

REPORT

**2021 Marine Fish and Fish Habitat Studies In Steensby
Port Area**

Field Summary Report

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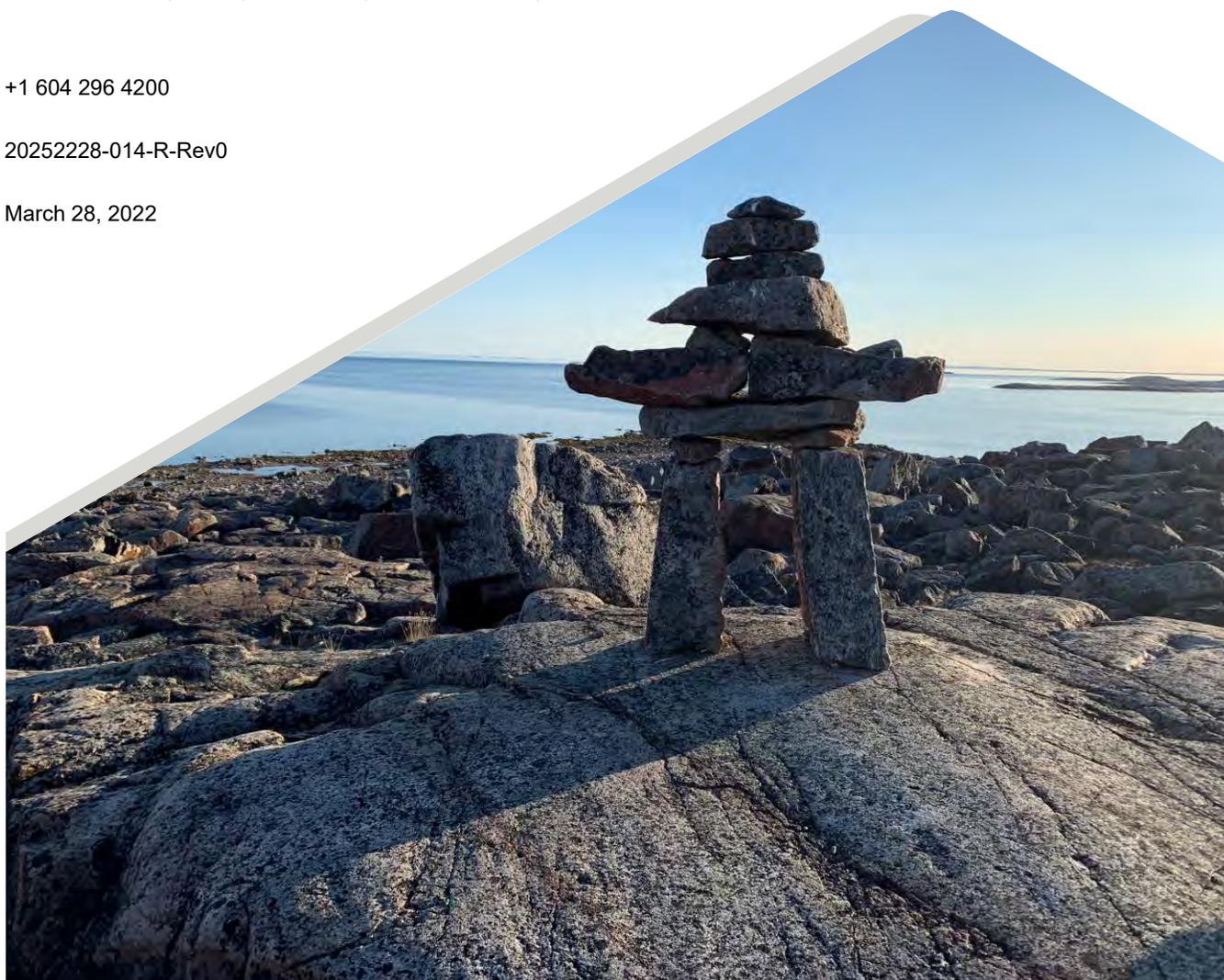
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1.0 INTRODUCTION

Nuqsana Golder Engineering and Environmental Consulting Inc. (Nuqsana Golder) completed Year 1 of a two-year marine fish and fish habitat study at the Steensby Port Site between 05 and 21 September 2021. The primary objective of the field program was to collect marine biophysical data to support future marine permitting requirements for the Steensby Port construction Project, including a federal Fisheries Act Authorization (FAA) application and federal Disposal-at-Sea (DAS) permit application. The secondary objective of the field program was to update existing marine baseline data to serve as a point of reference (baseline case) for future environmental effects monitoring (EEM) initiatives at the Steensby Port Site.

This field summary report includes a summary of the scope of work completed in 2021, deviations from the existing workplan (Nuqsana Golder 2021), and a review of the health and safety aspects of the program including any lessons learned.

2.0 WORK SUMMARY

Nuqsana Golder was responsible for the management and implementation of the 2021 field program at Steensby Port, including program design, Inuit engagement, equipment procurement, data collection, data processing and analyses, and field summary reporting. The 2021 field program took place during a three-week sampling period (05 to 21 September 2021), corresponding with the open-water season. As there was no living accommodations or services at the Steensby Site, the field program was staged on the RV Nuliajuk, a 60-foot live-aboard (self-supported) research vessel that was chartered from the Government of Nunavut's Department of Environment (Photo 1 in Appendix A).

The field team consisted of five Golder scientific personnel, one Remotely Operated Vehicle (ROV) video operator (subcontractor Ocean Dynamics Inc.) and one Inuit field program assistant / polar bear monitor from Pond Inlet (Table 1). Five of the six field team members flew commercially to Igloolik, Nunavut where they boarded the RV Nuliajuk and transitted to the Steensby Site. The sixth field team member (Andy Clarke – Ocean Dynamics) mobilized to Mary River from the LUX terminal in Montreal using Baffinland's weekly charter flight in early September. Upon his arrival at Mary River and confirmation of a negative COVID-19 test, he was transported via Baffinland helicopter to the Steensby Site where he joined the rest of the team on the RV Nuliajuk (ship to shore transfer provided by a tender vessel from the RV Nuliajuk). Following completion of the 2021 field program in late September, all team members transitted back to Igloolik on the RV Nuliajuk where they debarked and demobilized via commercial flights out of Igloolik.

Table 1: Summary of Field Team Members and Weather Conditions for 2021 Marine Field Program

Program Dates (Year 1)	5 to 21 September 2021
Nuqsana Golder Field Staff	Trish Tomliens (Site Supervisor), Alex MacMillan, Brad Cox, Niallan O'Brien
Contracted Field Staff	Andy Clark (Ocean Dynamics Inc. - ROV subcontractor), Ronnie Kompangapik (Inuit subcontractor), RV Nuliajuk crew (consisting of 5 crew members)
Weather During Program	Temperatures ranged from -5 to 3°C with winds ranging from 2 to 20 knots. Most of the days were clear with several days seeing rain or snow.

The field program consisted of the following components (Figure 1):

- Data collection to support FAA application - administered by Fisheries and Oceans Canada (DFO) and future EEM program initiatives:
 - Collection of marine sediment samples, benthic infaunal samples, oceanographic data (currents, tides, water temperature, salinity) and fish and fish habitat information in the marine footprint areas of the proposed Freight Dock, Ore Dock, and Causeway; and in a pre-established reference area situated outside the zone of influence of the Port.
 - Collection of fish habitat information in the marine footprint areas of the proposed Construction Dock and in an existing tide pool located on Steensby Island adjacent to the Ore Dock footprint.
 - Collection of marine sediment samples, benthic infaunal samples and fish and fish habitat information in two potential fish habitat offset sites to counterbalance losses associated with the new marine infrastructure at Steensby Port.
 - Opportunistic observations of wildlife in and around Steensby Port.
- Data collection to support DAS application - administered by Environment and Climate Change Canada (ECCC):
 - Collection of surficial and subsurface sediment samples from the dredge footprints associated with the proposed Freight Dock, Ore Dock, and Causeway.
 - Collection of marine sediment samples, benthic infaunal samples, and marine fish and fish habitat information in the proposed dredged material side cast areas immediately adjacent to the dredge footprint areas.
 - Collection of marine fish and fish habitat information in three alternative offshore DAS disposal sites in Steensby Inlet to characterize these areas as potential disposal sites for the dredged material.

The following sections provide a detailed summary of the completed tasks for each of the above study components.

2.1 FAA Application and Future EEM Program Initiatives

2.1.1 Marine Sediment and Benthic Infauna

- A total of seven sediment samples (Table 2; Figures 2 to 4) were collected and submitted to ALS Environmental (ALS) for baseline analyses, as follows:
 - All samples: trace metals, trace mercury, particle size, moisture, total organic carbon (TOC), total inorganic carbon (TIC), total carbon (TC), polycyclic aromatic hydrocarbons (PAHs)
 - Subsample (three samples): Polychlorinated biphenyl (PCBs), Volatile organic carbons (VOCs; BTEX), petroleum hydrocarbons (PHCs; F1 – F4)

- A total of eight benthic infaunal samples were collected for benthic invertebrate analysis and were submitted to Biologica Environmental Services (Biologica; Table 2; Figure 1; Figures 2 to 4).
- A total of six sediment samples were collected at two potential habitat offsetting sites and submitted to ALS for particle size analysis to inform the FAA application (Table 2; Figure 6).
- The majority of the intended sediment and benthic infaunal samples in the Causeway area were unable to be collected due to existing substrate conditions resulting in hard bottom refusal and rejected samples during sediment grab sampling using the Petite Ponar and the Standard Ponar (both manually operated). Reason for sample rejection included inadequate sediment volume (<25% full) and/or incomplete closure of the grab sampler upon recovery (rocks and debris jammed in jaws of grab sampler).
- A portion of the intended sediment and benthic infaunal samples in the Ore Dock area were unable to be collected due to hard bottom refusal and associated time constraints. After several days of effort, sampling attempts in this area were suspended in favor of focussing on the fish habitat and DAS sediment sampling efforts.
- One attempt was made to collect sediment and benthic infaunal samples in the Reference area (Figure 5) but this was unsuccessful due to inadequate penetration of the grab (i.e., hard bottom refusal) and/or incomplete closure of the grab sampler. No additional sampling was undertaken in this area due to accessibility issues with the site (tide conditions) and time constraints with the overall field program.
- Fish Habitat Offset Site #1 and #3 (Figure 6): Sediment samples along the -5m (chart datum) contour were unable to be collected following considerable effort due to inadequate penetration of the grab (i.e., hard bottom refusal) and sample rejection at multiple locations. Reason for sample rejection included inadequate sediment volume (<25% full) and/or incomplete closure of the grab sampler upon recovery (rocks and debris jammed in jaws of grab sampler).
- One sediment sample for grain size was collected at Habitat Offset Site #2 (Figure 6); however, the site was subsequently deemed unsuitable as a monitoring site due to lack of deep water accessibility by the RV Nuliajuk and was not sent for analysis.
- A total of 10 opportunistic *in-situ* water quality measurements were collected in the Steensby Port area. These generally coincided with sediment sampling efforts, including:
 - Two measurements in each of the Freight and Ore Dock footprints.
 - Three measurements in the Causeway footprint.
 - One measurement in each of the Habitat Offset Sites and the Construction Dock.
- Representative photographs are provided in Appendix A.

Table 2: Marine Sediment and Benthic Infaunal Samples Collected in 2021 in Support of FAA Application

Project Area	Station Name	Depth (-m CD ^{1,2})	Sample Collected	UTM (17W) ³		Date of Collection
				Easting	Northing	
Freight Dock	BL-FD-01	31.0	Sediment (+ DUP) + Benthic	595126	7799049	11 Sept 2021
	BL-FD-02	27.6	Sediment + Benthic	595142	7799067	6 Sept 2021
				595447	7798816	
	BL-FD-03	25.7	Sediment + Benthic	595188	7799052	10 Sept 2021
	BL-FD-04	26.7	Sediment + Benthic	595184	7799031	6 Sept 2021
BL-FD-05	27.9	Sediment + Benthic	595142	7799032	5 Sept 2021	
			595149	7799028		
Ore Dock	BL-OD-05	29.9	Sediment + Benthic	592832 592847	7798048 7798029	11 Sept 2021
Causeway	BL-CW-04	6.4	Benthic	594507	7799961	14 Sept 2021
	BL-CW-05	9.7	Benthic	594483	7799983	14 Sept 2021
Offset Site 1	OS1-GS-10m	10.3	Sediment	593294	7801530	20 Sept 2021
	OS1-GS-15m	15.1	Sediment	593271	7801529	20 Sept 2021
	OS1-GS-20m	20.1	Sediment	593258	7801508	20 Sept 2021
Offset Site 2	OS2-P2	21.6	Sediment	584334	7809971	18 Sept 2021
Offset Site 3	OS3-GS-10m	11.0	Sediment	592335	7803074	19 Sept 2021
	OS3-GS-15m	14.4	Sediment	592319	7803102	19 Sept 2021
	OS3-GS-20m	19.4	Sediment	592277	7803118	19 Sept 2021

1 Chart datum calculated from Tide Table #5310 from Fisheries and Oceans Canada database.

2 Depth (m CD) averaged across sediment and benthic sampling depths.

3 Two coordinates listed if sediment sample location differed from benthic sample location. Sediment sample listed above benthic sample coordinates.

2.1.2 Marine Fish Community

- A total of 24 fish comprising 5 taxa were collected in 2021 using gill net, angling and Fukui net fish collection methods (Table 3; Figures 2 to 7), including:
 - Three Arctic Char (*Salvelinus alpinus*) within the Freight Dock and Ore Dock areas.
 - Four Fourhorn Sculpin (*Myoxocephalus quadricornis*) within the Freight Dock and Construction Dock areas.
 - Nine Shorthorn Sculpin (*Myoxocephalus scorpius*) within the Freight Dock, Ore Dock, Construction Dock and Causeway areas.

- Four Arctic Sculpin (*Myoxocephalus scorpioides*) within the Ore Dock, Construction Dock and Causeway areas.
- Four unidentified sculpin (Family Cottidae) within the Freight Dock and Reference site areas.
- 22 of the 24 collected fish were successfully released following processing.
 - Two Arctic char mortalities occurred during gill net efforts; these were given to the Inuit crew members and the remainder was used for Fukui trap bait (in accordance with fish permit allowances).
- Trawling efforts were unable to be completed during the 2021 program due to program time constraints.
- Representative photographs are provided in Appendix A.

Table 3: Summary of 2021 Marine Fish Sampling Effort in Support of FAA Application

Project Area	Gear Type	Date of Effort	Max Depth (-m CD) ²	UTM (17W) ³		Fish Taxa Captured (No. of Fish)
				Easting	Northing	
Freight Dock	Gill Net	16 Sept 2021	13.9 – 14.2	595605 595541	7798801 7798798	-
		16 Sept 2021	18.9 – 19.2	595566 595488	7798685 7798651	Fourhorn sculpin (3), Shorthorn sculpin (1), unidentified sculpin (1), Arctic char (1)
		16 Sept 2021	10.7 – 10.9	595691 595636	7798976 7799040	Shorthorn sculpin (1)
		16 Sept 2021	38.7 – 38.9	595485 595384	7798551 7798569	Shorthorn sculpin (1)
	Fukui Trap	15 Sept 2021	15.7 – 17.5	595514	7798924	-
		15 Sept 2021	12.7 – 14.5	595534	7798852	-
Ore Dock	Angling	8 Sept 2021	27.6	592816	7798449	-
		14 Sept 2021	29.3	592821	7798645	-
	Gill Net	8 Sept 2021	32.6 – 33.5	592883 592803	7798547 7798525	-
		8 Sept 2021	22.6 – 23.5	592857 592768	7798305 7798319	Shorthorn sculpin (1), Arctic char (2),
	Fukui Trap	20 Sept 2021	2.6 – 4.6	592880	7798205	Arctic sculpin (1)
		20 Sept 2021	32.6 – 34.6	592778	7798309	Shorthorn sculpin (1)
Knoll ⁴	Fukui Trap	20 Sept 2021	27.6 – 29.6	592676	7799247	-
		20 Sept 2021	27.6 – 29.6	592595	7798995	-

Project Area	Gear Type	Date of Effort	Max Depth (-m CD) ²	UTM (17W) ³		Fish Taxa Captured (No. of Fish)	
				Easting	Northing		
Causeway	Angling	16 Sept 2021	2.7	594308	7800323	Arctic sculpin (2)	
	Gill Net	15 Sept 2021	8.8 – 9.2	594279 594366	7800340 7800343	Shorthorn sculpin (3)	
		15 Sept 2021	6.8 – 7.2	594454 594361	7800490 7800522	-	
	Fukui Trap	15 Sept 2021	5.7 – 7.5	594450	7800232	-	
		15 Sept 2021	6.8 – 7.2	594354	7800487	-	
	Reference	Angling	17 Sept 2021	1.9	587880 587980	7807896 7807928	-
17 Sept 2021			3.9	587665 587755	7807468 7807535	-	
Gill Net		17 Sept 2021	4.9 – 5.3	587774 587683	7807557 7807555	-	
		17 Sept 2021	6.1 – 6.3	587722 587622	7807125 7807116	-	
Hoop/Fyke Net		18 Sept 2021	17.5 – 18.4	587734 587640	7806846 7806838	-	
		18 Sept 2021	3.2 – 4.4	587889 587797	7807867 7807839	-	
Fukui Trap		17 Sept 2021	2.7 – 4.4	587674	7807409	Unidentified sculpin (3)	
Construction Dock		Hoop/Fyke Net	13 Sept 2021	0.7 – 2.7	594823	7800193	Fourhorn sculpin (1), Shorthorn sculpin (1), Arctic sculpin (1)
Offset Site 1		Gill Net	20 Sept 2021	10.8 – 11.6	593454 593418	7801399 7801354	-
			20 Sept 2021	16.8 – 17.6	593354 593319	7801514 7801444	-
Offset Site 3	Angling	19 Sept 2021	12.4	592296	78306	-	

1 Chart datum calculated from Tide Table #5310 from Fisheries and Oceans Canada database.

2 Range of depths (m CD) given for efforts deployed for over 60 minutes.

3 Start and end coordinates are given for gill net and applicable angling efforts. Start positions are listed above end positions.

4 Knoll is located to the north of the Ore Dock to the west of the island.

2.1.3 Fish Habitat

- A total of 41 ROV transects were completed in eight target areas in Steensby Inlet (Table 4; Figures 2 to 7) to evaluate substrate, macroalgae, sessile/motile invertebrates and opportunistic occurrence of fish within each area:
 - Five transects from +3 to -30 m CD within the Freight Dock.
 - Nine transects from +3 to -50 m CD within the Ore Dock.
 - Two additional transects (-40 and -50 m CD contours) were added after crew arrival to Steensby Port.
 - Six transects from +3 to -10 m CD within the Causeway.
 - Eight transects from +3 to -50 m CD within the Reference site.
 - Two additional transects (-40 and -50 m CD contours) were added after crew arrival to Steensby Port.
 - Four transects from +3 to -20 m CD within the Construction Dock.
 - Construction Dock ROV surveys were added to the workplan after crew arrival to Steensby Port.
 - Four transects from +3 to -20 m CD within Offset Site 1.
 - One transect from -11 to -22 m CD within Offset Site 2.
 - During the field program, Offset Site 2 was removed from consideration as a potential offsetting site as it was inaccessible by the survey boat due to shallow water depths.
 - Four transects from +3 to -20 m CD within Offset Site 3.
- Systematic visual surveys were conducted in 7 target areas (Table 4, excluding Offset Site 2) in Steensby Inlet to evaluate the shoreline and intertidal areas and identify terrestrial and aquatic habitat features in the vicinity of each project area.
- A tide pool previously assessed by North/South Consultants in 2007 was re-surveyed in 2021. Biophysical data was collected along 5 shore-perpendicular transects (spaced 25 m apart), each comprising between 4 and 6 (0.25 m²) quadrats interspaced at 2 to 5 m intervals.
- Representative photographs are provided in Appendix A.

Table 4: Summary of 2021 Fish Habitat ROV Video Surveys Collected in Support of FAA Application

Project Area	Transect Name ¹	Depth Contour (m CD ²)	UTM (17W) Start		UTM (17W) End		HD Video Length (h:mm:ss)	Approx. Transect Length (m)	Date of Survey
			Easting	Northing	Easting	Northing			
Freight Dock	FD-01	+3 to 0	595585	7798707	595653	7798929	0:09:08	243	16 Sept 2021
	FD-02	0 to -5	595631	7798964	595543	7798713	0:27:58	376	11 Sept 2021
	FD-03	-5 to -10	595603	7799003	595552	7798789	1:09:39	415	12 Sept 2021
	FD-04	-10 to -20	595534	7799047	595520	7798733	1:52:58	550	13 Sept 2021
	FD-05 ³	-20 to -30	595397	7798986	595459	7798739	1:01:22	3903	13 Sept 2021

Project Area	Transect Name ¹	Depth Contour (m CD ²)	UTM (17W) Start		UTM (17W) End		HD Video Length (h:mm:ss)	Approx. Transect Length (m)	Date of Survey
			Easting	Northing	Easting	Northing			
Ore Dock	OD-01	+3 to 0	592840	7798354	592879	7798870	0:07:38	541	16 Sept 2021
	OD-02	0 to -5	592828	7798653	592819	7798399	0:28:11	266	15 Sept 2021
	OD-03	-5 to -10	592826	7798631	592808	7798415	0:34:58	227	15 Sept 2021
	OD-04	-10 to -20	592811	7798632	592804	7798408	0:43:11	235	14 Sept 2021
	OD-05	-20 to -30	592799	7798637	592794	7798436	0:49:21	214	14 Sept 2021
	OD-06A	-40	592756	7798591	592764	7798541	0:26:09	76	14 Sept 2021
	OD-06B	-40	592738	7798539	592764	7798467	0:25:10	102	15 Sept 2021
	OD-07A	-50	592697	7798563	592733	7798540	0:16:50	77	15 Sept 2021
	OD-07B	-50	592747	7798458	592721	7798589	0:23:12	149	15 Sept 2021
Causeway	CW-01E	+3 to 0	594578	7800266	594368	7800643	0:19:32	529	14 Sept 2021
	CW-02E	0 to -5	594310	7800593	594447	7800373	0:48:04	345	11 Sept 2021
	CW-03E	-5 to -10	594430	7800167	594319	7800519	1:15:07	1100	11 Sept 2021
	CW-01W	+3 to 0	594369	7800199	594158	7800460	0:12:02	399	16 Sept 2021
	CW-02W	0 to -5	594273	7800191	594129	7800445	1:14:11	777	10 Sept 2021
	CW-03W	-5 to -10	594243	7800195	594078	7800425	0:48:49	836	10 Sept 2021
Reference	RS-01	+3 to 0	588344	7805612	588538	7805366	0:9:25	346	17 Sept 2021
	RS-02	0 to -5	588349	7805471	588483	7805335	0:15:07	234	17 Sept 2021
	RS-03	-5 to -10	588354	7805401	588473	7805296	0:33:25	180	17 Sept 2021
	RS-04	-10 to -20	588255	7805418	588451	7805309	0:34:53	256	17 Sept 2021
	RS-05A	-20 to -30	588116	7805350	588312	7805333	1:08:07	321	17 Sept 2021
	RS-05B	-20 to -30	588327	7805299	588366	7805221	0:25:49	113	18 Sept 2021
	RS-06	-40	587522	7804780	587534	7804753	0:50:02	108	18 Sept 2021
	RS-07	-50	587240	7804737	587270	7804632	0:45:33	149	18 Sept 2021
Construction Dock	CD-01	+3 to 0	594995	7800090	595368	7799659	0:08:13	616	20 Sept 2021
	CD-02	0 to -5	595179	7799715	595290	7799649	0:39:16	569	21 Sept 2021
	CD-03	-5 to -10	594961	7799812	595156	7799660	0:56:29	370	21 Sept 2021
	CD-04	-10 to -20	594858	7799796	595043	7799624	0:52:16	390	20 Sept 2021

Project Area	Transect Name ¹	Depth Contour (m CD ²)	UTM (17W) Start		UTM (17W) End		HD Video Length (h:mm:ss)	Approx. Transect Length (m)	Date of Survey
			Easting	Northing	Easting	Northing			
Offset Site 1	OS1-01	+3 to 0	593383	7801504	593221	7801684	0:08:01	243	16 Sept 2021
	OS1-02	0 to -5	593358	7801482	593204	7801665	0:17:49	247	11 Sept 2021
	OS1-03	-5 to -10	593173	7801675	593344	7801484	0:37:20	331	11 Sept 2021
	OS1-04	-10 to -20	593319	7801467	593185	7801639	0:22:24	265	11 Sept 2021
Offset Site 2	OS2-P1	-11 to -22	584328	7909983	584446	7810058	0:28:20	221	18 Sept 2021
Offset Site 3	OS3-01	+3 to 0	592439	7803005	592194	7802842	0:09:57	495	19 Sept 2021
	OS3-02	0 to -5	592355	7802992	592237	7802890	0:19:04	205	19 Sept 2021
	OS3-03	-5 to -10	592306	7803043	592200	7802886	0:17:37	234	19 Sept 2021
	OS3-04	-10 to -20	592264	7803017	592169	7802913	0:25:21	162	19 Sept 2021

1 Transects with A or B indicate insufficient spatial coverage during initial surveys, prompting a second survey to be conducted in the same depth contour.

2 Chart datum calculated from Tide Table #5310 from Fisheries and Oceans Canada database.

3 FD-05 track was not recorded in the field due to GPS malfunction. Track was reconstructed during analysis.

2.2 DAS Application

2.2.1 Proposed Dredge Areas

- Subsurface sediment samples were unable to be collected for characterization of deeper sediments within the proposed dredge area due to existing substrate conditions resulting in sediment recovery issues using the vibracorer and manual sediment corer. A total of three subsurface sampling stations (two in Freight Dock footprint and one in Causeway footprint) were attempted (Figures 2, 3, and 5).
- A total of 21 surficial sediment samples were collected for characterization of three proposed dredge areas (Table 5; Figure 1), including:
 - Seven samples from the Freight Dock plus 2 duplicate samples.
 - Nine samples from the Ore Dock (1 from the Dredge Area and 8 included from the Side Cast area adjacent to the Dredge Area) plus 2 duplicate samples.
 - One sample opportunistically collected from the Reference site (bulk sample only for archive).
- Surficial sediment samples were sent to ALS for the following analyses:
 - All samples: trace metals, trace mercury, particle size, moisture, TOC, TIC, TC, PAHs.
 - Subsample (5 samples): PCBs.
- Additional surficial sediment samples for dredge characterization were unable to be collected for the following reasons (Figures 2 to 5):

- Freight Dock: After a number of unsuccessful Van Veen grabs, the remaining surface sediment samples were unable to be collected due to the coarse bottom substrate (i.e., gravel and cobble substrate) dominant in the area which resulted in hard bottom refusal, inadequate penetration of the grab and/or incomplete closure of the grab.
- Causeway: Deployment of the Petite Ponar and Standard Ponar by hand failed to trigger the grab properly and/or did not allow for sufficient penetration of the grab to collect enough sample for analysis. A reasonable number of attempts were conducted throughout the Causeway with several alterations to the deployment technique before sediment sampling was suspended in this area in favor of other stations with a higher likelihood of retrieval.
- Ore Dock: The dredge area was almost entirely made up of rocks and sampling the shallower nearshore area was challenging. A single sample (DA-OD-4) was retrieved in the dredge area (Figure 1) but only a small volume was available for analysis and greater than 88% of the sample was sand and gravel. After a reasonable number of attempts were made in this proposed dredge area, additional samples were targeted within the deeper side cast area in favor of stations with higher collection likelihood.
- Representative photographs are provided in Appendix A.

Table 5: Summary of 2021 Surficial and Subsurface Sediment Sampling Effort for DAS Program

Project Area	Station Name	Depth (-m CD ¹)	UTM (17W)		Date of Collection
			Easting	Northing	
Freight Dock	DA-FD-01	13.7	595539	7798750	10 Sept 2021
	DA-FD-03 (+ DUP)	7.4	595543	7798887	10 Sept 2021
	DA-FD-04	12.2	595526	7798923	9 Sept 2021
	DA-FD-05	6.2	595549	7798794	10 Sept 2021
	DA-FD-06 (+ DUP)	13.7	595514	7798896	9 Sept 2021
	DA-FD-07	6.3	595560	7798932	9 Sept 2021
	DA-FD-08	12.9	595529	7798981	10 Sept 2021
Ore Dock	DA-OD-01	19.2	592805	7798360	16 Sept 2021
	DA-OD-02	54.2	592748	7798361	16 Sept 2021
	DA-OD-03	53.8	592730	7798509	16 Sept 2021
	DA-OD-04 ²	13.1	592831 592837	7798559 7798572	8 Sept 2021
	DA-OD-05 (+ DUP)	35.3	592758	7798610	16 Sept 2021
	DA-OD-06	37.8	592741	7798750	16 Sept 2021
	DA-OD-07 (+ DUP)	32.8	592757	7798696	16 Sept 2021
	DA-OD-08	34.8	592761	7798797	16 Sept 2021
	DA-OD-09	31.9	592769	7798857	16 Sept 2021
Reference	DA-RD-01	26.5	588289	7805286	18 Sept 2021

1 Chart datum calculated from Tide Table #5310 from Fisheries and Oceans Canada database.

2 DA-OD-04 was a composite sample between two locations and both coordinates are listed.

2.2.2 Proposed Dredge Material Side Cast Disposal Areas

- A total of 3 sediment samples (Table 6; Figure 2) were collected and submitted to ALS for characterization of the Freight Dock side cast disposal areas.
- A total of 3 benthic samples (Figure 2) were collected for benthic invertebrate analysis and were submitted to Biologica (Table 6).
- Sediment samples in the Ore Dock side cast disposal areas were collected as part of the dredge sampling due to coarse substrate in the dredge area (i.e., gravel and cobble). A total of 8 samples were collected in the side cast area (see Table 5; Figure 3).
- Representative photographs are provided in Appendix A.

Sediment samples and benthic infaunal samples in the Causeway side cast disposal areas were unable to be collected due to existing hard substrate conditions resulting in unsuccessful grab attempts (i.e., hard bottom refusal) and rejected samples (inadequate penetration of grab, incomplete closure of grab) while deploying the Petite Ponar and/or Standard Ponar by hand (Figure 4). Rejected samples contained inadequate sediment volume (<25% full).

Table 6: Summary of 2021 Sediment and Benthic Infaunal Samples Collected in Side-Cast Disposal Areas

Project Area	Station Name	Depth (-m CD ^{1,2})	Sample Collected	UTM (17W)		Date of Collection
				Easting	Northing	
Freight Dock	SC-FD-01	27.2	Sediment (+ DUP) + Benthic	595460	7798735	10 Sept 2021
	SC-FD-02	27.6	Sediment + Benthic	595462	7798804	6 Sept 2021
	SC-FD-03	22.1	Sediment + Benthic	595463	7798911	6 Sept 2021

1 Chart datum calculated from Tide Table #5310 from Fisheries and Oceans Canada database.

2 Depth (m CD) averaged across sediment and benthic sampling depths.

2.2.3 Alternative Offshore Disposal Areas

- A total of three ROV transects were completed within three alternative offshore disposal areas in Steensby Inlet (Table 7; Figure 8) to evaluate substrate, macroalgae, sessile/motile invertebrates and opportunistic occurrence of fish within each area.
- Representative photographs are provided in Appendix A.

Table 7: Summary of 2021 Marine Fish Habitat ROV Video Surveys in Alternative Offshore Disposal Areas

Project Area	Transect Name	Depth Contour (m CD ¹)	UTM (17W) Start		UTM (17W) End		HD Video Length (h:mm:ss)	Approx. Transect Length (m)	Date of Survey
			Easting	Northing	Easting	Northing			
Disposal at Sea	DAS-A01	-39 to -58	592659	7799977	592800	7799870	0:33:35	271	20 Sept 2021
	DAS-A02	-40 to -49	594756	7798548	594918	7798622	1:21:56	332	13 Sept 2021
	DAS-A03	-49 to -54	595382	7797521	595570	7797463	0:52:53	357	20 Sept 2021

1 Chart datum calculated from Tide Table #5310 from Fisheries and Oceans Canada database.

2.2.4 Physical Oceanography

A physical oceanography program was conducted in 2021 to support the DAS application and to update the oceanographic baseline in the Steensby Port area (Figure 9). This included the following data collection components:

- Oceanographic mooring (currents, water levels, ice, salinity, temperature)
- GPS drogue surveys (surface currents)
- Water level monitoring
- Vessel-based CTD profiles
- Wind level monitoring

Detailed information is provided below regarding oceanographic mooring design, calibration of instruments, and deployment of the oceanographic mooring, collection of water column conductivity, temperature and depth (CTD) profiles, and deployment of drogues for measurements of surface currents:

- A Trimble R8 Model 3 Global Navigation Satellite System (GNSS) real time kinematic (RTK) survey was used to establish a local ground control point on the island of the proposed Ore Dock (Appendix A). The local ground control point was established roughly 40 m inland on top of a rocky outcrop with an unobstructed field of view to the location of the deployed mooring. One water level measurement was taken with the rover on September 14 above the location of the deployed mooring which was referenced to the local ground control point (Table 9).
- The oceanographic mooring was deployed in water approximately 78 m deep (Appendix A). The mooring consisted of a subsurface taut line mooring with an upward-looking Acoustic Doppler Current Profiler (ADCP) and downward-looking ADCP to measure currents (speed and direction), and water level; and an RBR Ltd. conductivity and temperature (CT) sensor to measure temperature and salinity. The mooring consisted of a subsurface frame housing the two ADCP and the CT sensor, Viny floats attached to the frame for buoyancy, a XEOS Technologies Inc. GPS beacon to aid in mooring recovery, buoyant line, a tandem acoustic release (EdgeTech), and a chain connection from the acoustic release to an anchor weight on the seabed. The compasses on each of the two ADCPs were successfully calibrated to the earth’s local hard and soft iron effects present at Steensby Port on September 5 prior to deployment. The mooring will measure currents, water levels, salinity, and temperature around Steensby Port. The original deployment failed due to

equipment failure – shear force from the attempted deployment caused the release link on the EdgeTech to break, releasing the anchor to the ocean floor. Due to the loss of the first mooring anchor, and the knowledge that only one anchor remained, the 3-week long mooring deployment was cancelled in order to use the remaining anchor for the year-long mooring deployment. The sampling strategy used for the oceanographic mooring instrumentation for the 12-month deployment is shown in Table 8.

- Representative photographs are provided in Appendix A.

Table 8: 2021 Oceanographic Mooring Instrumentation and Sample Programming

Instrumentation	Sampling Strategy	Instrument Uncertainty
Sensor: Nortek 500 kHz Signature Series ADCP, measuring water column currents (u, v, w), and relative water surface elevations Sensor direction: Upward-looking Elevation above seabed: 40 m	Currents: Measurement interval: 600 s Configured Average Interval: 240 s Number of Pings: 72 Bin size: 2 m Blanking distance: 0.5 m Last cell range: 42.5 m	Horizontal standard deviation: 0.81 cm/s Vertical standard deviation: 0.27 cm/s Compass direction accuracy: ±2° (tilt < 30°) Tilt accuracy: ±0.2° (tilt < 30°)
Sensor: Sensor: Nortek 500 kHz Signature Series ADCP, measuring water column currents (u, v, w) and relative water surface elevations Sensor direction: Downward-looking Elevation above seabed: 36 m	Currents: Measurement interval: 600 s Configured Average Interval: 120 s Number of Pings: 48 Bin size: 2 m Blanking distance: 0.5 m Last cell range: 42.5 m	Horizontal standard deviation: 0.99 cm/s Vertical standard deviation: 0.33 cm/s Compass direction accuracy: ±2° (tilt < 30°) Tilt accuracy: ±0.2° (tilt < 30°)
Sensor: RBR duo salinity and temperature (CT) data logger Elevation above seabed: 37 m	Ensemble interval: 600 s Measurement interval: 60 s Sampling rate: 1 Hz	Temperature accuracy: ±0.002°C Conductivity accuracy: ±0.003 mS/cm

- A total of three GPS drogue surveys, using four GPS drogues were conducted to measure near-surface current speed and direction around Steensby Port. The drogues were constructed from PVC pipes, tarpaulin fabric, and floats, and outfitted with a handheld Garmin GPSMAP 64x device capable of recording GPS location in real-time. The four drogues were deployed 50 m apart from each other in a straight line and were left to drift over a tidal cycle or until they were observed to have drifted into shallow water. The drogues were deployed in the following areas, with the start locations and end locations of the four drogues in each area averaged (Table 9):
 - To the west of the Freight Dock between the mainland and the island (Drogue Station D-02).
 - South of the Freight Dock and island (Drogue Station D-06).
 - One drogue (out of four) was not recovered after the drogue survey was completed due to rough sea conditions.

- In the Causeway (Drogue Station D-03).
 - Only three drogues were used during this survey due to the loss of one drogue during the Drogue Station D-06 deployment.
- One CTD transect consisting of eight profiles (up and down casts) was conducted using a Seabird SBE-19plus V2 profiler installed in a mooring cage that was lowered using rigging on the RV Nuliajuk. The instrument measured conductivity, temperature, and depth/pressure. The transect was conducted along a 4.5 km route consisting of 8 profiles from the southern end of the Causeway to roughly 2.9 km offshore and south of the Ore Dock (Table 9).
- Wind data measured by the existing meteorological station on Steensby Island will be processed in 2022 following the second field program. Wind data will be compared to the measured oceanographic data and used to identify wind events which may explain variation in oceanographic parameters such as current speed and direction; wave height and direction; and salinity and/or temperature variation.
- Additional oceanographic program components (i.e., three GPS drogue deployments, two CTD transects, and additional water level measurements) were not completed during the 2021 field program due to program timing constraints and have therefore been rescheduled to the 2022 field program.
- Representative photographs are provided in Appendix A.

Table 9: Summary of 2021 Physical Oceanography Program at Steensby Port

Program Component	UTM (17W) Start		UTM (17W) End		Date of Deployment	Ocean Depth (m)
	Easting	Northing	Easting	Northing		
RTK Survey Local Ground Control Point	592897	7798617	-	-	5 Sept 2021	
ADCP Mooring	592107	7798622	-	-	8 Sept 2021	78
Drogue Station D-02	595145	7798897	594724	7800063	9 Sept 2021	
Drogue Station D-03	594221	7800504	594189	7800177	13 Sept 2021	
Drogue Station D-06	595483	7797510	595769	7796979	12 Sept 2021	
CTD TX03-01	594751	7799452	-	-	11 Sept 2021	19.3
CTD TX03-02	594637	7798967	-	-	11 Sept 2021	33.5
CTD TX03-03	594686	7798261	-	-	11 Sept 2021	54.4
CTD TX03-04	594552	7797727	-	-	11 Sept 2021	67.0
CTD TX03-05	594255	7797112	-	-	11 Sept 2021	64.6
CTD TX03-06	594050	7796638	-	-	11 Sept 2021	36.5
CTD TX03-07	593631	7795938	-	-	11 Sept 2021	39.9
CTD TX03-08	593023	7795430	-	-	11 Sept 2021	46.3

3.0 HEALTH AND SAFETY

Golder crew completed a vessel orientation with the Nuliajuk crew once on board the vessel in Igloolik and upon the arrival of additional crew to the vessel mid-program. On the first day of the program prior to the start of any sampling, the Golder crew and Nuliajuk crew reviewed and signed the Health, Safety and Environment Plan, and reviewed and signed the Baffinland Job Hazard Analysis (JHA) forms for each field component. The field crew conducted daily tailgate meetings and completed a Job Safety and Environment Analysis (JSEA) at the start of each workday. During the tailgate meetings, the crew discussed specific health and safety aspects, such as weather forecast, vessel logistics, team task breakdown, communication devices, equipment to be used, and other basic safety considerations. The crew arranged a check-in schedule with Baffinland and the Nuqsana Golder Project team prior to departure from Igloolik and amended the schedule as necessary to complete program components. The Golder crew used an InReach device and emails to communicate with project staff daily. A daily report was submitted at the end of each day to both the Nuqsana Golder and Baffinland project management teams.

Health and safety updates from the 2021 field program included the following:

- Careful navigation using spotters when entering a new area due to lack of chart data for the area. Nuliajuk's transponder located on the sounder provides water depths at the time the vessel passes through which are input on to the Nuliajuk's navigational system.
- A field crew of three (including a Golder employee, polar bear monitor and vessel crew member) were temporarily stranded on shore for two hours on 05 September due to low tide levels which prevented the boat from departing shore. During this time, the shore team was in radio contact with the vessel at all times and the polar bear monitor remained on active watch. The crew was able to reboard the vessel once the tide rose with no additional safety concerns noted. Note that accurate tide information for the Steensby area is limited.
- Strong winds were forecasted for 12 September 2021 and the decision was made not to use the zodiac tender vessel to transit to the Causeway area due to safety reasons. A 2-hour check-in procedure was also established for the day for any tender vessel departure from the Nuliajuk.
- On 17 September 2021, a spotter, in radio contact with the captain, was established at the stern of the vessel for all sediment sampling work when going into shallow waters close to shore as a precaution for lack of chart data in the area and extreme drop offs in depth.
- A polar bear approached the Nuliajuk on 20 September 2021 and swam around the vessel for approximately half an hour. The zodiac tender vessel was not deployed until the polar bear monitor deemed the bear was a safe distance away from the vessel. The last noted observation was of the bear swimming towards Steensby camp and the Causeway area away from the RV Nuliajuk.

4.0 LESSONS LEARNED 2021

A number of lessons learned were discussed with the field team during the program debriefs and are noted below:

- Better communication with regards to the helicopter support required for the Steensby program. A helicopter will be required at the start and end of the program for gear drop off/pick up, and scheduled sediment sample pickup a few times during the program to meet sample hold times.
- Shipping issues with Canadian Air Cargo out of Igloolik (shipments were lost causing exceedance of hold times for DAS sediment samples, Edmonton flights were cancelled, and all shipments were rerouted through Ontario).
- Benthic sample shipping issues with FedEx. FedEx TDG requirements are unclear when shipping samples preserved in 10% formalin and Golder has stopped using this courier for benthic samples. All benthic samples shipped from Baffinland should be sent through either Yellowknife flights or via Purolator through LUX Airport.
- Improved logistics for transferring equipment to/from the seacan at Steensby camp to the beach. Something motorized (quad with trailer) would be beneficial. Alternative is to place a seacan closer to the beach.
- Ensure that any older fuel drums transferred to site have been treated with fuel stabilizers. Several of the fuel drums provided in 2021 contained bad fuel and this resulted in down time for the vessels.
- Due to difficulties of collecting sediment samples in coarse substrate and because of the overall shallow depths present in the Causeway area, alternate sampling methods will be required in 2022. Options discussed are securing an additional support vessel with a davit winch system or to use divers to collect the sediment and benthic samples.
- Nuliajuk related learnings included the use of only one of the tender vessels as the keys for the second vessel were left in Newfoundland, Inuit support was lacking in some instances, need to register extra berth for additional staff member and public perception with the vessel affecting whales in the area.

5.0 CLOSURE

We trust the information contained in this technical memo is sufficient for your present needs. Should you have any additional questions regarding the project, please do not hesitate to contact the undersigned.

WSP Canada Inc.



Niallan O'Brien, BSc
Marine Biologist



Trish Tomliens, BSc, EPT
Benthic Ecologist



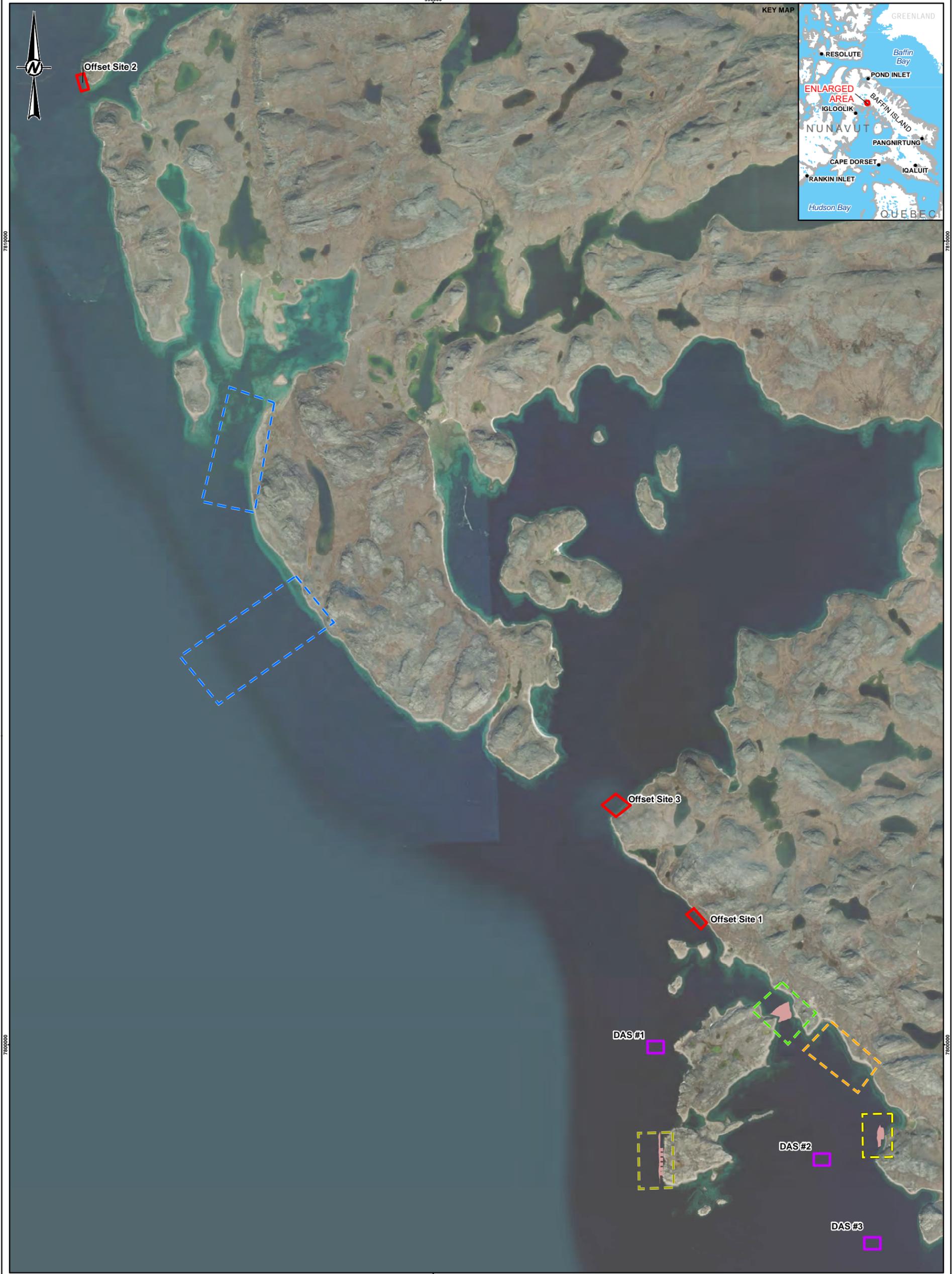
Phil Rouget, MSc, RPBio
Senior Marine Biologist

NOB/TT/PR/AM/asd

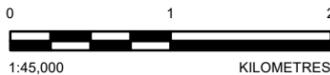
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6.0 REFERENCES

Nuqsana Golder. 2021. Workplan for Marine Fish and Fish Habitat Studies in Steensby Inlet. Document #CX20252228. 18 June 2021.



- LEGEND**
- OFFSET SITE
 - DAS OFFSHORE SITES
 - CUT AREA
 - CAUSEWAY OUTLINE
 - CONSTRUCTION DOCK OUTLINE
 - FREIGHT DOCK OUTLINE
 - ORE DOCK OUTLINE
 - REFERENCE SITE OUTLINE



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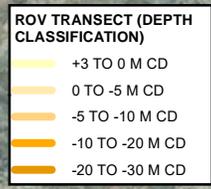
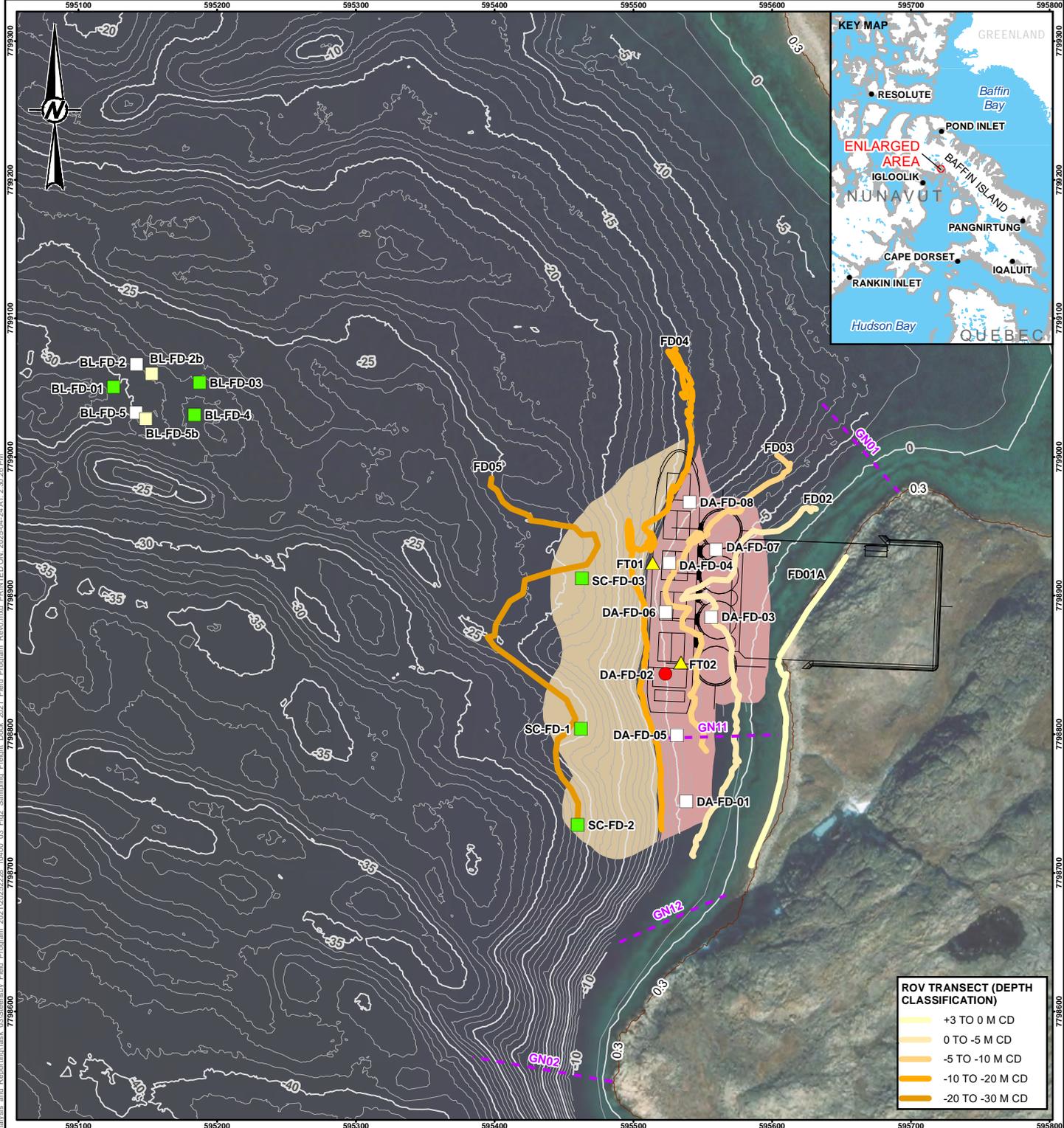
CLIENT
BAFFIN LAND IRON MINES CORPORATION

PROJECT
SECOND IRON ORE PORT – STEENSBY 2021 FIELD PROGRAM

CONSULTANT	WSP GOLDER
YYYY-MM-DD	2022-03-23
DESIGNED	JD
PREPARED	NB/AA
REVIEWED	PR
APPROVED	PR

TITLE	PROJECT SAMPLING AREAS IN STEENSBY INLET DURING STEENSBY 2021 FIELD PROGRAM		
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- BATHYMETRIC CONTOUR (5 m INTERVAL)
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- SHORE (0.3 m CD)
- CUT AREA
- DISPOSAL AREA
- FISHING EFFORTS
 - FUKUI TRAP
- GILL NET
- SEDIMENT/BENTHIC SAMPLING**
 - BENTHIC ONLY LOCATION
 - SEDIMENT AND BENTHIC LOCATION
 - SEDIMENT ONLY LOCATION
 - UNSUCCESSFUL LOCATION

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1:4,000 METRES

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CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
SECOND IRON ORE PORT – STEENSBY 2021 FIELD PROGRAM

TITLE
SAMPLING WITHIN THE FREIGHT DOCK DURING STEENSBY 2021 FIELD PROGRAM

CONSULTANT
wsp GOLDER

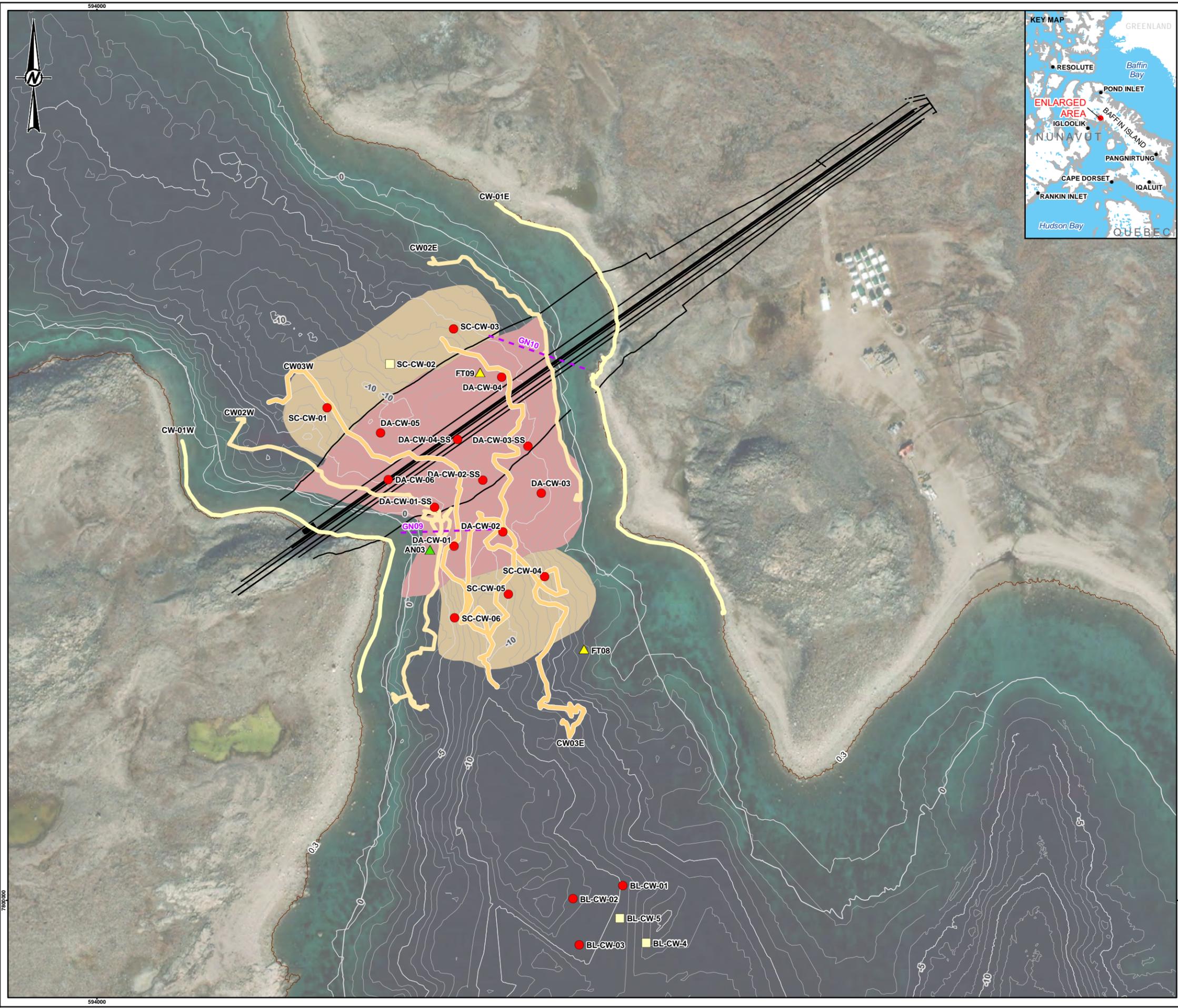
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DESIGNED	JD
PREPARED	NB/AA
REVIEWED	PR
APPROVED	PR

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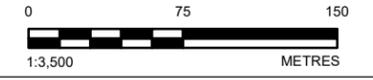
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 - SHORE (0.3 m CD)
 - CUT AREA
 - DISPOSAL AREA
 - FISHING EFFORTS**
 - ▲ FUKUI TRAP
 - ▲ ANGLING
 - GILL NET
 - SEDIMENT/BENTHIC SAMPLING**
 - BENTHIC ONLY LOCATION
 - UNSUCCESSFUL LOCATION
 - ROV TRANSECT (DEPTH CLASSIFICATION)**
 - +3 TO 0 m CD
 - 0 TO -5 m CD
 - -5 TO -10 m CD



REFERENCE(S)
 STEENSBY SITE INFRASTRUCTURE AND BATHYMETRY DATA PROVIDED BY CLIENT, JULY 2021.
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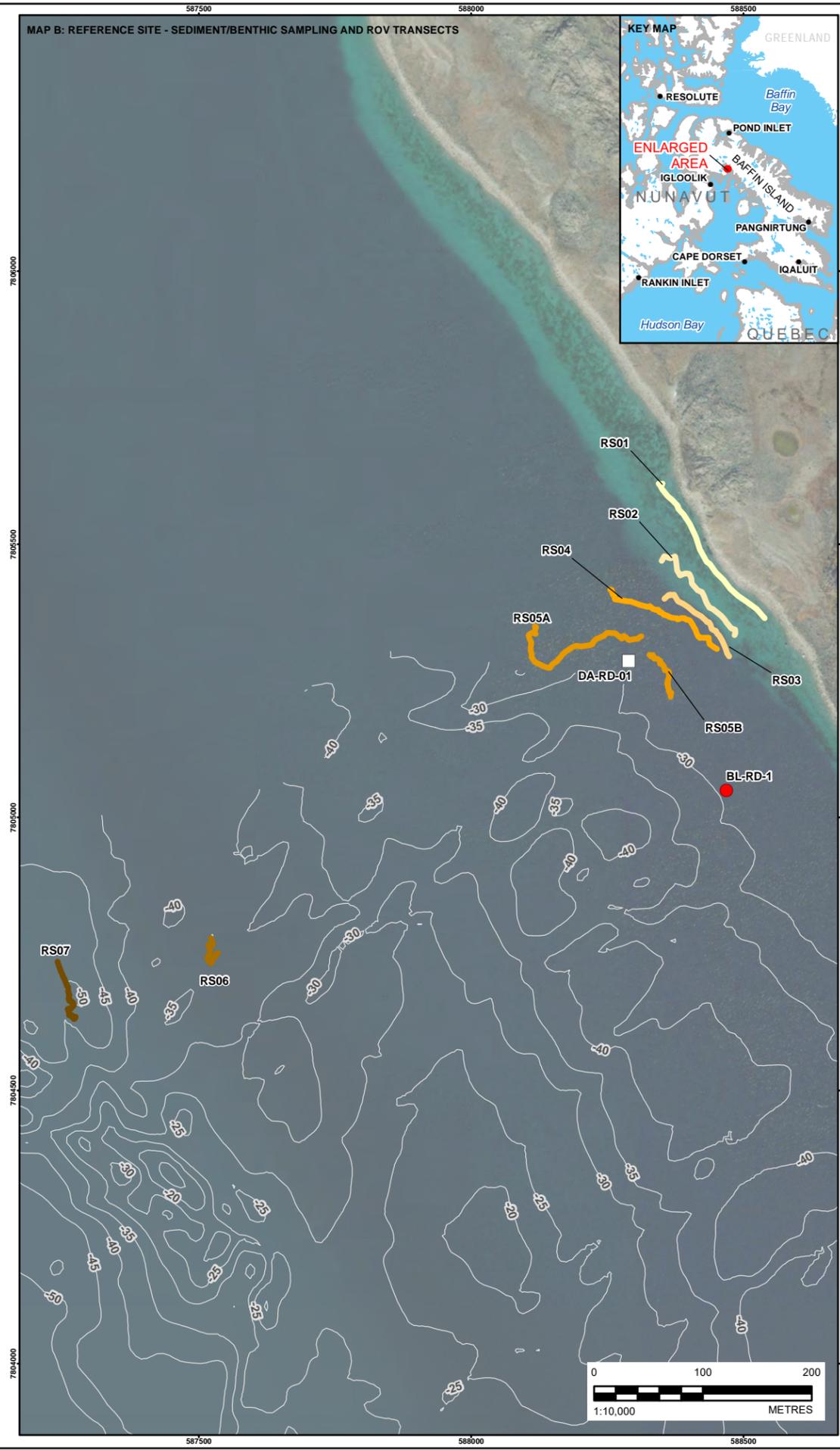
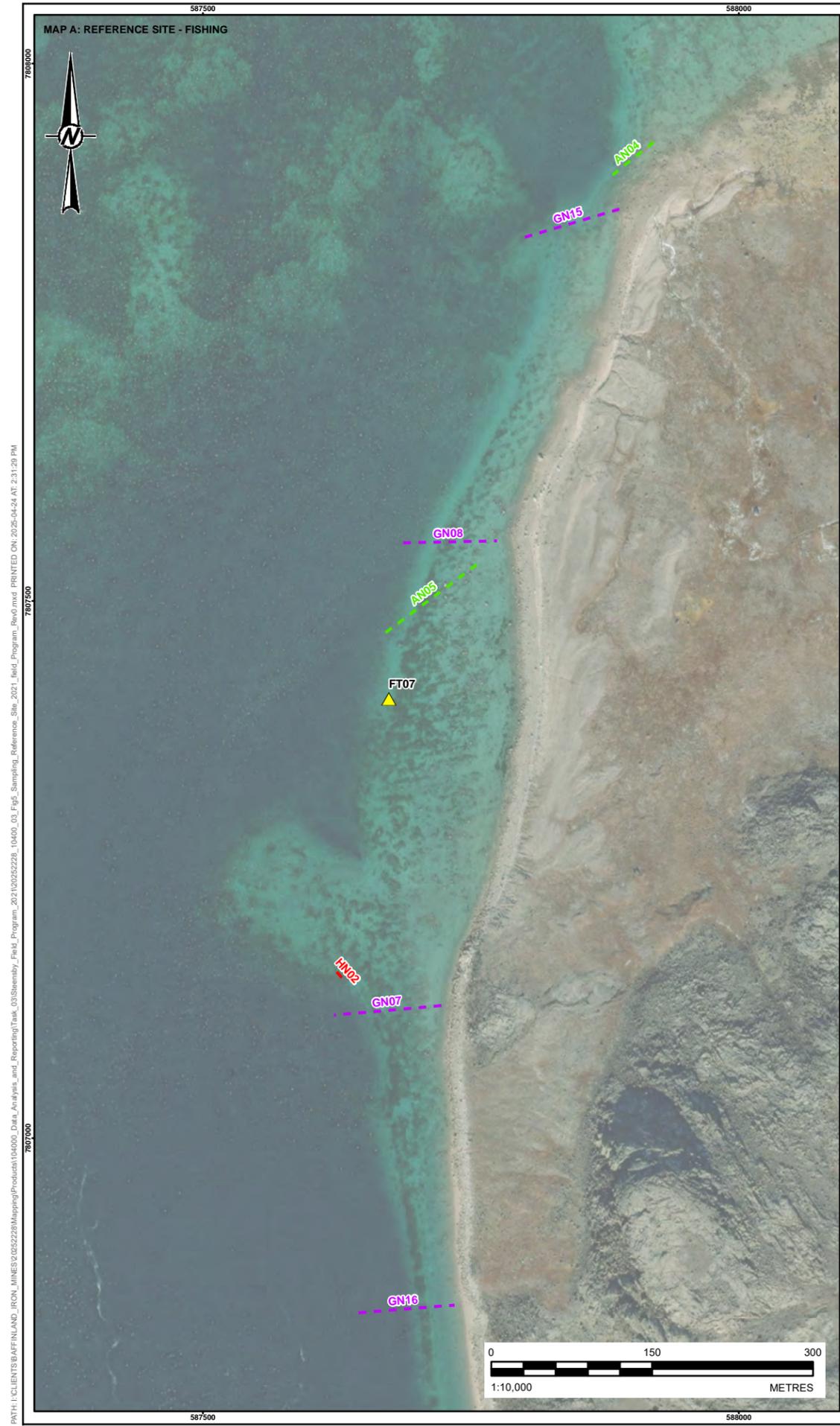
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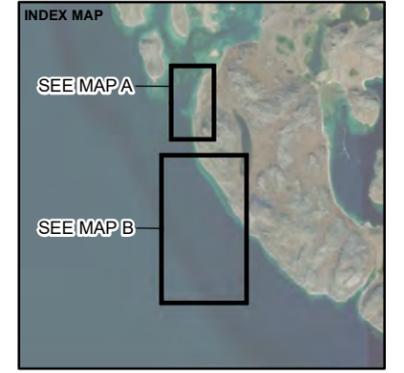
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wsp GOLDER	DESIGNED	JD
	PREPARED	NB/AA
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	APPROVED	PR

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 - FISHING EFFORT**
 - FUKUI TRAP
 - ANGLING
 - GILL NET
 - HOOP/FYKE NET
 - SEDIMENT/BENTHIC SAMPLING**
 - SEDIMENT ONLY LOCATION
 - UNSUCCESSFUL LOCATION
 - ROV TRANSECT (DEPTH CLASSIFICATION)**
 - +3 TO 0 M CD
 - 0 TO -5 M CD
 - 5 TO -10 M CD
 - 10 TO -20 M CD
 - 20 TO -30 M CD
 - 40 M CD
 - 50 M CD



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PROJECT
SECOND IRON ORE PORT – STEENSBY 2021 FIELD PROGRAM

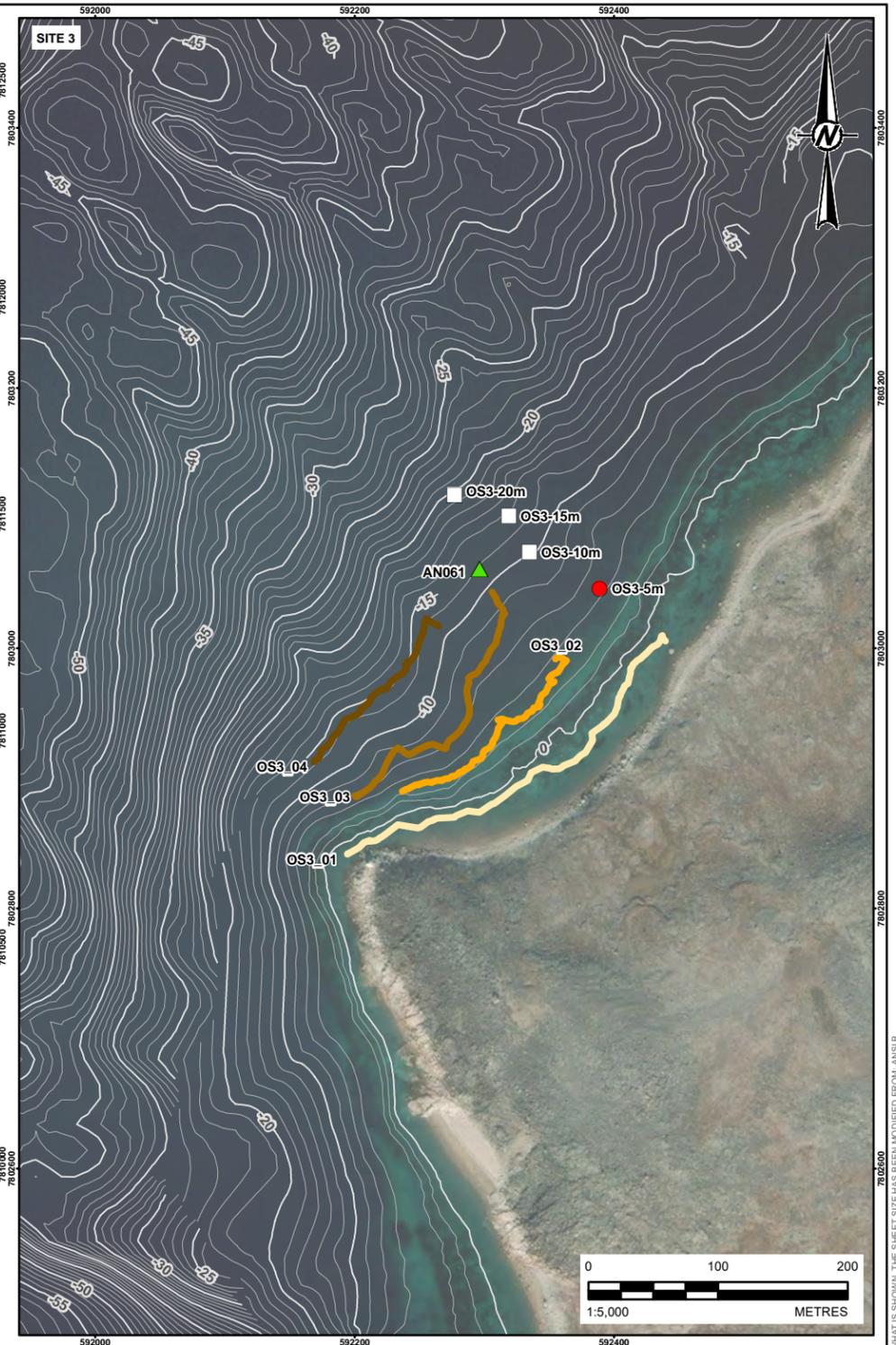
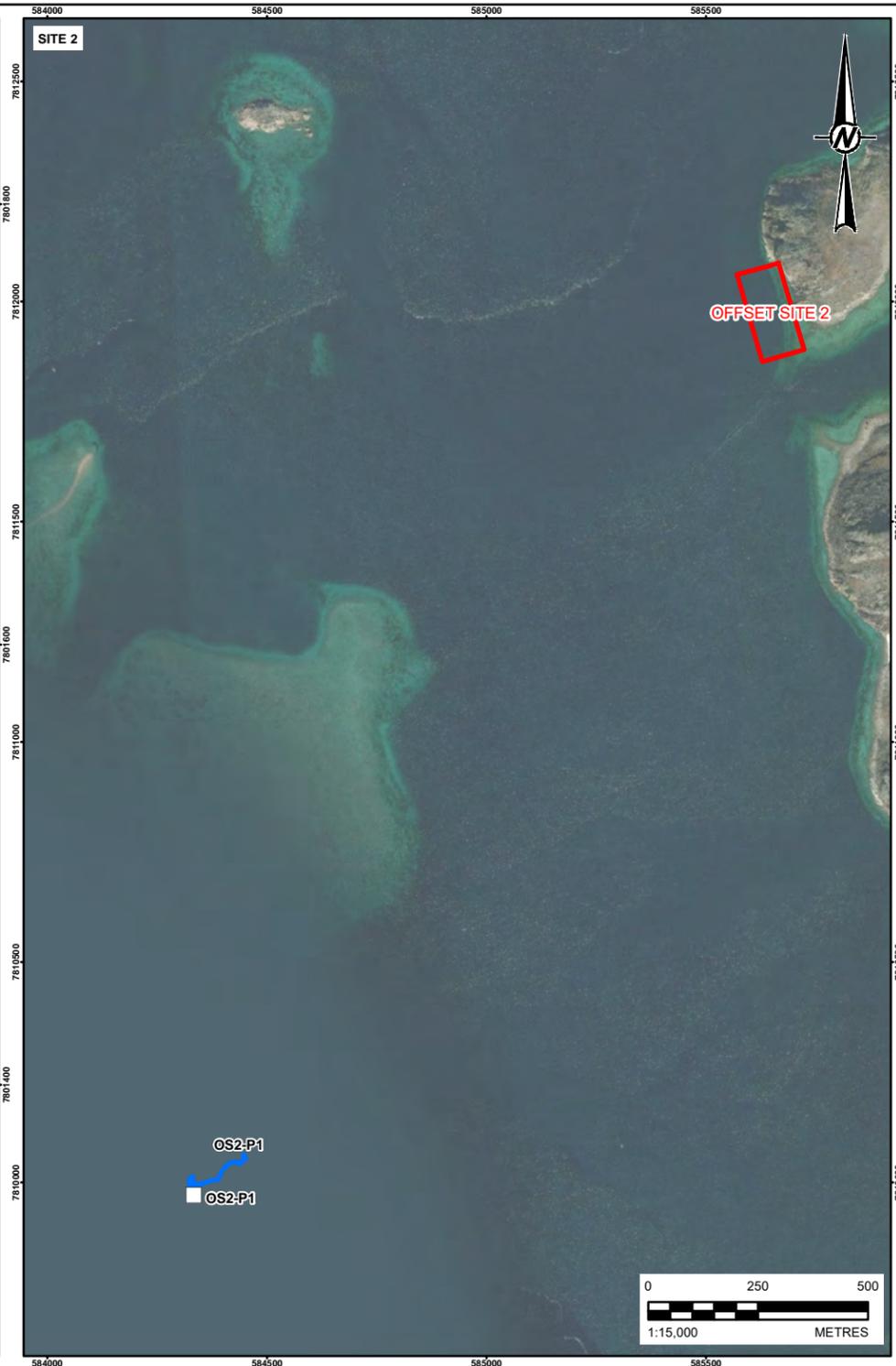
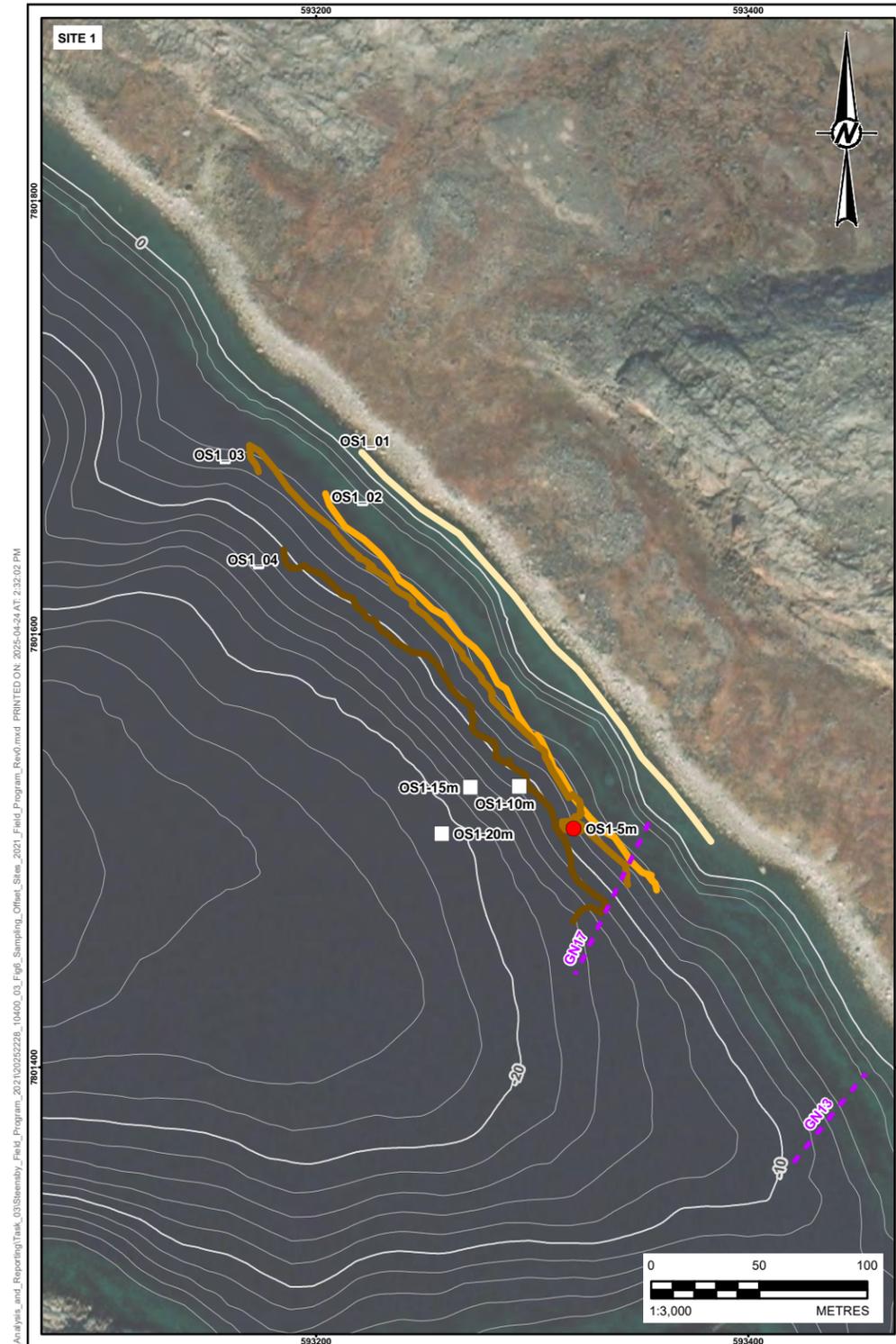
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DESIGNED		JD
PREPARED		NB/AA
REVIEWED		PR
APPROVED		PR

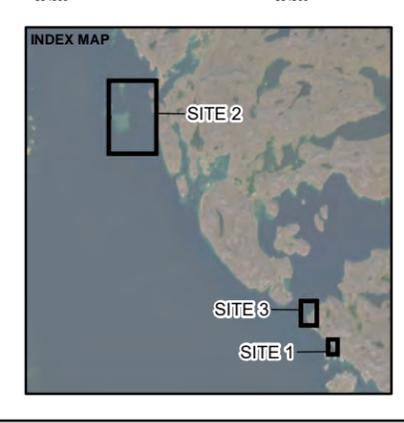
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 - BATHYMETRIC CONTOUR (5 m INTERVAL)
 - ROV TRANSECT
 - OFFSET SITE
 - ▲ ANGLING
 - GILL NET
 - SEDIMENT LOCATION
 - UNSUCCESSFUL LOCATION
- ROV TRANSECTS**
- +3 TO 0 M CD
 - 0 TO -5 M CD
 - -5 TO -10 M CD
 - -10 TO -20 M CD



CLIENT
BAFFINLAND IRON MINES CORPORATION

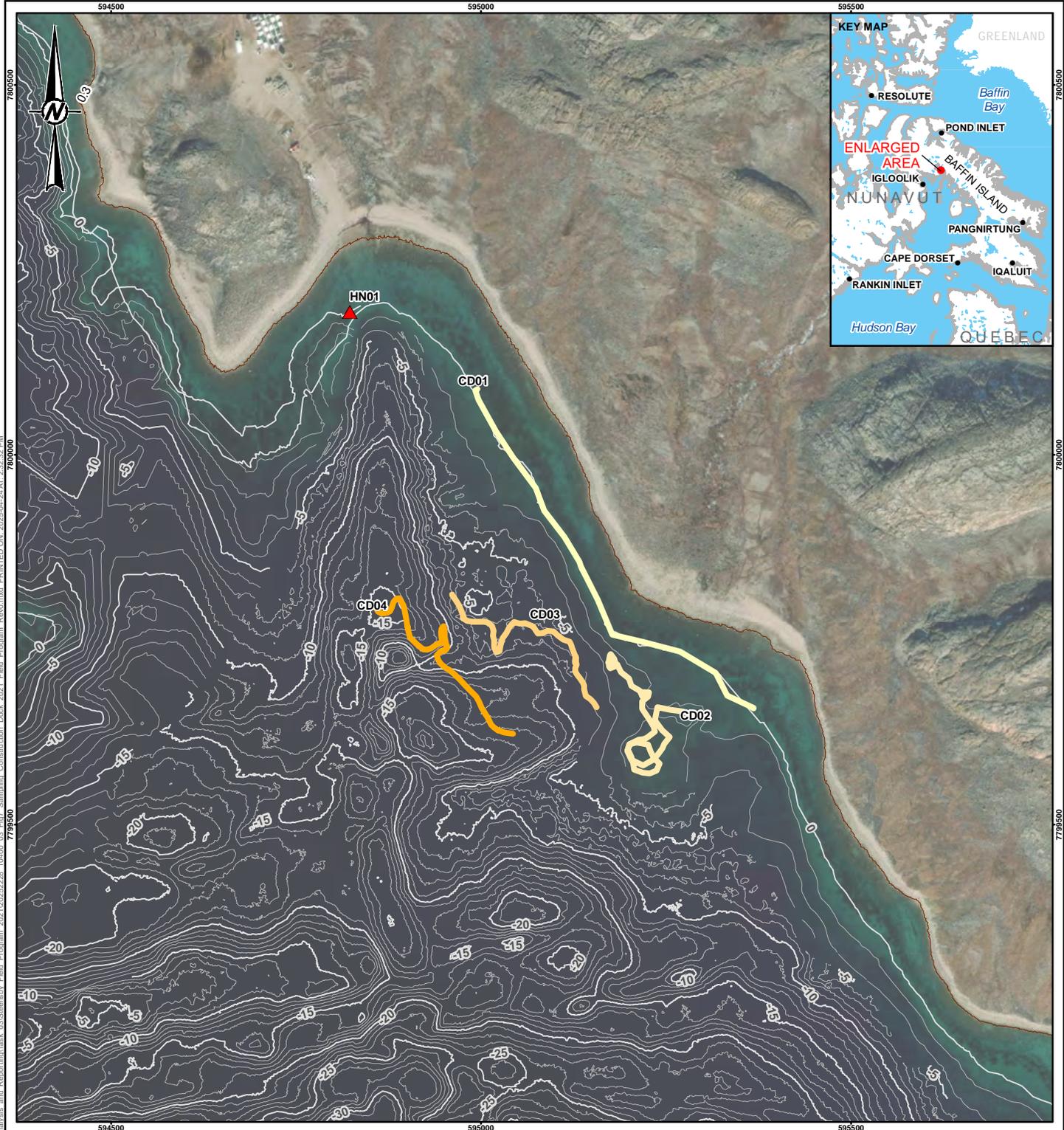
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PROJECT
SECOND IRON ORE PORT – STEENSBY 2021 FIELD PROGRAM

TITLE	PROJECT NO.	CONTROL	REV.	FIGURE
SAMPLING WITHIN THE OFFSET SITES DURING STEENSBY 2021 FIELD PROGRAM	20252228	10400-03	0	6

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 IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- BATHYMETRIC CONTOUR (1 m INTERVAL)
- BATHYMETRIC CONTOUR (5 m INTERVAL)
- SHORE (0.3 m CD)
- ▲ FISHING EFFORTS
- ▲ HOOP/FYKE NET
- ROV TRANSECT (DEPTH CLASSIFICATION)
- +3 TO 0 M CD
- 0 TO -5 M CD
- -5 TO -10 M CD
- -10 TO -20 M CD



REFERENCE(S)

STEENSBY SITE INFRASTRUCTURE AND BATHYMETRY DATA PROVIDED BY CLIENT, JULY 2021. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. IMAGERY COPYRIGHT © 20210816 ESRI AND ITS LICENSORS. SOURCE: MAXAR VIVID. USED UNDER LICENSE, ALL RIGHTS RESERVED. PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
SECOND IRON ORE PORT – STEENSBY 2021 FIELD PROGRAM

TITLE
SAMPLING WITHIN THE CONSTRUCTION DOCK DURING STEENSBY 2021 FIELD PROGRAM

CONSULTANT
YYYY-MM-DD 2022-03-23

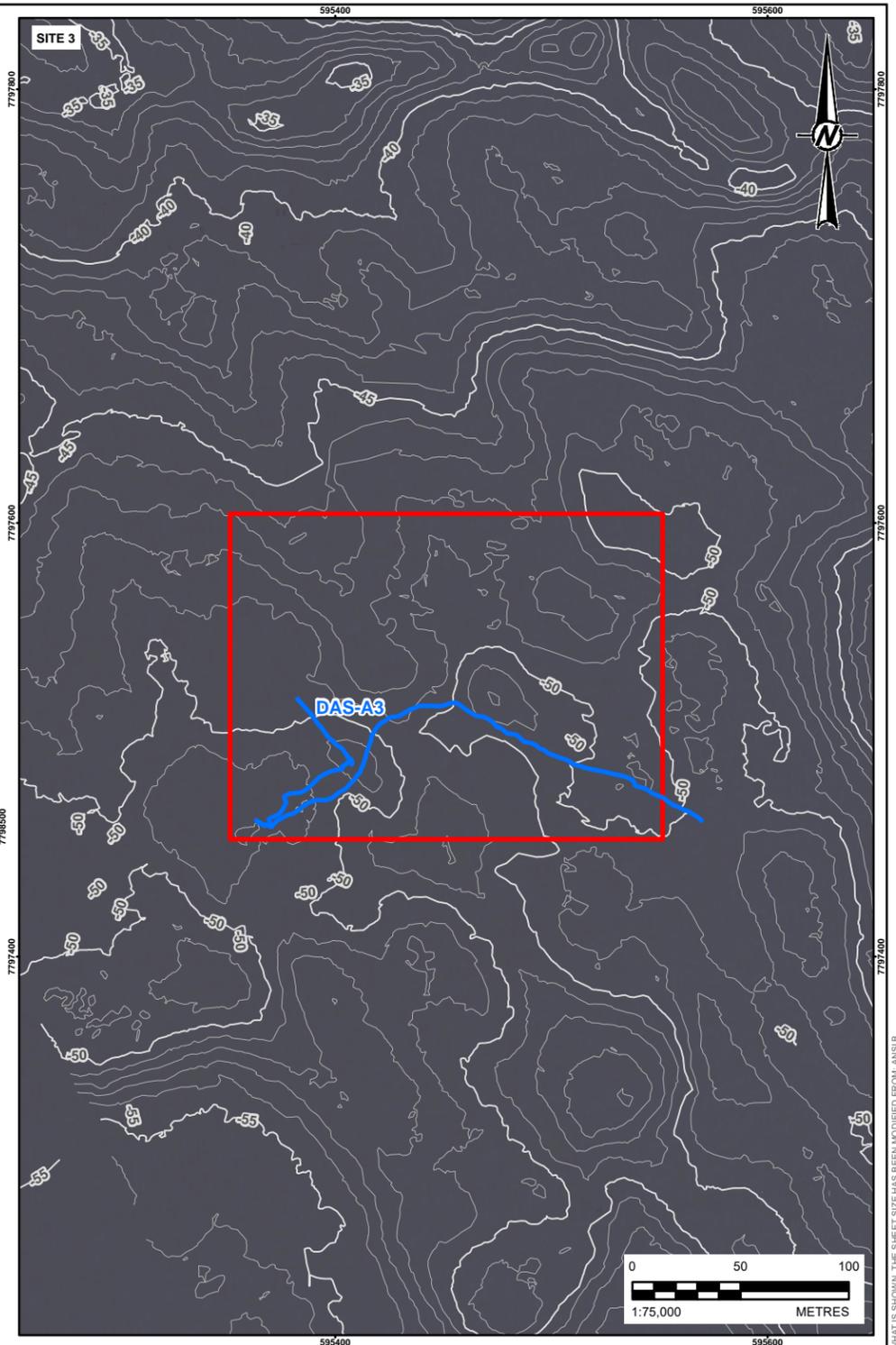
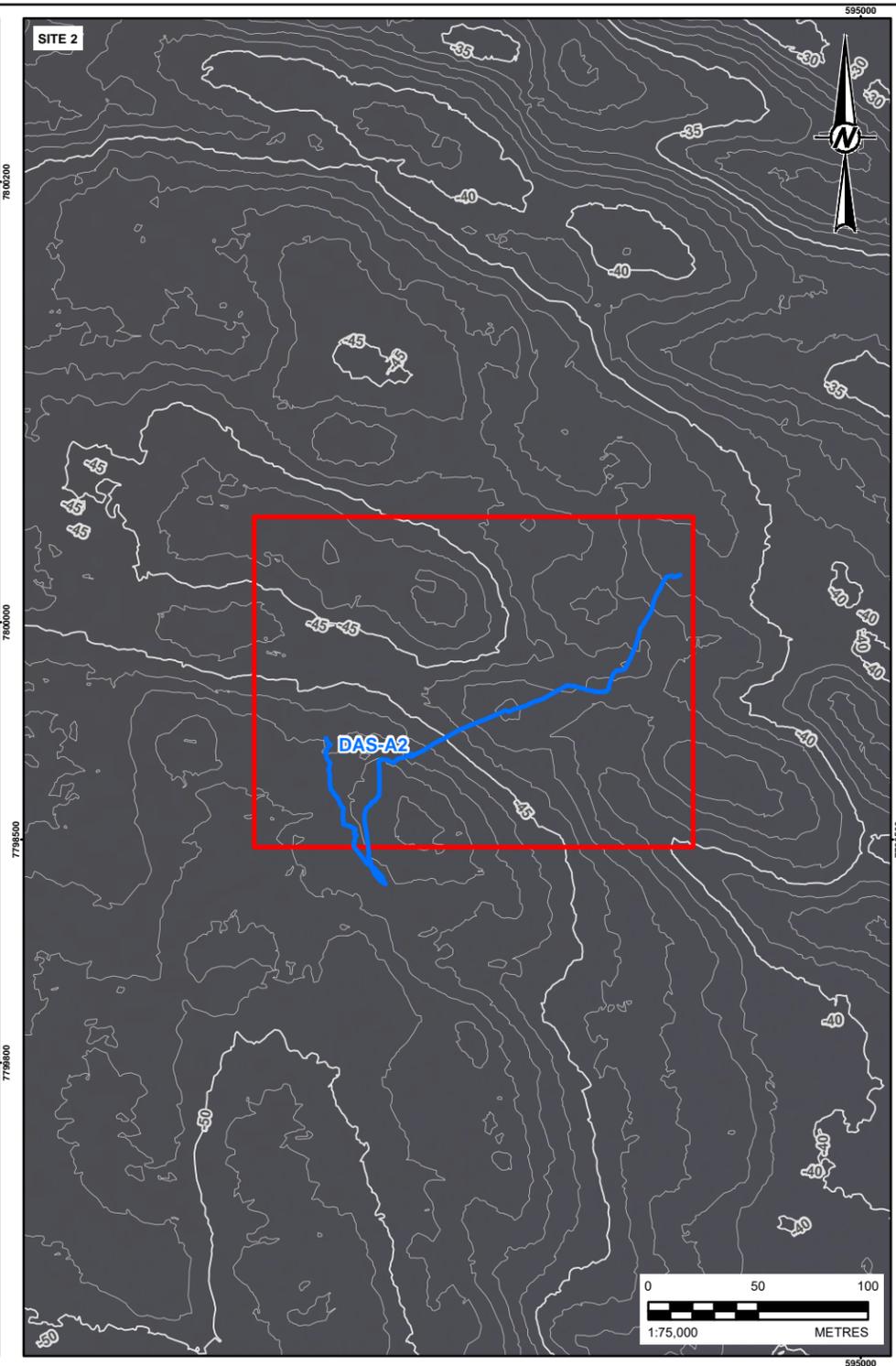
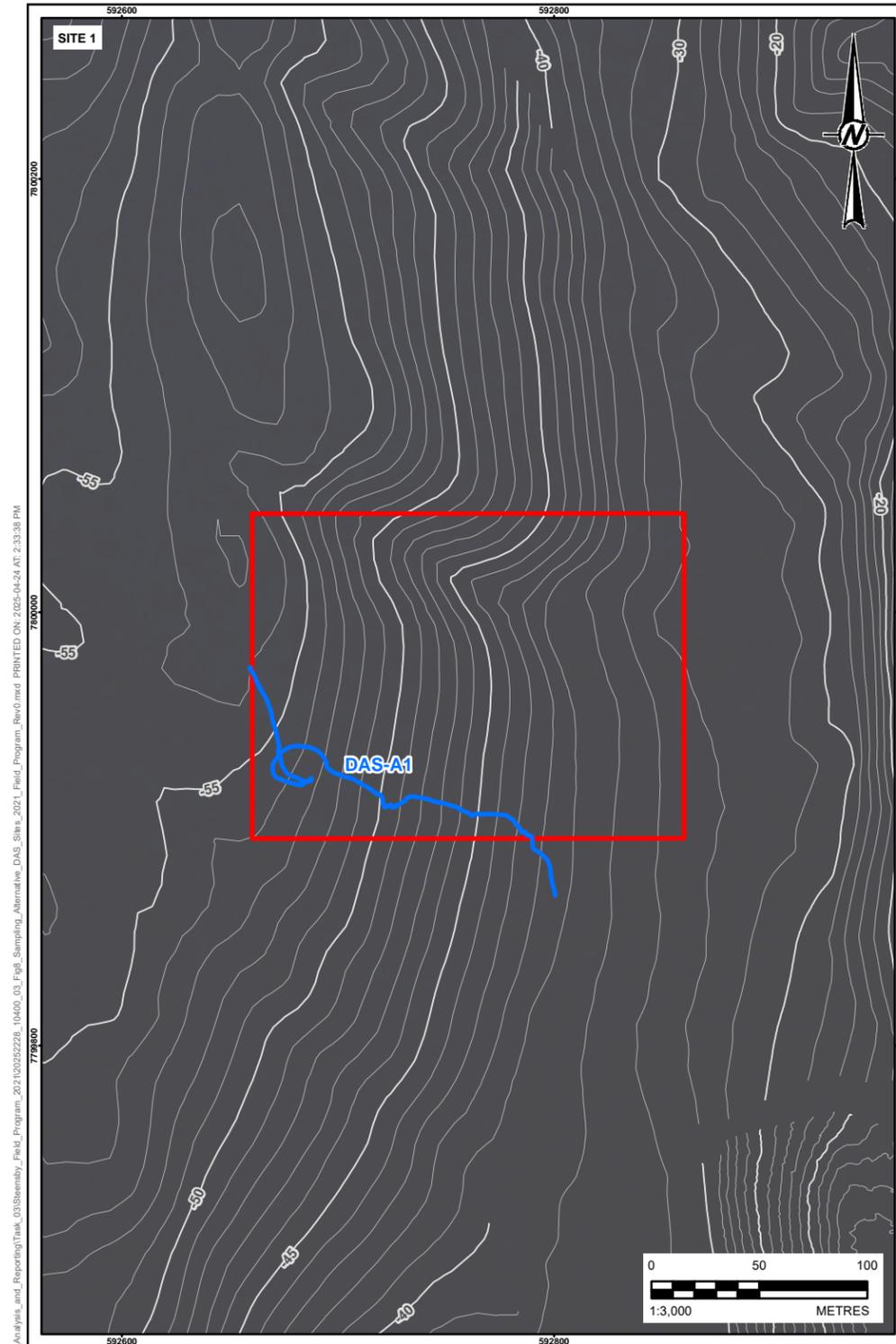


DESIGNED	JD
PREPARED	NB/AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
20252228	10400-03	0	7

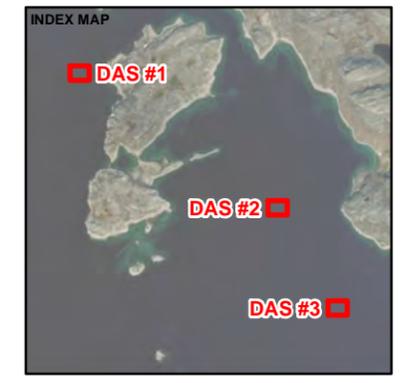
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 25mm



LEGEND

- BATHYMETRIC CONTOUR (1 m INTERVAL)
- BATHYMETRIC CONTOUR (5 m INTERVAL)
- ROV TRANSECT
- ▭ ALTERNATIVE DAS SITE



CLIENT
BAFFINLAND IRON MINES CORPORATION

CONSULTANT	YYYY-MM-DD	2022-03-23
wsp GOLDER	DESIGNED	JD
	PREPARED	NB/AA
	REVIEWED	PR
	APPROVED	PR

REFERENCE(S)
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PROJECT
SECOND IRON ORE PORT – STEENSBY 2021 FIELD PROGRAM

TITLE
SAMPLING WITHIN THE ALTERNATIVE DAS SITES DURING STEENSBY 2021 FIELD PROGRAM

PROJECT NO.	CONTROL	REV.	FIGURE
20252228	10400-03	0	8

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