Former U.S. Coast Guard LORAN Station, Cape Christian, Nunavut

Remediation Action Plan

Former U.S. Coast Guard Loran Station, Cape Christian, Nunavut

Remediation Action Plan (FINAL)

Prepared for:

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January 2007

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EXECUTIVE SUMMARY

As the caretaker of federal lands in Canada's north, Indian and Northern Affairs Canada (INAC) is responsible for the care and management of sites that are no longer maintained by the original owner/operator. These sites are often contaminated as a result of mining, oil and gas activities, as well as from government military activities, which took place before environmental impacts were understood. Through the Contaminated Sites Program (CSP), INAC has made it a priority to assess, prioritize, mitigate and remediate the environmental impacts of contaminated sites in Canada's North. As a result, INAC is required to develop a Remedial Action Plan (RAP) for the former United States Coast Guard Long Range Navigation (LORAN) Station at Cape Christian, Nunavut.

In support of the RAP, Earth Tech Canada, on behalf of INAC, has prepared this report which identifies remediation options, critiques potential remediation methods, and provides recommendations for site restoration.

This RAP for the former Cape Christian LORAN site was designed in accordance with the INAC Abandoned Military Site Remediation Protocol (March 2005). This Protocol is designed to address legal requirements, health and safety issues, INAC's Contaminated Sites Management Policy requirements and standard environmental issues. The Protocol identifies financially prudent methodologies that address all the requirements listed above while maintaining a cost effective remediation project.

The table below provides a summary of the issues and associated action items for the remediation of the Cape Christian site.

Site Access	Details	Recommended Action
Barge Landing Area	Barge access is an option for getting heavy equipment and required materials to the Cape Christian site for the remediation program.	Contractor to select site access option.
Site Roads	Site roads at Cape Christian are not adequate to facilitate required remediation activities.	Contractor to upgrade site roads as required for remediation activities. Suggested to upgrade roads leading from beach to the main station to facilitate travel of heavy equipment.
Airstrip	Airstrip is not in usable state.	If Contractor plans to use existing airstrip, upgrade airstrip as per recommendations prior to use.

Site Facilities	Details	Recommended Action
Camp	Camp facilities for remediation staff.	Contractor to select camp location as desired. Suggested locations indicated in **Figure 2.0** of **Appendix A.**
Borrow Sources	Borrow material is required for road improvements, airstrip upgrade, land farm and landfill construction.	As borrow is required by Contractor, develop identified borrow sources in accordance with the INAC Abandoned Military Site Remediation Protocol, (March 2005).
Waste Handling Facility	A contained waste handling facility is required to accept, sort and containerize waste generated from the remediation activities at Cape Christian.	Contractor to construct waste handling facility as required. Suggested location is indicated on **Figure 8.0** of **Appendix A.**
Landfill	An on site landfill is required on site for the deposition of all on site non hazardous material.	Contractor to drain existing freshwater reservoir and convert into an onsite landfill. Modify drainage in surrounding area to promote drainage away from landfill.
Land Farm	An on site land farm is required for the on site treatment of the hydrocarbon contaminated soils.	Contractor to construct land farm for soil treatment. It is suggested to construct land farm at proposed land farm area shown on **Figure 8.0** of **Appendix A.**

Environmental Issue	Details	Recommended Action
Site Debris	Approximately 2,800 m^3 of non-hazardous debris (heavy equipment, buildings, building foundations, tanks, etc.).	Consolidate and dispose of in on site non hazardous landfill.
Worked Areas 2 through 8 (South Beach Area)	7 areas of land filled material (barrels, building material, etc.).	Excavate land filled and consolidate buried material in the on site hazardous waste landfill.
Tier 1 Soils	Approximately 66 m^3 of soils with contaminant concentrations in exceedance of INAC Abandoned Military Site Remediation Protocol Tier 1 soils criteria.	Excavate and place in on site non hazardous waste landfill.
Tier 2 Soils	Approximately 395 m^3 of soils with contaminant concentrations in exceedance of INAC Abandoned Military Site Remediation Protocol Tier 2 soils criteria.	Excavate contaminated soils and place into containers, and ship off site to a licensed disposal facility.

Environmental Issue	Details	Recommended Action
Petroleum Hydrocarbon Contaminated Soils	Approximately 1700 m^3 of hydrocarbon contaminated soil in exceedance of the INAC Abandoned Military Site Remediation Protocol, modified CCME CWS Petroleum Hydrocarbon Criteria.	Excavate and treat in an on site land farm cell.
POL Fluids	Approximately 6,800 L of Petroleum, Oil and Lubricant fluids.	Place POLs into containers, and ship off site to a licensed disposal facility.
PCB Contaminated Paint Items	Approximately 12 m^3 of PCB painted materials.	Dismantle contaminated paint items and ship off site to licensed disposal facility.
Lead Contaminated Paint Items	Approximately 113 m^3 of lead painted materials.	Dismantle contaminated paint items and ship off site to licensed disposal facility.
Hazardous Materials	Approximately 30 m^3 of hazardous materials (lead acid batteries, pressurized cylinders, paints and chemicals).	Containerize and dispose all hazardous materials in accordance with the INAC Protocol.
Asbestos	Approximately 21 m^3 of asbestos containing materials (pipe insulation, transite board and matted insulation). Some of the transite board is painted with Lead/PCB contaminated paint and will therefore have to be shipped of site for disposal.	Abate asbestos not painted with Lead/PCB Paint (approximately 10 m^3) in accordance with the appropriate legislation. Double bag and place in on site engineered landfill. Transite board painted with Lead/PCB paint (approximately 10 m^3) shall be abated and disposed of off site at a licensed disposal facility.
Archeological Site	There is a historic archeological site located as indicated in **Figure 8.0** of **Appendix A.**	Ensure the historic archeological site is not disturbed during remediation activities.

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

The Department of Indian Affairs and Northern Development (DIAND), as the caretaker of federal lands in Canada's north is responsible for the care and management of contaminated sites that are no longer maintained by the original owner/operator. These sites are often a result of mining, oil and gas activities, as well as government military activities, which took place before environmental impacts were a major concern. Through the CSP, DIAND has made it a priority to assess, prioritize and mitigate/remediate the environmental impacts of contaminated Sites in Canada's North. The former United States Coast Guard Long Range Navigation (LORAN) Station at Cape Christian, Nunavut is one of these sites.

The previously identified environmental site issues at Cape Christian include contaminated soils, landfills, site buildings, hazardous materials, petroleum products, fuel storage tanks, and empty and full barrels.

2.0 OBJECTIVES

The main purpose of this RAP was to identify remediation options, critique potential remediation methods, and provide recommendations for site restoration. Based on assessment activities completed by Earth Tech in August 2006, a comprehensive site remediation work plan was developed. Remediation options were developed for each waste stream identified at the site, and were critically evaluated to discuss potential risks, advantages, and disadvantages of each remediation option. Based on a number of factors, outlined below, recommendations were made as to the preferred remediation approach. Also, INAC has conducted a community meeting in Clyde River and incorporated community input in selecting the remedial option for each waste stream.

The RAP was designed to meet the following cleanup objectives in accordance with the INAC Abandoned Military Site remediation Protocol:

1. Restore the site to an environmentally safe condition;
2. Prevent the migration of contaminants info the Arctic ecosystem;
3. Remove physical hazards for the protection of human health and safety; and
4. Implement a cost effective remediation solution.

The end product was a cost effective RAP for Cape Christian.

3.0 SITE DESCRIPTION

Cape Christian is located on the north shore of Baffin Island, Nunavut. The U.S. Coast Guard used this site as a LORAN Communication Station, during the Cold War era from 1954 to 1974. The site is somewhat remote and is located near the mouth of the Clyde River approximately 16 km northeast of the Hamlet of Clyde River, on the northeast coast of Baffin Island. The station coordinates are Latitude $70^0$31'N, and Longitude $68^0$17'W. Access to the former station is either by ATV or fixed wing aircraft with tundra tires. The location of Cape Christian relative to the coastline of Baffin Island is provided in **Figure 1.0** of **Appendix A**. **Figure 2.0** shows the overall site layout and major features. Major site features include three (3) buildings, six (6) large AST's, a water reservoir, a large equipment dump, and eight (8) buried debris areas along the beach. Identified environmental site issues at Cape Christian include contaminated soils, hazardous materials and petroleum products.

4.0 BIOPHYSICAL ENVIRONMENT

4.1 Physiographic Description

The site resides near the mouth of the Clyde River in the Baffin Island Coastal Lowlands. The terrain is rolling with some bedrock outcrops. The surface drainage of the site is generally to the north towards the Baffin Bay. Depending on the season, permafrost is encountered between 0.5 and 0.75 meters below ground surface.

4.2 Climate

The climate at Clyde River is described as a humid cold arctic climate with short summers and long winters. The annual precipitation measured at Clyde River is 225.6 mm with the majority (87%) coming from snow. The mean daily temperatures vary from -28 degrees Celsius to 4.2 degrees Celsius with an average of -12.4 degrees.

4.3 Flora

The flora at the Cape Christian site consists of mosses, sedges, willows, grasses, mosses, and flowering herbs.

4.4 Fauna

Fauna in the area includes caribou, arctic hare, arctic fox, lemming and several species of birds (King eider, rock ptarmigan, northern fulmar, plover, hoary redpoll and snow bunting). Typical marine fauna includes walrus, seal, whale and polar bear.

5.0 INAC SITE REMEDIATION PROTOCOL

5.1 General

Numerous factors affect the suitability of site remediation plans, and must be considered when determining a site specific remediation plan. For this reason, INAC has created the Abandoned Military Site Remediation Protocol (March 2005) to provide a consistent approach for designing RAPs for abandoned military sites. This protocol is designed to address all legal requirements, health and safety issues, INAC' Contaminated Sites Management Policy requirements and standard environmental issues. The protocol identifies financially prudent methodologies that address all the requirements listed above while maintaining a cost effective remediation project. This RAP for the former Cape Christian LORAN site was designed in accordance to the INAC Protocol.

The following sections provide an outline of typical environmental issues and their remedial action procedures addressed by the Protocol. These technical aspects are described in greater detail in the INAC Abandoned Military Site Remediation Protocol. The following considerations (as outlined in the INAC Protocol) need to be considered in the development and implementation of the RAP for the Cape Christian site:

- Respect all historical agreements and obligations in a fair and reasonable manner;
- Ensure consistency with federal guidelines for the management of contaminated sites;
- Apply the Canadian Council of Ministers of the Environment (CCME) environmental protection and management approaches (CCME 1996, 1997, 1999, 2001);
- Apply simple, practical remedial solutions wherever possible, with flexibility as necessary to adjust to site-specific conditions when they are identified;
- Establish cost effective solutions through the use of best practices to ensure appropriate levels of environmental protection for all sites;
- Recognize the concerns of global warming in an Arctic setting; and
- Ensure the long-term effectiveness of the environmental remedial measures.

5.2 Landfills

5.2.1 Landfill Closure

Landfills on INAC abandoned military sites are classified as Class A, Class B or Class C. A Class A landfill is a landfill located in an unstable, high erosion location. These landfills require relocation. If during the relocation process, hazardous materials are noted, the hazardous materials are segregated and disposed of off site. A Class B landfill is a landfill located in a suitable, stable location but there is contaminated leachate being released from the landfill. These landfills require the contaminated leachate to be contained within an engineered containment system. If this is not feasible, the landfill must be relocated to an engineered landfill or the waste must be disposed of off site. Lastly, a Class C landfill is a landfill located in a suitable and stable location with no contaminated leachate being released. These landfills can be left in place and additional granular material can be placed to prevent erosion and promote proper drainage if required.

Worked Areas 2 through 8 are noted as containing land filled materials. As these areas have been covered with borrow material in the past and continue to resurface due to wind erosion and frost heave, it is recommended that these areas be excavated and the materials be consolidated in the on site non hazardous landfill.

5.2.2 Landfill Development

The design of landfills at abandoned military sites must give consideration to the type of waste that is to be stored in the landfill, proximity to drainage courses and distance to borrow sources required for landfill construction. Only non hazardous materials and/or non regulated contaminated soils are to be stored in newly constructed on site landfills. All hazardous waste is to be disposed of off site.

Capping of the landfills must include a minimum 0.6 m granular cover, promote run-off, prevent infiltration and minimize erosion. Visual inspection monitoring must be conducted to confirm the integrity of the landfill.

Based on a review of the Cape Christian Proposed landfill locations, it is recommended that the existing freshwater reservoir be drained and converted into an on site non hazardous landfill. This will be the main landfill for the deposition of the non hazardous material generated from the remediation of the Cape Christian site.

5.3 Physical Debris

Debris throughout the site must be collected and segregated into hazardous and non hazardous waste streams. To reduce volumes, non hazardous material shall be crushed, shredded and/or incinerated prior to placement in the on site landfill. Hazardous materials shall be disposed of off site in accordance with applicable guidelines and regulations.

5.4 Contaminated Soils

Contaminated soils identified will be categorized as exceeding the DCC Tier 1, DCC Tier 2 or soil exceeding the Canadian Council of Ministers for the Environment (CCME) Canada Wide Standards (CWS) for Petroleum Hydrocarbon Contaminated Soil. Soil that exceeds the DCC Tier 1 criteria and does not exceed the DCC Tier 2 Criteria is to be excavated and buried in an on site nonhazardous landfill. Soils that exceed the DCC Tier 2 Criteria and/or are regulated by the Canadian Environmental Protection Act (CEPA) are to be excavated and shipped off site for disposal at a licensed facility. Petroleum Hydrocarbon Contaminated soil that exceeds the CCME CWS criteria must be addressed via mitigation, remediation or risk analysis depending on the amount of soil and the site conditions.

5.5 Contaminated Water

Temporary surface puddles with heavy metal contamination were observed at Cape Christian; however, it should be noted that the puddles are a significant distance away from any possible fish habitats. It also must be noted that the volumes of surface puddles where the exceedances were noted are minimal. It is not anticipated that contamination noted on site is adversely affecting water sources downgradient and off site.

5.6 Hazardous Materials

In general, all hazardous materials will be shipped off site to a licensed hazardous waste disposal facility. Exceptions include asbestos, which is to be double bagged and disposed in an engineered landfill onsite, in accordance with the INAC Protocol. Heavier petroleum products remaining at the Cape Christian site are recommended to be shipped off site. Compressed gas cylinders, with known contents, are to be vented and subsequently placed in engineered landfills on site. Creosote treated timbers are to be wrapped in polyethylene and disposed of in an on site landfill. PCB Paint and PCB painted components regulated under the CEPA (greater than 50 ppm) are to be disposed of off site at an appropriate facility. Lead-based paint considered to be hazardous (greater than 600 ppm) will be collected and transported offsite, whereas painted components not considered hazardous will be disposed in on site landfills.

5.7 Barrels

The majority of the barrels at the Cape Christian site are empty, buried and inert. Barrels that contain fluids at the Cape Christian site will be addressed in accordance with the DEW Line Cleanup Barrel Protocol. Barrels noted as containing fluids include the barrels buried in Worked Area #1, barrels of lubricating oil at the main station garage and barrels of used oil within the main station building.

Barrels containing fluids within Worked Area # 1 will be excavated and the contents will be inspected and tested. It is predicted that the content of the barrels is water contaminated with hydrocarbons. Water from the excavated barrels shall be treated in accordance with the DEW Line Cleanup Barrel Protocol.

5.8 Buildings and Infrastructure

All existing buildings and infrastructure shall be demolished to their foundations. All hazardous material is to be removed prior to or during demolition activities. All removed hazardous material is to be disposed of in accordance with the INAC protocol.

5.9 Borrow Sources

Borrow sources for granular material will be required for the construction of the landfill and for general site grading purposes. Existing borrow sources, including abandoned gravel pads and road infrastructure, will be fully exhausted prior to exploiting new sources. Upon completing remedial activities, all borrow areas will be recontoured to restore natural drainage and to match surrounding topography.

The borrow sources identified on site are outlined in the following table.

Borrow Source	Location	Type of Material	Estimated Amount of Material Available (m^3)
Borrow Source # 1	Freshwater Reservoir Embankment (Figure 3.0)	Poorly graded sand	9000
Borrow Source # 2	Berms of Proposed Landfill # 2 (Figure 3.0)	Poorly graded silty sand	1000
Borrow Source # 3	main Approach Road before River Crossing (Figure 5.0)	Poorly graded sand	10000
Borrow Source # 4	Building, AST and Garage Gravel Pads	Fairly well graded gravel	3300
Borrow Source # 5	End of Road Past Equipment Dump (Figure 5.0)	Fairly well graded gravelly sand	1700
Borrow Source # 6	Near South Beach Barrel Cache (Figure 2.0)	Poorly graded gravelly sand	5250
Borrow Source # 7	750 m Northeast of Main Station Building	Fairly well graded gravelly sand	4000

All applicable permitting and licensing for borrow source use must be completed prior to use of any identified borrow material.

5.10 Site Grading

Disturbed areas on the site will be graded and shaped to blend in with the natural contours and to eliminate potential hazards for wildlife and humans accessing the site in the future. The disturbed areas include contaminated soils excavations, existing and new landfills, debris areas, disturbed areas resulting from demolition activities, borrow areas, and any areas disturbed as a result of remediation activities and existing infrastructure (roads, gravel pads and dams) that pose a risk to humans and wildlife.

5.11 Contractor Support Activities

For the completion of remedial activities, it is suggested that a camp be established on site and situated in one of the two areas identified in **Figure 2.0** of **Appendix A** to minimize the extent of new disturbances. However, the final selection of the camp site location is at the discretion of the contractor. Waste generated by the camp will be incinerated and disposed of in on site landfills. Sewage will be treated using an appropriately sized treatment system, and effluent quality will adhere to applicable licenses. Potable water located on site will be tested and used in accordance with the applicable water license. Contingencies for water supply will include filters, and a supply of bottled water. Fuel required to operate the camp and to complete remedial activities will be stored on site in accordance with applicable legislation and licenses.

6.0 COMMUNITY MEETINGS

A community meeting was held at Clyde River on November 29, 2006. Approximately 40 Clyde River community members attended and their comments have been incorporated into this RAP.

7.0 EVALUATION OF REMEDIAL OPTIONS

7.1 Cleanup Objectives

The following remedial objectives are based on the INAC Abandoned Military Site Remediation Protocol, March 2005.

1. Restore the site to an environmentally safe condition;
2. Prevent the migration of contaminants info the Arctic ecosystem;
3. Remove physical hazards for the protection of human health and safety; and
4. Implement a cost effective remediation solution.

7.2 Site Issues and Remedial Solutions

The following sections present a summary of the contaminant issues, as well as the potential remedial methods, for site issues identified at Cape Christian. In the cases where more than one remedial method is identified, the options will be evaluated based on the remedial objectives and a recommendation for the favorable remedial method will be provided. It shall be noted that a historical archeological site exists as indicated in **Figure 8.0** of **Appendix A**. It must be ensured by the Contractor that this site is not disturbed during the remedial activities at Cape Christian. The term "remediation" refers to any activities directly involved in returning the Cape Christian Site back to a natural state. Also, the Contractor must provide a detailed contingency plan for the event that contaminants are released into the environment during remedial activities.

7.3 Contaminated Soils

It is estimated that there is approximately 2,160 m^3 of contaminated soils identified at the Cape Christian site and as outlined by the following table.

Table 1: Summary of Contaminated Soils at Cape Christian

Location	Contaminant Exceeding INAC Criteria (Max Concentration ppm)	DCC I m^3	DCC II m^3	INAC PHC m^3	Comments
Main Station Area ASTs (Figure 3.1)	**PHC**s (F2: 12100)			381	Additional sampling during remedial activities may reduce the predicted plume size.
Main Station Building North of West Wing (Figure 3.1)	**Metals** (Lead: 723)		10		
Main Station Building East of East Wing (Figure 3.2)	**PHCs** (F2: 9370)			287	
Main Station Building East of East Wing (Figure 3.2)	**PCBs** (PCB: 1.7)	18			Plume associated with ESG sample G6516
Main Station Building East of East Wing (Figure 3.2)	**Metals** (Cadmium: 6.9, Zinc: 1200)		2		Plume associated with ESG sample G6512 and delineated in previous Earth Tech Report, 2001
Main Station Building East of East Wing (Figure 3.2)	**Metals** (Lead: 290, Zinc: 4500)		1		Plume associated with ESG sample G6508 and delineated in previous Earth Tech Report, 2001
Main Station Building East of East Wing (Figure 3.2)	**Metals** (Cadmium: 7.4, Zinc: 7350)		55		Plume associated with samples in floor sumps
Main Station Building East of East Wing (Figure 3.2)	**Metals** (Lead: 210)	41			Plume associated with ESG Sample G6576
Main Station Area Maintenance Garage (Figure 3.3)	**Metals** (Cadmium: 5.9)		126		
Main Station Area Maintenance Garage (Figure 3.3)	**PHCs** (F3: 41100)			160	
Main Station Area Disaster Hut (Figure 3.3)	**Metals** (Cadmium: 5.9)		1		Plume associated with ESG sample G6593 and delineated in previous Earth Tech Report, 2001

Location	Contaminant Exceeding INAC Criteria (Max Concentration ppm)	DCC I m^3	DCC II m^3	INAC PHC m^3	Comments
Beach Area, Outfall (Figure 4.1)	**Metals** (Copper: 273)		207		Plume associated with Earth Tech 2001 samples CC43 and CC40
Beach Area, Worked Area #1 (Figure 4.2)	**PHCs** (F2: 8450)			871	
	Total Estimated Volumes	**59**	**402**	**1699**	

In accordance with the INAC Abandoned Military Site Remediation Protocol, March 2005, the following remedial options are presented for consideration at Cape Christian. Cape Christian can be accessed from Clyde River; therefore the remedial design must be designed accordingly. Solutions that achieve remedial objectives and minimize site remediation costs will be deemed favorable.

Despite the fact that in-situ technologies reduce contaminant exposure to humans and the environment, in situ remediation technologies were not researched in detail. In situ remedial technologies are care and maintenance intensive and have not generally proven to be pragmatic technologies for northern site remediation activities.

7.3.1 PCB Contaminated Soils

Contaminant Issue

The 18 m^3 of PCB contaminated soil that exists on site is located at the main station building area as shown in **Figure 3.2** of **Appendix A**. The soil exceeds the INAC Abandoned Military Sites Remediation protocol (Greater than DCC I but less than DCC II for PCBs). It is understood that DCC-1 soil can be land filled on site in accordance with the INAC protocol. It is recommended that the soils be excavated and placed in the on site non hazardous landfill.

Remedial Method

The soil shall be excavated, and placed in the on site non hazardous waste landfill.

7.3.2 Metal Contaminated Soils

Contaminant Issue

The 443 m^3 (41 m^3 –DCC -I and 402 m^3 DCC – II) of metal contaminated soil that exists on site is located at the main station building (**Figures 3.1 and 3.2**), the main station garage and disaster hut (**Figure 3.3**) and the outfall area (**Figure 4.1**).

Remedial Method

Due to the smaller amounts of metal contaminated soils on site and the large operational and maintenance costs of metal contaminated soil remedial technologies, remediation of the soils on site was not explored. The soil that exceeds the INAC Abandoned Military Sites Remediation protocol Tier 2 Criteria shall be excavated, containerized, labeled in accordance with the Transportation of dangerous Goods Act and shipped off site to a disposal facility that is licensed to accept metals contaminated soils. It should be noted that additional sampling at the outfall area may greatly reduce the amount of soil to be removed off site.

The Tier 1 metal contaminated soils shall be excavated and disposed of in the on site non hazardous waste landfill.

7.3.3 Hydrocarbon Contaminated Soils

Contaminant Issue

Environmental investigations at Cape Christian have identified approximately 1699 m^3 of PHC contaminated soil that exceed the INAC Abandoned Military Sites Remediation protocol. It should be noted that full delineation of impacted soils was not achieved at the main station ASTs and soil volumes are likely to increase as a result of bulking during excavation, therefore a 15% contingency should be applied to the total volume of PHC contaminated soil. The hydrocarbon contaminated soils are located at main station ASTs area (**Figure 3.1**), the main station building area (**Figure 3.2**), the main station garage (**Figure 3.3**), and the Worked Area #1 (**Figure 4.2**).

The hydrocarbon fractions in the contaminated soils at Cape Christian are mostly fraction 2 (F2) hydrocarbon exceedances typical of diesel fuel contamination. The hydrocarbons associated with the main station garage are fraction 3 (F3) hydrocarbon exceedances associated with the lubricating oil barrels spilled at this location.

Remedial Options

Excavation and Off-Site Disposal

The first potential remedial option for the hydrocarbon soils at Cape Christian is to excavate the PHC contaminated soils ship them south to a facility licensed to accept hydrocarbon contaminated soils. Since the contamination is completely removed from the site, it meets all of the remedial objectives; however, the major disadvantage of this method is the cost for shipping the material off site.

Cape Christian is accessible via boat and material can be removed via barge. However, the volume of PHC contaminated soils is 1,699 m^3 making transportation of the material cost intensive.

On Site Land Farming

Option 2 is for handling the petroleum contaminated soils is the use of a land farm. Land farming is a remediation technique used to reduce the hydrocarbon levels in soil via volatilization, biodegradation and photo degradation. The hydrocarbon soils are spread out on a self contained, lined land farm cell in a lift approximately 0.3 m thick. It should be noted that the lack of clay material on site will require the use of a synthetic liner for the land farm containment system. Chemical amendments (fertilizer) and water are added to the soil to promote biodegradation of the hydrocarbons. The soil is scarified or "turned" using heavy equipment to break up the soil, adding oxygen and promoting volatilization. Microbes in the soil, (bacteria and fungi) breakdown the hydrocarbon chains converting them into biomass.

Advantages of land farming are that the contamination is eventually eliminated. This eliminates the need for long term inspections and monitoring and removes any long term liability of the site. Notable disadvantages include the time and effort required for the construction of the land farm cell and the remediation process, as well as monitoring the activity and ensuring the material is remediated to the applicable criteria.

In a northern climate, a minimum of two to three years is required for remediation depending on temperatures, moisture, soil contaminants and fertilizer application/soil turning. Land farming also requires a work crew to visit the Cape Christian site to scarify the contaminated soil, add the chemical fertilizer and monitor the soil contamination levels. Once the soil has been remediated below the applicable criteria, the land farm cell will be decommissioned in place and contoured into natural topography. Due to the time requirement for this method, additional site trips are required after the initial remedial program has been completed.

Land farming of the contaminated soils would meet the INAC Cleanup Objectives one, two and three. Once the soil is remediated there are no further monitoring requirements, reducing the long term costs. Special precautions must be taken during remedial activities to protect workers from hydrocarbon vapor exposure. Fit tested half masks with appropriate filter cartridges must be worn by exposed workers wherever hydrocarbon odor is strong or hydrocarbon levels exceed applicable exposure limits. Also proper Personal Protective Equipment (PPE) in accordance with all applicable legislations shall be worn by all workers involved in the Cape Christian Remediation Program.

Landfill On Site

A secure landfill was evaluated as a third option. A landfill can be constructed at the Cape Christian site using the available borrow sources. A landfill containing contaminated soils shall have an engineered synthetic liner to ensure the contaminants within the soil are not allowed to become mobile. Proper design of the landfill will also ensure that permafrost is developed within the landfill to further decrease the mobility potential of the contaminants.

Advantages of the landfill are that the remedial work can be completed in one season. Disadvantages for this option are similar to the capping option. The disadvantages of land filling the contaminated soil are that the contamination will remain on site. This requires long term inspections and monitoring of the landfill at a significant extra capital and labour cost to ensure the contamination is contained within the landfill, however this could be conducted concurrently with the required inspections of the non hazardous material engineered landfill.

The landfill option meets INAC Cleanup Objectives; however, long term monitoring and inspections of the landfill are required as the contamination will remain on site.

Engineered Cap in Place

Option 4 for dealing with the hydrocarbon contamination at the Cape Christian site is to grade and cover the contaminated areas with an engineered cap. The cap would consist of a 1.0 m thick layer of compacted engineered fill, graded to promote drainage.

A cap would reduce the amount of rain and surface water coming into contact with the contamination and prevent further dispersion of the hydrocarbon contamination. The cap would also eliminate the possibility of humans and/or fauna from coming into contact with the contamination. This remedial option has a relatively low cost and a minimal level of effort. The capping of the hydrocarbon contaminated soils could easily take place during other site remedial activities.

In addition to the engineered cap a chemical amendment can be added to the contaminated soil. The chemical amendment (fertilizers, nutrients, nitrogen etc.) promote biodegradation of the hydrocarbons by providing the necessary chemicals and nutrients required by the microbes for the degradation to occur. The hydrocarbon impacted soils are excavated and the chemical amendment would be mixed into the soils and the soils would be replaced and capped as noted above. The additional costs for the chemical amendment include the costs for the excavation of the impacted areas; the addition of the amendment, the amendment itself and the cost to replace and compact the soils after the amendment is added.

Disadvantages associated with this remedial option is that it would require further monitoring events to ensure the capping system remains in good condition (no erosion, frost heaving) and that the hydrocarbons do not become mobile. The capping would also greatly reduce the naturally occurring bioremediation of the soils by limiting the amount of oxygen reaching the contaminated soil. Less oxygen reduces the rate of aerobic degradation of the hydrocarbons. There would be little to no control over the bioremediation process and ongoing monitoring of the contaminated area would be required.

In Situ Soil Vapor Extraction

Vapor extraction is a remedial method used to remediate hydrocarbon contaminated soils. Air is pushed or drawn through the contaminated soils and the lighter end hydrocarbons volatilize into the air. The air is then released into the atmosphere or run through carbon filters to remove the hydrocarbons. Contamination favoring this option is light end hydrocarbons (F1 Fractions). Heavier fractions of hydrocarbons are less likely to volatilize and require different remediation methods. The soils must also be porous, freely allowing the air to move through the soil and volatilize the hydrocarbons. The poorly graded dry sands and gravels at Cape Christian are ideal for vapor extraction.

Vapor Extraction systems rely on powered blowers and require frequent adjustments and maintenance during the extraction process. Since Cape Christian is a semi-remote unmanned site the cost of instituting this remedial measure is not cost effective. The type of hydrocarbon contamination at Cape Christian is not compatible with vapor extraction remediation methods. The contamination at the Cape Christian site is the larger fractions of hydrocarbons (F2 and F3). Also, during the investigation, much of the investigation areas were noted to be saturated with water. Vapor extraction will not be explored further as a remedial option.

Biopile

A biopile is a remediation technology used to remediate hydrocarbon contaminated soils. The PHC contaminated soils are collected into piles and wrapped in synthetic liners to promote anaerobic degradation of the hydrocarbons and retain heat to promote the bioactivity. Temperatures measured within an active biopile are often much higher than ambient temperatures. Biopiling has had limited success as an effective remediation technique at remote and unmanned northern sites due to low ambient temperatures and the care and maintenance involved with operating the biopile system. Biopiles will not be explored further as a remedial option.

Recommendation

Based on the evaluation of the remedial options in the context of the remedial objectives, it is recommended that the hydrocarbon soils be excavated and placed in an on site land farm cell. The goal is to remediate the soil so that the hydrocarbon levels are below the hydrocarbon criteria listed in the INAC Abandoned Military Site Remediation Protocol, March 2005. The Contractor shall submit a plan outlining the design, construction and operation of the land farm with details on the amount of time (seasons) required to complete the remediation of the soils and the monitoring and decommissioning of the land farm facility.

7.4 Site Materials

7.4.1 Non Hazardous Materials

Approximately 2,800 m^3 of non hazardous materials were inventoried at the site. The barrels and materials noted in Worked Areas 2 through 8 were not included in the materials inventory. These areas were test pitted to identify the material contained in each area as inert and the underlying soil was sampled to confirm the absence of contamination. Worked Areas 2 through 8 were noted as being Class C landfills in accordance with the INAC abandoned military site protocol. Remedial options for non hazardous materials are described below, and options for hazardous materials are discussed in Section 7.4.2.

Remedial Options

Buried in Place

Once all the structures have been demolished to their foundations, the site materials can be buried in place. The debris would be flattened and covered with compacted engineered fill or placed in a nearby excavation or low spot in the surrounding terrain and then covered with compacted fill. The cover of compacted fill must be engineered to promote positive drainage and the cap must also be graded to match surrounding terrain. Advantage of this method is that it is less expensive as the contractor does not have to remove and transport and place material in a landfill some distance away. The disadvantage of this method is that the material is not placed in a secure engineered landfill. In the event that additional debris is discovered on site, the debris shall be addressed using the INAC Abandoned Military Site Remediation Protocol, March, 2005.

Place in On Site Non Hazardous Waste Landfill

Once all the structures have been demolished to their foundations, the demolished material and site debris can be transported to the engineered landfill. This option gathers all the site material into one secure area reducing future monitoring inspection efforts. Placing the non hazardous demolition waste in an on-site engineered landfill is in accordance with the INAC Abandoned Military Site Protocol, March, 2005.

Off Site Disposal

Once all the structures have been demolished to their foundations, the demolished material can be collected and transported off site. Due to the large costs associated with barging and tipping off site disposal is deemed too expensive and not cost effective. Materials can also be disposed of in the Clyde River Hamlet Landfill; however transportation costs to get the material from Cape Christian to Clyde River make this option less favourable.

Recommendation

All buildings/infrastructure shall be demolished to their foundations in accordance with the INAC Abandoned Military Site Remediation Protocol, March, 2005. All hazardous materials shall be removed and disposed of in accordance with applicable legislation prior to demolition. Hazardous materials noted in the Hazardous Materials building include a pile of friable asbestos at the east end of the building and potentially PCB contaminated concrete. Once the asbestos has been abated from the hazmat building in accordance with the Northwest Territories, Guidelines for the Management of Waste Asbestos, the remaining contents of the building will be cleaned up and removed. Any stained concrete noted on the floor of the Hazmat Building will be sampled for PCB contamination. Any areas noted as being PCB contaminated will be removed and disposed of in accordance with the INAC protocol. The concrete shall be sampled again to confirm the concrete is clean. The building will then be demolished to its foundations. All barrels shall be addressed using the Department of National Defense (DND) DEW Line Clean up Barrel Protocol.

It is recommended that the existing freshwater reservoir be converted to an engineered non hazardous waste landfill. All non hazardous material on site is to be placed in the landfill and compacted and capped in accordance with the landfill design. Location of the landfill is shown on **Figure 3.0** of **Appendix A**. It shall be noted that there are six 102,000 liter tanks that are to be demolished and placed in the on site landfill. The existing equipment dump contains numerous pieces of large heavy equipment. These pieces of large heavy equipment must be drained of all hazardous fluids and placed in the on site landfill. Stained soils beneath the equipment shall be excavated and treated as hydrocarbon contaminated soils. There are also numerous power poles and associated power lines on site that all require demolition and placement in the on site landfill. A complete listing of all non-hazardous materials is located in the Earth Tech Cape Christian LORAN Station Supplementary Environmental Site Assessment, Materials Audit and Geotechnical Investigation, 2006.

7.4.2 Hazardous Materials

Hazardous materials are present at the Cape Christian Site. A detailed inventory of hazardous wastes is provided in Appendix D of the Earth Tech Cape Christian LORAN Station Supplementary Environmental Site Assessment, Materials Audit and Geotechnical Investigation. All hazardous materials (with the exception of Asbestos Containing Materials) will be containerized and labeled in accordance with the Transportation of Dangerous Goods Act and shipped off site in accordance with the INAC Abandoned Military Sites Remediation protocol.

Approximately 12 m^3 of PCB contaminated painted materials, 113 m^3 of lead contaminated painted materials and 57 m^3 of hazardous materials were identified during the 2006 waste assessment.

Petroleum Oil and Lubrication (POL) Fluids

Disposal off Site

The amount of POL fluids existing at Cape Christian is minimal (7 m^3). The POL fluids at the Cape Christian site can be collected and shipped off site for disposal or incinerated. However, due to the nature of the POL fluid it is suspected that off site disposal will be preferred.

Asbestos

Asbestos containing material at the Cape Christian site is noted as being limited to the main station building and the hazardous materials building. Asbestos Containing materials include pipe insulation, transite board and asbestos containing insulation. All asbestos is to be properly abated, in accordance with the Guidelines for the Management of Waste Asbestos, Northwest Territories and all other applicable Federal and Territorial Asbestos regulations, prior to any demolition activities.

Asbestos Abatement, Place in On Site Landfill

All asbestos is to be abated in accordance with applicable Federal and Territorial Asbestos regulations and guidelines. All asbestos debris shall be abated and placed in a sealed, airtight container, clearly labeled "ASBESTOS". The asbestos is then placed in an engineered on-site landfill. The location of the asbestos material located within the landfill should be noted for future reference. This method is in accordance with the INAC Abandoned Military Site Remediation Protocol. Due to the transport costs associated with transport of materials from the Cape Christian site, off site disposal is not recommended for the asbestos waste.

PCB & Lead Contaminated Paint

Remedial Options

Paint Removal, Off Site Disposal

Paint abatement consists of physically removing the PCB and/or lead contaminated paint from the substrate. This is accomplished by physical scrapping, chemical stripping, sand blasting and various other abrasive physical removal techniques. As the paint being removed contains lead and or PCBs, abatement methods must be conducted in a manner that protects the worker and the environment from PCB and lead contamination. Some of the main station roof and floor has collapsed making the areas

unsafe for worker presence. Abatement methods generating dust must be conducted in a sealed, negative pressure environment with the area exhaust filtered with a certified High Efficiency Particulate Air (HEPA) Filter. Misted water is also used to control the paint dust, requiring the waste water to be filtered to remove the contaminated paint or collected and treated as hazardous waste. These required mitigation measures increase costs dramatically. This option would meet the INAC cleanup objectives for restoring the site to an environmentally safe condition and preventing the migration of the contaminants as all of the PCB containing paint would be removed from site. The abatement process is costly. The abatement costs combined with the required isolation, decontamination and disposal costs (estimated to be $800,000) make this option less cost effective.

Remove Painted Materials, Off Site Disposal

As an alternative to paint abatement, building materials painted with contaminated paint can be dismantled and disposed of as hazardous materials, bypassing the requirement for the paint to be abated. The transport and disposal costs are higher due to the fact that the painted building materials are disposed of along with the paint; however, these additional costs are smaller than the additional costs of paint abatement. As there is minimal scrapping and abrasion during the dismantling activities, negative air enclosures and filtration systems are not required. Dismantled material volumes can be minimized by cutting and compacting. It is estimated that there is approximately 133 m^3 of lead contaminated paint materials and 12 m^3 of PCB contaminated paint materials at the Cape Christian site. The PCB material would be transported to a PCB incineration facility and the lead painted material would be transported to a hazardous waste disposal facility.

This option meets the INAC Abandoned Military Site Clean up Protocol Cleanup Objectives one, two and three. This option is also less expensive than the abatement options making it more cost effective than the other options proposed. It should be noted that impending landfill disposal restrictions taking effect in 2007 in Ontario and Quebec may affect upcoming landfill disposal requirements and may severely affect disposal costs.

Remove Painted Materials, On Site Disposal

Onsite disposal of hazardous materials is not permitted under the March 2005, INAC Abandoned Military Site Remediation Protocol.

Recommendation

It is recommended that the contaminated paint materials be dismantled and disposed of off site. This remedial method is in accordance with the INAC Abandoned Military Site Remediation Protocol, March 2005. Care is to be taken during the dismantling to prevent dust and paint chips from being released into the environment and to protect the workers that are conducting the dismantling from PCB and Lead contamination. All dismantled PCB and/or Lead contaminated paint material shall be packaged, transported and disposed of in accordance with the current regulations governing the handling and disposal of hazardous materials.

7.5 Remedial Options Recommendation Summary

The following table presents a summary of the recommended remedial methods.

Table 8: Summary of Recommended Remediation Methods

Environmental Issue	Details	Recommended Action
Site Debris	Approximately 2,800 m^3 of non-hazardous debris (heavy equipment, buildings, building foundations, tanks, etc.).	Consolidate and dispose of in on site non hazardous landfill.
Worked Areas 2 through 8 (South Beach Area)	7 areas of land filled material (barrels, building material, etc.).	Excavate land filled and consolidate buried material in the on site hazardous waste landfill.
Tier 1 Soils	Approximately 66 m^3 of soils with contaminant concentrations in exceedance of INAC Abandoned Military Site Remediation Protocol Tier 1 soils criteria.	Excavate and place in on site non hazardous waste landfill.
Tier 2 Soils	Approximately 395 m^3 of soils with contaminant concentrations in exceedance of INAC Abandoned Military Site Remediation Protocol Tier 2 soils criteria.	Excavate contaminated soils and place into containers, and ship off site to a licensed disposal facility.
Petroleum Hydrocarbon Contaminated Soils	Approximately 1700 m^3 of hydrocarbon contaminated soil in exceedance of the INAC Abandoned Military Site Remediation Protocol, modified CCME CWS Petroleum Hydrocarbon Criteria.	Excavate and treat in an on site land farm cell.
POL Fluids	Approximately 6,800 L of Petroleum, Oil and Lubricant fluids.	Place POLs into containers, and ship off site to a licensed disposal facility.
PCB Contaminated Paint Items	Approximately 12 m^3 of PCB painted materials.	Dismantle contaminated paint items and ship off site to licensed disposal facility.
Lead Contaminated Paint Items	Approximately 113 m^3 of lead painted materials.	Dismantle contaminated paint items and ship off site to licensed disposal facility.
Hazardous Materials	Approximately 30 m^3 of hazardous materials (lead acid batteries, pressurized cylinders, paints and chemicals).	Containerize and dispose all hazardous materials in accordance with the INAC Protocol.

Environmental Issue	Details	Recommended Action
Asbestos	Approximately 21 m^3 of asbestos containing materials (pipe insulation, transite board and matted insulation). Some of the transite board is painted with Lead/PCB contaminated paint and will therefore have to be shipped of site for disposal.	Abate asbestos not painted with Lead/PCB Paint (approximately 10 m^3) in accordance with the appropriate legislation. Double bag and place in on site engineered landfill. Transite board painted with Lead/PCB paint (approximately 10 m^3) shall be abated and disposed of off site at a licensed disposal facility.
Archeological Site	There is a historic archeological site located as indicated in **Figure 8.0** of **Appendix A.**	Ensure the historic archeological site is not disturbed during remediation activities.

8.0 SITE ACCESS

High tide at the Cape Christian site is noted as being approximately at 2 am and 5 pm with a low tide at around 10 am and 10 pm during the month of August. The maximum tide elevation variance is noted to be approximately 1.2 meters. Sites that were investigated for barge landings are indicated in **Figure 2.0** of **Appendix A**. It was stated by the son of a former RCMP officer at Cape Christian that the barge servicing the Cape Christian site landed at BLA # 2. This requires two river crossings at the areas indicated on **Figure 2.0** if heavy equipment is to be offloaded at BLA #2 and driven to the Cape Christian site. Barge Landing Area #1 is closer to the site and does not require a temporary bridge to be built over the Clyde River; however the barge operator shall investigate the underlying marine topography in this area prior to selecting barge landing area #1. It should also be noted that at all beach landing areas have very high groundwater tables which may cause heavy equipment to sink into the sand and become stuck. Consideration should be given to stabilization of the areas where equipment is off loaded. The site can also be accessed via Clyde River. The contractor can barge into Clyde River and CAT Train out to the site. If the CAT Train is to take place during the summer, significant improvements to the road from Clyde River to Cape Christian will be required. If the Contractor decides to upgrade the existing road or build a new road between Clyde River and the Cape Christian site, it shall be noted that it is the responsibility of the Contractor to return the upgraded road to its original state or decommission the newly constructed road.

8.1 Site Roads

Currently all areas of the Cape Christian site can be accessed via ATVs. Due to lack of upkeep and erosion, some of the existing roads to be utilized during remedial activities will require repair and upgrading before heavy equipment can use these roads. The existing roads at the Cape Christian site will require upgrading depending on the site remediation methodology implemented by the successful contractor. The successful contractor is to refer to the Earth Tech Cape Christian LORAN Station Supplementary Environmental Site Assessment, Materials Audit and Geotechnical Investigation for a detailed description of the existing site roads.

The existing roads that lead up to the main station building are in poor condition and have a very steep incline. It is expected that these roads require significant repair and improvement for use by heavy equipment trying to access the main station area and main station building.

It is also recommended that additional temporary roads be constructed in order to access the freshwater reservoir landfill, waste handling facility and land farm as shown in **Figure 8.0** of **Appendix A**. The roads must be adequate for heavy equipment use and provide easy access to the reservoir landfill and the waste handling facility as required. A summary of the amount of borrow material required for the road improvements is located in Section 9.2 of this RAP.

8.2 Airstrip

The airstrip at Cape Christian is to be upgraded in accordance with the recommendations made in the Earth Tech Cape Christian LORAN Station Supplementary Environmental Site Assessment, Materials Audit and Geotechnical Investigation, if the airstrip is to be used during the remediation of the Cape Christian site. In order to re-establish the serviceability of the runway the drainage ditches on either side of the runway should be dug out and a longitudinal drainage profile should be re-established in order to reduce the saturated condition of the runway.

The surface should then be re-graded to establish proper longitudinal and transverse profiles to ensure positive drainage. The material should then be re-compacted at optimum moisture content between 12 and 15% to a maximum dry density of approximately 1800 kg/m^3.

In order to establish a suitable landing surface capable of handling standard gear loadings and tire pressures, it is recommended that a surfacing gravel layer be overlaid on the runway at a minimum depth of 100mm. The surfacing gravel should be comprised of well-graded gravel having a minimum Spring Reduced Lower-Quartile Point Subgrade Bearing Strength of 290. This material should then be graded to ensure positive drainage (2% minimum transverse cross-slope) and compacted to 98% of the material's maximum dry density. This material is available at borrow sites #4, 5 and 7 however it is expected that screening and crushing of the borrow material will be required to produce a surfacing gravel that will meet the engineering requirements.

9.0 SITE FACILITIES

9.1 Camp

A camp will be required during the remedial activities. It is recommended that the camp be located at Site #2 as shown on **Figure 2.0** of **Appendix A**, however the final camp location is at the discretion of the Contractor. The camp must be large enough to support the Contractor staff, the camp staff approximately 3-5 visitors, consultants and/or inspectors. There shall be a potable water supply that meets the Canadian Drinking Water Quality Guidelines. Potable water can be obtained from Clyde River and the Freshwater Reservoir on site; however the water used must be sampled to ensure the water meets the Canadian Drinking Water Quality Guidelines. Non potable water can be obtained from the ocean or the freshwater reservoir as required. The sewage and greywater from the site will be treated in accordance with applicable regulations. Any solid waste developed will be collected and disposed of with other non hazardous materials in the on site landfill. The camp shall also have bear safety measures, emergency rations and an emergency rescue contingency plan in place.

9.2 Borrow Source Development

Borrow Sources shall be developed in accordance with the INAC Abandoned Military Site Remediation Protocol. Required borrow material shall be drawn preferentially from the existing infrastructure (building pads and existing roads). Borrow source requirements required beyond those available amounts shall be taken from the additional borrow sources identified in the Earth Tech Cape Christian LORAN Station Supplementary Environmental Site Assessment, Materials Audit and Geotechnical Investigation.

Once the borrow source requirements for the Cape Christian remediation have been satisfied, all borrow sources will be recontoured to restore natural drainage and to match surrounding topography and to minimize changes to the existing permafrost profile.

The borrow material noted on site is presented in the following table:

Borrow Source	Location	Type of Material	Estimated Amount of Material Available m^3
Borrow Source # 1	Freshwater Reservoir Embankment (Figure 3.0)	poorly graded sand	9000
Borrow Source # 2	Berms of Proposed Landfill # 2 (Figure 3.0)	poorly graded silty sand	1000
Borrow Source # 3	main Approach Road before River Crossing (Figure 5.0)	poorly graded sand	10000
Borrow Source # 4	Building, AST and Garage Gravel Pads	fairly well graded gravel	3300
Borrow Source # 5	End of Road Past Equipment Dump (Figure 5.0)	fairly well graded gravelly sand	1700
Borrow Source # 6	Near South Beach Barrel Cache (Figure 2.0)	poorly graded gravelly sand	5250
Borrow Source # 7	750 m Northeast of Main Station Building	fairly well graded gravelly sand	4000

The following table presents the estimated amount of borrow material required for each of the listed remediation activity:

Site Activity	Material Required	Estimated Amount Required m^3	Source
Airstrip upgrade	Well graded gravel	3,600	Well graded gravel not available on site existing borrow material must be screened and/or crushed to produce well graded material or imported from the Clyde River airstrip gravel source
Land Farm Construction	Fairly well graded gravel	1,300	Borrow Source 4
Landfill Cap	Fairly well graded gravelly sand or fairly well graded gravel	3,500	Borrow Sources 7, 5 and 4
Road Improvements	Poorly graded gravelly sand, fairly well graded gravelly sand or fairly well graded gravel	5,000	Borrow Sources 7, 6, 5 and 4
Camp Site Pad	Poorly graded gravelly sand, fairly well graded gravelly sand or fairly well graded gravel	800	Borrow Sources 7, 6, 5 and 4

Adequate amounts of borrow material have been identified for the required remedial activities on site. Well graded gravel is required if the contractor decides to upgrade the existing airstrip in accordance with the airstrip upgrade recommendations. A well graded gravel is not readily available on site it is predicted that the existing borrow material at borrow sites 4, 5, and 7 can be screened and crushed on site to meet the material requirements. It is also possible to import well graded gravel material from Clyde River, however the material would need to be transported at a significant additional cost.

9.3 Waste Handling Facility Construction

A Waste Handling Facility (WHF) will be required at the Cape Christian site to receive and sort various waste items. The fluids handling area within the WHF shall be lined with an engineered synthetic liner to prevent the migration of contaminants resulting from any accidental spills. The fluids handling area is to be bermed and the engineered liner should have some fill cover to protect the liner integrity. The waste handling facility shall have applicable safety items and Personal Protective Equipment (PPE) which include but are not limited to: fire extinguisher, first aid kit, eye wash station, emergency spill kit etc. Materials to be received and sorted at the WHF include but are not limited to:

- Barrels (Barrel Protocol)
  - Empty
  - Unknown fluids
  - POLs
  - Cleaning, rinsate, crushing
- Batteries
- Compressed Gas Cylinders
- Items painted with PCB and Lead Paint
- Soils for off Site Removal
- Creosote Treated timbers (wrap in poly, on site landfill).

The suggested location for the WHF area is shown on **Figure 8.0** of **Appendix A**, however the location of the WHF is to be selected at the Contractors discretion. The WHF should be accessible by temporary roads to provide access to vehicles and equipment required in the delivery sorting and transport of the site waste. Upon decommissioning of the WHF the area beneath the facility shall be sampled for confirmatory purposes.

9.4 Non-Hazardous Waste Landfill Engineering and Construction

The landfill location was selected based on the required landfill size, distance to material to be landfilled and distance to borrow sources. The landfill location at the existing freshwater reservoir, shown in **Figure 3.0** at the main station area requires the least amount of transportation for the majority of the waste at the Cape Christian site.

It should be noted that an engineered plan shall be developed for the draining of the freshwater reservoir. The plan to drain the reservoir must be designed by an engineer and approved by the site engineer and INAC prior to implementation.

It is noted that the drainage at and around the existing reservoir was designed to catch run off from the snow melt each spring. For this reason the existing drainage patterns near the water reservoir must be diverted away from the selected landfill area. Consideration should be given to proper landfill design, drainage diversion and erosion control.

Surface water run-on and run-off will be controlled through proper grading to positively shed water and to prevent ponding and seepage into the landfill. Consideration to the landfill cap angles must be designed as to not to encourage erosion of capping and embankment materials.

Leachate control should be accomplished by control measures (rather than containment and collection such as synthetic liner cover). Control measures include placing only dry and stable material in the landfill and preventing water infiltration into the landfill to prevent leachate generation. Fill material shall be "frost stable" and placement outside of high groundwater or constant surface water area recharge area.

Landfilled material shall be placed in a controlled manner with minimal lifts to control compaction and settlement of the material. Settling of the landfill shall be mitigated by placing thin lifts (0.15 m) and compacting/vibrating with borrow material to fill voids. The reduction of surface settlement over the landfill should be completed by ensuring all debris voids are filled in and the total debris thickness in the landfill does not exceed 3 m. The landfill cap shall be compacted to 95% of the maximum density.

It is recommended that the outside landfill berms be constructed at 3H:1V and inside berms at 1.5H:1V. The top of the berm should have a minimum width of 2 m. The berms should have a minimum 0.5 m thick cover of gravel and cobbles. It is predicted that the bottom of the reservoir will require stabilization activities as there may be unstable sediment and/or sludge.

9.5 Land Farm Construction

The land farm shall be located north of the Beach AST as shown in **Figure 4.2** of **Appendix A.** The land farm is to be constructed with a synthetic liner as there is no suitable impermeable clay material known to exist at the Cape Christian Site. The land farm treatment cell shall have monitoring wells placed around the perimeter with preference given to locating wells down gradient for groundwater monitoring purposes. The land farm cell shall be graded to promote positive drainage within the cell and the cell shall have a water collection sump at its low point to collect any excess water that has come in contact with the soil. The collected water will be run through an oil water separator and the water and oil will be disposed of in accordance with applicable regulations. Once the remediation program is complete the land farm cell shall be decommissioned, the monitoring wells removed and the area under the land farm cell shall be sampled.

9.6 Schedule

Assuming the project is tendered in February of 2007, the following is a proposed schedule for the remediation of this site. The actual schedule may vary depending on the specific Contractor plan:

- Contractor barges to Clyde River (Fall 2007)
- Contractor cat trains to Cape Christian (Winter 2007/2008)
- Contractor completes 1st season of work at Cape Christian (Summer 2008)
- Equipment remains on site (Winter 2008/2009)
- Contractor completes 2nd season of work (Summer 2009)
- Contractor cat trains back to Clyde River (Winter 2009/2010)
- Contractor barges equipment from Clyde River (Fall 2010).

10.0 VERIFICATION AND POST REMEDIATION LONG-TERM MONITORING PROGRAM

10.1 Verification and Monitoring During Remediation Activities

During the project, quantities of all site materials shall be estimated, tracked and measured by the Contractor. Contaminated areas that have been excavated shall be confirmed clean by field screening methods and then samples shall be taken from the base and walls of the excavation for laboratory confirmation of the contaminant of concern. The purpose of verification sampling is to confirm compliance of the remedial activities with the specified clean up objectives outlined in the INAC Protocol. Prior to construction of the land farm cell, samples will be taken to confirm the soil beneath the land farm is clean. Once the land farm has been constructed, monitoring wells shall be installed around the cell to monitor the groundwater. Once the land farm cell is decommissioned the underlying soil will be sampled again to confirm the absence of hydrocarbon contamination.

10.2 Post remediation Long-Term Monitoring Program

The on site land farm shall be monitored each season that it is in operation. The inspection will include a visual inspection to confirm the cell and liner integrity. The chemical inspection will consist of groundwater samples taken from the monitoring wells installed during the land farm construction. Once the land farm cell has been decommissioned, a final groundwater monitoring event will occur and the soils beneath the land farm cell shall be sampled and analyzed for hydrocarbon contamination.

Long term monitoring of the on site landfill shall be in accordance with the INAC protocol. The Cape Christian on site landfill will be inspected once a year for the first five years after the remediation program has been completed. Monitoring activities will include a visual inspection to ensure that the land fill cover is not eroding and there is proper and adequate drainage on and around the landfill. Initial monitoring activities will also include sampling of the soils around the landfill to ensure that there is no contamination (metals, hydrocarbons and other suspected contaminants) associated with the contents of the landfill. Once it has been established that the landfill is both physically and chemically stable for five consecutive monitoring events, the monitoring program frequency may be reduced based on the inspection data to once every five years for the next twenty years unless additional inspections are warranted due to the condition of the landfill at the most recent inspection.

11.0 REFERENCES

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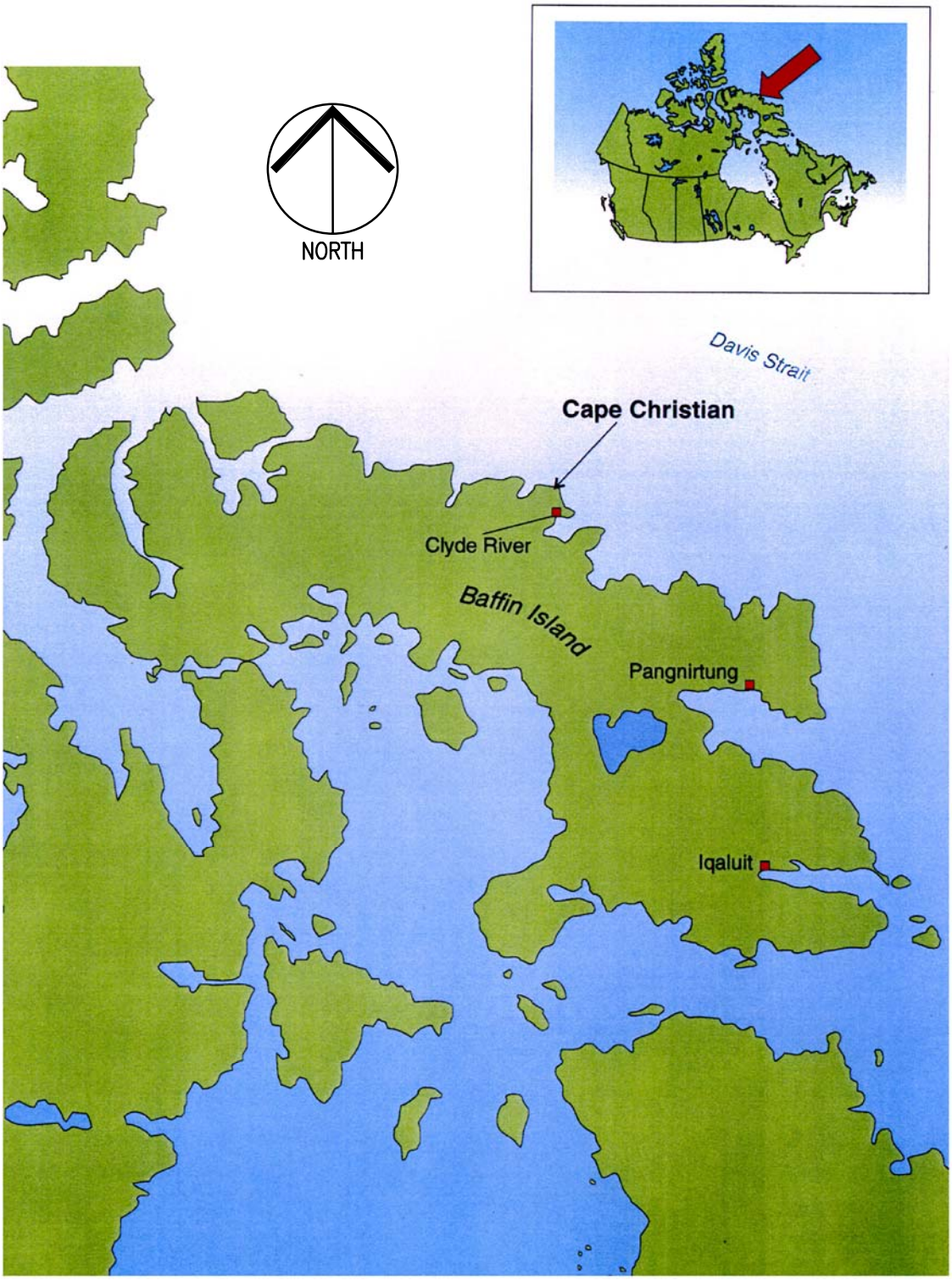
APPENDIX A

FIGURES



Date: January, 2007

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN, BAFFIN ISLAND, NUNAVUT

LOCATION PLAN

Figure 1.0

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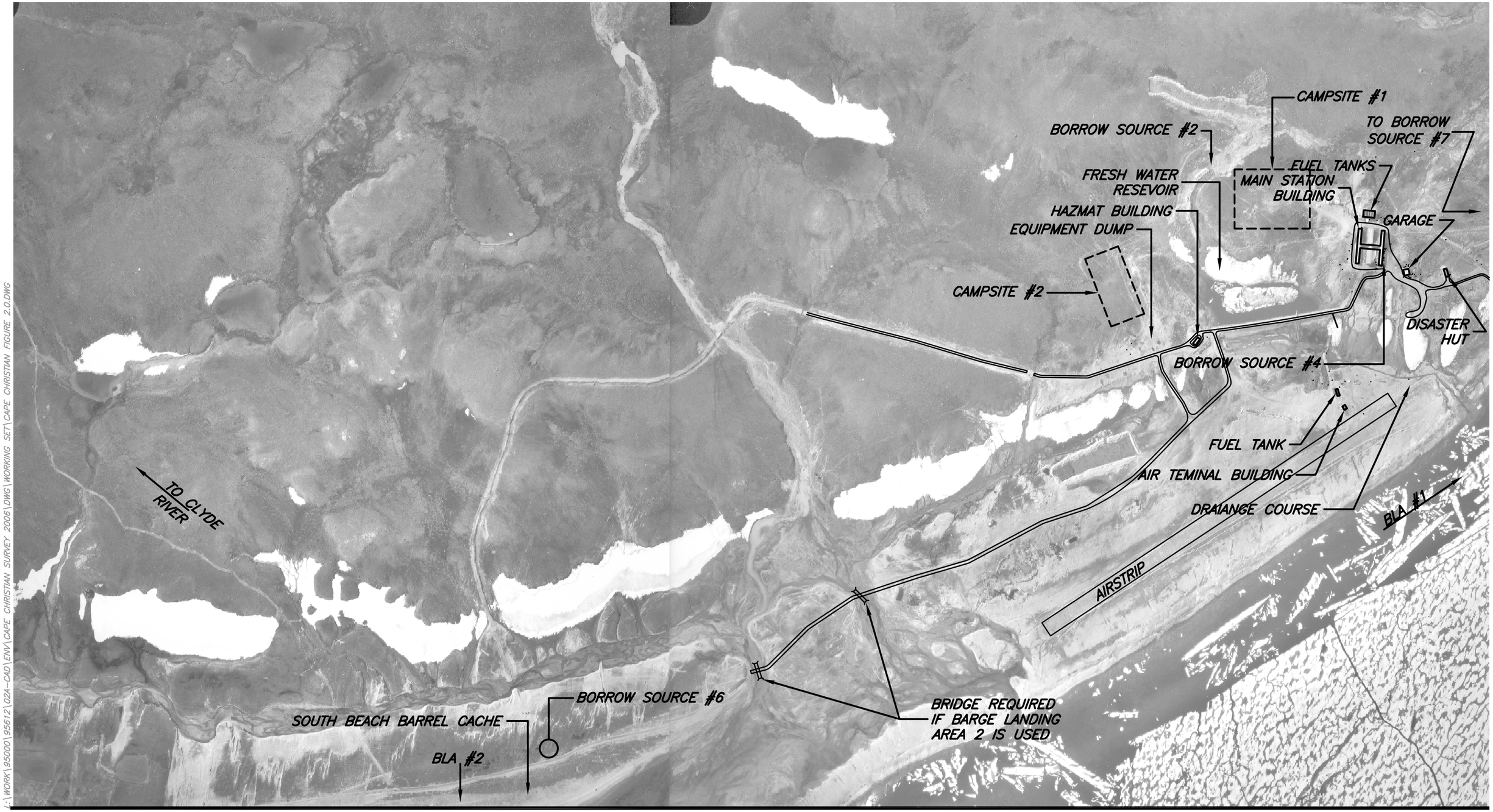

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EarthTech
A Tyco International Ltd. Company

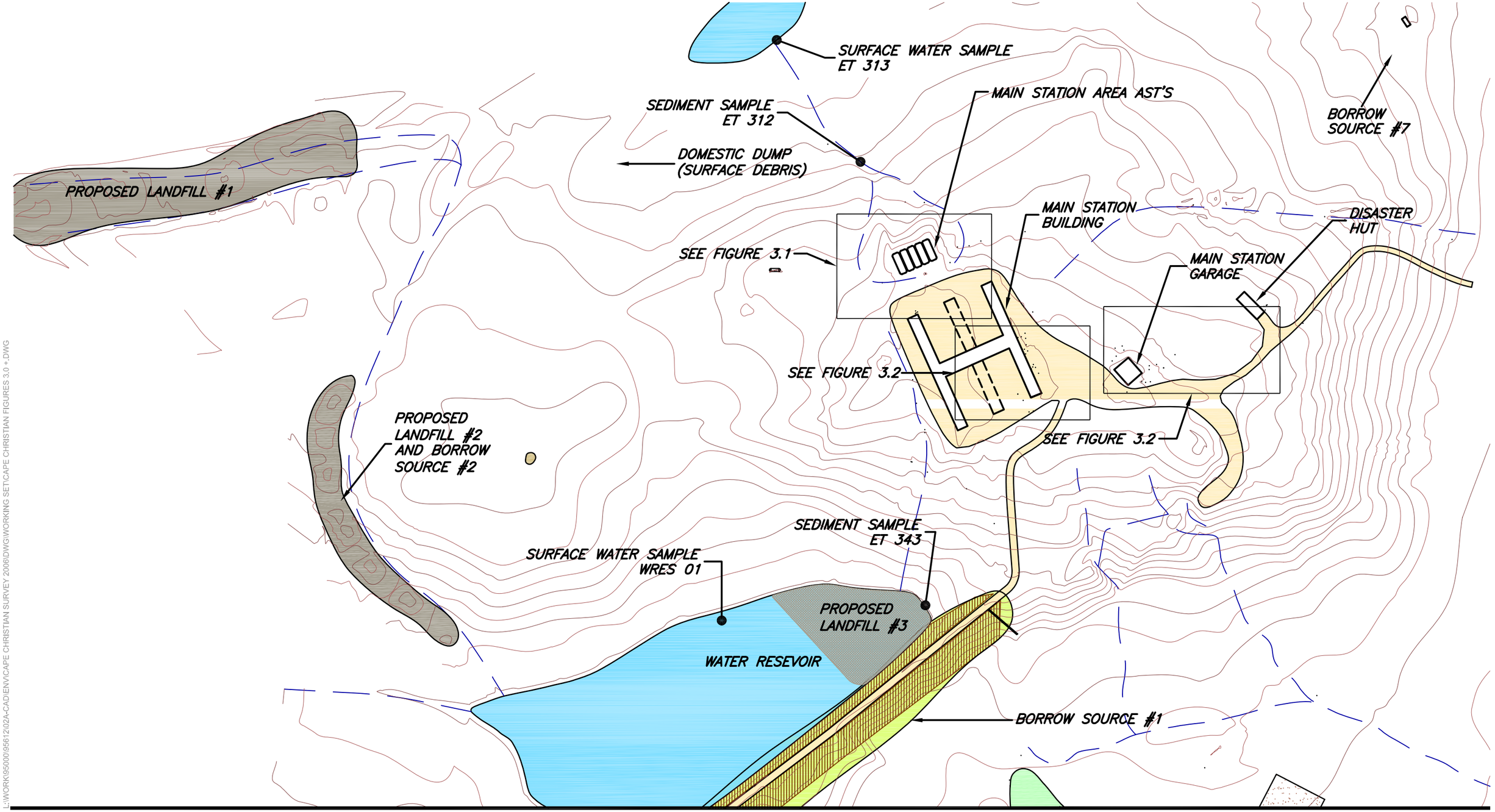
NOTE: BLA = BARGE LANDING AREA

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

OVERALL SITE PLAN

FIGURE 2.0



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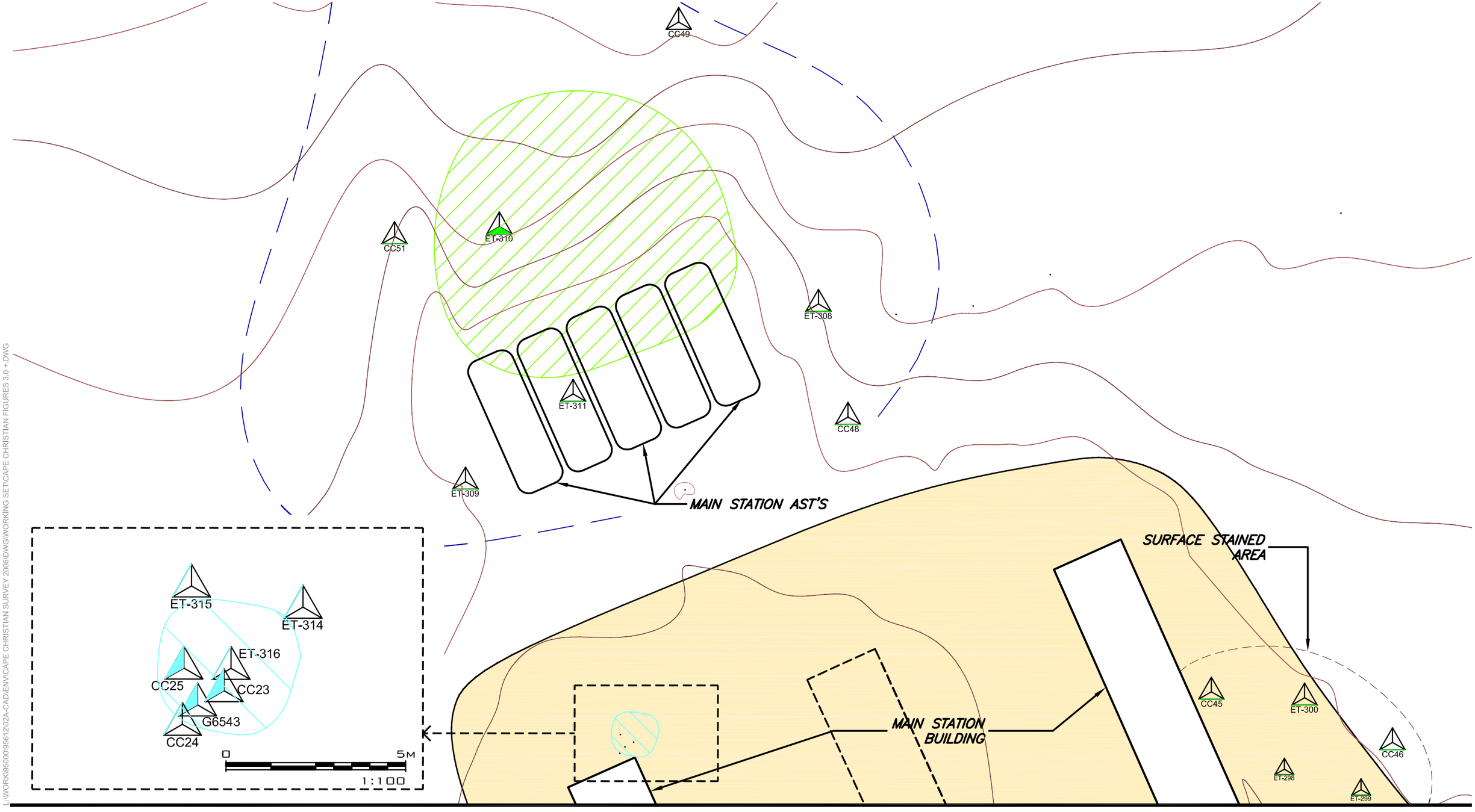
INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

MAIN STATION AREA

FIGURE 3.0



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Legend

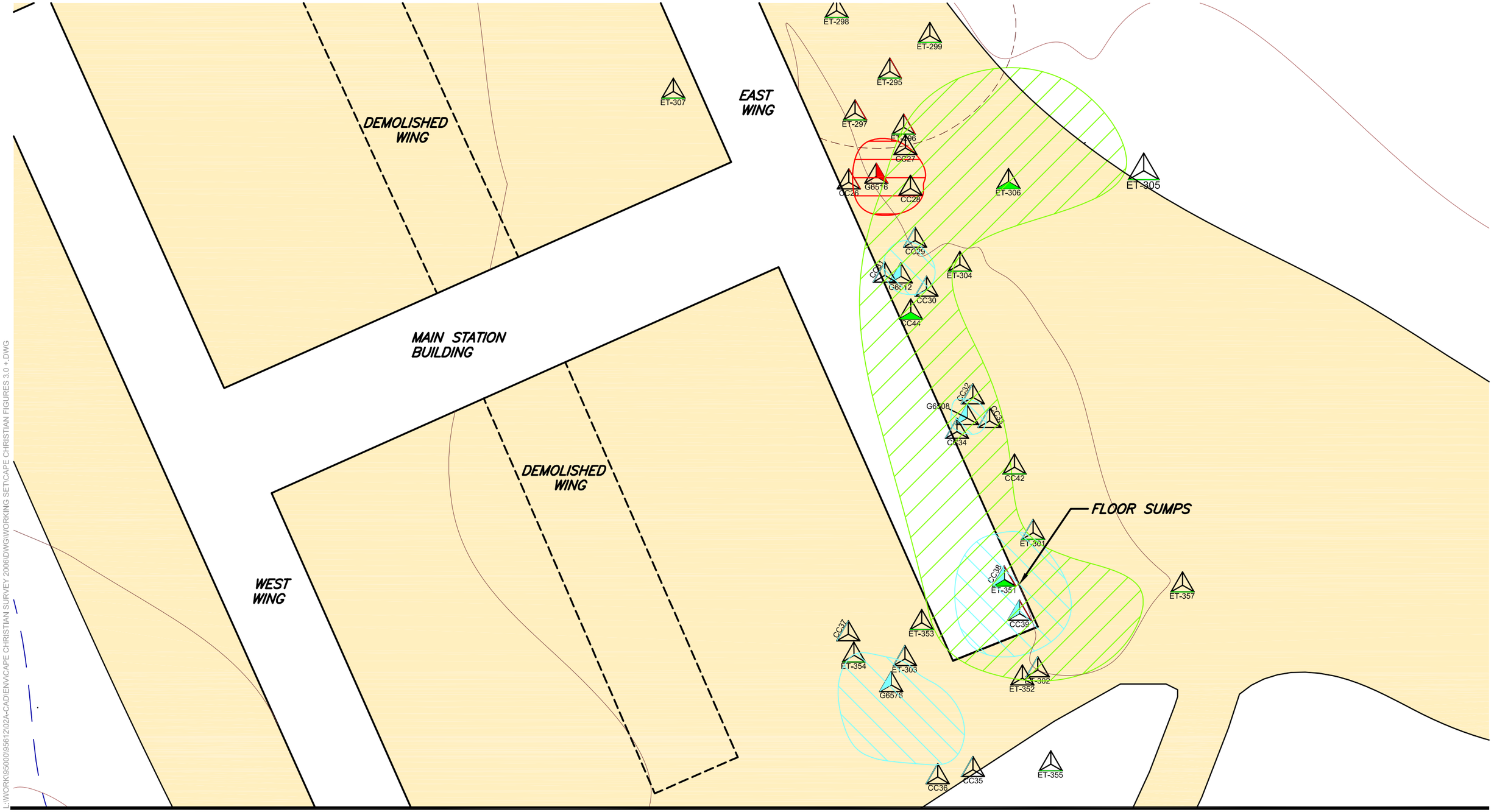
- PCBs SAMPLE
- METALs SAMPLE
- PHCs SAMPLE
- SURFACE DEBRIS
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- DRAINAGE COURSE
- ET EARTH TECH 2006 SAMPLE
- CC EARTH TECH 2001 SAMPLE
- G6543 ESG SAMPLE

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

MAIN STATION AST'S AREA

FIGURE 3.1



L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SETICAPE CHRISTIAN FIGURES 3.0 +.DWG

Date: January, 2007
SCALE:
0 5 10M
1:250

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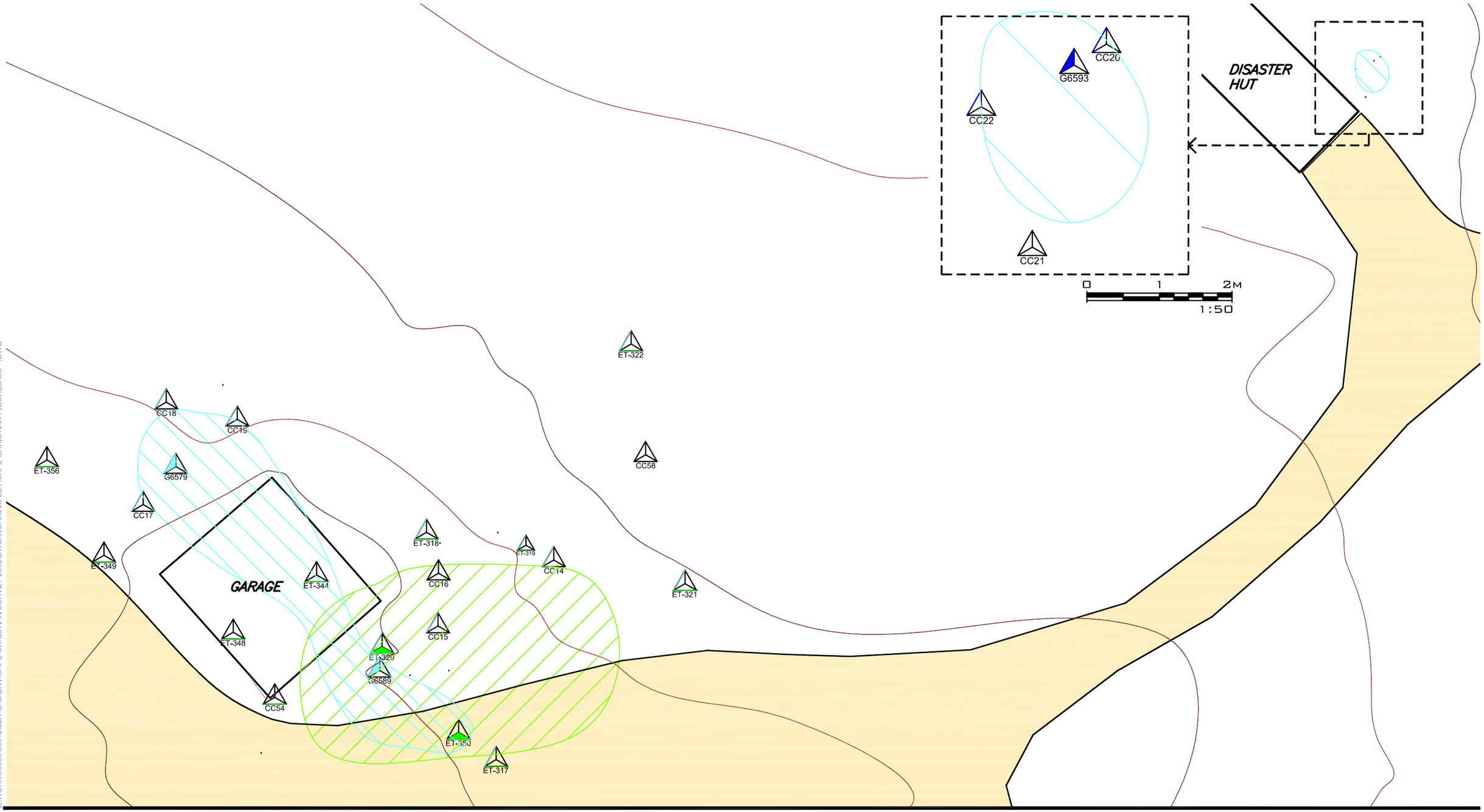
Legend

ET-300	PCBs SAMPLE	ET-300	PCBs EXCEEDANCE
ET-300	METALs SAMPLE	ET-300	METALs EXCEEDANCE
ET-300	PHCs SAMPLE	ET-300	PHCs EXCEEDANCE
	SURFACE DEBRIS		BURIED DEBRIS

	PCBs CONTAMINATION PLUME
	METALs CONTAMINATION PLUME
	PHCs CONTAMINATION PLUME
	DRAINAGE COURSE
ET	EARTH TECH 2006 SAMPLE
CC	EARTH TECH 2001 SAMPLE
G6543	ESG SAMPLE

INDIAN AND NORTHERN AFFAIRS CANADA
CAPE CHRISTIAN LORAN STATION
MAIN STATION BUILDING AREA
FIGURE 3.2



L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 3.0 +.DWG

Date: January, 2007
SCALE:
0 5 10M
1:250

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N

Legend

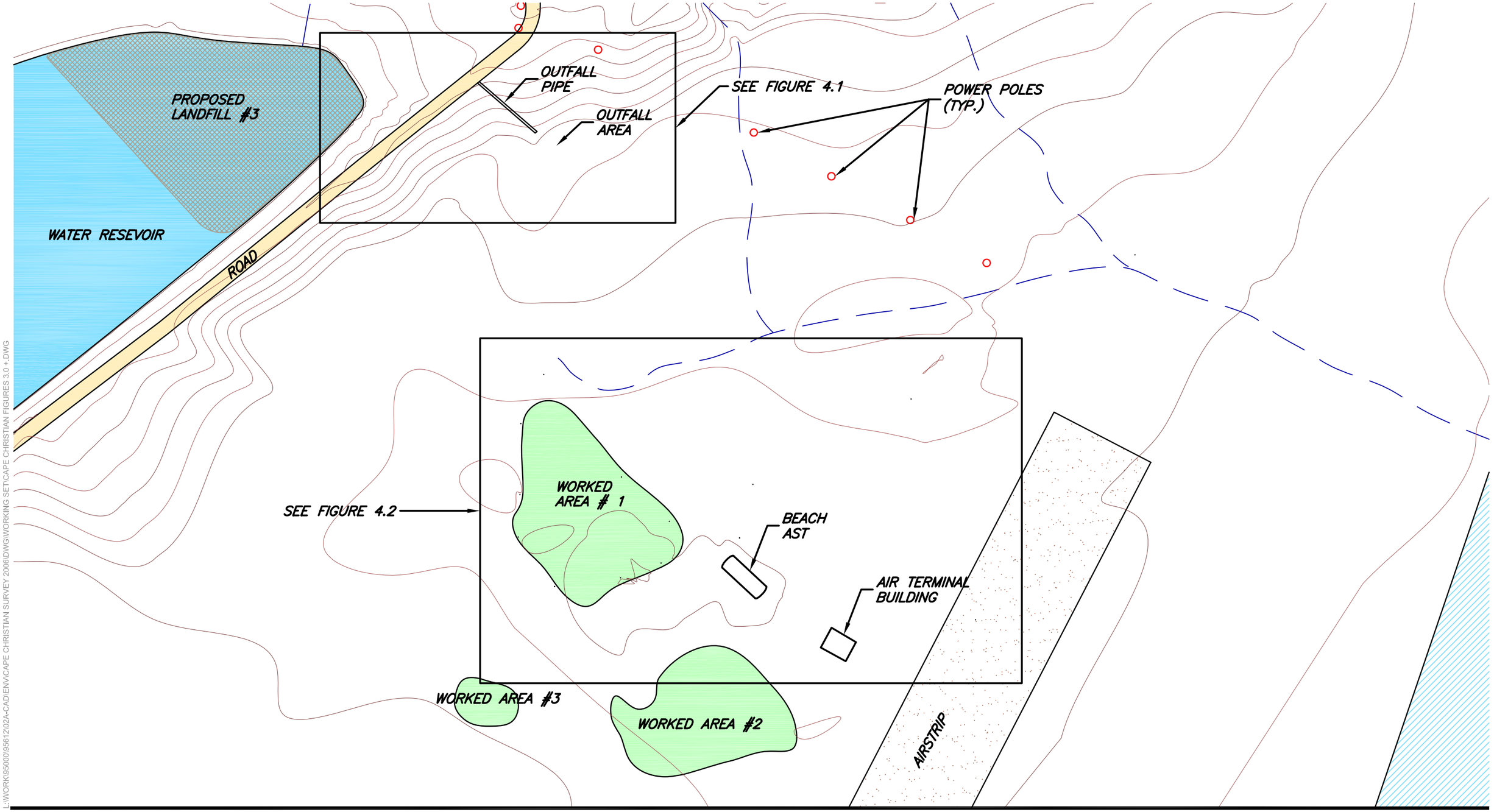
- PCBs SAMPLE (ET-300)
- METALs SAMPLE (ET-300)
- PHCs SAMPLE (ET-300)
- SURFACE DEBRIS
- PCBs EXCEEDANCE (ET-300)
- METALs EXCEEDANCE (ET-300)
- PHCs EXCEEDANCE (ET-300)
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- DRAINAGE COURSE
- ET EARTH TECH 2006 SAMPLE
- CC EARTH TECH 2001 SAMPLE
- G6543 ESG SAMPLE

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

MAIN STATION AREA

FIGURE 3.3



L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 3.0 +.DWG

Date: January, 2007

SCALE:

0 25 50M

1:1000

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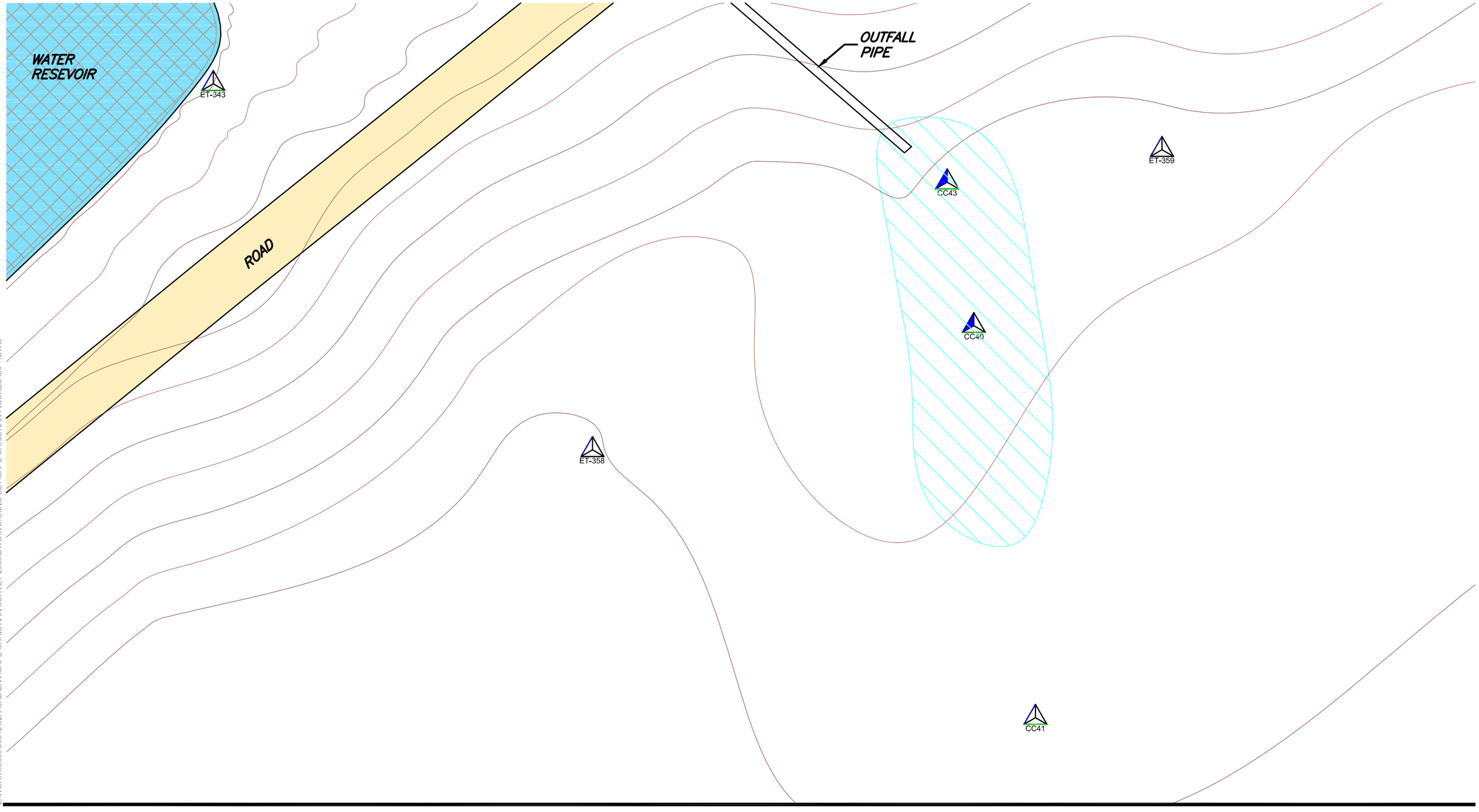
INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

BEACH AREA

FIGURE 4.0



L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SETS\CAPE CHRISTIAN FIGURES 3.0 +.DWG

Date: January, 2007

SCALE:

0 5 10M

1:250

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Legend

- ET-300 PCBs SAMPLE
- ET-300 METALs SAMPLE
- ET-300 PHCs SAMPLE
- SURFACE DEBRIS
- ET-300 PCBs EXCEEDANCE
- ET-300 METALs EXCEEDANCE
- ET-300 PHCs EXCEEDANCE
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- DRAINAGE COURSE
- ET EARTH TECH 2006 SAMPLE
- CC EARTH TECH 2001 SAMPLE
- G6543 ESG SAMPLE

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

OUTFALL AREA

FIGURE 4.1

L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 3.0 +.DWG

CC09
CC42
ET-327
ET-346
CC13
ET-345
ET-330
ET-347
PIPE LINE
ET-329
CC01
CC12
CC07
WORKED AREA #1
CC11
ET-323
ET-334
CC10
ET-324
CC03
CC04
BEACH AST
ET-326
CC05
ET-325
ET-333
CC60
AIR TERMINAL BUILDING DEBRIS
ET-332
AIRSTRIP

Date: January, 2007
SCALE:
0 10 20M
1:400

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Legend

ET-300 PCBs SAMPLE	ET-300 PCBs EXCEEDANCE
ET-300 METALs SAMPLE	ET-300 METALs EXCEEDANCE
ET-300 PHCs SAMPLE	ET-300 PHCs EXCEEDANCE
SURFACE DEBRIS	BURIED DEBRIS

	PCBs CONTAMINATION PLUME
	METALs CONTAMINATION PLUME
	PHCs CONTAMINATION PLUME
	DRAINAGE COURSE
ET	EARTH TECH 2006 SAMPLE
CC	EARTH TECH 2001 SAMPLE
G6543	ESG SAMPLE

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

BEACH AST and BURIED DEBRIS AREA

FIGURE 4.2

L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 3.0 +.DWG

Date: January, 2007

SCALE:

0 175 350M

1:7500

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Legend

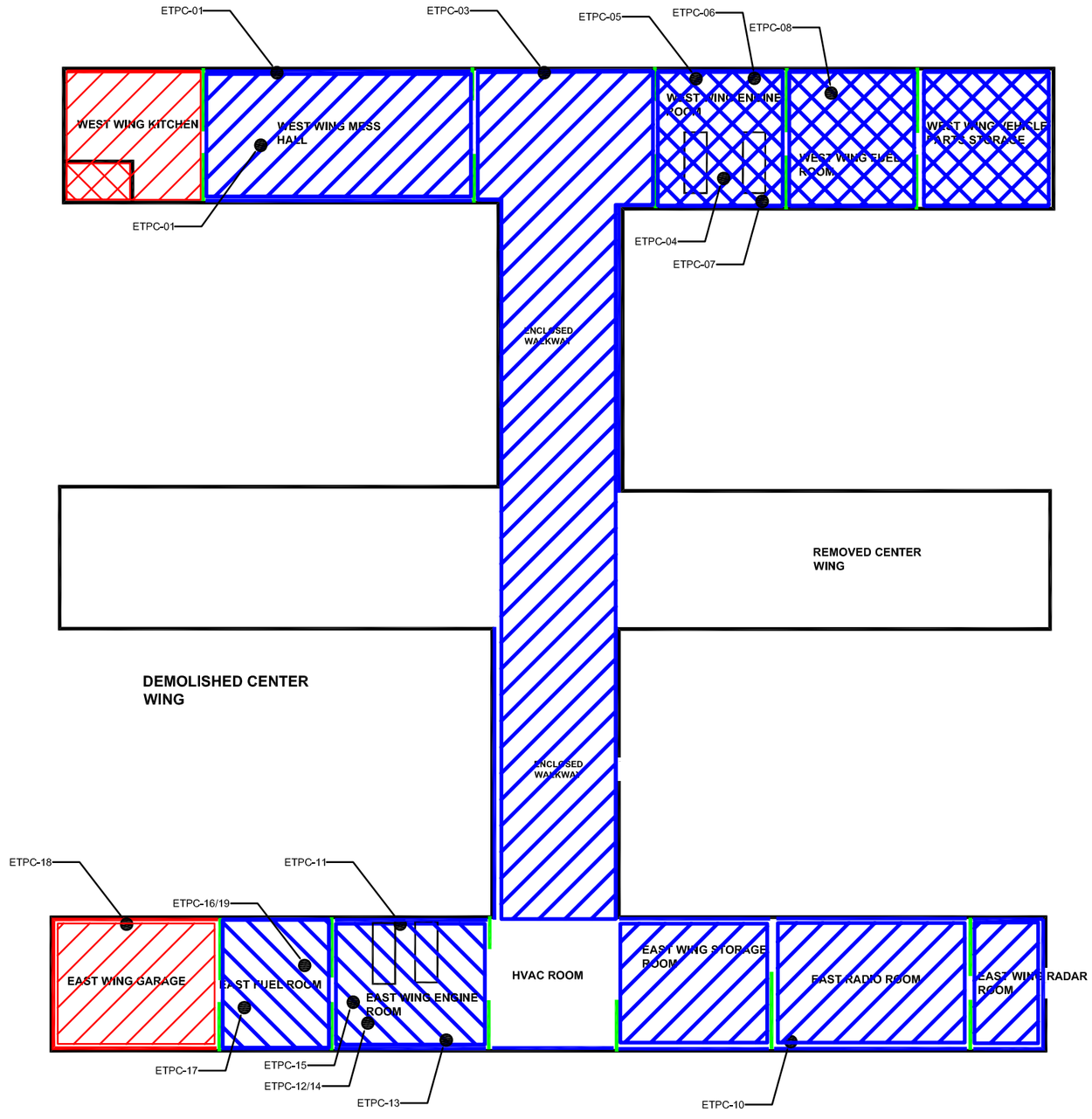
- PCBs SAMPLE (ET-300)
- METALs SAMPLE (ET-300)
- PHCs SAMPLE (ET-300)
- SURFACE DEBRIS
- PCBs EXCEEDANCE (ET-300)
- METALs EXCEEDANCE (ET-300)
- PHCs EXCEEDANCE (ET-300)
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- DRAINAGE COURSE
- ET EARTH TECH 2006 SAMPLE
- CC EARTH TECH 2001 SAMPLE
- G6543 ESG SAMPLE

INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

SOUTH BEACH AREA

FIGURE 5.0



L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 6.0-7.0.DWG

Date: January, 2007
SCALE: Not to Scale

- Lead paint on ceiling
- Lead paint on floor
- PCB paint on ceiling
- PCB paint on floor
- Lead paint on wall
- PCB paint on wall
- Asbestos

Note: asbestos piping throughout building

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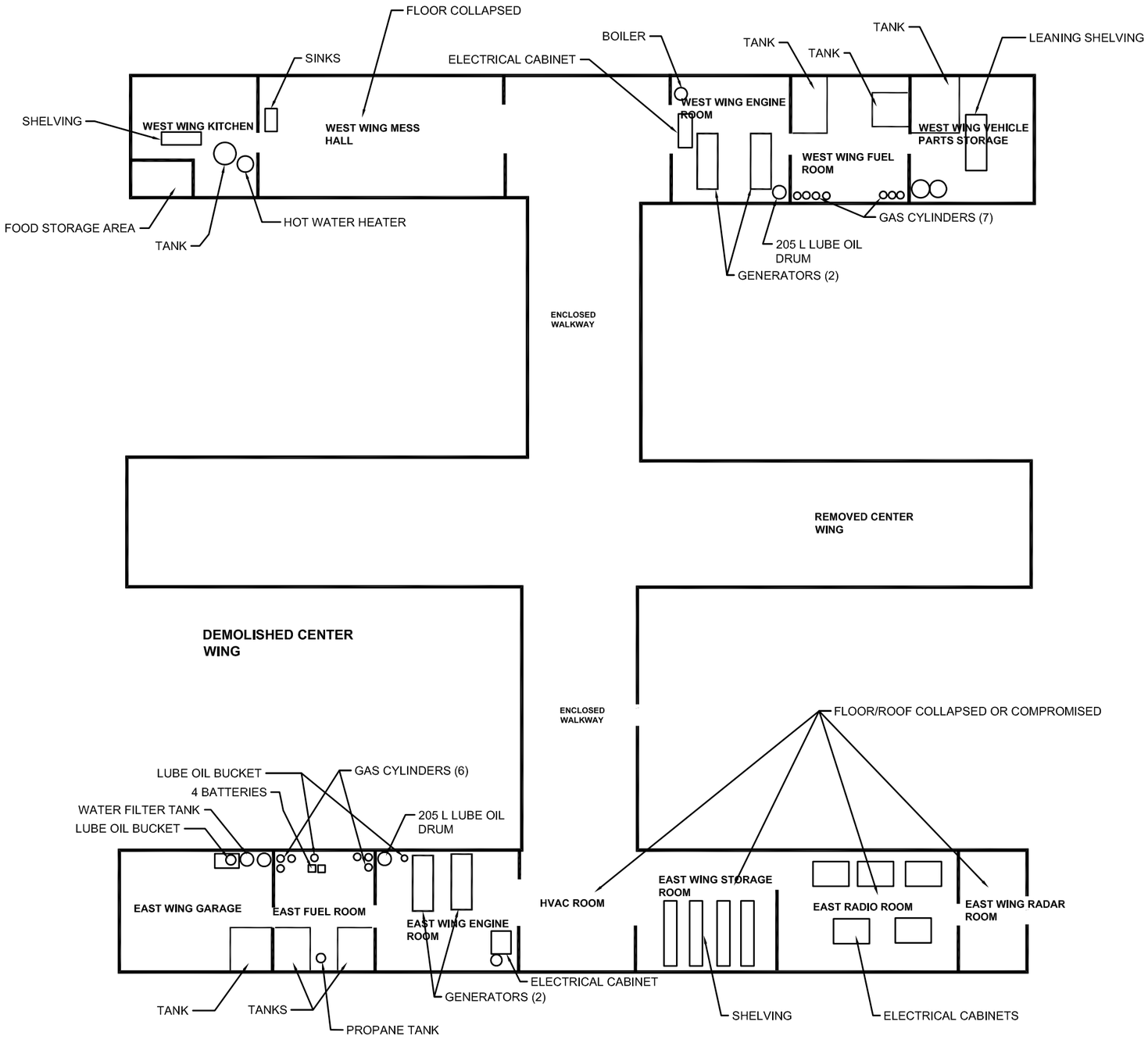
INDIAN AND NORTHERN AFFAIRS CANADA
CAPE CHRISTIAN LORAN STATION
MAIN STATION BUILDING PAINT ASSESSMENT
FIGURE 6.0



L:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 6.0-7.0.DWG

Date: January, 2007
SCALE: Not to Scale

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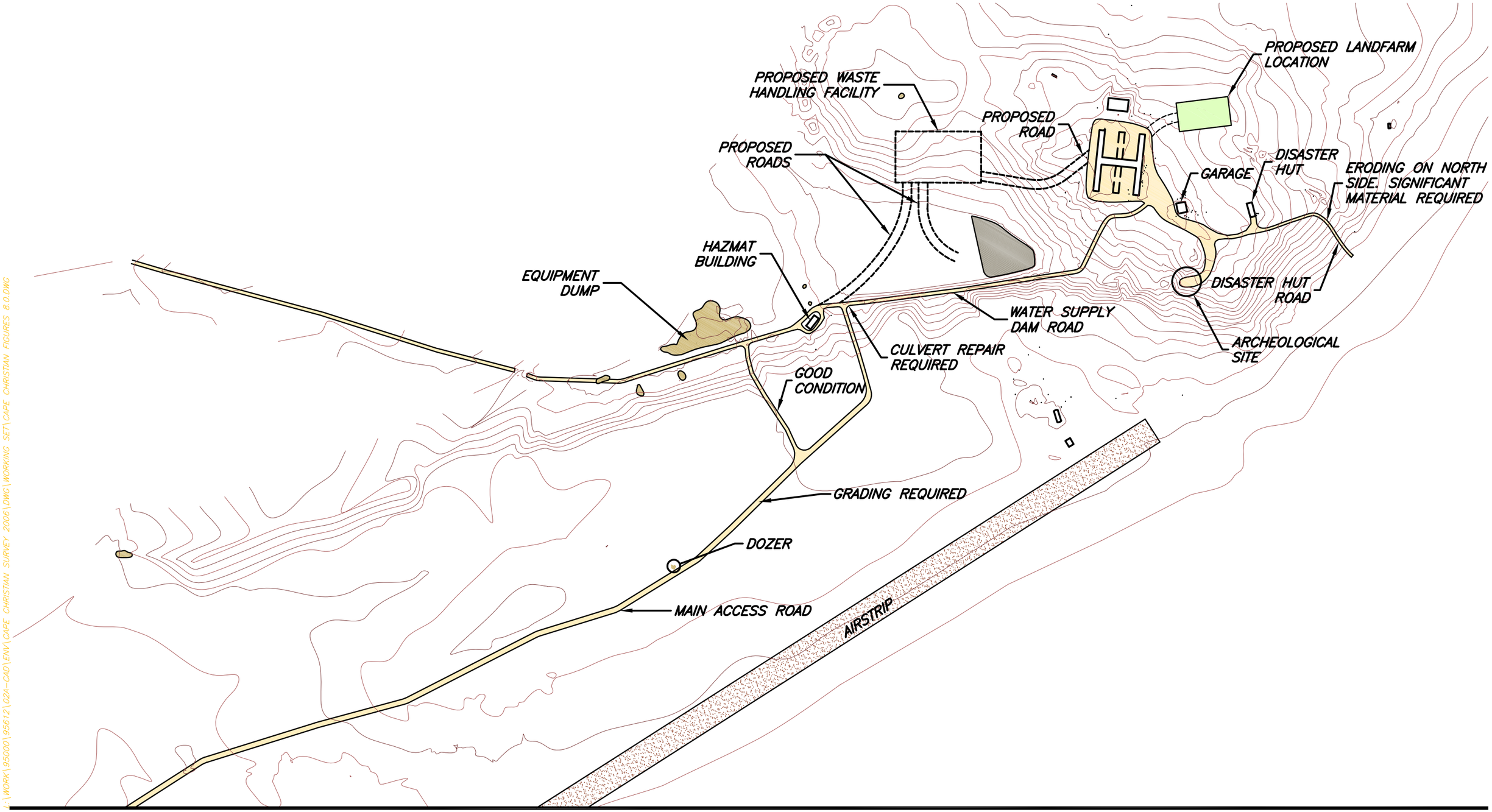
INDIAN AND NORTHERN AFFAIRS CANADA
CAPE CHRISTIAN LORAN STATION
MAIN STATION BUILDING CONTENTS
FIGURE 7.0



V:\WORK\95000\95612\02A-CAD\ENV\CAPE CHRISTIAN SURVEY 2006\DWG\WORKING SET\CAPE CHRISTIAN FIGURES 8.0.DWG

Date: January, 2007
SCALE:

0 100 200M
1:4000

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INDIAN AND NORTHERN AFFAIRS CANADA

CAPE CHRISTIAN LORAN STATION

OVERALL ROAD CONDITIONS

FIGURE 8.0