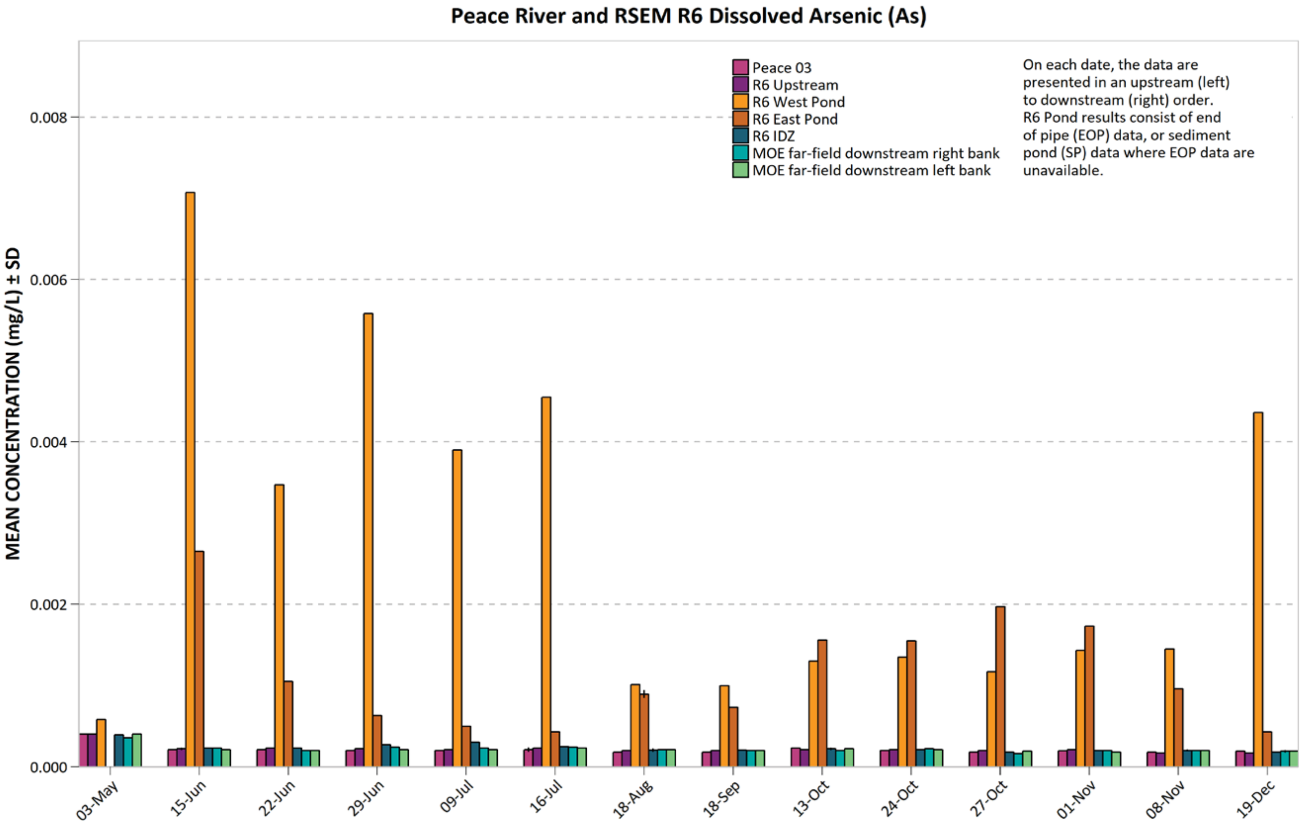


Figure 145. 2017 Peace River and RSEM R6 Dissolved Barium (Ba).

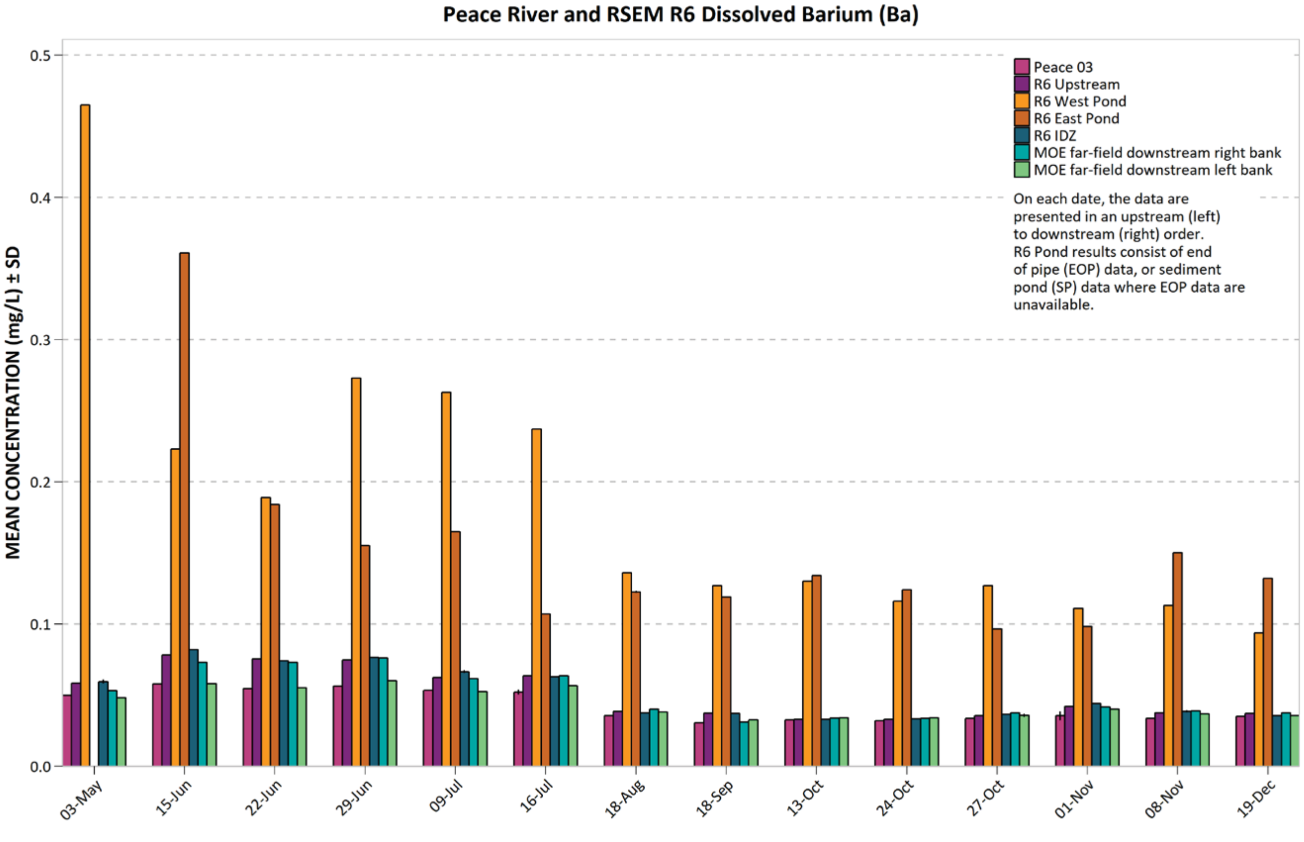
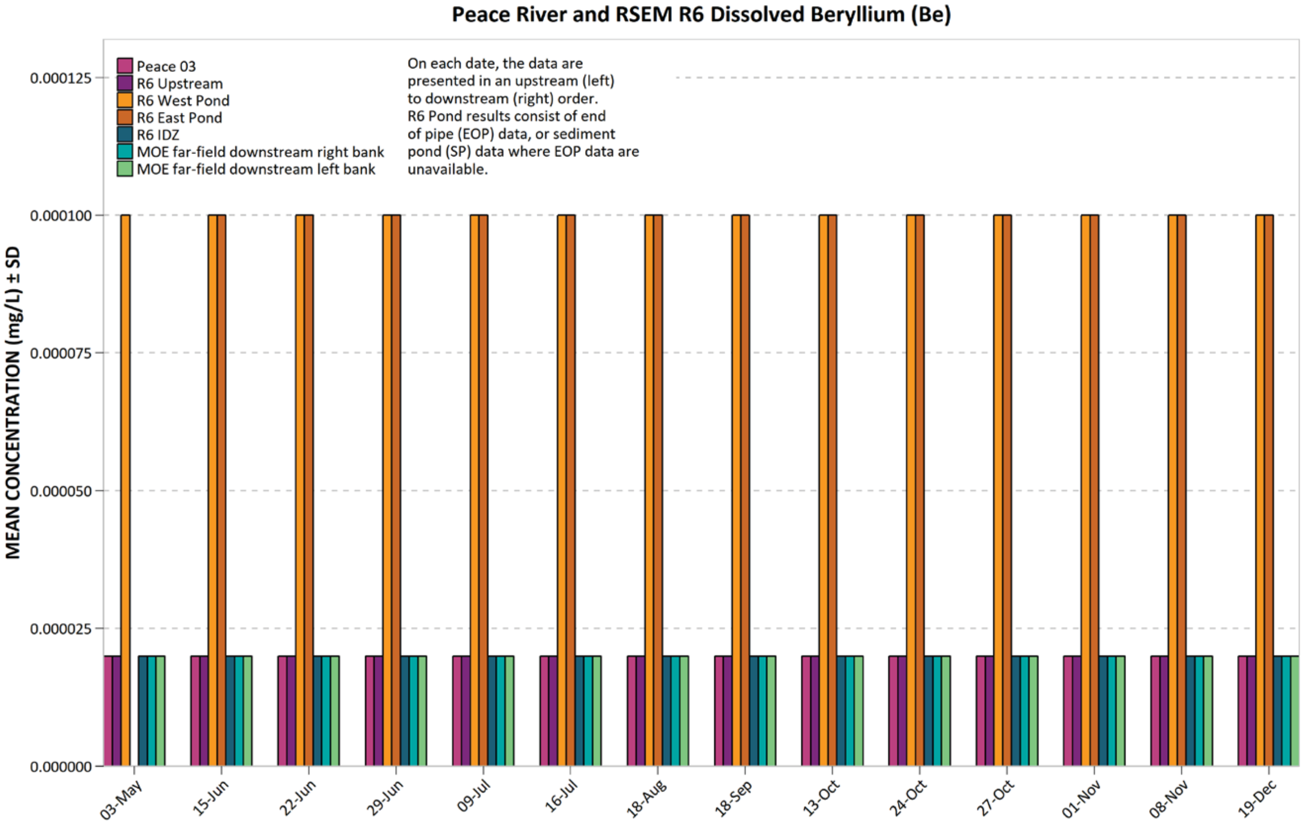
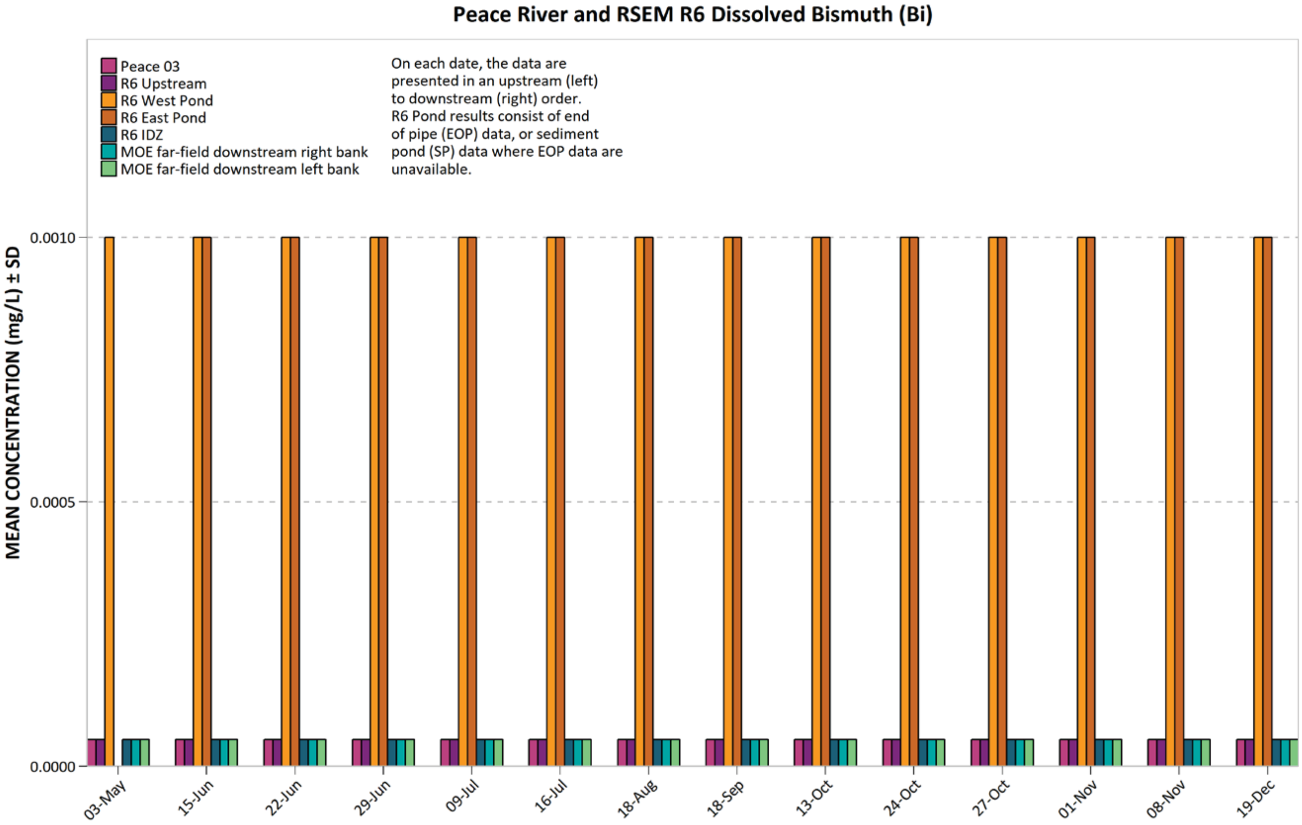


Figure 146. 2017 Peace River and RSEM R6 Dissolved Beryllium (Be).



All R6 pond data and Peace River data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 147. 2017 Peace River and RSEM R6 Dissolved Bismuth (Bi).



All R6 pond data and Peace River data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 148. 2017 Peace River and RSEM R6 Dissolved Boron (B).

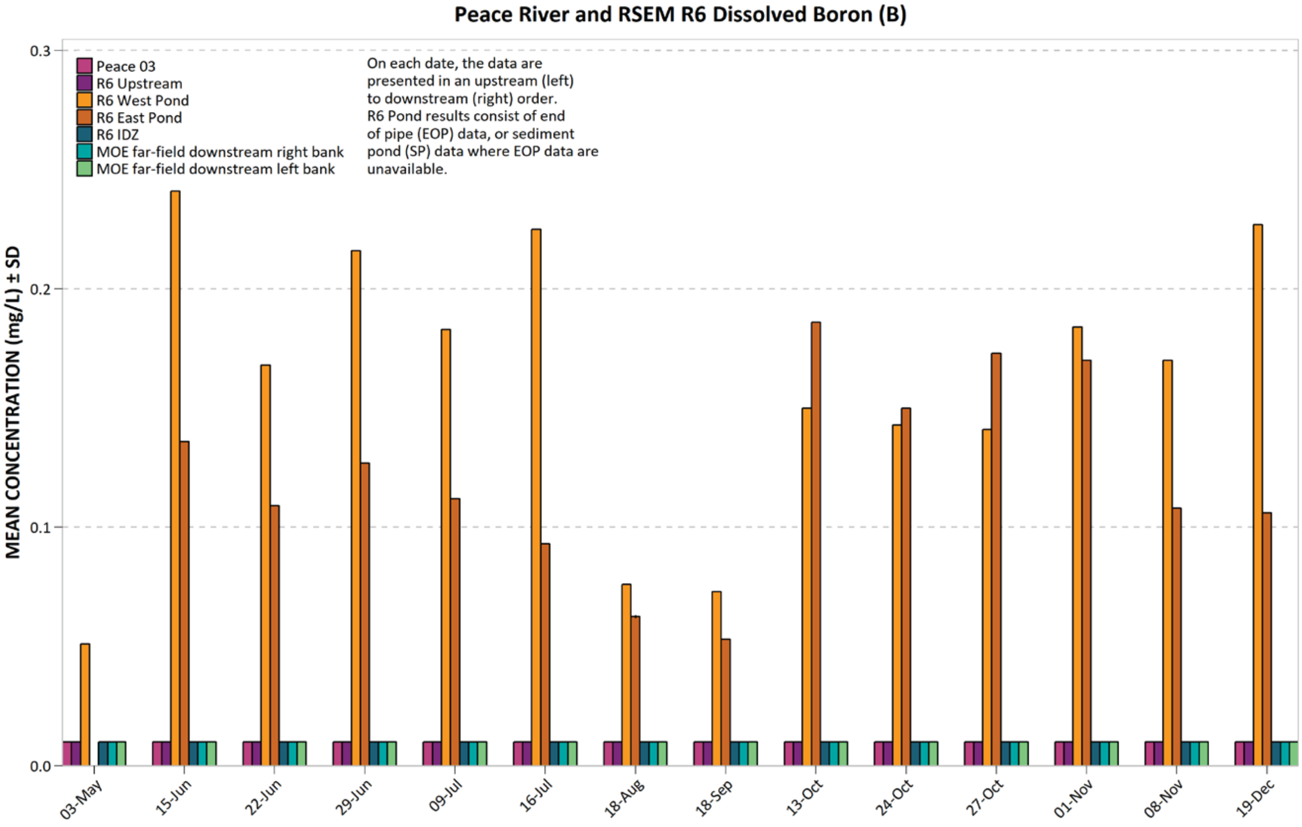


Figure 149. Peace River and RSEM R6 Dissolved Cadmium (Cd).

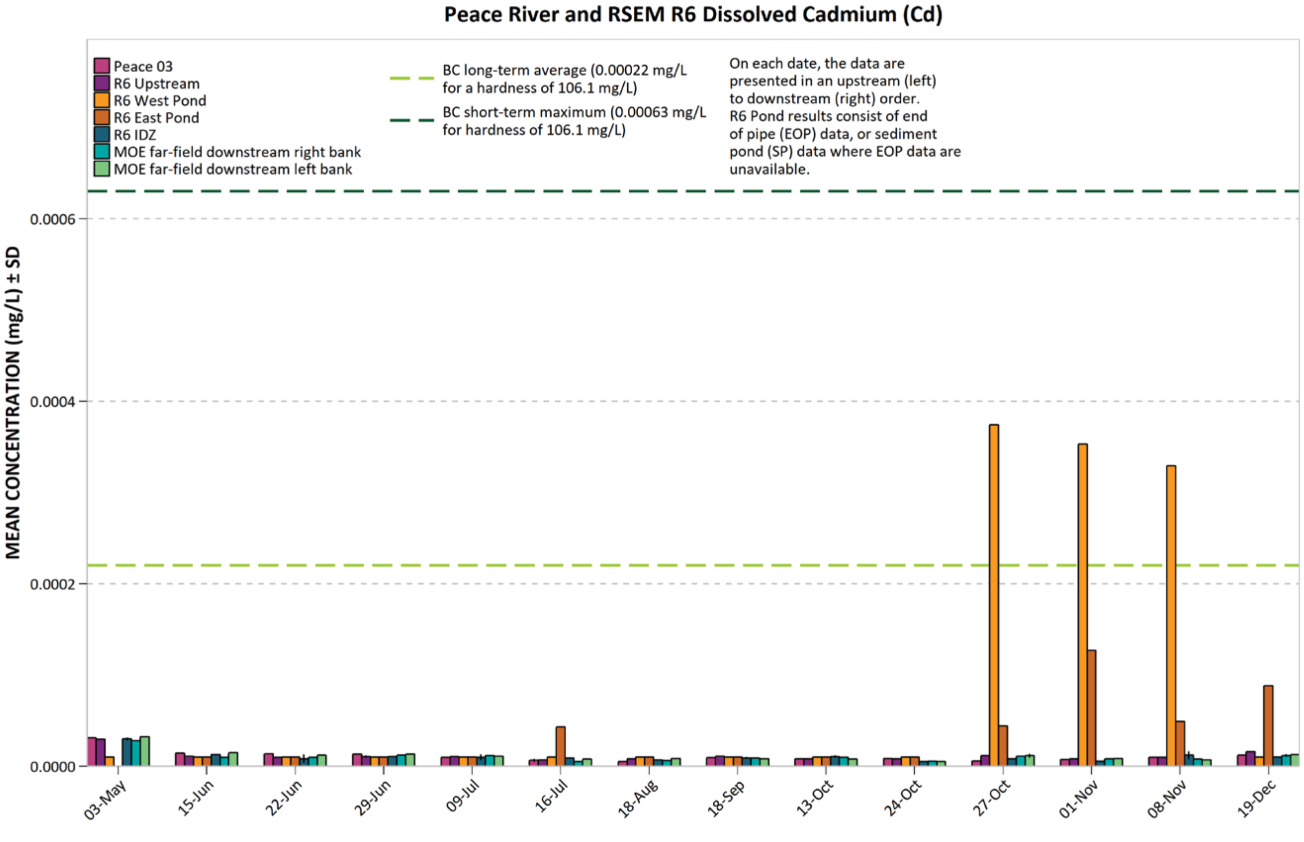


Figure 150. 2017 Peace River and RSEM R6 Dissolved Calcium (Ca).

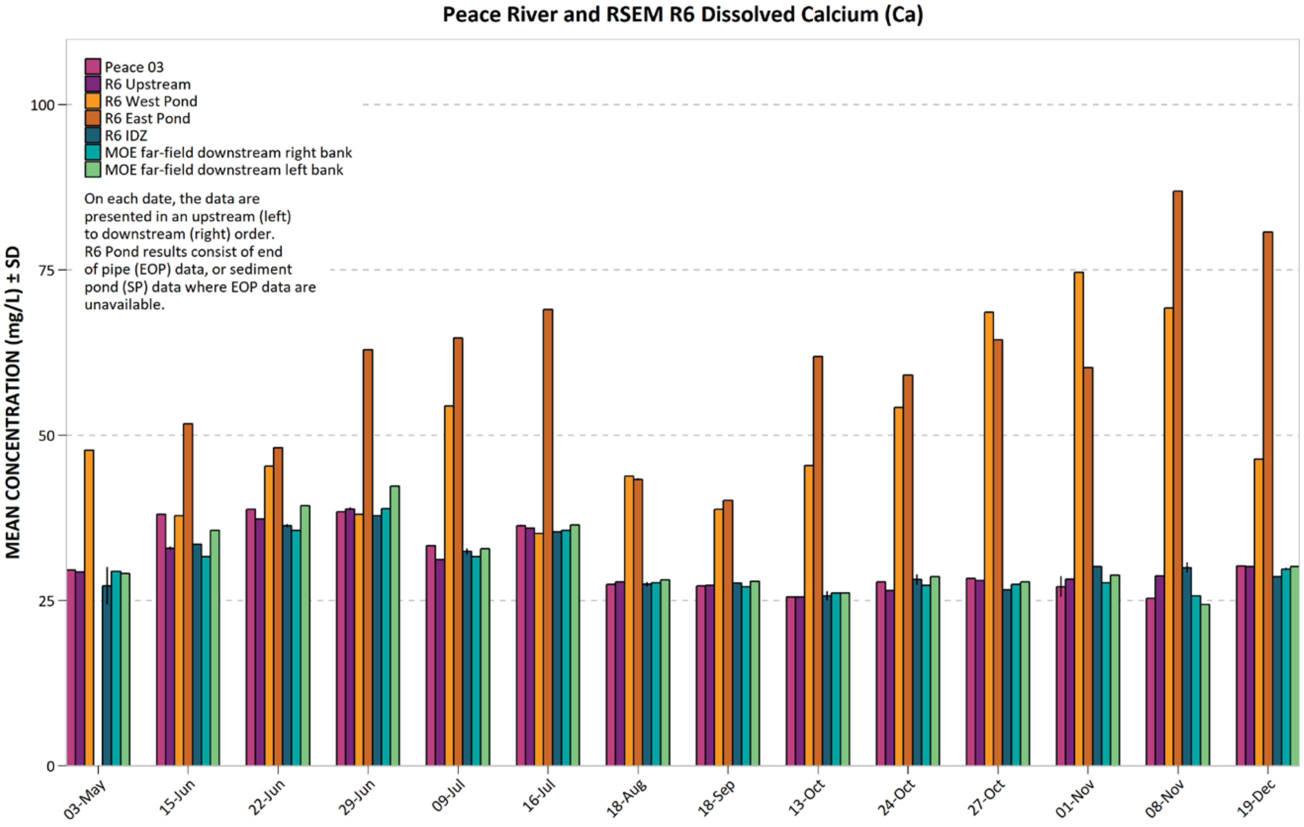


Figure 151. 2017 Peace River and RSEM R6 Dissolved Chromium (Cr).

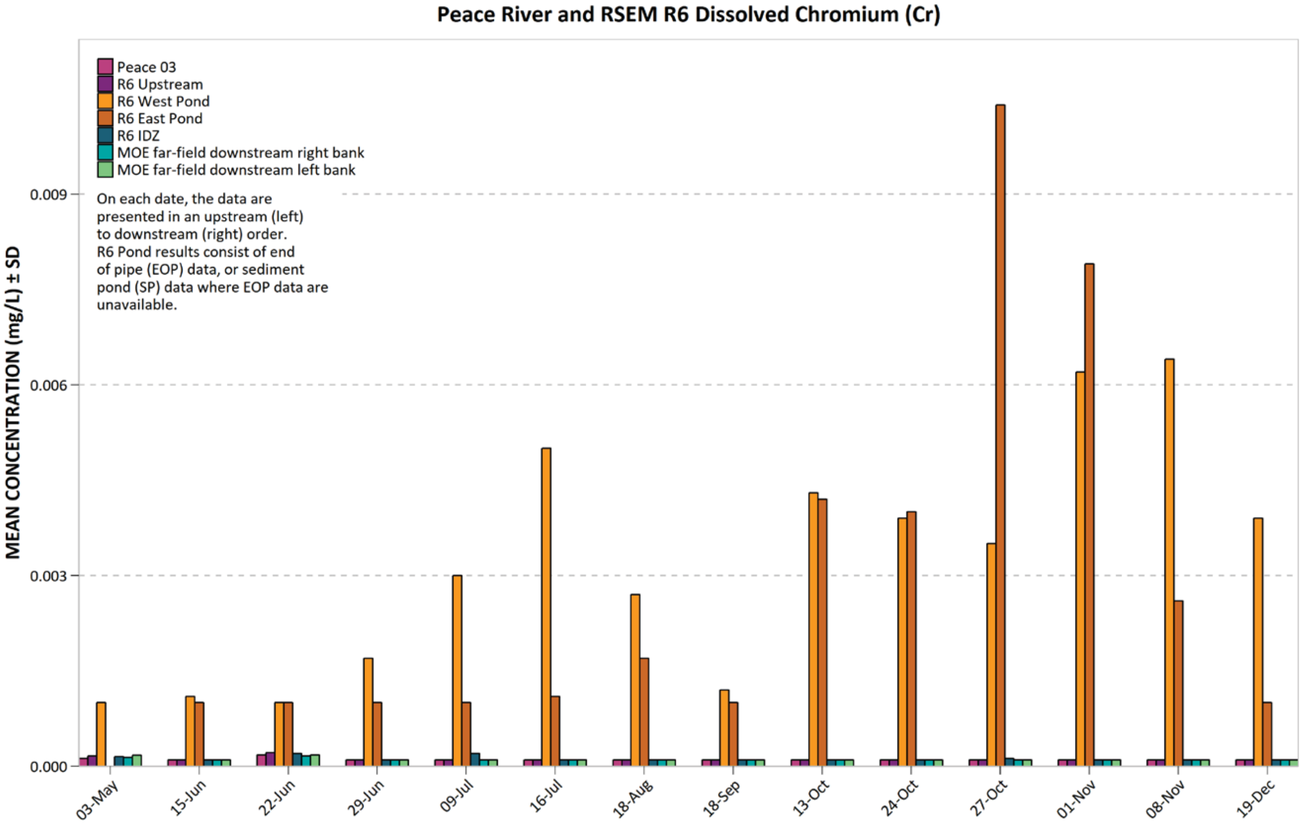


Figure 152. Peace River and RSEM R6 Dissolved Cobalt (Co).

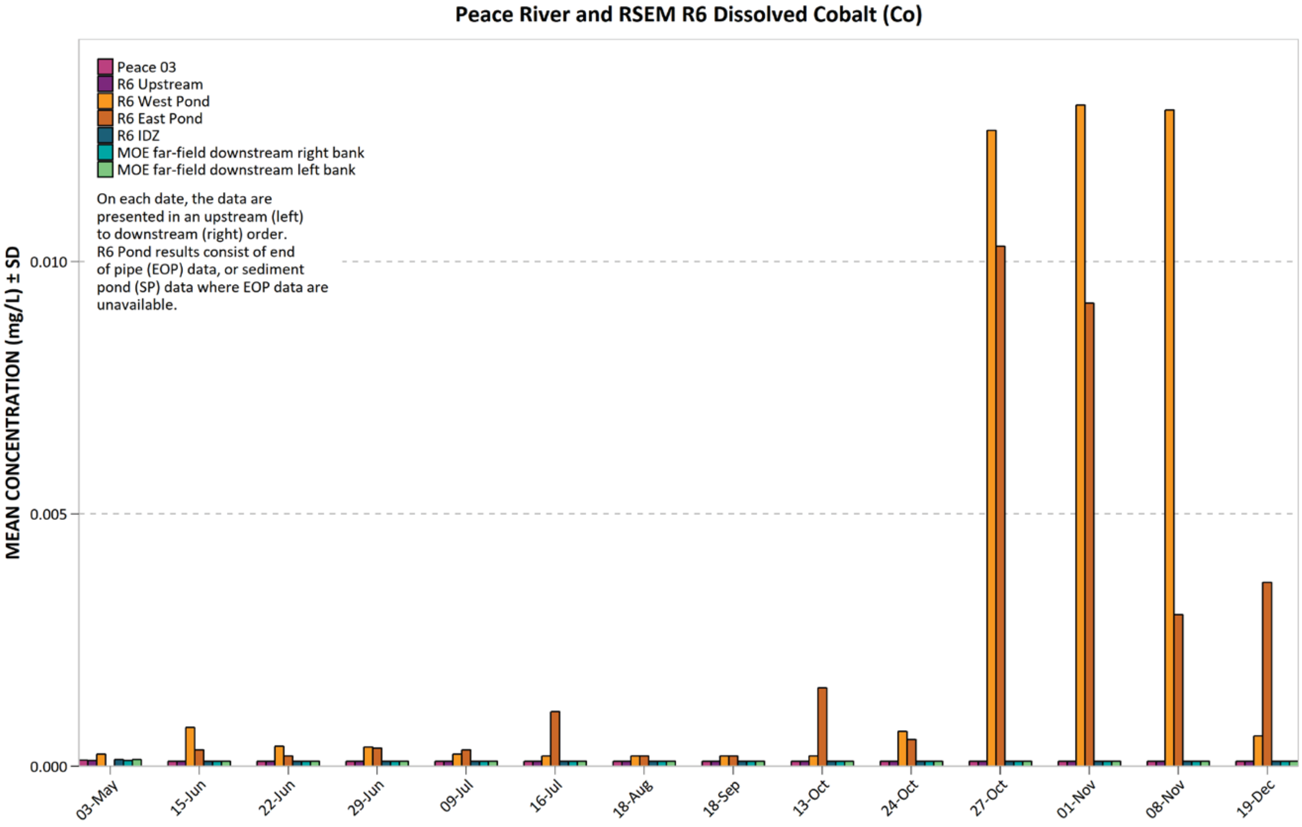


Figure 153. Peace River and RSEM R6 Dissolved Copper (Cu).

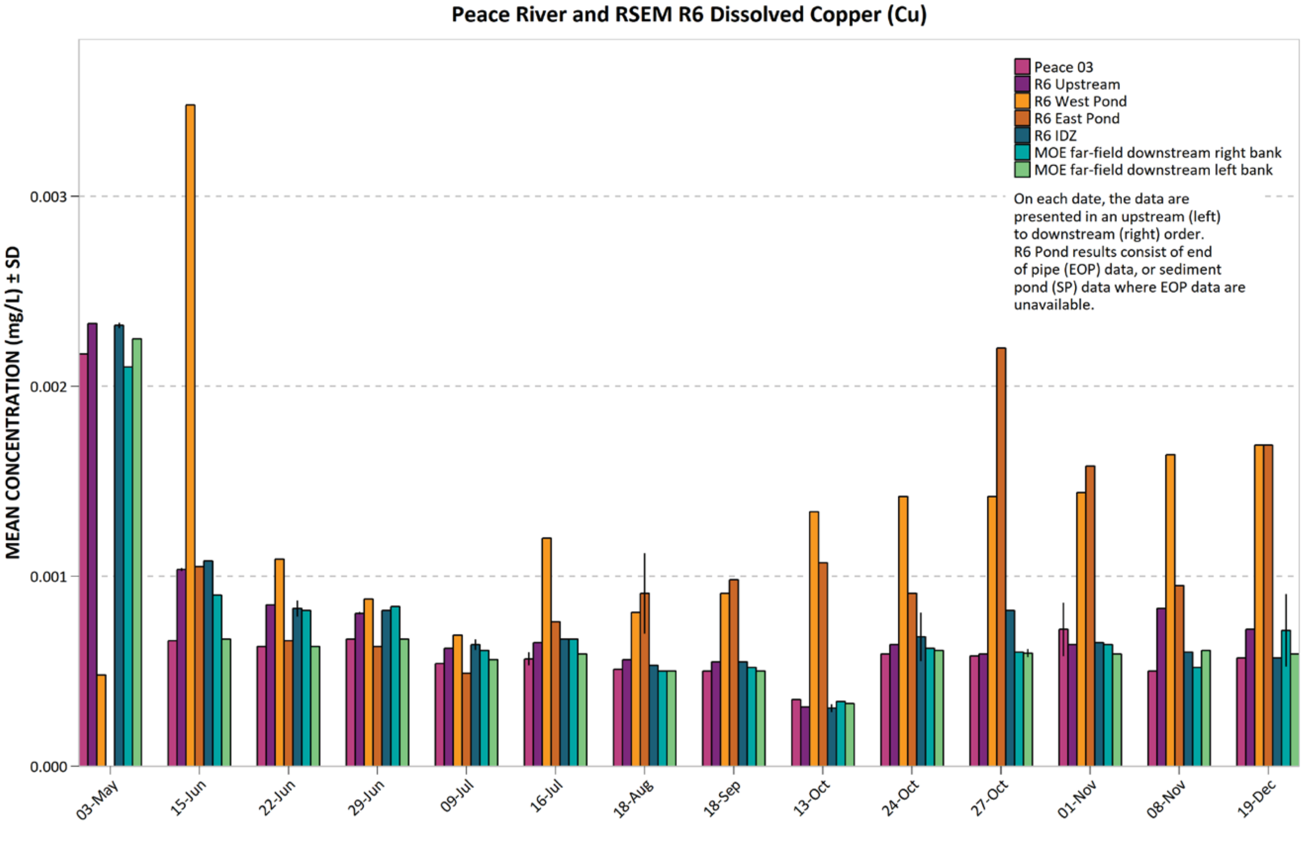


Figure 154. Peace River and RSEM R6 Dissolved Iron (Fe).

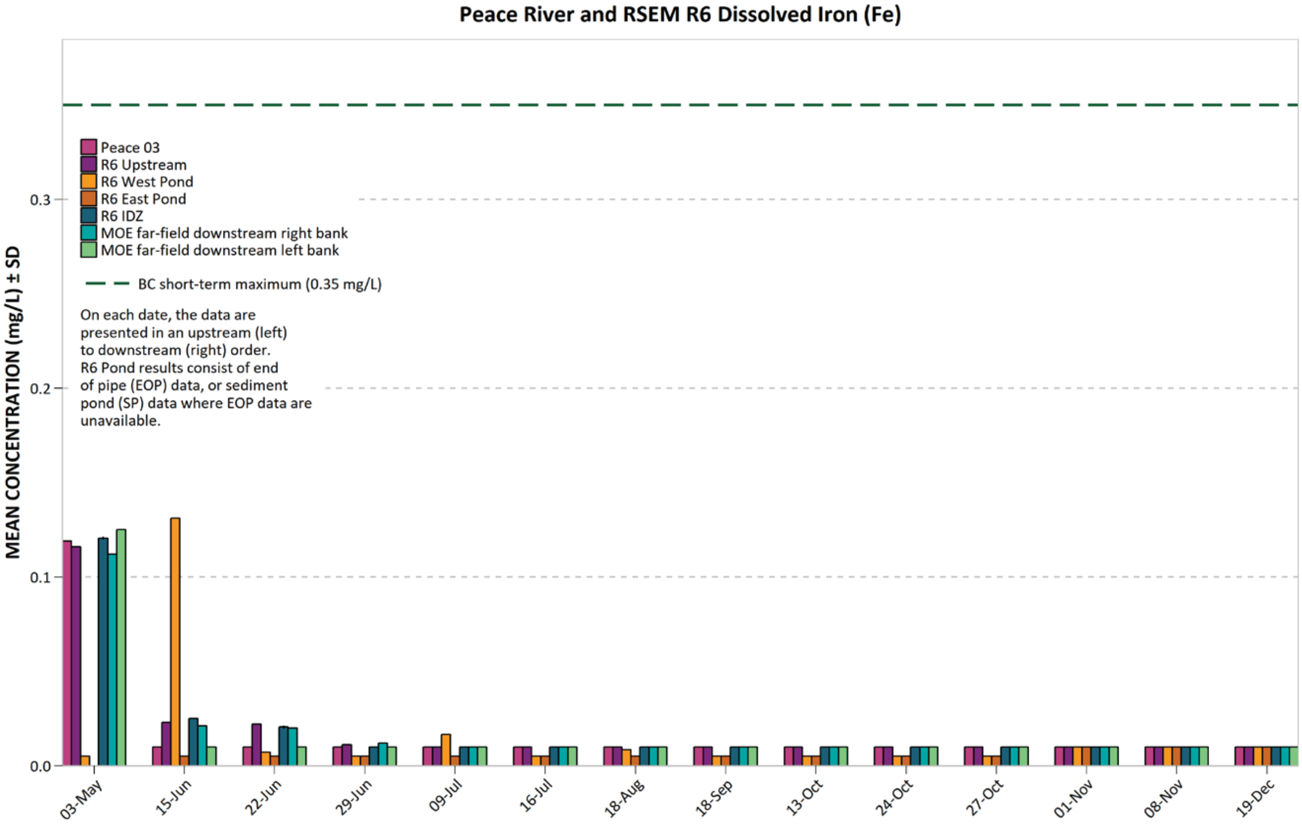
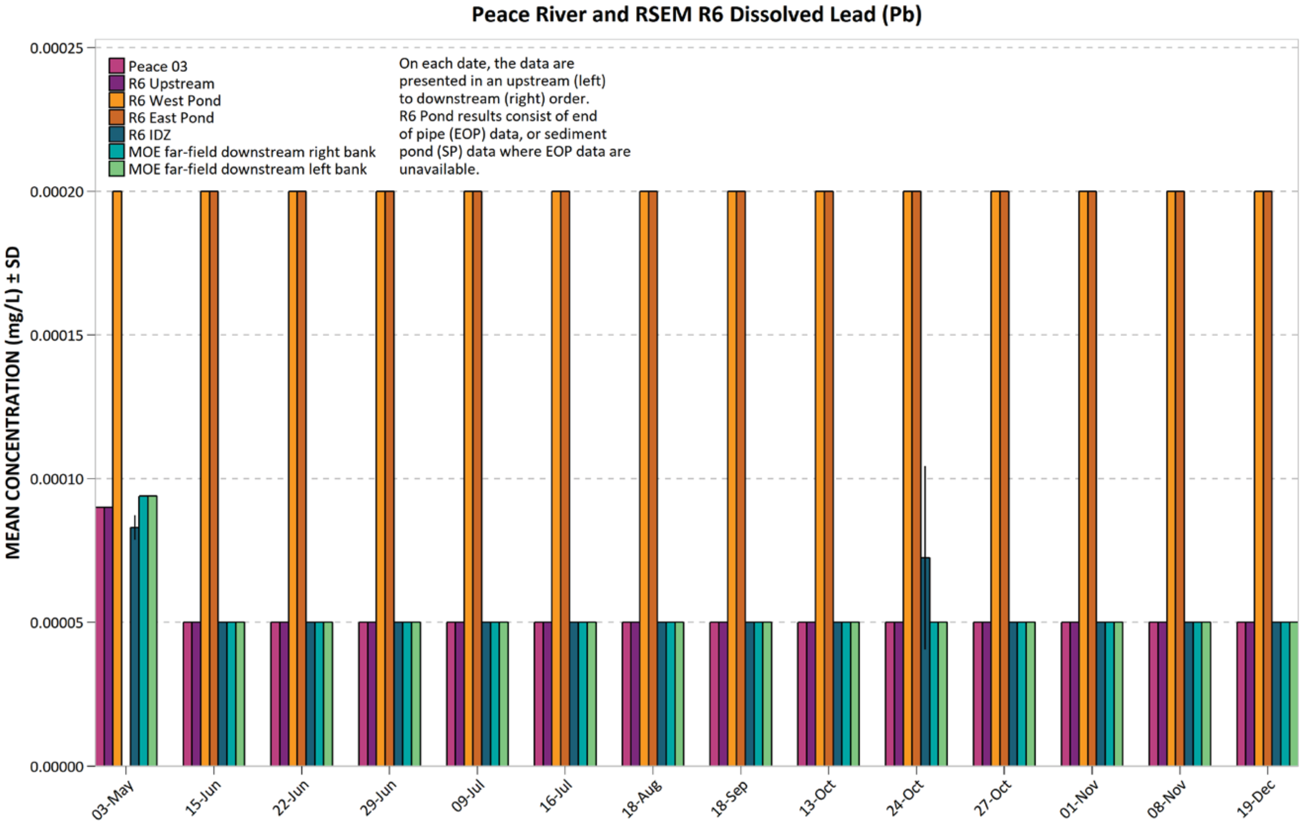


Figure 155. **2017 Peace River and RSEM R6 Dissolved Lead (Pb).**



All R6 pond data are <MDL and most of the Peace River data are <MDL Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 156. 2017 Peace River and RSEM R6 Dissolved Lithium (Li).

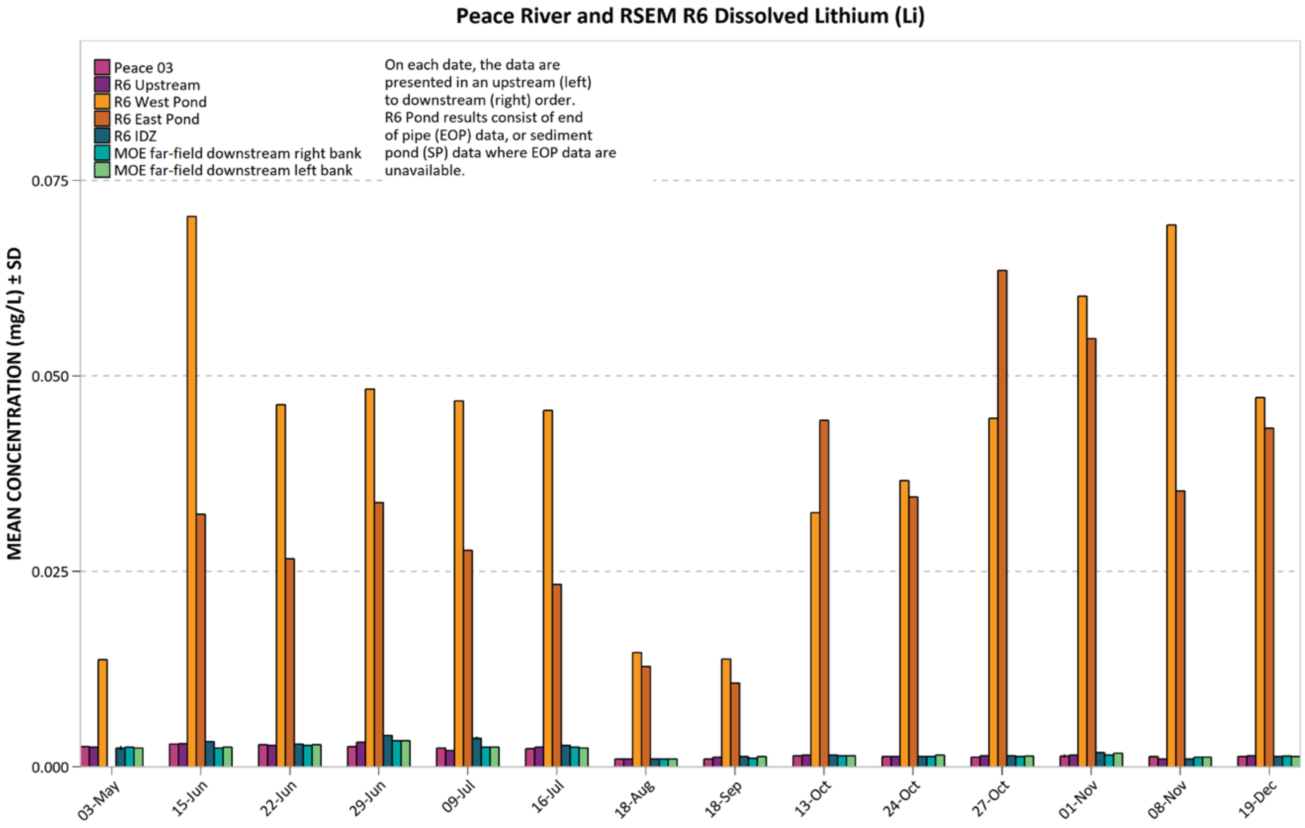


Figure 157. 2017 Peace River and RSEM R6 Dissolved Magnesium (Mg).

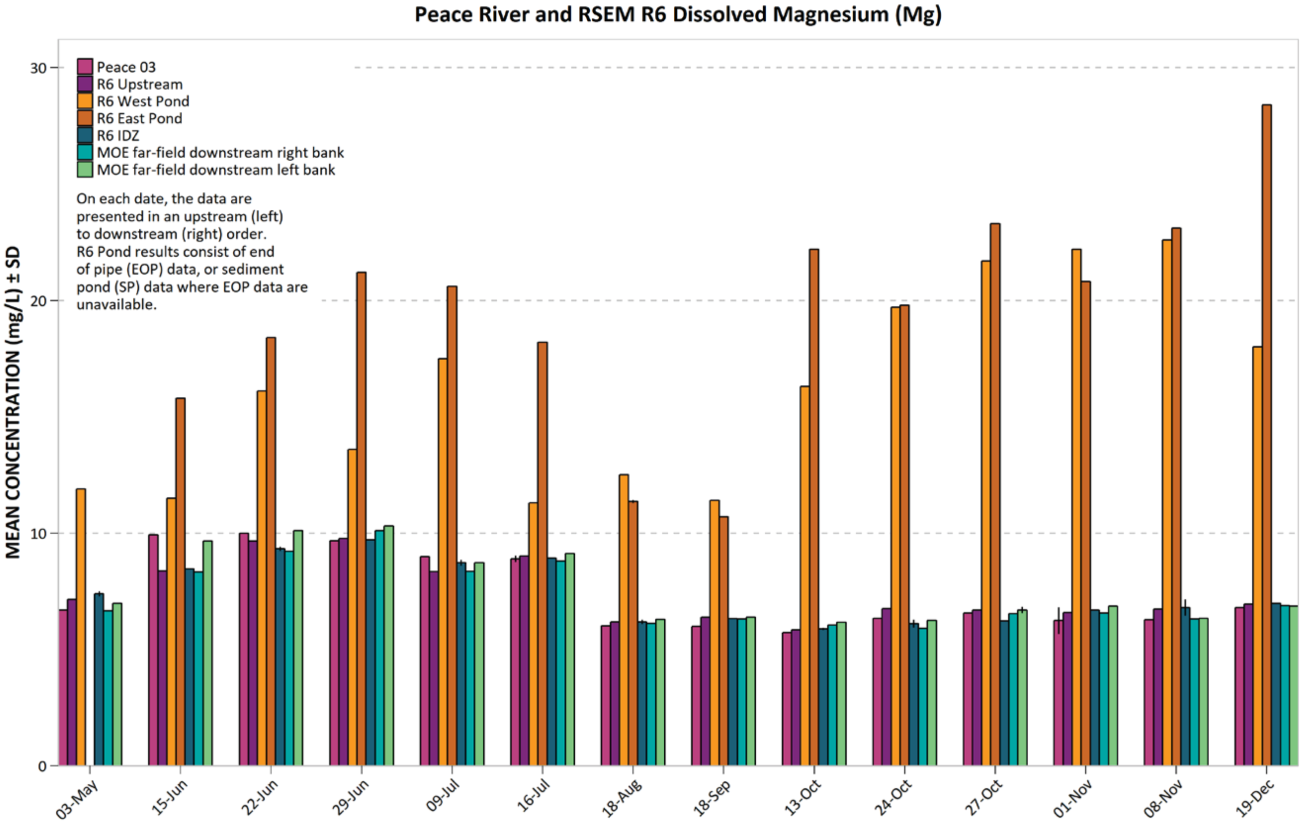


Figure 158. Peace River and RSEM R6 Dissolved Manganese (Mn).

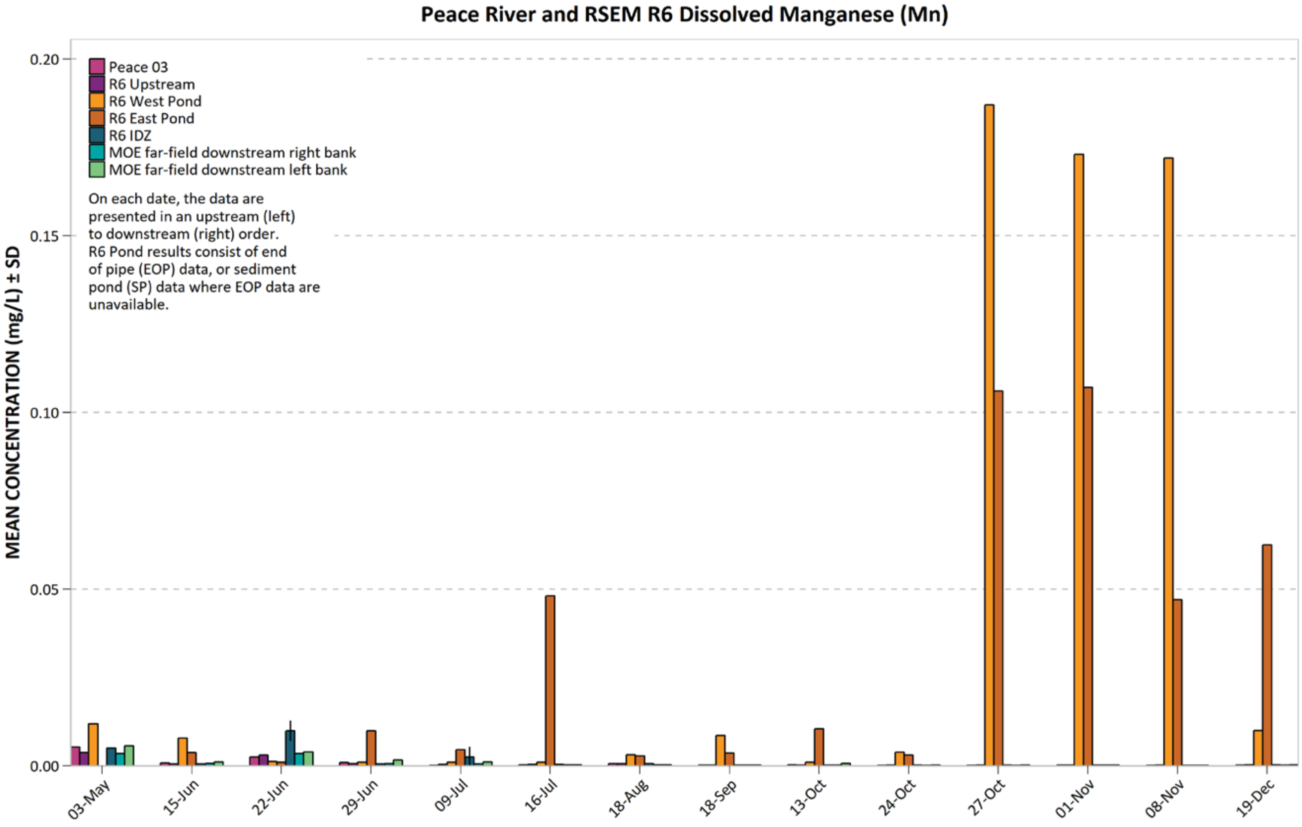
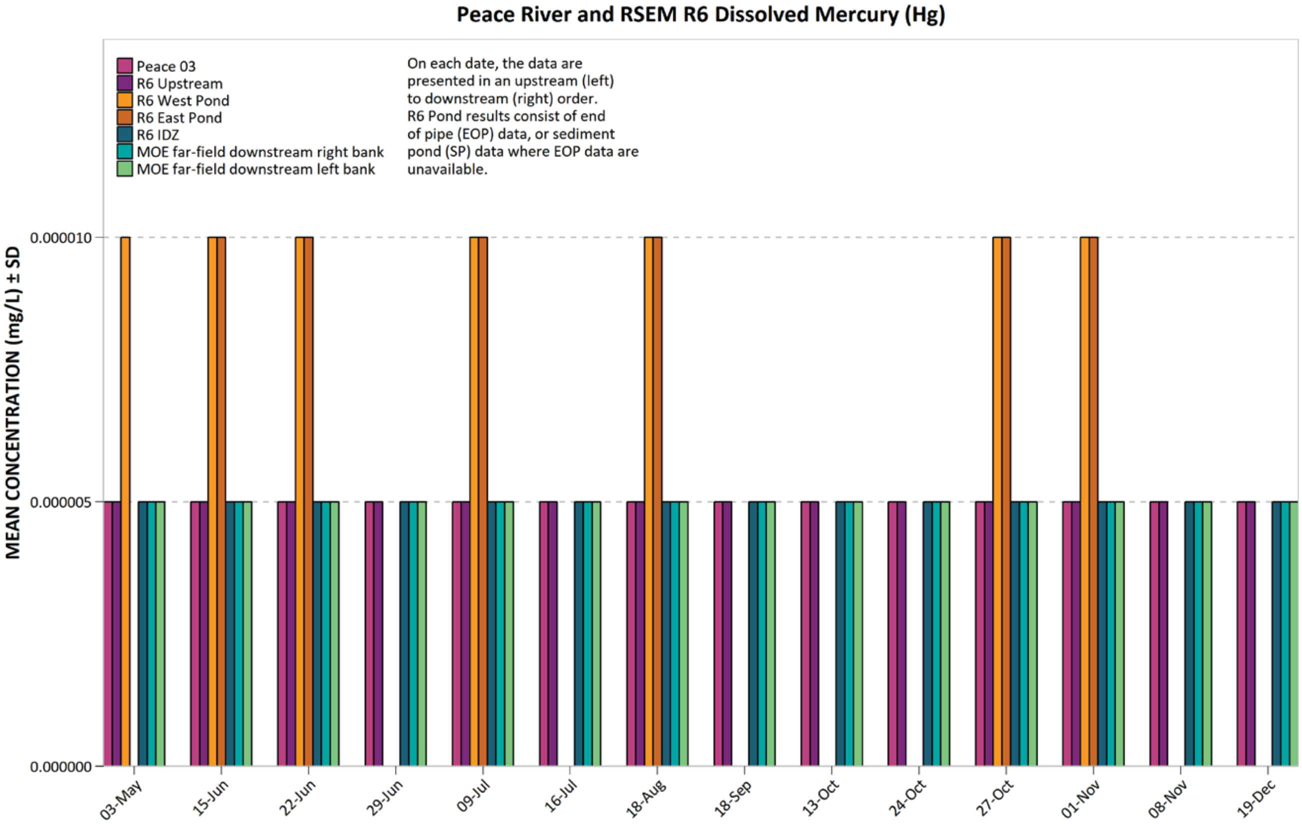


Figure 159. 2017 Peace River and RSEM R6 Dissolved Mercury (Hg).



All R6 pond data and Peace River data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 160. 2017 Peace River and RSEM R6 Dissolved Molybdenum (Mo).

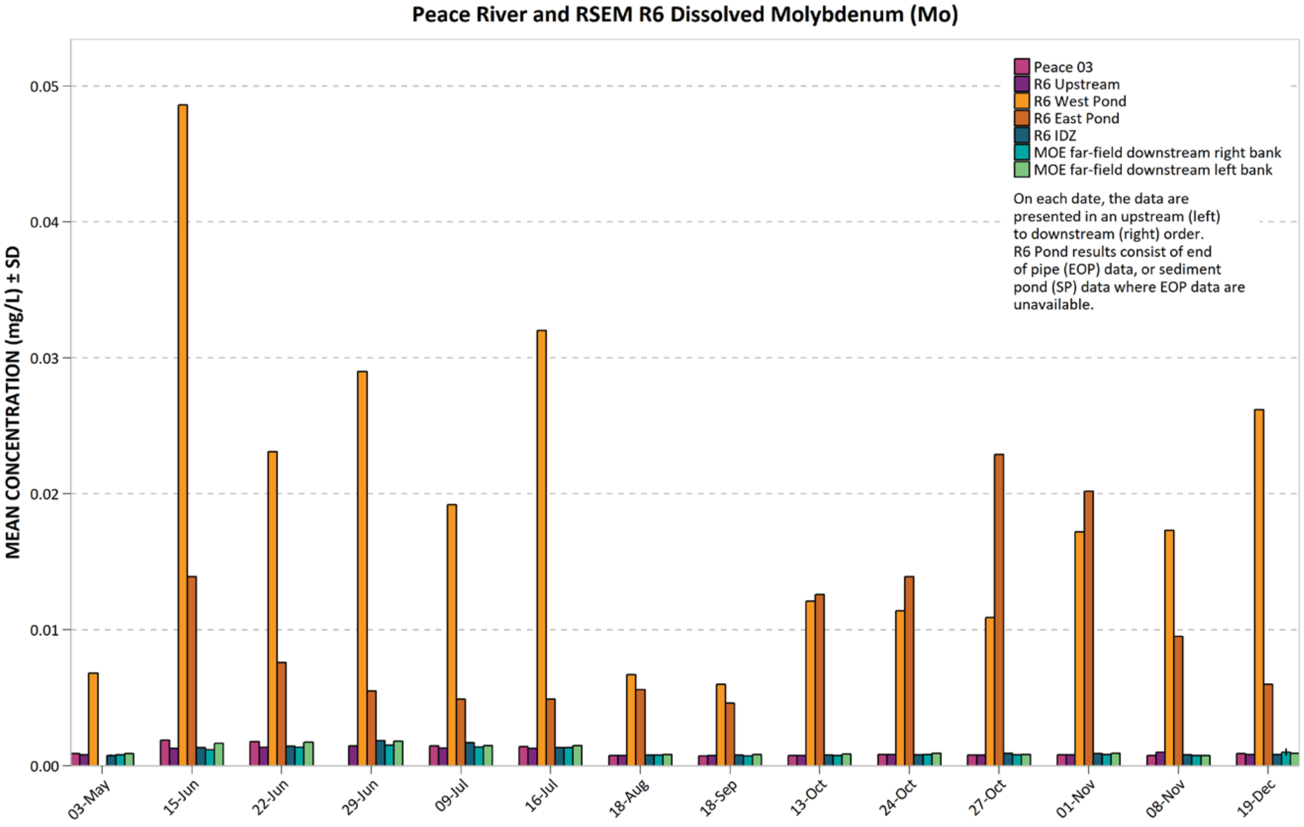


Figure 161. 2017 Peace River and RSEM R6 Dissolved Nickel (Ni).

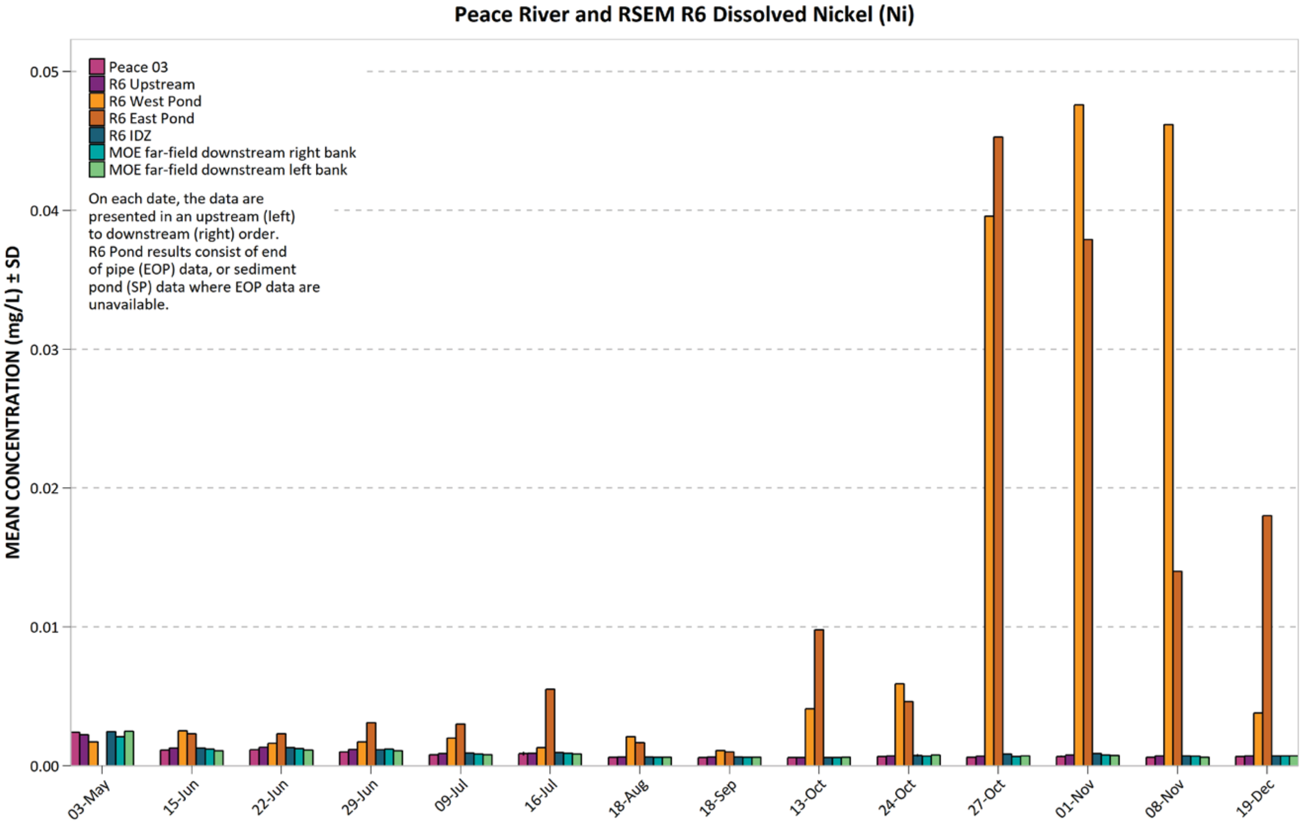


Figure 162. 2017 Peace River and RSEM R6 Dissolved Potassium (K).

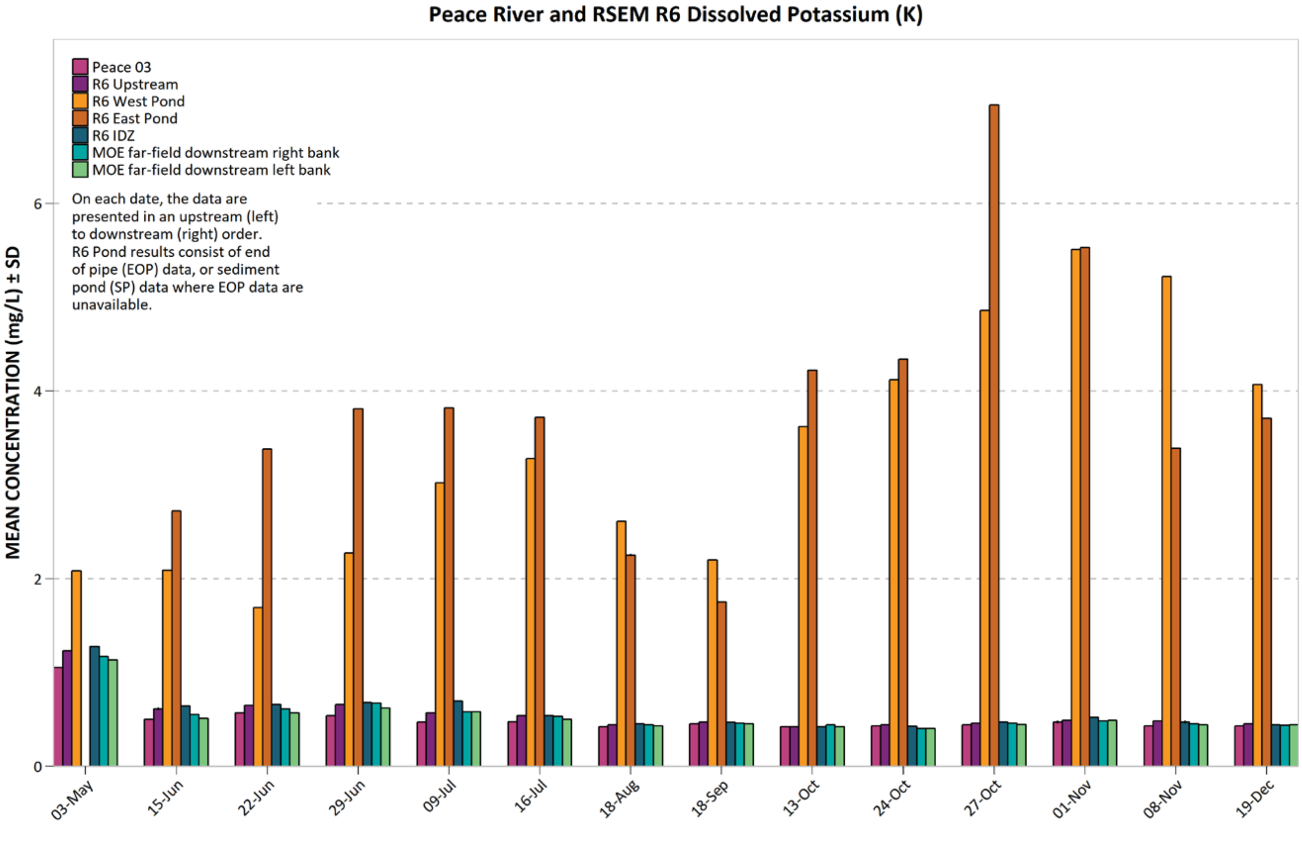


Figure 163. 2017 Peace River and RSEM R6 Dissolved Selenium (Se).

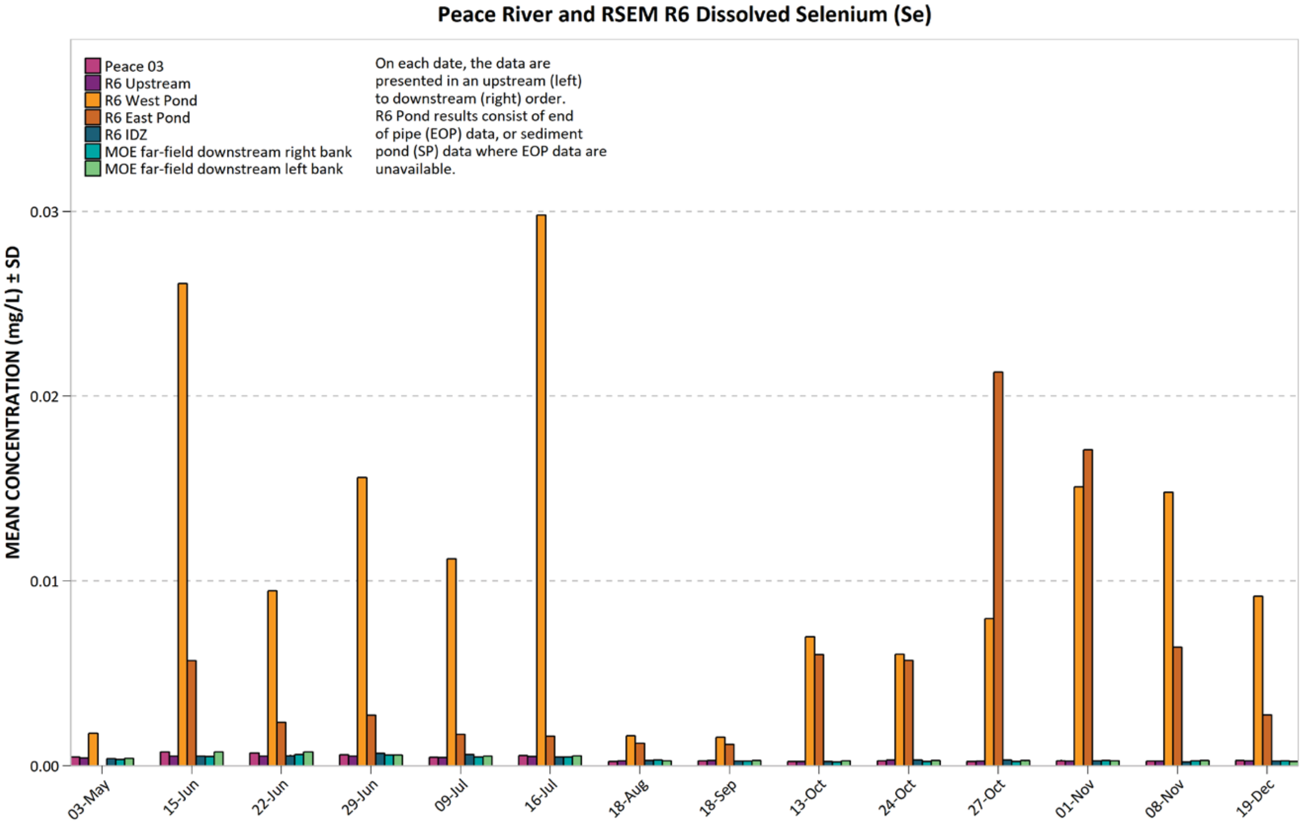


Figure 164. 2017 Peace River and RSEM R6 Dissolved Silicon (Si).

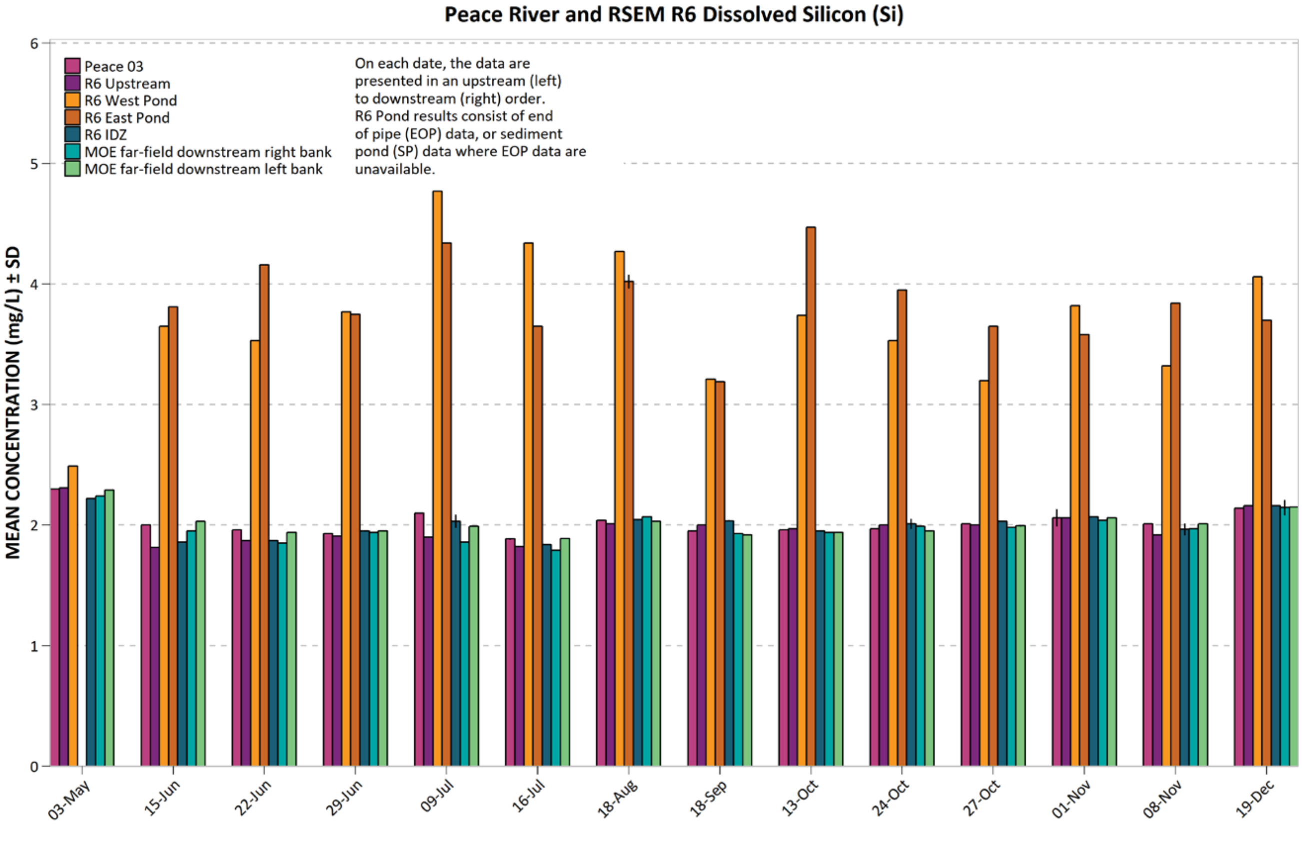
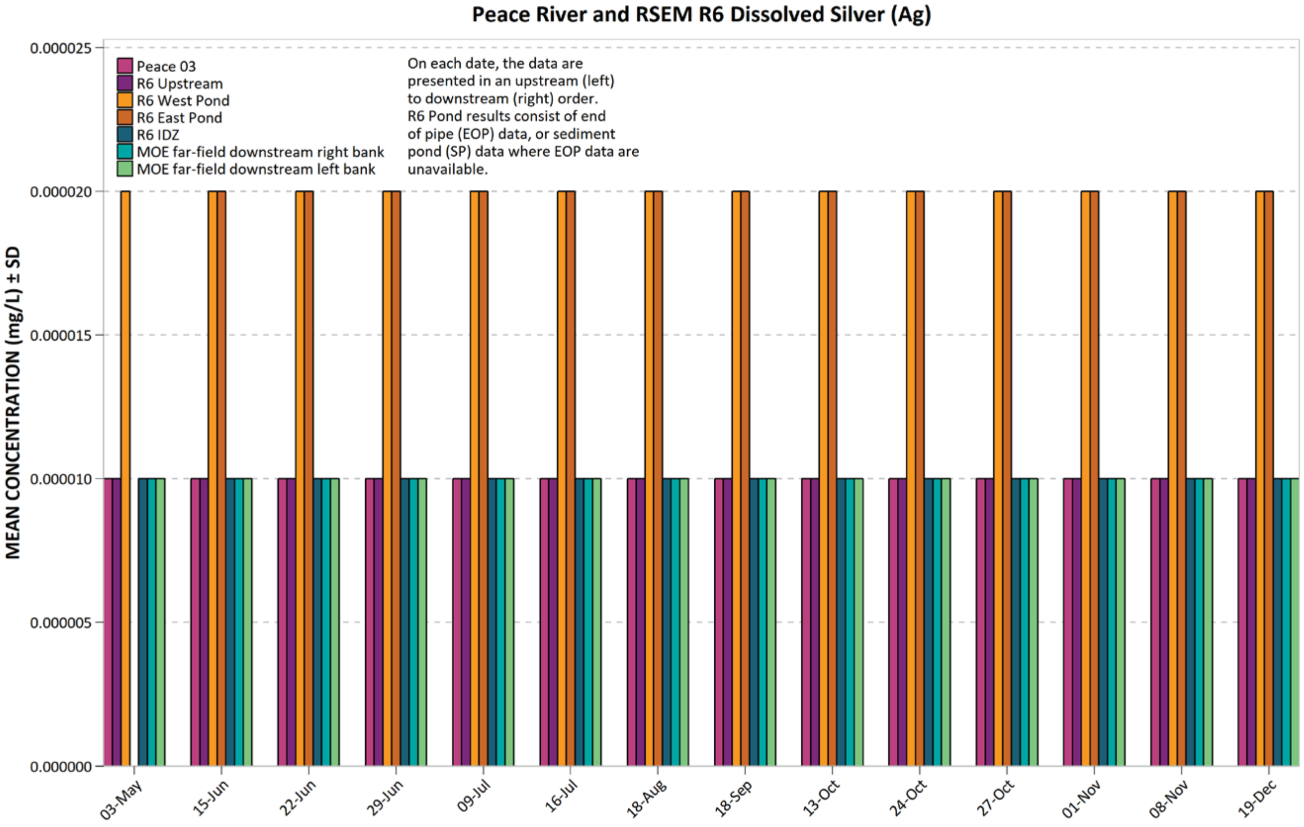


Figure 165. 2017 Peace River and RSEM R6 Dissolved Silver (Ag).



All R6 pond data and Peace River data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 166. 2017 Peace River and RSEM R6 Dissolved Sodium (Na).

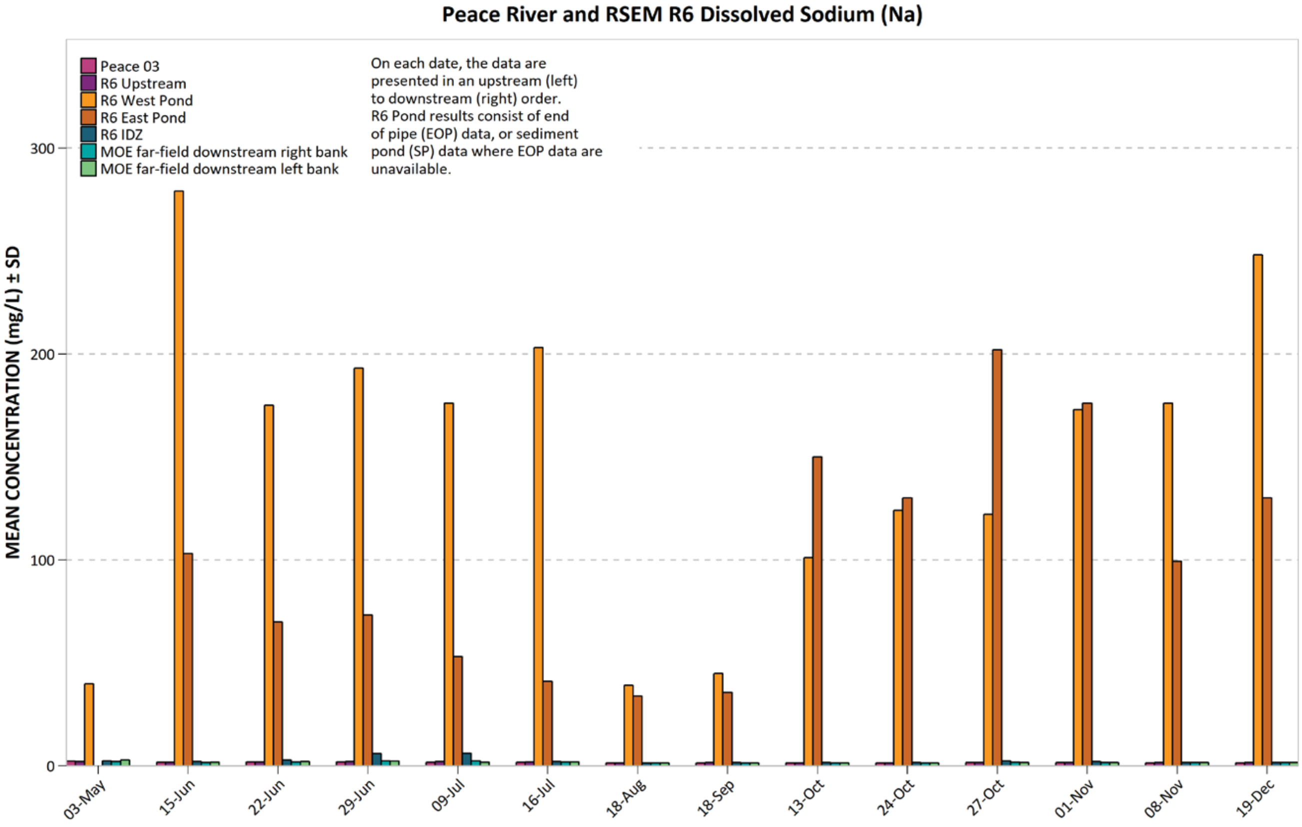


Figure 167. 2017 Peace River and RSEM R6 Dissolved Strontium (Sr).

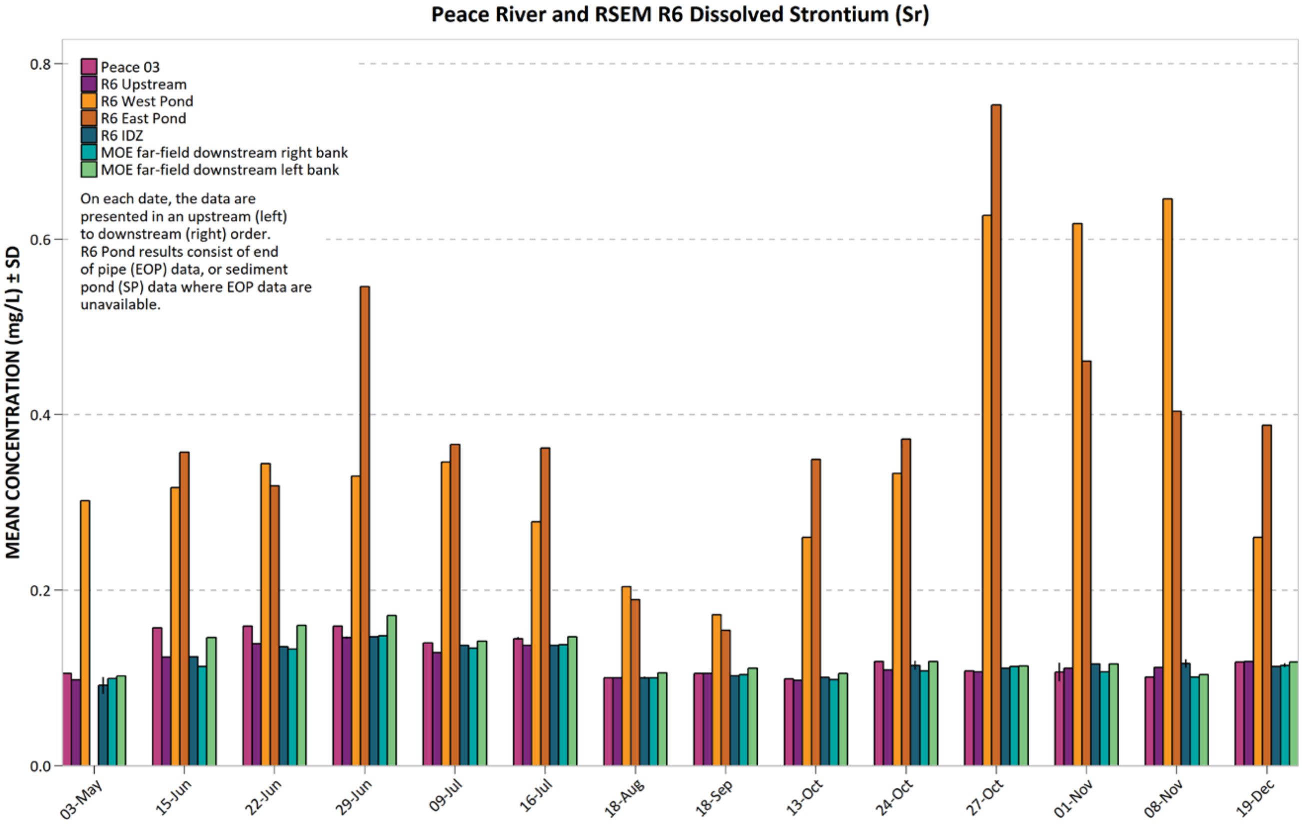


Figure 168. 2017 Peace River and RSEM R6 Dissolved Sulfur (S).

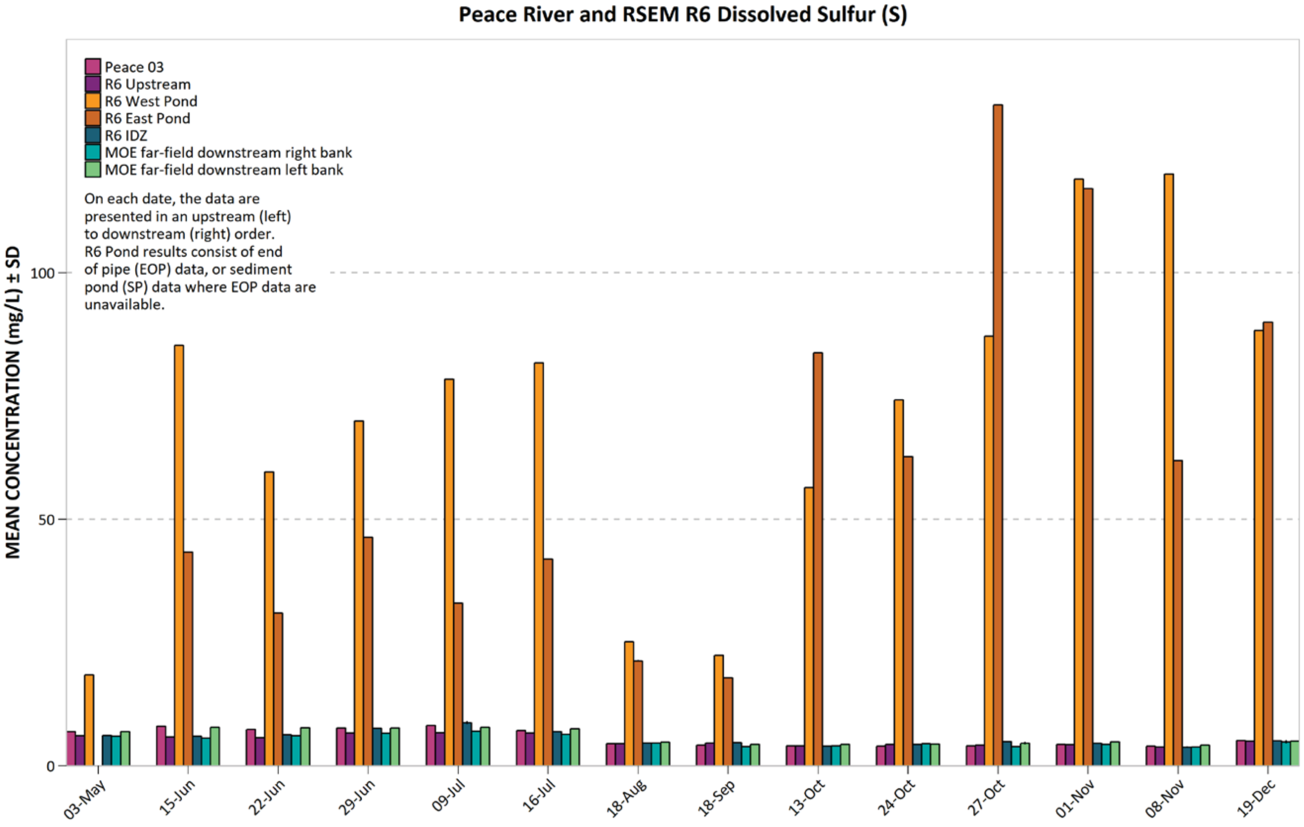
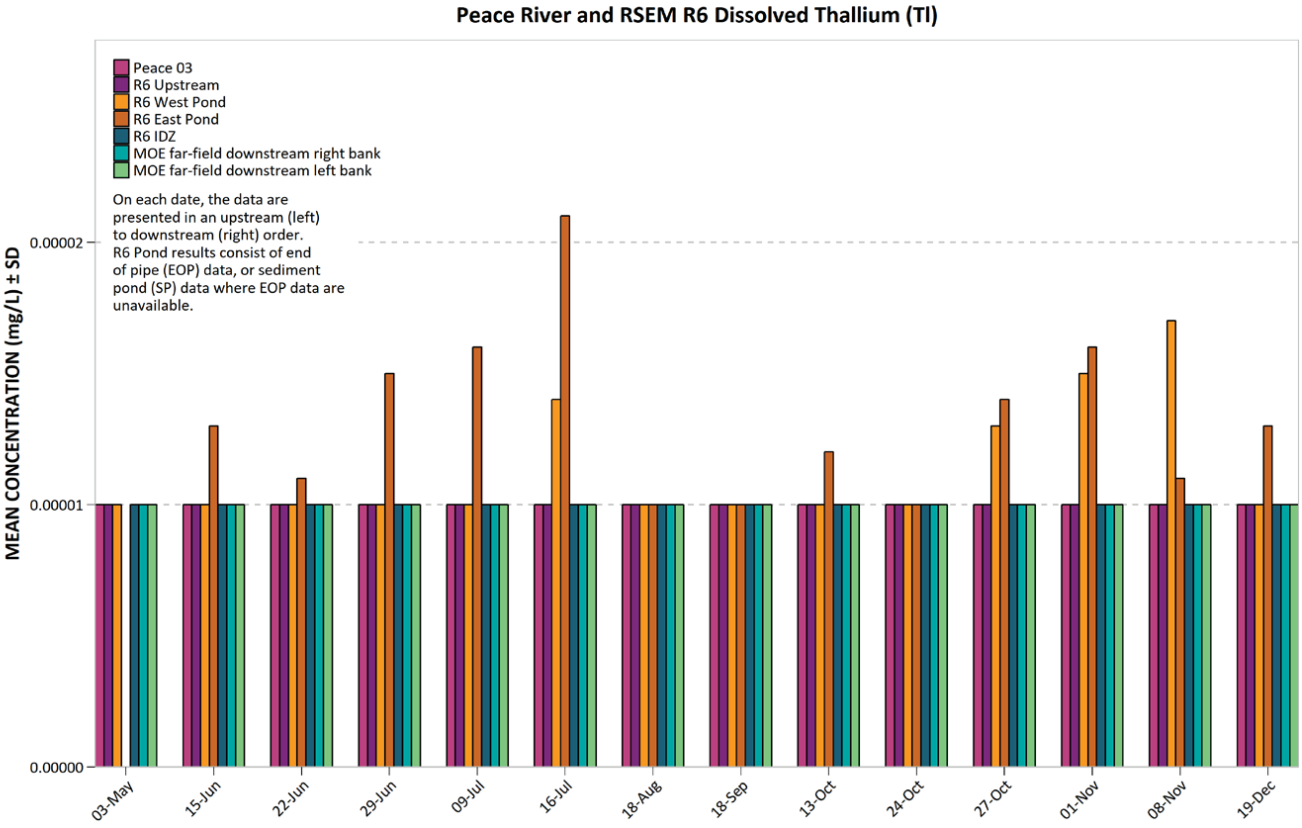
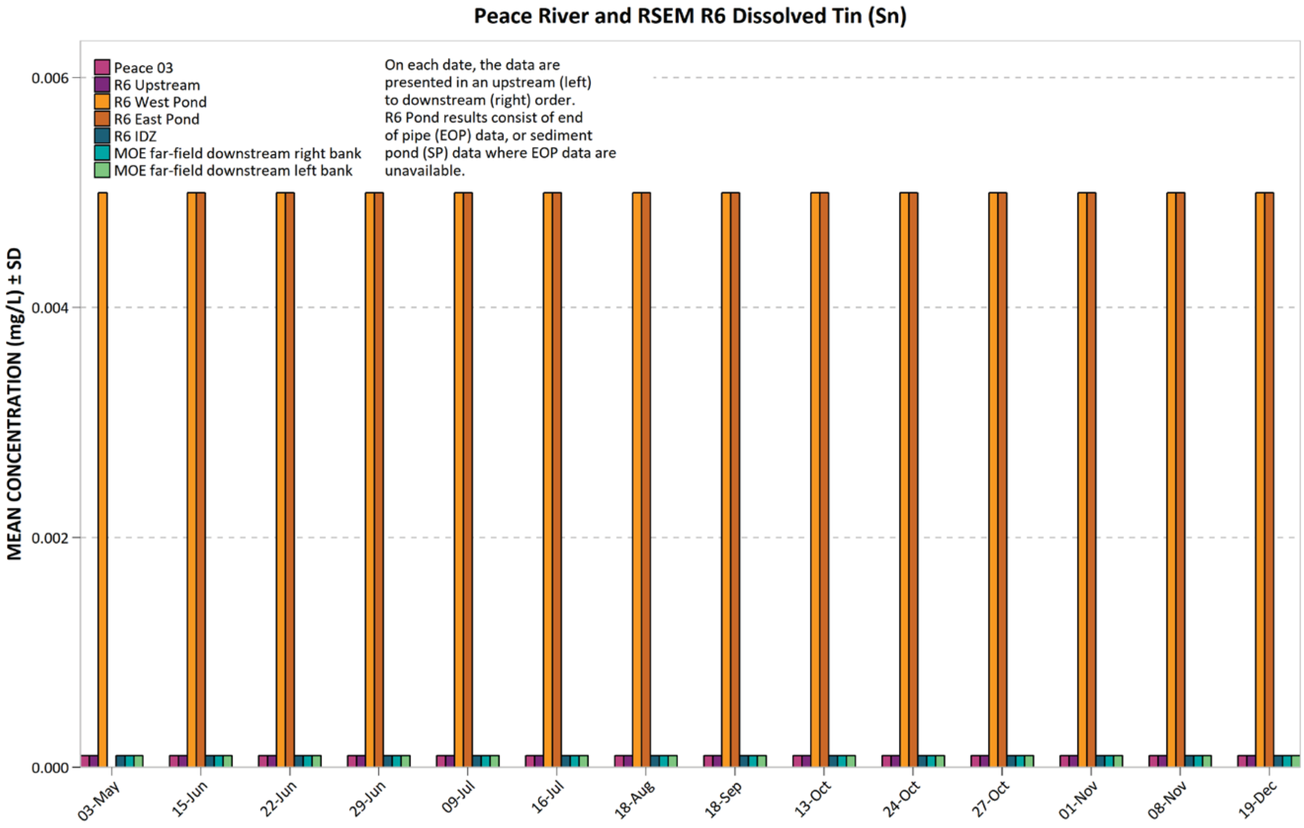


Figure 169. 2017 Peace River and RSEM R6 Dissolved Thallium (Tl).



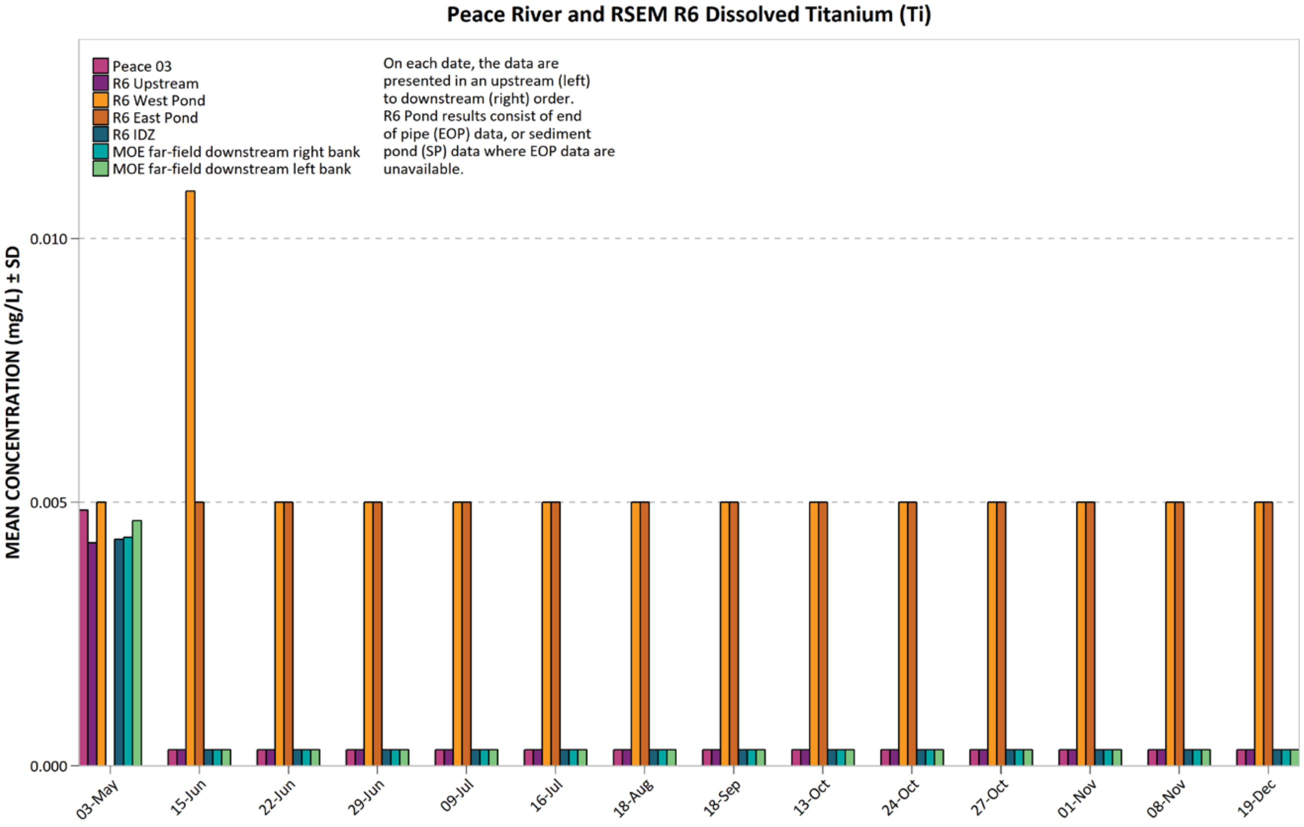
All Peace River data and most of the R6 Pond data are <MDL.

Figure 170. **2017 Peace River and RSEM R6 Dissolved Tin (Sn).**



All R6 pond data and Peace River data are less than their respective MDLs. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 171. 2017 Peace River and RSEM R6 Dissolved Titanium (Ti).



Most of the R6 pond data and Peace River data are less than their respective MDLs. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 172. 2017 Peace River and RSEM R6 Dissolved Uranium (U).

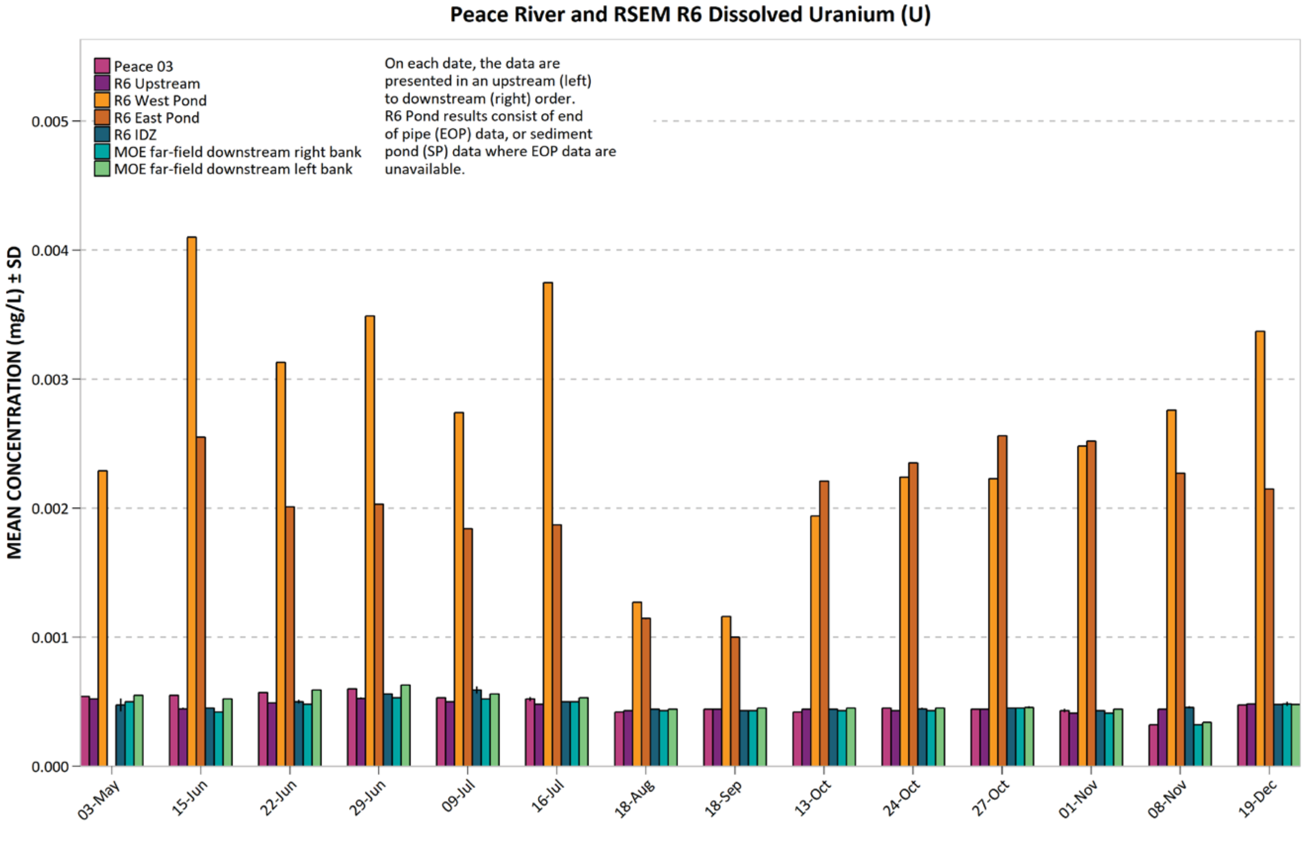
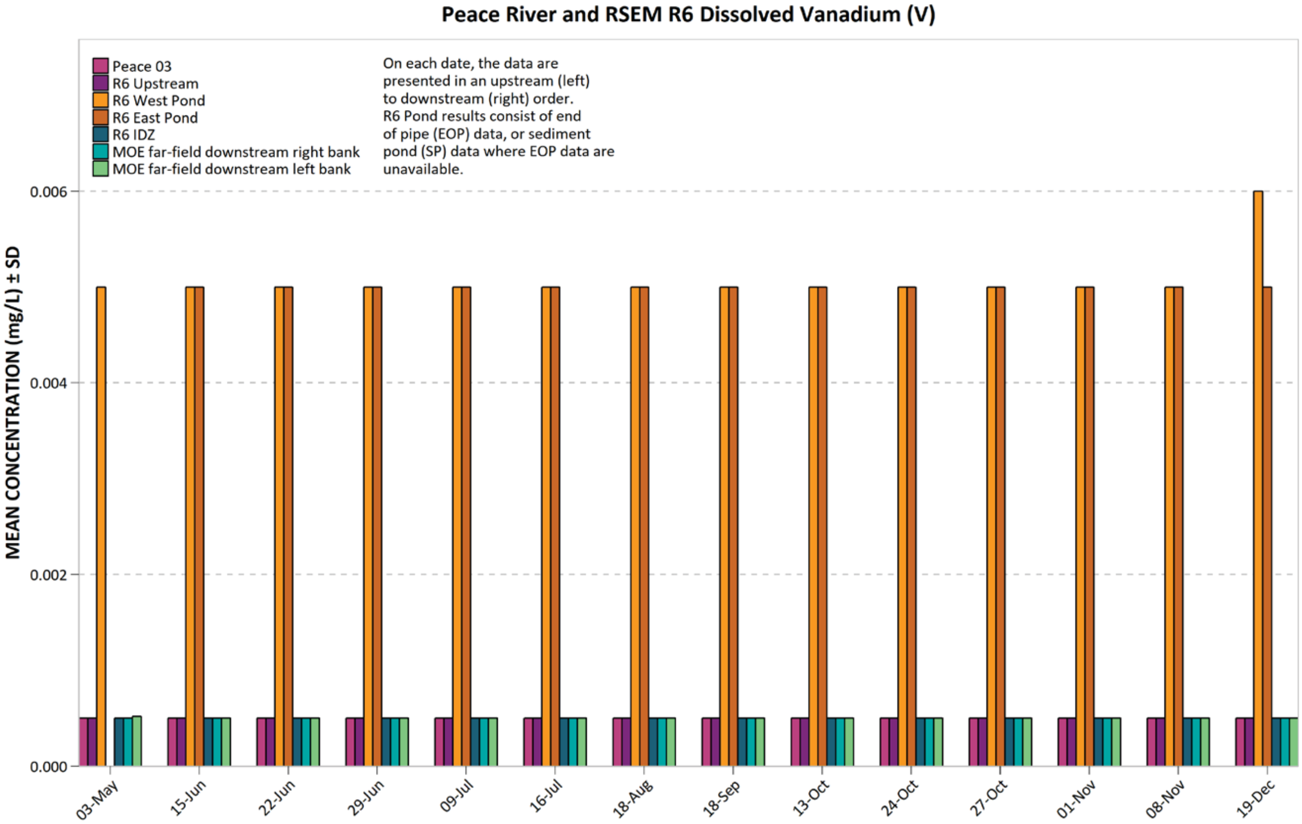
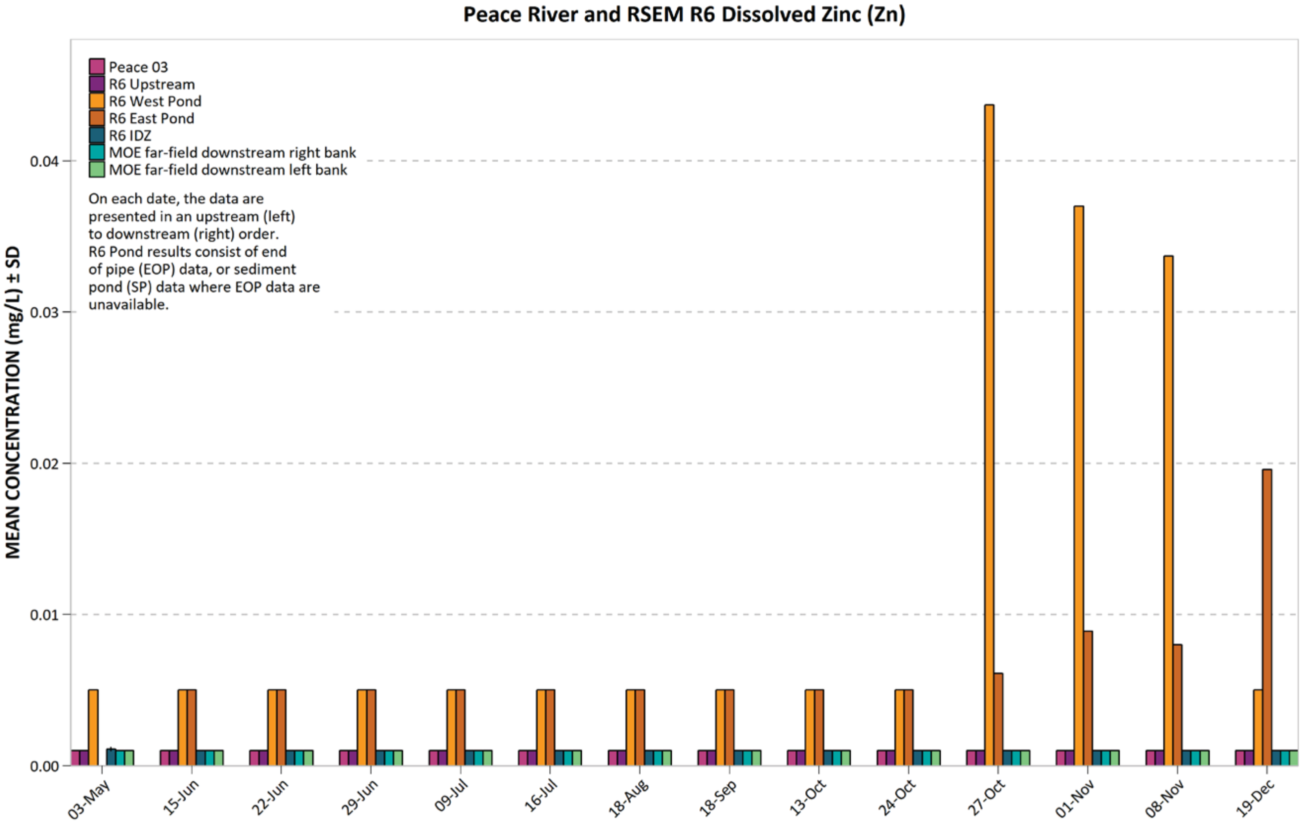


Figure 173. 2017 Peace River and RSEM R6 Dissolved Vanadium (V).



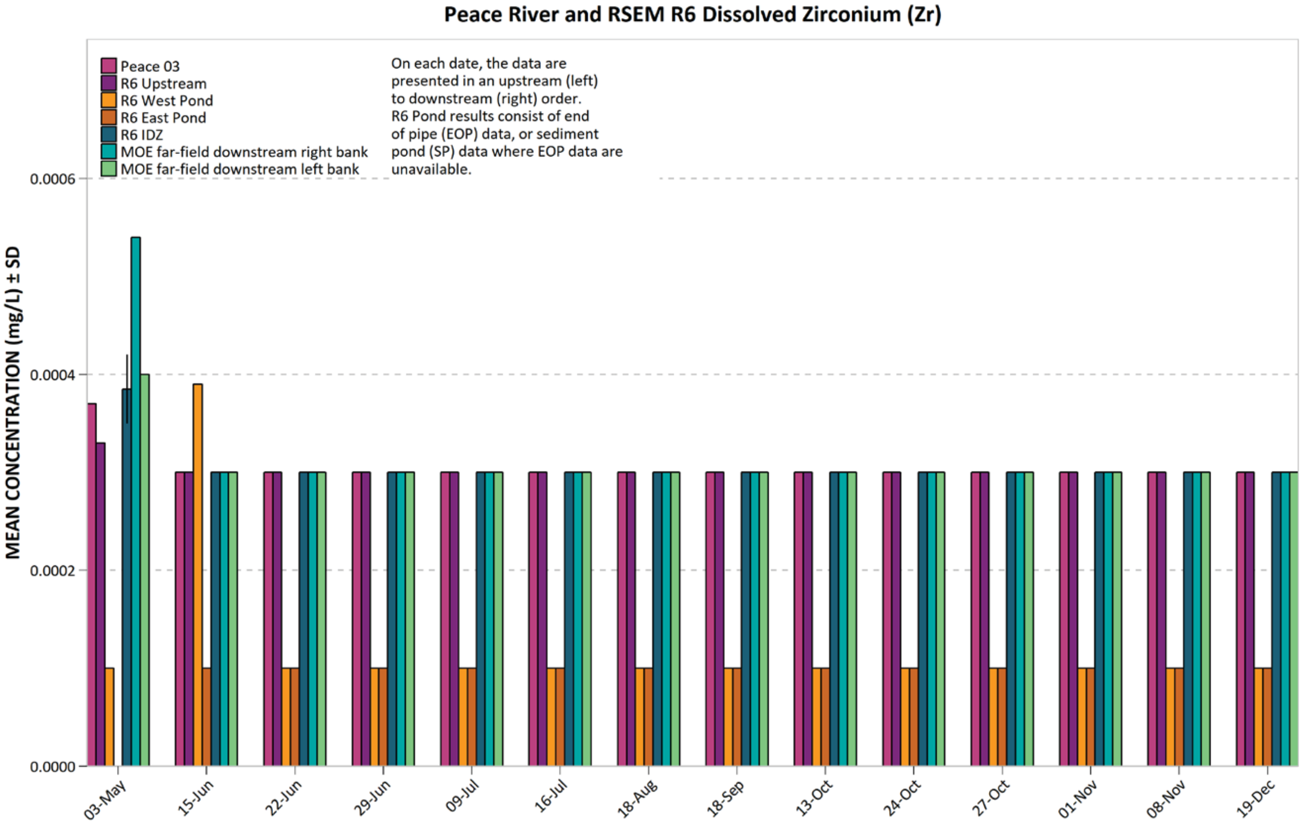
All Peace River data are <MDL and most of the R6 pond data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 174. 2017 Peace River and RSEM R6 Dissolved Zinc (Zn).



All Peace River data are <MDL and most of the R6 pond data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Figure 175. 2017 Peace River and RSEM R6 Dissolved Zirconium (Zr).



Most of the R6 pond data and Peace River data are <MDL. Pond data are from Maxxam Analytics and the remainder of the data are from ALS Environmental, and the two laboratories have different detection limits.

Appendix D. 2017 Quality Assurance and Quality Control Summary

Table 34. ALS Environmental hold time exceedance summary for 2017.

Parameter	Date	Hold Time Recommended	Hold Time Actual	Number of Samples Exceeded[1]	Qualifier
Diss. Orthophosphate in Water by Colour	24-Jan	3	8	2	EHT
	2-Jun	3	5	7	EHT
	19-Dec	3	4	9	EHT
Nitrate in Water by IC (Low Level)	24-Jan	3	7	2	EHT
	18-Aug	3	4	10	EHT
	13-Oct	3	6	2	EHT
Nitrite in Water by IC (Low Level)	24-Jan	3	7	2	EHT
	9-Feb	3	7	1	EHT
	18-Aug	3	4	10	EHT
	13-Oct	3	6	2	EHT
Total Dissolved Phosphate in Water by Colour	24-Jan	3	7	2	EHT
Total Dissolved Solids by Gravimetric	19-Dec	7	10	10	EHT
Total Phosphate in Water by Colour	24-Jan	3	7	2	EHT
	10-Mar	3	4	1	EHT
	26-May	3	4	6	EHT
	15-Jun	3	4	1	EHT
	20-Oct	3	4	1	EHT
Total Suspended Solids by Grav. (1 mg/L)	19-Dec	7	9	10	EHT
Turbidity by Meter	24-Jan	3	7	2	EHT
	4-Feb	3	8	2	EHTR
	7-Apr	3	5	2	EHTR
	8-Apr	3	4	5	EHTL
	26-May	3	4	8	EHT
	30-Jun	3	7	4	EHTR
	6-Jun	3	4	1	EHTL
	7-Jun	3	6	1	EHT
	13-Jun	3	4	2	EHTL
	1-Jul	3	4	4	EHTL
	2-Jul	3	4	1	EHTL
	5-Jul	3	4	4	EHTL
	18-Aug	3	4	9	EHT
	19-Dec	3	4	10	EHT

[1] Specific sample sites where hold time exceedances occurred are provided in ALS laboratory reports.

Hold time exceedances for monthly, 5 in 30 day and TSS/turbidity grab samples collected in 2017.

ALS Legend & Qualifier Definitions

EHT: Exceeded ALS recommended hold time prior to analysis.

EHTR: Exceeded ALS recommended hold time prior to sample receipt.

EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.

Table 35. Field blank and travel blank detections in 2017.

Sample Type	No. of Samples Collected	Field Blank QA/QC Objective (≤5.0% Detectable)			
		No. of Parameter Results (n) [1]	No. of Detectable Results (>MDL)	% Detectable Results	QA/QC Objective Met
Field Blanks	23	1993	3	0.15%	Yes
Travel Blanks	30	1498	5	0.33%	Yes

[1] n refers to the total number of parameters analyzed in the field and travel blanks (non-detectable and detectable).

pH is not included in the calculation of detectable results.

Table 36. Summary of cases with relative percent difference >25% for duplicate samples in 2017.

Date (2017)	Clear/ Turbid Flow [1]	Site	Parameter	Relative Percent Difference (%) [2]
3-Mar	Clear	PR-3.88	Aluminum (Al) - Dissolved	59.5
			Manganese (Mn) - Dissolved	130
4-Apr	Turbid	RBPR-5.81	Arsenic (As) - Total	28.8
			Vanadium (V) - Total	31.6
17-May	Very Turbid	RBPR-5.69	Total Suspended Solids	25.3
2-Jun	Very Turbid	RBPR-9.34	Hardness (as CaCO3)	45.6
			Antimony (Sb) - Total	26.1
			Aluminum (Al) - Dissolved	187
			Arsenic (As) - Dissolved	118
			Barium (Ba) - Dissolved	91.9
			Beryllium (Be) - Dissolved	162
			Cadmium (Cd) - Dissolved	191
			Calcium (Ca) - Dissolved	48.4
			Chromium (Cr) - Dissolved	162
			Cobalt (Co) - Dissolved	186
			Copper (Cu) - Dissolved	135
			Iron (Fe) - Dissolved	181
			Lead (Pb) - Dissolved	187
			Magnesium (Mg) - Dissolved	38.8
			Molybdenum (Mo) - Dissolved	95.3
			Nickel (Ni) - Dissolved	134
			Phosphorus (P) - Dissolved	160
			Selenium (Se) - Dissolved	26.9
			Silicon (Si) - Dissolved	32.1
			Strontium (Sr) - Dissolved	30.9
			Titanium (Ti) - Dissolved	119
			Uranium (U) - Dissolved	55.9
			Vanadium (V) - Dissolved	168
			Zinc (Zn) - Dissolved	185
			Manganese (Mn) - Dissolved	198
22-Jun	Turbid	RBPR-7.15	Aluminum (Al) - Total	51.2
			Arsenic (As) - Total	59.5
			Barium (Ba) - Total	35.3
			Beryllium (Be) - Total	41.2
			Cadmium (Cd) - Total	54
			Chromium (Cr) - Total	54.2
			Cobalt (Co) - Total	63.4
			Copper (Cu) - Total	50
			Iron (Fe) - Total	61.7
			Lead (Pb) - Total	54.3
			Manganese (Mn) - Total	56.5

[1] Clear flow: Peace River sampling site TSS ≤ 25 mg/L; Turbid flow: Peace River TSS > 25 mg/L and ≤ 100 mg/L; Very Turbid: Peace River TSS > 100 mg/L.

[2] RPD was calculated if at least one replicate was > 5 times the MDL.

Table 36. continued.

Date (2017)	Clear/ Turbid Flow [1]	Site	Parameter	Relative Percent Difference (%) [2]
22-Jun	Turbid	RBPR-7.15	Nickel (Ni) - Total	47.5
			Potassium (K) - Total	27
			Silicon (Si) - Total	26.6
			Silver (Ag) - Total	58.2
			Thallium (Tl) - Total	42.2
			Titanium (Ti) - Total	48
			Total Suspended Solids	78.7
			Vanadium (V) - Total	50.4
			Zinc (Zn) - Total	41.5
			Manganese (Mn) - Dissolved	40.9
29-Jun	Turbid	RBPR-7.05	Manganese (Mn) - Dissolved	29.1
9-Jul	Clear	RBPR-7.15	Manganese (Mn) - Total	62.8
			Manganese (Mn) - Dissolved	154
18-Aug	Turbid	RBPR-7.15	Barium (Ba) - Total	30
			Chromium (Cr) - Total	33.7
			Iron (Fe) - Total	34.3
			Lead (Pb) - Total	50.6
			Total Phosphorus (P)	26
			Manganese (Mn) - Dissolved	26.4
13-Oct	Clear	RBPR-7.15	Dissolved Organic Carbon	130
			Aluminum (Al) - Total	26.6
			Cadmium (Cd) - Total	30.2
			Iron (Fe) - Total	38.2
			Total Phosphorus (P)	95.7
20-Oct	Clear	PR-3.88	Turbidity (lab, NTU)	34.9
			Total Dissolved Solids	25.7
			Aluminum (Al) - Total	74.2
			Iron (Fe) - Total	69.4
			Manganese (Mn) - Total	31.7
24-Oct	Clear	RBPR-7.15	Aluminum (Al) - Total	46.7
			Iron (Fe) - Total	33.3
27-Oct	Clear	LBPR-9.34	Cadmium (Cd) - Total	31.5
			Selenium (Se) - Dissolved	25.6
			Titanium (Ti) - Total	64
1-Nov	Clear	PR-3.88	Chromium (Cr) - Total	91.2
8-Nov	Clear	RBPR-7.15	Turbidity (lab, NTU)	29.1
			Selenium (Se) - Total	33.2
			Total Phosphorus (P)	88.9
19-Dec	Clear	RBPR-9.34	Turbidity (lab, NTU)	28.2
			Molybdenum (Mo) - Dissolved	40.5
			Selenium (Se) - Total	27.5
			Titanium (Ti) - Total	32

[1] Clear flow: Peace River sampling site TSS ≤ 25 mg/L; Turbid flow: Peace River TSS > 25 mg/L and ≤ 100 mg/L; Very Turbid: Peace River TSS > 100 mg/L.

[2] RPD was calculated if at least one replicate was > 5 times the MDL.

Table 37. Summary of cases with a relative standard deviation >18% for triplicate samples in 2017.

Date (2017)	Site	Parameter (units)	Average	SD	Relative Standard Deviation (%)[1]
6-Jan	RBPR-5.84	Cadmium (Cd) - Total (mg/L)	0.000028	0.000006	19.5
30-Jan	RBPR-5.84	Turbidity (In Situ, NTU)	4.13	1.03	24.8
22-Feb	RBPR-5.84	Turbidity (In Situ, NTU)	13.4	4.53	33.8
10-Apr	RBPR-5.81	Turbidity (In Situ, NTU)	161	29.9	18.6
28-May	RBPR-5.69	Turbidity (In Situ, NTU)	538	106	19.8
3-Jul	RBPR-7.15	Turbidity (In Situ, NTU)	59.4	12.3	20.6
4-Jul	RBPR-7.15	Turbidity (In Situ, NTU)	73.3	23.3	31.8
15-Jul	RBPR-5.65	Turbidity (In Situ, NTU)	59.9	12.8	21.4
22-Jul	RBPR-7.15	Turbidity (In Situ, NTU)	21.4	7.57	35.4
25-Jul	RBPR-5.65	Specific Conductivity (In Situ, µS/cm)	244	51	21
27-Jul	RBPR-5.65	Turbidity (In Situ, NTU)	12.1	2.24	18.4
1-Aug	RBPR-5.81	Turbidity (In Situ, NTU)	59.2	25.6	43.2
24-Oct	PR-3.88	Turbidity (In Situ, NTU)	3.57	1.68	47
8-Nov	PR-3.88	Turbidity (In Situ, NTU)	2.27	1.68	74
	RBPR-9.34	Turbidity (In Situ, NTU)	4.13	0.85	20.6

[1] RSD was calcuated if at least one replicate was > 5 times the MDL.

Table 38. ALS Environmental cation – anion balance: samples with >10% difference in 2017.

Date (2017)	Site Name	TSS (mg/L)	Cation - Anion Balance (%)	Anion Sum (meq/L)	Cation Sum (meq/L)
3-May	RBPR-7.15	462	-10.8	2.51	2.02
26-May	PR-3.88	663	-10.3	2.98	2.42
26-May	LBPR-9.34	989	-11.2	3.19	2.55
26-May	RBPR-9.34	488	-12.3	2.79	2.18
2-Jun	RBPR-9.34	565	19.8	2.67	3.99

For electrical neutrality the sum of the milliequivalents (meq/L) of major cations and anions should be nearly equal. The meq/L is calculated by dividing the concentration (mg/L) by the molar mass (g/mol) and the valence state of the ion (electrical charge).

Cation-Anion balance (%) is calculated by: ([Cation]-[Anion])/([Cation]+[Anion]).

Table 39. Summary of cases where the dissolved metals to total metals ratio was >1.2 in 2017.

Date (2017)	Site	Parameter	Concentration (mg/L)		D-Metal/ T-Metal Ratio
			Total Metal	Dissolved Metal	
3-Mar	PR-3.88	Arsenic (As)	0.00018	0.00025	1.39
		Lead (Pb)	<0.000050	0.000132	2.64
	RBPR-5.70	Lithium (Li)	0.0032	0.0039	1.22
6-Mar	RBPR-5.81	Barium (Ba)	0.0753	0.0978	1.30
		Lithium (Li)	0.0024	0.0033	1.38
		Magnesium (Mg)	7.72	9.74	1.26
		Selenium (Se)	0.000255	0.00031	1.22
		Sodium (Na)	2.51	3.35	1.33
10-Mar	RBPR-5.81	Tin (Sn)	<0.00010	0.00016	1.60
3-May	RBPR-9.34	Zirconium (Zr)	0.0004	0.00054	1.35
9-May	PR-3.88	Zirconium (Zr)	0.00035	0.00046	1.31
	RBPR-5.69	Zirconium (Zr)	0.00034	0.00042	1.24
	RBPR-5.81	Zirconium (Zr)	0.00031	0.00042	1.35
	LBPR-9.34	Zirconium (Zr)	0.00036	0.00053	1.47
	RBPR-9.34	Zirconium (Zr)	<0.00030	0.00044	1.47
22-May	LBPR-9.34	Zirconium (Zr)	<0.00030	0.00039	1.30
2-Jun	RBPR-9.34	Zirconium (Zr) - replicate 1	<0.00030	0.0004	1.33
		Zirconium (Zr) - replicate 2	<0.00030	0.00052	1.73
24-Oct	RBPR-7.15	Lead (Pb)	<0.000050	0.000095	1.90
	LBPR-9.34	Selenium (Se)	0.000237	0.000294	1.24
27-Oct	RBPR-5.70	Molybdemun (Mo)	0.000376	0.000525	1.40
	RBPR-5.81	Barium (Ba)	0.0793	0.0962	1.21
		Lithium (Li)	0.0029	0.0037	1.28
		Molybdemun (Mo)	0.000505	0.000638	1.26
		Sodium (Na)	2.4	3.25	1.35
1-Nov	PR-3.88	Lithium (Li)	0.0012	0.0015	1.25
	RBPR-7.15	Barium (Ba)	0.0365	0.0441	1.21
		Calcium (Ca)	25	30.1	1.20
		Lithium (Li)	0.0014	0.0018	1.29
	LBPR-9.34	Lithium (Li)	0.0014	0.0017	1.21
8-Nov	PR-3.88	Lithium (Li)	<0.0010	0.0013	1.30
	RBPR-7.05	Molybdemun (Mo)	0.000806	0.000985	1.22
	RBPR-7.15	Strontium (Sr)	0.0981	0.12	1.22
	RBPR-9.34	Selenium (Se)	0.00021	0.00026	1.24
19-Dec	RBPR-9.34	Molybdemun (Mo)	0.000919	0.0012	1.31

Appendix C

TECHNICAL MEMO

ISSUED FOR USE

To:	Greg Scarborough, Molly Brewis BC Hydro	**Date:**	March 15, 2018
c:		**Memo No.:**	
From:	Lara Reggin/James Barr	**File:**	704-V13103415-07
Subject:	Site C Clean Energy Annual Report Site Audits 2017		

1.0 INTRODUCTION

This report presents a summary of a field reviews completed during 2017 for the Site C Clean Energy Project related to auditing the acid rock drainage and metal leaching (ARD-ML) materials management on-site in reference to:

- BC Hydro Construction Environmental Management Plan (CEMP rev 04, July 26, 2016);
- PRHP Environmental Management Plan (EMP), Appendix A: Acid Rock Drainage and Metal Leachate Management Plan (rev_1, 2016-10-27); and
- PRHP Environmental Protection Plans (EPP), specific to facility or construction area.

Four site audits were completed in 2017 conducted by James Barr, P.Geo., and/or Lara Reggin, P.Geo., both of Tetra Tech, on the following dates: March 22–24, May 19, August 15-16, and October 2-3, 2017. Mr. Barr and Ms. Reggin fulfill the role as BCH QP(ARD) as per the CEMP Appendix E, S. 6.1.2.

- On the March 22-24, 2017 site audit, James Barr and Lara Reggin were accompanied by a member of BC Hydro Site C Environmental Team on March 22, and had intermittent contact with Tetra Tech geotechnical engineers, and BC Hydro Site C Construction Officer, Transmission Line, and Environmental Team Manager while completing the site tour. Time on-site was spent reviewing ARD/ML materials management at various construction areas, RSEM facilities and designated water discharge points. In addition, rock and water samples were collected for audit purposes.
- The site audit on Friday, May 19, 2017, was conducted by James Barr, P.Geo., of Tetra Tech, with time on-site spent reviewing ARD/ML materials management at various construction areas, RSEM facilities and designated water discharge points.
- The site audit from August 15-16, 2017 was conducted by James Barr, P.Geo., of Tetra Tech. James was accompanied by a member of BC Hydro Site C Environmental Team on the Main Civil Works site on August 15 and Site C Senior Environmental Coordinator to the Portage Mountain Quarry and Transmission Line on August 16. Time on-site was spent reviewing ARD-ML materials management at various construction areas and RSEM facilities and designated water discharge points.
- The site audit from October 2-3, 2017 was conducted by Lara Reggin, P.Geo., of Tetra Tech. Lara was accompanied by a member of BC Hydro Site C Environmental Team to the Portage Mountain Quarry and on the Main Civil Works site on Monday, and by two members of BC Hydro Site C Environmental Team to the Main Civil works on Tuesday, and accompanied by a member of BC Hydro Site C Environmental Team and BC Hydro Construction Officer, Transmission Line to Trapper Main Road on Tuesday. Time on-site was spent reviewing ARD-ML materials management at various construction areas and RSEM facilities and designated

water discharge points. While on site contact and discussions were also had with BC Hydro Environmental Task Manager for Portage Mountain Quarry, Site C Environmental Manager, and Site C Construction manager of BC Hydro; Plan B Environmental representative; and PRHP representatives.

2.0 2017 SITE AUDITS OVERVIEW

Each site visit and ARD-ML audit was comprised of visiting areas on-site with stored or exposed shale rock (PAG), or areas in construction intended for future storage of PAG. In addition, several water conveyances and settlement ponds potentially influenced by PAG materials were observed and field data collected, as required. Figure 1 provides an overview of the site and locations of samples collected during the site audits.

2.1 Weather Conditions

The weather conditions during the four site visits in 2017 varied from frozen to melting or dry conditions with temperatures as low as 0°C in March and October, to highs of 16°C (May) and 22°C (August).

Flowing water or seepages were noted as variable to infrequent or high overland flows within ditches and slopes due to low (August and October) or high (March and May) 7-day and 24-hour total precipitation measurements. During low precipitation, most drainage conveyances were dry or damp with minimal standing water and very little flowing water, whereas during or directly following high precipitation, overland flow can cause local erosion, accumulation and pooling of water, and slumping of ground materials.

Table 1: Weather Conditions and Observations during Site Audits

Site Audit Date	Weather	Observations
March 22-24, 2017	Sunny, cold (-5°C), 5 cm of fresh snow, melt starting over some areas of the site	On Mar. 22, frozen ground conditions sustained with ambient air temperature from 0° to +5°C, slight warming in the afternoon, overcast skies, and 3 – 8 cm of ground-cover snow. On Mar. 23, temperatures range (-2° to +7°C), with frozen conditions in the morning to warmer melting conditions due to sun exposure by mid-afternoon), causing overland water runoff conditions.
May 19, 2017	Sunny, clear skies (8-16°C), 0mm of 24hr precipitation, 58.1mm of 7-day trailing precipitation (YXJ stn).	Variable water flows and seepages were noted from within ditches and slopes due to high 7-day total precipitation (58.1mm). High overland flow created by the high rain event caused local erosion and slumping of round materials, and accumulation/pooling of water at various locations.
August 15-16, 2017	Sunny, clear skies (12-22°C), 0mm of 24hr precipitation; 1.24mm of 7-day trailing precipitation (North Camp_B_Met60)	Infrequent flowing water or seepages were noted within ditches and slopes due to low 7-day total precipitation (1.24mm). Some drainages were dry.
October 2-3, 2017	Sunny, clear skies (0-12°C), 0mm of 24hr precipitation; 13.47mm of 7-day trailing precipitation (North Camp_B_Met60)	Infrequent flowing water or seepages were noted within ditches and slopes due to low prior 7-day total precipitation (13.47 mm). Most drainage conveyances were dry or damp with minimal standing water and very little flowing water.

2.2 Locations Visited

For the purpose of site audits, known PAG exposures are listed according to their RSEM or catchment (Table 2).

Table 2: List of Locations Visited during Site Audits

Locations Visited			Site Audit Date			
			March 22-24	May 19	August 15-16	October 2-3
Left Bank Construction Areas	Left Bank Excavation Bench (LBEx) 5 Temporary PAG Stockpile		✓	Left Bank Excavation TPSA		
	Left Bank Excavation (LBEx) Bench 4 Sediment Pond		✓	Left Bank Excavation		
	RSEM L6	Waste Material with Hazardous Materials Sign	✓			
		Sediment Ponds and Drainage Channels	✓			
		PAG Escarpment behind L6 Sediment Pond	✓			
		Diversion Tunnel Outlet Portal			✓	✓
		LBEx Settlement Pond			✓	✓
		Terrace slope (natural)			✓	
		Diversion for natural drainage around LBEx Sed pond				✓
	RSEM L5	Garbage Creek	✓	Garbage Creek TPSA	Garbage Creek TPSA - stockpile; excavated outcrop	Garbage Creek TPSA - stockpile; excavated outcrop
		West Gully Diversion Channel	✓			
		PAG in RSEM			✓	
		Diversion Tunnel Inlet Portal			✓	✓
		LBEx				LBEx; and Former LBEx TPSA
		West Hill Slope (west of L5)				✓
	Howe Pit		✓	✓	✓	✓
	Drainage culvert north of Howe Pit		✓			
	River Road, culverts RR-10 and RR-11		✓			
	RSEM L3 Outlet		✓			L3 Creek (natural)
	River Road near Blind Corner			✓	✓	✓
	River Road – Upper cut-off ditch				✓	✓
	River Road at discharge culvert					✓

Table 2: List of Locations Visited during Site Audits

Locations Visited			Site Audit Date			
			March 22-24	**May 19**	**August 15-16**	**October 2-3**
Right Bank Construction Areas	Area 23 Temporary PAG Storage		✓			
	Moberly East Abutment		✓	Temporary Moberly Bridge East Abutment		
	RSEM R5a	RSEM PAG fill	✓	✓	PAG in RSEM	PAG in RSEM
		R5a Sediment Pond	✓	✓		
	RSEM R5b	Pond	✓	✓		
		Outlet, Rip-rap Channel to Peace River	✓	✓		
		Water Treatment Plant	✓	✓		
	Spillway Approach Channel		✓			
	Right Bank Drainage Tunnel (RBDT)		✓	✓		
	RSEM R6 Pond		✓			
	South Bank Initial Access Road (SBIAR)		✓	✓		✓
	Right Bank Cofferdam Excavation (RBCEx)			✓	RCC Cofferdam Excavation	
	R6 Sediment Pond East Cell					✓
	R6 Sediment Pond West Cell					✓
Off MCW	Portage Mountain Quarry				✓	✓
	Transmission Line Upper FSR				✓	✓

TPSA: Temporary PAG storage facility
RSEM: Relocated Surplus Excavation Material
RBDT: Right Bank Drainage Tunnel
RBCEx: Right Bank Cofferdam Excavation

2.3 2017 Site Audit 1: March 22-24

Key locations visited during the March 22-24, 2017 site audit are as follows:

- Construction areas on the Left Bank:
  - Left Bank Excavation Bench 5 Temporary PAG Stockpile.
  - Left Bank Excavation Bench 4 Sediment Pond.
  - RSEM L6:
    - Waste Material with Hazardous Materials Sign.
    - Sediment Ponds and Drainage Channels.
    - PAG Escarpment behind L6 Sediment Pond.

  - RSEM L5:
    - Garbage Creek.
    - West Gully Diversion Channel.
  - Howe Pit.
  - Drainage culvert north of Howe Pit.
  - River Road, culverts RR-10 and RR-11.
  - RSEM L3 Outlet.
- Construction areas visited on the Right Bank:
  - Area 23 Temporary PAG Storage.
  - Moberly East Abutment.
  - RSEM R5a:
    - RSEM PAG fill.
    - R5a Sediment Pond.
  - RSEM R5b:
    - Pond.
    - Outlet, Rip-rap Channel to Peace River.
    - Water Treatment Plant.
  - Spillway Approach Channel.
  - Right Bank Drainage Tunnel (RBDT).
  - RSEM R6 Pond.
  - South Bank Initial Access Road (SBIAR).

2.3.1 Field Data – Rock Sample Analysis

Along the escarpment behind the RSEM L6 ponds, one bedrock sample (LB16-01_032417) was collected and submitted to ALS for ABA testwork to assess the remaining potential for acid generation from the pre-existing strongly weathered bedrock material.

During the inspection of RSEM R5a, two samples were collected from the PAG rock material stored in the RSEM. The first sample R5A-01-032317 was collected from the upper (south) area of the RSEM and R5A-02-032317 was collected from the lower (north) side of the RSEM.

Within the SBIAR field area, rock samples were collected from the rock cut on the west side of the slope. Sample SBIAR-01 was collected from the south end of the cut and SBIAR-02 was collected from the North end of the rock cut. Both samples consisted of a friable black shale with no visible mineral precipitate and were collected from the lower third of the slope.

Table 3: Rinse pH Test Results for Rock Samples from RSEM L6, RSEM R5a AND SBIAR for the March 23-24, 2017 Site Audit

Site Area	Sample ID	Paste pH (ALS)	Rinse pH
RSEM L6	LB16-01_032418	4	3.8
RSEM R5a	R5A-01-032317	7	5.85
	R5A-02-032317	7.1	6.12
SBIAR	SBIAR-01_032417	6.7	8.1
	SBIAR-02_032417	6.5	7.84

NOTE: pH values less than 6 are considered acidic

2.3.2 Field Data – In situ Water Testing

Frozen site conditions prevented any in situ water pH and alkalinity measurements during the March 22-24, 2017 site audit.

2.4 2017 Site Audit 1: May 19, 2017

The key locations visited during the May 19, 2017 site audit include:

1. Construction areas visited on the Left Bank:
   a. Garbage Creek TPSA
   b. Left Bank Excavation Settlement Pond
   c. River Road near Blind Corner
   d. Howe Pit Area
   e. Left Bank Excavation TPSA
2. Construction areas visited on the Right Bank:
   a. South Bank Initial Access Road
   b. Right Bank Drainage Tunnel
   c. Right Bank Cofferdam Excavation
   d. RSEM R5b
   e. RSEM R5a
   f. Temporary Moberly Bridge East Abutment

2.4.1 Field Data - Rock Sample Analysis

At SBIAR, two rock samples were collected from outcrops along the western slope. Sample RB-SBIAR-001 was collected from a moist portion of the slope and RB-SBIAR-002 was collected from a dry portion of the slope. Both samples are described as fragmented, dark grey shale.

At the Moberly Bridge East abutment, a talus pile of rock fragments accumulated from failed portions of the PAG slope were observed along the toe of the slope, measuring approximately 2 metres high and 20 metres in length. Sample RB-TMB-003 was collected from the talus below a failed portion of the slope.

Table 4: Rinse pH test Results for Rock Samples from SBIAR and the temporary Moberly Bridge East Abutment Areas for the May 19, 2017 Site Audit

Site Area	Sample ID	Rinse pH
SBIAR	RB-SBIAR-001_051917	7.31
	RB-SBIAR-002_051917	7.1
Moberly Bridge East abutment	RB-TMB-003_051917	6.34

NOTE: pH values less than 6 are considered acidic

2.4.2 Field Data – In situ Water Testing

Data tables for in situ water pH, alkalinity, and estimated flow measurements resulting from the May 19, 2017, site audit are shown in Table 5.

Table 5: Results of In situ Water pH, alkalinity, and Estimated Flow Measurements documented during the May 19, 2017 Field Site Audit

Site Area	Location	Estimated Flow (L/s)	Description	In Situ Water pH	Alkalinity, total ($CaCO_3$, ppm)
LBEx Settlement Pond	RSEML6-001	0.5	Downstream of confluence with LBEx settlement pond outflow. Iron oxide coating rip-rap materials	8.6	40
	RSEML6-002	n/a	Ponded water diverted from naturel PAG slope. Strong iron oxide precipitation along base of pond.	2.62	0
River Road Ditch near Blind Corner	LBSBIAR-12+430	4		7.8	180-240
	LBRR-LC	3-4		8	180-240
	LBRR-12+500	<1		8.2	>240
Diversion Ditch Up-gradient of Lower Cut-off Chimney Ditch	HP_Diversion_flow	1-2		8.5	200
	HP_Diversion_still	0		6.5	100
Ponded Water, Left Bank Excavation	LBEx TPSA			3.47	n/a
	LBEx Bench 4, catchment			8.2	n/a
SBIAR	RBSBIAR-US	1		7.8	>240
	RBSBIAR-DS	2		8.33	180-240
	RBSBIAR-drainage	5		8.35	>240
	RBSBIAR-spill	stagnant		8.7	Not tested
RSEM R5b	RB-R5b-channel	2-3		9.4	>240

2.5 2017 Site Audit 1: August 15-16

The key locations visited during the August 15-16, 2017 site audit include:

1. Construction areas visited on the Left Bank:
   a. PAG in RSEM
   b. Garbage Creek TPSA - stockpile
   c. Garbage Creek – excavated outcrop
   d. Diversion tunnel inlet portal
   e. Diversion tunnel outlet portal
   f. LBEx settlement pond
   g. Terrace slope (natural)
2. Construction areas visited on the Right Bank:
   a. PAG in RSEM
   b. RCC cofferdam excavation
   c. SBIAR
3. Non-RSEM:
   a. River Road – blind corner
   b. River Road – upper cut-off ditch
   c. Howe Pit
   d. Portage Mountain Quarry
   e. Transmission line upper FSR

2.5.1 Field Data - Rock Sample Analysis

In the RSEM L5 site area, one grab sample was collected for Rinse pH testing at the SE corner of the "Northern temporary PAG" fill area (Table 6). One rock sample was collected from the excavation outcrop located at the base of the diversion channel in the Garbage Creek TPSA, RSEM L5 area.

At the upper River Road cut-off ditch, samples of the mineral precipitate, the shale rock, and the limestone rock were collected. A Rinse pH test on the limestone rock from within the ditch measured pH of 9.46 (Table 6), indicating that even with precipitate coating, the limestone gravel and rip-rap continues to contribute alkalinity and neutralization potential to the ditch system.

In the LBEx settlement pond berm, two samples were collected for Rinse pH testing for the shale from the northwest corner of the LBEx settlement pond. Four samples were collected from near the midstream and upstream areas of the eastern drainage ditch at SBIAR, and upstream and downstream areas of the western drainage ditch.

At the Portage Mountain Quarry switch back access road, two samples were collected of the shaley interbeds and submitted for Rinse pH tests, and results show circumneutral to slightly alkaline pH measurements indicating that the rocks were not producing acidic runoff at the time of the visit.

Table 6: Rinse pH Test Results for Rock Samples from Areas for the August 15-16, 2017 Site Audit

Site Area	Location	Description	Rinse pH
RSEM L5	LBL5-004	Grab sample of dark grey shale from the southeast corner of the Northern stockpile within the RSEM L5 facility. No iron oxide or other mineral precipitate was observed	3.46
Garbage Creek, shale outcrop	GCDO-003	Fissile/platy dark grey shale, orange and yellow precipitate. Collected from excavated outcrop at bottom of the diversion channel.	2.78
Upper River Road Cut-off Ditch	HPD-002	Limestone gravel with strong iron oxide precipitate coating from within ditch near to lower chimney ditch.	9.46
LBEx Settlement Pond Berm	LBL6P-001	Shale from the northwest corner of the LBEx settlement pond. Strong orange and white mineral precipitate.	2.92
	LBL6P-002	Shale from the northwest corner of the LBEx settlement pond. Strong orange and white mineral precipitate. Duplicate sample.	2.45
SBIAR	RBSB-005	Near midstream area of eastern drainage ditch. Shale is dry, dark grey, and fissile/flakey with white precipitate.	3.43
	RBSB-006	Near upstream area of eastern drainage ditch. Shale is dark grey and moist due to local seepage, white precipitate on sample.	8.55
	RBSB-007	Near upstream area of western drainage ditch, up-gradient from Area 21 drainage. Shale is brown/black, soft and moist from seepage.	7.99
	RBSB-008	Near downstream area of western ditch, down-gradient from Area 21 drainage. Shale is dark grey to black, moist and fissile. Low to no white precipitate.	5.92
Portage Mountain Quarry Switch Back Access Road	PRTM-001	Dark grey to black shale with iron oxide staining on outer surface and fractures. Trace amounts of fine grained pyrite.	8.55
	PRTM-002	Black siltstone. Trace to no fine grained pyrite visible.	6.67
	PRTM-003	Top of access road, approximate top of quarry elevation, sandstone with iron oxide staining.	n/a

2.5.2 Field Data - In situ Water Testing

Data tables for in situ water pH, alkalinity, and estimated flow measurements resulting from the August 15-16, 2017, site audit are shown in Table 7.

Table 7: Results of In situ Water pH, Alkalinity, and Estimated Flow Measurements documented during the August 15-16, 2017 Field Site Audit

Site Area	Location	Estimated Flow (L/s)	Description	In Situ Water pH	Alkalinity, total ($CaCO_3$, ppm)
SBIAR	RBSB-005	1-2	Midstream in eastern drainage ditch, water flowing clear. Shale is dry, dark grey, and fissile/flakey with white precipitate.	8.2	-
	RBSB-006	1-2	Upstream in eastern drainage ditch, water flowing clear. Shale is dark grey and moist due to local seepage, white precipitate on sample.	8.5	-
	RBSB-007	1-2	Upstream in western drainage ditch, up-gradient from Area 21 drainage, water flowing clear. Shale is brown/black, soft and moist from seepage.	8.5	120
	RBSB-008	3-4	Downstream in western ditch, down-gradient from Area 21 drainage, water is moderate to high turbidity. Shale is dark grey to black, moist and fissile. Low to no white precipitate.	7.8	-
	RBSB-OUT	~6	Collected from drainage in limestone outlet ditch from SBIAR to temporary pond.	8.8	180
Trapper Main FSR	Trapper Main FSR	5-8\	Trapper Main FSR, 2km	7.15	
		15-20	Trapper Main FSR, 4km, upstream	8.35	
		15-20	Trapper Main FSR, 4km, downstream	8.3	

2.6 2017 Site Audit 1: October 2-3

The key locations visited during the October 2-3, 2017 site audit are as follows:

- Upper River Road cut-off ditch and River Road ditch
- Garbage Creek area
- West Hill slope
- LBEx in the vicinity of the former TPSA
- LBEx settlement pond, RSEM L6 area
- RSEM R6 area
- SBIAR slopes and field area
- Portage Mountain quarry borrow source and access road.

2.6.1 Field Data – Rock Sample Analysis

During the October 2-3, 2017 site audit, rock samples were collected at 1) West Hill, from the exposed PAG slope north of the road, 2) SBIAR South Bank, from the west and east exposed PAG slopes, and at the 3) Portage

Mountain Quarry borrow source and access road, from the PAG slope near the quarry gate, the PAG Borrow source in the quarry, and mixed PAG, sandstone, and overburden from the Access Road.

Data tables with the results from rinse pH and lab testing for rock samples collected during the October 2-3, 2017, site visit are shown in Table 8.

Table 8: Rinse pH from Samples collected at West Hill, SBIAR, and Portage Mountain Quarry Borrow, on October 2-3, 2017

Site Area	Sample ID	Description	Rinse pH
West Hill Slope	West Hill	From exposed PAG slope north of road	2.93
SBIAR Slopes	SBW01	South Bank West exposed PAG slope	2.85
	SBE01	South Bank East exposed PAG slope	3.75
Portage Mountain Quarry Borrow	PRTM-001	PAG slope near quarry gate	9.1
	PRTM-003	Mixed PAG, Sandstone, Overburden from Access Road	7.25

2.6.2 Field Data – In situ Water Testing

Data tables for in situ water pH, alkalinity, and estimated flow measurements resulting from the October 2-3, 2017, site audit are shown in Table 9.

Table 9: Results of In situ Water pH, Alkalinity, and Estimated Flow Measurements documented during the October 2-3, 2017 Field Site Audit

Site Area	Location	Estimated Flow (L/s)	Description	In Situ Water pH	Alkalinity, total ($CaCO_3$, pm)
Upper River Road	RR-01	minimal	Mid-ditch, approximately 25 m E (up-gradient) from end of limestone rip-rap, in approximately 4 inches of trickling water.	8.12	-
	RR-02	minimal	At bottom of lower chimney ditch before discharge culvert	8.27	-
Garbage Creek	GC-01	Standing water	Ponding at start of Garbage Creek Diversion channel, upstream of culvert	7.79	80
	GC-02	minimal	Lower end of GC Diversion before Box culvert	8.16	100
	GC-03	5L/s	Ditch along road from Garbage Creek from Left Bank Seep	9	240
LBEx, Former TPSA vicinity	LBEx-01	Standing water	On remedial slope adjacent to well PS LB-28. Small areas of bubbles observed coming up through the ponded water.	8.02	0
	LBEx-02	Standing water	Bermed pond on upper bench.	8.3	60
LBEx Settlement Pond, RSEM L6 area	LBSP-01	Standing water	From within LBEx Settlement Pond	4.25	0
	LBSP-02	Standing water	Ditch outside of Settlement pond for conveyance of runoff from natural PAG runoff	3.07	0
RSEM R6	R6SP-East	Standing water	RSEM R6 Sed Pond East Cell	8.35	150
	R6SP-West	Standing water	RSEM R6 Sed Pond West Cell	8.43	180

Table 9: Results of In situ Water pH, Alkalinity, and Estimated Flow Measurements documented during the October 2-3, 2017 Field Site Audit

Site Area	Location	Estimated Flow (L/s)	Description	In Situ Water pH	Alkalinity, total ($CaCO_3$, pm)
SBIAR	SBW01	10-15	West ditch in lined area down-gradient of rip-rap.	8.2	240+
	SBW02	10	West ditch up-gradient of rip-rap and pipes	8	180
	SBE01	5	East Ditch in area of oxidation staining on slope	8.35	240+
Portage Mountain Quarry and Access Road	PMAR01	Standing water	At approximately KM 6.5 along access road, where PAG was placed as road upgrade materials	8.72	-
	PMQ01	Standing water	Near PAG Borrow source	8.42	-
	PMQ02	Standing water	Collection pond down-gradient of PAG borrow area	8.63	-
	PMQ03	Standing water	Seepage Diversion ditch below quarry	8.79	-

"-" indicates data not collected

3.0 SUMMARY OF RECOMMENDATIONS AND MITIGATION

The following presents a summary of the key findings, recommendations and mitigative actions which were prescribed or undertaken by BC Hydro or their contractor(s) as a result of the site audits and in response to the BC Hydro QP (ARD) recommendations.

3.1 Left Bank

3.1.1 Left Bank Excavation Settlement Pond and RSEM L6

The Left Bank Excavation (LBEx) Settlement Pond is located within the RSEM L6 area, however RSEM L6 has not yet began to receive RSEM materials. The berm which forms the LBEx Settlement Pond is partially made of shale. During the August Audit, evidence of ARD processes were observed at the northwest corner of the pond. This facility is designed and permitted as a NPAG water containment pond with the intended purpose of this pond as NPAG water containment and TSS settlement. Additionally, it was understood that PAG contact water from the shale exposed in the LBEx is being channelled to this pond. During the October Audit, the Left Bank Sediment pond continued to receive and hold contact runoff water from the left bank excavation, however there was no flow into the sediment pond at the time of the audit. Field pH measurements confirmed that the water in the pond is acidic, either as a result of PAG contact water from LBEx, or the PAG material with which the pond is constructed is producing acid.

During the March Audit, it was confirmed that the natural exposed shale slope along the northern bank of RSEM L6 is PAG and it had started to produce acidic leachate. During the May Audit, acidic water was measured in pooled water in several locations which were in direct contact with PAG materials, including near the LBEx settlement pond, and within the LBEx TPSA. During the August audit, it was observed that runoff waters from the natural shale exposed on the terrace slope adjacent to the RSEM L6 area, are diverted and either collected in a sump or allowed to infiltrate in the area of the legacy "West Pond". Within the diversion channels, where water pools, water quality degrades and can become acidic.

During the October Audit it was noted that the left bank excavation (and RSEM L5 and L6) areas were actively receiving excess waste slurry from construction of the slurry cut-off walls. Standing water measured within the LBEx proximal to the former TPSA was neutral, however, the ditch downstream from where disposal of the waste slurry was occurring had a pH of 9.0.

Recommendations: In August, alternate containment facilities for PAG contact waters as interim measure until the RSEM L5 pond is permitted.

Pooled water in direct contact with PAG material has the propensity to become acidic, and therefore pooling of water in areas of exposed shale outside of RSEM ponds should be avoided. It was recommended that careful planning for conveyance and containment of ‘natural’ PAG contact waters in this area is required so that water quality is not degraded through handling and that construction areas are not impacted by the non-construction related PAG contact water.

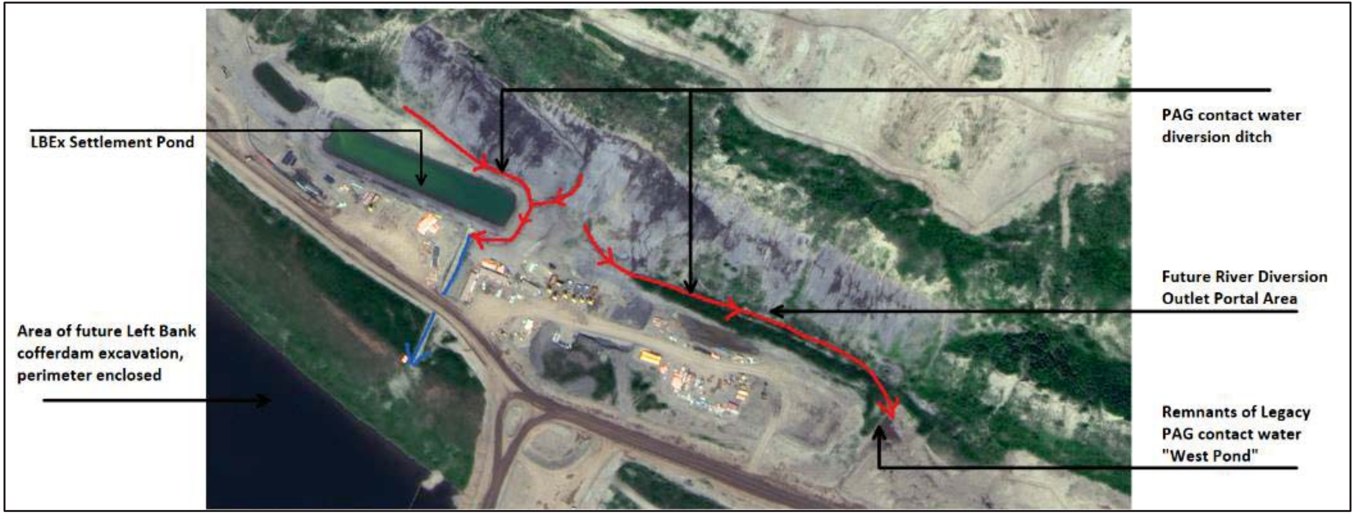
During the October Audit, it was recommended that care should be taken in locations for disposal of waste slurry and concrete at site, as there is an upper pH discharge limit of 9.0. There may be potential to use the waste slurry and concrete materials to assist with mitigating PAG on-site, however, this may require some analysis and trials to confirm validity of this approach.

Overall, it was recommended that this facility should continue to be monitored and drainage of the water into the Peace River mitigated. Runoff from the natural PAG slope north of the LBEx Sediment pond is captured by a construction cut-off ditch, which had very little water in it at the time of the audit. Some standing water within the ditch was measured as acidic due to prolonged contact with PAG sediment.

Mitigation Action: Reduced pH waters within the LBEx sediment pond was recognized by PRHP in July and August of 2017. Around this time, a plug was inserted into the outlet pipe of the pond to prevent the impacted water from discharging into the Peace River. Non-construction related PAG contact water was continued to be diverted around the pond and collected into the containment cell within the left bank coffer dam area. As the LBEx sediment pond was no longer functional, runoff from the LBEx was collected and conveyed to Cell 2 or Cell 3 in the RSEM L5 area. A management plan is being developed for the LBEx sediment pond water by PRHP.

PAG contact water has been trucked to the Right Bank as per PRHP/Lorax reports in the interim before the RSEM ponds are constructed on the LB. Although this was not observed during the audit, the PRHP weekly reports stated that PAG contact water from the LBEx is collected in a sump and trucked to RSEM R6 East Pond commencing in the last quarter of 2017.

Photo 1: Aerial view (June 2017) of LBEx Settlement Pond area and drainage schematic with PAG contact water (red lines) and blended PAG + NPAG water (blue lines)



3.1.2 RSEM L5 and Garbage Creek

During the August site audit, exposed PAG material was observed at RSEM L5 with acidic Rinse pH values. The area was isolated from the Peace River by a perimeter dyke, however, construction of the PAG contact water management structures had not yet been completed.

In August 2017, many upgrades had been completed at the Garbage Creek TPSA since the high volume rain event in May 2017. A PAG fill buttress located up-gradient of the diversion ditch and an excavated shale outcrop have potential to direct PAG contact water runoff and sediment into the non-contact diversion water channel thereby impacting these waters. It is noted that evidence of natural ARD processes can be observed in Garbage Creek up-gradient of the head pond indicating that the 'non-contact' diversion ditch may be channelling natural PAG contact waters.

Recommendations: Areas with exposed PAG in the RSEM should be covered and compacted with NPAG material if PAG is exposed for periods of greater than 30 days. Initial geochemistry reports for the main civil works indicated that one month is the minimum timeline for shale (PAG) materials to start generating acidic drainage. Covering the PAG prior to onset of acid production is recommended.

Mitigation Action: It was confirmed during the October site audit that the exposed PAG within RSEM L5 and within Garbage Creek TPSA had been covered with non-PAG Material, however, ongoing maintenance to address erosion of NPAG cover was also required.

Photo 2: At upper reach of Garbage Creek Diversion ditch, covered PAG slope with NAG Material

3.1.3 River Road and Howe Pit Area

During the August site visit, it was noticed that rip-rap in the center of the River Road ditch was partially encased in sludge and coated with iron oxide staining. The accumulation of sediment limits the effectiveness of the limestone for passive treatment of acidic drainage. In October it was noted that mineral precipitate, continues to accumulate on the limestone rip-rap, and check dams had been put in place to slow the water, resulted in several dispositions of sediment within the ditch which further limits the exposure of the limestone. The cistern at the downstream end of the ditch was not visible as it was buried in sediment.

Development and slow propagation of natural vegetation was observed on shale beside the upper chimney ditch. Evidence of ARD processes in the upper cut-off ditch are seen with formation of iron oxide, sulphate and/or aluminum hydroxide minerals. It was also noted that vegetation is starting to grow within the River Road ditch and the chimney ditches that feed it.

During the October audit it was noted that the Morgan PAG pile had been removed from the area between Howe Pit and River Road. Active construction in this area during the October, site audit included creating a large laydown area.

Recommendations: In August, it was recommended that the limestone be refreshed prior to seasonal freeze up and sediment removed from the cistern following each high volume rain event. The cistern works to remove sediment from the flow of ditch water prior to discharge into the Peace River, but has limited to no functionality if it is full and not cleaned out regularly. It was recommended to commence a regular schedule for cleaning of the cistern (e.g. quarterly during periods of flow) to provide the maintenance required for the cistern to work. It may mean that the cistern is periodically less than full when it is cleaned, however the current system of “cleaning when full” does not appear to be effective. If periodic maintenance is not achievable then the approach to mitigations should be revisited.

Shale exposed in this upper cut-off ditch should be covered and isolated from oxygen to prevent, or reduce, the rate of ARD process.

The wetland that is located to the south of the former Morgan PAG pile is important for maintaining alkalinity in the waters which flow down to river road, and care should be taken so that the new laydown area does not encroach on the wetland area nor affect the existing water drainage ditches.

Mitigation: In December 2017, work began for the development of an RSEM over the Howe Pit area. As part of this development, surface drainage through how pit will be diverted, thus reducing the amount of PAG contact water which is currently diverted along the River Road Ditch. In addition, conceptual plans to find a long-term solution to the sediment loading from River Road and long-term mitigation of shale slopes above River Road are in progress.

Photo 3: Comparison of vegetation growth at the Blind Corner upper chimney ditch from May 2017 (left) and August 2017 (right)

3.2 Right Bank

3.2.1 RSEM R5a

During the March Audit, samples collected, and measured for rinse pH, paste pH, and ABA confirmed that PAG materials placed in RSEM R5a were starting to generate net acid in contact waters.

During the August audit, some PAG was noted to be exposed along the crest of the starter dyke at RSEM R5a which could lead to acidic runoff into the ponds or propagate erosional gullies or rill through the NPAG cover. It was also noted in August that the up-gradient non-contact diversion ditch at RSEM R5a was incomplete.

Recommendation: It was recommended that all PAG within and along the crest of the RSEM R5a starter dyke is fully encased in comparted NPAG cover.

Mitigation Action: Ongoing monitoring within RSEM R5a to confirm contractor is adhering to CEMP and EPP requirements.

3.2.2 South Bank Initial Access Road and RSEM R6 Sediment Pond

During the March Audit, samples collected, and measured for rinse pH, and paste pH, confirmed that PAG exposed from construction at SBIAR was close to producing net acid in contact waters. The shale rock samples from SBIAR collected and submitted for acid-base accounting analysis, confirmed that the shale is PAG and some neutralizing potential exists to help buffer net acid generation.

During the May Audit, the leachate from the two SBIAR samples measured circumneutral pH (pH = 7.31 and 7.10) indicating that surface runoff from SBIAR was not yet producing net acidity.

During the August Audit, shale outcrop within SBIAR showed indications of net acid generating ARD processes. In situ pH tests within the ditches indicated that waters had not yet become acid, however, residual alkalinity is reduced.

Pooled water located at the northeast corner of Area 21, immediately above the western cutslope of SBIAR, is being passively drained down into the western SBIAR ditch. The water is turbid and negatively impacts the quality of the natural water flowing within the ditch. Additionally, the ponded water in Area 21 is an unlined facility that infiltrates though the shale and seeps through the western cutslope. This moist and oxygenated seepage is likely to accelerate ARD processes.

Recommendation: It was recommended that a cover strategy and design for the exposed shale within the SBIAR facility should be finalized and implemented as soon as possible to prevent further development of ARD-ML processes and to reduce acidic discharge from this facility into RSEM R6.

Mitigation Action: Several alternatives were evaluated for a long-term mitigation of the PAG exposures along SBIAR, and an engineering design for a cover to limit exposure and facilitate a permanent soil or vegetative cover has been developed, for construction and implementation during 2018.

3.3 Locations Off-Site of Main Civil Works

3.3.1 Portage Mountain Quarry

The Portage Mountain Quarry was visited during the August and October site audits. In August, numerous thin shale and carbonaceous beds were observed to be interbedded within a thicker and predominant sandstone to conglomerate rock package. No ARD-ML characterization test work had been completed on this site, however, this was to be undertaken during a trial blast program.

During the October site audit, excavation into shale PAG material within the laydown area at the base of the quarry was inspected. An unknown quantity of this material was used for road upgrades for the access road into the quarry. The material placed on the roads is mixed with other soil and rock materials, and visual inspection noted that the PAG was limited to a 2 km area between km 5.5 and km 7.5. It was difficult to estimate how much of the road cover material is comprised of shale, but it ranged between 20% to 40% with locally in concentrations of 70% over a few metres. There is also an exposed PAG slope at the entrance gate to the quarry that has potential to produce acidic drainage.

Recommendation It was recommended that the known shale outcrops be characterized to determine PAG classification, then evaluated based on location/elevation in relation to the ultimate quarry pit walls and haul road excavations. A more thorough ARD-ML mitigation and management plan may be required based on the results of the acid-base accounting test work. For the laydown area below the quarry, it was recommended that the exposed shale be covered back over with overburden and the contractor develop a “Chance Find” procedure for management and monitoring of PAG at the site. The exposed PAG slope near the gate of the quarry should be monitored for runoff at freshet. It was recommended not to place any additional shale rock on the access road.

Given the mixing with other materials and the localized presence on the road it was not considered to be an significant concern.

Mitigation Action The exposed PAG area within the laydown borrow source, was covered with overburden materials. Rinse pH data from samples collected at site are neutral indicating that this material was not yet producing acidic drainage.

3.3.2 Trapper Main Forest Service Road

During the October site audit, it was observed that Trapper Main FSR has an exposed PAG slope at the top of the hill at approximately Station 6+500. The material has been characterized as PAG (McElhanney 2017) and forms a 2 to 3 metre high slope above the road and ditch. The ditch drains downhill to a series of check dams prior to discharge into the environment. Some of the material from the cut has been used in road construction at approximately chainage 6+025, and also at 7+500. Where used on the road, the PAG has since been buried by almost a metre of compacted non-PAG materials and is not anticipated to be an issue.

Recommendation: It was recommended that mitigation of the exposed PAG slope occur prior to freshet. Although there are few surface receptors in the area, the project site is subject to the same discharge requirements as the MCW, and based on low pH of water pooled in the ditch below the slope it is producing acidic leachate.

Mitigation Action: In early November 2018, Duncan Robinson of BCH coordinated the placement of limestone rip-rap within ditches below PAG slopes to mitigate any potential PAG and ML runoff during freshet. In addition, a monitoring program will be put in place to monitor pH of runoff, and the requirement for further mitigation will be assessed should runoff become acidic. In addition, the contractor has developed a chance find procedure for any further unexpected PAG excavations.

Photo 4: Shale Exposure during Trapper Main upgrade at approximate Chainage 6+500

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Limitations on the Use of this Document (Appendix A) are attached to this memo.

5.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

L. Reggin

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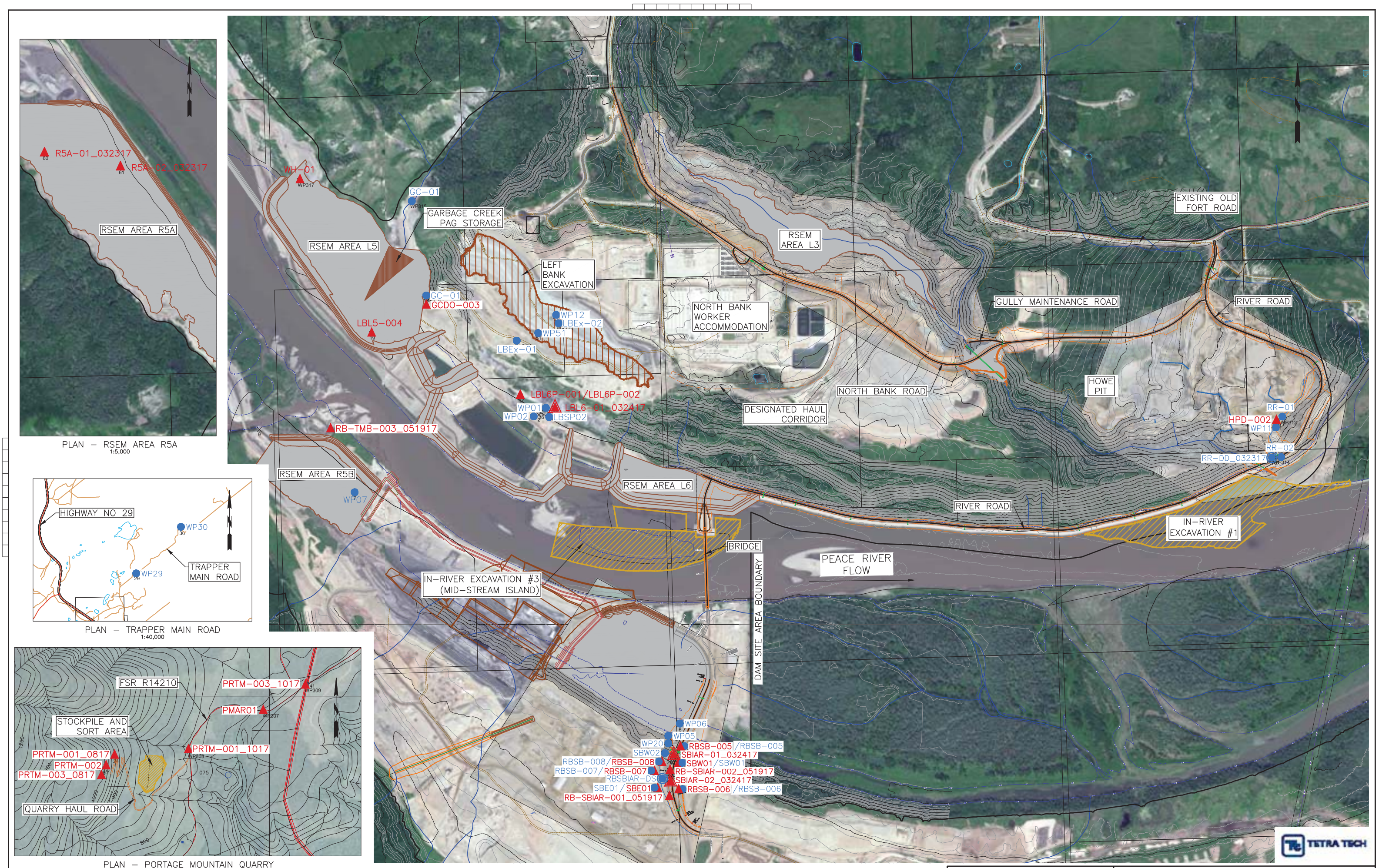
FIGURE



L E G E N D:

- 🔺 ROCK SAMPLE – RINSE pH
- 🔺 ROCK SAMPLE – RINSE pH & ABA
- ● WATER SAMPLE – IN SITU
- ◉ WATER SAMPLE – IN SITU & ROUTINE WQ

N O T E:
SOME SAMPLE NUMBERS INCLUDE THEIR DATE IN THE FORMAT DDMMYY OR MMYY.

0 250m
1:5000

0 500m
1:10,000

0 2000m
1:40,000

C:\BC Hydro Site C\Design Drawings\Sketches\SK-076-SAMPLING MAP.dwg
3/14/2018 9:12 AM

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP CIV	INSP STR	INSP MECH	INSP GEO	INSP ELEC	REV	ACPT

REFERENCE DRAWINGS

REFERENCE DRAWINGS

REVISIONS

SITE C CLEAN ENERGY PROJECT

BC Hydro

DSGN
INDEP CHK
DFTG
DFTG CHK
INSP
CIV STR MECH GEO ELEC
REV
ACPT

CLEAN ENERGY PROJECT - SITE C

SAMPLE LOCATIONS FROM 2017 AUDIT EVENTS
PLAN

DATE 12 MAR 2018
DIST
DWG NO FIGURE 1
SIZE A0
R 0

NOT TO BE REPRODUCED WITHOUT THE PERMISSION OF BC HYDRO

APPENDIX A

TETRA TECH’S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

APPENDIX B

CERTIFICATE OF ANALYSES 2017 SITE AUDIT

Tetra Tech Canada Inc.
ATTN: James Barr
150 - 1715 Dickson Avenue
KELOWNA BC V1Y 9G6

Date Received:	25-AUG-17
Report Date:	19-SEP-17 13:40 (MT)
Version:	FINAL REV. 3

Client Phone: 250-862-4832

Certificate of Analysis

Lab Work Order #:	L1981548
Project P.O. #:	NOT SUBMITTED
Job Reference:	704-V13103415-07
C of C Numbers:	
Legal Site Desc:	Site C

Comments:

19-SEP-2017 This report replaces the previous version and includes Dissolved Metals results for 0.1u and 0.45u filtering done from the same bottle for samples ALS ID -9 and -10.

B J Mack

Brent Mack, B.Sc.
Account Manager

	Sample ID	L1981548-1	L1981548-2	L1981548-3	L1981548-4	L1981548-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17
	Sampled Time	14:15	13:30	12:15	11:45	11:30
	Client ID	LBL3C-1.43	LBL3C-0.02	RBSC-DS	RBSBIAR-US	RBSBIAR-DS
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1510	2840	1650	566	294
	Hardness (as CaCO3) (mg/L)	815	1730	770	300	133
	pH (pH)	8.17	8.10	8.05	8.21	8.24
	Total Suspended Solids (mg/L)	72.3	14.1	<3.0	51.5	60.3
	Total Dissolved Solids (mg/L)	1320	2940	1470	371	198
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	283	301	349	292	125
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	283	301	349	292	125
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0091	0.0078	0.0077	0.0146
	Chloride (Cl) (mg/L)	17.7	25	18.1	8.47	7.86
	Nitrate (as N) (mg/L)	0.685	DLDS <0.10	DLDS <0.050	0.505	0.263
	Nitrite (as N) (mg/L)	DLDS <0.010	DLDS <0.020	DLDS <0.010	<0.0010	0.0036
	Sulfate (SO4) (mg/L)	606	1670	647	26.7	23.1
Total Metals	Aluminum (Al)-Total (mg/L)	1.63	0.369	0.0091	0.0106	1.05
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Total (mg/L)	0.00160	0.00069	<0.00050	<0.00050	0.00125
	Barium (Ba)-Total (mg/L)	0.087	0.040	0.027	0.228	0.178
	Beryllium (Be)-Total (mg/L)	0.00012	DLA <0.00020	<0.00010	<0.00010	<0.00010
	Boron (B)-Total (mg/L)	0.11	0.20	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	0.000132	0.000475	0.000261	0.0000132	0.0000773
	Calcium (Ca)-Total (mg/L)	216	450	224	88.7	39.6
	Chromium (Cr)-Total (mg/L)	0.0023	<0.0010	<0.0010	<0.0010	0.0022
	Cobalt (Co)-Total (mg/L)	0.00192	0.00539	<0.00030	<0.00030	0.00080
	Copper (Cu)-Total (mg/L)	0.0034	0.0016	<0.0010	<0.0010	0.0027
	Iron (Fe)-Total (mg/L)	2.50	0.995	0.133	<0.030	2.24
	Lead (Pb)-Total (mg/L)	0.00118	<0.00050	<0.00050	<0.00050	0.00116
	Lithium (Li)-Total (mg/L)	0.0337	0.0947	0.0561	0.0104	0.0056
	Magnesium (Mg)-Total (mg/L)	79.0	140	62.1	20.8	10.3
	Manganese (Mn)-Total (mg/L)	0.211	0.322	0.140	0.00106	0.0587
	Mercury (Hg)-Total (mg/L)	DLM <0.000025	DLM <0.000025	<0.0000050	<0.0000050	DLM <0.000025
	Molybdenum (Mo)-Total (mg/L)	0.0023	0.0028	<0.0010	0.0016	0.0025
	Nickel (Ni)-Total (mg/L)	0.0074	0.0545	0.0117	<0.0010	0.0037
	Potassium (K)-Total (mg/L)	6.6	6.9	<2.0	4.0	<2.0
	Selenium (Se)-Total (mg/L)	0.00457	0.00077	0.000190	0.000678	0.000474
	Silver (Ag)-Total (mg/L)	0.000021	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Total (mg/L)	52.6	123	84.8	6.8	7.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1981548-6	L1981548-7	L1981548-8	L1981548-9	L1981548-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17
	Sampled Time	10:30	17:00	13:30	15:45	15:45
	Client ID	TT-TB	TT-FB	LBL3C-0.02R	LBL3C-0.02 (0.1U FILTER)	LBL3C-0.02 (0.45U FILTER)
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	<2.0	<2.0	2890		
	Hardness (as CaCO3) (mg/L)	<0.50 HTC	<0.50	1700	1730	1690
	pH (pH)	5.35	5.24	8.08		
	Total Suspended Solids (mg/L)	<3.0	<3.0	14.3		
	Total Dissolved Solids (mg/L)	<10	<10	2920		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	<1.0	<1.0	296		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	<1.0	<1.0	296		
	Ammonia, Total (as N) (mg/L)	<0.02 RRV	<0.0050	0.0079		
	Chloride (Cl) (mg/L)	<0.50	<0.50	25		
	Nitrate (as N) (mg/L)	<0.0050	<0.0050	<0.10 DLDS		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.020 DLDS		
	Sulfate (SO4) (mg/L)	<0.30	<0.30	1670		
Total Metals	Aluminum (Al)-Total (mg/L)	<0.0050	<0.0050	0.353		
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Arsenic (As)-Total (mg/L)	<0.00050	<0.00050	0.00063		
	Barium (Ba)-Total (mg/L)	<0.020	<0.020	0.041		
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00020		
	Boron (B)-Total (mg/L)	<0.10	<0.10	0.19		
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	0.000472		
	Calcium (Ca)-Total (mg/L)	<0.10	<0.10	453		
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	<0.0010		
	Cobalt (Co)-Total (mg/L)	<0.00030	<0.00030	0.00523		
	Copper (Cu)-Total (mg/L)	<0.0010	<0.0010	0.0015		
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	0.931		
	Lead (Pb)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	0.0967		
	Magnesium (Mg)-Total (mg/L)	<0.10	<0.10	144		
	Manganese (Mn)-Total (mg/L)	<0.00030	<0.00030	0.321		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	0.0028		
	Nickel (Ni)-Total (mg/L)	<0.0010	<0.0010	0.0540		
	Potassium (K)-Total (mg/L)	<2.0	<2.0	6.6		
	Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	0.00064		
	Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Sodium (Na)-Total (mg/L)	<2.0	<2.0	120		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1981548-1	L1981548-2	L1981548-3	L1981548-4	L1981548-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17
	Sampled Time	14:15	13:30	12:15	11:45	11:30
	Client ID	LBL3C-1.43	LBL3C-0.02	RBSC-DS	RBSBIAR-US	RBSBIAR-DS
Grouping	**Analyte**					
WATER						
Total Metals	Thallium (Tl)-Total (mg/L)	0.000051	0.000036	<0.000010	<0.000010	0.000036
	Tin (Sn)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Total (mg/L)	<0.025 DLM	<0.010	<0.010	<0.010	0.016
	Uranium (U)-Total (mg/L)	0.00437	0.0112	0.00418	0.00142	0.00080
	Vanadium (V)-Total (mg/L)	0.00419	<0.0010 DLA	<0.00050	<0.00050	0.00385
	Zinc (Zn)-Total (mg/L)	0.0369	0.0579	0.0248	0.0106	0.0181
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0105	0.0974	<0.0050	<0.0050	0.0509
	Antimony (Sb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Barium (Ba)-Dissolved (mg/L)	0.047	0.037	0.025	0.226	0.137
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00020 DLA	<0.00010	<0.00010	<0.00010
	Boron (B)-Dissolved (mg/L)	<0.10	0.19	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	0.0000316	0.000306	0.000165	0.0000066	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	207	464	217	85.9	37.7
	Chromium (Cr)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Dissolved (mg/L)	<0.00030	0.00485	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Dissolved (mg/L)	<0.0010	0.0011	<0.0010	<0.0010	<0.0010
	Iron (Fe)-Dissolved (mg/L)	<0.030	0.046	0.074	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)	0.0299	0.0956	0.0455	0.0097	0.0045
	Magnesium (Mg)-Dissolved (mg/L)	72.2	139	55.6	20.8	9.30
	Manganese (Mn)-Dissolved (mg/L)	0.00312	0.292	0.127	0.00054	0.00283
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0020	0.0027	<0.0010	0.0016	0.0023
	Nickel (Ni)-Dissolved (mg/L)	0.0014	0.0505	0.0109	<0.0010	0.0010
	Potassium (K)-Dissolved (mg/L)	6.2	6.5	<2.0	4.0	<2.0
	Selenium (Se)-Dissolved (mg/L)	0.00431	0.00040	0.000145	0.000682	0.000431
	Silver (Ag)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Dissolved (mg/L)	48.5	119	76.3	6.6	7.0
	Thallium (Tl)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)	0.00386	0.0109	0.00380	0.00142	0.00069
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.0010 DLA	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0050	0.0336	0.0185	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1981548-6	L1981548-7	L1981548-8	L1981548-9	L1981548-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17	24-AUG-17
	Sampled Time	10:30	17:00	13:30	15:45	15:45
	Client ID	TT-TB	TT-FB	LBL3C-0.02R	LBL3C-0.02 (0.1U FILTER)	LBL3C-0.02 (0.45U FILTER)
Grouping	**Analyte**					
WATER						
Total Metals	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	0.000039		
	Tin (Sn)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010		
	Uranium (U)-Total (mg/L)	<0.00020	<0.00020	0.0114		
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	DLA <0.0010		
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	0.0570		
Dissolved Metals	Dissolved Mercury Filtration Location		FIELD	FIELD		
	Dissolved Metals Filtration Location		FIELD	FIELD	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)		<0.0050	0.0961	0.0597	0.0571
	Antimony (Sb)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Barium (Ba)-Dissolved (mg/L)		<0.020	0.040	0.035	0.034
	Beryllium (Be)-Dissolved (mg/L)		<0.00010	<0.00020	DLA <0.00020	DLA <0.00020
	Boron (B)-Dissolved (mg/L)		<0.10	0.20	0.20	0.20
	Cadmium (Cd)-Dissolved (mg/L)		<0.0000050	0.000316	DLA <0.000010	DLA <0.000010
	Calcium (Ca)-Dissolved (mg/L)		<0.10	446	458	454
	Chromium (Cr)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Dissolved (mg/L)		<0.00030	0.00484	0.00059	0.00057
	Copper (Cu)-Dissolved (mg/L)		<0.0010	0.0011	<0.0010	<0.0010
	Iron (Fe)-Dissolved (mg/L)		<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)		<0.0010	0.0930	0.0987	0.0982
	Magnesium (Mg)-Dissolved (mg/L)		<0.10	143	142	136
	Manganese (Mn)-Dissolved (mg/L)		<0.00010	0.306	0.00353	0.00339
	Mercury (Hg)-Dissolved (mg/L)		<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)		<0.0010	0.0026	0.0026	0.0026
	Nickel (Ni)-Dissolved (mg/L)		<0.0010	0.0502	0.0405	0.0391
	Potassium (K)-Dissolved (mg/L)		<2.0	6.6	6.6	6.3
	Selenium (Se)-Dissolved (mg/L)		<0.000050	0.00057	0.00052	0.00062
	Silver (Ag)-Dissolved (mg/L)		<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Dissolved (mg/L)		<2.0	115	120	115
	Thallium (Tl)-Dissolved (mg/L)		<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Dissolved (mg/L)		<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)		<0.00020	0.0106	0.00975	0.0100
	Vanadium (V)-Dissolved (mg/L)		<0.00050	DLA <0.0010	DLA <0.0010	DLA <0.0010
	Zinc (Zn)-Dissolved (mg/L)		<0.0050	0.0347	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1981548-2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1981548-10
Matrix Spike	Boron (B)-Dissolved	MS-B	L1981548-2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1981548-2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1981548-10
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1981548-2
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1981548-2
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1981548-10
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1981548-2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1981548-10
Matrix Spike	Sulfate (SO4)	MS-B	L1981548-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

Reference Information

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1981548-COFC

COC Number: 15 -

Page 1 of 2

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Tetra Tech	Select Report Format:	☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Contact:	James Barr	Quality Control (QC) Report with Report	☐ YES ☐ NO
Phone:	250-862-4832	☐ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☐ EMAIL ☐ MAIL ☐ FAX
Street:	150-1715 Dickson Ave.	Email 1 or Fax	james.barr@tetratech.com
City/Province:	Kelowna, BC	Email 2	labdata@tetratech.com
Postal Code:	V1Y 9G6	Email 3	molly.brewis@bchydro.com
Invoice To	Same as Report To ☑ YES ☐ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☑ YES ☐ NO	Select Invoice Distribution:	☐ EMAIL ☐ MAIL ☐ FAX
Company:		Email 1 or Fax	james.barr@tetratech.com
Contact:		Email 2	labdata@tetratech.com
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:	Q61495	AFE/Cost Center:	PO#
Job #:	704-V13103415-07	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:	Site C	Location:	
ALS Lab Work Order # (lab use only)	L1981548	**ALS Contact:**	**Sampler:**

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☐ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine (Alk-SPC, pH, Cl, SO4, EC, TSS,	TDS, NO3, NO2)	NH3	Tota CCME Metals	Total Hg	Dissolved CCME Metals	Dissolved Hg							Number of Containers
							P	P	P	F/P	F/P							
	LBL3C-3.32			Water														6
	LBL3C-1.65			Water														6
	LBL3C-1.43	24-Aug-17	14:15	Water	X	X	X	X	X	X	X							6
	LBL3C-0.02	24-Aug-17	13:30	Water	X	X	X	X	X	X	X							6
	LBL4C-0.18			Water														6
	LBRR-12+500			Water														6
	LBRR-LC			Water														6
	LBRR-DD			Water														6
	RBSC-DS	24-Aug-17	12:15	Water	X	X	X	X	X	X	X							6
	RBSBIAR-US	24-Aug-17	11:45	Water	X	X	X	X	X	X	X							6
	RBSBIAR-DS	24-Aug-17	11:30	Water	X	X	X	X	X	X	X							6
	TT-TB	24-Aug-17	10:30	Water	X	X	X	X	X	X	X							6

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☐ NO

Are samples for human drinking water use?
☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☒

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C	
14			6.2 avg	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: ERIC Gietz	Date: 25-Aug-17	Time: 10:30	Received by: Geoff	Date: Aug. 25/17	Time: 11:55	Received by: Code	Date: Aug 26	Time: 1115

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1981548-COFC

COC Number: 15 -

Page 2 of 2

Report To — Contact and company name below will appear on the final report

Company: Tetra Tech
Contact: James Barr
Phone: 250-862-4832

Company address below will appear on the final report

Street: 150-1715 Dickson Ave.
City/Province: Kelowna, BC
Postal Code: V1Y 9G6

Invoice To — Same as Report To ☑ YES ☐ NO
Copy of Invoice with Report ☑ YES ☐ NO
Company:
Contact:

Project Information

ALS Account # / Quote #: Q61495
Job #: 704-V13103415-07
PO / AFE:
LSD: Site C

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☐ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax james.barr@tetratech.com
Email 2 labdata@tetratech.com
Email 3 molly.brewis@bchydro.com

Invoice Distribution

Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax james.barr@tetratech.com
Email 2 labdata@tetratech.com

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Contact:
Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine (Alk-SPC, pH, Cl, SO4, EC, TSS,	TDS, NO3, NO2)	NH3	Tota CCME Metals	Total Hg	Dissolved CCME Metals	Dissolved Hg							Number of Containers
							P	P	P	F/P	F/P							
	TT-FB	24-Aug-17	17:00	Water	X	X	X	X	X	X	X							6
	LBL3C-0.02 R	24-Aug-17	13:30	Water	X	X	X	X	X	X	X							6
	LBL3C-0.02*	24-Aug-17	15:45	Water						X								2
				Water														
				Water														
				Water														
				Water														
				Water														
				Water														
				Water														
				Water														
				Water														

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO
Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

LBL3C-0.02* Metals are not filtered or preserved. To be lab filtered at 45 um and 0.1 um. All other Samples filtered + preserved

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☒
INITIAL COOLER TEMPERATURES °C: 14
FINAL COOLER TEMPERATURES °C: 6.2 [illegible]

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: ERIC GRETZ Eric Gretz	Date: Aug 25, 2017	Time: 10:30	Received by: Geoff	Date: Aug. 25/17	Time: 11:55	Received by: Cade	Date: Aug 26	Time: 1115

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 18- APR- 2017
Account: TGM

CERTIFICATE VA17063258

Project: V13103415- 07

This report is for 2 Other samples submitted to our lab in Vancouver, BC, Canada on 3- APR- 2017.

The following have access to data associated with this certificate:

J. BARR	LARA REGGIN	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI- 21	Received Sample Weight
LOG- 22	Sample login - Rcd w/o BarCode
CRU- 31	Fine crushing - 70% <2mm
SPL- 21	Split sample - riffle splitter
PUL- 31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
OA- ELE07	Paste pH

To: TETRA TECH CANADA INC.
ATTN: J. BARR
150- 1715 DICKSON AV
KELOWNA BC V1Y 9G6

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 18- APR- 2017
Account: TGM

Project: V13103415- 07

CERTIFICATE OF ANALYSIS VA17063258

Sample Description	Method	WEI- 21	OA- ELE07
	Analyte	Recvd Wt.	pH
	Units	kg	Unity
	LOR	0.02	0.1
R5A- 01_032317		0.78	7.0
R5A- 02_032317		0.56	7.1

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

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www.alsglobal.com

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Project: V13103415- 07

CERTIFICATE OF ANALYSIS VA17063258

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	CRU- 31	LOG- 22	OA- ELE07	PUL- 31
	SPL- 21	WEI- 21		

ALS Minerals

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Page: 1
Total # Pages: 2 (A)
Plus Appendix Pages
Finalized Date: 21- APR- 2017
This copy reported on
25- APR- 2017
Account: TGM

CERTIFICATE VA17064115

Project: V13103415- 07

This report is for 3 Other samples submitted to our lab in Vancouver, BC, Canada on 3- APR- 2017.

The following have access to data associated with this certificate:

J. BARR	LARA REGGIN	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI- 21	Received Sample Weight
LOG- 22	Sample login - Rcd w/o BarCode
CRU- 31	Fine crushing - 70% <2mm
SPL- 21	Split sample - riffle splitter
PUL- 31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
S- IR07	Sulphide Sulphur (Leco)	LECO
C- GAS05	Inorganic Carbon (CO2)	
OA- VOL08	Basic Acid Base Accounting	
S- IR08	Total Sulphur (Leco)	LECO
OA- ELE07	Paste pH	
S- GRA06a	Sulfate Sulfur (HCl leachable)	WST- SEQ

To: TETRA TECH CANADA INC.
ATTN: J. BARR
150- 1715 DICKSON AV
KELOWNA BC V1Y 9G6

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Comments: ***Corrected copy with sample ID SBIAR- 03_032417 corrected to LBL6- 01_032417***

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Minerals

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 21- APR- 2017
Account: TGM

Project: V13103415- 07

CERTIFICATE OF ANALYSIS VA17064115

Sample Description	Method	WEI- 21	OA- VOL08	OA- VOL08	OA- VOL08	OA- VOL08	OA- VOL08	OA- ELE07	S- IR08	S- IR07	C- GAS05	C- GAS05	S- GRA06a
	Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	Sulphide	C	CO2	S
	Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%
	LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01
SBIAR- 01_032417		0.92	1	34.7	-27	8	0.23	6.7	1.11	0.82	0.09	0.3	0.10
SBIAR- 02_032417		1.00	1	36.3	-28	8	0.22	6.5	1.16	0.84	0.09	0.3	0.11
LBL6- 01_032417		0.76	1	18.1	-22	-4	-0.22	4.0	0.58	0.05	<0.05	<0.2	0.51

Comments: ***Corrected copy with sample ID SBIAR- 03_032417 corrected to LBL6- 01_032417***

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 21- APR- 2017
Account: TGM

Project: V13103415- 07

CERTIFICATE OF ANALYSIS VA17064115

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C- GAS05
OA- VOL08
S- IR08
CRU- 31
PUL- 31
SPL- 21
LOG- 22
S- GRA06a
WEI- 21
OA- ELE07
S- IR07

Your C.O.C. #: 519194-02-01

Attention:James Barr

Tetra Tech EBA
#150 - 1715 Dickson Avenue
Kelowna, BC
CANADA V1Y 9G6

Report Date: 2017/04/03
Report #: R2365346
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B721867
Received: 2017/03/24, 13:45

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2017/03/25	2017/03/26	BBY6SOP-00026	SM 22 2320 B m
Conductance - water	3	N/A	2017/03/26	BBY6SOP-00026	SM 22 2510 B m
Hardness Total (calculated as CaCO3)	3	N/A	2017/03/30	BBY WI-00033	Auto Calc
Hardness (calculated as CaCO3)	3	N/A	2017/03/29	BBY WI-00033	Auto Calc
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	3	N/A	2017/03/29	BBY7SOP-00002	EPA 6020B R2 m
Elements by ICPMS Low Level (dissolved)	1	N/A	2017/03/28	BBY7SOP-00002	EPA 6020B R2 m
Elements by ICPMS Low Level (dissolved)	2	N/A	2017/03/29	BBY7SOP-00002	EPA 6020B R2 m
Elements by ICPMS Digested LL (total)	3	2017/03/27	2017/03/29	BBY7SOP-00003,	BCLM2005,EPA6020bR2m
Na, K, Ca, Mg, S by CRC ICPMS (total)	3	N/A	2017/03/30	BBY7SOP-00003,	BCLM2005,EPA6020bR2m
Ammonia-N (Preserved)	3	N/A	2017/03/27	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	3	N/A	2017/03/25	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	3	N/A	2017/03/25	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	3	N/A	2017/03/28	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	3	N/A	2017/03/27	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	3	N/A	2017/03/26	BBY6SOP-00026	SM 22 4500-H+ B m
Total Suspended Solids-Low Level	3	2017/03/28	2017/03/28	BBY6SOP-00034	SM 22 2540 D

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Your C.O.C. #: 519194-02-01

Attention:James Barr
Tetra Tech EBA
#150 - 1715 Dickson Avenue
Kelowna, BC
CANADA V1Y 9G6

Report Date: 2017/04/03
Report #: R2365346
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B721867
Received: 2017/03/24, 13:45

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key LPrefontaine
Letitia Prefontaine
Senior Project Manager
03 Apr 2017 17:38:55

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Letitia Prefontaine, B.Sc., Senior Project Manager
Email: LPrefontaine@maxxam.ca
Phone# (604)639-2616

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		QT9432		QT9433			QT9434		
Sampling Date		2017/03/23 17:00		2017/03/24 22:15			2017/03/24 12:30		
COC Number		519194-02-01		519194-02-01			519194-02-01		
	UNITS	**RR-DD**	**RDL**	**RBSB1AR-DS**	**RDL**	**QC Batch**	**TT-CTB**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	0.0204	0.0050	0.0113	0.0050	8587522	<0.0050	0.0050	8587522
Calculated Parameters									
Filter and HNO3 Preservation	N/A	LAB		LAB		8587817	LAB		8587817
Total Hardness (CaCO3)	mg/L	1450	0.50	51.1	0.50	8587280	<0.50	0.50	8588184
Nitrate (N)	mg/L	0.451	0.020	0.199	0.020	8587282	<0.020	0.020	8587282
Misc. Inorganics									
Dissolved Hardness (CaCO3)	mg/L	304	0.50	50.5	0.50	8587180	<0.50	0.50	8587180
Alkalinity (Total as CaCO3)	mg/L	74.5	0.50	333	0.50	8587461	<0.50	0.50	8587461
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	8.07	0.50	8587461	<0.50	0.50	8587461
Bicarbonate (HCO3)	mg/L	90.9	0.50	387	0.50	8587461	<0.50	0.50	8587461
Carbonate (CO3)	mg/L	<0.50	0.50	9.68	0.50	8587461	<0.50	0.50	8587461
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	8587461	<0.50	0.50	8587461
Nutrients									
Total Ammonia (N)	mg/L	0.39	0.0050	0.86	0.0050	8587654	0.20	0.0050	8587654
Nitrate plus Nitrite (N)	mg/L	0.472	0.020	0.210	0.020	8587521	<0.020	0.020	8587521
Physical Properties									
Conductivity	uS/cm	746	1.0	699	1.0	8587460	<1.0	1.0	8587460
pH	pH	7.96		8.55		8587459	5.25		8587459
Physical Properties									
Total Suspended Solids	mg/L	14900 (1)	20	15.8 (2)	2.0	8589112	<1.0	1.0	8589112

RDL = Reportable Detection Limit

(1) RDL raised due to high concentration of solids in the sample.

(2) RDL raised due to sample matrix interference.

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		QT9432		QT9433		QT9434		
Sampling Date		2017/03/23 17:00		2017/03/24 22:15		2017/03/24 12:30		
COC Number		519194-02-01		519194-02-01		519194-02-01		
	UNITS	**RR-DD**	**RDL**	**RBSB1AR-DS**	**QC Batch**	**TT-CTB**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS								
Dissolved Aluminum (Al)	ug/L	12.1	0.50	1.88	8588950	<0.50	0.50	8588950
Dissolved Antimony (Sb)	ug/L	0.237	0.020	1.88	8588950	<0.020	0.020	8588950
Dissolved Arsenic (As)	ug/L	0.212	0.020	2.70	8588950	<0.020	0.020	8588950
Dissolved Barium (Ba)	ug/L	84.3	0.020	684	8588950	<0.020	0.020	8588950
Dissolved Beryllium (Be)	ug/L	<0.010	0.010	<0.010	8588950	<0.010	0.010	8588950
Dissolved Bismuth (Bi)	ug/L	<0.0050	0.0050	<0.0050	8588950	<0.0050	0.0050	8588950
Dissolved Boron (B)	ug/L	20	10	114	8588950	<10	10	8588950
Dissolved Cadmium (Cd)	ug/L	0.0340	0.0050	<0.0050	8588950	<0.0050	0.0050	8588950
Dissolved Chromium (Cr)	ug/L	<0.10	0.10	<0.10	8588950	<0.10	0.10	8588950
Dissolved Cobalt (Co)	ug/L	1.35	0.0050	0.617	8588950	<0.0050	0.0050	8588950
Dissolved Copper (Cu)	ug/L	2.14	0.050	0.538	8588950	<0.050	0.050	8588950
Dissolved Iron (Fe)	ug/L	1.5	1.0	3.7	8588950	<1.0	1.0	8588950
Dissolved Lead (Pb)	ug/L	0.0050	0.0050	<0.0050	8588950	<0.0050	0.0050	8588950
Dissolved Lithium (Li)	ug/L	9.64	0.50	49.6	8588950	<0.50	0.50	8588950
Dissolved Manganese (Mn)	ug/L	160	0.050	1.61	8588950	<0.050	0.050	8588950
Dissolved Molybdenum (Mo)	ug/L	6.17	0.050	8.83	8588950	<0.050	0.050	8588950
Dissolved Nickel (Ni)	ug/L	4.85	0.020	3.98	8588950	<0.020	0.020	8588950
Dissolved Selenium (Se)	ug/L	1.59	0.040	2.56	8588950	<0.040	0.040	8588950
Dissolved Silicon (Si)	ug/L	1600	50	2860	8588950	<50	50	8588950
Dissolved Silver (Ag)	ug/L	<0.0050	0.0050	<0.0050	8588950	<0.0050	0.0050	8588950
Dissolved Strontium (Sr)	ug/L	186	0.050	171	8588950	<0.050	0.050	8588950
Dissolved Thallium (Tl)	ug/L	0.0180	0.0020	0.0100	8588950	<0.0020	0.0020	8588950
Dissolved Tin (Sn)	ug/L	<0.20	0.20	<0.20	8588950	<0.20	0.20	8588950
Dissolved Titanium (Ti)	ug/L	<0.50	0.50	<0.50	8588950	<0.50	0.50	8588950
Dissolved Uranium (U)	ug/L	1.70	0.0020	2.49	8588950	<0.0020	0.0020	8588950
Dissolved Vanadium (V)	ug/L	<0.20	0.20	0.26	8588950	<0.20	0.20	8588950
Dissolved Zinc (Zn)	ug/L	1.55	0.10	0.34	8588950	<0.10	0.10	8588950
Dissolved Zirconium (Zr)	ug/L	<0.10	0.10	<0.10	8588950	<0.10	0.10	8588950
Dissolved Calcium (Ca)	mg/L	90.9	0.050	14.0	8587291	<0.050	0.050	8587291
Dissolved Magnesium (Mg)	mg/L	18.7	0.050	3.77	8587291	<0.050	0.050	8587291
Dissolved Potassium (K)	mg/L	5.94	0.050	1.36	8587291	<0.050	0.050	8587291
Dissolved Sodium (Na)	mg/L	28.1	0.050	136	8587291	<0.050	0.050	8587291
Dissolved Sulphur (S)	mg/L	77.1	3.0	13.8	8587291	<3.0	3.0	8587291
RDL = Reportable Detection Limit								

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		QT9432		QT9433		QT9434		
Sampling Date		2017/03/23 17:00		2017/03/24 22:15		2017/03/24 12:30		
COC Number		519194-02-01		519194-02-01		519194-02-01		
	UNITS	**RR-DD**	**RDL**	**RBSB1AR-DS**	**QC Batch**	**TT-CTB**	**RDL**	**QC Batch**
Total Metals by ICPMS								
Total Aluminum (Al)	ug/L	49300	15	1080	8588517	<3.0	3.0	8588517
Total Antimony (Sb)	ug/L	1.05	0.10	1.74	8588517	<0.020	0.020	8588517
Total Arsenic (As)	ug/L	26.8	0.10	3.22	8588517	<0.020	0.020	8588517
Total Barium (Ba)	ug/L	3810	0.25	740	8588517	0.119	0.050	8588517
Total Beryllium (Be)	ug/L	4.05	0.050	0.065	8588517	<0.010	0.010	8588517
Total Bismuth (Bi)	ug/L	0.892	0.050	0.011	8588517	<0.010	0.010	8588517
Total Boron (B)	ug/L	63	50	124	8588517	<10	10	8588517
Total Cadmium (Cd)	ug/L	7.28	0.025	0.0160	8588517	<0.0050	0.0050	8588517
Total Chromium (Cr)	ug/L	158	0.50	1.30	8588517	<0.10	0.10	8588517
Total Cobalt (Co)	ug/L	84.0	0.050	1.07	8588517	<0.010	0.010	8588517
Total Copper (Cu)	ug/L	161	0.50	1.84	8588517	0.26	0.10	8588517
Total Iron (Fe)	ug/L	167000	25	950	8588517	<5.0	5.0	8588517
Total Lead (Pb)	ug/L	91.8	0.10	0.757	8588517	<0.020	0.020	8588517
Total Lithium (Li)	ug/L	77.9	2.5	53.4	8588517	<0.50	0.50	8588517
Total Manganese (Mn)	ug/L	5460	0.50	10.2	8588517	<0.10	0.10	8588517
Total Molybdenum (Mo)	ug/L	5.53	0.25	8.73	8588517	<0.050	0.050	8588517
Total Nickel (Ni)	ug/L	215	0.50	5.49	8588517	<0.10	0.10	8588517
Total Selenium (Se)	ug/L	2.07	0.20	2.34	8588517	<0.040	0.040	8588517
Total Silicon (Si)	ug/L	57100	250	4580	8588517	<50	50	8588517
Total Silver (Ag)	ug/L	1.63	0.050	0.010	8588517	<0.010	0.010	8588517
Total Strontium (Sr)	ug/L	876	0.25	162	8588517	0.072	0.050	8588517
Total Thallium (Tl)	ug/L	1.24	0.010	0.0320	8588517	<0.0020	0.0020	8588517
Total Tin (Sn)	ug/L	<1.0	1.0	<0.20	8588517	<0.20	0.20	8588517
Total Titanium (Ti)	ug/L	210	10	15.7	8588517	<2.0	2.0	8588517
Total Uranium (U)	ug/L	10.9	0.025	2.69	8588517	<0.0050	0.0050	8588517
Total Vanadium (V)	ug/L	153	1.0	3.34	8588517	<0.20	0.20	8588517
Total Zinc (Zn)	ug/L	632	5.0	4.3	8588517	<1.0	1.0	8588517
Total Zirconium (Zr)	ug/L	4.25	0.50	0.72	8588517	<0.10	0.10	8588517
Total Calcium (Ca)	mg/L	446	1.3	13.9	8587292	<0.25	0.25	8588249
Total Magnesium (Mg)	mg/L	80.8	1.3	3.98	8587292	<0.25	0.25	8588249
Total Potassium (K)	mg/L	12.8	1.3	1.66	8587292	<0.25	0.25	8588249
Total Sodium (Na)	mg/L	30.4	1.3	135	8587292	<0.25	0.25	8588249
Total Sulphur (S)	mg/L	82	15	13.3	8587292	<3.0	3.0	8588249
RDL = Reportable Detection Limit								

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.0°C

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER) Comments

Method Blank Elements by ICPMS Digested LL (total): Method Blank exceeds acceptance limits for (Cadmium) - 2X RDL acceptable for low level metals determination.

Sample QT9432 [RR-DD] Elements by ICPMS Digested LL (total): RDL raised due to sample matrix interference.

Results relate only to the items tested.

Maxxam Job #: B721867
Report Date: 2017/04/03

QUALITY ASSURANCE REPORT

Tetra Tech EBA

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8587459	pH	2017/03/26			102	97 - 103			0	N/A
8587460	Conductivity	2017/03/26			101	80 - 120	<1.0	uS/cm	0.27	20
8587461	Alkalinity (PP as CaCO3)	2017/03/26					<0.50	mg/L	NC	20
8587461	Alkalinity (Total as CaCO3)	2017/03/26	NC	80 - 120	98	80 - 120	<0.50	mg/L	2.6	20
8587461	Bicarbonate (HCO3)	2017/03/26					<0.50	mg/L	2.6	20
8587461	Carbonate (CO3)	2017/03/26					<0.50	mg/L	NC	20
8587461	Hydroxide (OH)	2017/03/26					<0.50	mg/L	NC	20
8587521	Nitrate plus Nitrite (N)	2017/03/25	104	80 - 120	103	80 - 120	<0.020	mg/L	NC	25
8587522	Nitrite (N)	2017/03/25	101	80 - 120	99	80 - 120	<0.0050	mg/L	NC	20
8587654	Total Ammonia (N)	2017/03/27	111	80 - 120	104	80 - 120	<0.0050	mg/L	0.54	20
8588517	Total Aluminum (Al)	2017/03/29	103	80 - 120	101	80 - 120	<3.0	ug/L	7.8	20
8588517	Total Antimony (Sb)	2017/03/29	102	80 - 120	101	80 - 120	<0.020	ug/L	3.9	20
8588517	Total Arsenic (As)	2017/03/29	99	80 - 120	100	80 - 120	<0.020	ug/L	7.8	20
8588517	Total Barium (Ba)	2017/03/29	102	80 - 120	103	80 - 120	<0.050	ug/L	3.9	20
8588517	Total Beryllium (Be)	2017/03/29	104	80 - 120	101	80 - 120	<0.010	ug/L	10	20
8588517	Total Bismuth (Bi)	2017/03/29	99	80 - 120	101	80 - 120	<0.010	ug/L	NC	20
8588517	Total Boron (B)	2017/03/29	103	80 - 120	101	80 - 120	<10	ug/L	3.1	20
8588517	Total Cadmium (Cd)	2017/03/29	99	80 - 120	100	80 - 120	0.0050, RDL=0.0050	ug/L	3.4	20
8588517	Total Chromium (Cr)	2017/03/29	100	80 - 120	100	80 - 120	<0.10	ug/L	3.1	20
8588517	Total Cobalt (Co)	2017/03/29	100	80 - 120	102	80 - 120	<0.010	ug/L	5.1	20
8588517	Total Copper (Cu)	2017/03/29	98	80 - 120	103	80 - 120	<0.10	ug/L	5.5	20
8588517	Total Iron (Fe)	2017/03/29	105	80 - 120	105	80 - 120	<5.0	ug/L	7.0	20
8588517	Total Lead (Pb)	2017/03/29	100	80 - 120	100	80 - 120	<0.020	ug/L	0.60	20
8588517	Total Lithium (Li)	2017/03/29	102	80 - 120	101	80 - 120	<0.50	ug/L	0.093	20
8588517	Total Manganese (Mn)	2017/03/29	96	80 - 120	101	80 - 120	<0.10	ug/L	2.2	20
8588517	Total Molybdenum (Mo)	2017/03/29	102	80 - 120	102	80 - 120	<0.050	ug/L	0.068	20
8588517	Total Nickel (Ni)	2017/03/29	103	80 - 120	102	80 - 120	<0.10	ug/L	0.73	20
8588517	Total Selenium (Se)	2017/03/29	98	80 - 120	100	80 - 120	<0.040	ug/L	3.5	20
8588517	Total Silicon (Si)	2017/03/29					<50	ug/L	2.9	20
8588517	Total Silver (Ag)	2017/03/29	107	80 - 120	103	80 - 120	<0.010	ug/L	NC	20
8588517	Total Strontium (Sr)	2017/03/29	95	80 - 120	97	80 - 120	<0.050	ug/L	3.3	20
8588517	Total Thallium (Tl)	2017/03/29	100	80 - 120	99	80 - 120	<0.0020	ug/L	5.7	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8588517	Total Tin (Sn)	2017/03/29	101	80 - 120	98	80 - 120	<0.20	ug/L	NC	20
8588517	Total Titanium (Ti)	2017/03/29	100	80 - 120	96	80 - 120	<2.0	ug/L	NC	20
8588517	Total Uranium (U)	2017/03/29	100	80 - 120	101	80 - 120	<0.0050	ug/L	0.54	20
8588517	Total Vanadium (V)	2017/03/29	99	80 - 120	101	80 - 120	<0.20	ug/L	4.1	20
8588517	Total Zinc (Zn)	2017/03/29	97	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
8588517	Total Zirconium (Zr)	2017/03/29					<0.10	ug/L	2.2	20
8588950	Dissolved Aluminum (Al)	2017/03/28	96	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
8588950	Dissolved Antimony (Sb)	2017/03/28	100	80 - 120	102	80 - 120	<0.020	ug/L	NC	20
8588950	Dissolved Arsenic (As)	2017/03/28	99	80 - 120	102	80 - 120	<0.020	ug/L	NC	20
8588950	Dissolved Barium (Ba)	2017/03/28	97	80 - 120	100	80 - 120	<0.020	ug/L	NC	20
8588950	Dissolved Beryllium (Be)	2017/03/28	92	80 - 120	96	80 - 120	<0.010	ug/L	NC	20
8588950	Dissolved Bismuth (Bi)	2017/03/28	101	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
8588950	Dissolved Boron (B)	2017/03/28	92	80 - 120	95	80 - 120	<10	ug/L	NC	20
8588950	Dissolved Cadmium (Cd)	2017/03/28	109	80 - 120	102	80 - 120	<0.0050	ug/L	NC	20
8588950	Dissolved Chromium (Cr)	2017/03/28	103	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
8588950	Dissolved Cobalt (Co)	2017/03/28	101	80 - 120	102	80 - 120	<0.0050	ug/L	NC	20
8588950	Dissolved Copper (Cu)	2017/03/28	100	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
8588950	Dissolved Iron (Fe)	2017/03/28	101	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
8588950	Dissolved Lead (Pb)	2017/03/28	95	80 - 120	95	80 - 120	<0.0050	ug/L	NC	20
8588950	Dissolved Lithium (Li)	2017/03/28	91	80 - 120	94	80 - 120	<0.50	ug/L	NC	20
8588950	Dissolved Manganese (Mn)	2017/03/28	98	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
8588950	Dissolved Molybdenum (Mo)	2017/03/28	103	80 - 120	103	80 - 120	<0.050	ug/L	NC	20
8588950	Dissolved Nickel (Ni)	2017/03/28	103	80 - 120	104	80 - 120	<0.020	ug/L	NC	20
8588950	Dissolved Selenium (Se)	2017/03/28	103	80 - 120	105	80 - 120	<0.040	ug/L	NC	20
8588950	Dissolved Silicon (Si)	2017/03/28					<50	ug/L	NC	20
8588950	Dissolved Silver (Ag)	2017/03/28	104	80 - 120	107	80 - 120	<0.0050	ug/L	NC	20
8588950	Dissolved Strontium (Sr)	2017/03/28	101	80 - 120	103	80 - 120	<0.050	ug/L	NC	20
8588950	Dissolved Thallium (Tl)	2017/03/28	101	80 - 120	101	80 - 120	<0.0020	ug/L	NC	20
8588950	Dissolved Tin (Sn)	2017/03/28	103	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
8588950	Dissolved Titanium (Ti)	2017/03/28	92	80 - 120	103	80 - 120	<0.50	ug/L	NC	20
8588950	Dissolved Uranium (U)	2017/03/28	97	80 - 120	96	80 - 120	<0.0020	ug/L	NC	20
8588950	Dissolved Vanadium (V)	2017/03/28	102	80 - 120	102	80 - 120	<0.20	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8588950	Dissolved Zinc (Zn)	2017/03/28	103	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
8588950	Dissolved Zirconium (Zr)	2017/03/28					<0.10	ug/L	NC	20
8589112	Total Suspended Solids	2017/03/28			98	80 - 120	<1.0	mg/L		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Ph.D., P.Chem., Scientific Specialist

Appendix D

TETRA TECH

Site C Clean Energy Project
Water Quality Monitoring for
River Road, South Bank Initial Access Road and L3 Creek
2017 Annual Report

PRESENTED TO

BC Hydro

MARCH 15, 2018
ISSUED FOR USE
FILE: V13103415-07

Tetra Tech Canada Inc.
150, 1715 Dickson Avenue
Kelowna, BC V1Y 9G6 CANADA
Tel 250.862.4832 Fax 250.862.2941

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EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) was retained by BC Hydro (the client) to develop and implement a surface water quality monitoring program for discharge locations along River Road ditch near Blind Corner and below Howe Pit, in proximity to the South Bank Initial Access Road (SBIAR), and along the L3 Creek catchment. Monitoring locations were also established upstream from the discharge to characterize variation to water chemistry within the catchment due to mixing and inflow of water from multiple sources. Water sampling locations are shown in the attached Figures 1 through 3.

Requirements for the development and implementation of the water quality monitoring programs are mandated under the Environmental Assessment Certificate – Condition 3, and the Federal Decision Statement – Condition 7. Reporting of the program results are required on an annual basis. The requirements described in the BC Hydro Site C Clean Energy Project Construction Environmental Management Plan (CEMP), Revision 4, Appendix E Acid Rock Drainage and Metal Leachate Management Plan, Revision 5.2 (App E) is consistent with the requirements listed.

In accordance with the CEMP App E Section 5.2.1.7, results for the River Road and SBIAR locations were evaluated against the British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture (January 2017) (BCAWQG) freshwater short term maximum (FSTM) values. Water quality measurements recorded at the discharge, or downstream, locations which were in exceedance to the BCAWQG-FSTM were reported to BC Hydro.

The water conveyance facilities at River Road ditch near Blind Corner and SBIAR are identified as having potential for direct ARD-ML impacts due to exposure of shale bedrock during construction related activities. The catchment for L3 Creek includes RSEM L3 which is currently not considered, nor permitted, for placement of construction related PAG material. Due to potential influence on discharge water quality from the Howe Pit area and inflow from L4 Creek, the water quality within the L3 Creek catchment is being monitored in context of ARD-ML management.

Monitoring Locations

Nine monitoring locations were established along the River Road ditch between road stations 12+400 and 12+920 and within the lower chimney ditch draining surface water from a cut-off ditch on the Howe Pit bench. In situ testing was conducted at all locations to monitor the effectiveness of the limestone rip-rap, and to observe longer term influences from the PAG outcrop at Blind Corner and run-off/seepage from Howe Pit on run-off water within the River Road catchment. Laboratory and in situ testing was conducted at three of these nine locations to understand water quality prior to mixing and discharging into the Peace River. These three locations are located: in the lower chimney drain (LBRR-LC), upstream of the lower chimney drain within the River Road ditch (LBRR-12+500), and at the discharge of culvert RR-11 (LBRR-DD).

Two monitoring locations were established to monitor water quality flowing within the western ditch of the SBIAR road cut. These locations allow for monitoring of water quality and potential impacts of the exposed PAG cut-slope by comparison of the downstream location (RBSBIAR-DS) to the upstream location (RBSBIAR-US). A third monitoring location was established in the side channel down-gradient of the SBIAR facility (RBSC-DS) to monitor for potential long term influence of the side channel water quality from construction of the SBIAR facility. The side channel is hydraulically connected to the Peace River.

The catchment for L3 Creek includes RSEM L3 which is currently not considered, nor permitted, for placement of construction related PAG material. Due to potential influence on discharge water quality from the Howe Pit area and inflow from L4 Creek, the water quality within the L3 Creek catchment is being monitored in context of ARD-ML management. In April 2017, three monitoring locations were re-established by Tetra Tech personnel within the L3 Creek catchment to be coincident with locations monitored by Lorax in 2016. These locations were selected to characterize water quality along the creek and at the discharge location. A baseline location up-gradient of RSEM

L3 (LBL3C-3.32) and midstream location below the confluence of L4 Creek and below the Gulley Road box culvert (LBL3C-1.43) were monitored to characterize water quality at the downstream discharge location at culvert RR-10 (LBL3C-0.02).

The monitoring locations are shown in Figures 1 through 3 and photos of the locations established in April 2017 are included in the Photographs (1 through 7) section of the Appendix.

Testing and Analysis

Monitoring locations were established by Tetra Tech in conjunction with BC Hydro personnel. Where possible, they are coincident with the locations and station names used in 2016 by Lorax Environmental Services Ltd. (Lorax) on behalf of Peace River Hydro Partners (PRHP).

Field notes documented at each monitoring location included date and time of test, measurements for: water temperature, water hardness, water alkalinity, pH, and electrical conductivity using a hand-held meter; and, estimation of flow and water clarity.

An off-site laboratory analytical program was designed to screen water quality against the BCAWQG-FSTM for surface water and to be commensurate with the program previously implemented in 2016 by Lorax in regards to the analytical methods and detection limits. Analysis was conducted for total and dissolved elements (metals), hardness, pH, alkalinity, total suspended and total dissolved solids, and anions including sulphate, nitrogen species and chloride. Samples were collected in a set of clean bottles provided by the lab and were submitted for analysis.

Quality Assurance and Quality Control

The Quality Control (QC) program included sample collection by experienced field staff who were familiar with the water quality monitoring program. Samples were collected using a method consistent with the British Columbia Field Sampling Manual, Part E: Water and Wastewater Sampling (Clark, 2003).

The Quality Assurance (QA) program incorporated use of a Travel Blank, Field Blank, and a replicate sample to test for potential contamination during sample collection, handling or laboratory preparation, and to evaluate the precision of laboratory analysis. Tetra Tech also reviewed the data for more general anomalies and inconsistencies, assessed on a case by case basis.

The analytical results of these samples were reviewed by Tetra Tech, and if potential contamination or concerns with analytical results were identified, they were discussed with the laboratory and the samples were re-analyzed for verification. Blank samples were considered to ‘fail’ where any measured value was in concentrations above the reported detection limits for that parameter.

ALS Laboratories was used as the principle laboratory for sample analysis. The lab implements a detailed QC program into the sample analysis which includes a series of checks and evaluations for consistency in the sample analysis. The QC program includes method blanks, certified reference materials, laboratory control samples and duplicates. Tetra Tech reviewed the results of the QC Lot reported on Assay Certificates to verify the program consistently met internal ALS Data Quality Objectives.

No significant concerns were identified and the data is believed to be representative and reliable.

Monitoring Program

River Road

Sufficient flowing water permitted samples to be collected in April, May, June, July, September, and October at the LBRR-DD and LBRR-LC locations, and in June, July and October at the LB-12+500 location. Dry conditions prevailed in August at all locations, and low flow to dry conditions prevented reliable sampling at the LBRR-12+500 location in April, May and September. Sampling in October coincided with the onset of heavy precipitation which permitted measurement of water quality under unique conditions. Frozen conditions prevailed in November and December. Field observations were documented each month.

Concentrations of total iron, dissolved aluminum, arsenic, cobalt, copper, silver, and zinc were measured above the BCAWQG-FSTM guidelines within the catchment. At the discharge location (LBRR-DD), exceedances were reported for at least once over the 2017 sampling period for chloride, total arsenic, cobalt, copper, lead, silver, zinc, and dissolved aluminum. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 7, and the screening results based on the laboratory data are tabulated in Appendix B2.

Results for each monthly sampling event were plotted on time series charts for trend and qualitative correlation analysis. Throughout the monitoring period, water quality at the discharge location were not deteriorated by advanced ARD-ML process as shown by relatively consistent pH values in the slightly alkaline range, and dissolved elements below the BCAWQG-FSTM guidelines. TSS concentrations were elevated during high flow events, and TDS measurements were generally negatively correlated having concentrations proportionally higher during periods of low flow. Variable concentrations of dissolved sulphate was observed. Increasing concentrations of total aluminum and total iron suggest that active ARD-ML processes on exposed PAG at Blind Corner and within Howe Pit are influencing water quality.

Elevated concentrations of dissolved aluminum were measured from the LBRR-LC location in May through July. Investigation into the potential cause concluded likely cause as clay size aluminum hydroxide particles in suspension were passing the field filters and reporting to the dissolved fraction rather than the total aluminum fraction. Presence of fine grained white and orange minerals (interpreted as gibbsite and limonite) on shale exposed in the upper cut-off ditch, on the Howe Pit bench may be a potential source as water from the upper cut-off ditch drains into LBRR-LC.

Limestone rip-rap lines the River Road ditch between monitoring locations LBRR-12+920 and LBRR-DD and is effective at mitigating the pH of the drainage water. The limestone material used as rip-rap along this road section has become progressively coated with a mineral precipitate (visually estimated as iron-oxides and aluminum hydroxides) due to chemical neutralization reactions, and has become encased by sludge due to settlement of suspended solids within the water and encroachment of sand and gravel sediment from grading activities on River Road. The effectiveness of the limestone to provide the neutralizing potential is considered to be negatively compromised by these coatings.

SBIAR

Sufficient flowing water permitted samples to be collected each month from April through October from all three monitoring locations RBSBIAR-US, RBSBIAR-DS and RBSC-DS. Frozen conditions prevailed November and December.

Concentrations of total iron were measured above the BCAWQG-FSTM guidelines within the catchment. At the downstream location (RBSBIAR-DS), exceedances were reported for total iron. The water flowing from RBSBIAR-DS does not have a direct downstream receptor. Prior to the July 24th sampling event, water passing the downstream monitoring location (RBSBIAR-DS) flowed directly into a temporary polyethylene lined pond via a limestone rip-rap spillway prior to being transported to the RSEM R6 pond by hydrovac truck for management prior to discharge. From the September sampling event onwards, water passing the RBSBIAR-DS location was channeled into a ditch at the base of the limestone spillway and conveyed directly to the RSEM pond for management prior to discharge.

In July 2017, it was observed that a large diameter PVC pipe had been installed within the SBIAR ditch between locations RBSBIAR-US and RBSBIAR-DS, which conveyed water from a pond in Area 21 acting as catchment for water from gravel washing operations. This additional input of water was generally noted as being turbid, and increased flows at the RBSBIAR-DS location. Additionally, the ponded water in Area 21 is an unlined facility permitting infiltration though the shale resulting in seeps through the western cut-slope. This moist and oxygenated seepage is likely to accelerate ARD processes. Due to continued water conveyance into the SBIAR ditch from Area 21, one sample was collected from the RBSBIAR-DS location on Dec 4, 2017. Field observations were documented each month.

Results for each monthly sampling event were plotted on time series charts for trend and qualitative correlation analysis. Throughout the monitoring period, water quality at the downstream monitoring location remained below the BCAWQG-FSTM guidelines. Measurements for pH trended slightly downwards while alkalinity values, as bicarbonate, were increasing, suggesting increased acidity loading within the SBIAR ditch due to ARD-ML processes on the exposed PAG cut-slopes within the facility.

Total and dissolved iron were in exceedance of BCAWQG-FSTM guidelines in September and October 2017, at RBSC-DS which is in the Peace River side channel at the base of SBIAR. This location is sampled as a verification point to check for potential leakage from, or direct connectivity with, the SBIAR PAG contact water with the side channel. There does not appear to be hydraulic connectivity between SBIAR and the side channel, and this exceedance is not considered to be influenced by construction related PAG contact water but rather related to natural turbidity.

L3 Creek

Sufficient flowing water permitted samples to be collected each month from April through October for monitoring locations LBL3C-0.02 and LBL3C-1.43; in May, June and July from location LBL3C-1.65; in April, May, June and July from location LBL3C-3.32; and in May, June and July from LBL4C-0.18. Frozen conditions prevailed in November and December. Due to construction related activities at LBL3C-1.65, samples were unable to be collected at this location since July. Field observations were documented each month.

Concentrations of total iron, dissolved aluminum, total zinc, total copper, and total arsenic were measured above BCAWQG-FSTM guidelines within the catchment. At the discharge location (LBL3C-0.02) exceedances were reported for total iron, total arsenic, and dissolved aluminum. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 12, and the screening results based on the laboratory data are tabulated in Appendix B4.

Results for each monthly sampling event were plotted on time series charts for trend and qualitative correlation analysis. Throughout the monitoring period, water quality at the discharge location remained below the BCAWQG-FSTM guidelines. Measurements for pH were consistent throughout the period and dissolved metals remained low.

Influence of ARD-ML processes on water within the catchment are limited to natural occurrences within L4 Creek and previous disturbance within Howe Pit. Input volume from L4 Creek is low and is generally diluted by L3 Creek water. Input volume from the Howe Pit area is uncertain, however, water quality between monitoring locations LBL3C-1.43 and LBL3C-0.02 is believed to be influenced by groundwater that has been impacted from Howe Pit.

L4 Creek

Reconnaissance investigation of L4 Creek conducted in September 2017, revealed naturally exposed shale bedrock at the base of the incised creek valley in contact with flowing creek water. In situ aqueous pH measurements were collected at 50 metre spaced intervals between the exposed shale in L4 Creek and the downstream confluence of L4 Creek with L3 Creek. The pH values observed ranged between 4.17 and 5.75. A pH value of 8.5 was measured immediately downstream of the confluence of the two creeks.

The investigation aimed to explain the occurrence of metal concentrations, including arsenic, copper, cobalt and zinc, that were measured above detectible concentrations in the downstream location LBL3C-1.43 but were absent at comparable concentrations in the upstream L3 Creek location LBL3C-1.65. Evidence of PAG outcrop in L4 Creek, reduced pH levels in L4 Creek and occurrence of anomalous metal concentrations at the LBL4C-0.018 location and downstream LBL3C-1.43 locations exemplify background water quality of local naturally occurring PAG contact waterways. L4 Creek waters are eventually diluted, or attenuated, by L3 Creek waters and PAG related metal concentrations are significantly reduced by monitoring location LBL3C-0.02.

General Conclusions

Across all sampling events in 2017, high to very high hardness values (118 to 3,460 mg/L) were observed in all waters sampled. The River Road ditch and SBIAR catchments are generally ephemeral. Monthly water quality monitoring measures instantaneous water quality and may not be reflective of longer term baseline conditions. Flow volumes are highly susceptible to precipitation, and water quality is influenced by whether flow is derived from precipitation, shallow groundwater or regional groundwater flow.

Recommendations for River Road

The sediment source for elevated TSS measured at LBRR-DD is mainly attributed to scouring of accumulated sediment within the ditch from road grading and run-off from previous events, which includes washing, or flushing, of the exposed shale, colluvium and overburden cut-banks. Management of the drainage system is required to reduce the amount of sediment infilling to the ditch from road grading operations as this sediment encases the limestone which reduces chemical efficiency for ARD mitigation and prematurely fills the cistern, which limits its performance to capture TSS which may be present from erosion of cut-banks. In June 2017, the limestone rip-rap within the ditch between road stations 12+600 and 12+900 was removed, cleaned and replaced over a newly installed bentonite clay mat as part of road construction activities in the area. The work also included a slight widening of the ditch through this section and installation of silt fencing along the base of the shale cut-slope at Blind Corner. Following this work, the rate of sediment accumulation decreased in the ditch.

Additionally, it was also noted from in situ pH measurements within the ditch that acidic waters are collected in the upper portions of the ditch underlying the exposed shale cut-bank. The pH values progressively return to circumneutral levels at the discharge location in part due to contact with limestone rip-rap in the ditch, and potential alkalinity input from groundwater or outflow from the upper cut-off ditch. Orange coating, or mineral precipitate, continued to be observed in the visible limestone. Chemical efficiency of the limestone to buffer acidic water is decreased when coated in precipitate. The formation of mineral scale can concentrate metals from solution as a result of the aqueous acid-base reactions. The mineral scale and sludge is susceptible to scouring and being washed during heavier rain events which has potential to reduce overall water quality being discharged into the Peace River.

The limestone must be regularly maintained through cleaning and descaling. Interim mitigation includes cleaning the limestone rip-rap material within the River Road ditch in a controlled facility where the sludge can be recovered and relocated to an approved RSEM area, and placement of the refreshed limestone in the ditch. Sludge should also be removed from the cistern and transported to an approved RSEM area.

Identification of the source of dissolved aluminum in previous sampling events is hypothesized to be related to fine mineral particulate (<45 µm) that is passing through the field filter as colloid or fine microcrystalline form. Aluminum hydroxide mineral species (e.g., polymorphs of gibbsite or hydrargillite) can form on rock surfaces and can be indicators of acid generating processes under base flow conditions. Locally impacted groundwater may also be seeping into the lower chimney ditch and may contribute to the measured dissolved aluminum concentrations. Similar water quality characteristics are observed in the lower L3 Creek catchment which may indicate that locally impacted groundwater from the exposed shale in the legacy Howe Pit area may be a common contributing factor. BC Hydro is considering options for remediation of this facility.

In December 2017, an options study was being prepared by Tetra Tech for BC Hydro to present various options for management of the limestone rip-rap and for mitigation of the active ARD-ML processes from the shale exposure at Blind Corner along River Road. Options for control of sediment erosion should be considered by BC Hydro to reduce sedimentation into the River Road drainage system from shale slopes and road grading operations. These options will be discussed between Tetra Tech and BC Hydro.

Water quality measurements along River Road indicate that run-off water quality is influenced by active ARD-ML processes within the ditch catchment. Although flows are generally low and ephemeral, there is some potential for run-off to impact downstream water quality. As per CEMP Appendix E Section 5.2.1.7, it is recommended that water quality monitoring is continued on a monthly basis at the established locations within the River Road catchment. Continuous monitoring will enable the effectiveness of mitigation strategies that are implemented on the shale at Blind Corner.

Recommendations for SBIAR Water Quality Monitoring

Recommendations for future sampling include collection of water samples from the pooled water in Area 21, and collection of one up-gradient and one down-gradient water sample from the eastern SBIAR ditch to compare with quality observed from the western ditch samples.

In December 2017, BC Hydro had completed an options study and design for the installation of a cover system over the exposed shale at SBIAR. The system should be installed in 2018.

Evidence of active ARD-ML processes were observed in the shale exposed in the east and west ditch within SBIAR, however, the water quality measured throughout 2017 did not indicate significant impacts due to these processes. Downstream water is collected within the RSEM R6 pond for management prior to discharge into the Peace River. As per CEMP Section 5.2.1.7, since there is low risk of negative downstream effects on water quality, monitoring of water quality within SBIAR may be reduced to a quarterly frequency. BC Hydro may choose to continue monitoring water quality on a monthly frequency in order to measure the effectiveness of the planned cover system.

Recommendations for L3 Creek Water Quality Monitoring

The L3 Creek is not identified as a PAG management area in the CEMP. No PAG materials have been authorized for storage and bedrock is not being exposed or excavated within the catchment as part of the planned construction activities. Monthly water quality monitoring within the L3 Creek catchment was conducted by BC Hydro to maintain a continuous record of water quality within the catchment. Naturally occurring PAG was identified in L4 Creek upstream from construction activities in L3 Creek. Additionally, influence from ARD-ML processes at Howe Pit are observed in the lower portions of L3 Creek between locations LBL3C-1.43 and LBL3C-0.02. Water quality at the creek discharge remained below the BCAWQG-FSTM guidelines.

In December 2017, design was in progress to construct a RSEM facility at Howe Pit to provide additional storage capacity for NAG fill and to cover the exposed shale in Howe Pit. The design received input from Tetra Tech in regards to ARD-ML considerations and for long term monitoring options following placement of fill material.

Based on the 2017 water quality monitoring program there is low risk of significant negative downstream effects on water quality due to ARD-ML processes. As per CEMP Appendix E Section 5.2.1.7, monitoring of water quality for ARD-ML parameters within the L3 Creek catchment may be reduced to a quarterly frequency. BC Hydro may choose to continue monitoring water quality on a monthly frequency in order to measure the influence of the RSEM construction and filling of Howe Pit. An additional monitoring location should be added to any subdrain outlet of the Howe Pit RSEM. Monitoring at location LBL3C-1.65 may need adjustment to accommodate construction activities in the area.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
ARD	Acid Rock Drainage
ARD-ML	Acid Rock Drainage and Metal Leaching
BCAWQG	British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture
FSTM	Freshwater Short Term Maximum
LTA	Long Term Maximum
ML	Metal Leaching
NAG	Not Potentially Acid Generating
PAG	Potentially Acid Generating
RPD	Relative Percent Difference
WQG	Water Quality Guideline

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by BC Hydro (the client) to develop and implement a surface water quality monitoring program at midstream and discharge locations along River Road ditch near Blind Corner and below Howe Pit, in proximity to the South Bank Initial Access Road (SBIAR), and along the L3 Creek catchment. Water sampling locations are shown in the attached Figures 1 through 3, and summarized with UTM coordinates in Table 1.

This report documents the establishment of the water sampling locations and summarizes the sampling events conducted monthly between April and December of 2017. Results of the monitoring program are discussed in context of acid rock drainage and metal leaching (ARD-ML) management and mitigation.

Requirements for the development and implementation of the water quality monitoring programs are mandated under the Environmental Assessment Certificate – Condition 3, and the Federal Decision Statement – Condition 7. Reporting of the program results are required on an annual basis. The requirements described in the BC Hydro Site C Clean Energy Project Construction Environmental Management Plan (CEMP), Revision 4, Appendix E Acid Rock Drainage and Metal Leachate Management Plan, Revision 5.2 (App E) is consistent with the requirements listed,

In accordance with the CEMP App E Section 5.2.1.7, results for the River Road and SBIAR locations were evaluated against the British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture (January 2017) (BCAWQG) freshwater short term maximum (FSTM) values. Water quality measurements recorded at the discharge, or downstream, locations which were in exceedance to the BCAWQG-FSTM were reported to BC Hydro. The water conveyance facilities at River Road ditch near Blind Corner and SBIAR are identified as having potential for direct ARD-ML impacts due to exposure of shale bedrock during construction related activities.

The L3 Creek catchment is not identified as a waterway with potential for ARD-ML impacts arising from construction related activities. Water quality monitoring has been conducted within this catchment to monitor discharge water quality and to maintain a record for potential future use. The BCAWQG-FSTM values were also used as benchmark for monitoring the water quality at the discharge location (LBL3C-0.02) from L3 Creek.

2.0 BACKGROUND

Sampling locations were established in April 2017 by Tetra Tech in conjunction with BC Hydro personnel. Where possible, they are coincident with the locations and nomenclature used in 2016 by Lorax Environmental Services Ltd. (Lorax) on behalf of Peace River Hydro Partners (PRHP). Nomenclature for sampling locations begins with the applicable bank of the Peace River, e.g. Right Bank (RB) and Left Bank (LB).

Water quality sampling was conducted during the third week of each month to support a continuous monitoring record for reportable water quality compliance. The 2017 program was initiated on April 19, 2017, by Tetra Tech and BC Hydro personnel following seasonal frozen conditions to be consistent with the 2016 sampling timing, and was completed on December 20, 2017. Frozen conditions prevailed during November and December, during which time only a single sample was collected from SBIAR-DS on December 4, 2017. Each sampling event was documented by field notes and photographs, including during frozen conditions.

Field notes documented at each monitoring location included date and time of test, measurements for: water temperature, water hardness, water alkalinity, pH, and electrical conductivity; and, estimation of flow and water clarity.

The off-site laboratory analytical program was designed to screen water quality against the BCAWQG-FSTM for surface water and to be commensurate with the Lorax 2016 program with regards to the analytical methods and detection limits. Analysis was conducted for the following parameters:

- Total Metals, Low Level (including Hg);
- Dissolved Metals, Low Level (including Hg);
- Hardness;
- pH;
- Alkalinity: Total/Species (CO_3^{2-} , HCO_3^-, OH^-);
- Solids: Total Suspended (TSS) and Total Dissolved (TDS); and
- Anions: Nitrogen species (nitrite, nitrate, ammonia), Sulphate, Chloride.

2.1 Summary of Parameters of Interest

Some of the key indicators that were monitored during this program are described below. Although these parameters do not have BCAWQG-FSTM guidelines, they can be useful indicators to potential changes in water chemistry related to ARD-ML processes.

Alkalinity and pH are important water quality parameters to indicate the ratio between residual alkalinity and acidity in solution and are key indicators for onset of acidic conditions within neutral to alkaline waters when monitored over time. Neutralization of acidity by carbonate minerals can temporarily increase alkalinity through release of the bicarbonate ion into solution. Bicarbonate will continue to react, and deplete, with any residual acidity. Once all carbonate and bicarbonate sources are depleted, alkalinity no longer is available to neutralize acidity and pH will drop. The BCAWQG-FSTM guideline for pH ranges from 6.5-9.0. There is no guideline for alkalinity.

Water clarity is measured as turbidity (nephelometric turbidity unit, NTU) or as total suspended solids (TSS), which is an indicator of the amount of sediment (generally accepted as silt sized particles and coarser, or >0.45 µm in diameter), contained within the water column. TSS can increase if sediment loading occurs due to erosion, or due to rapid precipitation of secondary minerals from chemical reactions such as neutralization of acidic water. The bulk chemistry of water with high TSS tends to mimic the chemical composition of the source sediment being eroded, or in the case of mineral precipitation tends to be high in iron as iron-oxide minerals are the most common secondary mineral to form. The BCAWQG-FSTM guideline is based on deviations to background TSS.

Measurements such as total dissolved solids (TDS), electrical conductivity (EC) and salinity have similar tendencies and are indicators for the concentration of dissolved metals and ions in solution. Sudden or gradual increases in these parameters can indicate changes in water chemistry such as an increase in reactive ions or dissolved metals as a result of potential metal leaching processes. Changes to these parameters in association with changes to pH or alkalinity may also indicate active metal leaching processes. BCAWQG-FSTM guidelines are not specifically stated for these parameters.

Sulphate concentration can originate from anthropogenic sources, microbial processes and through chemical processes related to degradation of rock forming minerals in environments with potential for acid generation through the oxidation of primary sulphide (e.g., pyrite) or dissolution of sulphate minerals (e.g., gypsum). Elevated sulphate concentrations may indicate oxidation, or weathering, of potentially acid generating (PAG) materials in proximity to sample collection locations. Elevated sulphate with pH > 7.0 may indicate ARD-ML processes with sufficient acid neutralizing materials, whereas sulphate with decreasing pH may indicate a shortage of acid neutralizing materials.

Marine shales such as the local Shaftsbury Formation commonly contain sulphide minerals (mainly pyrite, FeS_2) and may also have primary sulphate minerals such as anhydrite ($CaSO_4$), gypsum ($CaSO_4 \cdot 2H_2O$), or barite ($BaSO_4$), and/or other sulphate minerals. Preliminary characterization determined that the primary sulphur species in the shale was sulphide with some detectable sulphate (Klohn Crippen Berger, 2015). Based on this mineral association and site observations, it is possible that groundwater contacting fractured bedrock would contain naturally elevated sulphate concentrations. Baseline groundwater sampling conducted as part of the project's Environmental Impact Statement (Hemmera Envirochem Inc. and BGC Engineering Inc., 2012) did not indicate groundwater within bedrock at these project locations contained elevated sulphate, however, samples from bedrock within the Main Civil Works area was limited. Tetra Tech did not seek additional information. The guideline value for sulphate is not stated in the BCAWQG-FSTM, however, a long term average guideline value is stated (variable with hardness) and is referenced in this report.

Water hardness (the concentration of calcium and magnesium ions) is known to mitigate the effect of certain metals on aquatic organisms, and the guidelines are presented with equations derived from experimental data for sulphate and numerous metals (cadmium, copper, fluoride, lead, manganese, silver and zinc that tests a range of hardness specific to each metal or sulphate. Water hardness measured on-site is considered hard and is often measured above the guideline threshold used to calculate BCAWQG-FSTM guideline values. The BC Approved WQG Summary Report (2017) states that a site-specific assessment may be necessary when ambient hardness values are outside the range tested in BC's Approved WQGs.

Water quality screening efforts have focused on elements with BCAWQG-FSTM guidelines, which include total concentrations of arsenic, boron, cobalt, copper, iron, lead, manganese, molybdenum, selenium, silver, and zinc, and dissolved concentrations of aluminum, cadmium, and iron.

Changes in concentrations of some elements or metals, reported as both total and dissolved, can have various implications for water quality under ARD-ML conditions. The solubility of individual elements can vary with pH. Geochemical modelling completed by Klohn Crippen Berger (2015) identified copper, cobalt, cadmium and zinc as having high probability of leaching into solution of site water during oxidation of the local shale bedrock under oxic acid rock generating and metal leaching conditions.

Formation of iron-oxide precipitate is the most widely recognized indicator of active ARD-ML processes. Total iron concentrations are associated with ARD-ML due to liberation of ferric iron from the oxidation of primary iron bearing sulphides. Subsequent formation of iron-oxide or iron hydroxides minerals can precipitate when acidic waters are neutralized and may be present as suspended solids or can form scaling on reactive surfaces such as limestone.

Aluminum concentration is abundant in rock forming minerals and can be released as part of oxidation and degradation of rocks during ARD-ML processes. Aluminum is soluble in acidic water and is typically not soluble in neutral and alkaline waters. When concentrations of aluminum are measured in detectible concentrations in neutral or alkaline water, it is possible that the formation of very fine aluminum hydroxide clays may occur in previously acidic waters that have been neutralized. Aluminum hydroxide mineral species (e.g., polymorphs of gibbsite or hydrargillite) can form on rock surfaces and are indicators of acid generating conditions.

Concentrations of aluminum, iron and copper are typically low in neutral pH drainage, however, elements such as antimony, arsenic, cadmium, molybdenum, selenium, and zinc can be present in neutral pH drainage.

Under BC's Approved WQG's, the intention of long term average (LTA; i.e., "chronic") WQG's are for the protection of the most sensitive species and life stage against sub-lethal and lethal effects for indefinite explores, and uses an averaging period, whereas the short term maximum (STM; i.e., “acute”) WQG’s are intended to protect against severe effects, e.g. lethality, to the most sensitive species and life stage over a defined short term exposure period approach (BC Approved WQG Summary Report, 2017). Working water quality guidelines (WWQG) have not been assessed as part of this monitoring program.

The sampling program in each area is briefly described in the following sections.

2.2 Description of River Road Sample Locations

Nine monitoring locations were established along the River Road ditch between road stations 12+400 and 12+920 and within the lower chimney ditch draining surface water from a cut-off ditch on the Howe Pit bench. In situ testing was conducted at all locations to monitor the effectiveness of the limestone rip-rap, and to observe longer term influences from the PAG outcrop at Blind Corner and run-off/seepage from Howe Pit on run-off water within the River Road catchment.

Laboratory and in situ testing was conducted at three of these nine locations to understand water quality prior to mixing and discharging into the Peace River. These three locations are located: in the lower chimney drain (LBRR-LC), upstream of the lower chimney drain within the River Road ditch (LBRR-12+500), and at the discharge of culvert RR-11 (LBRR-DD).

The monitoring locations are shown in Figure 1 and photos of the locations established in April 2017 are included in the Photographs (Photos 1 to 3) section of the Appendix.

2.3 Description of South Bank Initial Access Road Locations

Two monitoring locations were established to monitor water quality flowing within the western ditch of the SBIAR road cut. These locations allow for monitoring of water quality and potential impacts of the exposed PAG cut-slope by comparison of the downstream location (RBSBIAR-DS) to the upstream location (RBSBIAR-US). A third monitoring location was established in the side channel down-gradient of the SBIAR facility (RBSC-DS) to monitor for potential long term influence of the side channel water quality from construction of the SBIAR facility. The side channel is hydraulically connected to the Peace River.

In situ and laboratory analysis were conducted at all three locations.

In July, it was observed that two large diameter PVC pipes had been installed within the SBIAR ditch between locations RBSBIAR-US and RBSBIAR-DS which conveyed water from a pond in Area 21 acting as catchment for water from gravel washing operations. Scouring of the original ditch line and cut-slope led to bolstering of the ditch with installation of a bentonite clay mat and rip-rap materials. This additional input of water was generally noted as being turbid, and increased flows at the RBSBIAR-DS location. Additionally, the ponded water in Area 21 is an unlined facility permitting infiltration though the shale resulting in seeps through the western cut-slope. This moist and oxygenated seepage is likely to accelerate ARD processes.

It is noted that the water flowing from RBSBIAR-DS does not have a direct downstream receptor. Prior to the July 24th sampling event, water passing the downstream monitoring location (RBSBIAR-DS) flowed directly into a temporary polyethylene lined pond via a limestone rip-rap spillway prior to being transported to the RSEM R6 pond by hydrovac truck for management prior to discharge. From the July sampling event onwards, water passing the RBSBIAR-DS location was collected by a pipe and conveyed directly to the RSEM pond for management prior to discharge.

The monitoring locations are shown in Figure 2 and photos of the locations established in April 2017 are included in the Photographs (Photos 4 to 6) section of the Appendix.

2.4 Description of L3 Catchment Sample Locations

The catchment for L3 Creek includes RSEM L3 which is currently not considered, nor permitted, for placement of construction related PAG material. Due to potential influence on discharge water quality from the Howe Pit area and inflow from L4 Creek, the water quality within the L3 Creek catchment is being monitored in context of ARD-ML management.

Three monitoring locations were established in April 2017, within the L3 Creek catchment to characterize water quality along the creek and at the discharge location. A baseline location up-gradient of RSEM L3 (LBL3C-3.32) is 3.32 km from the L3 Creek discharge location. The midstream location below the confluence of L4 Creek and below the Gulley Road box culvert (LBL3C-1.43) is 1.43 km from the L3 Creek discharge location and monitored to characterize water quality at the downstream discharge location at culvert RR-10 (LBL3C-0.02), located 20 metres from the L3 Creek discharge location, and is used as a proxy for discharge water quality.

L4 Creek is a naturally incised gully which is located at the downstream extremity of the catchment where the future 85th Ave Industrial Lands gravel quarry will be constructed for the project. During the May 2017 sampling event, two additional monitoring locations were added to assess inputs from water flowing from L4 Creek into L3 Creek. These two monitoring locations were established in 1) L4 Creek, 180 metres upstream from the confluence with L3 Creek (LBL4C-0.18), and in 2) L3 Creek upstream of the confluence with L4 Creek (LBL3C-1.65) that is 1.65 km from the L3 Creek discharge location. Comparison of the measurements from these monitoring locations were used to characterize the mixed waters monitored at the pre-existing downstream location LBL3C-1.43.

The monitoring locations are shown in Figure 3 and a photo of one representative location established in April 2017 is included in the Photographs (Photo 7) section of the Appendix.

3.0 LOCAL CONDITIONS

3.1 Weather Conditions – Temperature and Precipitation

The mean, minimum and maximum daily and preceding seven-day temperature range, and the mean precipitation measured for the preceding seven days, day prior to and day of each sampling event between April and December, 2017, was collected from BC Hydro's Site C Meteorological and Air Quality Stations (Figure 4), specifically Station 7C Site C North Camp (June to December, 2017) and Station 1 Attachie Flat Upper Terrace (April and May, 2017 due to no precipitation data available at Station 7C during this period) , summarized in Table 2 (BC Hydro, 2017). During sampling events between April and December 2017, mean temperatures ranged from -18.4 °C (November 21st) to +14.7 °C (July 18th). Range of minimum temperatures on sampling events ranged from -20.7 °C (November 21st) to +10.4 °C (August 24th), whereas range of maximum temperatures on sampling events ranged from -15.6 °C (November 21st) to +21.7 °C (July 18th). Sampling events in August and October 2017 were coincident with precipitation. The August sampling event followed the driest conditions in the previous seven days to sampling, and May had the highest precipitation in the previous seven days to sampling.

Residence time for water is low in the SBIAR and River ditches due to their small catchment size. The climate data was used to evaluate water availability and potential water source for flows that were observed in the ditches.

3.1.1 Classification of Seasonal Flows in Ditch

The flows in ditches at SBIAR and River Road are susceptible to seasonal change and flow rate is highly influenced by local precipitation events, thus the classification of flow in ditches can assist to interpret the source and subsequent chemical fluctuations in water sampled. For example, seasonal flows in ditches can be attributed to shallow or regional groundwater, spring freshet or surface run-off, dependant on the season and amount of precipitation recorded in the previous 24-hours and 7-days to the sampling event. This association may be less apparent in L3 Creek due to a larger catchment size and residence time for water within the drainage, however, it is interpreted that similar trends may be observed.

Regional bedrock groundwater in locations sampled are suspected to have elevated concentrations of dissolved sulphates due to groundwater interaction with local pyritic-shale bedrock, and may, to some degree, be responsible for the high sulphate-content pervasive in water sampled following minimal precipitation during the previous 7-day and 24-hours to the sampling event (e.g., August 24, 2017). When significant precipitation has occurred in the previous 7-days, but minimal precipitation within the prior 24-hour period to the sampling event, the flows in ditches can result from shallow groundwater flow, mainly through unconsolidated overburden. During spring freshet and snow melt, sampling events (e.g., May 18, 2017) can be classified as such to have a 'dilution' effect to the water chemistry sampled in this season. To the contrary, during more arid seasons with little to no precipitation occurring in the previous 7-days and 24-hours (e.g., August 24th and October 24th, 2017), flows in ditches can be attributed to surface run-off. In this event, when precipitation and sampling occurs following dry periods, the surface chemistry of the rocks will be washed into the ditches and be concentrated. Heavy rain fall events coincident to sampling events produce increased turbidity and flow in the ditches, which have short term effects on measurements such as TDS, TSS and potentially total metal concentrations from flushing of exposed slopes and ditch fill material.

The classification of seasonal flows in ditches (Table 3), therefore, are important to consider when interpreting fluctuations and exceedances in parameters measured in water quality guidelines over the period of one year.

3.2 Peace River Turbidity and TSS (Total Suspended Sediment)

Turbidity of the Peace River is monitored by BC Hydro through a series of data loggers situated both upstream and downstream of the Main Civil Works (MCW) construction area. Time series data collected on the left and right banks of the Peace River up-gradient of the Moberly River (stations PAM-LB and PAM-RB, respectively) were provided to Tetra Tech by Ecofish Research Ltd. (Ecofish) to provide general understanding of influence by precipitation on natural sediment concentration within the Peace River upflow from the construction area during and following water quality monitoring events.

The data include turbidity measurements for the day prior, during, and day following the April through October sampling events in 2017 (Table 4). The turbidity data is converted to a value representing total suspended solids (TSS) using a preliminary factor of 3.14, developed by Ecofish using calibration of field measurements with laboratory data. Although the data have undergone initial verification and review for quality assurance, measurements may still have drift corrections applied, therefore, the TSS-turbidity relationship will be updated following sample collection over all range of river conditions during freshet in 2018. Subsequent quality assurance and verification procedures may result in differences between what is currently provided and what will become the official record.

4.0 WATER QUALITY MONITORING PROGRAM

A summary of each water quality sampling event and corresponding analytical results were reported monthly to BC Hydro in a routine memo for six sampling events during 2017: April 19, May 18, July 18, August 24, September 21 and October 24. A routine memo was not submitted for June and none were developed in November and December due to frozen conditions on-site. One sample collected on December 4, 2017, was not reported on. Laboratory results reported from the discharge or final downstream monitoring location in each catchment were evaluated against the BCAWQG-FSTM guidelines (Appendix B, Table B1). Results from the upstream and midstream locations were used to evaluate ambient conditions and to characterize the results at the discharge, or downstream, locations (Appendix B, Tables B2 to B4). The results for each location (River Road, South Bank Initial Access Road, and L3 Creek) are provided in Appendix B (Tables B2 to B4).

4.1 Quality Control and Quality Assurance Program

4.1.1 Tetra Tech QA/QC

The Quality Control (QC) program included experienced field staff familiar with the water quality monitoring program adhering to the British Columbia Field Sampling Manual, Part E: Water and Wastewater Sampling (Clark, 2003). New sample containers were acquired from the laboratory the day preceding the sampling event and all handling of the containers, sampling devices and equipment during sample collection was completed wearing new nitrile gloves to minimize potential for contamination of the samples. A new disposable syringe and 0.45 µm filter were used for each sample being submitted for dissolved metals, except when the concentration of TSS was observed as being high and field filtration was not possible. Samples not filtered and preserved in the field were identified and filtered at the laboratory. All samples were stored in a cooler filled with ice packs at a temperature between approximately 4°C and 8°C.

The Quality Assurance (QA) program incorporated use of a Travel Blank, Field Blank and replicate sample to test for potential contamination during sample collection, handling or laboratory preparation, and to evaluate the precision of laboratory analysis. Table 5 lists the results of the QA program.

The analytical results of these samples were reviewed by Tetra Tech, and if potential contamination or concerns with analytical results were identified, they were discussed with the laboratory and the samples were re-analyzed for verification. Blank samples were considered to ‘fail’ where any measured value was in concentrations above the reported detection limits for that parameter.

Replicate samples were evaluated using relative percent difference (RPD), where an RPD value of less than 30% is considered an acceptable threshold for variation of surface waters.

Tetra Tech also reviewed the data for more general anomalies and inconsistencies. The total and dissolved concentrations for the full suite of elements were compared and it was noted that there were frequent occurrences where the dissolved concentrations exceeded the total concentration. The results were screened for analytical error, then assessed for expected natural variability of surface waters. Most instances were due to measurements at low detection, and could be explained by falling within an acceptable range of error up to five times the lower detection limit for the respective element. Here, the total concentrations are considered equal to the dissolved concentrations.

4.1.2 Laboratory QA/QC

ALS Laboratories was used as the principle laboratory for sample analysis. In July, a set of replicate samples were sent to an independent umpire lab, Maxxam Analytics, to verify the analytical results received from ALS. The results reproduced well with values falling within an acceptable range of 30% RPD. Certificates of Analysis from ALS Laboratories and Maxxam Analytics are provided in Appendix C1 to C9.

The lab implements a detailed QC program into the sample analysis which includes a series of checks and evaluations for consistency in the sample analysis. The QC program includes method blanks, certified reference materials, laboratory control samples and duplicates. The QC Lot reported on Assay Certificates consistently met internal ALS Data Quality Objectives.

4.2 River Road Water Sampling

There was sufficient flowing water for samples to be collected in April, May, June, July, September, and October at the LBRR-DD and LBRR-LC locations, and in June, July and October at the LB-12+500 location. Dry conditions prevailed in August at all locations, and low flow to dry conditions prevented reliable sampling at the LBRR-12+500 location in April, May and September. In situ measurements were not collected from each station every month due to dry (August) or frozen (November and December) conditions. Field observations were documented each month. Two previous sampling events completed by Lorax in October and November 2016, are included in the attached time series charts (Figures 5 to 9) for continuity but are not discussed in this report.

4.2.1 In Situ Measurements and Field Observations

Values for water temperature, pH, total alkalinity and electrical conductivity measured at the River Road monitoring locations are included in Table 6. The range in water temperatures at LBRR-DD (6.3 – 24.4 °C), LBRR-LC (6.7 – 23.3 °C), LBRR-UC (6.1 – 18.6 °C), and LBRR-12+500 (5.9 – 19.3 °C), were recorded during 2017. The range in pH measured at LBRR-DD was 8.09 to 8.80, at LBRR-LC was 8.06 to 8.90 and at LB-12+500 was 7.67 to 8.60. The range in alkalinity at LBRR-DD was 80 to >240 ppm, at LBRR-LC was 40 to >240 ppm and at LB-12+500 was 80 to >240 ppm.

The collection ditch on the cut-bank (north) side of River Road between approximately 12+340 and 12+960 (Blind Corner) has been lined with limestone rip-rap to assist in mitigating potential effects of acid rock drainage (ARD) and metal leaching (ML) from potentially acid generating (PAG) bedrock which was exposed during the initial road construction in 2015 and early 2016. Potentially acidic leachate generated from the rock cut-slopes reacts with the alkaline limestone to help neutralize water as it passes through the rip-rap lined ditch. The ditch also serves to convey run-off water and fine sediment shed from River Road prior to discharging through culvert RR-11 into the Peace River.

Location LBRR-12+920 is located immediately up-gradient of the upper cut-off chimney and PAG exposure, whereas LBRR-12+810 is located immediately down-gradient the upper cut-off chimney and sits below the PAG exposure at Blind Corner. Notable decrease in water pH and alkalinity generally occurs between these stations with a gradual recovery from acidic to circumneutral pH and available alkalinity towards location 12+500. This trend is interpreted to be related to PAG contact waters draining into the ditch from location 12+810 and 12+700, and the increasing trending related to effects of limestone rip-rap within the ditch in additional to influence from alkaline run-off from the lower cut-off chimney near location 12+500.

The limestone is effective at mitigating the pH of the drainage when there are fresh surfaces of limestone available for chemical reactions. The limestone material used as rip-rap along this road section has become progressively coated with a mineral precipitate (visually estimated as iron-oxides and aluminum hydroxides) due to chemical neutralization reactions, and encased by sludge due to settlement of suspended solids within the water. Additionally, the roadside portion of the ditch, particularly from LBRR-12+600 downstream to the discharge at LBRR-DD, is being encroached with sand and gravel sediment from grading activities on River Road which covers the limestone, further reducing its exposure. The effectiveness of the limestone to provide the neutralizing potential is considered to be negatively compromised by these coatings.

In June 2017, the limestone rip-rap within the ditch between road stations 12+600 and 12+900 was removed, cleaned and replaced over a newly installed bentonite clay mat as part of road construction activities in the area. The work also included a slight widening of the ditch through this section and installation of silt fencing along the base of the shale cut-slope at Blind Corner. Sediment accumulation in this portion of the ditch was observed to be minimal during subsequent months.

Flows within the River Road ditch are ephemeral and baseline flow observed at the discharge is generally contributed by outflow from LBRR-LC. At the discharge location, flows were dry to an estimated maximum of 1 L/s, with exception to flows during onset of a heavy rain event coincided with sampling at River Road on October 13, 2017. This unique event estimated a flow of 3 L/s at the time of sampling at the discharge of culvert RR-11, location LBRR-DD, Air temperatures were 13°C and water temperatures were 6°C. The water in the ditch was as turbid and total suspended sediment (TSS) measurements at the LBRR-DD location were 11,900 mg/L, which is considered to be exceptionally high. The source of TSS is primarily from River Road run-off, scouring of sediment deposited within the River Road ditch and washing from the cut-slopes. Numerous elevated total metal concentrations measured from this October sampling event are interpreted to be directly related to washing, or flushing, of sediment and secondary mineral precipitant as the initial pulse of heavy rains contacted the accumulated sediment within the ditch in addition to the exposed shale, colluvium and overburden cut-banks. These conditions are interpreted to have been temporary and not reflective of water quality throughout the duration of the precipitation event. The pH values measured at the LBRR-DD discharge were slightly alkaline, with in situ pH equal to 8.30 (laboratory pH equal to 7.47).

4.2.2 Short Term Maximum Exceedances

Concentrations of total iron, dissolved aluminum, arsenic, cobalt, copper, silver, zinc, and chloride were measured above the BCAWQG-FSTM guidelines within the catchment. At the discharge location (LBRR-DD), exceedances were reported at least once over the 2017 sampling period for chloride, total arsenic, cobalt, copper, lead, silver, zinc, and dissolved aluminum. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 7, and the screening results based on the laboratory data are tabulated in Appendix B2.

4.2.3 Trend Monitoring

Monthly water quality monitoring measures instantaneous ambient conditions at the time of sampling and as discussed in Section 3.1 the measurements are highly susceptible to temporal climate conditions due to the small catchment and short residence time of water within the River Road ditch. Results have not been screened relative the BCAWQG-LTA (long term average) guidelines. Insufficient event data characterizing the influences of seasonal conditions at the site exist to observe true long term averages. Recurring trends over multiple months may be indicative of long term trends, and are discussed below for measured parameters for alkalinity and pH (Figure 5), TSS and TDS (Figure 6), sulphate (Figure 7), aluminum (Figure 8), and iron (Figure 9).

4.2.3.1 Alkalinity and pH

Alkalinity and pH values indicated relatively consistent values of slightly alkaline water at all three River Road locations (LBRR-DD, LBRR-LC, LBRR-12+500) since April 2017 (Figure 5) with deviation to the trend measured in October 2017. Measured pH ranged between 7.47 and 8.33 with mean of 8.16, and total alkalinity ranges between 188 and 749 mg/L $CaCO_3$ equivalent with mean value of 292 mg/L $CaCO_3$ equivalent.

Limited measurements collected at the midstream LBRR-12+500 station indicate a slight gradual decrease in pH towards circumneutral conditions and an increase in alkalinity between the two possible July and October sampling event. This trend indicates an increase in acidity from upstream waters over the monitoring period.

Both the alkalinity and pH at LBRR-LC measure a decrease in October 2017 relative to previously consistent trends observed from April to September 2017.

Following relatively consistent trends at the LBRR-DD location between April and September 2017, the alkalinity increased significantly, yet pH decreased slightly to 7.47 for the October 24th, 2017 sampling event. This is a combined effect from less alkalinity being provided from LBRR-LC and increased acidity from LBRR-12+500 relative to previous sampling events.

4.2.3.2 Total Suspended Sediment and Total Dissolved Sediment

The annual trend for TSS values at LBRR-DD indicate an overall decreasing trend through to September with a spike associated with the October sampling event (Figure 6). TSS measured at LBRR-12+500 and LBRR-LC followed a similar trend, with a subtle apparent overall increase at LBRR-12+500 between July and October. TSS measurements at LBRR-DD ranged between 5 to 11,900 mg/L with mean value of 1,992 mg/L.

The annual trend for TDS values at LBRR-DD shows an overall decrease through to September with a spike associated with the October sampling event. TDS measured in LBRR-12+500 and LBRR-LC followed similar trends, with a subtle overall increase apparent at LBRR-12+500 between July and October. TDS measurements at LBRR-DD ranged between 853 to 3,740 mg/L with mean value of 1,402 mg/L.

Measurements of elevated TSS within the River Road ditch, as observed at the LBRR-12+500 location, are attributed primarily to surface run-off from River Road, scouring of sediment deposited within the River Road ditch, and washing from the cut-slopes. Relative to previous months with drier conditions, the onset of precipitation and increasing flows in the catchment coincident with the October 24th, 2017, sampling event resulted in a significant increase of TSS at LBRR-DD in October 2017.

4.2.3.3 Sulphate

Sulphate concentration data collected in 2017 was variable within the River Road catchment, showing an overall decrease at LBRR-DD, overall increase at LBRR-LC and apparent overall increase at the LBRR-12+500 location due to the paucity of available samples in 2017 (Figure 7). Sulphate concentrations measured at the LBRR-DD location ranged from 358 to 554 mg/L with mean value of 437 mg/L.

A possible seasonal trend is observed, whereby at LBRR-DD, a ‘convex’ trend with lower concentrations measured in May and October versus higher concentrations measured in June and July. The opposite “concave” trend is noted for the LBRR-LC location, with higher concentrations measured in May and September/October versus lower concentrations in June and July 2017.

The origin of sulphate is uncertain and could be related to seepage of high sulphate groundwater, or local oxidation of sulphide minerals in exposed shale.

4.2.3.4 Total and Dissolved Aluminum

Total and dissolved aluminum concentrations show monthly variability during the 2017 sampling events, however, an overall increase of total aluminum is observed throughout the monitoring period (Figure 8). To the contrary, between July and October 2017, the River Road locations (LBRR-DD, LBRR-LC, and LBRR-12+500) have progressively decreasing measurements of dissolved aluminum. Total aluminum concentrations measured at

LBRR-DD ranged from 137 to 128,000 µg/L with mean value of 21.7 mg/L and dissolved aluminum ranged from 20 to 279 µg/L with mean value of 128 µg/L.

Dissolved aluminum concentrations at LBRR-DD and LBRR-LC dropped to below BCAWQ-FSTM guidelines for the October 24, 2017 sampling event, following a prior trend of elevated dissolved aluminum measurements (above the aforementioned guidelines) in the July and September of 2017 sampling events. Relative to water sampling events at LBRR-DD from the autumn of 2016, total aluminum has been more variable (overall increasing) than dissolved aluminum (overall decreasing) during 2017.

Accumulations of white and orange microcrystalline minerals were observed on exposed shale within the upper cut-off ditch on the Howe Pit area bench in August 2017. These minerals are potentially aluminum and iron hydroxide minerals (e.g., polymorphs of gibbsite or hydrargillite) which can form on rock surfaces and can be indicators of acid generating processes. The source of dissolved aluminum being measured in LBRR-LC is hypothesized to be related to suspension of these fine mineral particulate (<45um) that is passing through the field filter as colloid or fine microcrystalline form. Two high level filtration tests were undertaken at ALS in September and October, respectively, which evaluated water chemistry of water samples filtered at the standard 0.45um filter and using a finer 0.10um filter. The results of the first filtration test were inconclusive, and the results of the second filtration test did suggest that approximately 60% of the reported dissolved aluminum was captured between the 0.45um and 0.10um filters. More work would be required to substantiate this observation.

Locally impacted groundwater may also be seeping into the lower chimney ditch and may contribute to the measured dissolved aluminum concentrations. Similar water quality characteristics are observed in the lower L3 Creek catchment which may indicate that locally impacted groundwater from the exposed shale in the legacy Howe Pit area may be a common contributing factor to the downstream water quality.

4.2.3.5 Total and Dissolved Iron

Total iron concentrations measured an overall increase during the monitoring period (Figure 9), with concentrations at the LBRR-DD location ranging between 0.231 to 389.0 mg/L with mean value 65.5 mg/L. Due to extremely elevated TSS in October's sampling event the mean value is positively skewed. The samples collected at LBRR-12+500 and LBRR-DD were filtered in the laboratory rather than in the field for the October event.

Dissolved iron concentrations measured at LBRR-DD were at or below detection limit of 30 µg/L during the monitoring period. In 2017, elevated concentrations of dissolved iron were most prominent at the LBRR-LC location.

Due to low flows during the July and September events, the total iron was attributed to bottom sediment intake into the sampling device.

4.2.3.6 Hardness

Water hardness consistently measured above the upper bound (250 mg/L) used by the BCAWQG-FSTM to guide criteria for metal concentrations (Appendix B, Table B2). This value is based on toxicity tests and adapted by the Canadian Council of Ministers of the Environment (BCAWQG Summary Report, 2017). A site-specific assessment may be required since the water hardness exceeds the highest hardness tested (250 mg/L) in BC (BCAWQG Summary Report, 2017, pg. 32). Hardness concentration measured at LBRR-DD ranged between 583 and 2,360 mg/L with a mean value 914 mg/L.

4.3 SBIAR Water Sampling

Sufficient flowing water permitted samples to be collected each month from April through October from all three monitoring locations RBSBIAR-US, RBSBIAR-DS and RBSC-DS. Frozen conditions prevailed November and December. Due to continued water conveyance into the SBIAR ditch from the area, one sample was collected from the RBSBIAR-DS location on Dec 4, 2017. Field observations were documented each month.

4.3.1 In Situ Measurements and Field Observations

Values for water temperature, pH, total alkalinity and electrical conductivity measured at the SBIAR monitoring locations are included in Table 8. Flows in the SBIAR ditch system can vary from the upstream (-US) to downstream (-DS) location with flows of approximately 0.25 L/s to 10 L/s, respectively (Table 8). Piped inputs continued to be received from a catchment pond in Area 21, situated between the upstream and downstream locations. Water is collected near the downstream (RBSBIAR-DS) location, then conveyed to the RSEM R6 pond for management prior to discharging into the Peace River.

RBSC-DS is located in the side channel with connectivity to the Peace River where stagnant to minimal “flow” is usually observed. Water levels at RBSC-DS are coincident with the actual levels of the Peace River. Table 4 shows the measured upstream turbidity, and converted TSS concentrations, within the Peace River. Increased turbidity measured in the Peace River results from precipitation events which can be correlated with TSS measurements collected from RBSC-DS. Thus, TSS measured at the RBSC-DS location (Figure 10) are interpreted to be attributable to, or directly influenced by, the in-river turbidity measurements (Table 4). Algae was occasionally (August 24 and October 24, 2017) observed in the samples at RBSBIAR-US. The range in water temperatures at RBSBIAR-US (7.6 – 19.6 °C), RBSBIAR-DS (0.3 – 20.0 °C), and RBSC-DS (5.7 – 16.2 °C), were recorded during 2017.

4.3.2 Short Term Maximum Exceedances

Concentrations of total iron and dissolved iron were measured above the BCAWQG-FSTM guidelines within the catchment. At the downstream location (RBSBIAR-DS), exceedances were reported for total iron.

Total and dissolved iron were in exceedance of BCAWQG-FSTM guidelines in September and October 2017, at RBSC-DS which is in the Peace River side channel at the base of SBIAR. This location is sampled as a verification point to check for potential leakage from, or direct connectivity with, the SBIAR PAG contact water with the side channel. This exceedance is not considered to be influenced by construction related PAG contact water.

A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 9, and the screening results based on the laboratory data are tabulated in Appendix B, Table B3.

4.3.3 Trend Monitoring

Monthly water quality monitoring measures instantaneous ambient conditions at the time of sampling and, as discussed in Section 3.1, the measurements are highly susceptible to temporal climate conditions due to the small catchment and short residence time of water with the SBIAR ditch. Results have not been screened relative the BCAWQG-LTA guidelines. Insufficient event data characterizing the influences of seasonal conditions at the site exist to observe true long term averages. Recurring trends over multiple months may be indicative of long term trends, and are discussed below for measured parameters for TSS and TDS (Figure 10), alkalinity and pH (Figure 11), sulphate (Figure 12), iron (Figure 13), and aluminum (Figure 14).

As described in Section 2.2, water conveyed from Area 21 into the SBIAR ditch has likely influenced water quality measurements collected at RBSBIAR-DS since July 2017, mainly seen as dilution and concentration of TSS. As such, comparison of measurements from the upstream location (RBSBIAR-US) and downstream location (RBSBIAR-DS) are interpreted as only being indicative of potential changes in water quality caused by contact with PAG within the SBIAR facility.

4.3.3.1 Total Suspended Sediment (TSS) and Total Dissolved Sediment (TDS)

TSS measurements at the RBSBIAR-DS and –US locations are generally correlated, and show a wide variation over the 2017 sampling period (Figure 10). The overall variability in TSS is attributable to the relative small catchment and short residence time of waters within the SBIAR ditch and sensitivity to flux in surface water inputs from precipitation or uncontrolled inputs from Area 21. TSS concentrations measured at RBSBIAR-DS range between <3.0 and 443 mg/L with mean value of 97.2 mg/L, and measured TDS concentrations ranged between 10.9 and 428 mg/L with mean value of 310.7 mg/L. TSS measured in December 2017 was anomalously high for the year likely due to water conveyed from Area 21.

Measured TSS values within the RBSC-DS ranged between <3.0 and 10.4 mg/L with mean value of 6.3 mg/L. TSS does not appear to have a direct correlation with the SBIAR monitoring and follows a much more subdued range of variability. Measured TDS values within the RBSC-DS ranged between 507 and 2480 mg/L with mean value of 1324.3 mg/L showing a wide variability with peak values observed in the July sampling event. TDS does not appear to have a direct correlation with the SBIAR monitoring.

4.3.3.2 Alkalinity and pH

Alkalinity and pH values indicate that waters have remained alkaline since the April 2017, sampling event (Figure 11). A slight reduction in pH is observed at both the upstream and downstream location. Values for pH measured at RBSBIAR-DS range between 8.15 and 8.55 with a mean pH value of 8.29 (Table 10). Alkalinity trends between the upstream and downstream monitoring location have shown an overall decrease, and show a positive correlation at both stations, with the exception of the August sampling event where increased alkalinity at the upstream location was associated with decreased alkalinity at the downstream location, relative to previous months. Alkalinity at the downstream location has been trending upwards since August 2017. Values for alkalinity at RBSBIAR-DS range between 125 mg/L and 261 mg/L $CaCO_3$ equivalent with mean value of 209.5 mg/L $CaCO_3$ equivalent (Table 10).

Measured pH at the side channel location RBSC-DS range between 7.6 and 8.3 with mean value of 8.0, and alkalinity range between 226 and 395 mg/L $CaCO_3$ equivalent with mean value of 326 mg/L $CaCO_3$ equivalent. There is low to negligible correlation observed between pH and alkalinity between the side channel and the SBIAR waters.

4.3.3.3 Sulphate

Sulphate values measured at RBSBIAR-DS and –US locations remained consistently low (Figure 12). Sulphate concentrations measured at RBSBIAR-DS ranged between 23.1 and 88.4 mg/L with mean value of 65.3 mg/L. It can be observed that sulphate concentrations at the –DS location observed to be slightly higher compared to the –US for each sampling event, indicating a net increase in sulphate from groundwater seepage, local shale run-off or inputs form Area 21.

Measured sulphate concentrations at the RBSC-DS location varied widely within range between 343 and 1530 mg/L with mean value of 747.7 mg/L. A seasonal trend may be evident whereby concentration increased between May and July, then decreased between July and September, coincidentally showing a similar trend to TSS at only the

RBSC-DS location. Sulphate concentrations at RBSC-DS do not appear to have a direct correlation with the SBIAR monitoring.

The BCAWQG-LTA guideline for sulphate is variable with ambient hardness for each sample location. The LTA is plotted on Figure 12 for the RBSBIAR-DS location, for reference.

4.3.3.4 Hardness

Water hardness measured at RBSBIAR-DS was often above the upper threshold used by the BCAWQG-FSTM to guide criteria for various metal or element concentrations, with values ranging between 118 and 293 mg/L with mean value of 211.4 mg/L. These ambient water hardness values are consistent with measurements collected from other catchments on-site and are likely characteristic of background conditions.

4.3.3.5 Total and Dissolved Iron

Total iron concentrations are variable during the monitoring period (Figure 13), with concentrations at the RBSBIAR-DS location ranging between <0.03 to 2.24 mg/L with mean value 0.825 mg/L.

Dissolved iron concentrations measured at RBSBIAR-DS remained below detection limit of 30 µg/L during the monitoring period.

In 2017, at the RBSC-DS location, elevated concentrations of dissolved iron were measured between June and October, but most prominently during the September and October sampling events. Measured dissolved iron concentrations at the RBSC-DS location ranged between <0.03 and 1.15 mg/L with mean value of 0.386 mg/L.

4.3.3.6 Total and Dissolved Aluminum

Total aluminum concentrations show monthly variability during the 2017 sampling events, however, an overall decrease of total aluminum at RBSBIAR-DS is observed throughout the monitoring period (Figure 14). Total aluminum concentrations measured at RBSBIAR-DS ranged from 0.0179 to 1.68 mg/L with mean value of 0.444 mg/L. At RBSBIAR-DS, dissolved aluminum concentrations remained below the BCAWQ-FSTM guideline value (100.0 µg/L) and measurements ranged from <5.0 to 50.9 µg/L with a mean value of 0.0204 mg/L.

An overall decrease of total aluminum at RBSBIAR-US is observed throughout the monitoring period of 2017. Dissolved aluminum concentrations at RBSBIAR-US remained consistently below detection limit of 5.0 µg/L, and significantly below the BCAWQ-FSTM guideline value of 100.0 µg/L for the duration of sampling events in 2017.

A slight overall increase in total aluminum is measured at the RBSC-DS location during the monitoring period of 2017. Dissolved aluminum concentrations at RBSC-DS remained consistently below detection limit of 5.0 µg/L, and significantly below the BCAWQ-FSTM guideline value of 100.0 µg/L for the duration of sampling events in 2017.

It was noted that dissolved aluminum was more variable at RBSBIAR-DS than at RBSBIAR-US and RBSC-DS, with a general increase measured between April and August followed by a decreasing trend between August and December 2017.

4.4 L3 Creek Catchment Water Sampling

Sufficient flowing water permitted samples to be collected each month from April through October for monitoring locations LBL3C-0.02 and LBL3C-1.43; in May, June and July from location LBL3C-1.65; in April, May, June and July from location LBL3C-3.32; and in May, June and July from LBL4C-0.18. Frozen conditions prevailed in

November and December. Due to construction related activities at LBL3C-1.65, samples were unable to be collected at this location since July. Field observations were documented each month.

The L3 Creek catchment is not being monitored as a construction related PAG waterway. Water quality monitoring has been conducted within this catchment to monitor discharge water quality and to maintain a record for potential future use. The BCAWQG-FSTM values were also used as benchmark for monitoring the water quality the discharge location (LBL3C-0.02) from L3 Creek.

4.4.1 In Situ Measurements and Field Observations

Water flow estimated during water sampling events in 2017 range between 1.0 L/s (August) and 20.0 L/s from the LBL3C-0.02 location into the RR-10 culvert. Upstream water flow was estimated to range between 0.0 and 10.0 L/s at the LBL3C-1.43 site (Table 11).

In October 2017, the upstream sample (LBL3C-3.32) was collected later than the downstream samples (due to accessibility) following onset of a heavy precipitation event.

The range in water temperatures at LBL3C-0.02 (5.8 – 15.1 °C), LBL3C-1.43 (4.3 – 16.1 °C), LBL3C-1.65 (11.7 – 16.3 °C), LBL3C-3.32 (4.6 – 19.6 °C), and LBL4C-0.18 (11.0 – 12.7 °C), were recorded during 2017 (Table 11).

4.4.1.1 Reconnaissance Investigation of L4 Creek

Reconnaissance investigation of L4 Creek conducted in September 2017, revealed naturally exposed shale bedrock at the base of the incised creek valley in contact with flowing creek water. In situ aqueous pH measurements were collected at 50 metre spaced intervals between the exposed shale in L4 Creek and the downstream confluence of L4 Creek with L3 Creek. The pH values ranged from 4.17 to 5.75. A pH value of 8.5 was measured immediately downstream of the confluence of the two Creeks.

The investigation aimed to explain the occurrence of metal concentrations, including arsenic, copper, cobalt and zinc, that were measured above detectible concentrations in the downstream location LBL3C-1.43 but were absent at comparable concentrations in the upstream L3 Creek location LBL3C-1.65. Evidence of PAG outcrop in L4 Creek, reduced pH levels in L4 Creek and occurrence of anomalous metal concentrations at the LBL4C-0.018 and downstream LBL3C-1.43 locations exemplify background water quality of local naturally occurring PAG contact waterways. L4 Creek waters are eventually diluted by L3 Creek waters and PAG related metal concentrations are significantly reduced at monitoring location LBL3C-0.02.

4.4.2 Short Term Maximum Exceedances

Concentrations of total iron, dissolved iron, dissolved aluminum, total zinc, total copper, and total arsenic were measured above BCAWQG-FSTM guidelines within the catchment. At the discharge location (LBL3C-0.02) exceedances were reported for total iron, total arsenic, and dissolved aluminum. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 12, and the screening results based on the laboratory data are tabulated in Appendix B, Table B4.

The total iron exceedances in the samples collected from the LBL3C-0.02 and LBL3C-1.43 locations are interpreted to be directly related to TSS concentrations within the creek. Management of TSS originating from RSEM L3 was under active monitoring, management and mitigation through 2017. Minimal to no iron was measured in the dissolved phase at LBL3C-0.02, with dissolved iron reported as less than the detection limit of 30 µg/L, and it is not believed to be related to ARD-ML related processes.

The dissolved aluminum exceedance in the sample from LBL3C-0.02 is interpreted to be related to water inputs to L3 Creek between sample location LBL3C-1.43 and LBL3C-0.02. Dissolved aluminum is potentially measurable as concentrations of aluminum hydroxide complexes in solution. Groundwater seepage from the Howe Pit area is interpreted as the main input to this portion of the L3 Creek, with secondary inputs as surface run-off from the Howe Pit area.

The above-mentioned exceedances were reported to BC Hydro, who subsequently reported them to the Independent Environmental Monitor and applicable regulators, including the Comptroller of Water Rights and Ministry of Environment.

4.4.3 Trend Monitoring

4.4.3.1 Alkalinity and pH

Alkalinity and pH values measured in L3 Creek indicate that the waters have remained alkaline between April and October, with exception to measurements collected from LBL4C-0.18 which indicate variable acidic waters (Figure 15). Measured pH at location LBL3C-0.02 ranged between 8.1 and 8.2 with mean value of 8.1, and alkalinity ranging between 121 and 301 mg/L $CaCO_3$ equivalent with mean value of 210.6 mg/L $CaCO_3$ equivalent. Although a wide variability was observed in alkalinity values, strong correlation is observed on a monthly basis between the L3 Creek monitoring locations.

4.4.3.2 Total Suspended Sediment (TSS) and Total Dissolved Sediment (TDS)

TSS concentrations measured within L3 Creek were variable on a monthly basis between monitoring locations (Figure 16). Concentrations were generally observed to be reduced at the discharge location (LBL3C-0.02) relative to the immediate upstream location (LBL3C-1.43) due to settlement, except to measurements in September and October. TSS concentrations measured at LBL3C-0.02 ranged between 5.9 and 280 mg/L with a mean value of 86.4 mg/L.

TDS concentrations show moderate to high correlation between monitoring locations with overall variability on a monthly basis. TDS concentrations measured at the LBL3C-0.02 location ranged between 485 and 2,940 mg/L with a mean value of 1,520.4 mg/L.

Commonly, the trends observed for TDS are antithetic to those observed with TSS, where observed increases in TDS equate to observed decreases of TSS, and vice versa, from event to event. As discussed in Section 3.1, the role of dominant input waters to flow conditions in L3 Creek strongly influence the measured water quality. Events resulting in high TSS measurements may be related to precipitation or recent precipitation in form of shallow groundwater flow, and events resulting with high TDS and low TSS measurements may be related to low precipitation and high groundwater inflow.

4.4.3.3 Sulphate

Sulphate measurements have remained highly variable between May and October 2017, for the LBL3C-0.02 and LBL3C-1.43 locations, spiking in June, August and October 2017, at both locations (Figure 17). Sulphate concentrations measured at LBL3C-0.02 ranged between 265 and 1,670 mg/L with mean value of 975.7 mg/L.

Monthly variability correlates with similar trend observed for TDS, suggesting additional support for sampling events with elevated sulphate represent months where groundwater inputs dominate flow within L3 Creek.

The BCAWQG-LTA guideline for sulphate is variable with ambient hardness for each sample. The LTA is plotted on Figure 17 for the LBL3C-0.02 location, for reference.

4.4.3.4 Total and Dissolved Iron

Total iron values were measured at elevated concentrations throughout 2017 (Figure 18), with concentrations measured at LBL3C-0.02 ranging between 0.4 and 10.6 mg/L with mean value 3.9 mg/L, resulting in three of seven events measuring above the BCAWQG-FSTM guideline (Table 12).

For all sampling events in 2017 at LBL3C-0.02 and LBL3C-1.43, minimal to no iron was measured in the dissolved phase (Figure 19). At the LBL3C-0.02 location, dissolved iron was measured in low concentrations with values ranging from below the detection limit of 30 µg/L to a maximum value of 67 µg/L. Anomalous concentrations were measured in June at location LBL4C-0.18, and in June and July at location LBL3C-1.65, however, these extreme concentrations were not measured at LBL3C-0.02.

4.4.3.5 Total and Dissolved Aluminum

Total aluminum concentrations have shown monthly variability during 2017 (Figure 20). Concentrations of total aluminum measured at the LBL3C-0.02 location ranged between 281 and 4,770 µg/L with mean value of 1,911 µg/L.

Dissolved aluminum also shows variability throughout 2017 (Figure 21), with three of seven measurements at LBL3C-0.02 exceeding the BCAWQG-FSTM guideline (100 µg/L). Concentrations of dissolved aluminum measured at the LBL3C-0.02 location ranged between 40.5 and 173 µg/L with mean value of 111.2 µg/L. It is observed that dissolved aluminum concentrations are generally highest at the discharge location LBL3C-0.02, indicating excessive inputs between LBL3C-1.43 towards the discharge at LBL3C-0.02. This is attributed to impacted waters from the Howe Pit area possibly as hydroxide complexes, as discussed in Section 3.4.2.

4.4.3.6 Hardness

Water hardness measured at LBL3C-0.02 was consistently above the upper bound (250 mg/L) used by the BCAWQG-FSTM to guide criteria for metal concentrations, with values ranging between 292 and 1,730 mg/L with mean value of 900.1 mg/L (Table 10). This value is based on toxicity tests and adapted by the Canadian Council of Ministers of the Environment (BCAWQG Summary Report, 2017). A site-specific assessment may be required since the water hardness exceeds the highest hardness tested (250 mg/L) in BC (BCAWQG Summary Report, 2017, pg. 32).

5.0 CONCLUSIONS AND RECOMMENDATIONS

A water quality monitoring program was implemented on behalf of BC Hydro to monitor the water quality at discharge locations from River Road at Blind Corner, SBIAR, and L3 Creek. Upstream and midstream monitoring locations were established to characterize water quality at the discharge location and to maintain a continuous monitoring record commensurate with previous sampling completed in 2016 by Lorax on behalf of PRHP.

The program incorporated monthly in situ water quality measurements and observations with laboratory analysis. Field observations were recorded monthly regardless of weather conditions or ability to collect measurements.

5.1 Recommendations for River Road Water Quality Monitoring

Water quality data was collected from three locations and in situ measurements were collected at an additional six locations along the River Road catchment from April through October 2017.

Screening of analytical data for the LBRR-DD location resulted in identification of eight parameters (dissolved aluminum, and total iron, zinc, copper, arsenic, silver, cobalt, and chloride) that exceeded the BCAWQG-FSTM guidelines at variable times during 2017.

Sampling at these locations in October coincided with onset of a precipitation event which resulted in elevated estimated flow rates of 3 L/s in the ditch in addition to numerous exceedances to the BCAWQG-FSTM at the LBRR-DD location, at the time of sampling. Although this event data is real and suggests active ARD-ML processes, it is believed to represent instantaneous water quality from first flushing of surface materials as opposed to being representative of longer term steady flow conditions. The concentration of TSS measured along River Road ditch and at the discharge location was anomalously high relative to previous sampling events and is considered to be the main contributing factor the elemental exceedance which were observed.

The sediment source is mainly attributed to scouring of accumulated sediment within the ditch from road grading and run-off from previous events, in addition to washing, or flushing, of the exposed shale, colluvium and overburden cut-banks. Management is required to reduce the amount of sediment infilling to the ditch from road grading operations as this sediment encases the limestone which reduces chemical efficiency for ARD mitigation and prematurely fills the cistern which limits its performance to capture TSS which may be present from erosion of cut-banks.

Additionally, it was also noted from in situ pH measurements within the ditch that acidic waters are collected in the upper portions of the ditch underlying the exposed shale cut-bank. The pH values progressively return to circumneutral levels at the discharge location in part due to contact with limestone rip-rap in the ditch, and potential alkalinity input from groundwater or outflow from the upper cut-off ditch. Orange coating, or mineral precipitate, continued to be observed on the visible limestone. Chemical efficiency of the limestone to buffer acidic water is decreased when coated in precipitate or sediment. The formation of mineral scale can concentrate metals from solution as a result of the aqueous acid-base reactions. The mineral scale and sludge is susceptible to scouring and being washed during heavier rain events which has potential to reduce overall water quality being discharged into the Peace River.

The limestone must be regularly maintained through cleaning and descaling. This procedure would include cleaning the limestone rip-rap material within the River Road ditch in a controlled facility where the sludge can be recovered and relocated to an approved RSEM area, and placement of the refreshed limestone in the ditch. Sludge should also be removed from the cistern and transported to an approved RSEM area. Tetra Tech is preparing a prescriptive maintenance plan for these materials. Options for control of sediment erosion should be considered by BC Hydro to reduce sedimentation into the River Road drainage system from shale slopes and road grading operations. These options will be discussed between Tetra Tech and BC Hydro. The limestone was maintained between 12+600 and 12+900 in June 2017, through cleaning and descaling, and should continue regularly as an ongoing effort on all sections of the road down to the discharge location LBRR-DD.

Identification of the source of dissolved aluminum in previous sampling events is hypothesized to be related to fine mineral particulate (<45um) that is passing through the field filter as colloid or fine microcrystalline form. Aluminum hydroxide mineral species (e.g., polymorphs of gibbsite or hydrargillite) can form on rock surfaces and can be indicators of acid generating processes under base flow conditions. Locally impacted groundwater may also be seeping into the lower chimney ditch and may contribute to the measured dissolved aluminum concentrations. Similar water quality characteristics are observed in the lower L3 Creek catchment which may indicate that locally impacted groundwater from the exposed shale in the legacy Howe Pit area may be a common contributing factor. BC Hydro should consider options for remediation of this facility.

In December 2017, an options study was being prepared by Tetra Tech for BC Hydro to present various options for management of the limestone rip-rap and for mitigation of the active ARD-ML processes from the shale exposure at Blind Corner along River Road.

Water quality measurements along River Road indicate that run-off water quality is influenced by active ARD-ML processes within the ditch catchment. Although flows are generally low and ephemeral, there is some potential for run-off to impact downstream water quality. As per CEMP Appendix E Section 5.2.1.7, it is recommended that water quality monitoring is continued on a monthly basis at the established locations within the River Road catchment. Continuous monitoring will enable the effectiveness of mitigation strategies that are implemented on the shale at Blind Corner.

5.2 Recommendations for SBIAR Water Quality Monitoring

Water quality data was collected from three established sampling locations, two of which measure water directly from within the SBIAR facility and one which measures water outside of the SBIAR facility at the closet water receptor as a verification check for potential influence from, or direct connectivity with, the PAG contact water that is collected and diverted within the SBIAR facility.

Water flowing through the SBIAR ditch has no direct downstream receptor, and all water currently is conveyed to the RSEM R6 pond which is an approved PAG contact water management facility.

Based on water quality monitoring results collected within SBIAR and the downstream side channel, there does not appear to be correlation in trends and it is concluded that there is currently no hydraulic connectivity between SBIAR and the side channel.

Screening of analytical data for the RBSBIAR-DS location resulted in identification of two parameters (total and dissolved iron) that exceeded BCAWQG-FSTM guidelines during 2017.

Alkalinity indicate the waters have remained alkaline since the April 2017. A variable yet slight overall decreasing trend is observed for pH at the RBSBIAR-DS (Oct pH = 8.15) location. Lower pH values have been consistently observed at the upstream location (pH = 8.02), relative to the downstream location.

Water continues to be discharged into the SBIAR west ditch via a pipe which connects to a settlement pond in Area 21. The quality of this input water has not been evaluated. The elevated pH at the downstream location may be a result of influence from the conveyed Area 21 waters or groundwater.

Recommendations for future sampling include collection of water samples from the pooled water in Area 21, and collection of one up-gradient and one down-gradient water sample from the eastern SBIAR ditch to compare with quality observed from the west ditch samples.

In December 2017, BC Hydro had completed an options study and design for the installation of a cover system over the exposed shale at SBIAR. The system should be installed in 2018.

Evidence of active ARD-ML processes were observed in the shale exposed in the east and west ditch within SBIAR, however, the water quality measured throughout 2017 did not indicate significant impacts due to these processes. Downstream water is collected within the RSEM R6 pond for management prior to discharge into the Peace River. As per CEMP Section 5.2.1.7, since there is low risk of negative downstream effects on water quality, monitoring of water quality within SBIAR may be reduced to a quarterly frequency. BC Hydro may choose to continue monitoring water quality on a monthly frequency in order to measure the effectiveness of the planned cover system.

5.3 Recommendations for L3 Creek Water Quality Monitoring

Water quality data was collected from five established sampling locations within the L3 Creek catchment to maintain a continuous record of water quality within the catchment and to monitor potential changes to water chemistry related to construction related activities within the catchment.

L3 Creek is not being managed as a PAG contact water facility, however, occurrence of naturally occurring PAG outcrop was identified in L4 Creek. Water mixing from L4 Creek with L3 Creek is generally diluted and no significant effects were identified downstream at the discharge location due the L4 Creek water.

Screening of analytical data for the LBL3C-0.02 location resulted in identification of three parameters (dissolved aluminum, total iron, and total arsenic) that exceeded BCAWQG-FSTM guidelines at variable times during the sampling events in 2017.

Alkalinity and pH values measured in L3 Creek indicate that the waters have remained alkaline with significant variability in alkalinity since the April 2017, sampling event. TSS and TDS, sulphate and dissolved aluminum concentrations were all observed to increase slightly from the up-gradient LBL3C-1.43 location to the LBL3C-0.02 location. As discussed for River Road, the source of elevated dissolved aluminum concentration is believed to be related to fine mineral particulate (<45um) that is passing through the field filter as colloid or fine microcrystalline form (i.e. gibbsite, or equivalent polymorph) from secondary mineral precipitation within Howe Pit area, or locally impacted groundwater. Trend observations from TSS, TDS, and sulphate data also support interpretation of additional water input to L3 Creek between the up-gradient LBL3C-1.43 and LBL3C-0.02 discharge location. These inputs may be related to Howe Pit surface run-off, and or local impacted shallow groundwater seepage.

In December 2017, design was in progress to construct a RSEM facility at Howe Pit to provide additional storage capacity for NAG fill and to cover the exposed shale in Howe Pit. The design received input from Tetra Tech in regards to ARD-ML considerations and for long term monitoring options following placement of fill material.

Based on the 2017 water quality monitoring program there is low risk of significant negative downstream effects on water quality due to ARD-ML processes. As per CEMP Appendix E Section 5.2.1.7, monitoring of water quality for ARD-ML parameters within the L3 Creek catchment may be reduced to a quarterly frequency. BC Hydro may choose to continue monitoring water quality on a monthly frequency in order to measure the influence of the RSEM construction and filling of Howe Pit. An additional monitoring location should be added to any subdrain outlet of the Howe Pit RSEM. Monitoring at location LBL3C-1.65 may need adjustment to accommodate construction activities in the area.

6.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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TABLES

Table 1: Water Sampling Locations and Events with UTM Coordinates

Catchment	Sample Site	UTM Coordinates (WGS 84)		Elevation	19-Apr-17		18-May-17		22-Jun-17		18-Jul-17		24-Aug-17		21-Sep-17		24-Oct-17		4-Dec-17	
		Easting	Northing		In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab
Right Bank - South Bank Initial Access Road	RBSBIAR_US	630,327	6,228,397	468.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	RBSBIAR_DS	630,320	6,228,645	445.2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	RBSC_DS	630,475	6,228,672	418.6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Left Bank River Road	LBRR_DD	632,853	6,229,862	422.0	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
	LBRR_LC	632,856	6,229,899	427.2	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
	LBRR_UC	633,018	6,230,253	463.2	✓		✓		✓		✓						✓			
	LBRR_12+430	632,857	6,229,885	426.0	✓		✓		✓		✓									
	LBRR_12+500	632,914	6,229,921	432.0			✓		✓	✓	✓	✓			✓		✓	✓		
	LBRR_12+600	632,948	6,229,983	436.0			✓		✓		✓						✓			
	LBRR_12+700	632,992	6,230,078	442.8			✓		✓		✓						✓			
	LBRR_12+810	633,039	6,230,195	454.0			✓		✓		✓						✓			
	LBRR_12+920	633,000	6,230,282	463.0			✓		✓		✓						✓			
L3 Creek	LBL3C_0.02	632,767	6,229,860	418.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	LBL3C_1.43	631,728	6,230,210	486.6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	LBL3C_1.65	631,504	6,230,417	493.0			✓	✓	✓	✓	✓	✓	✓							
	LBL3C_3.32	630,248	6,231,262	579.0	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			
L4 Creek	LBL4C-0.18	631,524	6,230,578	507.0			✓	✓	✓	✓	✓	✓								

Note: In any months of the calendar year not listed (e.g. January, February, March, and November), frozen/dry conditions persisted at all sampling locations (verified by field staff).

Table 2: Daily and 7-Day Mean Temperature and Precipitation

Date	Time	Precipitation[1]		Temperature[1]			Summary
Sample Event Date Bolded	**Time Period**	**Precipitation Event**	**Mean (mm)**	**Mean (°C)**	**Minimum (°C)**	**Maximum (°C)**	**24 Hr and 7 Day Precipitation**
April 12-18, 2017	7 days	Apr. 13, 14, 15, 17	27.51	0.3	-7.4	8.4	[2] Moderate (27.51 mm) precipitation in preceding 7 days
April 18, 2017	24 hrs.	3am	0.07	-4.6	-7.4	-1.8	[2] Minimal (0.07 mm) to no precipitation in prior 24 hrs.
April 19, 2017	24 hrs.	none	0	1.9	-5.4	8.5	[2] No precipitation
May 11-17, 2017	7 days	May 12, 13, 15	64.79	7.9	1.1	18.5	[2] Significant (64.79mm) precipitation in preceding 7 days
May 17,2017	24 hrs.	none	0	9.4	5.8	13.2	[2] Minimal (1.65mm) to no precipitation in prior 24 hrs.
May 18, 2017	24 hrs.	4pm	1.65	13.9	9.4	17.3	[2] Minimal precipitation late in the day of sampling
June 15-21, 2017	7 days	June 16 and 21	9.18	13.5	6.1	19.6	Minimal (9.18mm) precipitation in preceding 7 days
June 21, 2017	24 hrs.	11am-8pm	5.29	9.5	7.1	13	Minimal (5.45mm) precipitation in previous 24 hrs.
June 22, 2017	24 hrs.	1am-5am	0.16	13.8	5.9	20	Very minimal precipitation early in the morning of sampling
July 11-17, 2017	7 days	July 13, 14, 15, 16	45.17	14.6	7.7	23.7	Significant (45.17mm) precipitation in preceding 7 days
July 17, 2017	24 hrs.	1am-5pm	0.58	12.2	10.9	14.6	Minimal (1.69mm) precipitation in previous 24 hrs.
July 18, 2017	24 hrs.	2am-6am	1.11	14.7	9.4	21.7	Minimal precipitation early in the morning of sampling
August 17-23, 2017	7 days	August 18th	0.54	17.3	8.5	27.9	Minimal (0.54mm) precipitation in preceding 7 days
August 23, 2017	24 hrs.	none	0	20.4	15.4	24.9	No precipitation
August 24, 2017	24 hrs.	5am-10pm	13.42	12.5	10.4	15.1	Significant precipitation early on day of sampling event
September 14-20, 2017	7 days	September 18, 19, 20	28.61	10	2.6	20.4	Moderate (28.61mm) precipitation in preceding 7 days
September 20, 2017	24 hrs.	1am-7am	13.5	9.4	7.1	12.4	Moderate (13.5mm) precipitation in prior 26-33 hrs.
September 21, 2017	24 hrs.	none	0	7.8	2.9	13.6	No precipitation
October 17-23, 2017	7 days	October 17, 18, 22	3.91	4.4	-1.5	11.5	Minimal (3.91mm) precipitation in preceding 7 days
October 23, 2017	24 hrs.	none	0	7.6	5.7	11.5	No precipitation
October 24, 2017	24 hrs.	12pm-24am	31.76	6.8	0.1	13.8	Significant precipitation during the afternoon of sampling event
November 14-20, 2017	7 days	Nov. 14, 15, 18	23.86	-14.7	-20.4	-9.9	Moderate (23.86 mm) precipitation in preceding 7 days
November 20, 2017	24 hrs.	none	0	-18.9	-20.4	-17	No precipitation. Frozen conditions.
November 21, 2017	24 hrs.	none	0	-18.4	-20.7	-15.6	No precipitation. Frozen conditions.
Nov. 27 - Dec. 3, 2017	7 days	none	0	-6.5	-18.5	3.8	No precipitation. Frozen conditions.
December 3, 2017	24 hrs.	none	0	-13.0	-18.5	-5.4	No precipitation. Frozen conditions.
December 4, 2017	24 hrs.	none	0	-1.3	-10.4	3.3	No precipitation. Frozen conditions.

[1] BC Ministry of Environment, BC Air quality data: Fort St John North Camp C_Met_60 weather station. Retrieved November 21, 2017 https://envistaweb.env.gov.bc.ca/.

[2] BC Ministry of Environment, BC Air quality data: Peace Valley Attachie Flat Upper Terrace_60 weather station (no precipitation data available at Camp C_Met_60 weather station). Retrieved November 21, 2017 https://envistaweb.env.gov.bc.ca/.

Table 3: Classification of Flows in Ditch

Date	Time	Precipitation		Summary	Classification
Sample Event Date Bolded	**Time Period**	**Precipitation Event**	**Precipitation (mm)**	**24 Hr. and 7 Day Precipitation**	**Flows in Ditch**
April 12-18, 2017	7 days		27.51	Moderate (27.51 mm) precipitation in preceding 7 days	Spring freshet
April 18, 2017	24 hrs.	3am	0.07	Minimal (0.07mm) to no precipitation in prior 24 hrs.	Shallow groundwater flow
April 19, 2017	24 hrs.	none	0	No precipitation	
May 11-17, 2017	7 days		64.79	Significant (64.79mm) precipitation in preceding 7 days	Spring freshet
May 17, 2017	24 hrs.	none	0	Minimal (1.65mm) to no precipitation in prior 24 hrs.	Shallow groundwater flow
May 18, 2017	24 hrs.	4pm	1.65	Minimal precipitation late in the day of sampling	
June 15-21, 2017	7 days		9.18	Minimal (9.18mm) precipitation in preceding 7 days	Regional groundwater flow
June 21, 2017	24 hrs.	11am-8pm	5.29	Minimal (5.45mm) precipitation in previous 24 hrs.	
June 22, 2017	24 hrs.	1am-5am	0.16	Very minimal precipitation early in the morning of sampling	
July 11-17, 2017	7 days		45.17	Significant (45.17mm) precipitation in preceding 7 days	Shallow groundwater flow
July 17, 2017	24 hrs.	1am-5pm	0.58	Minimal (1.69mm) precipitation in previous 24 hrs.	
July 18, 2017	24 hrs.	2am-6am	1.11	Minimal precipitation early in the morning of sampling	
August 17-23, 2017	7 days		0.54	Minimal (0.54mm) precipitation in preceding 7 days	Surface run-off
August 23, 2017	24 hrs.	none	0	No precipitation	
August 24, 2017	24 hrs.	5am-10pm	13.42	Significant precipitation early, on day of sampling event	
September 14-20, 2017	7 days		28.61	Moderate (28.61mm) precipitation in preceding 7 days	Shallow groundwater flow
September 20, 2017	24 hrs.	1am-7am	13.5	Moderate (13.5mm) precipitation in prior 26-33 hrs.	
September 21, 2017	24 hrs.	none	0	No precipitation	
October 17-23, 2017	7 days		3.91	Minimal (3.91mm) precipitation in preceding 7 days	Surface run-off
October 23, 2017	24 hrs.	none	0	No precipitation	
October 24, 2017	24 hrs.	12pm-24am	31.76	Significant precipitation during the afternoon of sampling event	

Table 4: Daily Mean Turbidity and TSS Measurements within the Peace River

Date	Turbidity (Daily Mean) within the Peace River above Moberly River			
Sampling Date Bolded	Left Bank		Right Bank	
	NTU [1]	TSS [2] (mg/L)	NTU [1]	TSS [2] (mg/L)
7-day Avg.	70.9	211.9	29.35	87.8
April 18, 2017	95.0	284.1	40.6	121.3
April 19, 2017	**133.8**	**400.1**	**23.9**	**71.5**
April 20, 2017	298.6	892.7	35.2	105.1
7-day Avg.	2487.9	7438.7	756.7	2262.4
May 17, 2017	2278.9	6813.9	971.5	2904.8
May 18, 2017	1592.5	4761.5	756.7	2262.4
May 19, 2017	1109.9	3318.7	559.4	1672.6
7-day Avg.	98.7	295.2	59.2	177.0
June 21, 2017	64.2	191.9	42.1	125.9
June 22, 2017	**58.5**	**174.8**	**39.3**	**117.5**
June 23, 2017	54.5	163.1	33.2	99.3
7-day Avg.	35.2	105.3	17.8	53.2
July 17, 2017	35.4	105.7	17.6	52.5
July 18, 2017	**28.0**	**83.7**	**16.1**	**48.2**
July 19, 2017	24.2	72.4	10.9	32.5
7-day Avg.	30.5	91.3	16.8	50.2
August 23, 2017	51.1	152.8	28.1	84.1
August 24, 2017	**44.1**	**131.9**	**26.7**	**79.7**
August 25, 2017	38.1	114.0	24.2	72.4
7-day Avg.	11.1	33.3	5.6	16.6
September 20, 2017	23.6	70.6	9.6	28.8
September 21, 2017	**15.2**	**45.4**	**7.5**	**22.4**
September 22, 2017	23.7	70.8	11.6	34.8
7-day Avg.	3.8	11.4	4.1	12.4
October 23, 2017	5.5	16.3	4.3	12.8
October 24, 2017	**5.3**	**15.8**	**5.5**	**16.4**
October 25, 2017	6.0	18.0	6.9	20.7

[1] NTU (Nephelometric Turbidity Unit); to some extent, measures (scattered light at 90 degrees from the incident light beam) how much light reflects for a given amount of particulates dependent upon properties of the particles, e.g. their shape, color, and reflectivity.

[2] TSS (total suspended sediment); calculated as (NTU*2.99).

Note: 7-day average turbidity values are calculated as the average turbidity measured on the sampling date and the prior seven days to sampling.

Data provided by Ecofish Research Ltd. Measurements may still have drift corrections applied. The TSS-Turbidity relationship will be updated following sample collection over all ranges of river conditions during freshet in 2018.

Table 5: Surface Water Quality Assurance/Quality Control Sample Results

Parameter	Unit	RDL	Field Blank	Travel Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Field Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Travel Blank	RBSBIAR-DS	Field Duplicate	Relative % Difference (RPD)
			19-Apr-17	19-Apr-17	18-May-17	19-May-17	22-Jun-17	22-Jun-17	18-Jul-17	18-Jul-17	24-Aug-17	25-Aug-17	21-Sep-17	21-Sep-17	24-Oct-17	24-Oct-17	19-Apr-17		
Physical Parameters																			
Electrical Conductivity (EC)	µS/cm	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1270	<2.0	<2.0	<2.0	<2	<2	<2	<2	634	639	0.8
Hardness as CaCO$_3$	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	118000	118000	0.0
pH	pH Units	0.1	5.42	5.15	5.28	5.26	5.31	5.37	8.32	5.46	5.24	5.35	5.44	5.98	5.39	5.4	8.55	8.54	0.1
Total Dissolved Solids (TDS)	µg/L	10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10,000	<10,000	<10,000	<10,000	428000	428000	0.0
Total Suspended Solids (TSS)	µg/L	3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	23700	19200	21.0
Anions and Nutrients																			
Alkalinity (Bicarbonate as CaCO$_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	189000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	245000	247000	0.8
Alkalinity (Carbonate as CaCO$_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	6800	<1000	<1000	<1000	<1000	<1000	<1000	<1000	16400	15400	6.3
Alkalinity (Hydroxide as CaCO$_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
Alkalinity (Total as CaCO$_3$)	mg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	196	<1.0	<1.0	<1.0	<1	<1	<1	<1	261	263	0.8
Ammonia (NH$_4$ as N)	µg/L	5.0	<5.0	<5.0	<5.0	<5.0	14.6	<5.0	<5.0	20.3	<5.0	<20	<5	5.1	<5	-	547	546	0.2
Chloride (Cl$^-$)	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	3290	3300	0.3
Nitrate (NO$_3^-$ as N)	µg/L	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5	<5	204	203	0.5
Nitrite (NO$_2^-$ as N)	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	46.7	47.4	1.5
Sulphate (SO$_4$)	µg/L	300	-	-	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300	-	-	-
Metals, Total																			
Aluminum	µg/L	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5	<5	1680	1750	4.1
Antimony	µg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	1.28	1.22	-
Arsenic	µg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	2.43	2.36	-
Barium	µg/L	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	431	438	1.6
Beryllium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	0.12	0.12	-
Boron	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	130	120	-
Cadmium	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.005	<0.005	0.0472	0.0539	13.3
Calcium	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	32800	31800	3.1
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	2.8	2.9	-
Cobalt	µg/L	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.3	<0.3	<0.3	<0.3	2.13	2.18	2.3
Copper	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	3.3	3.4	-
Iron	µg/L	30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	2200	2160	1.8
Lead	µg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	1.3	1.3	-
Lithium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	43.2	38.8	10.7
Magnesium	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	8650	8720	0.8
Manganese	µg/L	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.3	<0.3	<0.3	<0.3	38.1	40.5	6.1
Mercury	µg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.005	<0.005	<0.005	0.0111	0.0115	-
Molybdenum	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	12.5	11.3	10.1
Nickel	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	9.1	8.9	2.2
Potassium	µg/L	2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	2400	2500	-
Selenium	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	4.18	3.95	5.7
Silver	µg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.02	<0.02	0.03	0.03	-
Sodium	µg/L	2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	101000	99100	1.9
Thallium	µg/L	0.010	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01	<0.20	<0.20	-
Tin	µg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.50	<0.50	-
Titanium	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	16	20	-
Uranium	µg/L	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	2.85	2.65	7.3
Vanadium	µg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	6.43	6.81	5.7
Zinc	µg/L	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5	<5	9.1	9.7	-
Metals, Dissolved																			
Aluminum	µg/L	5.0	<5.0	<5.0		<5.0		<5.0	<5.0		<5.0		<5		<5	-	15.8	14.4	-
Antimony	µg/L	0.50	<0.50	<0.50		<0.50		<0.50	<0.50		<0.50		<0.5		<0.5	-	1.38	1.4	-
Arsenic	µg/L	0.50	<0.50	<0.50		<0.50		<0.50	<0.50		<0.50		<0.5		<0.5	-	1.03	1.09	-
Barium	µg/L	20	<20	<20		<20		<20	<20		<20		<20		<20	-	262	268	2.3
Beryllium	µg/L	0.10	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10		<0.1		<0.1	-	<0.10	<0.10	-
Boron	µg/L	100	<100	<100		<100		<100	<100		<100		<100		<100	-	120	120	-
Cadmium	µg/L	0.0050	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050		<0.005		<0.005	-	0.0115	0.0103	-
Calcium	µg/L	100	<100	<100		<100		<100	<100		<100		<100		<100	-	32800	32300	1.5
Chromium	µg/L	1.0	<1.0	<1.0		<1.0		<1.0	<1.0		<1.0		<1		<1	-	<1.0	<1.0	-
Cobalt	µg/L	0.30	<0.30	<0.30		<0.30		<0.30	<0.30		<0.30		<0.3		<0.3	-	0.66	0.68	-
Copper	µg/L	1.0	<1.0	<1.0		<1.0		<1.0	<10		<1.0		1		<1	-	<1.0	<1.0	-
Iron	µg/L	30	<30	<30		<30		<30	<30		<30		<30		<30	-	<30	<30	-
Lead	µg/L	0.50	<0.50	<0.50		<0.50		<0.50	<0.50		<0.50		<0.5		<0.5	-	<0.50	<0.50	-
Lithium	µg/L	1.0	<1.0	<1.0		<1.0		<1.0	<1.0		<1.0		<1		<1	-	41.7	39.7	4.9
Magnesium	µg/L	100	<100	<100		<100		<100	<100		<100		<100		<100	-	8780	9040	2.9
Manganese	µg/L	0.10	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10		<0.1		<0.1	-	8.79	9.61	8.9
Mercury	µg/L	0.0050	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050		<0.005		<0.005	-	<0.0050	<0.005	-
Molybdenum	µg/L	1.0	<1.0	<1.0		<1.0		<1.0	<1.0		<1.0		<1		<1	-	12.3	11.9	3.3
Nickel	µg/L	1.0	<1.0	<1.0		<1.0		<1.0	<1.0		<1.0		<1		<1	-	4.3	4.3	-
Potassium	µg/L	2000	<2000	<2000		<2000		<2000	<2000		<2000		<2000		<2000	-	2100	2200	-
Selenium	µg/L	0.050	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050		<0.05		<0.05	-	4.18	4.55	8.5
Silver	µg/L	0.020	<0.020	<0.020		<0.020		<0.020	<0.020		<0.020		<0.02		<0.02	-	<0.020	<0.020	-
Sodium	µg/L	2000	<2000	<2000		<2000		<2000	<2000		<2000		<2000		<2000	-	106000	109000	2.8
Thallium	µg/L	0.20	<0.020	<0.020		<0.020		<0.020	<0.20		<0.20		<0.2		<0.2	-	<0.020	<0.020	-
Tin	µg/L	0.50	<0.50	<0.50		<0.50		<0.50	<0.50		<0.50		<0.5		<0.5	-	<0.50	<0.50	-
Titanium	µg/L	10	<10	<10		<10		<10	<10		<10		<10		<10	-	<10	<10	-
Uranium	µg/L	0.20	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20		<0.2		<0.2	-	2.66	2.75	3.3
Vanadium	µg/L	0.50	<0.50	<0.50		<0.50		<0.50	<0.50		<0.50		<0.5		<0.5	-	<0.50	<0.50	-
Zinc	µg/L	5.0	<5.0	<5.0		<5.0		<5.0	<5.0		<5.0		<5		<5	-	<5.0	<5.0	-
Laboratory Work Order Number			L1914922	L1914922	L1929264	L1929264	L1947228	L1947228	L1960994	L1960994	L1981548	L1981548	L1996232	L1996232	L2012451	L2012451	L1914922	L1914922	
Laboratory Identification Number			L1914922-5	L1914922-6	L1929264-12	L1929264-13	L1947228-12	L1947228-13	L1960994-13	L1960994-12	L1981548-7	L1981548-6	L1996232-7	L1996232-6	L2012451-11	L2012451-10	L1914922-1	L1914922-4	

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Blank - Not analyzed

Table 5: Surface Water Quality Assurance/Quality Control Sample Results

Parameter	Unit	RDL	LBRR-DD	Field Duplicate	Relative % Difference (RPD)	LBL3C-0.02	Field Duplicate	Relative % Difference (RPD)	LBRR-DD	Field Duplicate	Relative % Difference (RPD)	LBL3C-0.02	Field Duplicate	Relative % Difference (RPD)	RBSBIAR-DS	Field Duplicate	Relative % Difference (RPD)	RBSBIAR-DS	Field Duplicate	Relative % Difference (RPD)
			18-May-17			22-Jun-17			18-Jul-17			24-Aug-17			21-Sep-17			24-Oct-17		
Physical Parameters																				
Electrical Conductivity (EC)	µS/cm	2.0	1170	1170	0.0	2620	2590	1.2	1260	1290	2.4	2840	2890	1.7	565	568	0.5	611	620	1.46
Hardness as $CaCO_3$	µg/L	500	623000	602000	3.4	1410000	1370000	2.9	642000	652000	1.5	1730000	1700000	1.7	271,000	263,000	3.0	273,000	276,000	1.09
pH	pH Units	0.1	8.3	8.31	0.1	8.22	8.2	0.2	8.28	7.66	7.8	8.10	8.08	0.2	8.26	8.26	0.0	8.15	8.17	0.25
Total Dissolved Solids (TDS)	µg/L	10000	902000	899000	0.3	2470000	2540000	2.8	912000	919000	0.8	2940000	2920000	0.7	376,000	398,000	5.7	402,000	407,000	1.24
Total Suspended Solids (TSS)	µg/L	3000	11800	6600	-	9100	5900	-	5000	5000	-	14100	14300	-	32,800	36,800	11.5	<3000	<3000	
Anions and Nutrients																				
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	223000	221000	0.9	283000	276000	2.5	197000	86100	**78.3**	301000	296000	1.7	185,000	183,000	1.1	226,000	229,000	1.32
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	2600	4000	**42.4**	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-	<1000	<1000	
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-	<1000	<1000	
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	225	225	0.0	283	276	2.5	197	86.1	**78.3**	301	296	1.7	185	183	1.1	226	229	1.32
Ammonia (NH_4 as N)	µg/L	5.0	26	21.8	17.6	14.2	14.6	-	6.6	7.2	-	9.1	7.9	-	234	248	5.8	374	354	5.49
Chloride (Cl^-)	µg/L	500	39300	39300	0.0	27000	26000	3.8	39000	39200	0.5	25000	25000	0.0	24,000	24,000	0.0	26,600	26,600	0.00
Nitrate (NO_3^- as N)	µg/L	5.0	73	74	1.4	160	140	13.3	<25	<25	-	<100	<100	-	2010	2020	-	2500	2510	0.40
Nitrite (NO_2^- as N)	µg/L	1.0	<5.0	<5.0	-	<20	<20	-	<5.0	<5.0	-	<20	<20	-	41.1	41	-	22.5	22.6	0.44
Sulphate (SO_4)	µg/L	300	387000	389000	0.5	1660000	1570000	5.6	509000	511000	0.4	1670000	1670000	0.0	88,400	88,400	0.0	71,300	71,400	0.14
Metals, Total																				
Aluminum	µg/L	5.0	137	128	6.8	503	530	5.2	373	379	1.6	369	353	4.4	270	270	0.0	17.9	27.1	**40.89**
Antimony	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.5	<0.5	-	<0.5	<0.5	
Arsenic	µg/L	0.50	0.55	0.51	-	<0.50	<0.50	-	0.62	0.65	-	0.69	0.63	-	0.58	0.6	-	<0.5	<0.5	
Barium	µg/L	20	101	100	1.0	47	47	-	55	55	-	40	41	-	188	196	-	189	191	1.05
Beryllium	µg/L	0.10	<0.10	<0.10	-	<0.20	<0.20	-	<0.10	<0.10	-	<0.20	<0.20	-	<0.1	<0.1	-	<0.1	<0.1	
Boron	µg/L	100	<100	<100	-	150	160	-	<100	<100	-	200	190	5.1	<100	<100	-	<100	<100	
Cadmium	µg/L	0.005	0.245	0.208	16.3	0.773	0.78	0.9	0.879	0.877	0.2	0.475	0.472	0.6	0.138	0.156	12.2	0.0081	0.012	**38.81**
Calcium	µg/L	100	157000	156000	0.6	442000	455000	2.9	167000	167000	0.0	450000	453000	0.7	76,400	75,500	1.2	73,600	71,500	2.89
Chromium	µg/L	1.0	<1.0	<1.0	-	<1.0	<1.0	-	<1.0	<1.0	-	<1.0	<1.0	-	1.1	1.7	**42.9**	<1	<1	
Cobalt	µg/L	0.30	2.18	2.08	4.7	9.55	9.51	0.4	10.1	10.1	0.0	5.4	5.2	3.0	3.44	3.42	0.6	0.32	0.34	6.06
Copper	µg/L	1.0	2	1.9	-	1.7	1.7	-	3.2	3.2	-	1.6	1.5	-	2.1	2.3	9.1	<1	<1	
Iron	µg/L	30	257	216	17.3	596	603	1.2	231	210	9.5	995	931	6.6	566	624	9.7	<30	<30	
Lead	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.5	<0.5	-	<0.5	<0.5	
Lithium	µg/L	1.0	29.8	29.9	0.3	81.5	82.9	1.7	63.3	69.7	9.6	94.7	96.7	2.1	17.7	18.2	2.8	17.9	17.3	3.41
Magnesium	µg/L	100	54500	51800	5.1	132000	136000	3.0	64400	64000	0.6	140000	144000	2.8	22,400	18,800	17.5	22,000	23,200	5.31
Manganese	µg/L	0.30	72.3	67.1	7.5	421	425	0.9	209	210	0.5	322	321	0.3	69	66.5	3.7	3.36	4	17.39
Mercury	µg/L	0.0050	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	0.0061	-	<0.025	<0.0050	-	<0.005	<0.005	-	<0.005	<0.005	
Molybdenum	µg/L	1.0	4.6	4.6	-	2.6	2.6	-	3.3	3.3	-	2.8	2.8	-	3	3.3	-	3.2	3.1	3.17
Nickel	µg/L	1.0	19.6	18.5	5.8	71.2	70.3	1.3	110	110	0.0	54.5	54.0	0.9	15.8	16.3	3.1	5.3	5.5	3.70
Potassium	µg/L	2000	6900	6600	-	6600	7000	-	8300	8200	-	6900	6600	-	3100	3000	-	3300	3400	2.99
Selenium	µg/L	0.050	1.12	0.957	15.7	0.62	0.66	6.3	0.845	0.776	8.5	0.770	0.640	18.4	0.943	0.949	0.6	0.834	0.885	5.93
Silver	µg/L	0.020	<0.020	<0.020	-	<0.020	<0.020	-	<0.020	<0.020	-	<0.020	<0.020	-	<0.02	<0.02	-	<0.02	<0.02	
Sodium	µg/L	2000	37600	34300	9.2	98300	101000	2.7	29300	29300	0.0	123000	120000	2.5	21,000	20,400	2.9	31,800	33,100	4.01
Thallium	µg/L	0.010	<0.20	<0.20	-	<0.20	<0.20	-	0.027	0.026	-	0.036	0.039	-	0.017	0.02	-	<0.01	<0.01	
Tin	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.5	<0.5	-	<0.5	<0.5	
Titanium	µg/L	10	<10	<10	-	<10	<10	-	<10	<10	-	<10	<10	-	<10	<10	-	<10	<10	
Uranium	µg/L	0.20	4.08	3.99	2.2	9.88	9.77	1.1	2.96	2.9	2.0	11.2	11.4	1.8	1.44	1.42	1.4	1.36	1.44	5.71
Vanadium	µg/L	0.50	<0.50	<0.50	-	<1.0	<1.0	-	<0.50	<0.50	-	<1.0	<1.0	-	1.09	1.21	-	<0.5	<0.5	
Zinc	µg/L	5.0	18.2	16.5	-	73.2	72.7	0.7	78.9	81.5	3.2	57.9	57.0	1.6	27.4	25.4	7.6	<5	<5	
Metals, Dissolved																				
Aluminum	µg/L	5.0	79.1	81.5	3.0	167	152	9.4	279	276	1.1	97.4	96.1	1.3	27.1	25.8	4.9	9.7	9.5	2.08
Antimony	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.5	<0.5		<0.5	<0.5	
Arsenic	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	0.51	-	<0.50	<0.50	-	<0.5	<0.5		<0.5	<0.5	
Barium	µg/L	20	100	102	2.0	38	37	-	53	52	-	37	40	-	178	190	6.5	195	202	3.53
Beryllium	µg/L	0.10	<0.10	<0.10	-	<0.20	<0.20	-	<0.10	<0.10	-	<0.20	<0.20	-	<0.1	<0.1		<0.1	<0.1	
Boron	µg/L	100	<100	<100	-	140	140	-	<100	<100	-	190	200	5.1	<100	<100	-	<100	<100	
Cadmium	µg/L	0.0050	0.189	0.180	4.9	0.556	0.536	3.7	0.807	0.767	5.1	0.306	0.316	3.2	0.0992	0.0998	0.6	0.0069	<0.005	
Calcium	µg/L	100	162000	158000	2.5	387000	381000	1.6	157000	161000	2.5	464000	446000	4.0	72,500	73,500	1.4	73,000	73,100	0.14
Chromium	µg/L	1.0	<1.0	<1.0	-	<1.0	<1.0	-	<1.0	<1.0	-	<1.0	<1.0	-	<1	<1	-	<1	<1	
Cobalt	µg/L	0.30	1.9	1.85	2.7	7.99	7.58	5.3	9.51	9.26	2.7	4.85	4.84	0.2	3.04	3.08	1.3	<0.3	0.31	
Copper	µg/L	1.0	1.6	1.5	-	1.2	1.1	-	2.8	2.7	-	1.1	1.1	-	1.1	1.1	0.0	<1	<1	
Iron	µg/L	30	<30	<30	-	<30	<30	-	<30	<30	-	46.0	<30	-	<30	<30	-	<30	<30	
Lead	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.5	<0.5	-	<0.5	<0.5	
Lithium	µg/L	1.0	28.6	27.6	3.6	76.7	73.5	4.3	61.3	68.2	10.7	95.6	93.0	2.8	17	17.9	5.2	17.7	17.8	0.56
Magnesium	µg/L	100	52800	50700	4.1	107000	101000	5.8	60700	60800	0.2	139000	143000	2.8	21,900	19,400	12.1	22,000	22,800	3.57
Manganese	µg/L	0.10	57.1	53.6	6.3	355	346	2.6	200	197	1.5	292	306	4.7	48.7	46.4	4.8	3.19	3.29	3.09
Mercury	µg/L	0.0050	<0.0050	<0.0050	-	<0.0050	<0.0050	-	0.0053	0.0052	-	<0.0050	<0.0050	-	<0.005	<0.005	-	<0.005	<0.005	
Molybdenum	µg/L	1.0	4.7	4.6	-	2.3	2.2	-	3.1	3.3	-	2.7	2.6	-	2.9	2.7	-	3	2.8	6.90
Nickel	µg/L	1.0	18.2	17.5	3.9	60.8	57.5	5.6	102	101	1.0	50.5	50.2	0.6	14.4	14.7	2.1	5.3	5.5	3.70
Potassium	µg/L	2000	6600	6400	-	6400	6100	-	7900	8000	-	6500	6600	-	3000	3100	-	3400	3600	5.71
Selenium	µg/L	0.050	1.17	0.964	19.3	0.65	0.54	18.5	0.801	0.804	0.4	0.400	0.570	**35.1**	0.956	0.861	10.5	0.814	0.874	7.11
Silver	µg/L	0.020	<0.020	<0.020	-	<0.020	<0.020	-	<0.020	<0.020	-	<0.020	<0.020	-	<0.02	<0.02	-	<0.02	<0.02	
Sodium	µg/L	2000	36200	33600	7.4	87800	82700	6.0	28100	27400	2.5	119000	115000	3.4	20,300	19,000	6.6	32,500	33,600	3.33
Thallium	µg/L	0.20	<0.020	<0.020	-	<0.020	<0.020	-	<0.20	<0.20	-	<0.20	<0.20	-	<0.2	<0.2	-	<0.2	<0.2	
Tin	µg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.50	<0.50	-	<0.5	<0.5	-	<0.5	<0.5	
Titanium	µg/L	10	<10	<10	-	<10	<10	-	<10	<10	-	<10	<10	-	<10	<10	-	<10	<10	
Uranium	µg/L	0.20	4.12	3.99	3.2	8.98	8.9	0.9	2.68	2.67	0.4	10.9	10.6	2.8	1.31	1.25	4.7	1.28	1.32	3.08
Vanadium	µg/L	0.50	<0.50	<0.50	-	<1.0	<1.0	-	<0.50	<0.50	-	<1.0	<1.0	-	<0.5	<0.5	-	<0.5	<0.5	
Zinc	µg/L	5.0	12	11.6	-	43.8	42	4.2	61.5	63.4	3.0	33.6	34.7	3.2	18.3	17.9	2.2	<5	<5	
Laboratory Work Order Number			L1929264	L1929264		L1947228	L1947228		L1947228	L1947228		L1981548	L1981548		L1996232	L1996232		L2012451	L2012451	
Laboratory Identification Number			L1929264-5	L1929264-7		L1947228-14	L1947228-4		L1947228-14	L1947228-4		L1981548-2	L1981548-8		L1996232-5	L1996232-10		L2012451-9	L2012451-1	

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Blank - Not analyzed

Table 6: In Situ Water Quality Sampling along the River Road Ditch

Sample Site	Date	Time	In-Situ Tests						
			Water Temp (°C)	Hardness (ppm)	pH	EC (µS)	Alkalinity (ppm)	Turbidity	Flow (L/sec)
LBRR-DD (discharge)	April 19, 2017	15:00	12.9	800	8.09	-	180	-	1.00
	May 18, 2017	-	17.6	450	8.50	1190	120	-	1.00
	June 22, 2017	11:50	19.3	300	8.31	-	140	none	0.25
	July 18, 2017	16:15	24.4	500	8.80	1150	120	none	1.00
	September 21, 2017		12.3	425	8.30	1120	240	-	0.25
	October 24, 2017		6.3	1000	8.30	4820	80	very turbid	3.00
LBRR-LC (mid-stream)	April 19, 2017	15:20	12.2	450	8.06	-	180	-	<1.00
	May 18, 2017	-	19.7	450	8.60	900	180	-	-
	June 22, 2017	12:05	20.1	450	8.39	785	220	None	0.25
	July 18, 2017	16:30	23.3	500	8.90	670	80	None	1.00
	September 21, 2017		12.5	425	8.50	950	240	-	0.50
	October 24, 2017		6.7	250	8.67	1061	40	-	0.20
LBRR-UC	April 19, 2017	15:55	8.1	800	7.66	-	180	Low	<<1.00
	May 18, 2017	-	14.7	800	8.10	1200	240	-	-
	June 22, 2017	13:05	14.6	500	7.80	990	180	None	<<1.00
	July 18, 2017	-	18.6	500	8.10	830	180	None	0.10
	October 24, 2017		6.1	250	8.04	750	120	-	0.20
LBRR-12+430	April 19, 2017	15:13	12.3	500	7.74	-	180	-	0.5-1.0
	May 18, 2017	-	18.6	450	8.10	1250	180	-	-
	June 22, 2017	12:32	22.3	500	8.23	1360	240	Low	0.50
	July 18, 2017	15:15	22.4	1000	8.70	1410	240	None	1.00
LBRR-12+500	May 18, 2017	-	14.0	450	8.50	1470	240	-	-
	June 22, 2017	12:20	18.6	1000	8.47	1230	240	Moderate	<0.25
	July 18, 2017	17:00	19.3	1000	7.80	2230	120	None	0.25
	September 21, 2017		15.7	425	8.60	830	180	-	0.50
	October 24, 2017		5.9	1000	7.67	4660	80	-	0.20
LBRR-12+600	May 18, 2017	-	12.7	450	8.70	1460	180	-	-
	June 22, 2017	12:43	16.0	500	8.30	1100	180	Low to Mod.	None
	July 18, 2017	14:45	-	500	8.80	1080	240	None	0.10
	October 24, 2017		5.9	500	4.91	4630	0	-	0.20
LBRR-12+700	May 18, 2017	-	14.6	450	8.70	1360	180	-	-
	June 22, 2017	12:48	17.2	500	8.50	920	180	None	Stagnant
	July 18, 2017	14:30	25.2	500	8.70	1050	180	None	0.25
	October 24, 2017		6.1	1000	4.66	4670	0	-	0.20
LBRR-12+810	May 18, 2017	-	14.5	450	8.50	1200	180	-	-
	June 22, 2017	13:15	19.3	500	8.51	940	180	None	Stagnant
	July 18, 2017	14:15	21.5	500	8.80	880	240	None	0.25
	October 24, 2017		6	1000	4.00	4590	0	-	0.50
LBRR-12+920	May 18, 2017	-	8.2	450	7.80	1240	180	-	-
	June 22, 2017	12:55	14.2	500	8.20	700	240	None	Stagnant
	July 18, 2017	14:00	17	500	8.10	1140	180	None	0.25
	October 24, 2017		5.7	500	7.23	4140	120	-	0.20

Table 7: Summary of Water Quality Exceedances (BCAWQG-FSTM) along River Road from Water Sampling Events in 2017

	Sampling Dates	Total Iron (Fe)	Dissolved Aluminum (Al)	Total Zinc (Zn)	Total Copper (Cu)	Total Arsenic (As)	Total Silver (Ag)	Total Cobalt (Co)	Chloride (Cl-)
LBRR-DD (discharge)	April 19, 2017		✓						
	May 18, 2017								
	June 22, 2017								
	July 18, 2017		✓						
	September 21, 2017	✓	✓						
	October 24, 2017	✓		✓	✓	✓	✓	✓	✓
LBRR-LC (midstream)	April 19, 2017								
	May 18, 2017								
	June 22, 2017								
	July 18, 2017		✓						
	September 21, 2017	✓	✓						
	October 24, 2017	✓				✓			
LBRR 12+500 (midstream)	June 22, 2017	✓							
	July 18, 2017	✓							
	October 24, 2017	✓		✓	✓	✓		✓	✓

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG. Exceedances denoted by a check mark.

Table 8: In Situ Water Quality Measurements along the South Bank Initial Access Road

Sample Site	Date	Time	In-Situ Tests						
			Water Temp (°C)	Hardness (ppm)	pH	EC (µS)	Alkalinity (ppm)	Turbidity	Flow (L/sec)
RBSBIAR-US	April 19, 2017	14:20	7.6	450	7.20	-	240	-	0.5-1.0
	May 18, 2017	-	13.2	250	8.30	560	180	-	-
	June 22, 2017	10:07	14.0	600	8.10	600	200	None	1.00
	July 18, 2017	15:45	19.6	250	8.40	580	120	None	2.00
	August 24, 2017	11:15	14.6	425	7.87	587	240	-	0.50
	September 21, 2017	12:15	14.1	425	7.80	510	180	-	0.50
	October 24, 2017	9:00	8.3	500	8.02	595	240	-	0.25
RBSBIAR-DS	April 19, 2017	13:55	12.4	125	8.36	-	200	-	2.0-3.0
	May 18, 2017	-	15.7	250	8.80	560	120	-	-
	June 22, 2017	9:45	15.2	350	8.39	657	170	None	3.00
	July 18, 2017	15:30	20.0	250	8.80	540	80	None	4.00
	August 24, 2017	11:00	13.7	425	8.14	298	120	-	10.00
	September 21, 2017		11.9	425	8.60	570	240	-	4.00
	October 24, 2017	9:00	6.8	250	8.48	640	180	-	2.00
	December 4, 2017	14:00	0.3	425	8.70	750	80	clear	4.00
RBSC-DS	April 19, 2017	13:28	12.0	600	7.70	-	180-240	-	Stagnant
	May 18, 2017	-	13.1	800	7.10	1430	180	-	Minimal
	June 22, 2017	9:02	10.6	600	7.00	1970	180	None	Stagnant
	July 18, 2017	13:15	16.2	1000	7.60	2040	240	None	Stagnant
	August 24, 2017	12:00	6.7	425	7.80	1630	240	-	n/a
	September 21, 2017	11:45	7.6	425	7.00	1160	240	-	n/a
	October 24, 2017	-	5.7	500	7.54	1395	120	-	n/a

Table 9: Summary of Water Quality Exceedances (BCAWQG-FSTM) along SBIAR from Water Sampling Events in 2017

	Sampling Dates	Total Iron (Fe)	Dissolved Iron (Fe)
RBSBIAR-DS (downstream)	April 19, 2017	✓	
	May 18, 2017		
	June 22, 2017		
	July 18, 2017		
	August 24, 2017	✓	
	September 21, 2017		
	October 24, 2017		
RBSBIAR-US (upstream)	April 19, 2017	✓	
	May 18, 2017		
	June 22, 2017		
	July 18, 2017		
	August 24, 2017		
	September 21, 2017		
	October 24, 2017		
RBSC-DS (side channel)	April 19, 2017		
	May 18, 2017		
	June 22, 2017		
	July 18, 2017		
	August 24, 2017		
	September 21, 2017	✓	✓
	October 24, 2017	✓	✓

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG. Exceedances denoted by a check mark.

Table 10: Minimum, Maximum and Mean Values for Measurements at Discharge and Downstream Locations

Discharge Locations	LBRR-DD [a]			RBSBIAR-DS [b]			LBL3C-0.02 [a]		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Hardness as $CaCO_3$, mg/L	583	2360	913.5	118	293	211.4	292	1730	900.1
pH	7.47	8.33	8.16	8.15	8.55	8.29	8.05	8.20	8.12
Total Dissolved Solids (TDS), mg/L	853	3740	1402.3	10.9	428	310.7	485	2940	1520.4
Total Suspended Solids (TSS), mg/L	5	11900	1992.2	<3.0	443	97.2 [c]	5.9	280	86.4
Anions and Nutrients									
Alkalinity, mg/L (Total as $CaCO_3$)	188	749	291.8	125	261	209.5	121	301	210.6
Sulphate (SO_4), mg/L	358	554	436.8	23.1	88.4	65.3	265	1670	975.7
Metals, Total									
Aluminum, mg/L	0.1370	128	21.6863	0.0179	1.6800	0.4439	0.2810	4.77	1.9110
Iron, mg/L	0.2310	389	65.5152	<0.03	2.2400	0.8248 [c]	0.4060	10.60	3.8739
Metals, Dissolved									
Aluminum, mg/L	0.0199	0.2790	0.1284	<0.005	0.0509	0.0204 [c]	0.0405	0.1730	0.1112
Iron, mg/L	<0.03	0.0300	0.0325 [c]	<0.03	<0.03	<0.03	<0.03	0.0670	0.0353 [c]

[a] Calculations from the period April to October, 2017.

[b] Calculations from the period April to December, 2017.

[c] Mean value calculated between the detection limit(s) and all other values.

Table 11: In Situ Water Quality Measurements along L3 Creek

Sample Site	Date	Time	In-Situ Tests						
			Water Temp (°C)	Hardness (ppm)	pH	EC (μS)	Alkalinity (ppm)	Turbidity	Flow (L/sec)
LBL3C-0.02	April 19, 2017	15:40	8.2	450	8.03	-	80	High	20.0
	May 18, 2017	-	11.6	450	8.30	1120	120	High	Fast
	June 22, 2017	11:10	13.1	700	8.19	2530	160	Very low	4.0
	July 18, 2017	13:45	15.1	500	8.10	1250	80	Slight	10.0
	August 24, 2017	13:30	12.5	425	8.20	2640	240	-	1.0
	September 21, 2017	-	6.8	425	8.00	810	180	-	8.0
	October 24, 2017	-	5.8	1000	8.55	2260	240	-	5.0
LBL3C-1.43	April 19, 2017	-	4.3	250	7.97	-	120	High	0.2
	May 18, 2017	-	16.1	450	8.00	940	120	-	-
	June 22, 2017	13:30	13.3	1000	7.90	2530	120	Moderate	3.0
	July 18, 2017	11:15	13.7	250	8.40	560	40	High	10.0
	August 24, 2017	14:30	11.2	425	8.00	1510	240	-	0.5
	September 21, 2017	-	11.0	250	8.50	290	80	-	8.0
	October 24, 2017	-	5.9	1000	8.17	1676	180	-	2.0
LBL3C-1.65	May 18, 2017	-	-	-	-	-	-	High	Minimal
	June 22, 2017	14:25	11.7	1000	6.40	2120	240	High	Stagnant
	July 18, 2017	11:30	16.3	500	7.30	1200	120	Clear	0.5
	August 24, 2017	14:45	13.1	425	7.00	2800	240	n/a	0.0
LBL3C-3.32	April 19, 2017	-	8.2	450	8.13	-	80	High	0.2
	May 18, 2017	-	13.5	250	8.60	600	120	-	Fast
	June 22, 2017	14:55	13.1	500	8.00	1200	240	Moderate	Stagnant
	July 18, 2017	12:30	19.6	500	8.40	930	180	Slight	5.0
	August 24, 2017	15:00	13.2	425	8.00	1730	240	-	n/a
	October 24, 2017	17:00	4.6	1000	7.90	1640	240	-	No flow
LBL4C-0.18	May 18, 2017	-	-	-	-	-	-	High	Fast
	June 22, 2017	14:05	12.7	1000	3.70	2620	0	Moderate	<0.1
	July 18, 2017	11:45	11.0	500	8.00	1200	40	Moderate	4.0

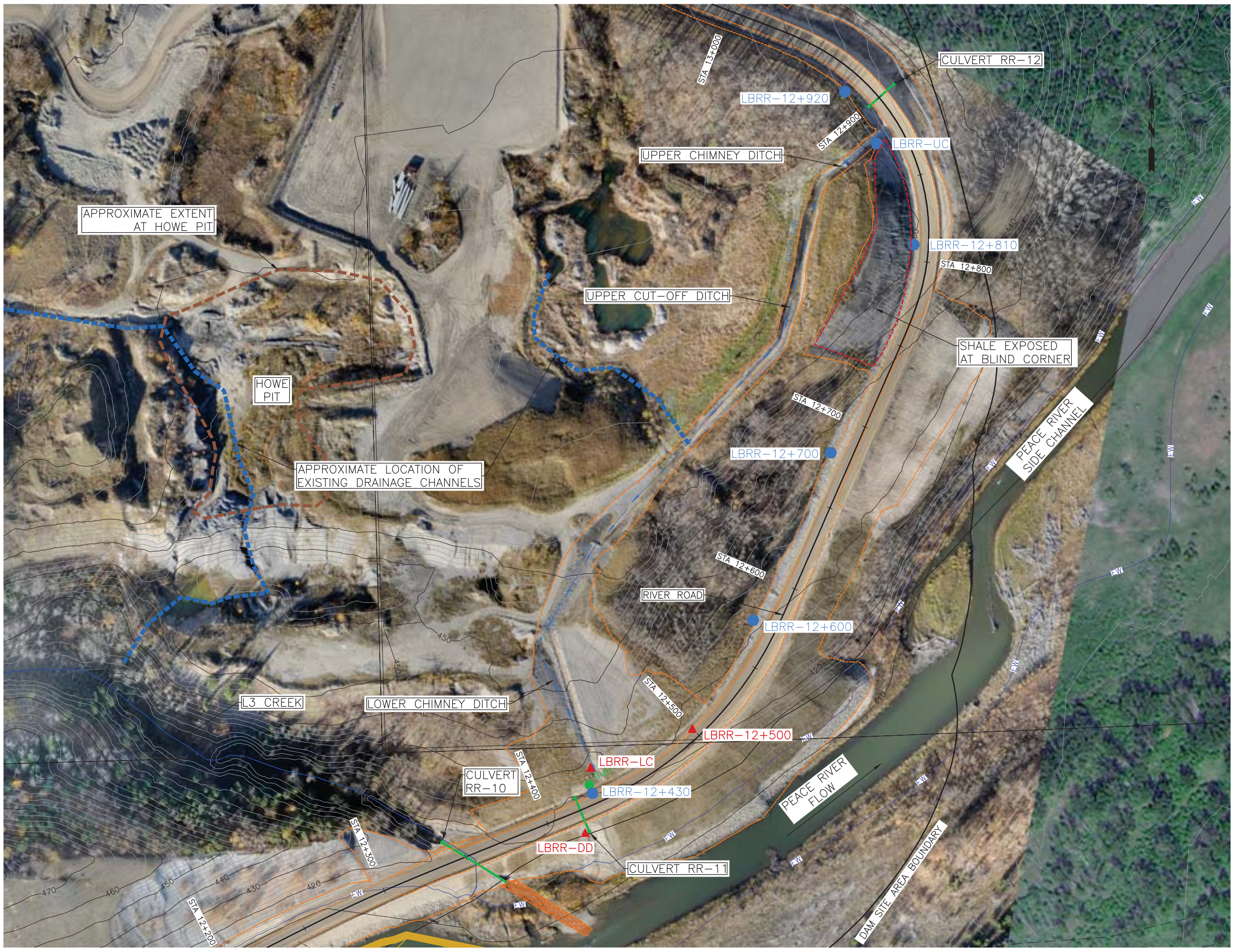
Table 12: Summary of Water Quality Exceedances (BCAWQG-FSTM) along L3 Creek from Water Sampling Events in 2017

	Sampling Dates	Total Iron (Fe)	Dissolved Iron (Fe)	Dissolved Aluminum (Al)	Dissolved Cadmium (Cd)	Total Zinc (Zn)	Total Copper (Cu)	Total Arsenic (As)
LBL3C-0.02 (discharge)	April 19, 2017	✓						✓
	May 18, 2017	✓		✓				
	June 22, 2017			✓				
	July 18, 2017			✓				
	August 24, 2017							
	September 21, 2017	✓						
	October 24, 2017			✓				
LBL3C-1.43 (midstream)	April 19, 2017	✓				✓	✓	✓
	May 18, 2017	✓		✓				✓
	June 22, 2017							
	July 18, 2017	✓		✓				
	August 24, 2017	✓						
	September 21, 2017	✓						
	October 24, 2017							
LBL3C-1.65	May 18, 2017	✓						
	June 22, 2017	✓	✓					
	July 18, 2017	✓	✓					
LBL3C-3.32 (upstream)	April 19, 2017	✓						
	May 18, 2017	✓						
	June 22, 2017							
	July 18, 2017							
LBL4C-0.18	May 18, 2017	✓				✓	✓	✓
	June 22, 2017	✓	✓	✓	✓	✓		
	July 18, 2017	✓		✓				

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG. Exceedances denoted by a check mark.

Note: L3 and L4 Creek are not considered a construction-related PAG management facility and are not monitored under requirement of the CEMP.

FIGURES



Location	Northing	Easting
River Road Ditch		
LBRR-12+430	6229885	632857
LBRR-12+500	6229921	632914
LBRR-12+600	6229983	632948
LBRR-12+700	6230078	632992
LBRR-12+810	6230195	633039
LBRR-12+920	6230282	633000
LBRR-UC	6230253	633018
LBRR-LC	6229899	632856
LBRR-DD	6229862	632853

TETRA TECH

LEGEND:

● WATER SAMPLE – INSITU TESTING ONLY (pH, ALKALINITY, EC, TEMPERATURE)

▲ WATER SAMPLE – INSITU TESTING (pH, ALKALINITY) & EXTERNAL LABORATORY TESTING (METALS, TSS)

AIR PHOTO FLOWN OCT 2017

0 50m
1:750

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP CIV	INSP STR	INSP MECH	INSP GEO	INSP ELEC	REV	ACPT

REFERENCE DRAWINGS
REFERENCE DRAWINGS
REVISIONS

SITE C CLEAN ENERGY PROJECT
BC Hydro

DSGN
INDEP CHK
DFTG
DFTG CHK
INSP
CIV STR MECH GEO ELEC
REV
ACPT

CLEAN ENERGY PROJECT - SITE C
LEFT BANK - RIVER ROAD

WATER QUALITY MONITORING
PLAN

DATE 12 MAR 2018
DIST
DWG NO FIGURE 1
SIZE A0
R 0

NOT TO BE REPRODUCED WITHOUT THE PERMISSION OF BC HYDRO

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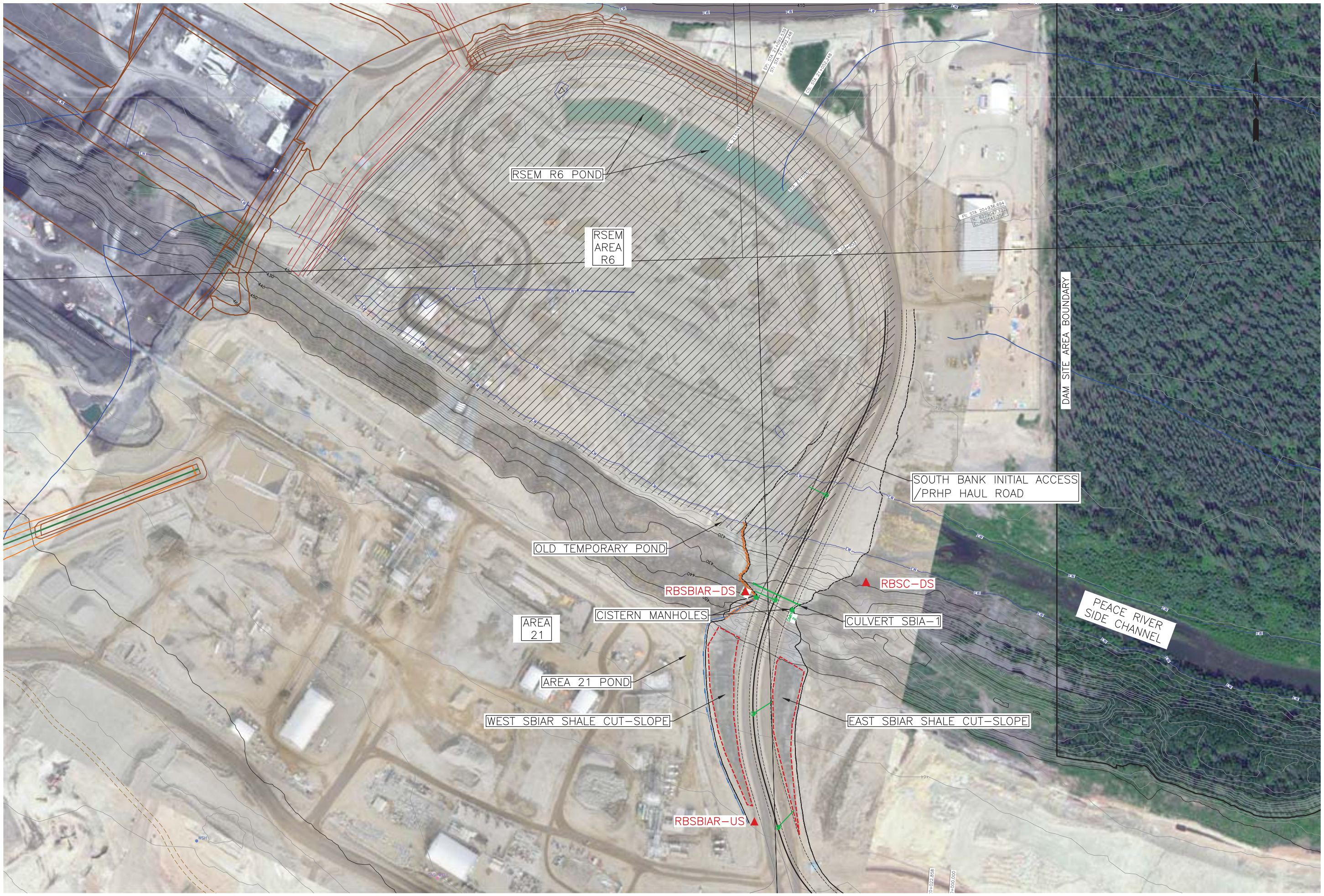
3/12/2018 2:58 PM



L E G E N D:

▲ WATER SAMPLE – INSITU, TESTING (pH, ALKALINITY, EC, TEMPERATURE) & EXTERNAL LABORATORY TESTING (METALS, TSS)

AIR PHOTO FLOWN OCT 2017

LOCATION	NORTHING	EASTING
RBSC–DS	6228672	630475
RBSBIAR–DS	6228645	630320
RBSBIAR–US	6228397	630327

0 15 1:1500 75m

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3/13/2018 9:13 AM

REF#	DRAWING NUMBER	TITLE

REFERENCE DRAWINGS

REF#	DRAWING NUMBER	TITLE

REFERENCE DRAWINGS

NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP CIV	INSP STR	INSP MECH	INSP GEO	INSP ELEC	REV	ACPT

REVISIONS

SITE C | CLEAN ENERGY PROJECT

BC Hydro

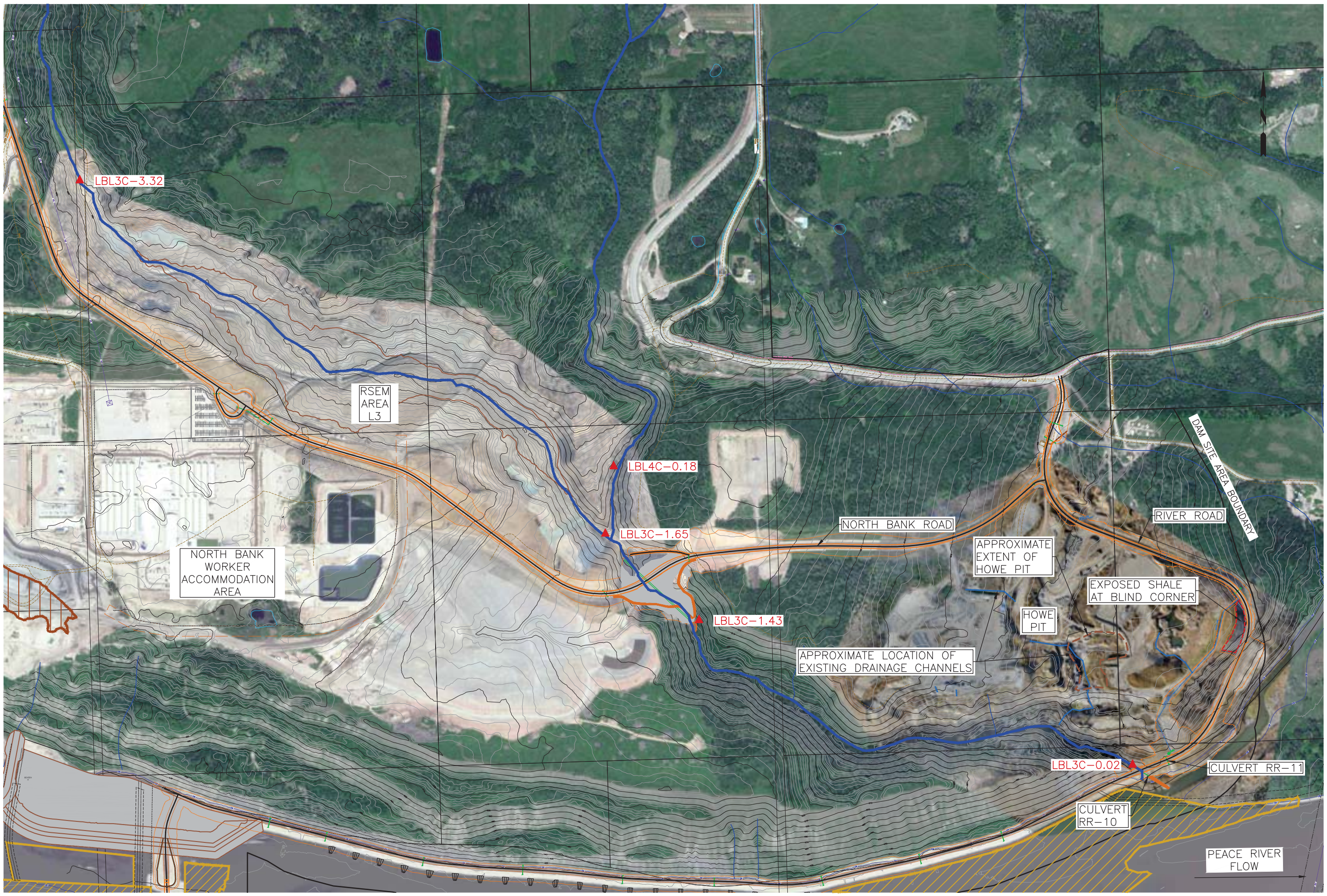
DSGN
INDEP CHK
DFTG
DFTG CHK
INSP CIV STR MECH GEO ELEC
REV
ACPT

CLEAN ENERGY PROJECT - SITE C
RIGHT BANK - SBIAR

WATER QUALITY MONITORING PLAN

DATE	DIST	DWG NO	SIZE	R
12 MAR 2018		FIGURE 2	A0	0

NOT TO BE REPRODUCED WITHOUT THE PERMISSION OF BC HYDRO



L E G E N D:

▲ WATER SAMPLE − INSITU TESTING (pH, ALKALINITY, TEMPERATURE) & EXTERNAL LABORATORY TESTING (METALS, TSS)

AIR PHOTO FLOWN OCT 2017

LOCATION	NORTHING	EASTING
LBL4C−0.18	6230578	631524
LBL3C−3.32	6231263	630244
LBL3C−1.65	6230417	631504
LBL3C−1.43	6230210	631728
LBL3C−0.02	6229860	632767

0 30 1:3000 150m

REF# DRAWING NUMBER TITLE
REFERENCE DRAWINGS

REF# DRAWING NUMBER TITLE
REFERENCE DRAWINGS

NO REMARKS DATE DESIGNED INDEP CHK DFTG DFTG CHK INSP CIV INSP STR INSP MECH INSP GEO INSP ELEC REV ACPT
REVISIONS

DSGN
INDEP CHK
DFTG
DFTG CHK
INSP CIV STR MECH GEO ELEC
REV
ACPT

CLEAN ENERGY PROJECT - SITE C
RIGHT BANK - L3 CREEK

WATER QUALITY MONITORING
PLAN

DATE 12 MAR 2018
DIST
DWG NO FIGURE 3
SIZE A0
R 0

NOT TO BE REPRODUCED WITHOUT THE PERMISSION OF BC HYDRO

C:\BC Hydro Site C\Design Drawings\Sketches\SK−067−L3 CREEK WATER SAMP−R1.dwg
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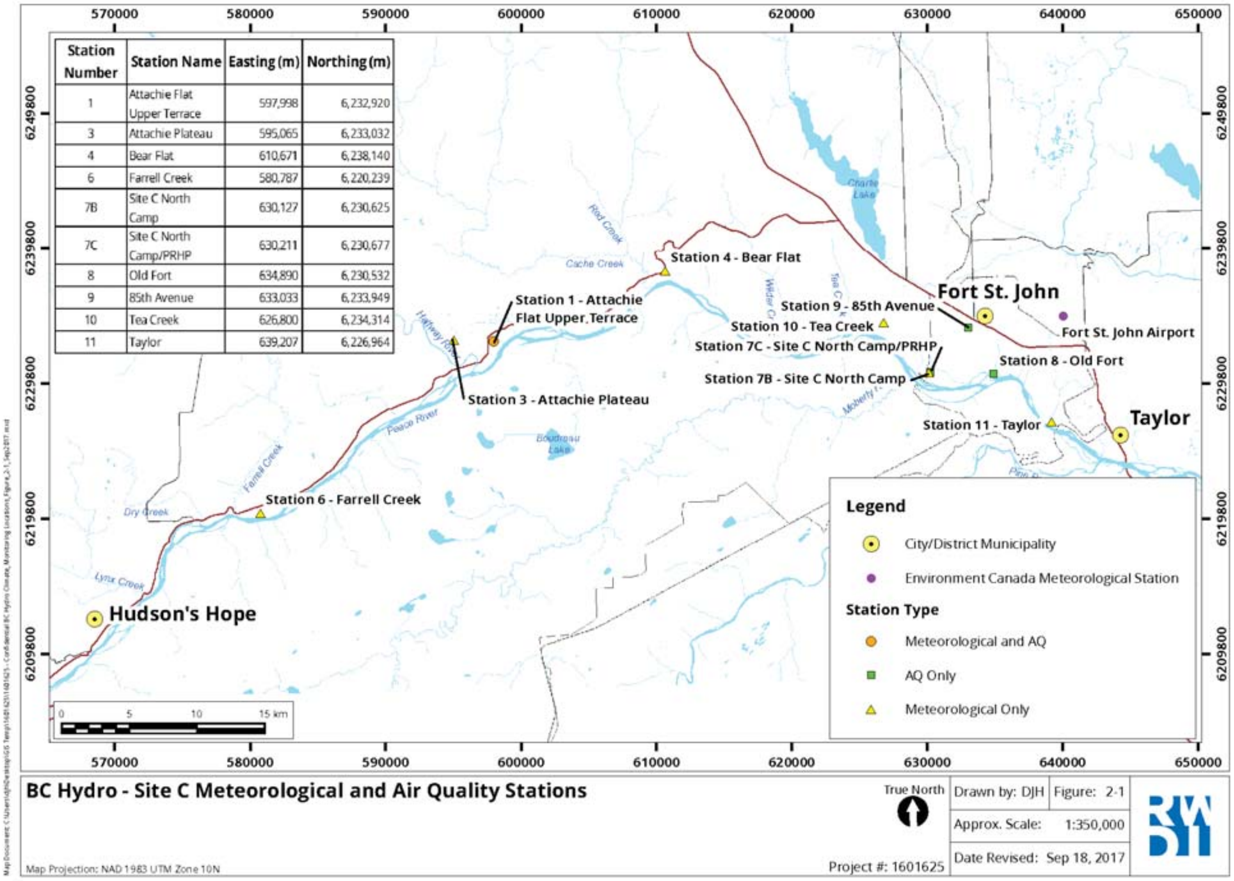
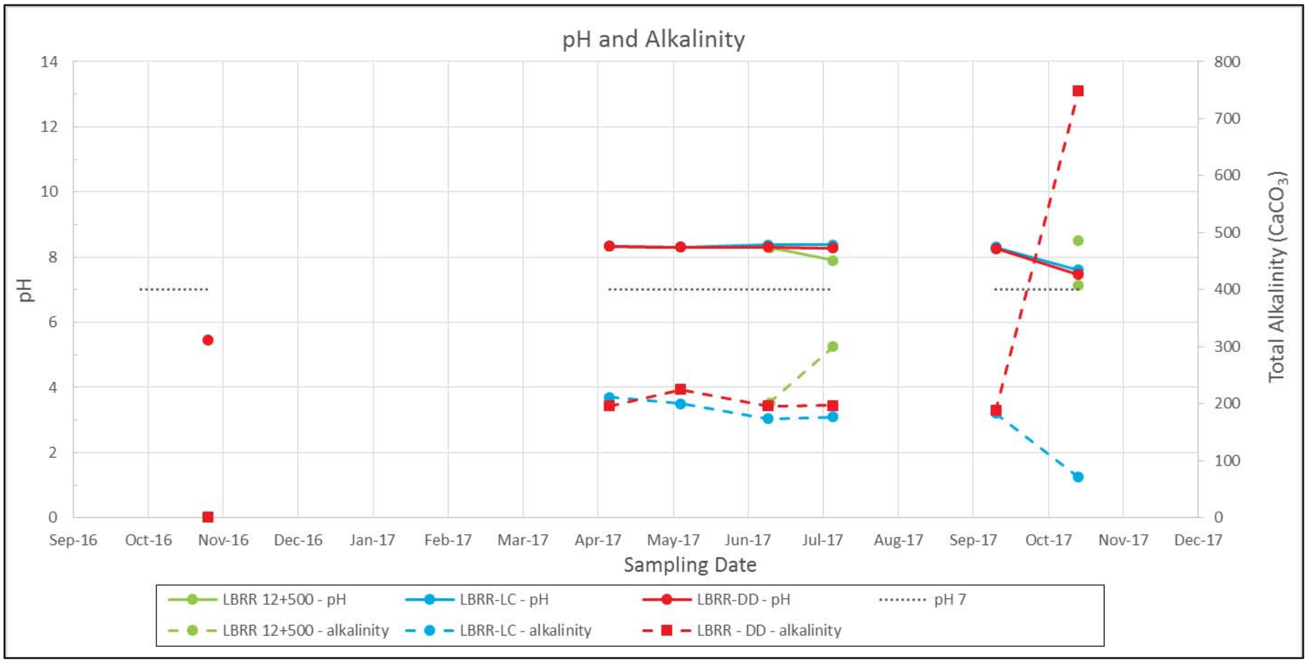
Figure 4: BC Hydro – Site C Meteorological and Air Quality Stations



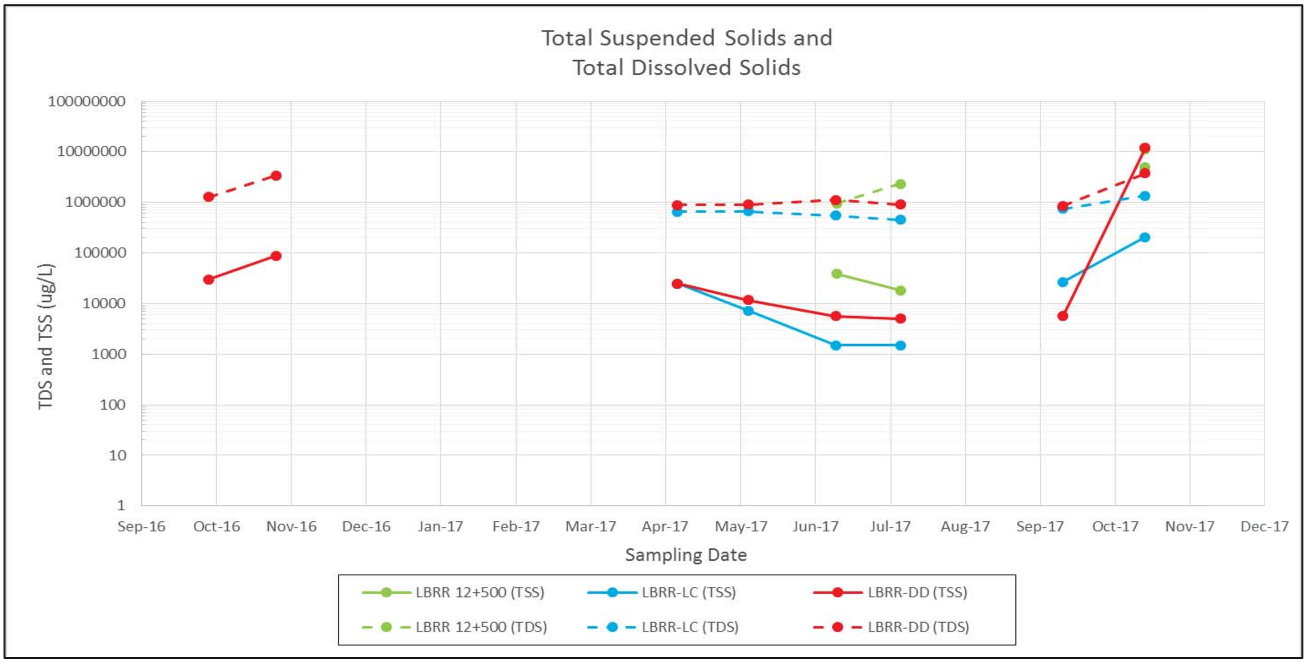
Station Number	Station Name	Easting (m)	Northing (m)
1	Attachie Flat Upper Terrace	597,998	6,232,920
3	Attachie Plateau	595,065	6,233,032
4	Bear Flat	610,671	6,238,140
6	Farrell Creek	580,787	6,220,239
7B	Site C North Camp	630,127	6,230,625
7C	Site C North Camp/PRHP	630,211	6,230,677
8	Old Fort	634,890	6,230,532
9	85th Avenue	633,033	6,233,949
10	Tea Creek	626,800	6,234,314
11	Taylor	639,207	6,226,964

Figure 5: Alkalinity and pH at River Road Locations



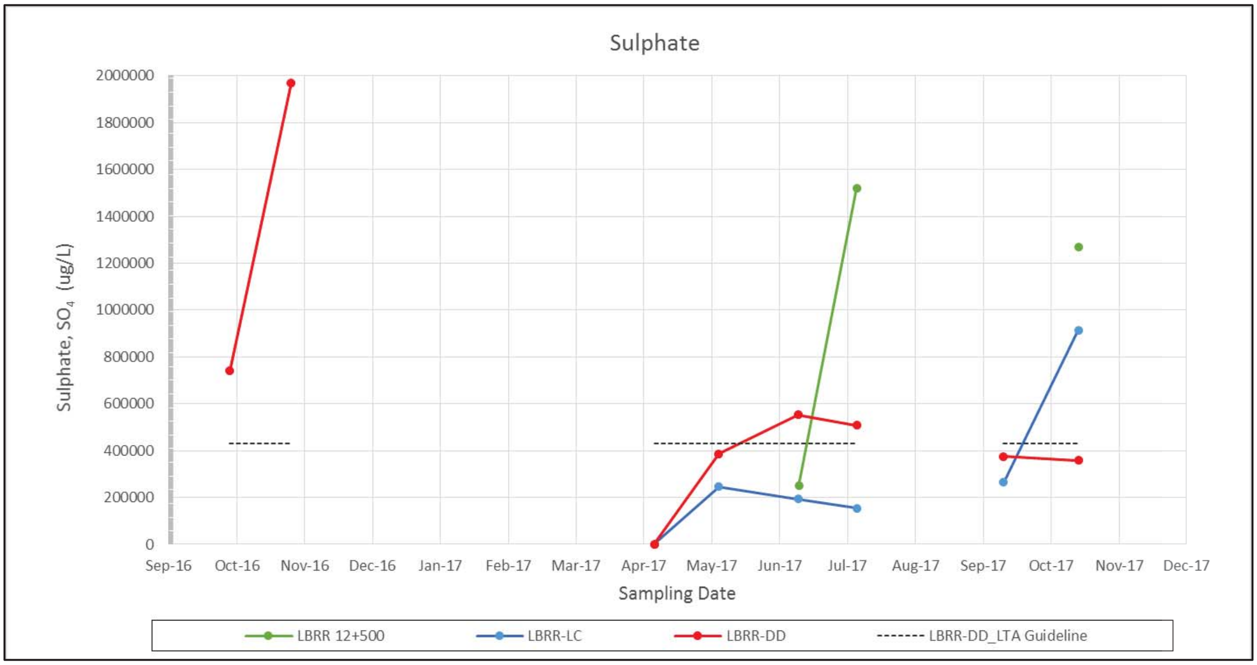
Note: Sampling stations appear in the order from upstream to downstream. The only compliance point/discharge location to the receiving environment is at River Road discharge location (LBRR-DD).

Figure 6: TSS and TDS at River Road Locations



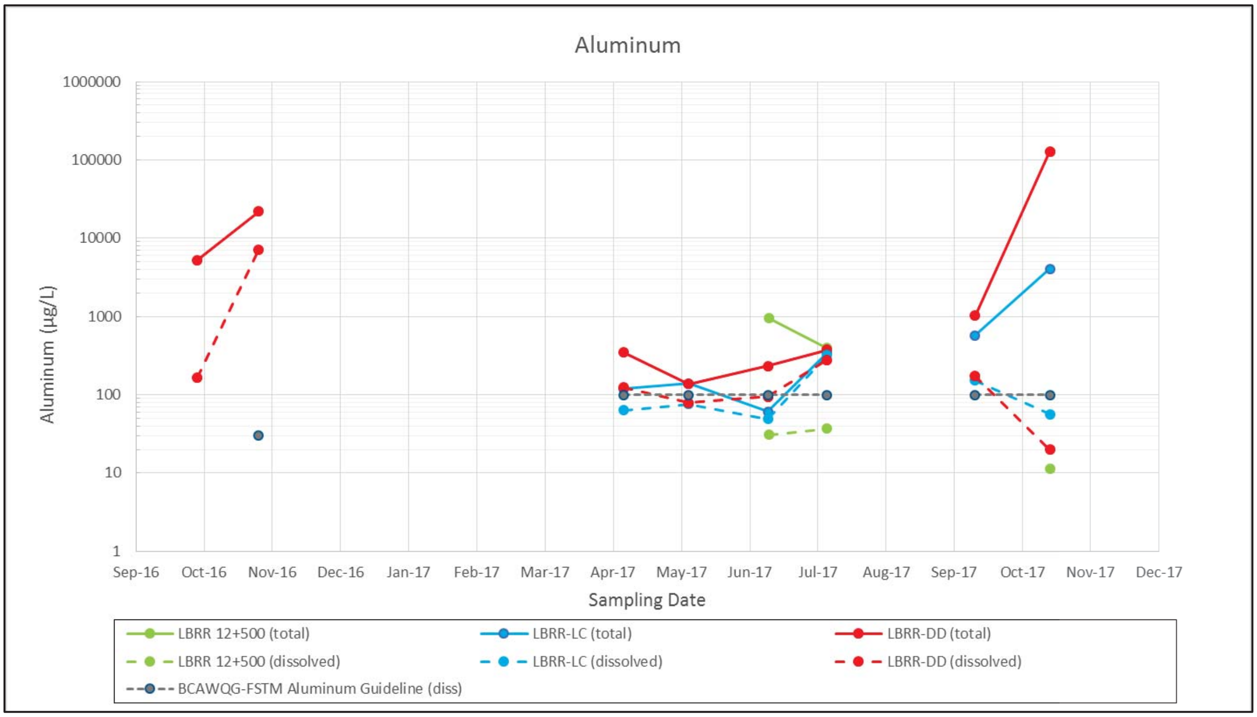
Note: Sampling stations appear in the order from upstream to downstream. The only compliance point/discharge location to the receiving environment is at River Road discharge location (LBRR-DD).

Figure 7: Sulphate at River Road Locations



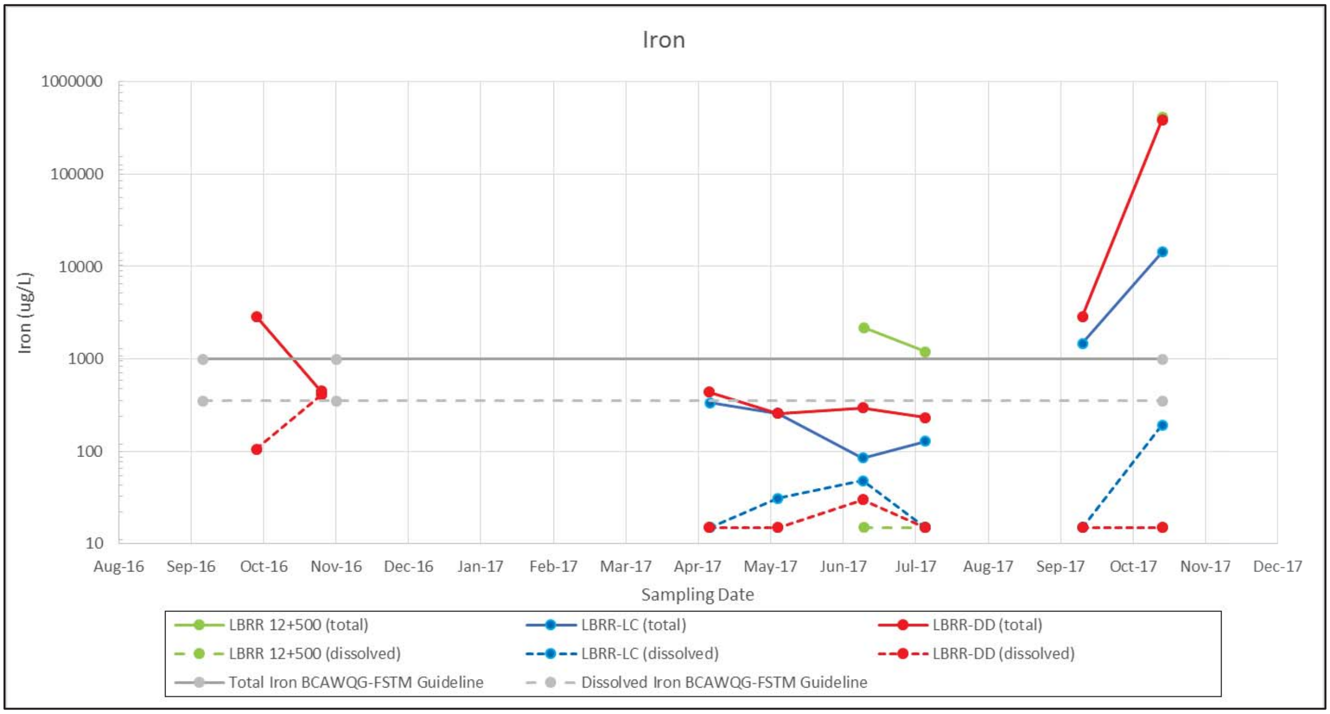
Note: Sampling stations appear in the order from upstream to downstream. The only compliance point/discharge location to the receiving environment is at River Road discharge location (LBRR-DD).

Figure 8: Total and Dissolved Aluminum at River Road Locations



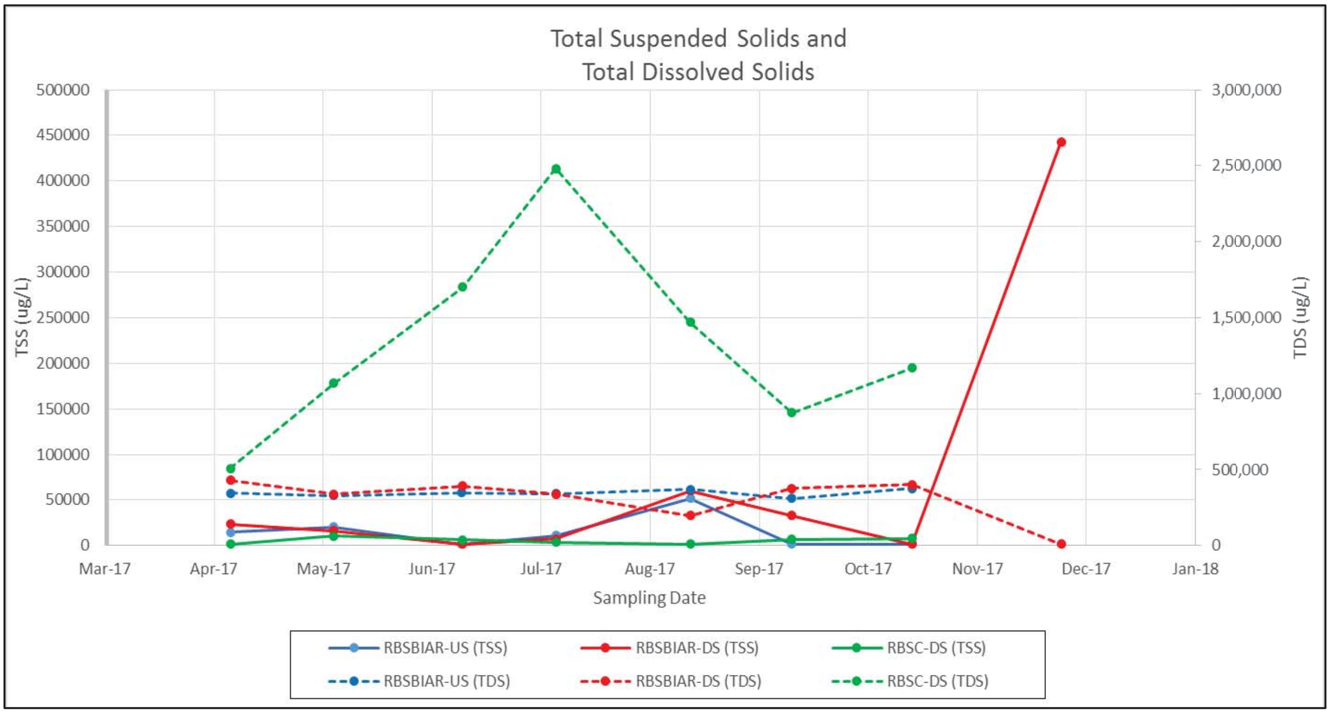
Note: Sampling stations appear in the order from upstream to downstream. The only compliance point/discharge location to the receiving environment is at River Road discharge location (LBRR-DD).

Figure 9: Total and Dissolved Iron at River Road Locations



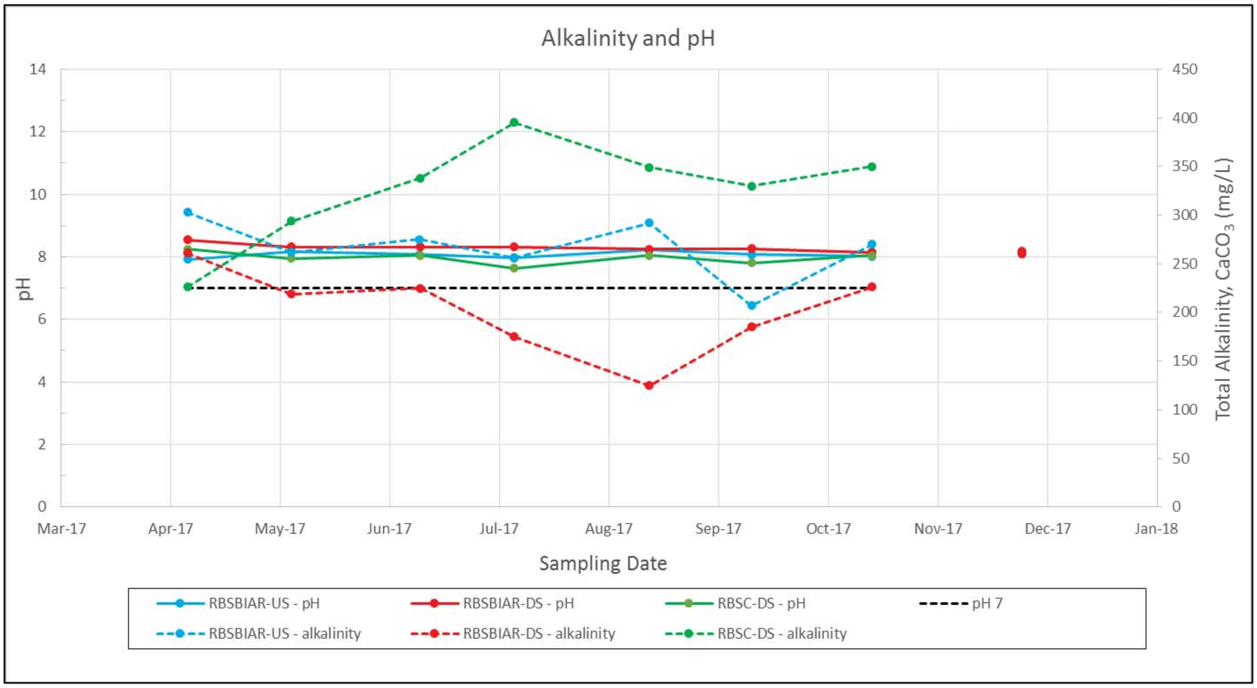
Note: Sampling stations appear in the order from upstream to downstream. The only compliance point/discharge location to the receiving environment is at River Road discharge location (LBRR-DD).

Figure 10: TSS and TDS at SBIAR Locations



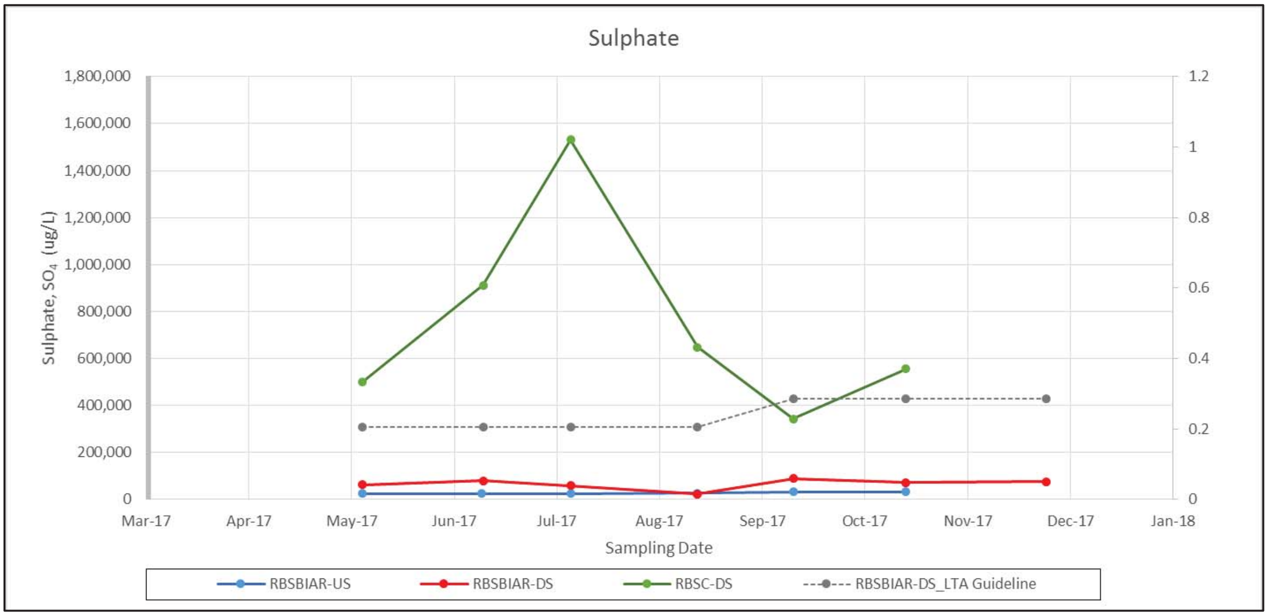
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 11: Alkalinity and pH at SBIAR Locations



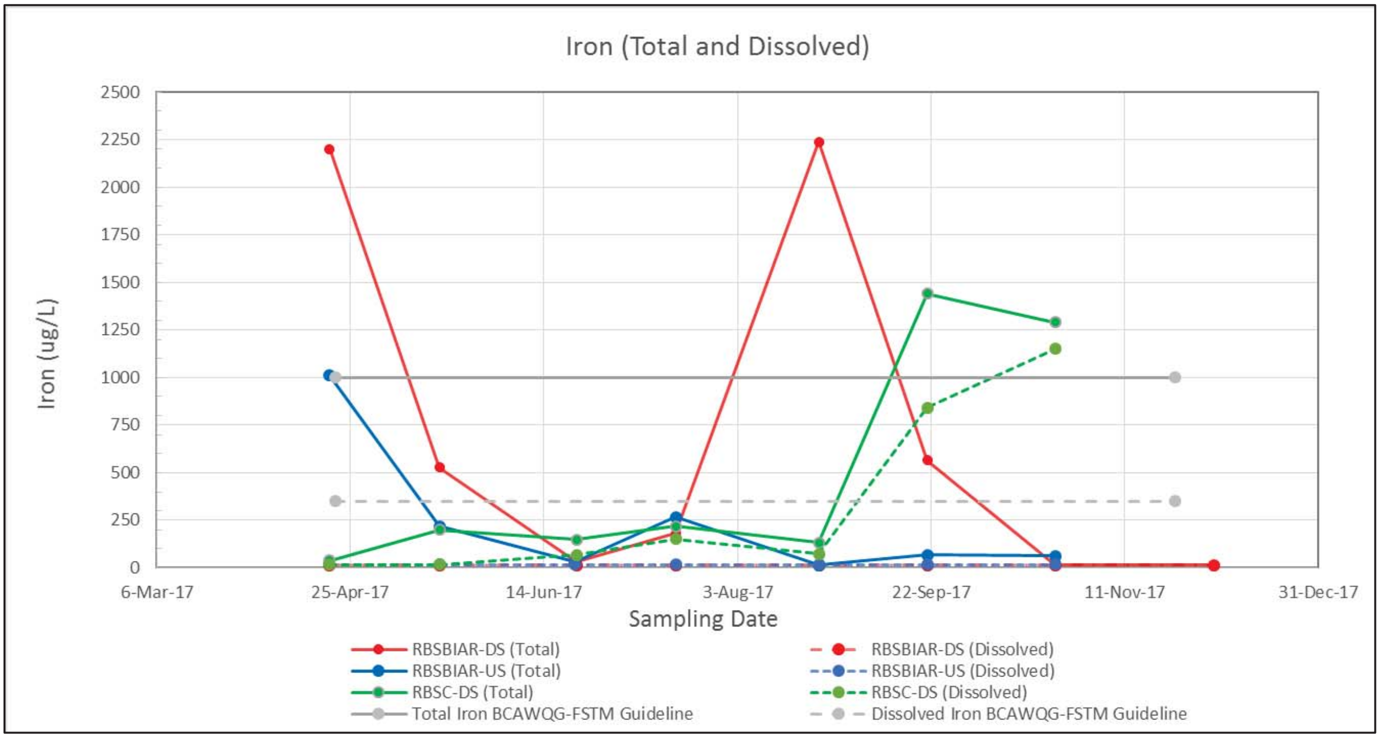
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 12: Sulphate at SBIAR Locations



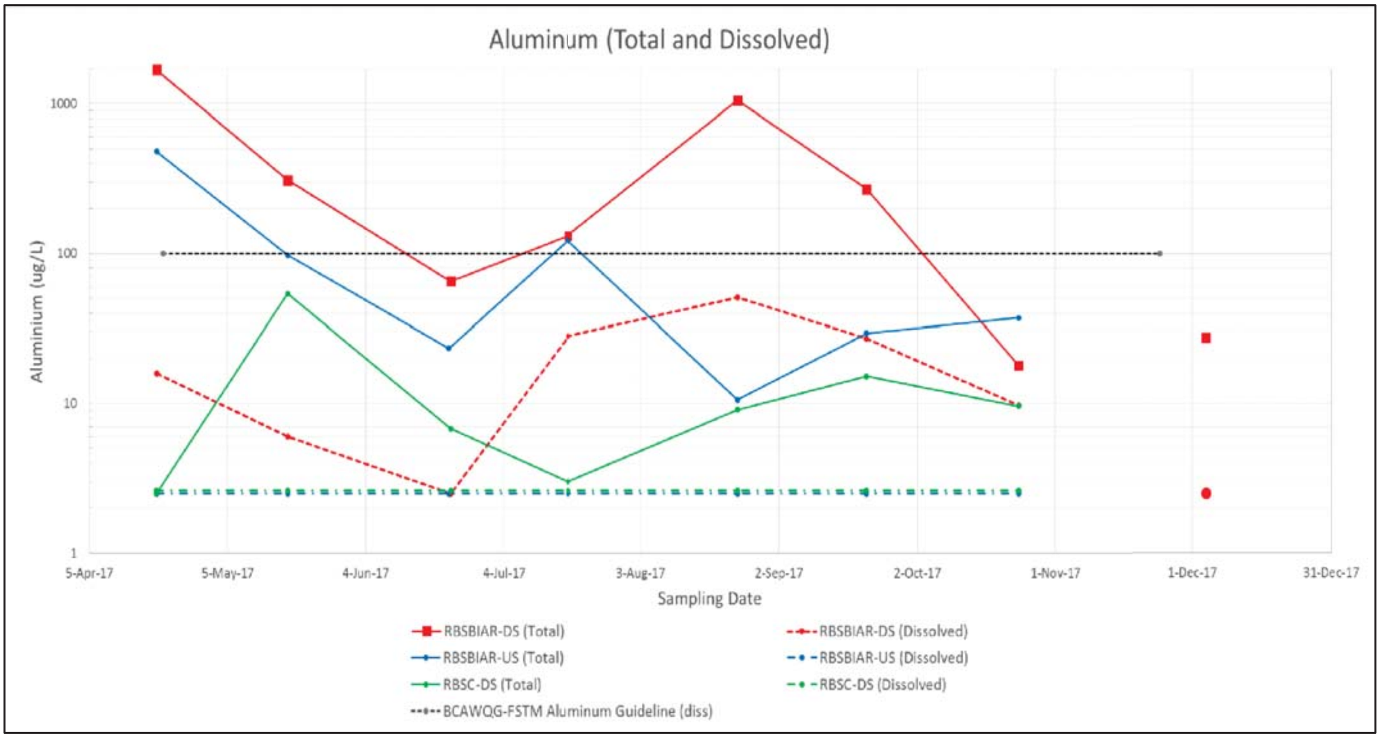
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 13: Total and Dissolved Iron at SBIAR Locations



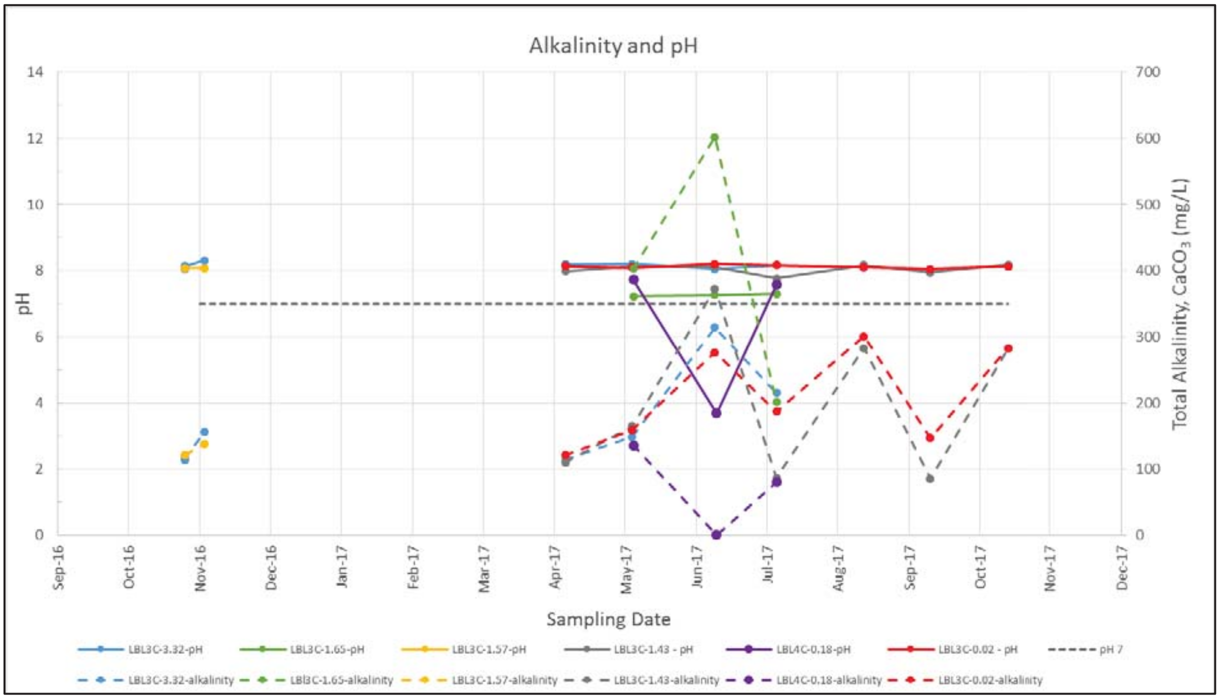
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 14: Total and Dissolved Aluminum at SBIAR Locations



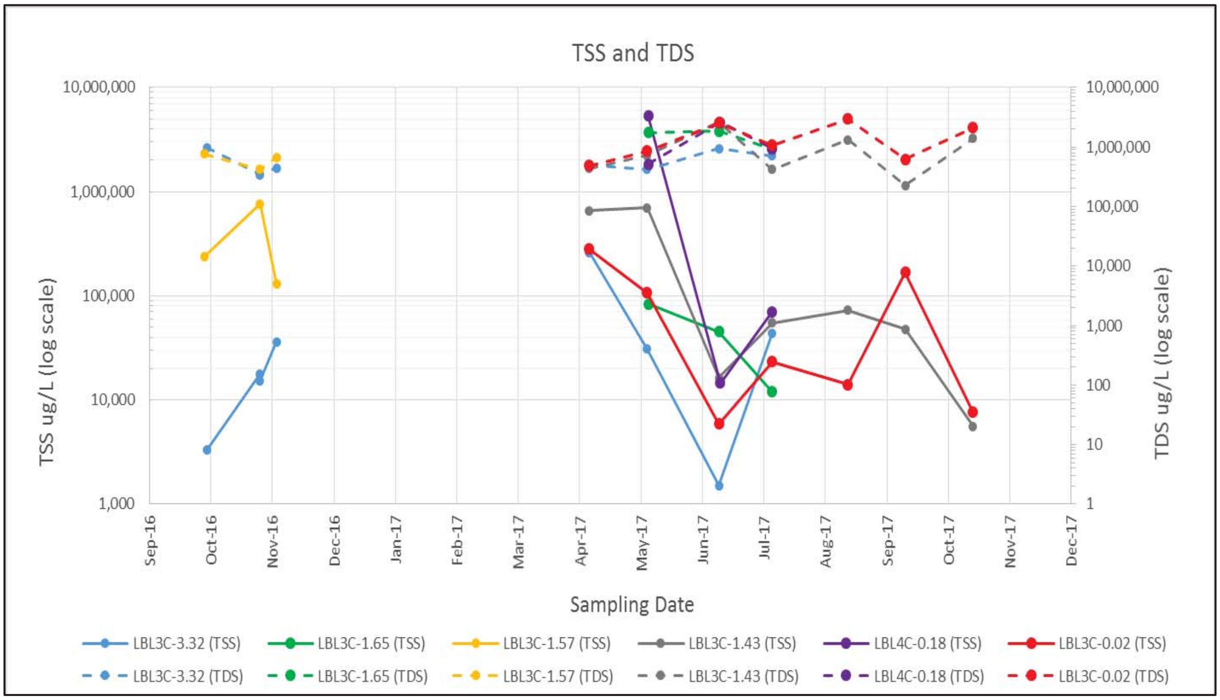
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 15: Alkalinity and pH at L3 Creek Catchment Locations



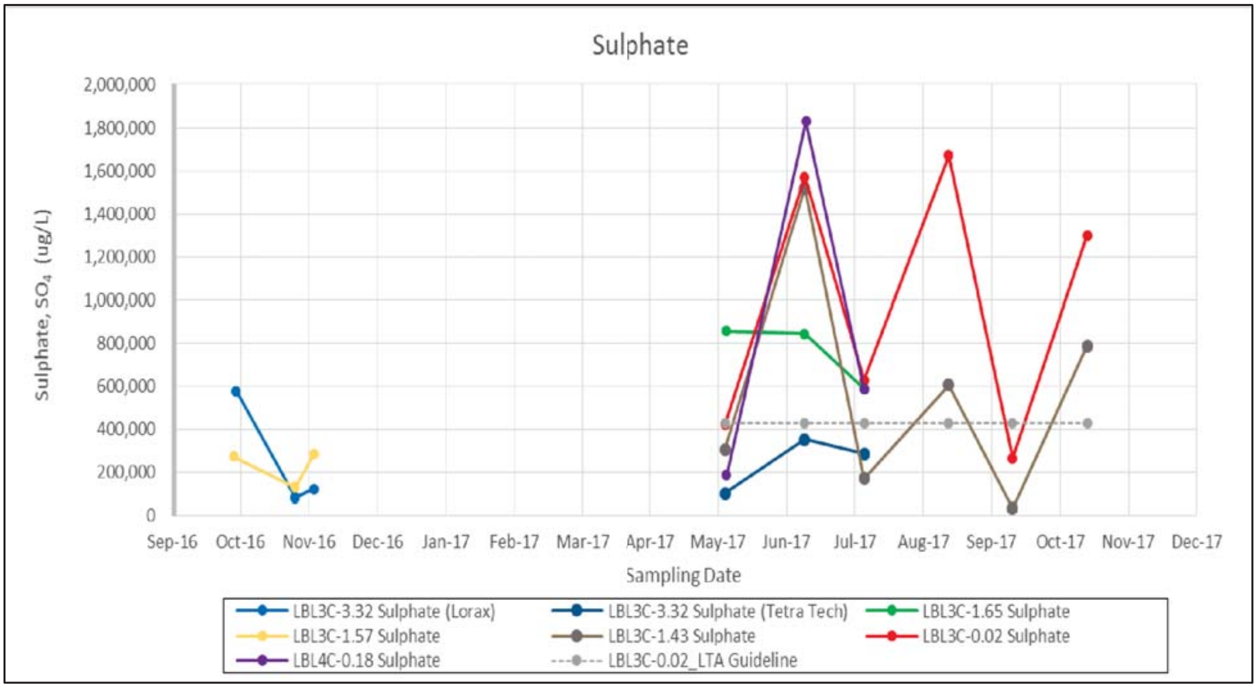
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 16: TSS and TDS Chart at L3 Creek Locations



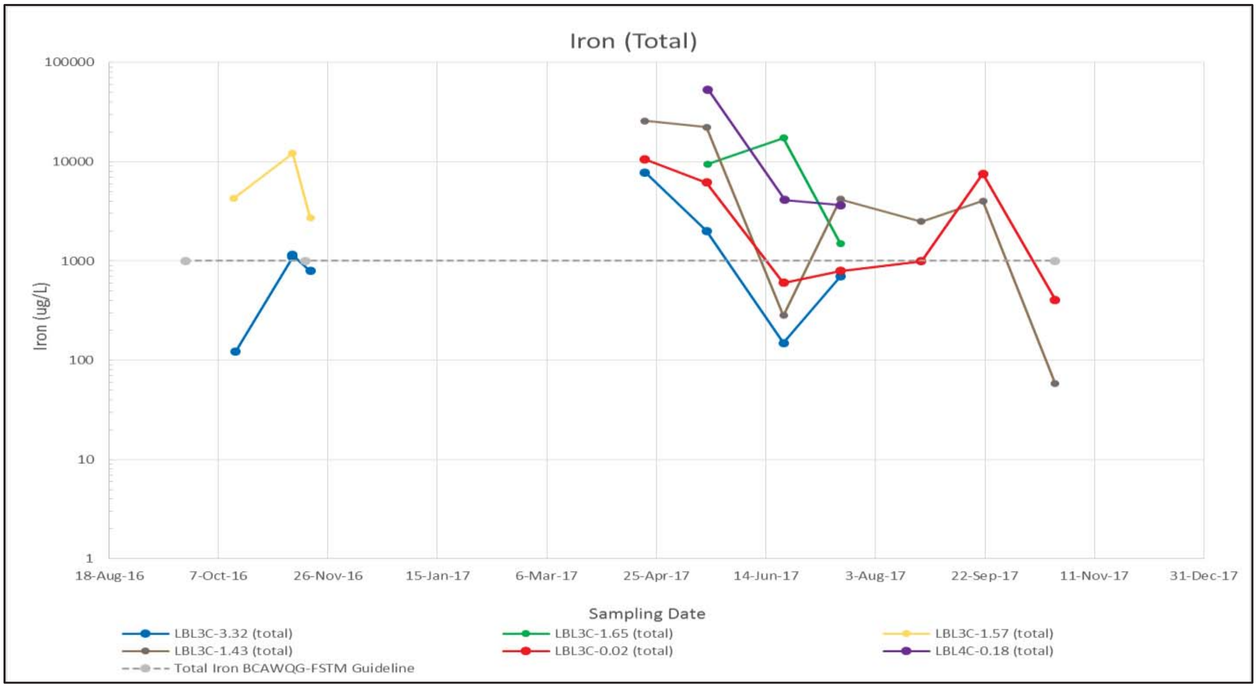
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 17: Sulphate at L3 and L4 Creek Locations



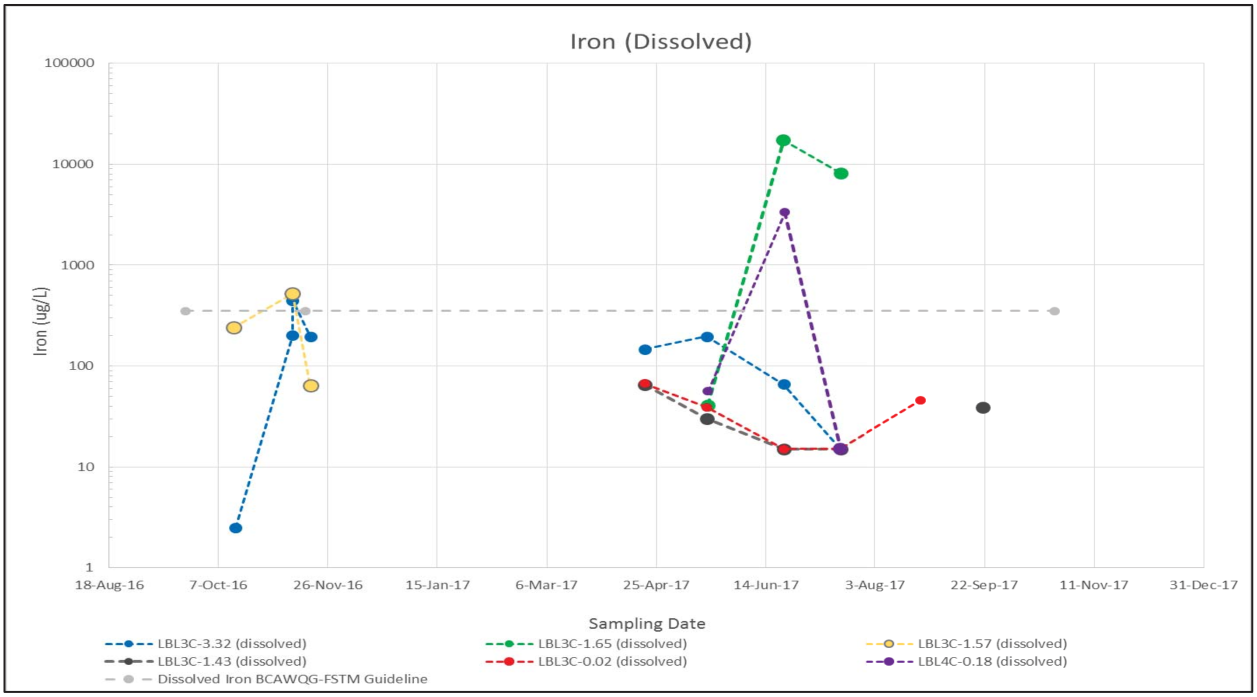
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 18: Total Iron at L3 and L4 Creek Locations



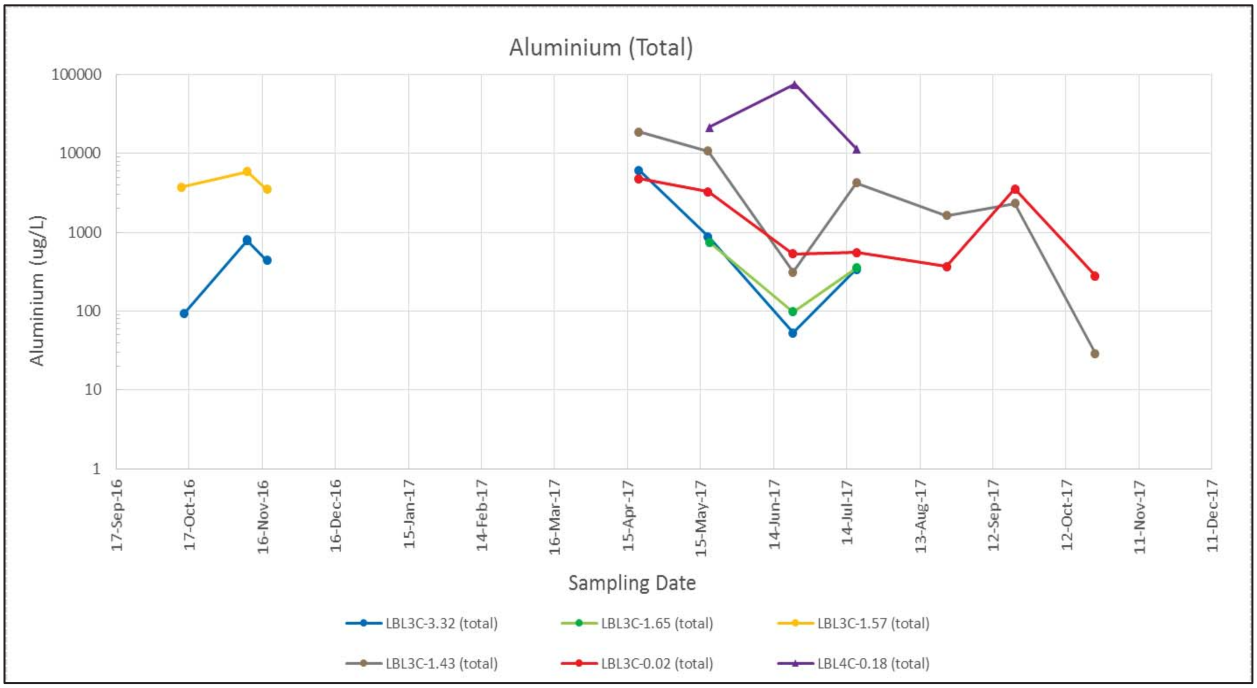
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 19: Dissolved Iron at L3 and L4 Creek Locations



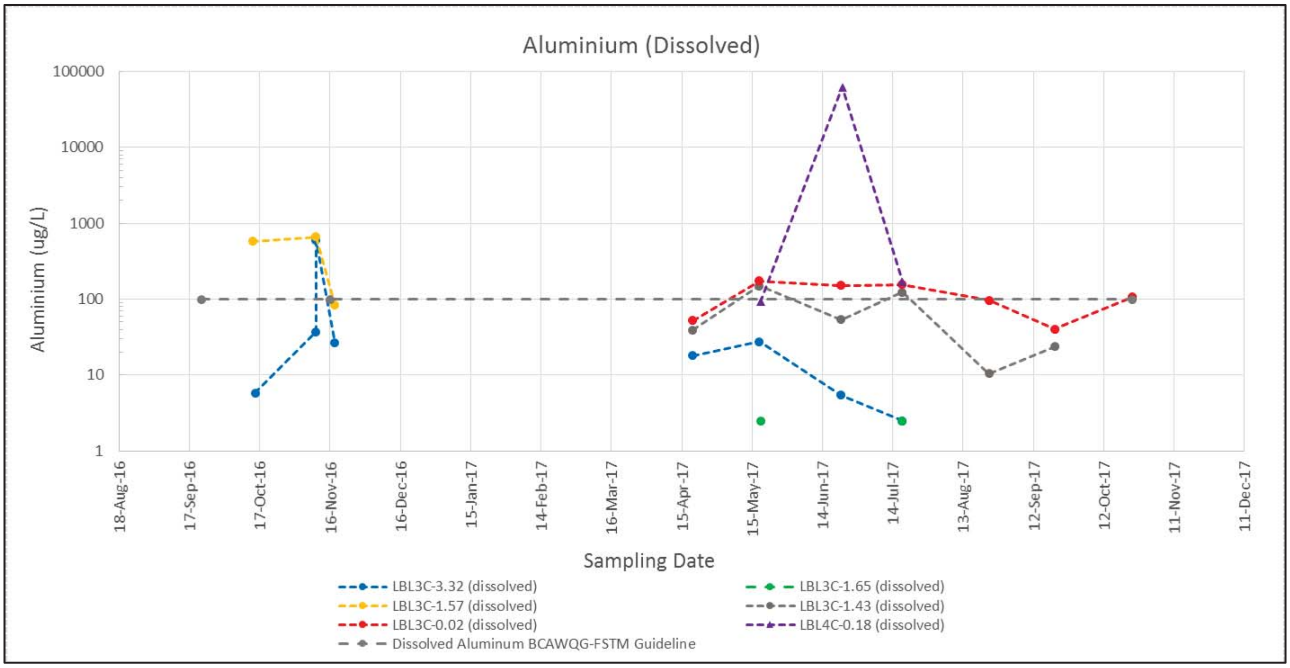
Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 20: Total Aluminum at L3 and L4 Creek Locations



Note: Sampling stations appear in the order from upstream to downstream locations.

Figure 21: Dissolved Aluminum at L3 and L4 Creek Locations



Note: Sampling stations appear in the order from upstream to downstream locations.

PHOTOGRAPHS

Photo 1: Photo of water sampling location LBRR-UC, taken April 17, 2017

Photo 2: Photo of water sampling location LBRR-12+500, taken April 17, 2017

Photo 3: Photo of water sampling location LBRR 12+600, taken April 17, 2017

Photo 4: Photo of water sampling location RBSBIAR-DS, taken April 17, 2017

Photo 5: Photo of water sampling location RBSBIAR-US, taken April 17, 2017

Photo 6: Photo of water sampling location RBSC-DS, taken April 17, 2017

Photo 7: Photo of water sampling location, looking upstream at LBL3C-1.43, taken April 17, 2017

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client’s expense upon written request, otherwise samples will be discarded.

APPENDIX B

SURFACE WATER ANALYTICAL LABORATORY RESULT TABLES

B1 - Surface Water Analytical Laboratory Results from Discharge and Downstream Locations at River Road, SBIAR, and L3 Creek Evaluated against the BCAWQG-FSTM Guidelines

B2 - Surface Water Laboratory Analytical Results from River Road Monitoring Locations Evaluated against the BCAWQG-FSTM Guidelines

B3 - Surface Water Laboratory Analytical Results from SBIAR Monitoring Locations Evaluated against the BCAWQG-FSTM Guidelines

B4 - Surface Water Laboratory Analytical Results from L3 Creek Monitoring Locations Evaluated against the BCAWQG-FSTM Guidelines

Appendix B1: Surface Water Analytical Results Discharge and Downstream Locations

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	LBRR-DD						RBSBIAR-DS								LBL3C-0.02						
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	4-Dec-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17
Physical Parameters									14:00	13:55	-	9:45	15:30	11:00		9:00	14:00	15:40	-	11:10	13:45	13:30		
				15:00	-	11:50	16:15																	
Flow Rate	L/sec			1.0	1.0	0.3	1.0	0.3	3.0	2.0 - 3.0	-	3.0	4.0	10.0	4.0	2.0		20.0	Fast	4.0	10.0	1.0	8.0	5.0
Electrical Conductivity (EC)	µS/cm	2	NG	1170	1170	1370	1260	1170	5520	634	522	610	557	294	565	611	688	655	1080	2590	1430	2840	782	2340
Hardness as CaCO$_3$	µg/L	500	NG Note: Acceptable ranges of Hardness exist when calculating exceedances for Cu, Pb, Mn, Zn, Ag, Cd	598000	623000	675000	642000	583,000	2360000	118000	180000	208000	215000	133000	271000	273000	293000	292000	545000	1370000	658000	1730000	376,000	1330000
pH	pH Units	0.1	6.5 - 9	8.33	8.30	8.31	8.28	8.27	7.47	8.55	8.31	8.32	8.32	8.24	8.26	8.15	8.18	8.14	8.09	8.2	8.16	8.1	8.05	8.12
Total Dissolved Solids (TDS)	µg/L	10000	NG	887000	902000	1120000	912000	853,000	3740000	428000	339000	393000	339000	198000	376,000	402,000	10,900	485000	862000	2540000	1080000	2940000	626,000	2110000
Total Suspended Solids (TSS)	µg/L	3000	NG	24900	11800	5700	5000	5800	11900000	23700	16000	<3000	7600	60300	32,800	<3000	443000	280000	107000	5900	23200	14100	167,000	7600
Anions and Nutrients																								
Alkalinity (Bicarbonate as CaCO$_3$)	µg/L	1000	NG	191000	223000	192000	197000	188,000	749,000	245000	216000	221000	170000	125000	185,000	226,000	260,000	121000	159000	276000	187000	301000	147,000	283,000
Alkalinity (Carbonate as CaCO$_3$)	µg/L	1000	NG	4800	2600	4400	<1000	<1000	<1000	16400	3200	4200	4800	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as CaCO$_3$	µg/L	1000	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as CaCO$_3$)	mg/L	1.0	NG	196	225	196	197	188	749	261	219	225	175	125	185	226	260	121	159	276	187	301	147	283
Ammonia [2] (Total as N)	µg/L	5.0	pH and Temperature Dependent	44.4	26.0	7.7	6.6	14.2	633	547	490	292	194	14.6	234	374	224	58	21	14.6	13.8	9.1	7.3	<5
				606	606.0	606	759	759	1970	387	606	606	606	759	759	952	759	952	1200	759	952	952	1200	952
Chloride (Cl$^-$)	µg/L	500	600,000	31000	39300	50400	39000	80100	**1830000**	3290	2690	19900	37400	7860	24000	26600	33000	25600	18600	26000	28300	25000	27300	26000
Nitrate (NO$_3^-$ as N)	µg/L	5.0	NG	111	73	33	<25	73	520	204	327	930	1750	263	2010	2500	1480	199	258	140	143	<100	63	<100
Nitrite (NO$_2^-$ as N)	µg/L	1.0	Dependent on Cl-	<5.0	<5.0	<5.0	<5.0	<5.0	<50	46.7	37.6	30.9	82	3.6	41.1	22.5	13.6	4.4	<5.0	<20	<5.0	<20	<5	<20
Sulphate (SO$_4$)	µg/L	300	NG	-	387000	554000	509000	376000	358000	-	61600	78700	58900	23100	88400	71300	75200		422000	1570000	627000	1670000	265000	1300000
Metals, Total																								
Aluminum	µg/L	5.0	NG	345	137	233	373	1030	128000	1680	310	65.2	131	1050	270	17.9	27.4	4770	3290	530	557	369	3580	281
Antimony	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	2.57	1.28	0.79	<0.50	<0.50	<0.50	<0.5	<0.5	0.5	0.53	<0.50	<0.50	<0.50	<0.50	0.57	<0.5
Arsenic	µg/L	0.50	5	0.51	0.55	0.51	0.62	2.34	**124**	2.43	0.71	<0.50	0.51	1.25	0.58	<0.5	<0.5	**5.35**	3.15	<0.50	0.72	0.69	3.95	<0.5
Barium	µg/L	20	NG	42	101	68	55	80	7110	431	213	227	203	178	188	189	166	234	142	47	71	40	138	41
Beryllium	µg/L	0.10	NG	0.13	<0.10	<0.10	<0.10	0.1	8.62	0.12	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.10	0.31	0.25	<0.20	<0.10	<0.20	0.24	<0.2
Boron	µg/L	100	1200	<100	<100	<100	<100	<100	370	130	110	<100	<100	<100	<100	<100	<100	<100	<100	160	<100	200	<100	160
Cadmium	µg/L	0.005	NG	0.748	0.245	1.02	0.879	0.411	14	0.0472	0.0361	0.0073	0.0266	0.0773	0.138	0.0081	0.0251	0.473	0.491	0.78	0.345	0.475	0.371	0.431
Calcium	µg/L	100	NG	170000	157000	184000	167000	156,000	1320000	32800	51500	59000	62200	39600	76,400	73,600	80,500	78600	149000	455000	180000	450000	102,000	355,000
Chromium	µg/L	1.0	NG	<1.0	<1.0	<1.0	<1.0	1.4	295	2.8	9.5	1.5	<1.0	2.2	1.1	<1	<1.0	9.4	5.5	<1.0	<1.0	<1.0	6.4	<1
Cobalt	µg/L	0.30	110	10.3	2.18	14.3	10.1	11.1	**147**	2.13	1.4	0.44	1.22	0.8	3.44	0.32	0.77	5.87	5.41	9.51	2.85	5.39	3.42	3.93
Copper [3] (Based on Hardness as CaCO$_3$)	µg/L	1.0	Calc. based on Hardness	2.3	2	1.9	3.2	7.4	**404**	3.3	2.2	<1.0	1.0	2.7	2.1	<1	<1.0	15.4	12.7	1.7	2.5	1.6	9.0	1.5
Cu STM Guideline Calc [4]	µg/L		Hardness ≤ 50,000 : calc.; Hardness > 50,000 : calc.; Hardness > 400,000: calc.	58.2	60.6	65.5	62.3	56.8	223.8	13.1	18.9	21.6	22.2	14.5	27.5	27.7	29.5	29.4	53.2	130.8	63.9	165	37	127
Iron	µg/L	30	1000	436	257	297	231	**2870**	**389,000**	**2200**	527	31	180	**2240**	566	<30	<30.0	**10600**	**6170**	603	793	995	**7550**	406
Lead [3] (Based on Hardness as CaCO$_3$)	µg/L	0.50	Calc. based on Hardness	<0.50	<0.50	<0.50	<0.50	1.15	155	1.3	<0.50	<0.50	<0.50	1.16	<0.5	<0.5	<0.5	5.8	2.71	<0.50	<0.50	<0.50	3.8	<0.5
Pb STM Guideline Calc [4]	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.	796	838	928	871	770	4567	101	173	207	216	117	290	293	321	319	707	2285	899	3076	441	2201
Lithium	µg/L	1.0	NG	34.7	29.8	74.6	63.3	42.1	256	43.2	23.6	26.1	17	5.6	17.7	17.9	27.3	16.5	33.5	82.9	35.4	94.7	18.7	57.2
Magnesium	µg/L	100	NG	39100	54500	69600	64400	52,200	216,000	8650	13800	17300	16500	10300	22,400	22,000	21,100	27700	39500	136000	53500	140000	34,400	118,000
Manganese [3] (Based on Hardness as CaCO$_3$)	µg/L	0.30	Calc. based on hardness	294	72.3	280	209	255	8390	38.1	27.4	2.69	15.5	58.7	69	3.36	8.79	212	182	425	178	322	201	192
Mn STM Guideline Calc [4]	µg/L		Applies to Hardness 25000-259000 Mn : calc.	7130	7405	7979	7615	6965	26547	1840	2524	2832	2909	2006	3526	3548	3769	3758	6546	15637	7791	19605	4684	15197
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.0050	NG	<0.0050	<0.0050	0.0091	<0.0050	<0.005	<0.5	0.0111	<0.0050	<0.0050	<0.010	<0.025	<0.005	<0.005	<0.005	0.0323	0.0137	<0.0050	<0.0050	<0.025	<0.025	<0.005
Molybdenum	µg/L	1.0	2000	4	4.6	4	3.3	4.8	12.4	12.5	5.6	4.3	4.3	2.5	3	3.2	4.7	2.3	2.3	2.6	2.5	2.8	3.4	2.5
Nickel	µg/L	1.0	NG	58.4	19.6	127	110	52.6	469	9.1	7.6	5	7	3.7	15.8	5.3	9.6	25.7	31	70.3	25.9	54.5	18	41
Potassium	µg/L	2000	NG	5500	6900	7700	8300	9100	53,300	2400	2900	3100	3600	<2000	3100	3300	2900	8800	8200	7000	5400	6900	4400	6100
Selenium	µg/L	0.050	NG	0.571	1.12	0.953	0.845	1.11	7.91	4.18	1.66	1.31	1.1	0.474	0.943	0.834	1.64	1.27	1.45	0.66	0.707	0.77	0.877	0.94
Silver [3] (Based on Hardness as CaCO$_3$)	µg/L	0.020	0.10 - 3.0	<0.020	<0.020	<0.020	<0.020	0.03	**3.0**	0.03	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.02	0.116	0.057	<0.020	<0.020	<0.020	0.07	<0.02
Ag STM Guideline Calc [4]	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Sodium	µg/L	2000	NG	18500	37600	32500	29300	32,300	69,200	101000	49500	54600	28900	7300	21,000	31,800	48,900	21300	33600	101000	43300	123000	25,200	88,700
Thallium	µg/L	0.010	NG	<0.20	<0.20	<0.20	0.027	0.063	2.58	<0.20	<0.20	<0.20	0.026	0.036	0.017	<0.01	0.012	<0.20	<0.20	<0.20	0.029	0.036	0.113	0.02
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	2.28	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Titanium	µg/L	10	NG	<10	<10	<10	<10	<10	551	16	<10	<10	<10	16	<10	<10	<10.0	63	32	<10	<10	<10	41	<10
Uranium	µg/L	0.20	NG	3.37	4.08	2.75	2.96	3.41	24.4	2.85	1.89	1.61	1.42	0.8	1.44	1.36	1.92	2.2	3.33	9.77	3.93	11.2	2.88	7.61
Vanadium	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	2.66	330	6.43	1.19	<0.50	0.6	3.85	1.09	<0.5	<0.5	18.2	9.49	<1.0	1.36	<1.0	12.8	<1
Zinc [3] (Based on Hardness as CaCO$_3$)	µg/L	5.0	Calc. based on Hardness	68.1	18.2	97.9	78.9	54.3	**1880**	9.1	<5.0	<5.0	<5.0	18.1	27.4	<5	6.9	60.4	54.8	72.7	39.5	57.9	54.1	51.8
Zn STM Guideline Calc [4]	µg/L		Hardness ≤ 90,000 Zn = 33.0 Hardness > 90,000 Zn = calc.	414	433	472	447	403	1736	54	101	122	127	65	169	170	185	185	374	993	459	1263	248	963

Appendix B1: Surface Water Analytical Results Discharge and Downstream Locations

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	LBRR-DD						RBSBIAR-DS								LBL3C-0.02						
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	4-Dec-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17
Metals, Dissolved																								
Aluminum [5]	µg/L	5.0	100	**124**	79.1	94.6	**279**	**174**	19.9	15.8	6.0	<5	28.1	50.9	27.1	9.7	<5.0	52.6	**173**	**152**	**157**	97.4	40.5	**106**
Aluminum STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Antimony	µg/L	0.50	NG	<0.50	<0.50	<0.5	<0.50	<0.5	0.65	1.38	0.73	<0.5	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Arsenic	µg/L	0.50	NG	<0.50	<0.50	<0.5	<0.50	<0.5	<0.5	1.03	<0.50	<0.5	<0.50	<0.50	<0.5	<0.5	<0.5	0.68	0.53	<0.50	<0.50	<0.50	<0.5	<0.5
Barium	µg/L	20	NG	50	100	61	53	37	265	262	190	195	197	137	178	195	148	61	73	37	67	37	34	41
Beryllium	µg/L	0.10	NG	<0.10	<0.10	<0.1	<0.10	<0.1	<0.5	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.20	<0.10	<0.20	<0.1	<0.2
Boron	µg/L	100	NG	<100	<100	<100	<100	<100	240	120	120	<100	<100	<100	<100	<100	<100.0	<100	<100	140	<100	190	<100	160
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.0050	Calc. based on Hardness	0.849	0.189	0.905	0.807	0.21	0.693	0.0115	<0.005	<0.005	0.02	<0.0050	0.0992	0.0069	0.0305	0.0523	0.213	0.536	0.293	0.306	0.108	0.36
Cd STM Guideline Calc [4]	µg/L		Applies to Hardness 7000-455000	3.71	3.87	4.20	3.99	3.62	15.26	0.70	1.08	1.25	1.29	0.79	1.64	1.65	1.78	1.77	3.37	8.72	4.10	11.08	2.30	8.45
Calcium	µg/L	100	NG	161000	162000	172000	157000	152,000	777,000	32800	49600	58300	60000	37700	72,500	73,000	81,500	73600	152000	381000	173000	464000	95,900	343,000
Chromium	µg/L	1.0	NG	<1.0	<1.0	<1.0	<1.0	<1	<1	<1.0	<1.0	1.2	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
Cobalt	µg/L	0.30	NG	12.2	1.9	12.8	9.51	8.21	3.01	0.66	0.96	0.35	1.04	<0.30	3.04	<0.3	0.73	<0.30	1.89	7.58	2.63	4.85	0.65	3.84
Copper	µg/L	1.0	NG	2.0	1.6	1.6	2.8	3.3	3.7	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1	<1.0	3.4	5.7	1.1	1.8	1.1	2.2	1.3
Iron	µg/L	30	350	<30	<30	30.00	<30	<30	<50	<30	<30	<30	<30	<30	<30	<30	<30.0	67	39	<30	<30	46	<30	<30
Lead	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Lithium	µg/L	1.0	NG	34.2	28.6	74.7	61.3	39.5	88.7	41.7	23.4	26.7	17	4.5	17	17.7	25.2	11.5	28.5	73.5	33.9	95.6	15.6	57.4
Magnesium	µg/L	100	NG	47400	52800	59300	60700	49,500	102,000	8780	13700	15100	15700	9300	21,900	22,000	21,600	26300	40200	101000	55000	139000	33,000	115,000
Manganese	µg/L	0.10	NG	356	57.1	250	200	203	676	8.79	11.6	1.99	11.3	2.83	48.7	3.19	8.6	1.78	119	346	173	292	61.2	189
Mercury	µg/L	0.0050	NG	<0.0050	<0.0050	<0.0050	0.0053	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	0.0051	<0.0050	<0.0050	<0.0050	0.0056	<0.0050	<0.005	<0.005
Molybdenum	µg/L	1.0	NG	3.6	4.7	3.6	3.1	4.5	9.2	12.3	5.8	3.9	4.5	2.3	2.9	3	4.2	1.4	1.6	2.2	2.4	2.7	2.7	2.5
Nickel	µg/L	1.0	NG	69.9	18.2	115	102	41.5	16.9	4.3	6.4	4.2	6.2	1.0	14.4	5.3	8.7	8.3	15.7	57.5	24.4	50.5	8	39.7
Potassium	µg/L	2000	NG	6900	6600	7700	7900	8800	35500	2100	2800	3000	3500	<2000	3000	3400	2800	8100	7800	6100	5700	6500	3600	6000
Selenium	µg/L	0.050	NG	0.534	1.17	1.01	0.801	0.896	4.31	4.18	1.65	1.27	1.14	0.431	0.956	0.814	1.66	0.943	1.23	0.54	0.69	0.4	0.736	0.91
Silver	µg/L	0.020	NG	<0.020	<0.020	<0.020	<0.020	<0.02	<0.05	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02
Sodium	µg/L	2000	NG	22000	36200	30800	28100	31,100	60,500	106000	52000	48700	27900	7000	20,300	32,500	47,100	21600	34200	82700	45300	119000	25,300	86,900
Thallium	µg/L	0.20	NG	<0.020	<0.020	<0.020	<0.20	<0.2	<0.2	<0.020	<0.020	<0.020	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Titanium	µg/L	10	NG	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10.0	<10	<10	<10	<10	<10	<10	<10
Uranium	µg/L	0.20	NG	3.02	4.12	2.7	2.68	2.95	4.44	2.66	1.93	1.62	1.36	0.69	1.31	1.28	1.69	1.87	3.38	8.9	3.87	10.9	2.43	7.4
Vanadium	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	<2.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<1.0	<0.50	<1.0	<0.5	<1
Zinc	µg/L	5.0	NG	73.2	12	73.7	61.5	16.5	16.4	<5.0	<5.0	<5.0	<5.0	<5.0	18.3	<5	5.9	<5.0	<5.0	42	22	33.6	7.7	43.5
Laboratory Work Order Number				L1914922	L1929264	L1947228	L1960994	L1996232	L2012451	L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451	L2030547-1	L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451
Laboratory Identification Number				L1914922-10	L1929264-5	L1947228-8	L1960994-8	L1996232-9	L2012451-6	L1914922-1	L1929264-2	L1947228-11	L1960994-11	L1981548-5	L1996232-5	L2012451-9	L2030547-1	L1914922-7	L1929264-4	L1947228-4	L1960994-4	L1981548-2	L1996232-2	L2012451-3

Notes:

Screening completed on BC AWQG-FWAL STM [1] values only.

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG

[2] Guideline for Ammonia is pH and temperature dependent; a temperature of 4 °C is assumed.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Where ambient hardness is higher than the recommended range given in the BCAWQG-FSTM, guideline values have been calculated based on ambient water hardness.

[5] Guideline is pH dependant.

RDL - Reportable detection limit

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded - Exceeds applicable guideline value.

Blank - Not analyzed

Appendix B2: River Road Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	LBRR-DD						LBRR-LC						LBRR-12+500		
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	21-Sep-17	24-Oct-17	22-Jun-17	18-Jul-17	24-Oct-17
Physical Parameters				15:00	-	11:50	16:15		14:00	15:20	-	12:05	16:30			12:20	17:00	
Flow Rate	L/sec			1.0	1.0	0.3	1.0	0.3	3.0	<1	-	0.25	1	0.5	0.2	<0.25	0.25	0.2
Electrical Conductivity (EC)	µS/cm	2	NG	1170	1170	1370	1260	1170	5520	904	917	773	700	1000	1530	1230	2610	6230
Hardness as $CaCO_3$	µg/L	500	NG Note: Acceptable ranges of Hardness exist when calculating exceedances for Cu, Pb, Mn, Zn, Ag, Cd	598000	623000	675000	642000	583,000	2360000	440000	446000	320000	304000	464000	880000	514000	1670000	2990000
pH	pH Units	0.1	6.5 - 9	8.33	8.30	8.31	8.28	8.27	7.47	8.33	8.30	8.37	8.37	8.30	7.60	8.29	7.90	7.13
Total Dissolved Solids (TDS)	µg/L	10000	NG	887000	902000	1120000	912000	853,000	3740000	660000	670000	546000	454000	744,000	1370000	958000	2340000	4960000
Total Suspended Solids (TSS)	µg/L	3000	NG	24900	11800	5700	5000	5800	11900000	24700	7200	<3000	<3000	27,000	205,000	38700	18200	11300000
Anions and Nutrients																		
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	191000	223000	192000	197000	188,000	749,000	206000	197000	167000	169000	179,000	71,200	202000	300000	487,000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	4800	2600	4400	<1000	<1000	<1000	5000	2400	6800	8800	3800	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	196	225	196	197	188	749	211	200	174	177	183	71.2	202	300	487
Ammonia [2] (Total as N)	µg/L	5.0	pH and Temperature Dependent	44.4	26.0	7.7	6.6	14.2	633	16.2	<5.0	<5.0	<5.0	7.7	366	5.9	13	807
				606	606.0	606	759	759	1970	606	606	606	606	606	1970	759	1430	1970
Chloride (Cl^-)	µg/L	500	600,000	31000	39300	50400	39000	80100	**1830000**	31700	39600	38200	38300	78,600	14,800	156000	44000	**1780000**
Nitrate (NO_3^- as N)	µg/L	5.0	NG	111	73	33	<25	73	520	66	<25	<25	<25	70	438	<25	160	530
Nitrite (NO_2^- as N)	µg/L	1.0	Dependent on Cl-	<5.0	<5.0	<5.0	<5.0	<5.0	<50	<5.0	<5.0	<5.0	<5.0	<5	5.3	<5.0	<20	<50
Sulphate (SO_4)	µg/L	300	NG	-	387000	554000	509000	376000	358000	-	247000	193000	155000	264000	915000	251000	1520000	1270000
Metals, Total																		
Aluminum	µg/L	5.0	NG	345	137	233	373	1030	128000	119	139	61.1	348	571	4050	944	393	127000
Antimony	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	2.57	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	0.74	<0.50	2.4
Arsenic	µg/L	0.50	5	0.51	0.55	0.51	0.62	2.34	**124**	0.53	<0.50	0.55	0.7	1.49	**5.39**	1.78	0.82	**227**
Barium	µg/L	20	NG	42	101	68	55	80	7110	54	122	73	62	65	218	124	47	4580
Beryllium	µg/L	0.10	NG	0.13	<0.10	<0.10	<0.10	0.1	8.62	<0.10	<0.10	<0.10	<0.10	<0.1	0.5	<0.10	<0.20	10.7
Boron	µg/L	100	1200	<100	<100	<100	<100	<100	370	<100	<100	<100	<100	<100	<100	<100	160	370
Cadmium	µg/L	0.005	NG	0.748	0.245	1.02	0.879	0.411	14	0.327	0.0245	0.0145	0.0426	0.211	1.58	0.0832	4.31	27.5
Calcium	µg/L	100	NG	170000	157000	184000	167000	156,000	1320000	116000	116000	78000	70800	119000	242000	153000	445000	1290000
Chromium	µg/L	1.0	NG	<1.0	<1.0	<1.0	<1.0	1.4	295	<1.0	<1.0	<1.0	<1.0	<1	5.1	1.9	1.0	262
Cobalt	µg/L	0.30	110	10.3	2.18	14.3	10.1	11.1	**147**	6.55	1.02	<0.30	0.62	2.6	13.4	1.26	2	**301**
Copper [3] (Based on Hardness as $CaCO_3$)	µg/L	1.0	Calc. based on Hardness	2.3	2	1.9	3.2	7.4	**404**	2.5	1.6	1.4	3.5	5.7	17.1	6.8	2.6	**443**
Cu STM Guideline Calc [4]	µg/L		Hardness ≤ 50,000 : calc.; Hardness > 50,000 : calc.; Hardness > 400,000: calc.	58.2	60.6	65.5	62.3	56.8	223.8	43.4	43.9	32.1	30.6	45.6	84.7	50.3	159.0	283.1
Iron	µg/L	30	1000	436	257	297	231	**2870**	**389000**	335	256	85	128	**1480**	**14400**	**2180**	**1200**	**415000**
Lead [3] (Based on Hardness as $CaCO_3$)	µg/L	0.50	Calc. based on Hardness	<0.50	<0.50	<0.50	<0.50	1.15	155	<0.50	<0.50	<0.50	<0.50	0.57	6.25	0.76	<0.50	123
Pb STM Guideline Calc [4]	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.	796	838	928	871	770	4567	538	548	359	336	576	1301	656	2941	6172
Lithium	µg/L	1.0	NG	34.7	29.8	74.6	63.3	42.1	256	24.7	20.9	22.2	18.6	20.7	68.3	23	176	330
Magnesium	µg/L	100	NG	39100	54500	69600	64400	52,200	216,000	34400	43100	38900	33200	42,800	70,500	46600	146000	227,000
Manganese [3] (Based on Hardness as $CaCO_3$)	µg/L	0.30	Calc. based on hardness	294	72.3	280	209	255	8390	153	26.8	3.32	6.77	95.6	330	77.5	720	8870
Mn STM Guideline Calc [4]	µg/L		Applies to Hardness 25,000-259,000 Mn : calc.	7130	7405	7979	7615	6965	26547	5389	5455	4066	3890	5653	10238	6204	18943	33490
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.0050	NG	<0.0050	<0.0050	0.0091	<0.0050	<0.005	<0.5	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.025	0.008	0.0068	0.57
Molybdenum	µg/L	1.0	2000	4	4.6	4	3.3	4.8	12.4	4.2	3.8	3.9	3.8	4.8	5.1	13.7	1.3	20.4
Nickel	µg/L	1.0	NG	58.4	19.6	127	110	52.6	469	27.4	8.7	5.6	5	13.1	61.4	8.3	428	1000
Potassium	µg/L	2000	NG	5500	6900	7700	8300	9100	53,300	6400	6600	6500	7200	9600	8300	6400	11900	47,000
Selenium	µg/L	0.050	NG	0.571	1.12	0.953	0.845	1.11	7.91	0.421	0.27	0.249	0.368	0.924	3.9	1.78	2.48	11.3
Silver [3] (Based on Hardness as $CaCO_3$)	µg/L	0.020	0.10 - 3.0	<0.020	<0.020	<0.020	<0.020	0.03	**3.0**	<0.020	<0.020	<0.020	<0.020	<0.02	0.249	<0.020	<0.020	2.32
Ag STM Guideline Calc [4]	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Sodium	µg/L	2000	NG	18500	37600	32500	29300	32,300	69,200	20300	27600	27400	25700	31,500	14,800	47300	38500	68,900
Thallium	µg/L	0.010	NG	<0.20	<0.20	<0.20	0.027	0.063	2.58	<0.20	<0.20	<0.20	0.022	0.041	0.316	<0.20	0.056	2.28
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	2.28	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	2.04
Titanium	µg/L	10	NG	<10	<10	<10	<10	<10	551	<10	<10	<10	<10	<10	19	20	<10	531
Uranium	µg/L	0.20	NG	3.37	4.08	2.75	2.96	3.41	24.4	3.61	3.48	2.1	2.38	3.19	4.72	7.3	4.41	37.4
Vanadium	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	2.66	330	<0.50	<0.50	<0.50	<0.50	1.37	10	3.68	1.6	319
Zinc [3] (Based on Hardness as $CaCO_3$)	µg/L	5.0	Calc. based on Hardness	68.1	18.2	97.9	78.9	54.3	**1880**	24.5	<5.0	<5.0	<5.0	21.9	140	9.9	426	**3300**
Zn STM Guideline Calc [4]	µg/L		Hardness ≤ 90,000 Zn = 33.0 Hardness > 90,000 Zn = calc.	414	433	472	447	403	1736	296	300	206	194	314	626	351	1218	2208

Appendix B2: River Road Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	LBRR-DD						LBRR-LC						LBRR-12+500		
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	21-Sep-17	24-Oct-17	22-Jun-17	18-Jul-17	24-Oct-17
Metals, Dissolved																		
Aluminum [5]	µg/L	5.0	100	**124**	79.1	94.6	**279**	**174**	19.9	63.8	75.6	48.7	**323**	**152**	56.3	31	37.1	11.5
Aluminum STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Antimony	µg/L	0.50	NG	<0.50	<0.50	<0.5	<0.50	<0.5	0.65	<0.50	<0.50	<0.5	<0.50	<0.5	<0.5	0.71	<0.50	<0.5
Arsenic	µg/L	0.50	NG	<0.50	<0.50	<0.5	<0.50	<0.5	<0.5	<0.50	<0.50	<0.5	0.62	<0.5	<0.5	0.73	<0.50	<0.5
Barium	µg/L	20	NG	50	100	61	53	37	265	54	114	70	60	45	22	85	34	123
Beryllium	µg/L	0.10	NG	<0.10	<0.10	<0.1	<0.10	<0.1	<0.5	<0.10	<0.10	<0.1	<0.10	<0.1	<0.1	<0.1	<0.20	<0.5
Boron	µg/L	100	NG	<100	<100	<100	<100	<100	240	<100	<100	<100	<100	<100	<100	<100	140	270
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.0050	Calc. based on Hardness	0.849	0.189	0.905	0.807	0.21	0.693	0.323	<0.005	0.0142	0.035	0.101	1.29	0.0195	4.25	7.11
Cd STM Guideline Calc [4]	µg/L		Applies to Hardness 7000-455000	3.71	3.87	4.20	3.99	3.62	15.26	2.71	2.74	1.95	1.85	2.86	5.53	3.18	10.69	19.47
Calcium	µg/L	100	NG	161000	162000	172000	157000	152,000	777,000	118000	112000	72400	67300	118,000	242,000	142000	429000	965,000
Chromium	µg/L	1.0	NG	<1.0	<1.0	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1	<1	<1.0	<1.0	<1
Cobalt	µg/L	0.30	NG	12.2	1.9	12.8	9.51	8.21	3.01	6.38	0.69	<0.30	0.57	1.45	11	0.52	32.7	73.1
Copper	µg/L	1.0	NG	2.0	1.6	1.6	2.8	3.3	3.7	2.0	1.2	1.4	3.2	3.6	6.9	4.5	1.5	2.4
Iron	µg/L	30	350	<30	<30	30.00	<30	<30	<50	<30	31.00	48.00	<30	<30	193.00	<30	<30	<50
Lead	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.5
Lithium	µg/L	1.0	NG	34.2	28.6	74.7	61.3	39.5	88.7	25.9	20.1	21.3	19	19.5	64.3	21	166	124
Magnesium	µg/L	100	NG	47400	52800	59300	60700	49,500	102,000	35400	40300	33900	33100	41,000	67,200	38600	144000	141,000
Manganese	µg/L	0.10	NG	356	57.1	250	200	203	676	151	8.96	2.88	6.25	73.4	284	32.7	695	3520
Mercury	µg/L	0.0050	NG	<0.0050	<0.0050	<0.0050	0.0053	<0.005	<0.005	<0.0050	<0.0050	<0.0050	0.0061	<0.005	<0.005	0.0062	<0.0050	<0.005
Molybdenum	µg/L	1.0	NG	3.6	4.7	3.6	3.1	4.5	9.2	4.1	3.8	3.5	3.8	4.3	1.8	13	1.2	5.4
Nickel	µg/L	1.0	NG	69.9	18.2	115	102	41.5	16.9	26.9	7.4	5.4	4.7	9.2	52.5	5.7	416	263
Potassium	µg/L	2000	NG	6900	6600	7700	7900	8800	35500	6500	6300	6600	7000	9400	6900	6100	11700	35500
Selenium	µg/L	0.050	NG	0.534	1.17	1.01	0.801	0.896	4.31	0.38	0.278	0.276	0.364	0.747	3.4	1.83	2.51	5.84
Silver	µg/L	0.020	NG	<0.020	<0.020	<0.020	<0.020	<0.02	<0.05	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.05
Sodium	µg/L	2000	NG	22000	36200	30800	28100	31,100	60,500	20000	26100	26500	24900	30,400	14,400	43500	38000	64,000
Thallium	µg/L	0.20	NG	<0.020	<0.020	<0.020	<0.20	<0.2	<0.2	<0.020	<0.020	<0.020	<0.20	<0.2	<0.2	<0.020	<0.20	<0.2
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.5
Titanium	µg/L	10	NG	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Uranium	µg/L	0.20	NG	3.02	4.12	2.7	2.68	2.95	4.44	3.3	3.56	2.06	2.29	2.81	3.88	7.09	4.14	4.1
Vanadium	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.5	<2.5	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<1.0	<2.5
Zinc	µg/L	5.0	NG	73.2	12	73.7	61.5	16.5	16.4	20.9	<5.0	<5.0	<5.0	9.7	82.9	<5.0	415	72.2
Laboratory Work Order Number				L1914922	L1929264	L1947228	L1960994	L1996232	L2012451	L1914922	L1929264	L1947228	L1960994	L1996232	L2012451	L1947228	L1960994	L2012451
Laboratory Identification Number				L1914922-10	L1929264-5	L1947228-8	L1960994-8	L1996232-9	L2012451-6	L1914922-11	L1929264-6	L1947228-7	L1960994-7	L1996232-8	L2012451-5	L1947228-6	L1960994-6	L2012451-4

Notes:

Screening completed on BC AWQG-FWAL STM [1] values only.

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG.

[2] Guideline for Ammonia is pH and temperature dependent; a temperature of 4 °C is assumed.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Where ambient hardness is higher than the recommended range given in the BCAWQG-FSTM, guideline values have been calculated based on ambient water hardness.

[5] Guideline is pH dependant.

RDL - Reportable detection limit

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded - Exceeds applicable guideline value.

Blank - Not analyzed

Appendix B3: South Bank Initial Access Road Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	RBSBIAR-DS								RBSBIAR-US							RBSC-DS						
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	4-Dec-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17
				13:55	-	9:45	15:30	11:00		9:00	14:00	14:20	-	10:07	15:45	11:15	12:15	9:00	13:28	-	9:02	13:15	12:00	11:45	
Flow Rate	L/sec			2.0 - 3.0	-	3.0	4.0	10.0	4.0	2.0		0.5 - 1.0	-	1.0	2.0	0.5	0.5	0.3	Stagnant	Minimal	Stagnant	Stagnant	n/a	n/a	n/a
Electrical Conductivity (EC)	µS/cm	2	NG	634	522	610	557	294	565	611	688	550	505	532	568	566	505	560	763	1370	1990	2730	1650	1170	1480
Hardness as $CaCO_3$	µg/L	500	NG Note: Acceptable ranges of Hardness exist when calculating exceedances for Cu, Pb, Mn, Zn, Ag, Cd	118000	180000	208000	215000	133000	271000	273000	293000	312000	276000	284000	300000	300000	255000	307000	463000	680000	1010000	1640000	770000	611000	681000
pH	pH Units	0.1	6.5 - 9	8.55	8.31	8.32	8.32	8.24	8.26	8.15	8.18	7.92	8.18	8.08	7.98	8.21	8.07	8.02	8.25	7.94	8.04	7.63	8.05	7.8	8.05
Total Dissolved Solids (TDS)	µg/L	10000	NG	428000	339000	393000	339000	198000	376,000	402,000	10,900	346000	330000	348000	341000	371000	309,000	377,000	507000	1070000	1700000	2480000	1470000	873,000	1170000
Total Suspended Solids (TSS)	µg/L	3000	NG	23700	16000	<3000	7600	60300	32,800	<3000	443000	14900	20400	<3000	11000	51500	<3000	<3000	<3000	10400	6100	3800	<3000	6600	7800
Anions and Nutrients																									
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	245000	216000	221000	170000	125000	185,000	226,000	260,000	303000	262000	275000	256000	292000	207,000	270,000	226000	294000	338000	395000	349000	330,000	350,000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	16400	3200	4200	4800	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	261	219	225	175	125	185	226	260	303	262	275	256	292	207	270	226	294	338	395	349	330	350
Ammonia [2] (Total as N)	µg/L	5.0	pH and Temperature Dependent	547	490	292	194	14.6	234	374	224	<5.0	14.8	<5.0	<5.0	7.7	100	<5	<5.0	5.0	<5.0	12.9	7.8	<5	<5
				387	606	606	606	759	759	952	759	1430	952	1200	1430	759	1200	1200	759	1430.0	1200	1970	1200	1690	1200
Chloride (Cl^-)	µg/L	500	600000	3290	2690	19900	37400	7860	24000	26600	33000	560	930	910	23800	8470	25800	13100	13600	16500	15500	15000	18100	20100	17000
Nitrate (NO_3^- as N)	µg/L	5.0	NG	204	327	930	1750	263	2010	2500	1480	235	422	360	511	505	1640	1130	<25	<50	<50	<100	<50	<25	<25
Nitrite (NO_2^- as N)	µg/L	1.0	Dependent on Cl^-	46.7	37.6	30.9	82	3.6	41.1	22.5	13.6	<1.0	1.5	<1.0	1.9	<1	104	<1	<5.0	<10	<10	<20	<10	<5	<5
Sulphate (SO_4)	µg/L	300	NG	-	61600	78700	58900	23100	88400	71300	75200	-	24300	24800	25300	26700	31700	31600	-	499000	911000	1530000	647000	343000	556000
Metals, Total																									
Aluminum	µg/L	5.0	NG	1680	310	65.2	131	1050	270	17.9	27.4	481	97.6	23.4	123	10.6	29.5	37.2	<5.0	53.9	6.8	<6.0	9.1	15.2	9.6
Antimony	µg/L	0.50	NG	1.28	0.79	<0.50	<0.50	<0.50	<0.5	<0.5	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Arsenic	µg/L	0.50	5	2.43	0.71	<0.50	0.51	1.25	0.58	<0.5	<0.5	0.59	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	0.9	1
Barium	µg/L	20	NG	431	213	227	203	178	188	189	166	238	229	249	250	228	186	235	107	83	70	48	27	49	41
Beryllium	µg/L	0.10	NG	0.12	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.20	<0.10	<0.1	<0.1
Boron	µg/L	100	1200	130	110	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	130	<100	<100	<100
Cadmium	µg/L	0.005	NG	0.0472	0.0361	0.0073	0.0266	0.0773	0.138	0.0081	0.0251	0.0317	0.0162	0.0099	0.0211	0.0132	0.0155	0.0688	0.064	0.104	0.169	0.235	0.261	0.0628	0.17
Calcium	µg/L	100	NG	32800	51500	59000	62200	39600	76,400	73,600	80,500	92200	85300	90800	99000	88700	73,600	88,600	141000	198000	285000	409000	224000	176,000	188,000
Chromium	µg/L	1.0	NG	2.8	9.5	1.5	<1.0	2.2	1.1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.9	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
Cobalt	µg/L	0.30	110	2.13	1.4	0.44	1.22	0.8	3.44	0.32	0.77	0.58	<0.30	<0.30	<0.30	<0.30	<0.3	<0.3	<0.30	<0.30	<0.30	<0.30	<0.30	1.09	0.79
Copper [3] (Based on Hardness as $CaCO_3$)	µg/L	1.0	Calc. based on Hardness	3.3	2.2	<1.0	1.0	2.7	2.1	<1	<1.0	1.4	<1.0	<1.0	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu STM Guideline Calc [4]	µg/L		Hardness ≤ 50,000 : calc.; Hardness > 50,000 : calc.; Hardness > 400,000: calc.	13.1	18.9	21.6	22.2	14.5	27.5	27.7	29.5	31.3	27.9	28.7	30.2	30.2	26.0	30.9	45.5	65.9	96.9	156.2	74.4	59.4	66.0
Iron	µg/L	30	1000	**2200**	527	31	180	**2240**	566	<30	<30.0	**1010**	219	30	267	<30	69	63	39	200	148	218	133	**1440**	**1290**
Lead [3] (Based on Hardness as $CaCO_3$)	µg/L	0.50	Calc. based on Hardness	1.3	<0.50	<0.50	<0.50	1.16	<0.5	<0.5	<0.5	0.6	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.30	<0.50	<0.50	<0.5	<0.5
Pb STM Guideline Calc [4]	µg/L		Based on Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.	101	173	207	216	117	290	293	321	348	297	308	331	331	269	340	574	937	1550	2874	1098	818	939
Lithium	µg/L	1.0	NG	43.2	23.6	26.1	17	5.6	17.7	17.9	27.3	6.9	7.2	8.1	8.4	10.4	8.8	8.4	17.6	36.5	46.3	77	56.1	25.3	34.7
Magnesium	µg/L	100	NG	8650	13800	17300	16500	10300	22,400	22,000	21,100	21900	19100	21400	20300	20800	18,400	21,200	32400	45400	73800	117000	62100	42,000	52,100
Manganese [3] (Based on Hardness as $CaCO_3$)	µg/L	0.30	Calc. based on Hardness	38.1	27.4	2.69	15.5	58.7	69	3.36	8.79	24.5	11.4	2.57	11.5	1.06	2.22	2.31	7.62	17.2	80.6	142	140	451	385
Mn STM Guideline Calc [4]	µg/L		Applies to Hardness 25000-259000 Mn : calc.	1840	2524	2832	2909	2006	3526	3548	3769	3978	3582	3670	3846	3846	3350	3923	5642	8034	11670	18613	9025	7273	8045
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.0050	NG	0.0111	<0.0050	<0.0050	<0.010	<0.025	<0.005	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005
Molybdenum	µg/L	1.0	2000	12.5	5.6	4.3	4.3	2.5	3	3.2	4.7	<1.0	1.3	1	1.2	1.6	1.7	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
Nickel	µg/L	1.0	NG	9.1	7.6	5	7	3.7	15.8	5.3	9.6	1.4	<1.0	<1.0	<1.0	<1.0	<1	<1	3	4.6	8.8	14.3	11.7	6.4	15
Potassium	µg/L	2000	NG	2400	2900	3100	3600	<2000	3100	3300	2900	2700	2900	3200	3800	4000	3700	3500	<2000	<2000	2000	2900	<2000	<2000	<2000
Selenium	µg/L	0.050	NG	4.18	1.66	1.31	1.1	0.474	0.943	0.834	1.64	0.817	0.78	0.755	0.707	0.678	0.692	0.838	0.605	0.988	0.53	0.40	0.19	0.055	0.06
Silver [3] (Based on Hardness as $CaCO_3$)	µg/L	0.020	0.10 - 3.0	0.03	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02
Ag STM Guideline Calc [4]	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Sodium	µg/L	2000	NG	101000	49500	54600	28900	7300	21,000	31,800	48,900	5800	6000	5100	5600	6800	7200	6600	45900	71200	105000	177000	84800	50,400	66,200
Thallium	µg/L	0.010	NG	<0.20	<0.20	<0.20	0.026	0.036	0.017	<0.01	0.012	<0.20	<0.20	<0.20	<0.010	<0.010	<0.01	<0.01	<0.20	<0.20	<0.20	<0.020	<0.010	<0.01	<0.01
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Titanium	µg/L	10	NG	16	<10	<10	<10	16	<10	<10	<10.0	13	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Uranium	µg/L	0.20	NG	2.85	1.89	1.61	1.42	0.8	1.44	1.36	1.92	1.56	1.43	1.37	1.32	1.42	0.86	1.42	2.23	2.94	5.2	8.3	4.18	2.82	2.75
Vanadium	µg/L	0.50	NG	6.43	1.19	<0.50	0.6	3.85	1.09	<0.5	<0.5	1.88	0.53	<0.50	0.75	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<1.0	<0.50	<0.5	<0.5
Zinc [3] (Based on Hardness as $CaCO_3$)	µg/L	5.0	Calc. based on Hardness	9.1	<5.0	<5.0	<5.0	18.1	27.4	<5	6.9	<5.0	<5.0	<5.0	5.3	10.6	<5	<5	5.2	8.1	14.6	20.6	24.8	5.8	15.2
Zn STM Guideline Calc [4]	µg/L		Hardness ≤ 90,000 Zn = 33.0 Hardness > 90,000 Zn = calc.	54	101	122	127	65	169	170	185	200	173	179	191	191	157	196	313	476	723	1196	543	424	476
Metals, Dissolved																									
Aluminum [5]	µg/L	5.0	100	15.8	6.0	<5	28.1	50.9	27.1	9.7	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Antimony	µg/L	0.50	NG	1.38	0.73	<0.5	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.5	<0.50	<0.50	<0.5	<0.5
Arsenic	µg/L	0.50	NG	1.03	<0.50	<0.5	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.5	<0.50	<0.50	0.67	0.88
Barium	µg/L	20	NG	262	190	195	197	137	178	195	148	212	213	219	239	226	185	214	106	77	69	41	25	48	40
Beryllium	µg/L	0.10	NG	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10	<0.1	<0.20	<0.10	<0.1	<0.1
Boron	µg/L	100	NG	120	120	<100	<100	<100	<100	<100	<100.0	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	160	<100	<100	<100
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.0050	Calc. based on Hardness	0.0115	<0.005	<0.005	0.02	<0.0050	0.0992	0.0069	0.0305	0.006	<0.005	0.0057	0.011	0.0066	0.0108	0.008	0.0509	0.0581	0.129	0.076	0.165	0.0223	0.036
Cd STM Guideline Calc [4]	µg/L		Applies to Hardness 7000-455000	0.70	1.08	1.25	1.29	0.79	1.64	1.65	1.78	1.90	1.67	1.72	1.82	1.82	1.54	1.87	2.85	4.24	6.37	10.49	4.82	3.79	4.24
Calcium	µg/L	100	NG	32800	49600	58300	60000	37700	72,500	73,000	81,500	89900	79200	84000	88300	85900	72,400	88,900	135000	196000	293000	434000	217000	176,000	188,000

Appendix B3: South Bank Initial Access Road Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	RBSBIAR-DS								RBSBIAR-US							RBSC-DS						
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	4-Dec-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17
Chromium	µg/L	1.0	NG	<1.0	<1.0	1.2	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.8	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
Cobalt	µg/L	0.30	NG	0.66	0.96	0.35	1.04	<0.30	3.04	<0.3	0.73	<0.30	<0.30	<0.30	<0.30	<0.30	<0.3	<0.3	<0.30	<0.30	<0.30	0.42	<0.30	0.93	0.79
Copper	µg/L	1.0	NG	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.3	<1	<1.0	<1.0	<1.0	<1.0	<1.0	1	<1
Iron	µg/L	30	350	<30	<30	<30	<30	<30	<30	<30	<30.0	<30	<30	<30	<30	<30	<30	<30	<30	<30	69	151	74	841	1150
Lead	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Lithium	µg/L	1.0	NG	41.7	23.4	26.7	17	4.5	17	17.7	25.2	6.3	7.4	7.6	7.9	9.7	8.1	7.8	16.9	36.1	47.3	93.6	45.5	26.3	38
Magnesium	µg/L	100	NG	8780	13700	15100	15700	9300	21,900	22,000	21,600	21200	19100	18000	19300	20800	18,000	20,600	30400	46100	67900	135000	55600	41,700	51,400
Manganese	µg/L	0.10	NG	8.79	11.6	1.99	11.3	2.83	48.7	3.19	8.6	1.09	3.71	1.32	3.64	0.54	0.22	0.18	7.4	9.78	80.1	98.3	127	414	391
Mercury	µg/L	0.0050	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	0.0051	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005
Molybdenum	µg/L	1.0	NG	12.3	5.8	3.9	4.5	2.3	2.9	3	4.2	<1.0	1.4	<1.0	1.2	1.6	1.7	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
Nickel	µg/L	1.0	NG	4.3	6.4	4.2	6.2	1.0	14.4	5.3	8.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	2.8	4.3	8.3	16.5	10.9	6.1	14.9
Potassium	µg/L	2000	NG	2100	2800	3000	3500	<2000	3000	3400	2800	2600	2900	3200	3800	4000	3700	3500	<2000	<2000	2100	3300	<2000	<2000	<2000
Selenium	µg/L	0.050	NG	4.18	1.65	1.27	1.14	0.431	0.956	0.814	1.66	0.83	0.878	0.734	0.781	0.682	0.717	0.817	0.702	0.991	0.507	0.32	0.145	0.05	0.055
Silver	µg/L	0.020	NG	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02
Sodium	µg/L	2000	NG	106000	52000	48700	27900	7000	20,300	32,500	47,100	5500	5600	4800	5400	6600	7100	6700	44300	71700	105000	210000	76300	50,300	66,100
Thallium	µg/L	0.20	NG	<0.020	<0.020	<0.020	<0.20	<0.20	<0.2	<0.2	<0.20	<0.020	<0.020	<0.020	<0.20	<0.20	<0.2	<0.2	<0.020	<0.020	<0.020	<0.20	<0.20	<0.2	<0.2
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5
Titanium	µg/L	10	NG	<10	<10	<10	<10	<10	<10	<10	<10.0	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Uranium	µg/L	0.20	NG	2.66	1.93	1.62	1.36	0.69	1.31	1.28	1.69	1.39	1.47	1.31	1.18	1.42	0.79	1.31	2.07	2.79	5.16	8.36	3.8	2.9	2.69
Vanadium	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<1.0	<0.50	<0.5	<0.5
Zinc	µg/L	5.0	NG	<5.0	<5.0	<5.0	<5.0	<5.0	18.3	<5	5.9	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5.0	6	14	16.5	18.5	<5	8
Laboratory Work Order Number				L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451	L2030547-1	L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451	L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451
Laboratory Identification Number				L1914922-1	L1929264-2	L1947228-11	L1960994-11	L1981548-5	L1996232-5	L2012451-9	L2030547-1	L1914922-2	L1929264-3	L1947228-10	L1960994-10	L1981548-4	L1996232-4	L2012451-8	L1914922-3	L1929264-1	L1947228-9	L1960994-9	L1981548-3	L1996232-3	L2012451-7

Notes:

Screening completed on BC AWQG-FWAL STM [1] values only.

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG.

[2] Guideline for Ammonia is pH and temperature dependent; a temperature of 4 °C is assumed.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Where ambient hardness is higher than the recommended range given in the BCAWQG-FSTM, guideline values have been calculated based on ambient water hardness.

[5] Guideline is pH dependant.

RDL - Reportable detection limit
NG - No Guideline
Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.
BOLD and shaded - Exceeds applicable guideline value.
Blank - Not analyzed

Appendix B4: L3 Creek Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	LBL3C-0.02							LBL3C-1.43							LBL3C-1.65			LBL3C-3.32				LBL4C-0.18		
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	18-May-17	22-Jun-17	18-Jul-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	18-May-17	22-Jun-17	18-Jul-17
Physical Parameters				15:40	-	11:10	13:45	13:30			-	-	13:30	11:15	14:30			-	14:25	11:30	-	-	14:55	12:30	-	14:05	11:45
Flow Rate	L/sec			20.0	Fast	4.0	10.0	1.0	8.0	5.0	0.2	-	3.0	10.0	0.5	8.0	2.0	Minimal	Stagnant	0.5	0.2	Fast	Stagnant	5.0	Fast	<0.1	4.0
Electrical Conductivity (EC)	µS/cm	2	NG	655	1080	2590	1430	2840	782	2340	494	922	2620	575	1510	279	1660	2000	2090	1350	698	542	1220	1000	668	2630	1240
Hardness as $CaCO_3$	µg/L	500	NG Note: Acceptable ranges of Hardness exist when calculating exceedances for Cu, Pb, Mn, Zn, Ag, Cd	292000	545000	1370000	658000	1730000	376,000	1330000	200000	451000	1460000	233000	815000	118,000	935,000	1180000	1140000	927,000	296000	248000	603000	472,000	289000	1,000,000	534,000
pH	pH Units	0.1	6.5 - 9	8.14	8.09	8.2	8.16	8.1	8.05	8.12	7.99	8.12	8.11	7.77	8.17	7.94	8.18	7.22	7.27	7.3	8.19	8.2	8.05	8.17	7.73	**3.68**	7.57
Total Dissolved Solids (TDS)	µg/L	10000	NG	485000	862000	2540000	1080000	2940000	626,000	2110000	437000	726000	2630000	421000	1320000	228,000	1410000	1760000	1850000	927000	500000	418000	939000	712000	517000	2600000	941000
Total Suspended Solids (TSS)	µg/L	3000	NG	280000	107000	5900	23200	14100	167,000	7600	656000	697000	16300	55200	72300	47,600	5600	83200	45500	12000	260000	30800	<3000	43800	5300000	14500	70200
Anions and Nutrients																											
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	121000	159000	276000	187000	301000	147,000	283,000	110000	165000	373000	87000	283000	86,000	282,000	403000	602000	201000	115000	149000	314000	215000	136000	<1000	79800
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	121	159	276	187	301	147	283	110	165	373	87	283	86	282	403	602	201	115	149	314	215	136	<1.0	79.8
Ammonia [2] (Total as N)	µg/L	5.0	pH and Temperature Dependent	58	21	14.6	13.8	9.1	7.3	<5	80.8	24.2	10	20.1	<5.0	5.8	<5	270	408	37.8	110	14.2	31.8	11.5	30.3	208	70.5
				952	1200	759	952	952	1200	952	1430	952	952	1980	952	1430	952	1970	1970	1970	952	759	1200	952	1980	no guide value	1970
Chloride (Cl^-)	µg/L	500	600000	25600	18600	26000	28300	25000	27300	26000	30300	24200	24000	26700	17700	19900	16700	17000	24000	13000	29200	22300	44100	53500	26900	34000	41000
Nitrate (NO_3^- as N)	µg/L	5.0	NG	199	258	140	143	<100	63	<100	180	97	<100	102	685	46.9	655	693	<100	5100	213	34.9	32	<25	11.4	130	<25
Nitrite (NO_2^- as N)	µg/L	1.0	Dependent on Cl-	4.4	<5.0	<20	<5.0	<20	<5	<20	6.2	5.9	<20	4.1	<10	2.2	<10	26	<20	72.6	3.1	1.8	<5.0	<5.0	<1.0	<20	<5.0
Sulphate (SO_4)	µg/L	300	NG		422000	1570000	627000	1670000	265000	1300000		306000	1520000	169000	606000	31700	787000	855000	844000	586000	-	101000	352000	284000	185000	1830000	587000
Metals, Total																											
Aluminum	µg/L	5.0	NG	4770	3290	530	557	369	3580	281	18900	10700	311	4260	1630	2340	29	752	97.7	352	6110	881	53.3	338	21500	75600	11500
Antimony	µg/L	0.50	NG	0.53	<0.50	<0.50	<0.50	<0.50	0.57	<0.5	0.85	0.65	<0.50	<0.50	<0.50	0.53	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.69	<0.50	<0.50
Arsenic	µg/L	0.50	5	**5.35**	3.15	<0.50	0.72	0.69	3.95	<0.5	**11.00**	**9.71**	1.17	2.42	1.6	2.56	<0.5	1.97	2.98	0.74	3.79	1.91	0.9	1.16	**22.7**	3.81	1.31
Barium	µg/L	20	NG	234	142	47	71	40	138	41	562	439	79	131	87	155	73	146	122	87	185	92	139	101	875	<20	89
Beryllium	µg/L	0.10	NG	0.31	0.25	<0.20	<0.10	<0.20	0.24	<0.2	0.77	0.76	*<0.20*	0.41	0.12	0.12	<0.1	<0.10	*<0.20*	<0.10	0.3	<0.10	<0.10	<0.10	1.29	8.83	1.39
Boron	µg/L	100	1200	<100	<100	160	<100	200	<100	160	<100	<100	120	<100	110	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	160	<100
Cadmium	µg/L	0.005	NG	0.473	0.491	0.78	0.345	0.475	0.371	0.431	0.964	0.967	0.442	0.481	0.132	0.113	0.049	0.576	0.074	0.147	0.258	0.0779	0.0403	0.056	2.06	12.8	1.74
Calcium	µg/L	100	NG	78600	149000	455000	180000	450000	102,000	355,000	74100	122000	453000	66000	216000	34,800	236,000	284000	373000	172000	80400	59600	166000	124000	87400	264000	137000
Chromium	µg/L	1.0	NG	9.4	5.5	<1.0	<1.0	<1.0	6.4	<1	30.5	17.6	<1.0	4.2	2.3	4.3	<1	1.6	<1.0	<1.0	10.2	1.9	<1.0	<1.0	36.1	9.8	2.7
Cobalt	µg/L	0.30	110	5.87	5.41	9.51	2.85	5.39	3.42	3.93	11.4	16.3	19.2	10.7	1.92	1.7	1.78	16.2	29.4	5.14	3.14	0.87	0.66	0.46	28.5	249	42.5
Copper [3] (Based on Hardness as $CaCO_3$)	µg/L	1.0	Based on Hardness	15.4	12.7	1.7	2.5	1.6	9.0	1.5	**31.4**	25.7	1.7	7.7	3.4	6.3	<1.0	3.5	1.3	2.6	10.4	4.5	1.9	3.2	**53.2**	65.2	11.5
Cu STM Guideline Calc [4]	µg/L		Hardness ≤ 50,000 : calc.; Hardness > 50,000 : calc.; Hardness > 400,000: calc.	29.4	53.2	130.8	63.9	165	37	127	20.8	44.4	139.2	23.9	78.6	13.1	89.9	112.9	109.2	89.1	29.8	25.3	58.7	46.4	29.2	96.0	52.2
Iron	µg/L	30	1000	**10600**	**6170**	603	793	995	**7550**	406	**25800**	**22300**	282	**4190**	**2500**	**4020**	58	**9460**	**17400**	**1500**	**7800**	**2010**	149	696	**53500**	**4140**	**3670**
Lead [3] (Based on Hardness as $CaCO_3$)	µg/L	0.50	101 - 3076	5.8	2.71	<0.50	<0.50	<0.50	3.8	<0.5	13.7	10.5	<0.50	2.17	1.18	2.31	<0.5	0.78	<0.50	<0.50	4.23	0.97	<0.50	<0.50	21.8	<0.50	0.53
Pb STM Guideline Calc [4]	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.	319	707	2285	899	3076	441	2201	197	556	2478	240	1180	101	1405	1890	1809	1390	325	259	804	589	315	1531	689
Lithium	µg/L	1.0	NG	16.5	33.5	82.9	35.4	94.7	18.7	57.2	25.4	34.8	39.6	19.4	33.7	5.7	25.3	15.3	18.5	7.8	14.1	6.3	15	11.2	47.7	343	60.4
Magnesium	µg/L	100	NG	27700	39500	136000	53500	140000	34,400	118,000	27900	41400	161000	21400	79000	9450	89,400	108000	117000	63900	33800	23200	56300	42000	36500	132000	52000
Manganese [3] (Based on Hardness as $CaCO_3$)	µg/L	0.30	Calc. based on Hardness	212	182	425	178	322	201	192	420	1030	4950	421	211	90.5	476	6950	8330	1540	118	27.7	96.2	26.4	976	7100	1510
Mn STM Guideline Calc [4]	µg/L		Applies to Hardness 25000-259000 µg/L Mn : calc.	3758	6546	15637	7791	19605	4684	15197	2744	5510	16629	3108	9521	1840	10844	13544	13103	10756	3802	3273	7185	5741	3725	11560	6425
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.0050	NG	0.0323	0.0137	<0.0050	<0.0050	<0.025	<0.025	<0.005	0.055	0.052	<0.0050	<0.0250	<0.025	<0.025	<0.005	0.0063	0.0062	<0.0050	0.0123	<0.025	<0.0050	<0.0050	0.123	<0.0050	0.0058
Molybdenum	µg/L	1.0	2000	2.3	2.3	2.6	2.5	2.8	3.4	2.5	3.2	2.9	1.6	2.4	2.3	2.9	1.4	2.0	1.2	3.8	1.5	1.2	1.3	1.3	4.1	<1.0	1.1
Nickel	µg/L	1.0	NG	25.7	31	70.3	25.9	54.5	18	41	41.4	50.7	54.1	35.8	7.4	6.5	7	44.6	39.7	10.4	15	8.3	6.1	6.2	95.1	822	139
Potassium	µg/L	2000	NG	8800	8200	7000	5400	6900	4400	6100	12000	9700	11500	3900	6600	2200	6100	10400	13400	7500	11700	11800	13300	10800	12000	5700	8400
Selenium	µg/L	0.050	NG	1.27	1.45	0.66	0.707	0.77	0.877	0.94	1.75	1.84	0.83	0.551	4.57	0.34	3.17	2.52	0.35	4.7	0.706	0.565	0.399	0.441	2.5	1.26	0.774
Silver [3] (Based on Hardness as $CaCO_3$)	µg/L	0.020	0.10 - 3.0	0.116	0.057	<0.020	<0.020	<0.020	0.07	<0.02	0.284	0.179	<0.020	0.027	0.021	0.034	<0.02	<0.020	<0.020	<0.020	0.089	<0.020	<0.020	<0.020	0.392	<0.050	<0.020
Ag STM Guideline Calc [4]	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Sodium	µg/L	2000	NG	21300	33600	101000	43300	123000	25,200	88,700	20000	27700	78100	22100	52600	8700	44,800	45600	46000	30700	23700	15600	42700	33200	25600	115000	58600
Thallium	µg/L	0.010	NG	<0.20	<0.20	<0.20	0.029	0.036	0.113	0.02	0.37	0.26	<0.20	0.055	0.051	0.067	<0.01	<0.20	<0.20	0.015	<0.20	<0.20	<0.20	0.013	0.52	<0.20	0.034
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Titanium	µg/L	10	NG	63	32	<10	<10	<10	41	<10	461	70	<10	36	<25	26	<10	17	<10	11	149	10	<10	<10	97	<10	<10

Appendix B4: L3 Creek Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	LBL3C-0.02							LBL3C-1.43							LBL3C-1.65			LBL3C-3.32				LBL4C-0.18		
				19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	24-Aug-17	21-Sep-17	24-Oct-17	18-May-17	22-Jun-17	18-Jul-17	19-Apr-17	18-May-17	22-Jun-17	18-Jul-17	18-May-17	22-Jun-17	18-Jul-17
Uranium	µg/L	0.20	NG	2.2	3.33	9.77	3.93	11.2	2.88	7.61	2.93	3.35	7.56	1.56	4.37	1.12	4.7	6.56	5.86	6.59	2.39	1.46	5.75	3.0	2.79	8.09	3.09
Vanadium	µg/L	0.50	NG	18.2	9.49	<1.0	1.36	<1.0	12.8	<1	62.7	31.6	<1.0	7.9	4.19	9.16	<0.5	3.2	<1.0	1.41	22.3	4.08	0.64	1.77	61.7	<2.5	1.87
Zinc[3] (Based on Hardness as $CaCO_3$)	µg/L	5.0	Calc. based on Hardness	60.4	54.8	72.7	39.5	57.9	54.1	51.8	**121**	135	32.9	70.7	36.9	21.5	<5	26.8	7.6	2	46	16.1	5.6	5.6	**279**	**1760**	248
Zn STM Guideline Calc [4]	µg/L		Hardness ≤ 90,000 Zn = 33.0 Hardness > 90,000 Zn = calc.	185	374	993	459	1263	248	963	116	304	1061	140	577	54	667	851	821	661	188	152	418	320	182	716	366
Metals, Dissolved																											
Aluminum [5]	µg/L	5.0	100	52.6	**173**	**152**	**157**	97.4	40.5	**106**	39.4	**149**	53.6	**124**	10.5	23.6	<5	<5	8.7	<5	18	27.7	5.4	<5	92.7	**62600**	**171**
Aluminum STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	21.61	100
Antimony	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Arsenic	µg/L	0.50	NG	0.68	0.53	<0.50	<0.50	<0.50	<0.5	<0.5	0.77	0.66	0.84	<0.50	<0.50	<0.5	<0.5	0.76	2.72	1.13	0.83	1.3	0.88	0.81	0.6	3.82	<0.50
Barium	µg/L	20	NG	61	73	37	67	37	34	41	62	111	63	87	47	89	74	112	104	81	54	70	133	93	87	<20	73
Beryllium	µg/L	0.10	NG	<0.10	<0.10	<0.20	<0.10	<0.20	<0.1	<0.2	<0.10	<0.10	<0.20	<0.10	<0.10	<0.1	<0.1	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	8.1	<0.10
Boron	µg/L	100	NG	<100	<100	140	<100	190	<100	160	<100	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	140	<100
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.0050	Calc. based on Hardness	0.0523	0.213	0.536	0.293	0.306	0.108	0.36	0.045	0.144	0.292	0.176	0.0316	0.0333	0.0545	0.445	0.022	0.15	0.026	0.0273	0.0351	0.0319	0.145	**10.9**	1.21
Cd STM Guideline Calc [4]	µg/L		Applies to Hardness 7000-455000	1.77	3.37	8.72	4.10	11.08	2.30	8.45	1.20	2.78	9.31	1.41	5.11	0.70	5.88	7.47	7.21	5.83	1.80	1.50	3.74	2.91	1.75	6.30	3.30
Calcium	µg/L	100	NG	73600	152000	381000	173000	464000	95,900	343,000	48000	116000	381000	60700	207000	32,400	233,000	298000	309000	236000	70400	62400	157000	121000	74300	229000	132000
Chromium	µg/L	1.0	NG	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	8.4	<1.0
Cobalt	µg/L	0.30	NG	<0.30	1.89	7.58	2.63	4.85	0.65	3.84	<0.30	3.22	15.4	1.73	<0.30	<0.3	1.69	15.1	24.9	15.4	<0.30	<0.30	0.63	<0.30	0.64	215	33.3
Copper	µg/L	1.0	NG	3.4	5.7	1.1	1.8	1.1	2.2	1.3	3.7	2.7	1.2	1.5	<1.0	1.7	<1	1.1	<1.0	1.3	2.4	2.6	1.9	2.4	3.3	55.9	3.2
Iron	µg/L	30	350	67	39	<30	<30	46	<30	<30	65	30	<30	<30	<30	39	<30	41	**17400**	**8230**	147	196	66	<30	56	**3350**	<30
Lead	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Lithium	µg/L	1.0	NG	11.5	28.5	73.5	33.9	95.6	15.6	57.4	5.3	18.1	32.9	13.5	29.9	3.2	24.3	14.3	15.6	12.2	5.5	5.7	14.9	11.3	16.9	301	59.4
Magnesium	µg/L	100	NG	26300	40200	101000	55000	139000	33,000	115,000	19600	39300	124000	19700	72200	8960	85,500	107000	89400	82400	29100	22400	51000	41500	25100	104000	49800
Manganese	µg/L	0.10	NG	1.78	119	346	173	292	61.2	189	1.46	689	4090	276	3.12	21.8	488	6880	6830	5020	2.13	7.5	96	1.59	249	5880	1440
Mercury	µg/L	0.0050	NG	<0.0050	<0.0050	<0.0050	0.0056	<0.0050	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.0050	0.0054	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum	µg/L	1.0	NG	1.4	1.6	2.2	2.4	2.7	2.7	2.5	1.5	1.4	1.4	2.3	2.0	2.5	1.2	1.9	1.0	3.3	1.0	1.0	1.3	1.3	1.1	<1.0	<1.0
Nickel	µg/L	1.0	NG	8.3	15.7	57.5	24.4	50.5	8	39.7	5.1	13.5	44.7	7.2	1.4	1.2	6.9	40.7	34	24.5	4.1	6.0	6.0	5.1	8.0	720	101.0
Potassium	µg/L	2000	NG	8100	7800	6100	5700	6500	3600	6000	7900	8300	10300	3300	6200	<2000	6300	9600	11600	8400	9900	11200	13300	10700	8000	5300	8300
Selenium	µg/L	0.050	NG	0.943	1.23	0.54	0.69	0.4	0.736	0.91	1.08	1.11	0.70	0.43	4.31	0.261	3.22	2.81	0.31	4.29	0.506	0.473	0.359	0.414	0.758	1.06	0.615
Silver	µg/L	0.020	NG	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.050	<0.020
Sodium	µg/L	2000	NG	21600	34200	82700	45300	119000	25,300	86,900	19200	29500	66300	20900	48500	8900	44,500	44900	38300	37900	21800	15200	42500	32500	24600	100000	57100
Thallium	µg/L	0.20	NG	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tin	µg/L	0.50	NG	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Titanium	µg/L	10	NG	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Uranium	µg/L	0.20	NG	1.87	3.38	8.9	3.87	10.9	2.43	7.4	1.58	2.75	7.04	1.26	3.86	0.91	4.39	6.9	5.54	7.6	1.86	1.45	5.86	2.85	1.72	7.68	1.48
Vanadium	µg/L	0.50	NG	<0.50	<0.50	<1.0	<0.50	<1.0	<0.5	<1	0.59	<0.50	<1.0	<0.50	<0.50	<0.5	<0.5	<0.50	<1.0	<0.50	0.55	0.79	<0.50	<0.50	<0.50	<2.5	<0.50
Zinc	µg/L	5.0	NG	<5.0	<5.0	42	22	33.6	7.7	43.5	<5.0	<5.0	19.6	<5.0	<5.0	<5	<5	16	<5.0	<5.0	<5.0	<5.0	5.7	<5.0	<5.0	1450	57.4
Laboratory Work Order Number				L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451	L1914922	L1929264	L1947228	L1960994	L1981548	L1996232	L2012451	L1929264	L1947228	L1960994	L1914922	L1929264	L1947228	L1960994	L1929264	L1947228	L1960994
Laboratory Identification Number				L1914922-7	L1929264-4	L1947228-4	L1960994-4	L1981548-2	L1996232-2	L2012451-3	L1914922-8	L1929264-8	L1947228-3	L1960994-3	L1981548-1	L1996232-1	L2012451-2	L1929264-9	L1947228-2	L1960994-2	L1914922-9	L1929264-11	L1947228-1	L1960994-1	L1929264-10	L1947228-5	L1960994-5

Notes:

Screening completed on BC AWQG-FWAL STM [1] values only.

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2017. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG.

[2] Guideline for Ammonia is pH and temperature dependent; a temperature of 4 °C is assumed.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Where ambient hardness is higher than the recommended range given in the BCAWQG-FSTM, guideline values have been calculated based on ambient water hardness.

[5] Guideline is pH dependant.

RDL - Reportable detection limit

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded - Exceeds applicable guideline value.