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DETAILED CHARACTERIZATION AND ECONET UPDATE OF MULTIPLE SITES AT CFS-EUREKA AND CFS-ALERT, NUNAVUT
Volume I : CFS-ALERT

Final Report 2007/08




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EXECUTIVE SUMMARY

This report presents the site characterization results from work performed by the National Research Council of Canada (NRC), Biotechnology Research Institute (BRI), during the 2007/08 sampling campaign at Canadian Force Station Alert (CFS-Alert), Nunavut. Located on Ellesmere Island, CFS-Alert is Canada's northernmost military site.

The results from the 2007/08 sampling campaign were necessary to complete the characterization of contaminated sites at CFS-Alert and to update the Econet database. This was the second sampling campaign for this characterization project. The results from the first sampling campaign were presented to 8 Wing Environmental Office in 2006/07, in the report entitled "Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut", (BRI, 2007).

The scope and objectives of the characterization project were to:

- Review the historical data for contaminated sites located at CFS-Alert;
- Identify data missing from the Econet database for these sites;
- Perform site characterization and complete data collection for contamination delineation;
- Classify each site according to the Federal Contaminated Sites Action Plan (FCSAP), developed by the National Classification System for contaminated sites;
- Update Geographic Information System (GIS) documentation for CFS-Alert;
- Update the Econet database;
- Enter new site characterization data into the Econet database for CFS-Alert.

Sampling Campaigns

2006/07

In 2006/07, two teams composed of BRI Environmental Microbiology group members collected samples at CFS-Alert. The first team was at CFS-Alert from June 21st to July 8th, with a brief sampling trip to CFS-Eureka on June 29th and June 30th. The second team was at CFS-Alert from July 3rd to July 22nd.

Field work was performed to obtain information regarding the location, extent and concentration(s) of contaminant(s) at each site. This information was used to classify the contaminated sites, according to the Federal Contaminated Sites Action Plan (FCSAP), and to update the Econet database.

In total, 34 sites were investigated. These sites included areas where contamination had previously been recorded, and areas where contamination was suspected. Of these 34 sites, 32 were contaminated.

Each sample collected during the 2006/07 sampling campaign was geo-referenced to update GIS documentation. All sample locations from the 2006/07 campaign were added to the database containing information regarding the 1999 and 2000 sampling campaigns performed by the Environmental Sciences Group (ESG) of the Royal Military College (RMC), Kingston.

2007/08

In 2007/08, two teams composed of BRI Environmental Microbiology group members worked at CFS-Alert. The first team was at CFS-Alert from July 31st to August 15th. The second team worked at CFS-Alert from August 13th to August 29th.

The fieldwork performed during the 2007/08 sampling campaign had several goals, including 1) determining background soil concentrations for heavy metals, 2) complete site characterization where required and 3) complete delineation of contamination identified during the 2006/07 sampling campaign. Information such as sample location and depth, sample description and odor, and a general site description were recorded on site, and samples were analyzed by accredited laboratories for selected contaminants. The results generated were used to classify the sites according to the Federal Contaminated Sites Action Plan (FCSAP) and to update the Econet database.

In total, 29 sites at CFS-Alert were investigated, including an underwater survey that was performed along the shoreline of Dumbell Bay and Alert Inlet, areas where contamination was

previously recorded and areas where contamination was suspected. All 29 sites demonstrated some degree of contamination.

Each sample collected during the 2007/08 field campaign was geo-referenced to update GIS documentation. All sample locations from the 2007/08 campaign were added to the pre-existing GIS database, originally compiled by ESG.

Approach to the Investigation

Samples were collected according to the methods described in *The Inspector's Field Sampling Manual* published by Environment Canada (2005) and the *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volume 1*, published by the Canadian Council of Resources and Environment Ministers (CCREM) (1993). Samples were sent to accredited laboratories for analysis. Replicate pairs, field blanks and transport blanks were collected and analyzed for collection and transportation quality control.

The chemical analyses performed on fuel contaminated samples included at least one of the following assays: benzene, toluene, ethylbenzene and total xylene (BTEX), total petroleum hydrocarbons (TPH) Fraction 1 (C_6-C_{10}), Fraction 2 (C_{10}-C_{16}), Fraction 3 (C_{16}-C_{34}), and Fraction 4 (C_{34}-C_{50}), polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

According to the available information and the suspected contamination on site, selected samples were analyzed for inorganic elements, including arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, tin and zinc. Several samples were analyzed for polychlorinated biphenyls (PCBs), glycols and phenols.

An approximate total of 320 soil samples, including 33 duplicate pairs, 22 field blanks, 4 transport blanks and 47 background samples, were collected at CFS-Alert. Additionally, 30 surface and groundwater samples and 60 sediment samples were collected and analyzed.

SOILS SAMPLES

Soil samples included soils collected at ground level, below ground level and at the suprapermafrost level (i.e. soil layer immediately above the permafrost). Samples collected within drainage pathways and drainage channels were considered soil samples.

Comparison guidelines for the assessment of soil contamination at CFS-Alert were based on the Canadian Council of Ministers of the Environment (CCME) Canada-Wide standards. The commercial/industrial guidelines for coarse soils from the 2006 CCME guidelines were used in this report, as they represent the activities and the soil types found at CFS-Alert.

WATER SAMPLES

Marine water samples were collected from Alert Inlet and Dumbell Bay. These samples were compared to the CCME Marine Quality Guidelines for the Protection of Aquatic Life. Water samples collected from standing water pools, the sewage outfall and drainage channels were compared to CCME Freshwater Quality Guidelines for the Protection of Aquatic Life. Groundwater samples collected from trenches or sampling holes were compared to the CCME Freshwater Quality Guidelines for the Protection of Aquatic Life.

SEDIMENT SAMPLES

Sediment samples collected from the shoreline during the underwater survey at CFS-Alert were compared to the CCME Canadian Sediment Quality Guidelines (CSQG). The CSQG contains two contaminant guideline levels. The first level, called the Interim Sediment Quality Guideline (ISQG), is the limit for contaminant concentrations that are not expected to be associated with any adverse biological effects. The second level, called the Probable Effect Level (PEL), represents the contaminant concentration limits that are frequently associated with adverse biological effects. Contaminant concentrations between the ISQG and PEL values represent the range in which adverse biological effects are occasionally observed.

Results of the 2007/08 Sampling Campaign

Forty-seven soil and three sediment background samples were collected during the 2007/08 sampling campaign and were analyzed for 15 different heavy metals: arsenic, barium, cadmium,

chromium, cobalt copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, tin, and zinc. Cadmium, mercury, molybdenum, and tin were not detected in any samples. With the exception of arsenic and nickel, the remaining metals were detected but not above guideline concentrations. In the case of arsenic and nickel, the guideline concentrations were slightly above the measured average background concentrations, and these elevated background metal concentrations are believed to be typical of Ellesmere Island. This was evident when high concentrations of arsenic and nickel were detected at CFS-Alert in soil samples where no anthropogenic source was identified. These elevated arsenic and nickel concentrations had a direct impact on the interpretation of results for numerous sites at CFS-Alert.

All 29 sites investigated during the 2007/08 sampling campaign were contaminated with either heavy metals, TPH or both. FCSAP classification was used to evaluate the contamination and establish a priority list of sites where actions are required.

Fifteen sites at CFS-Alert were classified as FCSAP Class 1sites. This classification indicates that action must be taken to address the contamination at these sites. Eleven sites were FCSAP Class 2 sites. These sites present a potential for adverse off-site impact without direct risk to human health or the environment. Finally, three sites were FCSAP Class 3 sites, which indicated that the contamination within each site was not a current concern, but additional information may be required to confirm the site classification. A summary table is presented below.

Class	Site Name and PRIN
Class 1	
	Alert (Underwater Survey) (S-146)
	Oxidator Building (S-349)
	Runoff Collection Basin (S-352)
	MSE-17 Vehicle Maintenance Building (S-10195)
	Main Station Landfill (S-10197)
	Curling Club/Gym Complex (S-10203)
	Airstrip Diesel Pipeline (S-10210)
	Airstrip Met Shack (S-10212)
	Main Station Day Tank Area (S-10214)
	Baker's Dozen (S-10216)
	Building 113, Heated Vehicle Storage (S-10217)
	New Fuel Line Spill 1999 (S-10219)
	AES Weather Station Remains-GA (S-10522)
	Sewage Outfall (S-10524)
	Lower Dumbell Lake (S-10529)

Class	Site Name and PRIN
Class 2	
	Apron Refueling Area inlcuding the Deicing Area (S-10194)
	Burn Pit (S-10196)
	CE-140 MCE Building Fire Hall (S-10199)
	B-145 Cat House (S-10200)
	1 CEU GP Hut (S-10201)
	CE Cold Storage General Purpose Hut "Dog House" (S-10202)
	Dump #3 (S-10205)
	Airstrip Building HIL-124 "The Hilton" (S-10207)
	Airstrip Building FH-128 (S-10208)
	Airstrip Hurricane Building (S-10211)
	Burner Project Site (Old Hazmat Storage Site) (S-10218)
Class 3	
	Airstrip Tank Farm (S-10193)
	50 Line GP Huts Drainage (S-10204)
	TX Site (S-10206)

Recommendations

According to the results from the 2007/08 sampling campaign, 18 sites require further investigation to refine contaminant delineation. Remediation is recommended for 20 sites and a regular monitoring campaign to record any off-site movement of contamination is recommended for 3 sites.

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1 INTRODUCTION

This report was prepared by the Biotechnology Research Institute (BRI) and presents the results of the 2007/08 field campaign for the characterization of multiple contaminated sites situated at CFS-Alert, Nunavut.

1.1 SCOPE AND OBJECTIVES

The scope and objectives of the 2007/08 investigations included the following activities:

- Review the historical data for the contaminated sites located at CFS-Alert;
- Identify missing data in the Econet database;
- Perform site characterization and complete data collection for contamination delineation;
- Classify each site according to the Federal Contaminated Sites Action Plan (FCSAP) developed by the National Classification System for contaminated sites;
- Update the Geographic Information System (GIS) documentation for CFS-Alert;
- Update the Econet database;
- Enter new site characterization data into the Econet database for CFS-Alert.

2 CFS-ALERT AND SITE LOCATIONS

CFS-Alert is located on the north-eastern tip of Ellesmere Island, Nunavut (82° 30'N, 62° 20' W), approximately 800 km south of the geographic North Pole and 40 km south of the northernmost point in Canada (Figure 1). CFS-Alert is the most northerly permanent settlement in the world. It has an average temperature in June, July and August of -0.8°C, 3.3°C and 0.8°C, respectively, and the total average annual precipitation is 153.8 mm (Environment Canada, 2004). Precipitation occurs primarily during the months of July, August, and September. Because of permafrost and the lack of significant surface vegetation, runoff is an important water redistribution process during the snowmelt period.

The closest non-military Canadian community to CFS-Alert is Grise Fiord, located approximately 800 km southeast of the station (Soulière 1997). The Ellesmere Island National Park Reserve is 40 km southwest of CFS-Alert. The CFS-Alert area was not included in the Park Reserve at the request of the Department of National Defence and Canadian Forces (DND/CF).

Built in 1950 as a weather station, Alert became a Canadian Military Communications Research Facility in 1956. At its peak of activity in the 1970's, 200 military staff were stationed year around at CFS-Alert. CSF-Alert is now a remotely operated listening facility, and staffing was reduced to approximately 50 to 100 military personnel for year around operation (Figure 2).

The subsurface stratigraphy of the CFS-Alert area is continuous permafrost. Holes drilled during a permafrost study indicated that the permafrost depth reaches a maximum of 480 m (Grey 1997). Recent observations indicated that the depth of the active layer is approximately 1 m (BRI 2007). The active layer is located above the permafrost and is the portion of the soil that is subjected to seasonal freeze thaw cycles.

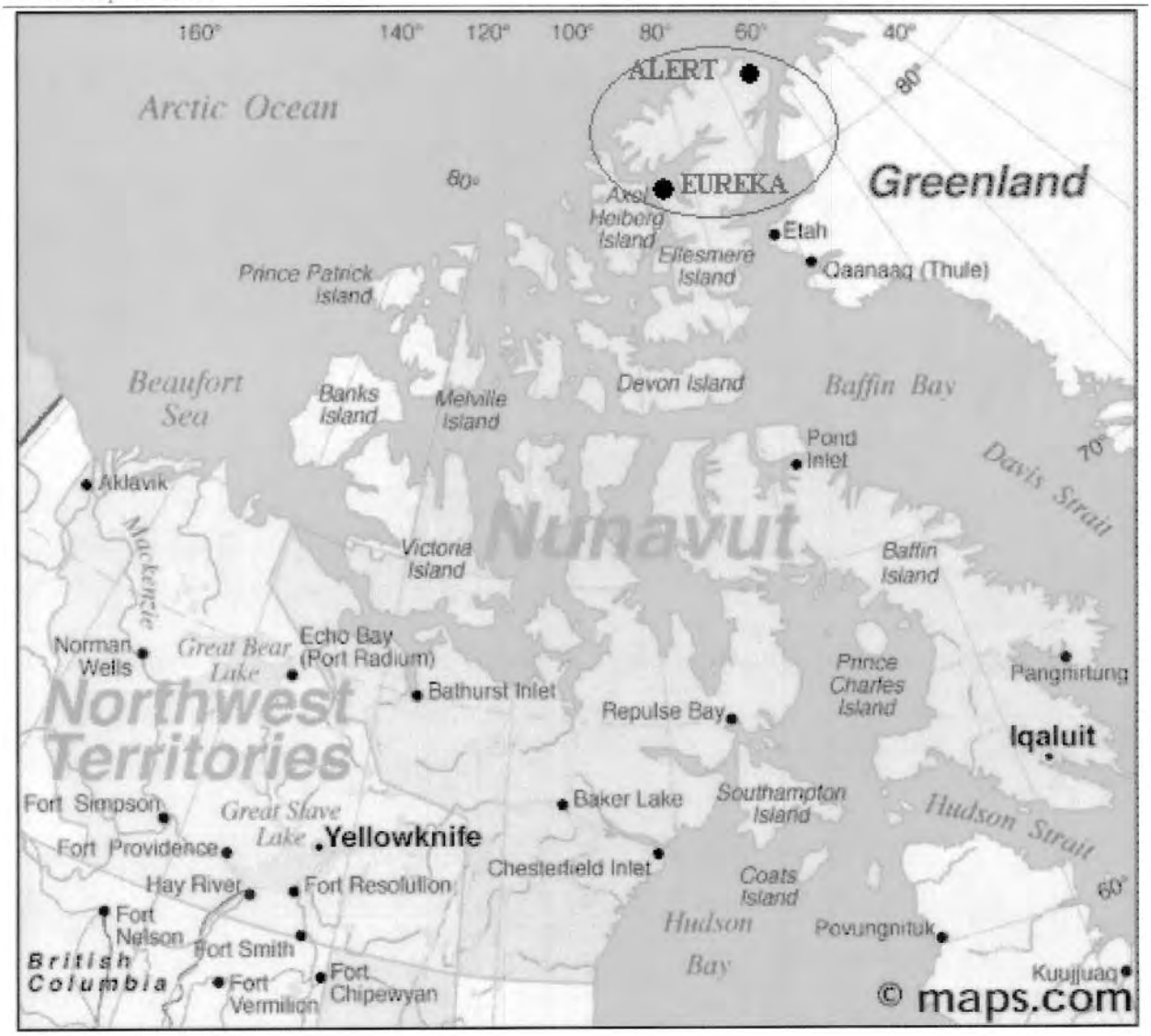

Figure 1. Map of Nunavut, showing CFS-Alert on Ellesmere Island (www.maps.com).

Figure 2. Aerial view of CFS-Alert with Upper Dumbell Lake the foreground (BRI 2007).

2.1 ENVIRONEMNTAL RECEPTORS

Alert Inlet and Dumbell Bay are important environmental receptors for most CFS-Alert sites. They receive contaminated drainage water coming from the station, whether migrating within the surface water or groundwater. Influenced by tidal cycles, the water in Alert Inlet enters Dumbell Bay and reaches the Arctic Ocean by way of the Lincoln Sea. Therefore, aquatic life is potentially affected by the contamination from CFS-Alert. During the underwater survey, plant and animal life such as seaweed, fish and seals, were observed near the shoreline of Alert Inlet and Dumbell Bay (Photograph 1, Appendix A). Lower and Upper Dumbell Lakes are the environmental receptors for the watershed surrounding the lakes. Artic Char fishing at Lower and Upper Dumbell Lakes is an occasional recreational activity for CFS-Alert personnel.

During the 2006/07 and 2007/08 sampling campaigns, animals such as polar bears, reindeers, muskoxen, wolves, hares, lemmings and birds were observed at or in the vicinity of CFS-Alert. When an animal was not directly observed at a study site, evidence of its presence or passage, such as feces and tracks, were generally recorded. An important quantity of birds was frequently observed at the sewage outfall site (Photograph 34, appendix A).

Various types of vegetation were observed at CFS-Alert during the 2006/07 and 2007/08 sampling campaigns. This vegetation was abundant at the sewage outfall site, and was present to a lesser degree throughout the station area.

Human activity is restricted to the building during the winter, with increased outdoor activities in the vicinity of the station during the summer months.

3 METHODOLOGY

3.1 REVIEW OF LITERATURE

A review of existing reports and previous site characterizations at CFS-Alert was completed

during the 2006/07 BRI investigations. The goal of this review was to assemble information pertaining to the contamination present at the study sites and assist in the planning of the required characterization work to complete the site characterizations. The result of this literature review was presented in the 2006/07 report submitted by BRI, entitled "Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut" (BRI, 2007).

3.2 SITE VISITS

Two teams composed of BRI staff members worked at CFS-Alert during 2007/08. The first team worked at CFS-Alert from July 31st to August 15th, and the second team worked at CFS-Alert from August 13th to August 29th.

3.3 SAMPLE IDENTIFICATION

The sample identification scheme followed this format: B07-XX-#### (Photograph 35, Appendix A). The letter B represents the BRI sampling campaign, the first 2 numbers represent the year of the sampling campaign (i.e. 2007/08), the 2 letters represent the site identification abbreviation and the last 4 numbers represent the sample identification. A list of the site abbreviations with the associated Property Record Identification Number (PRIN) and site name is presented in Table 1.

Bodycote Materials Testing, located in Pointe-Claire, Montreal, and Testmark Laboratories Ltd., located in Garson, Ontario, supplied all sample containers. The sample label was firmly attached to the side of the container, and the following information was legibly and indelibly written on the label:

- Project name;
- Sample identification;
- Sampling date;
- Tests required;
- Preservatives added;
- Sample collector's initials.

Table 1. Sites visited during the 2007/08 BRI sampling campaign.

	PRIN	Name	Abbreviation 2007
CFS-ALERT	S-146	Alert (Cont Sites/Underwater Survey)	US
	S-349	Oxidator Building (Back of building)	OX
	S-352	Runoff Collection Basin	RB
	S-10193	Airstrip Tank Farm	AF
	S-10194	Apron Refueling Area	RT
	S-10194	Deicing Area	DICE
	S-10195	MSE -17 Vehicle Maintenance Building	VM
	S-10196	Burn Pit	BP
	S-10197	Main Station Landfill	MS
	S-10199	CE-140 MCE Building Fire Hall	FH
	S-10200	B-145 Cat House	CH
	S-10201	1 CEU GP Hut	CE
	S-10202	Cold Storage Dog House GP Hut	DH
	S-10203	Curling Club/Gym Complex	GY
	S-10204	50 Line GP Huts Drainage	GP
	S-10205	Dump #3	D3
	S-10206	TX Site	TX
	S-10207	Airstrip Building HIL-124	HI
	S-10208	Airstrip Building FH-128	AS
	S-10210	Airstrip Diesel Pipeline	DP
	S-10211	Airstrip Hurricane Building	HB
	S-10212	Airstrip Met Shack	ME
	S-10214	Main Station Day Tank Area	DT
	S-10216	Baker's Dozen	KZ
	S-10217	Building 113, Heated Vehicle Storage	HV
	S-10218	Burner Project Site	BU
	S-10219	New Fuel Line Spill 1999	NF
	S-10522	AES Weather Station Remains-GA	WS
	S-10524	Sewage Outfall	SO
	S-10529	Lower Dumbell Lake	LL

3.4 SURVEYING OF EACH SAMPLE POINT

Each new sample point collected during the 2007/08 sampling campaign was geo-referenced to update the GIS documentation of the CFS-Alert sites. A post-processing differential CMT-Alto-G12 GPS was used to perform the geo-referencing survey. This differential GPS procedure involved a stationary receiver (base station), which continuously recorded satellite measurements at a fixed and known location, and a mobile receiver that recorded the location of each sampling point. The geo-reference of each sampling point recorded with the mobile receiver was corrected using the information recorded by the base station (differential GPS procedure). The reader should note that only sampling points from the 2006 and 2007 BRI field campaigns are presented on the maps. Please reference previous reports for all previous sampling points.

Geo-reference coordinates were collected using the global geodetic reference system WGS84. This system was established and is maintained by the U.S. Department of Defense to facilitate positioning and navigation worldwide (Kouba and Popelar, 1994), and has an accuracy of approximately 1 m.

3.5 PHOTOGRAPHIC DOCUMENTATION OF SAMPLE SITES

During the 2007/08 sampling campaign, photographs of each site were taken to facilitate site characterization and analysis. A selection of photos is presented in Appendix A.

3.6 SOIL AND SEDIMENT SAMPLING

Site assessment work performed during the 2007/08 campaign was based on the 2006/07 literature review and campaign results. The objective of the assessment work was to delineate and characterize contaminated areas in order to obtain the necessary information for updating of the Econet database and prepare potential remediation schemes, were applicable.

Total petroleum hydrocarbons fractions analysis (TPH Fractions 1 to 4) was carried out by Testmark Laboratories Ltd, accredited by the CCME. All other analyses (heavy metals, VOC, PAH, BTEX, PCB, glycols, phenolic compounds, nitrates, nitrites and total phosphorus) were performed by Bodycote Materials Testing, also an accredited laboratory.

Soil and sediment samples (surface, active layer and suprapermafrost layer) were collected from trenches made with a backhoe, using fresh disposable gloves for each sample and taken from newly exposed soil (i.e. soil not contacted by the backhoe). Some soil and sediment samples collected from the surface to approximately 60 cm below ground surface were dug with pick and shovel, which were decontaminated with an Alconox® soap solution between each sample. Samples for organic and inorganic element analyses were collected using glass sample jars with Teflon coated caps and dedicated gloves. For TPH Fraction 1 to 4 analyses, one 250 mL jar per sample was completely filled with soil or sediment to avoid contaminant volatilization.

The sediment samples taken during the underwater survey were collected by professional Navy divers. The distance from the shoreline to sample collection points ranged from a few meters to 40 m. The distance from the shoreline to the sampling point was limited by the presence of free floating and shifting ice. The samples were collected at an average depth of 15 m under the surface. For each sampling point, the divers filled a clean 1L polyethylene bottle with sediment using a stainless steel scoop. The scoop was washed with Alconox® soap solution between each sample. Once above the water, the sediments were transferred into the appropriated sample jar or bottle. Samples for organic and inorganic element analyses were placed in glass sample jars with Teflon coated caps. For TPH Fraction 1 to 4, one 250 mL jar per sample was completely filled with sediment to avoid contaminant volatilization.

Visual observations and odor descriptions were noted for each sample in the field logs. Samples were stored in coolers at 4°C before and during shipping. A total of 320 soil samples and 60 sediment samples were collected at Alert during the 2007/08 campaign.

In the compiled analyses results tables, several samples have the notation "Soil (Drainage sed.)." These samples were collected in different drainage pathways and they were treated as soils.

3.7 WATER SAMPLING

Site assessment work performed during the 2007/08 campaign was based on the 2006/07 literature review and campaign results. The objective of the assessment work was to delineate and characterize contaminated areas in order to obtain the necessary information for updating of the Econet database and prepare potential remediation schemes, were applicable.

TPH Fractions 1 to 4 analysis was carried out by Testmark Laboratories Ltd, accredited by the CCME. All other analyses (heavy metals, VOC, PAH, BTEX, PCB, glycols, phenolic compounds, nitrates, nitrites and total phosphorus) were performed by Bodycote Materials Testing, also an accredited laboratory.

Samples for TPH analysis were collected in one 1L amber glass bottle per sample, provided by Testmark Laboratories Ltd., paying special attention to eliminate air within the bottles. All other bottles were provided by Bodycote Material Testing. Samples for VOC and BTEX were collected in three 250mL glass bottles per sample, paying special attention to eliminate air within the bottles. Samples for PAH analyses were collected in one 1L amber glass bottle per sample. Samples analyzed for metals were collected in one 125mL plastic bottle per sample and the samples collected for nitrate, nitrite, and total phosphorus were collected in one 250mL plastic bottle per sample.

Visual observations and odor descriptions were noted for each sample in the field logs. Samples were stored in coolers at 4°C before and during shipping. A total of 60 water (surface and groundwater) samples were collected at Alert during the 2007/08 campaign.

3.8 ASSESSMENT GUIDELINE

3.8.1 Soil Guidelines

Comparison guidelines for the assessment of soil contamination at CFS-Alert are based on the CCME Canada-Wide standards.

Inorganic elements, BTEX, TPH, PAH, glycol, PCBs and other contaminant concentrations obtained during the 2007/08 sampling campaign were compared to CCME commercial/industrial generic levels. The CCME commercial/industrial land use category is assigned to a site where the primary activity involves the production, manufacture, or storage of materials, and where public access is restricted. Children are not permitted continuous access or occupancy on commercial/industrial sites. This land use category corresponds to the activities occurring at CFS-Alert.

3.8.2 Water Guidelines

Water samples collected from Dumbell Bay and Alert Inlet were compared to the CCME Marine Quality Guidelines for the Protection of Aquatic Life. Water samples collected from isolated standing water pools, sewage outfall and drainage channels were compared to CCME Freshwater Quality Guidelines for the Protection of Aquatic Life.

The Sewage Outfall and the Main Station Landfill at CFS-Alert were compared to both CCME and Environment Canada Effluent Quality and Wastewater Treatment at Federal Establishments guidelines (Environment Canada, 1976).

3.8.3 Sediment Guidelines

Canadian Sediment Quality Guidelines (CSQGs) are nationally endorsed, science-based benchmarks for evaluating the potential of adverse biological effects in aquatic systems. Freshwater and marine CSQGs have been developed and published for a number of contaminants of concern in sediments, with the exception of TPH Fractions 1 to 4, BTEX, VOC, nitrates, nitrites and total phosphorus (CCME 2006).

Sediment samples collected from the shoreline and offshore during the underwater survey at CFS-Alert were compared to the Canadian Sediment Quality Guidelines (CSQGs) produced by the CCME. The CSQG contains two contaminant guideline levels. The first level, called the Interim Sediment Quality Guideline (ISQG), is the limit for contaminant concentrations that are not expected to be associated with any adverse biological effects. The second level, called the Probable Effect Level (PEL), represents the contaminant concentration limits that are frequently associated with adverse biological effects. Contaminant concentrations between the ISQG and PEL values represent the range in which adverse biological effects are occasionally observed.

Sediment samples collected from Dumbell Bay and Alert Inlet were compared to the guidelines developed for marine sediment. Sediment samples collected from Lower Dumbell Lake were compared to the guidelines for freshwater sediment.

3.8.4 Sample Replicates and Blanks

Replicate pairs, field blanks and transport blanks were collected and analyzed for collection and transportation quality control (Photograph 36, Appendix A). Sample replicates were taken for 10 percent of the samples, and the collection method for the sample and the replicate was identical. One field blank was generally collected at each site during the sampling procedure. One transport blank was sent with each load shipped from CFS-Alert to the analytical laboratory, via CFB-Trenton. These blanks were 250 mL glass jars filled with silica sand provided by Bodycote Materials Testing. The results of the analyses of the sample replicates are presented within the results of each site and the results of the transport and field blanks are presented in Tables 2 and 3, respectively.

Table 2. Results of transport blank analyses from CFS-Alert.

		Transport blank 2007						
		SOIL			SOIL	SOIL	SOIL	SOIL
	PARAMETERS	UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	TB07-1 31/07/2007	TB07-2 14/08/2007	B-TB07-3 22/08/2007	TB07-4 01/09/2007
TPH	Benzene	mg/kg	0.03	0.02	<0.1	<0.1	<0.1	NA
	Toluene	mg/kg	0.37	0.02	<0.1	<0.1	<0.1	NA
	Ethylbenzene	mg/kg	0.082	0.02	<0.1	<0.1	<0.1	NA
	Total Xylene	mg/kg	11	0.04	<0.1	<01	<0.1	NA
	F1 (C6-C10)	mg/kg	310	10	<2.8	NA	<2.3	<2.7
	F2 (C10-C16)	mg/kg	760	10	12	NA	17	<2
	F3 (C16-C34)	mg/kg	1700	10	341	NA	310	322
	F4 (C34-C50)	mg/kg	3300	10	<4.8	NA	<8.7	<6.6
VOC	Vinyl chloride	mg/kg	---	0.04	<0.4	NA	NA	NA
	1,1-Dichloroethene	mg/kg	50	0.04	<0.1	NA	NA	NA
	Dichloromethane	mg/kg	50	20	<0.1	NA	NA	NA
	1,2-Dichloroethene (trans)	mg/kg	50	0.03	<0.1	NA	NA	NA
	1,1-Dichloroethane	mg/kg	50	0.03	<0.1	NA	NA	NA
	1,2-Dichloroethene (cis)	mg/kg	50	0.03	<0.1	NA	NA	NA
	Chloroform	mg/kg	50	0.03	<0.1	NA	NA	NA
	1,1,1-Trichloroethane	mg/kg	50	0.03	<0.1	NA	NA	NA
	Carbon tetrachloride	mg/kg	50	0.03	<0.1	NA	NA	NA
	Benzene	mg/kg	5	0.04	<0.1	NA	NA	NA
	1,2-Dichloroethane	mg/kg	50	0.03	<0.1	NA	NA	NA
	Trichloroethene	mg/kg	0.01	0.05	<0.1	NA	NA	NA
	1,2-Dichloropropane	mg/kg	50	0.04	<0.1	NA	NA	NA
	Bromodichloromethane	mg/kg	---	0.04	<0.1	NA	NA	NA
	1,3-Dichloropropene (trans)	mg/kg	50	0.05	<0.1	NA	NA	NA
	1,3-Dichloropropene (cis)	mg/kg	50	0.03	<0.1	NA	NA	NA
	Toluene	mg/kg	0.8	0.05	<0.1	NA	NA	NA
	1,1,2-Trichloroethane	mg/kg	50	0.04	<0.1	NA	NA	NA
	Tetrachloroethene	mg/kg	0.6	0.08	<0.1	NA	NA	NA

NA Not available

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Field blank collected at the CFS Alert							
SOIL							
10193	FB07-S10195	FB07-S10201 Drain. Sed.	FB07-S10211	FB07-S10212	FB07-S10216	FB07-S10217	FB07-S10524
007	8/25/2007	8/20/2007	8/27/2007	8/17/2007	8/21/2007	8/23/2007	8/15/2007
7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
	2	<2	<2	<2	<2	<2	2
9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	<2	<2	<2	<2	<2	<2	<2
	<1	<1	<1	<1	<1	<1	<1
	<1	<1	<1	<1	<1	<1	<1
1	<10	<10	<10	<10	<10	<10	<10
	<3	<3	<3	<3	<3	<3	<3
	<2	<2	<2	<2	<2	<2	<2
	<2	<2	<2	<2	<2	<2	<2
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	<5	<5	<5	<5	<5	<5	<5
	<4	<4	<4	<4	<4	<4	<4

Field blank collected at the CFS Alert									
SOIL									
352	FB07-S10193	FB07-S10194	FB07-S10195	FB07-S10200	FB07-S10201	FB07-S10203	FB07-S10207	FB07-S10208	FB07-S10210
007	8/22/2007	8/16/2007	8/25/2007	8/14/2007	8/20/2007	8/18/2007	8/17/2007	8/27/2007	8/08/2007
	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	<0.1
	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	<0.1
	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	<0.1
	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	<0.1
5	<2.4	<2.7	<3.2	<2.7	<2.5	6.4	<2.7	<2.9	4.9
3	273	24	<2	<1.8	29.9	14	20.7	<2.6	4.1
1	310	260	227	314	303	371	281	284	321
4	<5.2	<9.3	<6.5	<6	<5.9	<6.2	<6.3	<8.8	<6

Environmental Health in Industrial land uses, of the CCME. (2006)

ndustrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Field blank collected at the CFS Alert								
SOIL								
FB07-S10212 8/17/2007	FB07-S10214 8/20/2007	FB07-S10216 8/21/2007	FB07-S10217 8/23/2007	FB07-S10218 8/05/2007	FB07-S10219 8/11/2007	FB07-S10522 8/23/2007	FB07-S10529 8/14/2007	FB07-S10590 7/28/2007
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1
NA	<2.4	<2.4	<3.2	<2.2	2.4	<2.9	<2.7	NA
NA	30.3	16	<1.5	3.6	10	3.4	<1	NA
NA	293	319	277	381	292	342	159	NA
NA	<7	<5.5	5	<4.7	6.5	<5.2	<3.5	NA

Table 3. Results of field blank analyses from CFS-Alert sites (cont.).

		Field blank collected at the CFS Alert			
		SOIL			SOIL
	PARAMETERS	UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	FB07-S10217 8/23/2007
PAH	Naphthalene	mg/kg	22	0.008	<0.1
	2-methylnaphthalene	mg/kg	---	0.005	<0.1
	1-methylnaphthalene	mg/kg	---	0.005	<0.1
	1,3-Dimethylnaphthalene	mg/kg	---	0.005	<0.1
	Acenaphthylene	mg/kg	---	0.004	<0.1
	Acenaphthene	mg/kg	---	0.004	<0.1
	2,3,5-trimethylnaphthalene	mg/kg	---	0.007	<0.1
	Fluorene	mg/kg	---	0.007	<0.1
	Phenanthrene	mg/kg	50	0.010	<0.1
	Anthracene	mg/kg	---	0.004	<0.1
	Fluoranthene	mg/kg	---	0.008	<0.1
	Pyrene	mg/kg	100	0.008	<0.1
	Benzo(c)Phenanthrene	mg/kg	---	0.008	<0.1
	Benzo(a)Anthracene	mg/kg	10	0.007	<0.1
	Chrysene	mg/kg	---	0.008	<0.1
	[illegible]	mg/kg	---	0.005	<0.1
	Benzo(b,j,k)fluoranthene	mg/kg	10	0.008	<0.1
	Benzo(a)pyrene	mg/kg	0.7	0.008	<0.1
	3-methylcholanthrene	mg/kg	---	0.022	<0.1
	Indeno(1,2,3-cd)pyrene	mg/kg	10	0.008	<0.1
	Dibenzo(a,h)anthracene	mg/kg	10	0.008	<0.1
	Benzo(g,h,i)perylene	mg/kg	---	0.008	<0.1
	Dibenzo (a,l) pyrene	mg/kg	---	0.008	<0.1
	Dibenzo (a,i) pyrene	mg/kg	---	0.007	<0.1
	Dibenzo (a,h) pyrene	mg/kg	---	0.008	<0.1

NA Not available

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the Canadian CCME (January 2001)

3.9 BACKGROUND

A total of 47 background soil samples and 3 background sediment samples were collected during the 2007/08 sampling campaign (Figure 3). Of these samples, 40, 14, 2, and 1 samples were analyzed for heavy metals, TPH, PAH and BTEX, respectively (Tables 4 and 5). Fourteen different heavy metals were examined: arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, tin and zinc. The results showed that, with the exception of arsenic, all metal concentrations were below CCME guidelines. Arsenic concentrations in five background soil samples surpassed CCME guidelines and in another 12 samples were within 2 mg/kg of surpassing CCME guidelines (12 mg/kg). Nickel concentrations were slightly below the CCME guidelines.

During the 2006/07 and 2007/08 campaign, arsenic and nickel concentrations at several sites frequently exceeded the CCME guideline at CFS-Alert, and these sites had no known anthropogenic source of these metals. These elevated arsenic and nickel concentrations are believed to be due to the naturally elevated background concentrations of these metals in Ellesmere Island soils.

No TPH Fractions, PAH or BTEX was detected near or above CCME guidelines in any of the background samples.

Figure 3. Map of sampling points for background analyses at CFS-Alert.

Background collected at the CFS Alert																
	SOIL															
0075	B07BG0076	B07BG0077	B07BG0078	B07BG0079	B07BG0080	B07BG0081	B07BG0082	B07BG0083	B07BG0084	B07BG0085	B07BG0086	B07BG0087	B07BG0088	B07BG0089	B07BG0090	B07BG0091
cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm
/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07
:	8.3	10.6	10.5	8.7	9.9	9.4	8.3	7.6	8.2	7.4	9.1	8.8	7.5	9.3	5.7	10.4
	12	12	14	13	17	9	12	13	14	14	19	24	29	22	17	18
9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	22	24	23	23	26	23	21	22	25	21	23	28	22	27	20	22
	11	13	10	10	12	13	10	10	12	10	10	12	10	11	9	12
	17	21	17	18	20	19	29	18	24	18	19	22	18	15	11	27
1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	11	<10	<10	<10	<10
5	450	418	401	427	385	473	374	402	411	407	432	485	457	530	421	421
4	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	35	43	35	36	40	38	33	33	41	34	33	39	33	38	28	40
	0.7	0.7	0.7	0.7	0.8	0.9	0.7	0.8	0.6	0.7	0.7	0.5	0.5	0.6	0.6	0.7
5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5	<0.5	0.9	0.9	0.9	0.9	0.9	0.9	1	0.9	0.9
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	51	57	52	54	60	56	51	50	63	50	58	67	65	63	46	55

L	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL		
0096	B07BG0096-2	B07BG0097	B07BG0098	B07BG0099	B07BG0099-2	B07BG0100	B07BG0101	B07BG0102	B07BG0103	B07BG0104	B07BG0105	B07BG0180	KIRKLAKE BG	Query Sand Alert		
cm	40 cm	0-20 cm	0-20 cm	0-20 cm	60 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	0-20 cm	On a pile		
/07	10/08/2007	08/26/07	08/26/07	08/26/07	29/07/2007	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	08/26/07	02/08/2007	09/08/2007	09/08/2007	AVERAGE	RATIO
	8.1	9.4	8.6	13.5	5.4	13.1	13.1	12.1	11.9	11.9	7.8	8.9	9.6	10.2	8.74	1.37
	19	20	19	21	15	18	17	14	13	19	23	11	14	18	16.47	121.41
9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<09	<0.9	<0.9	ND	-
	23	24	22	24	26	25	22	24	23	24	25	29	21	17	23.84	3.65
	11	12	11	12	12	12	11	11	11	11	11	13	10	7	10.95	27.40
	20	20	20	22	20	20	20	22	18	19	19	23	19	10	19.68	4.62
1	17	<10	<10	<10	13	<10	<10	<10	<10	<10	<10	13	11	11	12.00	50.00
2	419	460	402	419	270	405	383	418	479	455	462	485	520	520	431.00	-
4	NA	<0.04	<0.04	<0.04	NA	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	NA	NA	NA	ND	-
	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	ND	-
	33	36	32	37	40	36	32	34	34	37	36	45	36	36	36.74	0.11
	0.6	0.7	0.6	0.8	0.8	0.8	0.7	0.7	0.5	0.6	0.6	<0.5	0.6	0.6	0.68	58.62
	<0.5	0.9	1	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.9	0.9	<0.5	<0.5	<0.5	0.91	329.67
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ND	-
	65	58	54	58	49	59	53	61	55	58	62	64	45	28	56.89	6.33

, of the CCME. (2006)

Background collected at the CFS Alert												
SOIL												
B07BG0031 10-20 cm 08/11/2007	B07BG0032 10-20 cm 08/11/2007	B07BG0033 10-20 cm 08/11/2007	B07BG0034 10-20 cm 08/11/2007	B07BG0035 10-20 cm 08/11/2007	B07BG0036 10-20 cm 08/11/2007	B07BG0049 10-20 cm 17/08/2007	BG07BG0060 10-20 cm 08/17/2007	B07BG0096-2 40 cm 10/08/2007	B07BG0099-2 60 cm 29/07/2007	B07BG0180 10-20 cm 02/08/2007	AVERAGE	RATIO
<3.3	<3.8	<3.4	<3.4	<3.6	<4.1	<4	<3.9	<3.5	<3.4	3.9	3.90	79.49
<1.8	<2	32	3.4	<2.8	<1.9	30	<2.2	<2.2	<1.9	25.4	19.78	38.42
22	50.2	25	31.9	36	101	66	36	9.3	19	65.9	36.56	46.49
19	28	91	18	34	48	31	20	<7.4	19	15	31.36	105.22

RATIO

alth in Industrial

. Results of sediment background sample analyses for CFS-Alert.

PARAMETERS	UNITS	MARINE SEDIMENT GUIDELINES AQUATIC LIFE (3) ISQG	(4) PEL	DETECTION LIMIT	Background collected at the CFS Alert MARINE SEDIMENT B07BG0029 Dup. 288 0-20 cm 8/07/2007	B07BG0288 0-20 cm 8/07/2007	B07BG1000 0-20 cm 8/03/2007	AVERAGE	RATIO
Arsenic (As)	mg/kg	7.24	41.6	0.27	9.4	7.2	5.8	7.47	0.97
Barium (Ba)	mg/kg	---	---	5	8	7	11	8.67	-
Cadmium (Cd)	mg/kg	0.7	4.2	0.22	<0.9	<0.9	<0.9	ND	-
Chromium (Cr)	mg/kg	52.3	160	3	19	17	26	20.67	2.53
Cobalt (Co)	mg/kg	---	---	1.9	7	6	9	7.33	-
Copper (Cu)	mg/kg	18.7	108	2.1	14	12	15	13.67	1.37
Lead (Pb)	mg/kg	30.2	112	1.2	13	<10	14	13.50	2.24
Manganese (Mn)	mg/kg	---	---	1.1	213	204	342	253	-
Molybdenum (Mo)	mg/kg	---	---	1.4	<2	<2	2	2	-
Nickel (Ni)	mg/kg	---	---	0.6	25	23	33	27	-
Selenium (Se)	mg/kg	---	---	0.5	0.5	<0.5	1.7	1.10	-
Silver (Ag)	mg/kg	---	---	0.4	<0.5	<0.5	<0.5	ND	-
Tin (Sn)	mg/kg	---	---	0.8	<5	<5	<5	ND	-
Zinc (Zn)	mg/kg	124	271	2.5	43	36	53	44.00	2.82
Naphthalene	mg/kg	0.0346	0.391	0.008	<0.01	<0.01	<0.01	ND	-
2-methylnaphthalene	mg/kg	0.0202	0.201	0.005	<0.01	<0.01	<0.01	ND	-
1-methylnaphthalene	mg/kg	---	---	0.005	<0.01	<0.01	<0.01	ND	-
1,3-Dimethylnaphthalene	mg/kg	---	---	0.005	<0.01	<0.01	<0.01	ND	-
Acenaphthylene	mg/kg	0.00587	0.128	0.004	<0.01	<0.01	<0.01	ND	-
Acenaphthene	mg/kg	0.00671	0.0889	0.004	<0.01	<0.01	<0.01	ND	-
2,3,5-trimethylnaphthalene	mg/kg	---	---	0.007	<0.01	<0.01	<0.01	ND	-
Fluorene	mg/kg	0.0212	0.144	0.007	<0.01	<0.01	<0.01	ND	-
Phenanthrene	mg/kg	0.0867	0.544	0.01	<0.01	<0.01	<0.01	ND	-
Anthracene	mg/kg	0.0469	0.245	0.004	<0.01	<0.01	<0.01	ND	-
Fluoranthene	mg/kg	0.113	1.494	0.008	<0.01	<0.01	<0.01	ND	-
Pyrene	mg/kg	0.153	1.398	0.008	<0.01	<0.01	<0.01	ND	-
Benzo(c)Phenanthrene	mg/kg	---	---	0.008	<0.01	<0.01	<0.01	ND	-
Benzo(a)Anthracene	mg/kg	0.0748	0.693	0.007	<0.01	<0.01	<0.01	ND	-
Chrysene	mg/kg	0.108	0.846	0.008	<0.01	<0.01	<0.01	ND	-
7,12-dimethylbenzo(a)anthracene	mg/kg	---	---	0.005	<0.02	<0.02	<0.02	ND	-
Benzo(b,j,k)fluoranthene	mg/kg	---	---	0.008	<0.01	<0.01	<0.01	ND	-
Benzo(a)pyrene	mg/kg	0.0888	0.763	0.008	<0.01	<0.01	<0.01	ND	-
3-methylcholanthrene	mg/kg	---	---	0.022	<0.01	<0.01	<0.01	ND	-
Indeno(1,2,3-cd)pyrene	mg/kg	---	---	0.008	<0.01	<0.01	<0.01	ND	-
Dibenzo(a,h)anthracene	mg/kg	0.00622	0.135	0.008	<0.01	<0.01	<0.01	ND	-
Benzo(g,h,i)perylene	mg/kg	---	---	0.008	<0.01	<0.01	<0.01	ND	-
Dibenzo (a,l) pyrene	mg/kg	---	---	0.008	<0.02	<0.02	<0.02	ND	-
Dibenzo (a,i) pyrene	mg/kg	---	---	0.007	<0.02	<0.02	<0.02	ND	-
Dibenzo (a,h) pyrene	mg/kg	---	---	0.008	<0.02	<0.02	<0.02	ND	-
Benzene	mg/kg	---	---	0.02	<0.1	<0.1	<0.1	ND	-
Toluene	mg/kg	---	---	0.02	<0.1	<0.1	<0.1	ND	-
Ethylbenzene	mg/kg	---	---	0.02	<0.1	<0.1	<0.1	ND	-
Total Xylene	mg/kg	---	---	0.04	<0.1	<0.1	<0.1	ND	-
F1 (C6-C10)	mg/kg	---	---	10	<3.9	<3.9	<2.4	ND	-
F2 (C10-C16)	mg/kg	---	---	10	<1.8	<1.8	<1.5	ND	-
F3 (C16-C34)	mg/kg	---	---	10	7	12	20	13	-
F4 (C34-C50)	mg/kg	---	---	10	<6	<5.9	5.1	5.10	-

3.10 CONTAMINATED SITE CLASSIFICATION

Using the results from the 2006/07 and 2007/08 sampling campaigns, the CFS-Alert sites were evaluated with the FCSAP Contaminated Site Classification Guidance system developed for Environment Canada (2003). Like the CCME National System of Classification of contaminated sites, this tool was created to help evaluate contaminated sites according to the actual or possible negative impacts of the contamination on the environment or human health. A copy of the guide and the evaluation results of each site are presented in Appendix B.

4 CFS-Alert Sites

4.1 S-146 ALERT (UNDERWATER SURVEY)

4.1.1 Location and Site Description

During the 2007/08 campaign, an underwater survey was performed along the western shorelines of Dumbell Bay and Alert Inlet (Figure 4). The evaluated area started at approximately 250 m to 300 m north of the airstrip refueling area, in Dumbell Bay, and finished at the southwestern end of Alert Inlet. Except for the annual Polar Dip event, no human activities are officially occurring within the shoreline area.

Debris and several empty barrels were, for the most part, found sparsely scattered along the shoreline in 2007/08 (Photograph 1, 5, 6, 7 and 8, Appendix A). At several sites there were significant quantities of buried barrels emerging as the overlaying material was washed away. There is also an inactive underground barrel dump (Barrels Cache S-10220) northeast of the Main Station Landfill. Over the years at CFS-Alert, sites used as dumps or landfills were often located uphill and short distances from the shoreline (Dump areas 1, 2, 3 and Millionaire's Dump). The drainage water coming from these dumps and landfills could have reached the shoreline. Currently, the active landfill (Main Station Landfill) is located northeast of the main station, approximately 265 m uphill of Dumbell Bay.

Many important sites are located near the shoreline, such as the Quarry, located less than 200 m from the shoreline, and the Sewage Outfall, located less than 150 m uphill from the Alert Inlet. Some sites situated further from the shoreline often possess drainage pathways leading surface water towards Dumbell Bay or Alert Inlet. Also, groundwater moving along the permafrost during the snowmelt and summer months may eventually reach the shoreline.

The topography of the land approaching the shoreline is generally strongly to moderately sloped, followed by flatland immediately adjacent to the shoreline. The marine sediments are generally muddy, but in some areas are composed of a mix of mud and coarse shale stones.

4.1.2 Summary of Previous BRI Investigations

There was no previous information available for the shoreline area. However, investigations at sites near Dumbbell Bay or Alert Inlet sometimes included an evaluation of the potential migration of contaminants to the shoreline (refer to each site separately).

4.1.3 Nature and Extent of Contamination

During 2007/08, a crew of Navy divers from CFB-Shearwater participated in the collection of 54 marine sediment samples, including 2 duplicate pairs and 1 surface water sample (Photographs 3 and 4, Appendix A). The sediments samples were taken approximately 5 m to 40 m from the shoreline, at an average depth of 15 m below the surface. The sampling distance from the shoreline was limited by the presence of free moving pack ice (Photograph 2, Appendix A). The samples were analyzed for metals, PAH, BTEX, TPH and VOC (Table 6). A total of 18 samples collected within the sewage outfall runoff area were analyzed for nitrate, nitrite and total phosphorus.

Samples were collected at regular intervals of approximately 100m along the shoreline. However, four specific areas of the shoreline were considered as potentially highly contaminated zones, and received additional attention. The first zone was located where drainage water coming from the area of the 2006/07 diesel pipeline new fuel spill enters into Dumbell Bay (Figure 5). The next two zones were near the mouth of Alert Inlet, where several underwater buried barrels were discovered. One underwater barrel zone was located a few meters south of the main station landfill in Dumbell Bay, and the second underwater barrel area was located near the sewage outfall runoff, immediately south of the narrow mouth of Alert Inlet (Figure 6). The last zone was located at the end of the sewage outfall runoff, where the waste enters Alert Inlet (Figure 7).

The majority of the sediment samples did not posses any hydrocarbon odor, but several samples collected near the two underwater barrel areas possessed very strong hydrocarbon odors. Iridescence on the water surface was observed during sediment collection in the northern underwater barrel area.

No BTEX or VOCs were detected in any marine sediment samples. Metals, TPH, PAH, nitrates, nitrites and phosphorus concentrations were variable depending upon the location of the sample. There are currently no CCME guidelines for the evaluation of TPH Fractions in sediment and water samples. For comparative purposes, TPH Fractions in sediment samples were evaluated against the CCME soil guidelines.

The first area started 250 m to 300 m north of the airstrip refueling area, in Dumbell Bay, and proceeded southward towards the shoreline area that collects drainage water from the area of the 2006/07 diesel pipeline new fuel spill (samples B07-US-1000 to 1009 and 1012 to 1015). The sediment samples collected within this area contained arsenic and copper concentrations above CCME guidelines in 10 and 5 samples, respectively.

The second area, adjacent to the Main Station Landfill, is the northern underwater barrel drainage collection area. This area is covered by samples B07-US-1010, 1011, 1018 to 1026, and 1030 to 1032. Arsenic and copper concentrations above CCME guidelines were detected in 12 and 12 samples, respectively, within this area. The samples collected near the mouth of Alert Inlet (B07-US-1030 to 1032), around underwater buried barrels, also contained chromium and lead concentrations higher than CCME guidelines, with B07-US-1030 also above the CCME guideline for zinc (approximately 3.5 times higher than guidelines). This sample contained 5 PAH compounds at concentrations exceeding CCME guidelines and B07-US-1031 contained 2-methylnaphthalene at concentrations above the CCME guideline. Sample B07-US-1030 contained TPH Fraction 3 at concentrations above the CCME guideline for soil. The marine water sample was collected within this area. This sample contained copper concentrations above the CCME guideline.

The next significant area started at the narrow mouth of Alert Inlet and continued to the sewage

outfall area (samples B07-US-1027 to 1029 and 1033 to 1037). Underwater buried barrels were noted within this area. The sediment samples collected were contaminated with metals. Arsenic, copper and lead concentrations were above CCME guidelines in 5, 8, and 5 samples, respectively, and chromium and zinc concentrations were higher than CCME guidelines in 1 and 1 sample, respectively. Naphthalene and 2-methylnaphthalene concentrations exceeding the CCME guideline were measured in 3 and 5 samples, respectively. Fluorene and phenanthrene concentrations above the CCME guidelines were detected in sample B07-US-1036.

The sediment samples collected within the sewage outfall runoff area (samples B07-US-1038 to 1041) contained arsenic, copper, and zinc concentrations above CCME guidelines in 5, 6, and 1 sample, respectively.

The shoreline area located south of the sewage outfall runoff at the southwestern end of Alert Inlet (samples B07-US-1042 to 1050 and 0287), contained arsenic concentrations slightly above the CCME guideline.

The information collected during the 2007/08 campaign classifies this site a Class 1 (82.7) according to the FCSAP classification, which makes it of high concern requiring action. The estimated volume of contaminated sediment is 3,600 m^3.

4.1.4 Recommendations

Two areas were found to possess elevated concentrations of TPH and heavy metals, notably copper and arsenic. The first area is located directly below the Main camp and the second area is at the entrance to Alert Inlet. In both cases a significant number of old 45 gallon barrels were partially exposed along the shoreline indicating that material was buried at these sites (ie. landfilled) and is gradually being exposed. A potential source of the copper may be the presence of copper sheeting, used to shield electromagnetic signals, from older demolished buildings. Of the 57 sediment samples taken, 31 were over the sediment copper guidelines (18.7 mg/kg), with 21 of these samples only just above the guideline (between 1 – 1.5 x criteria, 18.7 – 28.05 mg/kg, respectively). The average copper concentration in background sediments was 13.67 mg/kg. For

arsenic 42 sediment samples were above guidelines (7.24 mg/kg) with 28 of those between 1 -1.5 x guideline values (7.24 – 10.86 mg/kg). The average background sediment arsenic concentration was 7.47 mg/kg, again above the sediment guideline.

Three additional heavy metals were detected above sediment criteria; lead, zinc and chromium (8, 2 and 1 samples, respectively). All of the sites testing positive for these heavy metals were in the entrance to Alert Inlet, adjacent to the area of landfilled barrels and other metallic waste slowly being exposed.

Complete the characterization of the slopes immediately upgradient of the landfill sites and underwater to establish the extent and possible source of the contamination. The most appropriate action at these two sites is to leave the underwater sites undisturbed as any dredging or disturbances would result in liberation of the contaminants into the water column significantly increasing the extent of the contamination. The materials remaining in the landfills should be removed as they are exposed with minimal disturbance to the shoreline for the above mentioned reason. Finally, analyses of the toxicity within fishes and other aquatic animal bodies are recommended to measure the environmental impact of the contamination on the aquatic wildlife.

. (S-146) Alert (Underwater Survey) 2007/08 results.

PARAMETERS	UNITS	Underwater Survey (S-146) MARINE WATER GUIDELINES AQUATIC LIFE MARINE	DETECTION LIMIT	WATER B07US1051-W Surface Marine water 8/07/2007
Arsenic (As)	ug/L	12.5	0.0001	1
Barium (Ba)	ug/L	---	0.001	<10
Cadmium (Cd)	ug/L	0.12	0.0001	<1
Chromium (Cr)	ug/L	---	0.0007	5
Cobalt (Co)	ug/L	---	0.0006	3
Copper (Cu)	ug/L	2-4	0.0012	38
Lead (Pb)	ug/L	---	0.0011	7
Manganese (Mn)	ug/L	---	0.0003	361
Molybdenum (Mo)	ug/L	---	0.0078	2
Nickel (Ni)	ug/L	---	0.0005	8
Selenium (Se)	ug/L	---	0.0006	<1
Silver (Ag)	ug/L	---	0.0008	<0.6
Tin (Sn)	ug/L	---	0.011	<1
Zinc (Zn)	ug/L	---	0.006	20
Naphthalene	ug/L	1.4	0.04	<0.1
2-methylnaphthalene	ug/L	---	0.04	<0.1
1-methylnaphthalene	ug/L	---	0.04	<0.1
1,3-Dimethylnaphthalene	ug/L	---	0.04	<0.1
Acenaphthylene	ug/L	---	0.03	<0.1
Acenaphthene	ug/L	---	0.04	<0.1
2,3,5-trimethylnaphthalene	ug/L	---	0.05	<0.1
Fluorene	ug/L	---	0.05	<0.1
Phenanthrene	ug/L	---	0.04	<0.1
Anthracene	ug/L	---	0.04	<0.1
Fluoranthene	ug/L	---	0.04	<0.1
Pyrene	ug/L	---	0.04	<0.1
Benzo(c)Phenanthrene	ug/L	---	0.04	<0.1
Benzo(a)Anthracene	ug/L	---	0.04	<0.1
Chrysene	ug/L	---	0.04	<0.1
7,12-dimethylbenzo(a)anthracene	ug/L	---	0.01	<0.1
Benzo(b,j,k)fluoranthene	ug/L	---	0.04	<0.1
Benzo(a)pyrene	ug/L	---	0.04	<0.1
3-methylcholanthrene	ug/L	---	0.04	<0.1
Indeno(1,2,3-cd)pyrene	ug/L	---	0.05	<0.1
Dibenzo(a,h)anthracene	ug/L	---	0.04	<0.1
Benzo(g,h,i)perylene	ug/L	---	0.04	<0.1
Dibenzo (a,l) pyrene	ug/L	---	0.04	<0.1
Dibenzo (a,i) pyrene	ug/L	---	0.04	<0.1
Dibenzo (a,h) pyrene	ug/L	---	0.05	<0.1
Benzene	ug/L	110	0.03	<0.1
Toluene	ug/L	215	0.03	<0.1
Ethylbenzene	ug/L	25	0.02	<0.1
Total Xylene	ug/L	---	0.05	<0.1
F1 (C6-C10)	ug/L	---	100	<50
F2 (C10-C16)	ug/L	---	100	74
F3 (C16-C34)	ug/L	---	100	484
F4 (C34-C50)	ug/L	---	100	54
Vinyl chloride	ug/L	---	0.15	<0.5
1,1-Dichloroethene	ug/L	---	0.22	<0.1
Dichloromethane	ug/L	---	0.37	<0.1
1,2-Dichloroethene (trans)	ug/L	---	0.09	<0.1

Underwater Survey (S-146)

MARINE SEDIMENT

87	B07US1001	B07US1002	B07US1003	B07US1004	B07US1005	B07US1006	B07US1007	B07US1008	B07US1009	B07US1010	B07US1011	B07US1012	B07US1013	B07US1014
n	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
07	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/07/2007	8/07/2007	8/03/2007	8/03/2007	8/03/2007
	7.6	5.1	8.1	8.2	4.7	6.7	10.2	12.5	9.3	8.3	6.3	9.7	8	9.5
	5	7	10	7	7	8	9	11	7	7	14	15	7	11
	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	20	21	24	23	23	20	21	27	20	18	21	22	23	24
	8	8	8	9	8	8	10	11	7	10	9	10	8	10
	10	16	18	19	19	13	15	22	12	15	18	20	13	19
	16	10	13	13	12	12	13	17	12	17	16	15	12	14
	399	309	334	418	356	388	469	309	332	492	402	361	382	418
	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	29	28	31	30	29	29	32	36	25	34	32	31	31	33
	0.8	0.7	<0.5	<0.5	0.6	0.5	0.6	0.6	<0.5	<0.5	0.6	0.6	0.6	0.8
	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	40	43	49	45	44	40	46	66	40	39	51	49	46	52

MARINE SEDIMENT

18	B07US1019	B07US1020	B07US1021	B07US1022	B07US1023	B07US1024	B07US1025	B07US1026	B07US1027	B07US1028	B071029	B07US1030	B07US1031	B07US1032
n	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
07	8/05/2007	8/05/2007	8/05/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	04/08/2007	04/08/2007	8/04/2007
	12.2	8	12.5	14.8	15.7	11.4	14.6	10.6	6.4	9.9	9.4	12.1	9.1	7.1
	10	8	10	10	12	10	13	11	12	14	8	32	10	7
	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	22	23	24	24	25	25	27	25	17	40	20	65	33	24
	10	9	11	9	10	10	10	10	8	9	8	11	11	7
	21	28	27	24	25	29	25	26	28	51	22	78	35	24
	17	22	24	19	20	20	23	22	51	105	16	78	50	31
	437	372	362	261	280	296	217	247	473	415	398	363	346	343
	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	4	3	2
	33	31	34	34	35	34	38	35	28	34	28	38	34	29
	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9
	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	<0.5	<0.5	<0.5
	<5	<5	<5	<5	<5	<5	<5	<5	12	20	<5	8	18	7
	59	54	64	65	67	68	74	70	62	90	47	460	93	58

MARINE SEDIMENT

36	B07US1037	B07US1038	B07US1039	B07US1040	B07US1041	B07US1042	B07US1043	B07US1044	B07US1045	B07US1046	B07US1047	B07US1048	B07US1049	B07US1050
n	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
07	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	05/08/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007
	23.6	13.9	9.6	10.1	12.0	7.2	8.7	7.6	10.2	7	7.2	8.1	7.5	8.5
	13	11	9	9	10	9	10	13	10	8	6	10	7	11
	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	27	26	23	22	22	21	21	22	21	18	33	21	19	18
	10	8	7	7	8	8	7	9	8	6	6	8	8	8
	62	46	23	19	20	15	15	16	15	12	12	17	15	16
	23	24	18	16	21	13	12	14	13	13	16	14	12	13
	218	206	202	215	185	196	246	243	316	248	289	292	306	282
	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	38	31	28	28	29	27	26	29	27	24	24	28	28	25
	0.8	0.5	<0.5	0.7	0.5	<0.5	0.6	0.6	<0.5	<0.5	0.8	0.6	0.7	0.6
	2.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	10	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	80	70	57	53	54	49	49	54	49	57	36	50	47	46

1287	B07US1001	B07US1002	B07US1003	B07US1004	B07US1005	B07US1006	B07US1007	B07US1008	B07US1009	B07US1010	B07US1011	B07US1012	B07US1013	B07US1014
	MARINE SEDIMENT													
m	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/07/2007	8/07/2007	8/03/2007	8/03/2007	8/03/2007
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<2.3	<2.7	<3	<2.8	<2.7	<3.1	<3.3	<4	<2.9	<4	<3.7	<3.4	<2.9	<4
	<1.1	<1.7	4.9	7.1	<1.8	6.3	2	<2.5	<2.3	<1.8	<1.9	<2.3	50	<2.3
	7.7	14	26	16	17	18	13	92.1	21	<4.1	158	30	32	52
	<3.7	<5.6	8.4	<5.6	6.1	6.9	<5	36	8.3	<5.9	140	13	8.2	21

1018	B07US1019	B07US1020	B07US1021	B07US1022	B07US1023	B07US1024	B07US1025	B07US1026	B07US1027	B07US1028	B071029	B07US1030	B07US1031	B07US1032
	MARINE SEDIMENT													
m	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
007	8/05/2007	8/05/2007	8/05/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	04/08/2007	04/08/2007	8/04/2007
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<3.3	<3	<3.8	<3.4	<3.7	<3.6	<3.6	<3	<2.8	<3	<3.1	10	3.7	<2.8
	14.1	59.1	67.9	58.6	<1.6	39.5	115	3	<1	<1.3	<1.7	32.6	30.3	<1.5
	157	144	235	184	90.9	151	134	81.7	56.1	83.3	37	2080	159	73.8
	66.5	67	78.7	52.7	31	53.4	53.3	37	16	40	23	694	89.5	34

1036	B07US1037	B07US1038	B07US1039	B07US1040	B07US1041	B07US1042	B07US1043	B07US1044	B07US1045	B07US1046	B07US1047	B07US1048	B07US1049	B07US1050
	MARINE SEDIMENT													
m	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	05/08/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<6.3	<5.8	<4.8	<4.4	<5.6	<4.7	<4.3	<4.4	<5.1	<3.5	<3.5	<4.3	<3.5	<4.1
	15	<2.6	<2.9	<24	<2.6	<2.4	<2.3	<2.4	<2.2	<1.6	<2.5	<2.4	<2.1	<2.3
	379	249	99.7	67.9	77.2	42	34	31	104	38.9	19	56.8	70.9	58.6
	125	75	39	29	28	16	16	15	38	18	9.9	22	28	23

	1320	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	<0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Guidelines for the Protection of Aquatic Life of the CCME (2002)

uatic Life of the CCME (2002)

Underwater Survey (S-146)

MARINE SEDIMENT

B07US1001	B07US1002	B07US1003	B07US1004	B07US1005	B07US1006	B07US1007	B07US1008	B07US1009	B07US1010	B07US1011	B07US1012	B07US1013	B07US1014
0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/03/2007	8/07/2007	8/07/2007	8/03/2007	8/03/2007	8/03/2007
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

MARINE SEDIMENT

B07US1018	B07US1019	B07US1020	B07US1021	B07US1022	B07US1023	B07US1024	B07US1025	B07US1026	B07US1027	B07US1028	B071029	B07US1030	B07US1031	B07US1032
0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	8/04/2007	04/08/2007	04/08/2007	8/04/2007
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.02	0.02	0.01
<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02	0.02	<0.01	<0.01	0.09	<0.01	0.05	0.04	0.01
<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.03	0.01	<0.01
<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.05	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.04	0.02	<0.01
<0.01	<0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.03	0.01	<0.01
<0.01	<0.01	0.02	0.03	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.02	<0.01	0.16	0.01	<0.01
<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01
<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.16	<0.01	<0.01
<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.14	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01
<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.06	<0.01	<0.01
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

MARINE SEDIMENT														
B07US1036	B07US1037	B07US1038	B07US1039	B07US1040	B07US1041	B07US1042	B07US1043	B07US1044	B07US1045	B07US1046	B07US1047	B07US1048	B07US1049	B07US1050
0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm
8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	05/08/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007	8/05/2007
<0.03	0.05	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.12	0.23	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.07	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.15	0.16	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.12	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.07	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.13	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.04	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
0.04	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

uidelines for the Protection of Aquatic Life of the CCME (2002)
atic Life of the CCME (2002)

Figure 4. (S-146) Alert (Underwater Survey) map 1.

Figure 5. (S-146) Alert (Underwater Survey) map 2.

Figure 6. (S-146) Alert (Underwater Survey) map 3.

Figure 7. (S-146) Alert (Underwater Survey) map 4.

4.2 S-349 OXIDATOR BUILDING

4.2.1 Location and Site Description

The Oxidator Building is located within the main station area, southeast of the Headquarters, Administration and Personnel Services (HAPS) Building, and west of the curling club/gym complex (Figure 8). The Oxidator Building currently houses the waste incinerator and was the previous location of the power plant. All of the ash produced during the incineration of waste is disposed of in the main station landfill. Battery neutralization is also done inside and outside of the Oxidator Building. This site is active, and human activity occurs mainly on the northwest side of the building.

During the neutralization process, used batteries are disassembled and washed with hot water. The battery casings are incinerated, and the acid water is neutralized for 12 hours. The water is then filtered and the filters incinerated. Finally, the water is analyzed for zinc and if found to be clean, is sent into the drainage system.

The Oxidator Building sits on an embankment made of fill material, coarse gravel mix with shaly silt. The topography of the site is generally level, with a steep slope at the end of the embankment, going southeast, towards pools of standing water within a lower area. This low area, situated behind the Oxidator Building, collects the drainage water coming from other main station sites. There are drainage ditches located southeast of the building and a main drainage ditch running along the northwest side of the building. All ditches direct water into the low part of the site, behind the Oxidator Building. The drainage water goes from this area into the Baker's Dozen site, and eventually into the Runoff Collection Basin. The Oxidator Building is located approximately 600 m west of Dumbell Bay.

4.2.2 Summary of Previous BRI Investigations

A summary of site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, 22 surface soil samples were collected, including 3 soil samples collected in drainage ditches, 1 duplicate pair, and 2 depth soil samples. In addition, 4 surface water samples were collected in pools of standing water from several locations around the Oxidator Building (Photographs 9 to 12, Appendix A). The samples were tested for metals, BTEX and TPH (Figures 9 to 11). The main pool of standing water contained several small depressions filled with a pink coloration. This coloration is most likely a pH indicator used previously in the battery neutralization process.

Twelve samples had zinc concentrations exceeding the CCME guideline (Table 7). Some samples (06OX0047, 06OX0057, 06OX0060) had zinc concentrations 15 times higher than the CCME guideline. Two and 3 samples had arsenic and nickel concentrations, respectively, slightly exceeding CCME guidelines.

Benzene and total xylene concentrations were higher than CCME guidelines in one soil sample (06OX0039), and toluene and ethylbenzene concentrations exceeding the CCME guidelines in two soil samples (06OX0039 and 06OX0059). TPH concentrations exceeded the CCME guidelines in 18 soil samples. The concentrations TPH Fractions 1, 2, 3 and 4 were higher than the CCME guidelines in 6, 17, 10, and 6 soil samples, respectively. The variety of TPH Fractions observed in the soil samples suggested that the contamination originated from different sources.

All four water samples collected in pools of standing water contained important concentrations of zinc, from 20 to 35 times higher than the CCME guideline. All four water samples also contained arsenic, cadmium, copper and lead concentrations exceeding CCME guidelines. Selenium concentrations were above the guideline in three water samples, and the concentration

Table 7. (S-349) Previous contaminated samples (cont.).

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06OX0040	SOIL	0-10	ZINC (ZN)	360	2,500
		0-10	TPH / F2	760	16,000
		0-10	TPH / F3	1,700	7,900
		0-10	TPH / F4	3,300	3,600
06OX0058	SOIL	0-10	TPH / F2	760	3,000
06OX0059	SOIL	40	TOLUENE	0.37	0.4
		40	ETHYLBENZENE	0.08	0.4
		40	TPH / F1	310	670
		40	TPH / F2	760	12,000
06OX0060	SOIL	0-10	ZINC (ZN)	360	6,150
		0-10	TPH / F2	760	920
06OX0057	SOIL	0-10	ZINC(ZN)	360	8,360
		0-10	TPH / F2	760	2,600
06OX0039	SOIL	0-10	ZINC (ZN)	360	945
		0-10	BENZENE	0.03	0.7
		0-10	TOLUENE	0.37	16
		0-10	ETHYLBENZENE	0.08	27
		0-10	TOTAL XYLENE	11	260
		0-10	TPH / F1	310	4,700
06OX0073	WATER	SURFACE	ARSENIC (AS)	5	12
		SURFACE	CADMIUM (CD)	0.017	32
		SURFACE	COPPER (CU)	2-4	28
		SURFACE	LEAD (PB)	1-7	90
		SURFACE	NICKEL (NI)	25-150	40
		SURFACE	SELENIUM (SE)	1	3
		SURFACE	ZINC (ZN)	30	13,000
06OX0074	WATER	SURFACE	ARSENIC (AS)	5	5
		SURFACE	CADMIUM (CD)	0.017	3
		SURFACE	COPPER (CU)	2-4	40
		SURFACE	LEAD (PB)	1-7	75
		SURFACE	SELENIUM (SE)	1	1
		SURFACE	ZINC (ZN)	30	12,300
06OX0075	WATER	SURFACE	ARSENIC (AS)	5	5
		SURFACE	CADMIUM (CD)	0.017	2
		SURFACE	COPPER (CU)	2-4	35
		SURFACE	LEAD (PB)	1-7	51
		SURFACE	SELENIUM (SE)	1	1
		SURFACE	ZINC (ZN)	30	7,990
06OX0076	WATER	SURFACE	ARSENIC (AS)	5	5
		SURFACE	CADMIUM (CD)	0.017	2
		SURFACE	COPPER (CU)	2-4	17
		SURFACE	LEAD (PB)	1-7	13
		SURFACE	ZINC (ZN)	30	7,520

4.2.3 Nature and Extent of Contamination

In 2007/08, 31 soil samples were collected, including one soil from a drainage ditch and two duplicate pairs. In addition, three surface water samples were collected (from standing pools and ditches) and one groundwater sample was collected from an excavated hole. All samples were analyzed for metals, TPH, PAH, while several samples were also analyzed for PCBs (Table 8).

Arsenic and nickel concentrations slightly above CCME guidelines were observed in 8 and 3 soil samples, respectively. Zinc was detected at 14 times the guideline value in a soil sample (B07-OX-0204) collected from a drainage ditch located downgradient of the Oxidator Building, across Doe Road, at the exit of a culvert situated in the Baker's Dozen site. One soil sample (B07-OX-0188) contained copper concentrations above the CCME guideline. This sample was collected near a drainage pathway located beside the northwest corner of the Oxidator Building.

Fourteen soil samples collected at the Oxidator Building site demonstrated TPH concentrations above the CCME guideline. TPH Fractions 1, 2 and 3 were measured at concentrations higher than the guideline values in 11, 14 and 3 soil samples, respectively. Important concentrations of TPH Fraction 2 were measured in the samples collected on the western side of the site, near a diesel pipeline joint, behind the Cold Storage Doghouse Building site. No PAHs, such as naphthalene, fluorine, and phenanthrene, were detected above the CCME guidelines despite being present in several samples. PCBs were detected in 3 of the 7 soil samples tested, but always at concentrations below the CCME guidelines.

Arsenic, cadmium, copper, lead and zinc concentrations exceeding the CCME guideline were measured in all 4 water samples. Selenium and nickel concentrations above the CCME guidelines were detected in 3 and 1 water samples, respectively. TPH Fractions 1, 2, 3 and 4 were detected in the water samples at significantly elevated concentrations but there are currently no CCME guidelines for TPH in water. Iridescence on pools of standing water were noted on site. Naphthalene concentrations above the CCME guideline were measured in all water samples. Finally, acenaphthylene was detected in one water sample.

According to the FCSAP classification system, the Oxidator Building site is Class 1 (84.2) and action is required to address the existing contamination. The estimated volume of contaminated soil is 14,500 m^3.

4.2.4 Recommendations

Remediation of the site should be undertaken in 2 phases; the first phase addressing the zinc contamination and the second phase addressing the TPH contamination.

Zinc: Refined delineation of the zinc contamination in the surface layer needs to be performed, focused on determining the depth of zinc contamination. Once the depth of the contamination has been established, the upper contaminated surface layer should be excavated and placed in a contained landfill. The contaminated surface water should be removed and the zinc precipitated as is currently done to treat the battery wash water. The precipitated zinc can then be disposed of according to the standard operating protocol for precipitated zinc.

TPH: The most appropriate approach for the combined sites is an *in situ* treatment involving the application of nutrients and increased aeration into the subsurface. The Oxidator Building/Cold Storage Dog House was chosen as 1 of 3 development and demonstration sites for the optimization of an *in situ* bioremediation program at CFS-Alert (refer to the conclusion section). The results from this developmental work will be used to design a larger system to address both sites completely.

Oxidator builiding (S-349)

SOIL

…0175 …m …007	B07OX0176 40 cm 8/01/2007	B07OX0177 40 cm 8/01/2007	B07OX0178 20 cm 8/01/2007	B07OX0179 70 cm 8/02/2007	B07OX0182 80 cm 8/02/2007	B07OX0184 40 cm 8/02/2007	B07OX0185 40 cm 8/02/2007	B07OX0186 20 cm 8/01/2007	B07OX0187 50 cm 8/01/2007	B07OX0188 0-10 cm 8/02/2007	B07OX0189 40 cm 8/01/2007	B07OX0191 65 cm 8/01/2007	B07OX0192 45 cm 8/01/2007
2	12.3	11.8	17.3	11	7.2	9.8	12.5	10.5	9.3	14.1	9.1	8.9	9.3
	21	20	22	16	17	20	19	19		38	19	13	17
9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	24	32	30	31	27	31	27	25	31	36	29	20	29
	9	14	15	17	12	15	13	12	13	16	12	9	13
	17	31	32	30	30	26	23	24	27	313	27	19	23
	18	20	21	22	18	16	15	20	17	40	21	14	14
2	500	504	612	678	465	573	512	492	564	597	501	358	551
	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	29	49	49	57	47	47	42	43	46	49	42	36	43
5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	0.9	<0.5	0.5
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	53	76	70	72	108	72	65	69	73	269	77	51	63
	4.2	111	3.5	<3.4	743	3.2	<2.7	813	4.7	81.4	3.4	786	4.5
	18	8,780	8.7	4.7	8,870	31.3	5.2	17,500	16	1,130	14	17,500	7
	250	2,130	67.4	17	561	161	63.4	2,430	111	668	136	1,570	56.5
	92.8	195	31	8.6	17	26	31	198	56.9	194	76.7	28	41
1	<0.1	<0.1	<0.1	<0.1	1.9	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	4.2	<0.1
1	<0.1	<0.1	<0.1	<0.1	7.2	<0.1	<0.1	5.6	<0.1	0.6	<0.1	72.2	<0.1
1	<0.1	1.8	<0.1	<0.1	7.4	<0.1	<0.1	11.6	<0.1	0.6	<0.1	58.6	<0.1
1	<0.1	4.9	<0.1	<0.1	12.4	<0.1	<0.1	27.9	<0.1	0.6	<0.1	58.2	<0.1
1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	0.5	<0.1
1	<0.1	0.2	<0.1	<0.1	0.4	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.8	<0.1
1	<0.1	1.1	<0.1	<0.1	1.2	<0.1	<0.1	3.2	<0.1	<0.1	<0.1	6.5	<0.1
1	<0.1	0.4	<0.1	<0.1	0.4	<0.1	<0.1	0.5	<0.1	<0.1	<0.1	0.9	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.6	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
A	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.028	NA	NA	0.005

SOIL										
07OX0199 30 cm 8/02/2007	B07OX0200 80 cm 8/02/2007	B07OX0202 65 cm 8/01/2007	B07OX0203 60 cm 8/02/2007	B07OX0204 Drainage sed. 0-10 cm 8/01/2007	B07OX0205 10 cm 8/01/2007	B07OX0207 80 cm 8/02/2007	B07OX0208 35 cm 8/01/2007	B07OX0209 20 cm 8/01/2007	B07OX0210 110 cm 8/02/2007	B07OX0211 90 cm 8/02/2007
10.9	7.7	7.5	9.1	11	10.8	8	8	9.2	7.3	8.2
16	21	24	11	20	18	9	22	16	11	11
<0.9	<0.9	<0.9	<0.9	2.3	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
23	26	24	32	26	27	27	25	28	23	23
10	11	10	15	12	10	12	11	14	10	11
18	21	18	32	23	19	25	18	27	19	22
23	15	16	15	32	24	12	16	18	16	16
433	464	463	504	476	476	430	508	469	445	502
<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
38	38	39	53	41	33	44	38	45	39	42
<0.5	<0.5	<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
51	75	94	72	5,190	172	60	61	58	51	52
<3.3	19	440	<3.2	879	3.5	665	3.6	<3.5	667	3.6
12	314	8,120	11	1,940	18.6	3,040	<1.8	<2.2	7,210	5,580
99.5	200	860	11	524	237	168	60.9	52	325	344
35	134	381	6.6	48.5	96.6	8	40	26	43	21
<0.1	<0.1	0.2	<0.1	17.3	<0.1	5.9	<0.1	<0.1	8.3	<0.1
<0.1	<0.1	2.7	<0.1	38.7	<0.1	17.7	<0.1	<0.1	27.7	<0.1
<0.1	<0.1	13.9	<0.1	28.3	<0.1	10.1	<0.1	<0.1	16.9	<0.1
<0.1	0.5	30.9	<0.1	27.7	<0.1	9.7	<0.1	<0.1	15.4	<0.1
<0.1	<0.1	0.4	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.2	<0.1
<0.1	<0.1	0.5	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	0.3	<0.1
<0.1	0.1	4.1	<0.1	2	<0.1	0.8	<0.1	<0.1	1.4	<0.1
<0.1	<0.1	0.3	<0.1	0.4	<0.1	0.1	<0.1	<0.1	0.3	<0.1
<0.1	<0.1	0.2	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.005	NA	0.005	NA	NA	NA	NA	NA	NA	<0.005	<0.005

Table 8. (S-349) Oxidator Building 2007/08 results (cont.).

			WATER		Oxidator Building (S-349) FRESH WATER			
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B07OX0196W Surface 8/02/2007	B07OX0197W Groundwater 8/02/2007	B07OX0205W Surface 8/02/2007	B07OX0206W Surface 8/02/2007
METALS	Arsenic (As)	ug/L	5	0.0001	14	7	14	9
	Barium (Ba)	ug/L	---	0.001	80	80	60	20
	Cadmium (Cd)	ug/L	0.017	0.0001	49	<1	1	<1
	Chromium (Cr)	ug/L	---	0.0007	4	11	11	1
	Cobalt (Co)	ug/L	---	0.0006	14	12	7	2
	Copper (Cu)	ug/L	2-4	0.0012	4	15	83	5
	Lead (Pb)	ug/L	1-7	0.0011	4	10	17	1
	Manganese (Mn)	ug/L	---	0.0003	418	2,130	552	130
	Molybdenum (Mo)	ug/L	73	0.0078	13	4	4	2
	Nickel (Ni)	ug/L	25-150	0.0005	20	29	23	8
	Selenium (Se)	ug/L	1	0.0006	4	1	2	<1
	Silver (Ag)	ug/L	---	0.0008	<0.6	<0.6	<0.6	<0.6
	Tin (Sn)	ug/L	---	0.011	<1	1	4	<1
	Zinc (Zn)	ug/L	30	0.006	14,100	30	210	280
TPH	F1 (C6-C10)	ug/L	---	100	50	670	<50	60
	F2 (C10-C16)	ug/L	---	100	419,000	1,860	6,950	122,000
	F3 (C16-C34)	ug/L	---	100	68,500	1,870	7,220	24,000
	F4(C34-C50)	ug/L	---	100	1,860	290	110	38,200
PAH	Naphthalene	ug/L	1.1	0.04	3.3	72.5	3.1	2.6
	2-methylnaphthalene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	1-methylnaphthalene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	1,3-Dimethylnaphthalene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Acenaphthylene	ug/L	---	0.03	0.2	7.4	<0.1	<0.1
	Acenaphthene	ug/L	5.8	0.04	<0.1	<2.7	<0.1	<0.1
	2,3,5-trimethylnaphthalene	ug/L	---	0.05	<0.1	<2.7	<0.1	<0.1
	Fluorene	ug/L	3	0.05	<0.1	<2.7	<0.1	<0.1
	Phenanthrene	ug/L	0.4	0.04	<0.1	<2.7	<0.1	<0.1
	Anthracene	ug/L	0.012	0.04	<0.1	<2.7	<0.1	<0.1
	Fluoranthene	ug/L	0.04	0.04	<0.1	<2.7	<0.1	<0.1
	Pyrene	ug/L	0.025	0.04	<0.1	<2.7	<0.1	<0.1
	Benzo[c]Phenanthrene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Benzo[a]Anthracene	ug/L	0.018	0.04	<0.1	<2.7	<0.1	<0.1
	Chrysene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	7,12-Dimethylbenz[a]anthracene	ug/L	---	0.01	<0.1	<2.7	<0.1	<0.1
	Benzo[b,j,k]fluoranthene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Benzo[a]pyrene	ug/L	0.015	0.04	<0.1	<2.7	<0.1	<0.1
	3-methylcholanthrene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Indeno[1,2,3-cd]pyrene	ug/L	---	0.05	<0.1	<2.7	<0.1	<0.1
	Dibenzo[a,h]anthracene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Benzo[g,h,i]perylene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Dibenzo [a,l] pyrene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Dibenzo [a,i] pyrene	ug/L	---	0.04	<0.1	<2.7	<0.1	<0.1
	Dibenzo [a,h] pyrene	ug/L	---	0.05	<0.1	<2.7	<0.1	<0.1

NA Not available

Higher than the criteria

High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the ccme. (2006)

Figure 8. (S-349) Oxidator Building map 1.

Figure 9. (S-349) Oxidator Building map 2.

Figure 10. (S-349) Oxidator Building map 3.

Figure 11. (S-349) Oxidator Building map 4.

4.3 S-352 RUNOFF COLLECTION BASIN

4.3.1 Location and Site Description

The Runoff Collection Basin is located southwest and downgradient of the CFS-Alert main station on the west side of Herc Drive (Figure 12). This site is a low lying area in which significant snowmelt water accumulates. Several main drainage ditches from the CFS-Alert main station lead into the Runoff Collection Basin. There is no human activity on this site.

Drainage water from the CFS-Alert main station, including the Oxidator Building and the power plant Cat House Building, drains into the Baker's Dozen site, which in turn drains into the Runoff Collection Basin. For many years, the Baker's Dozen site was the location of 13 fuel tanks (refer to Baker's Dozen for more information). These tanks were replaced by the diesel fuel storage tanks located north of the CFS-Alert main station, and were removed from the Baker's Dozen site.

The topography of the site is level. The soil is composed of a mix of native clay and silt with several shaly types of gravel. The middle of the site is saturated during the summer months, which gives these soils the appearance of fresh concrete. The Runoff Collection Basin is located roughly 440 m west of Alert Inlet and 2,000 m north of Upper Dumbell Lake.

4.3.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitle "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, three soil samples collected from drainage channels and two freshwater samples were taken within the runoff collection basin (Figure 13). These samples were analyzed for metals, TPH and BTEX. Only one sample (06RB0192) contained a metal, zinc, exceeding the

CCME guideline concentration (Table 9). This sample also contained TPH Fractions 2 and 3 exceeding CCME guideline concentrations. TPH Fraction 2 was detected above the CCME guideline concentrations in one other soil sample.

The two surface water samples were collected from two pools of standing water. Despite the different locations, both samples contained similar contaminants. Cadmium, copper, lead, selenium and zinc concentrations exceeded CCME guidelines in both water samples (Table 9). The contaminant concentrations were always slightly higher in the upgradient, northwestern pool of water compared to the downgradient, southeastern pool of water. The results suggested that the contamination came from the drainage network, entering the northwestern pool of water first.

Table 9. (S-352) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06RB0192	SOIL	0-10	ZINC (ZN)	360	463
		0-10	TPH / F2	760	2,800
		0-10	TPH / F3	1,700	1,700
06RB0195	SOIL	0-10	TPH / F2	760	930
06RB0300	WATER	SURFACE	CADMIUM (CD)	0.017	2
		SURFACE	COPPER (CU)	2-4	17
		SURFACE	LEAD (PB)	1-7	8
		SURFACE	SELENIUM	1	2
		SURFACE	ZINC	30	5,210
06RB0301	WATER	SURFACE	CADMIUM (CD)	0.017	1
		SURFACE	COPPER (CU)	2-4	13
06RB0301	WATER	SURFACE	LEAD (PB)	1-7	3
		SURFACE	SELENIUM	1	1
		SURFACE	ZINC	30	3,090

4.3.3 Nature and Extent of Contamination

During the 2007/08 campaign, 30 soil samples, including 2 duplicate pairs, were collected within the Runoff Collection Basin to delineate previously reported TPH contamination. The soil samples were collected from a depth of 30 to 50 cm, with the exception of one sample that was collected in a drainage channel at the soil surface. All soil samples were tested for metals and TPH (Table 10) and two samples were tested for PAHs. Metals were detected but none exceeded the CCME guidelines. Concentrations of TPH Fraction 2 above the CCME guideline were measured in six soil samples, including one duplicate pair.

One water sample was collected in the drainage channel running from the Baker's Dozen site into the Runoff Collection Basin. This water sample was analyzed for metals and TPH. Arsenic, cadmium, copper, lead, nickel, selenium and zinc concentrations were all above the applicable CCME guidelines. The concentration of zinc was particularly important, being more than 140 times higher than the CCME guideline. Elevated concentrations of TPH Fractions 2, 3 and 4 were also detected, but currently no CCME guidelines exist for TPH in water. Based on the 2006/07 and 2007/08 results, a contaminated area of approximately 975 m^2, with a volume of 488 m^3, was delineated.

According to the FCSAP classification system, the Runoff Collection Basin site is Class 1 (74.7). The estimated volume of contaminated soil is 488 m^3. The results from the 2006/07 and 2007/08 campaigns indicated that there is a high potential for off-site contamination and actions are required.

4.3.4 Recommendations

A total of 30 soil samples and one surface water sample were collected from the runoff collection basin. Of the 30 soil samples, only six were above guidelines for TPH (all Fraction F2), ranging from 870 – 3,060 mg/kg. No heavy metals were detected above guidelines in any of the soil samples. In the water sample, a total of seven heavy metals were detected at or above guidelines; arsenic, cadmium, copper, lead, nickel, selenium and zinc. Zinc was particularly

high (4,210 mg/kg) and is most likely the result of the previous battery neutralization protocols. This contamination would have originated from the Oxidator Building.

The TPH contaminated soils are spread over a fairly wide area and the most appropriate approach to address this contamination would be an *in situ* treatment system. Details of a possible system will be elucidated by the pilot scale study to be performed in 2008 at other sites. To address the zinc contaminated water, the pooled water should be collected and treated using the current battery neutralization protocols designed to precipitate and capture dissolved zinc. The runoff water should be tested and treated yearly until the source of dissolved zinc is identified and removed and dissolved zinc concentrations fall below guideline levels. The potential source of the zinc contamination will be addressed under the site management plan for the Oxidator Building (refer to section 4.2).

Runoff Collection Basin (S-352)											
SOIL											
B07-RB-0338 30 cm 8/09/2007	B07-RB-0339 30 cm 8/09/2007	B07-RB-0340 30 cm 8/09/2007	B07-RB-0341 30 cm 8/10/2007	B07-RB-0342 40 cm 8/10/2007	B07-RB-0343 40 cm 8/10/2007	B07-RB-0344 40 cm 8/09/2007	B07-RB-0345 35 cm 8/09/2007	B07-RB-0346 35 cm 8/09/2007	B07-RB-0347 50 cm 8/09/2007	B07-RB-0348 35 cm 8/09/2007	B07-RB-0349 35 cm 8/09/2007
7.2	7.5	7.9	7.4	7.6	7.9	8.3	8.4	7.8	7.3	7.0	9.1
17	14	14	15	12	18	18	21	16	23	14	22
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
20	18	22	25	23	26	24	24	21	26	19	26
10	10	11	10	11	11	10	12	11	10	9	11
24	23	24	17	19	19	18	28	24	25	21	21
<10	<10	<10	13	13	14	14	12	<10	32	<10	16
467	503	511	411	441	401	405	454	488	444	522	339
<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2
32	34	36	35	36	37	34	38	36	33	29	37
<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	<5
54	48	56	49	48	52	52	63	54	92	48	63
<3.7	66	<3.3	<3.3	<3.1	<3.3	<3.7	<3.6	10	<3.4	<3.3	40
472	564	5.4	2.1	<1.7	<2.1	<2.1	16	537	3.9	3	1,770
47	208	15	54.4	13	38	42	185	61.3	88.8	14	383
79.4	42	<5.4	18	6.1	13	11	55	13	48	<6.6	64

Runoff Collection Basin (S-352)											
SOIL											
B07-RB-0353 40 cm 8/10/2007	B07-RB-0354 35 cm 8/10/2007	B07-RB-0355 40 cm 8/10/2007	B07-RB-0356 45 cm 8/09/2007	B07-RB-0357 50 cm 8/10/2007	B07-RB-0358 40 cm 8/10/2007	B07-RB-0359 40 cm 8/10/2007	B07-RB-0360 0-10 cm Drain. Sed. 8/10/2007	B07-RB-0361 40 cm 8/10/2007	B07-RB-0362 0-10 cm Drain. Sed. 8/10/2007	B07-RB-0363 40 cm 8/10/2007	B07-RB-0364 0-10 cm Drain. Sed. 8/10/2007
7.1	8.5	7.7	8.3	9.4	8.0	7.9	10.1	10.6	7.1	9.2	8.1
15	19	8	16	12	18	14	21	11	15	11	19
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
23	25	24	23	26	24	23	25	25	24	23	23
10	11	12	10	13	10	11	11	16	10	11	11
17	20	21	19	24	19	20	20	27	18	22	20
13	15	14	14	17	14	14	17	19	13	16	17
394	381	363	402	399	359	395	326	415	436	416	419
<2	<2	<2	<2	<2	<2	2	<2	<2	<2	<2	<2
34	35	39	33	39	34	35	34	47	34	38	33
<0.5	0.7	<0.5	0.7	0.5	<0.5	1.1	0.9	<0.5	<0.5	0.6	0.6
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
47	54	50	47	57	51	51	61	61	55	51	65
<3.4	<3.9	5.3	<3.2	<3.4	99.5	47.7	12	14	5.2	3.1	6.5
<1.7	<1.8	6.9	<1.8	20.2	870	2,360	8.1	2,070	29.3	7.3	5.4
44	51.6	8.5	19	18	441	716	328	240	164	9.8	169
15	12	<6.7	8.1	6.9	59	197	74.5	19	45	10	46

Table 10. (S-352) Runoff Collection Basin 2007/08 results (cont.).

					Runoff Collection Basin (S-352)
		WATER			WATER
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B07-RB-0355W Fresh water Surface 8/10/2007
METALS	Arsenic (As)	ug/L	5	0.0001	5
	Barium (Ba)	ug/L	---	0.001	60
	Cadmium (Cd)	ug/L	0.017	0.0001	1
	Chromium (Cr)	ug/L	---	0.0007	4
	Cobalt (Co)	ug/L	---	0.0006	87
	Copper (Cu)	ug/L	2-4	0.0012	33
	Lead (Pb)	ug/L	1-7	0.0011	3
	Manganese (Mn)	ug/L	---	0.0003	881
	Molybdenum (Mo)	ug/L	73	0.0078	14
	Nickel (Ni)	ug/L	25-150	0.0005	54
	Selenium (Se)	ug/L	1	0.0006	1
	Silver (Ag)	ug/L	---	0.0008	<0.6
	Tin (Sn)	ug/L	---	0.011	1
	Zinc (Zn)	ug/L	30	0.006	4,210
TPH	F1 (C6-C10)	ug/L	---	100	<50
	F2 (C10-C16)	ug/L	---	100	10,600
	F3 (C16-C34)	ug/L	---	100	7,250
	F4 (C34-C50)	ug/L	---	100	210

NA Not available

Higher than the criteria

High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME (2006)

Figure 12. (S-352) Runoff Collection Basin map 1.

Figure 13. (S-352) Runoff Collection Basin map 2.

4.4 S-10193 AIRSTRIP TANK FARM

4.4.1 Location and Site Description

The Airstrip Tank Farm is an active site located on the southwestern side of the airstrip runway, behind the apron refueling facilities and is composed of a pumphouse and a fuel hydrant building (Figure 14). Four 50,000 gallon tanks were erected in 1995 and two 100,000 gallon tanks were erected in 1978 (Photograph 13, Appendix A). The tanks were arranged in a row parallel to the airstrip on membrane-lined gravel pads and are surrounded by a berm that has been stabilized with a geogrid material. The topography of the bermed area is relatively level, with a small slope on the north side of the last 100,000 gallon tank. Outside the berm, the south side of the site slopes towards Dumbell Bay. The tanks are refilled once a year and contain a full years worth of diesel fuel. The fuel for the CFS-Alert main station is pumped from the tanks using a 3 km long diesel pipeline that transfers fuel to storage tanks and to the station day tank.

One pool of standing water was noted in 2006/07, outside of the bermed area, on the nothwestern side of the last 100,000 gallon tank. No standing water was noted outside of the bermed area in 2007/08. One drainage pathway starting north of the bermed area and heading towards Dumbell Bay was recorded in 2006/07 and 2007/08.

The Barrel Cache site (S-10220) is located downgradient from the Airstrip Tank Farm, between the tanks and Dumbell Bay. In 2006/07 and 2007/08, the barrel cache site was not characterized.

4.4.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, a total of four samples were collected (Figure 15). This included one duplicate pair of soil samples, one drainage soil sample (06AF0158) and one freshwater sample. These were tested for metals and TPH contamination (Table 11). In all soil samples, contaminant concentrations remained below the CCME guidelines, with the exception of arsenic. No TPH exceeded the CCME guidelines in the soil samples. No metals were found in the surface water and TPH was not analyzed in this sample.

Table 11. (S-10193) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration mg/kg)
06AF0157	SOIL	0-10	ARSENIC (AS)	12	13.2
06AF0159	SOIL	0-10	ARSENIC (AS)	12	15.7
06AF0158	SOIL	0-10	ARSENIC (AS)	12	19.7

4.4.3 Nature and Extent of Contamination

In 2007/08, 6 samples were collected from the southeast side of the site, outside the bermed area. These samples included one surface water and one soil sample collected from the drainage pathway, and four soil samples collected outside the bermed area, at an average depth of 50 cm. All samples were analyzed for TPH Fractions, BTEX and metals (Table 12). The sample collection points were selected to verify the possible migration of contaminated water from the bermed area towards Dumbell Bay.

Several metals were detected in the surface water sample, but the concentrations were below the CCME guidelines for aquatic life. No BTEX or TPH Fractions were detected above the CCME guidelines in the water surface sample. Only one soil sample had arsenic concentrations slightly above the CCME guideline.

The FCSAP score, based on the 2006/07 and 2007/08 results, was 42.5, making this a Class 3 site, which indicates that no action is likely required for this site.

4.4.4 Recommendations

There is little if any TPH contamination at the Airstrip Tank Farm site and as such the site could be closed. The contamination present appears to be limited and is not moving off site (ie. no contamination detected downgradient). An adjacent site (S-10220 Barrel Cache) might be combined with this site although the Barrel Cache requires additional characterization therefore may delay closure of the Airstrip Tank Farm site. Excavation of contaminated soils to biopiles for *ex situ* treatment is recommended, which would permit closure of the site.

Table 12. (S-10193) Airstrip Tank Farm 2007/08 results.

								Airstrip Tank Farm (S-10193)					
		WATER			SOIL			WATER	SOIL				
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-AF-0474W Fresh water Surface water 8/21/2007	B07-AF-0495 Drainage sed. 0-10 cm 8/21/2007	B07-AF-0496 50 cm 8/21/2007	B07-AF-0497 50 cm 8/21/2007	B07-AF-0498 50 cm 8/21/2007	B07-AF-0499 50 cm 8/21/2007
METALS	Arsenic (As)	ug/L	5	0.0001	mg/kg	12	0.27	1	8.5	9.7	7.9	9.2	12.5
	Barium (Ba)	ug/L	---	0.001	mg/kg	2,000	5	<10	20	16	17	16	19
	Cadmium (Cd)	ug/L	0.017	0.0001	mg/kg	22	0.22	<1	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	ug/L	---	0.0007	mg/kg	87	3	1	28	27	29	28	27
	Cobalt (Co)	ug/L	---	0.0006	mg/kg	300	1.9	<1	12	11	12	12	13
	Copper (Cu)	ug/L	2-4	0.0012	mg/kg	91	2.1	1	55	31	30	38	33
	Lead (Pb)	ug/L	1-7	0.0011	mg/kg	600	1.2	<1	17	13	14	14	15
	Manganese (Mn)	ug/L	---	0.0003	mg/kg	---	1.1	<5	602	508	472	478	460
	Molybdenum (Mo)	ug/L	73	0.0078	mg/kg	40	1.4	2	<2	<2	<2	<2	<2
	Nickel (Ni)	ug/L	25-150	0.0005	mg/kg	50	0.6	1	41	42	42	43	42
	Selenium (Se)	ug/L	1	0.0006	mg/kg	3.9	0.5	<1	<0.5	1.0	1.1	1.4	0.7
	Silver (Ag)	ug/L	---	0.0008	mg/kg	40	0.4	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	ug/L	---	0.011	mg/kg	300	0.8	<1	<5	<5	<5	<5	<5
	Zinc (Zn)	ug/L	30	0.006	mg/kg	360	2.5	<10	61	62	65	64	63
TPH	Benzene	ug/L	370	0.03	mg/kg	0.03	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Toluene	ug/L	2	0.03	mg/kg	0.37	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Ethylbenzene	ug/L	90	0.02	mg/kg	0.082	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Total Xylene	ug/L	---	0.05	mg/kg	11	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	F1 (C6-C10)	ug/L	---	100	mg/kg	310	---	<50	<2.6	<2.9	<3.2	<3.3	<3.4
	F2 (C10-C16)	ug/L	---	100	mg/kg	760	---	<48	16	6.6	8.5	23	15
	F3 (C16-C34)	ug/L	---	100	mg/kg	1,700	---	160	43.6	31	29	47.8	82.9
	F4 (C34-C50)	ug/L	---	100	mg/kg	3,300	---	<48	12	14	14	19	33

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME (January 2001)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME (2006)

DRAINAGE SEDIMENT = Sediments collected in a dry or temporary drainage, considered like a soil.

Figure 14. (S-10193) Airstrip Tank Farm map 1.

Figure 15. (S-10193) Airstrip Tank Farm map 2.

4.5 S-10194 APRON REFUELING AREA INCLUDING THE DEICING AREA

4.5.1 Location and Site Description

- The Apron Refueling Area: This site is situated on the south side of the runway (Figures 16 and 17). The area includes the airstrip pumphouse and a fuel hydrant building, located in front of the Airstrip Tank Farm. Fuel stored in the airstrip tank farm is first pumped through a pipeline from the tanks to the pumphouse, and up a slope, to the fuel hydrant building, where it is pumped using hoses to fuel aircraft (ESG 1999). The topography of the site is relatively level at the pumphouse, and slopes toward the fuel hydrant building to reach the airstrip runway. The pumphouse and fuel hydrant building are built on a very compacted fill material that consists mainly of crushed gravel that is finer than seen in most areas of the site.

  The site is located less than 315 m upgradient from Dumbell Bay. The Bay is the principal receptor, although no drainage channels were observed.

- The Deicing Area: In the deicing area, type 1 ethylene glycol is used to deice airplanes. There are three main deicing areas (Figures 18 and 19). The first is located in front of the apron refueling fuel hydrant building with the second and third areas located at the end of the runway on the west side, in a small semi-circular area (Photograph 15, Appendix A). The topography is level at the runway and the ground material consists of well compacted fine gravel. The runway is usually leveled out every year, with the occasional addition of material.

  Two principal drainage channels were present on-site. The first one started beside the first deicing area and went downhill, toward Dumbell bay, located less than 500 m away from this area. The second drainage channel was a ditch circumscribing the second and third deicing areas, collecting water from both the runway and the upgradient terrain located northwest of the airstrip runway.

4.5.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

- Apron Refueling Area: In 2006/07, 5 soil samples were taken at this site including one duplicate. Four of these samples were evaluated for TPH and metals. The first contaminated sample (06AP0130) was taken in a trench situated southeast of the site, downgradient of the refueling shed (Photograph 14, Appendix A). This sample contained concentrations of TPH Fractions 1 and 2 and total xylene just above CCME guidelines (Table 13). In a second sample (06AP0131) taken at a depth of 60 cm in the same trench, TPH Fraction 2 was detected at the CCME guideline concentration. No contaminants exceeded the CCME guidelines at the apron refueling area.

- Deicing Area: Site characterization was performed around the first, second and third deicing areas in 2006/07. This campaign included the collection of 20 surface soil samples. All of the samples were collected on the runway, at a depth of 0-10 cm. Deeper investigation was not authorized on site.

  Of all the samples, 17 were analyzed for glycols and three for TPH. None of the samples exceeded the applicable guideline for either glycols or TPH. However, two samples (06DICE12 and 06DICE15) showed high concentrations of propylene glycol; 1,900 and 1,200 mg/kg, respectively. There is currently no guideline for propylene glycol. Petroleum hydrocarbon Fraction 2 was detected in sample 06DICE25, collected just beside the refueling shed. One freshwater sample, collected in the drainage pathway (just before it crosses Lancaster Drive) was tested for glycols. There was no glycol contamination detected in the water sample.

Table 13. (S-10194) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline(mg/kg)	Concentration (mg/kg)
06AP0130	SOIL	0-10	TOTAL XYLENE	11	14
		0-10	TPH / F1	310	370
		0-10	TPH / F2	760	1,100
06AP0152	SOIL	60	TPH / F2	760	760

4.5.3 Nature and Extent of Contamination

- Apron Refueling Area: During the 2007/08 sampling campaign, 14 soil samples were tested for TPH and BTEX, including one duplicate sample. The sampling depth ranged from 35 cm to 50 cm below ground (Table 14). TPH Fractions 2, 3 and 4 were below the CCME guidelines in all samples. Concentrations above CCME guidelines were found in one sample (B07-RT-0553) for toluene, ethylbenzene, total xylene, and TPH Fractions 1 and 2. This sample was collected between the pumphouse and the fuel hydrant building, at the foot of the slope.

- Deicing Area: During the 2007/08 sampling campaign, a total of 10 soil samples were collected from depths between 20-40 cm. This included one duplicate pair and 2 drainage soil samples collected at a depth of 10 cm near the second and third deicing areas. Due to its continued use as an active airstrip, the sampling depth was limited to 40 cm. No samples from the suprapermafrost layer were collected. One surface water sample was also collected in a drainage pathway located west of the second and third deicing areas. All samples were analyzed for glycol and no contamination was detected (Table 15).

According to the FCSAP classification system, the Apron Refueling and Deicing area is a Class 2 site (60.8) and action is likely required to reduce the contamination. The estimated volume of contaminated soil is 78 m^3.

4.5.4 Recommendations

- Apron Refueling Area: The only glycol contamination detected at the site has been limited to the upper 20 cm of soil, although deeper subsurface sampling has been restricted due to its continued use as an active airstrip. The contamination detected has been restricted to a small area and does not represent a significant level of contamination. Subsurface sampling to the permafrost layer needs to be performed in downgradient areas immediately adjacent to the contaminated areas to determine if migration of the de-icing solution has occurred. If no additional contamination is detected and the contaminated soil is removed, closure of the site may be possible.

- Deicing Area: A small localized area of TPH contamination has been identified. The contaminated area should be excavated and treated *ex situ* in a biopile system which would permit closure of the site.

Table 14. (S-10194) Apron refueling area 2007/08 results.

	PARAMETERS	SOIL			Apron Refueling Area (S-10194)													
					SOIL													
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-RT-0060 Dup. 0553 50 cm 8/16/2007	B07-RT-0550 50 cm 8/16/2007	B07-RT-0551 50 cm 8/16/2007	B07-RT-0552 35 cm 8/16/2007	B07-RT-0553 50 cm 8/16/2007	B07-RT-0554 50 cm 8/16/2007	B07-RT-0555 50 cm 8/16/2007	B07-RT-0556 45 cm 8/16/2007	B07-RT-0557 45 cm 8/16/2007	B07-RT-0558 45 cm 8/16/2007	B07-RT-0559 50 cm 8/16/2007	B07-RT-0560 50 cm 8/16/2007	B07-RT-0561 45 cm 8/16/2007	B07-RT-0562 45 cm 8/16/2007
TPH	Benzene	mg/kg	0.03	0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.37	0.02	<0.1	<0.1	<0.1	<0.1	5.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Ethylbenzene	mg/kg	0.082	0.02	<0.1	<0.1	<0.1	<0.1	3.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Total Xylene	mg/kg	11	0.04	<0.1	<0.1	<0.1	<0.1	28.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	F1 (C6-C10)	mg/kg	310	10	516	<2.6	<2.6	<3.2	1,840	<3.2	<2.6	<2.6	4.5	<3.2	<2.9	<3	<2.6	<2.4
	F2 (C10-C16)	mg/kg	760	10	1,030	39.2	29.3	24.7	1,710	23.5	23.5	26	215	30.7	18	45.1	49.8	27.6
	F3 (C16-C34)	mg/kg	1,700	10	77.6	19	39	15	91.6	17	13	18	27	30	24	30	35	17
	F4 (C34-C50)	mg/kg	3,300	10	14	9.3	16	<7.9	14	<5.5	<6.4	7	7.7	9.3	<7.7	10	<9.6	<8.2

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 15. (S-10194) Deicing Area 2007/08 results.

	PARAMETERS	WATER			SOIL			Deicing Area at the Apron refueling area (S-10194)						
								WATER	SOIL					
		UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-DICE-0440W Fresh water Surface 8/16/2007	B07-DICE-0047 Dup. 433 20 cm 8/16/2007	B07-DICE-0429 20 cm 8/16/2007	B07-DICE-0430 20 cm 8/16/2007	B07-DICE-0431 20 cm 8/16/2007	B07-DICE-0432 20 cm 8/16/2007	B07-DICE-0433 20 cm 8/16/2007
GLYCOL	Ethylene glycol	ug/L	192,000	<0.001	mg/kg	960	<8	<5,000	<20	<20	<20	<20	<20	<20
	Diethylene glycol	ug/L	---	<0.001	mg/kg	---	<4	<2,000	<8	<8	<8	<8	<8	<8
	Triethylene glycol	ug/L	---	<0.002	mg/kg	---	<16	<2,000	<16	<16	<16	<16	<16	<16
	Tetraethylene glycol	ug/L	---	<0.010	mg/kg	---	<60	<10,000	<60	<60	<60	<60	<60	<60
	Propylene glycol	ug/L	500,000	<0.001	mg/kg	---	<8	<5,000	<20	<20	<20	<20	<20	<20

Table 15. (S-10194) Deicing Area 2007/08 results (cont.).

	PARAMETERS	SOIL			Deicing Area at the Apron refueling area (S-10194)							
					SOIL							
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-DICE-0435 20 cm 8/16/2007	B07-DICE-0436 40 cm Drain. Sed. 8/16/2007	B07-DICE-0437 40 cm Drain. Sed. 8/16/2007	B07-DICE-0438 40 cm 8/16/2007	B07-DICE-0439 40 cm 8/16/2007	B07-DICE-0434 20 cm 8/16/2007	B07-DICE-0048-BG Background 40 cm 8/16/2007
GLYCOL	Ethylene glycol	mg/kg	960	<8	<20	<20	<20	<20	<20	<20	<20
	Diethylene glycol	mg/kg	---	<4	<8	<8	<8	<8	<8	<8	<8
	Triethylene glycol	mg/kg	---	<16	<16	<16	<16	<16	<16	<16	<16
	Tetraethylene glycol	mg/kg	---	<60	<60	<60	<60	<60	<60	<60	<60
	Propylene glycol	mg/kg	---	<8	<20	<20	<20	<20	<20	<20	<20

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

DRAINAGE SED. = Sediments collected in a dry or temporary drainage, considered like a soil.

Figure 16. (S-10194) Apron refueling area map 1.

Figure 17. (S-10194) Apron refueling area map 2.

Figure 18. (S-10194) Deicing area map 1.

Figure 19. (S-10194) Deicing area map 2.

4.6 S-10195 MSE-17 VEHICLE MAINTENANCE BUILDING

4.6.1 Location and Site Description

The MSE-17 Vehicle Maintenance Building is located at the CFS-Alert main station, southwest of the Construction Engineering Building/Fire Hall (CE-140) and southeast of the Heated Vehicle Storage Building (Bldg 113). The vehicle maintenance building is adjacent to the ice shelf building remains (Figure 20). The west side of the building complex is used for vehicle maintenance, and offices are located midway along the building. A supply storage area is located at the east end of the building. The Vehicle Maintenance Building is constructed on beams which creates an empty space between the ground and the building. The ground is composed of fill material, mainly coarse to small gravels mixed with some fine material found in low spots.

During the 2006/07 and 2007/08 sampling campaigns, a drainage pathway that went from the southwest to the southeast of the site, along a small slope, was recorded. Eventually, the drainage pathway leads to a ditch situated along Herc drive.

4.6.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitlde "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

Four soil samples, including one duplicate pair, were taken during the 2006/07 campaign (Figure 21). All the samples were taken at depths ranging from 0 to 20 cm. No PAH concentrations higher than the CCME guideline were detected. Concentrations of TPH Fractions 1, 2 and 3 were detected above the CCME guidelines in all of the samples, and TPH Fraction 4 was detected above the CCME guideline in 3 soil samples (Table 16). Metals were found in three different samples. Arsenic was detected in two soil samples slightly above the CCME guideline. Copper was detected above the CCME guideline in the two surface soil samples 06VM0118 and

60VM0121. The sample 06VM0118 was taken from inside an interior drain and had a zinc concentration above the CCME guideline. Ethylbenzene, toluene and total xylene were detected at concentrations above CCME guidelines in several soil samples. The odor of fuel in samples 06VM0117 and 06VM0119 was strong and detectable in the field.

Table 16. (S-10195) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Criterion (mg/kg)	Concentration (mg/kg)
06VM0118	SOIL	0-10	ARSENIC (AS)	12	13.1
		0-10	COPPER (CU)	91	101
		0-10	ZINC (ZN)	360	400
		0-10	ETHYLBENZENE	0.08	0.58
		0-10	TPH / F1	310	450
		0-10	TPH / F2	760	11,000
		0-10	TPH / F3	1,700	68,000
		0-10	TPH / F4	3,300	3,900
06VM0119	SOIL	15	TOLUENE	0.37	0.9
		15	TOTAL XYLENE	11	21
		15	TPH / F1	310	2,200
		15	TPH / F2	760	31,000
		15	TPH / F3	1,700	51,000
		15	TPH / F4	3,300	5,400
06VM0121	SOIL	15	COPPER (CU)	91	124
		15	TOLUENE	0.37	0.7
		15	ETHYLBENZENE	0.08	0.3
		15	TOTAL XYLENE	11	21
		15	TPH / F1	310	580
		15	TPH / F2	760	32,000
		15	TPH / F3	1,700	51,000
		15	TPH /F4	3,300	6,400
06VM0117	SOIL	15-20	ARSENIC (AS)	12	12.1
		15-20	TPH / F1	310	1,300
		15-20	TPH / F2	760	13,000
		15-20	TPH / F3	1,700	26,000

4.6.3 Nature and Extent of Contamination

The contamination detected in 2006/07 was spread over two main zones. During the 2007/08 campaign, sampling of these zones was not authorized because of high tension cables buried within these zones. Therefore, the 2006/07 contamination situated on the northwest side of the building was not delineated in 2007/08.

Six soil samples were collected in the suprapermafrost layer and analyzed for metals, BTEX,

TPH and PAHs. The samples were collected on the southeast side of the site, behind the Vehicle Maintenance Building, in front of Herc drive. One surface water sample was collected in the drainage ditch on the southeast corner of the site behind the building. This sample was analyzed for metals, TPH and PAHs. One groundwater sample was collected from a soil sampling trench and was analyzed for TPH and PAHs. The sampling locations were perpendicular to the direction of water flow and runoff, in order to measure the extent of the contamination. For this reason, and also because of the proximity of the site, many samples were collected in the ice shelf building remains, situated downhill and southeast of the Vehicle Maintenance Building.

Arsenic and nickel concentrations slightly above CCME guidelines were found in two soil samples. No other soils containing metals contamination were found (Table 17). Toluene, ethylbenzene and total xylene concentrations in one soil sample (B07-VM-0505) were above the CCME guidelines. Concentrations of TPH Fractions 1 and 2 exceeded the CCME guidelines in three soil samples. No PAHs were detected above the CCME guidelines.

The concentration of toluene in groundwater was above the CCME guideline. Total xylene and TPH Fractions 1, 2, 3 and 4 were detected at significantly elevated concentrations in the groundwater sample, but no guidelines currently exist for these contaminants.

Arsenic, copper and zinc concentrations above CCME guidelines for aquatic life were detected in the surface water sample. Naphthalene was the only PAH detected above CCME guidelines in the surface water sample. Total xylene and TPH Fractions 1, 2 and 3 were detected at elevated concentrations in this sample.

According to the FCSAP classification system, this is a Class 1 site (76.7), with action required. The estimated volume of contaminated soil is 878 m^3.

4.6.4 Recommendations

The outer limits of the contaminated area remain to be delineated. The contamination also appears to overlap the former Ice Shelf Building remains and the two areas should be treated as a

single site.

The site requires additional delineation, in particular in the area upgradient of the MSE-17 building as well as downgradient of the MSE-17 building and Ice Shelf Building remains, including the opposite side of the adjacent road. Once the extent of contamination is established, the decision as to whether an *in situ* or *ex situ* treatment of the site can be made.

Table 17. (S-10195) Vehicle Maintenance Building 2007/08 results.

			MSE 17 - Vehicle Maintenance Bldg (S-10195)											
			SOIL			WATER			FRESH WATER		SOIL					
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT		B07-VM-0501W Groundwater 8/28/2007	B07-VM-0521W Surface water 8/28/2007	B07-VM-0500 100 cm 8/28/2007	B07-VM-0501 50 cm 8/28/2007	B07-VM-0502 50 cm 8/28/2007	B07-VM-0503 60 cm 8/28/2007	B07-VM-0504 90 cm 8/28/2007	B07-VM-0505 60 cm 8/28/2007
METALS	Arsenic (As)	mg/kg	12	0.27	ug/L	5	0.0001		NA	5	7.8	12.3	8.1	11.2	12.5	NA
	Barium (Ba)	mg/kg	2,000	5	ug/L	---	0.001		NA	30	15	21	13	14	18	NA
	Cadmium (Cd)	mg/kg	22	0.22	ug/L	0.017	0.0001		NA	<10	<0.9	<0.9	<0.9	<0.9	<0.9	NA
	Chromium (Cr)	mg/kg	87	3	ug/L	---	0.0007		NA	10	29	33	24	27	33	NA
	Cobalt (Co)	mg/kg	300	1.9	ug/L	---	0.0006		NA	<10	10	19	11	13	16	NA
	Copper (Cu)	mg/kg	91	2.1	ug/L	2-4	0.0012		NA	10	28	34	21	23	42	NA
	Lead (Pb)	mg/kg	600	1.2	ug/L	1-7	0.0011		NA	<10	20	19	14	15	17	NA
	Manganese (Mn)	mg/kg	---	1.1	ug/L	---	0.0003		NA	517	444	530	484	505	558	NA
	Molybdenum (Mo)	mg/kg	40	1.4	ug/L	73	0.0078		NA	<20	<2	<2	<2	<2	<2	NA
	Nickel (Ni)	mg/kg	50	0.6	ug/L	25-150	0.0005		NA	20	29	59	37	45	50	NA
	Selenium (Se)	mg/kg	3.9	0.5	ug/L	1	0.0006		NA	<1	0.7	0.9	<0.5	0.6	1.1	NA
	Silver (Ag)	mg/kg	40	0.4	ug/L	---	0.0008		NA	<20	<0.5	<0.5	<0.5	<0.5	<0.5	NA
	Tin (Sn)	mg/kg	300	0.8	ug/L	---	0.011		NA	<10	<5	<5	<5	<5	<5	NA
	Zinc (Zn)	mg/kg	360	2.5	ug/L	30	0.006		NA	170	108	76	53	60	64	NA
TPH	Benzene	mg/kg	0.03	0.02	ug/L	370	0.03		<6.5	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.37	0.02	ug/L	2	0.03		75.1	0.4	<0.1	0.1	<0.1	<0.1	<0.1	2.6
	Ethylbenzene	mg/kg	0.082	0.02	ug/L	90	0.02		<6.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3.0
	Total Xylene	mg/kg	11	0.04	ug/L	---	0.05		570	11.2	5.7	<0.1	<0.1	1.0	<0.1	27.6
	F1 (C6-C10)	mg/kg	310	10	ug/L	---	100		3,690	130	1,670	11	7.9	331	47	345
	F2 (C10-C16)	mg/kg	760	10	ug/L	---	100		293,000	1,390	12,500	<2.7	286	2,610	136	6,870
	F3 (C16-C34)	mg/kg	1,700	10	ug/L	---	100		14,880	623	546	<6.2	24	44.9	14	497
	F4 (C34-C50)	mg/kg	3,300	10	ug/L	---	100		948	<43	69	<8.9	11	7.1	9.6	35
PAH	Naphthalene	mg/kg	22	0.008	ug/L	1.1	0.04		0.1	7.8	12.2	0.1	<0.1	0.3	<0.1	NA
	2-methylnaphthalene	mg/kg	---	0.005	ug/L	---	0.04		NA	NA	45.3	0.7	<0.1	5.7	<0.1	NA
	1-methylnaphthalene	mg/kg	---	0.005	ug/L	---	0.04		NA	NA	38.9	0.6	<0.1	6.1	<0.1	NA
	1,3-Dimethylnaphthalene	mg/kg	---	0.005	ug/L	---	0.04		NA	NA	20.7	0.5	<0.1	6	<0.1	NA
	Acenaphthylene	mg/kg	---	0.004	ug/L	---	0.03		<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	NA
	Acenaphthene	mg/kg	---	0.004	ug/L	5.8	0.04		<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	NA
	2,3,5-trimethylnaphthalene	mg/kg	---	0.007	ug/L	---	0.05		NA	NA	1.7	<0.1	<0.1	0.5	<0.1	NA
	Fluorene	mg/kg	---	0.007	ug/L	3	0.05		<0.1	0.2	0.5	<0.1	<0.1	<0.1	<0.1	NA
	Phenanthrene	mg/kg	50	0.01	ug/L	0.4	0.04		<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	NA
	Anthracene	mg/kg	---	0.004	ug/L	0.012	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Fluoranthene	mg/kg	---	0.008	ug/L	0.04	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Pyrene	mg/kg	100	0.008	ug/L	0.025	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Benzo(c)Phenanthrene	mg/kg	---	0.008	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Benzo(a)Anthracene	mg/kg	10	0.007	ug/L	0.018	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Chrysene	mg/kg	---	0.008	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	7,12-dimethylbenz(a)anthracene	mg/kg	---	0.005	ug/L	---	0.01		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Benzo(b,j,k)fluoranthene	mg/kg	10	0.008	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Benzo(a)pyrene	mg/kg	0.7	0.008	ug/L	0.015	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	3-methylcholanthrene	mg/kg	---	0.022	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Indeno(1,2,3-cd)pyrene	mg/kg	10	0.008	ug/L	---	0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Dibenzo(a,h)anthracene	mg/kg	10	0.008	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Benzo(g,h,i)perylene	mg/kg	---	0.008	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Dibenzo (a,l) pyrene	mg/kg	---	0.008	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Dibenzo (a,i) pyrene	mg/kg	---	0.007	ug/L	---	0.04		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA
	Dibenzo (a,h) pyrene	mg/kg	---	0.008	ug/L	---	0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA

NA Not available
Higher than the criteria
High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)
SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)
F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME (January 2001)
FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

Figure 20. (S-10195) MSE-17 Vehicle Maintenance Building map 1.

Figure 21. (S-10195) MSE-17 Vehicle Maintenance Building map 2.

4.7 S-10196 BURN PIT

4.7.1 Location and Site Description

The Burn Pit site is situated north of the CFS-Alert main station, at the junction of Tower Way and the road leading to the Main Station Landfill (Figure 22). The site was previously used to burn combustible waste generated by the station before being disposed of in the Main Station Landfill (ESG 1999). The burned waste included paper, tin cans, plastics, wood and Styrofoam, using fuel to ignite the garbage pile. Currently this site is inactive.

The Burn Pit site covers an area of approximately 30 m by 25 m, with the topography generally level. The east side of the site slopes gently towards Dumbell Bay. The Burn Pit site is located less than 500 m from Dumbell Bay. The description of the Burn Pit site from previous reports describes a berm surrounding the site. At the time of the 2006/07 and 2007/08 sampling campaigns, the majority of the berm surrounding the site was destroyed. The only obvious site remnants are situated in the northeast of the site. It was suspected that after the closure of the Burn Pit, the site had been leveled with the soil from the berms.

The soil at the Burn Pit site is composed of fill material mixed with natural soil; coarse to fine gravels mixed with light grey silt and clay and interspersed with shale stones. Drainage ditches are located along the roads near the burn pit. During the 2007/08 sampling campaign, a drainage pathway was noted on the southeast side of the site, heading towards Dumbell Bay. The drainage ditches and drainage pathway were dry at the time of the 2007/08 sampling campaign.

4.7.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2007/08 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, four soil samples were collected and analyzed for metals, PAHs, TPH and VOCs. Three of the soil samples were collected at ground level, and one soil sample (06BP0127) was collected at a depth of 60 cm, in a trench dug south of the previous berm (Figure 23). All four soil samples contained arsenic concentrations exceeding the CCME guideline, and the subsurface soil sample contained nickel concentrations above the CCME guideline (Table 18). An attempt to collect groundwater and install an observation well failed because no groundwater was present on site at the time of well installation and after 24 hours. No surface water was collected.

Table 18. (S-10196) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06BP0127	SOIL	0-10	ARSENIC (AS)	12	23.6
		0-10	NICKEL (NI)	50	53
06PB0128	SOIL	50	ARSENIC (AS)	12	24.8
06BP0129	SOIL	40	ARSENIC (AS)	12	24.5
06BP0147	SOIL	40	ARSENIC (AS)	12	21.4

4.7.3 Nature and Extent of Contamination

In 2007/08, soil samples were collected at a depth of 45 cm, and analyzed for metals. The sample locations were selected to investigate potential off-site migration of contaminants by the drainage pathways. A variety of metals were detected, but only arsenic concentrations were slightly above the CCME guideline in all samples (Table 19). Although below the guideline, nickel concentrations were elevated. No hydrocarbon odor was detected on site and no TPH was detected.

According to the FCSAP classification system, this is a Class 2 site (53.1). The estimated volume of contaminated soil is 600 m^3. This class indicates that further investigations should be performed to completely evaluate the state of the site and extent of contamination.

4.7.4 Recommendations

The former Burn Pit is situated in an area circumscribed by roads and drainage ditches. No TPH contamination was detected in the 2007/08 samples, but arsenic was detected in all six samples, ranging from 15.2 – 19.6 mg/kg. No lead or copper was detected, as was the case in previous samples (1999). There are several drainage ditches on the peripheries of the Burn Pit area and these drainage ditches are connected to both upgradient and downgradient areas, some of which have been identified as possessing TPH contamination (eg. Operations Building, Station Day Tank). Determination of the source of contamination in these drainage ditches is complicated by the interconnectedness of the drainage areas.

Delineation of the site needs to be completed for both heavy metals and TPH, in particular, the downgradient region of the area circumscribed by the roads. The TPH contaminated soils appear to be confined to a small area and would be addressed by excavation and *ex situ* biopile treatment. The arsenic contamination, once the area has been delineated, could be excavated and permit closure of the site.

Table 19. (S-10196) Burn Pit 2007/08 results.

					Burn Pit (S-10196)					
		SOIL			SOIL					
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-BP-0130 45 cm 8/25/2007	B07-BP-0131 45 cm 8/25/2007	B07-BP-0132 45 cm 8/25/2007	B07-BP-0133 45 cm 8/25/2007	B07-BP-0134 45 cm 8/25/2007	B07-BP-0563 45 cm 8/25/2007
METALS	Arsenic (As)	mg/kg	12	0.27	19.6	16.1	15.2	19.2	17.2	16.5
	Barium (Ba)	mg/kg	2,000	5	17	20	20	23	13	16
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	29	29	32	31	30	29
	Cobalt (Co)	mg/kg	300	1.9	15	14	14	14	13	13
	Copper (Cu)	mg/kg	91	2.1	25	27	39	31	23	25
	Lead (Pb)	mg/kg	600	1.2	14	19	16	35	13	14
	Manganese (Mn)	mg/kg	---	1.1	538	534	517	550	501	480
	Molybdenum (Mo)	mg/kg	40	1.4	2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	46	45	47	47	46	46
	Selenium (Se)	mg/kg	3.9	0.5	1.0	0.6	0.6	0.7	<0.5	0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	70	77	69	102	68	69

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

Figure 22. (S-10196) Burn Pit map 1.

Figure 23. (S-10196) Burn Pit map 2.

4.8 S-10197 MAIN STATION LANDFILL

4.8.1 Location and Site Description

The Main Station Landfill has been a waste disposal site since 1980 and is still active. It is located north of the CFS-Alert main station (Figure 24), on a small embankment that faces Dumbell Bay. A quarry and gravel-crushing operation is immediately to the east. The landfill itself is approximately 100 m x 75 m, and contains a mixture of potentially hazardous and non-hazardous materials, including crushed POL (petroleum, oil, and lubricants) tanks and barrels, batteries, blasting caps, construction waste, furniture and domestic debris (ESG 2000) (Photograph 16, Appendix A). The oldest part of the landfill is located at the south end of the site, where debris has been covered with gravel. The newer part, located at the northern end of the site, is left exposed and regularly pushed over the edge of the embankment in order to make room for new material.

The topography of the embankment is level and there is a north-facing slope at the end of the embankment that levels out towards Dumbell Bay. A drainage pathway flows from the landfill area directly into Dumbell Bay, passing through the middle of the slope (Photographs 17 and 18, Appendix A). The soil in the slope is composed of coarse to fine gravel with clay and ashes from burned garbage. The soil at the toe of the slope is mainly native clay and silts with interspersed shale stones and is saturated with water.

4.8.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2007/08 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, four surface water samples were collected within the Main Station Landfill site and one sediment sample was collected on the edge of Dumbell Bay, at the end of the main drainage pathway (Figure 25). All samples were analyzed for metals. The monitoring well-points

installed by ESG in 2000 were malfunctioning and could not be used during the 2006/07 campaign. Therefore, no groundwater samples were collected. Three surface water samples contained copper, lead and zinc in concentrations that exceeded the CCME guidelines (Table 20). One water sample (06MS0082) also exceeded the CCME guidelines for arsenic and nickel. This sample was collected in the main drainage pathway, just before it reaches Dumbell Bay. The sediment sample (06MS0030) had no metals exceeding CCME guidelines, although copper and zinc were detected at slightly elevated levels.

Table 20. (S-10197) Previous contaminated samples.

Sample Name	Sample Type	Water	Contaminant	Criterion (ug/L)	Concentration (ug/L)
06MS0082	WATER	SURFACE	ARSENIC (AS)	5	6
		SURFACE	COPPER (CU)	2-4	24
		SURFACE	LEAD (PB)	1-7	14
		SURFACE	NICKEL (NI)	25-150	37
		SURFACE	ZINC (ZN)	30	60
06MS0084	WATER	SURFACE	COPPER (CU)	2-4	11
		SURFACE	LEAD (PB)	1-7	5
		SURFACE	ZINC (ZN)	30	160
06MS0085	WATER	SURFACE	COPPER (CU)	2-4	7
		SURFACE	LEAD (PB)	1-7	4
		SURFACE	ZINC (ZN)	30	90

4.8.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign, 10 soil samples, including one duplicate pair, were collected at a depth of 45 cm in the drainage pathway to investigate whether any contaminants were migrating away from the site (Figure 24). One surface water sample was collected in the drainage pathway, but the sample was lost during analysis. The soil samples were collected along a line perpendicular to the drainage pathways, at mid-slope, and near the shoreline. All samples were tested for metals. The results showed arsenic and nickel concentrations above the CCME guidelines in 5 and 4 soils samples, respectively (Table 21, Figure 25). Other metals were detected in the samples, but none were above the CCME guidelines. Three sediment

samples were collected in Dumbell Bay, in front of the landfill drainage discharge area. The chemical analysis results of these three sediment samples (07US1007 to 07US1009) are discussed in the underwater survey section (section 4.1).

According to the FCSAP classification system, this is a Class 1 site (74.1) indicating a high potential for adverse off-site impact. The estimated volume of contaminated soil is 16,500 m^3.

4.8.4 Recommendations

The soil samples collected below (and downgradient) of the Main Station Landfill demonstrated slightly elevated concentrations of both arsenic and nickel. Of the ten samples taken, five surpassed the arsenic guideline, with four of these between 12.2-13.0 mg/kg (guideline of 12 mg/kg) and one sample at 16.9 mg/kg. For nickel, 4 of 10 samples were above the guideline (50 mg/kg), but again only slightly (51-57 mg/kg). Based on the results of the soil background survey, these values may be in the higher range of normal concentrations for this area.

Due to the design of the landfill (ie. no underlying impermeable membrane) and its active use, it remains a potential continual source of leachable materials such as heavy metals. At a minimum, regular downgradient sampling of the site should be performed to monitor for the movement of heavy metals and other potential contaminants. The installation of a downgradient lined catch basin is one alternative to be considered if it is determined that the heavy metals detected in the downgradient area are 1) significantly above natural concentrations 2) originating from the landfill and 3) found in leachates moving from the landfill towards the water.

Table 21. (S-10197) Main Station Landfill 2007/08 results.

					Main station landfill (S-10197)									
		SOIL			SOIL									
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-MS-0040 0-15 cm 8/14/2007	B07-MS-0041 Dup. 399 0-10 cm 8/14/2007	B07-MS-0384 20-30 cm 8/14/2007	B07-MS-0385 20-30 cm 8/14/2007	B07-MS-0388 0-10 cm 8/14/2007	B07-MS-0389 0-15 cm 8/14/2007	B07-MS-0391 0-10 cm 8/14/2007	B07-MS-0392 0-15 cm 8/14/2007	B07-MS-0398 Drain. Sed. 0-10 cm 8/14/2007	B07-MS-0399 Drain. Sed. 0-10 cm 8/14/2007
METALS	Arsenic (As)	mg/kg	12	0.27	12.5	13	8.6	8.7	8.3	10.3	10.1	12.6	12.2	16.9
	Barium (Ba)	mg/kg	2,000	5	25	16	20	22	15	25	22	16	16	19
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	35	27	33	36	31	34	31	31	25	28
	Cobalt (Co)	mg/kg	300	1.9	15	13	13	15	12	13	12	16	12	17
	Copper (Cu)	mg/kg	91	2.1	24	26	50	31	22	23	23	29	29	37
	Lead (Pb)	mg/kg	600	1.2	18	20	16	16	15	17	15	16	19	25
	Manganese (Mn)	mg/kg	—	1.1	597	535	452	583	467	461	415	500	534	535
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	53	43	51	57	47	48	46	51	41	49
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	0.6	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	76	78	73	79	67	77	68	70	74	86

NA Not available
Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)
SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)
DRAINAGE SEDIMENT. = Sediments collected in a dry or temporary drainage, considered like a soil.

Figure 24. (S-10197) Main Station Landfill map 1.

Figure 25. (S-10197) Main Station Landfill map 2.

4.9 S-10199 CE-140 MCE BUILDING FIRE HALL

4.9.1 Location and Site Description

The main Construction Engineering building, CE-140 MCE Building Fire Hall, is located adjacent to the CFS-Alert main station west of Doe Road (Figures 26 and 27). It contains the fire hall, the trash compactor/crusher and the construction engineering offices and facilities. The building is located on a small embankment of coarse gravel and fills material. A vehicle approach that moderately slopes down toward the south is located east of the building, beside Doe Road. A second vehicle approach that slopes down toward the north is located behind the MCE building, starting from Herc Drive, and going towards the Vehicle Maintenance Building.

The topography of the site is generally level, with the exception of the 2 vehicle approaches. During the 2006/07 sampling campaign, a standing pool of water was located north of the fire hall building, but no pool of water was noted in 2007/08. Drainage pathways were noted during the 2007/08 sampling campaign. The drainage pathways generally followed both vehicle approaches. A drainage ditch was located along Herc Drive.

4.9.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, a total of 5 soil samples, including 1 duplicate, were collected from around the buildings and analyzed for metals and TPH. Three soil samples contained arsenic concentrations slightly exceeding the CCME guideline (Table 22). TPH Fraction 2 concentrations were above the CCME guideline in two soil samples. It was observed that the soil from these samples was greasy with a light oily odor.

Table 22. (S-10199) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06FH0182	SOIL	35	ARSENIC (AS)	12	12.7
		35	TPH / F2	760	1,200
06FH0183	SOIL	20	ARSENIC (AS)	12	16.7
06FH0185	SOIL	0-10	ARSENIC (AS)	12	12.4
06FH0184	SOIL	35	TPH / F2	760	1,400

4.9.3 Nature and Extent of Contamination

During the 2007/08 campaign, 2 contaminated sections were investigated. The first section was situated east of the site in front of the MCE building, and the second section was situated west of the site behind the MCE building. A total of 21 soil samples were collected in these 2 sections; 16 soil samples (including 2 duplicate pairs) were collected in the first section and 5 soil samples were collected in the second section. Two soil samples (B07-FH-0476A and B07-FH-0486A) were taken at ground level, one in each section. The rest of the soil samples were collected at a depth of 50 cm. Six soil samples were analyzed for metals (all in the first section), all soil samples were analyzed for TPH and 4 soil samples were analyzed for PAHs (B07-FH-476A/B and B07-FH-486 A/B). One groundwater sample from the first contaminated section was also collected. The groundwater sample was analyzed for TPH only (Table 23).

In the first section, arsenic concentrations slightly above the CCME guideline were detected in four soil samples. No other metals were detected above the CCME guidelines. All TPH fractions were detected in the soil samples. TPH Fraction 3 was detected above the CCME guideline in one soil sample, B07-FH-0485. TPH Fraction 2 was detected above CCME guideline in two soil samples (B07-FH-0067 and B07-FH-0477). TPH Fractions 2 and 3 were detected at elevated concentrations in the groundwater sample, but there are currently no guidelines for these contaminants in water. PAHs were not detected.

In the second section, TPH Fractions 1 and 2 were detected above CCME guidelines in 1 (B07-FH-0486) and 3 (B07-FH-0486/A/B) soil samples, respectively. PAH compounds were not detected.

Using the FCSAP classification system, the MCE Building Fire Hall is a Class 2 site (64.7). The estimated volume of contaminated soil is 313 m^3. There is a high potential for adverse off-site impact, although the contaminated zones are restricted to specific areas and the FCSAP score indicates that further action is likely required at this site.

4.9.4 Recommendations

There were 3 separate TPH contaminated areas identified around the Fire Hall; 2 on the northeast side of the building and 1 on the southwest. For two of the areas (southwest side of building and northeast side directly in front of door) the extent of TPH contamination has been clearly delineated while the third area requires further characterization towards the southeast. Four samples from the 2007/08 campaign demonstrated arsenic concentrations above criteria (12.3 – 18.3 mg/kg) all in close proximity to one another.

The area to the southwest of the building can be addressed by excavation and *ex situ* biopile treatment of the TPH contamination. For the second well delineated area (northeast area in front of door), the TPH contamination can also be addressed by excavation and *ex situ* biopile treatment. The arsenic detected on site is just to the east – northeast of this area. Excavation of the arsenic contaminated soil and internment into a contained landfill would be the most appropriate approach to address this area if it is determined that the observed arsenic concentrations are significantly above background. The remaining site (front corner of the Supply Building) requires further delineation, after which the TPH contaminated soil can be excavated and treated in an *ex situ* biopile. At this point the site could be closed.

ICE Building Fire Hall (S-10199)					
	SOIL				
480	B07-FH-0481	B07-FH-0482	B07-FH-0485	B07-FH-0486A	B07-FH-0486B
	50cm	50cm	50cm	0-15 cm	50cm
07	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007
	15	18.3	14.7	NA	NA
	18	19	33	NA	NA
	<0.9	<0.9	<0.9	NA	NA
	24	30	23	NA	NA
	11	14	12	NA	NA
	13	21	21	NA	NA
	15	15	15	NA	NA
	540	553	519	NA	NA
	<2	<2	<2	NA	NA
	30	45	42	NA	NA
	<0.5	0.7	<0.5	NA	NA
	<0.5	<0.5	<0.5	NA	NA
	<5	<5	<5	NA	NA
	44	64	68	NA	NA

CE-140 MCE Building Fire Hall (S-10199)							
SOIL							
07-FH-0475	B07-FH-0476A	B07-FH-0476B	B07-FH-0477	B07-FH-0478	B07-FH-0479	B07-FH-0480	B07-FH-0481
50cm	0-15 cm	50 cm	50cm	50cm	50cm	50cm	50cm
8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007
<2.9	<3.4	NA	80.6	<3.3	<3.6	<2.9	<3.1
10	475	NA	2,110	4.4	38.6	13	<2.1
147	371	NA	496	54.5	57.5	196	31
51	72	NA	80.2	23	20	27	13

SOIL								
07-FH-0484	B07-FH-0485	B07-FH-0486	B07-FH-0486A	B07-FH-0486B	B07-FH-0487	B07-FH-0488	B07-FH-0489	B07-FH-0490
50cm	50cm	50cm	0-15 cm	50cm	50cm	50cm	50cm	50cm
8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007	8/20/2007
8.2	<3	407	232	292	<3.1	5	<3	<4.7
177	3.4	4,870	2,590	3,260	7.6	544	603	11
64.6	4,920	266	392	151	66.7	39	185	444
14	496	47	72	26	19	8.4	42	138

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trial/Eco Soil Contact), endorsed by the CCME (January

Figure 26. (S-10199) CE-140 MCE Building Fire Hall map 1.

Figure 27. (S-10199) CE-140 MCE Building Fire Hall map 2.

4.10 S-10200 B-145 CAT HOUSE

4.10.1 Location and Site Description

The Main Power Plant, also known as the Cat House, is situated at the CFS-Alert main station, south of the Main Supply Building and north of the Alternate Power Plant Building (Figures 28 and 29). Four diesel-powered generators are located inside the Cat House and provide power to the station. On the west side of the building are two wooded pallets on metal racks with several drums stacked on the pallets. The metal supports have a recovery receptacle to collect any drum leaks.

The topography of the Cat House site in mainly level, with an abrupt downward slope on the southwest side that leads towards Herc Drive and Baker's Dozen. The soil is composed of fill material, coarse to fine gravel, and a little silt. A drainage ditch is located east of the site in front of the building. The ditch contains melt water and actively drains water to the south of the CFS-Alert main station, ultimately into the Baker's Dozen and the Runoff Collection Basin areas.

4.10.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, four surface soil samples were collected at the Cat House. Two samples had arsenic concentrations slightly above the CCME guideline (Table 24). Nickel was detected above the guideline concentration in one soil sample collected from a stained area near the exhaust fans (06CH0111). TPH Fractions 2 and 3 were measured above the CCM guidelines in 2 and 1 surface soil samples, respectively.

Table 24. (S-10200) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06CH0108	SOIL	0-10	TPH / F2	760	2,500
06CH0110	SOIL	0-10	ARSENIC (AS)	12	17.7
		0-10	TPH / F3	1,700	6,400
06CH0111	SOIL	0-10	ARSENIC (AS)	12	20.1
		0-10	NICKEL (NI)	50	58
06CH0112	SOIL	0-10	TPH / F2	760	4,800

4.10.3 Nature and Extent of Contamination

In 2007/08, 16 soil samples were collected from depths between 10-45 cm, along with 1 groundwater sample collected northwest of the Cat House building. Seven soil samples were analyzed for metals and 11 samples were analyzed for TPH (Table 25). Arsenic and nickel concentrations slightly above CCME guidelines were detected in 4 and 4 soil samples, respectively. One soil sample (B07-CH-0045) had TPH Fraction 2 concentrations above the CCME guideline. This sample was taken under a pipeline valve on the southeast corner of the building (Photograph 19, Appendix A).

Based on the results from the 2006/07 and 2007/08 sampling campaigns, the Cat House site is Class 2 (62.5) based on the FCSAP classification system. This classification indicates that there is a concern for off-site migration of the contamination and that action may be required to reduce the risk of environmental impacts and/or human health threats. The estimated volume of contaminated soil is 13 m^3.

4.10.4 Recommendations

A small localized area of TPH contamination has been delineated at the site. Additionally, two areas demonstrated concentrations of arsenic and/or nickel above guidelines. Nickel concentrations in 4 of 7 samples measured 57 mg/kg (guideline of 50 mg/kg) and arsenic was above guidelines in 4 of 7 samples (range of 12.7 – 20.9 mg/kg, guideline of 12 mg/kg). The

small TPH contaminated area should be excavated and treated in an *ex situ* biopile. To address the arsenic and nickel contamination, the contaminated soils should be excavated and interred in a contained landfill. The site could then be closed.

B-145 Cat House (S-10200)					
SOIL					
H-0394 0 cm /2007	B07-CH-0396 0-10 cm 8/14/2007	B07-CH-0397 30-50 cm 8/14/2007	B07-CH-0404 10-40 cm 8/14/2007	B07-CH-0405 10-40 cm 8/14/2007	B07-CH-0407 10-40 cm 8/14/2007
7.9	11.2	12.7	10.7	19.1	10.9
18	54	17	13	21	14
0.9	<0.9	<0.9	<0.9	<0.9	<0.9
33	32	29	25	26	28
21	19	16	12	16	13
30	30	27	20	45	22
19	19	18	15	14	14
47	848	600	608	537	559
<2	4	<2	<2	<2	<2
57	57	57	40	37	45
0.5	0.9	<0.5	0.6	<0.5	<0.5
0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5
76	75	67	56	58	58

B-145 Cat House (S-10200)									
SOIL									
H-0049 . 390 0 cm /2007	B07-CH-0386 10-30 cm 8/14/2007	B07-CH-0390 0-10 cm 8/14/2007	B07-CH-0395 0-10 cm 8/14/2007	B07-CH-0400 10-20 cm 8/14/2007	B07-CH-0401 10-40 cm 8/14/2007	B07-CH-0402 0-20 cm 8/14/2007	B07-CH-0403 10-40 cm 8/14/2007	B07-CH-0404 10-40 cm 8/14/2007	B07-CH-0407 10-40 cm 8/14/2007
2.8	24	<2.9	<2.9	<2.7	<3.1	<3	<3.4	18	<3.2
6.8	615	<1.7	258	<1.8	<1.8	<2.3	<2.2	222	<1.9
18	25	15	34.1	11	<4.1	<5.3	15	351	19
.7	<4.6	8.4	13	<6	<5.9	<7.6	<7.3	55	8.6

or Environmental Health in Industrial land uses. of the CCME (2006)

Figure 28. (S-10200) Building B-145, Cat House area map 1.

Figure 29. (S-10200) Building B-145, Cat House area map 2.

4.11 S-10201 1 CEU GP HUT

4.11.1 Location and Site Description

The 1 CEU GP Hut was one of the original buildings constructed in the 1950s and originally housed the Canadian Wildlife Services and Environmental Sciences Group laboratories. It was subsequently used as office and warehouse space for the construction engineers and as a storage room for construction equipment (ESG 2000). The building is now demolished and the area was covered with fill materials and graded (Photograph 20, Appendix A). This site is located at the CFS-Alert main station, southwest of the HAPS building and north of the Cat House (Figures 30 and 31).

The topography of the site is level. During the 2006/07 and 2007/08 sampling campaigns, two drainage ditches were active on site. The first one was located along the east side of the site and the second was located along the south end of the site, parallel to Doe Road. Drainage pathways were noted leading from the southeast end of the site to the ditches.

4.11.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, 3 soil samples were collected; two in the drainage ditches and one in the middle of the site, where several barrels were temporarily stored. The samples were analyzed for metals, TPH and BTEX. Arsenic and nickel concentrations exceeded the CCME guidelines in one soil sample (06CE0148) collected in the eastern drainage ditch (Table 26). No TPH or BTEX were detected above CCME guidelines. During the visual inspection of the site, green algae and rust colored water was noted in the southern drainage ditch.

Table 26. (S-10201) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06CE0148	SOIL	0-10	ARSENIC (AS)	12	20
	SOIL	0-10	NICKEL (NI)	50	66

4.11.3 Nature and Extent of Contamination

In 2007/08, the area appeared to have been recently backfilled and graded. Four soil samples were collected from depths between10-40 cm, mainly along the eastern drainage ditch. At the time of the investigation, no surface water was present on site or in the drainage ditches. All samples were analyzed for metals and TPH (Table 27). Arsenic concentrations slightly above the CCME guideline were detected in two soil samples.

According to the FCSAP classification system, the site is Class 2 (52.8). The estimated volume of contaminated soil is 3 m^3. The data collected indicates that there are probably no significant environmental impacts or human health threats posed by this site.

4.11.4 Recommendations

The contamination at this site was a small localized region of TPH contaminated soil identified during the previous ESG sampling campaign, and one sample contaminated with heavy metals in the most northerly drainage. The area also appears to have been backfilled recently. Two of the four samples taken in 2007/08 had arsenic concentrations just above the guideline (13.3 and 13.6 mg/kg). The contaminated area should be excavated (if not already performed) and treated in an *ex situ* biopile system. The site could then be closed.

Table 27. (S-10201) 1CEU GP hut 2007/08 results.

					1 CEU GP hut (S-10201)			
		SOIL			SOIL			
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-CE-0471 Drain. Sed. 10-40 cm 8/20/2007	B07-CE-0472 Drain. Sed. 10-40 cm 8/20/2007	B07-CE-0473 Drain. Sed. 10-40 cm 8/20/2007	B07-CE-0598 Drain. Sed. 10-40 cm 8/20/2007
METALS	Arsenic (As)	mg/kg	12	0.27	8.7	13.3	7.5	13.6
	Barium (Ba)	mg/kg	2,000	5	18	24	28	20
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	30	29	26	22
	Cobalt (Co)	mg/kg	300	1.9	12	15	11	8
	Copper (Cu)	mg/kg	91	2.1	22	25	24	19
	Lead (Pb)	mg/kg	600	1.2	17	20	20	11
	Manganese (Mn)	mg/kg	---	1.1	507	586	508	504
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	45	45	39	25
	Selenium (Se)	mg/kg	4	0.5	<0.5	<0.5	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	64	63	99	37
TPH	F1 (C6-C10)	mg/kg	310	10	12	<3	<3.2	<2.6
	F2 (C10-C16)	mg/kg	760	10	289	28.2	33.6	23.6
	F3 (C16-C34)	mg/kg	1,700	10	45.4	211	111	17
	F4 (C34-C50)	mg/kg	3,300	10	10	66	36	6.5

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

DRAINAGE SED. = Sediments collected in a dry or temporary drainage, considered like a soil.

Figure 30. (S-10201) 1CEU GP hut map 1.

Figure 31. (S-10201) 1CEU GP hut map 2.

4.12 S-10202 CE COLD STORAGE GENERAL PURPOSE HUT – "DOG HOUSE"

4.12.1 Location and Site Description

The Dog House is located at the CFS-Alert main station, east of the Cat House and adjacent to the Oxidator Building (Figures 32 and 33). This is one of the original buildings at the main station and is now used for cold storage. The interior of the building is one large warehouse, with a bay door at the east end of the north side of the building (ESG 2000). According to the ESG 1999 report, barrels were previously buried in the east side of the site, on the south side of the Dog House building. It is unknown whether or not the barrels were removed from the site.

The Dog House is built on a small embankment composed of coarse to find gravel fill material. South of the site, behind the building, is a lower area composed mainly of gravel mixed with native clay and silt. The topography of the site is mainly level, with a downward slope southeast of the building. There is a drainage ditch between the north side of the building and Doe Road, leading water into a collection area situated southeast of the site within the Oxidator Building area. The drainage water leaving the Oxidator Building site passes by the Baker's Dozen to ultimately reach the Runoff Collection Basin area.

4.12.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, three soil samples were collected and tested for metals, TPH, PAHs and PCBs. The samples were collected east (06CS0005), southwest (06CS0004) and north (06CS0003) of the Dog House building. Sample 06CS0004 contained copper and arsenic above the CCME guidelines (Table 28). The concentrations of TPH Fractions 1 and 2

were above the CCME guidelinse in one soil sample (06CS0003). No PAHs or PCBs were detected above the CCME guidelines in the samples.

Table 28. (S-10202) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06CS0003	SOIL	30	TPH / F1	310	790
		30	TPH / F2	760	6,900
06CS0004	SOIL	0-10	ARSENIC (AS)	12	13
		0-10	COPPER (CU)	91	880
06CS0005	SOIL	0-10	ARSENIC (AS)	12	21

4.12.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign, 19 soil samples, including one duplicate pair, were collected in the active layer at depths between 10-80 cm, and analyzed for metals and TPH. Eight samples were also analyzed for PCB (Table 29).

Two samples collected southwest (B07-DH-0230) and east (B07-DH-0227) of the Dog House building contained zinc concentrations above the CCME guideline, and the concentration of copper was above the CCME guideline in 1 of these 2 samples (B07-DH-0230).

All soil samples collected southeast of the Dog House building contained concentrations of TPH Fractions 1 and 2 above the CCME guidelines. Two of these samples (B07-DH-0227 and B07-DH-0228) also contained TPH Fraction 3 concentrations above the CCME guideline. Of all the other samples, only one sample (B07-DH-0224) collected north of the building contained TPH Fraction 2 concentrations above the CCME guideline.

Based on the 2006/07 and 2007/08 results, the Dog House site is a Class 2 FCSAP site (62.8). The estimated volume of contaminated soil is 1,200 m^3. Further action is likely required.

4.12.4 Recommendations

Due to the proximity and the similarity of the contamination, it is recommended that a combined remediation plan be created for the Dog House and Oxidator Building sites (refer to the section 4.2 for Oxidator Building recommendations).

Table 29. (S-10202) Cold Storage Dog House GP Hut 2007/08 results.

					Cold Storage Dog House GP Hut (S-10202)									
		SOIL			SOIL									
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-DH-0212 50 cm 8/03/2007	B07-DH-0213 60 cm 8/03/2007	B07-DH-0214 40 cm 8/03/2007	B07-DH-0215 30 cm 8/03/2007	B07-DH-0216 70 cm 8/03/2007	B07-DH-0217 90 cm 8/03/2007	B07-DH-0218 80 cm 8/03/2007	B07-DH-0219 90 cm 8/03/2007	B07-DH-0220 70 cm 8/03/2007	B07-DH-0221 60 cm 8/03/2007
METALS	Arsenic (As)	mg/kg	12	0.27	6.5	8.3	6	7	6.7	6.7	8.3	7.1	8.1	6.6
	Barium (Ba)	mg/kg	2,000	5	11	15	15	29	14	16	19	18	14	13
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	1.1	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	25	25	20	23	24	25	22	24	25	24
	Cobalt (Co)	mg/kg	300	1.9	11	12	8	11	9	10	11	11	13	9
	Copper (Cu)	mg/kg	91	2.1	22	25	16	84	19	26	25	23	27	20
	Lead (Pb)	mg/kg	600	1.2	<10	<10	<10	12	<10	<10	<10	<10	<10	<10
	Manganese (Mn)	mg/kg	---	1.1	494	493	405	466	471	428	450	466	530	468
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	39	39	28	35	36	37	36	36	42	36
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	58	60	47	92	58	59	57	60	60	56
PCBs	BPC totaux	mg/kg	33	0.01	<0.005	<0.005	NA	NA	<0.005	<0.005	<0.005	<0.005	NA	NA
TPH	F1 (C6-C10)	mg/kg	310	10	1,380	2,350	1,110	640	1,830	1,630	581	NA	<3	238
	F2 (C10-C16)	mg/kg	760	10	15,000	18,400	13,100	3,190	12,000	23,700	4,930	NA	<1.9	14,800
	F3 (C16-C34)	mg/kg	1,700	10	991	567	1,380	444	501	1,330	156	NA	13	606
	F4 (C34-C50)	mg/kg	3,300	10	27	26	114	142	20	53	33	NA	6.5	19

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME (January 2001)

Table 29. (S-10202) Cold Storage Dog House GP Hut 2007/08 results (cont.).

					Cold Storage Dog House GP Hut (S-10202)								
		SOIL			SOIL								
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-DH-0222 60 cm 8/03/2007	B07-DH-0223 50 cm 8/03/2007	B07-DH-0224 60 cm 8/03/2007	B07-DH-0225 50 cm 8/03/2007	B07-DH-0226 30 cm 8/03/2007	B07-DH-0227 10 cm 8/03/2007	B07-DH-0228 Dup. 227 10 cm 08/03/2007	B07-DH-0229 20 cm 08/03/2007	B07-DH-0230 10 cm 8/03/2007
METALS	Arsenic (As)	mg/kg	12	0.27	6.6	8.1	7.2	7	8.2	5.4	5.7	6.3	6.5
	Barium (Ba)	mg/kg	2,000	5	16	18	17	19	24	169	441	23	26
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	0.9	<0.9	1.4	1.1	<0.9	2.5
	Chromium (Cr)	mg/kg	87	3	24	23	25	25	33	26	23	30	24
	Cobalt (Co)	mg/kg	300	1.9	10	11	11	11	11	10	10	11	9
	Copper (Cu)	mg/kg	91	2.1	21	26	25	29	32	51	45	27	144
	Lead (Pb)	mg/kg	600	1.2	<10	<10	<10	11	19	37	45	50	62
	Manganese (Mn)	mg/kg	----	1.1	480	498	479	485	494	524	523	502	532
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	37	37	34	38	36	34	34	38	34
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	57	58	60	63	69	574	269	116	371
PCBs	BPC totaux	mg/kg	33	0.01	<0.005	NA	NA	NA	NA	NA	NA	<0.005	NA
TPH	F1 (C6-C10)	mg/kg	310	10	24	23	208	<2.8	<2.8	538	363	25	<3.2
	F2 (C10-C16)	mg/kg	760	10	18.9	646	834	3.7	12	39,500	35,000	633	21.7
	F3 (C16-C34)	mg/kg	1,700	10	19	131	419	50.4	361	2,570	2,320	823	91.9
	F4 (C34-C50)	mg/kg	3,300	10	7.4	30	88.9	19	95.9	118	133	415	39

NA Non available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Figure 32. (S-10202) Cold Storage Dog House GP Hut map 1.

Figure 33. (S-10202) Cold Storage Dog House GP Hut map 2.

4.13 S-10203 CURLING CLUB / GYM COMPLEX

4.13.1 Location and Site Description

The Curling Club/Gym Complex is located at the southeast end of the CFS-Alert main station area, beside the HAPS building (Figures 34 and 35). The Gym Complex contains offices, a weight room, a workout area and a bowling alley. Although the Gym Complex is still active, the Curling Club is currently not in operation. ESG reported that the Curling Club building was set for demolition with the possibility of also demolishing the Gym Complex being debated due to its poor insulation and high heating costs. The buildings were still standing during the 2007/08 sampling campaign. On the northwest side of the Gym Complex, there is an air-cooled condenser that was used for the Curling Club ice (ESG 2000). A fuel tank was located on the southwest corner of the site and was removed before the 2006/07 sampling campaign.

The Curling Club/Gym Complex is built on coarse to fine gravel fill material. Behind the buildings, on the northeast side of the site, the soil is composed of fill material mixed with native soil such as silt and small shale stones. The Gym Complex is built on stilts and drainage channels from the main station pass under the building toward the north part of the site. This part of the site is saturated with water and acts as a small drainage catchment area. A drainage ditch ends at the southwest corner of the site with the drainage water passing from the south to the east sides of the site.

The topography of the site is level at the building foundation, but slopes sharply east of the site, towards a small road adjacent to the Gym Complex building. Drainage water accumulates on the road and drains into an eastern drainage pathway that leads towards Alert Inlet. Alert Inlet is situated less than 300 m downgradient of the site.

4.13.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, two surface water and two soil samples were collected and tested for metals, TPH and BTEX contamination. The surface water samples contained no contaminants exceeding CCME guidelines. The soil samples contained TPH concentrations exceeding the CCME guidelines (Table 30). Sample 06GY0001, collected near the south corner of the Gym Complex building, had toluene, ethylbenzene, total xylene, TPH Fraction 1 and TPH Fraction 2 concentrations above the CCME guidelines. Sample 06GY0002, collected in a drainage pathway along the south side of the site, contained TPH Fraction 2 above the CCME guideline. Iridescence and rusty coloured water was noted during sample collection.

Table 30. (S-10203) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06GY0001	SOIL	30	TOLUENE	0.37	2.5
		30	ETHYLBENZENE	0.08	1.2
		30	TOTAL XYLENE	11	38
		30	TPH / F1	310	6,300
		30	TPH / F2	760	24,000
06GY0002	SOIL	0-10	TPH / F2	760	5,500

4.13.3 Nature and Extent of Contamination

In 2007/08, two soil samples (B07-GY-0457 and B07-GY-0458) were collected on the north side of the site behind the Gym Complex building, and 9 soil samples with 2 surface water samples were collected on the south side of the gym complex (Photograph 21, appendix A). The soil samples were all collected from depths of between 30-50 cm, with the exception of one sample collected in a drainage pathway at the soil surface and two other soil samples collected at depths of 0-30 cm.

The samples collected on the north side of the site were tested for metals contamination, but no metals were found above the CCME guidelines (Table 31). The samples on the south side of the site were tested for metals, TPH and BTEX. Two samples contained arsenic and 1 sample contained nickel concentrations slightly above the CCME guidelines. One soil sample showed TPH Fraction 1 contamination above the CCME guideline. TPH Fraction 2 was detected above CCME guideline concentrations in three samples. No toluene or total xylene was detected in the samples. The surface water samples contained copper, lead and selenium concentration above the CCME guidelines. TPH Fraction 2 (and to a lesser extent Fraction 3) was detected at elevated concentrations in the surface waters, but no guidelines currently exist for TPH surface water contamination.

The FCSAP classification system scores this site at 76.5 which classifies it as Class 1. The proximity of Alert Inlet and the important network of drainage pathways increases the potential for contaminant migration and off-site contamination. The estimated volume of contaminated soil is 50 m^3.

4.13.4 Recommendations

A relatively small area of moderate TPH contamination was identified adjacent to the curling club complex. The recommended remediation approach is excavation of the contaminated soil to a contained biopile for *ex situ* treatment and then closure of the site.

Table 31. (S-10203) Curling Club / Gym Complex 2007/08 results.

		WATER			SOIL			Curling Club / Gym Complex (S-10203)							
								WATER		SOIL					
	PARAMETERS	UNITS	GUIDELINES aquatic life FRESH	DETECTION LIMIT	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-GY-0455W Fresh water Surface 8/18/2007	B07-GY-0459W Fresh water Surface 8/18/2007	B07-GY-0050 Dup. 461 30-50 cm 8/18/2007	B07-GY-0456 Drain. Sed. 0-10 cm 8/18/2007	B07-GY-0457 0-30 cm 8/18/2007	B07-GY-0458 0-30 cm 8/18/2007	B07-GY-0460 30-50 cm 8/18/2007	B07-GY-0461 30-50 cm 8/18/2007	B07-GY-0462 30-50 cm 8/18/2007
METALS	Arsenic (As)	ug/L	5	0.0001	mg/kg	12	0.27	1	1	10.8	14.8	8.9	8.5	10.2	8.7	8.5
	Barium (Ba)	ug/L	---	0.001	mg/kg	2,000	5	90	20	21	40	18	23	23	21	24
	Cadmium (Cd)	ug/L	0.017	0.0001	mg/kg	22	0.22	<1	<1	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	ug/L	---	0.0007	mg/kg	87	3	3	3	28	31	31	29	29	28	28
	Cobalt (Co)	ug/L	---	0.0006	mg/kg	300	1.9	1	6	12	15	12	12	12	12	12
	Copper (Cu)	ug/L	2-4	0.0012	mg/kg	91	2.1	7	9	22	33	22	23	24	22	25
	Lead (Pb)	ug/L	1-7	0.0011	mg/kg	600	1.2	2	1	13	23	13	14	13	14	14
	Manganese (Mn)	ug/L	---	0.0003	mg/kg	---	1.1	42	1,610	480	819	516	509	495	453	534
	Molybdenum (Mo)	ug/L	73	0.0078	mg/kg	40	1.4	1	2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	ug/L	25-150	0.0005	mg/kg	50	0.6	5	13	42	46	48	45	42	41	43
	Selenium (Se)	ug/L	1	0.0006	mg/kg	3.9	0.5	1	2	<0.5	1.1	<0.5	0.7	0.7	0.7	<0.5
	Silver (Ag)	ug/L	---	0.0008	mg/kg	40	0.4	0.6	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	ug/L	---	0.011	mg/kg	300	0.8	1	<1	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	ug/L	30	0.006	mg/kg	360	2.5	10	10	66	121	61	62	62	102	59
TPH	Benzene	ug/L	370	0.03	mg/kg	0.03	0.02	<0.5	<0.5	<0.1	<0.1	NA	NA	<0.1	<0.1	<0.1
	Toluene	ug/L	2	0.03	mg/kg	0.37	0.02	<0.5	<0.5	<0.1	<0.1	NA	NA	<0.1	<0.1	<0.1
	Ethylbenzene	ug/L	90	0.02	mg/kg	0.082	0.02	<0.5	<0.5	<0.1	<0.1	NA	NA	<0.1	<0.1	<0.1
	Total Xylene	ug/L	---	0.05	mg/kg	11	0.04	<0.5	<0.5	<0.1	<0.1	NA	NA	<0.1	<0.1	<0.1
	F1 (C6-C10)	ug/L	---	100	mg/kg	310	10	<50	250	420	28	NA	NA	<3.2	157	<3.2
	F2 (C10-C16)	ug/L	---	100	mg/kg	760	10	280	2,190	15,700	899	NA	NA	36.2	10,300	25.6
	F3 (C16-C34)	ug/L	---	100	mg/kg	1,700	10	521	662	706	155	NA	NA	53	557	33
	F4 (C34-C50)	ug/L	---	100	mg/kg	3,300	10	44	<37	40	31	NA	NA	27	39	20

NA Not available

Higher than the criteria

High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

DRAINAGE SED. = Sediments collected in a dry or temporary drainage, considered like a soil.

Table 31. (S-10203) Curling Club / Gym Complex 2007/08 results (cont.).

					Curling Club / Gym Complex (S-10203)			
		SOIL			SOIL			
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-GY-0463 30-50 cm 8/18/2007	B07-GY-0464 30-50 cm 8/18/2007	B07-GY-0465 30-50 cm 8/18/2007	B07-GY-0466 30-50 cm 8/18/2007
METALS	Arsenic (As)	mg/kg	12	0.27	8.7	14.6	9.4	9.9
	Barium (Ba)	mg/kg	2,000	5	22	21	17	19
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	29	25	30	32
	Cobalt (Co)	mg/kg	300	1.9	12	13	14	14
	Copper (Cu)	mg/kg	91	2.1	25	32	36	28
	Lead (Pb)	mg/kg	600	1.2	13	16	15	16
	Manganese (Mn)	mg/kg	---	1.1	528	504	529	557
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	43	41	49	52
	Selenium (Se)	mg/kg	3.9	0.5	0.6	0.7	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	59	54	66	70
TPH	Benzene	mg/kg	0.03	0.02	<0.1	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.37	0.02	<0.1	<0.1	<0.1	<0.1
	Ethylbenzene	mg/kg	0.082	0.02	<0.1	<0.1	<0.1	<0.1
	Total Xylene	mg/kg	11	0.04	<0.1	<0.1	<0.1	<0.1
	F1 (C6-C10)	mg/kg	310	10	<3.2	<2.9	<3.3	<3.1
	F2 (C10-C16)	mg/kg	760	10	90.9	52.6	33.9	25.4
	F3 (C16-C34)	mg/kg	1,700	10	44	109	77.2	71.3
	F4 (C34-C50)	mg/kg	3,300	10	24	45	27	26

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Figure 34. (S-10203) Curling Club / Gym Complex map 1.

Figure 35. (S-10203) Curling Club / Gym Complex map 2.

4.14 S-10204 50 LINE GP HUTS DRAINAGE`

4.14.1 Location and Site Description

Originally, there were several parallel lines of General Purpose (GP) huts constructed at the CFS-Alert main station. The 50 Line was the last line of huts, located on the east side of the main station overlooking Dumbell Bay. The huts were demolished in 1995 after the accommodations were relocated to the HAPS building. The only remaining evidence of the old 50 Line are rectangular gravel pads, constructed out of the same fill material that is used throughout the main station (Figures 36 and 37). The rest of the area features relatively undisturbed soils composed of native clays and silts with some shale stones.

The topography of the site is level, with a three stage slope leading down towards Dumbell Bay on the east side of the site. The first part of the slope is abrupt and is located at the end of the gravel pads. The second is moderate and the third stage is a long gentle slope that goes into Dumbell Bay. The site is located approximately 135 m from Dumbell Bay. Two main drainage pathways were identified on site, both heading towards the east side of the site and finishing in pools of standing water at the end of the second part of the slope.

The 50 Line GP Huts Drainage site appears to have been graded and leveled since 2000 due to the fact that sample points from a 2000 sampling campaign were buried under fill material. During the 2006/07 and 2007/08 sampling campaigns, debris (nails, metal pieces, etc.) was present on the gravel pads, but no fuel or oil stains were noted. The debris was believed to have be left over from bonfires celebrating statutory holidays. Several additional types of debris, such as pieces of plastic, were also present at the bottom of the first part of the slope.

4.14.2 Summary of BRI Previous Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, two soil samples were collected in drainage pathways, and were analyzed for metals and TPH. These samples contained arsenic in concentrations slightly over the CCME guideline (Table 32). The two surface soil samples were collected at the end of the second part of the slope and were tested for metals and TPH. No contamination was detected above the CCME guidelines in these samples.

Table 32. (S-10204) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06GP0063	SOIL	0-10	ARSENIC (AS)	12	12
06GP0064	SOIL	0-10	ARSENIC (AS)	12	13

4.14.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign, 4 subsurface soil samples were collected and analyzed for metals and TPH. These samples were collected at the end of the first part of the slope, in front of the third old foundation pad from the south of the site. Concentrations of arsenic slightly above the CCME guideline were measured in one sample (Table 33), which may be attributable to natural arsenic concentrations in the soil. No TPH was detected above the guidelines.

According to the results from the 2006/07 and 2007/08 sampling campaigns, the site is a Class 3 FCSAP site (40.8). This classification indicates that there is probably no significant environmental impact or human health threat from this site.

4.14.4 Recommendations

No TPH contamination above guidelines was detected in the four soil samples from this site. This site can be closed.

Table 33. (S-10204) 50 Line GP Huts Drainage 2007/08 results.

					50 Line GP Huts Drainage (S-10204)			
		SOIL			SOIL			
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-GP-0491 40 cm 8/20/2007	B07-GP-0492 40 cm 8/20/2007	B07-GP-0493 40 cm 8/20/2007	B07-GP-0494 40 cm 8/20/2007
METALS	Arsenic (As)	mg/kg	12	0.27	8.4	11.9	13.3	9.1
	Barium (Ba)	mg/kg	2,000	5	17	22	25	17
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	23	22	23	23
	Cobalt (Co)	mg/kg	300	1.9	11	10	12	11
	Copper (Cu)	mg/kg	91	2.1	16	14	24	19
	Lead (Pb)	mg/kg	600	1.2	<10	<10	<10	<10
	Manganese (Mn)	mg/kg	---	1.1	379	408	463	367
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	32	28	31	33
	Selenium (Se)	mg/kg	3.9	0.5	0.5	0.6	0.6	0.6
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	55	52	56	55
TPH	F1 (C6-C10)	mg/kg	310	10	4.4	3.3	NA	<3.2
	F2 (C10-C16)	mg/kg	760	10	<2.3	<2	NA	<1.7
	F3 (C16-C34)	mg/kg	1700	10	47	33	NA	<4
	F4 (C34-C50)	mg/kg	3300	10	26	15	NA	9.3

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME (January 2001)

Figure 36. (S-10204) 50 Line GP Huts Drainage map 1.

Figure 37. (S-10204) 50 Line GP Huts Drainage map 2.

4.15 S-10205 DUMP #3

4.15.1 Location and Site Description

Dump #3 is located near Dumps #1 and #2, at the end of Line Road to the southwest of the CFS-Alert main station (Figures 38 and 39). The site was set up on a moderate to strong slope, roughly 200 m uphill and west of Alert Inlet (ESG 2000). Dump #3 is approximately 200 m long, from north to south. Rusting metal and a broken vehicle battery were found on site. The visible debris at Dump #3 leads to the conclusion that this dump was used to discard old vehicle parts, wire and other metallic objects. Dump #3 is not in use and has been inactive for several years. The new active dump, Millionaire's Dump, is located approximately 200 m east and upgradient of Dump #3. Millionaire's Dump is surrounded on the east and west side by berms that prevent potential contaminants from migrating with drainage water.

There is an important drainage network that leads surface water downhill into a main drainage channel towards Alert Inlet. This drainage network collects water from the surrounding uphill areas, including Dump #1, #2, #3 and Millionaires Dump.

4.15.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, 2 soil samples were collected near Dump #3 and analyzed for metals and 2 soil samples collected in the drainage network were collected and analyzed for BTEX and TPH. No contaminants exceeded the CCME guideline concentrations.

4.15.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign the area downhill from the Dump #3 was investigated

through the collection of 8 subsurface soil samples and 1 surface water sample (Photograph 22, Appendix A). The samples were tested for metals (Table 34). Nickel concentrations above the CCME guideline were measured in 5 soil samples. Of these samples, 1 sample (B07-D3-0234) also contained arsenic at concentrations slightly higher than the CCME guideline. The surface water sample, collected at the end of the drainage channel near Alert Inlet, contained copper, lead and zinc at concentrations above the CCME guideline for aquatic life.

Dump #3 site is a Class 2 site (56.2) according to the FCSAP classification system. The available information indicates that the site is currently not of high concern but future action may be required. The estimated volume of contaminated soil is 1 m^3.

4.15.4 Recommendations

The lead and zinc contamination present at the original site (99-1147) is localized and limited to a very small area. The 2007/08 samples from adjacent areas were negative for lead and zinc, and the only heavy metal above criteria was nickel (50 mg/kg) in 2 of 2 samples (59 and 72 mg/kg). The downgradient area sampled during the 2007/08 season ('underneath' Dump #3) only had nickel at concentrations which equaled or exceeded the guidelines (50, 50 and 51 mg/kg). In the natural drainage channel leading to Alert Inlet located south west of the original site, no contamination was detected in the soil, but in the surface water sample copper, lead and zinc were above guidelines (7 [2-4], 6 [1-7] and 90 [30] mg/kg, respectively [criteria in square brackets]). Based on the distance between the original site and the upgradient source of the drainage channel, the source of this heavy metal contamination would likely be the 'Millionaire's Dump' and as such the drainage channel should be monitored in association with the Millionaire's Dump.

The heavy metal contamination from Dump #3 does not appear to be migrating and is located approximately 200 m away from Alert Inlet. A monitoring program designed to confirm the immobility of the heavy metal contamination (sampling every 3 years) is the most appropriate response and the site can be considered closed. The drainage channel contaminants should be addressed in association with Millionaire's Dump.

Table 34. (S-10205) Dump #3, 2007/08 results.

		WATER			SOIL			Dump #3 (S-10205)								
								WATER	SOIL							
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07D30236-W Fresh water Surface 8/04/2007	B07D30231 50 cm 8/04/2007	B07D30232 50 cm 8/04/2007	B07D30233 60 cm 8/04/2007	B07D30234 40 cm 8/04/2007	B07D30235 60 cm 8/04/2007	B07D30236 Drain. Sed. 80 cm 8/04/2007	B07D30237 Drain. Sed. 60 cm 8/04/2007	B07D30238 60 cm 8/04/2007
METALS	Arsenic (As)	ug/L	5	0.0001	mg/kg	12	0.27	2	9.7	11.6	9.1	13.5	11.1	8.7	9.1	10.9
	Barium (Ba)	ug/L	---	0.001	mg/kg	2,000	5	20	8	7	10	25	12	11	7	13
	Cadmium (Cd)	ug/L	0.017	0.0001	mg/kg	22	0.22	<1	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	ug/L	---	0.0007	mg/kg	87	3	10	33	37	30	33	30	29	24	31
	Cobalt (Co)	ug/L	---	0.0006	mg/kg	300	1.9	4	20	21	15	14	17	9	7	10
	Copper (Cu)	ug/L	2-4	0.0012	mg/kg	91	2.1	7	49	49	24	22	26	17	15	22
	Lead (Pb)	ug/L	1-7	0.0011	mg/kg	600	1.2	6	24	17	15	15	15	15	11	19
	Manganese (Mn)	ug/L	---	0.0003	mg/kg	---	1.1	136	425	373	432	432	452	236	303	197
	Molybdenum (Mo)	ug/L	73	0.0078	mg/kg	40	1.4	<1	3	<2	<2	<2	<2	<2	<2	4
	Nickel (Ni)	ug/L	25-150	0.0005	mg/kg	50	0.6	14	72	59	51	50	50	37	30	43
	Selenium (Se)	ug/L	1	0.0006	mg/kg	3.9	0.5	<1	1.3	0.8	<0.5	0.8	0.6	<0.5	<0.5	0.8
	Silver (Ag)	ug/L	---	0.0008	mg/kg	40	0.4	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	ug/L	---	0.011	mg/kg	300	0.8	<1	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	ug/L	30	0.006	mg/kg	360	2.5	90	73	74	62	75	62	62	47	73

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

DRAINAGE SED. = Sediments collected in a dry or temporary drainage, considered like a soil.

Figure 38. (S-10205) Dump #3 map 1.

Figure 39. (S-10205) Dump #3 map 2.

4.16 S-10206 TX SITE

4.16.1 Location and Site Description

The transmitter site (TX) is located roughly 4 km south-southwest of the CFS-Alert main station, on the top of a ridge about 60 m above sea level (ESG 2000) (Photograph 23, Appendix A). In 1982 the old main building was demolished and a new building was constructed on another part of the site (Figures 40 to 43). The new main building hosts working, sleeping and eating areas. The old auxiliary power unit and diesel fuel tank were replaced and the new auxiliary power unit and diesel fuel tank are located at a slightly different location from the old ones. The old transformer building is still standing on the site.

During the previous ESG investigations, the remains and debris of the main station demolished in 1982 were located in an inactive small dump situated southeast of the new main building. During the 2006/07 and 2007/08 sampling campaigns, the remains and debris had been relocated to the Millionaire's Dump along with soil excavated from the old small dump.

The topography of the site is gently undulating, with the some small depressions in which standing water accumulates during summer months. Two major pools of standing water were located south of the previous location of the old main building and northwest of the old excavated dump. There was no apparent surface drainage network in the area, and the site is located approximately 3,000 m from Upper Dumbell Lake, 2,800 m from Lower Dumbell Lake, and 3,365 m from Alert Inlet. The soil is saturated with water during snowmelt and the summer months. It is composed mainly of native shaly silt and clay with a few shale stones.

4.16.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

The TX site was snow covered during the 2006/07 sampling campaign, which made locating the old main building remains and old dump very difficult. Five soil samples were collected around the old main building remains and the dump, including one duplicate pair. These samples were analyzed for metals and PCB. None of the soil samples contained metals or PCBs above the CCME guidelines.

4.16.3 Nature and Extent of Contamination

In 2007/08, 16 subsurface soil samples were collected and analyzed for metals and TPH. Two soil samples and one duplicate pair were analyzed for PCBs, and the duplicate pair was also analyzed for PAHs (Table 35). The samples were collected in two separate areas associated with the TX site. The area surrounding the old main building remains contained no heavy metal or TPH contamination above CCME guidelines. The lead and cadmium contamination previously detected (ESG 1999) appeared to be localized.

In the second area, adjacent to the new auxiliary building, TPH Fraction 2 was detected at concentrations above the CCME guideline in one soil sample. No PAHs or PCBs were detected in the soil samples tested.

Based on the 2006/07 and 2007/08 results and according to the FCSAP classification system, the site is a Class 3 (42.3). The available information indicates that there is probably no significant environmental impact or human health threats and further action is not likely required. The estimated volume of contaminated soil is 600 m^3.

4.16.4 Recommendations

The two separate areas associated with the TX site were sampled. The area surrounding the building remains demonstrated no heavy metal or TPH contamination. The previously detected (1999) lead and cadmium contamination would appear to be very localized. The second area adjacent to the transformer had a single sample just above criteria; Fraction F2 at 859 mg/kg (criteria of 760 mg/kg). No other heavy metal or TPH contamination was detected. The lead

and cadmium contaminated soils should be excavated and placed into a contained area to prevent further leaching. Completion of the delineation in this area may be required to close to area. The TPH contamination should also be excavated and treated in an *ex situ* biopile permitting closure of the site.

Table 35. (S-10206) TX Site 2007/08 results.

					TX Site (S-10206)					
		SOIL			SOIL					
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07TX0100 Dup. 333 50 cm 8/09/2007	B07TX0325 60 cm 8/09/2007	B07TX0326 60 cm 8/09/2007	B07TX0327 60 cm 8/09/2007	B07TX0328 60 cm 8/09/2007	B07TX0329 60 cm 8/09/2007
METALS	Arsenic (As)	mg/kg	12	0.27	5.4	6.5	7.3	6.1	6.5	5.3
	Barium (Ba)	mg/kg	2,000	5	15	33	35	29	30	27
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	26	31	30	21	22	24
	Cobalt (Co)	mg/kg	300	1.9	12	13	13	10	11	11
	Copper (Cu)	mg/kg	91	2.1	20	22	22	16	18	18
	Lead (Pb)	mg/kg	600	1.2	13	15	15	12	13	12
	Manganese (Mn)	mg/kg	---	1.1	270	383	380	414	354	347
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	40	43	45	32	34	35
	Selenium (Se)	mg/kg	3.9	0.5	0.8	0.7	0.7	0.8	0.7	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	49	60	62	43	46	48

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

Figure 40. (S-10206) TX Site map 1.

Figure 41. (S-10206) TX Site map 2.

Figure 42. (S-10206) TX Site map 3.

Figure 43. (S-10206) TX Site map 4.

4.17 S-10207 AIRSTRIP BUILDING HIL-124 "THE HILTON"

4.17.1 Location and Site Description

Airstrip Building HIL-124, commonly known as "The Hilton", is located on the west side of the airstrip entrance northeast of the DREP (Defence Research Establishment Pacific) building (Figures 44 and 45) (Photograph 24, Appendix A). Currently, CFS-Alert traffic personnel use the building for equipment storage. The site is still active and there is one fuel tank situated west of the site, behind the building.

The topography of the site is gently sloping towards the south-southeast in front of the building, and gently sloping west-northwest behind the building. On the west side, behind the building, the site slopes into a drainage area and ditch. The ditch comes from deicing areas 2 and 3, on the western part of the airstrip, and proceeds on the east side of the airstrip towards Dumbell Bay. During the 2006/07 and 2007/08 sampling campaigns, a pool of standing water was observed in the drainage area and there was water in the ditch. The site is composed of fill materials with silt and clay and a few shale stones as underlying material in the drainage area. The site is less than 400 m from Dumbell Bay.

4.17.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, 3 surface soil samples were collected. These samples were analyzed for metals, PAHs and TPH. Cadmium was the only element that showed a concentration above the CCME guideline (Table 36). No PAH or TPH was detected above the CCME guidelines.

Table 36. (S-10207) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Criterion (mg/kg)	Concentration (mg/kg)
06HI0154	SOIL	0-10	CADMIUM (Cd)	22	53

4.17.3 Nature and Extent of Contamination

During the sampling campaign of 2007/08, a total of 13 soil and 1 surface water samples were collected. Four soil samples were tested for metals, 8 soil samples were tested for TPH, 1 soil sample (from a drainage pathway) and 1 surface water sample were tested for metals and TPH (Table 37). The samples were collected from depths of 10 to 40 cm.

No metal concentrations were detected above the CCME guidelines for soil. However, copper and lead concentrations in the surface water sample were above the CCME guidelines for aquatic life. TPH Fractions 1 and 2 were above the CCME guideline concentrations in 1 soil sample (B07-HI-0442). This sample was collected on the east side of the side in front of the building.

According to the FCSAP classification system, the site is a Class 2 (55.7) and further action may be required. The estimated volume of contaminated soil is 13 m^3.

4.17.4 Recommendations

Only one sample possessed TPH contamination at this site and it was limited to a very small area on the east side of the building. No soil samples and only one surface water sample were above guidelines for heavy metals; 07HI0441W, located northwest of the building, possessed elevated copper and lead concentrations (10 and 1 mg/kg, respectively). The TPH contaminated soil can be excavated and treated *ex situ* in a biopile. The copper and lead contamination in the surface water should be examined further to determine the source as no contaminated soil was identified in the immediate area. A series of samples collected from the water body and channel as well as the surrounding area should be collected. The average soil background concentrations for copper and lead were 19.3 and 13.5 mg/kg, respectively, and may be the source of the observed contamination. In this case, closure of the site could be completed.

Airstrip Bldg HIL-124 (S-10207)						
SOIL						
B07-HI-0443 0-20 cm 8/17/2007	B07-HI-0444 0-20 cm 8/17/2007	B07-HI-0445 0-20 cm 8/17/2007	B07-HI-0446 0-20 cm 8/17/2007	B07-HI-0447 0-20 cm 8/17/2007	B07-HI-0448 0-20 cm 8/17/2007	B07-HI-0449 0-20 cm 8/17/2007
7	4.4	<2.9	<2.9	<2.5	<3	<2.5
24.5	21.6	21	26.1	22	22.6	25
36	19	49.5	22	19	33.8	25.4
19	8.1	21	9.1	<8.9	12	7.5

	Airstrip Bldg HIL-124 (S-10207)					
	WATER	SOIL				
ion r	B07-HI-0441W Fresh water Surface 8/17/2007	B07-HI-0450 10-20 cm 8/17/2007	B07-HI-0451 10-40 cm 8/17/2007	B07-HI-0452 Drain. Sed. 10-40 cm 8/17/2007	B07-HI-0453 10-40 cm 8/17/2007	B07-HI-0454 10-40 cm 8/17/2007
1	2	10.1	9.3	9.6	8.8	7.6
1	10	22	21	22	22	24
1	<1	<0.9	<0.9	<0.9	<0.9	<0.9
7	3	28	27	31	29	29
6	1	12	11	12	11	12
.2	10	21	19	24	21	22
.1	1	15	13	14	14	16
3	32	478	473	484	436	510
8	4	<2	<2	<2	<2	<2
5	5	40	36	46	40	42
6	1	0.7	0.9	<0.5	0.5	<0.5
8	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5
1	1	<5	<5	<5	<5	<5
5	10	61	56	69	64	64
	<50	NA	NA	7.9	NA	NA
	38	NA	NA	559	NA	NA
	329	NA	NA	101	NA	NA
	74	NA	NA	26	NA	NA

wironmental Health in Industrial land uses, of the CCME (2006)
dustrial/Eco Soil Contact), endorsed by the CCME (January 2001)

Figure 44. (S-10207) Airstrip Building HIL-124 map 1.

Figure 45. (S-10207) Airstrip Building HIL-124 map 2.

4.18 S-10208 AIRSTRIP BUILDING FH-128

4.18.1 Location and Site Description

The Airstrip Garage (Airstrip Building FH-128) is located at the southeastern end of the airstrip apron, approximately 80 m west of the apron refueling area (Figures 46 and 47). The building sits on a raised gravel embankment. The raised gravel pad extends 8 m from the end of the building towards the southeast. The platform subsequently drops 3 m. The airstrip garage is marked for demolition in the next few years (ESG 2000), although was still standing during the 2006/07 and 2007/08 sampling campaigns. Currently, the garage is used for storing an airplane deicing machine. There is a fuel tank located behind the building, on the southeast side of the site. This fuel tank is no longer in use (ESG 1999). A bay door is situated at the northwestern side of the building and there is a regular doorway on the southeastern side of the building.

Active drainage pathways flow from the gravel embankment downhill towards Dumbell Bay. which is situated approximately 320 m from the site. There are two important drainage pathways surrounding FH-128, one each on the north and south sides of the site. A diesel pipeline and several high tension wires pass within and near the south side of the site, at the foot of the talus.

4.18.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, 7 soil samples, including 1 duplicate pair, were collected and tested for TPH and BTEX. Samples 06AS0009 and 06AS0013 were taken from between 40 and 100 cm downhill from the fuel tank, respectively. Samples 06AS0009/10/11 were taken from 50 cm around the fuel tank. A fuel odor was detected on site around the tank. Three samples (06AS0010, 06AS0011 and 06AS0012) showed TPH Fraction 2 concentrations above the CCME guideline

(Table 38). Two samples taken in the drainage pathways contained traces of TPH, but the concentrations were below the CCME guidelines. No BTEX was detected.

Table 38. (S-10208) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06AS0010	SOIL	5	TPH / F2	760	1,700
06AS0011	SOIL	30	TPH / F2	1,700	6,800
06AS0012	SOIL	5	TPH / F2	3,300	11,000

4.18.3 Nature and Extent of Contamination

In 2007/08, 9 subsurface soil samples were collected and analyzed for TPH and PAH. Two samples (B07-AS-0128 and B07-AS-0143) were also tested for metals (Table 39). Collection of samples was restricted by the presence of underground wires and pipelines. No surface water was noticed on site at the time of the sampling campaign.

No metal concentrations above CCME guidelines were detected. TPH Fractions 1, 2 and 3 were detected above the CCME guidelines in 3 soil samples and 1 duplicate pair. These samples were collected on the southeast end of the site between the fuel tank and the southern drainage pathway. PAH contaminants at concentrations above the CCME guidelines were also detected in 2 of these 5 soil samples. One soil sample collected near the southern drainage pathway (07AS0441) on the southwest side of the site did not contain TPH or PAH contamination.

Based on the results from the 2006/07 and 2007/08 sampling campaigns, the site is Class 2 (56.0) based on FCSAP classification. The estimated volume of contaminated soil is 630 m^3. The available information is not sufficient to properly determine the environmental impact or the threat to human health of the contamination. Further action at the site is likely required.

4.18.4 Recommendations

A series of heavily contaminated samples were taken in 2007/08 from the area south-southwest of the Airstrip Building FH-128. TPH concentrations ranged from 1440 – 3250 mg/kg for Fraction 1 and 1130 – 24,200 mg/kg for Fraction 2 in 4 and 5 samples, respectively. Fraction 3 was also found above criteria in one soil sample (2,000 mg/kg) and 2 samples had naphthalene concentrations above criteria (106 and 112 mg/kg, criteria of 22 mg/kg). No heavy metal concentrations surpassed CCME guidelines.

Delineation of the TPH contamination on the southern side of the site needs to be completed. This site may be a potential candidate for *in situ* bioremediation although further study would be required due to the high TPH concentrations observed on site.

Table 39. (S-10208) Airstrip Building FH-128, 2007/08 results.

	PARAMETERS	SOIL			Airstrip Building FH-128 (S-10208)								
					SOIL								
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-AS-0074 Dup. 141 140-160 cm 8/27/2007	B07-AS-0126 75 cm 8/27/2007	B07-AS-0127 100-120 cm 8/27/2007	B07-AS-0128 100-120 cm 8/27/2007	B07-AS-0140 140 cm 8/27/2007	B07-AS-0141 140-160 cm 8/27/2007	B07-AS-0143 140-150 cm 8/27/2007	B07-AS-0145 140 cm 8/27/2007	B07-AS-0441 80-100 cm 8/27/2007
TPH	F1 (C6-C10)	mg/kg	310	10	1440	<3.2	<3	<3	188	2,090	3,250	1,860	<3.3
	F2 (C10-C16)	mg/kg	760	10	13,700	<2.1	<1.9	3	1,130	17,600	22,100	24,200	<1.7
	F3 (C16-C34)	mg/kg	1,700	10	693	33	<4.5	4.3	41	1,300	2,000	1,250	<4.1
	F4 (C34-C50)	mg/kg	3,300	10	<9.9	18	<6.4	<5.4	<8.6	15	60	60	<5.8
PAH	Naphthalene	mg/kg	22	0.008	<0.1	<0.1	<0.1	<0.1	0.6	13.3	112	106	<0.1
	2-methylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1	<0.1	6.4	42.1	310	400	<0.1
	1-methylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1	<0.1	3.9	22.8	144	188	<0.1
	1,3-Dimethylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1	<0.1	3.4	15.6	95.1	80.7	<0.1
	Acenaphthylene	mg/kg	---	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	0.7	0.4	<0.1
	Acenaphthene	mg/kg	---	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.3	<0.1
	2,3,5-trimethylnaphthalene	mg/kg	---	0.007	<0.1	<0.1	<0.1	<0.1	0.3	2.8	5.6	3.4	<0.1
	Fluorene	mg/kg	---	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	0.4	0.2	<0.1
	Phenanthrene	mg/kg	50	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	1.6	3.0	<0.1
	Anthracene	mg/kg	---	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluoranthene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Pyrene	mg/kg	100	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(c)Phenanthrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(a)Anthracene	mg/kg	10	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chrysene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	7,12-dimethylbenzo(a)anthracene	mg/kg	---	0.005	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(b,j,k)fluoranthene	mg/kg	10	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(a)pyrene	mg/kg	0.7	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	3-methylcholanthrene	mg/kg	---	0.022	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Indeno(1,2,3-cd)pyrene	mg/kg	10	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo(a,h)anthracene	mg/kg	10	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(g,h,i)perylene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo (a,l) pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo (a,i) pyrene	mg/kg	---	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo (a,h) pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

NA Not available
Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Figure 46. (S-10208) Airstrip Building FH-128 map 1.

Figure 47. (S-10208) Airstrip Building FH-128 map 2.

4.19 S-10210 AIRSTRIP DIESEL PIPELINE

4.19.1 Location and Site Description

The Airstrip Diesel Pipeline runs from the Airstrip Fuel Tank Farm (S-10193) to the 8 diesel fuel storage tanks (Figures 48 to 51). The pipeline continues from the 8 diesel fuel storage tanks to reach the Main Station Day Tank (S-10214).

Over the years, several fuel spills have occurred along the Airstrip Diesel Pipeline and in 2006/07, the entire pipeline was replaced. The new pipeline was however quickly out of service and under repair as an expansion joint situated downgradient from airstrip building FH-128 (S-10208) broke, creating a diesel spill running towards Dumbell Bay. The diesel pipeline was completely investigated in 2006/07, at which time three contaminated areas were identified (apart from the above mentioned spill). Area 1 is located at a bend in the pipeline between the 8 diesel fuel storage tanks and the Main Station Day Tank. Areas 2 and 3 are located between the Airstrip Fuel Tank Farm and the 8 diesel fuel storage tanks. During the 2007/08 sampling campaign these 3 contaminated areas were delineated.

The topography of areas 1, 2 and 3 is generally level to gently undulating. The site slopes gradually east-southeast towards Dumbell Bay. The diesel pipeline areas 1, 2 and 3 are approximately 800 m , 515 m and 515 m from Dumbell bay, respectively. During the snowmelt an important quantity of drainage water passes through the Diesel Pipeline areas to reach Dumbell Bay. There are two main ditches on each side of Landcaster Drive that collect some of the snowmelt water and protect the road from runoff. The soil under the pipeline is generally saturated with water during the snowmelt. It is composed mainly of natural shaly silt and clay, with a few shale stones and gravel from nearby fill material.

4.19.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, 5 soil samples including one duplicate pair were collected along the Airstrip Diesel Pipeline and analyzed for TPH. One sample was also analyzed for metals, and arsenic was detected slightly above the guideline concentration (Table 40). TPH Fractions 1 and 2 exceeded the CCME guideline concentrations in all 5 samples. No visual contamination was noted but moderate to strong odors were present in each sampling area. No samples were collected on the east side of Lancaster drive.

Table 40. (S-10210) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06DP0160	SOIL	20	TPH / F1	310	360
		20	TPH / F2	760	5,700
06DP0163	SOIL	10	TPH / F1	310	1,200
		10	TPH / F2	760	9,500
06DP0196	SOIL	100	TPH / F1	310	1,600
		10	TPH / F2	760	8,800
06DP0197	SOIL	20	TPH / F1	310	370
		20	TPH / F2	760	9,500
06DP0199	SOIL	20	ARSENIC (AS)	12	12.2
		20	TPH / F1	310	710
		20	TPH / F2	760	7,300

4.19.3 Nature and Extent of Contamination

In 2007/08, 3 contaminated areas along the Airstrip Diesel Pipeline were delineated (Photograph 25, Appendix A). A total of 51 subsurface soil samples were collected, including 3 duplicate pairs. Of these soil samples, 9, 21, and 18 were located in the areas 1, 2 and 3, respectively. All samples were tested for TPH and BTEX (Table 41).

In area 1, only one sample (B07DP0267) contained TPH Fractions 1 and 2 above the CCME guideline concentrations. No BTEX was detected above the CCME guidelines in any of the 9 samples.

In area 2, TPH Fractions 1, 2 and 3 exceeding the CCME guidelines were detected in 6, 11, and 1 sample, respectively. Samples B07-DP-277, -292, and -295 contained significantly elevated concentrations of TPH Fraction 2; approximately 15 to 20 times the CCME guideline. Toluene, ethylbenzene and total xylene concentrations above the guidelines were also detected in 2, 7 and 5 samples, respectively. No benzene was detected.

In area 3, 6 and 7 samples contained TPH Fractions 1 and 2 above the CCME guidelines, respectively. Sample B07-DP-299 and -304 contained significant concentrations of TPH Fraction 2; approximately 10 to 20 times the CCME guideline. Ethylbenzene concentrations were above the guideline in 4 samples. No benzene, toluene or total xylene was detected above the CCME guidelines.

According to the FCSAP classification system, the Airstrip Diesel Pipeline is a Class 1 site (80.7). There are important concentrations of TPH in the soil, the contamination covers extended areas and the risk of off-site migration is elevated. The estimated volume of contaminated soil for areas 1, 2 and 3 is 3 m^3, 4,320 m^3 and 1,080 m^3, respectively. Action is required at these sites.

4.19.4 Recommendations

A total of 3 areas were sampled adjacent to the diesel pipeline. The areas have been designated 1, 2 and 3, starting from the between the Main Station Day Tank and the 8 Diesel Fuel Storage Tanks descending towards the airstrip. The TPH contamination in area 1 is localized to a very small accessible area just adjacent to the pipeline. The TPH contamination in areas 2 and 3 cover larger areas and are present underneath or just adjacent to the pipeline supports.

- Area 1: the most appropriate remediation strategy for area 1 is to excavate the TPH contaminated soil and treat it in an *ex situ* biopile. This area can then be closed.

- Areas 2 and 3: Due to the proximity of the TPH contamination to the pipeline supports, excavation in these areas is not recommended. An *in situ* treatment program is the most appropriate approach to remediate these sites. The design of the treatment system would be based on the results of a proposed pilot study to be performed during the 2008 field season. In general, this would involve the application of nutrients and increased subsurface aeration.

Diesel pipeline (S-10210)												
SOIL												
7DP0264 70 cm 07/2007	B07DP0265 80 cm 8/07/2007	07DP0266 60 cm 8/07/2007	B07DP0267 60 cm 8/07/2007	B07DP0268 60 cm 8/07/2007	B07DP0269 50 cm 8/07/2007	B07DP0270 60 cm 8/07/2007	B07DP0271 50 cm 8/07/2007	B07-DP-0272 > 80 cm 8/11/2007	B07DP0273 60 cm 8/07/2007	B07DP0274 80 cm 8/07/2007	B07DP0275 70 cm 8/08/2007	B07DP0276 65 cm 8/08/2007
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<0.1	<0.1	0.3	<0.1
<0.1	<0.1	<0.1	9.8	0.2	<0.1	<0.1	<0.1	NA	<0.1	0.7	2	<0.1
<3.4	<3.4	<3.5	483	26	4.5	<3.3	<3.5	<3	<3.1	318	209	7.6
36.6	24.8	30	5,090	252	33.7	29.9	23.5	<1.7	50.1	3,690	1,380	27.2
68.5	18	52.1	189	43	22	28	8.7	5	30	195	147	39.5
22	15	25	11	11	8.5	11	<6.4	12	10	23	30	20

SOIL												
7DP0280 80 cm 08/2007	B07DP0281 70 cm 8/08/2007	B07DP0282 60 cm 8/08/2007	B07DP0283 70 cm 8/08/2007	B07DP0284 70 cm 8/08/2007	B07DP0285 70 cm 8/08/2007	B07DP0292 70 cm 8/08/2007	B07DP0293 60 cm 8/08/2007	B07DP0294 70 cm 8/08/2007	B07DP0295 80 cm 8/08/2007	B07DP0296 60 cm 8/08/2007	B07DP0297 80 cm 8/08/2007	B07DP0298 60 cm 8/08/2007
<0.1	<0.1	NA	NA	NA	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3.2	<0.1	NA	NA	NA	NA	0.4	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
5.3	0.2	NA	NA	NA	NA	6.5	<0.1	0.5	0.4	<0.1	<0.1	<0.1
35.3	8.3	NA	NA	NA	NA	61.3	<0.1	3.5	2.9	<0.1	<0.1	<0.1
532	472	110	<3.7	<3.4	<3.9	1,080	9.3	192	694	6.1	<3.6	7
6,860	6,220	1,360	33.7	3.8	208	15,200	255	2,210	17,900	6.6	5.6	<2.4
301	205	95.9	38.1	46	67	1,780	115	138	1,370	33	40.1	59.6
21	13	27	16	13	18	43	30	12	52	20	14	30

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ontact), endorsed by the CCME. (January 2001)

Diesel pipeline (S-10210)								
SOIL								
B07DP0300 60 cm 8/08/2007	B07DP0301 60 cm 8/08/2007	B07DP0302 60 cm 8/08/2007	B07DP0303 60 cm 8/08/2007	B07DP0304 55 cm 8/08/2007	B07DP0305 50 cm 8/08/2007	B07DP0306 65 cm 8/08/2007	B07DP0373 60 cm 8/12/2007	B07DP0374 60 cm 8/12/2007
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	2.2	<0.1	<0.1	2.1	0.3	<0.1	<0.1	<0.1
<0.1	8.1	<0.1	<0.1	8.1	4.9	<0.1	<0.1	<0.1
<3.6	539	3.7	<3.7	487	166	4.1	35	<3.3
4.2	6,370	3.3	4.2	10,100	1,050	121	943	<1.8
65.3	209	34	30	382	52.6	64.3	60.2	39
18	15	13	10	13	11	18	19	28

SOIL							
B07DP0376 50 cm 8/12/2007	B07DP0377 60 cm 8/12/2007	B07DP0378 50 cm 8/12/2007	B07DP0379 60 cm 8/12/2007	B07DP0380 60 cm 8/12/2007	B07DP0381 60 cm 8/12/2007	B07DP0382 60 cm 8/12/2007	B07DP0383 70 cm 8/12/2007
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.4	<0.1
6.3	266	5.6	<3.6	110	4.4	95.7	<3.4
<2.7	1,600	<1.6	<1.9	3,110	<2.5	3,170	<2.4
23	111	<3.8	22	102	22	140	<5.6
17	19	<5.5	12	16	10	14	<7.9

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f Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

(PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME (January 2001)

Figure 48. (S-10210) Airstrip Diesel Pipeline map 1.

Figure 49. (S-10210) Airstrip Diesel Pipeline map 2.

Figure 50. (S-10210) Airstrip Diesel Pipeline map 3.

Figure 51. (S-10210) Airstrip Diesel Pipeline map 4.

4.20 S-10211 AIRSTRIP HURRICANE BUILDING

4.20.1 Location and Site Description

The Airstrip Hurricane Building is located on the west side of the south end of the airstrip, directly east of the Airstrip Building HIL-124 (S-10207) and south of Airstrip Building FH-128 (S-10208) (Figures 52 and 53). Personnel supporting *Operation Hurricane* (DND activities at CFS-Eureka and its associated radio towers) use this building for storage and for maintenance of vehicles and aircraft.

During the 2006/07 and 2007/08 sampling campaigns, one fuel tank located beside the east corner of the building was noted on site. In 2006/07, a white tank with unknown contents was located northeast of the building. This tank was not on site in 2007/08. A control box for electrical purposes is located 15 m west of the building, and a HAZMAT emergency trailer is occasionally parked adjacent to the building. During the 2006/07 and 2007/08 samping campaigns, several piles of debris, such as old antennas and wood pallets, were present on the southeast side of the site.

The topography of the site is level at the building and slopes on the east side, behind the building, towards Dumbell Bay. The slope is at first steep, and gradually becomes gentle as it approaches the shoreline. Dumbell Bay is located approximately 330 m from the Hurricane Building. The building was constructed on coarse to fine gravel fill material. The soil on the east side, behind the building, is more natural, containing some gravel mixed with native clay and silt. Drainage water goes from northwest (upgradient) to south-southeast (downgradient) of the site. Although there was no drainage pathway evident on site, there are active drainage channels in the general vicinity of the site.

4.20.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

Six soil samples were collected in 2006/07, including 2 duplicate pairs. Five of these samples were tested for metals, and 4 were tested for BTEX and TPH. Arsenic at concentrations above the CCME guideline was detected in one sample and zinc concentrations above the CCME guideline was measured in a different soil sample (Table 42). Concentrations of TPH Fractions 1 and 2 were detected above the CCME guidelines in a duplicate pair of samples (06HB0166 and 06HB0170) taken 20 cm away from the fuel tank. Sample 06HB0164, collected at a depth of 50 cm and near to the fuel tank, also showed high TPH Fraction 1 and 2 concentrations, exceeding the CCME guidelines.

Table 42. (S-10211) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06HB0164	SOIL	50	TPH / F1	310	1,800
		50	TPH / F2	760	7,900
06HB0165	SOIL	1-10	ARSENIC (AS)	12	14.2
06HB0166	SOIL	20	ZINC (ZN)	360	590
		20	TPH / F1	310	310
		20	TPH / F2	760	5,300
06HB0170	SOIL	20	TPH / F1	310	420
		20	TPH / F2	760	4,200

4.20.3 Nature and Extent of Contamination

During 2007/08, 11 soil samples were collected, including one duplicate pair. The samples were analyzed for metals, TPH and PAHs (Table 43). One sample contained arsenic concentrations slightly above the CCME guideline. Two soil samples (duplicate pair B07-HB-0118 and B07-HB-0052) had concentrations of TPH Factions 1 and 2 higher than the CCME guidelines. This duplicate sample was collected south of the site, behind the hurricane building, near the diesel pipeline. No PAH was detected in the 4 samples analyzed (B07-HB-0114, -0115, -0181 and -0183).

According to the FCSAP classification system, the site is Class 2 (60.8). The estimated volume of contaminated soil is 90 m^3. TPH Fraction 1 has high mobility, thus the potential for off-site migration of the contamination is elevated. Further action is likely required at this site.

4.20.4 Recommendations

Two localized TPH contaminated areas were identified during the 2007/08 sampling campaign. For each contaminated area, only a single positive sample was collected, as the surrounding samples were negative. The TPH Fraction 1 concentration for both positive samples was 1,110 and 1,420 mg/kg, while the TPH Fraction 2 concentration was 2,160 and 1,400 mg/kg. Delineation of the hot spots, and in particular determining the edge of each hot spot, needs to be completed. Excavation of these small areas and *ex situ* biopile treatment would permit closure of this site.

Table 43. (S-10211) Airstrip Hurricane Building 2007/08 results.

	PARAMETERS	SOIL			Airstrip Hurricane Building (S-10211)									
					SOIL									
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-HB-0052 Dup. 118 70-80 cm 8/27/2007	B07-HB-0114 10-20 cm 8/27/2007	B07-HB-0115 80-110 cm 8/27/2007	B07-HB-0116 90-100 cm 8/27/2007	B07-HB-0117 80-90 cm 8/27/2007	B07-HB-0118 70-80 cm 8/27/2007	B07-HB-0123 140 cm 8/27/2007	B07-HB-0124 140 cm 8/27/2007	B07-HB-0181 70-120 cm 8/27/2007	B07-HB-0506 70-140 cm 8/27/2007
METALS	Arsenic (As)	mg/kg	12	0.27	8.1	NA	13.4	7.9	8.9	8.2	8.4	11.5	8.0	7.7
	Barium (Ba)	mg/kg	2,000	5	20	NA	36	19	20	23	27	29	27	18
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	NA	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	21	NA	28	16	23	21	22	22	21	21
	Cobalt (Co)	mg/kg	300	1.9	9	NA	13	8	11	10	10	11	11	11
	Copper (Cu)	mg/kg	91	2.1	21	NA	32	17	26	23	23	23	23	25
	Lead (Pb)	mg/kg	600	1.2	16	NA	18	13	16	15	16	17	16	16
	Manganese (Mn)	mg/kg	---	1.1	398	NA	487	446	401	402	401	489	469	355
	Molybdenum (Mo)	mg/kg	40	1.4	<2	NA	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	33	NA	45	27	39	34	33	37	34	36
	Selenium (Se)	mg/kg	3.9	0.5	0.9	NA	0.6	0.7	0.5	0.7	0.7	0.6	0.7	0.7
	Silver (Ag)	mg/kg	40	0.4	<0.5	NA	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	NA	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	50	NA	77	42	56	54	56	59	55	51
TPH	F1 (C6-C10)	mg/kg	310	10	1,110	<3.3	<3.5	<3.3	<3.5	1,420	<3.1	<3.4	NA	<3.3
	F2 (C10-C16)	mg/kg	760	10	2,160	<2.2	<2.4	<2.6	<2.1	1,400	<1.8	<1.8	NA	<3.1
	F3 (C16-C34)	mg/kg	1,700	10	85.1	<5.2	7.2	<6.1	6.1	45	20	<4.2	NA	<7.2
	F4 (C34-C50)	mg/kg	3,300	10	<10	<7.5	8.7	<8.7	<7	<9.5	22	<6	NA	<10

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the

Figure 52. (S-10211) Airstrip Hurricane Building map 1.

Figure 53. (S-10211) Airstrip Hurricane Building map 2.

4.21 S-10212 AIRSTRIP MET SHACK

4.21.1 Location and Site Description

The Airstrip Meteorological Shack (Met Shack) is located approximately halfway down the west side of the airstrip (Figures 54 and 55) (Photograph 26, Appendix A). This building hosts the airport control tower and the airport meteorological station. The meteorological instruments are installed to the southwest of the Met Shack building. There are three small sheds situated northeast of the site; an electrical storage shed and 2 electrical generator sheds. The electrical storage shed was marked for demolition in 2005, but was still standing during the 2006/07 and 2007/08 sampling campaigns. Two fuel tanks located beside the north corner of the Met Shack were noted during a previous campaign. During the 2007/08 sampling campaign, one tank was relocated beside one of the electrical generator sheds and one tank was left standing beside the Met Shack.

The Met Shack is built on a compacted gravel pad. This pad is extended on the each side of the Met Shack allowing for parking. The area west of the Met Shack is composed of a native mix of shaly silt and clay. This area is a drainage discharge for the surrounding lands, and is important in preventing flooding of the airstrip during snowmelt. The soil is saturated with water during snowmelt and summer, and the cryoturbations within the soil are important. There is a large swampy area located on the northeast side of the site that measures approximately 12 m by 15 m. The southeast part of the site was still frozen during the 2006/07 sampling campaign, but was completely thawed during the 2007/08 sampling campaign.

The topography is generally level with a few very gentle slopes toward the west end of the site. Two main drainage pathways were noted in 2007/08. The first one goes westward from the Met Shack to the second drainage pathway. The second drainage pathway goes from the southwestern end of the site to the northwestern end of the site, towards the Lincoln Sea. The site is approximately 602 m upgradient of the Lincoln Sea.

4.21.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2007/08 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, five soil samples (including 1 duplicate pair) and one duplicate pair of surface water samples were collected. The soil samples were tested for BTEX and TPH, and the water samples were tested for metals and glycol. Soil sample 06ME0115 possessed toluene, ethylbenzene and total xylene concentrations exceeding the CCME guidelines, and the replicate (06ME0076) showed ethylbenzene concentrations above the CCME guideline (Table 44). TPH Fractions 1 and 2 were also measured above the CCME guidelines in sample 06ME0115 and TPH Fraction 2 was above the CCME guideline in sample 06ME0076.

The duplicate pair of surface water sample (06ME0080 and 06ME0081) showed extensive metals contamination. Arsenic, cadmium, copper, lead and zinc concentrations were above the CCME guidelines for aquatic life. No glycol compounds were detected above the CCME guidelines.

Table 44. (S-10212) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Criterion (mg/kg)	Concentration (mg/kg)
06ME0115	SOIL	0-10	TOLUENE	0.37	0.7
		0-10	ETHYLBENZENE	0.082	3.2
		0-10	TOTAL XYLENE	11	19.5
		0-10	TPH / F1	310	450
		0-10	TPH / F2	760	2,600
06ME0076	SOIL	0-10	ETHYLBENZENE	0.082	1.3
		0-10	TPH / F2	760	1,200
06ME0080	WATER	SURFACE	ARSENIC (AS)	5	6
		SURFACE	COPPER (CU)	2-4	14
		SURFACE	LEAD (PB)	1-7	1
		SURFACE	ZINC (ZN)	30	30
06ME0081	WATER	SURFACE	ARSENIC (AS)	5	5
		SURFACE	CADMIUM (CD)	0.017	1
		SURFACE	COPPER (CU)	2-4	13
		SURFACE	LEAD (PB)	1-7	1
		SURFACE	ZINC (ZN)	30	30

4.21.3 Nature and Extent of Contamination

In 2007/08, 9 deep soil samples were collected, including one duplicate pair. Also, 3 surface water samples were collected on the southwestern side of the site and in the drainage pathways located west of the site. The samples were analyzed for metals, TPH and PAHs (Table 45). Arsenic and nickel concentrations slightly exceeding the CCME guidelines were found in soil samples B07-ME-0574 and B07-ME-0573, respectively. Metals concentrations in all other soil samples analyzed were below the CCME guidelines. No TPH or PAH concentrations above the CCME guidelines were not detected in the soil samples.

Copper, lead and zinc concentrations above the CCME guidelines for aquatic life were measured in one surface water sample (B07-ME-0566W) collected in the first drainage pathway. Copper

and selenium concentrations were slightly above the CCME guidelines in the surface water sample (B07-ME-0565W) collected in the second drainage pathway. Slight concentrations of TPH Fraction 3 were observed in the 3 surface water samples, but there is currently no guideline to properly evaluate this contamination. No PAHs were detected above the CCME guidelines in the surface water samples.

According to the 2006/07 and 2007/08 results, the site is Class 1 (72.7) based on the FCSAP classification system. The estimated volume of contaminated soil is 10 m^3. The presence of surface contamination increases the likelihood of off-site contaminants migration. Considering that the drainage pathway leads directly towards the Lincoln Sea, further action is highly recommended.

4.21.4 Recommendations

The only TPH contamination detected on site was from a single sample just adjacent to the main building taken in 2006/07. A total of 4 heavy metals were detected at or above the guidelines in 2 water and 1 soil samples: lead; 1 mg/kg (guideline 1 mg/kg), nickel; 50 mg/kg (guideline 50 mg/kg), selenium; 1 mg/kg (guideline 1 mg/kg), zinc; 100 mg/kg (guideline 30 mg/kg).

The TPH contamination requires additional delineation towards the north-northwest to establish the limit of contamination. After delineation is completed and the proximity of the contamination to the building established, a decision as to the most appropriate remediation approach (either excavation and *ex situ* treatment or *in situ* treatment) can be made. If excavation is a viable option (ie. does not affect the building foundation) then closure of the site is dependent upon addressing the heavy metal contamination.

The heavy metal of most concern at this site is zinc, detected in surface water from a drainage channel at the site. This drainage channel and the surface water contained within should be sampled at several points towards the north to determine where the source of zinc is located, although it would appear that it is a localized hot spot. The site could be closed if the zinc contamination is a hotspot and is excavated.

Airstrip MET Shack (S-10212)								
SOIL								
61	B07-ME-0564	B07-ME-0568	B07-ME-0569	B07-ME-0570	B07-ME-0571	B07-ME-0572	B07-ME-0573	B07-ME-0574
	40 cm	40 cm	40 cm	40 cm	40 cm	40 cm	40 cm	40 cm
7	8/17/2007	8/17/2007	8/17/2007	8/17/2007	8/17/2007	8/17/2007	8/17/2007	8/17/2007
	6.7	NA	NA	7.8	6.6	NA	8.3	13.9
	27	NA	NA	23	28	NA	33	20
	<0.9	NA	NA	<0.9	<0.9	NA	<0.9	<0.9
	33	NA	NA	30	32	NA	36	29
	11	NA	NA	10	11	NA	12	10
	25	NA	NA	24	26	NA	31	13
	14	NA	NA	14	15	NA	15	16
	401	NA	NA	367	362	NA	376	528
	<2	NA	NA	<2	<2	NA	<2	<2
	43	NA	NA	40	44	NA	50	28
	1.2	NA	NA	0.6	1.1	NA	0.5	0.5
	<0.5	NA	NA	<0.5	<0.5	NA	<0.5	<0.5
	<5	NA	NA	<5	<5	NA	<5	<5
	72	NA	NA	68	75	NA	90	46
	<4.2	<4.1	<3.3	<3.7	<3.7	<4.2	<4	<3
	<3.1	<2.7	<1.8	<2.2	<2.1	<2.8	<3.2	<2.8
	58	44	80.7	26	53.5	48	48	39
	42	30	43	19	31	34	34	14

Table 45. (S-10212) Airstrip Met Shack 2007/08 results (cont.).

					Airstrip MET Shack (S-10212)		
		WATER			FRESH WATER		
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B07-ME-0565W Surface 8/17/2007	B07-ME-0566W Surface 8/17/2007	B07-ME-0567W Surface 8/17/2007
METALS	Arsenic (As)	ug/L	5	0.0001	<1	1	NA
	Barium (Ba)	ug/L	---	0.001	<10	<10	NA
	Cadmium (Cd)	ug/L	0.017	0.0001	<1	<1	NA
	Chromium (Cr)	ug/L	---	0.0007	3	3	NA
	Cobalt (Co)	ug/L	---	0.0006	<1	<1	NA
	Copper (Cu)	ug/L	2-4	0.0012	3	3	NA
	Lead (Pb)	ug/L	1-7	0.0011	<1	1	NA
	Manganese (Mn)	ug/L	---	0.0003	<6	25	NA
	Molybdenum (Mo)	ug/L	73	0.0078	<1	<1	NA
	Nickel (Ni)	ug/L	25-150	0.0005	2	2	NA
	Selenium (Se)	ug/L	1	0.0006	1	<1	NA
	Silver (Ag)	ug/L	---	0.0008	<0.6	<0.6	NA
	Tin (Sn)	ug/L	---	0.011	<1	<1	NA
	Zinc (Zn)	ug/L	30	0.006	3	100	NA
TPH	F1 (C6-C10)	ug/L	---	100	<50	<50	<50
	F2 (C10-C16)	ug/L	---	100	<38	<43	<49
	F3 (C16-C34)	ug/L	---	100	110	200	210
	F4 (C34-C50)	ug/L	---	100	<38	<43	<49

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

Figure 54. (S-10212) Airstrip Met Shack map 1.

Figure 55. (S-10212) Airstrip Met Shack map 2.

4.22 S-10214 MAIN STATION DAY TANK AREA

4.22.1 Location and Site Description

The Main Station Day Tank area is located at the north end of the CFS-Alert main station, west of the Operations Building and beside the Old Upper POL line areas (S-354) (Figures 56 and 57). The site consists of one diesel day tank for vehicle refueling, a pumphouse, a fuel-dispensing shed and a refueling building. The refueling building hosts the pumping system that fills the station day tank from the airstrip tank farm. A couple of storage trailers are located on the east side of the site and many utilidors carrying power and other utility lines pass through the site (ESG 1999). The site is surrounded by three gravel berms which contain any fuel spills. One berm surrounds the pumphouse and the day tank, a second berm surrounds a diesel pipeline valve situated north of the pumphouse and a third berm surrounds the refueling building area east of the 2 other berms. In 2006/07, a fuel additive building was placed beside the fuel-dispensing shed. This building was the old refueling building and was replaced by the new building situated inside the third bermed area. In 2007/08, the fuel additive building was not observed on site. The current Main Station Day Tank is slated for replacement in the near future.

The topography of the site is generally level, with a gentle slope on the east side of the site. The buildings are constructed on elevated gravel pads and the soil in the area is mainly native shaly silts and clays with a few shale stone. The bermed areas occasionally fill with water. The water appears to drain out of the berms from holes in the berm structures (Photograph 27, Appendix A). A drainage pathway was noted during the 2006/07 and 2007/08 sampling campaigns, starting from the second bermed area, passing through the third bermed area to a drainage channel located east of the site alongside the Operations Building (Photograph 28, appendix A). The drainage channel eventually reaches a drainage ditch situated along Tower Way road. The site is approximately 650 m from Dumbell Bay.

4.22.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, 5 soil samples were collected around the fuel dispensing shed and the day tank area. The samples were analyzed for metals, TPH and BTEX. A light to medium hydrocarbon odor was noted at each sampling point and iridescence was visible in a pool of standing water inside the second bermed area. No metals were measured above CCME guidelines. Three soil samples exceeded the TPH Fraction 1 CCME guideline and all samples exceeded the TPH Fraction 2 CCME guidelines (Table 46). Toluene, ethylbenzene and total xylene exceeded the CCME guidelines in two soil samples (06DT0103 and 06DT0104). Sample 06DT0103 was collected east of the pumphouse inside the first bermed area and sample 06DT0104 was collected east of the day tank, near the grounds of the Main Station.

Table 46. (S-10214) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06BI0187	SOIL	10	ARSENIC (AS)	12	19.2
06BI0188	SOIL	20	ARSENIC (AS)	12	12.1
06DT0103	SOIL	0-10	TOLUENE	0.37	18
		0-10	ETHYLBENZENE	0.08	45
		0-10	TOTAL XYLENE	11	320
		0-10	TPH / F1	310	9,500
		0-10	TPH / F2	760	30,000
06DT0104	SOIL	0-10	TOLUENE	0.37	1
		0-10	ETHYLBENZENE	0.08	1.3
		0-10	TOTAL XYLENE	11	24
		0-10	TPH / F1	310	1,900
		0-10	TPH / F2	760	12,000
06DT0106	SOIL	0-10	TPH / F2	760	3,600
06DT0107	SOIL	0-10	TPH / F2	760	6,200

4.22.3 Nature and Extent of Contamination

In 2007/08, three soil samples and two surface water samples were collected from the drainage network of the Station Day Tank area. The soil samples were collected from depths between10-40 cm. All samples were tested for BTEX, TPH and PAHs (Table 47). No BTEX was detected in any samples. TPH Fraction 2 was detected above the CCME guideline in one soil sample (B07-DT-0469). TPH Fractions 1, 2 and 3 were detected at elevated concentrations in the surface water samples, but currently no surface water guidelines exist for these contaminants. Naphthalene was above the CCME guideline concentrations for aquatic life in one surface water sample (B07-DT-0469W). PAHs were not detected in any soil and surface water samples.

Based on the results from the 2006/07 and 2007/08 sampling campaigns, the site is classified as Class 1 (80.7) according to the FCSAP classification system. This classification indicates that further action is required. The estimated volume of contaminated soil is 4,500 m^3.

4.22.4 Recommendations

TPH contamination was found in the area immediately in front of the day tank at the vehicle refueling area and in the drainage channel located behind the raised day tank support berm leading away from the day tank area. This drainage channel passes beside the Operations Building (S-10523) and continues downgradient past the Burn Pit area (S-10196) towards Dumbell Bay.

The current Main Station Day Tank is slated for replacement in the near future. Further work at this site should be postponed until after the new tank is installed and operational in case any additional spills should occur during the replacement and disposal process. Additionally, due to the proximity of the Main Station Day Tank and the Old Upper POL Line areas, the two sites should be combined and treated as a single area.

The Station Day Tank area, and in particular the contaminated area in front, is in continual use due to vehicle refueling. An *in situ* approach may be the most appropriate approach if disruption

to the site can be kept to a minimum (eg. no above surface infrastructure such as soil vents). A decision on what is the most appropriate treatment approach will be based on the *in situ* pilot treatment studies to be performed during the summer of 2008. Excavation and immediate re-filling of the subsequent hole followed by *ex situ* biopile treatment of the contaminated soils is an option if an *in situ* system proves to be too disruptive.

Table 47. (S-10214) Main Station Day Tank Area 2007/08 results.

					Main Station Day Tank Area (S-10214)	
		WATER			FRESH WATER	
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B07-DT-0468W Surface 8/20/2007	B07-DT-0469W Surface 8/20/2007
TPH	Benzene	ug/L	370	0.03	<0.5	<0.5
	Toluene	ug/L	2	0.03	<0.5	<0.5
	EthylBenzene	ug/L	90	0.02	<0.5	<0.5
	Total Xylene	ug/L	---	0.05	<0.5	23.5
	F1 (C6-C10)	ug/L	---	100	<50	330
	F2 (C10-C16)	ug/L	---	100	1,710	2,810
	F3 (C16-C34)	ug/L	---	100	1,520	1,910
	F4 (C34-C50)	ug/L	---	100	77	58
PAH	Naphthalene	ug/L	1.1	0.04	<0.1	12.3
	2-methylnaphthalene	ug/L	---	0.04	NA	NA
	1-methylnaphthalene	ug/L	---	0.04	NA	NA
	1,3-Dimethylnaphthalene	ug/L	---	0.04	NA	NA
	Acenaphthylene	ug/L	---	0.03	<0.1	<0.5
	Acenaphthene	ug/L	5.8	0.04	<0.1	<0.5
	2,3,5-trimethylnaphthalene	ug/L	---	0.05	NA	NA
	Fluorene	ug/L	3	0.05	0.5	<0.5
	Phenanthrene	ug/L	0.4	0.04	<0.1	<0.5
	Anthracene	ug/L	0.012	0.04	<0.1	<0.5
	Fluoranthene	ug/L	0.04	0.04	<0.1	<0.5
	Pyrene	ug/L	0.025	0.04	<0.1	<0.5
	Benzo(c)Phenanthrene	ug/L	---	0.04	<0.1	<0.5
	Benzo(a)Anthracene	ug/L	0.018	0.04	<0.1	<0.5
	Chrysene	ug/L	---	0.04	<0.1	<0.5
	7,12-dimethylbenz(a)anthracene	ug/L	---	0.01	<0.1	<0.5
	Benzo(b,j,k)fluoranthene	ug/L	---	0.04	<0.1	<0.5
	Benzo(a)pyrene	ug/L	0.015	0.04	<0.1	<0.5
	3-methylcholanthrene	ug/L	---	0.04	NA	NA
	Indeno(1,2,3-cd)pyrene	ug/L	---	0.05	<0.1	<0.5
	Dibenzo(a,h)anthracene	ug/L	---	0.04	<0.1	<0.5
	Benzo(g,h,i)perylene	ug/L	---	0.04	<0.1	<0.5
	Dibenzo (a,l) pyrene	ug/L	---	0.04	<0.1	<0.5
	Dibenzo (a,i) pyrene	ug/L	---	0.04	<0.1	<0.5
	Dibenzo (a,h) pyrene	ug/L	---	0.05	<0.1	<0.5

NA Not available
Higher than the criteria
High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME (2006)

Table 47. (S-10214) Main Station Day Tank Area 2007/08 results (cont.).

					Main Station Day Tank Area (S-10214)		
		SOIL			SOIL		
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B07-DT-0468 10-40 cm 8/20/2007	B07-DT-0469 10-40 cm 8/20/2007	B07-DT-0470 10-40 cm 8/20/2007
TPH	Benzene	mg/kg	0.03	0.02	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.37	0.02	<0.1	<0.1	<0.1
	Ethylbenzene	mg/kg	0.082	0.02	<0.1	<0.1	<0.1
	Total Xylene	mg/kg	11	0.04	<0.1	<0.1	<0.1
	F1 (C6-C10)	mg/kg	310	10	3.2	84.4	<3.1
	F2 (C10-C16)	mg/kg	760	10	105	1,300	34.9
	F3 (C16-C34)	mg/kg	1,700	10	38	206	37
	F4 (C34-C50)	mg/kg	3,300	10	<8.3	30	10
PAH	Naphthalene	mg/kg	22	0.008	<0.1	<0.1	<0.1
	2-methylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1
	1-methylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1
	1,3-Dimethylnaphthalene	mg/kg	---	0.005	<0.1	0.1	<0.1
	Acenaphthylene	mg/kg	---	0.004	<0.1	<0.1	<0.1
	Acenaphthene	mg/kg	---	0.004	<0.1	<0.1	<0.1
	2,3,5-trimethylnaphthalene	mg/kg	---	0.007	<0.1	<0.1	<0.1
	Fluorene	mg/kg	---	0.007	<0.1	<0.1	<0.1
	Phenanthrene	mg/kg	50	0.01	<0.1	<0.1	<0.1
	Anthracene	mg/kg	---	0.004	<0.1	<0.1	<0.1
	Fluoranthene	mg/kg	---	0.008	<0.1	<0.1	<0.1
	Pyrene	mg/kg	100	0.008	<0.1	<0.1	<0.1
	Benzo(c)Phenanthrene	mg/kg	---	0.008	<0.1	<0.1	<0.1
	Benzo(a)Anthracene	mg/kg	10	0.007	<0.1	<0.1	<0.1
	Chrysene	mg/kg	---	0.008	<0.1	<0.1	<0.1
	7,12-dimethylbenzo(a)anthracene	mg/kg	---	0.005	<0.1	<0.1	<0.1
	Benzo(b,j,k)fluoranthene	mg/kg	10	0.008	<0.1	<0.1	<0.1
	Benzo(a)pyrene	mg/kg	0.7	0.008	<0.1	<0.1	<0.1
	3-methylcholanthrene	mg/kg	---	0.022	<0.1	<0.1	<0.1
	Indeno(1,2,3-cd)pyrene	mg/kg	10	0.008	<0.1	<0.1	<0.1
	Dibenzo(a,h)anthracene	mg/kg	10	0.008	<0.1	<0.1	<0.1
	Benzo(g,h,i)perylene	mg/kg	---	0.008	<0.1	<0.1	<0.1
	Dibenzo (a,l) pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1
	Dibenzo (a,i) pyrene	mg/kg	---	0.007	<0.1	<0.1	<0.1
	Dibenzo (a,h) pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Figure 56. (S-10214) Main Station Day Tank Area map 1.

Figure 57. (S-10214) Main Station Day Tank Area map 2.

4.23 S-10216 BAKER'S DOZEN

4.23.1 Location and Site Description

The Baker's Dozen site is located at the southeast end of the CFS-Alert main station, downhill from the Cat House and the Auxiliary Power Plant Building (B-143) (Figures 58 and 59). The 'V' shaped site is approximately 6,800 m^2 and is located between Herc Drive and Doe Road (Photograph 30, Appendix A). Thirteen POL tanks were previously located in this area. The tanks were removed and replaced by the 8 diesel fuel storage tanks located north of the CFS-Alert main station.

The petroleum hydrocarbon contamination found at the Baker's Dozen site is most likely due to spills that occurred during the active life of the site and/or during demolition of the tanks. Also, the site is located southwest and downgradient of the Oxidator and the Cold Storage Dog House buildings which are 2 areas significantly contaminated with TPH and metals (refer to sections 4.2 and 4.13, respectively).

The topography of the Baker's Dozen site slopes gently from the northeast towards the southwest. A large drainage ditch which collects water from the CFS-Alert main station enters Baker's Dozen at the northeast corner of the site (Photograph 29, Appendix A). Drainage pathways cross the entire Baker's Dozen site and the drainage water exits the site in a culvert situated at the southern point of the site. The drainage water goes directly into the Runoff Collection Basin. The site is located approximately 370 m from Alert Inlet and 2,250 m from Upper Dumbell Lake. The southern part of the Baker's Dozen site is often saturated during snowmelt and the summer months. The soil is mainly composed of natural shaly silt and clay, with a few shale stones.

Previous to the 2006/07 and 2007/08 sampling campaigns, a small volume of TPH contaminated soil was excavated from the northeast corner of the site beside the site entrance. In August 2007/08, approximately 7,000 L of diesel fuel was spilled from the Auxiliary Power Plant

building into the northern part of the Baker's Dozen site. The 2007/08 sampling campaign at the Baker's Dozen site occurred before this spill occurred.

4.23.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, two soil and two freshwater samples were collected. The soil samples were analyzed for metals, BTEX and TPH, and the surface water samples were analyzed for metals contamination. One soil and one fresh water sample (06KZ0070 and 06KZ0071, respectively) were collected upgradient in a drainage channel in the northeast corner of the Baker's Dozen site. The second soil and freshwater samples (06KZ0077 and 06KZ0072, respectively) were collected south of the Baker's Dozen site, in the downgradient drainage channel located west of Herc Drive. The metals contamination within the two freshwater samples was similar, with the exception of the selenium and the zinc concentrations (Table 48). The downgradient sample exceeded the CCME guideline for selenium, while the upgradient sample did not contain selenium. The upgradient sample contained zinc at 16 times the CCME guideline, whereas the downstream sample was 2 times the CCME guideline for zinc. Both of these surface water samples exceeded the CCME guidelines for copper and lead.

The two soil samples collected in the drainage pathways demonstrated varying degrees of metals contamination. The upgradient sample exceeded the CCME guideline for zinc seven fold and the downgradient sample exceeded the CCME guidelines for selenium and zinc 2 and 17 fold, respectively.

TPH Fractions 1 and 2 exceed the CCME guideline in both soil samples. The highest concentration was found in the upgradient sample (06KZ0070), where Fraction 2 was 23,000 mg/kg. This sample also demonstrated TPH Fraction 3 contaminations above the CCME guideline. Ethylbenzene was above the CCME guideline in both samples.

An attempt to collect groundwater samples was made during the 2006/07 sampling campaign, but no groundwater was found.

Table 48. (S-10216) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06KZ0070	SOIL	0-10	ZINC (ZN)	360	2,570
		0-10	ETHYLBENZENE	0.082	0.16
		0-10	TPH / F1	310	640
		0-10	TPH / F2	760	23,000
		0-10	TPH / F3	1,700	3,200
06KZ0077	SOIL	0-10	SELENIUM (SE)	4	7.8
		0-10	ZINC (ZN)	360	42,800
		0-10	ETHYLBENZENE	0.082	0.36
		0-10	TPH / F1	310	660
		0-10	TPH / F2	760	5,400
06KZ0071	WATER	SURFACE	COPPER (CU)	2-4	4
		SURFACE	LEAD (PB)	1-7	2
		SURFACE	ZINC (ZN)	30	490
06KZ0072	WATER	SURFACE	COPPER (CU)	2-4	4
		SURFACE	SELENIUM (SE)	1	4
		SURFACE	LEAD (PB)	1-7	2
		SURFACE	ZINC (ZN)	30	490

4.23.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign, 15 subsurface soil samples, including one duplicate pair, were collected from the suprapermafrost layer at depths of 80 to 100 cm. These samples were collected on both sides of Doe Road, the east side of Herc Drive and beside the diesel pipeline that crosses the north end of the site. Four soil and two water samples were collected from the surface of drainage pathways. The first surface water sample (B07-KZ-0525W) was collected from a pool of standing water in the north of the site, in front of the foundation talus for the Auxiliary Power Plant building. The second sample (B07-KZ-0526W) was taken in a

drainage pathway east of Herc Drive. All samples were analyzed for metals, BTEX, TPH and PAHs (Table 49).

Arsenic, nickel and zinc concentrations were detected above the CCME guidelines in 1, 11 and 1 subsurface soil samples, respectively, and in 2, 1 and 2 drainage soil samples, respectively.

Benzene, toluene, ethylbenzene and total xylene concentrations higher than the CCME guidelines were detected in 1, 6, 8 and 8 subsurface soil samples collected throughout the Baker's Dozen site, respectively. Concentrations of TPH Fractions 1 and 2 were above the CCME guidelines in 9 and 10 subsurface soil samples, respectively. The four soil samples collected in the drainage pathways contained TPH Fraction 2 concentrations above the CCME guideline.

Naphthalene was the only PAH to be detected above the CCME guideline in one subsurface soil sample (B07-KZ-0539) collected north of the site near a drainage channel. Additional PAHs such as 2-methylnaphthalene, 1-methylnaphthalene, 1,3-dimethylnaphthalene, acenaphthylene, acenaphthene, 3,5-trimethylnaphthalene, fluorene and phenanthrene were observed in other soil samples, but were either below guideline concentrations or no guidelines currently exist.

The subsurface soil samples collected east of Doe Road (B07-KZ-0535 and B07-KZ-0530) only demonstrated contamination by nickel at concentrations slightly above the CCME guideline.

The surface water sample collected in the pool of standing water (B07-BZ-0525W) contained copper, lead and selenium slightly above the CCME guidelines. Toluene and naphthalene were also detected above the CCME guidelines for aquatic life. The water sample (B07-BZ0526W) collected downgradient from B07-KZ-0525W in the drainage pathway contained arsenic, copper, lead, nickel, selenium and zinc concentrations higher than the CCME guidelines. Several TPH fractions were detected in this sample at elevated concentrations. No BTEX or PAHs were measured above the CCME guidelines.

Based on the results from the 2006/07 and 2007/08 sampling campaigns, the site is a Class 1 (84.7) FCSAP site. Actions are required to address the existing contamination. The estimated volume of contaminated soil is 9,180 m^3.

4.23.4 Recommendations

A total of 19 soil samples and 2 surface water samples were collected during the 2007/08 sampling campaign. Of the soil samples, four were at or above guidelines for arsenic (12 – 48 mg/kg), 11 were above guidelines for nickel (51 – 98 mg/kg) and 3 were above guidelines for zinc (461 – 1950 mg/kg). TPH contamination was prevalent at the site with 9, 14 and 1 samples possessing Fractions 1, 2 and 3 above guidelines, respectively. In addition, benzene, toluene, ethylbenzene and total xylene were above guideline concentrations in 1, 6, 8 and 8 samples, respectively. A single soil sample possessed naphthalene just above guidelines (22.2 mg/kg vs 22 mg/kg guideline). Of the two water samples collected, one sample was above guidelines for naphthalene (24.6 mg/kg vs 1.1 mg/kg guideline) while the other was above guidelines for the following heavy metals: arsenic, copper, nickel, selenium and zinc. As was observed in the Runoff Collection Basin, zinc was significantly above the guideline of 30 mg/kg (8,420 mg/kg) and would be a direct result of migration from the Oxidator Building during battery neutralization using the previous protocols.

The Baker's Dozen site was selected for inclusion in the *in situ* biotreatment pilot study addressing TPH contamination. Once the most appropriate conditions and techniques have been identified, a larger scale treatment system will be implemented.

The heavy metal contamination, and in particular the zinc contamination, appears to have originated from upgradient sources such as the Oxidator Building. Once the Oxidator Building site has been addressed, the downgradient artifacts (eg. zinc contaminated surface water) should be significantly reduced. The surface water should be collected and treated using the battery neutralization protocols to remove zinc contamination. The surface water should be tested and treated annually until concentrations are below guidelines.

Table 49. (S-10216) Baker's Dozen 2007/08 results.

					Baker's Dozen (S-10216)	
	PARAMETERS	WATER			FRESH WATER	
		UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B07-KZ-0525W Surface 8/21/2007	B07-KZ-0526W Surface 8/21/2007
METALS	Arsenic (As)	ug/L	5	0.0001	4	7
	Barium (Ba)	ug/L	---	0.001	10	60
	Cadmium (Cd)	ug/L	0.017	0.0001	<1	<1
	Chromium (Cr)	ug/L	---	0.0007	3	4
	Cobalt (Co)	ug/L	---	0.0006	1	183
	Copper (Cu)	ug/L	2-4	0.0012	2	98
	Lead (Pb)	ug/L	1-7	0.0011	1	1
	Manganese (Mn)	ug/L	---	0.0003	45	1,040
	Molybdenum (Mo)	ug/L	73	0.0078	24	13
	Nickel (Ni)	ug/L	25-150	0.0005	3	121
	Selenium (Se)	ug/L	1	0.0006	2	4
	Silver (Ag)	ug/L	---	0.0008	<0.6	<0.6
	Tin (Sn)	ug/L	---	0.011	1	1
	Zinc (Zn)	ug/L	30	0.006	20	8,420
TPH	Benzene	ug/L	370	0.03	<0.5	<0.1
	Toluene	ug/L	2	0.03	9	0.3
	Ethylbenzene	ug/L	90	0.02	<0.5	<0.1
	Total Xylene	ug/L	---	0.05	36.8	0.5
	F1 (C6-C10)	ug/L	---	100	310	<50
	F2 (C10-C16)	ug/L	---	100	1,710	442
	F3 (C16-C34)	ug/L	---	100	813	280
	F4 (C34-C50)	ug/L	---	100	<36	<39
PAH	Naphthalene	ug/L	1.1	0.04	24.6	<0.1
	2-methylnaphthalene	ug/L	---	0.04	<0.1	<0.1
	1-methylnaphthalene	ug/L	---	0.04	<0.1	<0.1
	1,3-Dimethylnaphthalene	ug/L	---	0.04	<0.1	<0.1
	Acenaphthylene	ug/L	---	0.03	0.2	<0.1
	Acenaphthene	ug/L	5.8	0.04	<0.1	<0.1
	2,3,5-trimethylnaphthalene	ug/L	---	0.05	<0.1	<0.1
	Fluorene	ug/L	3	0.05	<0.1	<0.1
	Phenanthrene	ug/L	0.4	0.04	<0.1	<0.1
	Anthracene	ug/L	0.012	0.04	<0.1	<0.1
	Fluoranthene	ug/L	0.04	0.04	<0.1	<0.1
	Pyrene	ug/L	0.025	0.04	<0.1	<0.1
	Benzo(c)Phenanthrene	ug/L	---	0.04	<0.1	<0.1
	Benzo(a)Anthracene	ug/L	0.018	0.04	<0.1	<0.1
	Chrysene	ug/L	---	0.04	<0.1	<0.1
	7,12-dimethylbenz[a]anthracene	ug/L	---	0.01	<0.1	<0.1
	Benzo(b,j,k)fluoranthene	ug/L	---	0.04	<0.1	<0.1
	Benzo(a)pyrene	ug/L	0.015	0.04	<0.1	<0.1
	3-methylcholanthrene	ug/L	---	0.04	<0.1	<0.1
	Indeno(1,2,3-cd)pyrene	ug/L	---	0.05	<0.1	<0.1
	Dibenzo(a,h)anthracene	ug/L	---	0.04	<0.1	<0.1
	Benzo(g,h,i)perylene	ug/L	---	0.04	<0.1	<0.1
	Dibenzo (a,l) pyrene	ug/L	---	0.04	<0.1	<0.1
	Dibenzo (a,i) pyrene	ug/L	---	0.04	<0.1	<0.1
	Dibenzo (a,h) pyrene	ug/L	---	0.05	<0.1	<0.1

NA Not available
Higher than the criteria
High concentration /No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME (2006)

Table 49. (S-10216) Baker's Dozen 2007/08 results (cont.).

	PARAMETERS	UNITS	SOIL INDUSTRIAL GUIDELINES (Coarse)	SOIL DETECTION LIMIT	Baker's Dozen (S-10216) SOIL B07-KZ-0051 Dup 544 > 80 cm 8/21/2007	B07-KZ-0527 40-80 cm 8/21/2007	B07-KZ-0528 40-80 cm 8/21/2007	B07-KZ-0529 50-100 cm 8/21/2007	B07-KZ-0530 50-125 cm 8/21/2007	B07-KZ-0531 50-110 cm 8/21/2007	B07-KZ-0532 50-105 cm 8/21/2007	B07-KZ-0533 Drain. Sed. 0-10 cm 8/21/2007	B07-KZ-0534 50-90 cm 8/21/2007	B07-KZ-0535 50-135 cm 8/21/2007	B07-KZ-0536 Drain. Sed. 0-10 cm 08/21/07
METALS	Arsenic (As)	mg/kg	12	0.27	10	9	8	8	9	11	48	16	12	9	9
	Barium (Ba)	mg/kg	2,000	5	15	16	17	12	13	7	23	31	22	9	19
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	1	<0.9	<0.9	<0.9	1	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	30	25	26	31	31	32	33	34	33	31	29
	Cobalt (Co)	mg/kg	300	1.9	16	18	12	14	14	14	25	22	14	14	14
	Copper (Cu)	mg/kg	91	2.1	28	34	19	22	25	33	66	25	29	26	24
	Lead (Pb)	mg/kg	600	1.2	15	14	12	13	13	17	52	26	16	13	18
	Manganese (Mn)	mg/kg	---	1.1	544	411	476	393	548	572	431	580	527	570	529
	Molybdenum (Mo)	mg/kg	40	1.4	<2	2	<2	<2	<2	<2	5	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	53	53	42	49	55	53	98	53	51	54	47
	Selenium (Se)	mg/kg	4	0.5	1	1	1	1	1	1	2	1	1	<0.5	1
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	461	71	59	89	65	137	95	1,950	79	186	64
TPH	Benzene	mg/kg	0.03	0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.37	0.02	<0.1	0.6	1.3	4.3	<0.1	1.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Ethylbenzene	mg/kg	0.082	0.02	<0.1	0.8	1.9	4.4	<0.1	1.8	0.5	<0.1	<0.1	<0.1	<0.1
	Total Xylene	mg/kg	11	0.04	<0.1	13.1	24.3	32	<0.1	16.7	7.2	<0.1	<0.1	<0.1	<0.1
	F1 (C6-C10)	mg/kg	310	10	8	483	660	492	10	1,010	392	25	162	5	162
	F2 (C10-C16)	mg/kg	760	10	997	5,630	21,100	1,400	26	6,280	1,440	491	2,090	14	3,750
	F3 (C16-C34)	mg/kg	1,700	10	148	199	900	30	5	201	19	261	87	18	294
	F4 (C34-C50)	mg/kg	3,300	10	21	48	19	<6.1	<5.3	<5.2	<5.4	47	23	<3.7	66.3
PAH	Naphthalene	mg/kg	22	0.008	<0.1	0.4	7.2	11.5	<0.1	2.3	0.6	<0.1	<0.1	<0.1	<0.1
	2-methylnaphthalene	mg/kg	---	0.005	<0.1	0.8	50.8	30.7	<0.1	7.1	2.8	<0.1	0.3	<0.1	0.1
	1-methylnaphthalene	mg/kg	---	0.005	<0.1	2.8	75.7	27.5	<0.1	6.2	2.9	<0.1	0.3	<0.1	0.2
	1,3-Dimethylnaphthalene	mg/kg	---	0.005	0.2	4.5	83.8	17.9	<0.1	7.5	1.7	0.2	0.5	<0.1	1
	Acenaphthylene	mg/kg	---	0.004	<0.1	<0.1	<1.7	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthene	mg/kg	---	0.004	<0.1	<0.1	<1.7	0.3	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
	2,3,5-trimethylnaphthalene	mg/kg	---	0.007	0.2	<0.1	3.3	0.6	<0.1	1	<0.1	0.2	<0.1	<0.1	0.2
	Fluorene	mg/kg	---	0.007	<0.1	<0.1	1.7	0.4	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
	Phenanthrene	mg/kg	50	0.01	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Anthracene	mg/kg	---	0.004	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluoranthene	mg/kg	---	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Pyrene	mg/kg	100	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(c)Phenanthrene	mg/kg	---	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(a)Anthracene	mg/kg	10	0.007	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chrysene	mg/kg	---	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	7,12-dimethylbenz[a]anthracene	mg/kg	---	0.005	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(b,j,k)fluoranthene	mg/kg	10	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(a)pyrene	mg/kg	0.7	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	3-methylcholanthrene	mg/kg	---	0.022	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Indeno(1,2,3-cd)pyrene	mg/kg	10	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo[a,h]anthracene	mg/kg	10	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(g,h,i)perylene	mg/kg	---	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo (a,l) pyrene	mg/kg	---	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo (a,i) pyrene	mg/kg	---	0.007	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo (a,h) pyrene	mg/kg	---	0.008	<0.1	<0.1	<1.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

9. (S-10216) Baker's Dozen 2007/08 results (cont.).

ETERS	UNITS	SOIL INDUSTRIAL GUIDELINES (Coarse)	SOIL DETECTION LIMIT	Baker's Dozen (S-10216) SOIL B07-KZ-0537 0-10 cm 8/21/2007	B07-KZ-0538 Drain. Sed. 0-10 cm 8/21/2007	B07-KZ-0539 50-90 cm 8/21/2007	B07-KZ-0540 100 cm 8/21/2007	B07-KZ-0541 50-120 cm 8/21/2007	B07-KZ-0542 100 cm 8/21/2007	B07-KZ-0543 50-95 cm 8/21/2007	B07-K Drair 0-1 8/21
	mg/kg	12	0.27	10	20	11	10	9	8	8	
	mg/kg	2,000	5	20	34	20	10	14	11	16	1
d)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<(
Cr)	mg/kg	87	3	30	35	33	31	33	32	33	3
	mg/kg	300	1.9	13	17	14	14	15	14	13	1
	mg/kg	91	2.1	24	31	25	31	31	28	34	2
	mg/kg	600	1.2	19	21	17	15	18	15	16	1
Mn)	mg/kg	---	1.1	547	829	547	556	581	591	398	5
(Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	<
	mg/kg	50	0.6	49	49	50	55	57	51	48	4
e)	mg/kg	4	0.5	1	<0.5	1	1	1	1	<0.5	
	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<(
	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<
	mg/kg	360	2.5	69	103	67	64	71	66	72	6
	mg/kg	0.03	0.02	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<(
	mg/kg	0.37	0.02	<0.1	<0.1	6	3.8	<0.1	<0.1	<0.1	<(
e	mg/kg	0.082	0.02	<0.1	<0.1	6.5	4.4	0.4	<0.1	<0.1	<(
	mg/kg	11	0.04	<0.1	<0.1	53.8	28	16.2	<0.1	26.3	<(
	mg/kg	310	10	5.3	190	1810	1480	657	23	671	1
)	mg/kg	760	10	55.6	4510	15400	11700	1910	136	20200	17
)	mg/kg	1,700	10	200	220	296	332	49.1	23	1110	2
)	mg/kg	3,300	10	68.3	47	68	9.6	22	<7.1	16	2
	mg/kg	22	0.008	<0.1	<0.1	22.2	19.2	2.3	<0.1	1.7	0
hthalene	mg/kg	---	0.005	<0.1	<0.1	24.4	36.5	6	<0.1	20.3	<(
hthalene	mg/kg	---	0.005	<0.1	<0.1	17.2	29.6	4	3	20.5	<(
aphthalene	mg/kg	---	0.005	<0.1	<0.1	10	19.5	2.4	4.2	21.1	0
ene	mg/kg	---	0.004	<0.1	<0.1	0.1	0.2	<0.1	<0.1	0.3	<(
ie	mg/kg	---	0.004	<0.1	<0.1	0.3	0.7	<0.1	<0.1	0.5	<(
naphthalene	mg/kg	---	0.007	<0.1	<0.1	0.5	1.2	0.2	0.3	1.8	0
	mg/kg	---	0.007	<0.1	<0.1	0.1	0.5	<0.1	<0.1	0.5	<(
ie	mg/kg	50	0.01	<0.1	<0.1	<0.1	0.2	<0.1	0.2	0.2	<(
	mg/kg	---	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
e	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
	mg/kg	100	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
nanthrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
hracene	mg/kg	10	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
	mg/kg	---	0.005	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
oranthene	mg/kg	10	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
ene	mg/kg	0.7	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
lanthrene	mg/kg	---	0.022	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
cd)pyrene	mg/kg	10	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
anthracene	mg/kg	10	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
erylene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
pyrene	mg/kg	---	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(
)pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<(

the criteria

ICIL OF MINISTERS OF THE ENVIRONMENT (CCME)

e Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

e Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

iediments collected in a dry or temporary drainage, considered like a soil.

Figure 58. (S-10216) Baker's Dozen map 1.

Figure 59. (S-10216) Baker's Dozen map 2.

4.24 S-10217 BUILDING 113, HEATED VEHICLE STORAGE

4.24.1 Location and Site Description

Building 113, Heated Vehicle Storage, is located at the northwest end of the CFS-Alert main station, north of the Vehicle Maintenance building (Figures 60 and 61). This building is sheathed in corrugated steel and has a gravel floor. Station vehicles are stored in this building during the winter and periods of inclement weather. One fuel tank covered by a metal hut and a small pipeline are located in the northeast corner of the building. A fuel tank was located west of the building but was removed prior to the 2006/07 sampling campaign. A Cold Storage building (Building 110) was located north of the Building 113 and was demolished prior to the 2006/07 sampling campaign. During the 2006/07 and 2007/08 sampling campaigns, a pool of standing water was noted at the old location of Building 110. Several pools of standing water were present on the west side of the site, behind the Heated Vehicle Storage building.

The topography is level. Clayey, silty soils with some gravel and shale stones are predominant in the surrounding area. No drainage channels were noted around Building 113, but a drainage ditch is located at the west end of the site. This drainage ditch leads downhill to the south and links to the drainage ditch adjacent to Herc Drive. The site is located roughly 650 m from Dumbell Bay.

4.24.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, a strong hydrocarbon odor was detected on site and stained areas inside and outside Building 113 were noted. Three soil samples, including one subsurface sample, were collected at this time. Subsurface sample (06VH0135) was collected at a depth of 50 cm from a stained

area reported during the 1999 sampling campaign on the northern exterior corner of the building. This sample contained toluene, ethylbenzene, total xylene and TPH Fractions 1 and 2 at concentrations exceeding the CCME guidelines (Table 50). No metals were detected above the CCME guidelines in this sample. Sample 06VH0136 was collected inside Building 113 and had concentrations of TPH Fractions 2, 3 and 4 moderately (Fractions 2 and 4) to significantly (Fraction 3) above CCME guidelines. No metals or PAHs exceeded CCME guidelines in this sample. The last sample was collected at the southeast corner of Building 113 and analyzed for metals and hydrocarbons. No metals, BTEX or TPH exceeded the CCME guidelines.

Table 50. (S-10217) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06HV0135	SOIL	50	TOLUENE	0.37	2
		50	ETHYLBENZENE	0.08	2.4
		50	TOTAL XYLENE	11	28
		50	TPH / F1	310	2,100
		50	TPH / F2	760	8,400
06HV0136	SOIL	0-10	TPH / F2	760	1,700
		0-10	TPH / F3	1,700	52,000
		0-10	TPH / F4	3,300	3,900

4.24.3 Nature and Extent of Contamination

In 2007/08, 11 subsurface soil samples, including one duplicate pair, were collected from the north and west sides of Building 113. The soil samples were collected at the suprapermafrost layer, ranging from 60 cm to 110 cm below surface, and were analyzed for metals, BTEX, TPH and PAHs (Table 51). No soil sample was collected on the south side of Building 113 due of the presence of underground high-tension cables and wires. One groundwater sample was collected and analyzed for metals, BTEX TPH and PAHs.

One soil sample contained arsenic concentrations slightly above the CCME guideline. Eight soil samples had petroleum hydrocarbon concentrations above the applicable CCME guidelines.

Sample B07-HV-0575, collected near the old fuel tank location and upgradient from the other collection points, had concentrations of benzene, toluene, ethylbenzene, total xylene and TPH Fractions 1 and 2 above CCME guidelines. The samples collected downgradient from the fuel tank had varying degrees of BTEX and TPH contamination. The hydrocarbon concentrations tended to decrease as the distance from the fuel tank increased, providing a rough indication of the shape of the contaminated area. The size of the plume is approximately 70 m long by 30 m wide by 1 m deep, which gives equals roughly 2,100 m^3 of contaminated soil.

The groundwater sample (B07-HV-0595W) was collected from a trench dug to collect soil sample B07-HV-0581. Copper, lead and selenium were detected above the CCME guidelines. TPH Fractions 2 and 3 were detected at low concentrations in this sample, but no guidelines currently exist for these contaminants. Naphthalene concentrations exceeded the CCME guideline for aquatic life.

According to the FCSAP classification system, this is a Class 1 site (76.7). The estimated volume of contaminated soil is 1,890 m^3. The results from the 2006/07 and 2007/08 sampling campaigns indicated that action is required to address the existing contamination.

4.24.4 Recommendations

The majority of the TPH contamination at this site is located to the south-west of the building and follows a shallow drainage channel away from the building. The drainage ditch heads downhill and links to the drainage ditch adjacent to an access road. Complete delineation of the drainage ditch needs to be completed to establish the total extent of contamination originating from this site. This includes taking multiple depth samples to determine the level of TPH penetration into the drainage channel. Once the total extent of contamination is established a remediation plan can be developed, examining either *in situ* or *ex situ* options.

Bldg 113, Heated Vehicle Storage (S-10217)											
WATER	SOIL										
B07-HV-0595W Fresh water Groundwater 8/23/2007	B07-HV-0062 Dup. 576 100 cm 8/23/2007	B07-HV-0575 110 cm 8/23/2007	B07-HV-0576 100 cm 8/23/2007	B07-HV-0577 90 cm 8/23/2007	B07-HV-0578 100 cm 8/23/2007	B07-HV-0579 110 cm 8/23/2007	B07-HV-0580 60 cm 8/23/2007	B07-HV-0581 70 cm 8/23/2007	B07-HV-0582 100 cm 8/23/2007	B07-HV-0583 80 cm 8/23/2007	B07-HV-0584 60 cm 8/23/2007
3	3.9	11.6	9.4	11.1	14.4	11.8	9.0	4.3	4.9	3.9	3.5
20	14	18	16	17	18	18	18	19	16	16	14
<1	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
3	16	27	25	26	25	29	24	17	17	17	19
<1	6	13	11	11	11	14	10	6	7	6	8
8	12	26	21	20	18	25	18	10	9	10	11
1	12	17	15	15	15	17	18	25	11	16	11
43	317	530	494	468	549	578	480	327	306	321	363
3	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
7	22	44	38	39	35	48	35	23	22	22	27
2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
20	26	66	56	58	55	69	58	29	28	29	29
<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	0.9	3.0	2.1	1.5	3.0	<0.1	<0.1	<0.1	<0.1	0.4	<0.1
<0.1	0.2	6.7	1.6	2.2	3.9	<0.1	0.4	<0.1	<0.1	0.9	0.3
<0.1	7.2	35.3	30.4	20.3	45.9	<0.1	2.8	<0.1	<0.1	82.8	1.0
<25	1,610	689	1,060	1,870	2,100	<2.7	628	<2.7	<3.6	2,300	772
420	11,600	4,630	6,520	12,500	18,800	<2.9	7,460	<1.8	<2.1	6,490	7,980
170	272	124	327	172	264	<6.7	361	35	48	1360	916
<55	32	22	41	39	39	<9.5	165	17	21	540	206
2.26	2.0	8.1	8.4	18.2	0.4	<0.1	0.4	<0.1	<0.1	1.6	<0.1
NA	5.5	17.2	22.8	44.8	1.3	<0.1	1.6	<0.1	<0.1	3.1	0.9
NA	4.0	10.7	17.0	37.5	2.4	<0.1	7.0	<0.1	<0.1	3.2	1.0
NA	2.6	8.5	10.3	21.0	3.5	<0.1	8.0	<0.1	<0.1	4.4	0.8
NA	<0.1	0.1	0.2	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.27	<0.1	0.3	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	0.2	0.7	1.0	1.1	0.3	<0.1	0.4	<0.1	<0.1	0.3	<0.1
0.17	<0.1	0.2	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.03	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.03	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.04	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Figure 60. (S-10217) Building 113, Heated Vehicle Storage map 1.

Figure 61. (S-10217) Building 113, Heated Vehicle Storage map 2.

4.25 S-10218 BURNER PROJECT SITE (Old Hazmat Storage Site)

4.25.1 Location and Site Description

The Burner Project site is situated in the area northwest of the CFS-Alert main station, on the west side of Pusher Road (Figures 62 and 63). In 1998 this site was allocated for the burning of hydrocarbon wastes. The burner site was used until 2000 to reduce the inventory of hydrocarbon waste. During the three years of operation, it was estimated that thousands of liters of fuel and oil were disposed of (ESG 2000). A burner, mixer and diesel tank were removed from the site when it was decommissioned. The Burner Project site is currently inactive and human activities no longer occur on site. Soil was excavated from the site to construct a berm on the northeast and southeast sides of the site.

The topography is level with a gentle southwest slope. During the 2006/07 and 2007/08 sampling campaigns one large pool of standing water was observed on site, contained on one side by the southeast berm. This indicates that the underlying material is highly impermeable to water. No drainage channel was observed on site. The soil is mainly composed of natural coarse shaly material mixed with silt and shale stones.

4.25.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, four trenches 4 to 6 m in length, 1.0 m in width and 0.60-1.0 m in depth were excavated in and around the old burner location and at the southeast end of the site. One composite soil sample was collected in each trench at a depth ranging from 40 to 60 cm. The samples were analyzed for metals, TPH and BTEX.

Sample 06BU0125 collected northeast of the site contained nickel concentrations exceeding the CCME guideline. TPH Fractions 1 and 2, toluene, ethylbenzene and total xylene concentrations above the CCME guidelines were also found in this soil sample (Table 52).

The samples collected around the old burner location (06BU0122 and 06BU0126) contained arsenic and nickel concentrations slightly higher than the CCME guidelines. Sample 06BU0000 was collected in the middle of the old burner location. This sample contained chromium, copper, nickel and zinc concentrations above CCME guidelines. Concentrations of TPH Fraction 2, 3 and 4 above the CCME guidelines were also observed in this sample.

Table 52. (S-10218) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06BU0000	SOIL	0-10	CHROMIUM (CR)	87	302
		0-10	COPPER (CU)	91	118
		0-10	NICKEL (NI)	50	1,670
		0-10	ZINC (ZN)	360	1,660
		0-10	TPH / F2	760	4,300
		0-10	TPH / F3	1,700	25,000
		0-10	TPH / F4	3,300	4,800
06BU0122	SOIL	40	ARSENIC (AS)	12	14
		40	NICKEL (NI)	50	51
06BU0125	SOIL	50	NICKEL (NI)	50	76
		50	TOLUENE	037	6
		50	ETHYLBENZENE	0.08	6.5
		50	TOTAL XYLENE	11	48
		50	TPH / F1	310	1,200
		50	TPH / F2	760	4,300
06BU0126	SOIL	60	ARSENIC (AS)	12	19.9
		60	NICKEL (NI)	50	51

4.25.3 Nature and Extent of Contamination

In 2007/08, 25 soil samples, including two duplicate pairs and one surface groundwater sample were collected at the Burner Project site. The samples were collected mainly along the southern limit of the site to delineate the extent of the metals and TPH contamination previously reported. The samples were analyzed for metals, TPH, BTEX and PAHs (Table 53).

Nickel and arsenic concentrations exceeding the CCME guidelines were detected in 13 and 22 samples, respectively. This contamination was wide spread over the south end of the site. In the areas demonstrating metals contamination, the subsurface geology is predominantly larger grained material interspersed between fractured shale deposits. One sample had selenium concentration slightly above the CCME guideline.

Six soil samples, including one duplicate pair, contained TPH Fraction 2 above the CCME guideline. One of these samples was also above TPH Fraction 3 guidelines (B07-BU-0240). These samples were generally located within and around the former location of the burner. These contaminated areas appear to be relatively small and contained. No BTEX or PAH concentrations were measured above the CCME guidelines.

The Burner Project is a Class 2 site (65.8) according to the FCSAP classification system. The estimated volume of contaminated soil is 1,103 m^3. The contamination is widely spread and there is a risk of off-site contamination towards the south. Action is likely required.

4.25.4 Recommendations

The nature of this site poses several challenges. In the center of the site there was a large accumulation of water suggesting that the underlying material is highly impermeable to water. TPH was detected above guidelines in several areas including the former location of the burner and in the storage area. These contaminated areas appear to be relatively small and contained. Heavy metal contamination, and in particular arsenic and nickel, is more widespread. In almost all of the samples taken from the south side of the site, one or both of arsenic (12 mg/kg) and nickel (50 mg/kg) surpassed the guidelines (18 and 12 sites, respectively). In the areas demonstrating heavy metal contamination, the subsurface geology is predominantly larger grained material interspersed between fractured shale deposits.

The site requires further delineation. For the TPH contamination, the standing water at the site needs to be removed prior to sampling. The most appropriate approach to remediate the TPH contamination, based on the highly impermeable nature of the soil, is excavation and *ex situ* biopile treatment permitting proper aeration and fertilizer amendment. The heavy metal contamination at the burner site requires further delineation, particularly towards the south and southwest which are areas of lower elevation.

Table 53. (S-10218) Burner Project Site 2007/08 results.

		Burner Project Site (S-10218)			
		WATER			WATER
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B07BU0259-W Groundwater Fresh water 8/05/2007
TPH	F1 (C6-C10)	ug/L	---	100	<50
	F2 (C10-C16)	ug/L	---	100	99
	F3 (C16-C34)	ug/L	---	100	431
	F4 (C34-C50)	ug/L	---	100	<33
PAH	Naphthalene	ug/L	1.1	0.04	<0.03
	2-methylnaphthalene	ug/L	---	0.04	NA
	1-methylnaphthalene	ug/L	---	0.04	NA
	1,3-Dimethylnaphthalene	ug/L	---	0.04	NA
	Acenaphthylene	ug/L	---	0.03	NA
	Acenaphthene	ug/L	5.8	0.04	<0.05
	2,3,5-trimethylnaphthalene	ug/L	---	0.05	NA
	Fluorene	ug/L	3	0.05	<0.01
	Phenanthrene	ug/L	0.4	0.04	<0.01
	Anthracene	ug/L	0.012	0.04	<0.03
	Fluoranthene	ug/L	0.04	0.04	0.01
	Pyrene	ug/L	0.025	0.04	<0.01
	Benzo(c)Phenanthrene	ug/L	---	0.04	<0.02
	Benzo(a)Anthracene	ug/L	0.018	0.04	NA
	Chrysene	ug/L	---	0.04	<0.03
	[illegible]	ug/L	---	0.01	NA
	Benzo(b,j,k)fluoranthene	ug/L	---	0.04	<0.04
	Benzo(a)pyrene	ug/L	0.015	0.04	NA
	3-methylcholanthrene	ug/L	---	0.04	NA
	Indeno(1,2,3-cd)pyrene	ug/L	---	0.05	<0.01
	Dibenzo(a,h)anthracene	ug/L	---	0.04	<0.02
	Benzo(g,h,i)perylene	ug/L	---	0.04	NA
	Dibenzo (a,l) pyrene	ug/L	---	0.04	NA
	Dibenzo (a,i) pyrene	ug/L	---	0.04	NA
	Dibenzo (a,h) pyrene	ug/L	---	0.05	NA

NA Not available
Higher than the criteria

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

Burner Project Site (S-10218)										
SOIL										
07BU0241 80 cm 8/05/2007	B07BU0242 70 cm 8/05/2007	B07BU0243 60 cm 8/05/2007	B07BU0244 90 cm 8/05/2007	B07BU0245 90 cm 8/05/2007	B07BU0246 80 cm 8/05/2007	B07BU0247 80 cm 8/05/2007	B07BU0248 70 cm 8/05/2007	B07BU0249 80 cm 8/05/2007	B07BU0250 Dup. 244 90 cm 8/05/2007	B07BU0251 70 cm 8/05/2007
24.7	21.9	14.8	14.0	29.2	19.8	14.5	48.1	12.1	20.6	11.8
23	23	16	16	22	17	56	102	51	20	24
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
34	23	23	23	29	25	26	33	28	23	25
23	21	21	13	17	14	27	74	22	15	14
24	23	26	16	29	20	52	71	30	21	22
17	17	14	14	20	17	22	16	13	16	18
673	652	499	352	577	509	1270	3390	750	403	462
<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
59	41	46	32	46	35	78	107	53	40	39
<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.8	0.5	<0.5	<0.5
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
74	53	55	49	64	51	77	91	63	54	57

SOIL									
07BU0254 70 cm /05/2007	B07BU0255 60 cm 8/05/2007	B07BU0256 100 cm 8/05/2007	B07BU0257 80 cm 8/05/2007	B07BU0258 80 cm 8/05/2007	B07BU0259 40 cm 8/05/2007	B07BU0260 40 cm 8/05/2007	B07BU0261 70 cm 8/05/2007	B07BU0262 60 cm 8/05/2007	B07BU0263 60 cm 05/08/2007
23.3	9.3	34.5	15.1	15.1	89.5	28.5	2.5	17.4	16.5
41	23	23	10	20	8	14	19	26	19
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	0.9	<0.9	<0.9
31	35	33	24	27	31	28	35	23	30
20	21	22	11	18	27	16	17	17	17
26	32	33	18	20	77	36	46	31	29
19	19	19	14	27	32	18	<10	<10	16
721	501	681	486	564	285	532	281	576	480
<2	<2	<2	<2	<2	2	<2	<2	<2	<2
53	64	58	36	37	73	47	51	47	52
<0.5	<0.5	0.6	<0.5	<0.5	0.8	<0.5	<0.5	<0.5	4
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
65	77	70	48	58	88	61	87	63	66

Burner Project Site (S-10218)										
SOIL										
240 07	B07BU0241 80 cm 8/05/2007	B07BU0242 70 cm 8/05/2007	B07BU0243 60 cm 8/05/2007	B07BU0244 90 cm 8/05/2007	B07BU0245 90 cm 8/05/2007	B07BU0246 80 cm 8/05/2007	B07BU0247 80 cm 8/05/2007	B07BU0248 70 cm 8/05/2007	B07BU0249 80 cm 8/05/2007	B07BU0250 Dup. 244 90 cm 8/05/2007
	<3.6	<2.5	<3.2	215	100	3.4	<2.6	<2.3	<2.7	199
	22.1	22.2	13.9	2,360	352	17	<2	<1.9	1.3	2,010
	13	18	6.5	54.8	23	5.8	9.8	<4.5	5.2	49.4
	<6	<6.2	<4.1	<6.2	<5.6	<7.2	8.9	<6.4	<3.9	<7

Burner Project Site (S-10218)										
SOIL										
B07BU0253 Dup. 252 70 cm 8/05/2007	B07BU0254 70 cm 8/05/2007	B07BU0255 60 cm 8/05/2007	B07BU0256 100 cm 8/05/2007	B07BU0257 80 cm 8/05/2007	B07BU0258 80 cm 8/05/2007	B07BU0259 40 cm 8/05/2007	B07BU0260 40 cm 8/05/2007	B07BU0261 70 cm 8/05/2007	B07BU0262 60 cm 8/05/2007	B07BU0263 60 cm 05/08/2007
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
229	3.5	<3	<2.8	118	<2.8	<2.8	<2.8	<3.1	<2.7	<3.3
1,650	22.9	17.5	13	1,330	19.2	14	21.2	<1.7	7.3	<1.8
41	10	21	12	39.3	23	13	19	<4	<3.3	<4.3
<5.3	<6.3	7.6	<7	<5.4	6	<5.4	6.2	<5.7	<4.6	<6.1

Environmental Health in Industrial land uses, of the CCME (2006)

Figure 62. (S-10218) Burner Project Site map 1.

Figure 63. (S-10218) Burner Project Site map 2.

4.26 S-10219 NEW FUEL LINE SPILL 1999

4.26.1 Location and Site Description

In 1999 a fuel spill occurred from a broken valve on the Diesel Fuel Pipeline which connects the Airstrip Fuel Tanks to the 8 Diesel Fuel Storage tanks. The broken valve was located approximately halfway along the pipeline, north of the Gravel Storage pile, on the west side of Lancaster Drive (Figures 64 and 65).

The area of the 1999 spill is a natural drainage area where large volumes of water from the snowmelt pass through to reach Dumbell Bay. There are a multitude of drainage pathways and channels across this area. Upon discovery of the fuel spill, 2 dykes were constructed in an effort to redirect snowmelt waters and minimize the amount of water passing through the site.

The topography of the site slopes gently eastward towards Dumbell Bay. The 1999 New Fuel Line Spill site is located approximately 400 m upgradient from Dumbell Bay. The soil is mainly composed of natural shaly material mixed with fill material and coarse to fine gravels.

4.26.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During the 2006/07 sampling campaign, there was a strong hydrocarbon odor in the vicinity of the site but no iridescence was visible on the surface water. A total of three soil samples, including 1 duplicate pair, were collected and tested for BTEX and TPH. An attempt at collecting a groundwater sample was made but there was not sufficient groundwater.

In the duplicate pair of soil samples collected near the diesel pipeline, concentrations of toluene, ethylbenzene, total xylene and TPH Fractions 1 and 2 were above the CCME guidelines (Table

54). The soil sample collected further west from the diesel pipeline contained no petroleum hydrocarbons above the CCME guidelines.

Table 54. (S-10219) Previous contaminated sample.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06NF0022	SOIL	30	TOLUENE	0.37	20
		30	ETHYLBENZENE	0.08	41
		30	TOTAL XYLENE	11	170
		30	TPH / F1	310	7,200
		30	TPH / F2	760	29,000

4.26.3 Nature and Extent of Contamination

In 2007/08, 30 subsurface soil samples, including four duplicate pairs, were collected and analyzed for TPH and BTEX. Four soil samples were also analyzed for PAHs (Table 55). Five and 9 soil samples contained TPH Fractions 1 and 2 at concentrations greater than the CCME guidelines, respectively. Toluene, ethylbenzene and total xylene concentrations exceeded the CCME guidelines in two of these samples (B07-NF-0307 and B07-NF-0365). Ethylbenzene at a concentration above the CCME guideline was also detected in one additional sample (B07-NF-0311). The delineation of the TPH contamination gives an area of approximately 5,875 m^2. No PAHs were detected above the guidelines for the four samples analyzed (B07-NF-0310, -0323, -0324 and -0366).

According to the FCSAP classification system, the New Fuel Spill 1999 site scored 77.7 and is a Class 1 site. The estimated volume of contaminated soil is 8,320 m^3. The proximity of Dumbell Bay increases the risk of environmental impact, and combined with the FCSAP score, indicates that action is required at this site.

4.26.4 Recommendations

The contamination at this site is fairly extensive (approximately 5,875 m^2) and has migrated a significant distance downgradient from the initial break in the pipeline. Due to the nature of the

TPH migration, a potentially smaller volume of soil may be contaminated. Once the contamination exited the initial impacted area (approximately half the measured area), it descended to the level of the permafrost and is only found in the layer of soil approximately 40 cm immediately above the permafrost. The upper approximately 40 cm of soil (ie. from the surface to 40 cm below surface) is not contaminated. The direction of contaminant migration has been towards a large drainage ditch bordering on the road leading to the airstrip. This drainage is connected directly to other drainage areas eventually leads to Dumbell Bay (approximately 400 m away) and as such is of concern.

Due to the extent of contamination and the presence of both pipeline supports and runway landing lights, *in situ* treatment is deemed the most appropriate remediation approach for this site.

New Fuel Line Spill 1999 (S-10219)												
SOIL												
37 2 7	B07-NF-0038 Dup.311 80 cm 8/11/2007	B07-NF-0307 60 cm 8/11/2007	B07-NF-0308 80 cm 8/11/2007	B07-NF-0309 60 cm 8/11/2007	B07-NF-0310 60 cm 8/11/2007	B07-NF-0311 80 cm 8/11/2007	B07-NF-0312 80 cm 8/11/2007	B07-NF-0314 70 cm 8/11/2007	B07-NF-0315 65 cm 8/11/2007	B07-NF-0316 55 cm 8/11/2007	B07-NF-0317 65 cm 8/11/2007	B07-NF-0318 65 cm 8/11/2007
	NA	<0.2	<0.1	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	NA	0.7	<0.1	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	NA	2.2	<0.1	NA	<0.1	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	NA	73.8	<0.1	NA	6.1	4.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
	138	545	166	18	365	85.4	102	4.3	255	3.1	63.4	<2.7
	839	5,660	588	54.4	1,400	423	378	8.7	843	7.2	444	5.4
	20	87	19	<4.4	22	23	28	85.9	26	12	39.7	24.5
	10	46	6.3	<6.3	5.9	6.5	13	29	13	6.9	17	13

New Fuel Line Spill 1999 (S-10219)											
SOIL											
NF-0321) cm 1/2007	B07-NF-0322 45 cm 8/11/2007	B07-NF-0323 80 cm 8/11/2007	B07-NF-0324 60 cm 8/11/2007	B07-NF-352 > 80 cm 8/11/2007	B07-NF-0365 70 cm 8/11/2007	B07-NF-0366 50 cm 8/11/2007	B07-NF-0367 65 cm 8/11/2007	B07-NF-0368 40 cm 8/11/2007	B07-NF-0369 40 cm 8/11/2007	B07-NF-0370 60 cm 8/11/2007	B07-NF-0371 40 cm 8/11/2007
<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	NA	<0.1	<0.1	NA	1.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<0.1	NA	<0.1	<0.1	NA	4.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2.6	NA	<0.1	<0.1	NA	38.1	<0.1	<0.1	<0.1	<0.1	1	<0.1
16.7	264	7.1	60	<2.5	607	16	19	<3.6	<3.5	392	4
168	3,570	32.7	318	20.8	7,200	63.5	316	<2.1	9.8	1,830	<2.1
16	74.3	15	24	362	83.1	22.1	96	77.4	61.9	17	59.4
12	22	13	12	<6.4	26	11	41	34	31	11	30

umental Health in Industrial land uses, of the CCME. (2006)
ial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Figure 64. (S-10219) New Fuel Line Spill 1999 map 1.

Figure 65. (S-10219) New Fuel Line Spill 1999 map 2.

4.27 S-10522 AES WEATHER STATION REMAINS-GA

4.27.1 Location and Site Description

The AES Weather Station Remains-GA site is located in an area southeast of the CFS-Alert main station and east of the ESG C-Span building (Figures 66 and 67). The Weather Station buildings were demolished in 1995 and all that remains are two concrete foundations: the first one (weather station building) is located directly east of the C-Span building and the second one (weather station storage) is 200 m east of the first one (Photograph 31, Appendix A). Debris from old burn piles were found south of the Weather Station Remains site.

The area south of the Weather Station Remains is used as storage for material such as wood pallets, antenna, machinery, new wire spools, gas cylinders, construction materials, etc. Heavy road equipment is also stored at the site, near the C-Span building. During the 2007/08 sampling campaign, four new tanks were stored at the east end of the site.

The topography of the site is flat with a strong slope at the east end of the site heading towards Alert Inlet. The Inlet is located approximately 300 m downhill from the site. The soil in the area consists of native clay and silt, with some gravel from the fill material of the old foundation. All drainage pathways lead into a main drainage pathway located southeast of the site leading into Alert Inlet.

4.27.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

During 2006/07, four soil samples were collected: 3 samples were taken near the concrete foundations and 1 sample was taken near an old burn pile. The samples were analyzed for

metals, BTEX and TPH. Nickel at concentrations slightly above the CCME guideline was detected in one soil sample collected east of the foundations (Table 56). The sample collected near the old burn pile contained arsenic slightly above the CCME guideline.

One sample collected west of the first foundation (06WS0146) contained toluene and ethylbenzene above the CCME guideline concentrations. This sample, as well as a sample collected northwest of the first foundation (06WS0144), showed TPH Fraction 2 concentrations above the CCME guideline.

Table 56. (S-10522) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06WS0141	SOIL	0-10	ARSENIC (AS)	12	14.3
06WS0144	SOIL	0-10	TPH / F2	760	1,300
06WS0145	SOIL	0-10	NICKEL (NI)	50	52
06WS0146	SOIL	0-10	TOLUENE	0.37	0.38
		0-10	ETHYLBENZENE	0.08	0.28
		0-10	TPH / F2	760	6,100

4.27.3 Nature and Extent of Contamination

In 2007/08 a total of 16 soil samples were collected from around the remains of the foundations and one soil sample was collected in the area south of the site, near an old burn pile. The samples were taken from depths between 40-70 cm and analyzed for BTEX, TPH and PAHs. Eight samples were also analyzed for metals (Table 57). The results showed copper at a concentration slightly higher than the CCME guideline in 1 soil sample (B07-WS-0109). Toluene, ethylbenzene and total xylene concentrations exceeding the CCME guidelines were measured in 5, 5 and 3 soil samples, respectively, collected around the south and the east sides of the first foundation. Three of these samples contained naphthalene concentrations higher than the CCME guidelines. TPH Fractions 1 and 2 were also detected above the CCME guideline concentrations in 7 and 10 samples, respectively, collected next to and south of the foundations.

The samples collected on the north side of the foundations did not demonstrate petroleum hydrocarbon concentrations exceeding the CCME guidelines.

The AES Weather Station Remains-GA site is Class 1 (75.6) according to the FCSAP classification system. The estimated volume of contaminated soil is 1,800 m^3. The results from the 2006/07 and 2007/08 sampling campaigns indicate that the potential for adverse off-site contamination is high and action is required.

4.27.4 Recommendations

The TPH contamination detected on site has so far been located to the east of the remaining building (the other 2 buildings have been removed). The eastern limit of contamination has been detected, but remains to be determined for the area due south of the remaining building.

Delineation of the contamination at the southern portion of the site is required. Once the limits have been established, remediation of the site can proceed. Due to the size of the site and its location, the most appropriate approach to remediation of the site is an *in situ* system. A final design will be based on the *in situ* treatment pilot study to be performed during the summer of 2008.

AES Weather Station Remains-GA (S-10522)					
SOIL					
B07-WS-0106 50-70 cm 8/23/2007	B07-WS-0107 50-70 cm 8/23/2007	B07-WS-0108 50-70 cm 8/23/2007	B07-WS-0109 50 cm 8/23/2007	B07-WS-0112 50-70 cm 8/23/2007	B07-WS-0113 70 cm 8/23/2007
8.3	7.5	8.0	7.1	9.5	9.1
16	15	12	15	17	15
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
25	27	23	21	26	25
11	11	10	9	13	12
15	15	14	95	17	15
<10	<10	<10	<11	<10	<10
474	588	479	463	528	495
<2	<2	<2	<2	<2	<2
39	41	36	34	41	38
1.0	0.6	<0.5	<0.5	<0.5	<0.5
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<5	<5	<5	<5	<5	<5
55	61	52	57	60	55

.).

AES Weather Station Remains-GA (S-10522)												
SOIL												
0104 m 07	B07-WS-0105 50 cm 8/23/2007	B07-WS-0106 50-70 cm 8/23/2007	B07-WS-0107 50-70 cm 8/23/2007	B07-WS-0108 50-70 cm 8/23/2007	B07-WS-0109 50 cm 8/23/2007	B07-WS-0112 50-70 cm 8/23/2007	B07-WS-0113 70 cm 8/23/2007	B07-WS-0545 40-50 cm 8/23/2007	B07-WS-0546 40-50 cm 8/23/2007	B07-WS-0547 40-50 cm 8/23/2007	B07-WS-0548 40-50 cm 8/23/2007	B07-WS-0549 50 cm 8/23/2007
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.4	<0.1	0.4
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.4
	<0.1	<0.1	4.4	<0.1	<0.1	<0.1	<0.1	2.4	<0.1	4.4	1.6	7.4
	301	<3.6	418	15	<3.6	<3.8	<3.6	180	<3.4	764	373	379
0	8,750	60	19,100	919	38.7	<2.5	<2.1	6,370	<2.7	11,700	4,640	7,530
	691	126	4,800	202	341	24	38	1,320	150	1,710	292	1,930
	42	33	126	41	140	23	19	406	83	258	54	514
	0.4	<0.1	1.9	<0.4	<0.1	<0.1	<0.1	2.1	<0.1	1.2	1.2	10.3
	<0.1	<0.1	26.3	<0.4	<0.1	<0.1	<0.1	14.8	<0.1	9.5	16.1	62.5
	<0.1	<0.1	51.3	<0.4	<0.1	<0.1	<0.1	8.4	<0.1	31.0	19.1	26.7
	0.2	<0.1	51.4	<0.4	<0.1	<0.1	<0.1	9.5	<0.1	33.8	12.7	19.3
	0.2	<0.1	0.9	<0.4	<0.1	<0.1	<0.1	0.1	<0.1	0.5	0.1	0.1
	0.2	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	0.4	<0.2	0.8	0.3	0.5
	1.0	<0.1	8.3	<0.4	<0.1	<0.1	<0.1	0.6	<0.3	4.5	0.9	2.8
	<0.1	<0.1	0.9	<0.4	<0.1	<0.1	<0.1	<0.1	<0.4	0.5	0.3	0.6
	<0.1	<0.1	2.5	<0.4	<0.1	<0.1	<0.1	0.2	<0.5	0.8	0.4	0.8
	<0.1	<0.1	0.2	<0.4	<0.1	<0.1	<0.1	0.2	<0.6	<0.1	<0.1	<0.1
	<0.1	<0.1	0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.7	0.1	<0.1	0.1
	<0.1	<0.1	0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.8	0.1	<0.1	0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.9	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.10	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.11	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.12	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.13	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.14	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.15	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.16	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.17	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.18	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.19	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.20	<0.1	<0.1	<0.1
	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	<0.21	<0.1	<0.1	<0.1

Figure 66. (S-10522) AES Weather Station Remains-GA map 1.

Figure 67. (S-10522) AES Weather Station Remains-GA map 2.

4.28 S-10524 SEWAGE OUTFALL

4.28.1 Location and Site Description

The Sewage Outfall is located southeast of the CFS-Alert main station, behind the Gym and Curling Club complex (Figures 68 and 69). The sewage pipeline ends approximately 150 m uphill from Alert Inlet (Photograph 32, Appendix A). The waste stream runs down the slope the northwest to southeast ending in Alert Inlet. The drainage channel created by the waste stream is called the outfall runoff (Photograph 33, Appendix A). The topography of the site is a strong slope and the soil is mainly natural shale stone mixed with shaly silt and clay. Domestic garbage and barrels are sparsely spread around the area.

There is a proliferation of vegetation such as plants and algae along the outfall runoff. The proliferation is due to the nutrients contained in the waste stream. This site represents a habitat for insects, birds and small mammals (Photograph 34, Appendix A).

4.28.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07 a total of 7 samples were collected, including 4 soil samples, 1 marine sediment sample (06SO0036) and 2 freshwater samples (06SO0078 and 06SO0079). All samples were tested for metals, phenols, nitrates-nitrites, phosphates and total phosphorus. Copper concentrations exceeded the guidelines in all samples except one soil sample (Table 58). Lead and zinc concentrations above the CCME guidelines were measured in 1 surface water sample. Cadmium, lead, and zinc concentrations exceeded the CCME guidelines in the marine sediment sample. Phenolic compounds were not detected above the CCME guidelines in the samples.

Table 58. (S-10524) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06SO0031	SOIL	0	COPPER	91	790
06SO0033	SOIL	0	COPPER	91	94
06SO0037	SOIL	0-10	COPPER	91	91
06SO0036	SOIL	0	CADMIUM	0.7	1.7
		0	COPPER	18.7	1,100
		0	LEAD	30.2	47
		0	ZINC	124	350
06SO0078	WATER	SURFACE	COPPER (CU)	2-4	52
06SO0079	WATER	SURFACE	COPPER (CU)	2-4	64
		SURFACE	LEAD (FE)	1-7	14
		SURFACE	ZINC (ZN)	30	30

4.28.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign 16 subsurface soil samples, including one duplicate pair, were collected. Three marine sediment samples were collected from Alert Inlet (B07-SO-0422, -0423 and -0425) and two surface water samples were taken at the sewage pipeline outfall and at the end of the outfall runoff (B07-SO-0408 and B07-SO-0428, respectively). The samples were analyzed for metals, non-chlorinated phenolic compounds, nitrates, nitrites and total phosphorus. (Table 59) The soil and sediments samples were also analyzed for non-chlorinated phenolic compounds.

Only copper concentrations exceeded the CCME concentrations in the duplicate pair of soil samples. No phenolics compounds were detected in the soil samples.

All marine sediment samples contained copper concentrations above the CCME guideline for aquatic life. Arsenic, cadmium and lead concentrations exceeded the CCME guidelines in one sediment sample. No guidelines for phenolics in sediments currently exists, however phenol (6.6

mg/kg) and p-cresol (37.5 mg/kg) concentrations in one marine sediment sample were higher than the CCME guidelines (3.8 mg/kg and 10 mg/kg, respectively) for soil.

The water sample collected at the sewage pipeline outfall (B07-SO-0408) contained cadmium, copper, lead, selenium and zinc concentrations exceeding the CCME guidelines for aquatic life. The zinc concentration was of concern as it was 10 times above CCME guideline. The water sample collected at the end of the outfall runoff, before the entrance into Alert Inlet (B07-SO-0428), contained copper, lead and zinc concentrations higher than the CCME guidelines for aquatic life. The zinc concentration was the same as the CCME guideline. The difference of total phosphorus and metal concentrations between the two water samples suggests an attenuation of the water contamination occurring within the outfall runoff.

The Sewage Outfall is a Class 1 FCSAP site (75.7). The estimated volume of contaminated soil is 1,575 m^3. The contamination directly impacts the environment and potentially threatens human health; therefore this site requires further action.

4.28.4 Recommendations

The raw water exiting from the sewage pipe surpasses guidelines for 5 heavy metals: cadmium (1 µg/L, guideline of 0.017 µg/L), copper (276 µg/L, guideline of 2 - 4 µg/L), lead (3 µg/L, guideline of 1 - 7 µg/L), selenium (3 µg/L, guideline of 1 µg/L), and zinc (340 µg/L, guideline of 30 µg/L). At the bottom of the hill just before entering Alert Inlet, only copper, lead and zinc remain at or above guidelines (60 µg/L, 2 µg/L and 30 µg/L respectively). Only a single soil sample (B07-SO-0420), out of 17, came back positive for heavy metals; copper was detected at 121 mg/kg. The three Alert Inlet sediments sampled directly in front of the sewage outfall were positive for several heavy metals. Samples B07-SO-0422 and B07-SO-0425 were above ISQG and PEL guidelines, respectively, for copper while B07-SO-0423 was above ISGQ guidelines (but below PEL guidelines) for arsenic, cadmium, copper and lead. The presence of copper in the marine sediments was most likely due to leaching from the buried material, as previously discussed in the results of the S-146 Underwater Survey (Section 4.1.4).

The installation of a permanent sewage treatment system is the most appropriate approach to eliminate the discharge of contaminants into Alert Inlet. A second, temporary option would be the construction of a series of linked sequential retention ponds which would permit the precipitation of metals and removal of organic material before discharge into Alert Inlet. The major concern with retention ponds is that most of the year (approx. 9-10 months), average temperatures are at or below freezing which would render the system minimally- or non-functional. Continued sampling of the discharge water before and after entering Alert Inlet should be performed regularly to monitor the concentrations of contaminants entering into Alert Inlet.

One additional point should be addressed; the elevated zinc concentrations detected in water directly from the sewage pipe indicate that a significant source of zinc contamination is present in the system. The source of zinc should be investigated. This would include sampling Upper and Lower Dumbell Lake as well as the water distribution system. Health Canada Guidelines for Drinking Water Quality recommend that zinc does not exceed 5 mg/L in drinking water.

Table 59. (S-10524) Sewage Outfall 2007/08 results.

						Sewage outfall (S-10524)	
		WATER				WATER	
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	EC Discharge Criteria	DETECTION LIMIT	B07-SO-0408 Surface Fresh water 8/15/2007	B07-SO-0428 Surface Fresh water 8/15/2007
METALS	Arsenic (As)	ug/L	5	100	0.0001	1	<1
	Barium (Ba)	ug/L	---	---	0.001	20	<10
	Cadmium (Cd)	ug/L	0.017	10	0.0001	1	<1
	Chromium (Cr)	ug/L	---	10	0.0007	9	6
	Cobalt (Co)	ug/L	---	50	0.0006	1	<1
	Copper (Cu)	ug/L	2-4	200	0.0012	276	60
	Lead (Pb)	ug/L	1-7	50	0.0011	3	2
	Manganese (Mn)	ug/L	---	---	0.0003	78	30
	Molybdenum (Mo)	ug/L	73	---	0.0078	3	1
	Nickel (Ni)	ug/L	25-150	200	0.0005	9	2
	Selenium (Se)	ug/L	1	---	0.0006	3	<1
	Silver (Ag)	ug/L	---	---	0.0008	<0.6	<0.6
	Tin (Sn)	ug/L	---	---	0.011	3	2
	Zinc (Zn)	ug/L	30	1,000	0.006	340	30
	NO2	ug/L	13000	---	20	<40	<20
	NO3	ug/L	60	---	20	<20	<20
	Total phosphorus	ug/L	---	---	250	49,500	570

NA Not available
Higher than the criteria
High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

Table 59. (S-10524) Sewage Outfall 2007/08 results (cont.).

						Sewage outfall (S-10524)		
		MARINE SEDIMENT				MARINE SEDIMENT		
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE		DETECTION LIMIT	B07-SO-0422 0-10 cm 8/15/2007	B07-SO-0423 0-10 cm 8/15/2007	B07-SO-0425 0-10 cm 8/15/2007
			(3) ISQG	(4) PEL				
METALS	Arsenic (As)	mg/kg	7.24	41.6	0.27	6.5	15.7	6.5
	Barium (Ba)	mg/kg	---	---	5	5	19	16
	Cadmium (Cd)	mg/kg	0.7	4.2	0.22	<0.9	1	<0.9
	Chromium (Cr)	mg/kg	52.3	160	3	25	20	18
	Cobalt (Co)	mg/kg	---	---	1.9	13	10	7
	Copper (Cu)	mg/kg	18.7	108	2.1	46	101	194
	Lead (Pb)	mg/kg	30.2	112	1.2	12	46	16
	Manganese (Mn)	mg/kg	---	---	1.1	629	429	341
	Molybdenum (Mo)	mg/kg	---	---	1.4	<2	<2	<2
	Nickel (Ni)	mg/kg	---	---	0.6	34	36	28
	Selenium (Se)	mg/kg	---	---	0.5	1	1	1
	Silver (Ag)	mg/kg	---	---	0.4	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	---	---	0.8	<5	<5	<5
	Zinc (Zn)	mg/kg	124	271	2.5	72	99	87
	NO2	mg/kg	---	---		<0.4	<0.4	<1.0
	NO3	mg/kg	---	---	2	<0.2	<0.2	<0.7
	Phosphore total	mg/kg	---	---	155	615	767	1,120
NON CHLORINATED PHENOLIC COMPOUNDS	Phenol	mg/kg	---	---	0.06	<0.1	<0.1	6.6
	o-Cresol	mg/kg	---	---	0.03	<0.1	<0.1	<0.3
	m-Cresol	mg/kg	---	---	0.04	<0.1	<0.1	<0.3
	p-Cresol	mg/kg	---	---	0.03	<0.1	<0.1	37.5
	2-nitrophenol	mg/kg	---	---	0.05	<0.5	<0.5	<1.5
	2,4-Dimethylphenol	mg/kg	---	---	0.03	<0.1	<0.1	<0.3
	2,4-Dinitrophenol	mg/kg	---	---	0.04	<10	<10	<29
	4-Nitrophenol	mg/kg	---	---	0.04	<0.5	<0.5	<1.5
	2-Methyl-4,6-Dinitrophenol	mg/kg	---	---	0.04	<10	<10	<29

NA Not available
Higher than the criteria
High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

MARINE SEDIMENT (3) Following the Interim Marine Sediment Quality Guideline (ISQG) of the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life of the CCME. (2002)

MARINE SEDIMENT (4) Following the Probable Effect Level (PEL) of the Canadian Sediment Guidelines for the Protection of Aquatic Life of the CCME. (2002)

Sewage outfall (S-10524)													
SOIL													
0410 m 07	B07-SO-0411 0-20 cm 8/15/2007	B07-SO-0412 0-20 cm 8/15/2007	B07-SO-0413 0-20 cm 8/15/2007	B07-SO-0414 0-20 cm 8/15/2007	B07-SO-0415 0-20 cm 8/15/2007	B07-SO-0416 0-20 cm 8/15/2007	B07-SO-0417 0-20 cm 8/15/2007	B07-SO-0418 0-20 cm 8/15/2007	B07-SO-0419 0-20 cm 8/15/2007	B07-SO-0420 0-20 cm 8/15/2007	B07-SO-0421 0-20 cm 8/15/2007	B07-SO-0426 Drain. Sed. 0-10 cm 8/15/2007	B07-SO0427 Drain. Sed. 0-10 cm 8/15/2007
	8.1	6.9	6.6	6.8	8.3	7.6	7.5	8.7	7.1	5.9	8.3	10.7	10.6
	22	40	21	26	16	23	18	18	11	20	24	7	7
	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9	≤0.9
	19	20	20	21	22	20	20	19	17	19	20	16	16
	11	14	11	14	13	12	12	12	9	8	12	9	9
	19	22	35	22	21	19	79	20	16	121	20	19	24
	13	12	15	12	<10	13	12	11	<10	15	14	12	11
	523	623	442	503	540	531	477	473	493	392	496	394	395
	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	38	47	40	47	43	39	41	41	33	34	40	34	34
	0.9	1	1	1	1	1	1	1	1	1	1	1	1
	≤0.5	≤0.5	1	≤0.5	≤0.5	≤0.5	≤0.5	≤0.5	≤0.5	6	≤0.5	≤0.5	≤0.5
	≤5	≤5	≤5	≤5	≤5	≤5	≤5	≤5	≤5	≤5	≤5	≤5	≤5
	64	60	75	63	62	65	61	59	51	79	62	54	55
	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4	≤0.4
	≤0.2	≤0.2	0.3	≤0.2	≤0.2	≤0.2	4	≤0.2	3.3	≤0.2	≤0.2	≤0.2	2
	515	596	690	536	506	534	549	520	475	1,290	554	512	535

ımental Health in Industrial land uses, of the CCME. (2006)

Figure 68. (S-10524) Sewage Outfall map 1.

Figure 69. (S-10524) Sewage Outfall map 2.

4.29 S-10529 LOWER DUMBELL LAKE

4.29.1 Location and Site Description

Lower Dumbell Lake is located approximately 2 km southeast of the CFS-Alert main station, west of Upper Dumbell Lake (Figures 70 and 71). The part of the lake under investigation is located on the northwest side of the lake in a small bay. Access to the site is difficult as there is no established route after the Pumphouse Station at Upper Dumbell Lake.

Several years ago the study area were used for fishing with a hut built near the shore. Later on, the hut was demolished when the fishing spot was moved. The floor of the old hut was pushed directly into the lake and was still underwater during the 2006/07 and 2007/08 sampling campaigns. Two barrels were previously pulled out of the lake; the content of the barrels was unknown, and there was no information on whether the barrels were full or empty when disposed of in the lake. One theory is that they contained fuel for the generator of the old hut. Debris from the old hut foundation such as old barrels, wood pallets, and other construction debris was still lying along the shoreline during the 2006/07 and 2007/08 investigations.

The topography of the study area slopes gently towards the lake. A peak on the northwest side rises approximately 125 m above sea level and a second peak on the southwest side rises approximately 165 m above sea level. The soil in this area is dominated by sand with a few shale stones on the shoreline and shaly silt with clay in the lake.

4.29.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*", submitted to the Wing Environmental Office, 8 Wing, Trenton.

In 2006/07, one freshwater and one sediment sample were collected at the Lower Dumbell Lake site. Both samples were analyzed for metals and TPH. The freshwater sample showed no contaminants exceeding the CCME guidelines for aquatic life. The sediment sample (06LL0176) showed arsenic concentrations above the CCME guideline (Table 60). With the exception of the mentioned debris, no visual contamination was observed on site.

Table 60. (S-10529) Previous contaminated samples.

Sample Name	Sample Type	Depth (cm)	Contaminant	Guideline (mg/kg)	Concentration (mg/kg)
06LL0176	SEDIMENT	0-10	ARSENIC (AS)	5.9	8.6

4.29.3 Nature and Extent of Contamination

During the 2007/08 sampling campaign, six sediments, including one duplicate pair, and 1 freshwater sample were collected at the Lower Dumbell Lake site. These samples were tested for metals, TPH and PAHs (Table 61). Five of the 6 sediment samples contained arsenic concentrations above the CCME guideline for aquatic life. No other metal was detected above the CCME guidelines. TPH Fractions 1, 2, 3 and 4 were detected at low levels within the sediment samples, but there are currently no guidelines available for these contaminants. No PAHs were detected in the sediment samples. The freshwater sample contained copper, selenium and zinc concentrations exceeding the CCME guidelines for aquatic life. The elevated zinc concentration was of particular concern, being 10 times higher than the guidelines. TPH Fraction 3 was detected in the freshwater sample at a low concentration, but there is currently no guideline to evaluate the importance of this value. No PAHs, except for naphthalene, were detected, while naphthalene was well below the CCME guideline.

Based on the FCSAP classification system, the Lower Dumbell Lake study area is Class 1 (74.7). This indicates an important potential for human health threats and environmental impacts. Action is required. The estimated volume of contaminated soil is 1 m^3.

4.29.4 Recommendations

A series of four sediment samples (2 approximately 1 m from the shore and 2 at the water/shore boundary) and one water sample were taken. The sediment samples were all below guidelines except for B07-LL-1200, which had an arsenic concentration of 15.1 mg/kg. This concentration is higher than the Interim Freshwater Sediment Quality Guideline (ISQG) but lower than the Probable Effect Level (PEL) (5.9 and 17 mg/kg, respectively) as established by the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life of the Canadian Council of Ministers of the Environment (2002). In the collected water sample, both selenium and copper concentrations (1 and 4 mg/kg, respectively) were at the guideline limits (1 and 2-4 mg/kg, respectively) but zinc was over 10 fold higher; 320 mg/kg versus the guideline limit of 30 mg/kg.

Additional water samples to confirm the high zinc concentrations should be taken from both Lower and Upper Dumbell Lakes. These samples should be taken adjacent to the site as well as other parts of the lakes. If high zinc values are found throughout the lake or the values adjacent to the site are below criteria in the next set of samples, the site can be closed.

		Lower Dumbell Lake (S-10529)						
MENT		WATER	FRESHWATER SEDIMENT					
ELINES WATER IC LIFE (2) PEL	DETECTION LIMIT	B07-LL-1201-W Fresh water Surface 8/14/2007	B07-LL-0043 Dup. 1202 0-10 cm 8/14/2007	B07-LL-0044 0-10 cm 14/08/2007	B07-LL-1200 0-10 cm 8/14/2007	B07-LL-1201 0-10 cm 8/14/2007	B07-LL-1202 0-10 cm 8/14/2007	B07-LL-1203 0-10 cm 8/14/2007
17	0.27	<1	8.1	9.7	15.1	10.6	7.8	<0.7
---	5	<10	12	18	23	16	13	<2
3.5	0.22	<1	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
90	3	5	18	24	30	26	19	<2
---	1.9	<1	8	11	14	11	8	<1
197	2.1	4	15	23	26	22	14	<1
91.3	1.2	<1	<10	13	17	12	<10	<10
---	1.1	<6	517	585	498	546	559	<3
---	1.4	2	<2	<2	<2	<2	<2	<2
---	0.6	1	28	37	45	39	36	<2
---	0.5	1	0.8	<0.5	0.8	<0.5	<0.5	<0.5
---	0.4	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
---	0.8	3	<5	<5	<5	<5	<5	<5
315	2.5	320	39	56	73	57	41	<4
---	10	<50	<3.5	<5.6	5.7	<3.4	<4	<3.9
---	10	<36	<1.9	11	8.7	12	15	18
---	10	77	<4.5	214	17	17	13	7.9
---	10	<36	<6.4	52	6.6	<6.1	6.5	<5.7
0.391	0.008	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.201	0.005	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.005	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.005	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.128	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.0889	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.007	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.144	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.875	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.245	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2.355	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.875	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.385	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.862	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.005	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.782	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.022	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.135	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
---	0.008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Figure 70. (S-10529) Lower Dumbell Lake map 1

Figure 71. (S-10529) Lower Dumbell Lake map 1

4.30 CFS-ALERT CONCLUSIONS

4.30.1 FCSAP Priority Sites

The high priority sites at CFS-Alert were classified using the FCSAP Contaminated Site Classification system provided by CFB-Trenton (Appendix B). The list of high priority areas is as follows:

Class 1 Sites / Action Required:

- Underwater Survey (S-149)
- Curling Club/Gym Complex (S-10203)
- Oxidator Building (S-349)
- Runoff Collection Basin (S-352)
- Vehicle Maintenance (S-10195)
- Main Station Landfill (S-10197)
- Airstrip Diesel Pipeline (S-10210)
- Met Shack (S-10212)
- Main Station Day Tank (S-10214)
- Baker's Dozen (S-10216)
- Heated Vehicle Storage (S-10217)
- New Fuel Line Spill 1999 (S-10219)
- Weather Station Remains (S-10522)
- Sewage Outfall (S-10524)
- Lower Dumbell Lake (S-10529)

4.30.2 Over all Contamination at CFS-Alert

Contamination at CFS-Alert is mainly heavy metals and petroleum hydrocarbons. The metals contamination is presented in Figure 72. The geographic distribution of the arsenic, copper, lead, nickel and zinc contamination is presented in Figure 73. Petroleum hydrocarbons contamination is presented in Figure 74.

Figure 72. Heavy Metals Contamination map 1.

Figure 73. Heavy Metals Contamination map 2.

Figure 74. Petroleum Hydrocarbons Contamination.

4.30.3 Sites Not Assessed in 2007/08

Four sites were not assessed in 2007/08 and should be assessed during the next sampling campaign. The following outlines our recommendations for the four sites:

S-148 Battery Dump

Characterization was not performed during the 2007/08 sampling campaign due to a lack of time.

FCSAP Classification: Score 17.5 / Class N (2006/07/2007/08)

Recommendations:

Delineation should be performed as was planned for the 2007/08 sampling campaign.

S-10213 Main Station POL Pallet Line

Characterization was not performed during the 2007/08 sampling campaign due to a lack of time.

FCSAP Classification: Score 33.0 / Class N (2006/07/2007/08)

Recommendations:

Delineation should be performed as was planned for the 2007/08 sampling campaign.

S-10215 Main Station HAPS

Characterization was not performed during the 2007/08 sampling campaign due to a lack of time.

FCSAP Classification: Score 38.0 / Class 3 (2006/07/2007/08)

Recommendations:

Delineation should be performed as was planned for the 2007/08 sampling campaign.

S-10220 Barrel Cache

Characterization was not performed during the 2007/08 sampling campaign due to a lack of time.

FCSAP Classification: There is no classification as no recent work has been performed on this site.

Recommendations:

Delineation should be performed as was planned for the 2007/08 sampling campaign.

4.30.4 Projected Work for the Next Sampling Campaign

Based on previous work performed at CFS-Alert by the Environmental Microbiology group of BRI-NRC, effective bioremediation of TPH contaminated soils using biopiles has been demonstrated. Several of the sites currently being examined at CFS-Alert (Table 62) have been identified as being candidates for *in situ* bioremediation due to one or more of the following factors: extent of contamination, proximity to structures and infrastructure or active use. At all of these sites compacted soil, which potentially limits proper aeration, and a lack of nutrients due to minimal organic input, are the main issues to be examined and addressed for successful *in situ* bioremediation of the TPH contamination.

Table 62. Sites recommended for *in situ* bioremediation

PRIN	Site Name	PRIN	Site Name
S-349	Oxidator Building	S-10214	Main Station Day Tank Area
S-352	Runoff Collection Basin	S-10216	Baker's Dozen
S-10195	MSE-17 Vehicle Maintenance Building	S-10217	Building 113, Heated Vehicle Storage
S-10202	Cold Storage Dog House GP Hut	S-10219	New Fuel Line Spill, 1999
S-10210	Airstrip Diesel Pipeline	S-10522	AES Weather Station Remains - GA
S-10212	Airstrip Met Shack		

The proposed experimental program will be performed initially at 2 representative sites: S-349 Oxidator Building and S-10216 Baker's Dozen. This experimental program is aimed at identifying and validating the most appropriate conditions for successful *in situ* bioremediation. Once the optimal conditions for the 2 sites are determined, this information will be used to address the TPH contamination at the remaining (and future) contaminated sites. The work can be broken down into 3 distinct phases, to be carried out simultaneously at the two sites (Figure 75).

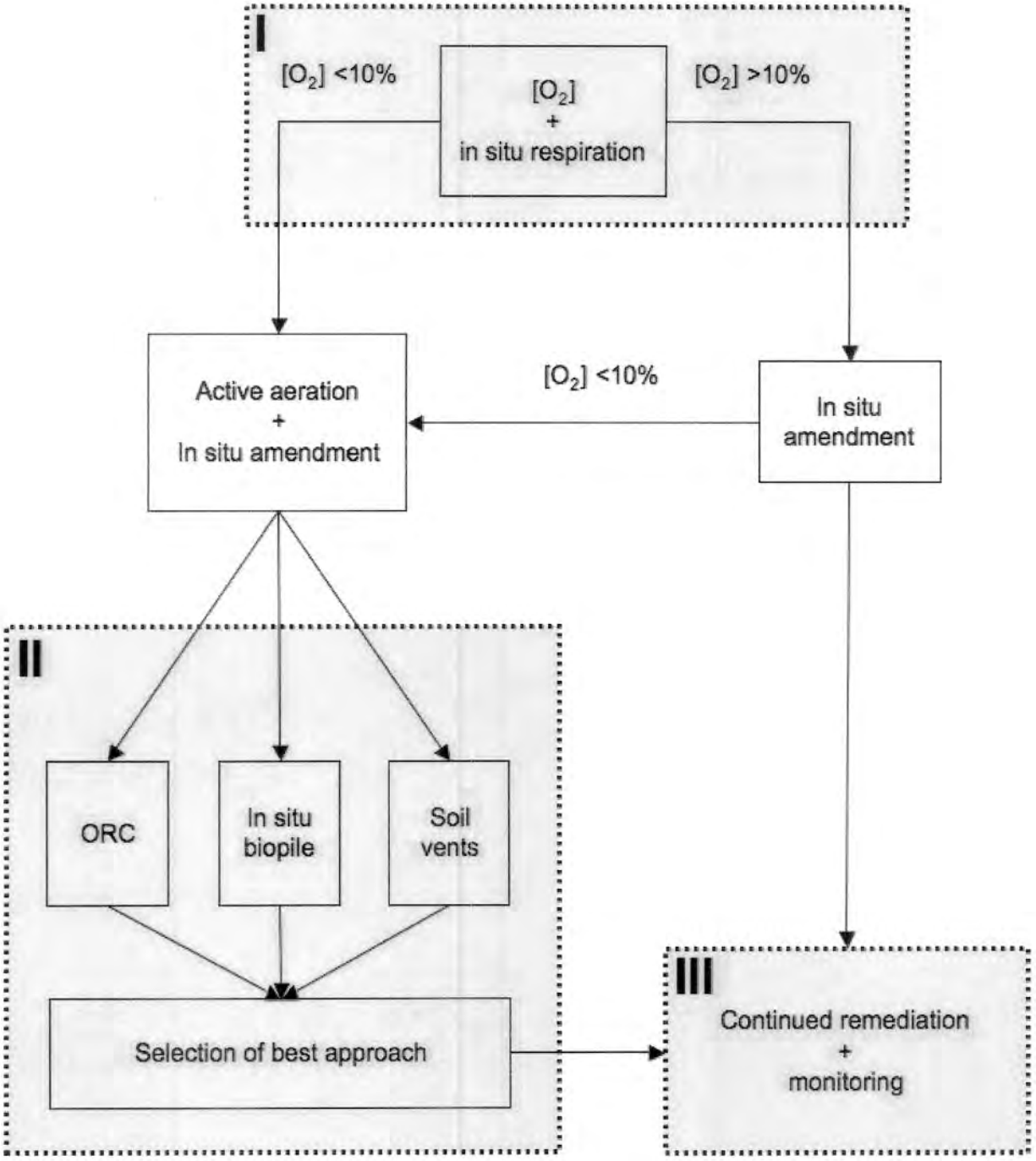

Figure 75. Flow chart for experimental work designed to establish and validate the most appropriate conditions for successful in situ bioremediation.

Phase 1 is to determine the current level of subsurface aeration and *in situ* microbial respiration. To achieve these goals, filter points will be installed at several locations within each site and oxygen concentrations measured in the subsurface. These values will be used as a baseline to determine whether additional aeration needs to be provided (minimum 10% O_2 desired), the concentration of oxygen during bioremediation, and if necessary, whether implemented aeration systems are providing adequate subsurface aeration. Once the base line subsurface oxygen concentrations are established, *in situ* respiration will be examined using the same filter points. Air will be pumped down the sealed filter points for 24-48 hours, after which the concentration of O_2 and CO_2 will be regularly measured for approximately 24-48 hours. This data will provide an indication of the current microbial aerobic respiration rates (i.e. baseline rates) at each site by comparing the consumption of O_2 and production of CO_2. If sufficient O_2 is present in the subsurface, a nutrient amendment program will be developed to accelerate the *in situ* biodegradation of TPH contamination. Based on previous work by this lab, the suggested nutrient amendment is monoammonium phosphate (MAP) at a final concentration of 250 mg/kg.

The more likely scenario of insufficient subsurface O_2 concentrations will be addressed in Phase II of the program. Three alternate methods of subsurface aeration combined with nutrient amendment will be compared at each of the 2 test sites. The 3 methods are soil venting, *in situ* biopiles and a commercial product ORC^{Tm}. The three methods will be tested side by side in plots of approximately 5 x 15 m (5 x 5 m for each method).

Soil venting involves the installation of a series of screened filter points down to the permafrost that are open to the atmosphere at the top providing subsurface aeration. The nutrient amendment in this case will be added by creating shallow trenches (ca. 15 cm depth) where the amendment will be placed, covered, and then sufficiently watered to allow percolation of the nutrients into the subsurface.

In situ biopiles involve the direct application of amendments to the soil followed by mixing of the soil on site with heavy equipment to distribute the amendment and provide aeration. The contaminated soil will be left in position and mixed at regular intervals (every 2 weeks).

ORC^{Tm} (Oxygen Release Compound) is a commercial product developed by Regenesis Inc. and provides a slow release of O_2 into the subsurface. It is transported as a powder and mixed into think paste for application. A series of screened filter points will be installed on site and the ORC paste, combined with the nutrient amendment, will be placed into the filter points. Distribution and activation of ORC requires contact with water which will be pumped down the filter points.

Samples from each test plot at each study site will be taken at the beginning and end of the treatment period (ca. 6-8 weeks) for chemical and microbiological analysis. Microbiological analysis will consist of bacterial enumeration (total and diesel degrading bacterial numbers) as well as mineralization of hexadecane and naphthalene. Based on the chemical and microbiological data the most appropriate method will be selected. Large scale implementation on the 2 test sites as well as the remaining sites identified as candidates for *in situ* remediation can proceed the following year.

4.30.5 Conclusion

A summary of the site recommendations is presented in Table 63. Under the heading 'Closure', 'Direct' relates to sites which can be closed immediately whereas 'Manipulation' relates to sites which can be closed after additional work to remove the contaminated soil is completed. Sites highlighted with a grey box indicate sites selected for the *in situ* pilot study described in section 4.30.3. 'DND Monitoring' refers to sites at which it is recommended that DND establish a long term monitoring program to ensure that no contamination migrates from the indicated sites.

A summary and breakdown of projected costs for future work is presented in Table 64. The final costs are calculated as 'Characterization Costs' (further delineation), 'Analyses & Materials' (site remediation costs) and 'Labour Costs' (estimated labour costs). The figures presented do not include costs associated with the design, construction and materials associated with a contained biopile treatment area. This is the responsibility of DND. Sites highlighted with a grey box indicate sites selected for the *in situ* pilot study described in section 4.30.4.

3. Summary of site recommendations.

	Closure			Bioremediation			
Name	Direct	Manipulation	Delineation	In situ	Ex situ	DND Monitoring	Time (d
LERT							
Alert (Cont Sites/Underwater Survey)			X				2.5
Battery Dump			X				0.5
Oxidator Building (Back of building)			X	X			5
Runoff Collection Basin				X			---
Old Upper POL Farm (3)			X				1
Airstrip Tank Farm		X			X		---
Apron Refueling Area		X			X		0.5
Deicing Area		X	X				1
MSE -17 Vehicle Maintenance Building			X				1
Burn Pit		X	X		X		0.5
Main Station Landfill						X	---
CE-140 MCE Building Fire Hall		X	X		X		0.5
B-145 Cat House		X			X		0.5
1 CEU GP Hut		X			X		---
Cold Storage Dog House GP Hut			X	X			---
Curling Club/Gym Complex		X			X		0.5
50 Line GP Huts Drainage	X						---
Dump #3	X					X	---
TX Site		X	X		X		0.5
Airstrip Building HIL-124			X		X		0.5
Airstrip Building FH-128			X				0.5
Airstrip Diesel Pipeline		X		X	X		---
Airstrip Hurricane Building		X	X		X		---
Airstrip Met Shack			X				0.5
Main Station POL Pallet Line			X				0.5
Main Station Day Tank Area			X	X			0.5
Main Station HAPS			X				0.5
Baker's Dozen				X			5
Building 113, Heated Vehicle Storage			X				0.5
Burner Project Site			X		X		1
New Fuel Line Spill 1999				X			---
Barrel cache			X				0.5
AES Weather Station Remains-GA			X	X			0.5
Sewage Outfall						X	---
Lower Dumbell Lake		X	X				1

oxes indicate sites selected for in situ bioremediation pilot study.

ON ANALYSES					REMEDIATION			OTHER WORK		LABOUR COSTS		
RATES $20	NITRITES $12	GLYCOL $60	CHARACTERIZATION COSTS	FSCAP 2007/08	NUMBER OF IN SITU SAMPLES	NUMBER OF EX SITU SAMPLES	ANALYSES & MATERIALS	NUMBER OF DELINEATION SAMPLES	SAMPLES TOTAL	STAFF TIME (hrs)	LABOUR COSTS ($110/hr)	S-TOTAL
0	0	0	$3,450	Score 82.7 / Class 1	0	0	$0	30	30	98	$10,780	$14,230
0	0	0	$720	Score 17.5 / Class N (2006/07)	0	0	$0	8	8	54	$5,940	$6,660
0	0	0	$350	Score 84.2 / Class 1	24	0	$7,480	10	34	248	$27,280	$35,110
0	0	0	$0	Score 74.7 / Class 1	0	0	$715	0	13	117	$12,870	$13,585
0	0	0	$1,200	---	0	0	$0	10	12	62	$6,820	$8,020
0	0	0	$0	Score 42.5 / Class 3	0	8	$440	0	8	54	$5,940	$6,380
0	0	0	$0	Score 60.8 / Class 2	0	5	$275	0	5	48	$5,280	$5,555
0	0	10	$600		0	0	$0	10	10	58	$6,380	$6,980
0	0	0	$2,275	Score 76.7 / Class 1	0	0	$0	10	12	62	$6,820	$9,095
0	0	0	$540	Score 53.1 / Class 2	0	0	$0	6	6	50	$5,500	$6,040
0	0	0	$0	Score 74.1 / Class 1	0	0	$0	0	0	0	$0	$0
0	0	0	$275	Score 64.7 / Class 2	0	13	$715	5	18	74	$8,140	$9,130
0	0	0	$180	Score 62.3 / Class 2	0	5	$275	2	7	52	$5,720	$6,175
0	0	0	$0	Score 52.8 / Class 2	0	5	$275	0	5	48	$5,280	$5,555
0	0	0	$0	Score 62.8 / Class 2	0	0	$990	0	18	74	$8,140	$9,130
0	0	0	$0	Score 76.5 / Class 1	0	5	$275	0	5	48	$5,280	$5,555
0	0	0	$0	Score 40.8 / Class 3	0	0	$0	0	0	0	$0	$0
0	0	0	$0	Score 56.2 / Class 2	0	0	$0	0	0	0	$0	$0
0	0	0	$780	Score 42.3 / Class 3	0	5	$275	6	11	60	$6,600	$7,655
0	0	0	$450	Score 55.7 / Class 2	0	5	$275	5	10	58	$6,380	$7,105
0	0	0	$825	Score 56.0 / Class 2	0	0	$0	15	15	68	$7,480	$8,305
0	0	0	$2,100	Score 80.7 / Class 1	0	5	$1,595	12	41	120	$13,200	$16,895
0	0	0	$0	Score 60.8 / Class 2	0	9	$495	0	9	56	$6,160	$6,655
0	0	0	$450	Score 72.7 / Class 1	0	0	$0	5	5	48	$5,280	$5,730
0	0	0	$330	Score 33 / Class N (2006/07)	0	0	$0	6	6	50	$5,500	$5,830
0	0	0	$1,040	Score 80.7 / Class 1	0	0	$0	8	8	54	$5,940	$6,980
0	0	0	$440	Score 38 / Class 3 (2006/07)	0	0	$0	0	8	54	$5,940	$6,380
0	0	0	$0	Score 84.7 / Class 1	24	0	$6,580	0	24	228	$25,080	$31,660
0	0	0	$440	Score 76.7 / Class 1	0	0	$0	8	8	54	$5,940	$6,380
0	0	0	$700	Score 65.8 / Class 2	0	8	$440	20	28	94	$10,340	$11,480
0	0	0	$0	Score 77.7 / Class 1	0	0	$5,630	0	22	224	$24,640	$30,270
0	0	0	$1,300	---	0	0	$0	10	10	58	$6,380	$7,680
0	0	0	$550	Score 75.6 / Class 1	0	0	$1,210	10	32	102	$11,220	$12,980
4	4	0	$192	Score 75.7 / Class 1	0	0	$0	4	4	46	$5,060	$5,252
0	0	0	$1,080	Score 74.7 / Class 1	0	0	$0	12	12	62	$6,820	$7,900
$20	$12	$60										$332,337

6	6	0	$2,088
0	0	0	$1,100
0	0	0	$780

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