

APPENDIX D

Hydrology

Appendix D SURFACE WATER RESOURCES SUPPLEMENTAL INFORMATION

D.1 Regional Hydrology Assessment Results

An assessment of the regional hydrology was conducted with data from stations within 600 km of the Signal Gold site. The following appendix provides results of this analysis including the Mean Annual Flow (MAF), 2-, 5-, 10-, 20-, 50-, and 100-year flood flows, Environmental Flows and low flows, Mean Monthly Flows (MMFs), Flow Duration curves, and climate normal precipitations.

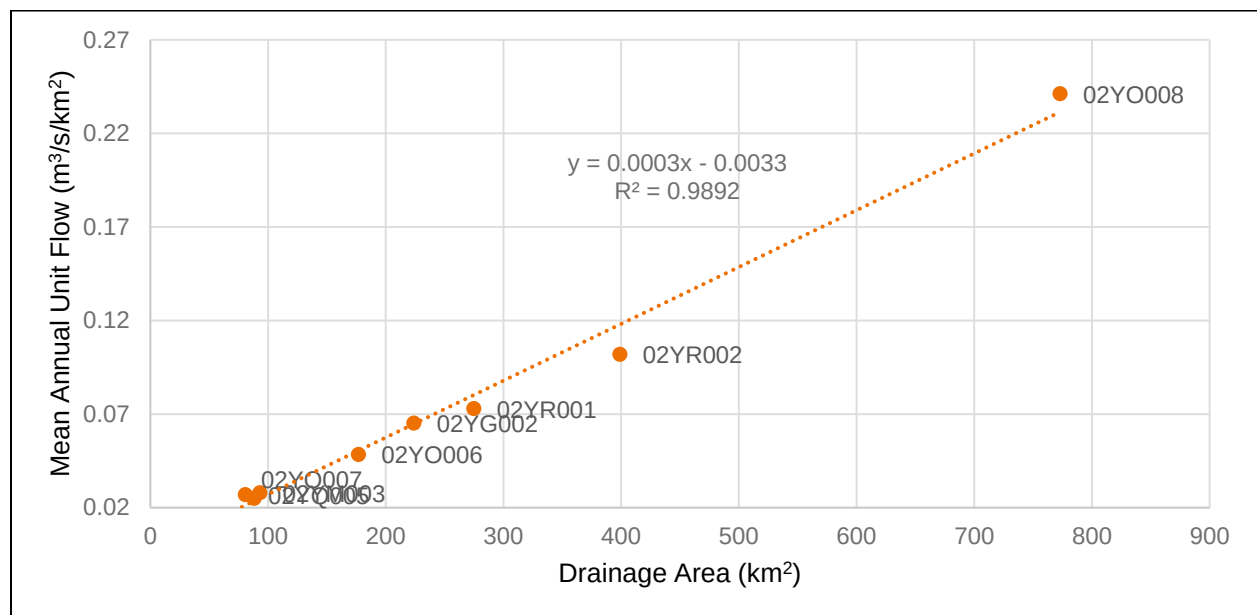


Figure D.1 Mean Annual Unit Flow for 11 WSC stations in NE Region



STOG'ER TIGHT EXPANSION PROJECT – 278 OPEN PIT MINE

Table D.1 Return Period Flood Flows for the 11 WSC stations in the NE Region

Station ID	Drainage Area (km ²)	Q2	Q5	Q10	Q20	Q50	Q100	Q200
02YM003	93.2	36.5	53.3	65	78.6	92.1	104.2	116.6
02YO006	177	44.9	62.1	73.6	84.6	99.1	110	121.1
02YO008	773	206.1	266.3	304.4	340	385.1	418.4	451.4
02YO012	58.7	14.9	20.2	23.6	26.9	31.2	34.4	37.7
02YP001	63.8	21.2	26.7	30.1	33.2	37.1	40	42.8
02YQ005	80.8	36.9	53.6	65.1	76.5	91.7	103.5	115.6
02YR001	275	28.7	37.7	43.5	48.9	55.8	61	66.1
02YR002	399	67.2	85.6	97.2	107.9	121.3	131.2	141
02YR003	554	58.5	77	88.9	100.1	114.4	125.1	135.7
02YG002	224	46.1	65.2	78.1	90.7	107.4	120.1	133.1
02YO007	88.3	29.8	37.6	42.4	46.9	52.5	56.6	60.7
02YO010	61.6	10.9	15	17.7	20.3	23.8	26.4	29



STOG'ER TIGHT EXPANSION PROJECT – 278 OPEN PIT MINE

Table D.2 Environmental Flows and Low Flows for 11 WSC stations in NE Region

	02YM003	02YO006	02YO012	02YP001	02YQ005	02YR002	02YG002	02YO007	02YO010	02YR001	02YR003
Summer Environmental Flow (50% MAF) (L/s)	0.0084	0.0242	0.0084	0.0099	0.0135	0.0326	0.0074	0.0364	0.0742	0.0509	0.0124
Winter Environmental Flow (30% MAF) (L/s)	0.0140	0.0050	0.0050	0.0060	0.0081	0.0195	0.0045	0.0219	0.0445	0.0306	0.0074
1Q2	0.3	0.62	0.18	0.2	0.26	1.52	0.8	0.29	0.19	1.01	2.19
7Q2	0.35	0.71	0.21	0.24	0.3	1.72	0.92	0.33	0.23	1.15	2.45
1Q10	0.14	0.29	0.09	0.09	0.12	0.72	0.38	0.14	0.09	0.48	1.03
7Q10	0.17	0.34	0.1	0.11	0.15	0.83	0.44	0.16	0.11	0.55	1.18
1Q20	0.11	0.21	0.06	0.07	0.09	0.53	0.28	0.1	0.07	0.35	0.75
7Q20	0.13	0.25	0.08	0.08	0.11	0.61	0.33	0.12	0.08	0.41	0.87
1Q50	0.06	0.13	0.04	0.04	0.05	0.32	0.17	0.06	0.04	0.21	0.46
7Q50	0.08	0.16	0.05	0.05	0.07	0.39	0.21	0.08	0.05	0.26	0.55
1Q100	0.04	0.08	0.02	0.03	0.03	0.19	0.1	0.04	0.02	0.13	0.28
7Q100	0.05	0.10	0.03	0.03	0.04	0.24	0.13	0.05	0.03	0.16	0.35



STOG'ER TIGHT EXPANSION PROJECT – 278 OPEN PIT MINE

Table A.3 Mean Monthly Flows for 11 WSC stations in NE Region

ID	Drainage Area (km ²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
02YM003	93.2	1.26	0.91	1.33	6.17	8.80	2.43	0.95	0.81	1.47	2.22	2.89	1.99
02YO006	177	2.77	2.71	4.28	12.90	7.01	3.27	2.05	2.14	3.31	4.31	5.25	4.14
02YO008	773	14.69	17.21	23.92	61.06	35.02	14.62	9.17	9.45	16.43	20.46	27.20	20.54
02YO012	58.7	1.08	1.05	1.38	3.92	2.65	1.22	0.71	0.61	1.17	1.51	1.92	1.48
02YP001	63.8	0.96	0.84	1.56	4.19	5.64	1.84	0.97	0.94	1.00	1.36	1.71	1.28
02YQ005	80.8	1.52	1.56	2.35	6.98	4.22	1.63	0.95	0.98	1.84	2.65	3.13	2.31
02YR002	399	6.01	5.58	6.99	14.01	13.55	6.25	3.45	2.49	3.15	4.93	7.55	7.56
02YG002	224	7.95	7.01	10.28	24.36	18.22	6.76	3.43	3.31	5.26	8.38	10.03	8.94
02YO007	88.3	12.35	10.65	13.17	30.69	26.35	10.91	6.36	5.20	7.07	11.36	15.78	16.12
02YO010	61.6	2.88	2.17	3.06	12.72	21.91	7.63	3.01	1.15	1.85	4.30	6.94	5.22
02YR001	275	0.95	1.30	2.25	6.82	5.14	1.80	1.01	1.02	1.53	2.02	2.45	1.60
02YR003	554	0.68	0.74	1.26	3.79	3.11	1.43	0.74	0.47	0.61	1.16	1.49	1.21



STOG'ER TIGHT EXPANSION PROJECT – 278 OPEN PIT MINE

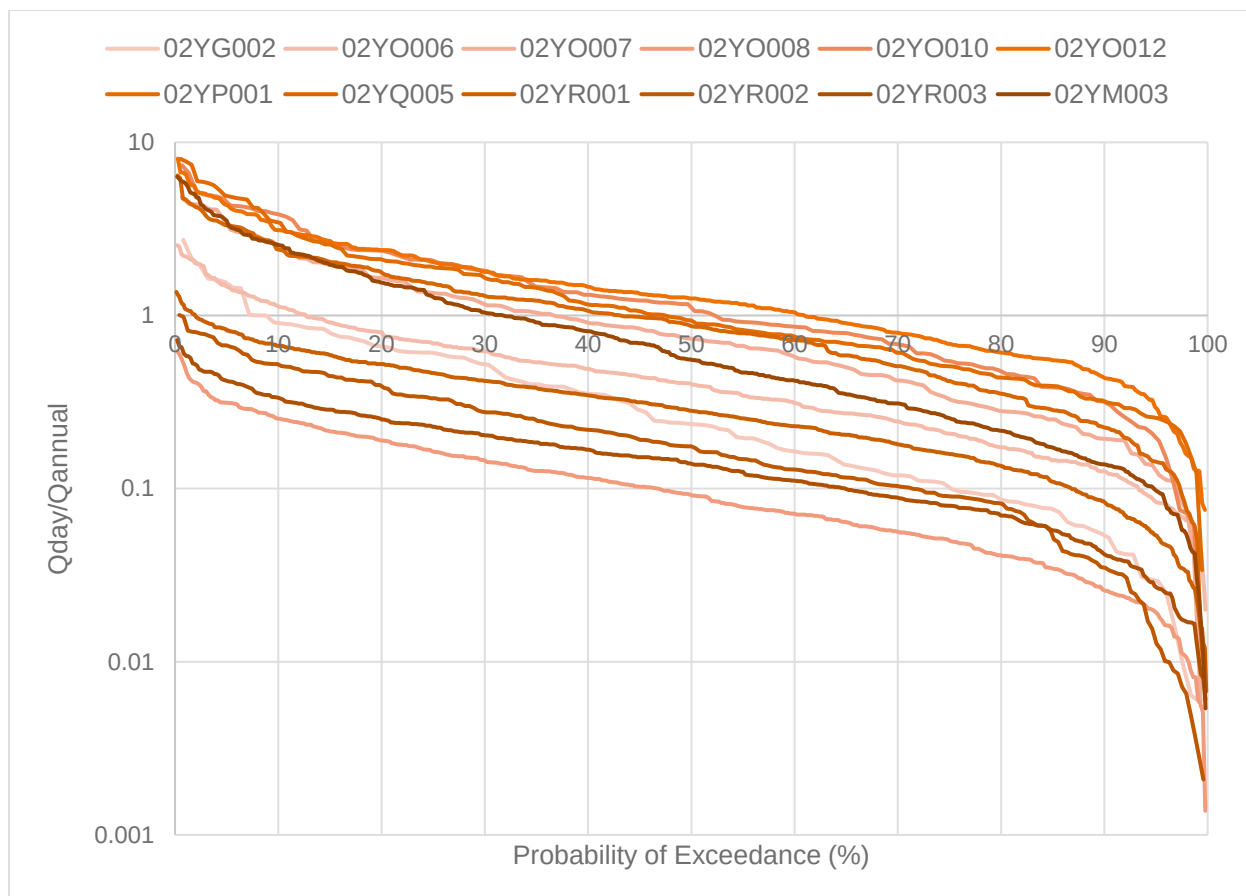


Figure D.2 Flow Duration Curves for 11 WSC Stations in NE Region



STOG'ER TIGHT EXPANSION PROJECT – 278 OPEN PIT MINE

Table D.4 Climate Normal Precipitation for 11 WSC Stations in NE Region

Station ID	Distance to Site	Climate Station	Climate Normal Precipitation (mm) (1981-2010)
02YM003	12	Sops Arm White Bay	1002.4
02YG002	25	Sops Arm White Bay	1002.4
02YP001	69	Point Leamington	1092.1
02YO006	108	Rattling Brook Norris Arm	1139.6
02YO010	110	Grand Falls	1098.9
02YO012	112	Rattling Brook Norris Arm	1139.6
02YO007	115	Grand Falls	1098.9
02YO008	133.00	Rattling Brook Norris Arm	1139.6
02YQ005	135	Gander International Airport	1270.2
02YR002	156	Musgrave Harbour	1043.1
02YR001	186	Gambo	984.4
02YR003	189	Gambo	984.4



D.2 Hydrometric Station Summaries



Hydrometric Station Summary

Hydrometric Station ID	LL1	Flow meter used	FlowTracker
Location	SS1	Time Averaging	20 seconds
Installation Date	10/28/2020	Data Collected at site	Water temperature, water level, manual flow
Coordinates	49.96678°N, 56.08350°W	Number of spot measurements	5
Slope of Channel	1.54%	Channel Bottom	Cobble, Gravel
Drainage Area	0.592 km²	Flood Plain	Grasses, Shrubs
Period of Logger Record	2020 (October-January), May 2021 - Present		
		Comments	



LL1 Catchment Area



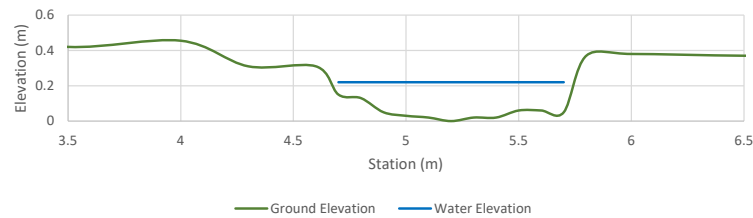
LL1 Looking Upstream



LL1 Looking Downstream

Date	Time	Max Depth (m)	Flow (m³/s)
10/28/2020	1:56:22 PM	0.09	-
5/10/2021	12:33:40 PM	0.2	-
6/19/2021	1:36:00 PM	0.1	-
12/13/2021	11:24:00 AM	0.2	-
5/14/2022	6:00:00 PM	0.3	-

December 13, 2021 LL1 Cross Section (Looking Downstream)

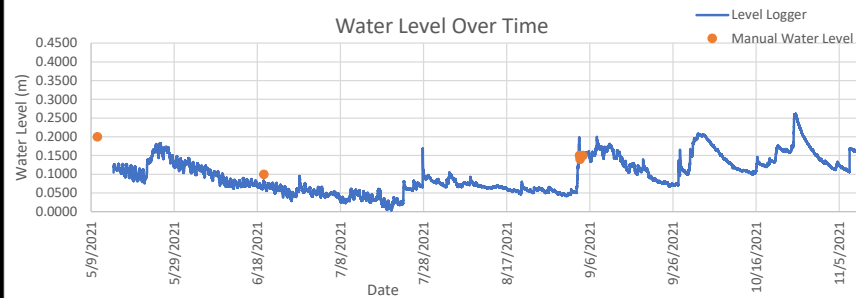


No Stage-Discharge Graph Available.

Water Temperature Over Time



Water Level Over Time



No Flow Data Available.

Hydrometric Station Summary

Hydrometric Station ID	LL2	Flow meter used	FlowTracker
Location	SS2	Time Averaging	20 seconds
Installation Date	10/30/2020	Data Collected at site	Water temperature, water level, manual flow
Coordinates	49.966033°N, 56.093726°W	Number of spot measurements	5
Slope of Channel	1.41%	Channel Bottom	Cobble, Gravel
Drainage Area	1.22 km ²	Flood Plain	Mixed wood forest, shrubs
Period of Logger Record	2020 (October-January), May 2021 - Present	Comments	



LL2 Catchment Area



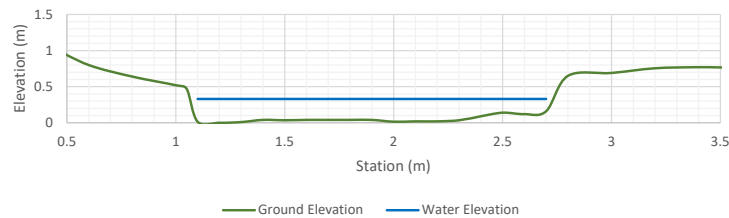
LL2 Looking Upstream



LL2 Looking Downstream

Date	Time	Max Depth (m)	Flow (m ³ /s)
10/30/2020	11:08:58 AM	0.08	-
6/19/2021	12:27:00 PM	0.32	-
9/3/2021	2:10:54 PM	0.32	-
10/25/2021	N/A	0.52	-
5/14/2022	5:15:00 PM	0.44	-

December 13, 2021 LL2 Cross Section (Looking Downstream)

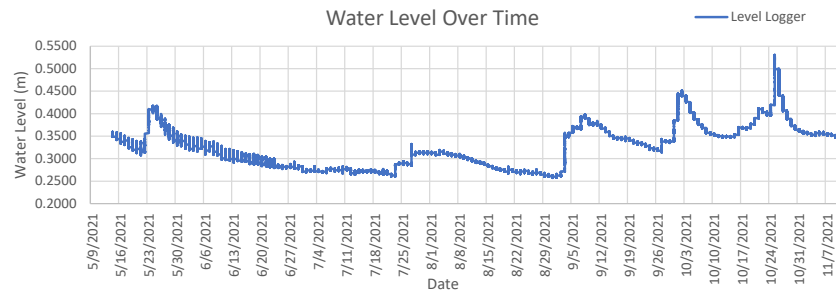


No Stage-Discharge Graph Available.

Water Temperature Over Time



Water Level Over Time



No Flow Data Available.

Hydrometric Station Summary

Hydrometric Station ID LL3
Location SS3 Upstream of Convergence
Installation Date 10/30/2020
Coordinates 49.965975°N, 56.094067°W
Slope of Channel 1.22%
Drainage Area 2.0 km²
Period of Logger Record 2020 (October-January), May 2021 - Present

Flow meter used FlowTracker
Time Averaging 20 seconds
Data Collected at site Water temperature, water level, manual flow
Number of spot measurements 6
Channel Bottom Cobble, Gravel
Flood Plain Mixed wood forest, shrubs
Comments



LL3 Catchment Area



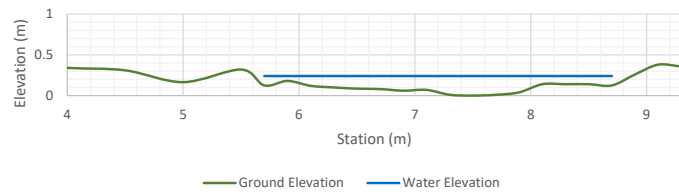
LL3 Looking Upstream



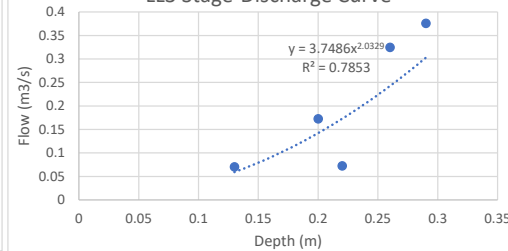
LL3 Looking Downstream

Date	Time	Max Depth (m)	Flow (m ³ /s)
10/30/2020	10:43:28 AM	0.2	0.009
5/10/2021	8:47:10 AM	0.13	0.070
9/3/2021	1:36:00 PM	0.29	0.376
9/4/2021	8:27:00 AM	0.26	0.325
12/13/2021	2:24:00 PM	0.22	0.072
5/14/2022	3:45:00 PM	0.2	0.172

December 13, 2021 LL3 Cross Section (Looking Downstream)



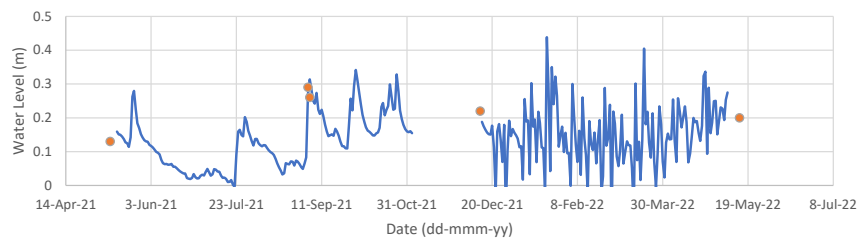
LL3 Stage-Discharge Curve



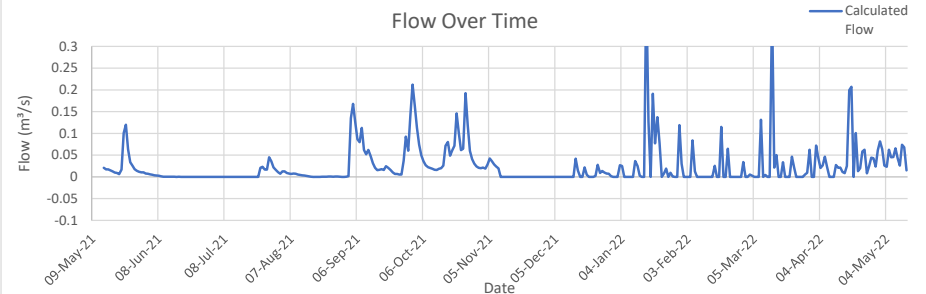
Water Temperature Over Time



Water Level Over Time



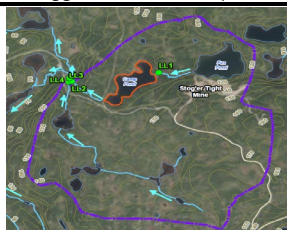
Flow Over Time



Hydrometric Station Summary

Hydrometric Station ID LL4
Location SS4
Installation Date 10/30/2020
Coordinates 49.966361°N, 56.093975°W
Slope of Channel 2.50%
Drainage Area 3.22 km²
Period of Logger Record 2020 (October-January), May 2021 - Present

Flow meter used FlowTracker
Time Averaging 20 seconds
Data Collected at site Water temperature, water level, manual flow
Number of spot measurements 9
Channel Bottom Cobble, Gravel
Flood Plain Mixed wood forest, shrubs
Comments



LL4 Catchment Area



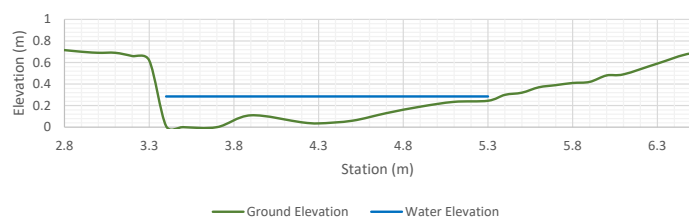
LL4 Looking Upstream



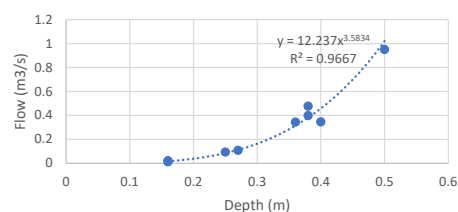
LL4 Looking Downstream

Date	Time	Max Depth (m)	Flow (m³/s)
10/30/2020	11:34:34 AM	0.16	0.022
5/10/2021	7:38:24 AM	0.27	0.108
6/19/2021	11:30:00 AM	0.16	0.012
9/3/2021	12:54:00 PM	0.38	0.399
9/3/2021	4:10:00 PM	0.38	0.478
9/4/2021	7:50:00 AM	0.36	0.345
10/25/2021	N/A	0.5	0.952
12/14/2021	11:25:00 AM	0.25	0.095
5/14/2022	14:15:00	0.4	0.347

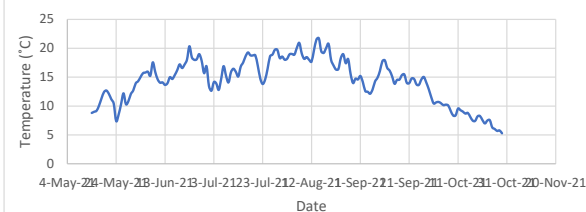
December 14, 2021 LL4 Cross Section (Looking Downstream)



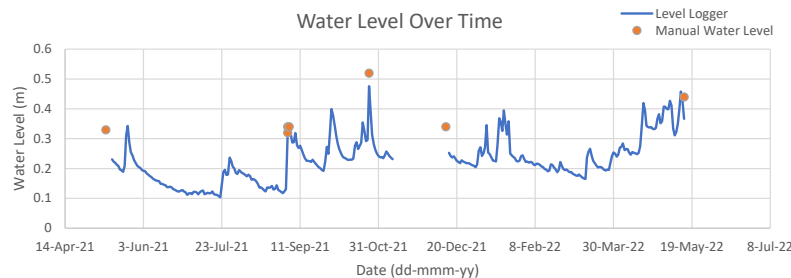
LL4 Stage-Discharge Curve



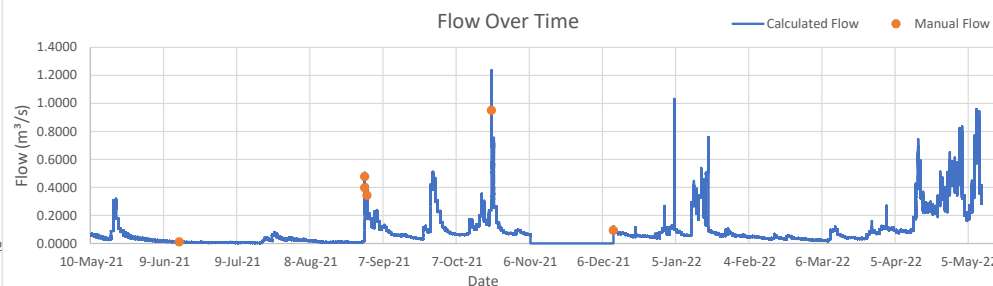
Water Temperature Over Time



Water Level Over Time



Flow Over Time



D.3 Water Quality Results



ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)														
Maxxam ID							CXL660	HML322	HFS221	ALG042	HUN773	ICS489	KHS130	KOF024
Sampling Date							8/16/2016	8/13/2018	7/12/2018	2015/06/10	9/17/2018	10/22/2018	7/15/2019	8/16/2019
COC Number					75th percentile		N/A	672078-02-01	672058-02-01	N/A	N/A	N/A	N/A	N/A
	UNITS	MIN	MAX	AVERAGE		RDL	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND
Calculated Parameters														
Anion Sum	me/L	0.75	1.42	1.24	1.41	N/A	0.94	1.27	1.18	0.75		1.38	1.4	1.4
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	26.000	49	41.11	45.5	1	34	45	40	26		49	40	45
Calculated TDS	mg/L	41.000	80	68.22	79.5	1	49	67	64	41		76	80	78
Carb. Alkalinity (calc. as CaCO3)	mg/L	DL	DL	0.50	0.5	1	ND	ND	ND	ND		ND	ND	ND
Cation Sum	me/L	0.790	1.46	1.25	1.445	N/A	0.94	1.2	1.18	0.79		1.38	1.44	1.43
Hardness (CaCO3)	mg/L	31.000	170	51.33	59.25	1	37	51	49	31	170	57	59	59
Ion Balance (% Difference)	%	0.000	2.83	1.15	2.005	N/A	0	2.83	0	2.6		0	1.41	1.06
Langelier Index (@ 20C)	N/A	(1.530)	-0.568	-0.85	-0.6015		-1.25	-0.622	-0.854	-1.53		-0.73	-0.697	-0.568
Langelier Index (@ 4C)	N/A	(1.780)	-0.819	-1.10	-0.8525		-1.5	-0.874	-1.11	-1.78		-0.981	-0.948	-0.819
Saturation pH (@ 20C)	N/A	8.400	8.91	8.53	8.645		8.73	8.48	8.56	8.91		8.4	8.46	8.41
Saturation pH (@ 4C)	N/A	8.650	9.17	8.78	8.9		8.99	8.73	8.81	9.17		8.65	8.72	8.66
Inorganics														
Total Alkalinity (Total as CaCO3)	mg/L	26.000	52	41.22	45.25	5	34	45	40	26	52	49	40	45
Total Ammonia-N	mg/L	0.013	0.14	0.14	0.043	0.05	ND	ND	ND	ND	ND	ND	0.14	ND
Colour	TCU	12.000	65	19.33	31	5	17	12	18	29		17	33	20
Dissolved Organic Carbon (C)	mg/L	4.300	7.9	5.07	6.4	0.5	5.4	5.2	5	4.3		5	5.2	5.4
Orthophosphate (P)	mg/L	<0.03	<0.03	<0.03	<0.03	0.01	ND	ND	ND	ND		ND	ND	ND
pH	pH	6.890	8.05	7.68	7.85	N/A	7.49	7.86	7.7	7.38		7.67	7.77	7.84
Reactive Silica (SiO2)	mg/L	0.400	2.6	1.01	1.45	0.5	0.71	0.55	0.5	1.4		1.5	1.3	0.93
Dissolved Sulphate (SO4)	mg/L	2.200	17	9.96	15	1	2.2	7.1	7.3	2.7		9.3	17	15
Turbidity	NTU	0.320	2.7	0.97	1.275	0.1	1.1	0.64	1.3	0.53		2.7	0.68	0.75
Dissolved Chloride (Cl)	mg/L	5.100	8	5.93	7.7	1	7.2	5.9	5.7	5.9		5.1	6.9	5.3
Conductivity	uS/cm	71.000	142.4	124.80	140	1	87	130	120	71	140	140	140	140
Nitrite (N)	mg/L	0.930	0.95	0.94	0.94	0.01	ND	ND	0.93	ND	ND	0.95	ND	ND
Nitrate (N)	mg/L	0.010	0.79	0.48	0.63	0.1	ND	0.63	0.017	ND	0.63	0.010	0.79	0.55
Nitrate + Nitrite (N)	mg/L	0.070	0.96	0.71	0.73	0.1	ND	0.63	0.92	ND	0.63	0.96	0.79	0.55

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)														
Maxxam ID							KVN966	LDL334	W20-1215	W20-1470	W20-1790	W20-1155	W21-1391	W21-1683
Sampling Date							9/17/2019	10/22/2019	8/3/2020	9/8/2020	10/12/2020	7/1/2020	6/30/2021	8/4/2021
COC Number					75th		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	UNITS	MIN	MAX	AVERAGE	percentile	RDL	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND	CAMP POND
Anion Sum	me/L	0.75	1.42	1.24	1.41	N/A	1.42	1.42						
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	26.000	49	41.11	45.5	1	45	46						
Calculated TDS	mg/L	41.000	80	68.22	79.5	1	80	79						
Carb. Alkalinity (calc. as CaCO3)	mg/L	DL	DL	0.50	0.5	1	ND	ND						
Cation Sum	me/L	0.790	1.46	1.25	1.445	N/A	1.46	1.45						
Hardness (CaCO3)	mg/L	31.000	170	51.33	59.25	1	60	59						
Ion Balance (% Difference)	%	0.000	2.83	1.15	2.005	N/A	1.39	1.05						
Langelier Index (@ 20C)	N/A	(1.530)	-0.568	-0.85	-0.6015		-0.581	-0.792						
Langelier Index (@ 4C)	N/A	(1.780)	-0.819	-1.10	-0.8525		-0.831	-1.04						
Saturation pH (@ 20C)	N/A	8.400	8.91	8.53	8.645		8.4	8.41						
Saturation pH (@ 4C)	N/A	8.650	9.17	8.78	8.9		8.65	8.66						
Total Alkalinity (Total as CaCO3)	mg/L	26.000	52	41.22	45.25	5	46	46	35.09	42.16	42.38	37.72	42.5	44.3
Total Ammonia-N	mg/L	0.013	0.14	0.14	0.043	0.05	ND	ND	0.024	0.013	0.023	0.029	0.057	0.028
Colour	TCU	12.000	65	19.33	31	5	14	14	17	13	13	24	41	29
Dissolved Organic Carbon (C)	mg/L	4.300	7.9	5.07	6.4	0.5	5.4	4.7	7	5.5	6	6.3	6.3	6.5
Orthophosphate (P)	mg/L	<0.03	<0.03	<0.03	<0.03	0.01	ND	ND	<0.03	<0.03	<0.03	<0.03	<0.05	<0.03
pH	pH	6.890	8.05	7.68	7.85	N/A	7.82	7.61	7.69	8.05	7.13	7.64	7.86	7.87
Reactive Silica (SiO2)	mg/L	0.400	2.6	1.01	1.45	0.5	0.98	1.2	0.9	0.7	1.8	1.3	0.4	2.6
Dissolved Sulphate (SO4)	mg/L	2.200	17	9.96	15	1	15	14	6	4.5	4.8	5	13	16
Turbidity	NTU	0.320	2.7	0.97	1.275	0.1	0.32	0.73	1.25	1	0.79	0.78	2	1.19
Dissolved Chloride (Cl)	mg/L	5.100	8	5.93	7.7	1	5.3	6.1	7	7.1	7.4	8	6.1	8
Conductivity	uS/cm	71.000	142.4	124.80	140	1	140	140	105.7	102.4	111.7	103.1	133.8	142.4
Nitrite (N)	mg/L	0.930	0.95	0.94	0.94	0.01	ND	ND	<0.03	<0.03	<0.03	<0.03	<0.023	<0.03
Nitrate (N)	mg/L	0.010	0.79	0.48	0.63	0.1	0.67	0.56	0.37	<0.06	<0.06	0.24	0.11	<0.06
Nitrate + Nitrite (N)	mg/L	0.070	0.96	0.71	0.73	0.1	0.67	0.56	0.37	<0.06	<0.06	0.24	0.11	<0.06

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)								
Maxxam ID							W21-2001	W21-2314
Sampling Date							9/9/2021	10/28/2021
COC Number					75th		N/A	N/A
	UNITS	MIN	MAX	AVERAGE	percentile	RDL	CAMP POND	CAMP POND
Anion Sum	me/L	0.75	1.42	1.24	1.41	N/A		
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	26.000	49	41.11	45.5	1		
Calculated TDS	mg/L	41.000	80	68.22	79.5	1		
Carb. Alkalinity (calc. as CaCO3)	mg/L	DL	DL	0.50	0.5	1		
Cation Sum	me/L	0.790	1.46	1.25	1.445	N/A		
Hardness (CaCO3)	mg/L	31.000	170	51.33	59.25	1		
Ion Balance (% Difference)	%	0.000	2.83	1.15	2.005	N/A		
Langelier Index (@ 20C)	N/A	(1.530)	-0.568	-0.85	-0.6015			
Langelier Index (@ 4C)	N/A	(1.780)	-0.819	-1.10	-0.8525			
Saturation pH (@ 20C)	N/A	8.400	8.91	8.53	8.645			
Saturation pH (@ 4C)	N/A	8.650	9.17	8.78	8.9			
Total Alkalinity (Total as CaCO3)	mg/L	26.000	52	41.22	45.25	5	45	40
Total Ammonia-N	mg/L	0.013	0.14	0.14	0.043	0.05	0.022	0.019
Colour	TCU	12.000	65	19.33	31	5	44	65
Dissolved Organic Carbon (C)	mg/L	4.300	7.9	5.07	6.4	0.5	6.9	7.9
Orthophosphate (P)	mg/L	<0.03	<0.03	<0.03	<0.03	0.01	<0.03	<0.03
pH	pH	6.890	8.05	7.68	7.85	N/A	7	6.89
Reactive Silica (SiO2)	mg/L	0.400	2.6	1.01	1.45	0.5	0.9	1.7
Dissolved Sulphate (SO4)	mg/L	2.200	17	9.96	15	1	15	14
Turbidity	NTU	0.320	2.7	0.97	1.275	0.1	1.45	1.24
Dissolved Chloride (Cl)	mg/L	5.100	8	5.93	7.7	1	8	8
Conductivity	uS/cm	71.000	142.4	124.80	140	1	129.2	129.9
Nitrite (N)	mg/L	0.930	0.95	0.94	0.94	0.01	<0.03	<0.03
Nitrate (N)	mg/L	0.010	0.79	0.48	0.63	0.1	0.07	0.23
Nitrate + Nitrite (N)	mg/L	0.070	0.96	0.71	0.73	0.1	0.07	0.23

D.4 Camp Pond and Pit 278 Refilling Calculations

Camp Pond and Pit 278 Refilling Calculations			
Volume of Camp Pond =	616,943	m ³	
Volume of Pit 278 =	1,671,135	m ³	
Total Volume to Fill =	2,288,078	m³	
(MAF - Environmental Flow requirement) per year =	574,654	m ³	
Time required to Fill Pit 278 and Camp Pond =	Volume to Fill	/	Excess Flow Amount
	= 2,288,078	/	574,654
Time required to Fill Pit 278 and Camp Pond =	3.98 years		

