Surface Water Monitoring Plan/Monitoring Plan, Nottingham Island, NU

Under Contract No. EW699-141143/002/NCS

Prepared for:
Northern Contaminated Sites Group, Public Works and Government Services Canada (PWGSC)

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1 Introduction

Public Works and Government Services Canada (PWGSC) are responsible for the environmental remediation of the abandoned weather station located on Nottingham Island. The site has undergone environmental site assessments that have identified waste and delineated contaminated materials that will require collection and removal from site. PWGSC has scheduled this remediation work to be completed during the summers of 2015 and 2016.

This monitoring plan is in response to the Nunavut Water Board (NWB) license No. 1BR-N1R1419 and memorandum dated September 24, 2015 to develop a surface water monitoring plan for the decommissioning and remedial activities at Nottingham Island.

The *Phase III Environmental Site Assessment, Nottingham Island, Nunavut*, report dated January 2013 completed by EBA, identified two lakes and two surface water bodies within the proposed work area and six samples from the ocean that exceeded the Canadian Council of Ministers of the Environment (CCME) guidelines for water. Observations made during the soil remediation work undertaken at the site between August 7 and October 5, 2015, determined that metal debris is present in each of the surface water bodies where the exceedances were measured. The removal of this debris is included in the remediation plan for the site. Remedial work undertakeng in 2015 did not disturb these surface water areas.

No metal exceedances were measure in water samples collected from the contact water in the competed remedial excavations conducted in 2015.

This document outlines the two proposed monitoring programs (Surface Water Monitoring and Monitoring Program) to be conducted in the vicinity of the work area.

The objective of the Surface Water Monitoring program is to establish the water quality in any permanent surface water bodies following one season of remedial excavation activities and to collect surface water quality data during the second season of excavation activities until the work is completed. This data will be evaluated to determine whether the excavation activities have impacted any surface water bodies within the vicinity of the remedial excavations. The locations to be sampled will be in the same general area as was previously sampled by EBA as presented in their report titled "Phase III Environmental Site Assessment", dated January 2013.

The Monitoring Program is to be undertaken at the Site by the remediation contractor (Biogenie) during the decommissioning and remedial activities. Surface water, effluent water, and groundwater samples, as appropriate, will be collected from eight monitoring points established in the vicinity of the fresh water intake, the sewage lagoon, and the landfarm facility. The intent of the program is to monitor the quality and volume of water used for the camp and other uses and the quality and quantity of effluent discharged from the sewage lagoon and landfarm facility.

2 Surface Water Monitoring Program

2.1 Scope of Work

The surface water monitoring program includes the following:

- Surface water monitoring locations;
- Surface water sampling procedures;

- Parameters to be monitored and monitoring frequency;
- QA/QC procedures for the surface water sampling and laboratory analyses; and
- Surface water response plan, specifying appropriate action(s) to be taken in the event of surface water impact identification.

2.2 Surface Water Monitoring Plan

2.2.1 SURFACE WATER MONITORING LOCATIONS

The surface water sampling locations will be the same general locations where samples were collected in 2013, as identified on the attached site plan in **Appendix A.** During the initial sampling event the sampling location will be marked with a stake, and GPS coordinates will be acquired and flagged so that subsequent sampling events can be performed at the same location.

2.3 Surface Water Monitoring Events

2.3.1 MONITORING EVENT FREQUENCY

The frequency of the surface water monitoring events at site will be every four weeks at each surface water body until the construction activities are completed for the year, commencing prior to the start of the 2016 excavation activities.

2.3.2 FIELD MONITORING PROTOCOL

Field monitoring protocols were developed to facilitate representative in-situ retrieval and preservation of surface water samples prior to laboratory analysis.

2.3.2.1 Field Log

Persons conducting the field-sampling program will record the following information for each day of field-sampling:

- Date;
- Field personnel;
- Weather conditions;
- Location visited;
- GPS coordinates;
- Field observations and measurements including depth from which sample taken; and
- Sample submission to laboratory procedure.

2.3.2.2 Field Observations and Measurements of Surface Water Quality

Field observations of the following surface water properties will be obtained during each sampling event and recorded:

- Colour;

- Odour;
- Any other visible substance or sheen; and
- Presence, thickness, and detection method of immiscible layers.

2.3.3 SURFACE WATER SAMPLING PROCEDURE

The following protocols will be utilized when sampling surface water:

- Sample bottle will not be allowed to come into contact with any surface that may contaminate the sample;
- Sample bottle will be lowered slowly into the water until it is entirely submerged with the bottle opening facing toward the flow direction (upstream or up-current);
- Intake depth should be duplicated for each monitoring event;
- Samples collected from the ocean will be collected as far as possible away from the shoreline (mid-stream preferred). Samples collected in ponds or other non-flowing water bodies will be collected away from the shoreline using waders or an extension rod attached to the sample bottle; and
- Sample will be preserved according to laboratory specifications.

2.3.3.1 Sample Submission to Laboratory

The following procedures are to be followed for sample submission to the laboratory:

- Confirm sample handling, preservation and shipping with the laboratory prior to sampling;
- Submit samples to the laboratory within the specified holding time limits;
- Use sample bottles and preservatives as outlined by the laboratory;
- Store and ship samples as specified by the laboratory; and
- Utilize a chain-of-custody program, and the chain of custody provided by the laboratory.

2.4 Quality Assurance and Quality Control Program

Quality Assurance and Quality Control (QA/QC) are actions taken to identify and prevent errors in the water chemistry data. The person collecting samples, the laboratory that analyzes the samples, and the person interpreting and analysing the results shall take actions for QA/QC.

There are three types of errors associated with water sampling and analysis: false positive errors, false negative errors, and undetermined errors. False positive errors include contaminated sample containers or laboratory derived contamination. False negative errors include volatile losses during sample collection. Undetermined errors include transcription errors and extraction errors in the laboratory.

2.4.1 SURFACE WATER SAMPLING

Sampling shall be in accordance with the detailed sampling protocols outlined in the CCME 2011 Protocols Manual for Water Sampling in Canada. During each surface water monitoring event, duplicate samples and blank samples shall be collected for QA/QC purposes.

2.4.2 LABORATORY ANALYSIS

The surface water samples will be submitted for laboratory analysis to Maxxam Analytics (Maxxam) at the Montreal, Quebec location. Maxxam is accredited to ISO/IEC 17025, the International Quality Standard for laboratories for the required analytical methods, and employs in-house QA/QC programs to govern sample analysis, including the analyses of method blanks, spiked blanks, and the analyses of duplicates (10%) for each sample batch.

2.5 Parameters of Interest

The parameters to be tested will monitor the impact of on-site activities on the surface water bodies. In general, the chemical parameters that may impact the water quality are major ions, trace metals and petroleum hydrocarbons.

Samples will be analyzed for the following parameters:

a. Copper, aluminum, lead, selenium, zinc, silver, fluoride, and chloride; and

b. Petroleum hydrocarbons.

2.6 Data Analysis

The surface water analytical results will be compared to the Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life.

The analytical data from the surface water monitoring events will be reviewed and a trend analysis performed to identify any increasing trends in the parameters of interest. If increasing trends are observed, the post-excavation data will be subjected to an Analysis of Variance (ANOVA) to determine whether a "statistically significant difference" exists between the pre and post excavation surface water data.

2.7 Surface Water Response Plan

In the event that any excavation analytical parameter values exhibit a "statistically significant difference", a response plan is required. The Surface Water Response Plan is described below and includes three stages: confirmation and verification, assessment, and development of a Risk Management/Remedial Action Plan.

2.8 Confirmation and Verification

In the event that a water monitoring result indicates a change in parameter concentration(s) in comparison to background or preexisting surface concentration(s), the monitoring results should be confirmed and verified by:

- Review of sampling and laboratory methods and procedures and the laboratory results including a review of the laboratory QA/QC data;

- Review of the excavation activities and operating records for apparent probable cause; and
- Resampling and analysis of the surface water from that location.

Should it be confirmed and verified that an error has occurred; the error will be documented with a report that includes the following:

- A clear indication that an error occurred;
- A clear indication of the source and reason for the error;
- The confirmatory sampling, testing, and analytical results; and
- Corrective measures to be taken in the future to prevent the recurrence of the error.

2.9 Assessment and Development of Risk Management/Remedial Action Plan

Should it be confirmed that the monitoring results accurately represent the existing surface water conditions, the departmental representative will assess whether the surface water results are due to naturally occurring conditions or due to site activities. Activities included in determining if the conditions are naturally occurring include:

- Checking for water infiltration from remedial excavation activities to the surface water; and
- Checking the environmental protection measures to prevent silt and water from entering the surface water.

If repairs or additional environmental protection measures are required to protect the surface water then all remedial excavation work will be stopped until these measures are completed.

The assessment will allow for the development of a risk management or remedial action plan, if required. This plan should identify the actions necessary to:

- Monitor the movement of the constituent plume;
- Develop action plans to capture or contain the plume;
- Determine the time frame for implementation of any action plan(s);
- Estimate the time frame to complete any implemented action plan(s); and
- Recommend any future actions

3 Monitoring Program

3.1 Scope of Work

The water monitoring program includes the following:

- Establishment of eight monitoring stations (NIR-1, NIR-2a, NIR-2b, and NIR-3 to NIR-7);

- Measurement and recording of the daily quantities of fresh water used;
- Measurement and recording the daily quantities of effluent NIR-2a, NIR-2b, NIR-3, and NIR4;
- Submission of effluent sample collected from NIR-4 for laboratory analyses;
- Collection of GPS coordinates of sources of water and waste disposal;
- Sampling of soil from the landfarm twice a year;
- Establishment of QA/QC procedures for the sampling and laboratory analyses; and
- Preparation of an annual report.

3.2 Water Monitoring Program

3.3 Water Monitoring Locations

The eight water monitoring locations will be established as outlined in the following table. The monitoring locations will be established in the same general locations as described in the water licence. The monitoring locations described below will be established by the contractor in consultation with Stantec during camp set-up. During the initial monitoring event, the monitoring point will be marked with a stake and sign, and GPS coordinates will be acquired so that subsequent monitoring and sampling events can be performed at the same location. The signs posted at each monitoring location will be in English, French, and Inuktitut.

Table 1 – Water Monitoring Locations

Water Monitoring Location ID	Location Description	Sample Type and Frequency
NIR-1	Fresh water intake	Potable water, sampled prior to use at camp and weekly thereafter, monitored daily
NIR-2a	Sewage lagoon cell 1 discharge	Sewage effluent, sampled prior to any discharge, monitored daily.
NIR-2b	Sewage lagoon cell 2 discharge	Sewage effluent, sampled prior to any discharge, monitored daily.
NIR-3	Discharge from demolition rinse area	Contaminant effluent, sampled prior to any discharge, monitored daily.
NIR-4	Discharge from landfarm, downgradient	Contaminant effluent, sampled prior to any discharge, monitored daily.
NIR-5	Monitoring well downgradient of landfarm	Landfarm seepage monitored and sampled prior to use of landfarm and at least twice annually.
NIR-6	Monitoring well downgradient of landfarm	Landfarm seepage monitored and sampled prior to use of landfarm and at least twice annually.
NIR-7	Monitoring well upgradient of landfarm	Background sample, monitored and sampled prior to use of landfarm and at least twice annually.

3.4 Water Monitoring Events

3.4.1 MONITORING EVENT FREQUENCY

Monitoring location NIR-1 at the fresh water intake will be monitored on a daily basis. The monitoring will include the volumes of surface water used for camp and construction purposes. The NWB licence permits the use of not more than 7 m^3 per day of surface water for camp purposes and not more than 13 m^3 per day for construction purposes.

The remaining monitoring locations, NIR-2a, NIR-2b, and NIR-3 to NIR-7, will be monitored as required by the terms of the NWB licence, as outlined in Table 1 above.

3.4.2 FIELD MONITORING PROTOCOL

Field monitoring protocols were developed to facilitate representative in-situ retrieval and preservation of surface water samples prior to laboratory analysis.

3.4.2.1 Field Log

Persons conducting the monitoring and sampling program will record the following information for each day of monitoring and sampling:

- Date;
- Name of field personnel;
- Weather conditions;
- Location visited;
- GPS coordinates;
- Quantity of water taken or discharged in cubic metres; and
- Sample collection according to laboratory submission procedure, if required.

3.4.2.2 Field Observations and Measurements of Water Quality

Field observations of the following water properties will be recorded during each monitoring event:

- Water colour;
- Odour;
- Any visible substance or sheen; and
- Presence, thickness, and detection method of immiscible layers.

3.4.3 SAMPLING EVENT FREQUENCY

The eight monitoring locations will be sampled as required throughout the remediation work. The frequency of sampling will be dependent on the progress of the remediation work. The fresh water intake (NIR-1) will be sampled prior to use of the water and weekly thereafter. The remaining monitoring locations (NIR-2a, NIR-2b, and NIR-3 to NIR-7) will be sampled as outlined in Table 1 prior to and following discharge.

3.4.4 WATER SAMPLING

The following protocols will be utilized when sampling surface water:

- Sample bottle will not be allowed to come into contact with any surface that may contaminate the sample;
- Sample bottle will be lowered slowly into the water until it is entirely submerged with the bottle opening facing toward the flow direction (upstream or up-current);
- Intake depth should be duplicated for each monitoring event;
- Samples collected in ponds or other non-flowing water bodies will be collected away from the shoreline using waders or an extension rod attached to the sample bottle; and
- Samples will be preserved according to laboratory specifications.

The following protocols will be utilized when sampling groundwater:

- Monitoring wells will be developed following installation;
- Monitoring wells will be purged prior to each sampling event;
- Sample bottle will not be allowed to come into contact with any surface that may contaminate the sample;
- Sample bottle will be filled by direct transfer, without agitation, from the pumping system to the appropriate sample bottle;
- Samples will be preserved according to laboratory specifications.

3.4.4.1 Sample Submission to Laboratory

The following procedures are to be followed for sample submission to the laboratory:

- Confirm sample handling, preservation and shipping with the laboratory prior to sampling;
- Submit samples to the laboratory within the specified holding time limits;
- Use sample bottles and preservatives as outlined by the laboratory;
- Store and ship samples as specified by the laboratory; and
- Utilize a chain-of-custody program, and the chain of custody provided by the laboratory.

3.5 Quality Assurance and Quality Control Program

Quality Assurance and Quality Control (QA/QC) are actions taken to identify and prevent errors in the water chemistry data. The person collecting samples, the laboratory that analyses the samples, and the person interpreting and analysing the results shall take actions for QA/QC.

There are three types of errors associated with water sampling and analysis: false positive errors, false negative errors, and undetermined errors. False positive errors include contaminated sample containers or laboratory derived contamination. False negative errors include volatile losses during sample collection. Undetermined errors include transcription errors and extraction errors in the laboratory. The QA/QC program includes preventive measures considering all three error types.

3.5.1 WATER SAMPLING

Sampling shall be in accordance with the detailed sampling protocols outlined in the *Standard Methods for the Examination of Water and Wastewater*. During each sampling event, duplicate samples and blank samples shall be collected for QA/QC purposes in accordance with the QA/QC Plan discussed below.

3.5.2 LABORATORY ANALYSIS

The water and soil samples will be submitted for laboratory analysis to Maxxam Analytics (Maxxam) at the Montreal, Quebec location. Maxxam is accredited to ISO/IEC 17025, the International Quality Standard for laboratories for the required analytical methods, and employs in-house QA/QC programs to govern sample analysis, including the analyses of method blanks, spiked blanks, and the analyses of duplicates (10%) for each sample batch.

At least 30 days prior to the first release of effluent from the sewage lagoons, rinse area, or landfarm, the contractor will submit a QA/QC Plan to the NWB for review. The QA/QC Plan will outline the sampling and analysis methods to be employed. The QA/QC Plan will include a cover letter from Exova (Biogenie's Laboratory)confirming their acceptance of the QA/QC Plan.

3.6 Parameters of Interest

The parameters to be analysed in the samples collected will vary according to the type of sample collected. The laboratory analyses are presented in Table 2 below.

Table 2 – Laboratory Analyses

Sample Type	Laboratory Analyses
Potable Water (NIR-1)	pH, total coliform, E.coli, total alkalinity, fluoride, nitrate, nitrite, turbidity, hardness, colour, conductivity, sulphate, chloride, total dissolved solids, total metals, total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, benzene, toluene, ethylbenzene, xylenes, and polychlorinated biphenyls.
Sewage Effluent Samples (NIR-2a and NIR-2b)	pH, oil and grease, fecal coliforms, total suspended solids, biological oxygen demand.
Contaminant Effluent/Seepage Samples (NIR-3 to NIR-7)	pH, total suspended solids, nitrate-nitrite, total phenols, total hardness, conductivity, ammonia nitrogen, oil and grease, sulphate, total alkalinity, potassium, calcium, sodium, magnesium, chloride, total and dissolved cadmium, total and dissolved copper, total and dissolved chromium, total iron, total and dissolved lead, total mercury, total and dissolved nickel, total zinc, total phosphorus, total aluminum, total arsenic, total manganese, total cobalt, total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, benzene, toluene, ethylbenzene, xylenes, and polychlorinated biphenyls.

3.7 Data Analysis

The water analytical results will be compared to the Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life and those outlined in the NWB Licence No. 1BR-NIR1419. The potable water analytical results will be compared to the Canadian Drinking Water Quality Guidelines (CDWQ).

The laboratory analytical results obtained by the Contractor will be submitted to Stantec for review as the Departmental Representative on the project.

3.8 Annual Report

An annual report will be prepared and submitted to the NWB, on or before March 31 of each calendar year following work at the Nottingham Island site. The annual report will meet the requirements of Part B: General Conditions of the NWB Licence No. 1BR-NIR1419. Specifically, the annual report will address the following items:

- The monthly and annual quantities (in cubic metres) of fresh water withdrawn from all sources;
- The monthly and annual quantities (in cubic metres) of material deposited at any Landfarm Facility constructed at the Project site;
- Characterization of the soils placed in any Landfarm Facility for treatment;
- The monthly and annual quantities (in cubic metres) of effluent discharged from any Landfarm Facility;
- The monthly and annual quantities (in cubic metres) of any rinse water discharged from activities associated with the project;
- The monthly and annual quantities (in cubic meters) of treated sewage discharged from the Sewage Treatment Facility;
- A summary of all waste backhauled for disposal, including hazardous waste at approved facilities under Part D, Item 15;
- A summary of any construction work, modification and major maintenance work (including as-built drawings) carried out on the Sewage Disposal Facility, Landfarm Facility, and other infrastructure or facilities associated with the project;
- Tabular summaries for all data and information generated under the "Monitoring Program";
- An analysis of data collected during the "Monitoring Program" and a brief description of any future studies planned by the Licensee;
- A summary of remediation work undertaken during the year and an outline of work anticipated for the following year;
- A summary of any studies requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned;
- A list of unauthorized discharges and a summary of follow-up actions taken;
- Any revisions to the approved plan entitled "Remedial Action Plan Former Weather Station Nottingham Island, Nunavut, dated April 2013;
- Any revisions to the approved Spill Contingency Plan dated July 2013;
- If applicable, a description of any trenches and sumps excavated, including but not limited to the following: GPS coordinates, dimensions, depth below active layer, and secondary containment features;
- If applicable, a public consultation/participation report describing consultation with local organizations and the residents of the nearby communities;
- A brief summary of work done to address concerns or deficiencies listed in the inspection reports and/or compliance reports prepared by an Inspector;
- An executive summary in English, French and Inuktitut of all plans, reports, or studies conducted under this Licence; and
- Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

4 Closure

We trust that the proposed work plan is satisfactory for your purposes at this time. If you have any questions or concerns, please do not hesitate to contact Allen MacGarvie.

Respectfully submitted,

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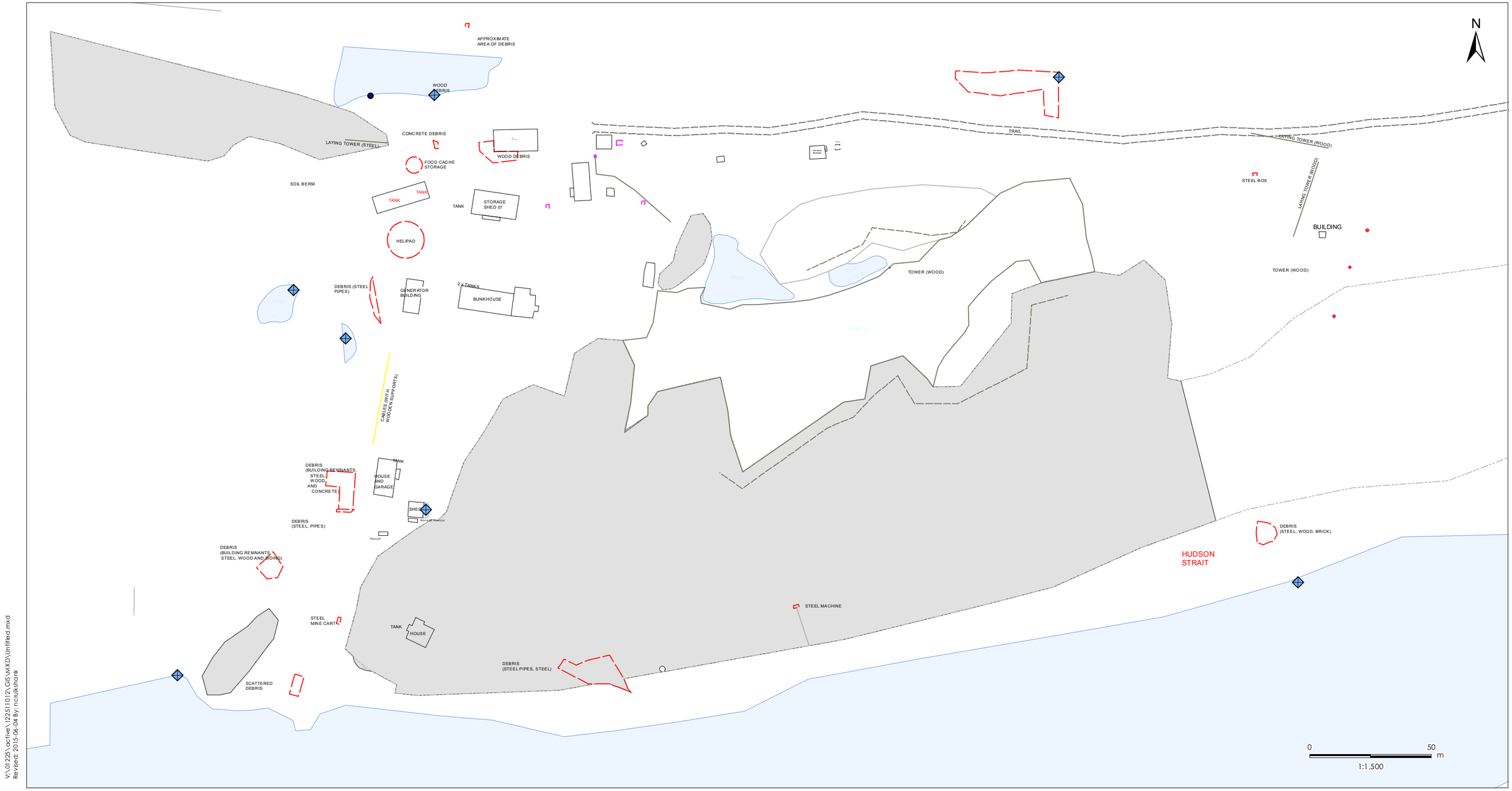
APPENDIX A

SAMPLE LOCATION PLAN



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Revised: 2015-06-04 By: ncruikshank

June 2015
Project No. 122511012

Stantec

Notes

1. Coordinate System: NAD 1983 UTM Zone 18N
2. Base features adapted from CAD files provided by previous research (EBA 2013)

Legend

- Surface Water Sample Location
- Building
- Rock Outcrop
- Water
- Other Site Feature

Client/Project

PWGSC
Nottingham Island Former Weather Station
Nunavut, Canada

Figure No.

1

Title

Surface Water Monitoring Plan