

- LEGEND**
- ☒ SOIL SAMPLES
 - STAMP MILL SOIL SAMPLES
 - WASTE ROCK SAMPLES
 - ◻ SAMPLE WAS TESTED FOR ACID ROCK DRAINAGE (ARD) AND METAL LEACHING (ML)
 - SAMPLE WAS NOT TESTED FOR ML & ARD

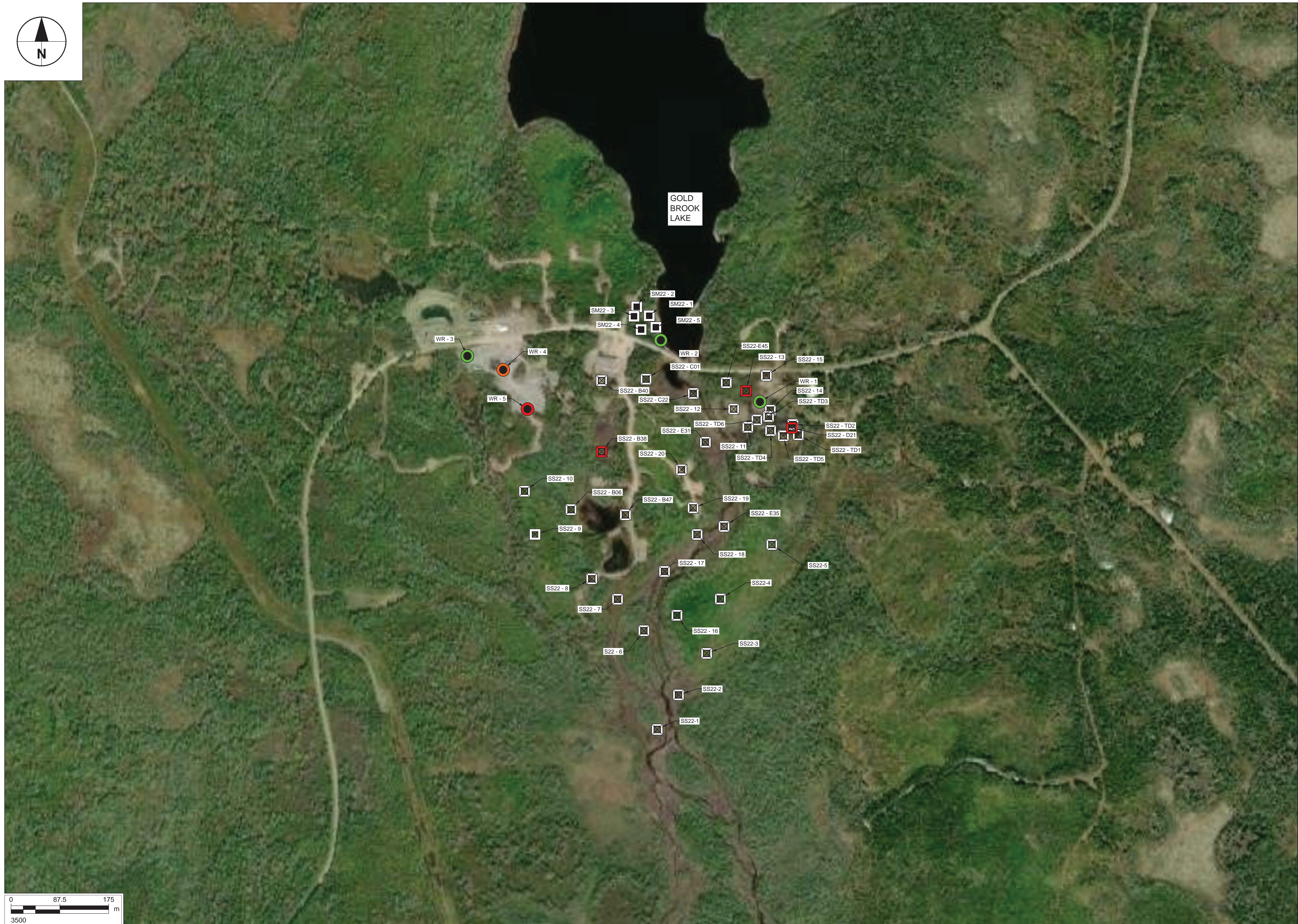
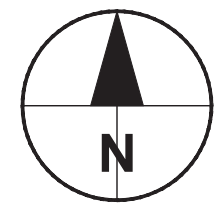
- DRAWING NOTES**
1. COORDINATE SYSTEM: NAD83 (CSRS.2010) NOVA SCOTIA ZONE 4.
 2. IMAGERY SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/ AIRBUS DS, USDA, USGS, AEROGRIID.

Issue Status: DRAFT

ACID ROCK DRAINAGE AND METAL LEACHING SCREENING MEMO

SOIL SAMPLE AND WASTE ROCK LOCATION PLAN

Nova Scotia Lands Inc., Gold Brook Lake and Seal Harbour Mine Site
Project No.: 60680068 Date: 2023-02-01



LEGEND

- SAMPLE TYPE**
- ☒ SOIL SAMPLES
 - STAMP MILL SOIL SAMPLES
 - WASTE ROCK SAMPLES
- ACID GENERATION POTENTIAL**
- POTENTIALLY ACID GENERATING (PAG)
 - UNCERTAIN
 - NOT POTENTIALLY ACID GENERATING (Non-PAG)
 - NOT TESTED

DRAWING NOTES

1. COORDINATE SYSTEM: NAD83 (CSRS.2010) NOVA SCOTIA ZONE 4.
2. IMAGERY SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/ AIRBUS DS, USDA, USGS, AEROGIRD.

Issue Status: DRAFT

ACID ROCK DRAINAGE AND METAL LEACHING SCREENING MEMO

**SOIL SAMPLE AND WASTE ROCK
ACID GENERATION POTENTIAL RESULTS**

Nova Scotia Lands Inc., Gold Brook Lake and Seal Harbour Mine Site
Project No.: 60680068 Date: 2023-02-01



Figure: 2

Appendix B

Photo Log



Photo 1: Sample SS22-13 Location (approx.)



Photo 2: Sample SS22-B38 Location (approx.)



Photo 3: Sample SS22-D21 Location



Photo 4: WR1 Location



Photo 5: Sample WR2 Location



Photo 6: Sample WR3 Location



Photo 7: Sample WR4 Location



Photo 8: Sample SS22-D21 Location



Appendix C

Laboratory Reports



Table 1: ABA Test Results for project SEAL HARBOUR

BV Labs Sample No	Sample ID	Paste pH	Total Carbon	CO2	CaCO3 Equiv.	Total S	HCl Extractable Sulphur	HNO3 Extractable Sulphur	Non Extractable Sulphur (by diff.)	Acid Generation Potential	Mod. ABA Neutralization Potential	Fizz Rating	Net Neutralization Potential	Neutralization Potential Ratio
	Units	pH Units	wt%	wt%	Kg CaCO3/T	wt%	wt%	wt%	wt%	Kg CaCO3/T	Kg CaCO3/T	N/A	Kg CaCO3/T	N/A
AYF417	WR-1	9.80	0.10	0.08	1.8	0.05	0.03	0.02	<0.02	0.6	13.0	SLIGHT	12.4	21.7
AYF418	WR-2	9.33	0.07	<0.08	<1.8	0.03	0.02	0.01	<0.02	0.3	9.40	NONE	9.10	31.3
AYF419	WR-3	9.52	0.08	0.12	2.7	0.13	0.02	0.01	0.10	0.3	10.0	SLIGHT	9.70	33.3
AYF420	WR-4	9.53	0.09	0.08	1.8	0.14	0.02	0.02	0.10	0.6	8.70	SLIGHT	8.10	14.5
AYF421	WR-5	9.28	0.12	<0.08	<1.8	0.40	0.01	0.10	0.29	3.1	8.60	NONE	5.50	2.8
AYF422	SS22-13	5.65	7.44	<0.08	<1.8	0.30	0.03	0.06	0.21	1.9	3.70	NONE(H)	1.80	1.9
AYF423	SS22-B38	5.61	7.88	<0.08	<1.8	0.26	0.01	0.06	0.19	1.9	2.60	NONE(H)	0.700	1.4
AYF424	SS22-D21	5.91	0.83	<0.08	<1.8	0.43	0.01	0.21	0.21	6.6	4.00	NONE	-2.60	0.6
<i>Detection Limits</i>		<i>N/A</i>	<i>0.02</i>	<i>0.08</i>	<i>1.8</i>	<i>0.02</i>	<i>0.01</i>	<i>0.01</i>	<i>0.02</i>	<i>0.3</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>0.1</i>
<i>Bureau Veritas SOP #</i>		<i>BBY0SOP</i>	<i>LECO</i>	<i>LECO</i>	<i>BBY WI-00033</i>	<i>LECO</i>	<i>BBY ARD-00009</i>	<i>BBY ARD-00009</i>	<i>BBY WI-00033</i>	<i>BBY WI-00033</i>	<i>BBY0SOP-00020</i>	<i>BBY0SOP-00</i>	<i>BBY WI-00033</i>	<i>BBY WI-00033</i>

Notes:

Lawrence, R.W. 1991. Acid Rock Drainage Prediction Manual

Sobek, A.A., Schuller, W.A., Freeman, J.R. and Smith, R.M. (March 1978), Field and Laboratory Methods Applicable to Overburden and Minesoils, Report EPA-600/2-78-054, U.S. National Technical Information Service Report PB-280 495 pages 46-47.

(H)-denotes that sample is hydrophobic

References:

Acid Generation Potential = HNO3 Extractable Sulphide Sulphur*31.25

CaCO3 Equivalency = Carbonate Carbon (CO2)*(100/44)*10

Fizz Rating - Reference method used is based on NP method.

HCl Extractable Sulphur and HNO3 Extractable Sulphur is based on a modified version of ASTM Method D 2492-02

HCl Extractable Sulphur is based on a modified version of ASTM Method D 2492-02

Mod. ABA Neutralization Potential - MEND Acid Rock Drainage Prediction Manual, MEND Project 1.16.1b (pages 6.2-11 to 17), March 1991.

Net Neutralization Potential = (Modified ABA Neutralization Potential)-(Acid Generation Potential (HNO3 Extr))

Neutralization Potential Ratio = (Neutralization Potential)/(Acid Generation Potential)

Non Extractable Sulphur = (Total Sulphur)-(HCl Extractable Sulphate Sulphur)-(HNO3 Extractable Sulphide Sulphur)

Paste pH - Field and Laboratory Methods Applicable to Overburdens and Minesoils, (EPA 600 / 2-78-054, March 1978).

Total sulphur, total carbon & carbonate carbon (CO2; HCl direct method) by Leco done at Bureau Veritas Commodities Canada



Client:

AECOM Canada Ltd

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Table 2: ABA QAQC Test Results for project SEAL HARBOUR

Duplicate QC		Sample ID	Paste pH Reported	Paste pH Dup	CO2 Reported	CO2 Dup	HCl Extractable Sulphur Reported	HCl Extractable Sulphur Dup	HNO3 Extractable Sulphur Reported	HNO3 Extractable Sulphur Dup	Mod. ABA Neutralization Potential Reported	Mod. ABA Neutralization Potential Reported Dup	Fizz Rating Reported	Fizz Rating Dup
BV Labs Sample No		Units	pH Units	pH Units	wt%	wt%	wt%	wt%	wt%	wt%	Kg CaCO3/T	Kg CaCO3/T	N/A	N/A
AYF417 Dup	WR-1		9.80	9.77			0.03	0.03	0.02	0.01	13.0	12.0	SLIGHT	SLIGHT
AYF421 Dup	WR-5				<0.08	<0.08								

Reference Material QC

Units	Paste pH	Total Carbon	CO2	Total S	HCl Extractable Sulphur	HNO3 Extractable Sulphur	Mod. ABA Neutralization Potential
	pH Units	wt%	wt%	wt%	wt%	wt%	Kg CaCO3/T

Reference Material

RMATSS-2021 HCX (A659727) (0.72 wt%)					0.61		
KZK-1 HNO3 SO4-S (A659728) (0.37 wt%)						0.31	
KZK-1ModS Slight (A707195) (58.9 Kg CaCO3/T)							58.30
Paste pH - 8.91 (A712430) (8.91 pH Units)	8.91						
ARD REF MAT GS311-1 (A759354) (1.02 wt%)		0.97					
ARD REF MAT GS311-1 (A759354) (2.35 wt%)				2.32			
CO2 COO2 (A759375) (3.3 wt%)			3.61				

Blank QC

Method Blank					<0.01		
Method Blank						<0.01	
Method Blank							-0.30
Method Blank		<0.02					
Method Blank				<0.02			
Method Blank			<0.08				



Table 4: MEND SFE Test Results for project SEAL HARBOUR

BV Labs Sample No	Sample ID	Sample Weight	Volume Used	pH	EC	SO4	Acidity to pH4.5	Acidity to pH8.3	Total Alkalinity	Bicarbonate	Carbonate	Hydroxide	Fluoride	Dissolved Chloride	Nitrate-N	Nitrite-N	Total Ammonia	Total Organic Carbon	Dissolved Organic Carbon	
	Units	g	ml	pH Units	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AYF417	WR-1	249	750	9.29	61	1.3	<0.5	1.7	21	26	<0.5	<0.5	0.21	<0.5	<0.2	<0.05	0.203	2.0	1.7	
AYF418	WR-2	249	750	7.99	93	2.9	<0.5	1.4	26	32	<0.5	<0.5	0.08	<0.5	<0.2	<0.05	0.130	1.4	2.5	
AYF419	WR-3	250	750	9.41	59	2.0	<0.5	0.7	18	22	<0.5	<0.5	0.09	0.8	<0.2	<0.05	0.141	0.6	1.2	
AYF420	WR-4	250	750	9.36	61	2.4	<0.5	0.6	17	21	<0.5	<0.5	0.10	1.4	<0.2	<0.05	0.152	0.6	1.1	
AYF421	WR-5	249	750	9.36	71	1.6	<0.5	<0.5	21	25	<0.5	<0.5	0.10	0.9	<0.2	<0.05	0.238	0.5	1.0	
AYF422	SS22-13	249	750	5.40	141	89.3	<0.5	9.9	5.6	6.8	<0.5	<0.5	0.05	14.7	<0.2	<0.05	0.959	31.7	39.2	
AYF423	SS22-B38	248	750	5.69	48	18.7	<0.5	5.1	4.7	5.7	<0.5	<0.5	0.06	4.4	<0.2	<0.05	0.507	35.4	28.4	
AYF424	SS22-D21	252	750	5.00	36	8.3	<0.5	7.1	<0.5	<0.5	<0.5	<0.5	0.02	<0.5	<0.2	<0.05	0.138	7.1	5.5	
QAQC																				
Duplicates																				
AYF417 Dup	WR-1			9.23	61															
AYF423 Dup	SS22-B38												0.06							
Blanks																				
AYF416	SFE BLANK	0	750	5.76	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.01	<0.5	<0.2	<0.05	<0.005	<0.5	<0.5	
AYF416 Dup	SFE BLANK					<0.5			<0.5	<0.5	<0.5	<0.5		<0.5		<0.05	<0.005			
Detection Limits				N/A	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.01	0.5	0.02	0.005	0.005	0.5	0.5	
Bureau Veritas																				
SOP #		BBY0SOP-00008	BBY0SOP-00008	BBY0SOP-00003	BBY0SOP-00006	BBY6SOP-00017	BBY6SOP-00037	BBY6SOP-00037	BBY6SOP-00026	BBY6SOP-00026	BBY6SOP-00026	BBY6SOP-00026	BBY6SOP-00048	BBY6SOP-00011	BBY WI-00033	BBY6SOP-00010	AB SOP-00007			

Notes:
Calculated parameter based on the concentration of Nitrate plus Nitrite(NO2+NO3) minus Nitrite(NO2)

References:
Anions = Dissolved Sulphate*2/96+Total Alkalinity*60/100*2/60 Cations = Dissolved Aluminum*3/27+Dissolved Calcium*2/40.08+Dissolved Copper*2/63.5+Dissolved Iron*2/55.8+Dissolved Magnesium*2/24.3+Dissolved Manganese*2/54.9+Dissolved Potassium*1/39.1+Dissolved Sodium*1/23+Dissolved Zinc*2/65.4
Hardness = (Calcium*2.497) + (Magnesium*4.118)



Client:

Table 4: MEND SFE Test Resu

BV Labs Sample No	Sample ID	Total Dissolved Phosphorous	Total Dissolved Solids	Hardness CaCO3	Dissolved Aluminum (Al)	Dissolved Antimony (Sb)	Dissolved Arsenic (As)	Dissolved Barium (Ba)	Dissolved Beryllium (Be)	Dissolved Bismuth (Bi)	Dissolved Boron (B)	Dissolved Cesium (Cs)	Dissolved Cadmium (Cd)	Dissolved Calcium (Ca)	Dissolved Chromium (Cr)	Dissolved Cobalt (Co)	Dissolved Copper (Cu)	Dissolved Lanthanum (La)	
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
AYF417	WR-1	1.11	52	11.9	0.749	0.000815	0.198	0.00887	0.000015	<0.000050	<0.050	0.000057	0.0000071	4.12	0.00038	0.000133	0.00293	0.000245	
AYF418	WR-2	0.98	86	15.7	0.593	0.000512	0.262	0.00949	0.000011	<0.000050	<0.050	0.000065	0.0000075	5.45	0.00036	0.0000799	0.00146	0.000409	
AYF419	WR-3	0.88	60	12.5	0.654	0.00103	0.564	0.0109	<0.000010	<0.000050	<0.050	<0.000050	<0.0000050	4.47	0.00018	0.0000262	0.00108	0.000111	
AYF420	WR-4	0.72	58	13.6	0.740	0.000883	0.632	0.00459	0.000014	<0.000050	<0.050	0.000062	0.0000056	4.99	0.00022	0.0000276	0.000142	0.000306	
AYF421	WR-5	1.10	66	12.2	0.834	0.00128	1.11	0.00300	<0.000020	<0.000010	<0.10	<0.00010	<0.000010	4.35	0.00035	0.000026	<0.00010	0.00016	
AYF422	SS22-13	10.43	130	84.2	0.321	0.00398	3.93	0.0631	0.000081	<0.000025	<0.25	0.00140	0.000138	26.5	0.00054	0.0708	0.00194	0.00153	
AYF423	SS22-B38	2.53	54	20.1	0.312	0.00749	2.93	0.0273	<0.000050	<0.000025	<0.25	0.00034	0.000042	5.84	<0.00050	0.00454	0.00596	0.00035	
AYF424	SS22-D21	5.56	28	4.24	0.0932	0.00535	4.11	0.00370	0.000052	<0.000010	<0.10	<0.00010	0.000147	0.99	0.00021	0.0124	0.00276	<0.00010	
QAQC																			
Duplicates																			
	AYF417 Dup	WR-1																	
	AYF423 Dup	SS22-B38																	
Blanks																			
	AYF416	SFE BLANK	<0.005	<10	<0.50	0.00117	<0.000020	0.000020	<0.000020	<0.000010	<0.000050	<0.050	<0.000050	<0.0000050	<0.050	<0.00010	<0.0000050	<0.000050	<0.000050
	AYF416 Dup	SFE BLANK				0.00135	<0.000020	<0.000020	<0.000020	<0.000010	<0.000050	<0.050	<0.000050	<0.0000050	<0.050	<0.00010	<0.0000050	<0.000050	<0.000050
	Detection Limits		0.005	10	0.50	0.00050	0.000020	0.000020	0.000020	0.000010	0.0000050	0.050	0.000050	0.0000050	0.050	0.00010	0.0000050	0.000050	0.000050
	Bureau Ventas					BBY6SOP-	BBY7WI-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-	BBY7SOP-
	SOP #					00033	00033	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002

Notes:
Calculated parameter based on the

References:
Anions = Dissolved Sulphate*2/96+
Hardness = (Calcium*2.497) + (Magnesium*1.4297)



Client:

Table 4: MEND SFE Test Resu

BV Labs Sample No	Sample ID	Dissolved Iron (Fe)	Dissolved Lead (Pb)	Dissolved Lithium (Li)	Dissolved Magnesium (Mg)	Dissolved Manganese (Mn)	Dissolved Phosphorus (P)	Dissolved Molybdenum (Mo)	Dissolved Nickel (Ni)	Dissolved Potassium (K)	Dissolved Rubidium (Rb)	Dissolved Selenium (Se)	Dissolved Silicon (Si)	Dissolved Silver (Ag)	Dissolved Sodium (Na)	Dissolved Strontium (Sr)	Dissolved Sulphur (S)	Dissolved Tellurium (Te)	Dissolved Thallium (Tl)
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AYF417	WR-1	0.116	0.000405	0.00309	0.401	0.00437	0.0397	0.000267	0.000766	5.31	0.00571	0.000144	2.32	0.0000763	2.29	0.0136	<10	<0.000020	0.0000563
AYF418	WR-2	0.172	0.000591	0.00179	0.513	0.0110	0.0391	0.000208	0.000298	5.79	0.00708	0.000072	2.21	0.0000483	3.21	0.00879	<10	<0.000020	0.0000509
AYF419	WR-3	0.0547	0.000671	0.00257	0.317	0.00248	0.0263	0.000324	0.000144	4.05	0.00416	0.000105	2.53	0.0000517	2.44	0.0157	<10	<0.000020	0.0000554
AYF420	WR-4	0.0953	0.000209	0.00312	0.288	0.00392	0.0237	0.000274	0.000146	4.60	0.00504	0.000054	2.68	0.0000316	1.90	0.0219	<10	<0.000020	0.0000310
AYF421	WR-5	0.0724	0.000122	0.0038	0.32	0.00283	0.0315	0.00015	0.000196	6.08	0.00580	<0.000080	2.20	<0.000010	1.73	0.0233	<20	<0.000040	0.0000108
AYF422	SS22-13	0.492	0.00406	0.0046	4.36	2.45	0.064	0.00037	0.0659	5.03	0.0195	<0.00020	2.52	<0.000025	10.0	0.171	<50	<0.00010	0.000110
AYF423	SS22-B38	0.227	0.00234	<0.0025	1.45	0.165	0.043	0.00027	0.00435	3.48	0.0205	<0.00020	1.27	<0.000025	4.44	0.0349	<50	<0.00010	0.000151
AYF424	SS22-D21	1.26	0.00109	<0.0010	0.43	0.0412	0.0346	<0.00010	0.0180	0.58	0.00050	0.000155	1.31	<0.000010	2.00	0.00213	<20	0.000081	0.0000100
QAQC																			
Duplicates																			
AYF417 Dup	WR-1																		
AYF423 Dup	SS22-B38																		
Blanks																			
AYF416	SFE BLANK	<0.0010	0.0000063	<0.00050	<0.050	0.000054	<0.0020	<0.000050	<0.000020	<0.050	<0.000050	<0.000040	<0.10	<0.0000050	<0.050	<0.000050	<10	<0.000020	<0.0000020
AYF416 Dup	SFE BLANK	<0.0010	0.0000056	<0.00050	<0.050	0.000058	<0.0020	<0.000050	<0.000020	<0.050	<0.000050	<0.000040	<0.10	<0.0000050	<0.050	<0.000050	<10	<0.000020	<0.0000020
Detection Limits		0.0010	0.0000050	0.00050	0.050	0.000050	0.0020	0.000050	0.000020	0.050	0.000050	0.000040	0.10	0.0000050	0.050	0.000050	10	0.000020	0.0000020
Bureau Veritas		BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-	BBY7/SOP-
SOP #		00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002

Notes:
Calculated parameter based on the

References:
Anions = Dissolved Sulphate*2/96+
Hardness = (Calcium*2.497) + (Mg



Client:

Table 4: MEND SFE Test Resu

BV Labs Sample No	Sample ID	Dissolved Thorium (Th)	Dissolved Tin (Sn)	Dissolved Titanium (Ti)	Dissolved Tungsten (W)	Dissolved Uranium (U)	Dissolved Vanadium (V)	Dissolved Zinc (Zn)	Dissolved Zirconium (Zr)	Dissolved Mercury (Hg)
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AYF417	WR-1	0.000055	<0.00020	0.00770	0.00127	0.000107	0.00251	0.00175	<0.00010	<0.000050
AYF418	WR-2	0.000116	<0.00020	0.0173	0.000521	0.0000786	0.00134	0.00243	0.00014	<0.000050
AYF419	WR-3	<0.000050	<0.00020	0.00525	0.000554	0.0000562	0.00264	0.00076	<0.00010	0.000056
AYF420	WR-4	0.000075	<0.00020	0.0110	0.000650	0.0000709	0.00207	0.00149	0.00020	<0.000050
AYF421	WR-5	<0.00010	<0.00040	0.0085	0.000587	0.0000714	0.00216	0.00174	<0.00020	<0.00010
AYF422	SS22-13	<0.00025	<0.0010	0.0029	0.000065	0.000034	0.0016	0.770	<0.00050	<0.00025
AYF423	SS22-B38	<0.00025	<0.0010	0.0047	0.000139	0.000034	0.0028	0.0162	<0.00050	<0.00025
AYF424	SS22-D21	<0.00010	<0.00040	<0.0010	0.000030	0.0000187	<0.00040	0.0442	<0.00020	0.00010
QAQC										
Duplicates										
AYF417 Dup	WR-1									
AYF423 Dup	SS22-B38									
Blanks										
AYF416	SFE BLANK	<0.000050	<0.00020	<0.00050	<0.000010	<0.0000020	<0.00020	<0.00010	<0.00010	<0.000050
AYF416 Dup	SFE BLANK	<0.000050	<0.00020	<0.00050	<0.000010	<0.0000020	<0.00020	<0.00010	<0.00010	<0.000050
Detection Limits		0.000050	0.00020	0.00050	0.000010	0.0000020	0.00020	0.00010	0.00010	0.000050
Bureau Veritas		BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002	BBY7SOP-00002
SOP #										BBY7SOP-00002

Anion Sum	Cation Sum	Balance %
N/A	N/A	N/A
0.46	0.58	11.40
0.58	0.68	7.83
0.43	0.54	11.83
0.43	0.57	13.38
0.48	0.59	9.62
2.39	2.48	1.87
0.61	0.77	11.60
0.17	0.27	20.74
BBY WI-00033	BBY WI-00033	BBY WI-00033

Notes:
Calculated parameter based on the

References:
Anions = Dissolved Sulphate*2/96+
Hardness = (Calcium*2.497) + (Magnesium*1.42)



Client:

AECOM Canada Ltd

Page 5 of 6

Table 5: Sample List Test Results for project SEAL HARBOUR

BV Labs Sample ID	Client Sample ID	Sample Form	Dry Weight Received (kg)
AYF417	WR-1	Waste Rock	4.64
AYF418	WR-2	Waste Rock	4.30
AYF419	WR-3	Waste Rock	3.69
AYF420	WR-4	Waste Rock	3.80
AYF421	WR-5	Waste Rock	4.23
AYF422	SS22-13	Wet Soil	2.67
AYF423	SS22-B38	Wet Soil	3.08
AYF424	SS22-D21	Wet Soil	4.66

Total Weight
Total Samples Received

Note:
BVM File: VAN22002679



Table 6: Sample Summary for project SEAL HARBOUR

AECOM Canada Ltd, SEAL HARBOUR
Page 6 of 6

Date Samples Rec'd by BV Labs: 8 samples were rec'd on 13-Jul-22

Sample Prep Conducted by BV Labs: YES

Date of Analysis: NP-MABA: 6/7-Sept-22
PPHARD: 8-Sept-22
SO4HCLV/SO4HNO3V: 6-Sept-22
MENDSFE: 7-Sept-22

Date Reported: 18-Oct-22

Client:	AECOM Canada Ltd
Client Project Name:	SEAL HARBOUR
Client Project No:	N/A
ARD Project #:	N/A
BV Labs Job No:	C254711
Contact Person:	Rory McNeil: rory.mcneil@aecom.com
E-mail Address:	Rory McNeil: rory.mcneil@aecom.com

Data Validated by:	Tim O'Hearn
Position:	Senior Scientific Specialist, ARD

Sample Storage

Sample rejects (and selected test residues where applicable) have been archived
Standard archive protocol is archiving for samples for 3 months after testing is complete.
If archiving is required past 3 months a fee will be required.

QUANTITATIVE PHASE ANALYSIS OF 8 POWDER SAMPLES USING THE RIETVELD METHOD AND X-RAY POWDER DIFFRACTION DATA

Project: C254711 – Aecom Canada Ltd – Seal Harbour

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6339 Stores Road
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September 13, 2022

EXPERIMENTAL METHOD

The 8 samples of **Project C254711 – Aecom Canada Ltd – Seal Harbour** were reduced to the optimum grain-size range for quantitative X-ray analysis (<10 μm) by grinding under ethanol in a vibratory McCrone XRD Mill (Retsch GmbH, Germany) for 10 minutes. Continuous-scan X-ray powder-diffraction data were collected over a range of 3-80°2 θ with CoK α radiation on a Bruker D8 Advance Bragg-Brentano diffractometer equipped with an Fe filter foil, 0.6 mm (0.3°) divergence slit, incident- and diffracted-beam Soller slits and a LynxEye-XE detector. The long fine-focus Co X-ray tube was operated at 35 kV and 40 mA, using a take-off angle of 6°.

RESULTS

The X-ray diffractograms were analyzed using the International Centre for Diffraction Database PDF-4+ and Search-Match software by Bruker. X-ray powder-diffraction data of the samples were refined with Rietveld program Topas 4.2 (Bruker AXS). The results of quantitative phase analysis by Rietveld refinements are given in Table 1 (separate file, ***BV Labs Results Sept 13 2022 – Proj C254711–Aecom Canada Ltd-Seal Harbour – 8 samples.xlsx***). These amounts represent the relative amounts of crystalline phases normalized to 100%. The Rietveld refinement plots are shown in Figures 1-8. Ideal formulae of the minerals are shown in Table 2.

Note that samples #6 to #8 contain some unknown clay minerals (likely illite-smectite) and sample #8 in addition some amorphous/nanoscale material which cannot be analyzed (see wide humps fitted with calculated peaks in Figures #6 to #8 (positions are marked with vertical blue lines)). Consider the results approximate.

Table 2. Ideal formulae of the present phases

Mineral	Ideal Formula
Arsenopyrite	FeAsS
Biotite	$K(\text{Mg},\text{Fe}^{2+})_3\text{AlSi}_3\text{O}_{10}(\text{OH})_2$
Calcite	CaCO_3
Clinocllore	$(\text{Mg},\text{Fe}^{2+})_5\text{Al}(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$
Illite-Muscovite 2M1	$\text{K}_{0.65}\text{Al}_{2.0}(\text{Al}_{0.65}\text{Si}_{3.35}\text{O}_{10})(\text{OH})_2 - \text{KAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$
Ilmenite	Fe_2TiO_3
K-feldspar (microcline, intermediate)	KAlSi_3O_8
Plagioclase (albite; albite, calcian)	$\text{NaAlSi}_3\text{O}_8 - \text{CaAl}_2\text{Si}_2\text{O}_8$
Pharmacosiderite	$\text{KFe}^{3+}_4(\text{AsO}_4)_3(\text{OH})_4 \cdot 7(\text{H}_2\text{O})$
Quartz	SiO_2
Siderite	$\text{Fe}^{2+}\text{CO}_3$

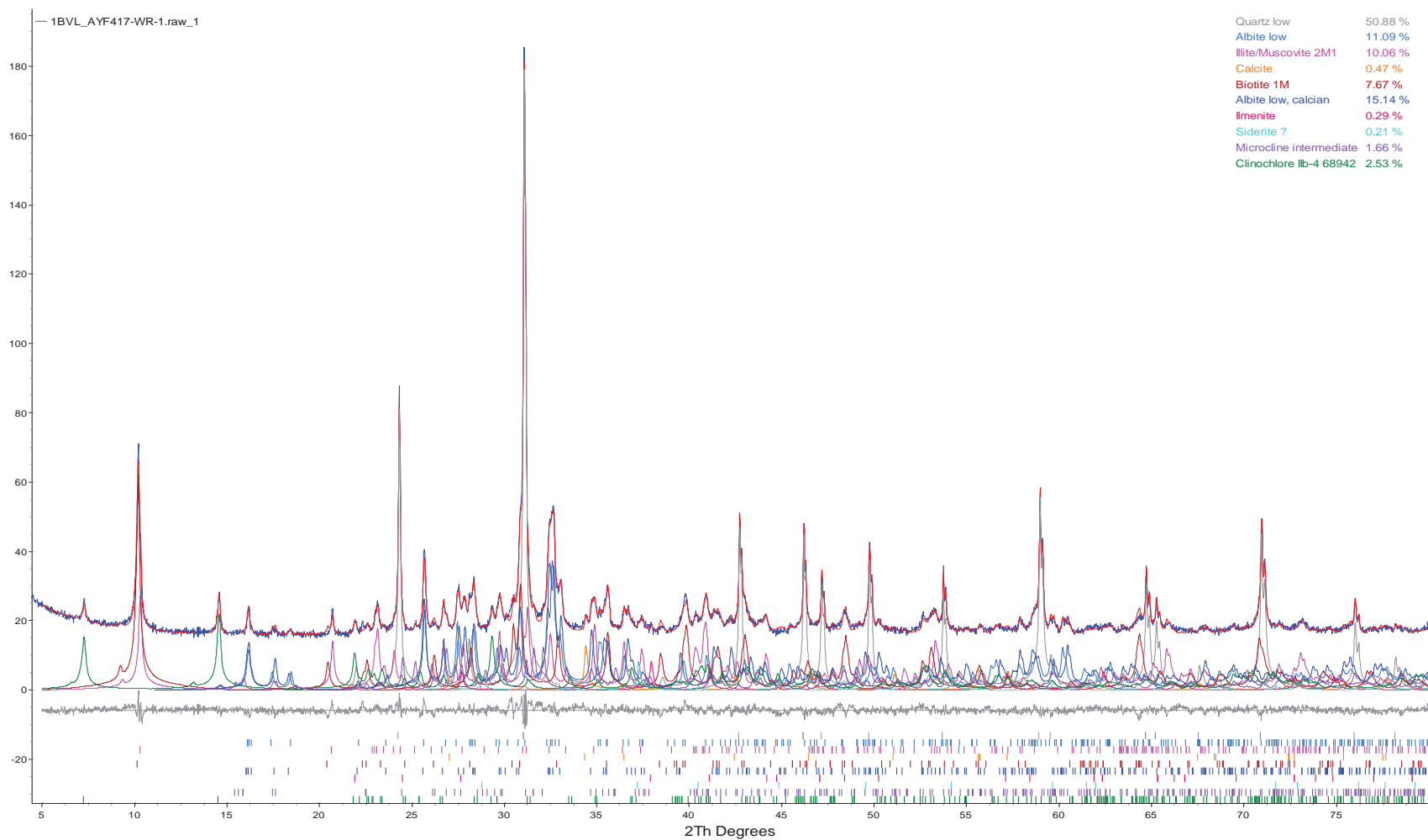


Figure 1. Rietveld refinement plot of sample **BV Labs #1: AYF417-WR-1** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

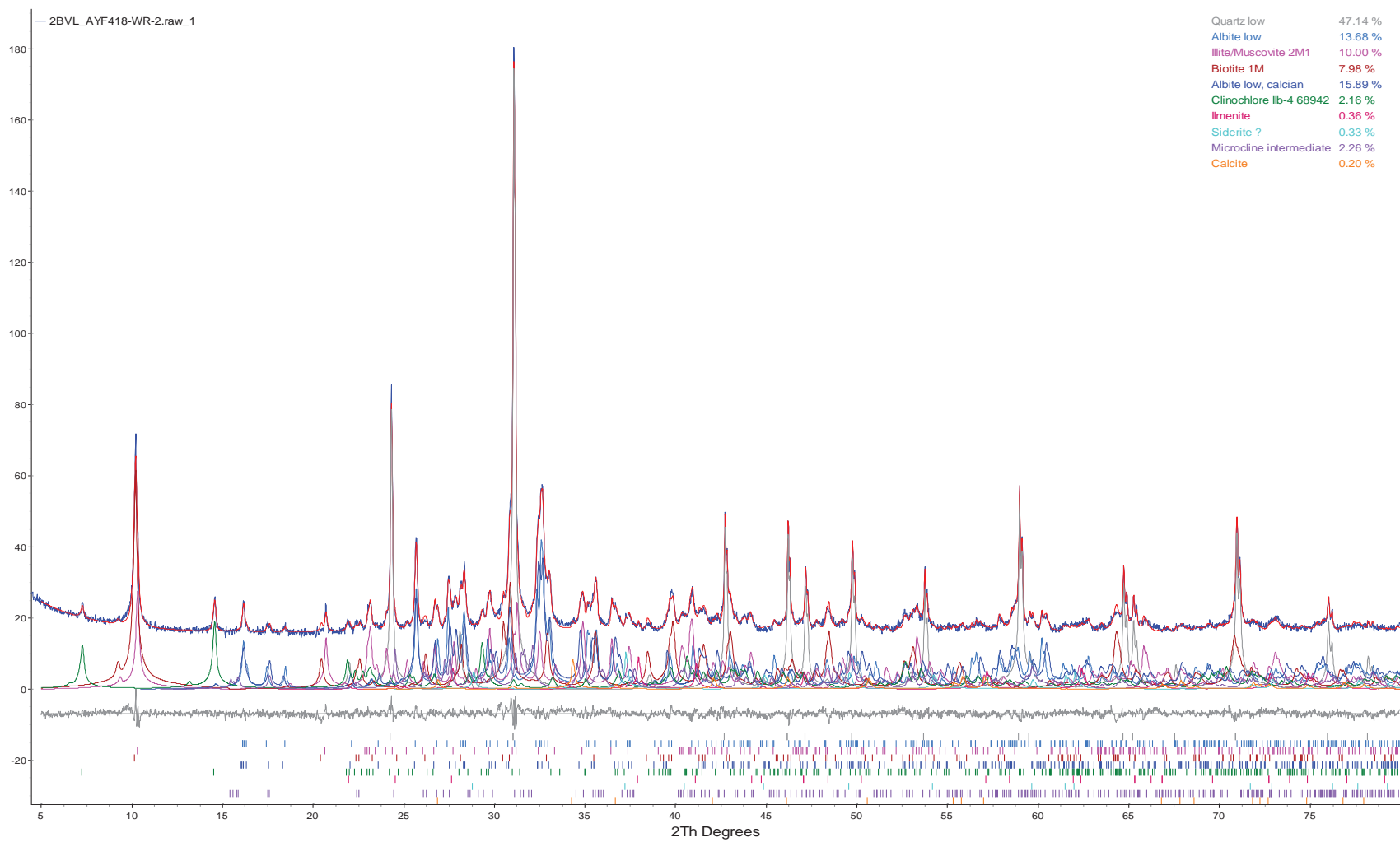


Figure 2. Rietveld refinement plot of sample **BV Labs #2: AYF418-WR-2** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

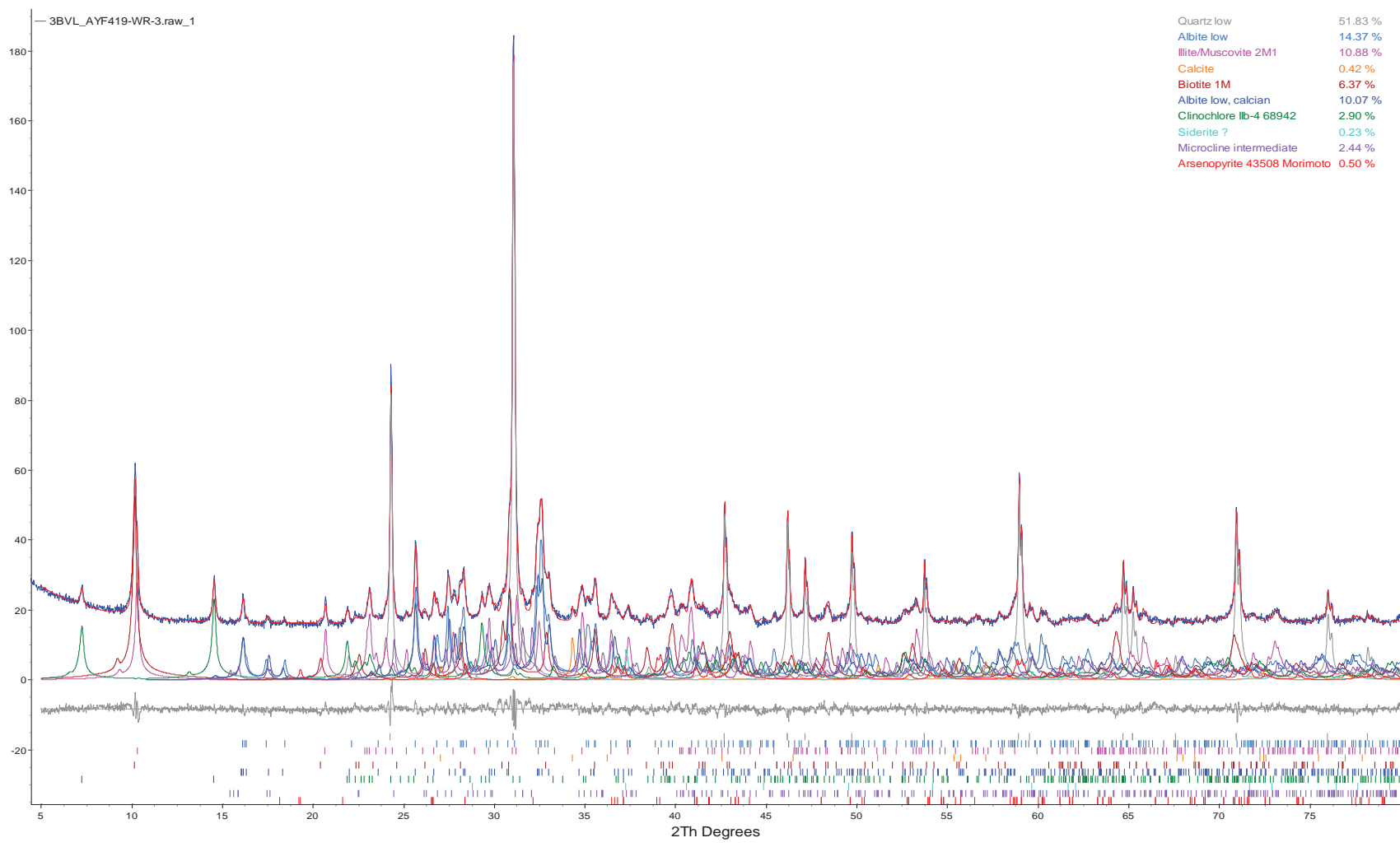


Figure 3. Rietveld refinement plot of sample **BV Labs #3: AYF419-WR-3** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

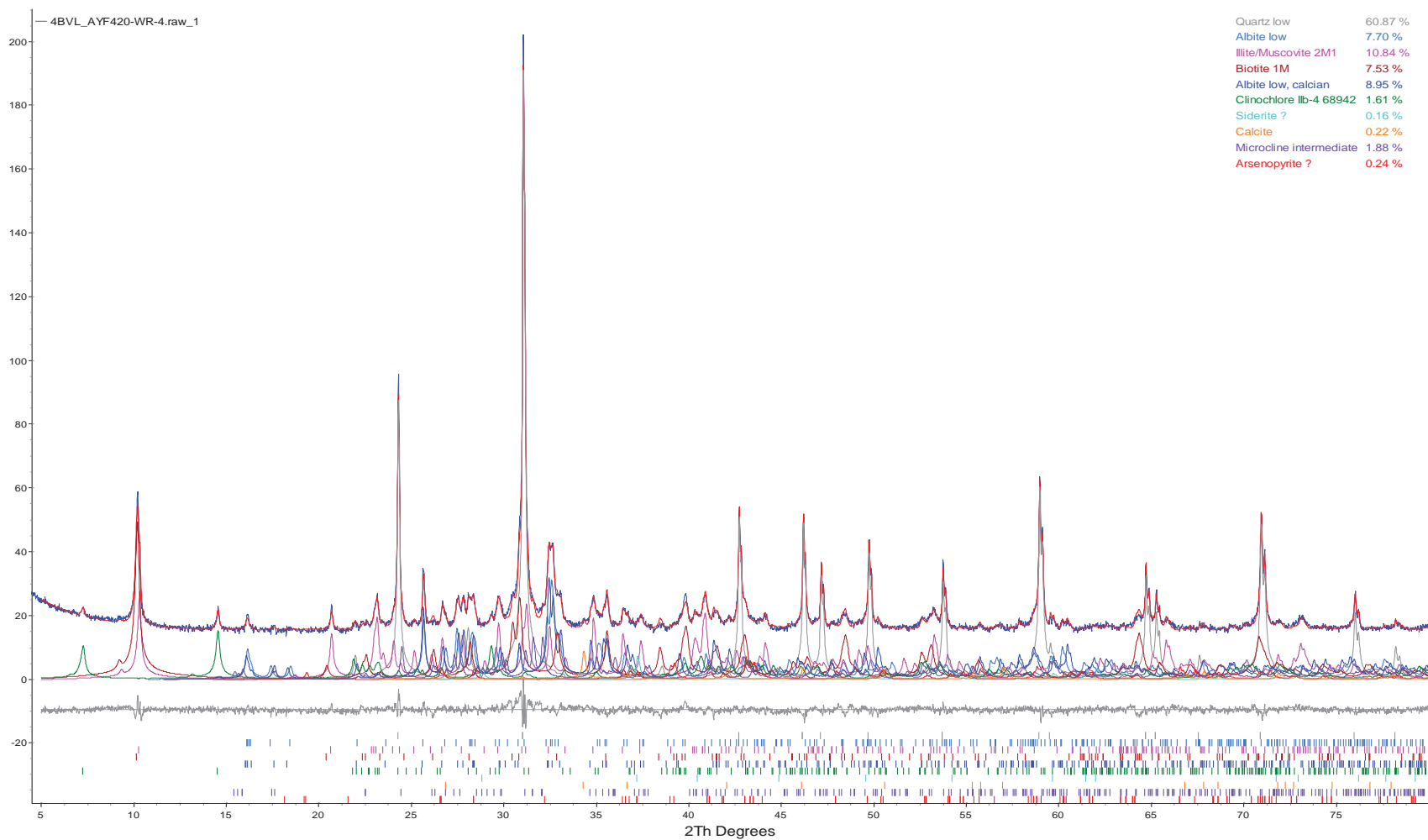


Figure 4. Rietveld refinement plot of sample **BV Labs #4: AYF420-WR-4** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

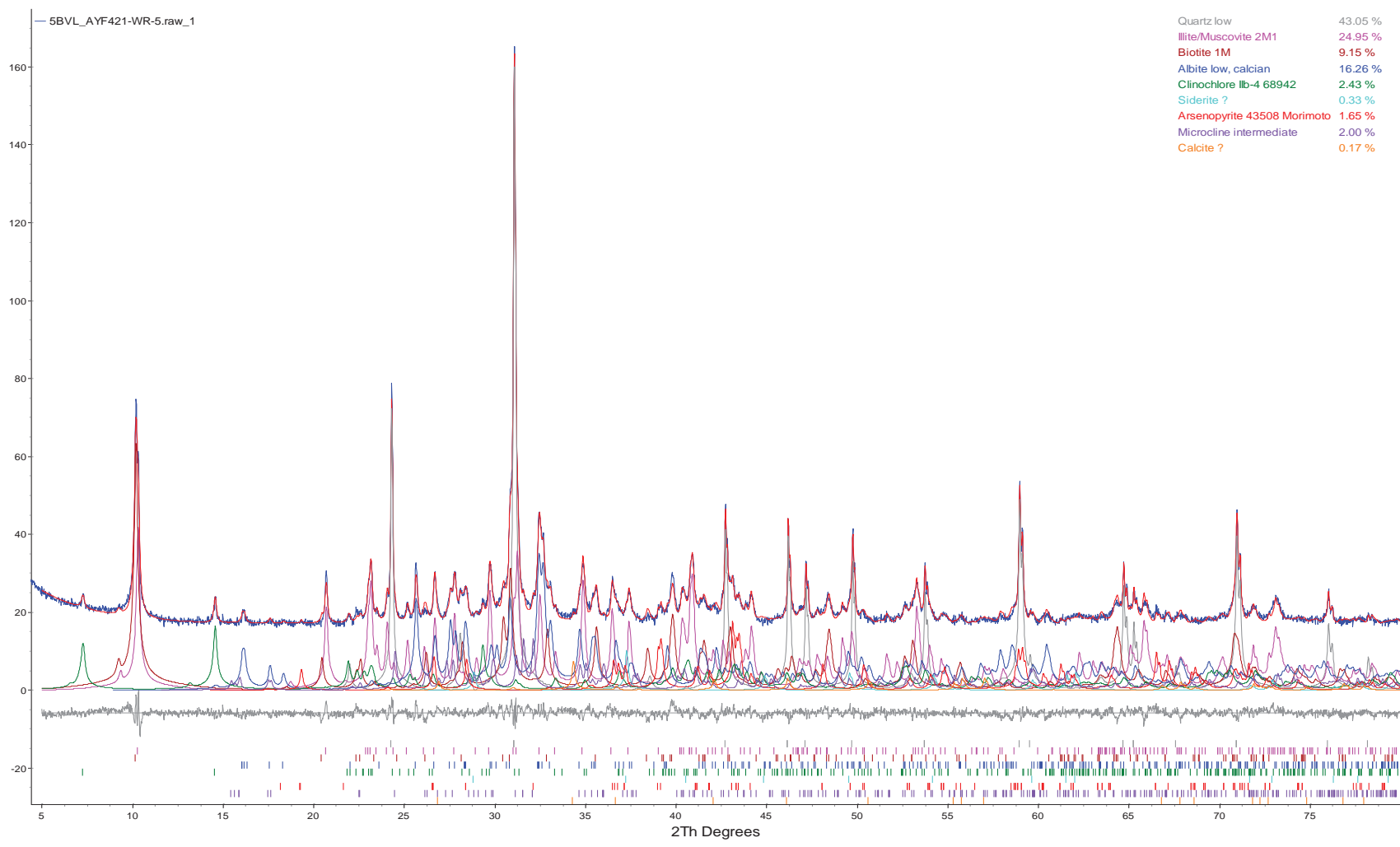


Figure 5. Rietveld refinement plot of sample **BV Labs #5: AYF421-WR-5** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

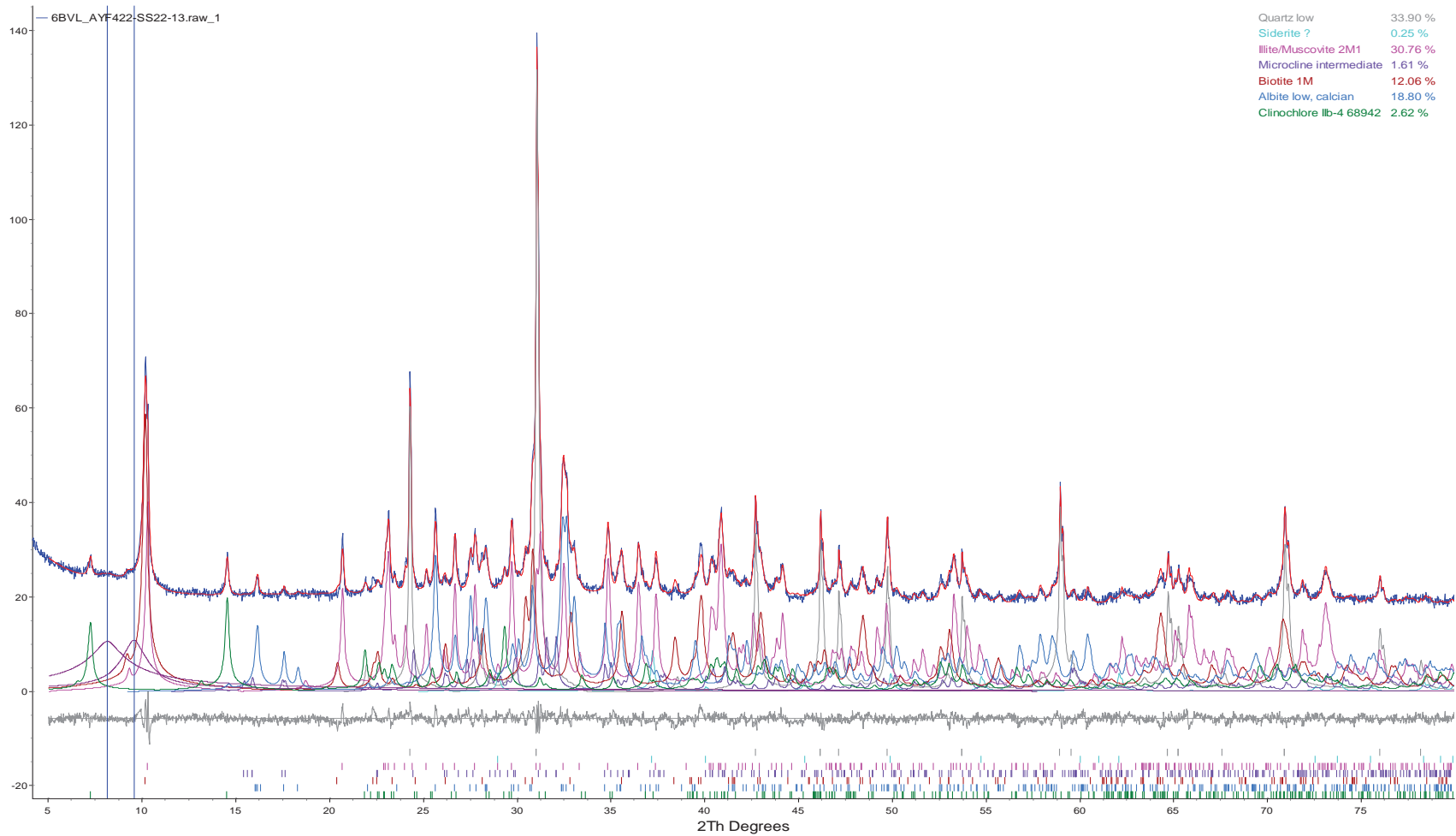


Figure 6. Rietveld refinement plot of sample **BV Labs #6: AYF422-SS22-13** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections; vertical blue lines - positions of peaks phases). Coloured lines are individual diffraction patterns of all phases.

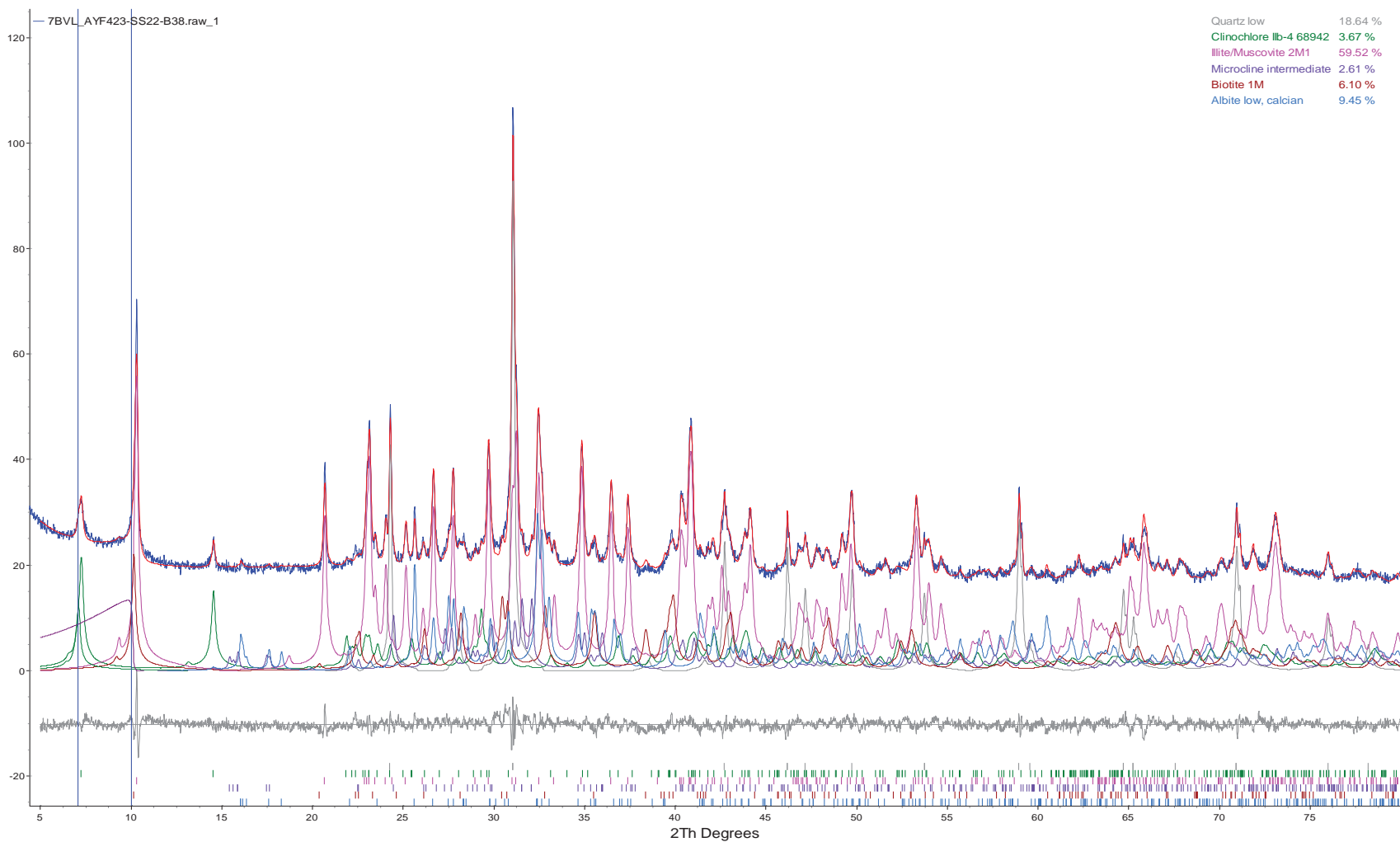


Figure 7. Rietveld refinement plot of sample **BV Labs #7: AYF423-SS22-B38** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections; vertical blue lines - positions of peaks phases). Coloured lines are individual diffraction patterns of all phases.

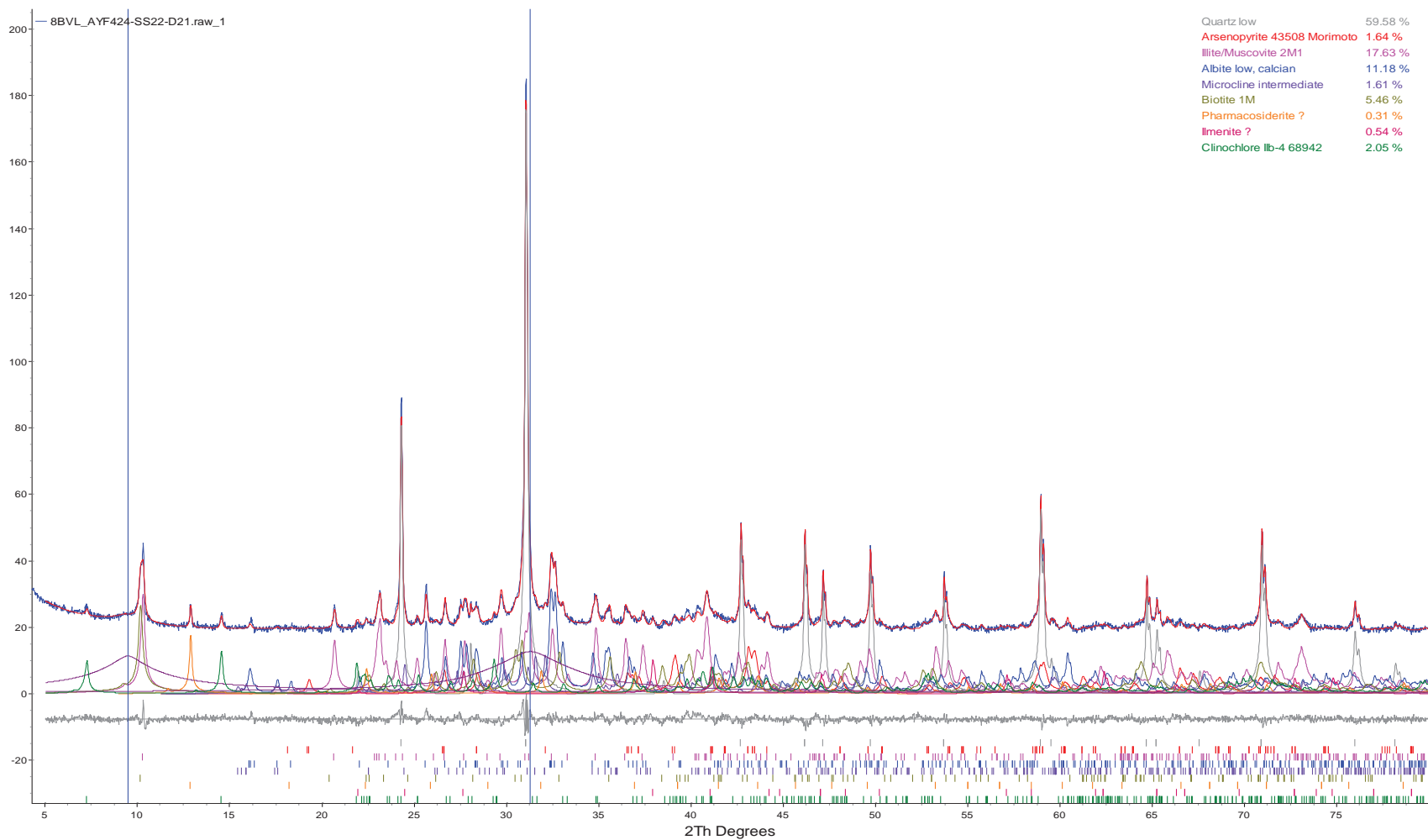


Figure 8. Rietveld refinement plot of sample **BV Labs #8: AYF424-SS22-D21** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections; vertical blue lines - positions of peaks phases). Coloured lines are individual diffraction patterns of all phases.

2023 Detailed Scope of Work for an Aquatic Tissue Field Program at the Gold Brook Lake and Seal Harbour Mine Sites

Human Health and Ecological Risk Assessment

Build Nova Scotia

Project number: 60680068

March 2023

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1 Introduction

1.1 Background

The two historic gold mine sites, Gold Brook Lake and Seal Harbour, are located in the southern portion of a 38172.8-hectare (94327.0-acre) property (PID#: 35094366) owned by Nova Scotia Department of Natural Resources and Renewables (NSDNRR), located in Goldboro of Guysborough County, Nova Scotia. These mines, both situated within the New Harbour/Salmon watershed, operated in the late 1800s to the early 1900s. The Gold Brook mine placed tailings directly into the upper reaches of Gold Brook, which flows into Seal Harbour Lake. The Seal Harbour Mine Site placed tailings directly into a small tributary to West Brook, which flows into the Atlantic Ocean (Seal Harbour). These tailings have been and continue to be eroded by local streams; visible tailings exist along the floodplain 2km from the mine site to the ocean at Seal Harbour.

AECOM Canada Ltd. (AECOM) completed Phase I and II Environmental Site Assessments (ESA) of the former Gold Brook Lake Mine and Seal Harbour Mine Sites (the “Sites”) for Build Nova Scotia (BNS). The Phase II ESA identified tailings containing elevated Arsenic (As) and Mercury (Hg) concentrations that may present a human health risk and adverse ecological effects, as well as impact to surface water and sediments in the surrounding waterbodies of the New Harbour/Salmon watershed.

Further environmental study and a quantitative Human Health and Ecological Risk Assessment (HHERA) is recommended to further understand extent and magnitude of contamination associated with the Sites and to understand potential risks to humans and the environment as a result of exposure to site-derived contaminants.

To support a quantitative risk assessment, AECOM is pleased to provide BNS with the following detailed workplan for the proposed 2023 Aquatic Tissues Field Program at the Sites to support the site-specific HHERA.

1.2 Purpose and Objectives

The Purpose of the proposed field program is to collect site-specific data related on contaminant uptake and concentrations into biotic tissues within the aquatic environment. The data-use objectives of this program are to provide a defensible estimate of substances of interest in fish tissues potentially being consumed by local populations, and to form a preliminary site-specific aquatic food-web model. This will be achieved through the collection of aquatic tissues from waterbodies with known Site-related impacts for analysis of contaminants of concern (COCs).

The objectives of the proposed field program are:

1. to collect aquatic tissue samples for analysis of COC concentrations by analytical laboratories
2. to acquire tissue chemistry datasets for five media types: benthic invertebrates, benthic feeding fish, forage fish, sport fish, and marine shellfish
3. to provide a preliminary understanding of COC exposure pathways to humans and ecological receptors. including the type and distribution of COC impacts and the magnitude of COCs in aquatic organisms

This report provides regional and Site background information for aquatic resources to support the planning of a aquatic tissues field program (Section 2) and details the proposed field study for collecting aquatic tissues from Site-impacted waterbodies (Section 3).

2 Information Review in Support of Aquatic Tissues Field Study

The following information has been summarized from publicly available reports and databases and is provided here to inform the study design for the aquatic tissues field program for the Site (Section 3).

2.1 Study Area

The former Gold Brook Lake Mine and Seal Harbour Mine (the "Sites") are located in the southern portion of the NSDRR owned property (PID#: 35094366) and make up the study area for this investigation.

The Gold Brook Lake Mine portion of the Sites is part of the Upper Seal Harbour Gold district and is approximately 3 km northeast of town of Goldboro, NS. The historical mine workings and tailings can be accessed via Goldbrook Road off Highway 316. The historic mine site is situated to the south of the waterbody of Gold Brook Lake on mostly forested land and wetlands (Figure 1). The elevation range of the Site is between approximately 35 and 65 meters above sea level (masl), with a downward slope direction of north-to-south. In the west-to-east direction the terrain is relatively flat.

The Seal Harbour Mine portion of the Sites is part of the Lower Seal Harbour Gold District and is approximately 4.5 km southeast of the town of Goldboro, NS. The historic Seal Harbour Mine site, which includes concrete foundations of historic infrastructure, waste rock piles, and tailings, is located in an area approximately 500-600 m southwest of Seal Harbour Lake (Figure 1). Seal Harbour Lake itself is outside of the PID#: 35094366 boundary. The Seal Harbour mine area is mostly forested land and wetlands. The elevation in the approximate area where the Lower Seal Harbour mining activities took place ranges between approximately 12 to 40 masl, with a downward slope from northwest-to-southeast.

The Sites are positioned in the Eastern Shore Ecodistrict (820) which is characterized by the climatic influence of the Atlantic Ocean which creates conditions for boreal-like coastal forest of spruce and fir (DNR, 2015). The coastal forests are primarily coniferous dominated by black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), and white spruce (*Picea glauca*). Freshwater lakes make up for 6% of the area in the Ecodistrict and loons (*Gavia sp.*) are known to breed in some of the larger lakes (DNR, 2015).

2.2 Contaminants of Concern

From investigations of on-site media, the Phase II ESA for the Sites identified the primary contaminants of concern (COCs) for the aquatic portion of the Site as mercury¹ (Hg) and arsenic (As), as they are associated with wastes released to the environment from the mineral processing and gold extraction, including waste rock and tailings. Additionally, potential COCs (PCOCs) for further consideration were identified based available analytical data for samples collected from areas impacted by historic mining activities at the Gold Brook Lake Mine and Seal Harbour Mine Sites and surrounding area: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, uranium, vanadium, zinc, and pH.

Heavy metals, like mercury and arsenic, that are often found in tailings, may bioaccumulate or biomagnify in biota, and can cause toxicity. Bioaccumulation and biomagnification of COCs has bearing on the proposed field study design, as fish feeding guild, fish age (size) and trophic position all influence COC concentration in tissues.

2.3 Fish and Fish Habitat

2.3.1 Aquatic Features

The Gold Brook Lake and Seal Harbour Mine Sites are located within the 443 km² New Harbour/Salmon Watershed of Guysborough County. The waterbody of Gold Brook Lake (79 ha) is the upstream extent of the Sites and is located

¹ Mercury occurs in a number of chemical forms in the environment. In fish, mercury is largely present as methylmercury (Bloom 1992). Thus, while the term "mercury" is often used generically in the context of fish, it is generally implicit that methylmercury is the specific form present unless stated otherwise.

immediately north and upstream of the Gold Brook Lake Mine Site and drains into the Gold Brook system which flows to the southeast. Gold Brook meanders through marsh habitat for approximately 1.7 km and drains into Seal Harbour Lake. Seal Harbour Lake drains into two tributaries to the south, West Brook and East Brook, both which eventually meet with the Atlantic Ocean in Seal Harbour. Seal Harbour Lake, and portions of East Brook and West Brook are outside the Site Boundary (Figure 1).

Gold Brook (between Gold Brook Lake and Seal Harbour Lake) is classified as a creek (based on drainage area²) with a moderate gradient (0.1 - 2% slope), cool temperature (19-21°C³) and low alkalinity (≤ 20 mg/L CaCO₃) (Millar et al. 2019). The river classification of East and West Brook (downstream of the Seal Harbour Lake) have the same waterbody classifications as Gold Brook (creek, moderate gradient, cool temperature, low alkalinity) except in one segment the gradient is classified as high (>2%). The furthest downstream segments in East Brook and West Brook are under tidal influence.

Gold Brook has a floodplain characterized by a braided system with one main channel, and is classified as a fen wetland (DNR, 2016). Swamp wetlands occur to the west and south of the Seal Harbour site and Seal Harbour Marshes and Rocky Lakes are located approximately 1.3 km east of the Seal Harbour site (DNR, 2016; AECOM, 2022). There are a number of wetland areas of fens, bogs, and swamps located along both East and West Brook before they discharge into Seal Harbour.

While channelization of the waterbodies described above may be poor in some areas, especially during low-flow, the full range from Gold Brook Lake to the Atlantic Ocean is expected to have surface connectivity year-round and support fish communities with no fish passage barriers identified.

2.3.2 Fish Species

Existing inventories of fish and shellfish species for the Sites were consulted including a recent fish baseline assessment for an operating gold mine (Goldboro Gold Project, McCallum Environmental 2020), to determine fish (freshwater and anadromous) and shellfish (marine) species that have the potential to be found in waterbodies in or downstream of the Site (AMEC, 2006; McCallum Environmental, 2020).⁴ Freshwater and anadromous fish species that have been documented in Gold Brook Lake, Gold Brook, Seal Harbour Lake, West Brook and East Brook (all of the New Harbour/ Salmon Watershed) are listed in Table 1, while marine shellfish species with a known range in Seal Harbour are listed in Table 2.

Many of the rivers that drain into the Atlantic Ocean along the coastline of the Eastern Shore Ecodistrict contain critical populations of Atlantic salmon (*Salmo salar*) (DNR, 2015). Though no recent records of direct catch or observation of Atlantic salmon in the New Harbour/ Salmon Watershed, eDNA samples tested positive for this species in the watershed (McCallum Environmental, 2020).

² Millar et al., 2019 defines a creek as having an upstream drainage area <100 km².

³ Mean summer temperature June, July, August, 1990-2016 (Millar et al., 2019).

⁴ The Nova Scotia fish database had no records for the New Harbour/ Salmon watershed.

Table 1. Fish species with documented presence in the New Harbour/ Salmon Watershed (Gold Brook Lake, Gold Brook, Seal Harbour Lake, and West/ East Brook)

Fish Species	Scientific Name
American eel	<i>Anguilla rostrata</i>
Atlantic salmon	<i>Salmo salar</i>
Banded killifish	<i>Fundulus diaphanous</i>
Blacknose shiner	<i>Notropis heterolepis</i>
Brook trout	<i>Salvelinus fontinalis</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
Ninespine stickleback	<i>Pungitius pungitius</i>
White sucker	<i>Catostomus commersonii</i>
Yellow perch	<i>Perca flavescens</i>

Source: AMEC, 2006; McCallum Environmental, 2020

Table 2. Marine shellfish species with documented presence on the eastern shore of Nova Scotia.

Marine Shellfish Species	Scientific Name
Soft-shell clam	<i>Mya arenaria</i>
Bar clam	<i>Spisula solidissima</i>
Bay quahaug	<i>Mercenaria mercenaria</i>
Mussel	<i>Mytilus edulis</i> and <i>Modiolusmodiolus</i>
Razor clam	<i>Enis directus</i>
Oyster	<i>Crassostrea virginica</i> and <i>Ostrea edulis</i>
Scallop	<i>Placopecten sp.</i>

Source: Maritimes Provinces Fishery Regulations (SOR/93-55)

2.3.2.1 Special Protections Species

There are no species at risk (SAR) species listed on Schedule 1 of the federal *Species at Risk Act* or critical habitat for those species within the Project Area (DFO aquatic Species at Risk map, accessed Feb 2023); however, there are two species of special conservation concern (SOCC) listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that have the potential to occur within the Site area of influence: Atlantic salmon (*Salmo salar*) and American eel (*Anguilla rostrata*). In addition, brook trout (*Salvelinus fontinalis*) are listed as “sensitive” by the Nova Scotia Department of Natural Resources (NSDNR), though there is a provincial recreational fishery for this species. For further information on each species with conservation protections, see Section 2.4.1.

In the marine environment of Eastern Shore of Nova Scotia there are SAR with the potential to be found in the area, according to the Aquatic Species at Risk map (DFO 2022); however, none of these species are expected to inhabit the nearshore environment of eastern shore Nova Scotia, including Seal Harbour. These marine SAR are listed in Table 3.

Table 3. Marine species at risk (SAR) with range in coastal Nova Scotia.

Species	Scientific Name	Status
Fin Whale	<i>Balaenoptera physalus</i>	Special Concern
Blue Whale	<i>Balaenoptera musculus</i>	Endangered
North Atlantic Right Whale	<i>Eubalaena glacialis</i>	Endangered
Leatherback Sea Turtle	<i>Dermochelys coriacea</i>	Endangered
White Shark	<i>Carcharodon carcharias</i>	Endangered
Northern Wolffish	<i>Anarhichas denticulatus</i>	Threatened

Source: DFO, 2022

2.3.2.2 Invasive Fish Species

The two aquatic invasive alien species in freshwater ecosystems of greatest concern in Nova Scotia are the chain pickerel (*Esox niger*) and smallmouth bass (*Micropterus dolomieu*). Any instances of either of these species must be euthanized and reported to the province. As these species are consumed by humans, and therefore are of interest to the site-specific risk assessment if available as potential catch to recreational fishers in the watershed, if these species are caught during the proposed field program they should be used for tissue specimen.

2.3.2.3 Fish and Shellfish Consumption Advisories

The Nova Scotia Department of Environment and Climate Change has a fish consumption advisory in place province-wide for certain fish species due to mercury levels in fish tissues (NSDECC, n.d).⁵ These species include brook trout, yellow perch, white perch, chain pickerel, and smallmouth bass.

Harvesting of bivalve shellfish, i.e., shellfish with two shells, is closed in Seal Harbour including all clam species, oysters, cockles, mussels and scallops. It is the harvester's responsibility to ensure that an area is designated as safe for harvesting as identified and defined by DFO. DFO provides an online real-time map of openings and closures of Canadian harvesting areas for bivalve shellfish.

2.3.2.4 Regional Fish Tissue Datasets

A review of available data for aquatic species tissue chemistry was conducted to assess the range of concentrations in targeted fish, shellfish and benthic invertebrates from background and contaminated waterbodies of Nova Scotia (NS). Data was obtained from a desktop search of the following sources:

- Academic papers (published and unpublished);
- Project Reports from the Impact Assessment Agency of Canada;
- Project Reports from the Nova Scotia Department of Environment and Climate Change;
- Community and non-profit publications; and
- Open Government of Canada Databases.

Data from these sources were included if they focused on the following criteria:

- Targeted fish species, shellfish, and benthic invertebrates
- Tissue type specified (i.e., wholebody, muscle, etc.)
- As and Hg tissue concentrations with unit of measure provided
- Collected from NS waterbodies
- Data collected in the year 2000 onwards

Province-wide data was collated and tabulated. This dataset and data sources are provided in Appendix D to the draft Updated Phase II ESA report (AECOM 2023). Data specific to the New Harbour/Salmon Watershed was uncovered

⁵ <https://novascotia.ca/nse/fish-consumption-advisory.asp>

for two targeted fish species, and three marine molluscs (including two targeted bivalve species). This data is summarized in Table 4.

Table 4. Gold Brook Lake and waterbodies and Seal Harbour aquatic tissue chemistry data (concentration provided in mg/kg wet weight unless otherwise noted).

Site/Reference	Species	Tissue Type	As	Hg
Gold Brook Lake and waterbodies (freshwater)				
GHC Limited. 2021	Brook trout	Fillet	<0.5-0.55	0.97-0.47
		Wholebody	<0.5-2.4	0.074-0.37
	Yellow perch	Fillet	<0.5	1.1-1.9
		Wholebody	<0.5	0.94-1.6
	Benthic Invertebrates	Composite	<1.1-170	0.06-0.19
Seal Harbour (marine)				
Doe et al. 2017	Blue mussel	Wholebody	4.55-7.85	0.07-0.14
Whaley-Martin et al. 2012. *	Blue mussel	Wholebody	60-109	-
Doe et al. 2017	Soft-shell clam	Wholebody	9.1-259	0.04-0.13
Whaley-Martin et al. 2012. *	Periwinkle	Wholebody	59-840	-

Note: '-' = no data.

* Concentration provided as dry weight, with no organisms moisture content provided.

2.4 Proposed Media and Species for Aquatic Tissues Field Study

Here we outline the rationale for collecting aquatic media for a proposed field program in support of a Site-specific HHERA. Tissue samples will be analysed for metals concentrations including mercury and arsenic, Site COPCs. For discussion of Site COPCs and their behaviour in biotic tissues, see Section 2.2.

Benthic Invertebrates (benthos): infaunal invertebrates (invertebrates living within the substrate) are in direct contact with the river bottom/lake bottom substrate. In the case of the Site, the river substrate may include historic mine tailings. Measuring benthos COC concentrations investigates the pathway of contaminant transfer from abiotic media (porewater and sediment) to biotic media (invertebrates) to inform an understanding of the possibility of contaminant exposure to higher trophic levels feeding on benthos. For the aquatic tissues field program, we recommend the collection of composite (all taxa) samples of benthic macroinvertebrates for tissue metals analysis. Additionally, we recommend paired sediment and porewater sampling for low-level metals chemistry analysis.

Benthic Feeding Fish: fish that feed in, at, or near the river or lake bottom are by definition, benthic feeding. These fish may be prey (smaller/younger individuals) consumed by birds, wildlife or other fish, and/or may be eaten by humans (larger/older individuals). This feeding guild is of particular interest for the HHERA as the Site tailings located on the shore of Gold Brook Lake, Gold Brook and further downstream, are considered to be the primary source of contaminants to the aquatic food web. For the aquatic tissues field program, we recommend the collection of whole body samples from benthic feeding fish for targeted species for chemistry analysis.

Forage Fish: forage fish are prey fish commonly consumed by avifauna, wildlife and other fish. They are fish small in size, on account of species or life stage (juvenile). Forage fish can be found in the pelagic or benthic food web, which impacts relative exposure to abiotic media (water column vs bottom substrate), what they feed on, and what feeds on them. Measuring forage fish COC concentrations will inform an understanding of the possibility of contaminant exposure for higher trophic levels feeding on forage fish (such as piscivorous birds, wildlife and fishes). For the aquatic tissues field program, we recommend the collection of composite (multiple fish) samples of forage fish from the near-shore environment for chemistry analysis.

Sport Fish: sport fish are fish targeted by recreational fishers. Sport fish are usually large-bodied fish, often upper trophic level species, and preferentially consumed by humans. COC exposure and uptake occurs largely through bioaccumulation and food-web transfer. Measuring sport fish COC concentrations will provide an understanding of the contaminant exposure to humans as well as other ecological receptors consuming upper trophic level fish species. For the aquatic tissues field program, we recommend the collection of muscle (fillet) samples from sport fish for targeted species for chemistry analysis.

Marine Shellfish: some species of bivalves living in or on the marine shoreline sediments of Nova Scotia are targeted by recreational fishers. As stated above, COC exposure and uptake occurs largely through bioaccumulation and food-web transfer. Measuring marine bivalves targeted by humans for consumption will provide an understanding of the contaminant exposure to human as well as other ecological receptors consuming infaunal (e.g., clams) or epifaunal (e.g., mussels and oysters) species of shellfish. For the aquatic tissues field program, we recommend the collection of tissue samples (shell removed) for targeted bivalve species for chemistry analysis.

2.4.1 Freshwater Fish Targeted Species

2.4.1.1 Criteria

Criteria for individual fish species inclusion in the proposed aquatic tissues field program includes the following:

- Human Health Risk (benthic feeding fish, sport fish, and marine bivalves)
 - Species consumed by humans
 - Known regional sport fish/bivalve (targeted by recreational fishers in the region)
 - Potential to have high COC tissue concentrations due to close contact with contaminated media (benthic environment), bioaccumulation (long lived species) and biomagnification (species at top of the food chain)
 - Expected to be present in the waterbodies on-site or proximate to Site
 - Upper trophic level invasive species, as lethal sampling is required.
- Ecological Risk (benthic feeding fish and forage fish)
 - Species consumed by piscivorous fish, avifauna and wildlife
 - High site fidelity (residency at capture site for large proportion of life cycle)
 - Situated in benthic food web (close contact with contaminant source)
 - Expected to be present in the waterbodies on-site or proximate to Site
 - Upper trophic level invasive species, as lethal sampling is required.

A selection of fish species identified in the New Harbour/Salmon watershed have been investigated for potential inclusion in the HHERA, based on regional data availability, life history characteristics, and presence proximate to the Site. As discussed above, fish have been loosely divided into three categories: benthic feeders, forage fish, and sport fish. The rationale for collecting (or not collecting) each species is provided below, in Table 5.

Table 5. Summary of proposed target fish species by feeding guild.

Fish Feeding Guild	Target Species	Comment
Benthic Feeding Fish (support ecological and human health risk assessment)	American eel, White sucker	Species are in the benthic foodweb and also happen to be in recreational fishery. Species selected depends on catch numbers and sizes. A range of fish sizes should be collected.
Forage Fish (support ecological risk assessment)	Banded killifish, Golden shiner, Ninespine stickleback, Blacknose shiner	Can collect all species (combined as composite samples). If catch numbers are high, could submit composites as species-specific.
Sport Fish (support human health risk assessment)	Brook trout, Yellow perch Invasive Species: Smallmouth bass, Chain pickerel	Species are targeted in recreational fishery and both species have historical data available for the Watershed. Species selected depends on catch numbers and sizes. Note that invasive species are prime candidates; however, it is not expected as a high catch in New Harbour/Salmon watershed. A range of fish sizes should be collected.

2.4.1.2 Benthic Feeding Fish

American eel (*Anguilla rostrata*): are catadromous, spending the majority of their lives in freshwater and moving to the ocean to spawn. Migrating elvers (juvenile eel) are bottom dwellers and spend most of their time burrowed or hidden, including directly into soft bottom sediments (Tomie, 2011). American eel are frequently found in watercourses that offer structural complexity and shade in the form of coarse woody debris, rocks, in-stream vegetation for daytime cover, and an available food source of forage fish, invertebrates, molluscs and vegetation.

American eel are listed as “threatened” by COSEWIC but are not protected under Schedule 1 of SARA, and, while other maritime provinces do afford this species protections, Nova Scotia does not. Due to this species close contact with bottom substrate and residency in the freshwater system for much of the lifecycle, American eel are recommended as a targeted species for the 2023 field program.

White sucker (*Catostomus commersonii*): are generalist bottom dwellers found in warm, shallow water areas of lakes, rivers, and quiet streams. They feed on the lake/riverbed on worms, clams, insect larvae and occasionally fish eggs (DFO, 2016). White suckers spawn in May-June when they migrate into small streams and tributaries with water temperatures of 10-18°C. Adults leave spawning grounds after a short period of time and return to the river or lake which they originated from (Scott and Crossman 1973). White suckers are known to be able to survive adverse water conditions that other fish species cannot tolerate, and are often used as environmental monitors for toxic chemicals (DFO, 2016). They are not widely targeted by anglers. Brook trout, Atlantic salmon and other piscivores feed on white sucker (DFO, 2016). Due to this species close contact with bottom substrate and residency in the freshwater system for their entire lifecycle, White sucker are recommended as a targeted species for the 2023 field program.

2.4.1.3 Forage Fish

Banded killifish (*Fundulus diaphanous*): are freshwater habitat generalists found within the quiet waters of lakes, ponds, and sluggish streams, tolerating a broad temperature, salinity, and DO range (COSEWIC, 2014). Seasonal movement by the species has not been documented, and it is not considered migratory (COSEWIC, 2014).

Blacknose Shiner (*Notropis heterolepis*): are primarily found in clear, vegetated bays and quiet streams with shallow water and sand or gravel bottoms. Spawning is thought to occur in spring and summer. They feed primarily along the bottom on macroalgae and aquatic vegetation (Scott and Crossman 1973).

Golden Shiner (*Notemigonus crysoleucas*): are schooling habitat generalists, primarily found in well vegetated lakes and extensive shallows (Scott and Crossman 1973). This species forages on plankton, macroalgae, aquatic insects, and sometimes molluscs. It is widely used by anglers as a bait fish.

Ninespine stickleback (*Pungitius pungitius*): are found in both brackish waters and the shallow areas of freshwater lakes and ponds. In rivers and streams, the species is generally found in sluggish, cool pools where there is plenty of aquatic vegetation. Spawning habitat is primarily characterized by shallow depths, low velocity, dense aquatic vegetation, and mud and silt substrates (Scott and Crossman 1973).

2.4.1.4 Sport Fish

Atlantic Salmon (*Salmo salar*): are a species of salmonid divided into unique populations based on genetic distinction and range. The Southern Upland (SU) population occupies rivers of mainland Nova Scotia, including the New Harbour/Salmon watershed (DFO, 2013). The SU Population has experienced significant reductions over recent decades, with present adult abundance declining 88-99% compared to observed abundances in the 1980s (DFO, 2013).

The SU Atlantic salmon population have been assessed as endangered by COSEWIC in 2010 and the Atlantic salmon recreational fishery is closed year-round for retention or catch and release in Nova Scotia Salmon Fishing Region 20 (eastern shore), where the Site is situated (Nova Scotia Ministry of Fisheries and Aquaculture). Atlantic salmon have been detected in the New Harbour/Salmon Watershed in e-DNA samples collected in 2022. However, due to conservation concerns, Atlantic salmon are not recommended as a targeted species for the 2023 field program.

Brook trout (*Salvelinus fontinalis*): are a migratory species of salmonid. In Nova Scotia, mature brook trout migrate to spawn in lakes or streams in the fall of the year. Brook trout spawning sites are usually near groundwater upwelling or spring seeps and within a lake or stream with gravel substrate (NSDNR, n.d.). Typically not anadromous, brook trout require free passage along streams to move between areas of use within a freshwater system, including spawning grounds, overwintering areas, and summer rearing areas. Brook trout feed on aquatic benthic invertebrate (such as mayflies and stoneflies), with adult brook trout also feeding on juvenile fish of their own species or others. Brook trout seldom live longer than 5 years and in Nova Scotia, their average length in brooks and rivers is 25 to 30 cm weighing less than 1 kg (NSDNR, n.d.). Gold Brook and Gold Brook Lake historical chemistry data is available for this species (see Section 2.3.2).

Brook trout are listed as “sensitive” by the Nova Scotia Department of Natural Resources (NSDNR). The open-water recreational fishery (retention with bag limits) is open April 1 – August 30, with a closure September 1-30. This is a sought-after sport fish with documented presence in the New Harbour/Salmon watershed. Therefore, it is recommended as a targeted species for the 2023 field program.

Yellow perch (*Perca flavescens*): are a schooling, shallow water fish that can adapt to a wide variety of warm or cool habitats. Most yellow perch do not appear to migrate, but some do in patterns which tend to be short and local (Brown et al., 2009). Adults and juveniles are found in large lakes, small ponds, or gentle rivers but are most abundant in clear, highly vegetated lakes (1-10 m depth) that have muck, sand, or gravel bottoms (DFO, 2018). Yellow perch directly compete with trout and salmonid species for planktonic food and preys on the juveniles of other fish species (DFO, 2018). Gold Brook and Gold Brook Lake historical chemistry data is available for this species (see Section 2.3.2).

2.4.2 Marine Shellfish Targeted Species

Bivalves with documented occurrence in Seal Harbour and the vicinity are provided in Table 2. Seal Harbour is located within the recreational Clam Harvesting Area (CHA) 5 (Inland and tidal waters of Guysborough County and that portion of Halifax County East of Pennant Point). CHA management includes clams and quahogs. There is no CHA equivalent recreational management area for mussels, scallops or oysters. For these species, harvesting restrictions depend on year and area.

Shellfish species recommended for targeting in the proposed field study to support site-specific HHERA are clam species, quahog and mussels. Historical chemistry data for soft-shell clam (*M. arenaria*), blue mussel (*M. edulis*) and periwinkle (not a bivalve, but a mollusc species) collected in Seal Harbour is available for comparison (see Section 2.3.2).

Scallops are usually found sub-tidally and therefore are not likely to be found in great abundance in the intertidal zone of Seal Harbour; therefore, this bivalve is not recommended for the proposed field program. Oysters from Seal

Harbour are not expected to be consumed by humans in great numbers due to license limits (see Section 2.5.3); therefore, it is not recommended that oysters be targeted as a bivalve species.

2.5 Permitting

2.5.1 Federal

Prior to conducting a fish collection survey, a federal License to Fish Finfish for Scientific Purposes under Section 52 of the fishery regulations in the Maritimes region, issued by Department of Fisheries and Oceans (DFO) is to be obtained. This is required under provisions of the *Fisheries Act*. There is no application fee and the estimated processing time is up to 30 days. Additionally, the license holder must notify DFO before fishing activities commence, as outlined in the license.

If clam or quahog are expected to be collected as targeted shellfish species, a federal recreational harvesting permit may be required. The seasonal license costs \$10 and is issued immediately by DFO.

All field staff must read and understand the conditions of the license and are required to have a hard copy of the license during all fish collection surveys.

2.5.2 Provincial

A provincial fishing license is required for any sampling methods using angling to catch fish (except salmon) in freshwater in Nova Scotia. The seasonal (annual) license is valid from April 1 of the current year to March of the next year. A general fishing license report card is to be submitted within 7 days of the end of the fishing season (August 31). The seasonal license costs \$35 and no processing time.

If any work is to occur on Crown Land, a Letter of Authority is required from the Department of Natural Resources and Renewables prior to the field program.

2.5.3 Management and Enforcement

The management of marine and sea-going (anadromous) Atlantic salmon, striped bass, eel, shad, mackerel, sturgeon, gaspereau, Atlantic whitefish and smelt is the responsibility of the DFO. The Nova Scotia Department of Fisheries and Aquaculture manages all other freshwater fish species. Enforcement falls under the jurisdiction of the DFO and Nova Scotia Environment.

The following size limit and bag restrictions from the Nova Scotia Angler's Handbook are in place for target species mentioned in Section 2.4.1 and 2.4.2:

- American eel: less than 53 cm from nose to tail not permitted to keep and maximum bag limit of 10 fish
- Brook trout and brown trout: maximum bag limit of 5 fish
- Landlocked salmon: minimum size limit not less than 35 cm, maximum size limit greater than 63 cm not permitted to keep; maximum bag limit of 2 fish
- White perch, yellow perch, brown bullhead, and white sucker: maximum bag limit of 25 fish
- Clam spp., quahog, mussel 300 per day; scallops 100 per day

2.6 Critical Timing Windows

The Site is located within the provincial Guysborough County Recreational Fishing Area 2. The 2022 Nova Scotia recreational fishing handbook (2023 edition not yet published) provides fishing regulations for sport fishing in freshwater (NSDFA, 2022); relevant regulations are as follows:

- Recreational fishery open-water season **April 1-September 30** (Nova Scotia Ministry of Fisheries and Aquaculture)
- Brook trout (aka Speckled trout) recreational fishery **closed September 1-30** (Nova Scotia Ministry of Fisheries and Aquaculture)

- Atlantic Salmon recreational fishery **closed year-round**, including catch & release (DFO; Salmon Fishing Area 20 – Eastern Shore)
- Timing window of **June 1 – September 30** to conduct projects in or around water for the province of Nova Scotia (DFO)

3 Aquatic Tissues Field Study

Waterbodies in proximity to the Gold Brook Lake Mine and Seal Harbour Mine (the Site) have known Site-related impacts from historical gold mining (ESA Phase 1 and 2, AECOM 2022). Site-related contaminant sources in the aquatic environment includes mine tailings deposits in Gold Brook Lake, Gold Brook and the marine foreshore in Seal Harbour, all within the New Harbour/Salmon watershed in Nova Scotia.

The purpose of the proposed field study is to collect aquatic tissues for chemistry analysis in samples collected upstream, adjacent and downstream of the Site. This information will inform the Site-specific Human Health and Ecological Risk Assessment (HHERA) by investigating contaminant transfer pathways and uptake of metals, in particular mercury and arsenic, in sediments and the water column into benthic and pelagic aquatic organisms. The following provides the details for a fish and aquatic invertebrate tissue sampling program to be conducted in the impacted waterbodies, with samples submitted to an analytical laboratory for metals analyses.

3.1 Field Program Design

Field sampling locations are provided in Appendix A, Figure 2, Figure 3 (Freshwater), Figure 4, Figure 5 (Marine) and a summary of the field program organized by sampling location and media type is provided in Table 6 and Table 7. Tissue samples will be collected from Gold Brook Lake, Gold Brook and the marine foreshore in Seal Harbour. Media to be collected includes benthic invertebrates, benthic feeding fish, forage fish, sport fish and marine shellfish. Targeted fish species are identified in Table 5.

This field study is exploratory and is not designed to meet statistical significance. Sample locations, media type and sample numbers as outlined are a guideline and are relatively low to allow for multiple media and species to be investigated at a preliminary level while being conscious of budget and numbers of fish sacrificed.

The field program is designed to be flexible, with options for alternative target species, methods for capture, etc., so field crews can pivot with field conditions. The field program as detailed herein should give the field crews the tools and information needed to complete a program that will be successful in meeting the Project objective of collecting aquatic tissues samples for analysis of metals concentrations by analytical laboratories in support of a site-specific HHERA.

Table 6. Field sample number and type organized by location and media.

Location	Media	Sample		
		Type	Number	
Upstream GBL (Control)	Sediment	composite	1	
	benthic invertebrates	composite	1	
	fish	benthic feeding ¹	wholebody	5
		forage ²	composite	3
		sport ³	muscle	5
On-Site (GBL Tailings Area)	sediment	composite	2	
	benthic invertebrates	composite	2	
	fish	benthic feeding ¹	wholebody	5
		forage ²	composite	6
		sport ³	muscle	5
Down Stream 1 (GB Near Field)	sediment	composite	2	
	benthic invertebrates	composite	2	
	fish	forage ²	2	
Down Stream 2 (GB Far Field)	sediment	composite	1	
	benthic invertebrates	composite	1	
	fish	benthic feeding ¹	wholebody	5
		forage ²	composite	3
		sport ³	muscle	5
Seal Harbour	marine bivalves ⁴	composite	2	
Reference 1	marine bivalves ⁴	composite	2	
Reference 2	marine bivalves ⁴	composite	2	
total:			62	

Notes:

GBL = Gold Brook Lake, GB = Gold Brook

¹ Benthic feeding fish target species = American eel. Alternative target species= white sucker.

² Forage fish species = banded killifish, golden shiner, blacknose shiner, ninespine stickleback.

³ Sport fish target species = Brook trout or white perch (choose 1). If invasive species (bass and pickerel) captured, collect muscle sample.

⁴ Bivalve target species = soft-shell clams, bar clams, razor clams, quahogs, mussels (choose 2).

Table 7. Sample summary

Sample #s	n	Field duplicate n
sediment	6	1
benthos	6	-
benthic feeding	15	-
forage	14	-
sport	15	2
bivalves	6	-

3.2 Field Effort & Schedule

The proposed program is planned for spring/summer of 2023 to coincide with the open-water season and least risk window for fish reasonably expected to be present in the watershed. Two field crews, made up of 2-3 people per crew, would conduct the field program primarily from boat, with some work conducted on-shore. To realize efficiencies in mobilization, field crew travel times, and de-mobilization, it is recommended that the program described here for Gold Brook Lake and Seal Harbour Mine Site, and for BNS's sister program Mooseland Mine Site, be organized so the two programs occur consecutively. From a technical/scientific study design perspective, there is no preference as to which program occurs first.

3.2.1 Field Preparation

3.2.1.1 Permitting

- Apply for DFO License to Fish Finfish for Scientific Purposes under Section 52 of the fishery regulations in the Maritimes region. This is required under provisions of the *Fisheries Act*. There is no application fee and the estimated processing time is up to 30 days.
- If angling is anticipated as a form of fishing effort, apply for a provincial recreational fishing license. The seasonal (annual) license is valid from April 1 of the current year to March of the next year. A general fishing license report card is to be submitted within 7 days of the end of the fishing season (August 31). The seasonal license costs \$35 and is issued immediately.
- If clams or quahog are expected to be collected as targeted shellfish species, a federal recreational harvesting permit may be required. The seasonal license costs \$10 and is issued immediately by DFO.
- As the work is occurring on Crown Land, submit a request for a Letter of Authority from the Department of Natural Resources and Renewables prior to the field program.

3.2.1.1.1 Additional Requirements

Tagged Fish: Some species of fish (trout, smallmouth bass and Atlantic) have provincial tagging programs in place. If captured fish are observed to have a tag, the provincial government has a reporting framework that should be adhered to.

Invasive Species: if smallmouth bass or chain pickerel are captured, the provincial government has a reporting framework that should be adhered to.

Reporting requirements for tagged and invasive fish are provided in the provincial angling handbook (NSDFA, 2022).

3.2.1.2 Documents in Support of Field Program

- Preparation of an AECOM H&S plan and any BNS H&S requirements. See Section 3.5.
- Preparation of field maps and GPS coordinates loaded into field devices.
- Preparation of field data sheets (supplemental data, fish data, benthic invertebrate data [with porewater and sediment])

3.2.1.3 Field Gear Mobilization

There are potentially extensive gear needs for this program. Fishing and field equipment will need organizing in advance to determine if any repairs, purchases or rentals are required.

If the field crew is traveling by air, the fishing gear will require advance shipping to Site. Alternatively, if the field crew travel by land, field gear can travel with the crew to the Site so long as the vehicle(s) can accommodate. At this time, it is anticipated that the field crew would travel by land.

3.2.1.4 Analytical Laboratory

Coordinate with analytical laboratory for

- Data quality objectives (DQOs),
- Sampling containers and preservatives (if needed),
- Sample labelling,

- Sample storage/ shipping, and
- Chain of custody procedures

3.2.2 Field Program

The expected level of effort for each of the two field crews is 6-days (including travel) plus 1-day contingency, depending on the abundance of fish and conditions, with a breakdown provided below.

Note, the field crew must notify DFO before fishing activities commence, as outlined in the Fish Finfish for Scientific Purposes license. All field staff must read and understand the conditions of the license(s) and are required to have a hard copy of the license(s) during all fish/shellfish collection surveys.

Field Crew 1 (Sport fish and benthic feeding fish): This is a proposed schedule only and is subject to change.

- Day 1: Travel Day, gear mobilization, H&S briefing.
- Day 2: H&S tailgate, field reconnaissance to explore species of fish present and suitable gear types. Possible gear types include angling, gill netting, minnow trapping, Alaska traps, fyke netting, eel pots, beach seining, grab sampling, etc. Note that the lotic waterbodies may be relatively small/shallow/slow moving, as compared to the Mooseland Site.
- Day 3: H&S tailgate, depending on the outcome of reconnaissance, set gear and/or begin angling at a sampling location. If gear needs monitoring, stay on-site and while waiting to retrieve, angle or assist Field crew #2 (recommended that Field Crew #1 focus Day 3 efforts as same sampling location that Field Crew #2 will be collecting benthic invertebrates from). Throughout day, check gear and process fish as necessary. Could set up fish hold (Rubbermaid totes with aeration, in shade) and batch process fish (this may also be beneficial if target fish species not yet chosen), being cognizant that separating species may be necessary to prevent predation within the hold. Note that fish processing must occur on-shore/solid ground for accurate weight measurements.
- Day 4: H&S tailgate, depending on the outcome of Day 3, set gear and/or begin angling at the same or next sampling location. If gear needs monitoring, stay on-site and angle or assist Field crew #2 (recommended that Field Crew #1 focus Day 4 efforts as same sampling location that Field Crew #2 will be collecting benthic invertebrates from). Throughout day, check gear and process fish as necessary. Could set up fish hold and batch process fish.
- Day 5: H&S tailgate, depending on the outcome of Day 4, set gear and/or begin angling at a same or next sampling location. Try new fishing techniques if needed. If gear needs monitoring, stay on-site and angle or assist Field crew #2 (recommended that Field Crew #1 focus Day 5 efforts as same sampling location that Field Crew #2 will be collecting benthic invertebrates from). Throughout day, check gear and process fish as necessary. Could set up fish hold and batch process fish.
- Day 6: Shellfish sampling (work together with Field Crew 2).
- Day 7: Contingency (weather day or additional sample collection time).
- Day 8: Travel Day, gear de-mobilization.

Field Crew 2 (Forage fish, benthic invertebrates, sediment, and marine shellfish): This is a proposed schedule only and is subject to change. *note that benthos & forage fish team should work from area of least contamination to most contamination. *Clean hands/Dirty hands* procedures will need to be developed (similar to that described in USEPA Method 1669 (USEPA 1996)) and followed by Field Crew 2 for sediment sampling.

- Day 1: Travel Day, gear mobilization, H&S briefing.
- Day 2: H&S tailgate, field reconnaissance to explore species of fish present and suitable gear types. Possible gear types include angling, gill netting, minnow trapping, fyke netting, eel pots, beach seining, kicknetting, grab sampling, etc.
- Day 3: H&S tailgate, AM Set minnow traps in all three sampling locations (by boat), mid-day benthos sampling. PM minnow trap retrieval and fish processing.

- Day 4: H&S tailgate, AM Set minnow traps (if necessary), mid-day benthos sampling, PM minnow trap retrieval and fish processing. If no minnow trapping (samples collected day 1) then duration of day spent benthos sampling. If at the end of Day 4 have not collected all forage fish samples, leave minnow traps in to soak overnight.
- Day 5: H&S tailgate, collect overnight minnow traps (if set) and process forage fish. Remainder of day's activities TBD depending on status of sample collection for forage fish and benthos.
 - If forage fish samples still outstanding, try alternative sampling methods (beach seine or backpack electrofishing).
 - If benthos samples still outstanding continue to collect.
- Day 6: Shellfish sampling (work together with Field Crew 1).
- Day 7: Contingency (weather day or additional sample collection time)
- Day 8: Travel Day, gear de-mobilization, sample confirmations and shipment

3.3 Field Methods

Standard operating procedures are provided for the proposed program in Appendix C. Below is a summary of field procedures.

3.3.1 Data Collection, Sample Handling & Volume Requirements

Field Collection:

- Supplemental data collection: location (name and UTM), date/time, field crew, water quality parameters; environmental conditions (temperature, cloud cover, wind, wave, precipitation); fishing method, effort, catch; sediment characteristics (colour, grain size, odor, organics).
- Tissue data collection: Fish (sample ID, species, length, weight, DELTs, tissue type [WB/muscle/composite]), Benthic Invertebrates (sample ID, number of grabs, grain size, odor, organics, notable invertebrates [taxa/prevalence])
- Sample collection/labelling/storage/shipping

Laboratory Analysis:

- Total metals (including arsenic)
- Total mercury
- Moisture %
- Total methylmercury (for archive)
- Arsenic speciation (for archive)
- Fish age (for archive)

3.3.1.1 Sample Processing and Volume

3.3.1.1.1 Chemistry

Tissue and sediment chemistry analysis will be conducted by CALA certified laboratory. Preliminary lab quotes from ALS and Bureau Veritas for total metals including arsenic, mercury, and methylmercury analysis in tissues as well as Brooks Applied Labs (BAL; located in the USA) for arsenic speciation analysis are provided in Appendix B.

The following information is summarized from information provided by ALS for tissue weight requirements. Tissue weight requirements for analyses may be an important field planning consideration, as achieving minimum weight, especially for benthic invertebrates, may be time consuming.

- For routine tissue digestion and extraction, the laboratory recommended wet weight (ww) requirement for tissue analyses is **5 g ww** for metals (including mercury) and **5g ww** for methylmercury.

- For micro tissue digestion and extraction, the laboratory recommended wet weight (ww) requirement for tissue analyses is **2 g ww** for metals (including mercury) and **0.5g ww** for methylmercury.
- Comparing micro digestion against routine digestion:
 - the limits of reporting (LOR) for arsenic and lead increase slightly but there is no change for mercury or methylmercury.
 - the cost per sample differs by only \$10 (< 10 %)
- Arsenic speciation analysis (conducted by BAL) will require sample wet weight of **10 g ww**. These samples can be archived for analysis at a later date.

3.3.1.1.2 Fish Age

AECOM maintains an in-house fish aging laboratory out of Quebec, with capacity to age fin, scale and otolith structures, at an approximate rate of one structure per hour. Age structures can be archived for analysis at a later date.

3.3.2 Benthic Invertebrate Tissue

Benthic invertebrate sampling (with paired sediment and porewater sampling) will be conducted as follows:

- Collect bulk samples of macro invertebrates from each sampling locations (Appendix A, Figure 2, 3; Table 6)
- Samples will be collected by bulk-grab sampler (petit-ponar or the like).
- Grab sampler can be deployed from boat or shore. If on-shore, shovel will work just as well. Method, location (i.e., on-shore or near-shore), and sample depth (i.e., top 20 cm) should be standardized across sampling sites.
- As collected, sediment should be placed in sieve tray, bucket or bag with 500µm mesh size, and sieved using lake/river water.
- Once sieved down, macro invertebrates can be picked out by hand/forceps and collected into lab-supplied sample container. Do not wash invertebrates.
- One (1) composite sample will be collected from each location (likely requiring multiple grab samples to achieve sample volume requirements).
- Collect a sediment sample from each benthic sampling area:
 - Place contents of a grab/shovel full into a bowl (same depth as benthos). Homogenize. Place in sampling container(s) and follow laboratory procedure for headspace/preservative/hold temperature.
- Sample volume requirements for tissue chemistry and sediment chemistry provided in Section 3.3.1
- Sample processing and shipping requirements to be verified by the analytical laboratory

3.3.3 Forage Fish Tissue

Forage fish (small-bodied fish consumed by piscivorous birds, wildlife and other fish) tissue sampling will be conducted as follows:

- Collect composite (>1 fish/sample) samples of whole body fish from each sampling location (Appendix A, Figure 2, 3; Table 6). Samples made up of multiple fish and may or may not be from multiple species.
 - If fish are captured in abundance, separate by species and submit species-specific forage fish composite samples to the lab.
- Use baited G-minnow traps/fyke nets/Alaska traps and/or electrofishing and/or beach seine to collect forage fish.
- Samples may be submitted as whole fish, possibly as composite (multiple fish per sample) to achieve required sample volume. Do not fillet.
- For all fish caught, record species, weight and fork length, and external health assessment for DELTs (deformities, erosions, lesions, tumours). Alternatively, batch weigh, and record fork length of representative individuals, if fish catch numbers are high.

- Do not fillet. Fish are to be submitted as whole fish.
- Sample volume requirements for tissue chemistry and sediment chemistry provided in Section 3.3.1
- Sample processing and shipping requirements to be verified by the analytical laboratory

3.3.4 Benthic Feeding Fish and Sport Fish Tissue

Sampling of targeted species of benthic feeding fish and sport fish (large-bodied fish) will be conducted as follows:

- Collect fillet (muscle) samples for targeted fish species for benthic feeding fish and sport fish from each sampling location (Appendix A, Figure 2, 3; Table 6).
- Use angling, gill nets, eel pots, fyke nets/Alaska traps and/or electrofishing to capture large-bodied fish
 - Fishing gear/method to be determined based on Site reconnaissance (see Section 3.2.1).
- Record species, weight and fork length, and external health assessment for DELTs (deformities, erosions, lesions, tumours) of individual sport fish collected. This includes bycatch (non-target) species that are not retained for sampling. Take pictures of representative fish for each species.
 - Any non-target fish should be released back to the waterbody they were captured from.
- Collect muscle sample from the area anterior to the dorsal fin, with skin and bone removed
- Collect age structure
- Sample volume requirements for tissue chemistry and sediment chemistry provided in Section 3.3.1
- Sample processing and shipping requirements to be verified by the analytical laboratory

3.3.4.1 Invasive species and tagged fish

Tagged Fish: Some species of fish (trout, smallmouth bass and Atlantic) have provincial tagging programs in place. If captured fish are observed to have a tag, the provincial government has a reporting framework that should be adhered to.

Invasive Species: If smallmouth bass or chain pickerel are captured, euthanize and report to the provincial government. Collect a muscle sample from the invasives for the BNS program.

Reporting requirements for tagged and invasive fish are provided in the provincial angling handbook (NSDFA, 2022).

3.3.5 Marine Shellfish Tissue

Marine shellfish samples will be collected from the Seal Harbour foreshore, in the intertidal zone. The work will entail the following:

- Collect shellfish from three (3) sampling locations, two of which are reference locations, as shown in Figure 3,4,5.
- Samples will be collected by hand picking.
- Individual bivalves should be shucked (tissue separated from the shell) and tissue retained as a composite sample.
- One (1) composite sample will be collected from each location.
- Sample volume requirements for tissue chemistry and sediment chemistry provided in Section 3.3.1.
- Sample processing and shipping requirements to be verified by the analytical laboratory.

3.4 Quality Assurance and Quality Control (QA/QC)

Quality Assurance (QA) for the field program comprises the practices employed (e.g., use of experienced field staff, use of standard sampling procedures, and using of field data sheets) to collect scientifically defensible samples meeting pre-defined data quality objectives (DQOs). Quality Control (QC) are measures taken to verify that the specific DQOs (e.g., limits for bias and precision) are met. Combined, these elements help ensure that data collected are representative of the material or populations being sampled, are of known quality, have sufficient laboratory precision to be highly repeatable, are properly documented, and are scientifically defensible.

3.4.1 Field

The Site aquatic tissues field program QA/QC program requires that field samples will be collected in accordance with standard methods and best practices, and in accordance with analytical laboratory requirements. QA for the Gold Brook Lake Mine and Seal Harbour Mine Site aquatic tissues field program will include these items:

- Specific work instructions and established technical protocols for all field crew including:
 - Staffing program with appropriately qualified and trained personnel for sample collection
 - This may include program-specific training
 - Hosting pre-field meetings
 - Use of standard operating procedures (SOPs) for field sampling
 - Use of equipment decontamination procedures
 - Use of equipment appropriate to the task that allow for accurate and precise measurements/sample collection
 - Use of laboratory Chain of Custody (CofC) forms
- Specific work instructions and established protocols for data management, analysis and reporting, and senior review at appropriate milestones.

Field QC samples will consist of collecting field duplicates for sport fish (opposite fillet) and sediment for laboratory analysis at a rate of approximately 10% (1 in 10 samples collected in duplicate). DQOs for field duplicate is a Relative Percent Difference (RPD) between original and duplicate sample of <40% when concentrations are higher than 10x method detection limit (MDL); this applies to all sample types (i.e., fish tissue or invertebrate tissue). RPD values are calculated by comparing the original result to the duplicate sample. The equation used to calculate an RPD is:

$$RPD = (A - B) / ((A + B) / 2) \times 100$$

where: A = analytical result; B = duplicate result.

RPD values may be either positive or negative, and ideally should provide a mix of the two, clustered around zero. RPDs are not calculated for cases where one of the samples (i.e., either A or B in equation above) is below detection and the other is not. The duplicate sample can be plus or minus up to X% (X being the pre-determined DQO) of the original concentration and be 'acceptable', recognizing several factors including but not limited to sample heterogeneity, variance and precision of the instrumentation, calibration and user / operator variability (CCME 2016).

3.4.2 Analytical Laboratory

For quality assurance, the Gold Brook Lake Mine and Seal Harbour Mine Site Project will use CALA accredited laboratories to provide analytical services for tissue chemistry analyses. CALA accredited laboratories have their own specific QAQC procedures. Generic QC checks used to assess laboratory data quality is provided below for reference:

- Detection Limits (DL) – changes to DLs may be needed when the planned DLs are unattainable (e.g., due to low signal/noise ratios or variable replicate recoveries); while these changes can lead to unusable data, the modified DLs are often still acceptable and would not affect the utility of the data.
- Laboratory Duplicates –test reproducibility of laboratory results. DQOs were used to assess RPDs; for most parameters the DQO is an RPD of less than X% between duplicate samples.
- Method blanks (MB) – test for false positives. The MBs should meet the DQO of less than the DL.
- Laboratory Control Samples (LCS) / Certified Reference Material (CRM) / Internal Reference Material (IRM) – test for accuracy of the method against known standards.

3.5 Health and Safety

AECOM is committed to providing safe and healthy workplaces for AECOM employees and associated subcontractors. To do this, we focus on minimizing incidents and injuries, complying with all Occupational Health and Safety and environmental legislation, and reducing our impact on the environment.

Specific to this assignment, AECOM will:

- Prepare a Safe Work Plan including a site-specific risk assessment process that includes an overview of the tasks to be performed, the risks, and associated standard operating procedures applicable to the project (it must be stressed that the HASP is a “living” document, and is to be updated throughout the course of the works should circumstances dictate).
- AECOM employees will follow the Toxic and Hazardous Substances procedure (*S3AM-110-PR1*) developed by AECOM when working on a contaminated site (mercury, lead, arsenic), including specific exposure limit and action level for specified contaminant.
- Complete all relevant training prior to starting field work as required by AECOM. A systematic review of necessary training will be conducted to ensure field staff are adequately trained to conduct the field work as described.
- Conduct all fieldwork in accordance with AECOM SOPs. Have all AECOM team members and associated subcontractors review SOP documents specific to the tasks to be performed, including, but not limited to:
 - Boating safe work practices
 - Working on and near water
 - Toxic and hazardous substances
 - Remote work
 - Wildlife, plants, and insects
- Conduct regular health and safety meetings and site briefings prior to, and during, the proposed program.
- Empower all project team members to provide instruction to stop work, reassess risks, and control measures should conditions dictate.

4 References

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Appendix A Figures



Legend

- PHASE II ESA - STUDY AREA
- APPROXIMATE PROPERTY BOUNDARY
- WATERCOURSE

REFERENCE
NS Property Record Database, CanVec, Esri World Imagery



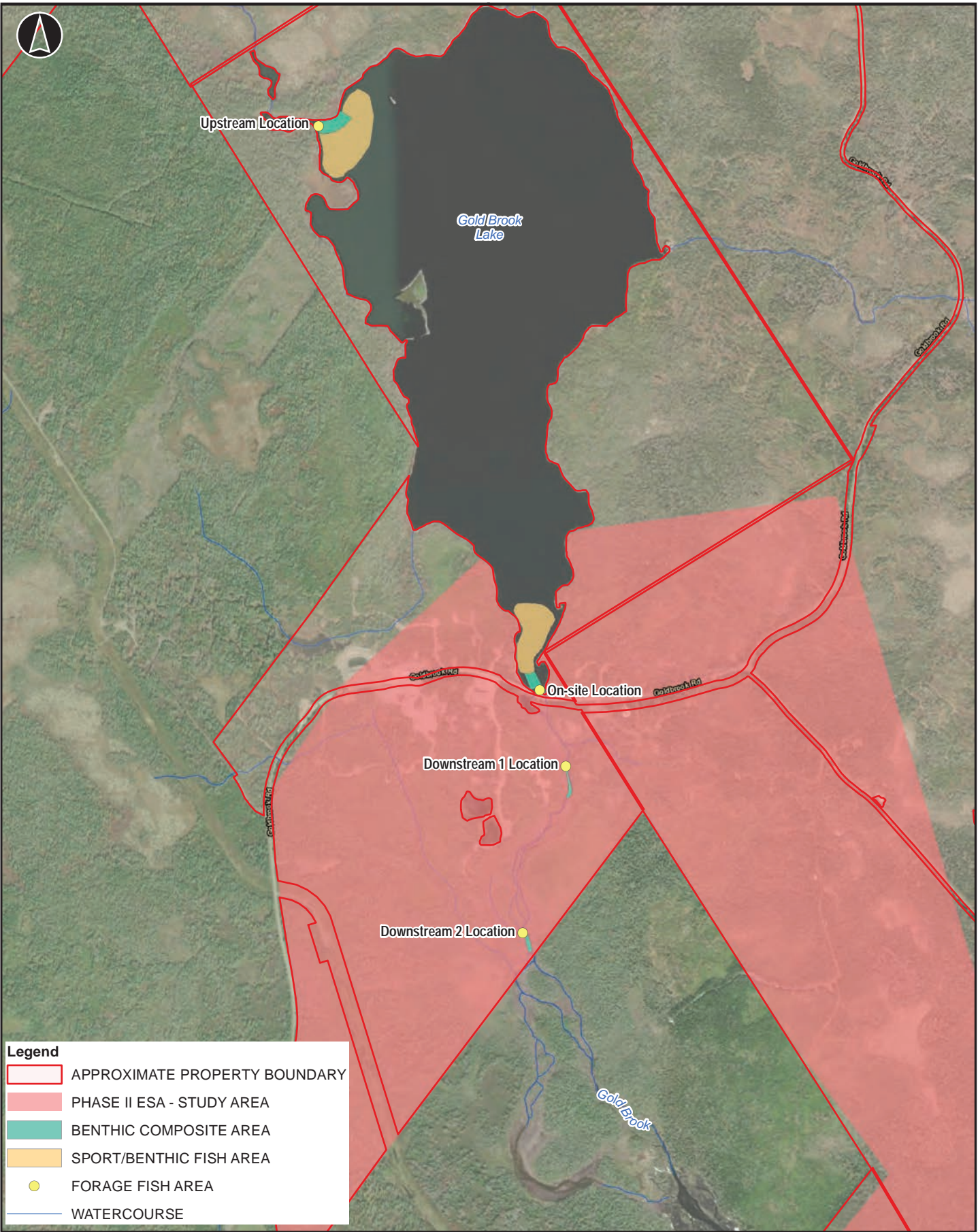
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GENERAL SITE MAP

CLIENT NAME: NOVA SCOTIA LANDS INC.		PROJECT LOCATION: GOLD BROOK LAKE AND SEAL HARBOUR MINE SITES		DRAWN BY: PC	SCALE: 1:50,000	FIGURE No. 1
				CHECKED BY: KM	DATE: 2023-03-28	PROJECT NO: 60680068

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Legend

- APPROXIMATE PROPERTY BOUNDARY
- PHASE II ESA - STUDY AREA
- BENTHIC COMPOSITE AREA
- SPORT/BENTHIC FISH AREA
- FORAGE FISH AREA
- WATERCOURSE

REFERENCE
NS Property Record Database, CanVec, Esri World Imagery



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**AQUATIC TISSUES FIELD PROGRAM
SAMPLING LOCATIONS**

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NOVA SCOTIA LANDS INC.

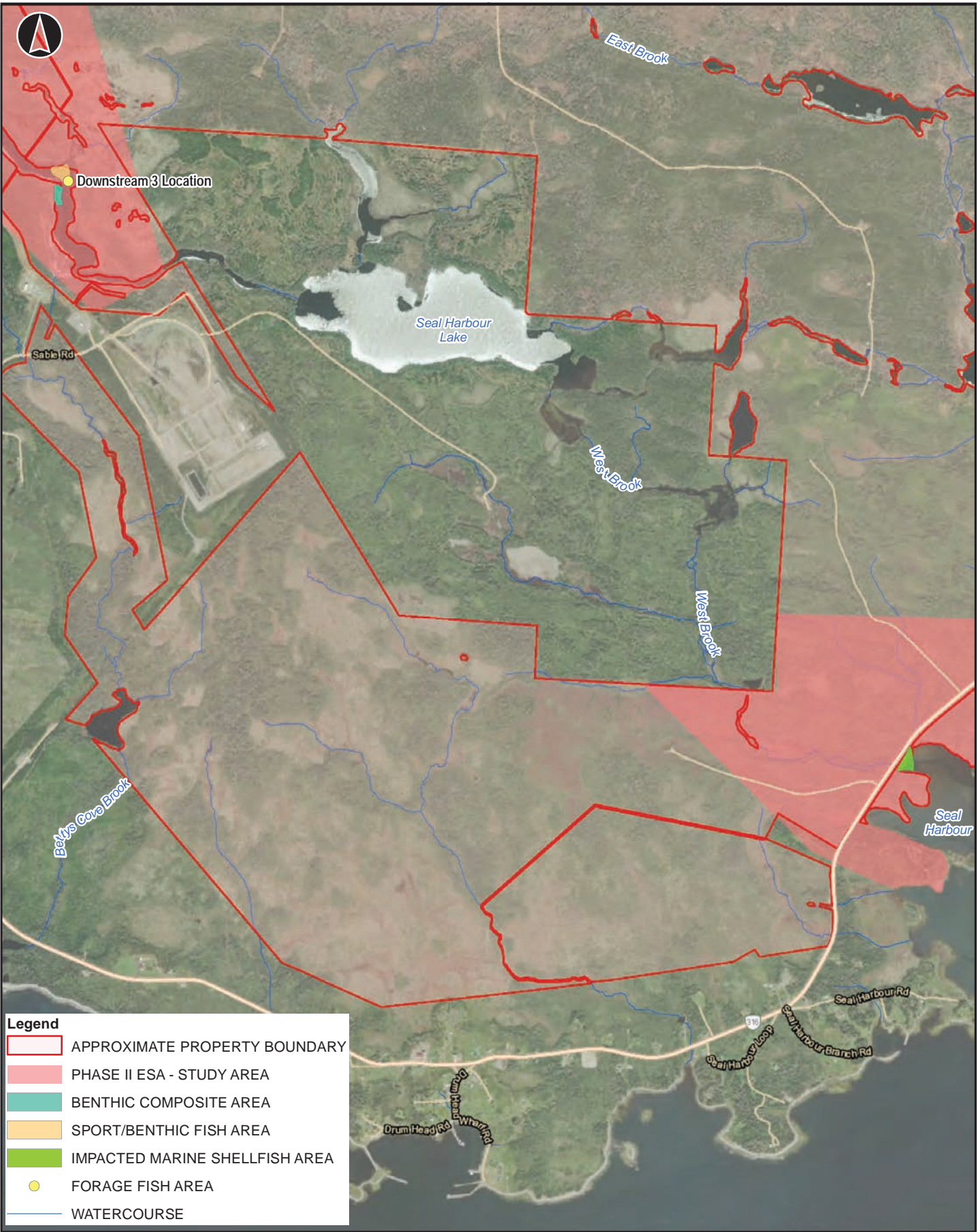
PROJECT LOCATION:
GOLD BROOK LAKE AND
SEAL HARBOUR MINE SITES

DRAWN BY: PC
CHECKED BY: KM

SCALE: 1:13,000
DATE: 2023-03-28

FIGURE No. 2
PROJECT NO: 60680068

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Legend

- APPROXIMATE PROPERTY BOUNDARY
- PHASE II ESA - STUDY AREA
- BENTHIC COMPOSITE AREA
- SPORT/BENTHIC FISH AREA
- IMPACTED MARINE SHELLFISH AREA
- FORAGE FISH AREA
- WATERCOURSE

REFERENCE

NS Property Record Database, CanVec, Esri World Imagery



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**AQUATIC TISSUES FIELD PROGRAM
SAMPLING LOCATIONS**

CLIENT NAME:
NOVA SCOTIA LANDS INC.

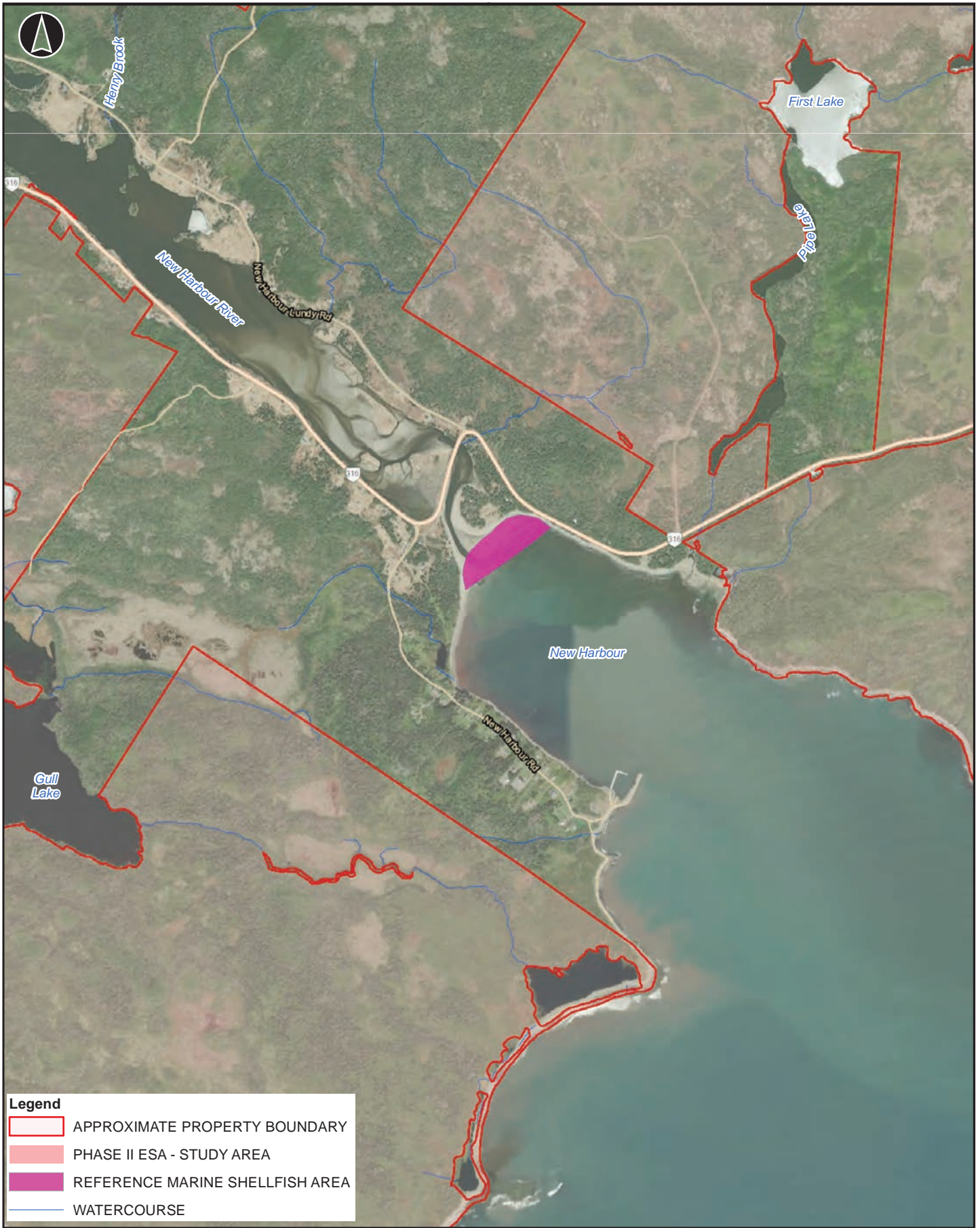
PROJECT LOCATION:
GOLD BROOK LAKE AND
SEAL HARBOUR MINE SITES

DRAWN BY: PC
CHECKED BY: KM

SCALE: 1:20,000
DATE: 2023-03-28

FIGURE No. 3
PROJECT NO: 60680068

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Legend

- APPROXIMATE PROPERTY BOUNDARY
- PHASE II ESA - STUDY AREA
- REFERENCE MARINE SHELLFISH AREA
- WATERCOURSE

REFERENCE
NS Property Record Database, CanVec, Esri World Imagery



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**AQUATIC TISSUES FIELD PROGRAM
SAMPLING LOCATIONS**

CLIENT NAME: NOVA SCOTIA LANDS INC.	PROJECT LOCATION: GOLD BROOK LAKE AND SEAL HARBOUR MINE SITES	DRAWN BY: PC CHECKED BY: KM	SCALE: 1:20,000 DATE: 2023-03-28	FIGURE No. 4 PROJECT NO: 60680068
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Country Harbour

Legend

- REFERENCE MARINE SHELLFISH AREA
- WATERCOURSE

REFERENCE
NS Property Record Database, CanVec, Esri World Imagery



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**AQUATIC TISSUES FIELD PROGRAM
SAMPLING LOCATIONS**

CLIENT NAME:
NOVA SCOTIA LANDS INC.

PROJECT LOCATION:
GOLD BROOK LAKE AND
SEAL HARBOUR MINE SITES

DRAWN BY: PC
CHECKED BY: KM

SCALE: 1:6,000
DATE: 2023-03-30

FIGURE No. 5
PROJECT NO: 60680068

Appendix B Laboratory Quotes

ALS Vancouver Tissue Analysis Details

Tissue Preparation and Analysis	Routine Tissue Digestion/Extraction Metals			Micro Tissue Digestion Metals			Biopsy Tissue Digestion Metals		
	LOR mg/kg dry wt	LOR mg/kg wet wt	ALS List Pricing	LOR mg/kg dry wt	LOR mg/kg wet wt	ALS List Pricing	LOR mg/kg dry wt	LOR mg/kg wet wt	ALS List Pricing
Sample Preparation									
Sample Dissection	-	-	\$125/hour	-	-	\$125/hour	-	-	-
Sample Homogenization	-	-	Included ¹	-	-	Included ¹	-	-	-
Sample Digestion²									
Routine Tissue Digestion	-	-	\$20.00	-	-	-	-	-	-
Micro & Biopsy Tissue Digestion	-	-	-	-	-	\$50.00	-	-	\$50.00
Moisture Content & Lipids									
Moisture	-	0.5%	\$5.00	-	2%	\$5.00	-	2%	\$5.00
Lipids	-	0.5% wwt	\$30.00	-	-	\$30.00	-	-	-
Metals Analysis									
Metals Package									
Aluminum	2	0.4	\$165.00	5	1	\$175.00	5	1	\$175.00
Antimony	0.01	0.002		0.01	0.002		0.02	0.004	
Arsenic	0.02	0.004		0.03	0.006		0.05	0.01	
Barium	0.05	0.01		0.05	0.01		0.05	0.01	
Beryllium	0.01	0.002		0.01	0.002		0.01	0.002	
Bismuth	0.01	0.002		0.01	0.002		0.01	0.002	
Boron	1	0.2		1	0.2		1	0.2	
Cadmium	0.005	0.001		0.01	0.002		0.01	0.002	
Calcium	20	4		20	4		20	4	
Cesium	0.005	0.001		0.005	0.001		0.005	0.001	
Chromium	0.05	0.01		0.2	0.04		0.2	0.04	
Cobalt	0.02	0.004		0.02	0.004		0.02	0.004	
Copper	0.1	0.02		0.2	0.04		0.2	0.04	
Iron	3	0.6		5	1		5	1	
Lead	0.02	0.004		0.05	0.01		0.05	0.01	
Lithium	0.5	0.1		0.5	0.1		0.5	0.1	
Magnesium	2	0.4		2	0.4		2	0.4	
Manganese	0.05	0.01		0.05	0.01		0.05	0.01	
Molybdenum	0.02	0.004		0.04	0.008		0.04	0.008	
Nickel	0.2	0.04		0.2	0.04		0.2	0.04	
Phosphorus	10	2		10	2		20	4	
Potassium	20	4		20	4		20	4	
Rubidium	0.05	0.01		0.05	0.01		0.05	0.01	
Selenium	0.05	0.01		0.1	0.02		0.1	0.02	
Sodium	20	4		20	4		20	4	
Strontium	0.05	0.01		0.1	0.02		0.1	0.02	
Tellurium	0.02	0.004		0.02	0.004		0.02	0.004	
Thallium	0.002	0.0004		0.002	0.0004		0.002	0.0004	
Tin	0.1	0.02	0.1	0.02	0.1	0.02			
Uranium	0.002	0.0004	0.002	0.0004	0.002	0.0004			
Vanadium	0.1	0.02	0.1	0.02	0.1	0.02			
Zinc	0.5	0.1	1	0.2	1	0.2			
Zirconium	0.2	0.04	0.2	0.04	0.2	0.04			
Additional Metals									
Mercury ⁵	0.005	0.001	\$20.00	0.005	0.001	\$20.00	0.01	0.002	\$20.00
Silver ^{3,6}	0.005	0.001	\$50.00	0.005	0.001	\$70.00	0.005	0.001	\$70.00
Titanium ^{4,6}	0.25	0.05	\$50.00	0.5	0.1	\$70.00	0.5	0.1	\$70.00
Sulfur ^{5,6}	100	20	Contact ALS	100	20	Contact ALS	100	20	Contact ALS
Thorium ^{5,6}	0.03	0.006		0.03	0.006		0.1	0.02	
Methyl Mercury ⁷	0.005	0.001	\$250.00	0.005	0.001	\$250.00	-	-	-
Notes									
Please note that the Limits of Reporting listed above are subject to change due to interferences that may be present within a submitted sample.									
1. Sample Homogenization costs are included with the tissue digestion/extraction price, with the exception of large volume samples (i.e. >300 grams of sample submitted). In these cases, homogenization costs will be billed at \$125.00/hour.									
2. Please note that the required tissue digestion will depend on the weight of sample submitted and available for analysis. Refer to the ALS Minimum Recommended Submission Weight for each digestion. The appropriate digestion price will apply.									
3. Silver is not part of the metals packages listed above. If Silver analysis is required, it must be requested separately and may require the submission of additional sample volume if the concentration is high (solubility/stability issues). Add additional charge for silver.									
4. Titanium is not part of the metals packages listed above. If Titanium analysis is required, please contact the lab for further details. Mechanical homogenization equipment contains titanium blades, therefore manual homogenization is required which can result in less precision. Add additional charge for titanium.									
5. Sulfur & Thorium are not part of the metals packages listed above. If Sulfur and/or Thorium analysis are required, they must be requested separately.									
6. Mercury, Titanium, Sulfur & Thorium can be analyzed from the same digestion as the Metals Package. Silver may also be analysed from the same digestion, but will depend on the concentration of Silver present in the sample.									
7. Methyl Mercury requires a separate digestion and analysis.									

Sample Weight Requirements for Tissue Analysis

Analysis ¹⁰	Routine Digestion/Extraction ¹			Micro Digestion ²			Biopsy Digestion ³	
	Minimum Sample Weight Required for Digestion ⁵ g (dry)	Minimum Sample Weight Required for Digestion ^{4,5} g (wet)	Minimum Recommended Submission Weight ^{6,7} g (wet)	Minimum Sample Weight Required for Digestion ⁵ g (dry)	Minimum Sample Weight Required for Digestion ^{4,5} g (wet)	Minimum Recommended Submission Weight ^{6,7} g (wet)	Minimum Sample Weight Required for Digestion ⁵ g (dry)	Minimum Sample Weight Required for Digestion ^{4,5,8} g (wet)
Trace Metals								
Moisture Content	---	0.5	5	---	0.5 - 1	2	---	0.05
Metals Scan (CCMS)	0.1	0.5		0.04	0.2		0.01	0.05
Mercury								
Methyl Mercury	0.4	1	5	0.04	0.1	0.5	NA	NA
Trace Organics								
Lipid Content	---	2	10	---	---	---	NA	NA
PAH ⁹	1	5	10	---	---	---	NA	NA
Notes								
NA = Not Available								
1. Routine Digestion: These digestion and analysis procedures are used for the majority of tissue samples submitted for analysis, and provide lower Limits of Reporting for some metals.								
2. Micro Digestion: These digestion and analysis procedures are designed for the analysis of low weight samples, and are used for samples where less than 0.5 g wet (or 0.1 g dry) is available for the digestion.								
3. Biopsy Digestion: These digestion and analysis procedures are designed for the analysis of biopsy plugs, or very low weight samples. Laboratory Replicates and any re-digestions of the original sample cannot be carried out on biopsy samples. Limits of Reporting will be adjusted accordingly for sample weights lower than 0.05 g wet (or 0.01 g dry).								
4. The wet sample weights listed in the table above are based on a typical tissue moisture content of 80%. If the submitted samples contain, or are suspected to contain, >80% moisture, then additional sample weight will be required to meet quoted Limits of Reporting.								
5. The sample weights listed for analysis are for one single digestion and/or analysis, and do not include additional sample weight required for Lab Replicates, or potential re-analyses, homogenization losses, container transfer losses, or potential freeze/thaw losses. Homogenization losses vary, but in general are typically 20%, but depend on the nature of the sample, the sample weight, and the type of homogenization equipment used.								
6. It is recommended that more than the minimum required sample weight be submitted for analysis to account for the factors identified in Note 5 above.								
7. In cases where less than the Minimum Recommended Submission Weights are submitted for analysis, ALS will contact the client and discuss various options for analysis.								
8. It is recommended that Biopsy sample results be reported on a dry weight basis only as the wet weight of the sample during analysis may not be representative of the wet weight when sampled, due to drying. If Moisture Content analysis is required, it can be performed by drying the sample in the digestion tube at <60°C prior to digestion.								
9. Selected Organic parameter analyses can be combined for sample extraction and analysis. Please contact ALS to discuss your specific analytical requirements prior to sampling.								
10. Additional analysis methods are available, please contact ALS to discuss your specific analytical requirements.								