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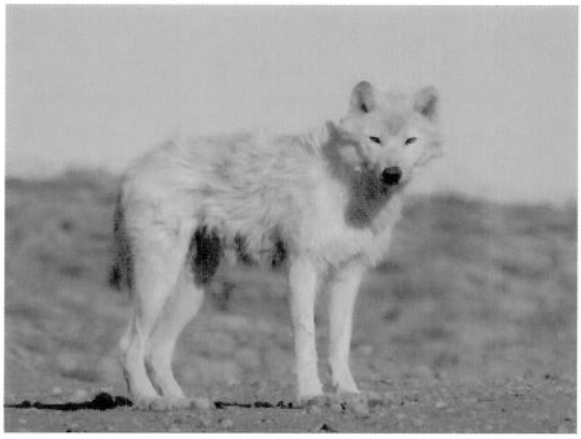
DETAILED CHARACTERIZATION AND ECONET UPDATE OF MULTIPLE SITES AT CFS-EUREKA AND CFS-ALERT, NUNAVUT
Volume III – CFS-EUREKA

Final Report 2007/08



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March 31, 2008

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EXECUTIVE SUMMARY

This report presents the site characterization data collected by the National Research Council of Canada (NRCC), Biotechnology Research Institute (BRI), during the 2007/08 sampling campaign at Canadian Force Station Eureka (CFS-Eureka), Nunavut. Located on Ellesmere Island, CFS-Eureka is one of the Canada's most northern military sites.

The results from the 2007/08 sampling campaign were necessary to complete the characterization of contaminated sites at CFS-Eureka 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 the contaminated sites located at CFS-Eureka;
- 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-Eureka;
- Update the Econet database;
- Enter new site characterization data into the Econet database for CFS-Eureka.

Sampling Campaigns

2006/07

In 2006/07, one team of BRI Environmental Microbiology group members collected samples at CFS-Eureka. The BRI worked at CFS-Eureka from June 29th to June 30th.

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, 11 sites were investigated. These sites included areas where contamination had previously been recorded, and areas where contamination was suspected. Of these 11 sites, 6 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, one team of BRI Environmental Microbiology group members worked at CFS-Eureka. The BRI team worked at CFS-Eureka from July 26th to July 31st.

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, 6 sites at CFS-Eureka were investigated. The investigation of these sites included areas where contamination was previously recorded and areas where contamination was suspected. Of these 6 sites, 3 were contaminated.

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.

Approximately 87 samples including 4 duplicate pairs, 4 field blanks, 1 transport blank and 5 background samples were collected at CFS-Eureka.

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-Eureka 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-Eureka.

WATER SAMPLES

Marine water samples were collected from Slidre Fiord. 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 at CFS-Eureka were compared to the CCME Canadian Sediment Quality Guideline (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

Five soil background samples were collected during the 2007/08 sampling campaign. These samples were analyzed for 14 different heavy metals: arsenic, barium, cadmium, chromium, cobalt copper, lead, manganese, molybdenum, nickel, selenium, silver, tin and zinc. The samples were also analyzed for TPH, PAHs and BTEX. None of the background samples were above the CCME guidelines for any of the tested compounds.

Three study sites located in and around CFS-Eureka were found to have concentrations of heavy metals, petroleum hydrocarbons, or both above the applicable CCME guidelines. FCSAP classification was used to evaluate the contamination and establish a priority list of sites where actions are required.

Two sites at CFS-Eureka were classified as FCSAP Class 1 sites. This classification indicates that action must be taken to address the contamination at these sites. One site was a FCSAP Class 2 site. This site presented a potential for adverse off-site impact without direct risk to human health or the environment. Finally, 3 sites were FCSAP Class N sites, which indicated that no contamination was detected within the site. A summary table is presented below.

Class	Site Name and PRIN
Class 1	
	Sewage Lagoon (S-10187)
	North Airstrip Apron (S-10527)
Class 2	
	Main Camp "The Fort" (S-10190)
Class N	
	Battery Dump (S-150)
	East Airstrip Landfill (S-10186)
	Barrel Dump (S-10525)

Recommendations

According to the results from the 2006/07 and 2007/08 sampling campaigns, active remediation is recommended for two sites and a regular monitoring campaign should be established for the remaining four sites to record any off-site movement of contaminants.

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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-Eureka, 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-Eureka;
- 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-Eureka;
- Update the Econet database;
- Enter new site characterization data into the Econet database for CFS-Eureka.

2 CFS-EUREKA AND SITE LOCATIONS

CFS-Eureka is located on the west coast of Ellesmere Island, Nunavut, (79°58.800' N, 85°55.800'W), approximately 450 km northwest of the hamlet of Grise Fiord (Figures 1 and 2). During the summer, CFS-Eureka experiences daily average temperatures of 2.3°C, 5.7°C and 2.6°C in June, July and August, respectively (Environment Canada, 2004). The average annual precipitation at CFS-Eureka is 75.5 mm. Precipitation falls primarily during the months of June, 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.

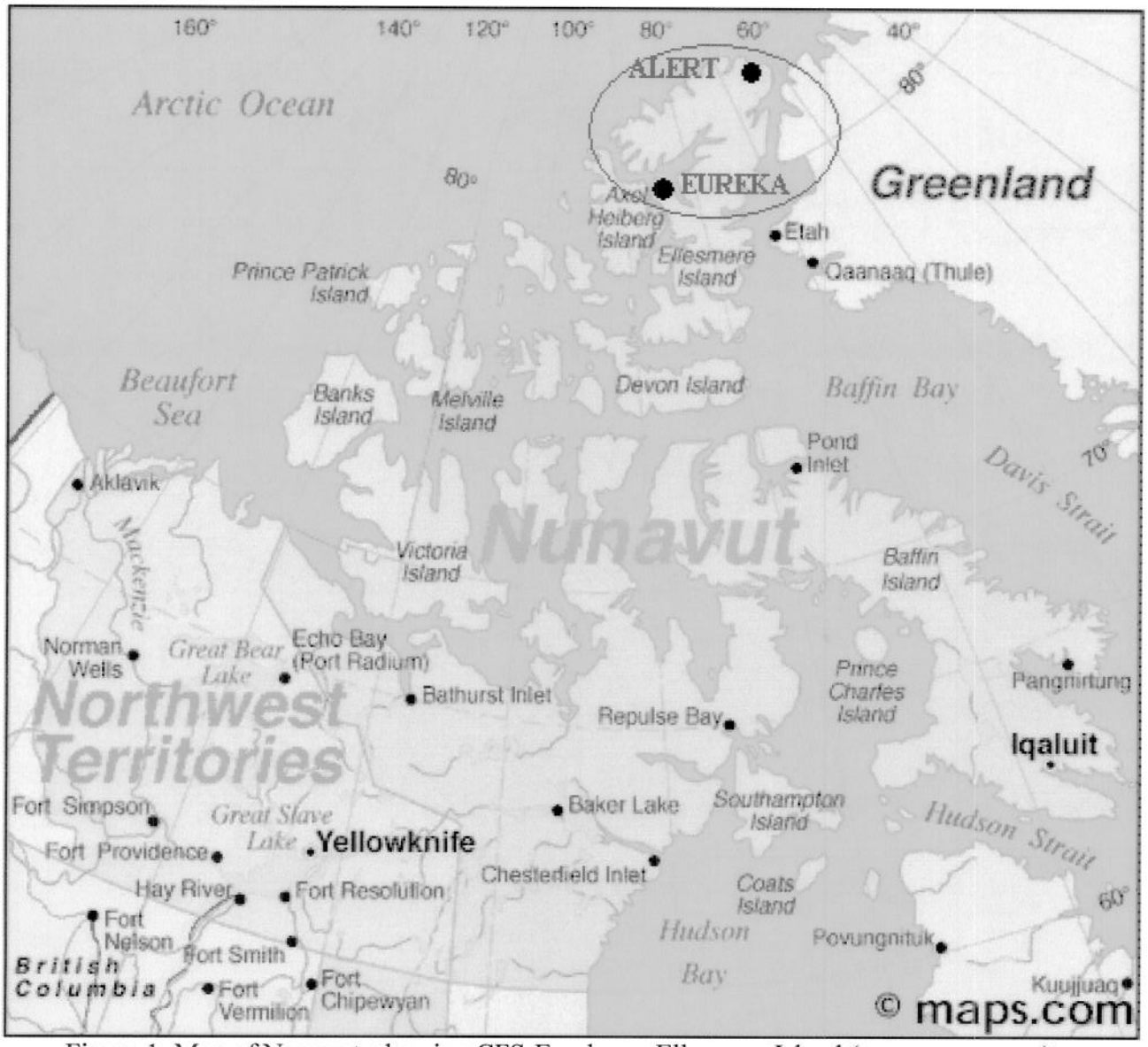

Figure 1. Map of Nunavut, showing CFS-Eureka on Ellesmere Island (www.maps.com).

Figure 2. Aerial view of the AES weather station Eureka (BRI, 2007).

CFS-Eureka was first established on Ellesmere Island in 1947 as the High Artic Weather Station (HAWS) for the Atmospheric Environment Service (AES) of Environment Canada. In 1982, the Department of National Defense (DND) installed as series of relay towers between CFS-Eureka and CFS-Alert to improve the communications for CFS-Alert. A satellite transmission facility was also installed approximately 10 km west of HAWS for direct satellite transmissions to the south. The primary facilities at CFS-Eureka are located at the Main Camp ("The Fort"), located approximately 2 km from HAWS and adjacent to the airstrip. DND infrastructure includes the Accommodations Building, a vehicle maintenance garage, aircraft refueling apron, fuel storage tanks and bladders, the old sewage lagoon, and several landfills.

The topography of the region is rolling and ridged, with elevations not exceeding 1,000 m above sea level. The underlying geology of the area is sand and shale stones, with drainage channels cut out during the spring freshet. These channels lead past CFS-Eureka towards the south to reach Slidre Fiord. Eureka is located within a continuous permafrost zone possessing an active layer of approximately 80 cm in depth. The soils of Eureka are mostly sand mixed with gravel underlain by silty and sandy clayey soil.

The source of freshwater at CFS-Eureka is Station Creek, located adjacent to HAWS, which flows from early June to early September and drains into Slidre Fiord.

2.1 ENVIRONEMENTAL RECEPTORS

Slidre Fiord, located to the south of CFS-Eureka, is the primary environmental receptor for several CFS-Eureka sites. It receives surface or groundwater draining from the area surrounding the station. Slidre Fiord then drains into Eureka Sound which connects to the Arctic Ocean. Due to the proximity of CFS-Eureka to Slidre Fiord, aquatic life is potentially affected by any contamination migrating from CFS-Eureka. Station Creek is also a potential environmental receptor from sites located north of the airstrip, although it is located several kilometers away.

During the 2006/07 and 2007/08 sampling campaigns, animals such as musk oxen, wolves,

hares, lemmings and birds were observed at or in the vicinity of CFS-Eureka. When not directly observed on site, the presence of animal life was evidenced by traces of feces or tracks. Various types of groundcover vegetation were observed at CFS-Eureka during the 2006/07 and 2007/08 sampling campaigns.

DND activity at CFS-Eureka is primarily for the maintenance of the transmitter network between CFS-Eureka and CFS-Alert and is limited to the months of May, June and July. Maintenance activities at and around both the DND and HAWS facilities occurs during the summer months of June to early September. HAWS is operated year round and human activity is generally restricted to the main station during winter months (late September to late May).

3 METHODOLOGY

3.1 REVIEW OF LITERATURE

A review of existing reports and previous site characterizations at CFS-Eureka 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

One team of BRI staff members performed sampling work at CFS-Eureka between June 26th and June 31st, 2007.

3.3 SAMPLE IDENTIFICATION

The sample identification scheme followed this format: B07-XX-#### (Photograph 19, 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.

CFS-EUREKA	S-150	Battery Dump	BD
	S-10186	East Airstrip Landfill	EL
	S-10187	Sewage Lagoon	SW
	S-10190	Main Camp "The Fort"	MC
	S-10525	Barrel Dump	BL
	S-10527	North Airstrip Apron	NA

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-Eureka 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, phenolics 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.

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.

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, phenolics 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.

3.8 ASSESSMENT GUIDELINE

3.8.1 Soil Guideline

Comparison guidelines for the assessment of soil contamination at CFS-Eureka 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-Eureka.

3.8.2 Water Guidelines

Water samples collected from Slidre Fiord were compared to the CCME Marine Quality Guidelines for the Protection of Aquatic Life. Water samples collected from isolated standing water pools and drainage channels were compared to CCME Freshwater Quality Guidelines for the Protection of Aquatic Life.

The water samples collected from the Sewage Lagoon at CFS-Eureka 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 at CFS-Eureka 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 Slidre Fiord were compared to the guidelines developed for marine sediment. Sediment samples collected from the Sewage Lagoon 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 20, 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 Table 2.

Table 2. 2007/08 results for the field and transport blanks.

		Transport blank 2007/08			
		SOIL			SOIL
	PARAMETERS	UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	TB07-1 31/07/2007
TPH	Benzene	mg/kg	0.03	0.02	<0.1
	Toluene	mg/kg	0.37	0.02	<0.1
	Ethylbenzene	mg/kg	0.082	0.02	<0.1
	Total Xylene	mg/kg	11	0.04	<0.1
	F1 (C6-C10)	mg/kg	310	10	<2.8
	F2 (C10-C16)	mg/kg	760	10	12
	F3 (C16-C34)	mg/kg	1700	10	341
	F4 (C34-C50)	mg/kg	3300	10	<4.8
VOC	Vinyl chloride	mg/kg	---	0.04	<0.4
	1,1-Dichloroethene	mg/kg	50	0.04	<0.1
	Dichloromethane	mg/kg	50	20	<0.1
	1,2-Dichloroethene (trans)	mg/kg	50	0.03	<0.1
	1,1-Dichloroethane	mg/kg	50	0.03	<0.1
	1,2-Dichloroethene (cis)	mg/kg	50	0.03	<0.1
	Chloroform	mg/kg	50	0.03	<0.1
	1,1,1-Trichloroethane	mg/kg	50	0.03	<0.1
	Carbon tetrachloride	mg/kg	50	0.03	<0.1
	Benzene	mg/kg	5	0.04	<0.1
	1,2-Dichloroethane	mg/kg	50	0.03	<0.1
	Trichloroethene	mg/kg	0.01	0.05	<0.1
	1,2-Dichloropropane	mg/kg	50	0.04	<0.1
	Bromodichloromethane	mg/kg	---	0.04	<0.1
	1,3-Dichloropropene (trans)	mg/kg	50	0.05	<0.1
	1,3-Dichloropropene (cis)	mg/kg	50	0.03	<0.1
	Toluene	mg/kg	0.8	0.05	<0.1
	1,1,2-Trichloroethane	mg/kg	50	0.04	<0.1
	Tetrachloroethene	mg/kg	0.6	0.08	<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 CCME. (January 2001)

Table 2. 2007/08 results for the field and transport blanks (cont.).

		Field blank collected at the CFS Eureka			
		SOIL			
	PARAMETERS	FB07-S10190 28/7/2007	FB07-S10196 27/7/2007	FB07-S10525 29/7/2007	FB07-S10527 27/7/2007
METALS	Arsenic (As)	NA	NA	<0.7	NA
	Barium (Ba)	NA	NA	2	NA
	Cadmium (Cd)	NA	NA	<0.9	NA
	Chromium (Cr)	NA	NA	<2	NA
	Cobalt (Co)	NA	NA	<1	NA
	Copper (Cu)	NA	NA	<1	NA
	Lead (Pb)	NA	NA	<10	NA
	Manganese (Mn)	NA	NA	<3	NA
	Molybdenum (Mo)	NA	NA	<2	NA
	Nickel (Ni)	NA	NA	<2	NA
	Selenium (Se)	NA	NA	<0.5	NA
	Silver (Ag)	NA	NA	<0.5	NA
	Tin (Sn)	NA	NA	<5	NA
	Zinc (Zn)	NA	NA	<4	NA
PAH	Naphthalene	NA	NA	<0.1	<0.1
	2-methylnaphthalene	NA	NA	<0.1	<0.1
	1-methylnaphthalene	NA	NA	<0.1	<0.1
	1,3-Dimethylnaphthalene	NA	NA	<0.1	<0.1
	Acenaphthylene	NA	NA	<0.1	<0.1
	Acenaphthene	NA	NA	<0.1	<0.1
	2,3,5-trimethylnaphthalene	NA	NA	<0.1	<0.1
	Fluorene	NA	NA	<0.1	<0.1
	Phenanthrene	NA	NA	<0.1	<0.1
	Anthracene	NA	NA	<0.1	<0.1
	Fluoranthene	NA	NA	<0.1	<0.1
	Pyrene	NA	NA	<0.1	<0.1
	Benzo(c)Phenanthrene	NA	NA	<0.1	<0.1
	Benzo(a)Anthracene	NA	NA	<0.1	<0.1
	Chrysene	NA	NA	<0.1	<0.1
	7,12-dimethylbenz[a]anthracene	NA	NA	<0.1	<0.1
	Benzo(b,j,k)fluoranthene	NA	NA	<0.1	<0.1
	Benzo(a)pyrene	NA	NA	<0.1	<0.1
	3-methylcholanthrene	NA	NA	<0.1	<0.1
	Indeno(1,2,3-cd)pyrene	NA	NA	<0.1	<0.1
	Dibenzo(a,h)anthracene	NA	NA	<0.1	<0.1
	Benzo(g,h,i)perylene	NA	NA	<0.1	<0.1
	Dibenzo (a,l) pyrene	NA	NA	<0.1	<0.1
	Dibenzo (a,i) pyrene	NA	NA	<0.1	<0.1
	Dibenzo (a,h) pyrene	NA	NA	<0.1	<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 CCME (January 2001)

Table 2. 2007/08 results for the field and transport blanks (cont.).

	PARAMETERS	Field blank collected at the CFS Eureka			
		SOIL			
		FB07-S10190 28/7/2007	FB07-S10196 27/7/2007	FB07-S10525 29/7/2007	FB07-S10527 27/7/2007
VOC	Vinyl chloride	NA	NA	NA	<0.4
	1,1-Dichloroethene	NA	NA	NA	<0.1
	Dichloromethane	NA	NA	NA	<0.1
	1,2-Dichloroethene (trans)	NA	NA	NA	<0.1
	1,1-Dichloroethane	NA	NA	NA	<0.1
	1,2-Dichloroethene (cis)	NA	NA	NA	<0.1
	Chloroform	NA	NA	NA	<0.1
	1,1,1-Trichloroethane	NA	NA	NA	<0.1
	Carbon tetrachloride	NA	NA	NA	<0.1
	Benzene	NA	NA	NA	NA
	1,2-Dichloroethane	NA	NA	NA	<0.1
	Trichloroethene	NA	NA	NA	<0.1
	1,2-Dichloropropane	NA	NA	NA	<0.1
	Bromodichloromethane	NA	NA	NA	NA
	1,3-Dichloropropene (trans)	NA	NA	NA	<0.1
	1,3-Dichloropropene (cis)	NA	NA	NA	<0.1
	Toluene	NA	NA	NA	NA
	1,1,2-Trichloroethane	NA	NA	NA	<0.1
	Tetrachloroethene	NA	NA	NA	<0.1
	Dibromochloromethane	NA	NA	NA	NA
	Chlorobenzene	NA	NA	NA	NA
	Ethylbenzene	NA	NA	NA	NA
	Bromoform	NA	NA	NA	NA
	1,1,2,2-Tetrachloroethane	NA	NA	NA	NA
	1,3-Dichlorobenzene	NA	NA	NA	NA
	1,4-Dichlorobenzene	NA	NA	NA	NA
	1,2-Dichlorobenzene	NA	NA	NA	NA
	o-xylene	NA	NA	NA	NA
	m+p-xylene	NA	NA	NA	NA
TPH	Benzene	<0.1	NA	<0.1	<0.1
	Toluene	<0.1	NA	<0.1	<0.1
	Ethylbenzene	<0.1	NA	<0.1	<0.1
	Total Xylene	<0.1	NA	<0.1	<0.1
	F1 (C6-C10)	NA	4.4	<2.3	5.9
	F2 (C10-C16)	NA	3	8.8	2.2
	F3 (C16-C34)	NA	278	290	289
	F4(C34-C50)	NA	7.8	6.7	<5.2

3.9 BACKGROUND

A total of 5 background soil samples were collected during the 2007/08 sampling campaign. Of these samples, 4 were analyzed for heavy metals and 3 were analyzed for TPH, PAHs and BTEX (Table 3). Fourteen different heavy metals were examined: arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, tin and zinc. The results showed no TPH Fractions, PAHs, BTEX or heavy metals were above the CCME guideline concentrations in the background samples.

One background sediment sample was collected during the 2007/08 sampling campaign (Table 4). This was analyzed for heavy metals and TPH. Eight heavy metals were detected but none were above the CCME guideline concentrations. TPH Fractions 2 and 3 were also detected but were below the CCME guidelines.

3.10 CONTAMINATED SITE CLASSIFICATION

Using the results from the 2006/07 and 2007/08 sampling campaigns, the CFS-Eureka 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.

Table 3. 2007/08 Soil background sample results.

	PARAMETERS	SOIL			Background collected at the CFS Eureka SOIL					
		UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	B07BG0012 70 cm 29/07/2007	B07BG0013 45 cm 29/07/2007	B07BG0111 0-20 cm 7/27/2007	B07BG0126 0-20 cm 7/28/2007	AVERAGE	RATIO
METALS	Arsenic (As)	mg/kg	12	0.27	8.2	3.1	8.83	9.69	7.46	1.61
	Barium (Ba)	mg/kg	2000	5	57	20	92.7	94	65.93	30.34
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	0.11	0.18	0.15	-
	Chromium (Cr)	mg/kg	87	3	17	7	33.8	34.8	23.15	3.76
	Cobalt (Co)	mg/kg	300	1.9	9	3	13.6	14.8	10.10	30
	Copper (Cu)	mg/kg	91	2.1	20	6	24	26.9	19.23	5
	Lead (Pb)	mg/kg	600	1.2	<10	14	13.3	13.8	13.70	43.80
	Manganese (Mn)	mg/kg	---	1.1	230	91	327	356	251.00	-
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	0.79	0.93	0.86	-
	Nickel (Ni)	mg/kg	50	0.6	18	6	28.2	31	20.80	2.40
	Selenium (Se)	mg/kg	3.9	0.5	0.7	<0.5	<0.5	<0.5	0.70	5.57
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	NA	-
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<0.5	<0.5	NA	-
	Zinc (Zn)	mg/kg	360	2.5	54	19	76.9	84.1	58.50	6.15

	PARAMETERS	SOIL			SOIL				
		UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	B07BG0013 45 cm 29/07/2007	B07BG0111 90 cm 27/07/2007	B07BG0126 70 cm 27/07/2007	AVERAGE	RATIO
TPH	F1 (C6-C10)	mg/kg	310	10	17	16	<3.4	16.50	18.79
	F2 (C10-C16)	mg/kg	760	10	126	6.2	<1.7	66.10	11.50
	F3 (C16-C34)	mg/kg	1700	10	104	143	70	105.67	16.09
	F4 (C34-C50)	mg/kg	3300	10	49	71.2	21	47.07	70.11
BTEX	Benzene	mg/kg	0.030	0.02	<0.1	<0.1	<0.1	ND	-
	Toluene	mg/kg	0.37	0.02	<0.1	<0.1	<0.1	ND	-
	Ethylbenzene	mg/kg	0.082	0.02	<0.1	<0.1	<0.1	ND	-
	Total Xylene	mg/kg	11	0.04	<0.1	<0.1	<0.1	ND	-

Table 3. 2007/08 Soil background sample results (cont.).

	PARAMETERS	SOIL			SOIL				
		UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	B07BG0013 45 cm 29/07/2007	B07BG0111 90 cm 27/07/2007	B07BG0119 80 cm 27/07/2007	AVERAGE	RATIO
PAH	Naphthalene	mg/kg	22	0.008	<0.1	<0.1	<0.1	ND	-
	2-methylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1	ND	-
	1-methylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1	ND	-
	1,3-Dimethylnaphthalene	mg/kg	---	0.005	<0.1	<0.1	<0.1	ND	-
	Acenaphthylene	mg/kg	---	0.004	<0.1	<0.1	<0.1	ND	-
	Acenaphthene	mg/kg	---	0.004	<0.1	<0.1	<0.1	ND	-
	2,3,5-trimethylnaphthalene	mg/kg	---	0.007	<0.1	<0.1	<0.1	ND	-
	Fluorene	mg/kg	---	0.007	<0.1	<0.1	<0.1	ND	-
	Phenanthrene	mg/kg	50	0.010	<0.1	<0.1	<0.1	ND	-
	Anthracene	mg/kg	---	0.004	<0.1	<0.1	<0.1	ND	-
	Fluoranthene	mg/kg	---	0.008	<0.1	<0.1	<0.1	ND	-
	Pyrene	mg/kg	100	0.008	<0.1	<0.1	<0.1	ND	-
	Benzo(c)Phenanthrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	ND	-
	Benzo(a)Anthracene	mg/kg	10	0.007	<0.1	<0.1	<0.1	ND	-
	Chrysene	mg/kg	---	0.008	<0.1	<0.1	<0.1	ND	-
	7,12-dimethylbenzo(a)anthracene	mg/kg	---	0.005	<0.1	<0.1	<0.1	ND	-
	Benzo(b,j,k)fluoranthene	mg/kg	10	0.008	<0.1	<0.1	<0.1	ND	-
	Benzo(a)pyrene	mg/kg	0.7	0.008	<0.1	<0.1	<0.1	ND	-
	3-methylcholanthrene	mg/kg	---	0.022	<0.1	<0.1	<0.1	ND	-
	Indeno(1,2,3-cd)pyrene	mg/kg	10	0.008	<0.1	<0.1	<0.1	ND	-
	Dibenzo(a,h)anthracene	mg/kg	10	0.008	<0.1	<0.1	<0.1	ND	-
	Benzo(g,h,i)perylene	mg/kg	---	0.008	<0.1	<0.1	<0.1	ND	-
	Dibenzo (a,l) pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	ND	-
	Dibenzo (a,i) pyrene	mg/kg	---	0.007	<0.1	<0.1	<0.1	ND	-
	Dibenzo (a,h) pyrene	mg/kg	---	0.008	<0.1	<0.1	<0.1	ND	-

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 4. 2007/08 Sediment background sample results.

PARAMETERS	Background collected at the CFS-Eureka				
	FRESHWATER SEDIMENT				SEDIMENT
	UNITS	GUIDELINES AQUATIC LIFE		DETECTION LIMIT	07BG0003 0-10 cm 07/26/07
		(1) ISQG	(2) PEL		
Arsenic (As)	mg/kg	5.9	17	0.27	5.8
Barium (Ba)	mg/kg	---	---	5	8
Cadmium (Cd)	mg/kg	0.6	3.5	0.22	<0.9
Chromium (Cr)	mg/kg	37.3	90	3	4
Cobalt (Co)	mg/kg	---	---	1.9	4
Copper (Cu)	mg/kg	35.7	197	2.1	8
Lead (Pb)	mg/kg	35	91.3	1.2	<10
Manganese (Mn)	mg/kg	---	---	1.1	177
Molybdenum (Mo)	mg/kg	---	---	1.4	<2
Nickel (Ni)	mg/kg	---	---	0.6	9
Selenium (Se)	mg/kg	---	---	0.5	<0.5
Silver (Ag)	mg/kg	---	---	0.4	<0.5
Tin (Sn)	mg/kg	---	---	0.8	<5
Zinc (Zn)	mg/kg	123	315	2.5	25

PARAMETERS	FRESHWATER SEDIMENT				SEDIMENT
	UNITS	GUIDELINES AQUATIC LIFE		DETECTION LIMIT	07BG0003 0-10 cm 07/26/07
		(1) ISQG	(2) PEL		
F1 (C6-C10)	mg/kg	---	---	10	<3
F2 (C10-C16)	mg/kg	---	---	10	10
F3 (C16-C34)	mg/kg	---	---	10	20
F4 (C34-C50)	mg/kg	---	---	10	<6.3

NA Not available

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)

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

4 CFS-EUREKA SITES

4.1 S-150 BATTERY DUMP

4.1.1 Location and Site Description

The Battery Dump is located north of the airstrip towards the eastern end, and covers an area of approximately 4,350 m^2 (Figure 4). The batteries used for the High Arctic Data Communications System relay towers are changed annually. The used batteries from this relay station were disposed of at the Battery Dump site in addition to used batteries from vehicles and other equipment. Prior to the 2006/07 and 2007/08 sampling campaigns, the Battery Dump was completely backfilled (Photographs 1 and 2, Appendix A). There is no visual evidence for current activity at the Battery Dump.

The topography of the site is mainly level and the soil is enriched in clays. In 2006/07 and 2007/08, there was some water accumulation in the low lying areas towards the south end of the site. The Battery Dump is located approximately 500 m north of Slidre Fiord.

4.1.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2007 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 subsurface soil sample was collected from the center of the Battery Dump. The sample was analyzed for metals. No metals was observed above the CCME guidelines.

4.1.3 Nature and Extent of Contamination

In 2007/08, six subsurface soil samples were collected from around the dump in order to monitor for off-site migration of contaminants. The samples were analyzed for metals, TPH, BTEX and PAHs. No compounds were detected above the applicable CCME guidelines (Table 5).

According to the FCSAP classification system, the Battery Dump site is a Class N site (26.3). Unless new information indicates contaminant migration is occurring, no action is required at this site.

4.1.4 Recommendations

No heavy metal contamination above guidelines was detected in the 6 samples collected from around the Battery Dump indicating that no leaching or migration of metals is occurring. However, the Battery Dump site remains a potential source of contamination. Monitoring of the site should be performed once every 3 years to confirm that no leaching and migration of the battery contents is occurring. The site can be closed.

Table 5. (S-150) Battery Dump 2007/08 results.

	PARAMETERS	SOIL			Battery Dump (S-150) SOIL						
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	07BD0151 45 cm 7/29/2007	07BD0152 70 cm 7/29/2007	07BD0153 60 cm 7/29/2007	07BD0154 50 cm 7/29/2007	07BD0155 70 cm 7/29/2007	07BD0156 60 cm 7/29/2007	07BD0157 Dup. 155 70 cm 7/29/2007
METALS	Arsenic (As)	mg/kg	12	0.27	7.1	6	8.3	6.2	7.1	7.4	7
	Barium (Ba)	mg/kg	2,000	5	108	91	112	98	97	113	109
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	31	21	27	23	24	26	25
	Cobalt (Co)	mg/kg	300	1.9	14	11	14	12	13	14	14
	Copper (Cu)	mg/kg	91	2.1	30	24	29	26	26	29	27
	Lead (Pb)	mg/kg	600	1.2	14	12	15	13	14	14	14
	Manganese (Mn)	mg/kg	---	1.1	356	353	317	335	382	384	390
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	28	22	28	24	27	26	28
	Selenium (Se)	mg/kg	3.9	0.5	1.1	1.2	0.8	0.9	0.7	0.9	0.5
	Silver (Ag)	mg/kg	40	0.4	<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
	Zinc (Zn)	mg/kg	360	2.5	91	76	91	81	83	87	87

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 4. (S-150) Eureka Battery Dump map.